MS4 Permit NMS000101
AMAFCA Annual Report
2015

Attachment II.A – Discharges to Impaired Waters – Implementation of New Bacteria TMDL, Approved by EPA on June 30, 2010

- Status of Implementation and Performance Assessment Table II.A
- Middle Rio Grande Rio Grande E. coli Analysis and Research report for AMAFCA by water quality on-call engineer (CDM Smith).
- Plot of E. coil Results in Rio Grande

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
TABLE II.A: Discharges to Impaired Waters – Implementation of New Bacteria TMDL, Approved by EPA on June 30, 2010						
A. Revision of Bacteria Target Values for Consistency with the New TMDL. Review the current bacteria reduction program for consistency with new TMDL requirements and allocations. In consultation with NMED and EPA Region 6, revise target values included in the bacteria control plan, as necessary, based on the new TMDL. Adopt the new E. coli WLAs as measurable goals for the SWMP. 1) Submit certification of completion of review and revisions.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	Submit certification to EPA of review of the program within 3 months of permit effective date.	• Met 2012 Goals. MS4 co-permittee, COA, submitted certification of the revision of bacteria target values on June 1, 2012 to EPA.	• No Goals Required in 2013.	• No Goals Required in 2014.	• No Goals Required in 2015.
B. Revision of Monitoring Program. In consultation with NMED and EPA Region 6, revise the bacteria monitoring program as necessary for consistency with the new TMDL. The revised monitoring program must: 1) Use E. coli as the indicator parameter. 2) Provide information on discharges from all portions of the MS4 assigned a WLA under the TMDL. The monitoring program may be a cooperative effort with other MS4 operators affected by the TMDL, may sample a portion of the system each year, and may include in-stream measurements as a component of the monitoring effort. The monitoring program must provide information on the entire system over the term of the permit sufficient to determine compliance with applicable WLAs and consistency with TMDL assumptions. Should the EPA-approved TMDL assign a WLA to the MS4 on a system-wide or area basis, the monitoring program may adopt a method for dividing the total WLA into an approximate partial allocation for comparison with data from the portion of the system being monitored (e.g. percent of total WLA compared to percentage of total area in the	Activities removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	Submit certification of completion of review and revisions within 3 months of effective permit date.	• Met 2012 Goals. The AMAFCA co-permittee, COA, submitted certification of the review and revision of the monitoring program for consistency with the e-Coli TMDL on June 1, 2012. A copy of the monitoring program, conducted by the USGS was included in the June 1 submittal. A local consultant prepared a Storm Water E-coli study. The resulting monthly statistical summary by outfall location was used to compute the WLA by the Albuquerque Metropolitan Area outfalls to the Middle Rio Grande.	• No Goals Required in 2013.	• No Goals Required in 2014.	• No Goals Required in 2015.
C. Implementation of Revised Monitoring Program. Commence monitoring under the replacement E. coli TMDL monitoring program.	Activities removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	• Continue cost-sharing, planning and implementation with the participating MS4 co-permittees to comply with the Bacteria TMDL monitoring program. COA will submit E. coli results in DMRs and Annual Reports. • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• Met 2012 Goals. The monitoring for this revised program was through the MS4 joint monitoring program with USGS and put into effect in 2012.	• Met 2013 Goals. The monitoring for this revised program was through the MS4 joint monitoring program with USGS, COA and NMDOT in 2013.	• Met 2014 Goals. The monitoring for this revised program was through the MS4 cooperative monitoring program with AMAFCA, COA, NMDOT, and UNM. Through June 30, 2014 the monitoring was performed by the USGS. On July 1, 2014 the monitoring was performed under contract with two of AMAFCA's water quality on-call contractors.	• Met 2015 Goals. The monitoring for this revised program was through the MS4 cooperative monitoring program with AMAFCA, COA, NMDOT, and UNM. The monitoring in 2015 was performed under contract with two of AMAFCA's water quality on-call contractors.

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
D. Annual TMDL Progress Reports. The permittees shall submit annual reports describing progress on the activities required in Table II.A to comply with the Bacteria TMDL. The reports shall follow the requirements included in Part III. Results of the monitoring program shall be summarized in the Annual TMDL Progress Report, and shall include graphic representation of bacteria trends, along with computations of annual percent reductions achieved from the baseline loads and comparisons with the target loads.	Activities removed from AMAFCA's SWMP (Revision 1, May 29, 2013), because Annual TMDL Progress Reports will be prepared by COA. The purpose of TMDL E. coli Loading Report spreadsheet is to indicate if the flow conditions exist at the MS4 outfalls and the Rio Grande such that an exceedance of the Target WLA may have occurred. This spreadsheet is simply a statistical summary based on previously studied average monthly E. coli loading and does not take into account actual water quality monitoring results for the current Water Year. It is only a predictor/indicator and does not represent actual E. coli monitoring results.	• AMAFCA will coordinate with the other MS4 co-permittees in preparing the required annual Bacteria TMDL Loading Report and DMRs for submittal to the EPA with Annual Reports. COA will submit E. coli results in DMRs and Annual Reports. • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• Met 2012 Goals. The COA submitted in its 2012 Annual Report the E. coli Loading Results and DMRs. The resulting monthly statistical summary by outfall location was used to compute the predicted WLA by the Albuquerque Metropolitan Area outfalls to the Middle Rio Grande. A summary spreadsheet, "Total Load", shows the contribution by each of the 5 outfalls and compares the total calculated WLA value to the target allocation from Table II.B of the Permit. This spreadsheet simply identifies if the average daily flow conditions are such that there is a potential target load exceedance. It is only a predictor/indicator and does not represent actual E. Coli monitoring results. No predicted WLA values above the Permit allowed WLA values in Table II.B occurred during 2012 monitoring period.	• Met 2013 Goals. The COA completed the DMRs for the 2013 sample results. In addition, the COA completed the Bacterial TMDL Loading Report spreadsheet for the MS4 co-permittees. The spreadsheet identifies that there was only one day (July 19) in the 2013 monitoring period in which the flow conditions indicate that the target load may have been exceeded. For Water Year 2013, the estimated average total load was only 1% of the Target WLA. The Bacterial TMDL Loading Report and included in Attachment II.A. The DMRs are included in Attachment IX.	• Met 2014 Goals. The COA completed the DMRs for the 2014 sample results. In addition, the COA completed the Bacterial TMDL Loading Report spreadsheet for the MS4 co-permittees. This spreadsheet identifies if the average daily flow conditions are such that there is a potential target load exceedance. It is only a predictor/indicator and does not represent actual E. Coli monitoring results. No predicted WLA values above the Permit allowed WLA values in Table II.B occurred during 2014 monitoring period. The Bacterial TMDL Loading Report is included in Attachment II.A. The DMRs are included in Attachment IX. In addition to monitoring the bacteria, AMAFCA contracted with a consultant to restudy the bacteria within the Middle Rio Grande, specifically to evaluate the bacteria data over the recent history to report the trend analysis and the impact to the Rio Grande. This study is proceeding and the report is in the draft form at the end of 2014. The scope of work for this study is included in Attachment II.A.	• Met 2015 Goals. As part of a cooperative agreement, the COA will complete the Bacterial TMDL Loading Report spreadsheet for the MS4 co-permittees. This information can be provided to EPA subsequent to AMAFCA receiving it from the COA (anticipated to be received in early April 2016). The Bacterial TMDL Loading Report spreadsheet identifies if the average daily flow conditions are such that there is a potential target load exceedance. It is only a predictor/indicator and does not represent actual E. Coli monitoring results. In addition to monitoring the bacteria, AMAFCA contracted with a consultant to restudy the bacteria within the Middle Rio Grande, specifically to evaluate the bacteria data over the recent history to report the trend analysis and the impact to the Rio Grande. The report for this study - Middle Rio Grande Rio Grande E. coli Analysis and Research report for AMAFCA by water quality on-call engineer (CDM Smith) - is included in Attachment II.A. In addition, a plot of the E. coli data in the Rio Grande, upstream and downstream of the Albuquerque MS4, has been prepared for the results obtained in 2014 and it is included in Attachment II.A. The 2015 sampling of the Rio Grande was not completed before the end of June 2015, which is the extent of this annual report.

FINAL

MIDDLE RIO GRANDE *E. COLI* ANALYSIS AND RESEARCH

Albuquerque Metropolitan Flood Control Authority

April 21, 2015

CDM Smith

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Appendices

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Section 1

Introduction

The segment of the Rio Grande that flows through Albuquerque (**Figure 1-1**), designated as Rio Grande (Isleta Pueblo boundary to Alameda Street Bridge) or Rio Grande Basin 20.6.4.105, is considered to be impaired because the quality of the water does not support the designated uses for that segment. The amount of Escherichia coli (*E. coli*) bacteria in the water has been found to exceed the water quality standard, so a Total Maximum Daily Load (TMDL) has been adopted by the New Mexico Water Quality Commission (NMED, 2010). **Section 2** of this report provides a summary of the applicable regulatory framework.

This report addresses four questions revolving around the *E. coli* in the Rio Grande. Those four questions are:

1. What are the characteristics of the *E. coli* concentrations in the Rio Grande?
2. How does the *E. coli* concentration in the Rio Grande compare with other rivers?
3. What is the *E. coli* water quality standard based on?
4. What strategies and Best Management Practices (BMPs) are effective in protecting human health from *E. coli* exposure?

Section 3 in this report addresses question 1. A number of entities have collected data on *E. coli* in the middle Rio Grande – the US Geological Survey, New Mexico Environment Department, and the Bosque Environmental Monitoring Program – but these data sets have not been examined as a whole to develop the larger picture of *E. coli* in the Rio Grande (Isleta Pueblo boundary to Alameda Street Bridge) segment. **Section 3** describes what can be interpreted about *E. coli* in the Rio Grande through Albuquerque based on the data readily available at this time.

A comparison of the *E. coli* concentration in the Rio Grande to other rivers is presented in **Section 4**. Previous studies of *E. coli* sources for the Rio Grande (Isleta Pueblo boundary to Alameda Street Bridge) segment suggested that much of the *E. coli* in the river is from avian sources. Since the Rio Grande is part of the Central North American Flyway, there is a continuing source of avian generated *E. coli*. To understand how the Rio Grande compares, in terms of *E. coli*, to other rivers, the *E. coli* concentration in 5 rivers similar to the Rio Grande and 5 rivers that are dissimilar to the Rio Grande are compared.

Section 5 addresses the basis of the *E. coli* water quality standard. The federally recommended bacteria objectives are, to a degree, somewhat subjective; however, this does not discount or minimize the fact that increased pathogens have been shown to be related to increased illness. This has been demonstrated in numerous studies conducted around the world, especially in marine waters. However, while there should be no disagreement that this relationship exists, what can be debated and considered is how the federal recommended objectives are applied to different types of waters. **Section 5** provides a summary of findings regarding how the federal objectives were derived. With this understanding in mind, the applicability of the federally recommended bacteria objectives to waterbodies with varying qualities may be considered.

Finally, **Section 6** describes the Best Management Practices (BMPs) that have been used to remove *E. coli* from storm water. It identifies the mode of action for each BMP and, for those with data, describes the effectiveness. The use of warning-type BMPs is examined for possible use in the Albuquerque area.

Section 2

Regulatory Framework

The regulatory framework for water quality in the middle Rio Grande is complicated. There are state water quality standards, downstream Pueblo standards, and a Total Daily Maximum Load (TMDL) for *E. coli.* National Pollutant Discharge Elimination System (NPDES) permits for wastewater treatment plants in this segment incorporate the Pueblo water quality standard for *E. coli,* whereas storm water discharges must not exceed the *E. coli* load specified in the TMDL.

2.1 State and Pueblo Standards

The *E. coli* water quality standard for the State of New Mexico is based on primary contact and it requires that the monthly geometric mean be less than or equal to 126 colonies per 100 milliliters and a single sample be less than 410 colonies per 100 milliliters. The New Mexico *E. coli* standard is the same as the US Environmental Protection Agency criteria established in "Water Quality Criteria 1986" (EPA 440/5-86-001).

The Pueblo of Sandia is upstream of Albuquerque and the Pueblo of Isleta is downstream of Albuquerque. Both Pueblos have established *E. coli* standard to protect a ceremonial designated use. The *E. coli* water quality standard in both the Pueblo of Sandia and the Pueblo of Isleta requires that the monthly geometric mean be less than 47 colonies per 100 milliliters and a single sample less than of 88 colonies per 100 milliliters.

During the 2014 NMED Resource Protection Division Triennial Review, the enumeration methods and reporting units for *E. coli* concentration were clarified. Since exact *E. coli* counts are generally not feasible to obtain, the EPA currently uses most probable number (MPN) and colony forming units (cfu) interchangeably. The New Mexico Water Quality Commission adopted the same convention for reporting *E. coli* in New Mexico. The *E. coli* data collected by different organizations variably use MPN and cfu. Based on the convention adopted in the State Water Quality Standards the data used in this report will be used interchangeably. The original data, with the reporting units, is provided in **Appendix A**.

2.2 Total Maximum Daily Load (TMDL)

Section 303(d) of the Federal Clean Water Act requires states to develop a TMDL for waterbodies determined to be water quality limited. The purpose of a TMDL is to assess the amount of a pollutant a waterbody can assimilate without violating a state's or a Tribe's water quality standard. It also allocates the load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint sources and background conditions, and includes a Margin of Safety.

In 2001, the NMED developed TMDLs for fecal coliform for the Rio Grande from Isleta Pueblo boundary to Angostura Diversion. The water quality standard was changed from fecal coliform to *E. coli* and the TMDLs were updated to reflect the change in indicator bacteria.

The *E. coli* TMDL is based on data collected during a surface water quality survey of the Middle Rio Grande watershed in 2005 and additional collections by NMED and other agencies from 2000-2007. As a result of assessing data generated during this monitoring effort, impairments of the New Mexico water quality standards for *E.coli* on Rio Grande were found from the Pueblo of Isleta boundary to Alameda Street Bridge and from Alameda Street Bridge to Angostura Diversion (outside the Sandia Pueblo boundaries).

The TMDL uses flow duration curves to provide a technical framework for identifying "daily loads" because they account for the variable nature of water quality associated with different stream flow rates. With this approach, the ambient water quality data, taken with some measure or estimate of flow at the time of sampling, was used to compute an instantaneous load. Using the relative percent exceedence from the flow duration curve that corresponds to the stream discharge at the time the water quality sample was taken, the computed load was plotted in the duration curve format. Likewise, the Pueblo of Isleta water quality was plotted on the load duration curve. Ambient loads that plot above the standard curve indicate an exceedence of the water quality criterion, while those below the load duration curve are below the applicable criterion. The TMDL (NMED, 2010) establishes Waste Load Allocations (point source limits) and Load Allocations (for nonpoint sources and background) for *E. coli* bacteria. The TMDL bases the load allocations on the percent jurisdictional area approach.

2.3 Municipal Separate Storm Sewer System (MS4) Permit

In the Clean Water Act revisions of 1987, the U.S. Congress established a permitting program, under the NPDES program, for storm water discharges to "waters of the United States." One category of storm water discharges is from Municipal Separate Storm Sewer Systems (MS4s). Under the regulatory definition of an MS4 (40 CFR 122.26(b)(8)), MS4 does not solely refer to municipally owned storm sewer systems, but rather is a term with a much broader application that includes, in addition to local jurisdictions: state departments of transportation, public universities, local sewer districts, public hospitals, military bases and prisons. An MS4 is not always just a system of underground pipes; it can include roads with drainage systems, gutters, and ditches.

The 1987 revision was promulgated in two phases. Phase 1, issued in 1990, requires *medium* and *large* MS4s with populations of 100,000 or more to obtain NPDES permit coverage for their storm water discharges. For regulatory purposes, a medium MS4 is a system that is located in an incorporated place or county with a population between 100,000 - 249,999 and a large MS4 is a system that is located in an incorporated place or county with a population of 250,000 or more.

In 2003, a Phase 1 MS4 permit was issued by the EPA for the Albuquerque area. The Phase 1 MS4 had four co-permittees: the City of Albuquerque, Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), New Mexico Department of Transportation District 3, and the University of New Mexico. The Phase 1 MS4 permit was initially issued in 2003 and was renewed in 2012.

Phase 2, issued in 1999, required regulated small MS4s (population less than 100,000) to obtain NPDES permit coverage for their storm water discharges. A regulated small MS4 is any small MS4 located in an "urbanized area" (UA), as defined by the Bureau of the Census. Unlike the Phase 1 program that primarily utilizes individual permits for medium and large MS4s, the Phase 2 approach allows operators of regulated small MS4s be covered under general permits. The **"General Permits for Small Municipal Separate Storm Sewer Systems (MS4s) in New Mexico and on Indian**

Country Lands in New Mexico" (NMR040000) was issued originally issued by EPA Region 6 on June 13, 2007.

In 2014, EPA issued a watershed-based MS4 general permit for the middle Rio Grande (NMR04A000). The general permit supersedes and replaces the Phase 1 and Phase 2 permits that had been issued previously. The watershed-based MS4 permit requires that storm water discharges meet the load allocation in the TMDL.

In summary, although there is a water quality standard for *E. coli* set by the state, it is not applied in the middle Rio Grande. The water quality standard for *E. coli* set by Pueblo of Isleta is the basis of the *E. coli* TMDL, which in turn is incorporated in the NPDES permits in the middle Rio Grande. All point source discharges, wastewater or storm water must meet the load allocations in the TMDL.

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Section 3

Characterization of *E. coli* Spatially and Temporally in the Rio Grande Albuquerque Reach

The ambient concentration of *E. coli* in the Rio Grande is the combined result of *E. coli* flowing into the middle Rio Grande segment from upstream and the point source and the nonpoint source contributions of *E. coli* in the middle Rio Grande segment. The flow of water in the middle Rio Grande segment is mostly from snowmelt from the mountains of northern New Mexico and Colorado. The Rio Grande and its tributaries provide water for irrigation and municipal supply all along its course. **Figure 3-1** shows the Rio Grande and the location of the river sampling stations where *E. coli* data have been collected. Along the river there are features that impact the flow and quality of the river. At Cochiti Lake (Mile 0 in the following graphs), the flow of the Rio Grande comes out of Cochiti Lake Dam and into three conveyances - a river channel and two irrigation channels, one on each side of the river. There are two major river diversions, Angostura (mile 23.5, upstream of Albuquerque) and one at Isleta (mile 60, downstream of Albuquerque). These divert water for irrigation from March through October.

Within in the City of Albuquerque, there are large arroyos that drain storm water basins and contribute storm flow on both sides of the river, mainly during the summer monsoon when the Rio Grande flow is low due to irrigation diversions. Storm water from five of these basins within the City of Albuquerque is discharged at locations shown on **Figure 3-2**. Other discharges that affect the river are irrigation return canals which convey storm runoff to the river along with eighteen City of Albuquerque and Bernalillo County storm water pump stations that discharge directly or indirectly to the river. Three wastewater treatment plants from the cities of Rio Rancho and Albuquerque also contribute to the river flow and water quality. All these inflows influence both the flow magnitude and the water quality between the bacterial sampling sites. In addition to the stormwater and wastewater conveyance systems that discharge directly into the Rio Grande, there are a number of agricultural activities (crop irrigation, egg production facilities, and meat packing) located along the Rio Grande which may contribute to the water quality during storm events.

3.1 Data Available

In order to characterize the spatial and temporal variation of the *E. coli* concentration in the middle Rio Grande segment, data was compiled from the three agencies shown in **Table 3-1**: US Geological Survey (USGS), New Mexico Environment Department (NMED), and Bosque Environmental Monitoring Program (BEMP). The USGS collected and analyzed samples for *E. coli* for the City of Albuquerque's use of the river for water supply. NMED collected samples that were analyzed for *E. coli* to assess the status of the river with respect to water quality standards. The BEMP collected and analyzed samples for *E. coli* as funded by AMAFCA and the City of Albuquerque. Other potential sources of *E. coli* data are Bernalillo County, Sandoval County, Pueblo of Sandia, and Pueblo of Isleta. *E. coli* data from these agencies could not be obtained for this analysis.

The USGS has collected samples over periods of 4 to 10 years at three sites: Rio Grande below Cochiti, Rio Grande at San Felipe, and Rio Grande at Alameda Bridge (**Table 3-1**, **Figure 3-1**). The first two of these sites are substantially upstream of the middle Rio Grande segment. Samples from these sites were collected three times a year, one in the winter, one at high flow, and one at low flow. Samples were composited across the channel. The samples were analyzed for *E. coli* and fecal coliform. All of the data collected by USGS in 2014 data is provisional and subject to review.

USGS data from the Rio Grande at Otowi station (**Table 3-1, Figure 3-1)** were included in this analysis to provide an upstream comparison for the sites below Cochiti Reservoir. The Rio Grande at Otowi station has a 10 year long record of *E. coli* analysis and includes the results of 59 samples.

New Mexico Environment Department (NMED) collected samples for bacterial analysis once a month from March to October at 8 sites (**Table 3-1, Figure 3-1**). Samples were collected in 2005 and 2014 and were analyzed for *E. coli* and fecal coliform. Water samples consisted of a composite collected across the cross section of the channel. All of the data collected by NMED 2014 data is provisional and subject to review.

The BEMP collected and analyzed weekly water samples for *E. coli*, fecal coliform and associated physical characteristics. Data collection occurred from May 2011 to May of 2012, with the exception of the first week of July, December, and January and the last week of December resulting in a total of 49 samples. The samples were collected at four sites; Rio Grande at Coronado Monument, Rio Grande at Alameda Bridge, Rio Grande at Montano Bridge, Rio Grande at I-25 Bridge (**Figure 3-2)**. Each week, the samples were collected from the most downstream site, Rio Grande at I-25 Bridge, and proceeded upstream to the three other sampling sites. Grab samples from the Rio Grande at I-25 Bridge and Rio Grande at Alameda Bridge were collected from the east side of the channel and the samples from Rio Grande at Montano Bridge and Rio Grande at Coronado Monument were collected from the west side of the channel. This provides a useful data set for calculating the monthly geometric mean, as well as, a good estimate of the monthly and annual variation at each of the four sites.

Table 3-1 Rio Grande *E. coli* Sampling Locations

Sampling Site[1]	River Miles from Cochiti Lake	Sampling Agency[2]	Number of Samples	Years	Sampling Frequency	Sample Collection
Rio Grande at Otowi Bridge	-26.2	USGS	59	2001 - 2011	Monthly	Cross section composite
Rio Grande Below Cochiti	0	USGS	25	2006 - 2014	Winter, high, low	Cross section composite
Rio Grande at Pena Blanca	5.5	NMED	7	2014	Monthly	Cross section composite
Rio Grande at San Felipe	15.3	USGS	15	2005 - 2009	Winter, high, low	Cross section composite
Rio Grande at Angostura Diversion	23.5	NMED	7	2005	Monthly	Cross section composite
Rio Grande at Coronado Monument	27	BEMP	49	2011, 2012	Weekly	Grab
Rio Grande at Highway 550	27.5	NMED	18	2005, 2014	Monthly	Cross section composite
Rio Grande Above Rio Rancho WWTP	31	NMED	15	2005, 2014	Monthly	Cross section composite
Rio Grande at Alameda Bridge	38.5	NMED	19	2005, 2014	Monthly	Cross section composite
Rio Grande at Alameda Bridge	38.5	USGS	28	2004 - 2014	Winter, high, low	Cross section composite
Rio Grande at Alameda Bridge	38.5	BEMP	49	2011, 2012	Weekly	Grab
Rio Grande at Montano Bridge	44.5	BEMP	49	2011, 2012	Weekly	Grab
Rio Grande above Rio Bravo Bridge	53	NMED	8	2014	Monthly	Cross section composite
Rio Grande at Los Padillas	57	NMED	16	2005, 2014	Monthly	Cross section composite
Rio Grande at I-25 Bridge	58.5	BEMP	49	2011, 2012	Weekly	Grab
Rio Grande above Isleta Diversion	60	NMED	7	2005	Monthly	Cross section composite

[1] Sampling site locations are shown in **Figure 3-1**
[2] USGS – United States Geological Survey; NMED – New Mexico Environment Department; BEMP – Bosque Environmental Monitoring Program

3.2 Data Analysis

The available *E. coli* data from the three agencies listed in **Table 3-1** were collected with different sampling plans, sampling techniques, and laboratory reporting which results in data that are not directly comparable. The characteristics of each data set are examined separately and then general conclusions based on the three data sets are presented.

The BEMP data set is best suited to indicate concentration of *E. coli* on an annual and monthly basis as well as during storm flow for the four sampling locations in the Albuquerque reach of the Rio Grande (**Figure 3-2**). The USGS data set is most useful in showing the downstream variation of *E. coli* concentration in the Rio Grande water flowing into the Albuquerque reach and the effects of Cochiti Lake on *E. coli* concentration (**Figure 3-1**). The NMED data set shows the variation of *E. coli* concentration at eight locations sampled once a month for 8 months in two different years. No samples were collected for November, December, January, and February precluding annual and monthly concentration calculation for the months with no samples.

3.2.1 BEMP Results

The BEMP data is the best to illustrate the variation of *E. coli* concentration in the Rio Grande because it consists of weekly samples at four locations for a full year, with 49 samples for each location (**Table 3-1**). **Figure 3-3** shows the monthly *E. coli* concentrations with respect to the load duration curve for each site. The data plotted in **Figure 3-5** indicates that the highest concentration of *E. coli* occurs in July and August and the lowest *E. coli* concentrations occur in January, February and March. The concentration of *E. coli* increases downstream. **Figure 3-4** shows the same data as box-and-whisker plots to illustrate the distribution of *E. coli* concentration at each site. The box-and-whisker plots show the median, minimum, maximum, first and third quartiles of *E. coli* concentrations. Both **Figure 3-3** and **3-4** show a general increase in *E. coli* in a downstream direction through the reach from Bernalillo (Rio Grande at Coronado Monument) to Rio Grande at I-25 Bridge with the largest increase between Montano and I-25.

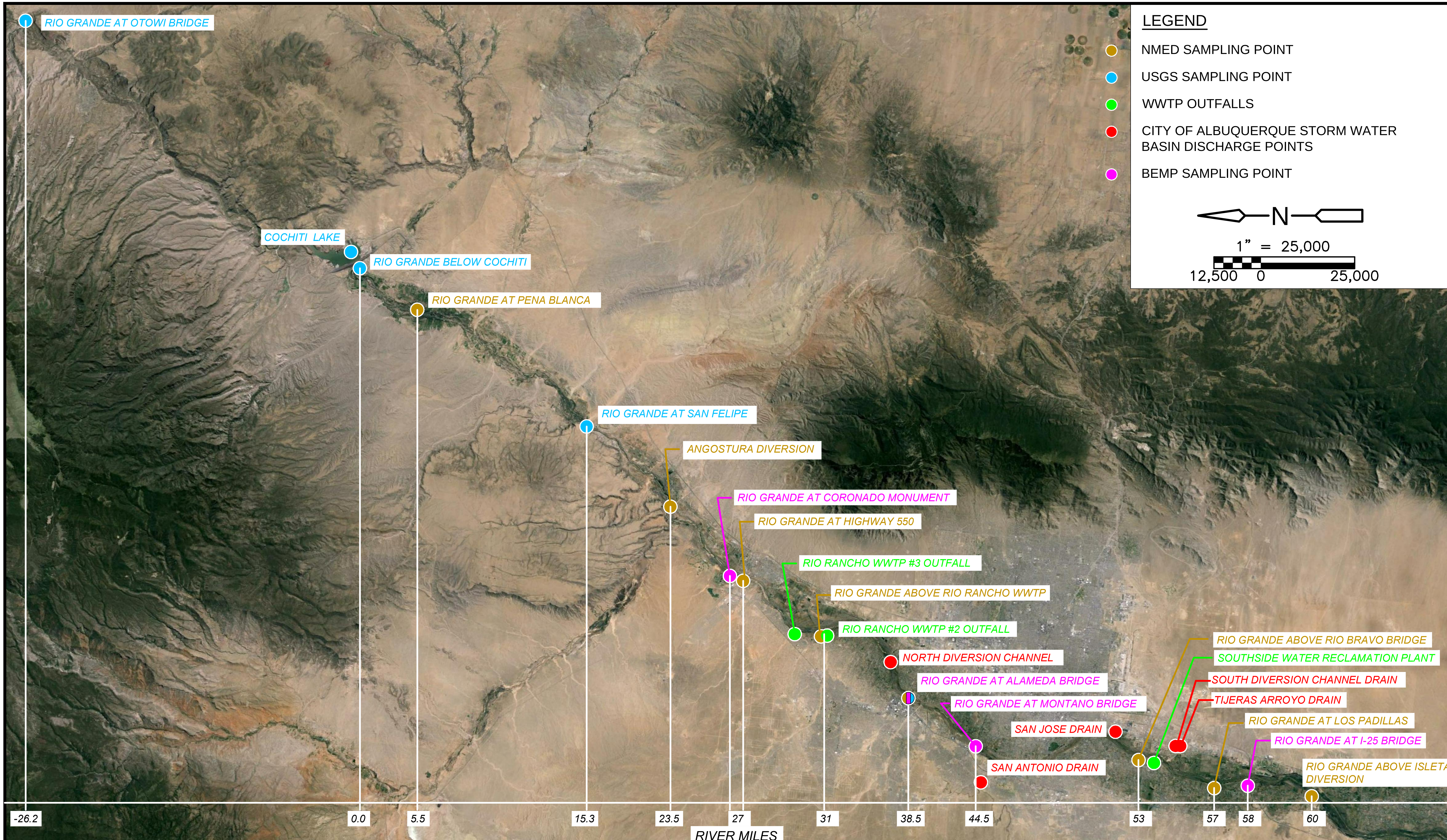

Figure No. 3-1
Sampling Point Location Map

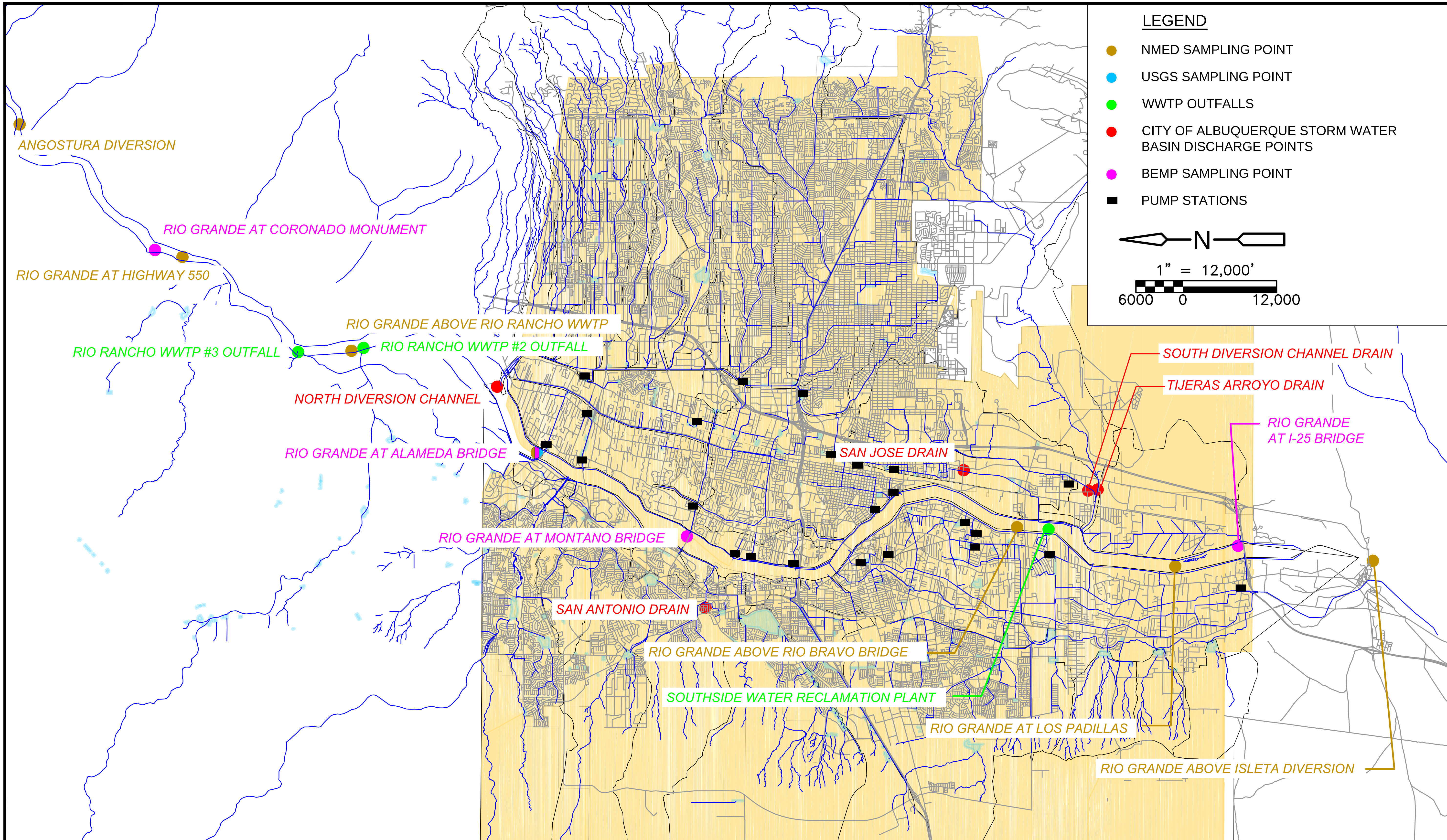

Figure No. 3-2
Drainage and Sampling Point Location Map

CDM Smith

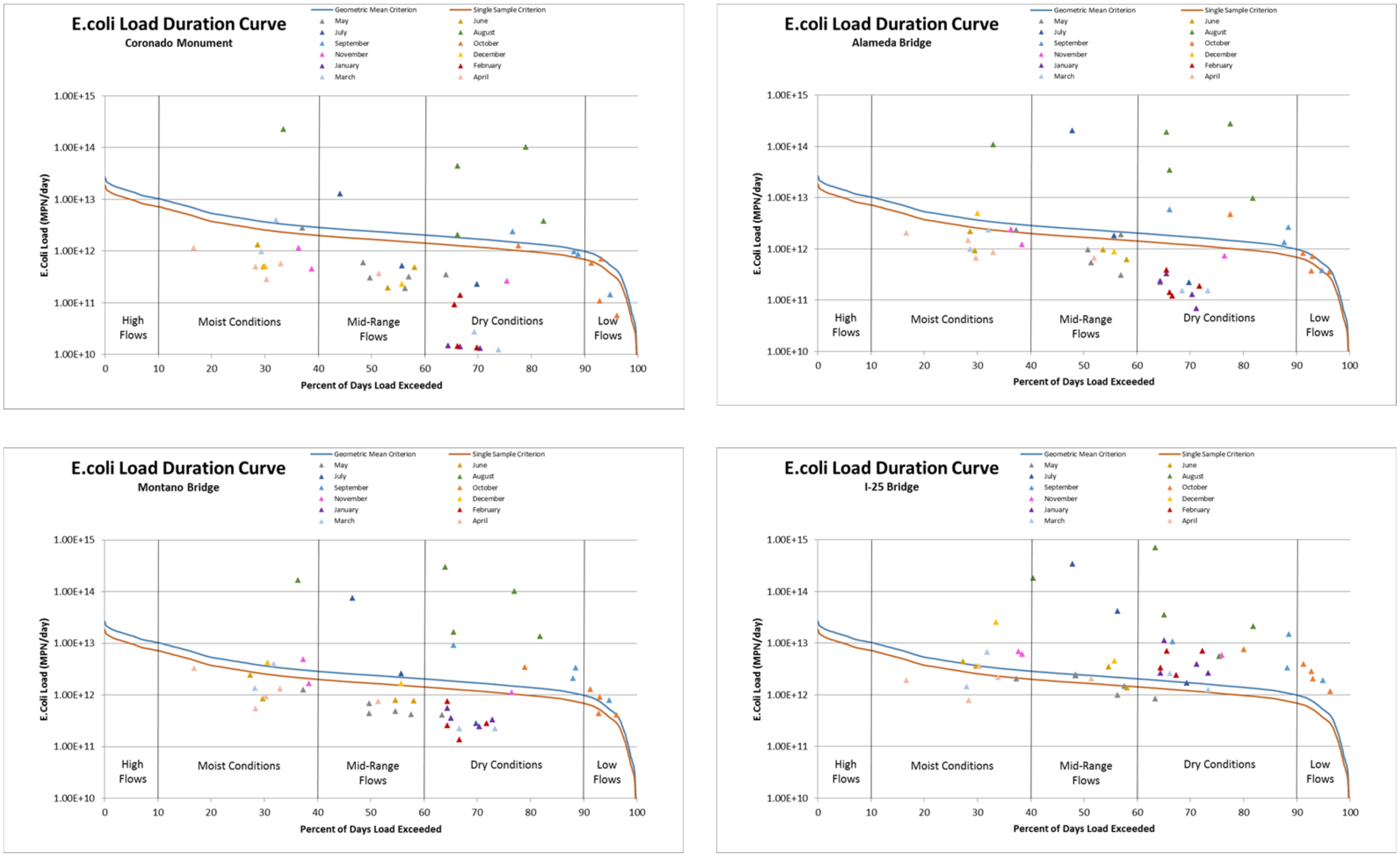

Figure 3-3 E.coli Load Duration Curves with BEMP Data

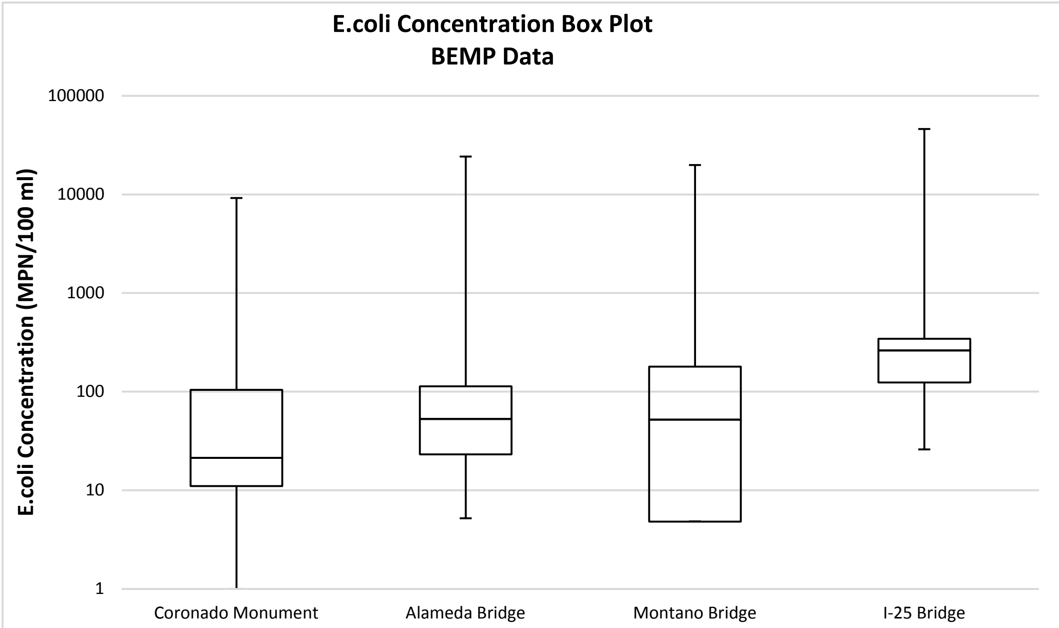

Figure 3-4 Box Plots of *E. coli* Concentrations at BEMP Sampling Sites

The geometric mean of *E. coli* concentration measured by BEMP show in **Figure 3-5** and in **Table 3-2** allows a direct comparison to the New Mexico Water Quality Standard of 126 cfu/100 mL and the Pueblo of Sandia and Pueblo of Isleta water quality standard of 44 cfu/100 mL. Figure 3-5 illustrates that during the warmer summer months, all four sites exceed the State and Pueblo standard for *E. coli* concentrations regardless of location.

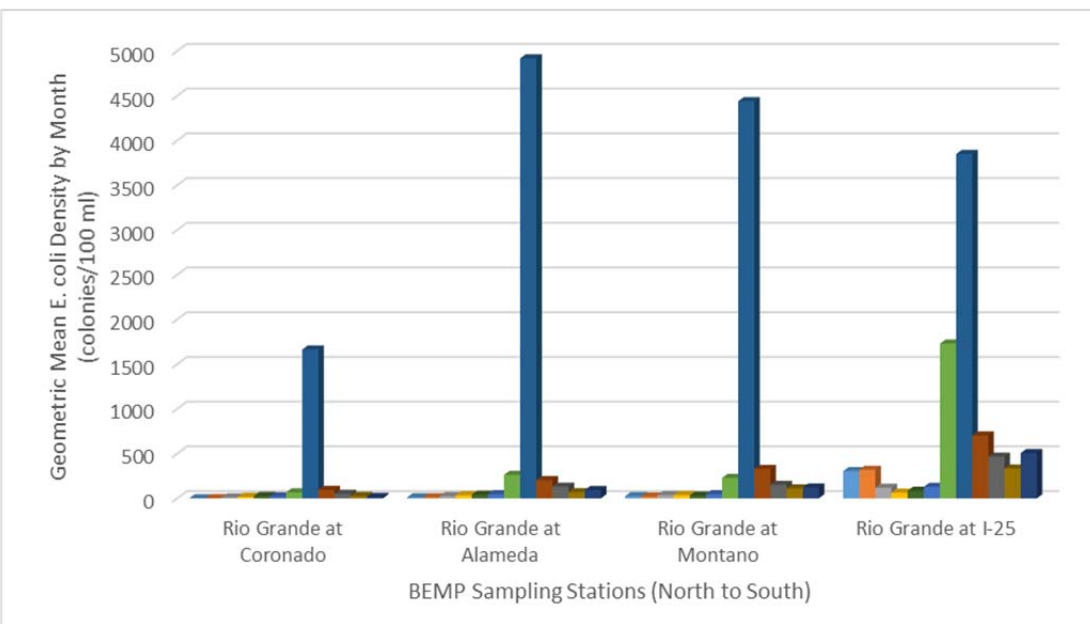

Figure 3-5 Monthly Geometric Mean of *E. coli* at the BEMP Sites

Table 3-2 Monthly Geometric Mean *E. coli* Concentration at BEMP Sampling Sites

Month	Rio Grande at Coronado	Rio Grande at Alameda	Rio Grande at Montano	Rio Grande at I-25
	Monthly Geometric Mean (MPN/100 ml)			
January	1	12	25	304
February	2.8	13	21	319
March	9.9	25	36	119
April	17	35	37	64
May	26	40	30	85
June	22	46	46	129
July	67	263	228	1730
August	1664	4920	4440	3850
September	95	205	328	702
October	51	130	151	465
November	27	69	111	334
December	15	93	120	506

The peak exceedances are observed in the month of August. The monthly geometric mean concentrations in the Rio Grande at Coronado indicate that the *E. coli* concentration coming into the middle Rio Grande segment generally meets the New Mexico and Pueblo of Sandia water quality standard, except in the summer months. The New Mexico and/or the Pueblo standards are exceeded in every month at the Rio Grande at I-25 Bridge sampling site.

The BEMP data is useful for identifying seasonal flow related *E. coli* concentrations. **Figure 3-6** shows that in the monsoon season (June 15 through September 30) only results in a slight increase in river flow for that year. However, the concentrations of *E. coli* are much greater during the monsoon season, likely due to increased turbidity resulting from storm water discharges. The *E. coli* concentrations during dry season (October through June) remain low and steady despite seasonal fluctuations in river flow. The steady dry season concentrations of *E. coli* could represent a baseline condition.

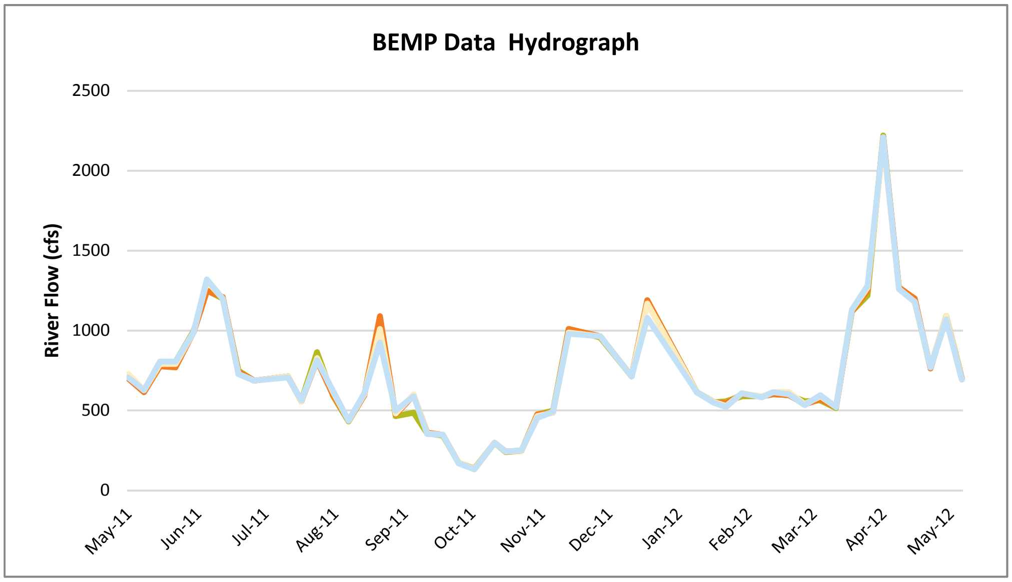

Figure 3-6 BEMP Data Hydrograph

3.2.2 USGS Results

E. coli data collected by the USGS gives insight into the *E. coli* concentration in the Rio Grande flowing into the middle Rio Grande segment and provides a "background" or "baseline" from which to assess the incremental contribution of *E. coli* within the middle Rio Grande. The four USGS sampling stations extend from Rio Grande at Otowi, near Santa Fe, to Rio Grande at Alameda, in the middle Rio Grande segment (**Table 3-1**). **Figure 3-7** plots the *E. coli* concentration for the four USGS sites and **Figure 3-8** provides box-and-whisker plot representing the median, minimum, maximum, 1st, and 3rd quartiles of *E. coli* concentrations. Both **Figure 3-7** and **3-8** show a marked decrease in *E. coli* between Otowi and the Cochiti Lake outflow, which demonstrates the effects of Cochiti Lake on *E. coli* bacterial concentration. A tenfold decrease in concentrations through Cochiti Lake is probably a result of die off, settling of sediment, and cooler release water from the deeper part of the reservoir. There is a gradual increase in *E. coli* concentration from Cochiti Lake to the Rio Grande at San Felipe sampling station, but the *E. coli* concentration does not reach the concentration measured at Otowi (pre-Cochiti Lake) until the Alameda sampling location.

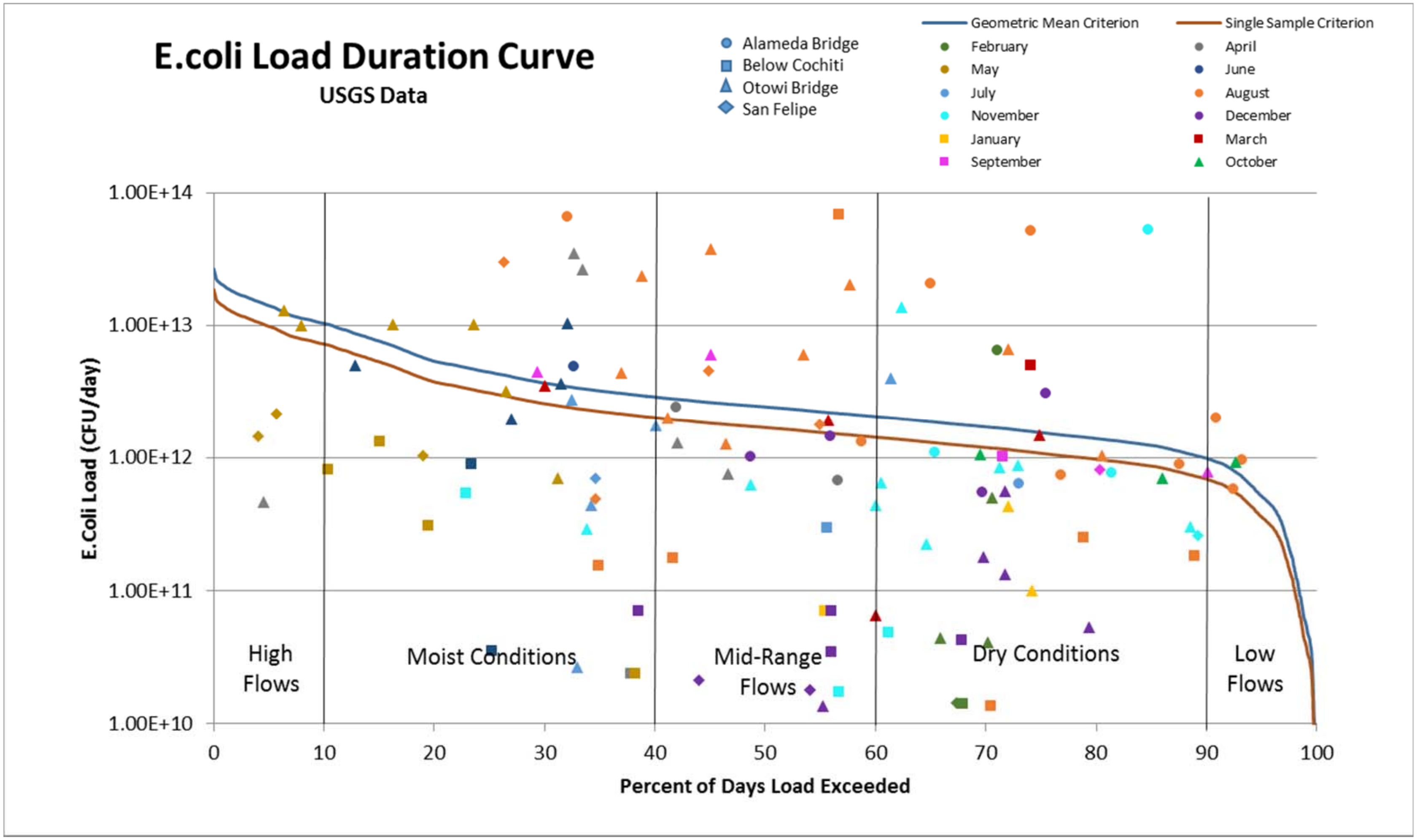

Figure 3-7 *E. coli* Load Duration Curves with USGS Data

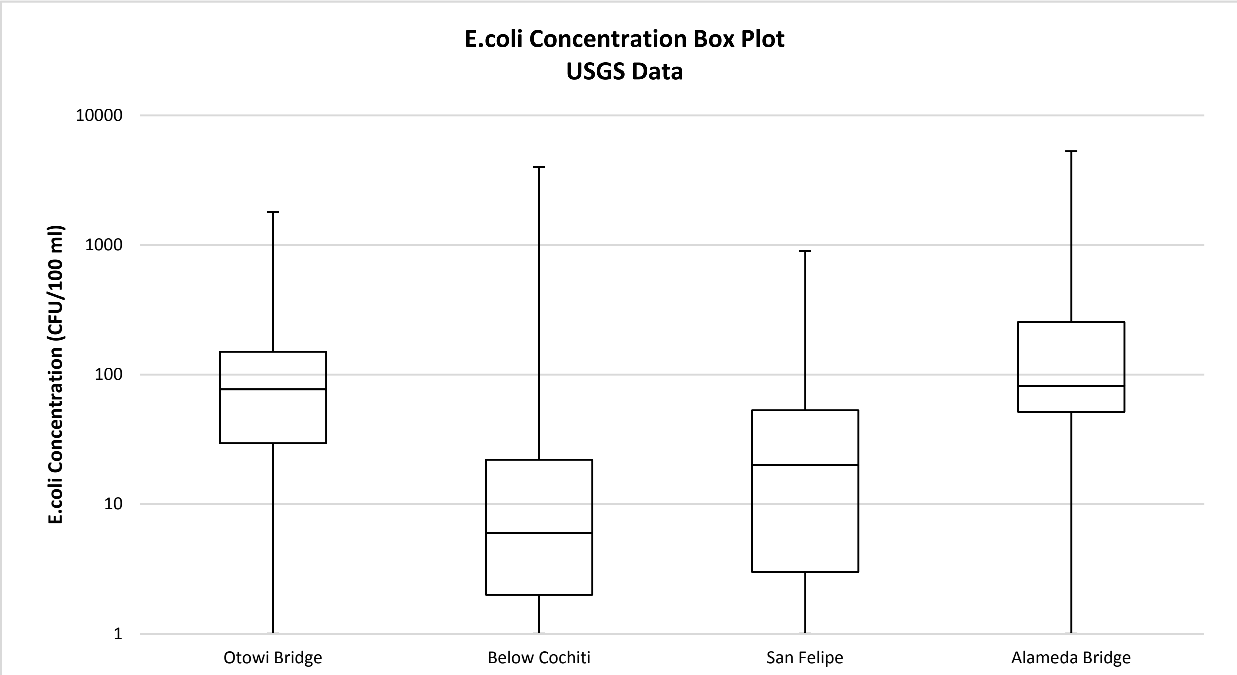

Figure 3-8 Box Plots of *E. coli* Concentrations at USGS Sampling Sites

3.2.3 NMED results

E. coli data collected by the NMED are listed in **Table 3-1** by distance from the Rio Grande below Cochiti Lake along with the number of samples, years sampled, how collected, frequency, collection technique, and source. For this analysis, the two sites sampled at Isleta were combined since they were so close to each other and there were only 7 total samples. Also, two sets of samples were collected above the two Rio Rancho wastewater treatment plant outfalls: 7 samples in 2005 from above the Wastewater Treatment Plant #3 and 8 samples in 2014 collected above Wastewater Treatment Plant #2 were combined for characterization of the reach downstream of Highway 550. Note that there have been no discharges from the Rio Rancho Wastewater Treatment Plants since 2006. The *E. coli* concentrations at those two sites both had a geometric mean of 36 colonies per 100 milliliters. **Figure 3-9** shows the *E. coli* concentrations for all NMED eight sampling locations while **Figure 3-10** shows box-and-whisker plot representing the median, minimum, maximum, first and third quartiles of *E. coli* concentrations. Both graphs show a gradual increase in *E. coli* concentrations as the Rio Grande flows through the middle Rio Grande segment. This is consistent with both the USGS and BEMP data sets. The NMED did not collect samples in the period between November and February, so the NMED data cannot be used to calculate monthly and annual geometric mean estimates.

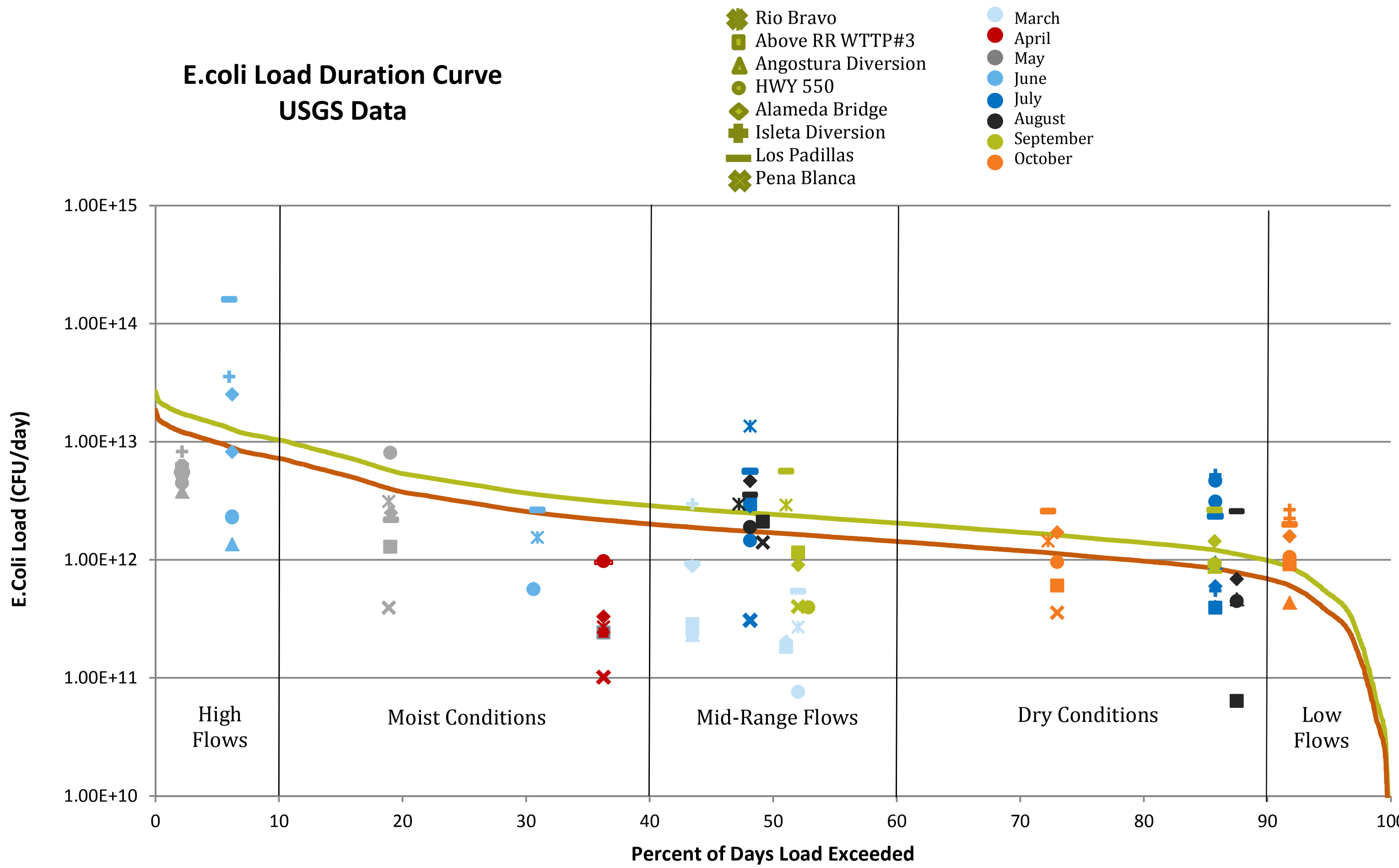

Figure 3-9 *E. coli* Load Duration Curves with NMED Data

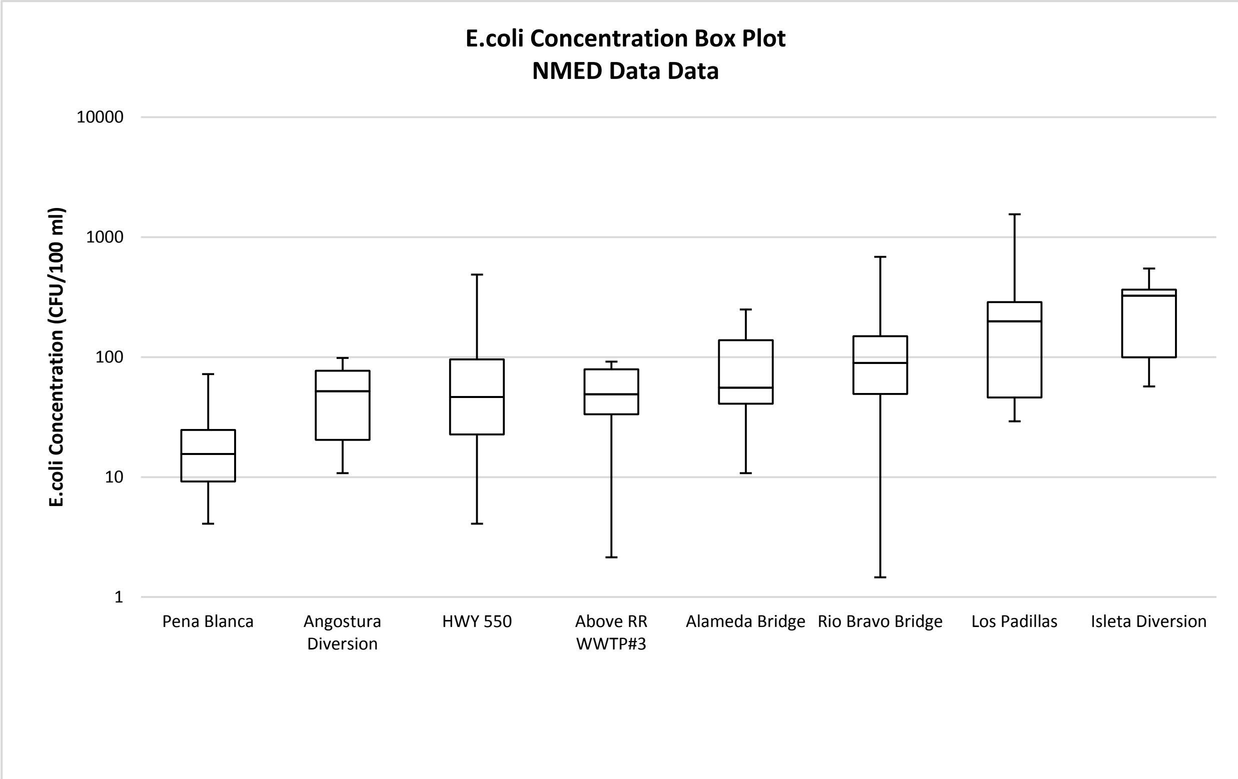

Figure 3-10 Box Plots of *E. coli* Concentrations at NMED Sampling Sites

3.3 Other Considerations

3.3.1 Tributary Contributions

The City of Albuquerque has 5 basins (or watersheds) that collect storm water which is conveyed to specific points along the Rio Grande. On behalf of the MS4 Phase 1 permittees, the USGS has monitored storm water flows at the 5 storm water discharge points. The data available from USGS storm water monitoring includes flow and *E. coli* concentration between 2003 and 2011. **Table 3-3** shows the *E. coli* concentration on a watershed basis. The San Jose drain has the smallest watershed area, but the highest *E. coli* concentration, particularly in the summer months. This analysis suggests that an evaluation of the activities within the San Jose drain watershed to identify sources of *E. coli* is warranted.

Table 3-3 Average *E. coli* Concentration per square mile of contributing area (2003-2011)

Month	North Diversion ($89.7\ mi^2$)	San Antonio ($30\ mi^2$)	San Jose Drain ($1.95\ mi^2$)	Tijeras Arroyo ($128\ mi^2$)	South Diversion ($11\ mi^2$)
	Colonies/100 ml				
January	ND	18	ND	ND	ND
February	ND	ND	113	ND	ND
March	47	84	268	2	10
April	20	9	ND	6	ND
May	ND	10	ND	14	ND
June	27	370	7,177	10	210
July	636	53	74,421	160	1,178
August	69	138	20,179	123	206
September	61	316	9,205	9	999
October	27	48	4,241	42	40,280
November	212	ND	3,896	ND	1,041
December	ND	ND	5,538	17	747

3.3.2 Regrowth

The source of *E. coli* bacteria is primarily from the feces of warm-blooded animals, however another source of *E. coli* is regrowth in the sediments of stream beds and other warm, moist areas. The *E. coli* bacteria adhere to media in natural environments such as sediment and algae. This potential for regrowth should be considered when identifying trends in sampling data. Research demonstrates that there are several factors that may positively influence growth of bacteria; these factors include the following:

- Wastewater effluent discharge of partially inactivated organisms (Bolster et al., 2005; Glassmeyer et al. 2005; Hancock and Davis 1999; Loge et al. 2002);
- Temperature (Auer and Niehaus 1993; Burkhardt et al. 2000; El-Sharkawi et al. 1989);
- Nutrient availability (Bowie et al. 1985; Surbeck et al. 2010);
- Organic carbon concentrations (Craig et al. 2002; du Preez et al. 1994; Muyima and Ngcakani 1998);
- Presence of debris and/or wetlands (Evanson and Ambrose 2006; Huang 2005; Jeong et al. 2008; Sanders et al. 2005); and
- Presence of sand or sediment (Byappanahalli et al. 2003; Desmarais et al. 2002; Edge and Hill 2007; Ishii et al. 2007; Yamahara et al. 2007).

The BEMP sampling procedure required measurement of physical parameters such as, flow, turbidity, temperature, dissolved oxygen, pH, and several other analytical and visual observations. Analysis and comparison of the concentrations of *E. coli* bacteria to related physical parameters was performed using the BEMP data. Turbidity was compared to the daily concentration at all four sites (**Figure 3-11**). There appears to be a correlation between the months when high concentrations of bacteria were observed and the months where turbidity was relatively high. Turbidity is higher at downstream sites, where *E. coli* concentrations also increase and are found to exceed the New Mexico and/or Pueblo water quality standards most often. This is consistent with research that has found a strong relationship between suspended sediments and *E. coli* concentrations (Lechevallier M. W.1990). The correlation between *E. coli* concentrations and turbidity in the BEMP data suggests that turbidity measurements could possibly be a practical and expeditious indicator of high *E. coli* concentrations. Temperature and dissolved oxygen were also compared to the *E. coli* concentrations at all four sites. Research has shown that temperature and the availability of nutrients play significant roles in the growth of bacteria in the sediment. When temperature was compared to the daily concentrations of *E. coli* from the BEMP data, there appears to be a correlation only during the winter months (**Figure 3-12**). The concentration of dissolved oxygen can be used as an indicator of the lack or abundance of nutrients. This is because low dissolved oxygen levels often indicate nutrient-fueled plant growth (McCrary et al. 2013). When the concentration of dissolved oxygen was compared to the concentrations of *E. coli* from the BEMP data, no correlation was observed (**Figure 3-13**).

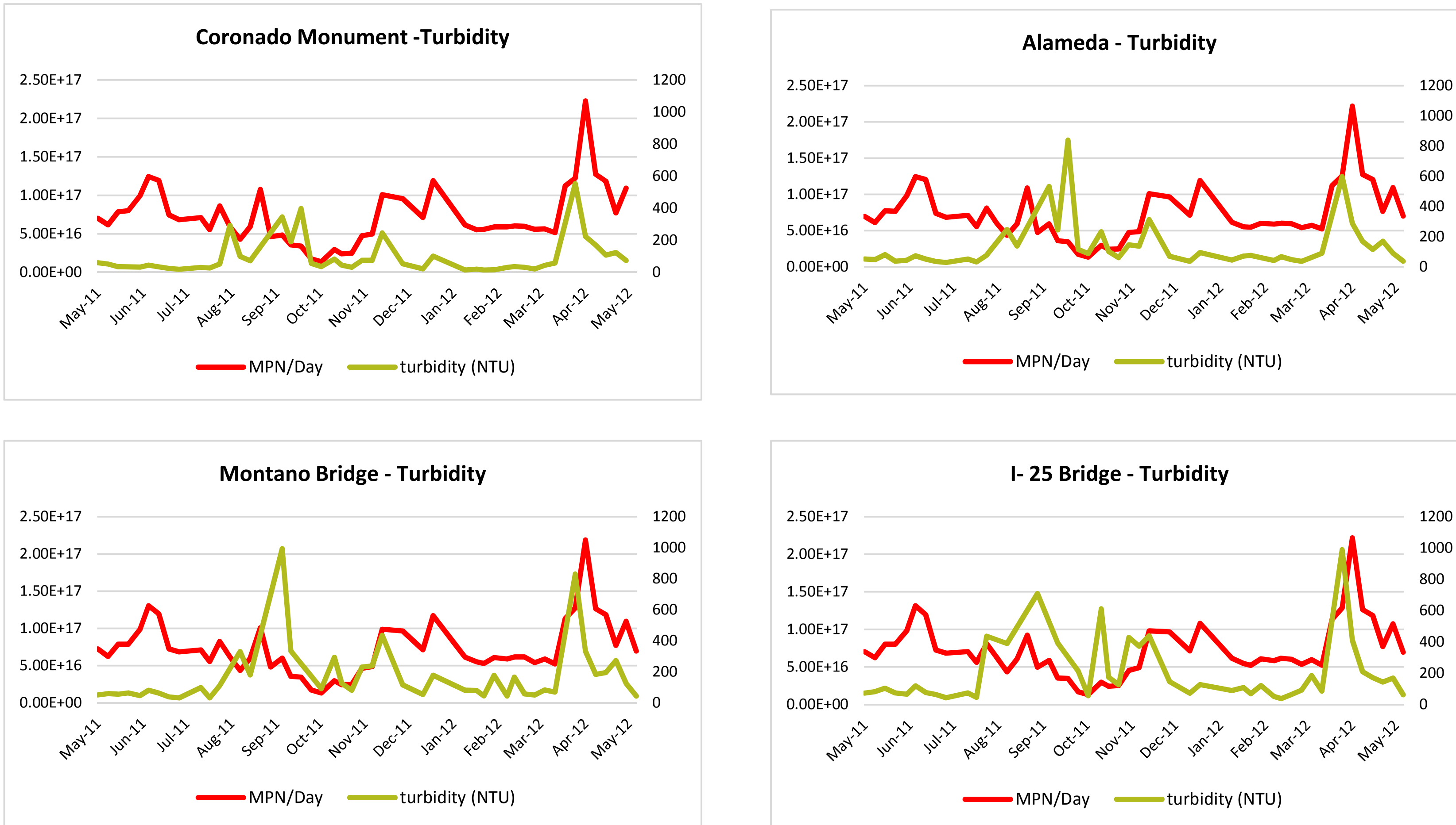

Figure 3-11 Comparison of BEMP Data *E. coli* Concentrations and Turbidity

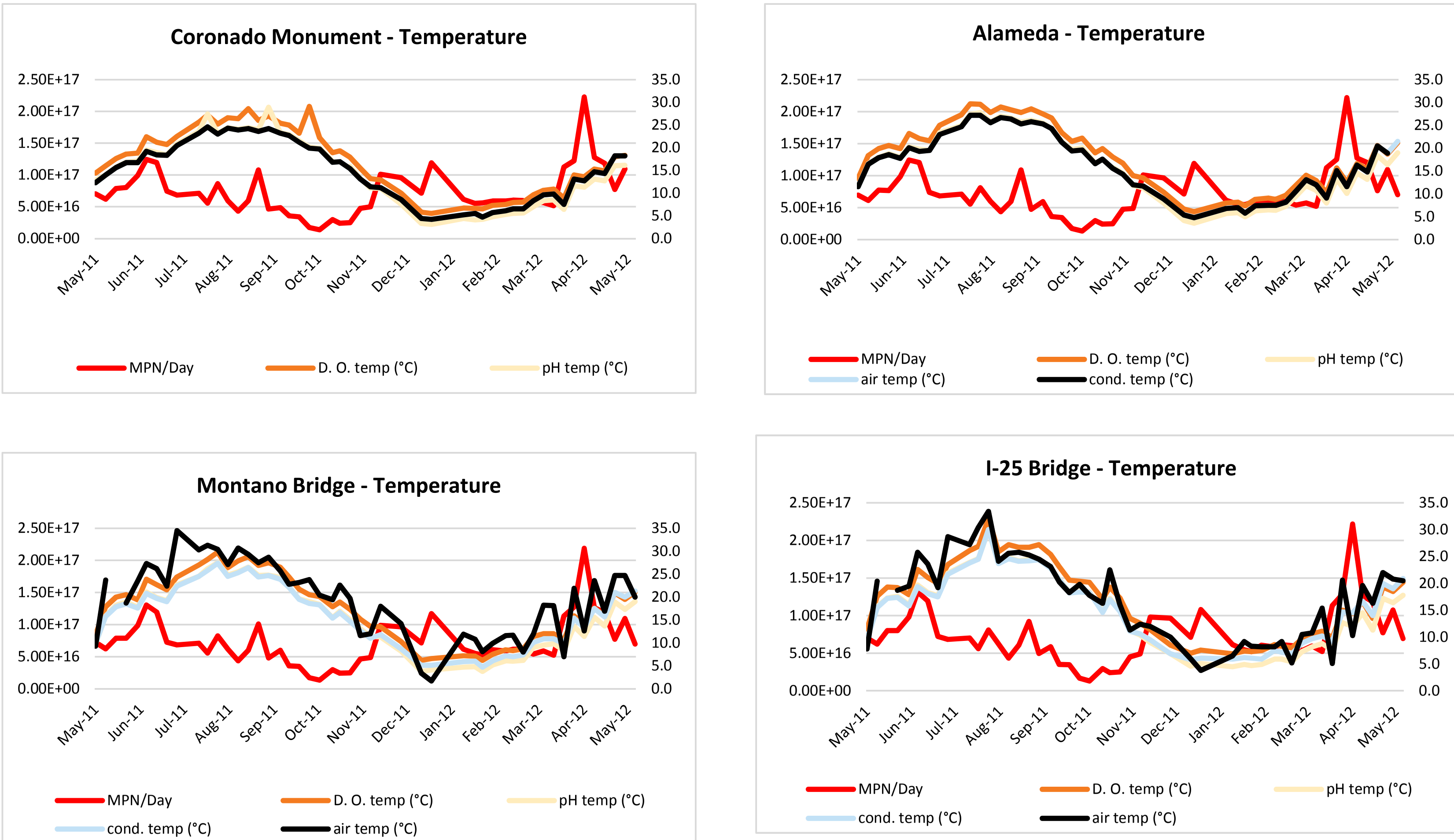

Figure 3-12 Comparison of BEMP Data *E. coli* Concentrations and Temperature

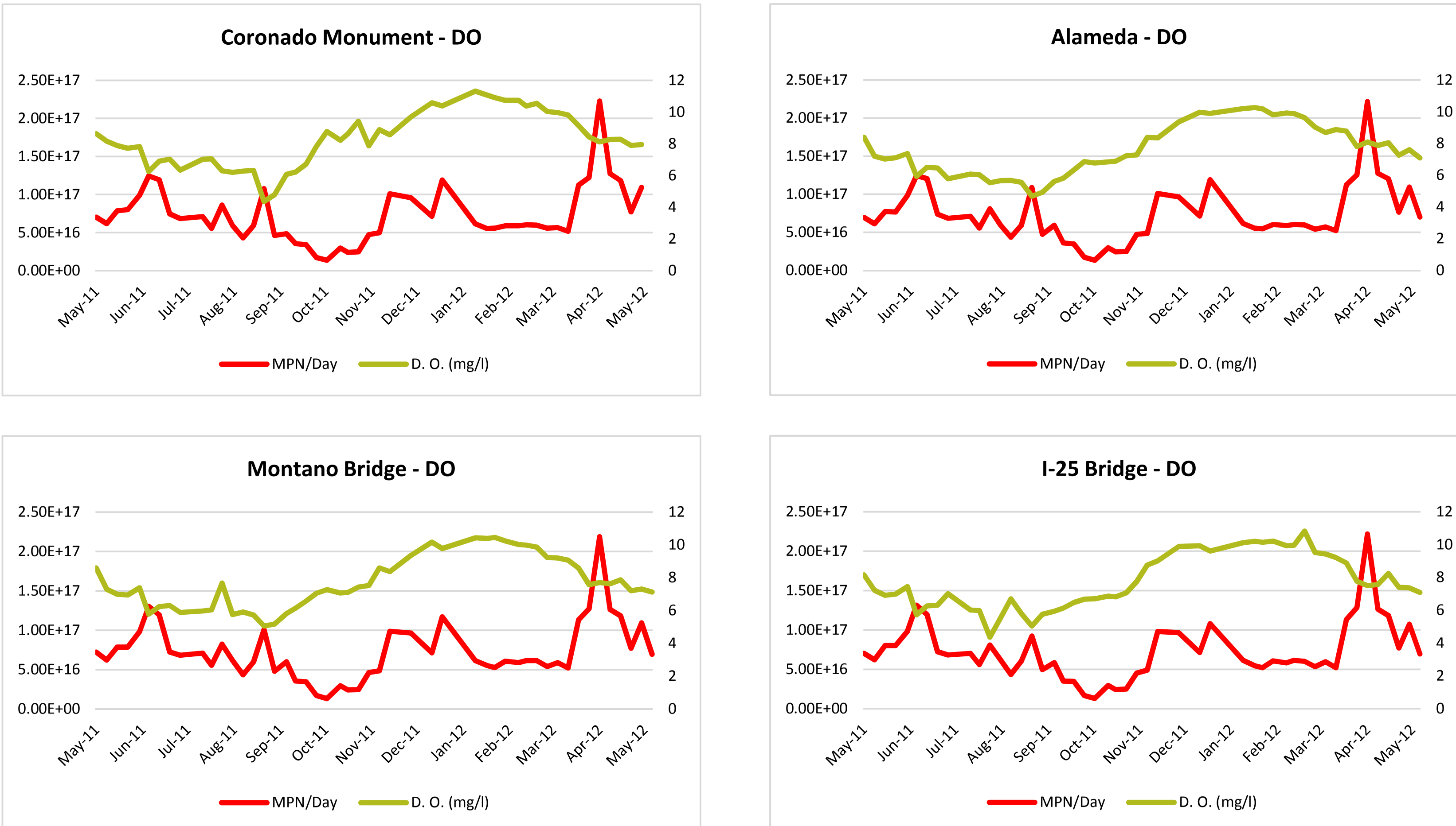

Figure 3-13 Comparison of BEMP Data *E. coli* Concentrations and Dissolved Oxygen

3.3.3 Avian Migratory Flyways

The microbial source tracking study for the Middle Rio Grande (Parsons Water & Infrastructure, 2005) suggested that the largest contributor of *E. coli* is avian. Therefore, avian migratory flyways must also be considered when evaluating the seasonal sources of *E. coli* concentrations. New Mexico is situated in the Central Migratory Flyway for waterfowl. Waterfowl counts for the Rio Grande is available from the Friends of the Bosque Del Apache National Wildlife Refuge. **Figure 3-14** graphically depicts the weekly waterfowl counts at the Bosque Del Apache between 2005 and 2010. It can be see that the waterfowl counts are greatest from November to March. Concentrations of *E. coli* found in the USGS, NMED, and BEMP data show that exceedances most often occur during the monsoon season (mid-June through October). The months in which high concentrations of *E. coli* are observed in the middle Rio Grande do not coincide with the months in which waterfowl counts are the highest at the Bosque Del Apache Wildlife Refuge, indicating that there may not be a correlation between the waterfowl migratory season and seasonal fluctuations of the *E. coli* concentrations.

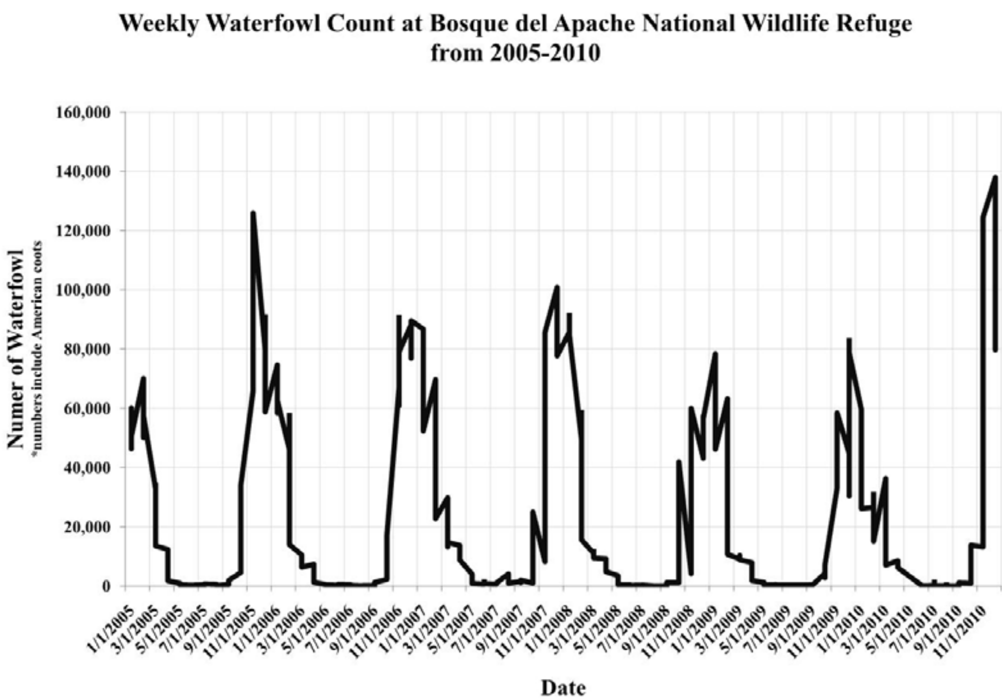

Figure 3-14 Weekly Waterfowl Count at Bosque Del Apache National Wildlife Refuge from 2005 – 2010 from the Bosque Del Apache NWR Waterbird Counts

3.4 Middle Rio Grande *E. coli* Characterization Conclusions

The conclusions that can be drawn from the analysis of the three *E. coli* data sets discussed in this section are:

- The concentration of *E. coli* in the Rio Grande increases downstream from Cochiti Lake to Isleta Pueblo, mirroring the increase in urban development.
- The "background" *E. coli* concentration for the middle Rio Grande segment generally meets the New Mexico water quality criterion, but exceeds the Pueblo of Sandia criterion in the summer months.
- In the middle Rio Grande segment, there is a downstream increase in *E. coli* concentrations, and the highest concentration is measured at the I-25 bridge.
- *E. coli* concentration varies seasonally and is highest in the summer months; however, E. coli concentration in the winter months may represent a baseline condition.

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Section 4

Basis of *E. coli* Water Quality Standard

This section presents the results of a research task conducted to address three key study questions raised by AMAFCA, as follows:

- What is the typical *E. coli* concentration in rivers and how does that compare to the Rio Grande?
- How much *E. coli* causes illness in humans?
- Which kinds of *E. coli* cause illness in humans?

4.1 Comparative Assessment of Rio Grande Bacterial Water Quality

To develop an answer to the question regarding typical *E. coli* concentrations, a comparative analysis of *E. coli* concentrations in rivers throughout the United States was completed. The study goals were to identify a typical riverine *E. coli* concentration and to understand how the Middle Rio Grande River's *E. coli* concentration compares to the typical concentration. This comparative analysis examined five rivers with similar characteristics to the Rio Grande and five rivers with different characteristics to the Rio Grande. The ten rivers selected for this analysis are described in **Table 4-1**. The river ID designates whether each river is considered similar (S) or different (D) to the Rio Grande, based on a combination of geographic location, drainage area, average annual precipitation, average annual flow, and land use.

Table 4-1 River Locations Included in the *E. coli* Comparative Analysis

ID	Site Name	Location	Average Annual Flow (cfs)	Average Annual Rainfall (in)	Drainage Area (mi^2)	Land Use
D1	Colorado River (Texas)	Webberville, TX	2410	32.15	39,009	Mixed Urban
D2	Charles River	Sherborn, MA	312	43.77	183	Suburban to Rural
D3	Salmon River (OR)	Otis, OR	ungauged	116	60	Rural
D4	Milwaukee River	Milwaukee, WI	451	34.76	696	Mixed Urban
D5	Ohio River	Cincinnati, OH	110,000	40.87	75,580	Mixed Urban
-	Rio Grande	Albuquerque, NM	1237	8.9	17440	Mixed Ag
S1	Fountain Creek	Colorado Springs, CO	70	15.1	392	Mixed Urban
S2	Santa Ana River	Riverside, CA	134	10.2	852	Mixed Urban
S3	Verde River	Camp Verde, AZ	389	13.97	4645	Mixed Rural & Urban
S4	Guadalupe River	Center Point, TX	40	32.27	533	Mixed Urban
S5	Tonto River	Payson, AZ	ungauged	35.2	23.6	Rural

Recent *E. coli* sampling data (2009-2014) were found for each of the rivers described in **Table 4-1**. Data sources include USGS, EPA's STORET database, watershed advocacy groups, municipalities, and researchers. Summary statistics – geometric mean, mean, minimum, maximum, and standard deviation – are reported for each river in **Table 4-2**. A box-and-whisker plot representing the median, minimum, maximum, 1st, and 3rd quartiles is shown in **Figure 4-1**.

Table 4-2 Summary Statistics Describing *E. coli* Concentration in Rivers in the United States

ID	Site Name	Location	Number of Samples (2009-2014)	*E. coli* Summary Stats (cfu/100 mL, except as noted)			
				Geometric Mean	Standard Deviation	Min	Max
D1	Colorado River (Texas)	Webberville, TX	34	46	115	6	550
D2	Charles River	Sherborn, MA	65	54	208	5	1,460
D3	Salmon River	Otis, OR	96	34	77	1	461
D4	Milwaukee River[1]	Milwaukee, WI	41	682	5,516	20	27,500
D5	Ohio River	Cincinnati, OH	244	59	1,277	4	14,200
-	Rio Grande at I-25[2, 3]	Albuquerque, NM	48	327	6,984	26	46,110
-	Rio Grande at Montano[2, 3]	Albuquerque, NM	48	99	3,234	10	19,863
S1	Fountain Creek[2]	Colorado Springs, CO	133	217	3,120	7	20,000
S2	Santa Ana River	Riverside, CA	181	170	1,002	9	9,400
S3	Verde River	Camp Verde, AZ	33	33	171	3	687
S4	Guadalupe River	Center Point, TX	90	50	575	3	4,839
S5	Tonto Creek	Payson, AZ	100	72	678	3	3,466

Notes:
1. CSO/SSO upstream of sample location
2. Analytical method used SM9221 reports bacteria as MPN/100 ml
3. Based on BEMP data

The data described in **Table 4-2** and **Figure 4-1** indicates a general central tendency for the geometric mean values to approach one another regardless of the drainage area and geographic location of the sample. For instance, the vast majority of the geometric mean *E. coli* concentrations are between 30 – 80 cfu/100 mL. There is, however, considerable spread in the data, with some very large maximum concentrations and large standard deviations. Some of this variation has to do with wet weather samples that include combined sewer overflows; this is especially evident in the high values observed in the Milwaukee River samples.

Two Rio Grande sites are shown in **Figure 4-1** and **Table 4-2**. Data from both of these sites were taken from the BEMP. BEMP data in general show that the upstream *E. coli* concentrations are similar to concentrations observed in rural Southwestern rivers and streams, whereas the concentration increases significantly as the river flows through the middle Rio Grande urban area. The Rio Grande at Montano site exhibits elevated concentrations relative to the sites north of Albuquerque (not shown in **Figure 4-1**), and the Rio Grande at I-25 site is characterized by even higher concentrations than the Montano site. This result is comparable to other urban systems evaluated in this study (e.g., the Milwaukee River and the Santa Ana River), and suggests that storm water runoff from the urbanized area contributes a significant amount of *E. coli* bacteria to the Rio Grande.

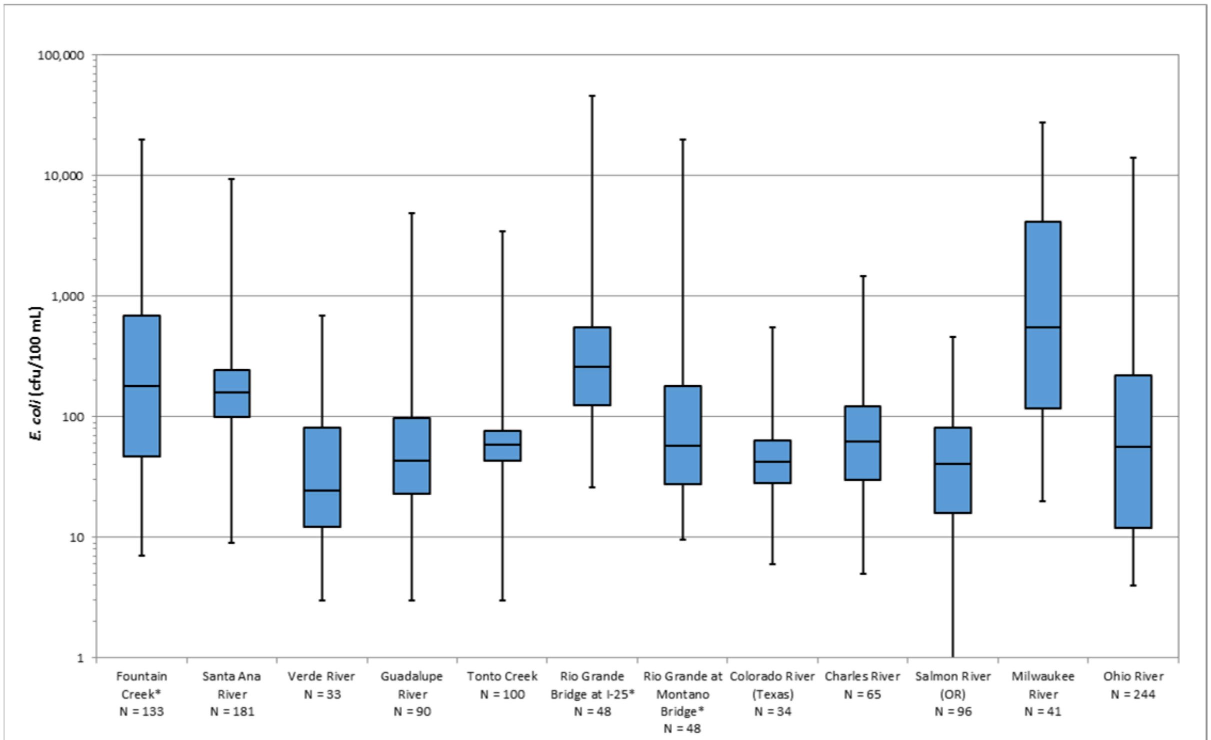

Figure 4-1: Box Plots of *E. coli* Concentrations in Rivers in the United States

4.2 Criteria for Water Contact Recreation

CWA Section 502(23) defines fecal indicator bacteria (FIB) as "pathogen indicators" and that term is defined by "a substance that indicates the potential for human infectious diseases". *E. coli* is as group of bacteria that are found in feces of warm blooded mammals, including humans. Most serotypes of *E. coli* do not cause illness in humans; however pathogenic bacteria are typically associated with fecal contamination. Thus, *E. coli* concentration is used in water quality criteria to protect human health because it indicates the potential for human infectious disease, and it would be technically and economically infeasible to analyze large volumes and numbers of water samples required to assess the presence of all potential pathogens.

Bacterial indicators or FIB are used as criteria for deriving permit limits, making listing decisions, and developing TMDLs associated with risk of illness as a result of water contact recreation, in lieu of more costly and complex analysis for specific human pathogens in water samples. Human pathogens are a set of viruses, bacteria, and protozoa that can cause illness in humans when ingested. **Table 4-3** lists the most common waterborne pathogens that cause illness in humans and are therefore of primary concern for protection of public health in waterbodies with high risk of exposure by water contact recreation.

One important group of pathogenic bacteria includes diarrheagenic *E. coli.* (DEC). The key distinguishing feature of pathogenic *E. coli* serotypes from non-pathogenic is the ability to colonize sites within the human body by attaching to host cells, typically in the small intestine or urinary track. There are several subgroups or pathotypes of DEC that generally categorized based on the means by which they cause illness. Possibly the most commonly identified DEC serotype in the United States is

E. coli 0157:H7, which causes illness by producing a Shiga toxin. A subgroup of DEC, which includes 0157:H7 and other serotypes, is associated with Shiga-toxin *E. coli* (STEC), also referred to as enterohemorrhagic *E. coli* (EHEC). Non-STEC subgroups of pathogenic *E. coli* include enteropathogenic (EPEC), enterotoxigenic (ETEC), enteroinvasive (EIEC), and enteroaggregative (EAEC). Studies in developing countries have evaluated the relative frequency of illness associated with contamination by exposure to one or more of these DEC pathotypes.

The basis for EPA's water quality criteria recommendations involves epidemiological studies that relate bacterial water quality with illness of swimmers. This relationship is the subject of AMAFCA's study question, which is the subject of this technical memorandum. Thus, the following sections summarize the findings from the epidemiological studies used by EPA over two key iterations of developing water quality criteria; published in 1986[3], referred to as EPA 1986 Guidance, and updated in 2012[4], referred to as EPA 2012 Guidance Update.

4.2.1 Basis for EPA 1986 Guidance

The bacteria objectives recommended in the EPA 1986 Guidance are based on two epidemiological studies conducted during summer months generally from 1979 to 1982 at Keystone Reservoir in Oklahoma and Lake Erie in Pennsylvania. The waters that were used in these epidemiological studies contained sources of human sewage and therefore are not representative of waters where non-human sources predominate. In such waters, *E. coli* and enterococci emanating from naturalized or non-fecal sources may result in the waterbody being incorrectly classified as impaired when the risk of illness is actually not above what had been determined to be acceptable

The difference in reported illness between swimmers and non-swimmers is used to investigate a causal relationship between illness and water contact recreation. McKee (1980), which provides part of the basis for EPA's recommended freshwater primary contact objectives (i.e., the studies involving Keystone Reservoir), provides a clear distinction between swimmers and non-swimmers:

Table 4-3 List of Common Pathogens that Cause Human Illness in Recreational Waters (adapted from EPA, 2003[5])

Pathogen	Source	Disease	Effects
Bacteria			
Campylobacter	Bird feces	Diarrhea	Acute diarrhea
Enterohemorrhagic *E. coli* (STEC) e.g. O157:H7	Cattle feces	Gastroenteritis	Vomiting, diarrhea, severe stomach cramps
Enterotoxigenic *E. coli* (ETEC)	Human or animal feces	Traveler's Diarrhea	Acute diarrhea
Enteropathogenic *E. coli* (EPEC)	Human or animal feces	Diarrhea	Acute and persistent diarrhea
Enteroinvasive *E. coli* (EIEC)	Human or animal feces	Diarrhea	Acute diarrhea
Enteroaggregative *E. coli* (EAEC)	Human or animal feces	Diarrhea	Acute diarrhea

[3] US Environmental Protection Agency, 1986. *Ambient Water Quality Criteria for Bacteria*, Office of Water Regulation and Standards Criteria and Standards Division, EPA 440/5-84-002.
[4] US Environmental Protection Agency, 2012. *Recreational Water Quality Criteria*, Office of Water, EPA 820-F-12-058.
[5] US Environmental Protection Agency, 2003. *Managing Urban Watershed Pathogen Contamination*, prepared by Joyce M. Perdek, Russell D. Arnone, and Mary K. Stinson Water Supply and Water Resources Division Urban Watershed Management Branch and Mary Ellen Tuccillo Oak Ridge Institute of Science and Education, EPA 600-R-03-111

Table 4-3 List of Common Pathogens that Cause Human Illness in Recreational Waters (adapted from EPA, 2003[5])

Pathogen	Source	Disease	Effects
Legionella pneumophila	Aquatic environments	Legionellosis	Acute respiratory illness
Leptospira (150 spp.)	Dog, livestock, wild animal urine	Leptospirosis	Jaundice, fever (Weil's disease)
Salmonella typhi	Domestic, wild animal feces	Typhoid fever	High fever, diarrhea, ulceration of small intestine
Salmonella (~ 1700 spp.)	Domestic, wild animal feces	Salmonellosis	Diarrhea, dehydration
Shigella (4 spp.)	Human feces	Shigellosis	Bacillary dysentery
Vibrio cholerae	Asymptomatic human feces	Cholera	Extremely heavy diarrhea, dehydration
Yersinia enterocolitica	Animal feces	Yersinosis	Diarrhea
Protozoan			
Cryptosporidium	Human, animal, and bird feces	Cryptosporidiosis	Diarrhea, death in susceptible populations
Cyclospora	Human feces	Cyclosporiasis	Diarrhea
Entamoeba histolytica	Human feces	Amebiasis (amoebic dysentery)	Prolonged diarrhea with bleeding, abscesses of the liver and small intestine
Giardia lamblia	Human, animal, and bird feces	Giardiasis	Mild to severe diarrhea, nausea, indigestion
Naegleria fowleri	Bird and aquatic mammal feces	Meningoence• phalitis	Inflammation of brain and meninges
Viruses			
Adenovirus	Humans	Respiratory disease, gastroenteritis	Acute respiratory disease, pneumonia, conjunctivitis, gastroenteritis
Astroviruses	Humans	Gastroenteritis	Vomiting, diarrhea
Calicivirus	Humans	Gastroenteritis	Vomiting, diarrhea
Enterovirus	Humans	Gastroenteritis, heart anomalies, meningitis	Respiratory illness, polio, common cold
Hepatitis A	Humans	Infectious hepatitis	Jaundice, fever
Hepatitis E	Humans, pigs	Infectious hepatitis	Jaundice, fever
Reovirus	Humans	Gastroenteritis	Vomiting, diarrhea
Rotavirus	Humans	Gastroenteritis	Vomiting, diarrhea
Helminth Worms			
Ascaris lumbricoides	Human feces	Ascariasis	Asymptomatic, respiratory problems
Ancylostoma duodenale	Human Feces	Ancylostomiasis	Anemia
Necator americanus	Human feces	hookworm	Anemia
Trichuris trichiura	Human feces	Trichuriasis	Gastrointestinal problems
Taenia solium	Pigs	Taeniasis	Intestinal disturbance
Diphyllobothrium latum	Fish	Diphyllobothriasis	Anemia, diarrhea
Schistosoma haematobium	Snails, human feces	Schistosomiasis	Diarrhea, lesions, cystitis
Schistosoma intercalatum	Snails, human feces	Schistosomiasis	Diarrhea, lesions, cystitis
Schistosoma japonicum	Snails, human feces	Schistosomiasis	Diarrhea, lesions, cystitis
Trichobilharzia spp.	Snails, waterfowl, aquatic animals	Swimmer's itch	Open sores and lesions in skin

Non-swimmers were those who either did not go in the water (non-bathers) or went in the water but did not get their head or face wet (waders). *Persons who reported that they were in the water for less than ten minutes were classified as non-swimmers regardless of whether they got their head or face wet, in view of their short water exposure time.* No explanation was offered for why ten minutes was selected as this threshold.

Swimmers were those who did swim for more than ten minutes.

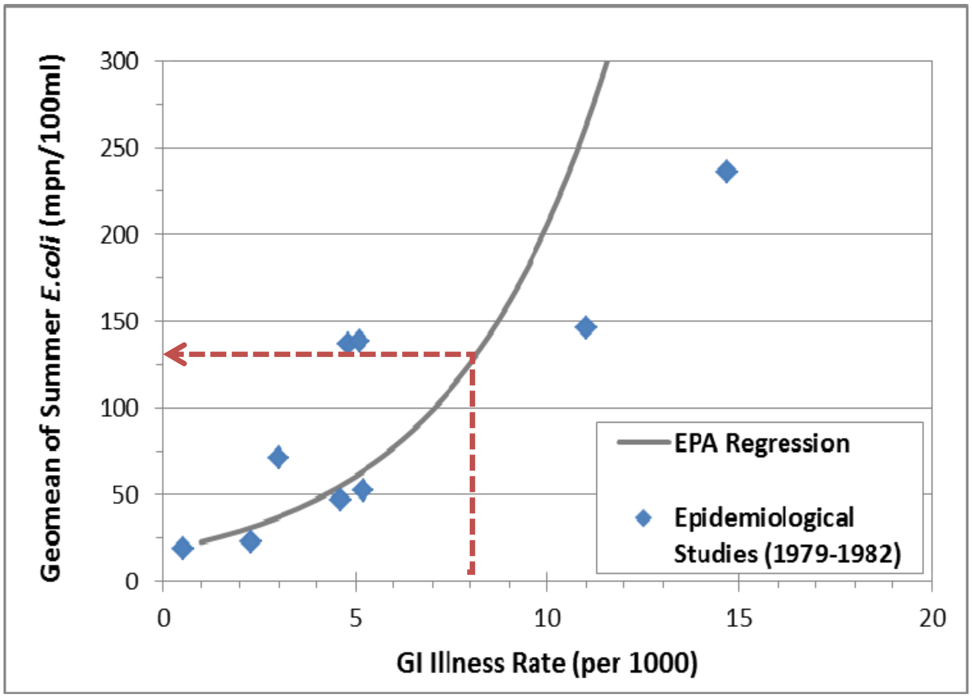

Figure 4-2: *E. coli* Concentrations vs. GI Illness Rate

The results of these studies were used to develop a relationship between *E. coli* concentration and risk of highly credible gastrointestinal illness (HCGI) (**Figure 4-2**). The regression analysis found a statistically significant correlation (Pearson's r = 0.80), thus a logarithmic trend was generated, as shown in **Figure 4-2**. In the 1986 Guidance, EPA did not make any new determination of an acceptable risk level of GI to recreational users for setting water quality criteria. Instead, the level of acceptable risk of 8 per 1000 for HCGI (e.g. symptoms such as vomiting and fevers) that served as the basis for recreational use water quality criteria for fecal coliform in the 1968 Green Book[6] was applied. This was despite the admission in the 1986 Guidance that this risk level was arbitrary. The hashed lines on **Figure 4-2** show how the current geometric mean criteria for *E. coli* of 126 MPN/100ml was developed by using the assumed level of acceptable risk of 8 per 1000 (0.8%).

The 1986 criteria also incorporated four different single sample maximum (SSM) values for varying use intensity of recreational waters corresponding to the 75th, 82nd, 90th, and 95th percentiles of the

[6] Federal Water Pollution Control Administration. 1968. *Water Quality Criteria* ("Green Book"). Report of the National Technical Advisory Committee to the Secretary of the Interior. U.S. Department of the Interior, Washington DC. The Green Book water quality criteria were developed from limited epidemiological data from three studies conducted by the United States Public Health Service (USPHS) on Midwestern waters (Great Lakes in Michigan, Inland River and Ohio River [Ohio]) from 1948-1950.

expected water quality sampling distribution at the GM criteria value. The SSM criteria are not to be exceeded in more than 10 percent of samples in a 30 day period, which equates to a single exceedance for most monitoring programs. EPA developed the SSM criteria to be more protective of recreational use by constraining the number of high water quality values.

In addition to *E. coli* concentration, the EPA 1986 Guidance also found *Enterococcus* to be a better indicator because of a higher Pearson's r of 0.74 in correlations with the rate of gastroenteritis cases than previously used fecal coliforms (Pearson's r = -0.08). Using the same regression based approach discussed above, a water quality criteria of 33 MPN/100ml was recommended for the same assumed level of acceptable risk.

4.2.2 EPA 2012 Guidance Update

In 2012, EPA developed an updated guidance document for recreational water quality criteria using more recent scientific information including the National Epidemiological and Environmental Assessment of Recreational Waters (NEEAR). The 2012 RWQC broadens the definition of GI to include symptoms of diarrhea, stomachache, or nausea without requiring the occurrence of fever and allowing for a longer incubation time (participants contact increased from 8 days following event as in the 1980s epidemiological studies to 10-12 days). These changes were made, referred to as NEEAR GI (NGI), because viral gastroenteritis does not always present with a fever and because some pathogens, such as *Cryptosporidium spp*., have longer incubation times of up to ten days. Because the NGI definition is broader than previously used HCGI, the risk levels are higher. Specifically, it was estimated that the risk level of 8 per 1000 for HCGI has an equivalent risk value of 36 per 1000 for NGI (Wymer *et al*., 2012[7]).

The NEEAR epidemiological studies used a different definition of a "swimmer" from the 1986 Guidance, which includes any person that fully immersed to the waste or higher for any amount of time.

Epidemiological studies conducted by the NEEAR did not include any measurement of *E. coli*. Geometric mean criteria for *E. coli* were kept at 126 cfu/100mL, and were described as being protective at a risk level of 36 instances of NGI per 1000 swimmers. SSM criteria for varying levels of recreational use intensity were replaced by a single statistical threshold value (STV) in the 2012 Guidance Update. The STV for *E. coli* in freshwaters is 410 cfu/100mL. The 2012 EPA Guidance Update also requires that both the GM and STV criteria must be achieved to demonstrate compliance with water quality standards in recreational use waterbodies.

The 2012 EPA Guidance Update compared culture-based *Enterococcus* concentrations for fresh and marine waters in these NEEAR studies and showed no significant difference based on salinity of the source water. Therefore, the same *Enterococcus* criteria apply for marine and fresh waters. Other factors were determined to be more important as statistical differences between individual sites did exist.

The NEEAR study results did not provide sufficient correlation of culture-based Enterococcus and illness rate to develop a statistically significant regression analysis that would be comparable to the analysis completed for the 1986 guidance. However, the majority of NEEAR paired results for culture-based *Enterococcus* and illness rate fell within the 95% confidence interval of the 1986 regressions

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[7] Wymer, Larry, Tim Wade and Al Dufour. 2012. Translation of 1986 Criteria Risk to Equivalent Risk Levels for Use with New Health Data Developed Using Rapid Methods for Measuring Water Quality, Appendix A of EPA 2012 Recreational Water Qaultiy Criteria.

(**Figure 4-3**, copied from EPA 2012 Guidance Update). Therefore, the same method was applied and yielded very similar results for Enterococcus concentration criteria for freshwaters (between 30-35 cfu/100ml).

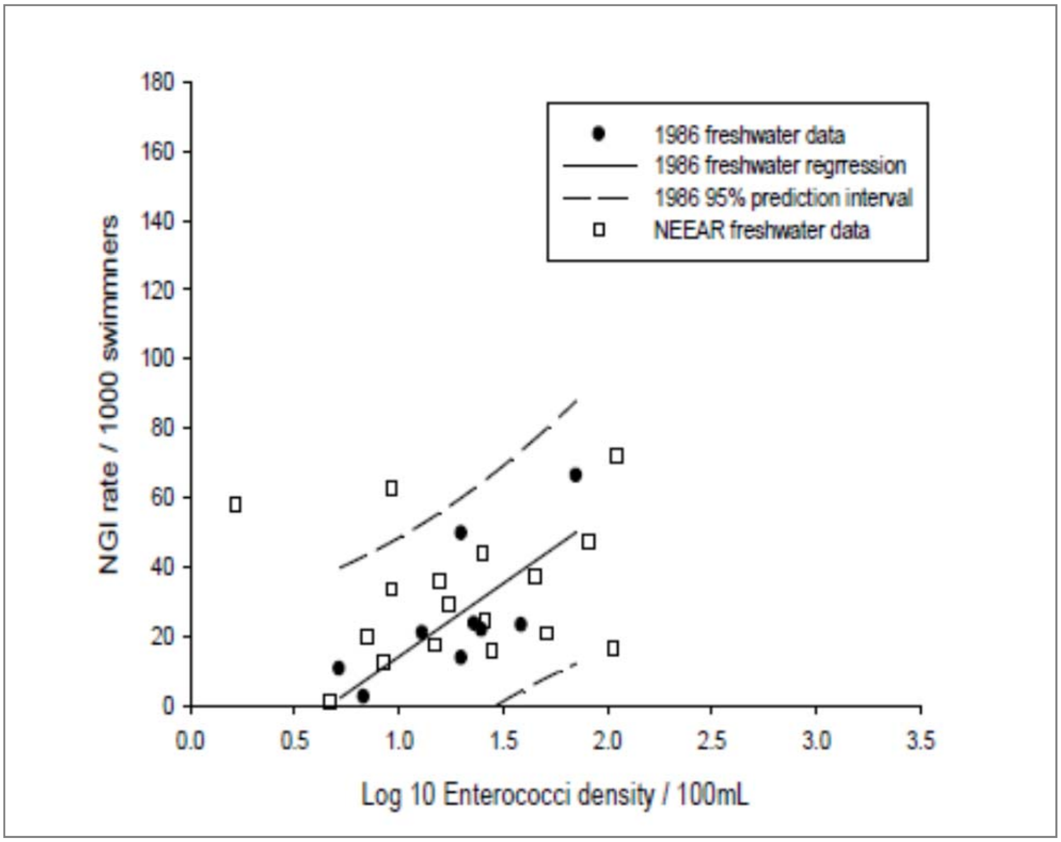

Figure 4-3: Relationship between Increased Risk of NGI Illness from Swimming and log Enterococci Concentration used to Develop EPA's 2012 Update to Recreational Water Quality Criteria

In marine and fresh waters, Wade et al. (2010[8]; 2008[9]) showed a significant relationship between *Enterococcus* measured using a relatively new rapid molecular method, quantitative polymerase chain reaction (qPCR). These relationships were used in the 2012 EPA Guidance Update to include recommendations for new RWQC for *Enterococcus* if analyzed using qPCR (geomean of 300 – 470 CE/100 mL for an acceptable risk of exposure of 32 per 1000 and 36 per 1000, respectively).

[8] Wade, T.J., Sams, E., Brenner, K.P., Haugland, R., Chern, E., Beach, M., Wymer, L., Rankin, C.C., Love, D., Li, Q., Noble, R., Dufour, A.P. 2010. Rapidly Measured Indicators or Recreational Water Quality and Swimming-Associated Illness at Marine Beaches: A Prospective Cohort Study. Environmental Health 9: 66.

[9] Wade, T.J., Calderon, R.L., Brenner, K.P., Sams, E., Beach, M., Haugland, R., Wymer, L., Dufour, A.P. 2008. High Sensitivity of Children to Swimming-Associated Gastrointestinal Illness – Results Using a Rapid Assay of Recreational Water Quality. Epidemiology 19(3): 375-383.

4.3 Bacteria Numeric Targets in the Middle Rio Grande TMDL

The Middle Rio Grande bacteria TMDL was approved by the EPA in 2010. This TMDL contains target *E. coli* load (cfu/day) duration curves for four segments of the river, based on concentrations based water quality standards, as follows:

- Rio Grande from San Marcial to Rio Puerco and from Rio Puerco to Isleta Pueblo Boundary - *E. coli* geomean of 126 cfu/100 mL and *E. coli* single sample maximum of 410 cfu/100 mL for secondary water contact recreation

- Rio Grande from Isleta Pueblo Boundary to Alameda Bridge and from non-pueblo Alameda Bridge to Angostura Diversion - *E. coli* geomean of 47 cfu/100 mL and *E. coli* single sample maximum of 88 cfu/100 mL for primary contact ceremonial use for religious or traditional purposes by members of the Pueblo of Sandia and the Pueblo of Isleta; such use involves immersion, and intentional or incidental ingestion of water

The WQS applied in the TMDL are based on EPA's RWQC guidance for the segments outside of the Pueblo of Sandia; thus a potential illness rate of HCGI of 8/1000 or NGI of 36/1000 was accepted. For Rio Grande segments within the Pueblo of Sandia and the Pueblo of Isleta, where the existing use involves a higher risk of exposure associated with ceremonial activities involving immersion and ingestion, a lower illness rate of 4/1000 of HCGI was selected, resulting in the more stringent water quality targets. The *E. coli* data for the middle Rio Grande discussed in Section 2 indicate that the Rio Grande in this reach exceeds the Pueblo water quality standard at most times of the year and exceed the New Mexico standard in the summer monthly, mostly associated with storm water events.

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Section 5

Implementation Strategies for Managing Bacteria

A variety of implementation strategies exist to protect recreational water contact beneficial use in bacteria impaired waters with inputs from urban MS4 systems. These strategies can protect existing uses by mitigating sources of controllable fecal indicator bacteria FIB, providing treatment of runoff containing FIB, or reducing exposure following an instance of increased contamination. Implementation strategies fall into the following broad categories:

- Source tracking and elimination methods
- Structural BMPs - Biofilters, Bioretention, Detention basins, Filters with sand or other media, Infiltration basins, Disinfection systems, Surface treatment wetlands, Subsurface treatment wetlands
- Beach closure notification systems
- Use attainability analysis

5.1 Source Tracking and Elimination

Source tracking and elimination generally involves four steps within large (>10 mi^2) urbanized watersheds, such as the City of Albuquerque MS4 drainage area to the Rio Grande. These steps include:

1. Identify controllable bacteria sources and their contribution to elevated FIB concentrations
2. Prioritize controllable sources for follow-up inspection and mitigation activity
3. Identify alternatives to mitigate prioritized controllable urban sources
4. Implement mitigation activity and monitor effectiveness

Tracking and eliminating sources of bacteria within subwatersheds can be a highly effective method to reduce FIB concentrations in downstream receiving waterbodies. A key component of an effective bacteria source tracking (BST) program is the evaluation of the host organisms that contributed fecal bacteria to watershed runoff. There are many analytical methods that can be applied to detect the presence of FIB from specific host organisms (EPA, 2011). The National Epidemiological and Environmental Assessment of Recreational Water (NEEAR) is a recent study of the human health effects associated with recreational water use, which uses a more comprehensive definition of gastrointestinal illness (GI) than the Highly Credible GI (HCGI) definition cited in EPA's 1986 Ambient Water Quality Criteria for Bacteria. Fecal bacteria from human sources (such as failing septic systems or cross connected sanitary sewers) pose the greatest risk of NEEAR-GI (NGI) to users of the downstream receiving waterbody. Accordingly, subwatersheds that show a presence of human sources of FIB can be prioritized for more rigorous investigation. If the specific controllable source(s) of the contamination can be located, actions required to eliminate the source are likely to be more cost effective than implementing a downstream structural BMP for the larger subwatershed. Conversely, if

BST shows that source of FIB in a subwatershed is naturally occurring and uncontrollable (such as from wildlife in riparian areas), then watershed managers can reduce the priority of the subwatershed and potentially avoid implementation of costly mitigation that may not provide any reductions of NGI risk to downstream recreational users. There is no universal EPA definition of uncontrollable source of bacteria. One definition was adopted by the California Water Resources Control Board in an amendment[10] to the Water Quality Control Plan for the Santa Ana River watershed (Basin Plan), and states the following:

> *"Uncontrollable bacteria sources refer to contributions of bacteria within the watershed from nonpoint sources that are not readily managed through technological or natural mechanisms or through source control and that may result in exceedances of water quality objectives for indicator bacteria. Specific uncontrollable indicator bacteria sources within the Santa Ana Region may include wildlife activity and waste, bacterial regrowth within sediment or biofilm, resuspension from disturbed sediment, concentrations (flocks) of semi-wild waterfowl, and shedding during swimming"*

5.2 Structural BMPs for Removal of Bacteria in Runoff

5.2.1 BMP Types

There are several commonly used structural BMPs to capture and treat runoff from urban drainage areas. Following is a brief description of BMP types that can be effective for reducing bacteria that were evaluated in this technical memorandum:

***Bioretention**:* Bioretention is a group a small scale BMPs that capture and filter runoff through amended soils and select vegetation. Runoff that is not evapotranspired infiltrates into the ground. One example of is a rain garden, which captures rooftop runoff in a depressed on-site area that contains wetlands plants.

Biofiltration: Biofiltration is similar to bioretention except runoff is not infiltrated into underlying soils. Instead runoff percolates through the biofilter soil and vegetation into an underdrain that conveys runoff to the downstream conveyance network.

***Detention basin**:* Detention facilities are designed to capture runoff and provide storage to increase residence time and facilitate pollutant settling. Detention facilities can be open-surface basins or subsurface galleries and can be designed to fully drain between events (dry detention) or to have a permanent pool (wet detention).

Filtration: Filtration involves the routing of runoff through flow-through devices that reduce bacteria and other pollutants in runoff. Types of filters include cartridge filters, media filters, and high-flow biotreatment devices.

Infiltration basin: Infiltration basins capture stormwater runoff and retain inflows up to the design volume by allowing for the stored runoff to infiltrate into the ground and then percolate through soil layers to recharge underlying groundwater basins. Water quality is improved by preventing runoff and associated pollutants from reaching downstream receiving waters. Infiltration facilities can be open-surface basins or subsurface galleries.

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[10] http://www.swrcb.ca.gov/rwqcb8/water_issues/programs/basin_plan/recreational_standards.shtml

Disinfection system: Disinfection systems provide disinfection of runoff by physical, chemical, or radiological processes, or a treatment train involving more than one of these processes. Most disinfection systems are fed by a diversion to regulate inflow rate. Treated runoff is then returned to the original channel which provides dilution of ambient water quality.

Surface wetlands: Surface wetlands are engineered, shallow-marsh systems that convey runoff and provide pollutant removal enhanced with uptake and filtration by select plants. Constructed wetlands must always maintain a baseflow into the system to maintain plants.

Subsurface gravel wetlands: Subsurface gravel wetlands are constructed wetlands that have no open surface water. These systems have longer residence times and provide enhanced pollutant removal with uptake and filtration by select plants and contact with longer contact with gravel or amended media. Constructed wetlands must always maintain a baseflow into the system to maintain plants.

5.2.2 Removal Mechanisms

Structural BMPs available to reduce bacteria in watershed runoff are constructed differently and range from large natural wetlands to small disinfection plants. There are a variety of bacteria removal mechanisms that are incorporated into structural BMPs to inactivate and remove bacteria from stormwater, which are described below.

- ***Natural Inactivation*** represents decay and removal of bacteria when exposed to light, air, and other environmental factors. For example, ultraviolet radiation contained in sunlight can destroy cell walls and air can dry and kill bacteria. This treatment mechanism is often found in large, open BMPs with significant areas of open water exposed to the environment.

- ***Predation*** occurs when microorganisms consume smaller bacteria. Common predators of bacteria are protozoa and other eukaryotic organisms, and studies have found that predation may account for 90% of overall bacteria mortality in BMPs utilizing large open water areas conducive to populations of microorganisms.

- ***Inert Filtration and Sedimentation*** occurs in most stormwater BMPs discussed in this memorandum, and refers to physical removal processes that cause bacteria bound to particulates in suspension to settle out or be removed. This removal mechanism can consist of a sand filter or similar to trap bacteria bound to particulates or sedimentation where particulates settle out of the water column over time. One caveat to this removal mechanism is that bacteria can survive on the trapped or settled particulates and can thus represent a source if the sediment is resuspended or released from the filter.

- ***Sorption*** refers to the bonding of bacteria to the surface of particles. This process can occur both within a filter media and within other BMPs that are comprised of particles or sediment that bacteria can sorb to. Sorption occurs due to steric, electrostatic, and hydrophobic interactions between the bacteria and the particle being adhered to. The bond is not permanent, and can be broken if conditions change or if the particle is exposed to forces such as shear and turbulence.

- ***Chemical Inactivation*** involves the use of a chemical (such as ozone, chlorine, or C-18 organosilane quaternary) to kill and destroy bacteria cells. Chlorine and ozone treatments are typically used for wastewater, CSO, and SSO treatment and are not well-suited to treatment of MS4 discharge because of the variability of MS4 discharge rates, the need for chemical storage facilities on-site, and the risk of disinfection byproducts (for chlorine treatments). Many proprietary bacteria structural BMP treatments use C-18 organosilane quaternary, a granular antimicrobial agent (Dow Corning Corp., 2011).

- ***UV inactivation*** uses ultraviolet light at a wavelength of about 254 nm to destroy bacteria cells. This method requires low turbidity water, so pretreatment using a filter or sedimentation is often necessary. UV inactivation is not widely used for the treatment of stormwater. The only known application of UV in a stormwater system is in the City of Malibu, CA that is designed to treat 100 gpm dry weather flow within the storm sewer system. This system consists of a three-stage treatment process, with three dual media filters composed of sand and anthracite, three activated media filters composed of organo-clay, and two UV disinfection units.

Each of the common stormwater BMPs were evaluated with respect to the bacteria removal mechanisms (**Table 5-1**).

Table 5-1 Matrix of BMP Bacteria Removal Mechanisms

BMP Type	Natural Inactivation	Predation	Inert Filtration and Sedimentation	Sorption	Chemical/UV Inactivation
Biofilter			✓	✓	
Bioretention			✓	✓	
Detention Basin	✓	✓	✓		
Filter			✓	✓	
Infiltration Basin			✓		
Disinfection System					✓
Surface Wetland	✓	✓			
Subsurface Gravel Wetland			✓	✓	

5.2.3 Comparison of Removal Effectiveness

Numerous studies on the effectiveness of stormwater BMPs used for bacteria removal have been compiled in the International Stormwater BMP Database. While significant work has been done to compile and analyze performance data for stormwater BMPs, several caveats are necessary while examining the effectiveness data.

- The vast majority of the stormwater bacteria measurements are from grab samples, so it is difficult to determine whether the concentration is representative of the event mean concentration (EMC) for the entire storm duration. This can bias the removal effectiveness depending on when the grab samples were collected during the course of a storm.

- Upper and lower detection limits are variable and are a function of the amount of dilution used during analysis. As such, the upper quantification limit may range over several orders of magnitude. This makes comparison amongst different BMP effectiveness studies more difficult if influent or effluent bacteria concentrations are recorded as too numerous to count.

- Effectiveness monitoring for *E. coli* is limited, and most studies contain limited data from a limited number of sites. As a result, it is difficult to draw any firm conclusions about the removal effectiveness of each BMP from these results because the sample size is limited.

- Geographic variation is limited, so it is possible that site-specific or region-specific processes can bias the effectiveness results. Similarly, seasonal variation in bacteria concentration may also bias results. For instance, winter bacteria concentrations are likely to be lower than summer concentrations. These factors are not considered in this analysis due to the limited amount of data available.

The effectiveness monitoring results from the International Stormwater BMP Database are reproduced from *Pathogens in Urban Stormwater Systems* in **Figure 5-1** and **Table 5-2** for the available *E. coli* sampling data.

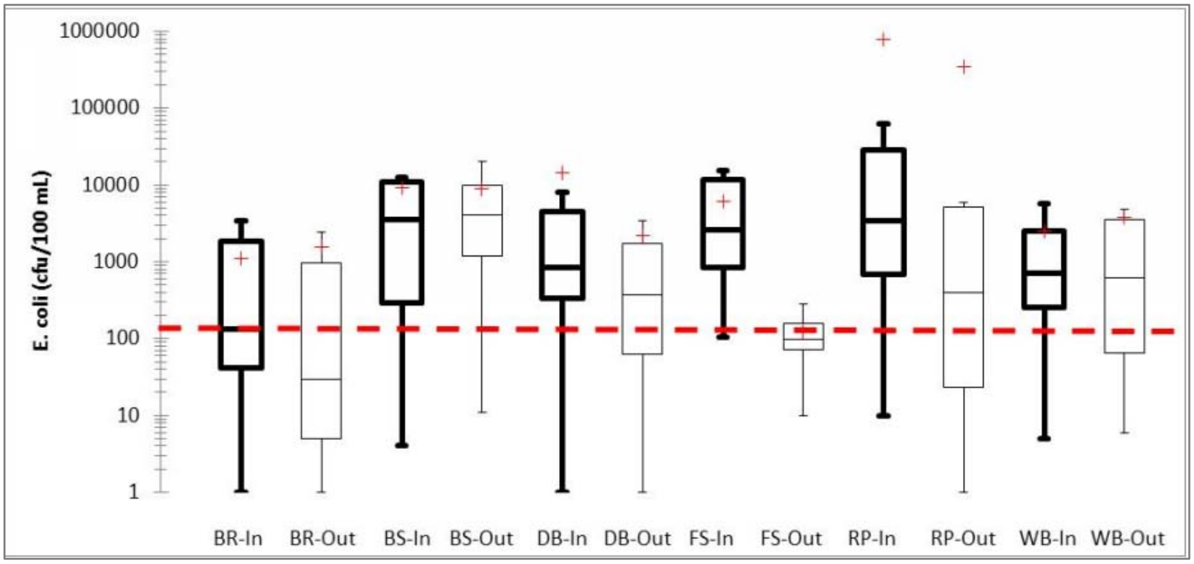

Figure 5-1: Efficacy of Bacteria Removal Mechanisms

5.3 Beach Notification System to Protect Public Health

One alternative to construction of large structural stormwater BMPs would be to implement a beach closure notification system for periods when elevated bacteria levels pose risk for gastro- intestinal illness (GI) to swimmers. This management approach can serve to protect public health in the near term, while other controls or source tracking and elimination activities are considered for improving water quality in watershed runoff. EPA defines a beach as any "sandy, pebbly, or rocky shore of a body of water", which would include the Rio Grande shoreline.

In the 2012 update to Recreational Water Quality Criteria, EPA suggests that states use a beach action value (BAV) as a conservative, precautionary tool (not a water quality standard) for making beach notification decisions. Specific BAVs were computed as the 75th percentile of a fitted distribution to FIB concentrations from supporting epidemiological studies (**Table 5-3**). **Table 5-3** shows two groups of BAVs that correspond to the alternative rates of NGI provided. If a sample exceeds the selected BAV, a beach notification is triggered and remains in effect until a subsequent sample result is below the BAV.

Table 5-2 *E. coli* Removal Effectiveness Statistics from the International Stormwater BMP Database

BMP Category	Flow Type	# of Events	Geo. Mean	Min	Max	1Q	Median	3Q	Mean	COV
Bioretention	In	54	145	1	7,701	42	135	1821	1121	1.6
	Out	54	60	1	19,863	5	30	965	1,539	3
Biofilter	In	39	1,440	4	41,000	295	3,500	11,000	9,270	1
	Out	39	2,365	11	40,000	1,200	4,100	10,000	8,993	1
Detention Basin	In	42	1,011	1	198,600	333	850	4,500	14,184	3
	Out	42	283	1	22,800	63	370	1,700	2,167	2
Sand Filter	In	5	2,099	105	15,500	830	2,600	11,605	6,128	1
	Out	5	79	10	280	72	98	160	124	1
Retention Pond	In	87	6,580	10	1.7E+9	686	3,466	29,028	799,060	3
	Out	84	726	1	1.2E+9	23	393	5,225	352,426	4
Surface Water Wetland Basin	In	42	681	5	14,136	257	714	2,509	2,516	2
	Out	42	539	6	36,540	65	622	3,577	3,822	2

Table 5-3 Beach Action Values Provided in the 2012 Guidance Update for Recreational Water Quality Criteria

Fecal Indicator Bacteria	Beach Action Value for NGI = 36/1000 (units/100ml)	Beach Action Value for NGI = 32/1000 (units/100ml)
Enterococci – culturable (fresh and marine)[a]	70 cfu	60 cfu
E. coli – culturable (fresh)[b]	235 cfu	190 cfu
Enterococcus spp. – qPCR (fresh and marine)[c]	1,000 cce	640 cce

a) Enterococci measured using EPA Method 1600 or equivalent
b) *E. coli* measured using EPA Method 1603 or equivalent
c) EPA *Enterococcus* spp. Method 1611 for qPCR

Rapid quantitative real-time polymerase chain reaction (qPCR) is an analytical method (EPA Method 1611) used to assess FIB concentrations. The method involves amplification of the specified bacterial DNA so that it can be detected using a probe which fluoresces only in the presence of its specific DNA target. Detecting cell components, rather than waiting for cell growth allows for results to be generated more quickly than culture-based methods; generally within three hours. The shorter analytical time allows an agency to notify for a beach closure or restore recreational uses (cease a closure) based on concentrations in samples collected from within the same day. EPA 1611 is a method that measures *Enterococcus* concentration; however, others have developed methods to enumerate *E. coli* using qPCR (Noble et. al., 2012).

This method was piloted for two Lake Michigan beaches near Milwaukee, WI. Samples collected in the morning were analyzed on 87 days between 7/23/10 and 9/7/10 and used to guide decisions on beach notifications. Samples were also evaluated using culturable methods and compared with the qPCR results, once available. Results showed approximately 90 percent agreement between the two analytical approaches for when evaluating exceedance of the water quality objective, 235 cfu/100ml (Lavendar and Kinzelman, 2009). Concurrent to this pilot, a comparable study was conducted at four marine beaches in Orange County, CA to compare results and closure notification differences between analytical methods for *Enterococcus* (Setty, 2012). This study found that the qPCR methodology is a viable technique for the rapid assessment of beach water quality, and noted a number of lessons learned during the pilot study. Based on the pilot test, Orange County officials modified their sampling protocols so results would be ready before noon, developed new electronic notification systems to share results with the public, and installed electronic signage at beaches to instantaneously share laboratory results.

5.5 High-flow Suspension of Recreational Use

Most exceedances of bacterial water quality standards are associated with wet weather events, which also create conditions that may present significant safety risk for swimmers in flowing waters, such as the Rio Grande. A different approach to managing changes in bacteria associated with storm events is to develop a use attainability analyses (UAAs) that provides the basis for a temporary suspension of water quality standards during storm events, when high flow conditions create conditions that are unsafe for swimming. In California, the State Water Resources Control Board has supported UAAs that identify unsafe conditions during high flows and have approved amendments to the Los Angeles and Santa Ana Regional Water Quality Control Plans to include provisions for a temporary suspension of water quality standards for certain waterbodies (http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/basin_plan/index.shtml and http://www.swrcb.ca.gov/rwqcb8/water_issues/programs/basin_plan/docs/rec_standards/SWRCB/20140121_Attachment%202.pdf). For example, the Los Angeles Basin Plan amendment to incorporate high flow suspension[11] applies as follows:

> *"on days with rainfall greater than or equal to ½ inch and the 24 hours following the end of the ½-inch or greater rain event, as measured at the nearest local rain gauge, using local Doppler radar, or using widely accepted rainfall estimation methods. The High Flow Suspension only applies to engineered channels, defined as inland, flowing surface water bodies with a box, V-shaped or trapezoidal configuration that have been lined on the sides and/or bottom with concrete to all storm events that exceed 0.5 inches of rainfall and last for 24 hours after the end of rain."*

A key element involved with implementing this type of approach to protect public health involves when to return the waterbody to supporting recreational use. Basin Plan amendments for Los Angeles (shown above) and Santa Ana regions, incorporating high-flow suspension specified that recreation use would be restored after a period of 24 hours after the end of rainfall. This timeframe was developed by evaluating historical FIB data collected during and following storm events. It would make sense to align the regulatory timeframes with beach notification system decisions; thus water contact uses could be restored when there is data showing bacterial levels do not pose greater than an acceptable levels of risk for NGI in swimmers.

Lastly, the process of preparing the documentation and proposing a UAA for a high-flow suspension of recreational use can be difficult and require several years of investigation, depending upon the scope of the proposed revisions to existing use designations. Prior to embarking on a UAA, meetings with stakeholders as well as regulatory agencies are important to assess the feasibility of gaining official approval.

[11] http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/basin_plan/wqs_list.shtml

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Section 6

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Appendix A

Raw Data

Site Name	River Miles	Date	Time	Test	E.Coli Count (CFU/100ml)	E.Coli Concentration (CFU/day)	River Flow (cfs)	Frequency
Rio Grande at Pena Blanca	5.5	3/20/2014	905	Escherichia coli	9.8	1.85338E+11	773	51.0
	5.5	4/29/2014	1000	Escherichia coli	4.1	1.01313E+11	1010	36.3
	5.5	5/12/2014	930	Escherichia coli	8.6	3.93458E+11	1870	18.9
	5.5	7/14/2014	1100	Escherichia coli	15.6	3.08385E+11	808	48.1
	5.5	8/13/2014	1310	Escherichia coli	72.3	1.40802E+12	796	49.2
	5.5	9/3/2014	1551	Escherichia coli	21.6	4.02158E+11	761	52.0
	5.5	10/8/2014	1430	Escherichia coli	27.9	3.57679E+11	524	73.0
Angostura Diversion	23.5	3/23/2005	836	Escherichia coli	10.8	2.30673E+11	873	43.5
	23.5	5/26/2005	1230	Escherichia coli	27.5	3.77445E+12	5610	2.2
	23.5	6/23/2005	900	Escherichia coli	13.4	1.35398E+12	4130	6.2
	23.5	7/27/2005	803	Escherichia coli	98.5	9.4467E+11	392	85.8
	23.5	8/24/2005	850	Escherichia coli	52.1	4.62703E+11	363	87.5
	23.5	9/28/2005	1801	Escherichia coli	90.9	8.74006E+11	393	85.7
	23.5	10/26/2005	1411	Escherichia coli	63.1	4.33804E+11	281	91.8
Highway 550	27.5	3/23/2005	850	Escherichia coli	11	2.34944E+11	873	43.5
	27.5	5/26/2005	1251	Escherichia coli	32.7	4.48816E+12	5610	2.2
	27.5	5/26/2005	1308	Escherichia coli	42.8	5.87441E+12	5610	2.2
	27.5	6/23/2005	930	Escherichia coli	23.1	2.3341E+12	4130	6.2
	27.5	6/23/2005	1000	Escherichia coli	22.6	2.28358E+12	4130	6.2
	27.5	7/27/2005	838	Escherichia coli	488.4	4.68403E+12	392	85.8
	27.5	7/27/2005	845	Escherichia coli	325.5	3.12173E+12	392	85.8
	27.5	8/24/2005	1000	Escherichia coli	50.4	4.47605E+11	363	87.5
	27.5	9/28/2005	1714	Escherichia coli	95.9	9.22081E+11	393	85.7
	27.5	10/26/2005	1341	Escherichia coli	153.9	1.05804E+12	281	91.8
	27.5	3/20/2014	1300	Escherichia coli	4.1	76335477996	761	52.0
	27.5	4/29/2014	1125	Escherichia coli	39.5	9.7606E+11	1010	36.3
	27.5	5/12/2014	1140	Escherichia coli	178.5	8.07919E+12	1850	19.0
	27.5	6/12/2014	1030	Escherichia coli	19.7	5.6391E+11	1170	30.6
	27.5	7/14/2014	1550	Escherichia coli	73.8	1.4589E+12	808	48.1
	27.5	8/13/2014	1136	Escherichia coli	96	1.89776E+12	808	48.1
	27.5	9/3/2014	1441	Escherichia coli	21.6	3.96345E+11	750	52.9
	27.5	10/8/2014	1300	Escherichia coli	74.9	9.60221E+11	524	73.0
Above RR WWTP #2	31	3/23/2005	905	Escherichia coli	13.4	2.86205E+11	873	43.5
	31	5/26/2005	1339	Escherichia coli	42.6	5.84696E+12	5610	2.2
	31	6/23/2005	1030	Escherichia coli	35	3.53652E+12	4130	6.2
	31	7/27/2005	910	Escherichia coli	41.1	3.94172E+11	392	85.8
	31	8/24/2005	1030	Escherichia coli	7.2	63943593247	363	87.5
	31	9/28/2005	1650	Escherichia coli	90.9	8.74006E+11	393	85.7
	31	10/26/2005	1318	Escherichia coli	133.4	9.17107E+11	281	91.8
	31	3/20/2014	1145	Escherichia coli	9.7	1.83446E+11	773	51.0
	31	4/29/2014	1230	Escherichia coli	9.8	2.42162E+11	1010	36.3
	31	5/12/2014	1235	Escherichia coli	28.5	1.28995E+12	1850	19.0
	31	6/12/2014	1130	Escherichia coli	21.3	6.0971E+11	1170	30.6
	31	7/14/2014	1520	Escherichia coli	150	2.96524E+12	808	48.1
	31	8/13/2014	1031	Escherichia coli	108.1	2.10522E+12	796	49.2
	31	9/3/2014	1407	Escherichia coli	62	1.15434E+12	761	52.0
	31	10/8/2014	1210	Escherichia coli	47.3	6.06388E+11	524	73.0

Site Name	River Miles	Date	Time	Test	E.Coli Count (CFU/100ml)	E.Coli Concentration (CFU/day)	River Flow (cfs)	Frequency
Alameda Bridge	38.5	3/23/2005	931	Escherichia coli	41.4	8.84245E+11	873	43.5
	38.5	5/26/2005	1415	Escherichia coli	36.8	5.0509E+12	5610	2.2
	38.5	5/26/2005	1415	Escherichia coli	40.4	5.54501E+12	5610	2.2
	38.5	5/26/2005	1426	Escherichia coli	47.3	6.49205E+12	5610	2.2
	38.5	6/23/2005	1130	Escherichia coli	81.3	8.21483E+12	4130	6.2
	38.5	6/23/2005	1145	Escherichia coli	249.5	2.52103E+13	4130	6.2
	38.5	7/27/2005	1000	Escherichia coli	62.2	5.96533E+11	392	85.8
	38.5	7/27/2005	1015	Escherichia coli	41.7	3.99926E+11	392	85.8
	38.5	8/24/2005	1100	Escherichia coli	77.6	6.8917E+11	363	87.5
	38.5	9/28/2005	1613	Escherichia coli	149.7	1.43937E+12	393	85.7
	38.5	10/26/2005	1245	Escherichia coli	231	1.58809E+12	281	91.8
	38.5	3/20/2014	1056	Escherichia coli	10.8	2.0425E+11	773	51.0
	38.5	4/29/2014	1315	Escherichia coli	13.4	3.31119E+11	1010	36.3
	38.5	5/12/2014	1245	Escherichia coli	55.6	2.50294E+12	1840	19.1
	38.5	6/12/2014	1200	Escherichia coli	19.9	5.69635E+11	1170	30.6
	38.5	7/14/2014	1430	Escherichia coli	143.9	2.84466E+12	808	48.1
	38.5	8/13/2014	1000	Escherichia coli	235.9	4.66334E+12	808	48.1
	38.5	9/3/2014	1335	Escherichia coli	48.7	9.06717E+11	761	52.0
	38.5	10/8/2014	1130	Escherichia coli	133.4	1.71019E+12	524	73.0
Rio Grande at Rio Bravo Bridge	53	3/19/2014	1700	Escherichia coli	14.5	2.69967E+11	761	52.0
	53	4/29/2014	1355	Escherichia coli	33.6	8.30269E+11	1010	36.3
	53	5/12/2014	1400	Escherichia coli	68.4	3.12936E+12	1870	18.9
	53	6/11/2014	1900	Escherichia coli	54.6	1.54956E+12	1160	30.9
	53	7/14/2014	1330	Escherichia coli	686.7	1.35749E+13	808	48.1
	53	8/12/2014	1055	Escherichia coli	148.3	2.97155E+12	819	47.2
	53	9/2/2014	1210	Escherichia coli	154.1	2.91434E+12	773	51.0
	53	10/7/2014	1120	Escherichia coli	110.6	1.44225E+12	533	72.3
Los Padillas	57	3/23/2005	1047	Escherichia coli	43.5	9.29098E+11	873	43.5
	57	5/26/2005	1131	Escherichia coli	40.4	5.54501E+12	5610	2.2
	57	6/22/2005	845	Escherichia coli	1553.1	1.6073E+14	4230	6.0
	57	7/27/2005	1420	Escherichia coli	245.3	2.35256E+12	392	85.8
	57	8/24/2005	1615	Escherichia coli	290.9	2.5835E+12	363	87.5
	57	9/28/2005	1341	Escherichia coli	275.5	2.64894E+12	393	85.7
	57	10/26/2005	1145	Escherichia coli	290.9	1.9999E+12	281	91.8
	57	3/19/2014	1814	Escherichia coli	29.2	5.43658E+11	761	52.0
	57	4/29/2014	1510	Escherichia coli	38.4	9.48878E+11	1010	36.3
	57	5/12/2014	1445	Escherichia coli	48.7	2.19232E+12	1840	19.1
	57	6/11/2014	1805	Escherichia coli	93.3	2.64788E+12	1160	30.9
	57	7/14/2014	1230	Escherichia coli	285.1	5.63594E+12	808	48.1
	57	8/12/2014	1000	Escherichia coli		0	808	48.1
	57	8/12/2014	1000	Escherichia coli	180.7	3.57213E+12	808	48.1
	57	9/2/2014	1300	Escherichia coli	298.7	5.64901E+12	773	51.0
	57	10/7/2014	1200	Escherichia coli	198.9	2.5937E+12	533	72.3
Isleta Diversion	60	3/23/2005	1104	Escherichia coli	139.6	2.98166E+12	873	43.5
	60	5/26/2005	1105	Escherichia coli	60.2	8.26261E+12	5610	2.2
	60	6/22/2005	1740	Escherichia coli	344.8	3.56833E+13	4230	6.0
	60	7/26/2005	1515	Escherichia coli	547.5	5.25083E+12	392	85.8
	60	7/27/2005	1300	Escherichia coli	57.1	5.47621E+11	392	85.8
	60	10/26/2005	1045	Escherichia coli	387.3	2.66264E+12	281	91.8
	60	10/26/2005	1100	Escherichia coli	325.5	2.23777E+12	281	91.8

USGS Raw Data

Site	River Miles	Month	Temp (C˚)	E. coli (CFU/100ml)	E.Coli Concentration (CFU/day)	River Flow (cfs)	Frequency
Otowi Bridge	-26.2	January	4.5	33	4.33E+11	536	72.0
	-26.2	January	3.5	8	1.00E+11	511	74.2
	-26.2	February	5	3	4.38E+10	597	65.9
	-26.2	February	7	3	4.06E+10	553	70.2
	-26.2	February	8	37	4.97E+11	549	70.6
	-26.2	March	7.5	120	3.49E+12	1190	30.0
	-26.2	March	7.5	110	1.92E+12	712	55.7
	-26.2	March	8	120	1.48E+12	503	74.9
	-26.2	March	10.5	4	6.50E+10	664	60.0
	-26.2	April	9	37	7.47E+11	825	46.6
	-26.2	April	12	59	1.29E+12	896	42.1
	-26.2	April	12.5	1300	3.50E+13	1100	32.7
	-26.2	April	11	4	4.65E+11	4750	4.5
	-26.2	April	12	1000	2.64E+13	1080	33.4
	-26.2	May	14	180	1.00E+13	2280	16.3
	-26.2	May	13	25	7.03E+11	1150	31.2
	-26.2	May	16	270	1.00E+13	1520	23.5
	-26.2	May	11	130	1.30E+13	4080	6.4
	-26.2	May	11	110	9.90E+12	3680	7.9
	-26.2	May	14.8	96	3.19E+12	1360	26.5
	-26.2	June	24	72	4.97E+12	2820	12.8
	-26.2	June	21	130	3.63E+12	1140	31.4
	-26.2	June	15	60	1.95E+12	1330	27.0
	-26.2	June	17.5	380	1.04E+13	1120	32.1
	-26.2	July	20	100	2.72E+12	1110	32.4
	-26.2	July	21	250	3.97E+12	649	61.4
	-26.2	July	20	1	2.67E+10	1090	33.0
	-26.2	July	21	17	4.41E+11	1060	34.2
	-26.2	July	20	77	1.76E+12	932	40.1
	-26.2	August	20	90	2.00E+12	910	41.2
	-26.2	August	22	500	6.56E+12	536	72.0
	-26.2	August	20	94	1.03E+12	447	80.6
	-26.2	August	20	330	6.00E+12	743	53.4
	-26.2	August	21	1800	3.73E+13	847	45.1
	-26.2	August	24.5	1200	2.03E+13	691	57.7
	-26.2	August	23	1000	2.34E+13	955	38.9
	-26.2	August	19.5	63	1.28E+12	829	46.4
	-26.2	August	20.3	180	4.39E+12	996	37.0
	-26.2	September	16	150	4.48E+12	1220	29.3
	-26.2	September	17	100	7.83E+11	320	90.1
	-26.2	September	18	290	6.01E+12	847	45.1
	-26.2	October	11	77	1.05E+12	559	69.5
	-26.2	October	12	150	9.28E+11	253	92.7
	-26.2	October	12	74	7.04E+11	389	86.0
	-26.2	November	9.5	68	8.73E+11	525	72.9
	-26.2	November	11.5	36	3.04E+11	345	88.5
	-26.2	November	2	63	8.38E+11	544	71.2
	-26.2	November	6.5	32	6.27E+11	801	48.7
	-26.2	November	5.5	11	2.88E+11	1070	33.8
	-26.2	November	7.5	27	4.39E+11	664	60.0
	-26.2	November	4	40	6.45E+11	659	60.5
	-26.2	November	6.5	880	1.37E+13	638	62.4
	-26.2	November	0.9	15	2.25E+11	612	64.6
	-26.2	December	2.5	42	5.54E+11	539	71.8
	-26.2	December	1	10	1.32E+11	539	71.8
	-26.2	December	1	4	5.27E+10	539	71.8
	-26.2	December	3.5	16	1.80E+11	459	79.4
	-26.2	December	1	1	1.36E+10	557	69.8
	-26.2	December	2	100	1.76E+12	719	55.2

Site	River Miles	Month	Temp (C˚)	E. coli (CFU/100ml)	E.Coli Concentration (CFU/day)	River Flow (cfs)	Frequency
Below Cochiti	0	January	3.5	4	7.01E+10	716	55.4
	0	February	4	1	1.41E+10	576	67.9
	0	March	7	400	5.02E+12	513	74.1
	0	April	13.1	1	2.39E+10	975	37.9
	0	May	14	22	1.32E+12	2460	15.1
	0	May	12.7	10	8.07E+11	3300	10.4
	0	May	13.6	1	2.37E+10	968	38.2
	0	May	13.4	7	3.08E+11	1800	19.4
	0	June	19	1	3.50E+10	1430	25.2
	0	June	16.4	24	8.98E+11	1530	23.3
	0	July	22	17	2.97E+11	713	55.6
	0	August	23	4000	6.86E+13	701	56.7
	0	August	22.7	6	1.53E+11	1040	35.0
	0	August	23.1	8	1.77E+11	902	41.7
	0	August	22.4	22	2.50E+11	464	78.9
	0	August	22.4	22	1.82E+11	338	88.9
	0	August	22.3	1	1.35E+10	550	70.5
	0	September	21	77	1.02E+12	541	71.5
	0	November	10.5	14	5.34E+11	1560	22.9
	0	November	9	1	1.72E+10	701	56.7
	0	November	9.7	3	4.79E+10	652	61.2
	0	December	6.2	2	3.47E+10	709	56.0
	0	December	5.6	4	6.94E+10	709	56.0
	0	December	4.7	3	7.05E+10	961	38.6
	0	December	3.8	3	4.24E+10	577	67.8
San Felipe	15.3	February	2.5	1	1.42E+10	581	67.4
	15.3	April	11	5	4.28E+09	35	98.3
	15.3	May	15	12	1.44E+12	4890	4.1
	15.3	May	13	23	1.04E+12	1850	19.0
	15.3	May	16	20	2.13E+12	4350	5.7
	15.3	July	21	27	6.94E+11	1050	34.6
	15.3	August	21	100	1.77E+12	722	54.9
	15.3	August	22.5	900	3.02E+13	1370	26.3
	15.3	August	21.5	220	4.58E+12	850	44.9
	15.3	August	19	19	4.88E+11	1050	34.6
	15.3	September	18	74	8.13E+11	449	80.4
	15.3	November	8	32	2.61E+11	334	89.2
	15.3	December	3.5	1	1.79E+10	733	54.1
	15.3	December	3.5	1	1.79E+10	733	54.1
	15.3	December	3.5	1	2.11E+10	864	44.0

Site	River Miles	Month	Temp (C˚)	E. coli (CFU/100ml)	E.Coli Concentration (CFU/day)	River Flow (cfs)	Frequency
Alameda Bridge	38.6	February	8.5	480	6.41E+12	546	71.0
	38.6	April	17	110	2.41E+12	897	41.9
	38.6	April	16	39	6.71E+11	703	56.6
	38.6	May	13.5	8	8.02E+11	4100	6.3
	38.6	May	14	370	1.86E+13	2050	17.6
	38.6	May	16	68	6.19E+12	3720	7.7
	38.6	May	13.6	35	3.10E+11	362	87.6
	38.6	May	16.3	40	6.37E+11	651	61.3
	38.6	May	11.9	56	2.26E+12	1650	21.5
	38.6	June	16.9	180	4.84E+12	1100	32.7
	38.6	July	27.5	50	6.41E+11	524	73.0
	38.6	August	22.5	100	8.88E+11	363	87.5
	38.6	August	22	4100	5.14E+13	512	74.1
	38.6	August	21	63	7.43E+11	482	76.8
	38.6	August	24.5	80	1.33E+12	678	58.7
	38.6	August	25.6	2400	6.58E+13	1120	32.1
	38.6	August	27.9	1400	2.08E+13	607	65.0
	38.6	August	23.5	170	9.69E+11	233	93.2
	38.6	August	23.2	270	1.99E+12	301	90.9
	38.6	August	21.4	92	5.81E+11	258	92.5
	38.6	November	13	5300	5.25E+13	405	84.7
	38.6	November	7.5	71	7.63E+11	439	81.4
	38.6	November	8.6	74	1.09E+12	603	65.4
	38.6	December	3	1	1.95E+10	797	49.1
	38.6	December	5.9	250	3.03E+12	496	75.5
	38.6	December	3.2	84	1.46E+12	710	55.9
	38.6	December	1.2	52	1.02E+12	801	48.7
	38.6	December	4	40	5.46E+11	558	69.7

BEMP Raw Data

Site	River Miles	Date	E. coli (MPN/100 mL)	D. O. (mg/l)	D. O. (% sat)	D. O. Temp (°C)	pH (SU)	pH Temp (°C)	Specific Cond. (µS/cm)	Cond. (µS/cm)	Cond. temp (°C)	Turbidity (NTU)	Water Appearance	Air Temp (°C)	General Weather Conditions	Upstream Water Fowl (0 or Approx.)	Unusual Odors	Watershed/Instream Activities	Specific Sample Info	Missing Parameters	River Flow (cfs) USGS Abq Centr	Frequency	Total E. Coli (MPN/100mL)
Coronado Monument	27	5/2/2011	11	8.64	84.4	14.4	8.35	12.8	335.3	253.6	12.3	59.5	tannish brown	11.5	partly cloudy, snowing in Sandia Mtns		.	.	.	.	706	56.3	1.90001E+11
	27	5/9/2011	23.3	8.16	82.6	16	8.43	14	339.3	267.7	14	51.4	tan, choppy, white caps	27.1	very windy, partly cloudy	0	.	.	.	.	620	63.9	3.53432E+11
	27	5/16/2011	16	7.89	83	17.6	8.34	15.7	318.8	261.4	15.6	34.8	greenish tan		sunny, warm	0	.	.	.	air temp	790	49.7	3.09247E+11
	27	5/23/2011	30.5	7.72	82.7	18.6	8.38	16.8	333.6	280.5	16.7		tan	18.7	sunny	0	.	.	.	.	805	48.4	6.00694E+11
	27	5/31/2011	116.9	7.82	83.5	18.8	8.38	17.1	315.5	265.2	16.7	32.2	greenish tan	26.4	sunny, calm	0	.	.	.	.	996	37.0	2.8486E+12
	27	6/6/2011	44.1	6.25	71.4	22.4	8.17	19.5	303.2	269.8	19.2	44.4	tan	35.1	clear, sunny	0	dead animal	.	.	.	1250	28.6	1.34867E+12
	27	6/13/2011	17.2	6.9	77.2	21.2	8.19	18.9	283.6	247.9	18.4	33.7	tan	30.7	full sun, strong wind/breeze	0	.	.	.	.	1200	29.7	5.04972E+11
	27	6/20/2011	10.8	7.03	78.4	20.7	8.35	18.4	276	240.6	18.3	24.3	greenish tan		clear, breezy	0	.	.	.	air temp	748	53.1	1.97644E+11
	27	6/27/2011	29.2	6.34	73	22.5	8.61	20.8	261.6	239	20.5	18.8	greenish tan	38.1	partly cloudy	0	.	.	.	.	686	58.1	4.90078E+11
	27	7/12/2011	30.1	7.02	86.1	25.6	8.52	23.6	251.8	242.9	23.2	30.3	tan	35.2	partly cloudy	0	.	.	.	.	713	55.6	5.25066E+11
	27	7/18/2011	16.9	7.05	89	27.2	8.67	27.4	274.6	272.4	24.6	26.7	tan	36.4	thicker clouds	0	.	.	.	.	557	69.8	2.30303E+11
	27	7/25/2011	613.1	6.3	76.7	25.2	8.16	23.2	271	260.6	23	51.6	dark brown	33	cumulonimbus cloudy	0	.	.	.	.	864	44.0	1.29599E+13
	27	8/1/2011	3076	6.2	77.4	26.6	8.11	24.4	280.8	276.6	24.3	293	reddish brown	33.7	sunny	0	.	.	.	.	595	66.1	4.47776E+13
	27	8/8/2011	365.4	6.28	78.1	26.4	8.2	24.1	289.2	283.1	23.9	98.9	lighter brown	36.7	wispy clouds	0	manure/decomposition	.	.	.	431	82.3	3.85304E+12
	27	8/15/2011	142.1	6.32	78.9	28.6	8.21	24.4	280.1	275.9	24.2	71.5	light brown	34.2	sunny, breezy	0	.	.	.	.	595	66.1	2.06856E+12
	27	8/22/2011	8664	4.37	53.9	26	7.68	24	309.2	301.2	23.6		chocolate; some debris	33.8	sunny, cumulonimbus clouds over Jemez	0	.	.	.	.	1080	33.4	2.28929E+14
	27	8/29/2011	9208	4.79	60.2	27	7.87	28.9	839	827	24.2		chocolate milk	33.4	sunny	0	.	.	.	.	464	78.9	1.0453E+14
	27	9/6/2011	200	6.07	74	25.4	8.13	23.3	313.7	302.8	23.2	346	brown	29.7	overcast	0	.	.	.	.	486	76.4	2.37807E+12
	27	9/12/2011	114.5	6.22	75.3	25	8.23	22.9	318.3	304.2	22.7	190	medium brown	27.5	mostly sunny	0	.	.	.	.	356	87.9	9.97271E+11
	27	9/19/2011	104.3	6.72	78.7	23.2	8.31	21.5	326.2	302.4	21.2	398	brown	30.5	sunny, clear	0	.	.	.	.	342	88.7	8.72707E+11
	27	9/26/2011	34.1	7.83	89.4	29.1	8.96	20.1	330.8	298.8	19.9	56	greenish-tan	30.1	sunny	0	.	.	.	.	173	94.8	1.44331E+11
	27	10/3/2011	16.9	8.77	100.6	22.2	8.87	19.9	323.9	291.1	19.7	35.1	greenish tan	35.1	partly cloudy	0	.	3 kayaks	.	.	137	96.1	56645470403
	27	10/12/2011	81.6	8.22	89.9	18.9	8.35	17	333	280.5	16.8	82	greenish tan	22	sunny	0	.	.	.	.	297	91.2	5.92932E+11
	27	10/17/2011	122.3	8.63	93.7	19.3			337.4	285.5	16.9	44.4	greenish tan	24	sunny, windy	0	.	.	.	pH	239	93.1	7.15126E+11
	27	10/24/2011	18.1	9.42	99.2	17.9	8.95	15.9	334.8	273.5	15.4	31.2	tannish green	24.5	clear, sunny, breezy	0	.	.	.	.	247	92.8	1.09379E+11
	27	10/31/2011	110.6	7.87	78.9	15.5	8.32	13.2	316.7	244.6	13.1	74.8	light brown	23.4	partly cloudy	0	.	.	.	.	475	77.5	1.28531E+12
	27	11/7/2011	21.8	8.89	84.8	13.2	8.29	11.1	328.1	242.6	11.4	74	tannish green	16.1	partly cloudy, windy	0	.	.	.	.	498	75.3	2.6561E+11
	27	11/14/2011	47.1	8.57	81.2	12.9	7.36	11	303.3	223.2	11.2	246	greyish brown	16.3	70% cumulus clouds, breezy	2	.	.	.	.	1010	36.3	1.16386E+12
	27	11/28/2011	19.3	9.69	85.8	10	8.2	7.6	299.6	205.6	8.6	53.5	dark green	16.5	90% cirrus clouds		.	.	.	.	957	38.7	4.51884E+11
	27	12/12/2011	13.4	10.59	84.6	5.8	8.22	3.3	307.2	186.5	4.4	21.1	brown	1.5	raining, overcast	0	.	.	.	.	713	55.6	2.3375E+11
	27	12/19/2011	17.5	10.39	82.4	5.5	8.09	3.1	328	197.9	4.2	101	brown	2.7	100% cloudy, dreary	0	.	.	.	.	1190	30.0	5.09499E+11
	27	1/10/2012	1	11.32	92.4	6.7	8.35	4.4	310	192.8	5.2	14.7	light tan, clear to 1 ft	14.2	clear and sunny	0	.	.	.	.	614	64.4	15021949133
	27	1/18/2012	1	11.07	90.3	6.6	8.36	4.1	307.4	192.8	5.5	20	green/clear	12.6	light clouds, sunny, breeze	0	.	.	.	.	551	70.4	13480609075
	27	1/23/2012	1	10.91	88.6	6.5	8.24	4.2	310.8	190.5	4.7	14	light tan	12.7	mostly sunny		.	.	.	.	557	69.8	13627403366
	27	1/30/2012	1	10.74	89.1	7.3	8.26	4.8	322.4	203.6	5.7	15.6	light tan	13.2	mostly clear, windy	3	.	.	.	.	588	66.6	14385840538
	27	2/8/2012	9.8	10.74	89.6	7.5	8.13	5.3	338.2	216	6.1	30.1	light brown	13.5	sunny, few clouds	0	.	.	.	.	588	66.6	1.40981E+11
	27	2/13/2012	6.3	10.38	87.5	7.9	8.2	5.5	332.5	214.7	6.5	35.6	brown	9.5	mostly cloudy, intermittent sprinkles	0	.	.	.	.	601	65.6	92634537462
	27	2/20/2012	1	10.55	88.8	8	8.39	5.6	322.6	208.8	6.5	30.7	light brown	7.9	windy, mostly clear	0	.	.	.	.	595	66.1	14557100544
	27	2/27/2012	1	10.03	88.1	9.6	8.2	7	324	220.4	8.3	20.5	brown	15.7	mostly clear, breezy	25	.	.	.	.	557	69.8	13627403366
	27	3/5/2012	2	9.97	89.5	10.6	8.29	8.3	327	230.8	9.6	43.7	brown	19.8	mostly clear, few cirrus clouds	5	.	.	.	.	563	69.2	27548395315
	27	3/12/2012	1	9.82	89	10.9	8.32	8.5	350	249.5	9.8	57.9	brown	19.2	sunny, clear	2	.	.	.	.	515	73.8	12599843328
	27	3/19/2012	145	9.15	79	8.9	7.15	6.4	318.5	212.1	7.5		murky red-brown	6	cloudy, windy, snowing	0	.	.	.	.	1120	32.1	3.97323E+12
	27	3/26/2012	33.1	8.43	81.8	14	7.9	11.6	292.6	226.2	13.1	553	murky brown	26.8	sunny, windy, mostly clear	0	.	.	.	.	1220	29.3	9.87975E+11
	27	4/2/2012	21.3	8.12	78.1	13.6	7.96	11.3	254.5	194.6	12.7	224	brown	14	pt. clouds, breezy	0	.	.	.	.	2220	16.6	1.15689E+12
	27	4/9/2012	16	8.27	82.4	15.3	8.08	13.1	245.5	196.7	14.7	170	brown	26.5	mostly cloudy, raining	0	.	.	.	.	1270	28.2	4.97143E+11
	27	4/16/2012	9.8	8.28	81.8	14.9	7.93	12.7	258.6	206	14.3	107	brown-tan	20.2	mostly cloudy, breezy	0	.	.	.	.	1180	30.3	2.82922E+11
	27	4/23/2012	19.7	7.9	80.4	18	8.13	16	268.5	233.5	18.2	123	tan/brown	28.5	mostly clear and breezy	0	.	.	.	.	769	51.3	3.70638E+11
	27	4/30/2012	21.6	7.95	84.6	18.3	7.08	16.1	276	239.7	18.2	73.2	tan-green	25.2	clear, breezy	0	.	.	.	.	1090	33.0	5.76021E+11
	27	5/7/2012	18.9	7.88	84.8	18.9	7.98	16.7	282.1	249.1	18.8	31.7	tan	24.5	breezy, partly cloudy	0	.	.	.	.	699	56.9	3.23219E+11

BEMP Raw Data

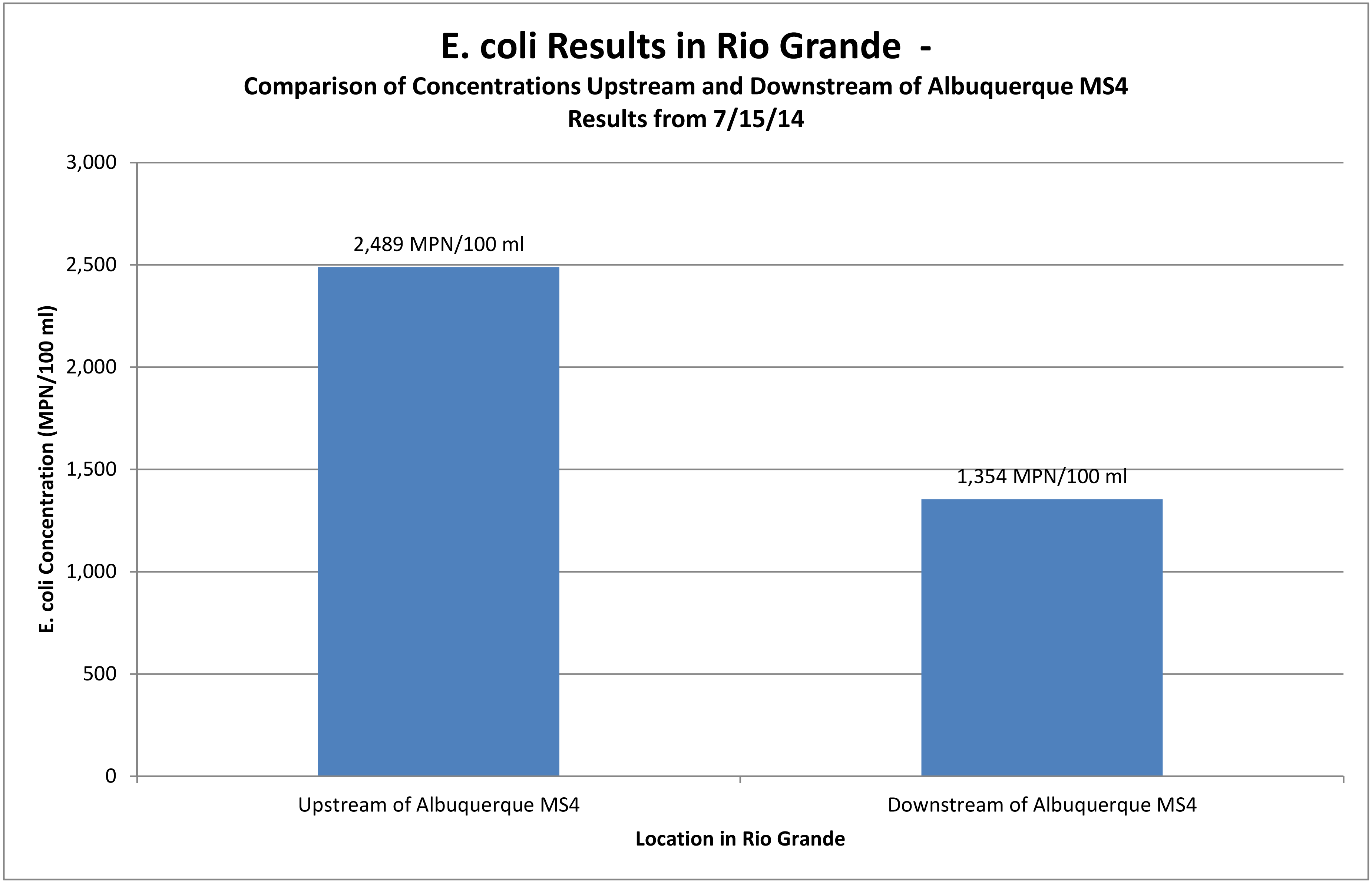
Site	River Miles	Date	E. coli (MPN/100 mL)	D. O. (mg/l)	D. O. (% sat)	D. O. Temp (°C)	pH (SU)	pH Temp (°C)	Specific Cond. (µS/cm)	Cond. (µS/cm)	Cond. temp (°C)	Turbidity (NTU)	Water Appearance	Air Temp (°C)	General Weather Conditions	Upstream Water Fowl (0 or Approx.)	Unusual Odors	Watershed/Instream Activities	Specific Sample Info	Missing Parameters	River Flow (cfs) USGS Abq Centr	Frequency	Total E. Coli (MPN/100mL)
Alameda Bridge	38.5	5/2/2011	18.3	8.4	80.5	13.4	8.34	11.7	326.5	243.1	11.6	51.9	tan	12.3	mostly cloudy	6	.	.	.	.	699	56.9	3.12958E+11
	38.5	5/9/2011	14.8	7.2	76.7	18.4	8.51	16.6	331.9	277.8	16.5	47.4	tan	25.3	windy, partly cloudy	0	.	.	.	.	614	64.4	2.22325E+11
	38.5	5/16/2011	51.2	7.02	77.2	19.9	8.56	18	314.5	272	17.9	80.8	tan		partly cloudy, warm	2	.	.	.	air temp	776	50.7	9.72052E+11
	38.5	5/23/2011	28.8	7.1	79.2	20.6	8.55	18.8	317.6	278.9	18.6	37.8	tan	17.1	sunny	0	.	.	turbidity vial lid lost	.	769	51.3	5.41847E+11
	38.5	5/31/2011	98.8	7.37	81.3	19.9	8.44	18	309.3	267	17.8	44.4	tan	27.3	sunny, calm	0	.	.	.	.	988	37.3	2.38821E+12
	38.5	6/6/2011	72.3	5.93	69.4	23.2	8.18	20.3	307	278	20.1	73	tan/brown	30.6	clear, sunny	0	.	.	.	.	1250	28.6	2.21109E+12
	38.5	6/13/2011	31.5	6.5	74.6	22.1	8.3	19.8	290.8	259.4	19.3	51.6	brown-tan	29.5	full sun, constant breeze	0	.	.	.	.	1210	29.5	9.32511E+11
	38.5	6/20/2011	53.8	6.46	73.3	21.6	8.51	19.5	279.2	249.6	19.5	35.8	tan	23	clear, slighly breezy	0	.	.	.	.	741	53.6	9.75345E+11
	38.5	6/27/2011	36.9	5.78	70	25	8.62	23.4	263.3	253.4	23	29.1	tan	36.5	sunny	0	.	.	.	.	686	58.1	6.1931E+11
	38.5	7/12/2011	104.6	6.07	76.8	27.3	8.43	24.9	253	251.7	24.7	51.9	brown	33.3	partly cloudy	0	.	.	.	.	713	55.6	1.82465E+12
	38.5	7/18/2011	16.6	6.03	79.2	29.7	8.64	27.4	275.8	287.3	27.2	33	tan	37	some clouds, still	0	.	.	.	.	557	69.8	2.26215E+11
	38.5	7/25/2011	10462	5.53	72.6	29.6	8.1	27.8	267	278.6	27.2	77.2	dark brown	32	partly cloudy	0	.	.	.	.	812	47.8	2.0784E+14
	38.5	8/1/2011	12997	5.65	71.9	27.8	8.08	25.7	290.5	294.3	25.6		redder	28.1	sunny	0	fishy	.	.	.	601	65.6	1.91107E+14
	38.5	8/8/2011	920.8	5.67	73.7	29	8.22	27	294.7	304.2	26.7	246	brown	32.3	wispy clouds	0	.	.	.	.	436	81.8	9.82222E+12
	38.5	8/15/2011	2419.6	5.55	71.9	28.4	8.22	26.6	290.4	298.1	26.4	138	light brown	30.7	sunny	0	.	.	.	.	595	66.1	3.52224E+13
	38.5	8/22/2011	4106	4.68	59.9	27.8	7.86	25.7	286.7	288.8	25.3		brown; lots of debris incl. big burnt logs	29.7	sunny	0	.	.	.	.	1090	33.0	1.09497E+14
	38.5	8/29/2011	24196	4.92	63.5	28.6	8.1	26.1	329.7	335.2	25.8		light brown	28.1	sunny	0	.	.	.	.	475	77.5	2.81187E+14
	38.5	9/6/2011	410	5.61	70.7	27.5	8.14	25.5	322.6	324.3	25.3	532	brown	27.7	overcast	0	.	.	.	.	595	66.1	5.96841E+12
	38.5	9/12/2011	152.9	5.81	72.3	26.6	8.22	24.3	327.8	323.4	24.3	245	medium brown	25.2	mostly sunny	0	.	.	.	.	361	87.7	1.35043E+12
	38.5	9/19/2011	313	6.33	74.3	23.4	8.29	21.4	325.1	302	21.3	839	brown	23.2	sunny, clear	0	.	.	.	.	347	88.4	2.65725E+12
	38.5	9/26/2011	90.8	6.86	77.6	21.5	8.77	19.7	337.8	302	19.4	115	tan/light brown	25.1	sunny	0	.	.	.	.	173	94.8	3.84317E+11
	38.5	10/3/2011	108.1	6.77	77.6	22.2	8.56	20.1	334.6	300.5	19.6	87.9	tan	24.4	sunny	0	.	.	.	.	134	96.1	3.54396E+11
	38.5	10/12/2011	113	6.84	73.6	19	8.26	16.7	337.2	283.2	16.6	232	tan	20.6	sunny	4	.	.	.	.	297	91.2	8.21094E+11
	38.5	10/17/2011	120.1	6.89	75.6	19.9			349.4	300.2	17.6	102	tan	23.7	sunny, super windy	0	.	.	.	pH	243	93.0	7.14015E+11
	38.5	10/24/2011	61.3	7.23	76.6	18.1	8.58	15.8	340.2	279	15.6	60.7	brown	21.4	clear, sunny	0	.	.	.	.	247	92.8	3.70438E+11
	38.5	10/31/2011	410.6	7.28	74.8	16.7	8.33	14.5	321.4	255.7	14.3	146	brown		sunnny	0	.	.	.	air temp	475	77.5	4.77167E+12
	38.5	11/7/2011	62.4	8.38	81.4	14	8.3	11.9	358.1	268.5	12	137	light brown	14.6	partly cloudy, breezy	5	.	.	.	.	486	76.4	7.41957E+11
	38.5	11/14/2011	98.5	8.35	80.2	13.5	7.4	11.3	323.6	241.6	11.7	313	greyish brown	16.6	50% cumulus clouds, breezy	1	.	.	.	.	1010	36.3	2.43397E+12
	38.5	11/28/2011	52.8	9.36	84.2	10.4	8.28	8	318.8	220.6	8.9	70.6	brown	15.6	cirrus clouds		.	.	.	.	965	38.4	1.24658E+12
	38.5	12/12/2011	50.4	9.97	81.5	6.7	8.27	4.2	317.7	198.6	5.4	36.8	dark brown	6.3	raining, overcast	0	.	.	.	.	713	55.6	8.7918E+11
	38.5	12/19/2011	172.3	9.9	79.6	6.1	8.19	3.6	297.9	183.1	4.8	94.3	brown	3.4	sprinkling	0	.	.	.	.	1190	30.0	5.01638E+12
	38.5	1/10/2012	15.8	10.2	86.1	8	8.63	5.7	322.8	210.4	6.8	45.2	light tan/brown	9.9	clear and sunny	100	.	.	.	.	614	64.4	2.37347E+11
	38.5	1/18/2012	9.7	10.26	87.2	8.2	8.8	5.9	318	208.3	7	71.4	tan	11.6	light clouds/sunny	75	.	.	.	.	551	70.4	1.30762E+11
	38.5	1/23/2012	5.2	10.18	84.8	7.4	8.73	5	316.2	200.2	5.8	76.2	brown	7.3	partly cloudy	20	.	.	.	.	545	71.1	69335836877
	38.5	1/30/2012	22.8	9.81	84.5	8.8	8.75	6.3	349.9	232.3	7.4	60.6	brown tan	11.9	mostly clear, breezy	50	.	.	.	.	601	65.6	3.35249E+11
	38.5	2/8/2012	8.5	9.92	85.9	9.1	8.67	6.5	357.3	238.9	7.5	42.4	light brown	12.2	sunny, few clouds	75	.	.	.	.	588	66.6	1.2228E+11
	38.5	2/13/2012	26.6	9.89	85.3	8.8	8.58	6.4	356.4	237.5	7.5	67.2	brown	9.5	mostly cloudy	0	.	.	.	.	601	65.6	3.91124E+11
	38.5	2/20/2012	9.8	9.63	84.7	9.7	8.5	7.3	350.1	238	8.2	47.4	brown	8.4	windy, mostly clear	10	.	.	.	.	595	66.1	1.4266E+11
	38.5	2/27/2012	14.5	9.03	83.5	11.9	8.31	9.5	353.8	256.5	10.6	36.9	brown	14	mostly clear, breezy	75	.	.	.	.	539	71.8	1.91212E+11
	38.5	3/5/2012	11	8.69	84.4	14.1	8.15	11.8	356.2	275.4	13.1	62.9	brown	19.9	clear, few cirrus clouds	5	.	.	.	.	570	68.5	1.534E+11
	38.5	3/12/2012	12	8.88	84.4	12.9	8.07	10.8	335.5	251.8	12	90.3	brown	19	sunny, clear	30	.	.	.	.	521	73.3	1.5296E+11
	38.5	3/19/2012	86.2	8.78	78.3	10.3	7.19	8	325.9	226.9	9.1		murky brown	7.7	cloudy, windy	3	.	.	.	.	1120	32.1	2.36202E+12
	38.5	3/26/2012	32.7	7.81	78.6	15.7	8.15	13.3	290.3	235.6	15.1	598	murky brown	24.2	sunny, breezy, mostly clear	0	.	.	.	.	1250	28.6	1.00004E+12
	38.5	4/2/2012	38.4	8.09	75.7	12.5	7.86	10.1	263.8	196.1	11.6	288	brown	13.2	mostly cloudy, breezy	0	.	.	.	.	2210	16.7	2.07626E+12
	38.5	4/9/2012	47.3	7.88	81.1	16.6	7.79	14.6	247.6	206.5	16.3	169	brown	25.9	breezy, cumulus to E, W, N and S	3	.	.	.	.	1270	28.2	1.46968E+12
	38.5	4/16/2012	23.1	8.05	80.8	15.5	8.03	13.2	254.5	204.8	14.8	115	brown	16.9	mostly cloudy, breezy	5	.	.	.	.	1200	29.7	6.7819E+11
	38.5	4/23/2012	36.4	7.26	80.9	20.6	8.64	18.4	268	245	20.5	170	tan/brown	25	mostly clear, occasional breeze	1	.	.	.	.	762	51.9	6.78601E+11
	38.5	4/30/2012	32.7	7.61	81.5	18.7	7.36	16.4	273.6	241.5	18.9	90.3	tan- brown	26.6	clear, breezy	2	.	.	.	.	1090	33.0	8.72031E+11
	38.5	5/7/2012	111.2	7.09	79.4	21.2	8.14	19	281.4	262.6	21.5	37.7	tan	21.2	windy, partly cloudy	0	.	.	.	.	699	56.9	1.90169E+12

BEMP Raw Data

Site	River Miles	Date	E. coli (MPN/100 mL)	D. O. (mg/l)	D. O. (% sat)	D. O. Temp (°C)	pH (SU)	pH Temp (°C)	Specific Cond. (µS/cm)	Cond. (µS/cm)	Cond. temp (°C)	Turbidity (NTU)	Water Appearance	Air Temp (°C)	General Weather Conditions	Upstream Water Fowl (0 or Approx.)	Unusual Odors	Watershed/Instream Activities	Specific Sample Info	Missing Parameters	River Flow (cfs) USGS Abq Centr	Frequency	Total E. Coli (MPN/100mL)
Montano Bridge	44.5	5/2/2011	27.5	8.6	79.6	11.8	8.16	9.7	330.4	234.7	9.8	51.3	tannish brown	9.3	mostly cloudy		.	.	.	.	727	54.6	4.89131E+11
	44.5	5/9/2011	27.2	7.3	77	17.9	8.35	15.9	335.8	277	15.8	58.8	tan	23.7	windy, overcast	2	.	.	.	.	626	63.4	4.16583E+11
	44.5	5/16/2011	35.9	6.99	76.6	20	8.35	18.2	315.3	271.6	17.9	55.2	tannish brown		partly cloudy, warm		.	.	.	air temp	790	49.7	6.93872E+11
	44.5	5/23/2011	23.1	6.95	77.3	20.5	8.36	18.9	315	275.8	18.5	63.7	tan	18.7	sunny		.	.	.	.	790	49.7	4.46475E+11
	44.5	5/31/2011	52	7.39	80.2	19.4	8.24	17.8	314.5	269.5	17.6	46.8	tan	23.5	sunny, calm	2	.	.	.	.	988	37.3	1.25695E+12
	44.5	6/6/2011	75.4	5.78	68.4	23.9	8.15	21.1	306.6	281.9	20.8	81.1	tan	27.3	clear, sunny	0	.	.	.	.	1310	27.3	2.41658E+12
	44.5	6/13/2011	29.2	6.24	71.8	22.7	8.28	19.9	291.5	261.8	19.7	62.8	brown	26.2	full sun, light breeze	0	.	.	.	.	1200	29.7	8.57279E+11
	44.5	6/20/2011	44.8	6.31	71.5	21.6	8.38	19.2	280.5	248.5	19	38.1	tan	22.4	clear, slighly breezy	0	.	.	.	.	727	54.6	7.96839E+11
	44.5	6/27/2011	46.4	5.89	70.2	24.4	8.47	22.7	369	255.8	22.4	32.1	tan	34.5	partly cloudy	0	.	.	.	.	686	58.1	7.78754E+11
	44.5	7/12/2011	151.5	5.97	74.8	27	8.4	24.5	253	250.2	24.5	98.8	tannish brown	30.3	partly cloudy	0	.	.	.	.	713	55.6	2.64277E+12
	44.5	7/18/2011	20.9	6.04	77.4	28.2	8.51	26.2	280.8	285.3	25.8	32	tan	31.3	sunny, still	0	.	.	.	.	557	69.8	2.84813E+11
	44.5	7/25/2011	3784	7.67	100.6	29.8	8.09	27.5	275.3	288.3	27.4	111	dark brown	30.4	partly cloudy - cumulus congestus	0	.	.	.	.	827	46.6	7.65622E+13
	44.5	8/1/2011	19863	5.76	71.9	26.4	8.07	24.8	314.9	311.9	24.5		red	27.1	sunny	0	fishy	.	.	.	620	63.9	3.01297E+14
	44.5	8/8/2011	1299.7	5.91	75.3	27.9	8.24	25.5	305.1	307.2	25.3	330	brown	30.7	wispy clouds	1	.	.	.	.	436	81.8	1.3864E+13
	44.5	8/15/2011	1119.9	5.73	74.1	28.8	8.25	26.5	294.4	286.9	26.4	180	brown	29.3	sunny	0	.	.	.	.	601	65.6	1.64669E+13
	44.5	8/22/2011	6867	5.06	63.4	26.9	7.91	24.7	304.2	309	24.4		brown; lots of debris	27.5	sunny	0	fishy	.	.	.	1010	36.3	1.69686E+14
	44.5	8/29/2011	8664	5.18	65.5	27.5	8.05	24.8	419.3	417.2	24.7		medium brown	28.7	sunny, light breeze	0	.	.	.	.	481	76.9	1.01958E+14
	44.5	9/6/2011	630	5.82	72.2	26.5	8.14	24.3	328	320.2	23.9	994	brown	25.7	partly cloudy	0	.	.	.	.	601	65.6	9.26345E+12
	44.5	9/12/2011	246	6.15	73.5	24.4	8.21	22.2	334.5	316.2	22.1	334	brown	22.8	partly cloudy	0	.	.	.	.	356	87.9	2.14261E+12
	44.5	9/19/2011	402	6.58	74.7	21.7	8.26	19.6	341	305.3	19.5		dark brown	23.2	sunny, clear	0	.	.	.	.	347	88.4	3.41282E+12
	44.5	9/26/2011	186	7.05	78.3	20.5	8.79	19	354.8	311.3	18.6	172	light brown/tan	23.8	sunny	0	.	.	.	.	173	94.8	7.87258E+11
	44.5	10/3/2011	127.4	7.28	80.3	20.1	8.61	18.4	353.6	307.2	18.3	91.3	tan	20.4	partly cloudy	0	.	.	.	.	134	96.1	4.17669E+11
	44.5	10/12/2011	178.9	7.07	74.7	17.9	8.29	15.5	348.8	284.5	15.4	294	tan	19.4	sunny	0	.	.	.	.	297	91.2	1.29994E+12
	44.5	10/17/2011	152.9	7.1	76.4	18.9	8.4	16.9	354	297	16.6	126	tan	22.6	sunny, windy	0	.	.	.	.	243	93.0	9.09016E+11
	44.5	10/24/2011	73.8	7.43	77.1	17.3	8.61	15.1	350.3	281.4	14.7	80.9	brown	19.7	clear, sunny	0	.	.	.	.	247	92.8	4.45976E+11
	44.5	10/31/2011	307.6	7.53	75.1	15.2	8.24	13.1	326.6	250	12.7	231	brown	11.6	sunny	20	.	.	.	.	464	78.9	3.4919E+12
	44.5	11/7/2011	95.9	8.6	82.5	13.6	8.27	11.4	350	260.8	11	238	brown	12	partly cloudy, more breezy	0	.	.	.	.	486	76.4	1.14028E+12
	44.5	11/14/2011	201.4	8.37	80.3	13.5	8.17	11.3	311.7	233	11.8	435	greyish brown	18	sunny, many cumulus clouds		.	.	.	.	988	37.3	4.86827E+12
	44.5	11/28/2011	71.7	9.36	83.5	10.3	8.17	8.2	309.9	213.8	8.7	116	brown	14.2	cirrus clouds	10	.	.	.	.	965	38.4	1.6928E+12
	44.5	12/12/2011	95.9	10.17	81.9	6.2	8.19	3.8	351.3	194.5	5.1	53.7	dark brown	3.4	raining, overcast	2	.	.	.	.	713	55.6	1.67288E+12
	44.5	12/19/2011	148.3	9.78	79.8	6.6	8.17	4.1	314.8	195.5	5.1	178	brown	1.7	snowing	0	.	.	.	.	1170	30.6	4.24507E+12
	44.5	1/10/2012	36.9	10.43	86.2	7.2	8.28	4.7	330.4	209.8	5.9	81.4	tan/brown	11.9	clear and sunny	40	.	.	.	.	614	64.4	5.5431E+11
	44.5	1/18/2012	18.3	10.39	85.8	7.1	8.42	4.8	326.5	207.9	6	78.9	tan/light brown	10.8	clear/sunny	20	.	.	.	.	551	70.4	2.46695E+11
	44.5	1/23/2012	25.9	10.45	84.6	6.2	8.32	3.8	325.5	199.1	4.7	44.9	tannish-brown	8.1	partly cloudy, breezy	10	.	.	.		527	72.8	3.3394E+11
	44.5	1/30/2012	24.1	10.24	85.3	7.5	8.32	5.2	354.2	226.4	6.1	177	brown tan	9.9	mostly clear, breezy	15	.	.	.	.	607	65.0	3.57902E+11
	44.5	2/8/2012	9.6	10.02	85.5	8.5	8.44	6.1	346.7	229	7.2	43.5	light brown	11.6	sunny, few clouds	5	.	.	.	.	588	66.6	1.38104E+11
	44.5	2/13/2012	50.4	9.99	85	8.3	8.4	6	352.5	231.6	7	166	brown	11.7	mostly cloudy, breezy	0	.	.	.	.	614	64.4	7.57106E+11
	44.5	2/20/2012	17.1	9.87	84.5	8.7	8.09	6.2	340.5	226	7.4	57.5	brown	8	breezy, mostly clear	0	.	.	.	.	614	64.4	2.56875E+11
	44.5	2/27/2012	21.6	9.23	84.4	11.4	8.08	9	343	245.6	10.1	50	brown	11.9	mostly clear, breezy	7	.	.	.	.	539	71.8	2.8484E+11
	44.5	3/5/2012	15.6	9.2	85.1	12	8.21	9.5	348.3	254.8	10.9	82.7	brown	18.2	clear, few cirrus clouds	0	.	.	.	.	588	66.6	2.24419E+11
	44.5	3/12/2012	17.5	9.07	83.8	12	8.01	9.8	339.5	248.9	10.9	68.9	brown	18.1	sunny, clear	2	.	.	.	.	521	73.3	2.23066E+11
	44.5	3/19/2012	145.5	8.59	77.3	10.7	7.96	8.3	328.4	232.2	9.8		murky brown	7	windy, mostly cloudy	0	.	.	.	.	1130	31.8	4.02253E+12
	44.5	3/26/2012	44.1	7.58	78.5	15.9	7.93	13.6	291.6	238.3	15.4	830	murky brown	21.9	sunny, windy, mostly clear	2	.	.	.	.	1270	28.2	1.37025E+12
	44.5	4/2/2012	62.4	7.71	75.1	14.1	7.99	11.4	265.7	206.4	13.3	332	brown	12.6	cloudy, breezy	0	.	.	.	.	2180	16.9	3.32812E+12
	44.5	4/9/2012	17.9	7.63	79.8	17.6	4.92	15.6	246.1	210.4	17.5	183	brown	23.6	sunny, high clouds, cumulus to E	0	.	.	.	.	1260	28.3	5.518E+11
	44.5	4/16/2012	32.7	7.87	79.5	15.9	7.8	13.7	250.8	206.3	15.7	195	brown	16.9	clear, sunny, breezy	0	.	.	.	.	1180	30.3	9.44034E+11
	44.5	4/23/2012	40.4	7.21	80.7	20.9	7.93	18.9	270.6	250.3	21	273	light tan/brown	24.7	mostly clear and breezy	2	.	.	.	.	769	51.3	7.60091E+11
	44.5	4/30/2012	50.4	7.31	79.7	19.5	7.3	17.3	271.2	245.1	20	125	tan- brown	24.7	clear, no breeze	2	.	swallows nesting under bridge over river	.	.	1090	33.0	1.34405E+12
	44.5	5/7/2012	24.9	7.13	80.5	21.1	7.92	19	280.2	260.4	21.3	43.6	tan	20	windy, partly cloudy	0	.	.	.	.	693	57.5	4.22173E+11

BEMP Raw Data

Site	River Miles	Date	E. coli (MPN/100 mL)	D. O. (mg/l)	D. O. (% sat)	D. O. Temp (°C)	pH (SU)	pH Temp (°C)	Specific Cond. (µS/cm)	Cond. (µS/cm)	Cond. temp (°C)	Turbidity (NTU)	Water Appearance	Air Temp (°C)	General Weather Conditions	Upstream Water Fowl (0 or Approx.)	Unusual Odors	Watershed/Instream Activities	Specific Sample Info	Missing Parameters	River Flow (cfs) USGS Abq Centr	Frequency	Total E. Coli (MPN/100mL)
I-25 Bridge	58.5	5/2/2011	58.3	8.16	75	11.5	7.34	9.5	407.5	287.3	9.6	73.1	brown	7.8	partly cloudy	5	light treated	.	.	.	706	56.3	1.007E+12
	58.5	5/9/2011	55.6	7.22	75.7	17.6	7.84	15.7	410.4	336.3	15.5	82.3	tan	20.4	windy, overcast		.	.	.	.	626	63.4	8.51544E+11
	58.5	5/16/2011	126.7	6.91	74.8	19.3	8.08	17.3	366.6	311.6	17.2	104	tannish brown		stratus clouds, warm		.	.	.	air temp	805	48.4	2.49534E+12
	58.5	5/23/2011	119.8	6.98	75.6	19.2	7.78	17.6	387.6	331.6	17.4	73.4	tan	18.7	sunny	0	.	.	.	.	805	48.4	2.35945E+12
	58.5	5/31/2011	86.2	7.44	79.2	17.9	7.91	16	366.1	301.8	15.8	65.2	tan	19.5	sunny, calm	0	.	.	.	.	988	37.3	2.08364E+12
	58.5	6/6/2011	137.6	5.72	66	22.6	7.79	19.7	346	309.3	19.4	119	brown	25.8	sunny, calm	0	super light treated	.	.	.	1320	27.2	4.44376E+12
	58.5	6/13/2011	123.6	6.27	70.7	21.1	7.89	18.3	327.3	284.4	18.1	76.8	brown	23.6	sunny, light breeze	0	light treated	.	.	.	1200	29.7	3.62875E+12
	58.5	6/20/2011	198.9	6.31	69.4	20	8.07	17.7	347.8	298.3	17.5	64.1	brownish tan	19.2	clear, slightly breezy	0	light treated	.	.	.	727	54.6	3.53775E+12
	58.5	6/27/2011	81.6	7.01	82.9	23.5	8.21	21.9	325	304	21.7	43.2	tan	28.7	sunny	0	.	.	.	.	686	58.1	1.36953E+12
	58.5	7/12/2011	2419.6	6.02	74.2	26.1	8.07	23.9	314	306	23.8	74.1	tannish brown	27.2	sunny	0	.	.	.	.	706	56.3	4.17933E+13
	58.5	7/18/2011	123.6	5.98	75	26.9	8.12	24.6	369.8	366.5	24.5	45.7	tan	30.4	sunny, still	0	.	.	.	.	563	69.2	1.70249E+12
	58.5	7/25/2011	17329	4.36	59.8	32.1	7.96	29.9	295.7	324	30	436	really dark brown, lots of trash	33.4	cloudy	0	dirty	.	.	.	812	47.8	3.44261E+14
	58.5	8/1/2011	46110	5.52	72.1	25.9	8.09	23.8	335	326	23.7		brown	24.1	sunny	2	.	.	.	.	626	63.4	7.06199E+14
	58.5	8/8/2011	1986.3	6.7	84.4	27.2	8.14	24.8	392.4	389.8	24.6	389	brown	25.6	wispy clouds	0	.	.	.	.	436	81.8	2.1188E+13
	58.5	8/15/2011	2419.6	5.8	72.4	26.7	8.15	24.2	319.7	314.6	24.1		brown	25.8	sunny	0	.	.	.	.	607	65.0	3.59327E+13
	58.5	8/22/2011	8164	5.04	63.1	26.7	7.86	24.5	316.7	312.1	24.2		chocolate	25.3	sunny	5	.	.	.	.	925	40.4	1.84758E+14
	58.5	8/29/2011	465	5.76	72.8	27.2	8.053333	24.5	474.8	469.4	24.4	709	light brown	24.5	sunny	3	light treated	.	birds were killdeer	.	498	75.3	5.66553E+12
	58.5	9/6/2011	759	5.94	72.4	25.4	8.1	22.8	389	373	22.8		medium brown	23.1	some cirrus clouds	0	.	some debris	.	.	588	66.6	1.09189E+13
	58.5	9/12/2011	389	6.14	71.7	23.1	8.03	20.8	460.1	422.6	20.7	392	brown	20.3	partly cloudy	0	.	.	.	.	352	88.1	3.35004E+12
	58.5	9/19/2011	1785	6.47	71.7	20.6	8.17	18.3	476.3	414.8	18.2		chocolate milk	18.3	sunny, clear	0	light treated	.	.	.	347	88.4	1.51539E+13
	58.5	9/26/2011	461.1	6.67	73.9	20.4	8.11	18.5	547	478	18.4	214	light brown	19.8	sunny	0	none/very light treated	.	.	.	169	94.9	1.90651E+12
	58.5	10/3/2011	365.4	6.7	74.3	20.2	8.19	18.4	639	558	18.3	55.7	greenish tan	17.8	cloudy	0	.	.	.	.	131	96.2	1.17111E+12
	58.5	10/12/2011	547.5	6.86	71.3	17.1	8.06	14.7	454.1	363.9	14.6	611	tan	16.3	sunny	0	very light treated	0	.	.	297	91.2	3.97831E+12
	58.5	10/17/2011	344.1	6.82	74	19.3	8.15	17.2	477.5	404.4	17	174	tan	22.5	sunny	0	light treated	.	.	.	243	93.0	2.04573E+12
	58.5	10/24/2011	461.1	7.06	73.5	17.3	8.34	14.9	467.3	376.4	14.8	126	brown	16	partly cloudy	0	light treated	.	.	.	251	92.7	2.83157E+12
	58.5	10/31/2011	686.7	7.75	74.4	13.5	8.25	11.2	367	268	11.1	428	brown	11.3	sunny	3	east side light treated	.	.	.	453	79.9	7.61067E+12
	58.5	11/7/2011	488.4	8.75	82.5	12.6	8.16	10.4	394.1	286.4	10.6	372	brown	12.4	partly cloudy, breezy	0	light treated	.	.	.	492	75.9	5.87894E+12
	58.5	11/14/2011	290.9	9.01	82.4	11.4	8.06	9	343.3	241.6	9.5	439	greyish brown	12	sunny		very light treated	.	.	.	980	37.6	6.97474E+12
	58.5	11/28/2011	261.3	9.88	84.3	8.5	7.78	6.9	343.5	224.4	6.9	146	brown	10	cirrus clouds 20%		.	.	.	.	965	38.4	6.16914E+12
	58.5	12/12/2011	261.3	9.93	82.2	7	7.89	4.6	385.9	243.6	5.8	72.1	dark brown	6	overcast	0	light treated	.	.	.	713	55.6	4.55813E+12
	58.5	12/19/2011	980.4	9.61	80.3	7.6	7.78	5.1	354.6	226.4	6.1	127	brown	3.8	snowing	0	.	.	.	.	1080	33.4	2.59051E+13
	58.5	1/10/2012	178.5	10.12	82.2	6.9	7.59	4.5	394.5	250.8	5.9	89.5	brown/tannish	6.5	clear and sunny	0	.	about 1 mi up construction - wetland re-creation	.	.	614	64.4	2.68142E+12
	58.5	1/18/2012	298.7	10.2	84.9	7.4	7.93	4.9	395.6	253.2	6.2	108	tan/light brown	9.2	clear/sunny	150	.	wetland re-creation 1 mi up	.	.	545	71.1	3.98281E+12
	58.5	1/23/2012	209.8	10.14	84	7.3	7.94	4.7	394.7	252.4	6.1	68.7	green/tan	8.3	lightly cloudy	20	slight treated smell	.	.	.	521	73.3	2.67424E+12
	58.5	1/30/2012	770.1	10.21	85.3	7.5	7.86	4.9	389.4	246.2	5.9	121	brown tan	8.2	mostly clear	0	light treated	about 1 mi up construction - wetland re-creation	.	.	607	65.0	1.14365E+13
	58.5	2/8/2012	172.3	9.93	84.8	8.6	7.93	5.9	394.8	263.3	7.5	51	light brown	8.2	sunny, light clouds	0	.	about 1 mi up construction - wetland re-creation	.	.	582	67.3	2.45339E+12
	58.5	2/13/2012	224.7	9.96	85.2	8.3	7.87	5.9	372.4	245.9	7.2	37.7	brown	9.2	partly cloudy, breezy	5	slight treated smell	.	.	.	614	64.4	3.37543E+12
	58.5	2/20/2012	488.4	10.82	91.2	8	8.08	5.4	376.6	246.2	6.9	63.7	brown	5.2	windy, clear	5	0	about 1 mi up construction - wetland re-creation	.	.	601	65.6	7.18138E+12
	58.5	2/27/2012	547.5	9.52	83.8	9.7	7.98	7.3	382.5	265	8.9	91.6	brown	10.5	mostly clear, breezy	5	.	.	.	.	533	72.3	7.13952E+12
	58.5	3/5/2012	178.9	9.43	84.8	10.6	7.99	8.2	373.5	265.1	9.7	185	brown	10.8	clear, few cirrus clouds	0	slight treated smell	.	.	.	595	66.1	2.60427E+12
	58.5	3/12/2012	99	9.21	84	11.1	7.89	8.8	376.9	269.9	10.2	85.1	brown	15.4	sunny, clear	5	slight treated smell	.	.	.	521	73.3	1.26192E+12
	58.5	3/19/2012	248.1	8.88	78.5	9.9	7.84	7.5	364.2	254.5	9.2		murky brown	5.1	windy, mostly cloudy	5	.	.	.	.	1130	31.8	6.85904E+12
	58.5	3/26/2012	46.4	7.77	77	15	7.82	12.7	308.9	249	14.7	989	murky brown	20.6	sunny, breezy, mostly clear	4	.	.	.	.	1280	28.0	1.45307E+12
	58.5	4/2/2012	35.5	7.5	73.3	14.4	7.8	12	272	217.3	14.5	410	brown	10.3	breezy, partly cloudy	8	light treated	.	.	.	2210	16.7	1.91946E+12
	58.5	4/9/2012	25.9	7.57	77.7	16.6	7.76	14.5	263.5	222.8	16.7	209	brown	19.6	sunny, high clouds, slight breeze	5	slight treated smell	.	.	.	1260	28.3	7.98414E+11
	58.5	4/16/2012	125.9	8.24	79.1	13.5	7.35	11.3	280	221	14	171	brown	16.3	clear and sunny	6	slight treated smell, smoke	.	.	.	1180	30.3	3.63468E+12
	58.5	4/23/2012	110.6	7.4	80.3	19.3	7.85	17.2	319.8	289.4	20	143	light brown	22	mostly clear and breezy	0	medium treated	.	.	.	769	51.3	2.08084E+12
	58.5	4/30/2012	83.6	7.36	78.5	18.5	7.69	16.4	292	259	19	169	brown - tan	20.8	clear, no breeze	10	slight treated	.	.	.	1070	33.8	2.18851E+12
	58.5	5/7/2012	88.4	7.09	78.4	20.2	7.67	17.8	322.9	297.2	20.9	61.9	brown	20.5	windy, partly cloudy	3	.	.	.	.	693	57.5	1.4988E+12


E. coli Results in Rio Grande -
Comparison of Concentrations Upstream and Downstream of Albuquerque MS4
Results from 7/15/14
E. coli Concentration (MPN/100 ml)
3,000
2,500
2,000
1,500
1,000
500
0
2,489 MPN/100 ml
1,354 MPN/100 ml
Upstream of Albuquerque MS4
Downstream of Albuquerque MS4
Location in Rio Grande

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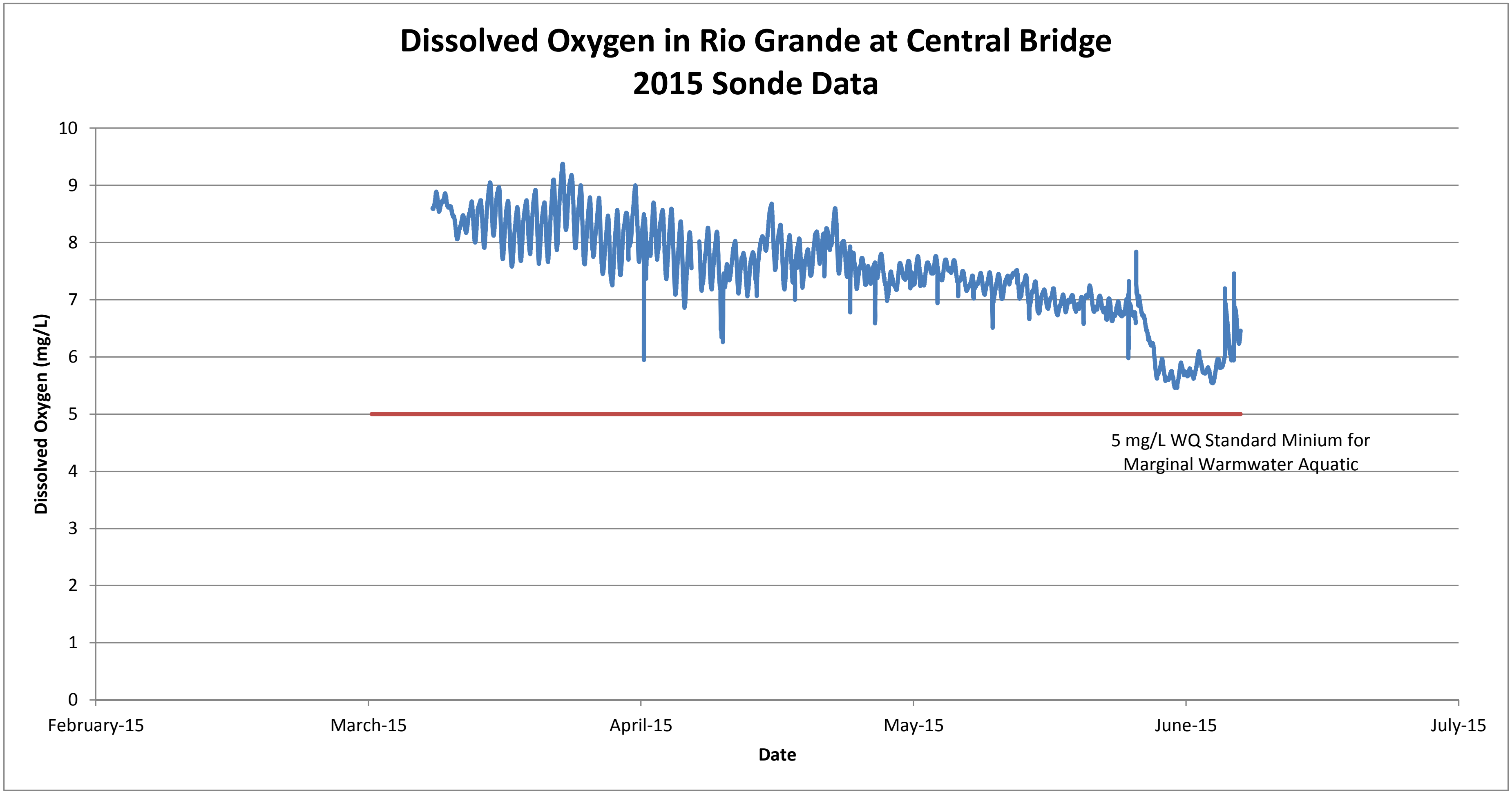
Attachment III – Compliance with Water Quality Standards Requirement – Dissolved Oxygen

- Status of Implementation and Performance Assessment Table III
- Plot of 2015 Dissolved Oxygen Sonde Data In Rio Grande at Central Bridge

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
TABLE III: Compliance with Water Quality Standards Requirement – Dissolved Oxygen						
A. Develop and implement a strategy to reduce the discharge of pollutants entering the receiving waters of the Rio Grande that cause or contribute to exceedances of applicable DO water quality standards in waters of the United States. Ensure the strategy complies with requirements in Part I.B.1.d.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	Refer to Permit Activity B.2 below for current strategy and implementation related to dissolved oxygen.	• Activity Completed in 2012. AMAFCA has implemented and developed a strategy to reduce and/or eliminate exceedances of applicable DO water quality standards in the Rio Grande. AMAFCA completed a project to re-grade the NDC Embayment at the outfall to the Rio Grande. A re-grading plan, re-vegetation plan and BA were prepared for the project and submitted to the USACE and the USFWS. A Formal Consultation between the two federal agencies and AMAFCA was conducted for the project and a 404 permit was issued by USACE. A BO was prepared by the USFWS. The BO pertained to the project's potential effects on the RGSM during construction. The project was begun on January 10, 2012 and the grading operation was completed on February 9, 2012. The re-vegetation aspect of the project was completed in April 2012. A description and details for the NDC Embayment were sent to EPA as part of the May 1, 2012 letter report "NPDES Permit No. NMS000101 – Initiation of DO Water Quality Requirements." In addition to the Embayment re-grading, AMAFCA worked with its other MS4 partners to develop strategies to reduce the discharge of pollutants that contribute to exceedances of DO water quality standards. These strategies include the installation of water quality structures within the watershed. Source reduction strategies, such as education and encouragement of LID, are also employed.	N/A	N/A	N/A
B. Continue the following activities:						
1) Identification of pollutants contributing to DO reductions in the receiving waters of the Rio Grande (and its tributaries within the COA) utilizing existing data and/or additional monitoring.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	N/A	• Activity Completed in 2012. The COA and AMAFCA have identified pollutants contributing to DO reductions in the Rio Grande. These pollutants, typically oils, grease, vegetative matter, along with strategies for pollutant control, have been discussed in several reports: AMAFCA/Albuquerque MS4 Floatable & Gross Pollutant Study (ASCG, 2005); NDC Illicit Discharge Investigation (DBS&A, 2009), and Investigation of DO in the NDC, Embayment, and Rio Grande (DBS&A, 2009). The findings in these reports have been submitted to EPA Region 6, the NMED and to the Pueblos.	N/A	N/A	N/A
2) Development and implementation of controls to eliminate the discharge of pollutants entering the receiving waters of the Rio Grande (and its tributaries within the COA) that cause or contribute to exceedances of applicable DO water quality standards in waters of the United States.	AMAFCA will continue to work with its MS4 partners to implement controls to minimize exceedances of applicable DO water quality standards in the Rio Grande. The identification and prioritization of these structural controls are included in the FY2014 Project Schedule (refer to Attachment I.B for this Project Schedule).	• AMAFCA will continue to implement controls to minimize exceedances of applicable DO water quality standards in the Rio Grande as a result of discharges from the NDC (see Table III.A above and Table VI below). • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• Met 2012 Goals. In addition to the improvements at the NDC Embayment, AMAFCA built structural BMPs (regional water quality structures) throughout the NDC watershed, specifically at: Grantline and Candelaria Inlets to the NDC; Hahn Arroyo (In-Line); and WQ Manholes for Private Development Projects along NDC. Please refer to Table I.B, A.14 for a complete list of structural BMPs built by AMAFCA in 2012 and 2013.	• Met 2013 Goals. In 2013, AMAFCA installed a pond aeration windmill at the NDC Embayment. This 33'-high windmill uses a double bellow compressor, which is rated for ponds up to 4 acres, to deliver oxygen to the water through two weighted air hoses with diffuser stones. As shown in the "Incidental Take Statement for NDC Discharges to the Rio Grande in CY 2013" in Attachment VI, the DO in the Embayment significantly improved after the windmill was installed in August. Before the windmill installation, 3 out of 9 storm events resulted in DO below 0.7 mg/L. When the DO is below 0.7 mg/L, this condition is potentially lethal to the RGSM according to the USFWS BO. After the windmill installation, NONE of the 13 storm events resulted in DO below 0.7 mg/L. This is a significant improvement as it eliminated the potentially lethal condition for the RGSM in the Embayment. Before the windmill installation, 4 out of 9 storm events resulted in DO below 4.4 mg/L. When the DO is below 4.4 mg/L, this condition is potentially harassing to the RGSM according to the BO. After the windmill installation, only 4 of the 13 storm events resulted in DO below 4.4 mg/L. This is a 31% reduction in the number of harassing storm events in the Embayment.	• Met 2014 Goals. In 2014, AMAFCA continued to operate the pond aeration windmill at the NDC Embayment in order to improve the dissolved oxygen. In addition, AMAFCA has completed the hydraulic modeling stage and begun the design and construction phase of the North Diversion Channel Outfall "Bathtub" Structure Project in May 2014. The project will modify three existing grade control features of the NDC outfall area, which include the Bathtub, Equipment Crossing, and the Embayment. The primary goal of the Bathtub modifications is to protect the New Mexico Rail Runner bridge crossing from overtopping during large storm events. The water quality improvement goal of the bathtub modifications is to improve maintenance operations by AMAFCA and improve efficiency of sediment, trash, and debris removal due to better access and improved geometry. The proposed modifications to the Embayment include raising the invert of the channel section in order to reduce the length of the backwater from the Rio Grande. Currently, the backwater from the Rio Grande is too large and it does not mix with the Rio Grande thus becoming stagnant water. The purpose of the modifications is to improve maintenance operations and correct a vertical datum conversion error that occurred during the previous Embayment modification completed in 2012.	• Met 2015 Goals. By the end of June 2015, AMAFCA completed construction of the first phase of the NDC Outfall Grade Control Structures Modification Project. This project modified the Bathtub and Equipment Crossing for the NDC outfall area. The Embayment area will be filled in regraded in a future project. The primary goal of the Bathtub modifications is to protect the New Mexico Rail Runner bridge crossing from overtopping during large storm events. The bathtub modification results in a storage volume of 72 ac-ft. The water quality improvement goal of the bathtub modifications is to improve maintenance operations by AMAFCA and improve efficiency of sediment, trash, and debris removal due to better access and improved geometry. In addition, with this improvement, water from the Rio Grande is not allowed to stagnate in the Embayment, therefore minimining low DO conditions at this location. In the first half of 2015, AMAFCA consulted with the Corps of Engineers and the USFWS. The USFWS is writing a new BO, including special conditions, for the NDC outfall/Embayment area.

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
TABLE III: Compliance with Water Quality Standards Requirement – Dissolved Oxygen						
C. Provide status reports to EPA. 1) Initial report to include; I. Findings regarding MS4 conveyed discharge contribution to exceedances of applicable DO water quality standards in waters of the United States. ii. Conclusions drawn, including support for any determination. iii. Activities undertaken to eliminate MS4 conveyed discharge contribution to exceedances of applicable DO water quality standards in waters of the United States. iv. Plan for stakeholder involvement.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	N/A	• Activity Completed in 2012. AMAFCA provided EPA with an initial report on May 1, 2012 which included: the findings, conclusions and recommendations of the DO report commissioned by AMAFCA and prepared by Danial B. Stephens and Associates, as well as the activities, either planned for, or being conducted, to mitigate the release of low DO discharges to the Rio Grande from the NDC.	N/A	N/A	N/A
2) Subsequent progress reports to include: I. Adherence to schedule. ii. Activities undertaken to identify MS4 discharge contribution to exceedances of applicable DO water quality standards in waters of the United States. iii. Conclusions drawn, including support for any determinations. iv. Activities undertaken to eliminate MS4 discharge contribution to exceedances of applicable DO water quality standards in waters of the United States. v. Accounting of stakeholder involvement.	AMAFCA will provide EPA with the 2nd year and subsequent annual reports which will include the results of DO monitoring from the deployed sondes which will indicate the effectiveness of the control measures. Stakeholder participation will be accounted for.	• AMAFCA will include subsequent progress reports in the 2nd year and subsequent annual reports. • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• No Goals Required for 2012. This activity applies to the second year and later annual report. Initial progress report requirement is detailed in Activity C.1 above.	• Met 2013 Goals. This annual report summarizes the progress regarding compliance with the DO Water Quality Standards. - AMAFCA has adhered to all schedule milestones identified in the Permit and the SWMP. - This annual report includes the DO continuous monitoring data, the DO Silvery Minnow Incidental Take Statement, and a description of all projects implemented with the objective of reducing the pollutant load and increasing the DO in the Embayment. - At the Rio Grande Central Bridge, the DO was continuously above 0.7 mg/L throughout 2013. - As stated above in Activity B.2, the installation of the windmill appears to have (1) eliminated the occurrence resulting from storm events of lethal condition for marginal warm water aquatic life and (2) reduced by 31% the occurrence resulting from storm events of harassing condition for marginal warm water aquatic life. - Stakeholders will receive this annual report as required by the MS4 Permit. - On 7/19/13 AMAFCA met with staff from the Corps and Sandia Pueblo at the Embayment in order to discuss the progress of the Embayment widening project. At this meeting, AMAFCA hand-delivered the 2013 Monitoring Report in compliance with the 404 Permit (see Attachment III for the report).	• Met 2014 Goals. This annual report summarizes the progress regarding compliance with the DO Water Quality Standards. - AMAFCA has adhered to all schedule milestones identified in the Permit and the SWMP. - This annual report includes the DO continuous monitoring data (see Attachment XI), the DO Silvery Minnow Incidental Take Statement (see Attachment VI), and a description of all projects implemented with the objective of reducing the pollutant load and increasing the DO in the Embayment. - At the Rio Grande Central Bridge, the DO was continuously above 0.7 mg/L throughout 2014. - Stakeholders will receive this annual report as required by the MS4 Permit. - AMAFCA delivered the 2014 Monitoring Report in compliance with the 404 Permit (see Attachment III for the report).	• Met 2015 Goals. This annual report summarizes the progress regarding compliance with the DO Water Quality Standards from January through June 2015. - AMAFCA has adhered to all schedule milestones identified in the Permit and the SWMP. - This annual report includes the DO Silvery Minnow Incidental Take Statement (see Attachment VI) and a description of all projects implemented with the objective of reducing the pollutant load and increasing the DO in the Embayment. - At the Rio Grande Central Bridge, the DO was above 5 mg/L during sonde monitoring from January through June 2015 (Sonde was not operational from January through March 2015 due to freezing water conditions). The average DO in the Rio Grande at the Central Bridge from 3/27/15 to 6/30/15 was 7.5 mg/L. See plot of DO in Rio Grande at Central in Attachment III. - Stakeholders will receive this Annual Report as required by the MS4 Permit. - AMAFCA does not need to complete a Monitoring Report in compliance with the previous 404 Permit because the USFWS is in the process of writing a new draft Biological Opinion (BO), including special conditions, for the NDC outfall/Embayment area.
D. Provide support for toxicity study as determined by co-permittees.	Activity no Longer Required by Permit. EPA Region 6 staff members have verbally indicated that toxicity monitoring is no longer a requirement of this permit. Therefore AMAFCA and the MS4 co-permittees are not required to comply with this activity or the requirements outlined in A through H of Table VIII and have deleted toxicity monitoring from the 2012-2013 USGS Cooperative Sampling Program.	N/A	• Activity no Longer Required by Permit. EPA Region 6 staff members have verbally indicated that toxicity monitoring is no longer a requirement of this permit. Therefore AMAFCA and the MS4 co-permittees are not required to comply with this activity or the requirements outlined in A through H of Table VIII and have deleted toxicity monitoring from the 2012-2013 USGS Cooperative Sampling Program.	N/A	N/A	N/A



Dissolved Oxygen in Rio Grande at Central Bridge
2015 Sonde Data
Dissolved Oxygen (mg/L)
0
1
2
3
4
5
6
7
8
9
10
February-15
March-15
April-15
May-15
June-15
July-15
Date
5 mg/L WQ Standard Minium for
Marginal Warmwater Aquatic

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Attachment IV – Compliance with Water Quality Standards – Investigation and Reduction of PCBs in the North Diversion Channel

- Status of Implementation and Performance Assessment Table IV
- Memorandum - PCB Sampling and Analysis - Data Review and Source Identification (June 29, 2015) – This Memorandum serves as the 2015 Progress Report
- AMAFCA PCB Sampling Analysis Plan (SAP) for the North Diversion Channel
- AMAFCA PCB Field Sampling Plan (FSP) for the North Diversion Channel
- AMAFCA PCB Quality Assurance Project Plan (QAPP) for the North Diversion Channel

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
TABLE IV: Compliance with Water Quality Standards – Investigation and Reduction of PCBs in the SJD and NDC						
A. Address concerns regarding PCBs in NDC conveyed discharges by developing a strategy to identify and eliminate controllable sources of PCBs that cause or contribute to exceedances of applicable water quality standards in waters of the United States. Ensure the strategy complies with requirements in Part I.B.1.e. 1) For the initial progress report, permittees shall: i. Conduct an evaluation regarding controllable sources of PCBs in the NDC.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	N/A	• Activity Completed in 2012. In 2012, AMAFCA and COA developed a strategy for testing key locations within the NDC and SJD watersheds in order to investigate the presence of PCBs. This strategy and initial findings were reported to EPA on June 1, 2012 and copied to NMED Surface Water Quality Bureau, Pueblos of Sandia and Isleta and USFWS. The initial testing determined the existence of PCBs within the NDC watershed through a single set of PCB water samples collected from a storm event on July 20, 2011 by USGS. Additionally, a field evaluation was conducted and no specific illicit discharges or sources were found.	N/A	N/A	N/A
ii. Design and implement a monitoring study and perform analytical monitoring to evaluate presence and magnitude of PCB levels in stormwater discharges to and within the NDC.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	N/A	• Activity Completed in 2012. AMAFCA and COA designed and implemented a PCB monitoring plan as part of the USGS Cooperative Monitoring Program. The original plan covered the NDC, SDC, Tijeras Arroyo, and San Antonio Arroyo. The plan was modified through collaboration with NMED to focus initially on soils within the NDC. Soil samples were collected from 12 tributaries at their confluences with the NDC in June 2012. The samples were tested using EPA Method 8082 (Aroclor Method). Clearance to use this method was obtained in a meeting between AMAFCA, COA and NMED on March 14, 2012. On March 16, 2012 a letter to the EPA asked for clarification regarding testing methods. A response letter was received from the EPA on June 4, 2012 agreeing to the use of the EPA Method 8082 (Aroclor Method) or USGS method (8093) for sediment screening. This monitoring plan and findings were reported to EPA on September 1, 2012 and copied to NMED Surface Water Quality Bureau, Pueblos of Sandia and Isleta and USFWS. PCBs were detected in the samples collected at the N. Camino and Grantline Inlets to the NDC and below the railroad tracks in the SJD.	N/A	N/A	N/A
iii. Report on results of the monitoring study to EPA, NMED, and the Pueblos of Isleta and Sandia.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	N/A	• Activity Completed in 2012. This Activity was completed ahead of schedule (see Activities A.1.i and A.1.ii above). AMAFCA and COA reported to EPA, NMED, the Pueblo of Sandia, and the Pueblo of Isleta, the results of the PCB study in letter reports, dated June 1 and Sept. 1, 2012. The September 2012 letter included the PCB testing lab results for testing performed under this MS4 Permit.	N/A	N/A	N/A
iv. Should results of the monitoring study confirm levels of PCBs in NDC discharges contain levels of PCBs that would cause or contribute to exceedances of applicable water quality standards in waters of the United States, commence activities to identify and eliminate controllable sources of PCBs that cause or contribute to exceedances of applicable water quality standards in waters of the United States.	The results from the 2012 monitoring of the NDC watershed indicated the presence of PCBs at the Grantline and N. Camino Inlets. Based on the data, MS4 partners conclude that there are no "hot spots" in the municipal area that are continuing to produce PCBs with the possible exception of the Grantline and N. Camino watersheds. Therefore, additional activities, such as monitoring and watershed assessments, are necessary to identify and eliminate controllable sources of PCBs that would cause an exceedance of the water quality standards.	• In 2013, AMAFCA will take additional samples for PCB analysis with the watersheds of the Grantline and N. Camino Channels, upstream of the NDC Inlet (i.e., where the 2012 sample detected PCBs). • In 2014 and 2015, AMAFCA will continue to focus on the Grantline and N. Camino basins, within the NDC watershed, to identify and eliminate controllable sources of PCBs in these two basins. Results from this continued study will be provided in subsequent Annual Reports. • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• No Goals Required for 2012.	• Met 2013 Goals. In 2013, AMAFCA commenced additional testing to identify sources of PCBs in the Grantline and N. Camino watersheds (see Attachment IV). In the Grantline watershed, 3 soil samples were collected in April 2013 along the channel at approx. 0.5, 1.2 and 1.6 mi. upstream of the NDC Inlet. Using EPA Method 8082, each sample was reported as Not Detected. In Aug. 2013 an additional soil sample was taken at the water quality structure located at the NDC Inlet. AMAFCA attempted getting a soil sample within 0.5 mi. of the Inlet; however, the channel was completely clean of sediment in this concrete-lined reach. Using EPA Method 8082, the sample reported Aroclor 1260 at 220 ppb. In 2014, AMAFCA will conduct an in-depth PCB study of the Grantline watershed. In the N. Camino watershed, 4 soil samples were collected in Aug. 2013 at the following locations: NDC Inlet; NDC; and along the arroyo at the San Mateo and I-25 crossings. The only sample that detected PCBs was to the north of the concrete inlet along the diversion ditch that drains into the inlet (Aroclor 1260 at 12 ppb). The NDC sample was taken where the soil was discolored, as if it was possibly an illicit discharge. Due to the heavy rains in Aug. and Sept., the topography of the north diversion changed entirely with approx. 2-3 feet of sediment deposition and the discolored soils were no longer present in the area in Sept. 2013. In 2014, AMAFCA will regrade the north diversion ditch to match the original grades and conduct an in-depth PCB study of the N. Camino watershed.	• Met 2014 Goals. In 2014, AMAFCA continued activities to identify and eliminate controllable sources of PCBs that cause or contribute to exceedances of applicable water quality standards in waters of the US in accordance with the MS4 Permit No. NMS000101 (Table IV.A.2 in the Permit). In particular, a water quality consultant was tasked with reviewing and assessing all past PCB data for the NDC; identifying commercial and industrial properties that may have contributed PCBs to the North Camino and the Grantline Channel; researching past PCB releases from PNM in these areas; and providing additional PCB monitoring activity recommendations. In addition, a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP) for soil and sediment sampling were developed. The project scope of work is included in Attachment IV. Sediment sampling and analysis for PCBs in the North Camino and the Grantline Channel area will occur in 2015 based on the results of the 2014 study and using the developed FSP and QAPP. Specifically for the N. Camino Arroyo, AMAFCA has programmed in FY 2016 through FY 2019 a Drainage and Water Quality Management Plan, as well as improvements at the NDC Inlet and completing the channel between the Inlet and San Mateo. A water quality structure will be included in these improvements.	• Met 2015 Goals. In 2015, AMAFCA continued activities to identify and eliminate controllable sources of PCBs that cause or contribute to exceedances of applicable water quality standards in waters of the US in accordance with the MS4 Permit No. NMS000101 (Table IV.A.2 in the Permit). A water quality consultant completed reviewing and assessing all past PCB data for the NDC; identifying commercial and industrial properties that may have contributed PCBs to the North Camino and the Grantline Channel; researching past PCB releases in these areas; and providing additional PCB monitoring activity recommendations. In addition, a Sampling and Analysis Plan (SAP), a Field Sampling Plan (FSP), and a Quality Assurance Project Plan (QAPP) for soil and sediment sampling were developed - these are included in Attachment IV. A Memorandum - PCB Sampling and Analysis - Data Review and Source Identification (June 29, 2015) is also included in Attachment IV. Sediment sampling and analysis for PCBs in the North Camino and the Grantline Channel area will occur later in 2015 into 2016 based on the results of the 2015 study and using the developed FSP and QAPP.

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
TABLE IV: Compliance with Water Quality Standards – Investigation and Reduction of PCBs in the SJD and NDC						
2) Initial progress report shall include: i. Findings regarding controllable sources of PCBs in the NDC drainage area that cause or contribute to exceedances of applicable water quality standards in waters of the United States via the discharge of municipal stormwater. ii. Conclusions drawn, including support for any determinations. iii. Activities undertaken to eliminate controllable sources of PCBs in the NDC drainage areas that cause or contribute to exceedances of applicable water quality standards in waters of the United States via the discharge of municipal stormwater including activities that extend beyond the 5 year permit term. iv. Account of stakeholder involvement in the process.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete. AMAFCA included a progress report in the 2012 Annual Report in compliance with the MS4 Permit requirements.	N/A	• Activity Completed Ahead of Schedule in 2012. As stated in Activity A.1 above, AMAFCA and COA submitted initial progress reports on the PCB monitoring study to EPA, NMED, USFWS and Pueblos of Sandia and Isleta in June and September of 2012. These reports included the extents of the monitoring in the NDC, PCB lab results, and recommendations for follow-up monitoring to further identify the source of PCBs. This information was also included in the 2012 Annual Report, which was amended to clearly identify the N. Camino lab result as detecting PCBs.	N/A	N/A	N/A
B. Address concerns regarding SJD conveyed discharges by performing activities to identify and eliminate controllable sources of PCBs that cause or contribute to exceedances of applicable water quality standards in waters of the United States. 1) Initial progress report shall include: i. Findings regarding controllable sources of PCBs in the SJD drainage area that cause or contribute to exceedances of applicable water quality standards in waters of the United States via the discharge of municipal stormwater. ii. Conclusions drawn, including support for any determinations. iii. Activities undertaken to eliminate controllable sources of PCBs in the SJD drainage areas that cause or contribute to exceedances of applicable water quality standards in waters of the United States via the discharge of municipal stormwater including activities that extend beyond the 5 year permit term. iv. Account of stakeholder involvement in the process.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete. MS4 co-permittee COA took the lead on the PCB evaluation in the SJD.	N/A	• Activity Completed in 2012. AMAFCA and the MS4 co-permittees have determined the existence of PCBs within the SJD watershed through a single set of PCB water samples collected from a storm event on July 20, 2011 by USGS. An evaluation was conducted and no specific illicit discharges or sources were found. This is described in an initial report that was submitted to EPA on June 1, 2012. AMAFCA and the MS4 co-permittees reported to EPA, NMED, USFWS and Pueblos of Sandia and Isleta, the results of the PCB study in a second letter report dated Sept. 1, 2012. This information was also included in the 2012 Annual Report.	N/A	N/A	N/A
C. Subsequent progress reports to include: i. Activities undertaken to identify controllable sources of PCBs in SJD and NDC drainage discharges that cause or contribute to exceedances of applicable water quality standards in waters of the United States via discharge of municipal stormwater. ii. Conclusions drawn, including support for any determinations. iii. Activities undertaken to eliminate controllable sources of PCBs in the SJD and NDC drainage areas that cause or contribute to exceedances of applicable water quality standards in waters of the United States. iv. Accounting of stakeholder involvement.	Based on ownership responsibilities, COA will continue to take the lead regarding follow-up PCB permit activities on the SJD and AMAFCA will continue to take the lead on follow-up PCB permit activities on the NDC. Please refer to the COA Annual Reports regarding PCBs in the SJD. AMAFCA will continue to include in its Annual Reports a progress report of PCB permit activities on the NDC.	With the second and subsequent Annual Reports, AMAFCA will include a progress report on the activities for that year pertaining to PCBs in the NDC watershed.	• No Goals Required for 2012. This activity applies to the second year and later annual report. Initial progress report requirement is detailed in Activity A.2 above.	• Met 2013 Goals. The progress report regarding activities in 2013 pertaining to PCBs in the NDC watershed is included in Attachment IV of this Annual Report.	• Met 2014 Goals. The progress report regarding activities in 2014 pertaining to PCBs in the NDC watershed is included in Attachment IV of this Annual Report.	• Met 2015 Goals. The *Memorandum - PCB Sampling and Analysis - Data Review and Source Identification* , CDM Smith, June 29, 2015, included in Attachment IV and the information in this Annual Report will serve as the Progress Report for January to June 2015.

Memorandum

To: *Patrick Chavez, P.E.*

From: *Kelly Collins, PG, BCES*

Date: *June 29, 2015*

Subject: *PCB Sampling and Analysis - Data Review and Source Identification*

The purpose of this memorandum is to provide the results of a preliminary survey of polychlorinated biphenyl (PCB) contamination sources. This document is intended to aid in establishing an effective PCB sampling plan that the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) can implement to satisfy the requirements of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) permit No. NMS000101. The survey described in this memorandum provides background information on the uses and characteristics of PCBs, summarizes soil sampling data, and identifies potential areas of concern.

Fish tissue monitoring in the Middle Rio Grande has revealed bioaccumulation of polychlorinated biphenyls (PCBs) and other contaminants. The levels found have made it necessary for New Mexico to issue fish consumption advisories. As a result of these findings, the State of New Mexico has issued a water quality advisory for the Middle Rio Grande with respect to PCBs (NMED, 2012). New Mexico has been experiencing extended droughts and continued population growth, two characteristics of a region that will heavily rely on surface water to fulfill the demand of the municipal water supply. PCBs rank eighth in the top ten causes for water quality impairments for lakes and reservoirs in New Mexico (NMED, 2012).

The source of the PCBs in fish tissue impairment is attributed to, in part, as "Municipal (High Density)" and "Impervious Surface/Parking Lot Runoff" in the 2014-2016 State of New Mexico CWA §303(d)/§305(b) Integrated List & Report". The New Mexico Environment Department (NMED) strongly suggests that the PCBs detected in the Rio Grande originated from the Albuquerque area and the urbanized watersheds are now under increased scrutiny (Glass, 2011). As a result, AMAFCA has included a proactive approach toward identifying any potential sources of PCBs in soils and stormwater that discharge to the Rio Grande in their NPDES permit.

BACKGROUND

Production of PCBs, a class of industrial chemicals that were once used as electrical insulators, lubricants, and coolants, began in 1929. In 1979 PCBs were banned from use in the United States (Safewater). PCBs occur in the water environment primarily attached to organic sediments. Surface waters become impaired by PCBs primarily when large storms disturb settled organic sediments and fish become exposed to the PCBs. PCBs accumulate in fish and marine mammals, reaching levels that may be thousands of times higher than in the water (ATSDR, 2001). Long term consumption of fish with PCBs may cause a variety of health problems including those related to nerve development, reproduction, hormones, and cancer. The most common health effects caused by PCBs after short-term consumption of contaminated fish are acne-like eruptions and pigmentation of the skin (Safewater). The toxicity (e.g. skin lesions) and probable carcinogenicity of PCBs has been known since 1937, and was the subject of a Harvard School of Public Health conference that year. (Glass, 2011)

PCBs comprise 209 possible congeners, based on the number and location of chlorine atoms attached to carbon atoms in two adjoined benzene rings. Aroclors are brand-name mixtures of PCB congeners produced by Mansanto Corporation between 1930 and 1977 (Glass, 2011). The Aroclor numbering convention (e.g. 1254, 1260) indicates the number of carbon atoms in the chemical structure (always 12), followed by the percentage of weight attributable to chlorine (e.g. 54%, 60%) (Safewater). Aroclors 1254 & 1260 were used pre-1950 and Aroclor 1242 was used between 1950 and 1971 (Glass, 2011), PCBs can be identified as thin, oily, light colored liquids to yellow or black solids. There is no known smell or taste. PCBs are not water soluble and readily absorb to porous sediments. PCBs do not break down easily in the environment, allowing for uncontained spills and leaks to essentially become immortalized. For this reason, PCBs are often considered a "legacy" pollutant, meaning there are no current uses, but past uses have left a large footprint in the environment (EOA, 2004).

Industries used PCBs for a variety of different applications including; closed system and heat transfer fluids, plasticizers, hydraulic fluids and lubricants, among many other uses. The chemical properties of PCBs provided inflammability, insulation, and durability when added to products or used as process fluids. After the ban, the manufacture and use of PCBs was stopped. However, 36 years later, PCBs are still being detected in air, soil, water, and tissue samples. It is suspected that the major sources of PCB contamination are:

- Volatilization cycling process;
- Landfills containing PCB waste materials and products;
- Spills or leaks that occurred at industrial locations or PCB recycling centers; and
- Improper or illegal disposal of PCB materials (ATSDR, 2001).

Each type of PCB was used for a variety of different applications. Sources can be more efficiently identified by being able to specify the type of PCB and its unique applications. **Table 1** below shows the outlines the typical uses of each PCB analyzed in EPA test method 8082 (ODEQ, 2003).

Table 1 Typical Uses by PCB

PCB	Use
Aroclor 1221	Capacitors
	Gas Transmission Turbines
	Rubber
	Polyvinyl Acetate - Improved Quick-Track and Fiber-Tear Properties
	Polystyrene - Plasticizer
	Epoxy Resins - Increased Resistance to Oxidation and Chemical Attach; Better Adhesive Properties
Aroclor 1232	Hydraulic Fluid
	Rubber
	Adhesives
	Polyvinyl Acetate - Improved Quick-Track and Fiber-Tear Properties
Aroclor 1016	Capacitors
Aroclor 1242	Transformers
	Heat Transfer
	Hydraulic Fluid
	Gas Transmission Turbines
	Rubber
	Carbonless Copy Paper
	Wax Extenders
	Polyvinyl Acetate - Improved Quick-Track and Fiber-Tear Properties
Aroclor 1248	Hydraulic Fluids
	Vacuum Pumps
	Rubber
	Polyvinyl Chloride - Secondary Plasticizers to Increase Flame Retardence and Chemical Resistance
	Epoxy Resins - Increased Resistance to Oxidation and Chemical Attach; Better Adhesive Properties
Aroclor 1254	Transformers
	Capacitors
	Hydraulic Fluids
	Vacuum Pumps
	Synthetic Resins
	Wax Extenders
	Dedusting Agents
	Inks
	Cutting Oils
	Pesticide Extenders
	Sealants and Caulking Compounds
	Polyvinyl Chloride - Secondary Plasticizers to Increase Flame Retardence and Chemical Resistance
	Styrene-Butadiene Co-Polymers - Better Chemical Resistance
	Ethylene Vinyl Acetate - Pressure Sensitive Adhesives
	Chlorinated Rubber - Enhanced Resistance, Flame Retardence, Electrical Insulation Properties
Aroclor 1260	Transformers
	Hydraulic Fluid
	Dedusting Agents
	Polyvinyl Chloride - Secondary Plasticizers to Increase Flame Retardence and Chemical Resistance
	Polyester Resins - Stronger Fiberglass; Reinforced Resins and Economical Fire Retardants
	Varnish - Improved Water and Alkali Resistance

SUMMARY OF PAST INVESTIGATIONS

Since 2003, stormwater in the stormwater conveyances entering the Rio Grande in Albuquerque has been analyzed for PCBs by local stormwater management agencies (AMAFCA, City of Albuquerque, NMDOT, and UNM). However, there have been no detections in water samples. Soil samples taken by agencies including, AMAFCA, United States Geological Survey (USGS), and Bernalillo County, have determined that there is PCB soil contamination along drainage ways that ultimately drain into the Rio Grande. Beginning in 2011, AMAFCA and the City of Albuquerque have joined together to perform screenings for PCBs. Most recently, 21 samples were taken along the Albuquerque storm drainage channels. PCBs were detected at the San Jose, Grantline, and North Camino Arroyo channels using EPA Test Method 8082 (AMAFCA, 2014). The attachment summarizes the results from this sampling event. The Grantline and North Camino Arroyo Channels have been designated as areas of concern for AMAFCA based on this analysis. AMAFCA has performed additional sampling events for three points east of each channel to evaluate potential source points. PCBs were only detected at two of the sampling locations during the additional sampling events: the North Inflow Channel (12 μg/kg) above the North Camino Arroyo and the Grantline Channel Mouth (220 μg/kg). The additional sample at the North Inflow Channel was taken where discolored soils outlined the appearance of an illicit discharge into the diversion ditch. None of the other soil samples were from discolored soils.

Upstream of Albuquerque, Los Alamos National Laboratories (LANL, 2012) and the NMED have performed a comprehensive assessment of the surface water quality of the Pajarito Plateau from 2004 to 2008. The majority of the soil samples were analyzed using EPA test method 1668A; a method that can be used to measure the concentration of individual PCB congeners with very low detection limits. In this assessment, water samples were collected during storm events, when the distribution of sediments in the river is greatest. It was found that stormwater throughout most of the study area, where sufficient data was available, exceeds the human health criterion of 0.00064 μg/L and wildlife habitat criterion of 0.014 μg/L. These results were primarily seen in Pajarito, Los Alamos, Pueblo, Sandia and their associated side canyons (NMED, 2012).

During both the AMAFCA and LANL sampling events, the prominent congener detected was Arclor-1260. Aroclor 1260 was most commonly used in transformers and hydraulic fluid. Other applications for Aroclor 1260 include used in transformers, dedusting agents, plasticizers, resins, and varnish to increase inflammability, chemical resistance, strength, and water resistance. Each type of PCB was used for a variety of different applications.

AREA ANALYSIS

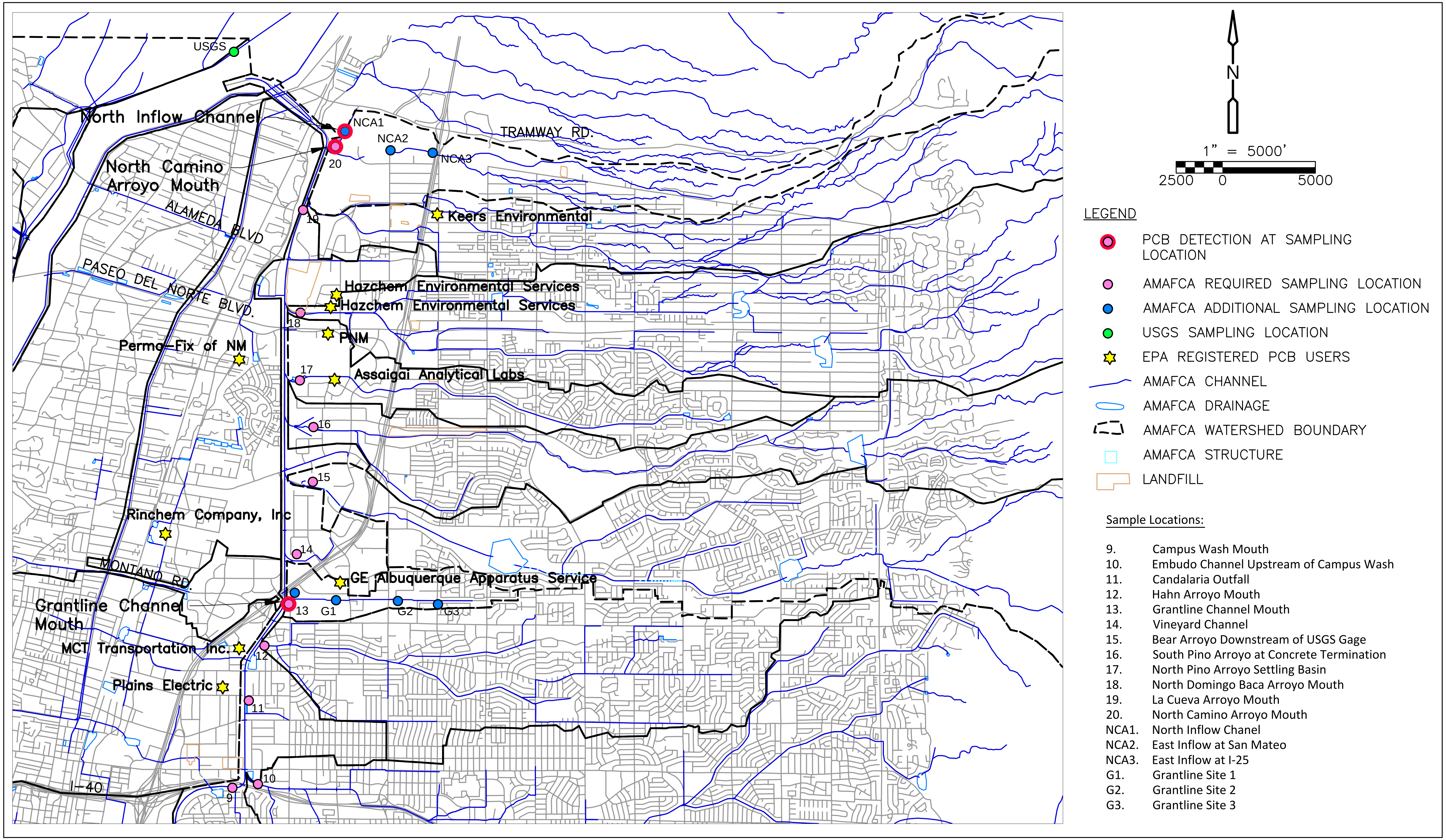
An area analysis was done on previous AMAFCA sampling points to identify hot spots and potential sources. **Figure 1** shows twelve of AMAFCA's NPDES permit required sampling locations, six supplemental sampling locations and associated PCB detection points, and, USGS soil sampling location at the Alameda Bridge gage. PCBs were detected at two of the sampling locations; North

Inflow Channel (NCA1), and the Grantline Channel (13). These locations will serve as areas of concern and will be the focus of further investigation.

The City of Albuquerque Storm Drainage Design Department's information for underground storm drain pipelines has been included in **Figure No. 1** to identify any diversions of stormwater that may not be apparent by the AMAFCA drainage plan.

The Environmental Protection Agency (EPA) PCB Activity Report for Region 6 (Arkansas, Louisiana, New Mexico, Oklahoma and Texas) was used to locate industries with registered PCB usage (Figure No. 1). **Table 2** provides a list of all the PCB registered users, identifiers, and PCB use activities at the site (EPA Region 06). A request for information was filed with the NMED on July 1, 2014. The New Mexico Department of Energy Oversight Bureau provided data on LANL and Bernalillo County PCB studies; both studies focused on areas not within the scope of this study. The NMED Hazardous Waste Bureau provided information on the former GE Plant and Sandia National Laboratories PCB documentation; again, areas not within the scope of this study. The request for information and correspondence is provided as an attachment.

Finally, active and inactive landfills and dump sites were located using City of Albuquerque data. This information could be useful in identifying potential sources of pollutants. It should be noted that the locations of the landfills in the figures were updated on June 26, 2014 to reflect the clean-closure of many of the inactive landfills in northeast Albuquerque. Clean-closures involve the removal of fill and any impacted soil. These closures took place within the last five years and could have remedied possible pollutant sources.



CDM Smith

Figure No. 1
Sampling Locations & PCBs Users
JUNE 2015

Table 2 EPA Registered PCB Users

EPA ID	Name	Street	City	St	Zip Code	Activity	Date Signed
NM0000182121	Perma-Fix of New Mexico, Inc.	7928 Ranchitos Loop NE	Albuquerque	NM	87113	Transporter	8/17/1995
NM0000590240	Envirosolve Southwest, Inc.	5338 Williams Street SE	Albuquerque	NM	87105	Generator, Transporter	4/3/1995
NM3890116129	Inhalation Toxicology Research Institute	Area Y Building 9200 Kirtland AFB E	Albuquerque	NM	87185	Generator	4/19/1990
NM5890110518	Sandia National Laboratories	Building 920N 1515 Eubank SE	Albuquerque	NM	87123	Generator	4/9/1990
NMD000000023	Public Service Company of New Mexico	4400 Paseo Del Norte NE	Albuquerque	NM	87109	Generator	1/22/1996
NMD002208627	Rinchem Company Inc	6133 Edith NE	Albuquerque	NM	87107	Storer, Transporter	1/29/1990
NMD047140256	GE Albuquerque Apparatus Service	4420 McLeod Rd NE	Albuquerque	NM	87109	Transporter	4/2/1990
NMD069417129	MCT Transportation Inc	7451 Pan American Freeway NE	Albuquerque	NM	87109	Transporter	8/13/1990
NMD147273528	Keers Environmental	5904 Florence Avenue	Albuquerque	NM	87113	Transporter	1/10/1995
NMD980621197	University of New Mexico	1801 Tucker St NE Building 233	Albuquerque	NM	87131	Generator	11/29/1993
NMD986669000	Hazchem Environmental Service Inc	8300 Corona Loop NE Suite A	Albuquerque	NM	87113	Transporter	4/5/1990
NMD986669596	Plains Electric Generation and Transportation Coop Headquarters	2401 Aztec Rd NE	Albuquerque	NM	87107	Generator	12/22/1998
NMD986669745	Hazchem Environmental Service Inc	4500 Anaheim NE Building B Suite 4	Albuquerque	NM	87113	Transporter	6/1/1990
NMR000008888	Assaigai Analytical Labs	4301 Masthead NE	Albuquerque	NM	87109	Research	6/16/2003
2398	Public Service Company of New Mexico	414 Silver SW	Albuquerque	NM	87102	Generator	11/17/1998

North Camino Arroyo Analysis

PCB detection areas were further evaluated to gather site specific information on land use, drainage patterns, and potential sources. Zoning information gathered from the City of Albuquerque was used to determine the land uses. The watershed that drains to the North Camino Arroyo Mouth and North Inflow Channel contains mixed land uses, including, industrial manufacturing, parks and public institutions, commercial, and residential areas. The AMAFCA drainage layout for the area surrounding these two sampling points suggests that if a spill or release were to occur at the facility of nearest EPA PCB registered user, Keers Environmental, would drain to the La Cueva channel. Historical laboratory results demonstrate no detections at the La Cueva Arroyo Mouth sampling point. This same justification rules out the Los Angeles and Coronado Landfills as potential sources.

A point of concern along eastern part of the North Camino Arroyo is the Russ Pitney Landfill. This private landfill was used from 1972 to 1984 for construction materials. Operation of this construction and debris landfill occurred before and after the ban of PCBs in 1979. This site is surrounded by natural drainage channels that ultimately drain into the North Camino Arroyo.

Underground stormwater drainage plans show drainage diversions that could provide insight on other landfill locations as potential PCB sources. Stormwater pipelines draining from the closed Nazareth landfill bypasses sampling points NCA2 and NCA3 and drains towards the North Camino Arroyo Mouth. This landfill was in operation before the PCB ban, from 1971 to 1972. **Table 3** provides a list of the landfills, owners, waste types, and fill dates that are located near the North Camino Arroyo.

Table 3 Landfills Located Near North Camino Arroyo

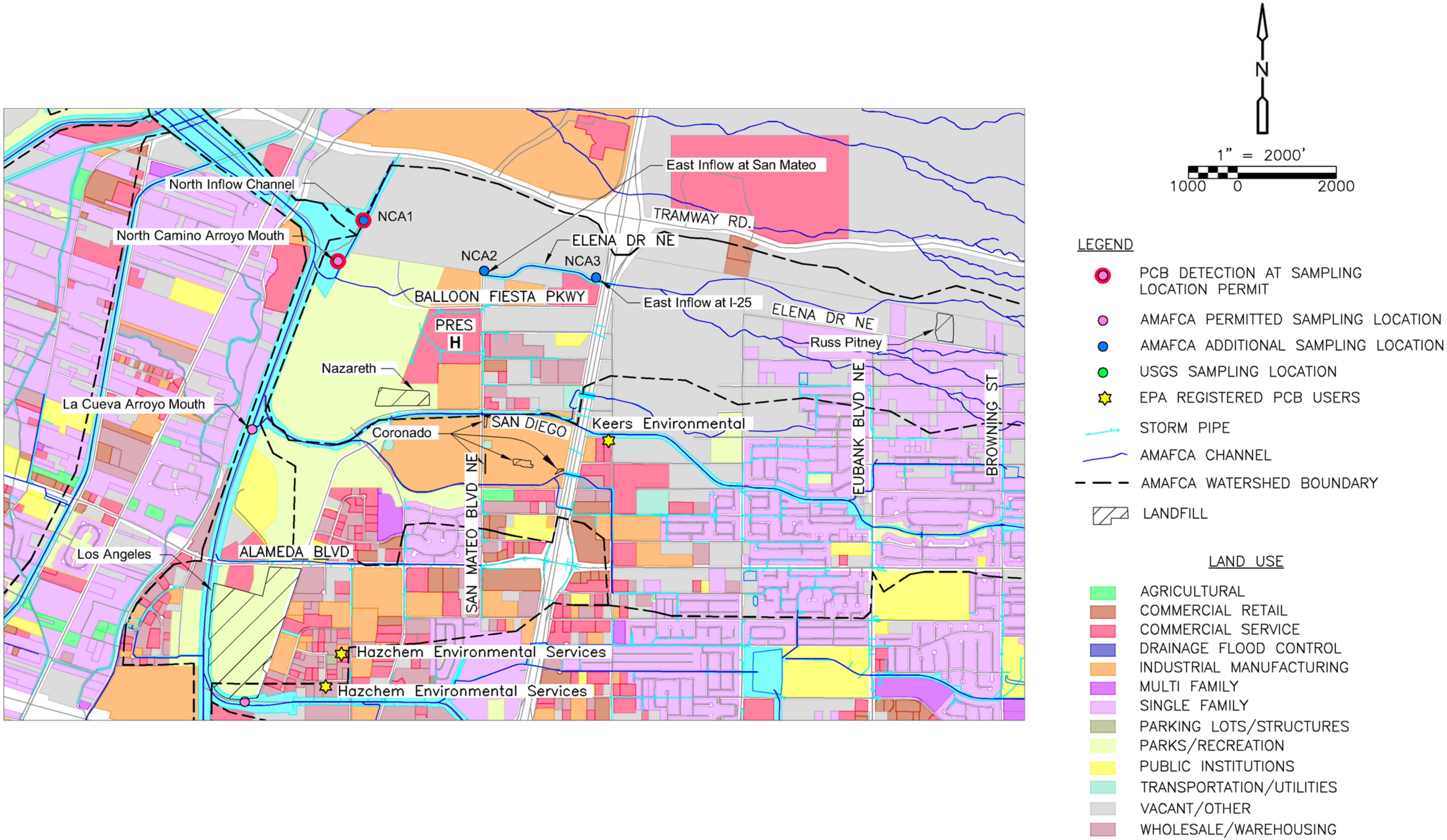
Landfill Name	Operator	Waste Type	Status	Fill Dates
Los Angeles	City of Albuquerque	Municipal	Closed	1978 - 1983
Nazareth	City of Albuquerque	Municipal	Closed	1971 - 1972
Coronado	City of Albuquerque	Municipal	Closed	1963 - 1966
Russ Pitney	Private	Construction	Closed	1972 – 1984

Note: Information gathered from interactive map at : http://www.cabq.gov/environmentalhealth/landfill-groundwater-monitoring/copy_of_landfill/

The land use, landfills, drainage, sampling locations, and other pertinent features are presented on **Figure No. 2**.

Grantline Channel Analysis

Further investigation of the Grantline Channel and watershed to identify the potential source of the PCB contaminated soils was similar to the analysis done on the North Camino Arroyo Mouth area. Land use analysis indicated that the Grantline watershed also contains mixed land uses, including



CDM Smith

Figure No. 2
North Camino Arroyo Analysis
JUNE 2015

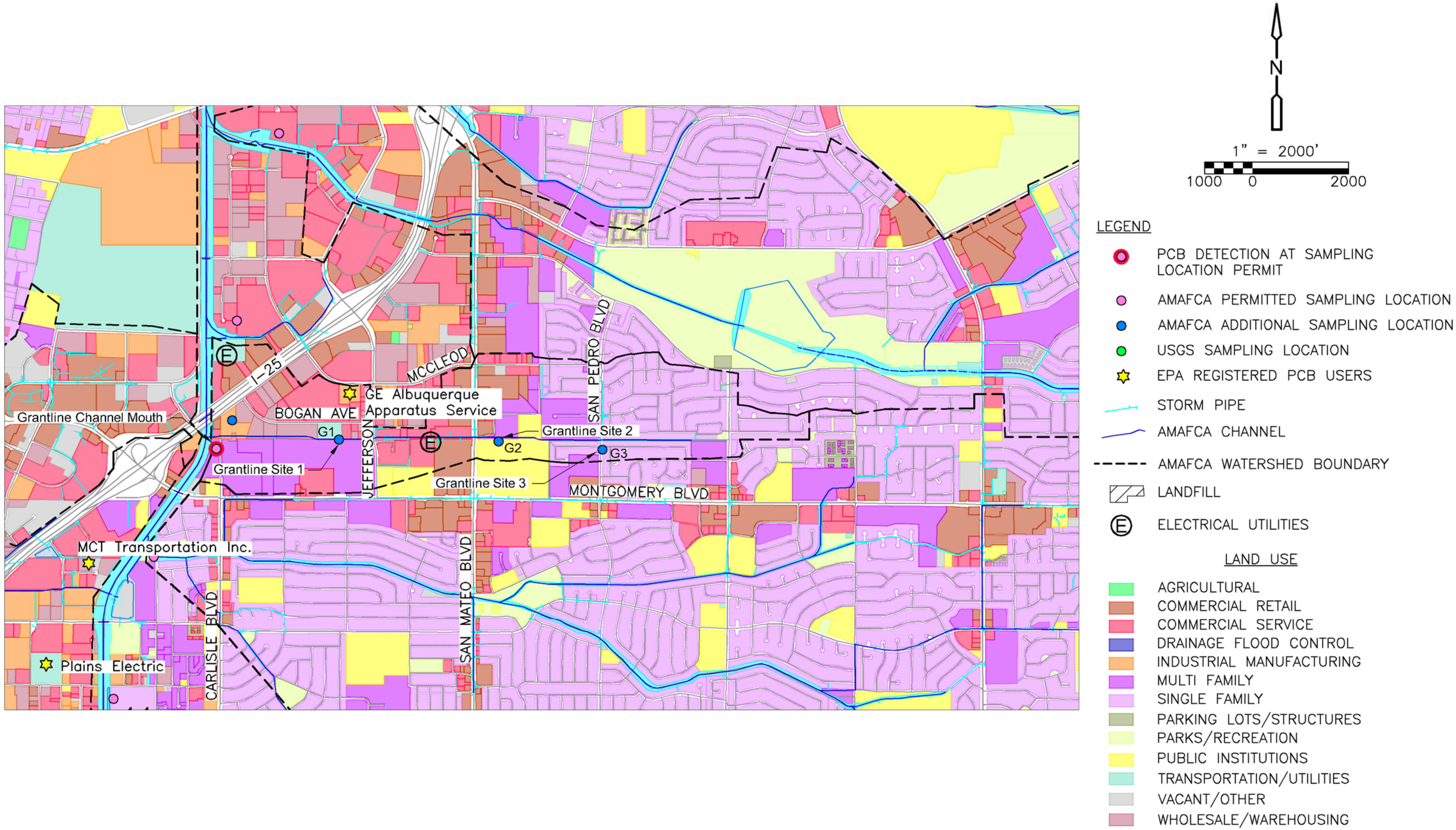


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Figure No. 3
Grantline Channel Analysis
JUNE 2015

industrial manufacturing, public institutions, transportation and utilities, commercial, and residential uses. Areas that are used for "utilities" and house electrical components, such as transformers, are noted as areas of concern. These areas include the site between Grantline Site 1 and 2 and the area north of I-25. There exists one EPA registered PCB user, GE Albuquerque Apparatus Service, located northeast of the PCB detection location. Although laboratory data shows that there were no detections at Grantline Site 1, the nearest sampling point, this location should not be ruled out as a potential pollutant source. Since PCBs absorb to porous soils, contaminated soils have the potential to be washed or blown down the channel and detected in areas that might not be adjacent to the source.

Analysis of the underground stormwater pipelines did not reveal any significant areas of concern. There are no landfills within the Grantline watershed that could contribute to PCB contamination. The land use, drainage, sampling locations, and other pertinent features are presented on **Figure No. 3**.

RECOMMENDATIONS

Since PCBs strongly adsorb onto organic sediment particles and sediment particles often travel or get distributed throughout channels when disturbed by stormwater, it becomes very difficult to identify the source of contamination. Weathering and dechlorination of the PCBs over time also camouflages the true source of contamination (EOA, 2004). The following sampling recommendations were made as a result of the analysis presented above. If PCBs are detected at soil samples from these sites, distribution and weathering of contaminated soils will make it difficult to mark these areas as *the* source of contamination. The sampling and analysis plan will address the identified areas of concern with the goal of locating contaminated soils that are the source(s) of PCBs that can be mitigated to keep PCBs from reaching the Rio Grande.

Landfills Containing PCB Waste Materials and Products

The location of the North Camino Arroyo Mouth and the North Inflow Channel where PCBs were detected by EPA test method 8082, suggests that landfills containing PCB waste materials and products could be potential sources. Two closed landfills or dumping sites near the North Camino Arroyo Mouth have been identified using City of Albuquerque data; Nazareth and Russ Pitney Landfills. These landfills were both operational before the ban of PCBs in 1979. These old landfills are currently surrounded by stormwater pipelines and natural arroyos that lead directly to the North Camino Arroyo Mouth. It is also noted that the outfall to the storm pipelines north of the Nazareth Landfill are downgradient of the additional sampling locations; East Inflow at San Mateo (NCA2) and East Inflow at I-25 (NCA3). PCBs were not detected at these sampling sites which could indicate the source being west of these sampling points. It is recommended to take soil samples at the inlets and outfalls of the storm pipe near the North Camino Arroyo Mouth and in the North Camino Arroyo near the Russ Pitney landfill.

Spills or Leaks that Occurred at Industrial Locations or PCB Recycling Centers

Improper or Illegal Disposal of PCB Materials

At the North Inflow Channel, PCBs were detected in a sample that was taken from an area that had signs of an illicit discharge (AMAFCA, 2014). Discoloration of soil may be an indication of contaminated soils that could contain PCBs. It is recommended that a preliminary visual investigation of drainage areas be performed to identify any unusual discoloration of sediments in the drainage ways.

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Attachments: Summary of Sampling Laboratory Results, NMED Request for Information Correspondence

cc: file

ATTACHMENT 1

Summary of Sampling Laboratory Results

Sample Locations	Sample Collector	Document	Sample Collection Date	EPA Test Method 8082						
				Aroclor 1221	Aroclor 1232	Aroclor 1016	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
				µg/kg						
Mecham Pond	AMAFCA	2013 Annual Report	6/25/2012	U	U	U	U	U	U	U
William and Kathryn Streets	AMAFCA	2013 Annual Report	6/25/2012	U	U	U	U	U	U	U
Santa Fe and Commercial Streets	AMAFCA	2013 Annual Report	6/25/2012	U	U	U	U	U	U	U
San Jose Street and Karsten Court (SE Corner)	AMAFCA	2013 Annual Report	6/25/2012	U	U	U	U	U	U	U
Upstream of USGS at San Jose	AMAFCA	2013 Annual Report	6/25/2012	U	U	U	U	U	U	U
San Jose Drain Downstream of RR Tracks	AMAFCA	2013 Annual Report	6/25/2012	U	U	U	U	U	U	20*
Pond at South End of Karsten Court	AMAFCA	2013 Annual Report	6/25/2012	U	U	U	U	U	U	U
Campus Wash Mouth	AMAFCA	2013 Annual Report	6/19/2012	U	U	U	U	U	U	U
Embudo Channel Upstream of Campus Wash	AMAFCA	2013 Annual Report	6/19/2012	U	U	U	U	U	U	U
Candalaria Outfall	AMAFCA	2013 Annual Report	6/19/2012	U	U	U	U	U	U	U
Hahn Arroyo Mouth	AMAFCA	2013 Annual Report	6/19/2012	U	U	U	U	U	U	U
Grantline Channel Mouth	AMAFCA	2013 Annual Report	6/19/2012	U	U	U	U	U	U	76
Vineyard Channel	AMAFCA	2013 Annual Report	6/19/2012	U	U	U	U	U	U	U
Bear Arroyo Downstream of USGS Gage	AMAFCA	2013 Annual Report	6/19/2012	U	U	U	U	U	U	U
South Pino Arroyo at Concrete Termination	AMAFCA	2013 Annual Report	6/13/2012	U	U	U	U	U	U	U
North Pino Arroyo Settling Basin	AMAFCA	2013 Annual Report	6/28/2012	U	U	U	U	U	U	U
North Pino Arroyo Outfall	AMAFCA	2013 Annual Report	6/25/2012							
North Domingo Baca Arroyo Mouth	AMAFCA	2013 Annual Report	6/28/2012	U	U	U	U	U	U	U
La Cueva Arroyo Mouth	AMAFCA	2013 Annual Report	6/28/2012	U	U	U	U	U	U	U
North Camino Arroyo Mouth	AMAFCA	2013 Annual Report	6/28/2012	U	U	U	U	U	U	40*
QA/QC Sample	AMAFCA	2013 Annual Report	6/26/2012	U	U	U	U	U	U	U
Grantline Site 1	AMAFCA	March 2014 Progress Report	4/12/2013	U	U	U	U	U	U	U
Grantline Site 2	AMAFCA	March 2014 Progress Report	4/12/2014	U	U	U	U	U	U	U
Grantline Site 3	AMAFCA	March 2014 Progress Report	4/14/2013	U	U	U	U	U	U	U
Grantline Channel Mouth	AMAFCA	Grantline Sampling Packet for Samples Collected in August 2013	8/22/2013	U	U	U	U	U	U	220
N. Inflow Channel	AMAFCA	N. Camino Sampling Packet for Samples Collected in August 2013	8/22/2013	U	U	U	U	U	U	12
North Camino Arroyo Mouth	AMAFCA	N. Camino Sampling Packet for Samples Collected in August 2013	8/23/2013	U	U	U	U	U	U	U
East Inflow at San Mateo	AMAFCA	N. Camino Sampling Packet for Samples Collected in August 2013	8/24/2013	U	U	U	U	U	U	U
East Inflow at I-25	AMAFCA	N. Camino Sampling Packet for Samples Collected in August 2013	8/25/2013	U	U	U	U	U	U	U

ATTACHMENT 2

NMED Request for Information Correspondence

SUSANA MARTINEZ
Governor
JOHN A. SANCHEZ
Lieutenant Governor

NEW MEXICO
ENVIRONMENT DEPARTMENT

Office of the Secretary

Harold Runnels Building
1190 Saint Francis Dr., Santa Fe, NM 87505
PO Box 5469, Santa Fe, NM 87502-5469
Phone (505) 827-2855 Fax (505) 827-2836
www.nmenv.state.nm.us

Jeffrey M. Kendall, General Counsel

RYAN FLYNN
Cabinet Secretary
BUTCH TONGATE
Deputy Secretary

July 2, 2014

VIA E-MAIL

Michaela Rempkowski
rempkowskimm@cdmsmith.com

Re: Request to Inspect Public Records

Dear Ms. Rempkowski:

On July 1, 2014 this office received a request for public information. You request information pertaining to: any past PCB reported releases that could contribute to the contamination of the Albuquerque watershed. Any public records concerning potential PCB contaminate source areas within the watershed. (See attached request).

I forwarded your request to the bureaus on July 2, 2014. The bureaus will respond by July 16, 2014.

Should you have any questions, please contact Hazardous Waste Bureau at (505) 476-6035, and the Surface Water Quality Bureau at (505) 476-3671.

Sincerely,

Melissa Y. Mascareñas
New Mexico Environment Department
Department Public Records Custodian

cc: John Kieling, Chief, Hazardous Waste Bureau
James Hogan, Chief, Surface Water Quality Bureau

Rempkowski, Michaela M.

From: Skibitski, Thomas, NMENV <thomas.skibitski@state.nm.us>
Sent: Thursday, July 10, 2014 3:36 PM
To: Rempkowski, Michaela M.
Cc: Mascarenas, Melissa, NMENV
Subject: IPRA request
Attachments: PCBs in Precipitation Snowpack Baseflow and Stormwater in the Upper and Middle Rio Grande Watershed.pdf; PCBs in Sediment at Bernalillo County Stormwater Stations.pdf

Michaela,
The DOE Oversight Bureau has about 30 megabytes of existing data and documents that may be responsive to this request (re: potential PCB contaminant source areas within the Albuquerque Metro Watershed). The files exist as Word documents, PDF, Power Point presentations, and Excel spreadsheets. The attached presentations should give you an idea of what kind of data is available.

I requested direction on how to calculate production fees for documents that may be transmitted electronically. The two attachments were available on the website at one time.

Cheers,
TS

Thomas Skibitski
Chief, DOE Oversight Bureau
Office (505) 845-5932
Cell (505) 377-8135

Rempkowski, Michaela M.

From: Kieling, John, NMENV <john.kieling@state.nm.us>
Sent: Thursday, July 24, 2014 8:37 AM
To: Rempkowski, Michaela M.
Cc: Allen, Pam, NMENV
Subject: RE: [HWB] Public Information Request - PCBs
Attachments: letter001 (6).pdf; Sandia Index 7-24-2014.pdf; GE Index 7-24-2014.pdf

Ms. Rempkowski,
This is in response to the Inspection of Public Records Act request regarding any past PCB reported releases that could contribute to the Albuquerque watershed.

At Sandia National Laboratories, SWMU 30 had PCB contaminated soil and was cleaned up to the 1 ppm standard. This site was determined to be corrective action complete without controls in April 2005.

At the General Electric facility a site was cleaned up under the EPA's oversight with assistance from NMED. This site was determine to be corrective action complete on September 7, 2007 by NMED which concurred with U.S. EPA.

Attached are indexes of records for both SNL and GE. If you could please identify the records which you would like to review please identify them and return to NMED. Please return the identified records to Pam Allen at the above e-mail address.

Thank you,
John Kieling

John E. Kieling, Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg 1
Santa Fe, NM 87505

(505) 476-6000 (HWB Main)
(505) 476-6030 (fax)
john.kieling@state.nm.us

From: Rempkowski, Michaela M. [mailto:rempkowskimm@cdmsmith.com]
Sent: Friday, July 18, 2014 10:02 AM
To: Kieling, John, NMENV
Subject: RE: [HWB] Public Information Request - PCBs

Mr. Kieling,

Thank you so much for your timely response and your help!

Talk to you soon!

Michaela Rempkowski, EI | CDM Smith | 6000 Uptown Blvd, Suite 200 | Albuquerque, NM 87110
T: 505.243.3200 | www.cdmsmith.com

From: Kieling, John, NMENV [mailto:john.kieling@state.nm.us]
Sent: Friday, July 18, 2014 9:58 AM
To: Rempkowski, Michaela M.
Subject: RE: [HWB] Public Information Request - PCBs

Ms. Rempkowski,
Thank you for forwarding this request to me. I was unaware of your request. I will work with staff to determine if the Hazardous Waste Bureau has any documents related to your request.
We should get back to you within the next week.

Sincerely,
John Kieling

John E. Kieling, Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg 1
Santa Fe, NM 87505

(505) 476-6000 (HWB Main)
(505) 476-6030 (fax)
john.kieling@state.nm.us

From: Rempkowski, Michaela M. [mailto:rempkowskimm@cdmsmith.com]
Sent: Friday, July 18, 2014 8:51 AM
To: Kieling, John, NMENV
Subject: [HWB] Public Information Request - PCBs

Good Morning, Mr. Kieling!

I submitted a request for information to the NMED on July 1, 2014 concerning reported PCB releases. I was told that this request was forwarded to the Hazardous Waste Bureau and the Surface Water Quality Bureau and that I would receive a response before July 16, 2014. Attached is the letter I received following my request.

I have not heard anything yet. Is there a response on the way? I am working research for AMAFCA to aid in a drainage channel sampling plan, and need this information soon.

Thanks for your time! Hope to hear from you soon!

Michaela Rempkowski
CDM Smith
6000 Uptown Boulevard NE, Suite 200
Albuquerque, NM 87110
(t) 505.243.3200 ext. 33738/ (f) 505.243.2700
(e) rempkowskimm@cdmsmith.com | cdmsmith.com

FINAL

Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA)

PCB Soil/Sediment Sampling, North Camino Channel and Grantline Channel Sampling and Analysis Plan

June 29, 2015

AMAFCA

Table of Contents

Tables

Figures

Acronyms

AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EDD	electronic data deliverables
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
MDL	method detection limit
MS4	Municipal Separate Storm Sewer System
NMED	New Mexico Environment Department
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
PCBs	polychlorinated biphenyls
P.E.	Professional Engineer
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedures
SQE	Stormwater Quality Engineer
SW	solid waste
SWMP	Storm Water Management Plan
SWQB	Surface Water Quality Bureau
VOC	volatile organic compound

Section 1
Introduction

The purpose of this sampling and analysis plan (SAP) is to provide a detailed description of soil and sediment sampling to be conducted in the North Camino and Grantline Channels; these channels are part of the North Diversion Channel flood control structure managed by the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA). CDM Smith Inc. (CDM Smith) will collect soil and sediment samples from the North Camino and Grantline Channels and submit the samples for laboratory analysis of polychlorinated biphenyl (PCB) analysis in an effort to identify controllable sources of the contaminant within the channels.

The field investigation is being conducted as part of a confirmation study to evaluate PCB concentrations in the North Diversion Channel flood control structure. Completion of the confirmation study is a requirement of AMAFCA's Phase 1 municipal separate storm sewer systems (MS4) permit. This plan follows the guidance of the AMAFCA Field Sampling Plan and incorporates the AMAFCA quality assurance project plan (QAPP) (CDM Smith, 2014). Data will be generated according to this SAP and the pertinent New Mexico Environment Department (NMED) standard operating procedures (SOPs) (NMED SWQB, 2014).

1.1 Project Personnel

Table 1 details the responsibilities for this project. Each team member is responsible for implementing the assigned responsibilities. If an individual is unable to fulfill his/her duties, it is that individual's responsibility to find assistance and/or a replacement, in coordination with appropriate supervisors.

Table 1 Personnel Roles and Responsibilities

Team Member	Position/Role	Responsibilities
Patrick Chavez	AMAFCA Project Coordinator	– Coordinate monitoring planning efforts. – Coordinate and participates in the collection of chemical data.
Patrick Chavez	Middle Rio Grande Stormwater Quality Team Liaison	– Provide information and data needs pertaining to sample locations within the permit area based on team member affiliations. – Assist with development of final survey report, as needed.
Todd Bragdon	CDM Smith Project Manager	– Responsible for overall execution of the project including sampling, analysis, validation and verification, and reporting activities.
Andy Freeman	Hall Environmental Analysis Laboratory (HEAL) Manager	– Analyze soil and sediment samples, and provide electronic data reports (EDR). Coordinate with field sampling team.
Cherie Zakowski	CDM Smith Data Validation	– Validate project analytical data.
Michaela Rempkowski	CDM Smith Field Staff	– Collect samples, complete field documentation, and deliver samples to the laboratory.

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Section 2

Project Description

2.1 Background

In 2012, the US Environmental Protection Agency (EPA) issued National Pollutant Discharge Elimination System (NPDES) Permit No. NM000101 (U.S. EPA, 2012) for the Albuquerque MS4 co-permittees: AMAFCA, COA, NMDOT, and the University of New Mexico (UNM). These four entities are currently participating in a cooperative monitoring program..

On December22, 2014, EPA published a draft of the proposed Watershed Based MS4 Permit NMR04A000 (U.S. EPA, 2013), which covers the Middle Rio Grande Watershed. As defined by EPA, watershed based NPDES permitting emphasizes addressing all stressors within a hydrologically defined drainage basin, rather than addressing individual pollutant sources, with the ultimate goal of better protecting an entire watershed. Once EPA accepts a permittees Notice of Intent (NOI) the Watershed Based MS4 Permit will replace the existing MS4 Permit NMS000101 for the existing four co-permittees. This Watershed Based MS4 Permit will potentially add 14 additional permittees in the Albuquerque area, all of which contribute stormwater runoff to the Middle Rio Grande.

PCB Description

Polychlorinated biphenyls (PCBs) are a group of chemicals that contain 209 individual compounds (known as congeners). PCBs made in the United States were marketed under the trade name Aroclor and most are identified by a four-digit numbering code in which the first two digits indicate that the parent molecule is a biphenyl and for the 1200 series Aroclors the last two digits indicate the chlorine content by weight. For example, Aroclor 1260 has 60 percent chlorine. Different Aroclors were used at different times and for different applications. In electrical equipment manufacturing in the USA, Aroclor 1260 and Aroclor 1254 were the main mixtures used before 1950; Aroclor 1242 was the main mixture used in the 1950s and 1960s until it was phased out in 1971 and replaced by Aroclor 1016.

Due to PCBs' environmental toxicity and classification as a persistent organic pollutant, PCB production was banned by the United States Congress in 1979. PCB mixtures found in the environment will differ in composition from the commercial mixtures because of partitioning, biotransformation, and bioaccumulation. Given that PCBs are no longer produced or used in the United States today; the major source of exposure to PCBs is the redistribution of PCBs already present in soil, sediment and water.

This section provides a summary of CDM Smith's understanding of the project including a summary of the cooperative study of the Upper Rio Grande Watershed; PCBs in the San Jose Drain and North Diversion Channel (NDC); and permitting.

PCBs in the Rio Grande Watershed

The New Mexico Environment Department (NMED) and Los Alamos National Lab (LANL) completed a cooperative study of the Upper Rio Grande Watershed (NMED 2012). The objectives of this study were to establish:

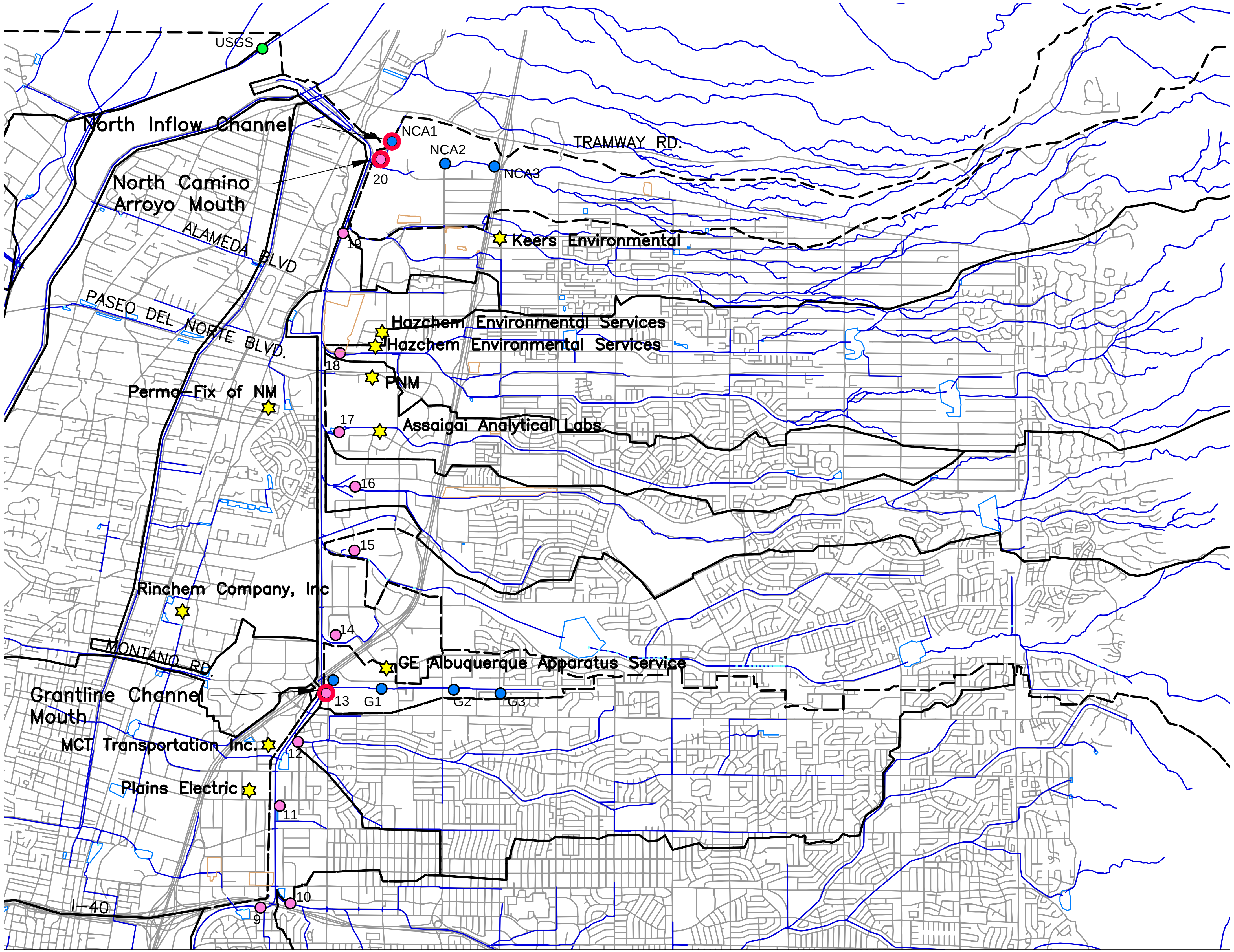
1. Background levels of PCB concentrations in precipitation and snowpack near Los Alamos, New Mexico, and from alpine peaks overlooking the northern Rio Grande watershed up to the state border with Colorado;
2. Background levels of PCB concentrations in stormwater in northern New Mexico streams and arroyos that are tributaries to the Rio Grande and Rio Chama;
3. The range of PCB concentrations found in the Rio Grande during base-flow (dry weather flow) and storm-flow conditions;
4. Background levels of PCBs in stormwater from undeveloped watersheds of the Pajarito Plateau and the northeast flank of the Jemez Mountains near Los Alamos;
5. The concentrations of PCBs in urban runoff from the Los Alamos townsite adjacent to LANL; and
6. How these findings may be used to target significant sources of PCBs.

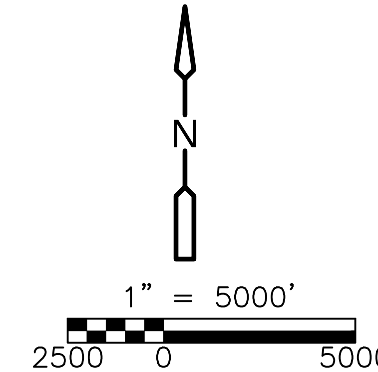
Elevated levels of PCBs were found in stormwater and sediment in the San Jose Drain. These findings, as presented in the cooperative study (NMED 2012), were meant to assist in identifying PCBs in surface waters originating from local industrial and urban sources versus global atmospheric deposition, thereby providing a context for future monitoring results used to determine environmental remedy priorities. In addition, a fish advisory was issued in March 2009 to limit consumption of channel catfish and white bass taken from this reach of the Rio Grande because of high levels of PCBs found in fish tissue.

PCBs in the San Jose Drain and North Diversion Channel

On April 15, 2010, NMED released results of a study conducted in 2009 of Rio Grande water quality near the Santa Fe Buckman Direct Diversion and in Albuquerque during storm flow conditions. The study indicated that storm water events in the Albuquerque area have the potential to carry concentrations of PCBs into the Rio Grande that can harm wildlife and humans via the consumption of contaminated fish. While it is possible that the PCBs are entering the Rio Grande from the NDC, which drains storm water from 89.7 square miles in the northeastern part of Albuquerque, further investigation is needed to confirm whether the source of the contamination is in the NDC watershed or further upgradient in the Rio Grande (NMED 2010).

As discussed in the investigation (NMED 2010), the San Jose Drain and the NDC are one of many sites in central New Mexico, along the middle Rio Grande River where elevated levels of PCBs have been found in the water column at levels near to or exceeding New Mexico water quality standards for protection of wildlife habitat/livestock watering and human health.





LEGEND

- PCB DETECTION AT SAMPLING LOCATION
- AMAFCA REQUIRED SAMPLING LOCATION
- AMAFCA ADDITIONAL SAMPLING LOCATION
- USGS SAMPLING LOCATION
- EPA REGISTERED PCB USERS
- AMAFCA CHANNEL
- AMAFCA DRAINAGE
- AMAFCA WATERSHED BOUNDARY
- AMAFCA STRUCTURE
- LANDFILL

Sample Locations:

9. Campus Wash Mouth
10. Embudo Channel Upstream of Campus Wash
11. Candalaria Outfall
12. Hahn Arroyo Mouth
13. Grantline Channel Mouth
14. Vineyard Channel
15. Bear Arroyo Downstream of USGS Gage
16. South Pino Arroyo at Concrete Termination
17. North Pino Arroyo Settling Basin
18. North Domingo Baca Arroyo Mouth
19. La Cueva Arroyo Mouth
20. North Camino Arroyo Mouth

NCA1. North Inflow Chanel
NCA2. East Inflow at San Mateo
NCA3. East Inflow at I-25
G1. Grantline Site 1
G2. Grantline Site 2
G3. Grantline Site 3

CDM Smith

Figure No. 1
Sampling Locations & PCBs Users
JUNE 2015

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Investigation and Reduction of PCBs in the NDC & San Jose Drain

In June 1, 2012, AMAFCA and the City of Albuquerque formulated a strategy to screen for PCBs in watersheds that drain to the NDC and San Jose drain portions of MS4. Specifically, the MS4 Permit (No. NMS000101), effective March 1, 2012, requires a screening level effort to locate sources of PBCs in the NDC (Table IV.A.2 in the Permit) and San Jose Drain (Table IV;B of the Permit). The permit includes control and monitoring requirements to address concerns regarding PCBs in the NDC and San Jose Drain drainage areas by updating/revising and implementing a strategy to identify and eliminate controllable sources of PCBs that cause or contribute to exceedances of applicable water quality standards in waters of the United States. AMAFCA's compliance with water quality standards, including the investigation and reduction of PCBs in the San Jose Drain and North Diversion Channel, are further described in the Storm Water Management Program (SWMP) (AMAFCA 2013d), which was prepared for coverage under the MS4 Permit (No. NMS000101). Specifically, Table IV of the SWMP describes AMAFCA's planned activities to identify and eliminate controllable sources of PCBs in the NDC.

2.1.1 Previous PCB Monitoring

Phase I PCB Monitoring/Confirmation Study: The Phase I investigation activities (also referred to as the confirmation study in the SWMP) included the collection of 20 sediment samples collected from the NDC and San Jose Drain. The 2012 Phase I investigation sampling locations are shown as "pink dots" (see **Figure 1**). Of the 20 sediment samples collected and analyzed by EPA Method 8082, only the following samples had PCB concentrations exceeding action levels (AMAFCA 2013c,b):

- One sediment sample, located at the outfall of the Grantline Channel, with Aroclor 1260 concentration of 78 micrograms per kilogram (µg/kg)
- One sediment sample, located at the outfall of the North Channel, with Aroclor 1260 concentration of 40 µg/kg

The Grantline and North Camino Arroyo Channels have been designated as areas of concern for AMAFCA based on this analysis.

Follow-Up Investigation: AMAFCA has performed additional sampling events for three points east of each channel to evaluate potential controllable sources of PCBs (AMAFCA 2013c). PCBs (Aroclor 1260) were detected at two of the sampling locations during the additional sampling events:

- The North Inflow Channel (12 µg/kg), located hydraulically above the North Camino Arroyo, and
- The Grantline Channel Mouth (220 µg/kg).

The additional sample at the North Inflow Channel was collected where there were discolored soils into the diversion ditch [AMAFCA, 2014]. None of the other soil samples were from discolored soils.

2.2 Objectives

The objective of AMAFCA's water quality monitoring program is to protect the waters of the Rio Grande and comply with the NPDES permit. This SAP describes sampling activities to locate PCBs within channel sediments and identify potential controllable sources of PCBs in soils and sediments within the drainage areas. **Table 2** provides a summary of the sampling activities for the areas of concern.

Table 2 Summary of Sampling Activities for North Camino and Grant Line Channels

Activity	Description
Collect up to 15 soil/sediment samples from the North Camino Channel and Grantline Channel	Sample locations have been selected based on the data review and source identification activities (CDM Smith 2014) and are consistent with activities recommended by AMAFCA to the EPA
Collect up to 4 background samples, two each from upgradient of the North Camino Channel and the Grantline Channel	Samples will be collected from undeveloped areas near the Sandia Mountain foothills or at the farthest upgradient end of the watershed to represent background conditions.

Note: All samples will be submitted to Hall Environmental Analysis Laboratory for PCB analysis **via EPA Method 8082.**

2.3 Schedule

The project schedule in **Figure 2** describes the anticipated execution sequence for the field investigation. CDM Smith anticipates field mobilization on July 13, 2015 to begin the collection of soil/sediment samples. The receipt of soil/sediment analytical results typically takes 14 days from the submittal date to the analytical laboratory. The data will be validated for completeness and usability as described in SOP 15.0 *Data Verification and Validation Procedures* (NMED [Surface Water Quality Bureau] SWQB 2011). Once all data have been received and validated, the data will be assessed according to the most recent version of the assessment protocols (http://www.nmenv.state.nm.us/swqb/protocols/index.html).

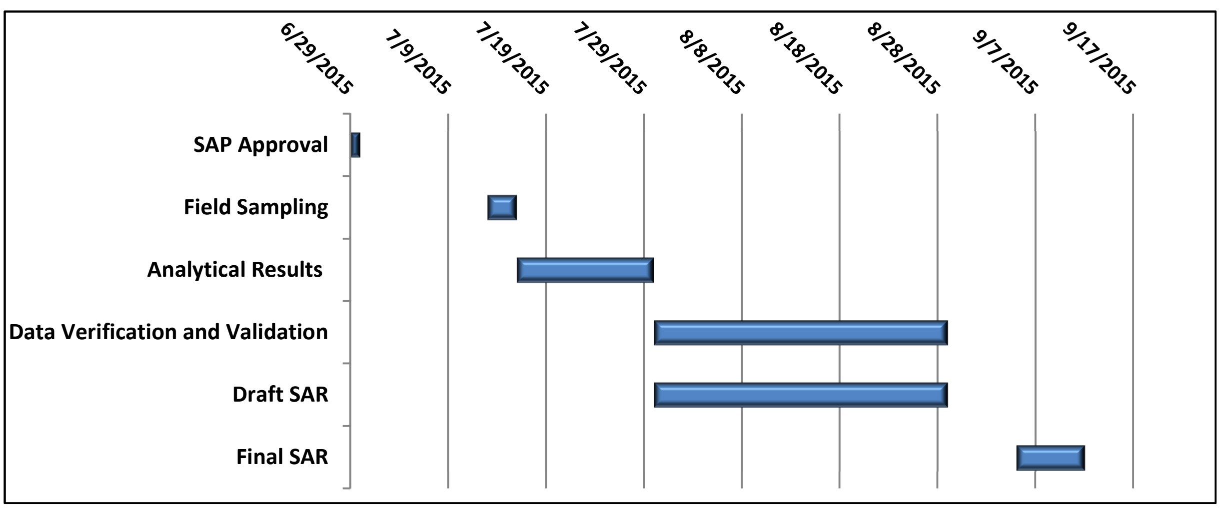

Figure 2: Sampling and Analysis Schedule

2.4 Location

The project area is the Middle Rio Grande Watershed, and is located primarily within the greater Albuquerque area (**Figure 1**). The Grantline and North Camino Channels are part of the North Diversion Channel flood control structure and are located in the Northeast quadrant of Albuquerque; sectioned off by I-40 and I-25.

Grantline Channel: The sampling area includes six sampling locations along the Grantline Channel in between Montgomery Blvd and McLeod Rd and span from the North Diversion Channel to San Mateo Blvd (**Figure 3**).

North Camino Channel: The sampling area includes nine sampling locations in the area between the North Camino Channel Mouth east towards the Sandia Mountains. Samples will be taken at the previous PCB detection areas on North Camino Channel Mouth and the North Inflow Channel. Sampling will also occur at storm drain inlets and outlets on the east side of Balloon Fiesta Park. Finally, four samples will be taken from the North Camino Arroyo on the east side of I-25; one at the North Camino Arroyo and I-25 underpass, one at the connection of two natural arroyos and two between Eubank Blvd and Browning St. in the two natural arroyos surrounding the former Russ Pitney Landfill (**Figure 4**).

Background Samples: Two background samples for the Grantline Channel will be taken at the beginning of the Grantline Channel near Louisiana Blvd. Two background samples for the North Camino Channel will be taken along the Sandia Mountains at the top of the watershed (**Figures 3 and 4**).

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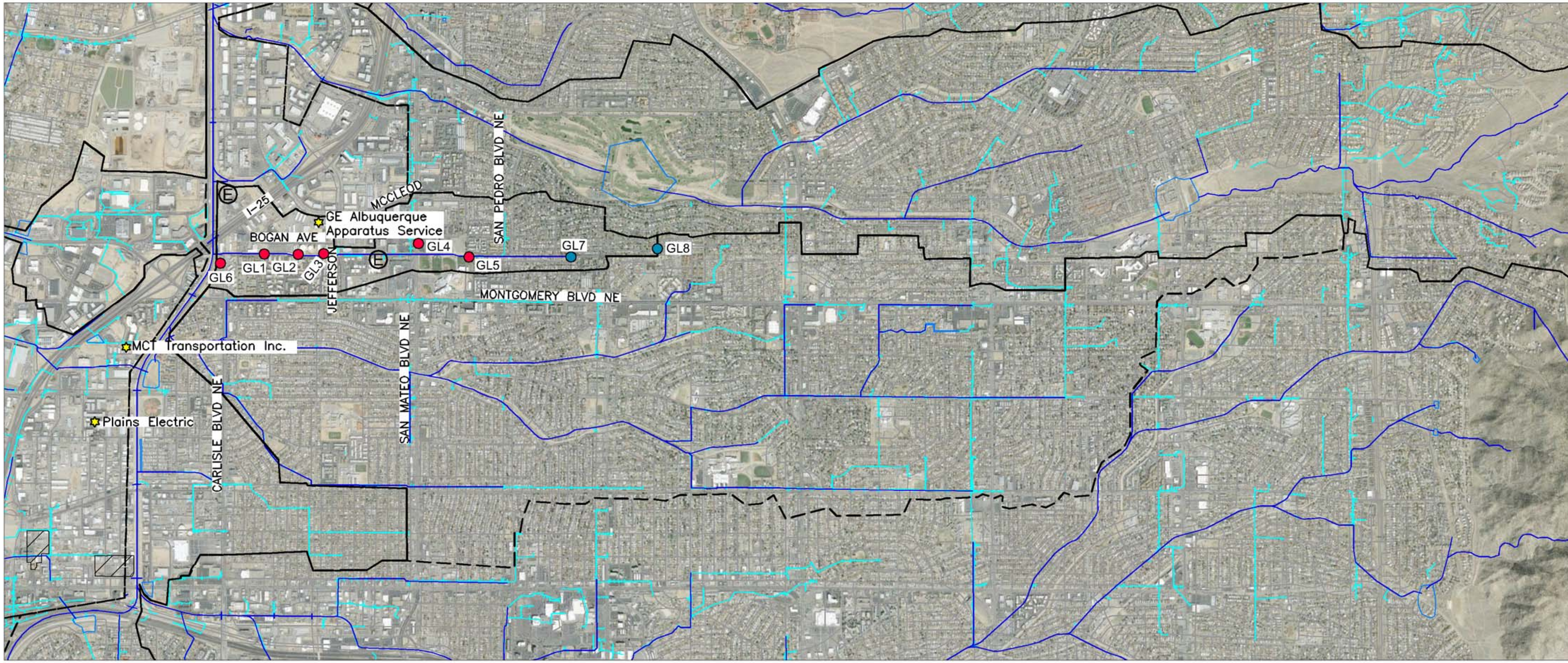


GL2


GL3


GL4

LEGEND

- SAMPLING LOCATION
- BACKGROUND SAMPLING LOCATION
- EPA REGISTERED PCB USERS
- STORM PIPE
- AMAFCA CHANNEL
- AMAFCA WATERSHED BOUNDARY
- LANDFILL
- ELECTRICAL UTILITIES

N

1" = 3000'

1500 0 3000

CDM Smith

Figure No. 3
Grantline Channel Sampling Locations
JUNE 2015

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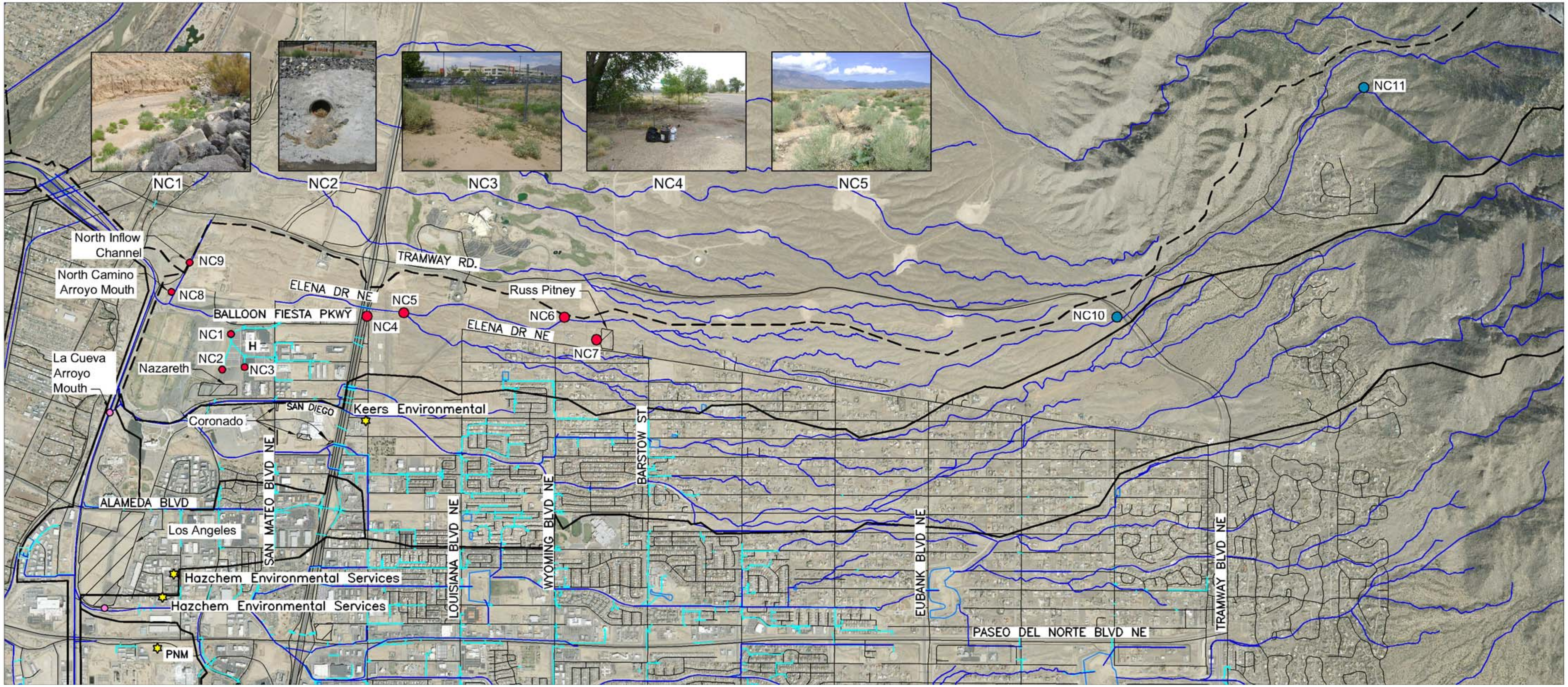

LEGEND

- SAMPLING LOCATION
- BACKGROUND SAMPLING LOCATION
- H PRESBYTERIAN HOSPITAL
- EPA REGISTERED PCB USERS
- STORM PIPE
- AMAFCA CHANNEL
- AMAFCA WATERSHED BOUNDARY
- LANDFILL

N

1" = 3000'

1500 0 3000

CDM Smith

Figure No. 4
North Camino Arroyo Sampling Locations
JUNE 2015

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Section 3

Sampling and Analysis

Past soil/sediment sampling and laboratory analytical results have indicated that sediments within the Grantline Channel and North Camino Channel may contain PCBs. This sampling event will focus on identifying potential sources of PCBs within these channels.

Fifteen (15) soil/sediment samples from the North Camino Channel and Grantline Channel will be collected and analyzed. The soil/sediment sample locations were selected based on the data review and source identification activities (CDM Smith, 2014) and are consistent with previously identified additional sampling activities recommended by AMAFCA to EPA.

Four (4) background samples, two each from upgradient of the North Camino Channel and the Grantline Channel will be collected. The samples will be collected from undeveloped areas near the Sandia Mountain foothills or at the farthest end of the watershed to represent background conditions.

3.1 Sample Location and Rationale

As previously described in Section 2.1, additional sampling is required to further evaluate potential presence of PCBs in soils and sediments within the North Camino Channel and Grantline Channel. **Figures 3 and 4** show the channels and sampling locations. Soil and sediment samples will be collected from these locations to identify sources of PCBs which maybe entering the MS4. The locations were chosen after reviewing the following:

1. Historical data generated by AMAFCA, investigations conducted under NMED oversight or permitting, and reports from Los Alamos National Laboratory, United States Geological Survey and the City of Albuquerque.

2. Historical uses of the site and adjacent properties determined from the United States Environmental Protection Agency Registered PCB Handlers database and the current City of Albuquerque Zoning database.

3. Physical features of the channels including, flow of surface water, connections to the MS4, areas where sediment has been deposited in the MS4, any abnormalities such as trash, construction debris, or illegal dumping. These features were determined by two site walkthroughs conducted on July 28 and 31, 2014. Photographs of these walk-throughs can be found in **Figures 3 and 4.**

4. Access to proposed sample location, some locations may not be accessible by reasonable means due to health and safety concerns, right of way, or consent from private property owners.

5. Established sampling locations used by other governmental agencies were considered to allow for the comparison of results, examination of trends, and quality assurance.

Sampling locations were selected to “bracket” potential pollution sources and represent each of the assessment units in the watershed; except for very small or mostly ephemeral systems. **Table 3** describes the locations and rationale for choosing each of the fifteen soil/sediment samples and four background sample locations.

Table 3: Sample Locations and Rationale

Sample Name	Sample ID	Location	Rationale	Type
Grantline-1	GL1	Along the Grantline Channel behind the Albuquerque Printing Company at 3838 Bogan Avenue NE.	Location downgradient of industrial areas where run-off drains directly to the channel. The industries include printing, shipping, leak detection and the former EPA registered GE Albuquerque Apparatus Service.	Sediment
Grantline-2	GL2	Along the Grantline Channel behind the water tanks. The area where the channel goes from arroyo to concrete.	Location downgradient of industrial areas where run-off drains directly to the channel. The industries include printing, shipping, leak detection and the former EPA registered GE Albuquerque Apparatus Service.	Soil
Grantline-3	GL3	Along the Grantline Channel behind the Forever Lawn Inc. at 4500 Bogan Avenue.	Location downgradient of industrial areas where run-off drains directly to the channel. The industries include printing, shipping, leak detection and the former EPA registered GE Albuquerque Apparatus Service.	Soil
Grantline-4	GL4	Along the Grantline Channel at the northwest corner Del Norte High School at the entrance of the underground stormwater system.	Location experiences run-off from the upper Grantline Channel. Detection of PCBs at this location would indicate that the source is an illicit discharge or caused from a neighboring watershed.	Sediment
Grantline-5	GL5	Along the Grantline Channel at the northeast corner of Del Norte High School where the channel goes from arroyo to concrete.	Location experiences run-off from the upper Grantline Channel. Detection of PCBs at this location would indicate that the source is an illicit discharge or caused from a neighboring watershed.	Soil
Grantline Channel Mouth	GL6	Along the Grantline Channel at the north end of Carlisle Blvd where the Grantline Channel connects to the North Diversion Channel.	Location had a past PCB detection. Detection of PCBs at this location would indicate a reoccurring issue.	Sediment
Grantline Background-1	GL 7	Along the Grantline Channel at the east end of the channel; near the corner of Louisiana Blvd and Prairie Rd.	Developed land at the end of Grantline Channel. Sampling at this location will determine the baseline for this watershed and may determine if sources are east of the Grantline Channel.	Soil
Grantline Background-2	GL8	In the natural arroyo at the south end of the concrete drainage channel east of the watershed; near the west end of Northridge Avenue.	Developed land at the end of watershed. Sampling at this location will determine the baseline for this watershed and may determine if sources are in neighboring watersheds.	Sediment
North Camino-1	NC1	At the outfall near the northwest corner of the Presbyterian Hospital parking. Accessed through Balloon Fiesta Park.	Location is the outfall of the City of Albuquerque storm drains that surround the former Nazareth Landfill.	Soil
North Camino-2	NC2	At the storm drain inlet or drainage channel in the southwest corner of Presbyterian Hospital parking lot.	Location is a drain inlet to City of Albuquerque storm drains that surround the former Nazareth Landfill.	Sediment
North Camino-3	NC3	At the storm drain inlet or drainage channel at southeast corner of Presbyterian Hospital parking lot.	Location is a drain inlet to City of Albuquerque storm drains that surround the former Nazareth Landfill.	Soil
North Camino-	NC4	Along the North Camino	Location is the storm pipe where all drainage in	Soil

Table 3: Sample Locations and Rationale

Sample Name	Sample ID	Location	Rationale	Type
4		Channel at the north end of San Pedro Blvd in the arroyo leading to the North Camino Channel underpass.	the watershed passes under I-25. Evidence of illegal dumping (motor oils, hydraulic fluids, and gasoline) was found less than 100 feet south of the channel, with water erosion indicating flow in the direction of the channel.	
North Camino-5	NC5	In the arroyo connection east of the North Camino Channel underpass where two arroyos connect.	Location is the connection of two natural arroyos that run through the entire North Camino watershed. Evidence of illegal dumping (cars and metals) was found in the channel at this location.	Soil
North Camino-6	NC6	Along the North Camino Channel where it crosses the access road northwest of the former Russ Pitney Landfill.	Location at point where the natural arroyo running from the former Russ Pitney Landfill and the North Camino Channel connect.	Soil
North Camino-7	NC7	Along natural arroyo on the southwest corner of the former Russ Pitney Landfill.	Location is at the southwest corner of the former Russ Pitney where storm water erosion has etched a small natural arroyo that eventually drains into the North Camino Arroyo.	Soil
North Camino Arroyo Mouth	NC8	Along the North Camino Channel at the northwest corner of Balloon Fiesta Park where the channel connects to the North Diversion Channel.	Location had a past PCB detection. Detection of PCBs at this location would indicate a reoccurring issue.	Soil
North Inflow Channel	NC9	Along the drainage ditch that runs parallel to the north end of Propane Rd.	Location had a past PCB detection. Detection of PCBs at this location would indicate a reoccurring issue.	Soil
North Camino Background-1	NC10	Along the North Camino Channel at the cross-section of Tramway and NM Forrest Rd 333.	Undeveloped land at the east end of the watershed. Sampling at this location will determine the baseline for the watershed at the base of the Sandia Mountains.	Soil
North Camino Background-2	NC13	Along the Juan Tabo Canyon Spring at the end of NM Forrest Rd 333 in the Sandia Mountains.	This location is an established USGS soil sampling location. This would determine the baseline for the watershed in the Sandia Mountains and results can be compared to previous studies to identify trends and ensure quality.	Soil

3.2 Field Procedures

Soil and sediment samples will be collected during fieldwork. Sample collection and shipment will be conducted according to CDM Smith Technical SOPs. Technical SOPs which are applicable to sample collection and documentation are:

- 1-2 Sample Custody
- 1-3 Surface Soil Sampling
- 1-11 Sediment Sampling
- 2-2 Guide to Handling Investigation-Derived Waste
- 4-1 Field Log book Content and Control

Field documentation will be recorded in the field book and on field forms.

Sampling equipment includes:

- Storing and Transporting Equipment (Sample containers/bottles, labels, blue ice, cooler, COCs, plastic bags, bubble wrap are provided from HEAL on request)
- Soil sampling equipment (trowel, spoon, rubber gloves)

3.3 Sample Analyses

CDM Smith will submit samples to HEAL for PCB analysis by EPA Method 8082. HEAL will be notified of the sampling at least 14 days before the field investigation.

Sample will be collected in 8 ounce glass jars and kept on ice in a cooler. The method detection limits for Method 8082 are shown in **Table 4** below.

Table 4: EPA Test Method 8082 Detection Limits

	Test Code:	8082_S	
	Test Number:	SW8082	
	Test Name:	EPA Method 8082	
	Matrix:	Soil	
Type	Analyte	MDL	PQL
		mg/Kg	
A	Aroclor 1016	0.012	0.02
A	Aroclor 1221	0.016	0.02
A	Aroclor 1232	0.016	0.02
A	Aroclor 1242	0.0079	0.02
A	Aroclor 1248	0.012	0.02
A	Aroclor 1254	0.006	0.02
A	Aroclor 1260	0.019	0.02
S	Decachlorobiphenyl	0	0
S	Decachlorobiphenyl	0	0

Samples will be submitted to Hall Environmental Analysis Laboratory (HEAL) for analysis. The Point of contact for HEAL is Mr. Andy Freeman. Mr. Freeman can be contacted at the following address and number:

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
(505) 345-3975
andy@hallenvironmental.com

3.3.1 Field QC Samples

The QAPP describes the QC sample type and frequency which will be collected during the field investigation. One field duplicate sample will be collected and analyzed.

3.3.2 Laboratory QC Samples

The HEAL Quality Assurance Plan and method SOPs describes the QC samples that will be analyzed.

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Section 4
Reporting

A report will be written to document the procedures and results of the field investigation. An overview of data evaluation, reporting, and documentation is described in the following sections.

4.1 Data Evaluation and Reporting

Following the receipt of laboratory analytical data, CDM Smith will evaluate the data and provide a summary report describing the following:

- Data verification and validation of analytical results to ensure data was in accordance with the QAPP and SWQB SOPs and provide laboratory analytical reports;
- Summarize field sample collection activities, observations, deviations from the SAP, provide completed field sampling forms, and provide photographs;
- Summarize PCB detections and sample locations; and
- Provide recommendations on sediment removal and disposal if controllable contaminant sources are identified.

The report will include an introduction to describe the objective of the field investigation and work performed. Field work and deviations from the site-specific SAP will be described in the report. Recommendations for additional actions (if necessary) that need to be taken to identify or eliminate controllable sources of PCBs that cause or contribute to exceedance(s) of applicable water quality standards in the MS4 permit will also be included in the report. Additional soil/sediment sampling locations or investigations will also be recommended, if necessary. Results from the analyses of chemical samples and field data will be used to answer decision statements and determine if the objective of the field investigation was met.

4.2 Documentation

Project documents include field forms, logbook, COCs, photographs, calibration records, validation and verification records, records of analytical data in hard copy or electronic form, and QC records. Documents will be maintained in accordance with the requirements of the associated QAPP.

Analytical data will be generated by HEAL and delivered as an electronic data deliverable (EDD), when possible, in addition to the required hard copy analytical data package. All data generated for AMAFCA will be maintained (in either hard copy or electronic formats, depending on how the data were received from the laboratory) by the AMAFCA Project Coordinator or his/her designee using the appropriate data management tools as specified in the QAPP. These tools consist of geographic information systems (GIS), spreadsheets, and word processing computer software. Analytical results will be maintained in a database by AMAFCA; CDM Smith will provide the analytical data to AMAFCA SQE in EDD and/or Excel Spreadsheet format.

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Section 5

References

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Albuquerque Metropolitan Arroyo Flood Control District (AMAFCA). 2013a. *Letter - NPDES MS4 Permit No. NMS000101, Compliance with Water Quality Standards, PCBs, Initial Progress Report of PCB Monitoring Efforts for the North Diversion Channel (per Table IV.A.2 in the Permit*.

AMAFCA. 2013b. *Letter - PCBs in the San Jose Drain, Initial Progress Report per Table IV;B, MS4 Permit No. NMS000101 Annual Report*.

AMAFCA. 2013c. *Albuquerque MS4 – NPDES General Permit No. NMS000101, Annual Report*.

AMAFCA. 2013c. *NPDES MS4 Permit No. NMS000101, Compliance with Water Quality Standards, PCBs, Revised Initial Progress Report of PCB Monitoring Efforts for the North Diversion Channel (per Table IV.A.2 in the Permit*.

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NMED Surface Water Quality Bureau (SWQB). 2014. *Standard Operating Procedures for Sample Collection and Handling*. Most recent versions of SOPs accessed April 2014 at <http://www.nmenv.state.nm.us/swqb/SOP/>.

NMED Office of the Secretary. 2010. *Environment Department Finds Elevated Levels of PCBs in the Rio Grande near Albuquerque during Storm Flows*.

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FINAL

Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA)

Middle Rio Grande Watershed Soil and Sediment Field Sampling Plan

June 29, 2015

AMAFCA

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List of Tables

Acronyms

AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EDD	electronic data deliverables
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
MDL	method detection limit
MS4	Municipal Separate Storm Sewer System
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
PCBs	polychlorinated biphenyls
P.E.	Professional Engineer
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedures
SQE	Stormwater Quality Engineer
SW	solid waste
SWQB	Surface Water Quality Bureau
VOC	volatile organic compound

Section 1

Introduction

The purpose of this field sampling plan is to describe the steps for planning, collecting, and analyzing soil and sediment from the Middle Rio Grande Watershed collected by the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) or their contractors. This field sampling plan will be used as guidance for developing Sampling and Analysis Plans (SAP) for investigations that involve soil or sediment sampling and analysis.

Generally, AMAFCA is expected to collect soil and sediment samples for one of two reasons:

1. To identify chemicals that could impact stormwater quality; or
2. To make decisions about management of contaminated soils.

Stormwater quality monitoring in the Albuquerque Municipal Separate Storm Sewer System (MS4) is performed by AMAFCA and required under the United States Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Permit No. NMS000101. Contaminated soil or sediments could result from accidental releases from AMAFCA operations or illegal dumping on AMAFCA property

This plan has been prepared in accordance with the New Mexico Environment Department (NMED's) Standard Operating Procedures (SOP) 2.1, *Field Sampling Plan Development and Execution* (NMED 2012). It describes the process for developing sampling objectives, identifying sampling locations, and determining decision criteria for soil and sediment data.

A Quality Assurance Project Plan (QAPP) has been developed for investigation of chemicals in soil and sediment which could impact stormwater quality or be used to determine how to manage soil or sediments that might be contaminated. Data will be generated according to the quality procedures described in the QAPP and include:

- Review of planned sample locations and rationale by the AMAFCA Project Manager and Quality Manager
- Field personnel will be trained by experienced personnel to collect soil and sediment samples
- Frequency and type of field and laboratory quality control (QC) samples
- Laboratory instrument maintenance, calibration, and testing procedures and QC limits
- Data validation and verification procedures
- Project filing requirements and audits of procedures

1.1 Personnel Roles and Responsibilities

Each SAP must describe the roles and responsibilities for conducting soil and sediment investigations. Each team member is responsible for implementing the assigned responsibilities. If an individual is unable to fulfill their duties it is that individual's responsibility to find assistance and/or a replacement, in coordination with appropriate supervisors**.** **Table 1** is provided as an example of the type of information that should be included in the SAP. The project-specific SAP will identify team members who are TBD.

Table 1 Personnel Roles and Responsibilities

Team Member	Position/Role	Responsibilities
Jerry Lovato	AMAFCA Executive Engineer/ Licensed Professional Engineer (P.E.) in New Mexico	– Oversees development and accuracy of MS4 Permit Reports – Identifies water quality exceedance(s) and the need to collect soil and sediment samples to locate source chemicals
TBD	AMAFCA Quality Assurance (QA) Manager	– Reviews planning documents and reports
Patrick Chavez	AMAFCA Stormwater Quality Engineer/Project Coordinator	– Coordinates monitoring and planning efforts. – Coordinates and participates in the collection of chemical data efforts. – Provides results for final report and writes appropriate portions of the annual report. – Coordinates development of project specific-sampling and analyses plan (SAP). – Reviews planning documents. – Coordinates Stakeholders. – Provides information and data needs pertaining to sample locations within the permit area based on team member affiliations. – Assists with development of final Sampling and Analysis report, as needed.
TBD	Field Team Leader and Field Staff	– Duties will vary, but may include any aspect of planning, sampling, analysis, validation and verification, and reporting of data. – Coordinate site access, laboratory space and containers, collect samples, field documentation.
TBD	Analytical Laboratory Manager	– Analyzes soil and sediment samples – Checks sample integrity – Produces electronic data deliverables (EDD) and hard copy reports – QCs laboratory reports
TBD	Data Validator	– Reviews laboratory reports for accuracy and completeness – Performs data validation

1.2 Planning Process

When the need to investigate soil or sediment arises, the investigation will be planned as described in this section. For example, an exceedance of one or more of the parameters listed in Tables XII.A and XII.B of National Pollutant Discharge Elimination System (NPDES) Permit No. NMS000101 could require additional investigation to locate the source of chemicals, as directed by the Executive Engineer. Once it has been determined that additional investigation is required, the AMAFCA Project Manager may follow these steps to plan an investigation:

- **Identify the sampling approach:** based upon the location and chemical(s) that exceeded the permit parameters, the Project Manager will determine what media needs to be sampled and if any historical data is available. AMAFCA staff or a Contractor will perform the investigation.
- **Prepare Project-Specific SAP:** a project-specific SAP will be produced by developed by AMAFCA staff or the Contractor to describe the roles and responsibilities of staff, define the data objectives, identify the decisions that will be made with the data, and present the analytical requirements to generate the data.
- **Review and Approval:** the draft SAP will be reviewed by the AMAFCA Stormwater Quality Engineer. Their comments will be addressed and the SAP will be finalized. The final SAP will be delivered to the Engineer and SQE for their approval signatures. Sampling will not be performed until the SAP has been approved.
- **Field Investigation:** the Field Team Leader will assign responsibilities to each field member to complete the planning and field investigation. Responsibilities include coordinating access to sample locations, preparing sampling supplies, reserving laboratory space, and notify utility (if subsurface sampling will occur). The Field Team Leader will verify that all field staff have read the SAP, QAPP, Health and Safety Plan, and applicable SOPs prior to sampling. The analytical laboratory will review the samples received and send a sample check-in report to the Field Team Leader.
- **Data Validation and Analysis:** field and laboratory data will be validated by the project chemist or validation contractor. Validated data will be tabulated and reviewed to determine if it met the data objectives. If so the decision statements included in the SAP will be answered or deferred.
- **Reporting:** the field procedures followed to during sampling will be reported along with any deviations from the SAP. Based upon the answer(s) to the decision statements conclusions will be prepared. Additionally, recommendations for the next action to be taken will be reported. The draft report will be reviewed by the AMAFCA Stormwater Quality Engineer. Their comments will be addressed and the report will be finalized. The final report will be signed by the SQE.

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Section 2

Project Description

2.1 Background

This section of the SAP should describe the information that is known about the site or sites. It should include the scope of previous investigations and results. It should also describe reports or other documentation that are available. An example of this type of information is:

> **The sampling in AMAFCA's channels is being conducted as part of the Phase 1 MS4 permit to evaluate the presence of chemicals within channel sediments and identify potential sources of chemicals within the drainage areas. Based on the Phase I investigation data, AMAFCA collected three (3) additional sediment samples within the channel to further evaluate potential sources of chemicals. AMAFCA recommended collecting three (3) additional sediment samples from the channel to further evaluate potential presence of chemicals in sediments within these drainages. The additional sediment sampling locations are shown in the attached figures.**

2.2 Objectives

The goal of AMAFCA's stormwater quality monitoring program is to protect the waters of the Rio Grande. The objectives of each investigation conducted by or for AMAFCA should be articulated in the site-specific SAP for the investigation. This Field Sampling Plan (FSP) will guide the development of project-specific SAPs and reports for source investigations.

2.3 Schedule

A schedule should be included to describe the anticipated schedule for the sampling and analysis. The progress of this project will be documented and tracked from its inception through implementation to ensure all sampling and analytical activities are performed in accordance with all applicable requirements and in a cost effective manner.

The schedule should indicate the expected date of SAP approval by the AMAFCA Project Coordinator, dates when field activities will be conducted, and when analytical results will be delivered. Soil/Sediment chemistry results typically take 14 days to return from an analytical laboratory. When the data are received, they are verified and validated as described in SOP 15.0 *Data Verification and Validation Procedures* (NMED 2011). Once all data have been received and validated, the data will be assessed according to the most recent version of the assessment protocols (http://www.nmenv.state.nm.us/swqb/protocols/index.html). The schedule should indicate when draft and final Sampling and Analysis Reports will be submitted to the AMAFCA Project Coordinator.

2.4 Location

The site-specific SAP should include a description of the site and a figure showing the location with callouts for landmarks and important features. The scale of the map should be such that a person can use the map to find the site(s) and sample locations.

An example of a location description appropriate for a SAP is:

The project area includes the Lower Rio Grande and tributaries from the USGS gage below Elephant Butte Reservoir to the lowest station near the New Mexico/Texas line at the Corchesne Bridge (Figure X). Sampling will occur on several tributaries to the Lower Rio Grande in New Mexico, including Alamosa, Palomas, Las Animas, Percha, and Tierra Blanca Creeks.

Section 3

Sampling and Analysis

Each project-specific SAP should describe the rationale for selecting each soil or sediment sample location. After the sample locations are identified, the appropriate field procedures and chemical analyses should be determined.

3.1 Sample Location and Rationale

Soil and sediment samples will be collected from MS4 locations in order to identify sources of chemicals which maybe entering the MS4. The number of soil or sediment samples and their location should be described in each project-specific SAP. The rationale should include a review or description of:

1. Historical data generated by AMAFCA, quasi-governmental agencies, investigations conducted under NMED oversight or permitting, to meet Resource Conservation and Recovery Act (RCRA) permits, or under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The usability of historical data should be reviewed prior to using it to make a decision.
2. Historical uses of the site and adjacent properties.
3. Physical features of the site including, flow of surface water, connections to the MS4, areas where sediment has been deposited in the MS4, any abnormalities such as trash, construction debris, or illegal dumping.
4. Sampling locations should be selected that bracket perceived pollution sources and represent each of the assessment units in the watershed except for very small or mostly ephemeral systems.
5. Where possible the use of established stations allows for the examination of trends.
6. Access to proposed sample location, some locations may not be accessible my reasonable means due to health and safety concerns, right of way, or consent from private property owners.
7. How the sample result will be used to identify chemicals entering the MS4. Each sample location should be linked to a decision statement that will be assessed during reporting.

A table should be included with the project-specific SAP describing each sample that will be collected and the rationale for collecting that sample. A figure should be included showing each sample location for field personnel to reference. An example of the sample rationale table is shown at Table 2.

Table 2 Example Sample Rationale

Sample Identification	Location	Rationale	Type
Grantline-1	Outfall associated with ABC Environmental, a registered Polychlorinated Biphenyls (PCB) user	Downstream from ABC Environmental property at a spot in the channel where sediment collects	PCB sediment sample

3.2 Field Procedures

The field procedures to be implemented for collecting soil or sediment samples should be selected based upon conditions at each sampling site. The project-specific SAP should include a description of procedures, or reference a SOP, which will be followed by field personnel and the equipment to be used during sampling. The project-specific SAP shall describe the following at a minimum:

- Utility clearance, if subsurface samples will be collected
- Surface and subsurface soil sampling
- Sediment sampling
- Sample containers
- Decontamination of sampling equipment
- Investigation-derived waste disposal
- Field screening and use of air monitoring equipment
- Procedures to describe sediment and soil samples
- Field documentation
- Sample management, handling, and packaging
- Sample IDs which will be assigned to samples

Example description of field procedures:

Field personnel will use stainless steel scopes to collect sediment samples from the MS4 channel. Sediment grab samples will be collected from 0 to 6-inches below ground surface. Stainless steel scopes will be decontaminated between each location, and before sampling, following the procedures described in *Chemical Sampling – Equipment Cleaning Procedures (NMED 2011)*. A field rinsate blank will be collected after sample collection and decontamination. Excess sediment will be placed back at the sample location. Gloves and disposable scoops will be disposed of as trash.

Sediment grab samples will be placed directly into 4 ounce glass jars supplied by an analytical laboratory. Samples will be stored in a cooler with ice to preserve samples until delivery to an analytical laboratory. A sediment sample field form, included in Attachment A, will be completed for each location. All samples will be delivered to an analytical laboratoryat the end of the day.

3.3 Sample Analyses

When possible, approved EPA Solid Waste (SW)-846 methods should be used for analysis. Background information on chemical sources is described in Section 2.1 and will be used to select the appropriate chemical analyses. For sampling conducted for compliance with the MS4 permit, Table XII.B of NPDES Permit No. NMS000101 list the chemicals included in the stormwater monitoring program. Soil and sediment samples will be analyzed for chemicals which have a chronic exceedance in the watershed the sample location represents.

The analytical laboratory will be contacted to evaluate the analytical method(s) for each chemical. The analytical laboratory will supply reporting limit (RL) and method detection limit (MDL) for each analyte.

Example of analytical method selection:

> **Volatile organic compounds (VOCs) samples will be analyzed by EPA Method 8260C because the RLs are below the NMED Soil Screening Levels.**

Additionally, the analytical laboratory will describe the sample containers, holding times, and preservation requirements for each analytical method.

Example of sample container and preservation information:

> **Soil samples will be collected using Terra Core soil samplers and soil cores will be extruded into pre-preserved VOAs.**

Detection limit and sampling information must be included in the project-specific SAP.

A table summarizing the number of samples (including QC samples) will be included in the project-specific SAP to aid with field planning and ordering supplies and containers. As part of the field planning, the analytical laboratory will be notified of the sampling at least 14 days before the field investigation.

3.3.1 Field QC Samples

The QAPP describes the QC sample type and frequency which will be collected during the field investigation. The project-specific SAP will list the QC samples applicable to the field investigation (i.e., field duplicates, field blanks, and equipment blanks) and include the number to be collected based upon the number of samples in the field investigation. Trip blanks for VOC analyses will not be included unless the cooler also includes aqueous VOC samples. **Table 3** is an example of a sample summary that should be included in the SAP.

Table 3 Example Sample Summary

Sample Location	Assessment Unit	PCBs/Pesticides	VOCs
ABC Environmental Outfall	Grantline	3	3
QC	Field Duplicate	1	1
QC	Equipment Blank	1	1
	Totals	**5**	**5**

3.3.2 Laboratory QC Samples

The analytical laboratory Quality Assurance Plan and method SOPs describes the QC samples that will be analyzed. The project-specific SAP should describe any changes to the Laboratory QC sample analysis.

3.3.3 Field Instruments

Field data can be generated from water quality probes, field spectrometers, field test kits, and observations. The project-specific SAP will list the specific instruments that will be used in the field and calibration procedures.

Example of field instrument description:

> **YSI water quality probe will be used to measure temperature, conductivity, and pH. The probe will be calibrated according to manufacture procedures. Field measurements and calibrations will be recorded in the field logbook.**

Section 4

Reporting

A report will be written to document the procedures and results of the field investigation. An overview of reporting should be described in the site-specific SAP. The overview of reporting in the SAP should include:

- An introduction to describe the objective of the field investigation and who performed the work
- Documentation from the field investigation including field forms, logbook, and COCs.
- A description of the field work and deviations from the site-specific SAP.
- Results from the analyses of chemical samples and field data. The results will be used to answer decision statements and determine if the objective of the field investigation were met.
- Conclusion and recommendations if any additional sampling is necessary.
- Appendix with the complete laboratory package and data validation report.

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Section 5

References

New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB). 2011. *Data Verification and Validation Procedures*.

NMED. 2012*. Field Sampling Plan Development and Execution.*

NMED. 2011. *Chemical Sampling – Equipment Cleaning Procedures*.

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Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA)

Soil and Sediment Sampling Quality Assurance Project Plan

June 29, 2015

AMAFCA

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Tables

List of Acronyms and Abbreviations

AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
CFR	Code of Federal Regulations
COC	chain-of-custody
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
°C	degree Celsius
EDD	electronic data deliverable
EPA	United States Environmental Protection Agency
FSP	field sampling plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
LCS	laboratory control sample
MDL	method detection limit
MS	matrix spike
MS4	municipal separate storm sewer system
MSD	matrix spike duplicate
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PARCC	precision, accuracy, representativeness, completeness, and comparability
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RPD	relative percent difference
SM	Standard Method
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SQE	Stormwater Quality Engineer
SQPE	Stormwater Quality Program Engineer
SW	Solid Waste
SWQB	Surface Water Quality Bureau

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Section 1
Project Management

This quality assurance project plan (QAPP) for soil and sediment investigations by Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) was prepared in accordance with U.S. Environmental Protection Agency (EPA) *Guidance for Quality Assurance Project Plans* (EPA, 2002). The format of this QAPP is modeled after the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) QAPP for water quality management programs for consistency with other field investigation programs. It is important to use uniform monitoring and sample collection procedures to ensure data usability and provide effective data analysis.

1.1 Introduction

Sediments and soil investigated as part of stormwater quality monitoring in the Albuquerque Municipal Separate Storm Sewer System (MS4) is performed by AMAFCA and required under the United States Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Permit No. NMS000101. Investigations of contaminated soil or sediments from accidental releases from AMAFCA operations or illegal dumping on AMAFCA property may also need to be investigated from time to time. The purpose of this QAPP is to outline the Quality Assurance (QA) procedures for conducting field investigations to collect soil and sediment samples for chemical analysis. A site-specific Sampling and Analyses Plan (SAP) will be produced for each field investigation. A guidance Field Sampling Plan (FSP [CDM Smith 2014]) was written to describe the development of site-specific SAPs for the investigation of soil and sediment. Each site-specific SAP will describe the data quality objectives (DQOs), chemical analyses, sample locations and rationale, field procedures, and other necessary information for conducting the field investigation.

Some standard operating procedures (SOPs) are referenced in this QAPP. Where appropriate, the SWQB SOPs have been included for use by AMAFCA. SWQB SOPs can be obtained from www.nmenv.state.nm.us/swqb/sop/. For activities where SWQB SOPs do not exist or are not applicable, task specific procedures should be described in the site-specific SAP. **Table 1** lists the NMED SWQB SOPs available for use during investigation activities.

1.2 Distribution List

AMAFCA's Stormwater Quality Engineer (SQE) will provide a copy of the approved QAPP to all AMAFCA staff that conduct or oversee the collection, handling, analysis, and use of soil and sediment data. The QAPP will also be provided to all co-permittees, contractors, laboratories, or other entities conducting work related to the collection, handling, analysis, and use of soil and sediment data.

The SQE will ensure that a copy of the approved QAPP is available upon request to other AMAFCA employees or parties involved in water quality monitoring.

Table 1 New Mexico Environmental Department Standard Operating Procedures

SOP/Section	Title	Revision	Next Revision Date
SOP 2.1	Field Sampling Plan Development & Execution	1	12/15/2013
SOP 6.1	Sonde Calibration and Maintenance	2	3/15/2016
SOP 6.2	Sonde Deployment	2	3/15/2015
SOP 8.1	Chemical Sampling - Equipment Cleaning Procedures	0	To be determined
SOP 15.0	Data Verification and Validation Procedures	1	10/1/2015
Section 8	The 2007 NMED/SWQB SOP for Data Collection; Sediment Sampling	Not Applicable	Not Applicable

Notes:
NMED - New Mexico Environmental Department
SOP - Standard Operating Procedure
SWQB - Surface Water Quality Bureau

1.3 Project/Task Organization

All project activities covered by this QAPP will be performed by AMAFCA personnel or contractors. AMAFCA is organized into five management groups that report to the Executive Engineer. The Stormwater Quality Program (SWQP) is the group primarily responsible for collecting and analyzing stormwater quality data. The other four management groups are not included in this QAPP. The organization and responsibilities of the SWQP, pertaining to MS4 soil and sediment sampling, are discussed below.

1.3.1 AMAFCA Executive Engineer and Stormwater Quality Engineer

Each field investigation will be initiated by the AMAFCA Executive Engineer. The AMAFCA Stormwater Quality Engineer will report directly to the Executive Engineer. The Stormwater Quality Engineer is responsible for:

- Coordinating development of the site-specific SAP, including review and approval
- Identifying AMAFCA Staff and contractors who will be working on the project and assigning their responsibilities
- Updating and maintaining the QAPP and receiving approval from the AMAFCA QA Manager for changes
- Reviewing Sampling and Analyses Reports

1.3.2 AMAFCA Staff

AMAFCA Staff may be responsible for the preparation of the site-specific SAP, conducting fieldwork, and reporting. All AMAFCA personnel who generate environmental data are responsible for the documentation and implementation of methods and procedures described in this QAPP, and must be familiar with and follow the provisions of this QAPP. The Stormwater Quality Engineer is responsible for verifying that all data collection, storage, and management activities conducted by AMAFCA staff complies with the provisions of this plan.

1.3.3 AMAFCA Contractors and Analytical Laboratories

AMAFCA may hire contractors to plan and perform the field investigation. Contractors must provide sufficient QA/quality control (QC) information to ensure that the data they collect meets the requirements of this QAPP. Each contractor will report data to the AMAFCA Stormwater Quality Engineer. The contractor will be responsible for incorporating all AMAFCA comments into final documents.

Environmental data collected by AMAFCA are analyzed by independent analytical laboratories. Each analytical laboratory must provide QA/QC information and conform to the specifications and requirements of this QAPP. Each analytical laboratory will be provided with a copy of this QAPP and will report and provide data to the Stormwater Quality Engineer or designee. An analytical laboratory may be subcontracted by another AMAFCA contractor. When this occurs, the primary contractor must ensure and document that the laboratory (and all other subcontractors) adhere to this QAPP.

1.4 Problem Definition/Background

1.4.1 Background

AMAFCA was created in 1963 by the New Mexico legislature with specific responsibility for flooding problems in the greater Albuquerque area. AMAFCA's purpose is to prevent injury or loss of life and to eliminate or minimize property damage. AMAFCA does this by planning, building, and maintaining large "backbone" flood control structures that help alleviate flooding.

Stormwater quality monitoring in the Albuquerque MS4 is performed by AMAFCA and required under the EPA NPDES Permit No. NMS000101. In New Mexico, stormwater general permits are written, managed, and enforced by EPA Region 6. The NMED SWQB assists EPA in regulation of stormwater discharges by performing inspections on behalf of EPA and by serving as a local point of contact for providing information to operators and other agencies regarding this federal regulatory program.

Soil and sediment investigations in response to operational releases or illegal dumping would be conducted under the authority of the NMED. Data collected and used by AMAFCA for EPA or NMED regulatory compliance will conform to this QAPP. If the data are collected or handled by co-permittees on behalf of AMAFCA, those co-permittees will also conform to this QAPP.

1.4.2 Problem Definition

As authorized by the Clean Water Act, the NPDES Permit Program controls water pollution by regulating sources that discharge pollutants into waters of the United States. Stormwater discharges from MS4s are covered under NPDES general permits. MS4 Permit NMS000101 requires AMAFCA to conduct regular stormwater quality monitoring and reporting. Stormwater monitoring includes water and soils sampling, depending on the constituent of concern. AMAFCA also collects water quality data for non-enforcement purposes (e.g., to evaluate best management practice [BMP] performance).

Water quality could be impacted in the future through the release of chemicals in soil and sediment. AMAFCA would be responsible for investigating the potential impact of chemicals which could impair water quality.

1.5 Project/Task Description

AMAFCA conducts a variety of environmental activities throughout the calendar year. Site-specific SAPs will be written to describe the objectives of field investigations and how they will be conducted. Generally, data will need to be generated to determine sources of chemicals impacting water quality or to make decisions about the management of contaminated soil.

All site-specific SAPs produced for the collection of soil or sediment to evaluate impacts to water quality will conform to this QAPP.

1.6 Quality Objectives and Criteria for Measurement Data

DQOs are statements made to explain the certainty of a decision that has been made based on data. DQOs will be described in each project-specific SAP based upon goal of the field investigation. DQOs will mostly be focused on answering decision statements to determine if chemicals in soil or sediment are present and if they are impacting stormwater quality; or making decisions about management of contaminated soils.

Measurement performance criteria are established based upon the quality of data needed to make decisions. Each data quality indicator (DQI) has specific performance criteria. DQIs are used to ensure that field procedures, sample matrix, field conditions, and the packaging and handling of samples are not impacting data quality. **Table 2** lists the measurement performance criteria and DQIs for soil and sediment sampling.

Table 2 Field Samples for Data Quality Indicators and Measurement Performance Criteria

Field Quality Control Sample	Frequency for Soil Matrix	DQI	Measurement Performance Criteria
Field duplicate	1 per 10 samples, rounded up	Homogeneity – precision	Relative percent difference (RPD) <50%
Equipment blank	1 per 20 or field event (which every is greater), if non disposable equipment is used	Contamination – accuracy	<Method Reporting Limit
Matrix spike(MS)/matrix spike duplicate (MSD)	1 per 20 samples	Matrix interference - accuracy	Laboratory in-house RPD
Temperature blank	1 per cooler	Accuracy	4 degrees Celsius(°C) $\pm$ 2°C

1.7 PARCC Parameters

Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are DQI. PARCC goals established for soil and sediment sampling will be used to aid in assessing data quality as discussed in the following sections.

1.7.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Combined field and laboratory precision is usually evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a RPD.

RPD is calculated as follows:

$$RPD = \frac{|A - B|}{(A + B)/2} \times 100\%$$

Where, A = First duplicate concentration
B = Second duplicate concentration

Field sampling precision is evaluated by analyzing field duplicate samples. For every ten samples collected, one blind duplicate sample will be collected and analyzed. Blind duplicate samples are samples submitted for analysis with a composition and identity known to the submitter but unknown to the analyst and used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

Laboratory analytical precision is evaluated by analyzing laboratory duplicates or MS/MSD samples. MS/MSD samples will be collected for all analytes. The results of the analysis of each MS/MSD pair will be used to calculate the RPD as a measure of laboratory precision.

1.7.2 Accuracy

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS/MSD samples, laboratory control samples (LCSs) or blank spikes, surrogate standards, and method blanks. MS and MSD samples will be prepared and analyzed at a frequency of 5 percent. LCSs or blank spikes are also analyzed at a frequency of 5 percent. Surrogate standards, where available, are added to every sample analyzed for organic constituents. The results of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

$$PercentRecovery = \frac{S - C}{T} \times 100\%$$

where, S = Measured spike sample concentration
C = Sample concentration
T = True or actual concentration of the spike

The laboratory in-house limits will be used as the measurement performance criteria for assess MS/MSD, LCS, and surrogate DQIs.

1.7.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. Representative data will be obtained through careful selection of sampling locations and analytical parameters. Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of the data will also be ensured through the consistent application of established field and laboratory procedures. Laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined by comparison with existing data to be non-representative will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

1.7.4 Completeness

Completeness is a measure of the percentage of site-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this QAPP, site-specific SAP, and when none of the QC criteria that affect data usability are exceeded.

When all data validation is completed, the percent completeness value will be calculated by dividing the number of usable sample results by the total number of sample results planned for this investigation, as shown in the formula below:

Completeness = DO/DP *100

Where: DO = Amount of usable data obtained
DP = Predicted amount of usable data

Completeness will be evaluated and at least 90% of the data must be valid. If less than 90% of the data are valid, the AMAFCA Stormwater Quality Engineer will evaluate if additional sampling is necessary for the field investigation.

1.7.5 Comparability

Comparability expresses the confidence with which one dataset can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data. Similar data that has been gathered using this QAPP can be readily compared. Data gathered using other QAPP procedures can be compared if the sampling and analysis procedures are determined to be equivalent.

1.7.6 Detection and Quantitation Limits

The method detection limit (MDL) is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The reporting limit represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a sample matrix. The analytical laboratory's reporting limits and MDLs will be included in the project-specific SAP for all of the analytes included in the field investigation. The reporting limits will be assessed to verify that analytical results will meet the field investigation's DQOs.

1.8 Special Training/Certifications

Draft Section - Pending Revision

Draft Section - Pending Revision

1.9 Documentation and Records

1.9.1 Documentation

The site-specific SAP and this QAPP will be reviewed by all personnel working on the project. Site-specific SAPs should include the most recent SOP and sampling procedures, an organization matrix identifying the roles and responsibilities of project staff, and any amendments to this QAPP for project specific QA procedures. The AMFCA Stormwater Quality Engineer will be responsible for ensuring that the project staff have read this QAPP. The field team leader will be responsible for ensuring the field staff have read the site-specific SAP and SOPs.

The analytical laboratory Quality Assurance Plan will be reviewed by the AMAFCASQE, or Contractor QA Manager, to ensure that the laboratory QA procedures meet the project requirements. The analytical laboratory will be responsible for updating their Quality Assurance Plan.

Each data report will contain a case narrative that briefly describes the number of samples, the analyses, and any analytical resolutions or QA/QC issues associated with the submitted samples. The data report will also include signed chain-of-custody forms, sample logs, cooler receipt forms, analytical data, a QC package, including all required QA/QC results as prescribed by the method, and raw data, if applicable.

The analytical laboratory will submit analytical data reports to the AMAFCASQE, or Contractor, in electronic format (PDF). Electronic data deliverables (EDDs) will be provided in Microsoft Excel format.

Data other than laboratory data include field log books, field forms, calibration logs, etc. and they will be recorded in standardized formats and in accordance with SOPs or procedures included in the site-specific SAP. Field data will be recorded during sampling activities and will be legible. Field forms and logbooks will be electronically scanned and stored in the project folder and filed in the hard copy project folder, for each sampling event.

The AMAFCA SQE will be responsible for maintenance of the document control system. This system shall include a document inventory procedure and filing system. Project personnel are responsible for project documents in their possession while working on a particular task. Field logbook(s) will be filed as part of the document control procedure. Documentation describing changes to approved plans, if they occur, will be included in the document control system. All documented correspondence, important field and management notes, letters, memoranda, field plans, etc. associated with soil and sediment sampling will be kept in the electronic or hard copy project folder. Hard copies will be stored for seven years. Electronic copies will be stored indefinitely.

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Section 2

Data Generation and Acquisition

This section provides information on how soil and sediment data are generated and acquired by AMAFCA, or the Contractor. The guidelines specified in this section were developed to ensure that data collected are appropriate and reliable and of sufficient quality to meet the DQOs.

2.1 Sampling Process Design

Sampling process design for soil and sediment sampling will be based on identifying sources of chemicals in sediment or soil; or identifying management decisions for soil or sediment. The site-specific SAP will identify sample locations and provide the rationale for selecting each locations and sampling method. The majority of the sampling done by AMAFCA will be judgmental sampling designed to answer decision statements or determine management of soil and sediment. Decision statements will be generated to select sample locations based upon the objective of the field investigation, physical features of the site, historical data, characteristics of the chemicals of concern and professional judgment.

2.2 Sampling Methods, Handling, and Custody

All field activities will be conducted in accordance with the SOPs or procedures referenced in the site-specific SAP. SOPs and procedures that must be incorporated by reference in the site-specific SAP include:

- Utility clearance, if a subsurface investigation will be conducted
- Soil and sediment sampling procedures
- Management of investigation-derived waste
- Document control for logbooks, field forms, and chain-of-custodies (COC)
- Field measurements using portable analyzers, if a photo ionizing detector, flame ionizing detector or similar devices are used
- Sample custody, packaging, and shipping
- Procedures for sampling with a drill rig, if one will be used to collect subsurface samples
- Soil boring abandonment, if a drill rig is used

A COC will accompany all samples analyzed by the laboratory. The COC will be filled out by field staff and include the number of samples, containers, preservative, date and time of sample collection, and requested analysis. When samples are not in the field staff's possession, they will be locked or secured. When samples are transferred to an overnight carrier or courier, the COC will be signed over. The laboratory sample custodian will check the COC against the contents of the cooler when they receive the samples. The laboratory custodian will send sample logins, with COCs, to the AMAFCA Stormwater

Quality Engineer, or Contractor, within 24 hours of receiving the samples. Sample coolers will be sealed with a custody seal if they are shipped by overnight carrier.

2.4 Analytical Methods

EPA Solid Waste (SW)-846 analytical methods will be used to analyze soil and sediment samples. If an EPA SW-846 method does not exist, then a Standard Method (SM) or American Society for Testing and Materials (ASTM) will be selected for analyses. Analytical methods will be identified in the site-specific SAP and will include rationale for selecting the method.

2.5 Quality Control

Various field and laboratory QC samples and measurements will be used to evaluate if the data meets DQOs for the project.

2.5.1 Field Quality Control

As described in Section 1.7, new staff and inexperienced staff will work with experienced field team members during field activities. The field logbook and field forms will be QC'ed by the field team leader prior to completing fieldwork.

2.5.2 Field Duplicates

Field duplicates will be collected identically and at the same time as primary samples. This type of field duplicate measures the total system variability (field and laboratory variance), including the variability component resulting from the inherent heterogeneity of soil. Field duplicate collection frequency is presented in **Table 2**.

2.5.3 Laboratory Quality Control

All samples will be analyzed by a laboratory with an established QA programs described in the Quality Assurance Plan. The plan shall include the following key elements:

- Demonstrate the laboratory's capability and qualifications to perform environmental analyses by summarizing and documenting the QA procedures employed by the laboratory.
- Control laboratory operations by establishing procedures that measure the laboratory's performance on a daily, weekly, monthly, quarterly, and yearly basis.
- Measure matrix effects to determine the effect of a specific matrix on method performance and analyte recoveries.
- Provide a means of ensuring that appropriate QC information is consistent, available, and recoverable to enable the end user to assess the quality of the data.

Analytical laboratories will follow all laboratory QC checks defined in the analytical methods. These can include the analyses of method blanks, surrogates, and LCS samples.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

2.6.1 Field Operations

Field instruments may be used to measure chemical properties, monitor site conditions for health and safety, and screen soil or sediment samples. The site-specific SAP will list the field equipment which will be used. All field equipment must be maintained according to the manufactures instructions. Any malfunctioning equipment must be noted in the field logbook and reported to the appropriate person or rental company. Rental companies shall include an inspection checklist with equipment stating the inspections performed prior to renting the equipment.

2.6.2 Laboratory Operations

Information regarding analytical equipment and associated maintenance used by analytical laboratories will be conducted according to the analytical laboratory's Quality Assurance Plan, SOPs, and the analytical method.

2.7 Instrument/Equipment Calibration and Frequency

The specific brand and model of field equipment or analytical instruments used by AMAFCA, contractors, or analytical laboratories will vary. Instrument calibration must be conducted in accordance with the equipment manuals or analytical laboratories Quality Assurance Plan or SOP. Calibrations will be checked and documented in field logbooks or analytical laboratory.

2.7.1 Field Operations

Field instrument will be calibrated before each use according to the manufacturer's instruction manual. All personnel using field equipment are expected to read and be familiar calibration procedures and have the required standards. Any equipment that fails calibration will be recalibrated. If it fails a second time or if the equipment malfunctions, the field sampling team will contact the manufacturer for assistance. If necessary, the equipment will either be replaced or any deviations from the sampling plan will be noted.

2.7.2 Laboratory Operations

Calibration of analytical laboratory equipment will be based on written procedures approved by laboratory management and documented in SOPs or the Quality Assurance Plan. Instruments and equipment will be initially calibrated and continuously calibrated at approved intervals, as specified by either the manufacturer or more updated requirements (e.g., methodology requirements). Calibration standards used as reference standards will be traceable to EPA, the National Institute of Standards and Technology, or another nationally recognized reference standard source.

Records of initial calibration, continuing calibration and verification, repair, and replacement will be filed and maintained by the laboratory. Calibration records will be filed and maintained at the laboratory where the work is performed and may be required to be included in data reporting packages.

2.8 Nondirect Measurement Data Acquisition Requirements

Data collected by individuals or organizations other than AMAFCA must, at a minimum, meet the QA/QC requirements described in this document. AMAFCA will determine whether the data meet these requirements.

Nondirect measurement data include information from site reconnaissance, literature searches, and interviews. The acceptance criteria for such data include a review by someone other than the author.

2.9 Data Management

The analytical laboratory will be responsible for QC of laboratory reports and generating EDDs. EDDs will contain the field and laboratory sample IDs, information on sample collection and analyses, results, reporting limits, and other information pertinent to reporting. Contractors shall maintain a project file with field data, laboratory reports and EDDs. If necessary, a database shall be set-up to manage data. The site-specific SAP will describe database requirements and identify a database manager.

The Project Manager of an investigation will coordinate QC and uploading field data to the database. The contractor will be responsible for ensure data integrity throughout the project including regularly scheduled backup of all data. The final database shall be delivered to AMAFCA at the end of the project.

All data will be handled in accordance with the AMAFCA data management requirements.

Section 3

Quality System Assessment and Oversight

3.1 Quality System Assessment and Response Actions

A field planning meeting will be conducted prior to mobilizing for each event. The AMAFCA Stormwater Quality Engineer or contractor equivalent will be present during the meeting along with the field staff. The meeting will review the equipment, supplies, role/responsibilities, notification of the analytical laboratory and property owners, and duration of the fieldwork. Any missing supplies, equipment, or deficiencies will be corrected prior to mobilizing to the field.

The SQE will plan and identify necessary field or office audits in the site-specific SAP based upon AMAFCA requirements and project complexity. Audit results will be maintained in the project file and will be used to correct deficiencies.

3.2 Reports to Management

The AMAFCA Stormwater Quality Engineer will be responsible for reporting to the Executive Engineer project status updates and the results of field investigations. AMAFCA staff, or contractors, will report the results of field investigations as described in the site-specific SAP.

Every report will describe data validation procedures and data usability. The report will be provided to AMAFCA in memo format in Microsoft Word, by hard copy or by electronic transmission.

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Section 4

Data Validation and Usability

Final analytical data packages will be reviewed and verified as described below.

4.1 Data Review, Verification, and Validation

Data review, verification, and validation are key steps for ensuring the integrity, suitability, and usability of the data. All field and analytical data are continually reviewed by the Project Engineer or designee and verified and validated according to the SOPs. Results from the data verification and validation process are summarized on the Data Verification and Validation Worksheet and maintained in the project file. The Project Engineer will resolve data quality issues. All information pertaining to this process will be documented thoroughly and maintained in the project file.

4.2 Verification and Validation Methods

Final data packages will be reviewed by the analytical laboratory in accordance with their Quality Assurance Plan. Data verification will be performed by the laboratory QA staff. All laboratory data will be verified by the laboratory performing the analysis for completeness and technical accuracy prior to reporting.

The data verification and validation procedures conducted by AMAFCA, or contractors, are described in *Data Verification and Validation Procedures* (NMED 2013). This process establishes the criteria for accepting, rejecting, or qualifying data. All data not meeting the appropriate QA/QC requirements as identified through the data verification and validation process are assigned appropriate data qualifier.

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Section 5

References

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MS4 Permit NMS000101
AMAFCA Annual Report
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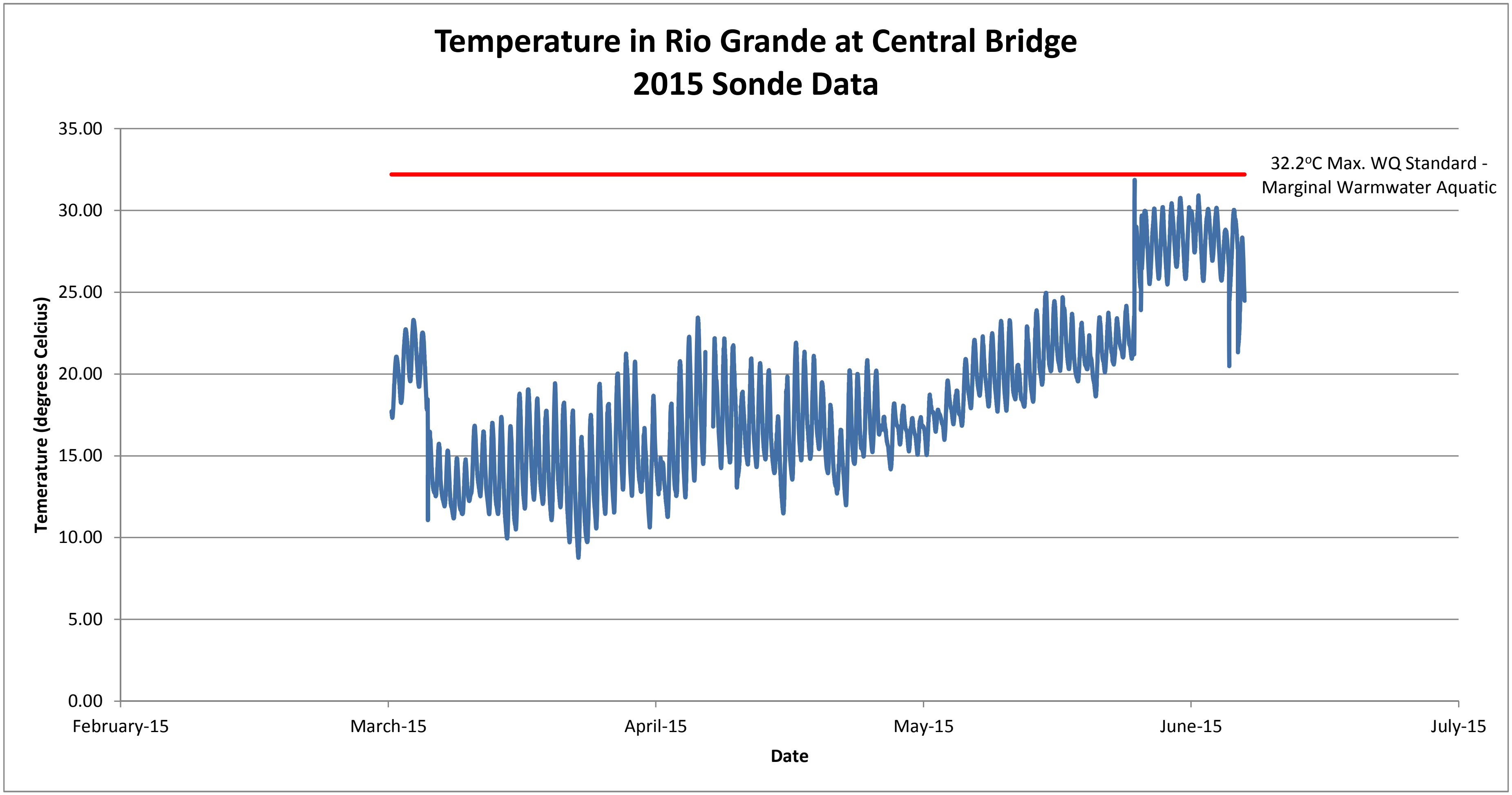
Attachment V – Compliance with Water Quality Standards Requirement – Temperature

- Status of Implementation and Performance Assessment Table V
- Plot of 2015 Temperature Sonde Data In Rio Grande at Central Bridge
- Temperature Analysis and Annual Summary for:
    - North Diversion Outfall - ML 1: North Floodway Channel near Alameda
    - ML 2: South Diversion Channel above Tijeras Arroyo near Albuquerque
    - ML 3: San Jose Drain at Woodward Road at Albuquerque
    - ML 4: Tijeras Arroyo near Albuquerque
    - ML 5: Mariposa Diversion of San Antonio Arroyo at Albuquerque
- Continuous Monitoring Gap Memo for 2015

NOTE - Included in Digital Copy – Spreadsheets with temperature Tidbit data for ML 2 – 5.

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
TABLE V: Compliance with Water Quality Standards Requirement – Temperature						
A. Develop and implement a strategy to reduce the effects of MS4 discharges on the temperature of receiving waters of the Rio Grande that cause or contribute to exceedances of applicable temperature water quality standards in waters of the United States. Ensure the strategy complies with requirements in Part I.B.1.f.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	N/A	• Activity Completed in 2012. AMAFCA and the MS4 co-permittees do not believe that MS4 discharges adversely affect temperature in the receiving waters of the Rio Grande. In order to prove this assertion, temperature data from 1982 to present was assembled and analyzed. This data analysis proved the assertion that the receiving waters of the Rio Grande are not adversely affected by the temperature of stormwater from the Albuquerque MS4. This data was presented in an initial report that was submitted to EPA on May 1, 2012.	N/A	N/A	N/A
B. Submit schedule for the following activities: 1) Identification of potential for MS4 discharges to contribute to raised temperatures in the receiving waters of the Rio Grande utilizing existing data and/or additional monitoring. 2) Development and implementation of controls to reduce the effects of MS4 discharges on the temperature of receiving waters of the Rio Grande that cause or contribute to exceedances of applicable temperature water quality standards in waters of the United States. C. Provide status reports to EPA. 1) Initial report to include; i. Findings regarding Rio Grande conveyed discharge contribution to exceedances of applicable temperature water quality standards in waters of the United States. ii. Conclusions drawn, including support for any determination. iii. Activities undertaken to reduce MS4 discharges contribution to exceedances of applicable temperature water quality standards in waters of the United States. iv. Plan for stakeholder involvement.	Activities removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activities are complete.	N/A	• Activity Completed in 2012. An initial report was submitted to EPA on May 1, 2012. The data analysis presented in the initial report proved the assertion that the receiving waters of the Rio Grande are not adversely affected by the temperature of stormwater from the Albuquerque MS4. A status report was submitted to EPA on September 1, 2012. Tidbit probe temperature data was collected at 5 outfall locations from June 1 to July 31, 2012. This data was provided to the EPA in this letter report. In addition, a summary of temperature exceedances was provided. There were two temperature exceedances recorded for a total time of less than 30 minutes over 196 hours of recorded water flow data. Therefore the time during which a temperature exceedance occurred represents less than 0.25% of the time during which discharges occurred.	N/A	N/A	N/A
2) Subsequent progress reports to include; i. Adherence to schedule. ii. Activities undertaken to identify MS4 discharge contribution to exceedances of applicable temperature water quality standards in waters of the United States. iii. Conclusions drawn, including support for any determinations. iv. Activities undertaken to reduce MS4 discharge contribution to exceedances of applicable temperature water quality standards in waters of the United States. v. Accounting of stakeholder involvement.	AMAFCA and the MS4 co-permittees will submit a progress report as part of the annual report to EPA regarding temperature impacts from stormwater to the Rio Grande that include adherence to schedule, activities undertaken and conclusions drawn.	• Temperature data for stormwater and the Rio Grande will continue to be collected by Tidbit probes and DO Sondes at the NDC and at a location downstream of the confluence with the Rio Grande to meet requirements related to the Endangered Species Act and BO (see Table VI). • AMAFCA will include a progress report as part of the annual report to EPA. • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• No Goals Required for 2012. This activity applies to the second and subsequent annual reports.	• Met 2013 Goals. Temperature data for stormwater and the Rio Grande was collected by Tidbit probes and DO Sondes to meet requirements related to the Endangered Species Act and BO (see Table VI). The temperature data was reviewed and tabulated for the 2013 qualifying storm events at the NDC outfall (see Attachment V for temperature data tabulation). The NDC storm events were determined as qualifying events if they were large enough to reach the Rio Grande. The NDC has an inverted section (aka, the Bathtub) which drains low flows to a large WQ MH and then to the Alameda Drain. The combined effects of the Bathtub and the Equipment Crossing (i.e., downstream weir) result in limiting flows that discharge to the Rio Grande to those that exceed 250 cfs and 13 acre-feet. This is the same approach for the Incidental Take in accordance with the BO. In summary, the discharge from all 2013 qualifying storm events did not exceed the water temperature water quality standards for the NDC. Co-permittee COA reviewed the temperature data for the remaining monitoring locations: ML2--SDC above Tijeras Arroyo (USGS Station 08330775) temp data through 11/7/13; ML3--SJD at Woodward Road (USGS Station 08330200) temp data through 9/16/2013; and ML4--Tijeras Arroyo (USGS Station 08330600) temp. data through 10/30/13. This data is provided in Attachment V. The temperature data for ML5--Mariposa Diversion of San Antonio Arroyo (USGS Station 083299375) was not received from USGS due to file corruption.	• Met 2014 Goals. This Annual Report serves as a progress report to EPA. Temperature data for stormwater and the Rio Grande was collected by Tidbit probes and DO Sondes to meet requirements related to the Endangered Species Act and BO (see Table VI). The temperature data was reviewed and tabulated for the 2014 qualifying storm events at the NDC outfall (see Attachment V for temperature data tabulation). The NDC storm events were determined as qualifying events if they were large enough to reach the Rio Grande. The NDC has an inverted section (aka, the Bathtub) which drains low flows to a large WQ MH and then to the Alameda Drain. The combined effects of the Bathtub and the Equipment Crossing (i.e., downstream weir) result in limiting flows that discharge to the Rio Grande to those that exceed 250 cfs and 13 acre-feet. This is the same approach for the Incidental Take in accordance with the BO. In summary, the discharge from all 2014 qualifying storm events did not exceed the water temperature water quality standards for the NDC. The temperature data was analyzed for the remaining monitoring locations: ML2--SDC above Tijeras Arroyo (USGS Station 08330775); ML3--SJD at Woodward Road (USGS Station 08330200) temp data; ML4--Tijeras Arroyo (USGS Station 08330600); and ML5--Mariposa Diversion of San Antonio Arroyo (USGS Station 083299375). The analysis and data for all of the monitoring locations is provided in Attachment V.	• Met 2015 Goals. This Annual Report serves as a progress report to EPA. Temperature data for stormwater and the Rio Grande was collected by Tidbit probes and DO Sondes to meet requirements related to the Endangered Species Act and BO (see Table VI). The sonde monitoring in early January shows that the temperature of the Rio Grande at Central Bridge was below 32.2^{0}C, which is the maximum temperature water quality standard for Marginal Warmwater Aquatic (plot is provided in Attachment V). The temperature data was reviewed and tabulated for the 2015 (Jan. to June) qualifying storm events at the NDC outfall (see Attachment V for temperature data tabulation). The NDC storm events were determined as qualifying events if they were large enough to reach the Rio Grande. The NDC has an inverted section (aka, the Bathtub) which drains low flows to a large WQ MH and then to the Alameda Drain. The combined effects of the Bathtub and the Equipment Crossing (i.e., downstream weir) result in limiting flows that discharge to the Rio Grande to those that exceed 250 cfs and 13 acre-feet. This is the same approach for the Incidental Take in accordance with the BO. In summary, the discharge from all 2015 qualifying storm events did not exceed the water temperature water quality standards for the NDC (ML1, from Table XII.C in Permit). The temperature data was analyzed for the remaining monitoring locations: ML2--SDC above Tijeras Arroyo; ML3--SJD at Woodward Road; ML4--Tijeras Arroyo; and ML5--Mariposa Diversion of San Antonio Arroyo. The analysis and data for all of the monitoring locations is provided in Attachment V.



Temperature in Rio Grande at Central Bridge
2015 Sonde Data
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Temerature (degrees Celcius)
32.2ºC Max. WQ Standard -
Marginal Warmwater Aquatic
February-15
March-15
April-15
May-15
June-15
July-15
Date

ML 1: North Floodway Channel near Alameda (USGS Station No. 08329900) 2015 Temperature Reporting (Jan. to June) for NDC Qualifying Storm Events (Volume > 13 acre-feet)						
NDC Qualifying Storm Events (Volume > 13 ac-ft)			Peak Time NDC* Temp (^oC)	Rio Grande at Central Temp (^oC)	Exceedance?	Reason/Explanation
Date	Peak Runoff Time	Season				
1/1/2015	20:25	Winter	NO DATA	NO DATA	NO	No temperature data in NDC or Rio Grande at Central; Sondes were taken offline from 1/1/15 to 3/26/15. Due to winter season, Rio Grande temperature likely < 32.2^{o}C, assume no exceedance.
1/1/2015	0:50	Winter	NO DATA	NO DATA	NO	No temperature data in NDC or Rio Grande at Central; Sondes were taken offline from 1/1/15 to 3/26/15. Due to winter season, Rio Grande temperature likely < 32.2^{o}C, assume no exceedance.
1/2/2015	22:10	Winter	NO DATA	NO DATA	NO	No temperature data in NDC or Rio Grande at Central; Sondes were taken offline from 1/1/15 to 3/26/15. Due to winter season, Rio Grande temperature likely < 32.2^{o}C, assume no exceedance.
1/21/2015	20:50	Winter	NO DATA	NO DATA	NO	No temperature data in NDC or Rio Grande at Central; Sondes were taken offline from 1/1/15 to 3/26/15. Due to winter season, Rio Grande temperature likely < 32.2^{o}C, assume no exceedance.
1/31/2015	10:35	Winter	NO DATA	NO DATA	NO	No temperature data in NDC or Rio Grande at Central; Sondes were taken offline from 1/1/15 to 3/26/15. Due to winter season, Rio Grande temperature likely < 32.2^{o}C, assume no exceedance.
2/28/2015	13:55	Winter	NO DATA	NO DATA	NO	No temperature data in NDC or Rio Grande at Central; Sondes were taken offline from 1/1/15 to 3/26/15. Due to winter season, Rio Grande temperature likely < 32.2^{o}C, assume no exceedance.
4/26/2015	9:45	Spring	13.3	14.7	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
4/26/2015	16:30	Spring	13.9	14.4	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
5/4/2015	18:30	Spring	NO DATA	18.4	NO	No temperature data in NDC or Rio Grande upstream of NDC Embayment; Sonde was out of service 5/1/15 to 5/12/15. Rio Grande at Central temperature < 32.2^{o}C. No exceedance.
5/13/2015	6:40	Spring	17.4	15.5	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
5/15/2015	20:20	Spring	13.9	13.8	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
5/19/2015	1:05	Spring	16.3	15.3	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
5/21/2015	20:20	Spring	16.0	15.7	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
5/25/2015	19:00	Spring	17.4	16.8	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
6/7/2015	15:25	Spring	20.4	23.2	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.
6/27/2015	20:40	Summer	23.7	29.2	NO	Rio Grande upstream of NDC Embayment temperature < 32.2^{o}C. Rio Grande at Central temperature < 32.2^{o}C.

Green Shading		Qualifying storm events in which the temperature of the NDC discharge into the Rio Grande did not cause the Rio Grande river temperature to exceed 32.2^{o}C
Gray Shading (No Sonde Data)		Sondes (Rio Grande at Central and Above Embayment) was taken offline from 1/1/15 to 3/26/15 Sonde (Rio Grande Above Embayment) was out of service 5/1/15 to 5/12/15

* Due to construction in the NDC Embayment, the NDC sonde was moved to the Rio Grande at Sandia Pueblo (just above the Embayment). As a result, Rio Grande at Central temperatures are also checked with a lag time of 3.5 hours from the NDC Peak Runoff Time.
Used same Qualifying Storm Events as reported in Incidental Take Statement for DO (per BO).
Temperature data collected in the NDC Embayment for the DO/BO Monitoring Requirement.
Exceedance = greater than 32.2^{o}C

ML 2: South Diversion Channel above Tijeras Arroyo near Albuqerque (USGS Station No. 08330775) 2015 (January to June) Temperature Reporting (Temperatures > 32.2 °C)								
(Temperatures > 32.2 °C)				Rio Grande at Central Temp (°C)	Mean Air Temperature (°C)	Max Air Temperature (°C)		
Date	Time	Season	Temp (°C)				Exceedance?	Reason/Explanation

No Temperature Exceedances from Jan. to June 2015. Tidbit probe often recorded air temperture for dry stream conditions.

Season - references season defined in the BO.
Temperature data collected by temp tidbit
Exceedance = greater than 32.2 °C
NCS data from 1/1/15 to 6/30/15 - did not include dates whan only 1 water temperature reading was available.

ML 3: San Jose Drain at Woodward Road at Albuquerque (USGS Station No. 08330200) 2015 Temperature Reporting (Temperatures > 32.2 °C)									
NOTE THAT THE MONITORING LOCATION FOR THIS OUTFALL IS LOCATED 2 MILES UPSTREAM OF THE DISCHARGE POINT TO THE RIO GRANDE. THE CHANNEL IS UNLINED. THEREFORE DISCHARGE TO THE RIO GRANDE AS RECORDED AT THE GAGE IS UNLIKELY.									
(Temperatures > 32.2 °C)									
Date	Time	Season	Temp (°C)	Rio Grande at Central Temp (°C)	Mean Air Temperature (°C)	Max Air Temperature (°C)	Exceedance?	Reason/Explanation
06/28/15	13:00	Summer	35.6	26.4	25.6	33.9	Potential	Potential stormwater discharge to Rio Grande > 32.2 °C

Used same Qualifying Storm Events as reported in Incidental Take Statement for DO (per BO).
Season - references season defined in the BO.
Temperature data collected by temp tidbit
Rio Grande at Central Temp is upstream of where San Jose Drain enters the Rio Grande - but this is the nearest temperature data that is available.
Exceedance = greater than 32.2 °C
NCS data from 1/1/15 to 6/30/15
Air Temp Data from Weather Underground History for KABQ
http://www.wunderground.com/history/airport/KABQ/2015/6/28/DailyHistory.html?req_city=Albuquerque&req_state=NM&req_statename=New+Mexico&reqdb.zip=87101&reqdb.magic=1&reqdb.wmo=99999

ML 4: Tijeras Arroyo near Albuqerque (USGS Station No. 08330600) 2015 (January to June) Temperature Reporting (Temperatures > 32.2 ^{o}C)								
(Temperatures > 32.2 ^{o}C)								
Date	Time	Season	Temp (^{o}C)	Rio Grande at Central Temp (^{o}C)	Mean Air Temperature (^{o}C)	Max Air Temperature (^{o}C)	Exceedance?	Reason/Explanation

No Temperature Exceedances from Jan. to June 2015. Tidbit probe often recorded air temperture for dry stream conditions. Where Tidbit data estimated wet stream conditions and had only 1 data point, temperature was not considered representative of water temperature.

Season - references season defined in the BO.
Temperature data collected by temp tidbit
Exceedance = greater than 32.2 ^{o}C
NCS data from 1/1/15 to 6/30/15 -
on AMAFCA server - S:\AMAFCA Files\035 000000 U.S. EPA\035 001000 MS4 Permit\035 0010005 2012 Permit\035 0010006G Annual Report - 2015 (Jan-June)\V Temperature\2015 Temp\Data\Copy of Tijeras Drain_Jun 2015.xlsx

ML 5: Mariposa Diversion of San Antonio Arroyo at Albuqerque (USGS Station No. 083299375) 2015 (January to June) Temperature Reporting (Temperatures > 32.2 ^{o}C)								
(Temperatures > 32.2 ^{o}C)				Rio Grande at Central	Mean Air Temperature	Max Air Temperature		
Date	Time	Season	Temp (^{o}C)	Temp (^{o}C)	(^{o}C)	(^{o}C)	Exceedance?	Reason/Explanation
06/14/15	14:45	Summer	33.2	22.6	22.2	30.0	Yes	Stormwater discharge at this outfall > 32.2 ^{o}C
06/28/15	15:30	Summer	34.0	27.7	25.6	33.9	Potential	Potential stormwater discharge to Rio Grande > 32.2 ^{o}C

Notes:
Season - references season defined in the BO.
Temperature data collected by temp tidbit
Exceedance = greater than 32.2 ^{o}C
NCS data from 1/1/15 to 6/30/15 - did not include temp. readings with only 1 or 2 water temperature measurement.
Air Temp Data from Weather Underground History for KABQ

Continuous Water Quality Monitoring Data

01/01/2015 – 06/30/2015

Gaps > 24 hours

All Sondes have data missing from 01/1/15 through 03/26/15 due to low water levels. The instruments were installed on 03/27/15.

Rio Grande upstream of Embayment (Site ID: 083296806) {Rio Grande at Sandia Pueblo}

Sonde was out of service from 05/01/15 through 05/12/15.

- Temperature (NONE)
- Specific Conductance
  - 03/27/15 – 05/1/15: Erroneous Values
- pH (NONE)
- Turbidity
  - 03/27/15 – 04/22/15: Erroneous Values
- Dissolved Oxygen
  - 04/27/15 – 04/30/15: Erroneous Values
  - 05/12/15 – 05/19/15: Erroneous Values

Embayment (Site ID: 083299176)

The Equipment at this site was not in service due to ongoing construction activity. Further, the instrument was sent for factory refurbishment during this period.

- Temperature (NONE)
- Specific Conductance (NONE)
- pH (NONE)

Embayment (Site ID: 083299176) - Continued

- Turbidity (NONE)
- Dissolved Oxygen (NONE)

Rio Grande at Central (Site ID: 08330000)

Sonde out of service 05/01/15 - 05/02/15, 05/26/15….

- Temperature (NONE)
- Specific Conductance (NONE)
- pH (NONE)
- Turbidity
    - 3/29/15 – 3/31/15: Erroneous Values
- Dissolved Oxygen

Rio Grande at Bernalillo (Site ID: 08329400)

Sonde out of service 05/01/15 - 05/02/15, 05/26/15 - ?

- Temperature: (NONE)
- Specific Conductance (NONE)
- pH (NONE)
- Turbidity (NONE)
- Dissolved Oxygen (NONE)

Isleta Drain (Site ID: 08331050)

Sonde out of service 05/01/15 - 05/02/15

- Temperature (NONE)
- Specific Conductance (NONE)
- pH (NONE)

Isleta Drain (Site ID: 08331050) - continued

- Turbidity
    - 03/27/15 – 03/31/15: Erroneous Values
    - 05/15/15 [9:15 am – 10:00 am]: Erroneous Values
- Dissolved Oxygen
    - 04/11/15 – 04/30/15: Erroneous Values
    - 05/11/15 – 05/15/15: Erroneous Values
    - 05/22/15 – 05/26/15: Erroneous Values

MS4 Permit NMS000101
AMAFCA Annual Report
2015

Attachment VI – U.S. Fish and Wildlife Service Biological Opinion Requirements

- Status of Implementation and Performance Assessment Table VI
- Letter to Joel Lusk, USFWS, dated December 1, 2015
- Incidental Take Statement for NDC Discharges to the Rio Grande from January to June 2015
- AMAFCA's Standard Operating Procedures for Sondes

Permit Activity Description	Proposed Plan	Measurable Goal	Status of Implementation and Performance Assessment CY 2012 (Permit Year 1)	Status of Implementation and Performance Assessment CY 2013 (Permit Year 2)	Status of Implementation and Performance Assessment CY 2014 (Permit Year 3)	Status of Implementation and Performance Assessment January to June 2015 (Half of Permit Year 4)
TABLE VI: U.S. Fish and Wildlife Service Biological Opinion Requirements						
To ensure actions required by this permit are not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat, permittees shall meet the following requirements, included in PART I.B.3. A. Conduct continuous monitoring of DO and temperature in the NDC Embayment and at one location in the Rio Grande downstream of the mouth of the NDC within the action area (e.g., Rio Bravo Bridge) to verify the remedial action is successful for the duration of the permit. It is recommended that continuous monitoring data be provided online for public review.	• AMAFCA will continue continuous monitoring of DO and temperature. depending on water depth and temperture, for the purposes of complying with the USFWS BO requirements. • AMAFCA currently contracts with an On-call Water Quality consultant to support the continuous monitoring.	For compliance with this Activity, AMAFCA will deploy two sondes, depending on water depth and temperture, to provide continuous DO and temperature monitoring at the following locations: - NDC Embayment - Rio Grande downstream of the confluence with the NDC within the "action area." According to Joel Lusk, the "action area" is along the Isleta Pueblo; therefore, the Rio Grande sonde can be located any where between the NDC and the I-25 crossing (i.e., Isleta Pueblo boundary). • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• Met 2012 Goals. AMAFCA has deployed two new sondes for purposes of complying with the USFWS BO requirements. The sondes are located at: 1) Rio Grande at the Central Avenue Bridge, and 2) NDC Embayment. The sondes are equipped to monitor DO and temperature as well as turbidity, pH and specific conductance. In addition to the sondes required for compliance, the following sondes are also deployed: 1) Rio Grande at the 550 Bridge, 2) Rio Grande upstream of the NDC Embayment, and 3) confluence of the Los Padillas and Arenal Drains. A letter to EPA was provided on May 1, 2012 stating that continuous monitoring had begun.	• Met 2013 Goals. AMAFCA continued the deployment of five sondes for collecting continuous DO and temperature data (same locations as 2012). Please refer to Table III for additional information.	• Met 2014 Goals. AMAFCA continued the deployment of five sondes for collecting continuous DO and temperature data (same locations as 2013). Please refer to Table III for additional information.	• Met 2015 Goals. AMAFCA continued the deployment of sondes for collecting continuous DO and temperature data; data collection is dependant on water depth and temperture. The sondes are equipped to monitor DO and temperature as well as turbidity, pH and specific conductance. There were three sondes in operation in the first half of 2015: 1) Rio Grande at the Central Avenue Bridge, 2) Rio Grande at Sandia Pueblo (just upstream of the Embayment) 3) Rio Grande at the 550 Bridge. Please refer to Table III - Dissolved Oxygen, above, for additional information.
B. Participate with EPA and the FWS in an annual meeting (may be via teleconference) during the permit period to review the remedial action progress, information gathered, and incidental take estimates associated with qualifying storm events.	AMAFCA will coordinate with EPA and USFWS annually to discuss status of the remedial action, information gathered and incidental take estimates.	• AMAFCA will participate with EPA R6 and USFWS in an annual meeting/conference call.	• Met 2012 Goals. In 2012, AMAFCA coordinated with EPA and USFWS to discuss status of the remedial action, which was completed in February 2012. Please refer to Table III for additional information.	• Met 2013 Goals. In 2013, AMAFCA coordinated with EPA and USFWS to discuss the status of the remedial actions of regrading the Embayment and installing the windmill and to share DO data and incidental take estimates. 2013 Meeting dates: July 9, December 19 and 23.	• Met 2014 Goals. In 2014, AMAFCA coordinated with EPA and USFWS on July 9 and July 17 to discuss the 2014 DO data and incidental take estimate. Sonde data was provided to Joel Lusk on July 8,2014 prior to the meetings.	• January to June 2015 - Did not complete this Goal. In the first half of 2015 (January to June), AMAFCA did not hold the coordination meeting with EPA and USFWS to discuss the 2015 DO data and incidental take estimate.
C. Provide the FWS with the following data and information on all qualifying storm events: date of any qualifying stormwater events, DO value in Embayment, DO value at downstream monitoring station, flow rate in the NDC, daily flow rate in the Rio Grande, and sum of silvery minnows taken. D. Describe, in annual reports, all standard operating procedures, quality assurance plans, maintenance, and implementation schedules to assure that timely and accurate water temperature, DO, oxygen saturation, and flow data are collected, summarized, evaluated and reported. E. Provide the FWS with electronic copies of all incidental take, interim, and annual reports required by this permit no later than March 31st for the preceding calendar year ending December 31st to nmesfo@fws.gov and joel_lusk@fws.gov or by mail to the New Mexico Ecological Services Field Office, 2105 Osuna Road NE, Albuquerque, New Mexico 87113; and	• AMAFCA, along with the MS4 co-permittees, will provide the necessary data elements for calculation of predicted incidental takes during qualifying storm events. • AMAFCA will take the lead on completing the RGSM estimated potential take spreadsheet created by USFWS for the BO. • The MS4 permittees are working the cooperative monitoring contractor to ensure that their quality assurance plans, maintenance, and implementation schedules to provide timely and accurate water temperature, DO, oxygen saturation. • The MS4 permittees are working with USGS to collect flow data for the program needs.	• AMAFCA will provide USFWS the necessary data for qualifying storm events so that USFWS can determine the actual incidental take. This data includes: - Date of the qualifying storm event, - DO value in the Embayment, - DO value in the Rio Grande at the Central Avenue Bridge, - Flow rate in the NDC, and - Daily flow rate in the Rio Grande. • AMAFCA will provide USFWS with electronic copies of the incidental take spreadsheet and interim and annual reports. • AMAFCA will document and incorporate, as applicable, these Program elements in the SWMP, currently being developed to meet the requirements in the new MS4 Permit (Permit NMR04A000).	• Met 2012 Goals. AMAFCA, in cooperation with COA, contracted with the USGS to collect the required continuous DO and temperature and gage data. USGS represented that they followed their QAPC for their means, methods, quality assurance and controls protocols. AMAFCA developed a letter and compilation of the incidental take data for the USFWS. A copy of this letter, dated March 13, 2013, to USFWS, New Mexico Ecological Services Field Office, regarding the "Data Related to the Incidental Take Related to the USFWS BO for the Albuquerque MS4 Permit No. NMS000101" is included in the 2012 Annual Report, Attachment E.	• Met 2013 Goals. AMAFCA, in cooperation with COA, continued the contract with USGS to collect the required continuous DO and temperature and gage data. There was improved data collection and less sonde malfunction in 2013 due to increased maintenance activities contracted with USGS. In addition, AMAFCA required USGS to review its quality assurance plans, maintenance, and implementation schedules. AMAFCA developed a letter and compilation of the incidental take data for the USFWS. A copy of this letter, dated March 31, 2014, to USFWS, New Mexico Ecological Services Field Office, regarding the "Data Related to the Incidental Take Related to the USFWS BO for the Albuquerque MS4 Permit No. NMS000101" is included in the 2013 Annual Report, Attachment VI.	• Met 2014 Goals. Through June 30, 2014 the monitoring cooperative (i.e., AMAFCA, COA, NMDOT, and UNM) received continuous monitoring data for DO and temperature from the USGS. The monitoring cooperative will continue to receive the required flow gage data for the NDC and the Rio Grande from USGS through June 30, 2015. From July 1, 2014 to June 30, 2015 the monitoring cooperative will receive continuous monitoring DO and temperature data from a consultant under contract with AMAFCA. AMAFCA developed a letter and compilation of the incidental take data for the USFWS. A copy of this letter to USFWS, New Mexico Ecological Services Field Office, is included in the 2014 Annual Report, Attachment VI.	• Met 2015 Goals. The monitoring cooperative (i.e., AMAFCA, COA, NMDOT, and UNM) received continuous monitoring data for DO and temperature from a water quality consultant under contract with AMAFCA. The monitoring cooperative continued to receive the required flow gage data for the NDC and the Rio Grande from USGS. AMAFCA developed a letter and compilation of the incidental take data for the USFWS. A copy of this letter to USFWS, New Mexico Ecological Services Field Office, is included in the 2015 Annual Report, Attachment VI. The standard operating procedures (SOPs) for the continuous monitoring were followed, as developed as part of the AMAFCA *Field Sampling Plan (FSP) for Wet Weather Monitoring in Compliance with the WSB MS4 Permit*, *Sampling Analysis Plan (SAP) for Wet Weather Monitoring in Compliance with the WSB MS4 Permit*, and *Quality Assurance Project Plan (QAPP) for Stormwater Monitoring in Compliance with the WSB MS4 Permi* t, Feb. 2015. Copies of the relevant SOPs for the sondes are provided in Attachment VI.
F. Complete the remedial action selected for the NDC Embayment.	Activity removed from AMAFCA's SWMP (Revision 1, May 29, 2013). Activity is complete.	N/A	• Activity Completed in 2012. AMAFCA implemented a strategy to reduce exceedances of applicable DO water quality standards in the NDC Embayment. AMAFCA re-graded the NDC Embayment at the outfall to the Rio Grande in order to create a wide and shallow channel cross-section, thereby eliminating decreasing DO with increasing water depth. Please refer to Table III, Activity A for additional information.	• Additional Activity in 2013. In 2013, AMAFCA completed the NDC Embayment Windmill Project. This project installed an aeration windmill adjacent to the Embayment to deliver oxygen to the water through two diffuser stones. Please refer to Table III, Activity B.2 for additional information.	• Additional Activity in 2014. In 2014, AMAFCA continued to operate the NDC Embayment Windmill. In addition, AMAFCA has completed the hydraulic modeling stage and begun the design and construction phase of the North Diversion Channel Outfall "Bathtub" Structure Project in May 2014. The project will modify three existing grade control features of the NDC outfall area, which include the "bathtub", the "equipment crossing", and the "embayment". The primary goal of the bathtub modifications is to protect the New Mexico Rail Runner bridge crossing from overtopping during large storm events. The water quality improvement goal of the bathtub modifications is to improve maintenance operations by AMAFCA and improve efficiency of sediment, trash, and debris removal due to better access and improved geometry. The proposed modifications to the embayment include filling the entire channel section up to a chosen design elevation along with the four existing riprap grade control structures within the embayment area. The purpose of the modifications is to improve maintenance operations and correct a vertical datum conversion that occurred during the previous embayment modification completed in 2012. Please refer to Table III, Activity B.2 for additional information.	• Additional Activity in 2015. By the end of June 2015, AMAFCA completed construction of the NDC Outfall Grade Control Structures Modification Project. The project modified three existing grade control features of the NDC outfall area, which include the Bathtub, Equipment Crossing, and the Embayment. The primary goal of the Bathtub modifications is to protect the New Mexico Rail Runner bridge crossing from overtopping during large storm events. The water quality improvement goal of the bathtub modifications is to improve maintenance operations by AMAFCA and improve efficiency of sediment, trash, and debris removal due to better access and improved geometry. In addition, with this improvement, water from the Rio Grande is not allowed to stagnate in the Embayment. In the first half of 2015, AMAFCA consulted with the Corps of Engineers and the USFWS. The USFWS is writing a new draft BO, including special conditions, for the NDC outfall/Embayment area. Please refer to Table III, Activity B.2 for additional information.

Jerry M. Lovato, P.E.
Executive Engineer

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Metropolitan
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Flood
Control
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December 1, 2015

Joel Lusk
New Mexico Ecological Services Field Office
2105 Osuna Road NE
Albuquerque, New Mexico 87113

RE: NPDES Permit No. NMS000101
2015 January to June Annual Report for AMAFCA

Dear Mr. Lusk:

Enclosed is an electronic disk containing those sections of the certified 2015 January to June Annual Report, which document AMAFCA's compliance efforts for the Biological Opinion and dissolved oxygen requirements of the MS4 Permit. Concurrently, electronic copies of the 2015 January to June Annual Report are being sent to EPA Region 6, NMED and the Pueblos of Sandia and Isleta.

As you may be aware, depending on the timing and determination of an ongoing Biological Assessment (BA) and Biological Opinion (BO), AMAFCA has construction activities planned for the second half of 2015 in the North Diversion Channel Embayment involving the placement of fill material.

If you have any questions or would like a hard copy of the report, please contact me or Patrick Chavez at (505) 844-2215.

Sincerely
AMAFCA

Jerry M. Lovato, P.E.
Executive Engineer

Encl: CD of 2015 Annual Report with Attachments III and VI
Cc: Correspondence File
File 035 001005C16

Incidental Take Report for NDC Discharges to the Rio Grande in Calendar Year 2015

NDC Qualifying Storm Event (V > 13 ac ft)			$Q_{P\ NDC\ Alameda}$	$Q_{P\ NDC\ Alameda}$	$DO_{SandiaPueblo}$	$DO_{Rio\ Grande}$	$Q_{Daily\ Rio\ Grande}$	$Q_{Daily\ Rio\ Grande}$	No. of RGSM Killed	No. of RGSM Harassed
Date	Peak Time	Season (Per BO Table 1)	Actual 08329900	Rounded (Per BO Table 1)	08329400 (mg/L)	08330000 (mg/L)	Actual 08330000	Rounded (Per BO Table 1)	in Lethal Zone DO <0.7 mg/L	in Impact Area 0.7<DO<4.4 mg/L
01/01/15	20:25	Winter	798	1,000	No Data	No Data	314	500	No Data	No Data
01/01/15	0:50	Winter	7,080	7,000	No Data	No Data	367	500	No Data	No Data
01/02/15	22:10	Winter	1,100	1,000	No Data	No Data	304	500	No Data	No Data
01/21/15	20:50	Winter	303	500	No Data	No Data	666	500	No Data	No Data
01/31/15	10:35	Winter	288	500	No Data	No Data	723	500	No Data	No Data
02/28/15	13:55	Winter	506	500	No Data	No Data	479	500	No Data	No Data
04/26/15	9:45	Spring	436	500	3.52	8.0	550	500	N/A	67
04/26/15	16:30	Spring	330	500	4.31	7.97	682	500	N/A	67
05/04/15	18:30	Spring	3,010	3,000	No Data	6.49	491	500	N/A	No Data
05/13/15	6:40	Spring	342	500	3.49	7.94	800	1,000	N/A	7
05/15/15	20:20	Spring	792	1,000	8.49	7.78	731	500	N/A	N/A
05/19/15	1:05	Spring	358	500	6.03	7.58	1,250	1,500	N/A	N/A
05/21/15	20:20	Spring	299	500	8.14	7.42	2,290	2,500	N/A	N/A
05/25/15	19:00	Spring	580	500	7.87	7.48	2,970	3,000	N/A	N/A
06/07/15	15:25	Spring	413	500	7.75	6.97	1,080	1,000	N/A	N/A
06/27/15	20:40	Summer	3,560	2,000	6.89	5.56	938	1,000	N/A	N/A

NOTE: No. of RGSM Killed or Harassed (columns 9 and 10) is based on lookup table. FWS to provide final incidental take number based on population count. From BO, p. 46, if stormwater discharges containing less than 0.7 mg/L DO occur during the period of May 15 to 31, then up to 973 larval silvery minnow may also die. Based on available information, this did not occur in 2013.

Green Shading	No Incidental Take according to BO; DO in NDC Embayment > 4.4 mg/L
Gray Shading (No Sonde Data)	1/1/2015 to 3/26/2015= Sonde was taken offline due to low water levels. The instrument was installed on 3/27/15.
	5/2/2015 to 5/7/2015 = Sonde was taken to offline to be calibrated. The calibrated instrument was installed on 5/8/2015.

No. Events in 2015 w/ Takes:	**3**	
	Incidental Take	
	Allowed	2015
Mortalities =	1,528	0
Harassments =	10,548	141

Incidental Take Allowance Source:
Summary of Biological Opinion on the Albuquerque MS4 Stormwater Permit, Sept. 2011, USFWS

AMAFCA Water Quality SOP #1
Water Quality Sonde Calibration and Maintenance

1. Purpose and Scope

The purpose of this document is to describe the procedure for calibrating and maintaining sondes.

This procedure is based on the capabilities of In-Situ Inc. (In-Situ) sonde and sensors described in Sections 2 and 3. A sonde is a water quality monitoring device that is placed in the water to gather water quality data.

AMAFCA owns and maintains a number of In-Situ sondes. The sondes are used primarily to monitor temperature and dissolved oxygen (DO), but they also monitor electrical conductivity (EC), pH, and turbidity.

This SOP describes the measures required to calibrate and maintain the sondes in a manner that is consistent with AMAFCA's Stormwater Quality Monitoring Program, as described in the QAPP and FSP.

2. Equipment and Tools

The sondes employed by AMAFCA are manufactured by In-Situ, an industry leader in water quality monitoring instrumentation and supplies. The manufacturer contact information is as follows:

In-Situ Inc.
Attn: Technical Support
221 E. Lincoln Avenue
Fort Collins, CO 80524
Phone: (800) 446-7488
e-mail: support@in-situ.com

The specific In-Situ sonde model number is the TROLL 9500 Professional, which uses Win-Situ 4 software to interface with PCs. This software is a proprietary product of In-Situ, and allows the user to program the sonde and download data from the sonde. Win-Situ 4 software and the user's manual (In-Situ, 2004) are available through the Stormwater Quality Engineer, and can also be downloaded from the In-Situ website (http://www.in-situ.com).

Sondes and sensors are described in Table 1. Instruction manuals for the sondes and sensors (e.g., In-Situ, 2009) are available through the Stormwater Quality Engineer. The following procedures are based largely on information in these manuals.

3. Step-by-Step Calibration Process Description

3.1 General

Sonde calibration should be conducted in the laboratory prior to deployment to ensure that probes and device are working properly. For existing deployed probes, calibrations and equipment inspections should be conducted every 2 to 3 weeks. Calibrations should be recorded in the field notebook at the time of calibration. Calibration records must not be discarded.

Table 1. In-Situ Troll 9500 Professional Sensor Characteristics

Sensor	Parameter	Units	Range	Accuracy
TROLL 9500	Temperature	°C	-5 to +50	± 0.10°C
33220	Conductivity	µS/cm	150–112,000	± 0.5% of reading or 2µS/cm, whichever is greater
32870	Dissolved oxygen	% saturation	0–450	± 1%
32870	Dissolved oxygen	mg/L	0–20	± 0.1 mg/L for 0–8 mg/L; ± 0.2 mg/L for greater than 8 mg/L
59510	pH	s.u.	0–12	± 0.1 s.u.
TROLL 9500	Turbidity	NTU	0–2,000	± 5% or 2NTU, whichever is greater

°C = Degrees Celsius
µS/cm = Microsiemens per centimeter
mg/L = Milligrams per liter
s.u. = Standard units
NTU = Nephelometric turbidity units

Between unattended sonde deployments and prior to redeployment, clean probes as necessary, replace the DO caps and recalibrate. If probes require cleaning, see Section 4 for specific cleaning procedures.

3.2 Calibration Range

In-calibration range limits are shown in Table 2. If sensors cannot be calibrated within these limits, the instrument should be returned to the staff member responsible for sonde managment or alternate for maintenance. Post-deployment checks that are not within the in-calibration range will be addressed by the Stormwater Quality Engineer.

Table 2. Calibration Ranges

Measurement	Standard	Standard Value	In-Calibration Range
Temperature (°C)	NIST traceable thermometer	Ambient temperature	± 0.5°C
Conductivity (µS/cm)	Standard solution	10,000	± 10 µS/cm
Dissolved oxygen (%)	Saturated air	100	± 10%
pH (s.u.)	Buffer solution	4, 7, 10	± 0.2 s.u.
Turbidity (NTU)	Deionized water Standard solution	0 100, 126	± 5 NTU ± 10 NTU

3.3 DO Sensor Calibration

The following steps should be followed to calibrate the DO sensor:

A. The DO sensor compensates for the temperature of the water. To perform an accurate calibration, it is important that the temperature of the water remain constant during the procedure. The easiest way to do this is to allow the water used for calibration to sit overnight in an open container until it equilibrates to room temperature. If the temperature changes by more than 0.5°C during calibration, DO measurements may be inaccurate and the sensor will need to be recalibrated when the temperature of the water stabilizes. For this reason, the calibration should also not be performed in direct sunlight.

B. Stand the sonde so that the sensors are pointed upward with the storage cup attached. Add about 1 liter (L) of room temperature deionized water (or clean tap water with a conductivity of less than 500 microsiemens per centimeter [µS/cm]) to a clean 1-gallon jug. A half-filled 1-L bottle can also be used. Shake the jug or bottle very vigorously for 40 seconds to ensure DO saturation.

C. Establish a connection to the sonde using Win-Situ 4. Wait for sonde to initialize the sensors. Progress can be monitored on the bar at the bottom of the screen.

D. Fill the storage cup with the DO saturated water over the sensors to the bottom of the threads and place the storage cap on upside-down. Do not screw the cap on.

E. When the sonde is ready to operate click the 'Calibration' tab in Win-Situ 4.

F. Select the 'DO (%Sat)' tab. A picture of the DO sensor should appear on the screen.

G. Wait for the current value and temperature readings to stabilize. If the cap was stored wet this should happen very quickly. A dry cap may take several minutes to stabilize.

H. Enter the current absolute barometric pressure in millimeters of mercury (mm Hg) in the box. Click 'Calibrate'. A "Calibration Successful" message will be displayed.

3.4 Specific Conductance Sensor Calibration

Conductivity standards are very sensitive to contamination. Inscribe the date the container is opened on the label and discard the solution 1 month after opening. Perform the conductivity calibration before the pH calibration. Ensure that the sensor and calibration cup are clean and rinse the sensor and calibration cup with the calibration standard.

A. Establish a connection to the sonde with Win-Situ 4. . When the sonde finishes its initialization, click the 'Calibration' tab, then click the 'SpCond [mS/cm]' tab. You will see a picture of the current conductivity reading, the date and time, and the current temperature.

B. The first calibration point is measured with a dry sensor to establish a zero point. Rinse the sensors with deionized water and dry them thoroughly. Be sure that the inside of the conductivity cell is dry. In the box on the Hydras screen, type a value of '0' and click 'Calibrate'. A "Calibration successful" message will appear.

C. Fill the storage cup about 25 percent with a conductivity standard higher than the highest expected value of the water at the sampling site. Screw the cap on and shake vigorously for 6 seconds. Discard the standard.

D. Fill the cup with the calibration standard again, this time so the conductivity cell is completely submerged. Wait 1 minute for the readings to stabilize. When the readings are stable, type the labeled value of the standard into the box and click the 'Calibrate' button. A "Calibration successful" message will appear. The sensor is now calibrated.

Optionally, a second standard midway between '0' and the calibration value can be used to check the linearity of the sensor. Repeat the process used for the high standard with the second standard, but do not click the calibrate button again. The reading for the second standard should be ± 1% of the labeled value.

3.5 pH Sensor Calibration

Calibrate the pH sensor with buffers of pH 7.0, and either pH 4.0 for acidic waters or pH 10.0 for alkaline waters. If the expected pH of the water being sampled is unknown, then a 3-point calibration should be performed following the pH 7, 4, then 10 pattern. The pH buffers contain high concentrations of phosphate. Take care during calibration to avoid leaving traces of buffer on equipment or at the work place that could contaminate water samples. Inscribe the date the container is opened on the label. Label buffer solutions prepared from reagent powder or concentrate with date of preparation. Buffer solutions decanted from larger air-locked bladder containers must be discarded after 1 month after each bottle was filled. Each buffer container should have the date written on the bottle when it was filled from the air-locked bladder container.

VERY CAREFULLY clean the glass bulb with a very soft brush and a mild soap. The bulb is made from extremely thin glass and is very fragile. Replace the reference junction if it is visibly fouled. Water with strong biological activity tends to foul the junction more rapidly. Replace the electrolyte solution regularly. Water with very low levels of dissolved solids or high flow rates will leach the salts out of the solution and dilute it more quickly. Your specific water conditions will determine how frequently this should be done.

Use of the salt tablets from the maintenance kit will keep the electrolyte solution saturated for longer periods of time.

A. Establish a connection to the sonde with Win-Situ 4. When the sonde finishes its initialization, click the 'Calibration' tab, then click the 'pH Units' tab. You will see pictures of the four different pH probes available as well as the current pH value, the date and time, and the current temperature.

B. Rinse with tap water. Either dry the sensors and rinse once with pH 7 buffer or rinse twice with pH 7 buffer. To rinse, fill the cup about 25 percent with pH buffer 7 and screw the storage cap on. Shake for 6 seconds. Remove the storage cap and pour the pH 7 buffer out. Fill the cup with pH 7 buffer again, this time over the top of the pH sensor. Wait 1 minute for the readings to stabilize. When the readings are stable, type a value of 7.00 into the box, adjusted for temperature if necessary, and click 'Calibrate'. A "Calibration Successful" message will appear.

C. If the pH readings continue to drift for an extended period of time, or jump up and down, the sensor may need to be cleaned or replaced.

D. Pour the pH 7 buffer out and rinse with tap water. Either dry the sensors and rinse once with pH 4 or 10 buffer or rinse twice with pH 4 or 10 buffer. To rinse, fill the cup about 25 percent with pH 4 buffer or pH 10 buffer solution depending on your expected deployment conditions. Screw on the storage cap and shake for 6 seconds. Remove the storage cap and pour the buffer solution out. Fill the cup with the same buffer solution again, this time over the top of the pH sensor. Wait 1 minute for the readings to stabilize. When the reading stabilizes, type the labeled value of the solution into the box, adjusted for temperature, and click 'Calibrate'. A "Calibration Successful" message will appear.

E. If the pH readings continue to drift for an extended period of time, or jump up and down, the sensor may need to be cleaned or replaced. The pH sensor is now calibrated.

If desired, a linearity test may be performed with a buffer opposite that used for pH slope calibration. For example, if pH 10 buffer was used to calibrate, check with pH 4, buffer; if pH 4 buffer was used to calibrate, check with pH 10 buffer. Repeat the process used for the previous calibration with the opposing buffer solution, but do not click the calibrate button again.

3.6 Temperature Sensor Calibration

Thermistors cannot be calibrated. Annually, or when a malfunction is suspected, check the temperature reading against a NIST traceable thermometer to ensure suitable instrument performance, ±0.5°C (see Table 2).

3.7 Turbidity Sensor Calibration

A. Establish a connection to Win-Situ 4. Wait for the sensors to initialize. To minimize ambient light interference during calibration, the calibration cup can be darkened by wrapping it in thick paper or cloth.

B. Zero Point Calibration – Fill the cup about 25 percent with deionized water and screw the storage cap on. Shake for 6 seconds. Remove the storage cap and pour the deionized water out.

C. With the sensors pointed upward, fill the storage cup approximately 75 percent with deionized water and screw the storage cap on tightly. Slowly turn the sonde over so the sensors point downward.

D. Ensure that sensors are clean, and click on the 'Turbidity [NTU]' tab. In the box labeled 'Turbidity [NTU]' enter a value of 0.3.

E. Wait 1 minute for the readings to stabilize. Click 'Calibrate'. Click the 'OK' button in the "Calibration Successful" window.

F. High-End Calibration – The high-end calibration point should be a value higher than the highest value anticipated at the deployment site. The standard factory high point is 100 NTU.

G. Pour the deionized water out of the storage cup and either dry the sensors or repeat rinse step I (below) twice.

H. Gently swirl and/or invert the bottle of 100 NTU solution for 2 to 3 minutes to mix the suspension. DO NOT shake the bottle of solution; this will suspend air bubbles in the solution and change the turbidity of the standard.

I. Pour the StablCal into the storage cup until it is about 25 percent filled. Screw the cap on tightly and shake the sonde. Remove the cap and pour the solution out.

J. Gently pour StablCal into the storage cup again, this time filling the cup to 75 percent. Screw the cap on and gently turn the sonde over so the sensors are pointing downward.

K. In the box labeled ‘Turbidity [NTU]’ enter a value of ‘100’.

L. Wait 1 minute for the readings to stabilize. Click ‘Calibrate’. Click the ‘OK’ button in the “Calibration Successful” window. The turbidity sensor is now calibrated.

4. Maintenance

4.1 General

Refer to the instrument manual or manufacturer for detailed maintenance requirements. Copies of all manuals are maintained by the Stormwater Quality Engineer.

Any staff member who performs maintenance activities (e.g., probe replacement, software updates) is responsible for recording this in the field notebook.

4.2 Replacement Parts

See the staff member responsible for sonde management or alternate for replacement parts. Do not discard any malfunctioning parts, as these may be under warranty.

4.3 O-Rings

If the O-rings and sealing surfaces on the sondes are not maintained properly, water can enter the battery compartment and/or sensor or cable connector ports of the sonde. Water can severely damage the battery terminals or probe ports, causing loss of battery power during a deployment, inaccurate readings and corrosion to the contacts. Therefore, when the battery compartment lid is removed, the O-rings that provide the seal should be carefully inspected for contamination (e.g. hair, grit, etc.) and cleaned if necessary using the instructions provided below. The same inspection should be made of the O-rings associated with the probes, port plugs and field cable connectors when they are removed. If no dirt or damage to the O-rings is evident, then they should be lightly greased (see below) without removal from their groove. However, if there is any indication at all of damage, the O-ring should be replaced with an identical item from the Hydrolab maintenance kit supplied with the sondes. At the time of O-ring replacement, the entire O-ring assembly should be cleaned as described below.

4.3.1 O-Ring Removal

Use a small, flat-bladed screwdriver or similar blunt-tipped tool to remove the O-ring from its groove. Check the O-ring and the groove for any excess grease or contamination. If contamination is evident, clean the O-ring and nearby plastic parts with lens cleaning tissue or equivalent lint-free cloth soaked in a mild detergent solution.

CAUTION: Do not use alcohol on O-rings as this may cause a loss of elasticity and promote cracking. Do not use a sharp object to remove the O-rings. Damage to the O-ring or the groove itself may result.

Before reinstalling the O-rings, make sure that you are using a clean workspace and clean hands, and are avoiding contact with anything that may leave fibers on the O-ring or grooves. Even a very small bit of contamination (hair, grit, etc.) may cause a leak.

4.3.2 O-Ring Installation

Place a small amount of lubricant supplied in the maintenance kit or food-grade silicone grease between your thumb and index finger (More grease is NOT BETTER!). Draw the O-ring through the grease while pressing the fingers together. Use this action to place a VERY LIGHT covering of grease to all sides of the O-ring. Place the O-ring into its groove making sure that it does not twist or roll. Use the previously grease-coated finger to once again lightly go over the mating surface of the O-ring. DO NOT use excess grease on the O-ring or the O-ring groove. The grease is a lubricant, not a sealant.

CAUTION: Do not overgrease the O-rings. The excess grease may collect grit particles that can compromise the seal. Excess grease can also cause the waterproofing capabilities of the O-ring to diminish, potentially causing leaks into the compartment. If excess grease is present, remove it using lens cloth or lint-free cloth.

4.4 Ports

4.4.1 Sonde Probe Ports

Whenever you install, remove, or replace a probe or port plug, it is extremely important that the entire sonde and all probes and plugs be thoroughly dried prior to removal of the probe or probe port plug. This will prevent water from entering the port. Once you remove a probe or plug, examine the connector inside the sonde probe port. If any moisture is present, rinse both the port and the probe with DI water, remove the water with three rinses of 95 percent ethanol and dry thoroughly with compressed air. Equipment subjected to this procedure must air dry for at least 24 hours before reassembly. If the connector is corroded, return the sonde to the staff member responsible for sonde management or alternate. When you reinstall a probe or port plug, lightly grease the O-ring with lubricant supplied in the Maintenance Kit or food-grade silicone grease.

4.4.2 Cable Connector Port

The cable connector port at the top of the sonde should be covered at all times. When a communications cable is not connected to the cable connector port, the pressure cap supplied with the instrument should be securely tightened in place.

If moisture has entered the connector port, dry it completely using 95 percent ethanol and compressed air. Never attempt to dry the connector port with a rag or paper towel as this may bend the pins. Apply a very thin coat of lubricant from the maintenance kit or food-grade silicone grease to the O-ring inside the connector cap periodically throughout the year.

4.5 Probe Maintenance

4.5.1 Conductivity Probes

The only maintenance required is cleaning of the probe's cell and body. Debris, organisms, and other contaminants in the sensor cell will have a negative impact on the accuracy and stability of the readings. The inside of the cell should be cleaned out after every deployment with a cotton swab or small brush.

Additionally, prior to calibration of conductivity, all sensors should be cleaned. Any residue or debris on the sensors may contaminate the conductivity standards and change their value, resulting in an inaccurate calibration. Clean the oval measurement cell on the specific conductance sensor with a small, non-abrasive brush or cotton swab. Use soap to remove grease, oil, or biological growth. Rinse with water.

The temperature portion of the probe requires no maintenance.

4.5.2 DO Probes

The DO probe is nearly maintenance free. To ensure accurate readings and long sensor life, the probe should be kept clean. After each deployment, the sensor should be cleaned with a cotton swab or soft brush and soapy water to remove any oils or organisms. Organisms living on the sensor will consume or produce oxygen and change the readings. Hard scrubbing will remove the black coating from the outside of the sensor cap. If more than half of the coating is removed, the cap must be replaced. If deposits on the sensor are difficult to remove, soak the sensor in warm tap water until the deposits soften. NEVER use organic solvents such as acetone or methanol on any part of the sensor or cap.

When the sensors are clean, the DO probe is ready to calibrate.

4.5.3 Optical Turbidity Probes

The standard turbidity sensor's only maintenance requirement is to be kept clean. The optics should be cleaned before and after each deployment with a soft brush or lint free wipe and soapy water. Rinse the sensors well with clean fresh water after cleaning to prevent soap residue from building up on the lenses.

4.5.4 Integrated Reference pH Probes

In order to give consistently accurate readings, the pH sensor should be maintained on a regular basis. Oils, sediment, and biological contaminants on the bulb or reference junction will result in errant readings or a very slow response. Leaching or dilution of the electrolyte solution in the reference will cause the readings to drift over time. The glass bulb is very thin and fragile. Care should always be taken not to damage it when servicing the instrument. The sensor should be cleaned with a cotton swab or soft brush and soapy water. The reference junction is a threaded cap with a sleeve of porous Teflon in the center. The Teflon allows the reference electrolyte to make an electrical connection to the sample water while preventing them from mixing freely. If it becomes clogged or dirty, replace it. Turn the junction counter-clockwise to unscrew it from the base. If you have the integrated sensor/reference, you will need a flat screwdriver to do this. With the junction off, pour the old electrolyte solution out and replace it with fresh solution.

For extended deployments or for monitoring extremely low conductivity water add a salt tablet to the reference electrolyte as well. This will maintain the saturation level of the electrolyte as the salt slowly leaches through the Teflon junction. Fill the reference until the electrolyte forms a slight dome over the top. Gently place the new junction into the top of the reference tube so that no air remains inside, and turn it clockwise until the O-ring is sealed tightly. As you tighten you will see a small amount of electrolyte and possibly bubbles being forced out of the junction. This is the air being purged from inside the junction. If this purging effect does not occur, the junction may be clogged and must be replaced.

5. Storage

Because batteries can degrade over time and release battery fluid, it is extremely important to remove the batteries from all sondes prior to long-term storage. Failure to remove batteries can result in corrosive damage to the battery compartment and terminals if the batteries leak.

When Troll 9500 equipment is not in use, most sensors must be kept moist to prevent damage. In-Situ recommends using pH 4.01 buffer as a storage medium for both long- and short-term storage. After performing a slope calibration with pH 4.01, rather than discarding the buffer, save it to use as a storage medium. Although calibration standards should never be reused for calibration, used pH 4.01 buffer is acceptable as a storage medium. In the absence of pH 4.01 buffer, clean tap water is second best. If field water must be used, replace it with a recommended medium as soon as the instrument is back at the laboratory. Do not use deionized water or allow the storage medium to freeze.

6. Troubleshooting

Troubleshooting guidelines are outlined in Table 3.

References

In-Situ, Inc. (In-Situ). 2004. *Win-Situ 4.0 user's guide with Pocket-Situ*. Rev. 003. November 2004. Available at <http://in-situ.com/force_download.php?file_id=367>.

In-Situ. 2009. Multi-Parameter TROLL 9500 Operators Manual. January 2009.

Table 3. Troubleshooting Guidelines

Symptoms	Possible Cause	Action
DO reading unstable or inaccurate	Probe not properly calibrated	Follow DO calibration procedures
	Membrane not properly installed	Follow setup procedure
	DO probe electrodes require cleaning	Follow DO cleaning procedure.
	Water in probe connector	Dry connector; reinstall probe
	Algae or other contaminant clinging to DO probe	Rinse DO probe with clean water
	Calibrated using improper barometric pressure	Repeat DO calibration procedure using proper barometric pressure
	Calibrated at extreme temperature	Recalibrate at (or near) sample temperature
	DO Charge too high (>75) Anodes polarized (tarnished) Moisture in probe port Probe has internal short.	Recondition probe with Maintenance Kit. Follow DO cleaning procedure. Dry carefully using instructions above. Replace probe. Return defective probe to the staff member responsible for sonde management.
	DO charge too low (<25) Insufficient or diluted electrolyte (membrane may be compromised). DO probe has been damaged Internal failure	Replace electrolyte and membrane. Replace probe Return sonde for service
pH readings are unstable or inaccurate. Error messages appear during calibration.	Probe requires cleaning,	Follow probe cleaning procedure
	Probe requires calibration	Follow calibration procedures
	pH probe sensor has dried out from improper storage.	Soak probe in tap water or buffer until readings become stable
	Water in probe connector	Dry connector; reinstall probe
	Probe has been damaged	Replace probe
	Calibration solutions out of spec or contaminated with other solution	Use new calibration solutions
	Internal failure	Return sonde for service
Conductivity unstable or inaccurate. Error messages appear during calibration.	Conductivity improperly calibrated.	Follow calibration procedure
	Conductivity probe contains bubbles or requires cleaning	Flush bubbles or follow cleaning procedure
	Conductivity probe damaged	Replace probe
	Calibration solution out of spec or contaminated	Use new calibration solution
	Internal failure	Return sonde for service
	Calibration solution or sample does not cover entire sensor.	Immerse sensor fully.

Table 3 (continued)

Temperature, unstable or inaccurate	Water in connector	Dry connector; reinstall probe
	Probe has been damaged.	Replace the probe
Turbidity probe: general	Probe requires cleaning.	Follow probe cleaning procedure
	Probe requires calibration	Follow calibration procedures
	Probe has been damaged	Replace probe
	Water in probe connector	Dry connector; reinstall probe
	Calibration solutions out of spec	Use new calibration solutions
	Wiper is not turning or is not synchronized.	Activate wiper. Assure rotation. Make sure setscrew is tight.
	Wiper is fouled or damaged.	Clean or replace wiper or wiper pad.
	Internal failure.	Return probe for service.
Installed probe has no reading	Sensor has been disabled	Enable sensor
	Water in probe connector	Dry connector; reinstall probe
	Probe has been damaged	Replace the probe
	Report output improperly set up	Set up report output
	Internal failure	Return sonde for service.

AMAFCA Water Quality SOP #2
Sonde Deployment

1. Purpose and Scope

The purpose of this document is to describe the procedure for deploying water quality sondes in rivers and streams for instantaneous or unattended measurements. This procedure covers use of the In-Situ Troll 9500 sondes described in SOP #1.

2. Background and Precautions

2.1 Streambed Dangers and Obstacles

Some channels contain quicksand-like areas, deep holes, sharp rocks, fallen logs, etc., that can cause foot entrapment, injury, or falls. The wading rod (without the current meter attached) can be gently used for stabilization and to probe the streambed when conditions are uncertain. Use professional judgment to assess risks involved with working in the streambed.

2.2 Rule of 10

Wading across a streambed can be dangerous depending on flow and substrate conditions. Do not attempt to wade into a stream if the depth (in feet) multiplied by the velocity (in feet per second [ft/s]) equals or exceeds 10. For example, a stream 2 feet deep with a velocity of 5 ft/s or more should be considered too dangerous to wade across. If you start to take measurements and discover part of the way across a stream that you are violating or will violate the rule of 10, return to the nearest bank and note "too fast/deep to measure" on the field form.

3. Equipment and Tools

The following equipment is used for unattended deployment or instantaneous measurements:

- In-Situ Troll 9500 sondes
- Interface cable
- Handheld datalogger or PC
- Nylon straps
- Hose clamps
- Bucket
- Field calibration standards
- Spare batteries
- Steel T-posts (6- and 8-foot) and driver
- Tie wire
- Chain/cable and weather-resistant padlock
- Diagonal pliers and lineman's pliers
- Sonde cover sleeve - perforated PVC tube of sufficient length to fully contain sonde
- Digital camera
- GPS unit
- 30-meter measuring tape
- Surveyor's flagging tape

4. Step-by-Step Process Description

4.1 Prior to Field Measurements or Unattended Deployment

Each sensor requires calibration in the laboratory before field use, and an accuracy check upon retrieval. Calibrate the sensors according to SOP #1: Sonde Calibration and Maintenance. Sensors should be calibrated and checked more frequently if there is reason to suspect a problem. Calibrate the dissolved oxygen (DO) sensor in the field to the appropriate elevation, and recalibrate whenever the elevation from one measurement location to the next changes by 300 meters (1,000 feet) or more. When calibrating the DO sensor as a result of an elevation change, record the calibration data in the field notebook. Record all calibration data and post-deployment check data in the field notebook.

4.2 Instantaneous Field Measurements

Measure field parameters during each sampling event as specified in the project Field Sampling Plan (FSP), and record the values in the field notebook. Record all of the digits that are displayed on the datalogger. Enter additional comments as appropriate.

In streams and rivers, if the flow appears to be well mixed from bank to bank, take measurements at the centroid of flow. The centroid is defined as the midpoint of the portion of the stream width that contains 50 percent of the total flow. If the stream is not well mixed, it may be necessary to take measurements at more than one location along the cross section of flow.

When field parameters cannot be measured in situ due to low flow, they may be measured in a container or a bucket used for sample collection. Use a bucket only when all efforts to obtain in situ measurements have been exhausted. Consider building small dams or depressions to create water deep enough to submerge the sensors. If a bucket is used, make clear notes in the field notebook indicating exactly what was done. Use a bucket that is large enough to allow full immersion of the sensors and bring the bucket to the same temperature as the water before it is filled.

At all locations, replace the calibration cup with the sensor guard and carefully place the sonde in the water. Allow the sensors to equilibrate for at least one minute in “Run” mode, which can be done while water samples are being collected.

Minimize entrapment of air in the probe chambers, which can be indicated by unstable conductance values fluctuating up to ±100 microsiemens per centimeter (μS/cm). Do this by slowly and carefully placing the probe into the stream and quickly moving it through the water while the probe is completely submerged, releasing any air bubbles. Record temperature, conductance, pH, turbidity, and finally DO on in the field notebook.

4.3 Unattended Deployment Monitoring

Deploy sondes as specified in the project FSP and calibrate the sonde sensors according to SOP #1 Sonde Calibration and Maintenance. Refer to Section 4.2 of this SOP for guidance on taking sonde measurements in rivers and streams. Sondes deployed for unattended sampling are to be checked and calibrated every two weeks (if practicable) and at the end of deployment, or as otherwise indicated in the Field Sampling Plan. Sensors should be checked and calibrated more frequently if there is reason to suspect a problem with the sensors or the data. Calibrate the DO sensor in the field to the elevation of the station and perform the DO post-deployment check upon retrieval before leaving the station, or at a location with a similar elevation. Record all calibration and post-deployment check data in the field notebook.

Ensure that sondes deployed for unattended monitoring are securely anchored and protected. An unattended sonde may be mounted inside a sonde cover sleeve and chained to a tree in the most secure location available. Other methods include mounting to a T-post, suspending from fenceposts or bridges, or attaching to USGS gauging station structures. Ideally the sonde should be deployed vertically in the centroid of flow where the sensors are most likely to remain submerged. However, the deployment location is subject to other factors such as the risk of vandalism or theft, and this may not always be feasible. If the sonde cannot be placed vertical it may be mounted horizontally 3 to 6 inches above the substrate with or without the cover sleeve and secured to a stable object such as rebar or a T-post. The sonde should not be laid horizontally directly on the substrate. If the sonde cannot be safely deployed due to a high risk of vandalism, theft, or imminent flooding, it should not be deployed for unattended monitoring.

Whenever possible, find an out-of-the-way place where the sonde is not easily detectable. If using, place the calibrated sonde with probe guard in the sonde cover sleeve (and note this in the comment field on the sonde deployment/retrieval form), which is perforated to allow the flow to contact the sensors while protecting the sonde from debris. Keep in mind that, while the cover sleeve may protect the sonde, it may also trap sediment in turbid waters and foul the sensors. Secure the sonde and cover sleeve to a T-post with nylon straps or hose clamps (Photograph 1).

1. Typical sonde deployment with T-post and cover sleeve

Keep the sonde from touching the substrate and allow sufficient space for sediment and bedload transport. Secure the sonde with a chain or cable to a tree or other immovable object and lock with a weather resistant padlock.

4.4 Programming Sondes for Unattended Monitoring

The In-Situ sonde uses Win-Situ 4 software to interface with PCs. This software is a proprietary product of In-Situ, and allows the user to program the sonde and download data from the sonde. Win-Situ 4 software and the user's manual (In-Situ, 2004) are available through the Stormwater Quality Engineer, and can also be downloaded from the In-Situ website (http://www.in-situ.com).

Note: A log file must be created and then enabled before data can be collected.

1. Connect the Data Cable to a computer and to the sonde.

2. Start Win-Situ 4. The software will automatically scan for sondes. All detected sondes are displayed in the 'Connected Sondes' list in the Main window displayed below. If a sonde is not found, reattach the data cable and press RE-SCAN FOR SONDES. Retry until the sonde(s) are found.

3. Click on the Log Files tab.

4. Click the CREATE button.

5. Enter the name for the new log file. The empty log file is now created.

6. Enter the start and end time of the logging, the logging interval (15 minutes is preferred, but should not be greater than 1 hour), the sensor warm-up time before logging (20 seconds is sufficient), how long before logging the circulator will be turned on (should be zero), and if audio signals will be used while logging.

7. Select the parameters in the 'Parameter in Sonde' list and click the ADD button to place them into the 'Parameters in log file' list. Change the order of the parameters using the ARROW buttons.

8. Click UPDATE SETTING to send the configuration to the sonde.

9. Click ENABLE to start collecting data. Click DISABLE to stop collecting data during logging. A fully completed logging run will automatically disable at the end of the run.

10. Click DOWNLOAD to download and display the log file. Select printable or spreadsheet format, and save the file to your chosen location.

Note: To delete a log file, select the log file in the Log File drop-down menu and click the DELETE button.

The status will change from Disabled to Enabled. The sonde will begin recording data in the new log file at the specified start time.

Important Note: Log files that have completed running cannot be activated for reuse by changing the date. For log files occurring in the future, always set up a new log file!

4.5 *Sonde Retrieval*

Upon retrieving a sonde, perform a post-deployment check of the DO calibration at the station or another location with a similar elevation. The post-deployment check for the other parameters can be performed either at the station or at the laboratory. This check is not a recalibration, but an accuracy test to verify that the sensors are still functioning properly and to check for drift in the calibrations. Enter the data in the field notebook.

Reference

In-Situ, Inc. (In-Situ). 2004. *Win-Situ 4.0 user's guide with Pocket-Situ*. Rev. 003. November 2004. Available at <http://in-situ.com/force_download.php?file_id=367>.

In-Situ. 2009. Multi-Parameter TROLL 9500 Operators Manual. January 2009.