

However, one-to-one discussions and one round of field observations by the author indicates appropriate documentation and custody of samples were maintained, that prepared bottles contain the appropriate preservatives, and that the samples were chilled upon collection until daily delivered to the analytical laboratory. All bottles used for sampling were field prepped by Pinnacle laboratories. It is routine practice for this laboratory to add the appropriate preservatives as part of the bottle preparation. For evaluation purposes, it is assumed that all samples were properly preserved.

For the March 2005 event, laboratory certificates could only be located for a subset of the analysis including only the samples for RBG-1, RBG-2, and RBS-2. The available documentation indicates that these analyses were performed within control limits and that surrogate recoveries were adequate.

For the June 2005 sampling event, multiple samples were qualified for total phosphorous, potassium and sodium which were found in the method blank. There is one incidence of an SVOC compound (3,3'-Dichlorobenzidine, 2-fluorobiphenyl) and of potassium being outside of matrix spike or method blank surrogate control limits.

For the October 2005 sampling event, analyses were performed by two separate laboratories due to the impacts of Hurricane Katrina on the laboratory normally used for analysis. All quality control problems are associated with analysis from the alternate laboratory. These issues include: low matrix spike recovery for sulfate for samples from RBG series of wells, instances of both high and low matrix spike recovery for potassium, sample matrix interference on chromium for MG-3, MS-1, and MS-2, and excess recoveries for calcium. Problems with precision and accuracy were also flagged for magnesium. The analyses also note low recovery for foaming agents. Although the problems were flagged, results do not appear anomalous from other samples at these locations. These problems do, however, impose a limitation on determining significant statistical differences involving the October 2005 sampling event.

### **3.0 Results of Water Quality Analyses**

The scope of the water quality analysis was previously discussed in Section 2.0. Analysis included organic compounds (herbicides, semivolatiles, volatiles, and surfactants), fecal coliform, metals, and other inorganic parameters.

#### *3.1 Organic Compounds*

##### *3.1.1 Herbicides and Pesticides*

Based on personal communications with the local New Mexico State University Agricultural Extension Agent for Bernalillo County, the commonly used pesticides/herbicides for pastures are Banvel and 2-4-D. Other pesticides that may be used include Poast, Pursuit, Sinbar, Treflan, Baylan, Bucril, Granoxon, Lorsban, and Sevine. On streambanks, the primary herbicide of

choice is Roundup and Rodeo. Table 3.1 provides brief descriptive information for each of these trade name compounds. Generally, these compounds are applied at the start of the growing season using foliar application techniques. The use of these compounds is not limited to agricultural applications. As can be seen on Table 3.1, not all of the commonly used agricultural chemicals can be detected using conventional analytical methods routinely performed by most laboratories (e.g., Method 8270 for semivolatiles), and not all of the compounds listed are identifiable using the more targeted analytical techniques (Methods 8081, 8141, or 5151) that are currently available upon request. There are many classes of pesticides and herbicides (such as carbamate, organophosphates, organochloride etc.) and the differing classes of compounds have significant variations in potential health effects.

Table 3.2 indicates the sample locations for which pesticide specific analyses are available. Pesticide and herbicide analysis are available for all of the Malpais Rd. groundwater wells, and only a subset of the Rio Bravo transect wells and surface locations. All available analyses are prior to July 2004.

There were no detections for pesticides using the pesticide specific methodology. No analysis for pesticides using Methods 8081 and 8141 were run for the listed locations after the initial sampling events and no herbicide-specific analyses were performed on the initial samples. Although the pesticide specific data set is limited in number, analyses using Method 8270 are more readily available as described in the following section. Analytical results available from Method 8270 have also consistently demonstrated that the analyzable herbicides and pesticides (See Table 3.1) were not detectable at concentrations in excess of the reported detection limits for any of the sample events.

Because of the lack of pesticide and herbicide specific testing during the initial sampling events, two additional grab sample from construction dewatering wells near agricultural fields were collected during 2006 and analyzed for pesticides and herbicides using Methods 8081 (organochlorine pesticides) and Method 5151(A) (chlorinated herbicides). Consistent with the earlier results and the results of the Method 8270 analyses, no pesticides or herbicides were detected in these samples. BCPW may perform additional sampling on South Valley dewatering projects in agricultural areas to confirm these results.

The lack of detection of herbicides and pesticides in this study suggests that the USGS NGWQA reported findings are site-specific, and perhaps time-specific, and are not representative of conditions occurring over a wider area within the South Valley. Given the interval between the USGS sampling and this study and that exact locations were not duplicated, the lack of agreement can be expected. The lack of detection is also not surprising given the short half-lives of the various compounds as listed in Table 3.1. It is also possible that samples collected for this study are representative only of the surface and groundwater affected by interaction along the irrigation drainages and canals and not of groundwater conditions in outlying areas. However, the grab samples collected from dewatering systems suggest that groundwater conditions near the agricultural fields are not significantly different those at the monitoring wells.

**Table 3.1 Agrichemicals in Common Use in Bernalillo County**

Trade Name	Common Name / CAS Number	Listed as Detectable by Method 8270	Listed as Detectable by Method 515.1	Half-life (Hydrolysis / Aerobic Soil / Anaerobic Soil)	K <sub>oc</sub>	Chemical Class
(H) 2,4-D	2,4-D 94-75-7	N	Y	39.0 / 34.0 / 333.0	45.0	Chlorophenoxy acid or ester
(H) Banvel	Dicamba 1918-00-9	N	Y	30.0 / 10.0 / 88.0	5.0	Benzoic acid
(H) Bayleton	Triadimefon 43121-43-3	N	N	1,760 / 6.0 / 23.0	364.0	Azole
(H) Buctril	Bromoxynil octonate 1689-99-2	Y	N	32.4 / -- / -- 24.2 / 2.82 / 4.15 *	255.6	Hydroxybenzoxitrile
(H) Gramoxone	Paraquat dichloride 1910-42-5 (Dichloride salt) 4685-14-7 (Paraquat dication)	Y	N	30.0 / 620.0 / 644.0	10,000	Bipyridylum
(H) Poast	Sethoxydim 74051-80-2	N	N	470.0 / 6.00 / 25.0	47.0	Cyclohexanone derivative
(H) Pursuit	Imazepathyr 81335-77-5	N	N	-- / 4,212 / 568	53.0	Imidazolinone
(H) Round-Up / Rodeo	Glyphosphate 38641-94-0	N	N	35 / 96 / 22	6922	Phosphonoglycine
(H) Sinbar	Terbacil 5902-51-2	N	N	42 .0/ 520.0/ 48.0	0.90	Uracil
(H) Treflan	Triflualin 1582-09-8	Y	N	32.0 / 198.7 / 37.3	121.0	2,6-Dinitroaniline
(P) Lorsban	Chlorpyrifos 2921-88-2	N	N	58.1 / 113.3 / 135.5	125.2	Organophosphorus
(P) Sevin	Carbaryl 63-25-2	Y	N	12/6/87	326	N-methylcarbamate

Source: <http://www.pesticideinfo.org> last visited 12/2/05 \*Based on related compounds only

(H) Herbicide (P) Pesticide

**Adsorption coefficient:** K<sub>oc</sub>, is a measure of how strongly a chemical adheres to soil in preference to remaining dissolved in water. The California Department of Pesticide Regulation has determined that pesticides with a K<sub>oc</sub> less than 1,900 have potential to contaminate groundwater.

**Hydrolysis half-life:** The amount of time required for half of the pesticide to degrade from reaction with water. The California Department of Pesticide Regulation has determined that pesticides with a hydrolysis half-life greater than 14 days have potential to contaminate groundwater

**Soil half-life:** The amount of time required for half of the pesticide to degrade in soil. This half-life is governed by the types of soil organisms that are present that can break down the pesticide, the soil type (e.g., sand, loam, clay), pH, and temperature. The California Department of Pesticide Regulation has determined that pesticides with an aerobic soil half-life greater than 690 days or an anaerobic soil half-life greater than 9 days have potential to contaminate groundwater.

**Table 3.2 Available Pesticide Analyses**

	October-01	September-03	December-03	January-February 04	July-04	March-05	June-05	August-September 05
BS-1								
BS-2								
BS-3								
BS-4								
BS-5								
BS-6								
BS-7								
RBS-1								
RBS-2								
RBS-3								
RBS-4	x							
RBS-5		x						
RBS-6	x	x						
RBS-7								
RBS-8								
RBS-9								
RBS-10	x							
RBG-1				x				
RBG-2				x				
RBG-3								
RBG-4								
RBG-5								
RBG-6								
RBG-7								
RBG-8				x				
RBG-9								
RBG-10				x				
MS-1	x							
MS-2		x						
MS-3	x							
MS-4								
MS-5								
MS-6								
MS-7		x						
MS-8		x						
MG-1			x					
MG-2			x					
MG-3			x					
MG-4			x					
MG-5			x					
MG-6				x				
MG-7				x				
MG-8				x				

These findings indicated that the irrigation water, drainage water and adjacent groundwater do not typically contain detectable levels of herbicides or pesticides on a study-side scale within the South Valley. These results do not preclude the existence of site-specific instances of pesticide or herbicide contamination or address conditions within areas of known contamination from other sources.

### 3.1.2 Semivolatile Organic Compounds (SVOCs)

The BNAs included as part of the initial analyte list include both semivolatile and volatile organic compounds. Method 8270 captures an extensive list of semivolatile organic compounds including some herbicides and pesticides as well as many other industrial and urban pollutants. Table 3.3 provides a listing of available semivolatile organic compound analyses for this study.

The October 2001 and September 2003 surface water samples, and the winter 2003-2004 groundwater samples were analyzed for semivolatile organic compounds (SVOCs) using Method 8270, though sampling of the locations occurred on an irregular basis. Samples have been more routinely collected since March 2005 and have all been analyzed for SVOCs.

A list of the compounds detected to date and the reported concentrations are provided as Table 3.4. The only detected compounds are non-agricultural and are most likely laboratory-induced contaminants, or “laboratory artifacts”. With one exception, there have been no reported detections for SVOCs other than for phthalate compounds.

Phthalates are used as a plasticizer and are a common laboratory contaminant stemming from the use of tubing and bottles for sampling and for analysis. The majority of the detections are reported from the SLD laboratory. After switching laboratories, the detection of phthalates essentially ceased. Due to the low reported concentrations, the cessation of detections after changing laboratories and the lack of repetitive detection for any given sample location, it is surmised that the reported detections are a laboratory artifact.

There is a single reported detection of 1,4-Dichlorobenzene for the 9/16/2003 sample from the MS-2 location. 1,4-Dichlorobenzene is a widely used compound in a number of household products and building materials. It is also used as a laboratory calibration standard as part of the normative QA/QC process for Method 8270. It is believed that the single incidence of this compound is also a laboratory artifact.

### 3.1.3 Volatile Organic Compounds (VOCs)

Volatile organic compounds include a wide range of compounds used in both agricultural and urban settings. Some of the compounds are used as carrying agents in chemical solutions. Table 3.5 provides a list of the available volatile organic compounds analyses for this project.

Due to the lack of detection of pesticides, herbicides and semivolatile organic compounds, the analyses list was expanded to include volatile organic compounds starting in July 2004. VOCs have been analyzed for all samples collected since March 2005.

There have been no reported detections of any volatile organic compounds to date. The lack of detection of volatile compounds the South Valley confirm the early reports by the USGS NWQA study wherein no volatile compounds were detected in South Valley groundwater samples.

**Table 3.3 Available Semivolatile Organic Compound Analyses**

	October-01	September-03	December-03	January-February 04	July-04	March-05	June-05	August-September 05
BS-1						x	x	
BS-2						x	x	
BS-3								
BS-4						x	x	
BS-5							x	
BS-6						x	x	
BS-7						x	x	
RBS-1								
RBS-2						x		x
RBS-3						x		x
RBS-4	x							x
RBS-5		x						x
RBS-6	x	x						x
RBS-7						x		x
RBS-8						x		x
RBS-9							x	x
RBS-10	x							x
RBG-1				x	x	x		x
RBG-2				x	x	x		x
RBG-3					x	x		x
RBG-4					x	x		x
RBG-5					x	x		x
RBG-6					x	x		x
RBG-7					x	x	x	x
RBG-8				x	x	x	x	x
RBG-9					x	x	x	x
RBG-10					x	x	x	x
MS-1	x					x	x	x
MS-2		x					x	x
MS-3	x					x	x	x
MS-4								
MS-5							x	x
MS-6						x	x	x
MS-7		x				x	x	x
MS-8		x				x	x	x
MG-1			x		x	x	x	x
MG-2			x		x	x	x	x
MG-3			x		x	x	x	x
MG-4			x		x	x	x	x
MG-5			x		x	x	x	x
MG-6				x	x	x	x	x
MG-7				x	x	x	x	x
MG-8				x	x			

**Table 3.4 Semivolatile Organic Compounds Detections**

Sample Date	Lab ID	Sample ID	Detected Analyte	Detection Limit (ug/L)	Result (ug/L)
12/17/2003	SLD OR 200303860	MG-1	bis(2-Ethylhexyl)phthalate	0.12	0.4
12/17/2003	SLD OR 200303861	MG-2	bis(2-Ethylhexyl)phthalate	0.12	0.5
12/17/2003	SLD OR 200303864	MG-3	Diethylphthalate	0.31	0.2
12/17/2003	SLD OR 200303864	MG-3	bis(2-Ethylhexyl)phthalate	0.12	2.6
12/17/2003	SLD OR 200303862	MG-4	bis(2-Ethylhexyl)phthalate	0.12	0.3
12/17/2003	SLD OR 200303863	MG-5	bis(2-Ethylhexyl)phthalate	0.12	1.2
3/8/2005	503047-01	MG-5	bis(2-Ethylhexyl)phthalate	<10	320
1/6/2004	SLD OR 200400011	MG-6	bis(2-Ethylhexyl)phthalate	0.13	0.7
1/6/2004	SLD OR 200400015	MG-7	Butylbenzylphthalate	0.32	1.7
1/6/2004	SLD OR 200400015	MG-7	bis(2-Ethylhexyl)phthalate	0.13	6.7
1/6/2004	SLD OR 200400013	MG-8	Diethylphthalate	0.32	0.6
1/6/2004	SLD OR 200400013	MG-8	bis(2-Ethylhexyl)phthalate	0.13	1.9
9/16/2003	SLD OR 200303061	MS-2	1,4-Dichlorobenzene (p-Dichlorobenzene)	0.25	0.9
9/16/2003	SLD OR 200303061	MS-2	Butylbenzylphthalate	0.32	0.7
9/16/2003	SLD OR 200303061	MS-2	bis(2-Ethylhexyl)phthalate	0.13	0.4
1/6/2004	SLD OR 200400014	RBG-1	Di-n-butylphthalate	0.19	1.1
1/6/2004	SLD OR 200400014	RBG-1	Diethylphthalate	0.32	5.8
1/6/2004	SLD OR 200400014	RBG-1	bis(2-Ethylhexyl)phthalate	0.13	22.5
1/6/2004	SLD OR 200400012	RBG-2	Diethylphthalate	0.32	6.3
1/6/2004	SLD OR 200400012	RBG-2	bis(2-Ethylhexyl)phthalate	0.13	9.4
2/5/2004	SLD OR 200400150	RBG-8	Diethylphthalate	0.32	0.4
2/5/2004	SLD OR 200400150	RBG-8	bis(2-Ethylhexyl)phthalate	0.13	3.5

**Table 3.5 Available Volatile Organic Compound Analyses**

	October-01	September-03	December-03	January-February 04	July-04	March-05	June-05	August-September 05
BS-1						x	x	
BS-2						x	x	
BS-3								
BS-4						x	x	
BS-5							x	
BS-6						x	x	
BS-7						x	x	
RBS-1								
RBS-2						x		x
RBS-3						x		x
RBS-4								x
RBS-5								x
RBS-6								x
RBS-7						x		x
RBS-8						x		x
RBS-9						x	x	x
RBS-10								x
RBG-1					x	x		x
RBG-2					x	x		x
RBG-3					x	x		x
RBG-4					x	x		x
RBG-5					x	x		x
RBG-6					x	x		x
RBG-7					x	x	x	x
RBG-8					x	x	x	x
RBG-9					x	x	x	x
RBG-10					x	x	x	x
MS-1						x	x	x
MS-2							x	x
MS-3						x	x	x
MS-4								
MS-5							x	x
MS-6						x	x	x
MS-7						x	x	x
MS-8						x	x	x
MG-1					x	x	x	x
MG-2					x	x	x	x
MG-3					x	x	x	x
MG-4					x	x	x	x
MG-5					x	x	x	x
MG-6					x	x	x	x
MG-7					x	x	x	x
MG-8					x	x	x	

### 3.1.4 Surfactants

Surfactants (**surface active agent**) are a class of compounds that serve as wetting agents. These compounds lower the surface tension of a liquid, allowing the liquid to spread more easily, and lower the interfacial tension between two liquids. They are widely used in a variety of household products (soaps, foams, waxes, cleansers) and industrial applications. Of particular interest is their use in agrichemical formulations to help in the disbursement of pesticides and herbicides.

Due to the lack of detection of pesticides, herbicides and semivolatile organic compounds, the analyses list was expanded to include surfactants starting in July 2004. Surfactants have been analyzed for all samples collected since March 2005. The analysis does not identify specific compounds, but addresses the concentration of the compounds as a class.

Table 3.7 presents a list of samples with detectable concentrations of surfactants. The only samples with detectable concentrations were from the Malpais Rd transect and only occurred in the June 2005 samples and at concentrations only slightly above the detection limit. Each of the locations is associated with an irrigation drain rather than a canal, and not all drains indicated detectable concentrations. The presence of these compounds indicates some minor impact by surfactants, but the source may be non-agricultural. Given the lack of detection of semivolatile or volatile organic compounds, a non-agricultural and non-industrial source is suspected. The source could be as simple as stormwater runoff from nearby roads or stormwater drains.

**Table 3.6 Available Surfactant Analyses**

	October-01	September-03	December-03	January-February 04	July-04	March-05	June-05	August-September 05
BS-1						x	x	
BS-2						x	x	
BS-3								
BS-4						x	x	
BS-5							x	
BS-6						x	x	
BS-7						x	x	
RBS-1								x
RBS-2						x		x
RBS-3						x		x
RBS-4								x
RBS-5								x
RBS-6								x
RBS-7						x		x
RBS-8						x		x
RBS-9							x	x
RBS-10								x
RBG-1					x	x		x
RBG-2					x	x		x
RBG-3					x	x		x
RBG-4					x	x		x
RBG-5					x	x		x
RBG-6					x	x		x
RBG-7					x	x	x	x
RBG-8					x	x	x	x
RBG-9					x	x	x	x
RBG-10					x	x	x	x
MS-1						x	x	x
MS-2							x	x
MS-3						x	x	x
MS-4								
MS-5							x	x
MS-6						x	x	x
MS-7						x	x	x
MS-8						x	x	x
MG-1					x	x	x	x
MG-2					x	x	x	x
MG-3					x	x	x	x
MG-4					x	x	x	x
MG-5					x	x	x	x
MG-6					x	x	x	x
MG-7					x	x	x	x
MG-8								

**Table 3.7 Detected Surfactants**

Sample Date	Sample ID	Detected Analyte	Detection Limit (ug/L)	Result (ug/L)
6/20/05	MS-1	Surfactants (MBAs Method 425.1)	<0.10	0.13
6/20/05	MG-1	Surfactants (MBAs Method 425.1)	<0.10	0.13
6/16/05	MG-6	Surfactants (MBAs Method 425.1)	<0.10	0.12
6/16/05	MS-7	Surfactants (MBAs Method 425.1)	<0.10	0.27
6/23/05	MG-7	Surfactants (MBAs Method 425.1)	<0.10	0.14
6/16/05	MS-8	Surfactants (MBAs Method 425.1)	<0.10	0.11

### 3.2 Fecal Coliform

Figure 3.1 provides a summary of the fecal coliform data by sample type (surface water, groundwater) and by transect location (Headwater, Rio Bravo, Malpais, and combined). The figure illustrates that the fecal coliform in groundwater wells is often not detected or is detected at concentrations less than a few colony forming units (cfu) / 100 ml along the transects. It also illustrates that the surface water samples at the headwaters and along both transects exhibit increased fecal coliform concentrations with respect to the adjacent groundwater. Figure 3.1 emphasizes that the surface water samples from the Malpais transect are significantly increased compared to the individual groupings and to the combined values for the entire data set.

The figure provides the maximum, minimum, mean, and geometric mean for each categorization. Fecal coliform counts ranged from Not Detected (assigned a value of 1 or 10 based on detection limit to allow for plotting and calculation) to as great as 7,200 cfu/100 ml. The greatest measured value was 7200 cfu / 100 ml at BS-3. The combined geometric mean and combined arithmetic mean were 18 and 228 cfu/100 ml respectively, with the geometric mean at the various transects ranging from 2 or 3 cfu / 100 ml for the groundwater monitoring wells, increasing to 54 to 64 cfu/ml for the headwaters and surface water locations along Rio Bravo, and up to 167 cfu/100 ml for the surface water locations along the Malpais transect. These results compare favorably with the results of the Middle Rio Grande Microbial Source Tracking Assessment Report discussed in Section 1.3 and summarized in Table 1.2. The results of that study indicated that under non-runoff conditions, the geometric mean values for the various sample locations in the South Valley under runoff and non-runoff conditions ranged from 9 to 490 cfu / 100ml.

At a more detailed level, the geometric means for the Las Padillas and Isleta Drains under runoff conditions were reported by the NMED as 36 and 200, respectively. These two locations correspond to Malpais surface sample locations 1, 2 and 3. The geometric mean for these three locations combined is 161 cfu /100 ml. Moving eastward along the transect, the reported values decrease for locations near the river. Of particular note, however, the surface sample locations for the Barr Drain exhibit some of the highest of the fecal coliform values for this study, ranging from 670 for site MS-7 and up to 4,800 cfu / 100 ml MS-8

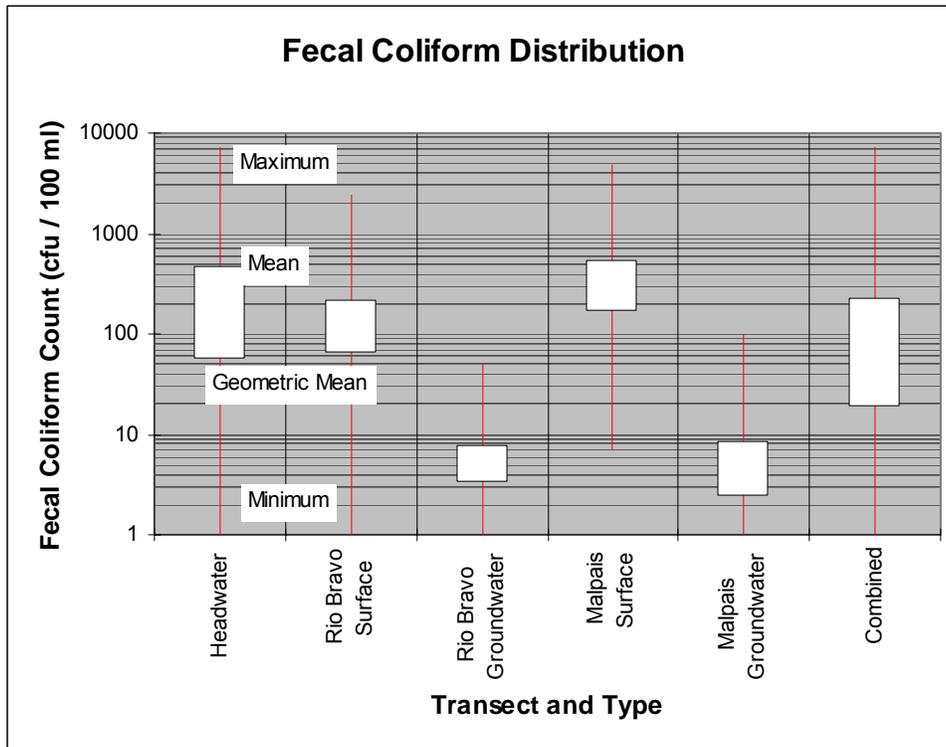


Figure 3.1 Summary of Fecal Coliform Analyses Results

A possible hypothesis is that the agricultural land use in the area east of the Las Padillas drain, particularly dairying and feedlot use, and attendant runoff and infiltration to the drains, may be causing the increase fecal coliform values. This area also exhibits low flow / stagnant conditions during much of the year.

### 3.3 *Inorganics*

Inorganics analyses for the program included nitrogen compounds and phosphorous (i.e., nutrients); trace metals analyses including arsenic, chromium, iron and manganese; and anion-cation analyses.

#### 3.3.1 *Nutrient Series*

The nutrient-series analyses (nitrate+nitrite, ammonia (NH<sub>3</sub>) and Total Phosphorous) are available for the period of record. The quantification of the individual species nitrite NO<sub>2</sub> and nitrate NO<sub>3</sub> are available only since the July 2004 sampling event. Table 3.8 provides a summary of the available nutrient-series analyses. In the following figures and discussion, if a nitrate + nitrite (as N) value was not provided, the NO<sub>3</sub> value was used.

**Table 3.8 Available Nutrient Series Analysis**

	October-01	September-03	December-03	January-February 04	July-04	March-05	June-05	August-September 05
BS-1						x	x	
BS-2						x	x	
BS-3								
BS-4						x	x	
BS-5							x	
BS-6						x	x	
BS-7						x	x	
RBS-1	x							
RBS-2						x		x
RBS-3						x		x
RBS-4	x							x
RBS-5	x							x
RBS-6	x	x				x		x
RBS-7								
RBS-8	x					x		x
RBS-9							x	x
RBS-10	x							x
RBG-1				x	x	x		x
RBG-2				x	x	x		x
RBG-3				x		x		x
RBG-4				x	x	x		x
RBG-5				x	x	x		x
RBG-6				x	x	x		x
RBG-7				x	x	x	x	x
RBG-8				x	x	x	x	x
RBG-9				x		x	x	x
RBG-10					x		x	x
MS-1	x					x	x	x
MS-2		x					x	x
MS-3	x					x	x	x
MS-4								
MS-5							x	x
MS-6						x	x	x
MS-7		x				x	x	x
MS-8		x				x	x	x
MG-1		x			x	x	x	x
MG-2		x			x	x	x	x
MG-3		x			x	x	x	x
MG-4		x			x	x	x	x
MG-5		x			x	x	x	x
MG-6		x			x	x	x	x
MG-7		x			x	x	x	x
MG-8				x	x			

Figure 3.2 provides a plot of nitrate + nitrite (as N) in comparison to the Total Kjeldahl Nitrogen (TKN) concentrations and the respective histograms. In general nitrate+nitrite values (N) are less than 2 mg/L and TKN concentrations are less than 2 mg/L as shown in the histograms and suggests that nitrogen contamination, whether from wastewater systems or from fertilizer application is not of particular concern at the scale of the study area.

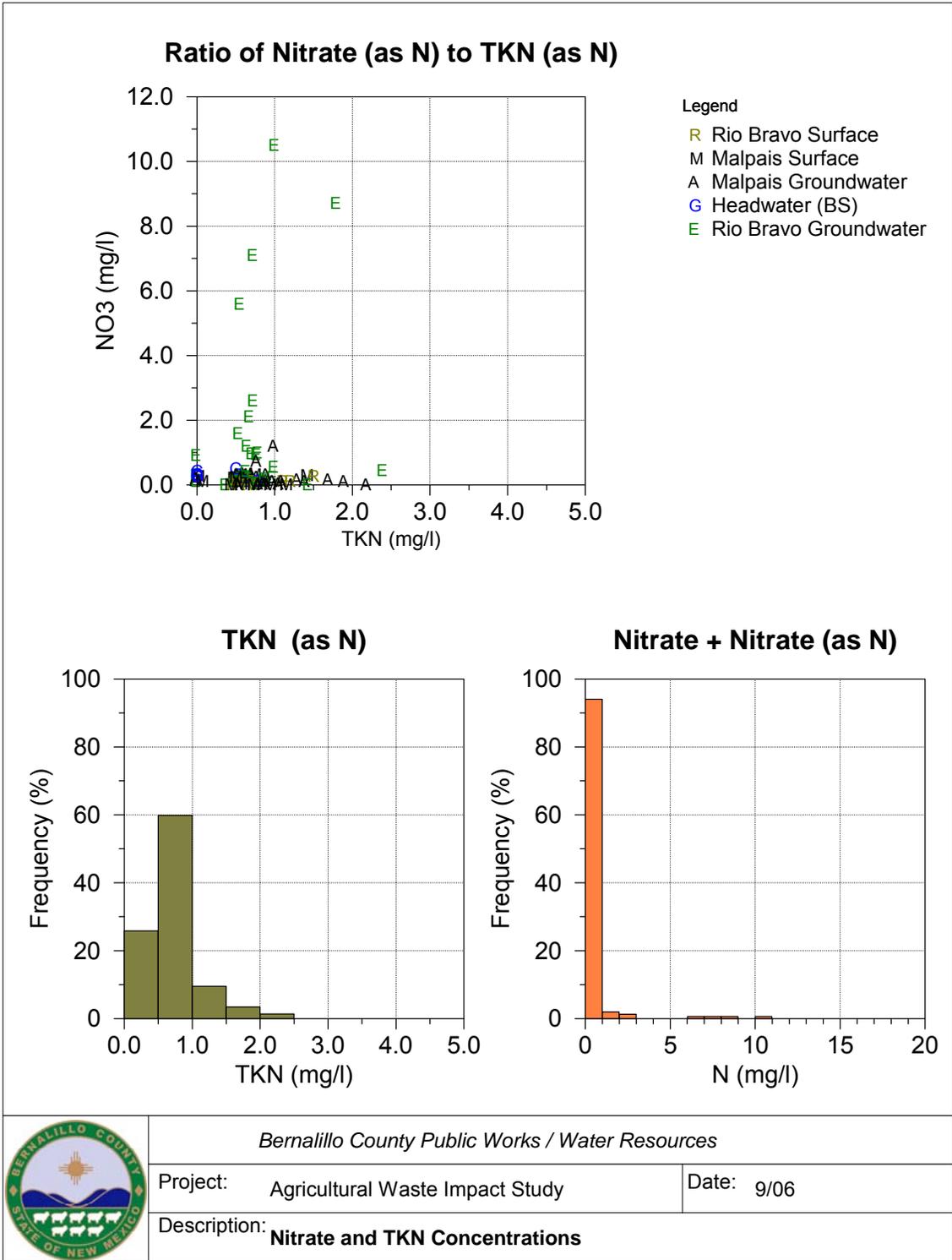
However, the figure also indicates that the nitrate+ nitrite values are of concern within the Rio Bravo groundwater transect, and TKN appears slightly elevated (greater than 2 mg/L) in the

Malpais groundwater transect. Detailed evaluation indicates that the samples with elevated nitrate+nitrite concentrations (i.e. greater than 5 mg/L) were collected from RBG-2, while the TKN concentrations greater than 1.5 mg/L were collected chiefly from MG-7 and MG-8 and, in one instance each from RBG-2 and RBG-10.

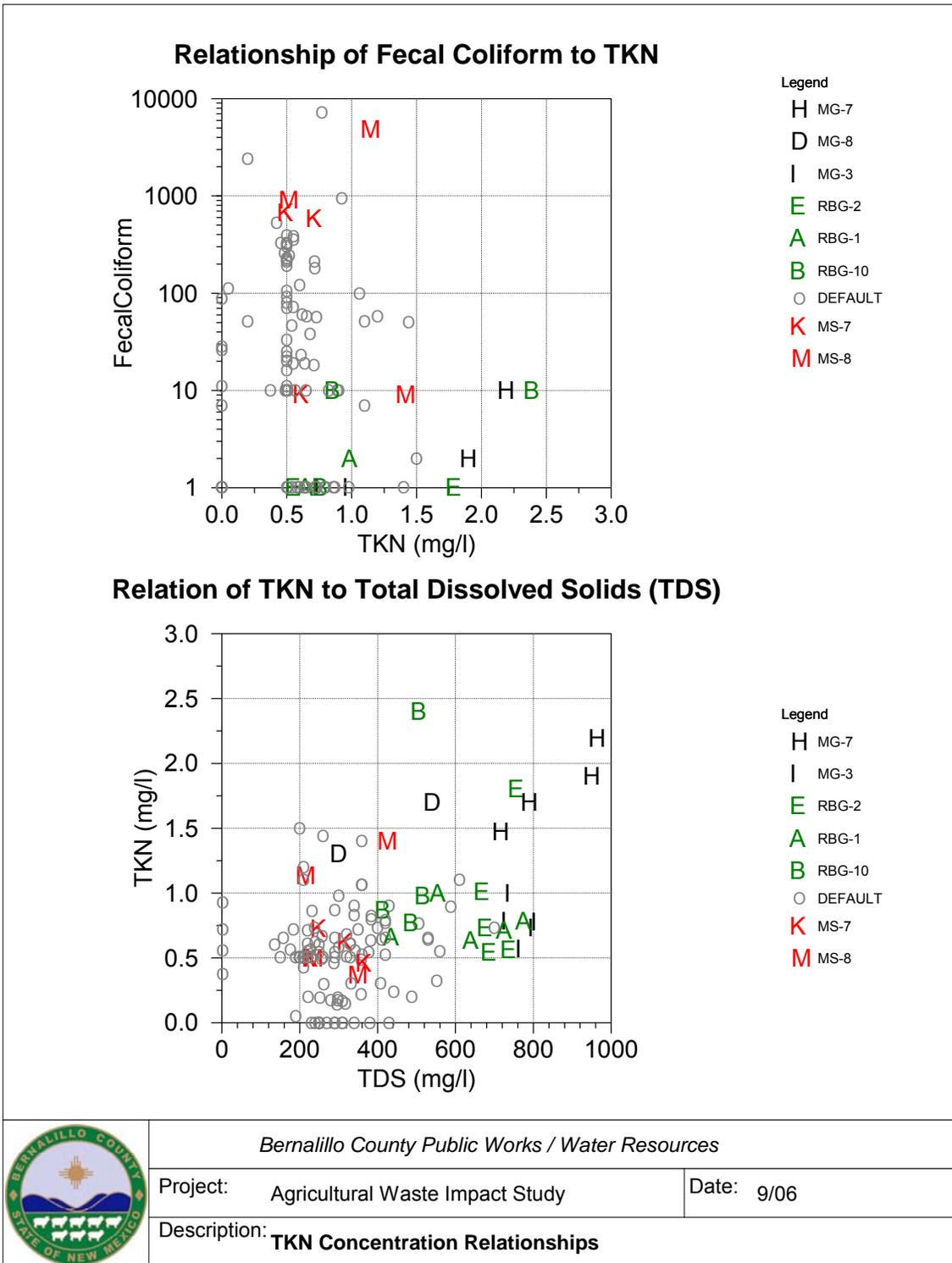
In the case of RBG-2, samples from companion well RBG-1 located across the drain and a few hundred feet north yielded samples with nitrate+nitrite concentrations <1 mg/L and associated surface water samples yielded nitrate concentrations less than 0.5 mg/L. Additionally, samples collected on 3/16/06 from a construction dewatering project along the Isleta drain near RBG-2 yielded samples with nitrogen concentrations of less than 0.2 mg/L. The construction dewatering wells screened a lower interval than that screened by RBG-2 and dewatered the monitoring well. These nearby sampling results indicate that regardless of the source of contamination (i.e. agricultural or septic), the extent (both laterally and vertically) was limited to near vicinity of RBG-2. Coupled with inorganic analyses discussed later, the elevated nitrate concentrations in RBG-2 are suggestive of septic contamination problems rather than a more widespread application of agricultural fertilizers.

TKN concentrations are slightly elevated (relative to the remainder of the samples) in samples from wells MG-7, MG-8, and RBG-10. The sample locations for MG-7, RBG-10, and RBG-2 also exhibited elevated total dissolved solids concentrations. As shown in Figure 3.3, this is of interest because surface water samples from those locations (MS-7 and MS-8) exhibited elevated levels of fecal coliform, but not elevated concentrations of TKN. A review of land use suggests that the presence of feedlot and dairying operations upstream of the surface locations and associated wells may be a contributing factor to these relationships. However, the concentrations for TDS remain less than 1,000 mg/l, and fecal coliform concentrations in the shallow wells do not appear excessively elevated. Additionally, nitrate concentrations in the groundwater remain below the primary drinking water standards (10 mg/L). The cause for elevated TDS concentrations in samples from MG-3 is not known.

The implication is that the Barr Drain may be source of fecal coliform contamination to the Rio Grande, but that shallow groundwater is only marginally affected. Future monitoring of the drain and shallow groundwaters is advisable, but would be better tied to stormwater quality investigations rather than future groundwater investigations.



**Figure 3.2 Nitrate and TKN Concentrations**



**Figure 3.3 TKN Concentration Relationships**

### 3.3.2 Metals

Sampling of surface water and wells prior to July 2004 included a protracted trace metal analyte list. Due to the generally low concentrations or non-detection, the analyte list was shortened to include only iron, manganese, arsenic, and chromium. Iron and manganese are indicator parameters for biological activity related to septic waste degradation and arsenic and chromium are common in agrichemical formulations. Table 3.9 provides a list of the available trace metals analysis. Since the July 2004 event, the indicator signifies only the existence of arsenic and chromium analysis and generally, iron and manganese as well. No analyses for lead have been performed.

**Table 3.9 Available Trace Metals Analyses**

	October-01	September-03	December-03	January-February 04	July-04	March-05	June-05	August-September 05
BS-1						x	x	
BS-2						x	x	
BS-3								
BS-4						x	x	
BS-5							x	
BS-6						x	x	
BS-7						x	x	
RBS-1								
RBS-2						x		x
RBS-3						x		x
RBS-4								x
RBS-5						x		x
RBS-6			x					x
RBS-7						x		x
RBS-8						x		x
RBS-9							x	x
RBS-10								x
RBG-1				x	x	x	x	x
RBG-2					x	x		x
RBG-3				x	x	x		x
RBG-4				x		x		x
RBG-5				x	x	x		x
RBG-6				x	x	x		x
RBG-7				x	x	x	x	x
RBG-8				x	x	x	x	x
RBG-9					x	x	x	x
RBG-10					x	x	x	x
MS-1						x	x	x
MS-2							x	x
MS-3						x	x	x
MS-4								
MS-5							x	x
MS-6						x	x	x
MS-7						x	x	x
MS-8						x	x	x
MG-1			x		x	x	x	x
MG-2			x		x	x	x	x
MG-3			x		x	x	x	x
MG-4			x		x	x	x	x
MG-5			x		x	x	x	x
MG-6			x		x	x	x	x
MG-7			x		x	x	x	x
MG-8			x		x			

Figure 3.4 provides a box and whiskers plot for trace metals concentrations. Analyses were run for groundwater samples from the Rio Bravo and Malpais transect on one sample from each of the wells. The analyses included each of the analytes shown in Figure 3.4. The absence of a plot for a given analyte signifies that there were no detections of that analytes in any of the samples (i.e. all value were reported as “<” the detection limit). The remaining values are all within normal ranges for surface and groundwater in the area. The seeming large range in concentrations for aluminum and zinc are likely due to difference in field sampling techniques – primarily whether the samples were filtered prior to acidification as discussed in Section 2. Unfiltered samples characteristically yield increased concentrations due to leaching of the metals from particulate and colloidal matter that may be present in the unfiltered samples.

### 3.3.2.1 Iron and Manganese

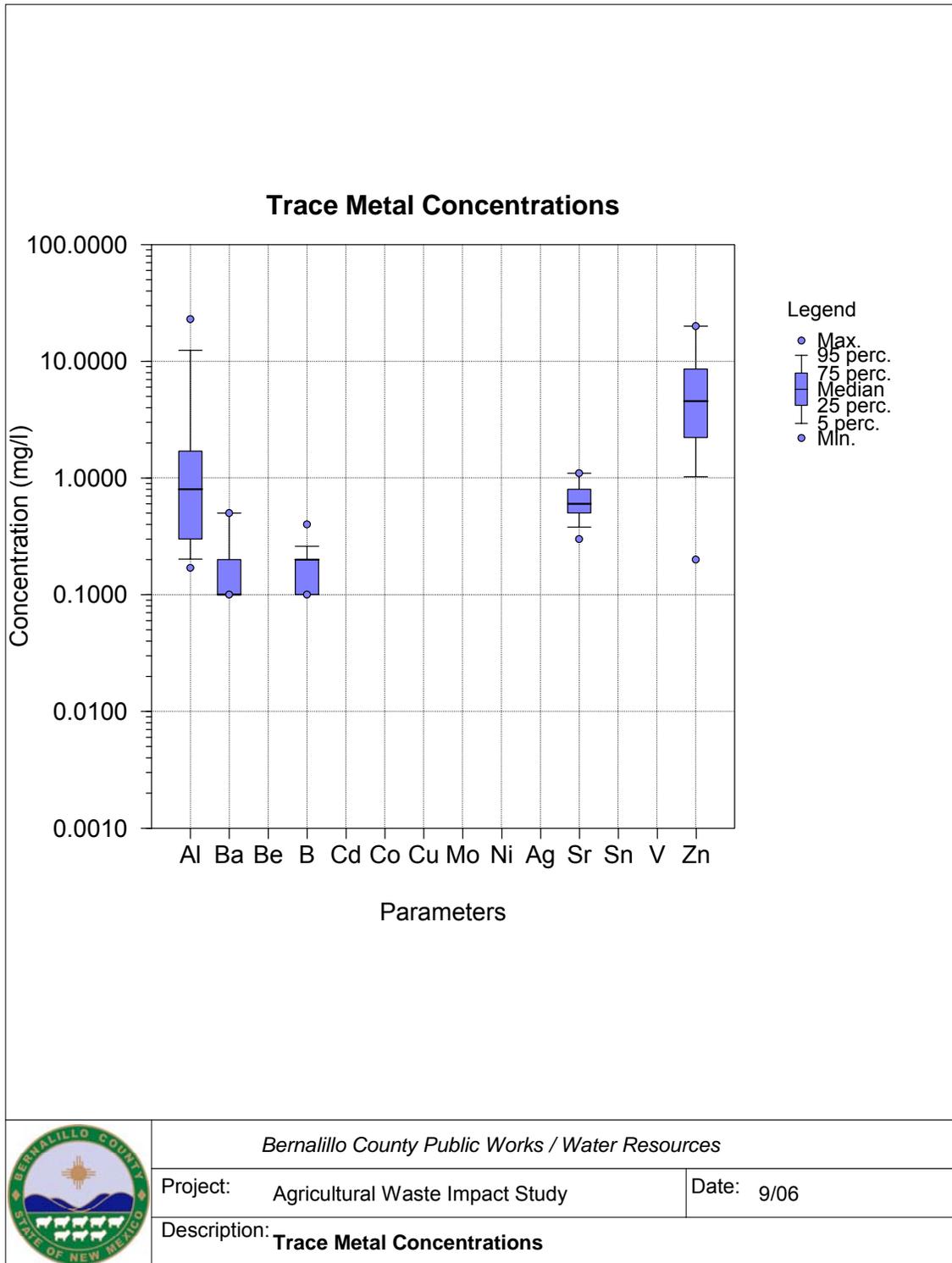
Iron and manganese analyses are available for most samples for the period of record. Of interest to this study are locations where concentrations of iron and manganese are greater than approximately 1.0 mg/L and particularly if there is an elevated nitrate concentration (i.e. greater than 1 mg/L). Such a condition is indicative of biological activity and denitrification processes. Figure 3.5 provides a plot for samples of interest.

Similar to the discussions for TKN, locations of interest include primarily RBG-2 and to a lesser degree RBG-1 and RBG-10. Location MG-7 demonstrates elevated concentrations of manganese, but without an associated elevated concentration of nitrate + nitrite. Location MG-5 also demonstrates elevated concentrations of iron and manganese, but without associated elevated nitrate + nitrite concentrations.

The presence of the elevated iron and manganese concentration again to the elevated nitrogen levels at RBG-2 being septic or wastewater related, particularly given that RBG-1 shows elevated concentrations of iron and manganese but not nitrates, suggesting that denitrification is occurring at the margins of the “hot-spot” surrounding RBG-2.

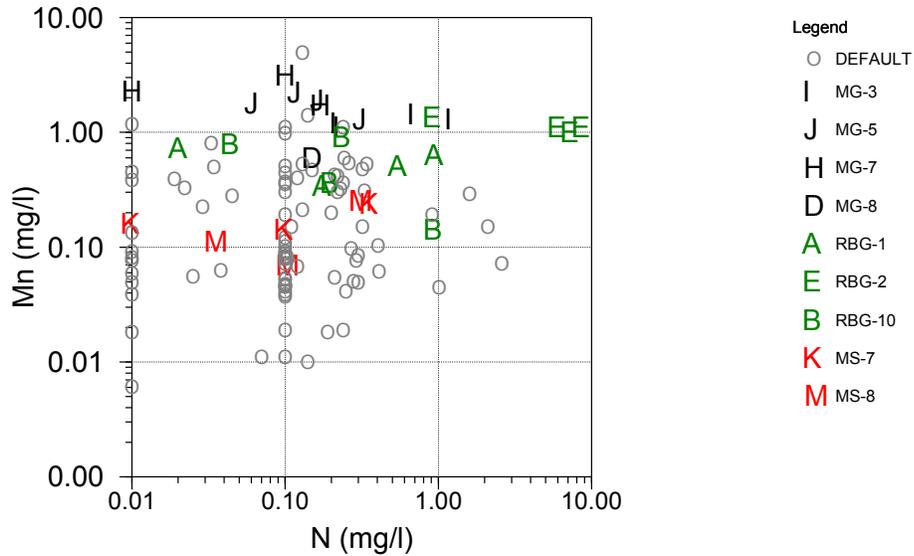
### 3.3.2.2 Arsenic and Chromium

Figure 3.6 provides a distribution plot for arsenic and chromium. Neither plot suggests that concentrations are abnormally distributed or that concentrations are indicative of study-scale contamination of groundwater or surface water. The narrow range in the interquartile for chromium is due to the large number of non-detects in the dataset. The non-detects are assumed equal to the detection limit for purposes of the calculation, and a narrow range results. Arsenic is naturally occurring in the aquifer of the study area. The two maximum points for chromium and arsenic were collected from wells RBG-4 and MG-6. These data points are anomalous given that other samples from these wells are reported with concentrations one to two orders of magnitude less than the maximums shown. There is no indication that the detected concentrations are elevated or indicate residual by-products from agricultural use or degradation.

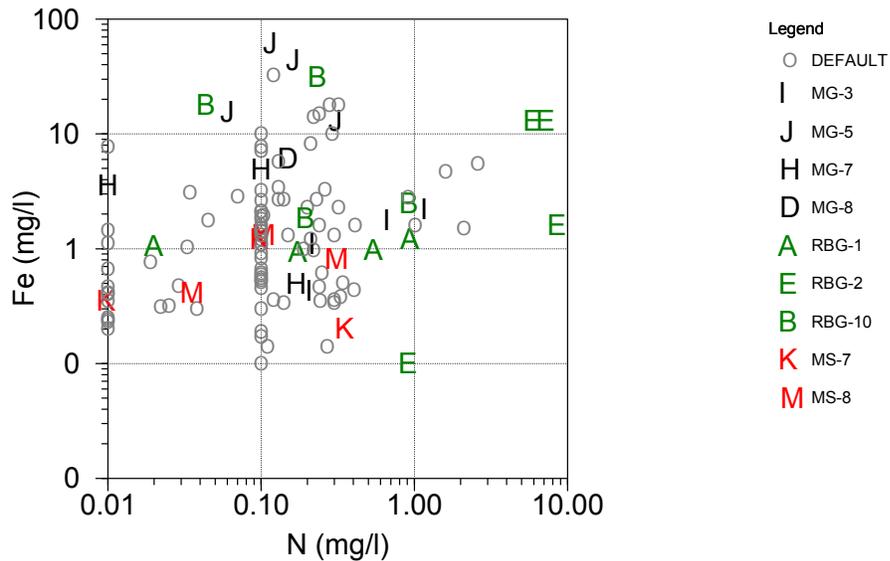


**Figure 3.4 Trace Metal Concentrations**

### Relationship of Manganese and Nitrate + Nitrite



### Relationship of Iron and Nitrate + Nitrite



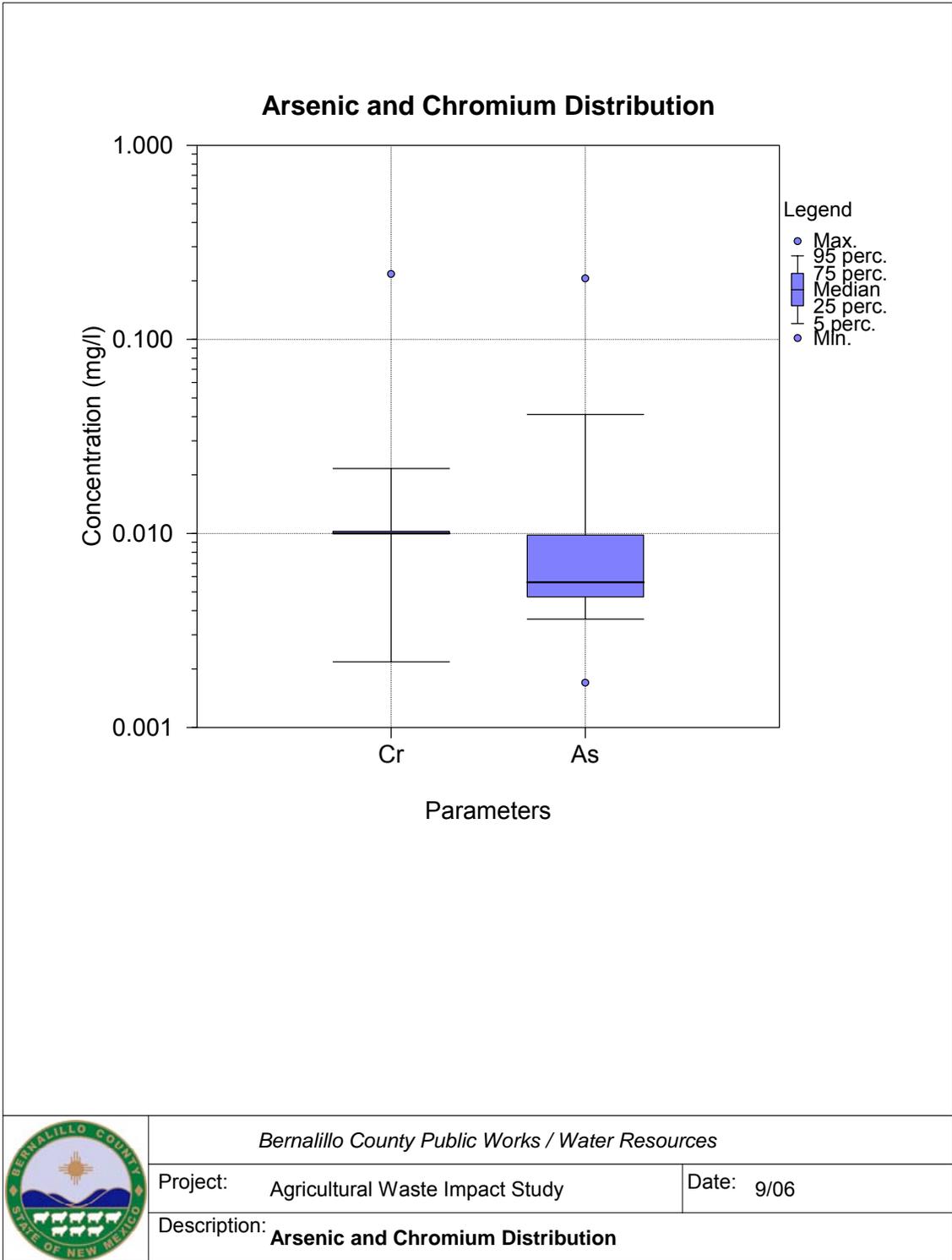
Bernalillo County Public Works / Water Resources

Project: Agricultural Waste Impact Study

Date: 9/06

Description: **Manganese and Iron Concentrations**

**Figure 3.5 Manganese and Iron Concentrations**



**Figure 3.6 Arsenic and Chromium Distribution**

### 3.3.3 Other Parameters

Analyses for the major cations and the major anions have been performed on all samples collected through September 2005. Additional descriptive parameters such as pH TDS, alkalinity and hardness generally are available for the period of record. Table 3.10 provides a list of the available anion-cation analysis for the period of record.

**Table 3.10 Available Anion–Cation Analyses**

	October-01	September-03	December-03	January-February 04	July-04	March-05	June-05	August-September 05
BS-1						x	x	
BS-2						x	x	
BS-3								
BS-4						x	x	
BS-5							x	
BS-6						x	x	
BS-7						x	x	
RBS-1	x							
RBS-2						x		x
RBS-3						x		x
RBS-4	x					x		x
RBS-5	x	x						x
RBS-6	x	x						x
RBS-7								x
RBS-8	x					x		x
RBS-9							x	x
RBS-10	x							x
RBG-1				x		x		x
RBG-2				x		x		x
RBG-3				x		x		x
RBG-4								
RBG-5				x		x		x
RBG-6				x		x		x
RBG-7				x		x	x	x
RBG-8				x		x	x	x
RBG-9						x	x	x
RBG-10						x	x	x
MS-1	x					x	x	x
MS-2							x	x
MS-3	x					x	x	x
MS-4								
MS-5							x	x
MS-6						x	x	x
MS-7		x				x	x	x
MS-8		x				x	x	x
MG-1		x				x	x	x
MG-2		x				x	x	x
MG-3		x				x	x	x
MG-4		x				x	x	x
MG-5		x				x	x	x
MG-6		x				x	x	x
MG-7				x		x	x	x
MG-8				x				

Figure 3.7 provides a plot of available anion-cation data using a conventional Piper diagram approach. From the upper left and moving counter-clockwise, the outlying values are single incidences of samples from locations BS-2, MG-1, MG-2, MG-3, RBG-4, and RBS-2. None of these anion-cation plots is abnormal for the South Valley based on area-side well sampling results by others. For comparison, Figure 3.8 provides anion-cation plots for samples collected throughout the South Valley by the USGS over a period of years. The only significant difference for the outlying values is the virtual absence of bicarbonate for samples taken from MG-1, MG-2, and MG-3.

Figure 3.9 provides correlation plots for sodium and chloride and for calcium and sulfate. Ideally, the sodium-chloride ratio should be 1:1 or higher. In this instance, a suggested ratio is approximately 1.67:1, with the increased sodium probably attributable to the predominance of silicate minerals stemming from the igneous nature of the alluvial fill material. Similarly, the ratio of calcium to sulfate should be 1:1 or lower. For the samples from this study, the ratio is approximately 0.77:1. Consequently, there is no indication of agricultural waste impact based on the inorganic analyses for anion and cation – the resulting ratios are attributable to the sediments comprising the source aquifer.

#### **4.0 Water Level Data**

No surface water elevation or flow rate measurements were made at the surface water sampling locations at the time of sampling, so determination of vertical gradients near the canals and drains is not feasible. Water level measurements in the shallow wells were made at the time of sampling. However, the records are incomplete and water level data for the sampling events prior to July 2004 are missing. The available data are presented in Table 4-1 and reflect a seasonal variation in water levels of approximately one-foot between irrigation and non-irrigation seasons.