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June 22, 2017

SENT CERTIFIED RETURN RECEIPT REQUESTED
7015 1660 0000 0779 9031

Ms. Amy Eschberger
Environmental Protection Specialist
Colorado Department of Natural Resources
Division of Reclamation, Mining and Safety
Office of Mined Land Reclamation
1313 Sherman Street, Room 215
Denver, Colorado 80203

Re: Cripple Creek & Victor Gold Mining Company ("CC&V"); Cresson Project M-1980-244; – Request for Demonstration of Compliance with WQCC Regulation No. 41 – The Basic Standards for Ground Water

Dear Ms. Eschberger:

CC&V hereby submits the requested documentation and analysis in response to the Division's request for Demonstration of Compliance with WQCC Regulation No. 41 – The Basic Standards for Ground Water.

Should you require further information, please do not hesitate to contact Ronald Parratt at 719.689.4019, or Ronald.Parratt@newmont.com, or myself at 719.689.4055 or Meg.Burt@newmont.com.

Sincerely,

Meg Burt
Senior Environmental Manager
Cripple Creek & Victor Gold Mining Co

MB/rp

Ec: A. Eschberger – DRMS
File

Executive Summary

Colorado Division of Reclamation, Mining and Safety (DRMS) has requested that Cripple Creek & Victor Gold Mining Company (CC&V) submit a review of the currently approved groundwater monitoring plan and available site groundwater monitoring data to demonstrate that CC&V is in compliance with Regulation No. 41's requirements. In the following demonstration of compliance with Regulation 41, CC&V has also provided an analysis of the mine-site conditions to support previously-approved, site-specific groundwater numeric protection limits (NPL) for Squaw Gulch, Arequa Gulch, Vindicator Valley, Poverty Gulch, Wilson Creek, and Grassy Valley. The analysis indicates that groundwater in Arequa Gulch, Poverty Gulch and Vindicator Valley has been impacted by historic mining activities within these drainages. Groundwater in Squaw Gulch is hypothesized to reflect very long-term natural elevations in dissolved constituents that resulted from diatreme groundwater discharge via Squaw Gulch prior to drainage tunnel construction, as well as historic mining. Wilson Creek and Grassy Valley groundwater sampled at designated compliance points has not been impacted, and represents the natural groundwater chemistry in those drainages.

1. Introduction

In December of 2016, DRMS issued a request to CC&V for Demonstration of Compliance with WQCC Regulation No. 41 – The Basic Standards for Groundwater. The request required that CC&V provide a review of the current approved groundwater monitoring plan and available site groundwater monitoring data against the Interim Narrative Standard requirements. These Interim Narrative Standard Requirements are presented below.

DRMS indicated that:

> "The 'Interim Narrative Standard' in 41.5(C)(6)(b)(i) below [in the letter] is applicable to all groundwater, to which standards have not already been assigned in the state… Until such time as use classifications and numerical standards are adopted for the groundwater on a site-specific basis throughout the state, and subject to the provisions of subsection (ii) below [in the letter], groundwater quality shall be maintained for each parameter at whichever of the following *is less restrictive*:
> (A) Existing ambient quality as of January 31, 1994, or
> (B) That quality which meets the most stringent criteria set forth in Tables 1 through 4 of 'The Basic Standards for Ground Water'"

In Regulation 41, the Water Quality Control Commission stated its intent about the application of the Interim Narrative Standard by implementing agencies including the DRMS:

> iii. In applying this narrative standard, the Commission intends that agencies with authority to implement this standard will exercise their best professional judgment as to what constitutes adequate information to determine or estimate existing ambient quality, taking into account the location, sampling date, and quality of all available data. Data generated subsequent to January 31, 1994, shall be presumed to be representative of existing quality as of January 31, 1994, if the available information indicates that there have been no new or increased sources of groundwater contamination initiated in the area in question subsequent to that date. If available information is not adequate to otherwise determine or estimate existing ambient quality as of January 31, 1994, such groundwater quality for each parameter shall be assumed to be no worse that the most stringent level provided for in Tables 1 through 4 of "The Basic Standards for Ground Water," unless the Commission has adopted alternative numerical standards for a given specific area.

In essence, if CC&V has sufficient water quality data to determine or estimate the existing ambient quality as of 31 January 1994, those data will be used to establish the NPL. If data are not adequate to determine or estimate the water quality as of 31 January 1994, item B above applies; the "most stringent criteria" have been assumed to be the criteria for domestic drinking water. DRMS notes:

> "If an operator wishes to propose a groundwater standard less restrictive than those contained in 'The Basic Standards for Ground Water' tables, it will be the operator's burden to sufficiently demonstrate to DRMS that their circumstances meet at least one of the two conditions outlined below [in the letter], thereby allowing DRMS to apply a less restrictive standard, and still fully implement the requirements of Regulation No. 41."

The first narrow circumstance and authority for DRMS to apply a groundwater quality standard that is less restrictive than the Table Value Standard at a Point of Compliance exists when a mine operator provides DRMS with adequate documentation and data to determine, to the satisfaction of DRMS, that the existing ambient groundwater quality on January 31, 1994, was above the Table Value Standard.

Only two of the drainages under review have analytical data prior to 31 January 1994: Grassy Valley (two samples) and Wilson Creek (six samples). In this situation, the DRMS letter asserted:

"The second narrow circumstance and authority for DRMS to apply a groundwater quality standard less restrictive than the Table Value Standard at a Point of Compliance exists when an operator provides DRMS with data generated after January 31, 1994 which exceeds Table Value Standards and can also demonstrate that no new or increased sources of groundwater contamination in the area in question have been initiated since January 31, 1994, and therefore ambient conditions exceeded Table Value Standards prior to January 31, 1994.

The only other way a DRMS permitted site may allowably exceed the standards set by the Interim Narrative Standards would be for the permittee/applicant to obtain site-specific exemption or variance from WQCC [Water Quality Control Commission] through a rulemaking process."

The interpretation in DRMS's letter is inconsistent with the language of Regulation 41. Section 41.5(C)(6)(b)(iii) requires the DRMS to exercise its best professional judgment to determine what constitutes adequate information to determine or estimate existing ambient quality. This requires consideration of all data. The regulation then creates a *presumption* that data after January 31, 1994 are representative of existing quality as of January 31, 1994, if the available information indicates that there have been no new or increased sources of groundwater contamination initiated in the area in question after that date. The regulation does not create a "narrow circumstance" for consideration of data after January 31, 1994; instead, it directs DRMS to weigh all the data but to apply a presumption that the data are representative of conditions before January 31, 1994, if the required conditions are met.

In December 2016, CC&V proposed NPL for seven compliance monitoring points. (CC&V, 2016, Table 2-1). The proposed NPL are given in Table 1, and the locations of the drainages are shown in Figure 1.

Table 1: Proposed NPL (CC&V, 2016) and domestic well standards (t is total, d is dissolved, WCMW 3 and 6 are in the Wilson Creek drainage).

Drainage	Sulfate (t) (mg/L)	pH	Manganese (d) (mg/L)	Zinc (d) (mg/L)	WAD CN (mg/L)
Arequa Gulch	1070	6 - 9	8.1	2	0.2
Grassy Valley	250	6 - 9	1	2	0.2
Vindicator Valley	800	6.5 – 8.5	4	2	0.2
WCMW 3	250	6 - 9	0.5	2	0.2
WCMW 6	250	6 - 9	0.5	2	0.2
Squaw Gulch	1070	6.5 – 8.5	8.1	2	0.2
Poverty Gulch	1070	6 – 8.5	8.1	2	0.2
Domestic Wells	250	6.5 – 8.5	0.05	5	0.2

Below is an analysis of the data and recommendations for additional work in support of the proposed NPL. WAD CN is not discussed because it has not approached the 0.2 mg/L standard in any of the drainages.

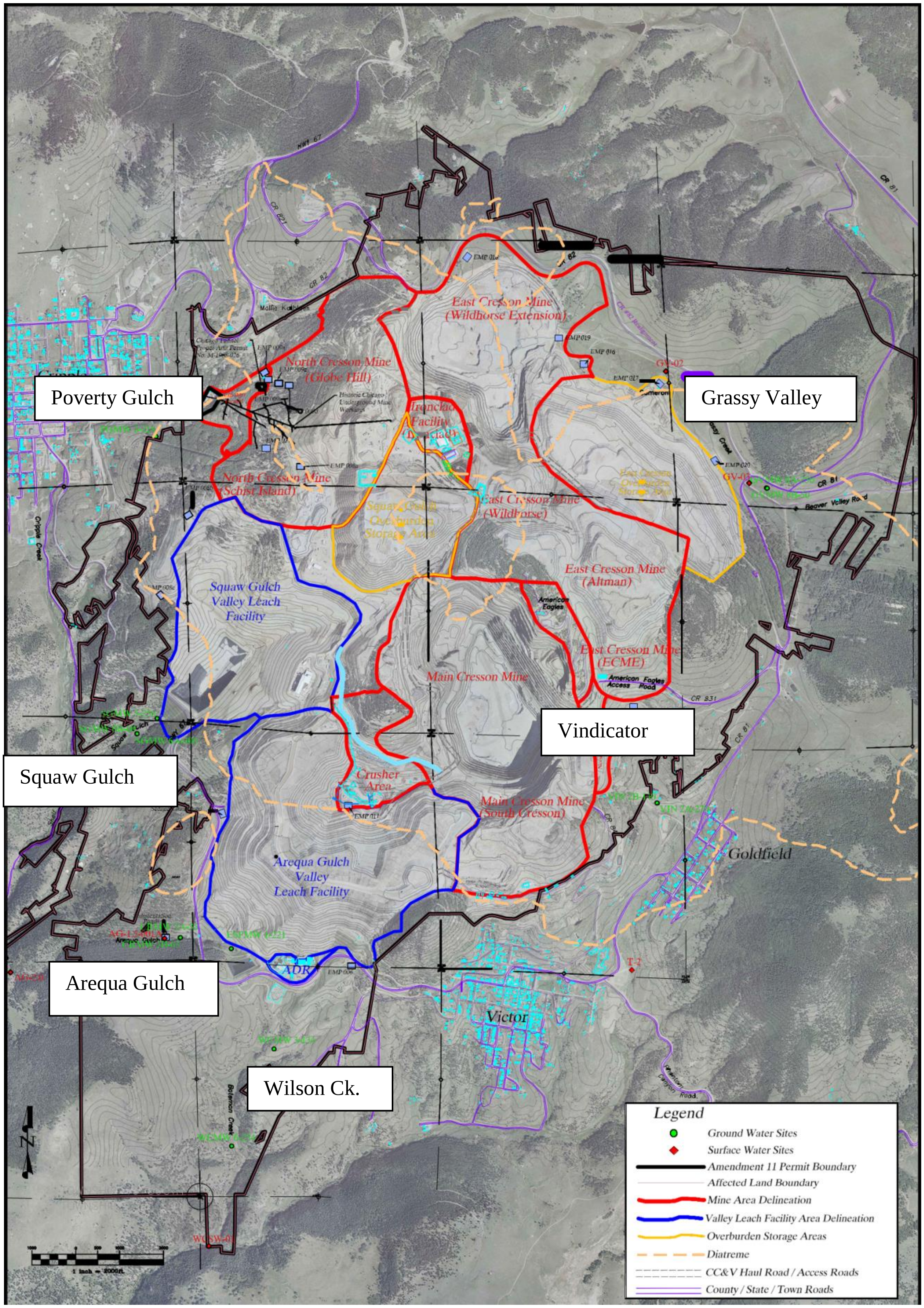

Figure 1: CC&V facilities and drainages that are the focus of the present report.

2. Monitoring Plan

Contained with the recently approved Amendment 11 to the Cresson permit M-1980-244 is the current approved groundwater monitoring plan for the CC&V mine site. This monitoring plan identifies the locations for groundwater monitoring, the frequency of monitoring, and analysis is to be performed. Section 11.2 states the following:

> "11.2 Groundwater
>
> Groundwater quality and depth to groundwater is monitored on a quarterly basis at the following locations: downgradient of the AGVLF in Arequa Gulch (CRMW-3A and CRMW-3B) and Wilson Creek (WCMW-3 and WCMW-6); downgradient of the SGVLF in Squaw Gulch (SGMW-5); downgradient of the East Cresson Mine area at two locations in Vindicator Valley (VIN-2A and VIN-2B) and five locations in Grassy Valley (GVMW-8A, GVMW-8B, GVMW-22A, and GVMW-22B); downgradient of the North Cresson Mine area in Poverty Gulch at one location (PGMW-2); and downgradient of the External Storage Pond ("ESP") in Arequa Gulch (ESPMW-1). A list of wells, parameters analyzed, and results are presented in Appendix 2, Volume II of this Amendment 11 documentation. Groundwater may not be encountered in some wells completed to within a few hundred feet of the surface. In these cases, monitoring will be limited to checking water levels (i.e., checking for the presence of water) and samples will not be analyzed unless sufficient water is encountered to allow sampling and analysis of non-turbid water."

Table 11-2 contained within section 11.2, the groundwater monitoring plan presents the monitoring intervals that are attributed to the monitoring locations identified within the monitoring plan. All groundwater monitoring locations listed within this table are to be sampled on a quarterly basis.

Our review of the monitoring locations identified within the monitoring plan confirms that CC&V is monitoring the appropriate locations for groundwater quality. For the identified facilities on site, appropriate down-gradient monitoring locations have been identified and monitoring points have been constructed. The monitoring frequency specified within the monitoring plan (quarterly) is appropriate for the mine site. Figure 2 presents the groundwater monitoring locations identified within the monitoring plan, and their position relative to existing mine facilities.

Figure 2. CC&V compliance groundwater monitoring locations

3. Previously Established Numeric Protection Limits

As further described below, DRMS has issued NPLs for the CC&V mine site four times over the last eleven years. In issuing these NPLs, we understand that DRMS personnel complied with the Division's regulatory mandate to use its best professional judgement in analyzing the submitted data to determine NPLs that deviated from the criteria in Tables 1 through 4 of Colorado Regulation 41, The Basic Standards for groundwater. In using their best professional judgement, DRMS personnel appropriately determined that the groundwater quality of the sites reviewed was not impacted by sources of groundwater contamination since January 31, 1994, and subsequently that the observed groundwater quality is representative of water quality prior to January 31, 1994.

DRMS issued NPLs to CC&V via correspondence on the following dates: October 7, 1996, November 20, 1998, May 18, 2006, and August 7, 2012. NPLs received on October 7, 1996, DRMS issued NPLs pertaining to all groundwater monitoring locations at the CC&V mine site and set numerical protection limits for the following analytes: aluminum, arsenic, cadmium, copper, fluoride, iron, lead, manganese, mercury, nickel, nitrite, nitrate, nitrate & nitrite, selenium, zinc, cyanide (WAD), and pH. On November 20, 1998, DRMS issued NPLs pertinent to monitor wells CRMW-3B-63, GVMW-8A-250, and WCMW 6-234 and contained NPL values for manganese, cyanide (WAD), pH and sulfate. On May 18, 2006, DRMS issued NPLs for Vindicator Valley compliance well VIN 2B, which included NPL information for manganese, cyanide (WAD), pH and sulfate. On August 7, 2012, DRMS issued updated NPL information for WCMW-6 and new NPL information for WCMW 3-134, which included NPL values for manganese, zinc, cyanide (WAD), pH, and sulfate. NPL documentation received from DRMS for the CC&V mine site for the above referenced dates are included within Attachment A.

4. Data

Results of chemical analyses of water samples taken from the wells were extracted from the CC&V environmental monitoring database and reviewed as spreadsheets. Table 2 provides a general overview of the data.

Table 2: Overview of groundwater monitoring well data.

Drainage	No. of Wells	Earliest Sample	Analyses Pre 1/31/94	General Comments
Arequa	2	12/7/93	2 each well	17 and 33% of samples below detection for manganese and Zn
Grassy	4	7/16/98		Zinc always below detection, 5-81% of samples below detection for Mn
Vindicator	2	6/30/04		31 and 100% of samples below detection for Zn
Wilson Ck.	2	3/15/92	6, WCMW 3-134 2, WCMW 6-234	2 and 47% of samples below detection for manganese, 81and 97% for Zn
Squaw	4	9/25/14		3 wells are essentially always dry, limited samples from SGMW 6B-60
Poverty	2	3/31/00		Dry except for 2000 and 2001

Tables 3 and 4 present summary statistics for each sampling location; Table 3 has the data for sulfate and field pH, Table 4 has the data for manganese and zinc. The data shown in Tables 3 and 4 generally indicate significant variability in the analytical results for any given sampling location, with the exception of the data for Vindicator Valley. Figure 3 shows the sulfate concentration data for the Arequa Gulch monitoring wells as an example of sample-to-sample variability.

Table 3: Summary statistics for sulfate and pH data used in the present analysis (S.D. is standard deviation, Max. is maximum, Min. is minimum, n is the number of samples with results above the detection limit, N.D. is not detected).

		Sulfate (mg/L)					Field pH				
Drainage	Well	Geomean	S.D.	Max	Min	n	Geomean	S.D.	Max	Min	n
Arequa	CRMW 3A-35	745	184	1260	424	120	6.25	0.20	6.88	5.25	123
	CRMW 3B-63	765	141	1130	200	140	6.73	0.16	7.09	6.13	139
	Geomean	755				260	6.49				262
Grassy	GVMW 8A-250	68	8	107	51	87	7.26	0.59	10.8	6.87	92
	GVMW 8B-50	96	44	246	53	75	6.84	0.41	8.84	6.17	88
	GVMW 22A-70	49	22	161	39	29	7.84	0.24	8.29	7.02	39
	GVMW 22B-30	70	17	104	27	28	6.71	0.21	7.17	6.19	28
	Geomean	69				219	7.15				247
Vindicator	VIN 2A-270	705	26	760	662	13	7.25	0.13	7.50	7.05	58
	VIN 2B-140	718	55	792	548	26	7.20	0.11	7.56	6.94	100
	Geomean	711				39	7.22				158
Wilson	WCMW 3-134	21	5	44	12	127	7.69	0.15	8.14	6.84	131
	WCMW 6-234	56	8	80	39	92	7.03	0.13	7.52	6.70	90
	Geomean	34				219	7.35				221
Squaw	SGMW 6B-60	971	80	1140	873	10	6.47	0.20	6.83	6.12	14
Poverty	PGMW 1A-200	521	6	529	513	6	6.56	1.50	10.28	4.52	13
	PGMW 1B-55	285	57	401	226	9	3.68	0.27	4.36	3.41	14
	Geomean	362					4.87				

Table 4: Summary statistics for manganese and zinc data used in the present analysis (S.D. is standard deviation, Max. is maximum, Min. is minimum, n is the number of samples with results above the detection limit, N.D. is not detected).

		Manganese (mg/L)					Zinc (mg/L)				
Drainage	Well	Geomean	S.D.	Max.	Min.	n	Geomean	S.D.	Max.	Min.	n
Arequa	CRMW 3A-35	0.24	0.44	2.06	0.01	84	0.08	0.06	0.31	0.01	81
	CRMW 3B-63	4.27	1.43	10.40	0.07	141	0.07	0.04	0.40	0.03	117
	Geomean	1.01				225	0.07				198
Grassy	GVMW 8A-250	0.40	0.21	0.93	0.01	83	N.D.				
	GVMW 8B-50	0.03	0.04	0.14	0.01	14	N.D.				
	GVMW 22A-70	0.03	0.02	0.11	0.01	20	N.D.				
	GVMW 22B-30	0.07	0.10	0.38	0.01	18	N.D.				
	Geomean	0.07				135	N.D.				
Vindicator	VIN 2A-270	0.03	0.01	0.05	0.02	13	0.08	0.04	0.17	0.05	9
	VIN 2B-140	2.63	0.53	3.45	0.78	56	N.D.				
	Geomean	0.28				69	0.08				9
Wilson	WCMW 3-134	0.03	0.03	0.26	0.01	70	0.007	0.002	0.011	0.005	26
	WCMW 6-234	0.16	0.02	0.27	0.10	90	0.012	0.004	0.017	0.010	3
	Geomean	0.06				160	0.01				29
Squaw	SGMW 6B-60	4.79	1.53	7.14	2.78	10	0.24	0.16	0.56	0.11	10
Poverty	PGMW 1A-200	8.61	1.52	10.3	6.09	6	0.61	0.28	1.15	0.37	6
	PGMW 1B-55	18.27	2.25	22.5	2.25	9	2.20	0.35	2.97	1.77	9
	Geomean	13.52					1.32				

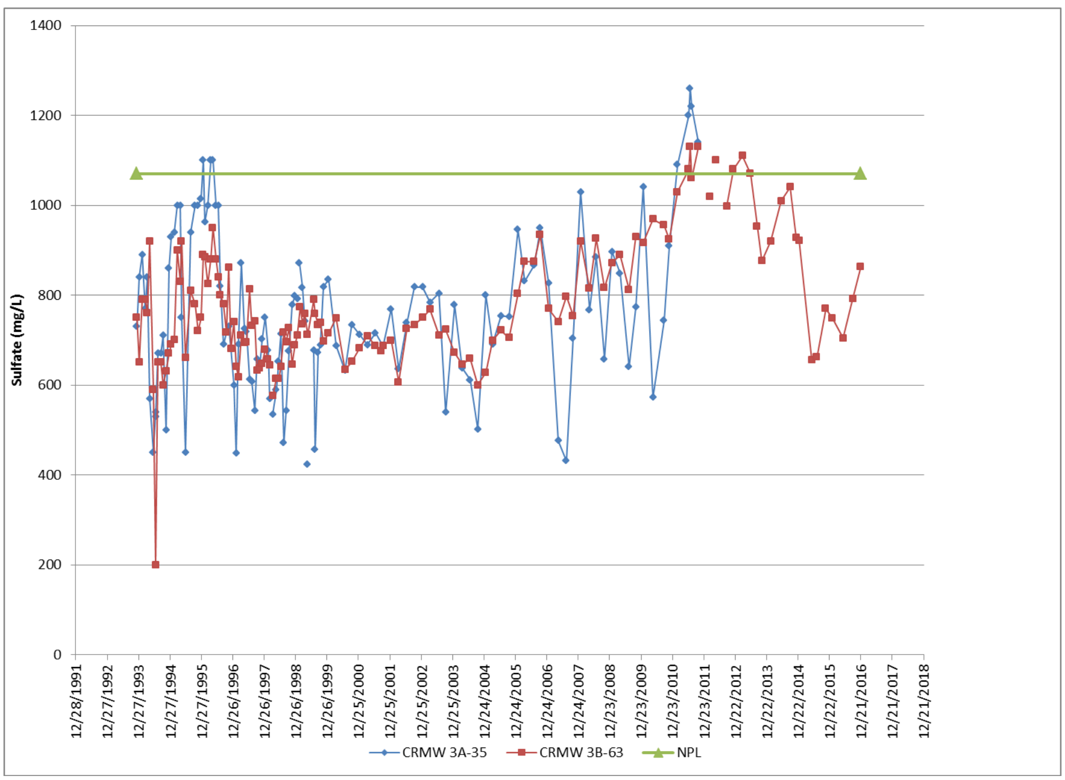

Figure 3: Sulfate concentration in the two Arequa Gulch monitor wells, and the proposed NPL.

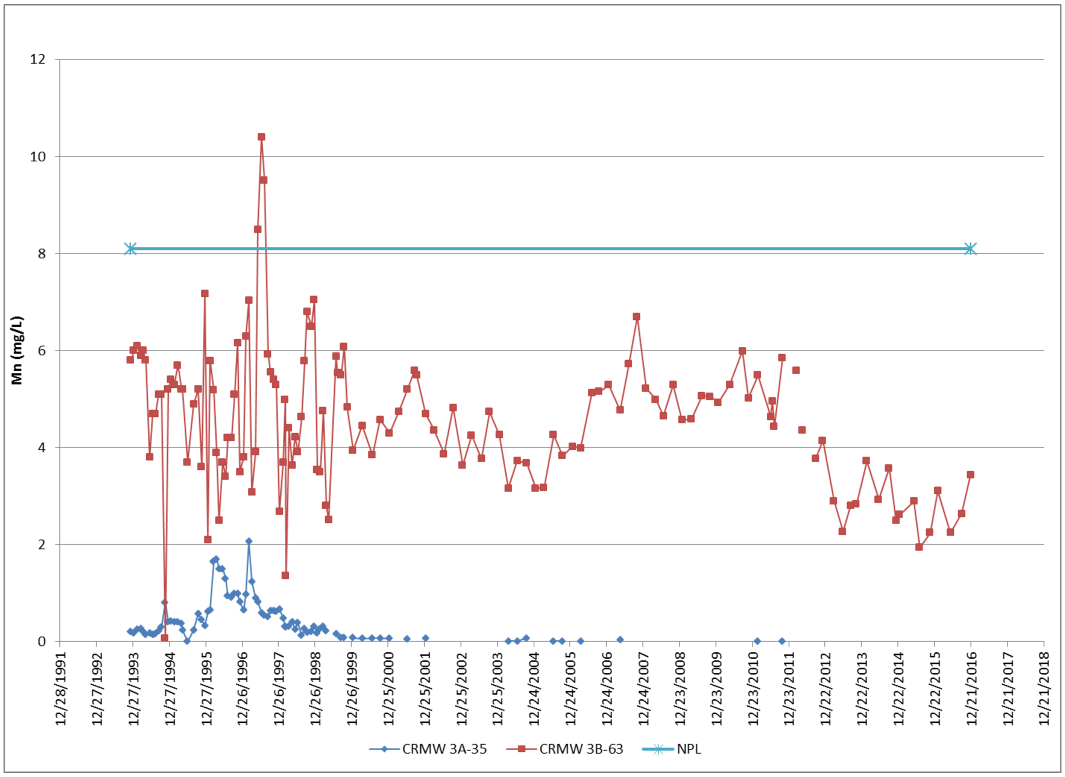

Figure 4: Manganese concentration in the two Arequa Gulch monitoring wells, and the proposed NPL.

Manganese concentration tends to be higher in the deeper monitoring wells than in the shallower wells in a given drainage (Vindicator Valley and Poverty Gulch are the exceptions to this observation). No other depth relationships are apparent from the data in Tables 3 and 4.

Squaw Gulch has the highest geometric mean sulfate concentrations of all the drainages, followed in decreasing order Arequa Gulch, Vindicator Valley, and Poverty Gulch. Poverty Gulch has the lowest pH, and the highest manganese and zinc. The geometric mean concentrations for these four analytes in each of the drainages are shown in Figure 5.

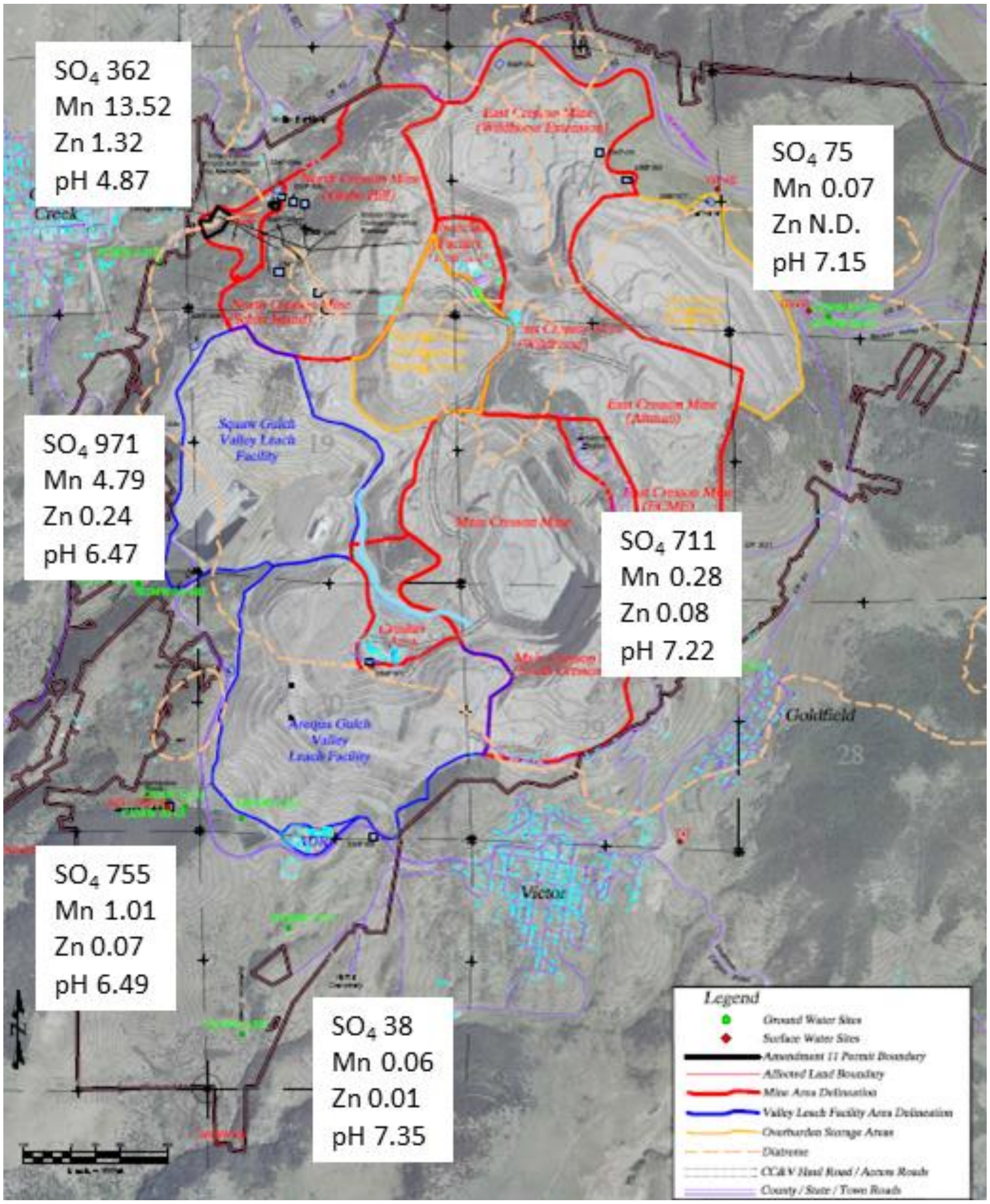

Figure 5: Distribution of geometric mean concentration of sulfate, manganese, zinc (all in mg/L) and field pH.

5. Analysis

As shown in Figure 5, the six drainages have significantly different geometric mean concentrations of sulfate, manganese, and zinc. The following sub-sections address the chemistry data by drainage. In those drainages where dissolved constituents are at elevated levels, working hypotheses are developed to account for the elevated constituents in Section 4.

5.1 Squaw Gulch

Of the six drainages, Squaw Gulch has the highest geometric mean concentration of sulfate and manganese, and second highest zinc, but has only one monitoring well upon which this assessment is based (SGMW 6B-60). The other three wells (SGMW 6A-400, SGMW 7B-60, and SGMW 7A-400) have been dry since their construction in April – June 2015, with the exception of SGMW 7B-60, which was sampled in June and July 2015. Table 5 presents the geometric mean data of the SGMW 7B-60 samples with the sample taken from SGMW 6B-60 in July 2015 (no sample was collected from SGMW 6B-60 in June 2015).

Table 5: Comparison of analytical results from SGMW 7B-60 and SGMW 6B-60, June-July 2015 (N.D. indicates not detected).

Analyte	SGMW 7B-60	SGMW 6B-60
SO_4 (mg/L)	953	1040
Mn (mg/L)	0.05	5.94
Field pH	6.62	6.36
Zn (mg/L)	N.D.	0.24
WAD CN (mg/L)	N.D.	N.D.

It is evident from Table 5 that sulfate and pH are relatively consistent between the two wells, but manganese and zinc are higher in SGMW 6B-60 by several orders of magnitude. The sulfate, manganese and zinc concentrations in SGMW 6B-60 are within one standard deviation of the overall geometric mean of the data from that well (see Table 3), suggesting that the July 2015 sample is reasonably representative. The more recent data indicate that sulfate varies over a narrow band of approximately 100 mg/L.

The water chemistry data from Squaw Gulch were examined against precipitation, as measured at the Rigi meteorological station, and the total precipitation between sampling events plotted against the various constituents. However, due to the short record of water chemistry data, no clear relationships were apparent.

Figure 6 presents the Squaw Gulch data for sulfate, and Figure 7 presents the data for manganese, zinc, and pH. Whilst there are few data available, it appears that since early 2016 manganese and zinc co-vary, and together with sulfate exhibit a temporary spike in concentration on 21 June 2016. Field pH has been very slowly declining since the initial sample was taken from SGMW 6B-60, and given the absence of detectable WAD CN, suggests that process solution from the Squaw Gulch valley leach facility (VLF2) does not enter the groundwater.

Precipitation, as measured at the Rigi meteorological station, was totaled between sampling events, and plotted against the analytes of interest. No clear relationships were evident, so precipitation has not been included in Figures 6 and 7.

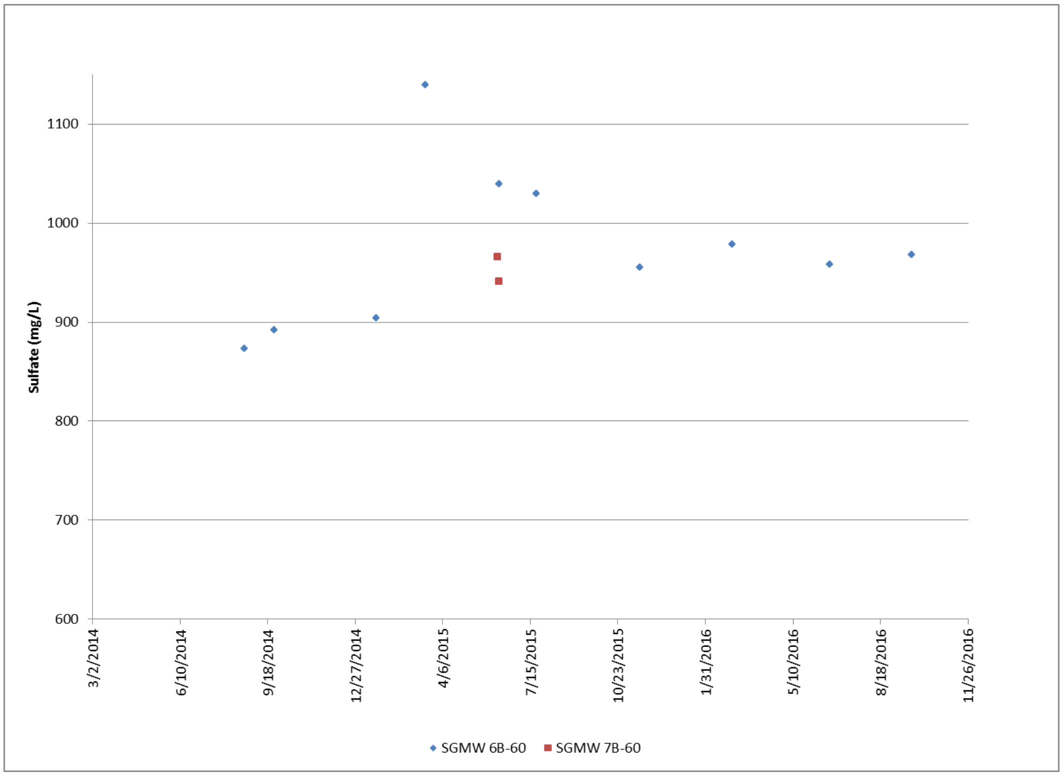

Figure 6: Sulfate data for Squaw Gulch.

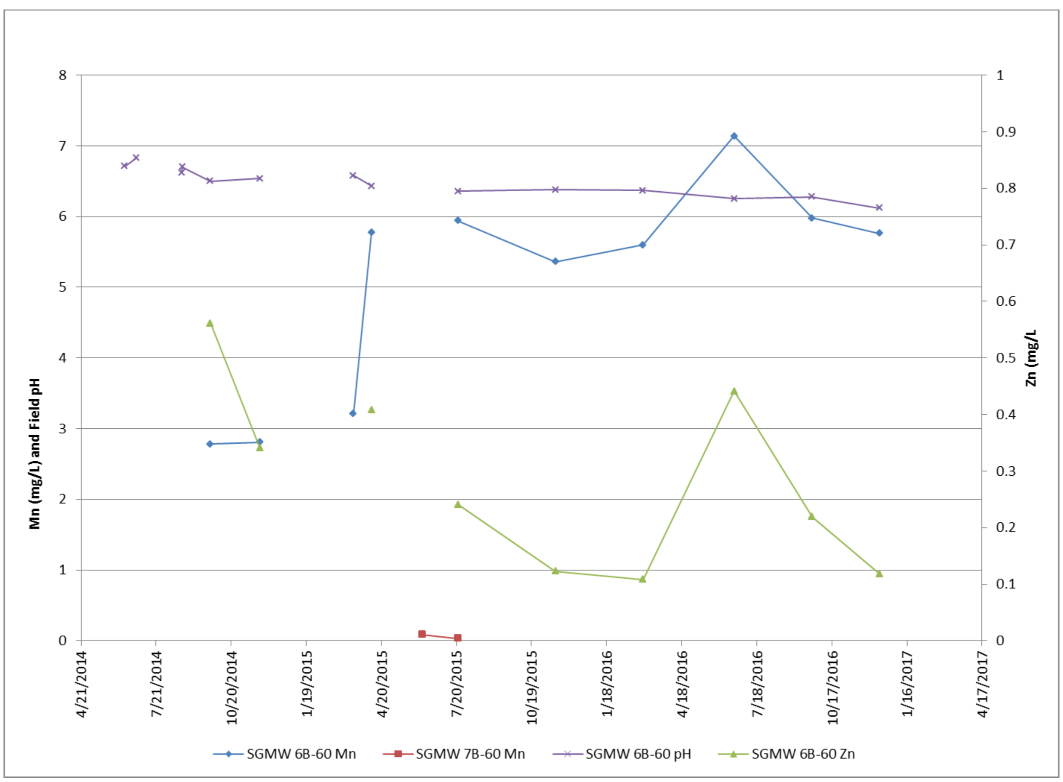

Figure 7: Manganese, Zinc, and field pH data for Squaw Gulch.

5.2 Arequa Gulch

Compared with the other five drainages, Arequa Gulch has the second highest concentration of sulfate, third highest manganese and fourth highest zinc, based on samples from two monitoring wells (CRMW 3A-35 and CRMW 3B-63). Sulfate and total precipitation between sampling events, as measured at the Rigi meteorological station, are shown in Figure 8.

Sulfate concentrations in both of the Arequa Gulch monitoring wells are similar, but the data for CRMW 3B-63 show less variability. Overall the sulfate data spread over a range of about 800 mg/L. Sulfate concentration increased from early 2000 until late 2011 and declined until mid-2015, when it began to increase. The data in Figure 8 suggest an inverse relationship between sulfate and precipitation in Arequa Gulch groundwater. It is probable that the sulfate load is relatively constant in the groundwater, but when there is an increase in recharge, the sulfate concentration is diluted.

There is a noticeable periodicity in the sulfate data, with approximately four years from low to low, until 2007, when the periodicity becomes annual.

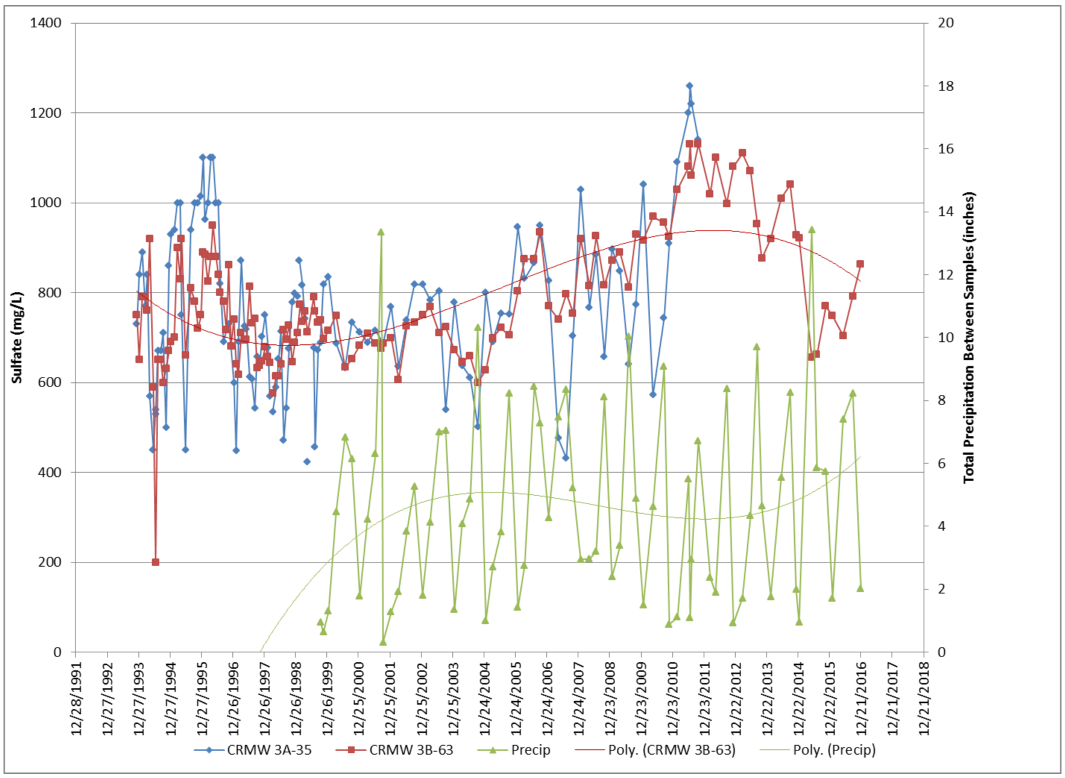

Figure 8: Sulfate and total precipitation between sampling events data for Arequa Gulch. Third order polynomial trend lines have been added to the data from CRMW 3B-63 and the precipitation data to illustrate the relationships between these two parameters.

Data for manganese and zinc are shown in Figure 9. Manganese and zinc co-vary in the two wells, and both constituents exhibit increasing trends in CRMW 3B-63 until late 2011, when concentrations began to decline. Since late 2013 zinc and manganese concentrations have been relatively stable. The very high zinc concentration in CRMW 3B-63 (0.4 mg/L) in September 2014 must be considered as a spurious measurement. Manganese in CRMW 3A-35 was elevated until late 1999, when it declined to less than 0.1 mg/L. However, beginning in early 2002 very few samples returned results for manganese above detection limits. Zinc in CRMW 3A-35 was more or less stable at around 0.6 mg/L until late 2003, after which very few samples returned results above detection limits. The reason for the change to non-detect results for manganese and zinc in CRMW 3A-35 is not clear.

No clear relationship between precipitation and manganese and zinc is apparent, so precipitation was not included in Figure 9, although since early 2011 both metals appear to vary inversely to precipitation.

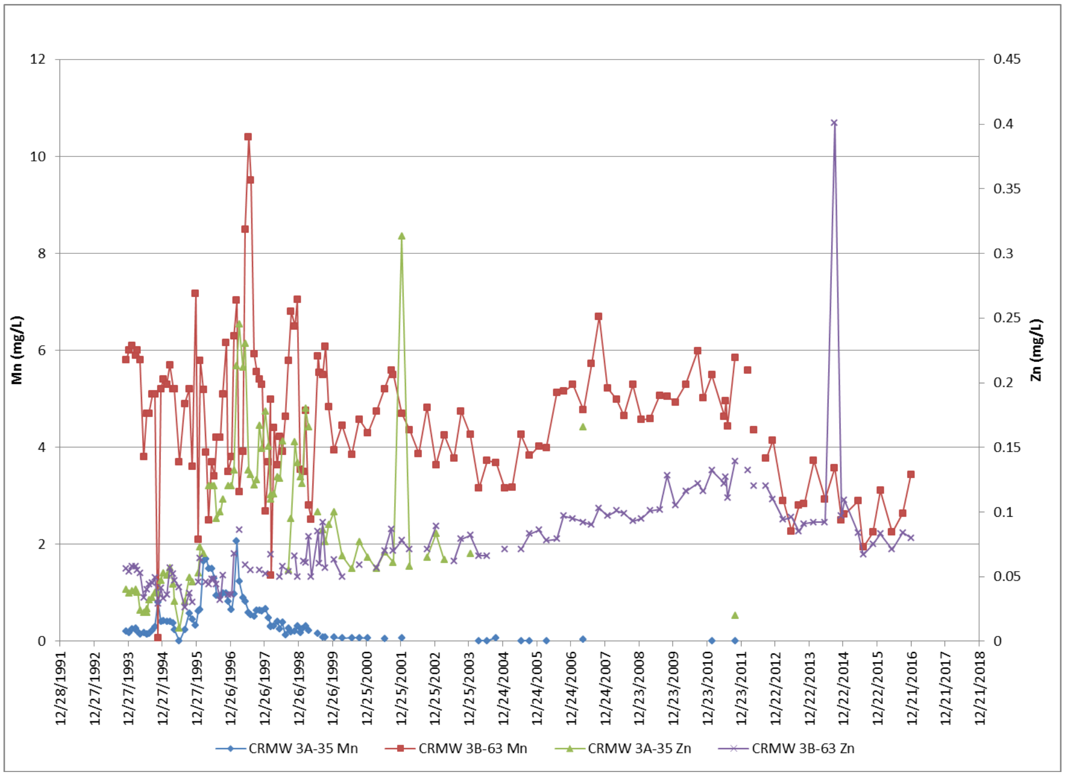

Figure 9: Manganese and zinc data from Arequa Gulch.

Figure 10 presents the pH and quarterly total precipitation data as measured at the Rigi meteorological station. Field pH in the two Arequa Gulch monitoring wells varied substantially until late 1999, after which the sample to sample variability diminished substantially. Figure 10 indicates that pH has been slowly increasing since achieving low values in late 2001 (CRMW 3A-35) and early 2005 (CRMW 3B-63). Over the period for which precipitation data are available, it is evident that pH rises and falls with precipitation, suggesting rapid recharge of groundwater. The very low pH recorded in CRMW 3A-35 in mid-2008 is considered to be an erroneous measurement because it is significantly outside the range of the rest of the data from this well.

The lack of elevated pH or WAD CN in the Arequa Gulch monitoring wells is solid evidence that process solution is not escaping from the Arequa Gulch valley leach facility (VLF1). Therefore, construction of the VLF1 did not create a new or increased source of sulfate, manganese, or zinc in Arequa Gulch. Instead, as described in Section 6.2 below, historical sources put in place well before January 31, 1994 are the likely explanation for groundwater concentrations of sulfate, manganese, and zinc.

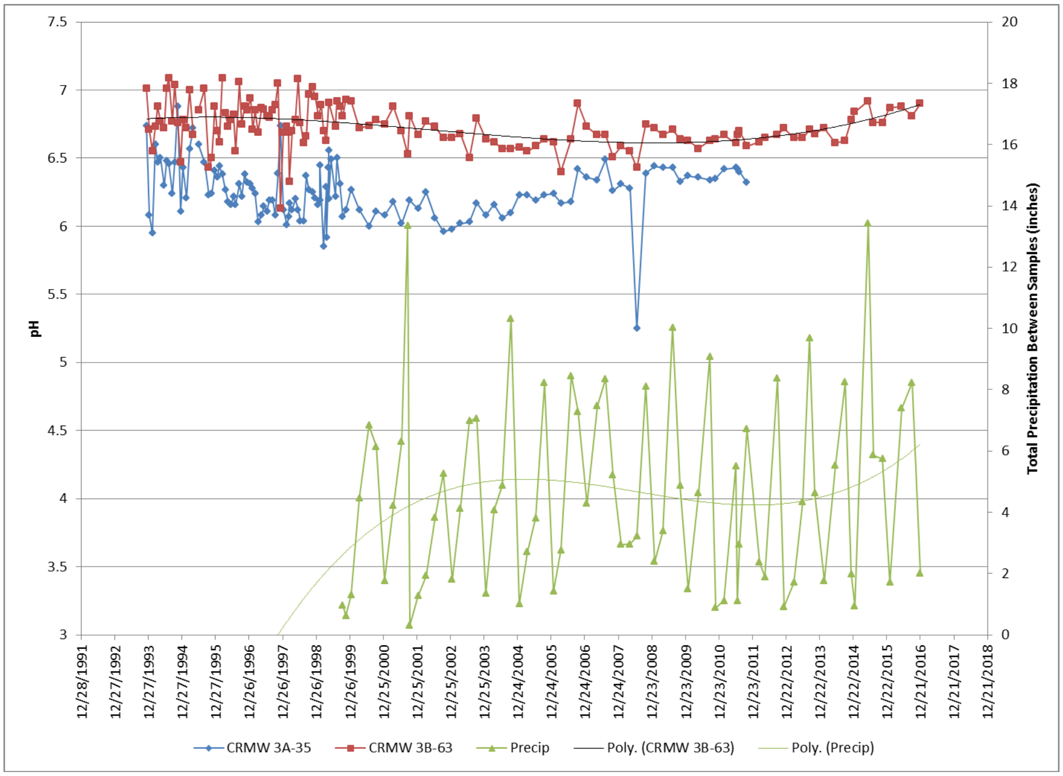

Figure 10: Arequa Gulch field pH and total precipitation between sampling events data. Third order polynomial trends have been added to the precipitation and data from CRMW 3B-63 to help illustrate the covariance.

5.3 Vindicator Valley

Groundwater in Vindicator Valley has the third highest concentrations of sulfate and zinc, and the fourth highest manganese, based on the results from two monitoring wells (VIN 2A-270 and VIN 2B-140). Sulfate and total precipitation between sampling events, from the Rigi meteorological station, are shown in Figure 11. The data suggest a general positive correlation between precipitation and sulfate in groundwater until 2010, when the relationship appears to have become somewhat negatively correlated. The sample-to-sample variability in sulfate concentration is not as great as in Squaw and Arequa Gulches, with a narrow range of slightly less than 200 mg/L. The data in Figure 11 suggest that sulfate has achieved a relatively stable concentration, and may have begun to decline.

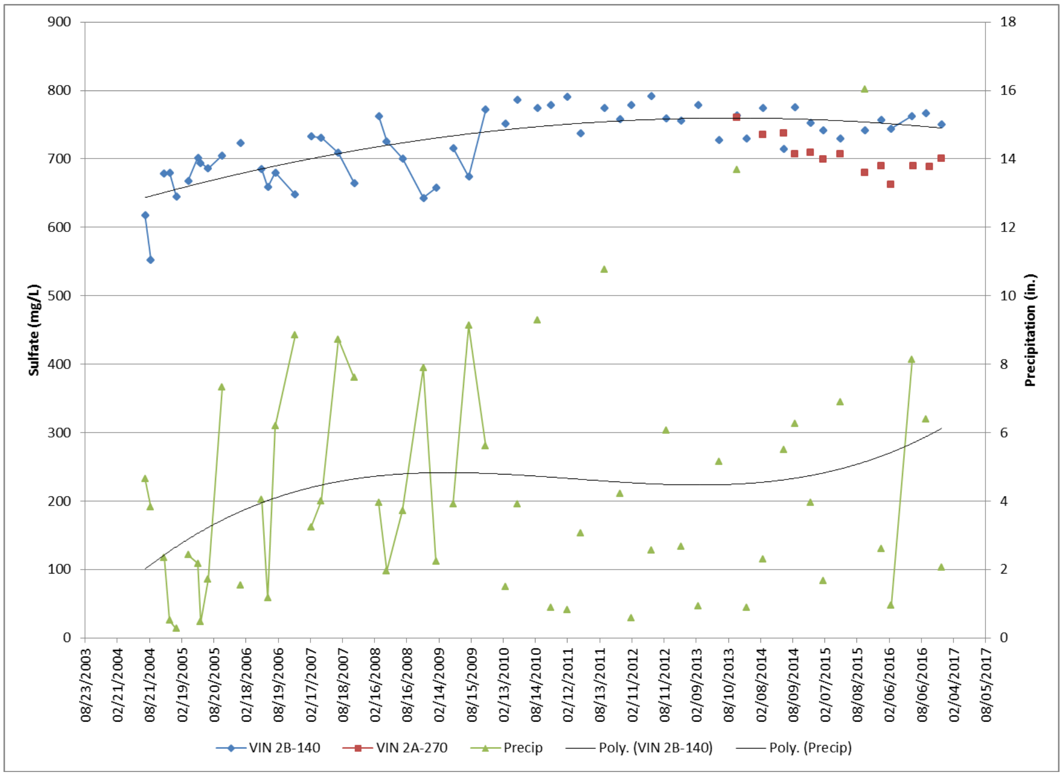

Figure 11: Vindicator Valley sulfate and precipitation (total between sampling events).

Manganese, zinc and precipitation data are shown in Figure 12. Manganese concentration is significantly higher in VIN 2B-140 than it is in VIN 2A-270, and VIN 2B-140 contains no detectable zinc. Interestingly, zinc was not detected in VIN 2A-270 until 2014, and with the exception of the 29 November 2016 sample, has been at relatively consistent concentration. The concentration of manganese in VIN 2B-140 appears to be on a declining trend. Manganese shows a positive correlation with precipitation until late 2010, when the relationship became negatively correlated.

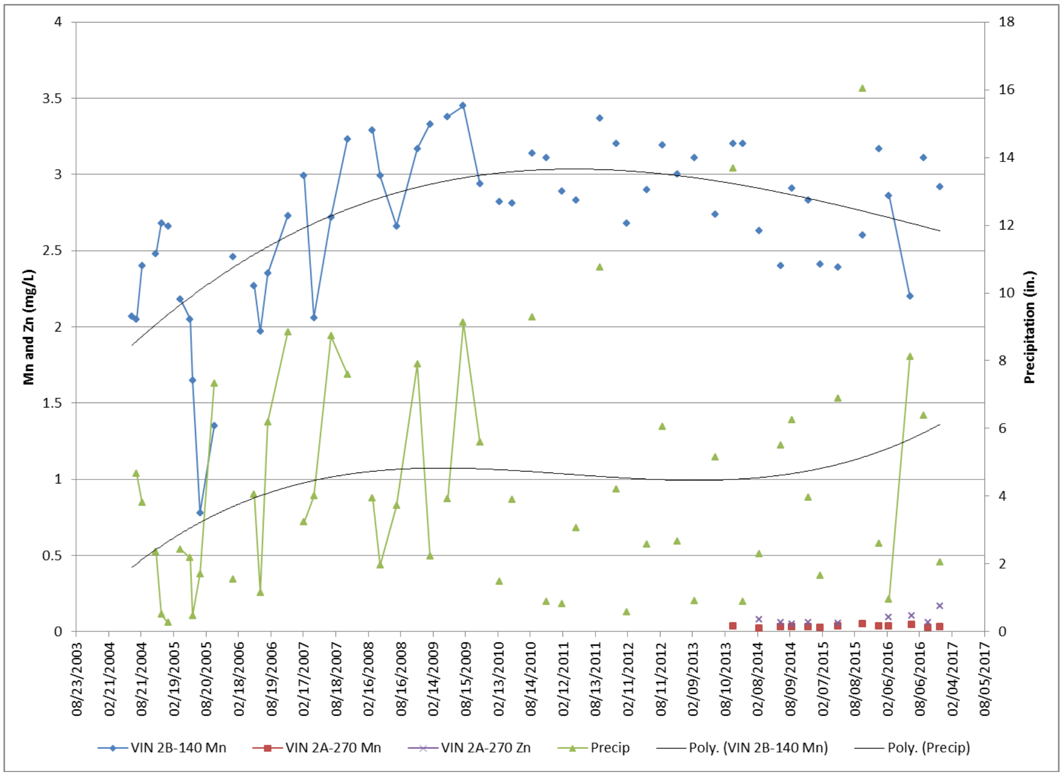

Figure 12: Manganese, zinc, and precipitation (total between sampling events) for Vindicator Valley groundwater.

Figure 13 presents the pH and precipitation data for Vindicator Valley. Overall pH has varied little, but displays a slightly increasing trend with time. Precipitation correlates somewhat positively with pH, suggesting that recharge of groundwater is rapid.

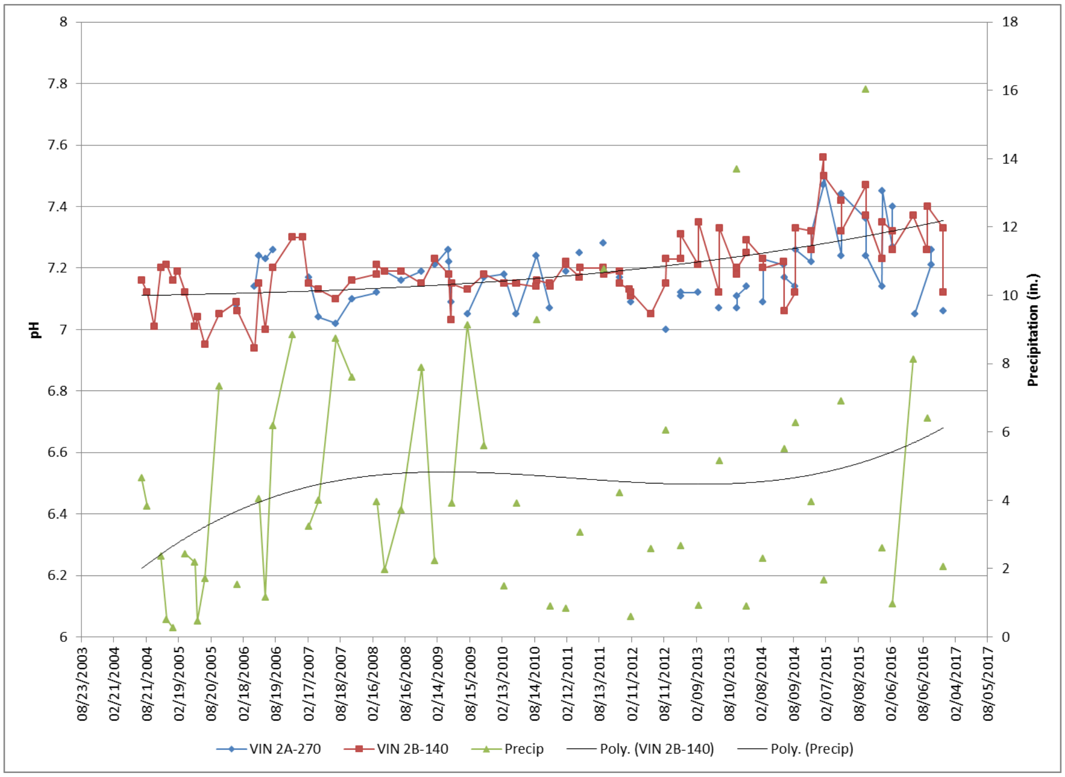

Figure 13: Precipitation (total between sampling events) and field pH in Vindicator Valley.

5.4 Poverty Gulch

The Poverty Gulch compliance monitoring well is PGMW 2. However, this well has been dry since it was constructed 19 December 2001. Two other monitoring wells in Poverty Gulch, PGMW 1A-200 and PGMW 1B-55, were sampled from 31 March 2000 through 10 April 2001, with one additional sample taken from PGMW 1B-55 on 9 July 2001 (these wells were subsequently dry until the last attempts were made to sample them in October 2005). Both of the PGMW 1 wells were plugged and abandoned sometime after October 2005. In the absence of data from PGMW 2, the data from the other two wells were used in the analysis.

Groundwater sampled in Poverty Gulch has the fourth highest geometric mean concentration of sulfate, the lowest field pH, highest zinc, and second highest manganese geometric mean concentrations of the six drainages, but the time period represented by the data is less than 1.5 years. Identification of trends for each of the analytes is difficult due to the short record of data.

Sulfate, field pH, and precipitation (measured at the Rigi meteorological station, totaled between sampling events) data are shown in Figure 14. No clear relationship between precipitation and sulfate or pH is evident. It appears that sulfate concentrations and pH are relatively stable.

Figure 15 presents the manganese and zinc concentrations, and precipitation totaled between sampling events, for the Poverty Gulch monitoring wells. No clear relationship is apparent between precipitation and either manganese or zinc. In general, concentrations are relatively stable, although both manganese and zinc were declining in PGMW 1B-55 during the last three sampling events.

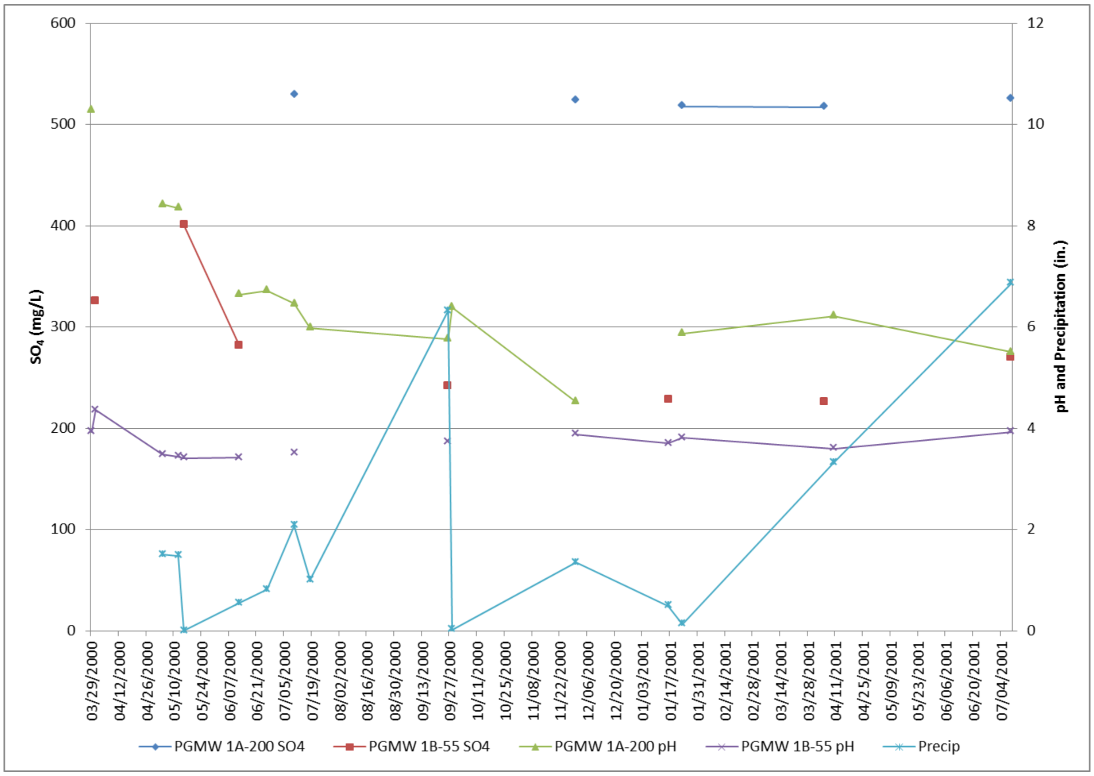

Figure 14: Poverty Gulch sulfate, field pH, and precipitation totaled between sampling events.

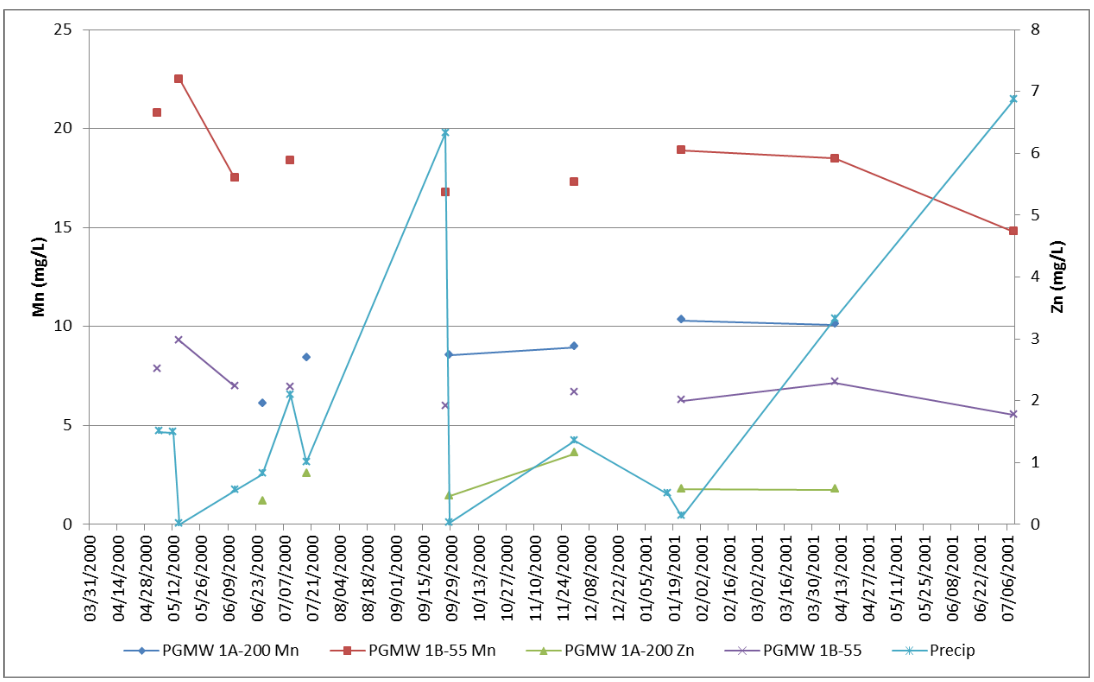

Figure 15: Poverty Gulch manganese, zinc, and precipitation totaled between sampling events.

5.5 Wilson Creek

The Wilson Creek groundwater monitoring wells (WCMW 3-134 and WCMW 6-234) are located on Bateman Creek, a tributary to Wilson Creek. An east-west trending ridge of Precambrian rock separates the head of Bateman Creek from Arequa Gulch. The only constituent in the Wilson Creek monitoring wells that exceeds domestic well standards is manganese in WCMW 6-234 (early samples from WCMW 3-134 exceeded the domestic well standard for manganese, but since sometime between March 1999 and March 2004, a period in which no manganese results were obtained, the concentration has remained below 0.02 mg/L).

Sulfate data for the Wilson Creek monitoring wells are shown in Figure 16. Included in Figure 16 are the precipitation data, totaled between sampling events, from the Rigi meteorological station. Third order polynomial trends have been fit to the precipitation and sulfate data. It is readily apparent that precipitation has a strong positive correlation with manganese in WCMW 3-134, and a moderately positive correlation with manganese in WCMW 6-234. The overall trend is for slightly increasing sulfate concentration in both wells, but the concentrations are significantly below the domestic well standard of 250 mg/L.

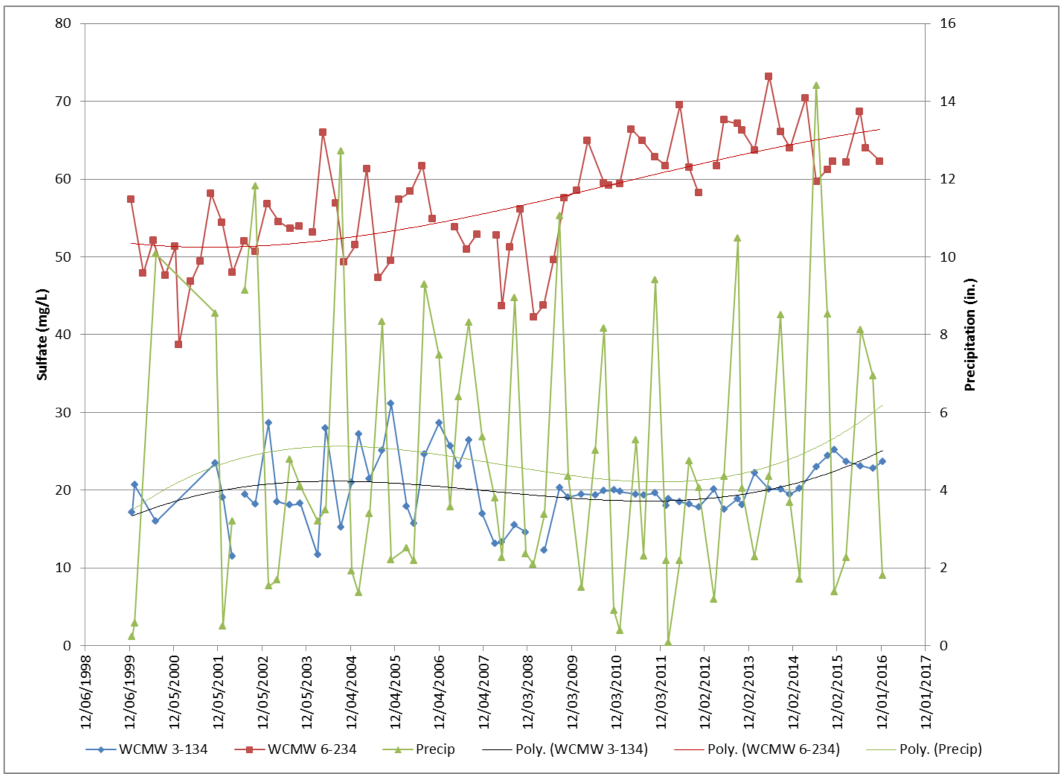

Figure 16: Sulfate and precipitation data for Wilson Creek monitoring wells. Third order polynomial trend lines have been added to aid in identification of correlations.

Manganese data are plotted with precipitation, totaled between sampling events, in Figure 17. There is a reasonably strong positive correlation between precipitation and manganese in both wells. The manganese concentration in WCMW 6-234 is above the domestic well standard of 0.05 mg/L, whereas manganese concentration is significantly less than the standard in WCMW 3-134. The trend for manganese in both wells appears to be essentially unchanging.

Zinc has not been quantified in the Wilson Creek wells since early 1997. During the period that zinc was measured, its geometric mean concentration was 0.007 mg/L in WCMW 3-134, and 0.012 mg/L in WCMW 6-234, several orders of magnitude less than the domestic well standard. The lack of zinc above the detection limit (since 1997) could be real, or it may be a function of analytical methodology. No time series plot of zinc in Wilson Creek is included in the present report.

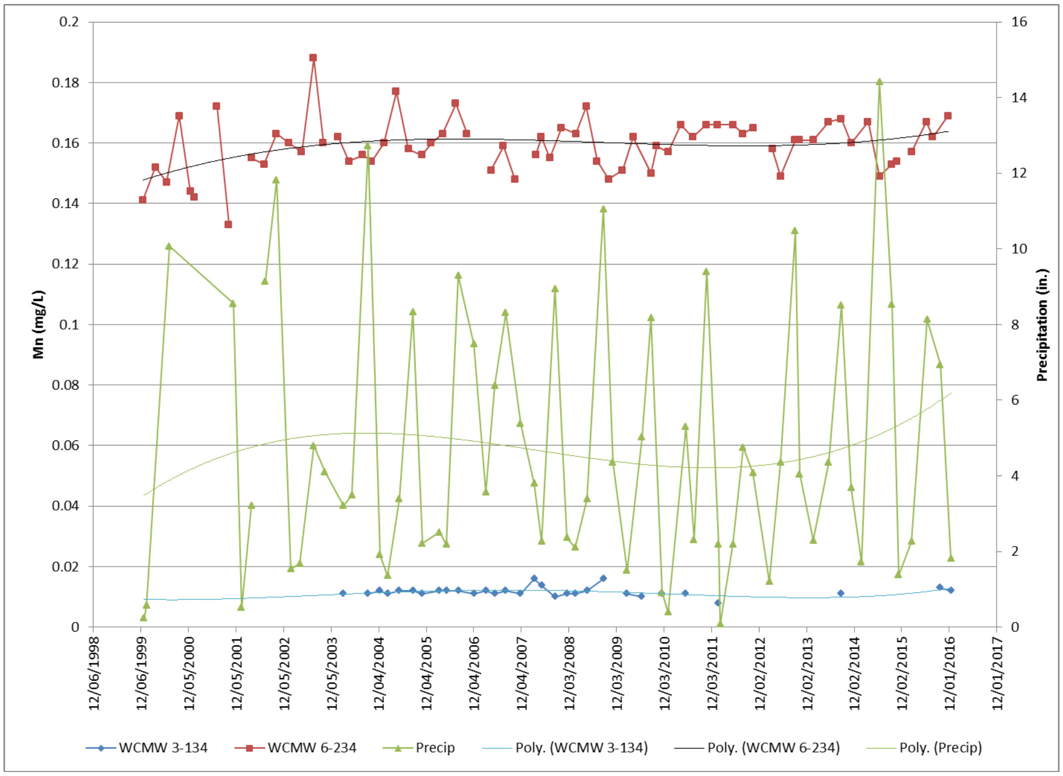

Figure 17: Manganese and precipitation data for Wilson Creek monitoring wells. Third order polynomial trends have been fit to the data to aid in recognition of correlations.

Field pH and precipitation data are shown in Figure 18. Precipitation correlates positively with pH in both wells, suggesting rapid recharge of groundwater. It is evident that pH has been slowly increasing since early 2012, but the rate of increase is very low.

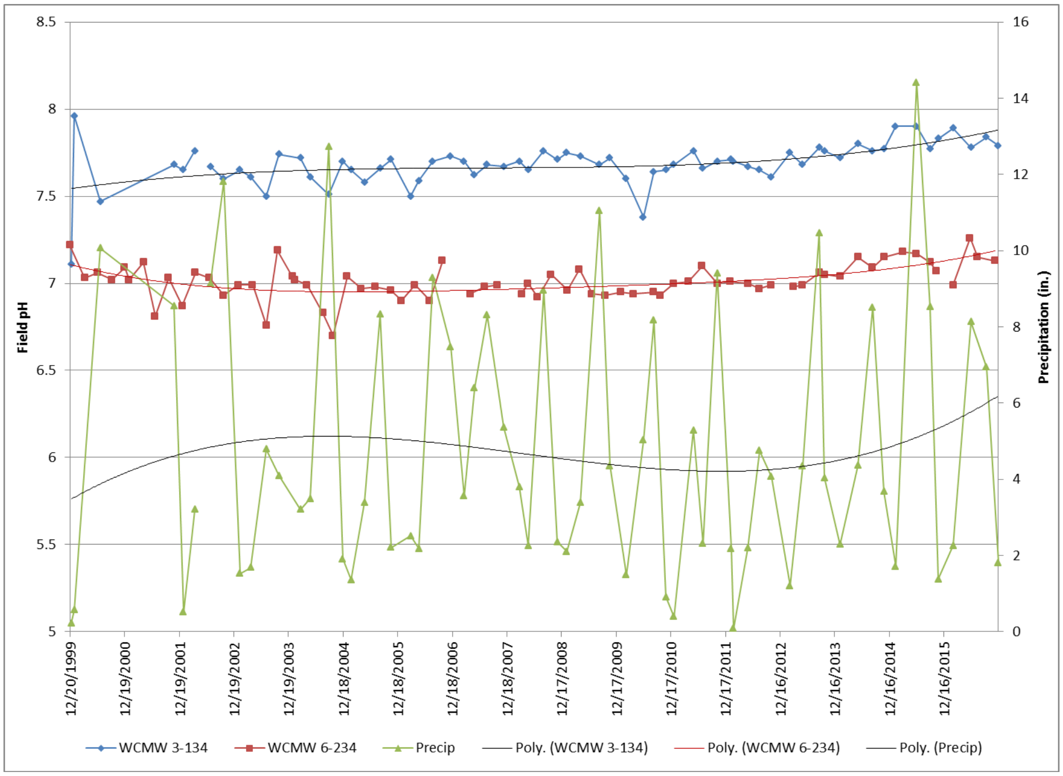

Figure 18: Field pH and precipitation data for Wilson Creek monitoring wells. Third order polynomial trends have been fit to the data to aid in recognition of correlations.

5.6 Grassy Valley

Grassy Valley lies north of the primary area of mining in the Cripple Creek district. Minor historic mining and milling occurred in the upper half of the valley, but the level of activity did not approach that in the Squaw Gulch, Arequa Gulch, Poverty Gulch and Vindicator Valley drainages.

Four monitoring wells are used for groundwater compliance monitoring in Grassy Valley (GVMW 8A-250, GVMW 8B-50, GVMW 22A-70, and GVMW 22B-30). The central portion of Grassy Valley is underlain by diatreme rocks, whereas the eastern and western portions are underlain by Precambrian rocks. As a result, the stream has both losing and gaining reaches, with the losing reach being above diatreme rocks, which permit a certain amount of vertical infiltration of surface water and groundwater.

No apparent trends with precipitation were observed with respect to any of the constituents of interest.

Sulfate concentration in the Grassy Valley monitoring wells is shown in Figure 19. Sulfate concentration in the Grassy Valley monitoring wells is substantially below the domestic well standard of 250 mg/L.
In general the trend in sulfate concentration has been declining in all of the wells over time. The data for GVMW 8B-50 tend to have more sample-to-sample variability than is observed in the other three wells. In addition, sulfate concentration spiked in this well in 2016. Previous work by Newmont showed that this spike resulted from a leak in the freshwater supply pipeline for the CC&V plant. The pipeline was buried beneath the East Cresson Overburden Storage Area (ECOSA). The water that leaked from the pipeline flushed sulfate from the ECOSA foundation, resulting in a temporary elevation in sulfate in groundwater sampled in GVMW 8B-50. The other wells were not impacted by the broken pipeline.

The occasional spikes in sulfate concentration measured in samples from GVMW 8B-50 are believed to result from periods of heavy runoff, because the runoff carries elevated chemical loads from areas in which historic mining and milling activity have occurred. The runoff rate exceeds the rate at which water infiltrates into the diatreme, resulting in temporary elevations in dissolved constituents.

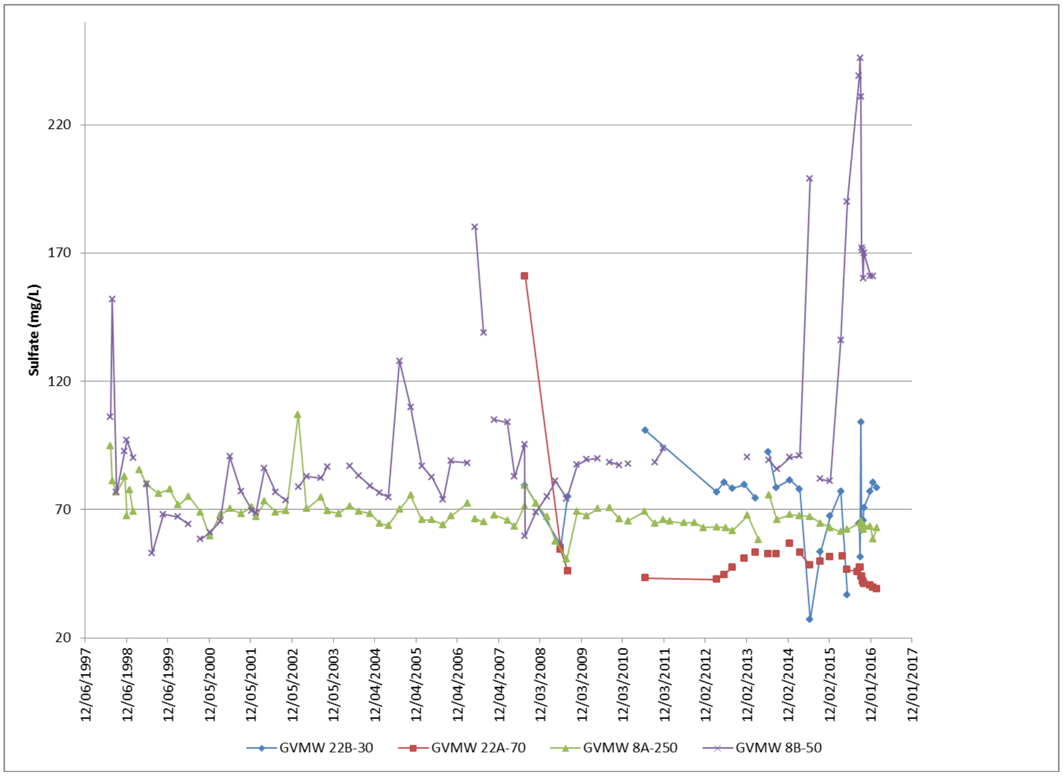

Figure 19: Sulfate data from Grassy Valley monitoring wells.

Manganese data are shown in Figure 20. Wells GVMW 2A-70 and GVMW 8B-50 have geometric mean manganese concentrations below the domestic well standard, GVMW 22B-30 is slightly above the standard, and GVMW 8A-250 has a geometric mean concentration significantly higher than the standard. However, manganese concentration in GVMW 8A-250 has been declining since the well was installed, although manganese concentration increased in 2015 and 2016. The most recent analytical results available for GVMW 8A-250 (28 November 2016 and 25 January 2017) indicate that manganese has declined to less than 0.07 mg/L.

It is unclear why manganese has been elevated in GVMW 8A-250, or why the concentration has for the most part been declining to levels similar to those measured in the other wells. It may be that the well bore intersected fractures that contained manganese oxide minerals, and over time these have been dissolved and flushed down-gradient. Continued monitoring will demonstrate whether groundwater in the well remains at low manganese concentrations.

Zinc has never been present at quantifiable concentrations in any of the Grassy Valley wells.

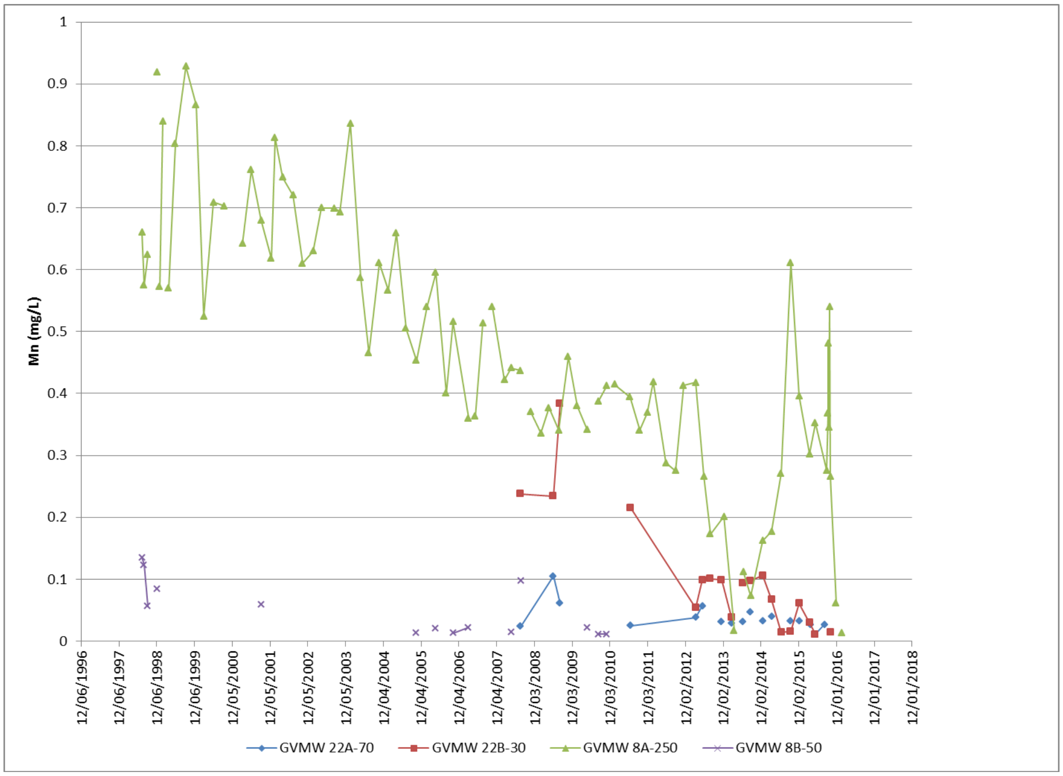

Figure 20: Manganese data for Grassy Valley monitoring wells.

Field pH data are shown in Figure 21. With the exception of the early time data, pH has been very consistent in all four wells. Well GVMW 8B-50 shows the greatest sample-to-sample variability, generally fluctuating ±0.4 pH units. GVMW 22A-70 has significantly higher pH than the other three wells, but it is still within the range of the domestic well standard.

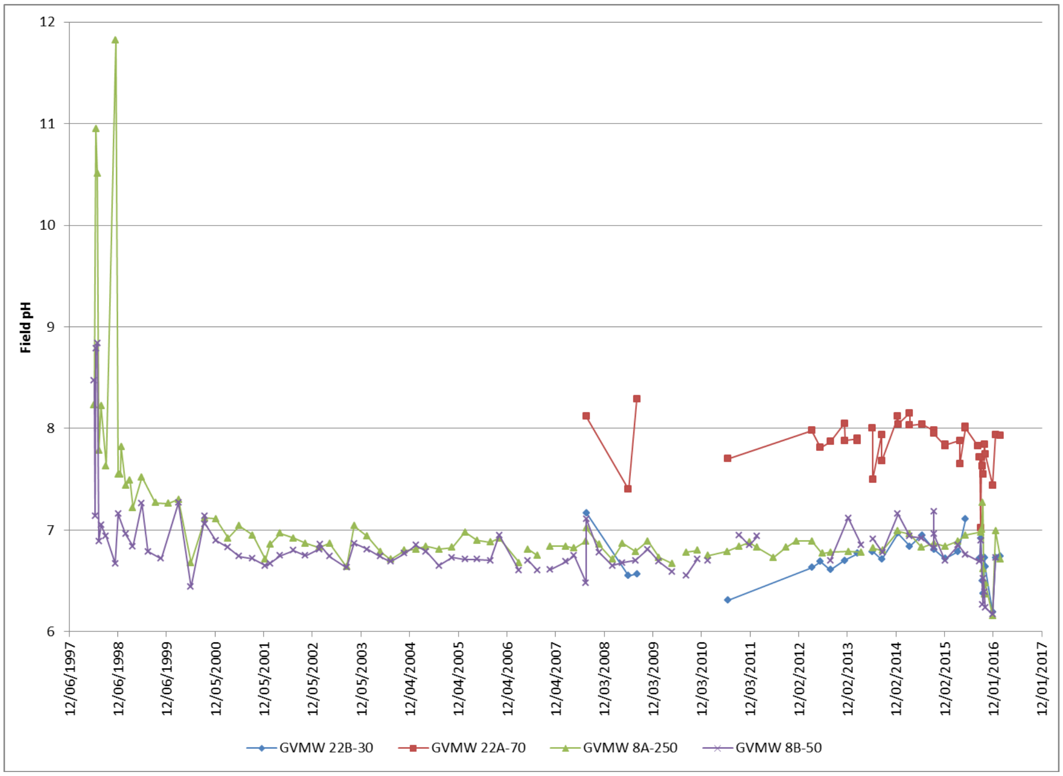

Figure 21: Field pH data for Grassy Valley monitoring wells.

6. Discussion

The six drainages that are the subject of this report fall into two categories: drainages with groundwater that exceeds the domestic well standard for one or more constituents, and drainages in which the groundwater does not exceed the domestic well standards. It is unfortunate that no solid baseline groundwater chemistry data exist prior to modern surface mining in the district. In lieu of baseline data, the current groundwater chemistry data have been evaluated from the perspective of historic and modern mining/milling activity in each of the drainages. The results of this evaluation suggest that the exceedances in Arequa Gulch, Vindicator Valley, and Poverty Gulch are the result of historic mining activity. Impacted groundwater in Squaw Gulch appears to result from pre-drainage tunnel groundwater discharge from the diatreme, with additional impacts resulting from historic mining in the gulch.

In addition to the historical evaluation, whole rock geochemistry data were obtained from Poverty Gulch (mainly the west side of Globe Hill), Arequa Gulch (Cresson area), and Vindicator Valley (southeast portion of the Vindicator Mine area, near the Lillie mine). Geometric means of the whole rock data were obtained after converting inclined borehole sample depths to true vertical depth, based on the drill hole deviation surveys, and only those data at depths from surface to the deepest compliance monitoring well in each drainage were used. Table 6 presents the geometric mean concentration for manganese and zinc in the compliance monitoring wells, the shallow whole rock data, and the ratio of the groundwater to whole rock concentrations.

Table 6: Comparison of geometric mean whole rock and groundwater chemistry (values in mg/L).

Drainage	Whole Rock		Groundwater		Water:rock	
	Mn	Zn	Mn	Zn	Mn	Zn
Poverty Gulch	495	240	13.5	1.3	0.027	0.005
Arequa Gulch	2065	139	1.4	0.07	0.001	0.001
Vindicator Valley	1176	170	1.2	0.08	0.001	0.0005

Even though Poverty Gulch groundwater has the highest zinc and second highest manganese concentrations of the six drainages, whole rock manganese is anomalously low, while whole rock zinc is the highest of the three areas for which whole rock chemistry data were available. Zinc in Poverty Gulch groundwater is two orders of magnitude higher than in the other two drainages, yet the whole rock zinc is the same order of magnitude in all three drainages.

The drill holes from which the whole rock data were obtained were all drilled within the diatreme, with the exception of one hole in Poverty Gulch (CCV-SEC-00007). The results from the one hole in outside the diatreme in Poverty Gulch show a geometric mean concentration of 61 mg/L for manganese and 248 mg/L for zinc. The data in Table 6 do not appear to shed any light on the source of the elevated constituents in Poverty Gulch, Arequa Gulch, or Vindicator Valley.

The six drainages are discussed in detail in the following sections.

6.1 Squaw Gulch

The source of the elevated sulfate, manganese, and zinc in Squaw Gulch may be anthropogenic, resulting from the rather substantial historic mining that took place in Squaw Gulch. Figure 22 is a portion of Plate 1 from Lindgren and Ransome (1906). In addition to the numerous mines up-gradient of the Squaw Gulch monitoring wells, three rail lines used to pass through the area. The significant mines near and up-gradient of the monitoring wells include the Anaconda, Blue Bell, Morning Glory, Doctor-Jackpot, and Mary McKinney. These mines produced ores that were sulfidic to partly oxidized (Lindgren and Ransome, 1906), and ore from the Blue Bell mine assayed up to 18% zinc (Cross and Penrose, 1895). However, these mines were largely within the limits of the diatreme, so it is probable that most of the soluble species leached from the waste rock dumps associated with the historic mines infiltrated into the diatreme. After construction of the various drainage tunnels, groundwater would have traveled down the Squaw Gulch drainage only in local perched, relatively shallow aquifers.

During recent mining (from the 1970s on), waste rock began to be placed in the head of Squaw Gulch around 1997. In 2000 the footprint of the waste rock pile began to be expanded, reaching its maximum in 2006, when the toe of the dump was approximately 2800 feet from the Precambrian-diatreme contact. In 2012 additional waste rock was placed near the head of Squaw Gulch for construction of the new processing plant, with the toe of this material approximately 1300 feet from the Precambrian-diatreme contact. Figure 22 shows the extent of waste rock in Squaw Gulch in 2006, 1997, and 1991, the Precambrian-diatreme contact, and the Squaw Gulch compliance monitoring point, in comparison with the 1951 USGS 1:24000 topography.

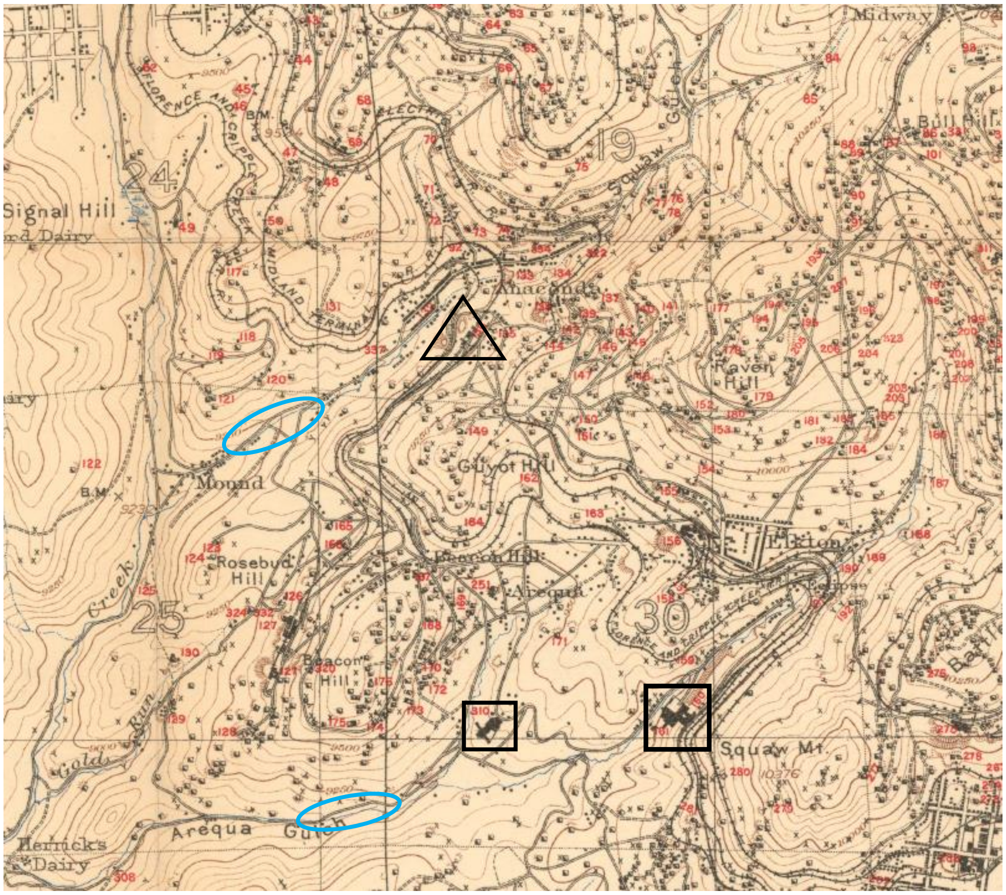

Figure 22: A portion of Plate 1 from Lindgren and Ransome (1906) showing the mining and milling facilities that existed in Squaw Gulch and Arequa Gulch in 1903. The current Squaw Gulch monitoring wells are within the ellipse at left center, and the current Arequa Gulch monitoring wells are within the ellipse at lower left. The Arequa mill is in the left black square, the Economic mill in the right black square, and the Mary McKinney mine in the triangle.

Figure 23 is photograph of the town of Anaconda and the Mary McKinney mine around 1893 (Campbell, 1922).

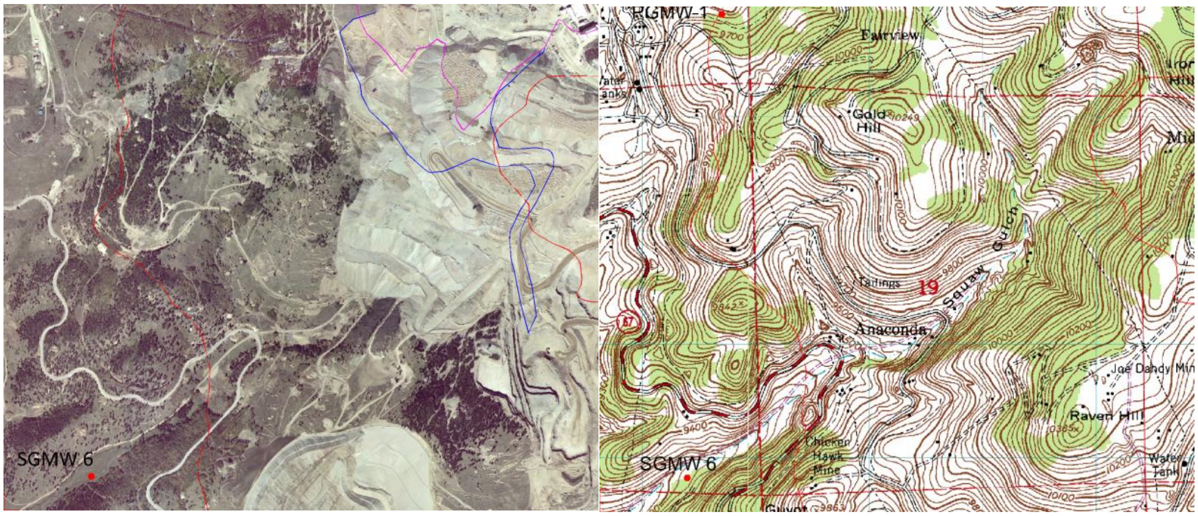

Figure 23: 2006 aerial image (L) showing the location of the Squaw Gulch compliance monitoring point; the footprint of the waste rock in 1997 is shown in blue, yellow shows the extent in 1991. Right side is the same area on the 1951 USGS 1:24000 topography. The red line in both images is the Precambrian-diatreme contact.

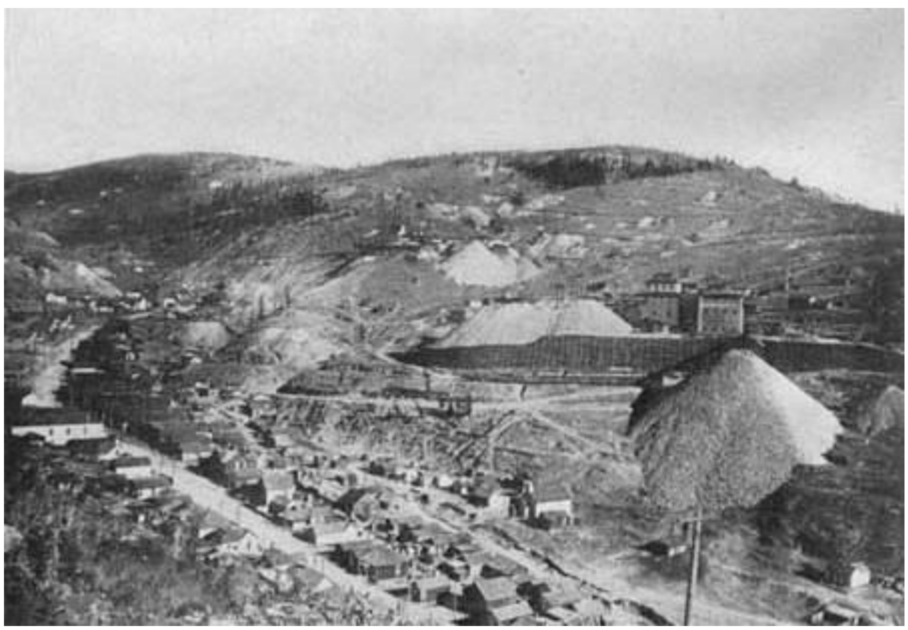

Figure 24: Photograph of the town of Anaconda and the Mary McKinney mine, probably around 1893 (Campbell, 1922, Plate 28).

Figure 25 shows the footprint of VLF2 (construction began in 2013), the location of the Squaw Gulch monitoring wells, and the Precambrian-diatreme contact, on the 1951 USGS 1:24000 topography. VLF2 incorporates a synthetic liner, which prevents meteoric water from infiltrating into the groundwater system within the footprint of the VLF.

Squaw Gulch groundwater monitoring data only go back to August 2014, after construction of VLF2 had begun, but prior to ore being placed in VLF2. The data in Figure 6 show that sulfate at SGMW 6B-60 was around 900 mg/L in 2014, spiked at 1140 mg/L in March 2015, then declined until November 2015, when it achieved a relatively stable concentration of around 968 mg/L.

First ore was delivered to VLF2 in October 2015, and data from SGMW 6B-60 begin in September 2014. Comparison of the chemical data prior to ore delivery suggests that sulfate and pH are within one standard deviation of the overall geometric mean, but manganese and zinc are lower than the overall geometric mean by more than one standard deviation (Figure 6).

A portion of the precipitation infiltrates into the relatively thin soil and travels downslope as shallow groundwater. If the underlying bedrock consists of diatreme rocks, the groundwater infiltrates into the diatreme and eventually discharges from the Carlton Tunnel. However, where the infiltrating water intersects Precambrian rocks, it has very limited ability to percolate vertically. As a result, the groundwater is essentially perched on top of or within the uppermost part of the Precambrian units.

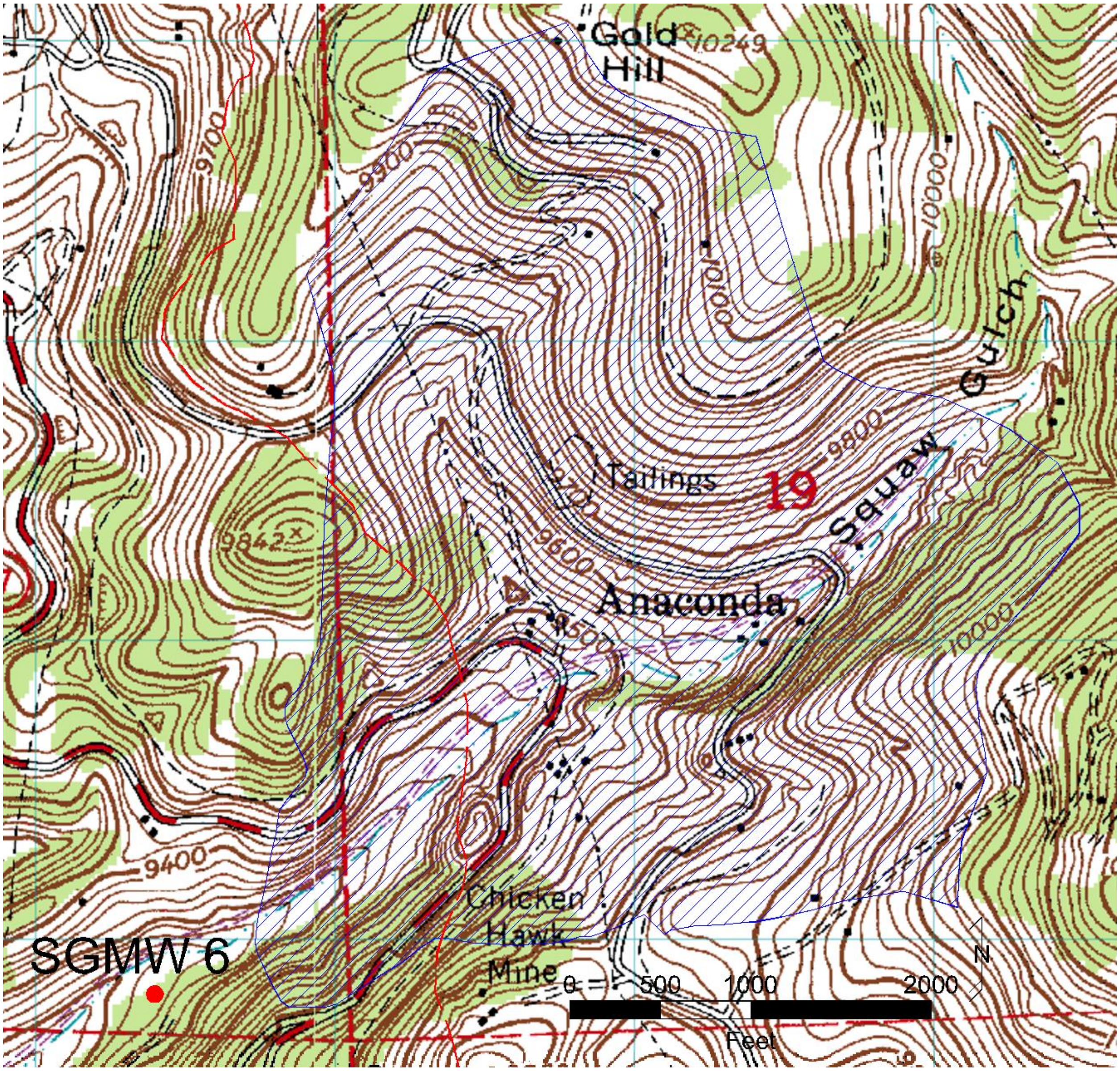

Figure 25: Footprint of VLF2 (blue hatched area), Squaw Gulch monitoring wells (red dot, SGMW 6 label), and the Precambrian-diatreme contact (red dashed line) on 1951 USGS 1:24000 topography.

Although there are no monitoring data prior to the expansion of waste rock facilities within Squaw Gulch, it is unlikely that a significant portion of solutes mobilized from the waste rock piles during precipitation would report to the groundwater monitored at SGMW 6B-60. This is due to the long interval of diatreme rocks through/above which the groundwater would have to travel. It is far more likely that precipitation that infiltrated through the waste rock piles would infiltrate into the diatreme, where it would ultimately report to the Carlton Tunnel. Therefore, the waste rock facilities were not new or increased sources of solutes to Squaw Gulch.

Prior to construction of the various drainage tunnels, which lowered the groundwater level within the diatreme, Squaw Gulch was the point at which groundwater discharged from the diatreme because the Precambrian-diatreme contact is at its lowest elevation in Squaw Gulch. Therefore, over geologic time, groundwater became enriched in dissolved constituents as it passed through mineralized zones within the diatreme before it discharged into Squaw Gulch. The solute-rich water would have enriched the soils and alluvium that host the shallow aquifer in Squaw Gulch, and current groundwater monitoring data reflect this natural enrichment. This explanation seems more reasonable to explain the elevated constituents than historic mining, because the bulk of historic mining took place within the diatreme, and since almost all of the precipitation that falls within the diatreme infiltrates into the diatreme and now discharges through the Carlton Tunnel, it is unlikely that after the construction of the drainage tunnels and prior to construction of VLF2 impacted water exited the diatreme to flow down Squaw Gulch.

The construction of VLF2 has effectively eliminated groundwater recharge within the footprint of the facility. Therefore, VLF2 is not a new or increased source of sulfate, manganese, or zinc to Squaw Gulch.

6.2 Arequa Gulch

The Arequa Gulch drainage contained numerous mines as well as two railroads and at least two mills (Arequa and Economic, see Figure 22). The Arequa mill recovered gold using cyanidation for oxide ore, and roasting followed by chlorination for sulfide ores (Lakes, 1899). No information was found regarding when the Arequa mill was constructed or its throughput, but it appears to have been destroyed by fire in 1903 (Mining and Scientific Press, 1903). Figure 26 is a photograph of the Arequa mill (Grimstad and Drake, 1983).

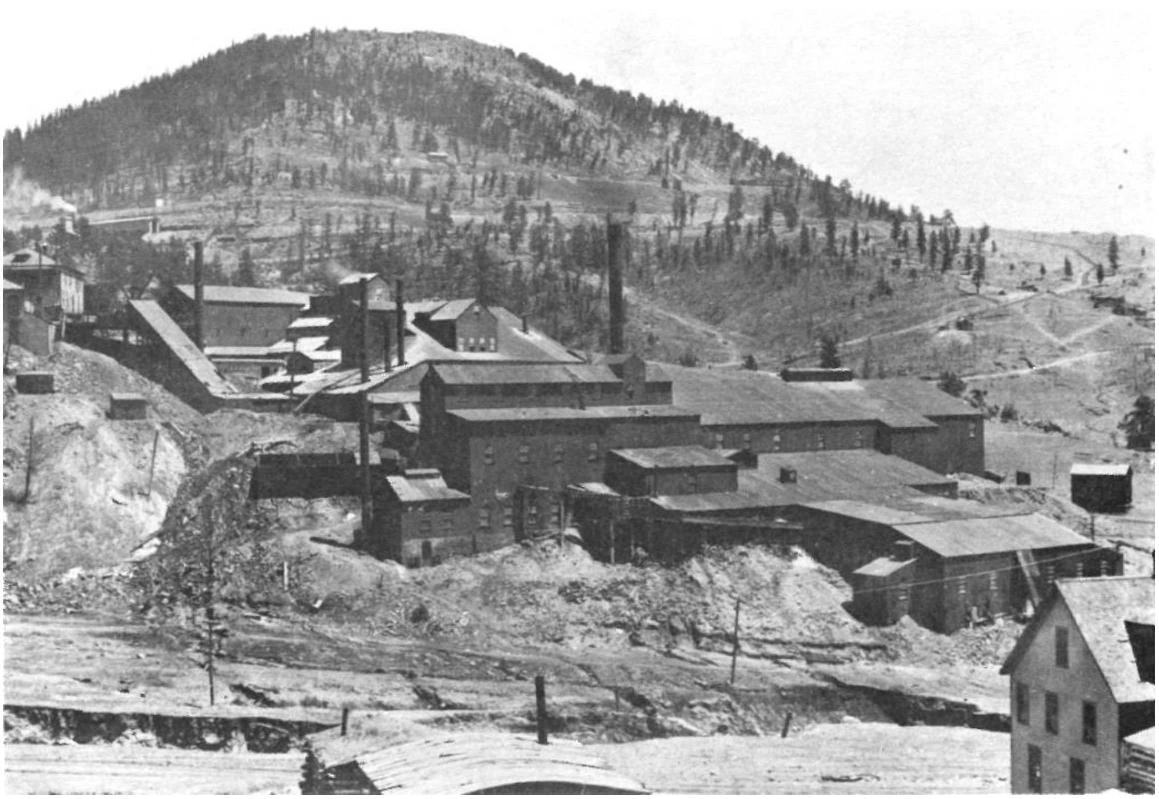

Figure 26: Photograph of the Arequa mill (Grimstad and Drake, 1983).

The Economic mill was built in 1899 (Levine, 1982) and utilized roasting and chlorination with hydrogen sulfide precipitation for gold recovery (Lakes, 1901). The Economic mill was a modestly-sized mill (300 tons per day), and operated until it was destroyed by fire in 1907 (Lindgren and Ransome, 1906; Henderson, 1926). Figure 27 is a photograph of the Economic Mill.

Figure 27: Photograph of the Economic mill (Woods, 1901).

No information regarding how these two mills disposed of tailings was available, but given the time period it is likely that the mill tailings were discharged to the Arequa Gulch drainage. Inefficiencies in metallurgical processing in the early 1900s would have resulted in incompletely oxidized sulfide minerals being contained within the tailings. After deposition of the tailings, the remaining sulfide minerals would gradually oxidize, resulting in soluble mineral species. These oxidation products, and soluble species that resulted from the beneficiation processes, could then be mobilized during precipitation events. A portion of these dissolved species would report to groundwater as a result of recharge following precipitation.

The Arequa Gulch monitoring wells are constructed in the bottom of the Arequa Gulch drainage, below the Arequa Gulch Valley Leach Facility (VLF1). Prior to construction of VLF1, tailings from the now-dismantled Carlton mill, which operated from 1951 into 1962 (Feitz, 1978) were deposited in an un-lined tailings facility which was located at the confluence of the north and east forks of Arequa Gulch, above the site of the Arequa mill (Grimstad and Drake, 1983). Figure 28 shows the Carlton mill, lower tailings facility, and two lined heap leach pads in a 1991 aerial view. The larger heap leach pad in Figure 28 was built on top of the upper Carlton Mill tailings pile (EPA, 1992). The Carlton mill tailings were relocated prior to construction of VLF1 (Henry et al., 1996). It is interesting to note that tailings were also removed from the active stream channel of Arequa Gulch as part of VLF1 construction (Henry et al., 1996). Figure 29 shows the footprint of VLF1, the Arequa Gulch monitoring wells, and the Precambrian-diatreme contact on the 1951 USGS 1:24000 topography.

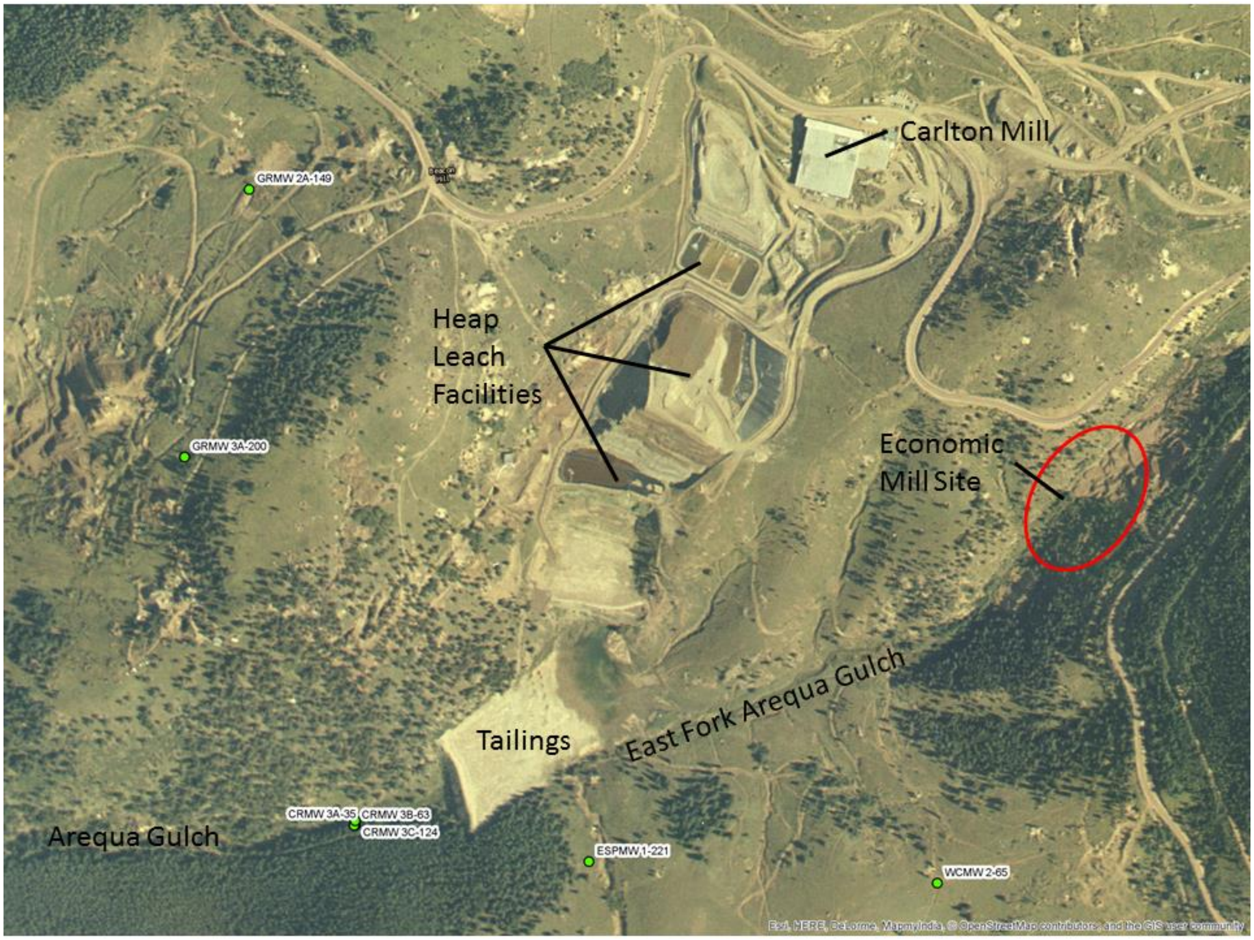

Figure 28: 1991 aerial view of Carlton mill and tailings facility. A heap leach facility, groundwater monitoring sites (most are not compliance monitoring points), and the approximate location of the historic Economic mill are also shown. The north fork of Arequa Gulch is essentially covered by the processing facilities and extends off the image at top center.

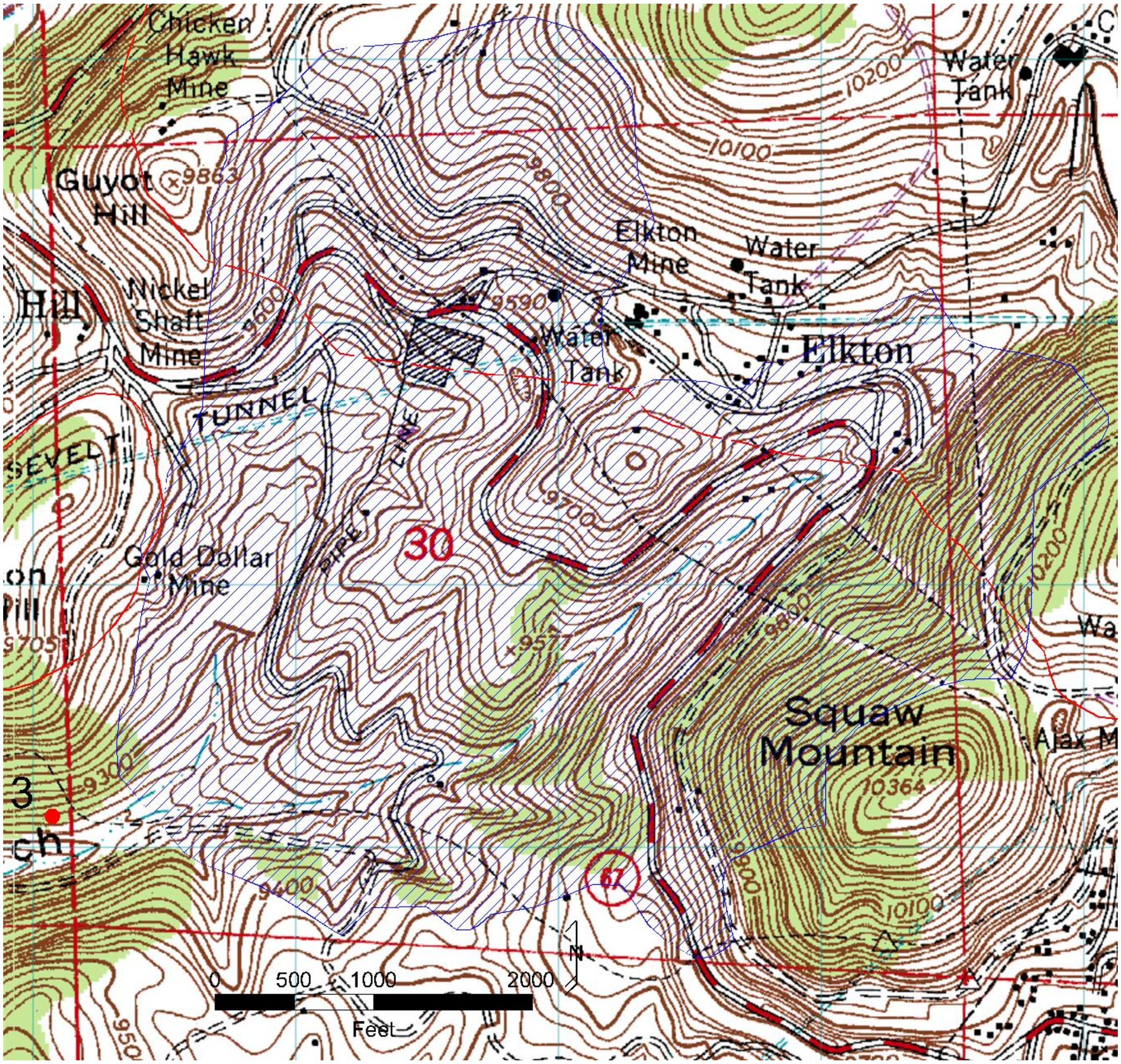

Figure 29: Footprint of VLF1 (blue hatched area), Arequa Gulch monitoring wells (red dot, lower left), and the Precambrian-diatreme contact (red dashed line) on 1951 USGS 1:24000 topography.

Texasgulf Minerals (later succeeded by Nerco Minerals) originally constructed the heap leach pads at the Carlton Mill (EPA, 1992). Nerco Minerals was required by Colorado Mined Land Reclamation Division (MLRD, a predecessor to DRMS) to monitor water quality in Arequa Gulch upstream and downstream of the tailings impoundments and heap leach facilities at the Carlton Mill (EPA, 1992). According to EPA (1992), Nerco Minerals sampled the french drain beneath Pad 1, monitoring wells driven into the tailings near the base of Dam 1, and well PZ-6 (the location of which is not given in EPA, 1992). Table 7 shows data from for the period 1987 to 1989 (EPA, 1992, Table 4-4).

Table 7: Groundwater and French drain water chemistry for Arequa Gulch near the Carlton Mill tailings and heap leach facilities (after EPA, 1992, Table 4-4). Geometric mean data for CC&V compliance monitoring wells in Arequa Gulch are also provided for comparison. Data are in mg/L except for pH, which is in standard units. Note that the data in the first four columns are for total species, whereas the data in the final two columns are for dissolved species (except for sulfate and TDS, which are total).

Analyte	French Drain	Arequa Gulch Upstream	Arequa Gulch Downstream	Well PZ-6	Geomean CC&V Wells	Range From CC&V
Field pH	6.6 – 7.89	4.32 - 5.1	7.69 - 8.1	8.8	6.49	5.25 – 7.09
TDS	850 - 860	1100	1400	6200	1389	700 - 2890
SO_4	350 - 440	450 - 970	400 - 3500	2700	755	200 – 1260
Zn	0.028 - 0.38	1.8 - 2.7	0.009 - 1.1	10	0.07	0.01 – 0.31

The data in Table 7 indicate that sulfate in Arequa Gulch groundwater has been above the domestic well standard of 250 mg/L for at least 30 years, and the CC&V compliance monitoring data are within the range of the older data. The geometric mean pH data from the CC&V compliance monitoring wells are within the range of the older upstream and downstream data, and zinc is within the range of the older downstream data.

CRMW 3A-35 and CRMW 3B-63 are constructed in an area underlain by Precambrian rock (the Precambrian-diatreme contact is slightly north of the old Carlton mill site). It is likely that due to the low permeability of the Precambrian rocks, groundwater does not infiltrate much below the alluvium-Precambrian contact. Thus, the chemical load resulting from historic mining and milling is contained within a relatively shallow aquifer.

The construction of the synthetically-lined VLF1 effectively eliminates recharge from the north and east forks of Arequa Gulch. As a result, recharge to the shallow Arequa Gulch aquifer can only come from the slopes north and south of the monitoring wells. Therefore, flushing of the soluble constituents from the shallow groundwater in Arequa Gulch is likely to be very slow. VLF1 is not a new or increased source of soluble constituents.

The data presented indicate that groundwater currently being sampled by CC&V has been impacted by historic mining activity that occurred before January 31, 1994.

6.3 Vindicator Valley

The Vindicator Valley compliance monitoring wells are constructed within the diatreme. Figure 30 shows the Vindicator Valley area from Plate 1 of Lindgren and Ransome (1906). Vindicator Valley contained a number of mines including the Vindicator, Lillie, Last Dollar, Hull City and Golden Cycle mines, which were located up-gradient of the current groundwater monitoring wells. These mines had significant waste rock dumps that spread down the hillside below the shafts, and the ore varied from oxidized to slightly sulfidic (Lindgren and Ransome, 1906). The dumps were removed for processing some time ago, and the slopes graded and revegetated. In addition, the valley contained multiple rail lines and the town of Independence.

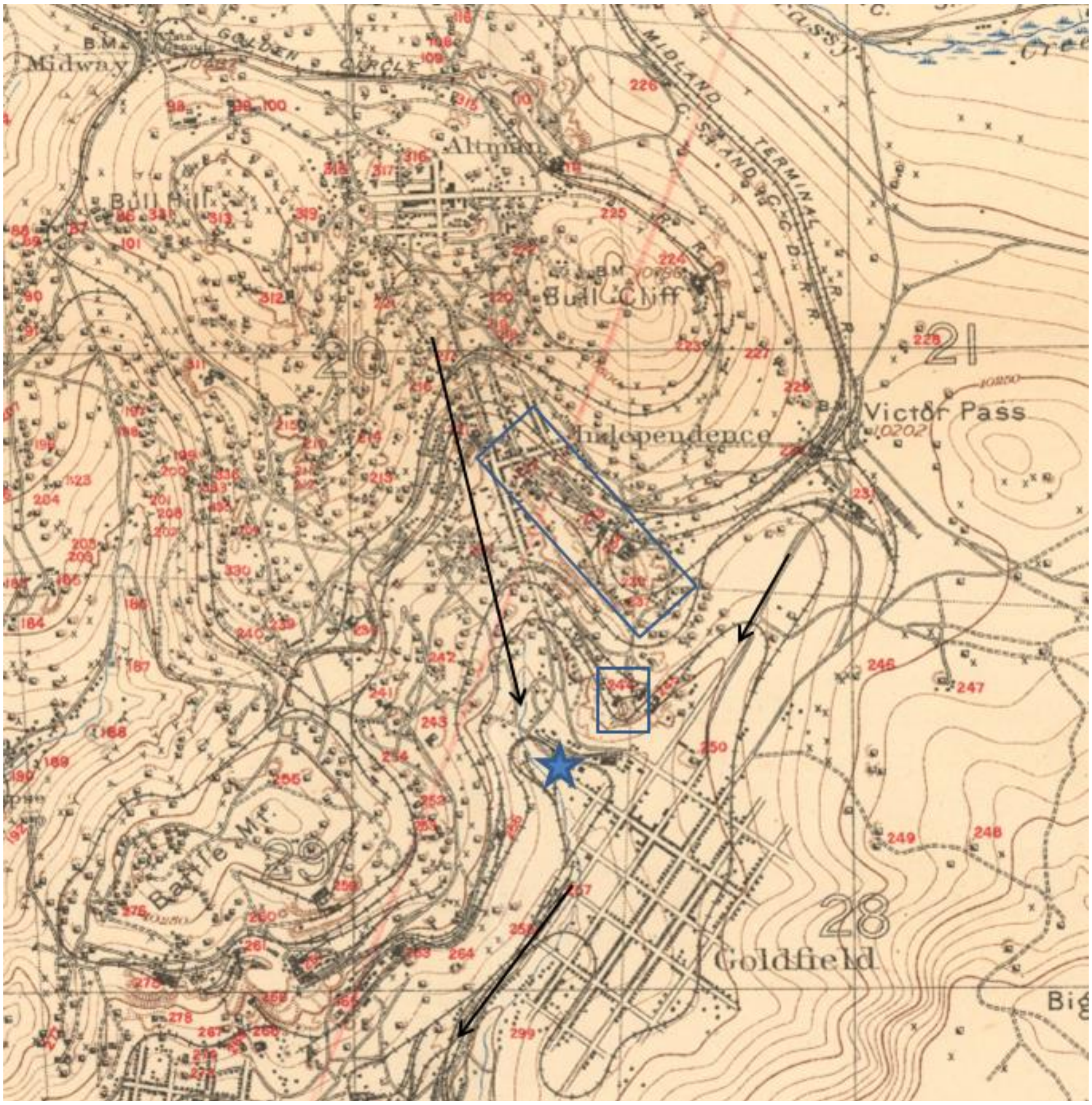

Figure 30: Vindicator Valley area from Plate 1 of Lindgren and Ransome (1906). The black rectangles indicate the locations of the Vindicator and Golden Cycle mines, the black arrows indicate the groundwater flow directions, and the blue star shows the location of the current groundwater monitoring wells.

Of particular relevance to the present discussion is the fact that the Golden Cycle mine was within a few hundred feet of the Vindicator Valley monitoring wells. Figure 31 shows the Vindicator Valley monitoring wells located on the 1951 USGS 1:24000 topography. The Golden Cycle, Vindicator, and Last Dollar mines are shown, as well as a number of “tailings” piles up-gradient of the monitoring wells. The “tailings” piles were more likely mine dumps, but these would have contributed chemical load to the shallow groundwater within Vindicator Valley. It is evident from Figures 30 and 31 that the monitoring wells are located at the focal point for impacted water that originates in the headwaters of the various tributaries to Vindicator Valley.

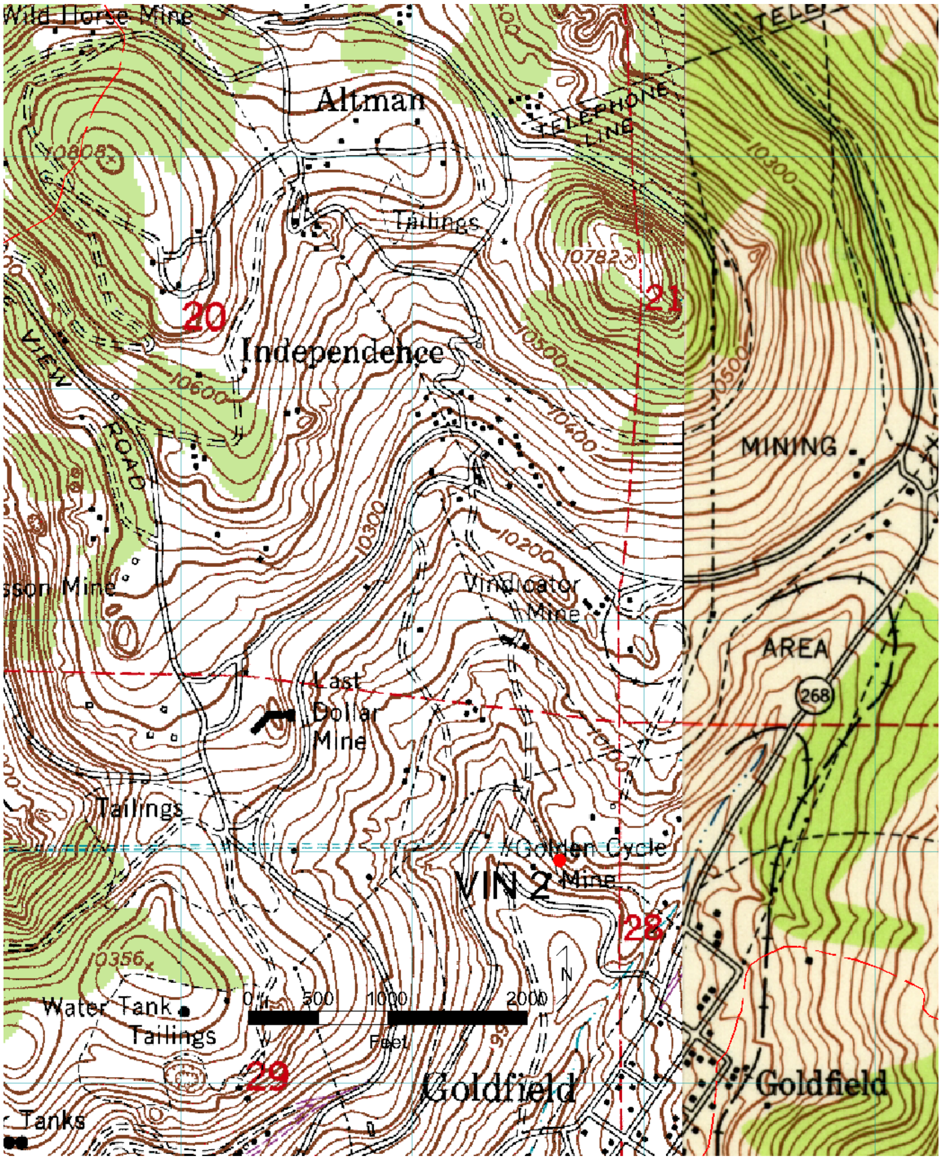

Figure 31: Location of the Vindicator Valley monitoring wells (red dot, VIN 2 label) on 1951 USGS 1:24000 topography. The red dashed line that passes through Goldfield from southwest to northeast, and then swings east-southeast, is the Precambrian-diatreme contact.

Figure 32 shows the Vindicator Valley in 1903. In 1915 a flotation mill was constructed at the Vindicator to process low grade material on waste dumps (Henderson, 1926). No information regarding the disposal of tailings from the Vindicator mill was available, but it is likely that they were deposited in Vindicator Valley. The mill closed 30 July 1918, and at that time there were still two million tons of low grade ore on the dumps (Henderson, 1926).

Figure 32: Vindicator Valley in 1903, including the town of Independence and the Vindicator (upper center and upper left) and Lillie (upper right) mines (US Geological Survey public domain photograph taken by F.L. Ransome, 1903). The Golden Cycle mine and the Vindicator Valley compliance monitoring wells are just off the lower right portion of the image.

Figure 33 shows the Golden Cycle mine, a portion of Goldfield (lower right), and part of the Vindicator dumps (upper left) in 1903. The approximate location of the Vindicator Valley compliance monitoring well is also shown, and demonstrates the intense historic mining disturbance adjacent to the monitoring wells. The monitoring well location was determined from rail lines, roads, and buildings in Figure 33 in comparison with the same features shown in the 1951 USGS 1:24000 topographic map and a 1991 aerial image. It is evident from Figures 32 and 33 that there was extensive disturbance in Vindicator Valley up-gradient of the current compliance monitoring wells.

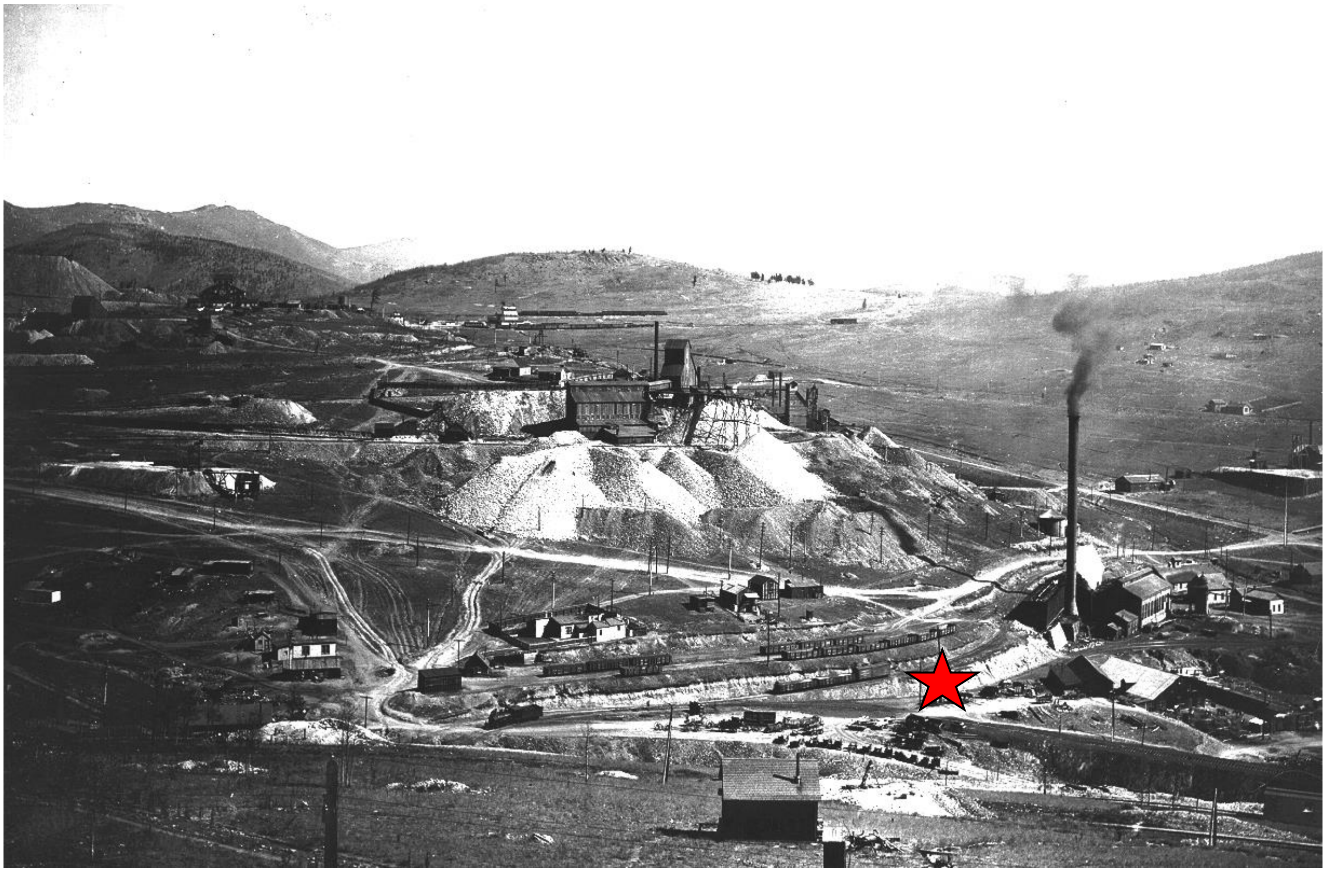

Figure 33: Golden Cycle mine from Battle Mountain (US Geological Survey public domain photograph taken by F.L. Ransome, 1903) . A portion of Goldfield is visible at lower right, and part of the Vindicator dumps are visible in the upper left. The red star is the approximate current location of the Vindicator Valley compliance monitoring wells.

Prior to 31 January 1994, there were fairly large waste rock dumps and a relatively small open pit at the head of Vindicator Valley. In 1999 the Altman pit was mined, ultimately consuming the earlier open pit. Mining of the Altman pit concluded in 2007, and the pit was back-filled over several years starting in 2008. Figure 34 shows Vindicator Valley in 1991 and in 2013. The location of the Vindicator Valley compliance monitoring point and the Precambrian-diatreme contact are also shown.

Figure 34: Aerial images of Vindicator Valley in 1991 (left) and 2013 (right), with the compliance monitoring point shown with a red dot labeled VIN 2. The Precambrian-diatreme contact is the red dashed line in the lower right portion of both images.

Mining of the Altman pit removed significant quantities of historic mine waste, and the backfill in the pit has significantly high vertical permeability, which allows for rapid infiltration of precipitation into the diatreme.

Figure 35 shows sulfate and pH data for the Vindicator Valley monitoring wells. The vertical red line is drawn at 11 March 2008 as an approximation of when backfilling of the Altman pit at the head of Vindicator Valley began (no reliable data of the exact end of mining or the beginning of backfilling was available, but aerial photographs from 2007 and 2008 constrain the timeframe for these two events). Third order polynomial trend lines have been fit to the data for VIN 2B-140 to clarify the trends. The geometric mean sulfate concentration for the period 30 June 2004 through 11 March 2008 is 673 mg/L with a standard deviation of 53 mg/L, and after 11 March 2008 the geometric mean is 746 mg/L with a standard deviation of 36. The two geometric means are within one standard deviation of one another, indicating that there is no significant difference between them.

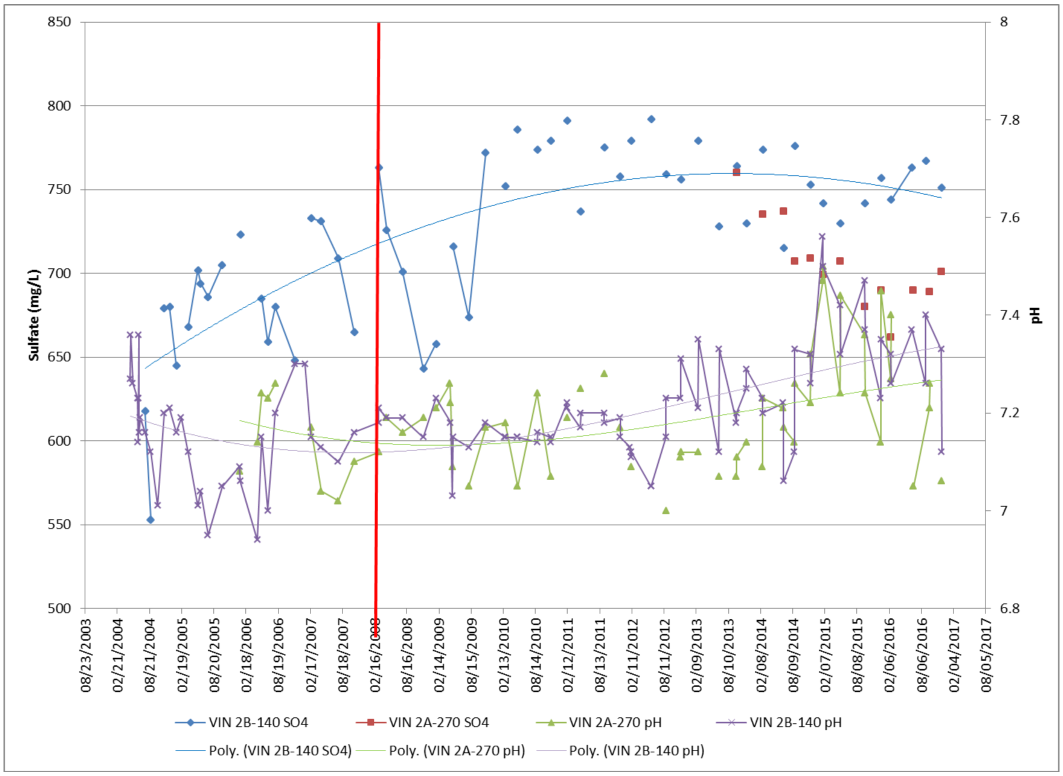

Figure 35: Sulfate and pH in groundwater from the Vindicator Valley compliance monitoring wells. Third order polynomial trend lines have been fit to the sulfate data for VIN 2B-140, and pH from both wells. The vertical red line is drawn at 11 March 2008 as an approximation for when backfilling of the pit at the head of Vindicator Valley began.

The time series data in Figure 35 suggest that recent mining of the Altman pit at the head of Vindicator Valley may have resulted in stabilization of sulfate concentration in groundwater, and the trend appears to be towards a gradual decline in sulfate. As shown in Figure 13, manganese concentration has been in decline since mid-2010.

The historical data support the hypothesis that the elevated concentrations of sulfate and manganese in the Vindicator Valley monitoring wells are the result of historic mining activity. Prior to being relocated for processing, the old waste dumps would have been a significant source of soluble species. With each precipitation event, soluble species would have been dissolved, and a portion of the water that infiltrated the dumps would have recharged the shallow groundwater, gradually building a chemical load. Recent open pit mining and reclamation appear to have resulted in improving groundwater quality, although several constituents still exceed the domestic well standard.

Given that Vindicator Valley and the compliance monitoring points are underlain by the diatreme, in order for the monitoring wells to have measurable water levels groundwater must be perched in recent unconsolidated sediments above the diatreme. It is apparent from Figures 30 and 31 that the groundwater gradient along the north fork of Wilson Creek, which flows southwesterly along the western side of the town of Goldfield, is fairly moderate.

The surface topography has a gradient of about 230 feet over 3870 feet, from near the monitoring wells to close to the northeast end of Victor. The groundwater surface generally mimics the topography, so it is probable that groundwater moves very slowly from Vindicator Valley to the North Fork of Wilson Creek near Victor. The recharge area in Vindicator Valley is substantially reduced after mining of the two pits visible in Figure 34 (Altman is the pit that has been backfilled), because the exposed pit walls and backfill offer ready infiltration into the diatreme. Therefore, the impacted groundwater is likely to have the current concentrations of dissolved constituents for some time.

6.4 Poverty Gulch

Groundwater sampled in the Poverty Gulch monitoring wells (PGMW 1A-200 and PGMW 1B-55) has elevated manganese and zinc. PGMW 1A-200 has slightly elevated sulfate, and PGMW 1B-55 has anomalously low pH. The wells are very close to the Precambrian-diatreme contact, and appear to be within the footprint of Precambrian rocks.

The first regular producing mine in the Cripple Creek district was the Gold King, which produced ores with little oxidation (Lindgren and Ransome, 1906). The C.O.D. mine was also one of the earliest mines in the district, having commenced production prior to 1894, and the Abe Lincoln began production in 1895 (Lindgren and Ransome, 1906). The Mollie Kathleen was staked in 1891 (www.goldminetours.com), but no information regarding when the mine began production was available. Both the C.O.D. and Mollie Kathleen produced unoxidized ores, and in the case of the Mollie Kathleen, the ore included galena (lead sulfide) and sphalerite (iron-zinc sulfide). No information regarding the production history or the nature of the ore mined in the Chicago Tunnel was available.

Figure 36 shows the location of the Poverty Gulch monitoring wells on a 1991 aerial image and on a portion of Plate 1 from Lindgren and Ransome (1906). It is evident that the monitoring wells are down-gradient and in close proximity to the historic mines. The modern open pit and heap leaching operation shown in the lower right of the aerial image began in 1978.

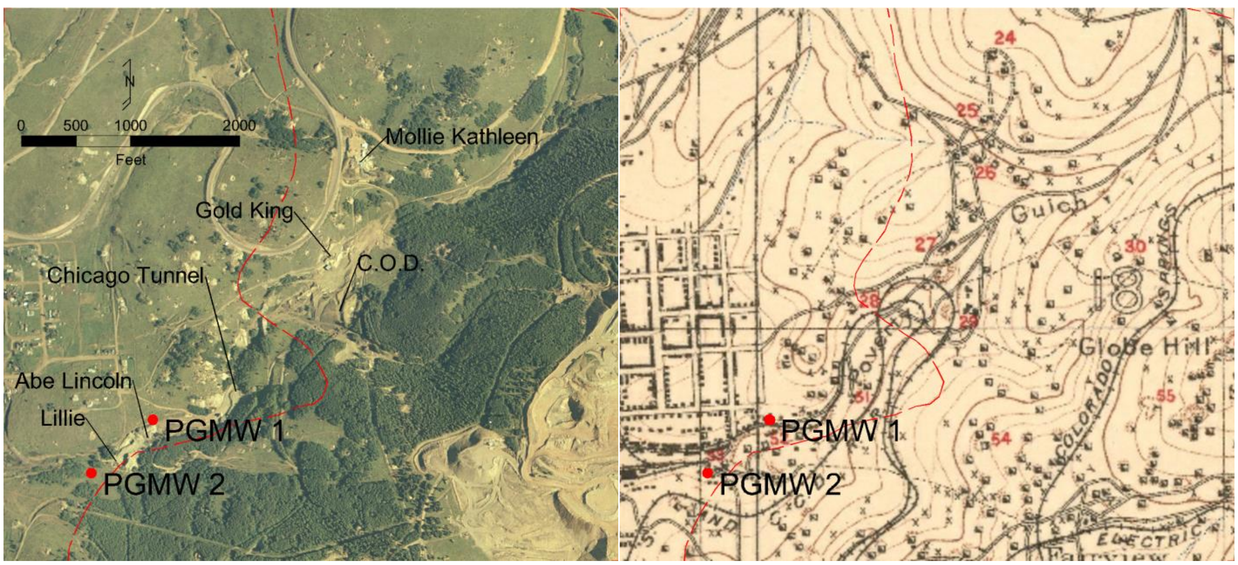

Figure 36: Poverty Gulch in a 1991 aerial image (left) and on a portion of Plate 1 from Lindgren and Ransome (1906). The current compliance monitoring wells are shown with a red dot and the label PGMW 1. The Precambrian-diatreme contact is shown by the red dashed line.

Figure 37 is a photograph looking up Poverty Gulch from a point just south of the Lillie (spelled Lily in Lindgren and Ransome, 1906) showing the mines in the period 1907-1915 (www.mtgothictimes.com). The Lillie is closest, followed by the Abe Lincoln, Chicago Tunnel, and C.O.D. The Gold King was located off the upper left of the image. Stars have been placed at the approximate locations of the current and abandoned Poverty Gulch monitoring wells, using features in the photograph as well as Plate 1 from Lindgren and Ransome (1906), 1951 USGS 1:24000 topography, and a 1991 aerial image.

Figure 37: Photograph of Poverty Gulch from south of the Lillie mine, taken by Julia Skolas sometime between 1907 and 1915 (www.mtgothictimes.com). The Lillie mine is in the foreground, followed by the Abe Lincoln, Chicago Tunnel, and C.O.D. mines. The approximate location of the PGMW 1 monitoring wells is indicated with a blue star, and PGMW 2 with a red star.

The low pH measured in the shallow monitoring well (PGMW 1B-55) probably results from oxidation of sulfide minerals (pH in this well has varied between 3.41 and 4.36, with a geometric mean of 3.7). The concentration of manganese in the shallow well is twice that in the deep well, and zinc concentration is almost four times higher in the shallow well than in the deep well. Sulfate concentration in the deep well is almost twice that in the shallow well. It is likely that manganese and zinc are being attenuated by the soil as water infiltrates to greater depths. Sulfate is a somewhat conservative solute, and the relatively low concentrations present in these two wells are unlikely to be attenuated.

It is hypothesized that the elevated constituents in water sampled from the Poverty Gulch monitoring wells result from leaching of soluble species from the waste rock that was dumped in Poverty Gulch during historic mining. The fact that these monitoring wells have only contained sufficient water to allow them to be sampled between March 2000 and July 2001 suggests that there is very little recharge to Poverty Gulch. Even though much of the historic waste rock has been removed for processing, the chemical load in the soil will take a long time to be removed by recharge and migration down-gradient.

6.5 Wilson Creek

The data from the Wilson Creek monitoring wells indicate that groundwater has not suffered impacts from historic or current mining and processing activities. Although Lindgren and Ransome (1906) show a number of small shafts and adits in the Bateman Creek drainage, there was very little production. Furthermore, as shown in Figure 38 (the location of the monitoring wells on the 1951 USGS 1:24000 topography), a natural divide separates the Bateman Creek catchment from the Arequa Gulch catchment. This divide has served to segregate the impacted groundwater in Arequa Gulch from Bateman Creek.

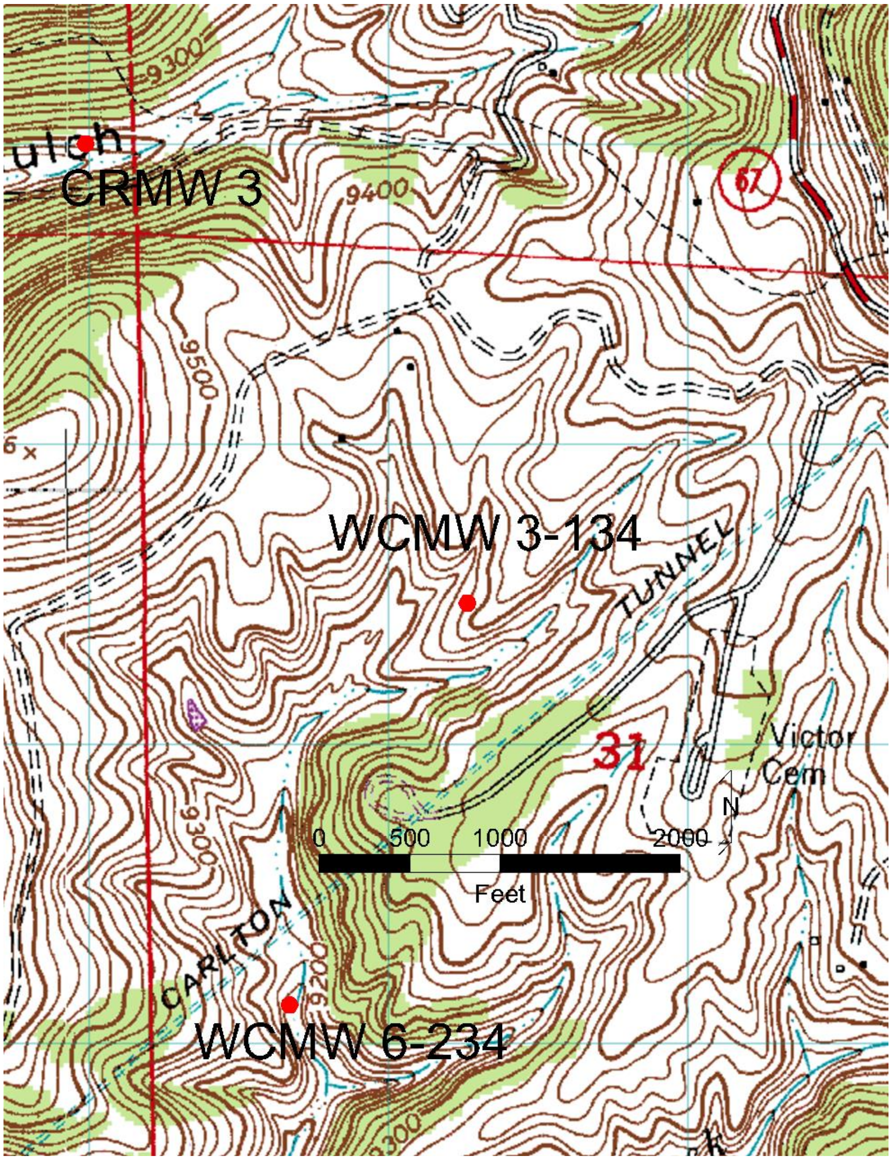

Figure 38: Wilson Creek monitoring well locations on 1951 USGS 1:24000 topography. The Precambrian-diatreme contact is about one mile north of WCMW 3-134.

It is Newmont's opinion that the marked difference in groundwater chemistry in Arequa Gulch and Wilson Creek is additional evidence to support the conclusion that historic mining, and milling, are the reason for the impacted groundwater in Arequa Gulch, because these two drainages are separated by a ridge of Precambrian rock. Groundwater chemistry in Wilson Creek represents the natural background condition.

6.6 Grassy Valley

The locations of the monitoring points and the portion of Grassy Valley upstream from the monitoring wells are shown on the 1951 USGS 1:24000 topography in Figure 39.

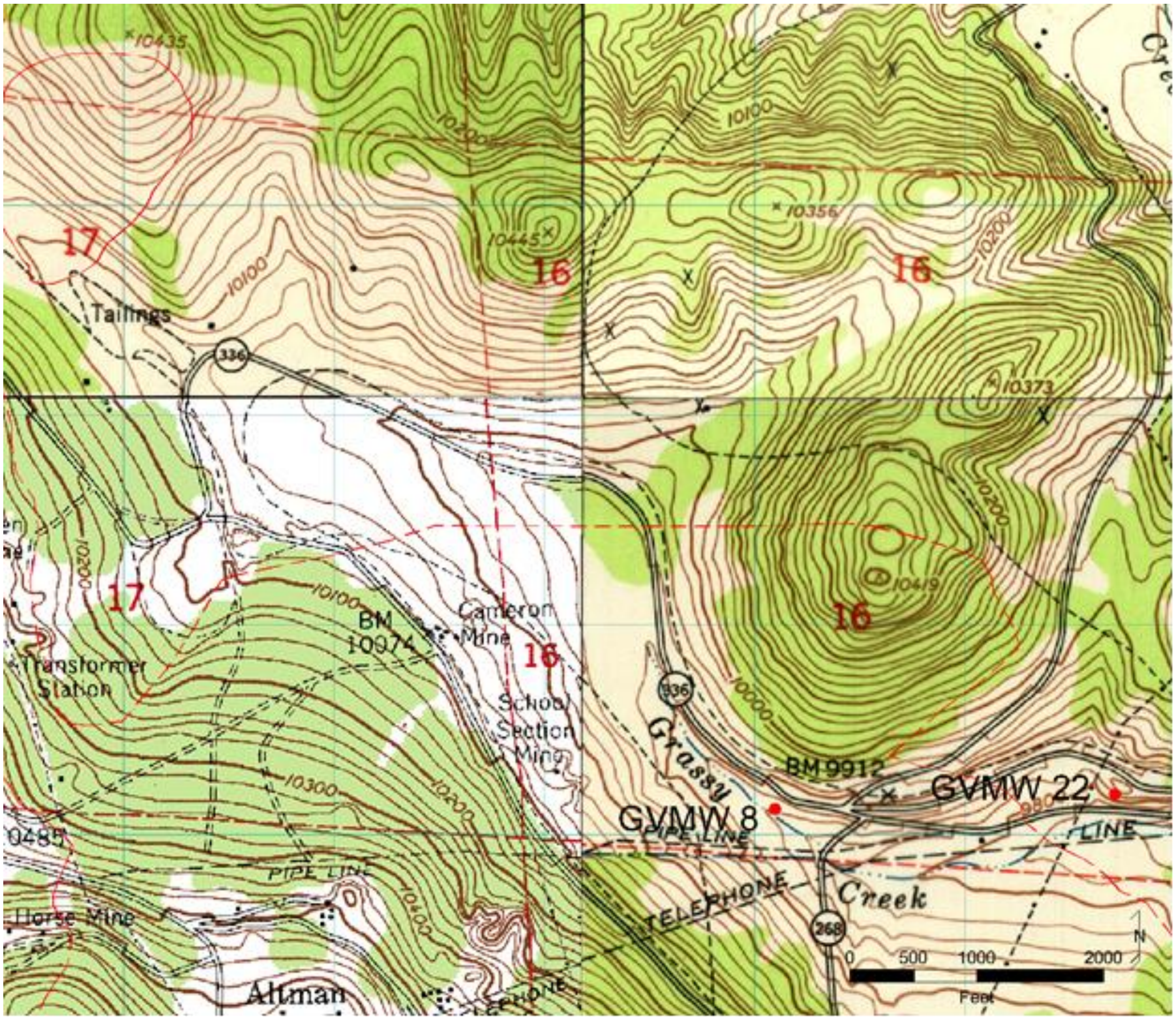

Figure 39: Grassy Valley groundwater compliance monitoring points (red dots, GVMW 8 and GVMW 22 labels) on 1951 USGS 1:24000 topography. The red dashed line represents the Precambrian-diatreme contact.

Even though there were waste rock and tailings piles up-gradient of the two compliance monitoring points in Grassy Valley, and waste rock began to be stored in the ECOSA facility in 2013, groundwater at the compliance points has not been impacted. It is hypothesized that groundwater infiltration into the diatreme along the reach of Grassy Creek from the northwest quarter of section 16 to just upstream of GVMW 22 reduces the chemical load in groundwater resulting from historic mining and milling. Furthermore, the ECOSA facility is constructed on the diatreme, so solutes mobilized by precipitation that infiltrates the waste rock are transported into the diatreme, rather than the shallow groundwater of Grassy Valley. As a result, groundwater sampled at GVMW 8 and GVMW 22 has not been impacted by anthropogenic activity, and therefore represents background conditions.

7. Conclusions and recommendations

The data and analysis presented indicate that groundwater in Arequa Gulch, Poverty Gulch and Vindicator Valley has been impacted by historic mining and milling activities. Precipitation has mobilized soluble species from mine dumps/tailings, and likely the native soils, and transported these in the groundwater. In Squaw Gulch, it appears that elevated dissolved constituents in groundwater chiefly stem from Squaw Gulch having been the discharge point from the diatreme prior to construction of the various drainage tunnels, and it is probable that historic mining activity has also contributed to the chemical load in groundwater. The solutes transported from the mineralized zones within the diatreme, and historic dumps/tailings, have enriched the shallow aquifer materials, and due to limited recharge, these solutes remain elevated in the groundwater.

The sources of the elevated constituents in these four drainages existed well before 31 January 1994, and the data presented in the present report show that mining/processing activities undertaken since 1994 have not resulted in any new or increased sources of groundwater contamination. Therefore, consistent with Regulation 41 the data collected after 1994 “shall be presumed to be representative of existing quality as of January 31, 1994.”

Groundwater in Wilson Creek and Grassy Valley does not appear to have been impacted by historic mining and milling and, therefore, the data represent the natural background concentrations of the constituents of interest.

8. References

Campbell, M.R., 1922, Guidebook of the Western United States: Part E – The Denver & Rio Grande Western Route, USGS Bulletin 707, 266 p.

CC&V, 2015, Cresson Project, Permit M-1980-244 Amendment 11 Application, dated 16 December 2015.

CC&V, 2016, Responses to Adequacy Review Comments, No. 2 Hydrology Section, Dated October 19, 2016, M-1980-244/Amendment 11, dated December 8, 2016.

Cross, W., and Penrose, R.A.F. Jr., 1895, Geology and Mining Industries of the Cripple Creek District, Colorado, Extract from the Sixteenth Annual Report of the Survey, 1894-95, Part II – Papers of an Economic Character, U.S. Government Printing Office, 209 p.

Drake, R.L. and Grimstad, W.N., 1983, The Last Gold Rush: A Pictorial History of the Cripple Creek & Victor Gold Mining District, Pollux Press, Victor, CO, 159 p.

EPA, 1992, 4.0 Site Visit Report: Nerco Minerals Cripple Creek, United States Environmental Protection Agency, Office of Solid Waste, 94 p.

Feitz, L., 1978, Cripple Creek! A Quick History of the World’s Greatest Gold Camp, thirteenth printing, Little London Press, Colorado Springs, CO, 68 p.

Grimstad, B., and Drake, R.L., 1983, The Last Gold Rush A Pictorial History of the Cripple Creek & Victor Gold Mining District, Pollux Press, Victor, Colorado, 159 p.

Henderson, C.W., 1926, Mining in Colorado: A History of Discovery, Development and Production, USGS Professional Paper 138.

Henry, T.W., Evanoff, E., Grenard, D., Meyer, H.W., and Pontius, J.A., 1996, Geology of the Gold Belt Back Country Byway, South-Central Colorado, Colorado Geological Survey Open-File Report 96-4, Field Trip No. 24, 48 p.

Lakes, A., 1899, Visit to a Cyanide Mill, *Mines and Minerals,* v. XX, no.1, pp. 5-7, August 1899.

Lakes, A., 1901, Chlorination Mills, *Mines and Minerals,* v. XXL, no. 8, pp. 337-339, March 1901.

Levine, B.H., 1982, Lowell Thomas’ Victor, The Man and the Town, Century One Press, 108 p.

Lindgren, W. and Ransome, F.L., 1906, Geology and Gold Deposits of the Cripple Creek District, Colorado, USGS Professional Paper 54, 516 p.

Mining and Scientific Press, 1903, v. LXXXVI, no. 16, p. 253.

Woods, W., 1901, Gold Fields of Cripple Creek, Woods Investment Co., 91 p.