Enchemica

Enchemica, LLC
2335 Buckingham Circle
Loveland, CO 80538 USA
1-970-481-9338

DRAFT TECHNICAL MEMORANDUM

TO: Vicky Peacey, Resolution Copper

FROM: Ted Eary, Enchemica

DATE: July 17, 2018

SUBJECT: Alternative 4 - Silver King Filtered: Prediction of Operational Tailings Circuit Solute Chemistry

1 INTRODUCTION

The draft environmental impact statement (DEIS) for the Resolution Copper mine includes assessment of the following tailings storage facility alternatives:

- Alternative 1: No Action
- Alternative 2: Near West Modified Proposed Action
- Alternative 3: Near West Modified Proposed Action – Thin Lift/PAG Cell
- Alternative 4: Silver King Filtered
- Alternative 5: Peg Leg
- Alternative 6: Skunk Camp

Water balances models have been developed for each of these alternatives. These water balance models have been augmented by the addition of chemical balances. The purpose of this memo is to provide a description of the predictions of the chemical balance and resulting solute chemistry for Alternative 4.

2 MODEL SETUP

2.1 Software

The predictive model was developed with a combination of GoldSim (version 12.0) and PHREEQC (Parkhurst and Appelo, 2013; version 3.0). GoldSim was used for the water and chemical mass balance components of the model. PHREEQC was used to simulate reactive processes that affect water chemistry. The WATEQ4F.DAT thermodynamic database was used for the PHREEQC calculations. The chemical portions of the model include calculations for:

- Ca, Mg, Na, K, Cl, HCO_3, SO_4, Si, F, NO_3-N, Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, Tl, Zn, and pH

The PHREEQC geochemical model was integrated directly into the GoldSim water balance model, so that changes to water chemistry resulting from reactive processes are made at each time step in the simulations and incorporated directly into the simulation results.

2.2 Input Data

A common set of inputs for water chemistry and flow rates from the block cave mine was used for all TSF alternatives. These inputs are described in Enchemica (2018).

2.3 Simulation Period

The simulation period was 41 years, which represents the life of mine per the mine plan of operations. A 1-day time step was used. Both the water balance and PHREEQC calculations are conducted at each time step. A 3-day timestep was found to be short enough prevent potential mass transfer warnings from GoldSim while being long enough to yield reasonably short model run times.

3 WATER BALANCE

A model of the water balance for Alternative 4 was developed by KCB (KCB, 2018). The boundaries of the KCB water balance model included the West Plant, tailings storage facility (TSF), and seepage collection systems. The details of the water balance relevant to the solute balance are provided in KCB (2018).

3.1 Makeup Water

The KCB water balance model provided calculations of the rate of reclaim water flow to the West Plant and the total demand for additional makeup water needed for ore processing at the West Plant. There are five sources of water for ore processing:

- **Reclaim water**:
  - **Scavenger Pond Reclaim**: Excess water pumped from the Scavenger Pond – this flow is provided by the KCB water balance model.
  - **Filter Plant Reclaim**: Water returned from filtering of tailings – this flow is provided by the KCB water balance model.
- **Makeup water:**
  - **Ore moisture**: Ore entering the West Plant is estimated to contain 4% by weight of water.
  - **Block cave sump water**: The block cave mine is expected to have an excess amount of water that will be pumped to the surface providing a source of makeup water.
  - **Freshwater**: The demand for makeup water in exceedance of reclaim and flows from the block cave mine will be comprised of a mixture of freshwater from the Central Arizona Project canal and well fields.

Figure 3-1 shows simulation results for process water sources. Reclaim from the filter plant is the largest source of water for ore processing followed by block cave sump water, ore moisture, and scavenger pond reclaim. There is a surplus of water from the sources listed above throughout the operational mine life as shown by the overflow of excess water in Figure 3-1 (KCB, 2018).

Figure 3-2 shows a simulation specifically for surplus water. The surplus water to the West Plant is comprised of filter plant reclaim and block cave water. Additional sources of surplus water include excess water from the Pyrite Pond that cannot be used for ore processing because of very poor water quality (Duke, 2017), and starting at about year 35 when ore processing ramps down, excess water from the Scavenger Pond. Flow of excess water from the Pyrite Pond is predicted to average about 90 gpm. Flow of excess water from the Scavenger Pond is predicted to average about 350 gpm after year 35.

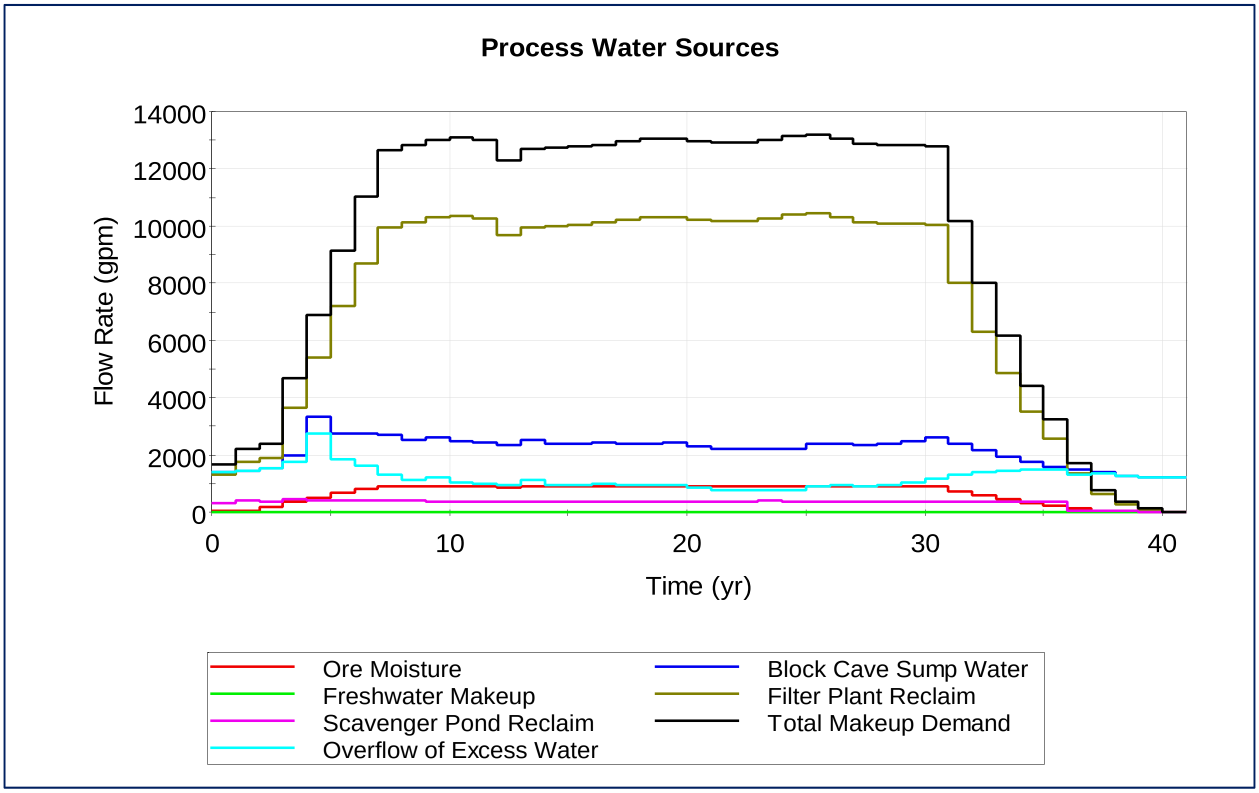

Figure 3-1. Simulation results for process water sources

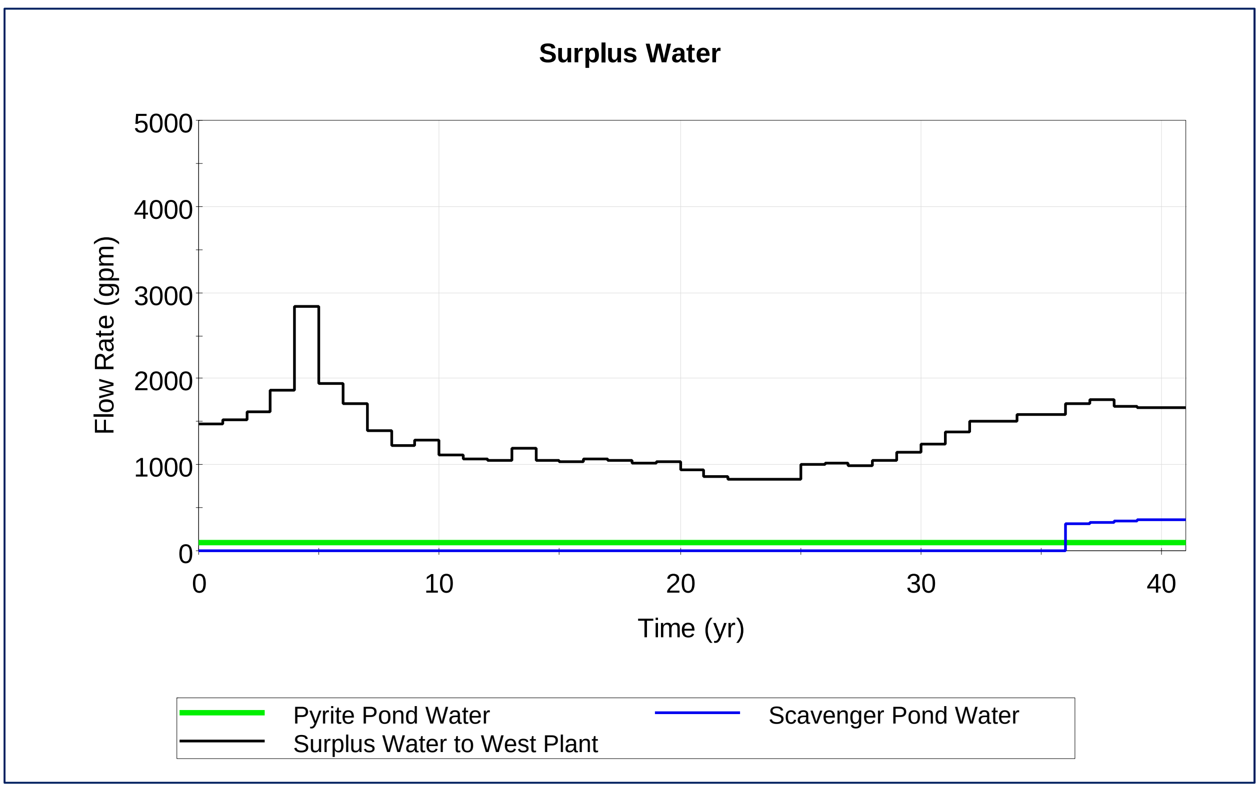

Figure 3-2. Surplus water requiring management

4 CALCULATION SEQUENCE FOR SOLUTE CHEMISTRY

The calculation sequence in the solute model is:

- Chemical loads are defined for all water sources entering the TSF system by multiplication of flow rates times concentrations. Descriptions of the source water chemistries are in Enchemica (2018).
- The chemical loads are converted to concentrations at locations of water mixing and storage.
- The concentrations are equilibrated with PHREEQC for aqueous speciation, solubility, and adsorption. The set of equilibria processes for PHREEQC are described in Enchemica (2018). There are five locations where PHREEQC is applied to produced equilibrated water chemistries:
    - **West Plant**: mixture of water entering the Plant
    - **Pyrite Tailings**: water contained in the pore space of deposited pyrite tailings
    - **Pyrite Pond**: water collected from the pyrite tailings and associated runoff areas. Water in this pond is not used as a reclaim to the West Plant due to very poor quality.
    - **Lost Seepage from Pyrite Tailings and Pyrite Pond**: combined flow of water predicted to seep from deposited pyrite tailings and pond.
    - **Scavenger Tailings/Embankment**: water contained in the pore space of deposited scavenger tailings.
    - **Scavenger Pond**: storage of water collected from the scavenger tailings and associated runoff areas. This pond is used as a reclaim water source for the West Plant.
    - **Lost Seepage from Scavenger Tailings/Embankment and Scavenger Reclaim Pond**: combined flow of water predicted to seep from deposited scavenger tailings and pond.
    - **Surplus Water**: The water balance indicates there would be excess water from the Pyrite Pond and other makeup sources.
- Equilibrated water chemistries are multiplied by flow rates to move chemical loads through the water distribution system.

The water balance model indicates four points of seepage that have the potential to bypass collection systems. These are:

- Scavenger Tailings/Embankment and Scavenger Pond – combined Lost Seepage
- Pyrite Tailings and Pyrite Pond – combined Lost Seepage

The two potential seepages from each of these combined sources are used to provide an estimate of the chemical compositions for the two types of lost seepage predicted to occur from the pyrite and scavenger TSFs. The pyrite pond will be lined and is predicted to have a low rate of (up to 1.3 gpm) but influences seepage chemistry due to its high chemical load.

Reactions and mixing of Lost Seepage with groundwater in flow paths from the TSF are not included in the modeling logic. Transport of Lost Seepage along flow paths is the subject of associated modeling studies by Montgomery and Associates.

5 RESULTS

A full set of results from the model are provided in tables below as annual average concentrations. The tables are organized as follows:

- Table 5-1: Pyrite Pond
- Table 5-2: Combined lost seepage from the Pyrite Pond and Pyrite Tailings
- Table 5-3: Combined lost seepage from the Scavenger Pond Scavenger Tailings
- Table 5-4 Predictions of average annual concentrations for Surplus Water: Surplus Water

5.1 Pyrite Pond and Tailings

Examples of model results are shown in Figure 5-1 for the Pyrite Pond and Figure 5-2 for lost seepage combined for the Pyrite Pond and Pyrite Tailings. The data in these charts are average annual concentrations for the 41-year operational mine life. The following observations are made from the predictions of Pyrite Pond chemistry:

- Figure 5-1a - pH: The pH is predicted to be acidic in the range of 2.8 to 3.0 for the entirety of the 41-year operational mine life.
- Figure 5-1b – major anions: Sulfate is the dominant anion at concentrations up 18,700 mg/L. Fluoride is next in importance with concentrations up to 280 mg/L. The predicted concentrations for chloride and nitrate-N are lower typically less than 15 mg/L and 3 mg/L, respectively.
- Figure 5-1c – divalent metals: Copper is predicted to have the highest concentrations, ranging up to 2160 mg/L. Concentrations of nickel, cobalt, and zinc are predicted to range from about 10 to 20 mg/L. Concentrations of cadmium and lead are predicted range up to 0.07 and 0.006 mg/L, respectively.
- Figure 5-1d: anionic metals and metalloids: Molybdenum concentrations are the highest for this group at concentrations up to about 0.5 mg/L. Arsenic is next highest at concentrations up to about 0.4 mg/L followed by selenium at concentrations up to about 0.2 mg/L. Antimony concentrations are predicted to be the lowest in this group at concentrations up to about 0.0005 mg/L.

The acidic, high metal concentrations predicted for the Pyrite Pond are due to runoff from the deposited tailings. The chemistry of runoff is represented by measured data from barrel tests conducted with samples of filtered tailings, which consistently produced leachates with low pH and high sulfate and metal concentrations (Duke, 2017).

A set of model predictions for combined lost seepage from the Pyrite Pond and Pyrite Tailings is shown in Figure 5-2. Seepage from the Pyrite Pond is acidic with high metal loads, but it is expected to have a very low flow due to placement of a liner under the pond. Seepage from the Pyrite Tailings is process water, but it is expected to have a higher flow rate than seepage from the Pyrite Pond. The following observations are made from the predictions of combined lost seepage from the Pyrite Pond and Pyrite Tailings:

- Figure 5-2a - pH: The pH is predicted to drop over time from 6.4 to 5.2 as the acidity of the Pyrite Pond increases over the 41-year operational mine life and mixes with the pyrite tailings seepage.
- Figure 5-2b – major anions: Sulfate is the dominant anion at concentrations from 670 to 2240 mg/L Chloride is next highest at concentrations up to 100 mg/L. Bicarbonate concentrations are predicted to be 0 mg/L and fluoride is in the range of 3 to 14 mg/L. Nitrate-N concentrations are predicted to be in the range of 2 to 4 mg/L.

- Figure 5-2c – divalent metals: Copper is predicted to have the highest concentrations, ranging up to 78 mg/L. Zinc is next highest, ranging up to 3.2 mg/L. Concentrations of cobalt and nickel are approximately the same at concentrations from 0.1 to 0.9 mg/L. Concentrations of cadmium and lead are predicted range up to 0.02 and 0.001 mg/L, respectively.
- Figure 5-2d: anionic metals and metalloids: Molybdenum concentrations are the highest for this group at concentrations up to about 1 mg/L. Selenium is next highest at concentrations up to about 0.27 mg/L followed by arsenic and antimony concentrations up to about 0.016 and 0.008 mg/L, respectively.

A set of model predictions for lost seepage combined for the Scavenger Tailings and Scavenger Pond is shown in Figure 5-3. The following observations are made from these predictions for combined lost seepage:

- Figure 5-3a - pH: The pH is predicted remain approximately constant at 7.6 to. 7.9 over the 41-year operational mine life.
- Figure 5-3b – major anions: Sulfate is the dominant anion at concentrations from 900 to 1520 mg/L Chloride is next highest at concentrations up to 106 mg/L. Bicarbonate concentrations are predicted to range from 15 to 20 mg/L and fluoride from 2.2 to 2.4 mg/L. Nitrate-N concentrations are predicted to be in the range of 3 to 4.5 mg/L.
- Figure 5-3c – divalent metals: Zinc is predicted to have the highest concentrations, ranging up to 2.7 mg/L. Concentrations of copper, nickel, cobalt are predicted to range from about 0.1 to 0.2 mg/L. Concentrations of cadmium and lead are predicted range up to 0.01 and 0.001 mg/L, respectively.
- Figure 5-3d: anionic metals and metalloids: Molybdenum concentrations are the highest for this group at concentrations up to about 1 mg/L. Selenium is next highest at concentrations up to about 0.3 mg/L followed by arsenic and antimony concentrations up to about 0.002 and 0.008 mg/L, respectively.

5.2 Treatment of Surplus Water from the Pyrite Pond

The Pyrite Pond is predicted to fill to capacity, yielding surplus water that cannot be used for ore processing because of its expected high acidity. This acidic surplus water will need to be treated. Using the average water chemistry predicted for year 26 for the Pyrite Pond (Table 5-4) and an average flow of 90 gpm for surplus water from the Pyrite Pond, estimates for treatment parameters are:

- Lime (as $Ca(OH)_2$) requirement to raise the pH from 2.9 to 9 is 11.9 g/L or 2340 tons/yr at 90 gpm. The assumptions for this calculation are 96% purity for hydrated lime, reaction efficiency of 0.8 (Cravotta et al. 2010), and the anticipated need to obtain a pH of 9 for removal of Mn and Zn. Also, it is assumed that the surplus water from the Pyrite Pond would be treated as a separate flow rather than being combined with surplus water from the Scavenger Pond and block cave mine.
- The TDS is predicted to be reduced from 21,118 mg/L to 5200 mg/L in treated water with SO_4 being the primary solute at 3830 mg/L.
- Sludge generation is estimated to be 28.2 g/L or 5570 ton/yr based on a PHREEQC calculation of precipitation of secondary minerals. The primary precipitants are gypsum, $Fe(OH)_3$, $Al(OH)_3$, and $Cu(OH)_2$. Sludge generation during the mine operational period of 41 years would be 228,370 tons. Sludge generation for a 200-year post-closure period would be an additional 1.114×10^6 tons.

The above calculations are based on treatment with lime to provide estimates for the potential capacity needed for water treatment and sludge disposal. Other water treatment methods would have different requirements and results.

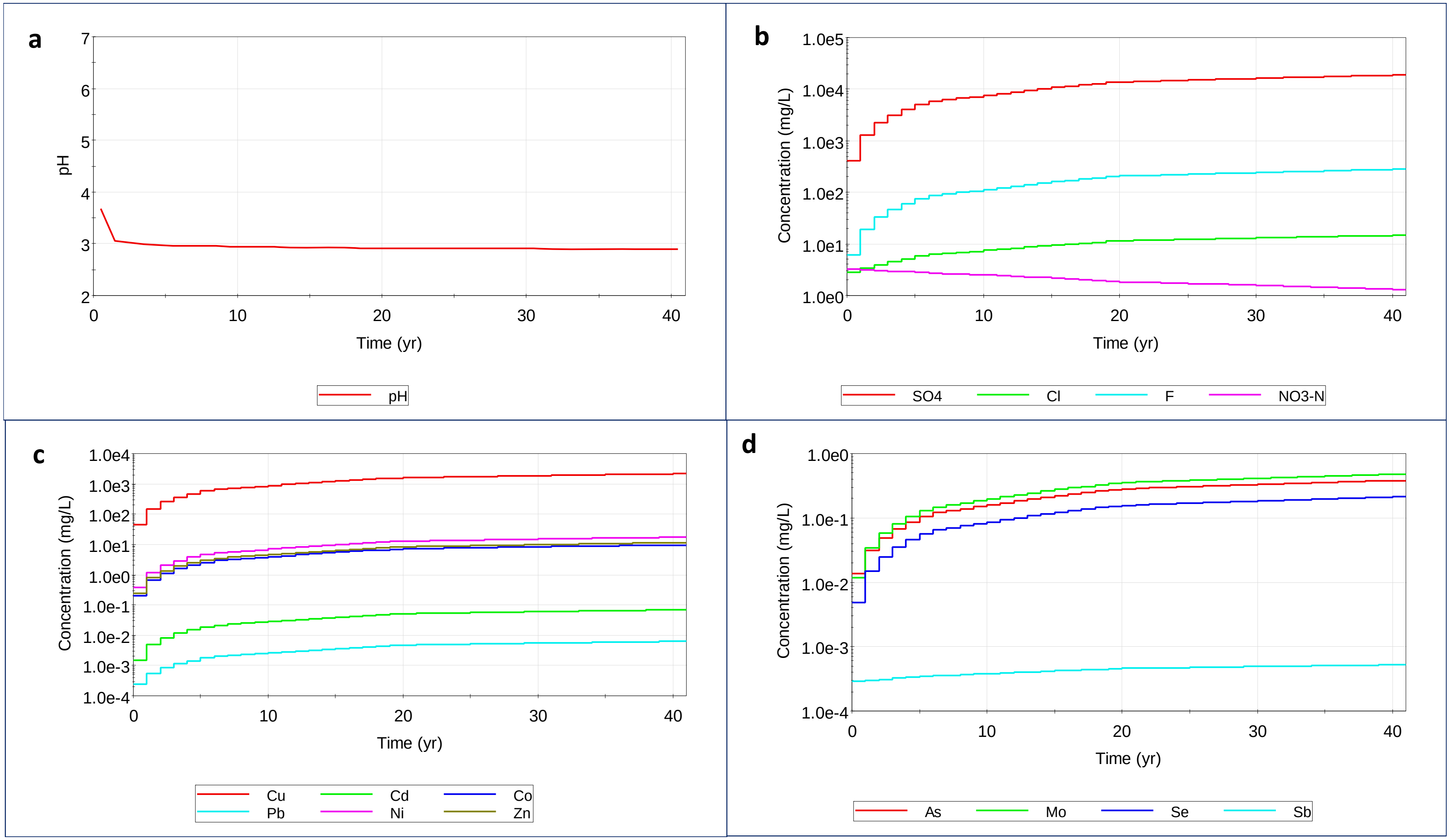

Figure 5-1. Predictions of average annual concentrations in the Pyrite Pond for a) pH, b) major anions, c) divalent metals, and d) anionic metals/metalloids

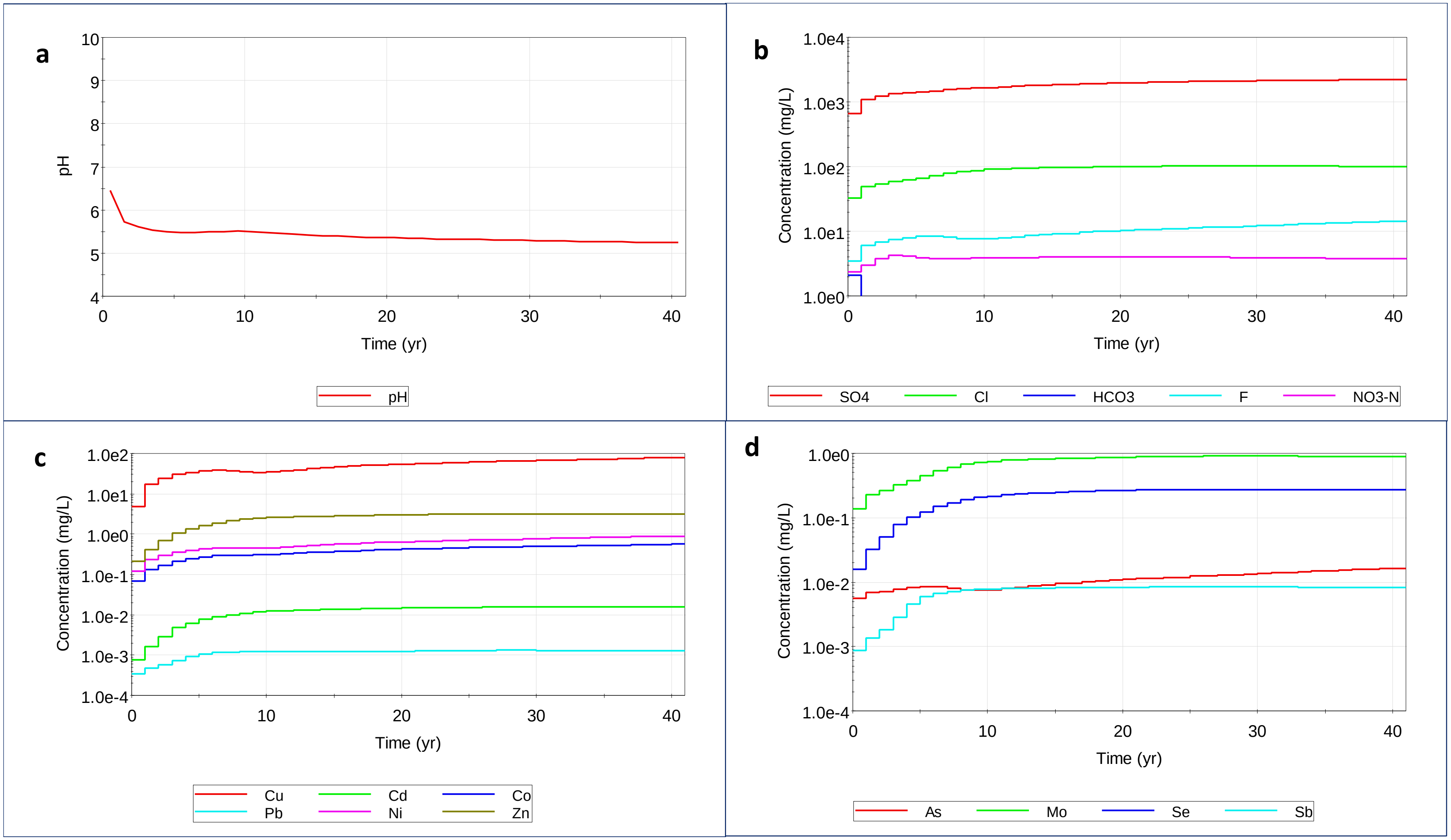

Figure 5-2. Predictions of average annual concentrations in lost seepage combined from the Pyrite Pond and Pyrite Tailings for a) pH, b) major anions, c) divalent metals, and d) anionic metals/metalloids

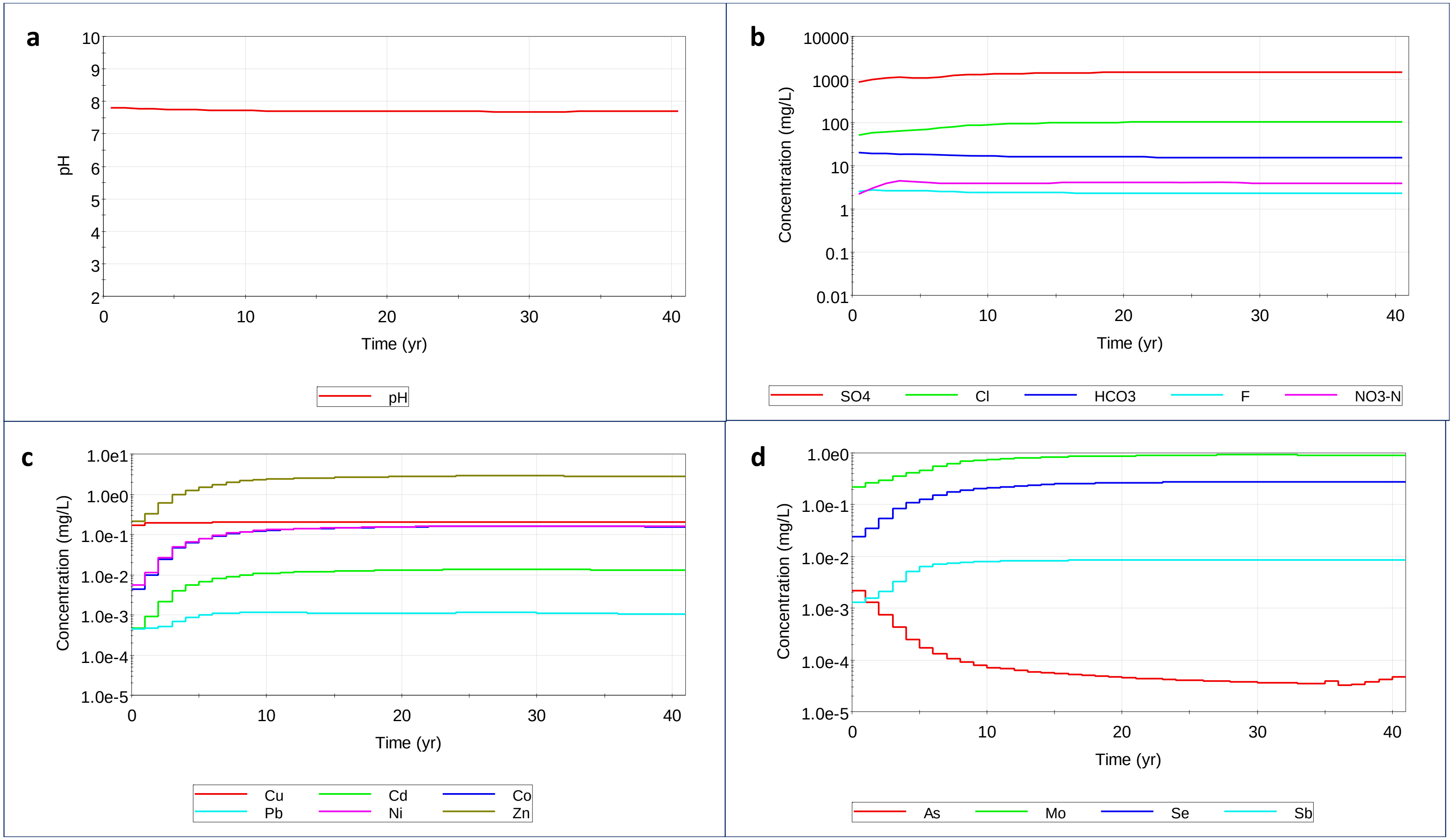

Figure 5-3. Predictions of average annual concentrations in lost seepage combined from the Scavenger Pond and Scavenger Tailings for a) pH, b) major anions, c) divalent metals, and d) anionic metals/metalloids

Table 5-1. Predictions of average annual concentrations for the Pyrite Pond

	Ca	Mg	Na	K	Cl	HCO_3	SO_4	Si	F	NO_3-N	Al	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Se	Ag	Tl	Zn	pH	TDS
Year	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.	mg/L
1	18	21	3	4	3	1	408	7.7	6.1	3.2	19.46	0.0003	0.0135	0.016	0.00322	0.03	0.002	0.129	0.206	46.220	43.019	0.000	0.62	0.012	0.372	0.005	0.025	0.0003	0.24	3.68	584
2	35	59	3	4	3	0	1291	9.6	19.3	3.2	62.46	0.0003	0.0313	0.017	0.00917	0.04	0.005	0.412	0.659	148.590	170.28	0.001	1.96	0.034	1.191	0.015	0.080	0.0008	0.78	3.06	1815
3	53	97	3	4	4	0	2197	11.5	32.8	3.1	106.45	0.0003	0.0494	0.016	0.01527	0.04	0.008	0.701	1.123	253.330	304.11	0.001	3.33	0.057	2.030	0.025	0.136	0.0014	1.33	3.02	3078
4	71	136	3	5	5	0	3117	13.5	46.5	3.0	151.19	0.0003	0.0679	0.015	0.02147	0.04	0.012	0.996	1.595	359.840	441.11	0.001	4.72	0.081	2.883	0.035	0.193	0.0019	1.89	2.99	4364
5	89	176	3	5	5	0	4052	15.5	60.5	2.9	196.62	0.0003	0.0867	0.014	0.02776	0.04	0.015	1.295	2.075	468.010	581.07	0.001	6.13	0.105	3.749	0.046	0.251	0.0025	2.46	2.98	5671
6	108	216	4	5	6	0	5004	17.4	74.6	2.8	242.86	0.0003	0.1058	0.014	0.03417	0.04	0.019	1.599	2.563	578.080	724.23	0.002	7.57	0.129	4.631	0.057	0.310	0.0031	3.04	2.97	7002
7	122	247	4	5	6	0	5736	18.5	85.6	2.7	278.43	0.0004	0.1204	0.014	0.03910	0.05	0.021	1.833	2.938	662.780	834.81	0.002	8.67	0.148	5.309	0.065	0.356	0.0036	3.48	2.96	8026
8	131	267	4	5	7	0	6192	18.7	92.4	2.6	300.61	0.0004	0.1296	0.013	0.04217	0.05	0.023	1.979	3.172	715.570	903.93	0.002	9.36	0.159	5.732	0.070	0.384	0.0039	3.76	2.95	8663
9	139	286	4	5	7	0	6650	18.6	99.2	2.6	322.85	0.0004	0.1388	0.013	0.04525	0.05	0.025	2.126	3.406	768.520	973.38	0.002	10.06	0.171	6.156	0.075	0.412	0.0041	4.04	2.95	9303
10	148	306	4	5	7	0	7113	18.6	106.1	2.5	345.36	0.0004	0.1481	0.013	0.04837	0.05	0.026	2.274	3.644	822.130	1043.8	0.002	10.76	0.183	6.585	0.081	0.441	0.0044	4.32	2.95	9951
11	159	329	4	5	7	0	7650	18.6	114.1	2.5	371.41	0.0004	0.1588	0.013	0.05198	0.05	0.028	2.445	3.919	884.150	1125.4	0.003	11.57	0.197	7.082	0.087	0.474	0.0048	4.64	2.94	10700
12	171	355	4	5	8	0	8273	18.5	123.4	2.4	401.70	0.0004	0.1714	0.013	0.05618	0.05	0.031	2.645	4.238	956.260	1220.4	0.003	12.51	0.212	7.659	0.094	0.513	0.0051	5.02	2.94	11572
13	183	382	4	5	8	0	8899	18.5	132.7	2.4	432.11	0.0004	0.1839	0.013	0.06039	0.06	0.033	2.845	4.559	1028.700	1316	0.003	13.45	0.228	8.239	0.101	0.552	0.0055	5.40	2.94	12447
14	195	408	4	5	9	0	9532	18.4	142.1	2.3	462.87	0.0004	0.1966	0.013	0.06466	0.06	0.035	3.047	4.884	1101.900	1412.7	0.003	14.41	0.245	8.826	0.108	0.591	0.0059	5.79	2.93	13332
15	208	436	4	6	9	0	10168	18.4	151.6	2.2	493.80	0.0004	0.2094	0.013	0.06894	0.06	0.038	3.251	5.210	1175.500	1510.1	0.003	15.37	0.261	9.415	0.115	0.631	0.0063	6.17	2.93	14223
16	220	463	4	6	10	0	10809	18.3	161.2	2.2	524.96	0.0004	0.2223	0.013	0.07326	0.06	0.040	3.456	5.539	1249.700	1608.3	0.004	16.34	0.277	10.009	0.122	0.671	0.0067	6.56	2.93	15120
17	233	490	5	6	10	0	11453	18.3	170.8	2.1	556.23	0.0004	0.2352	0.012	0.07759	0.06	0.043	3.662	5.869	1324.200	1706.8	0.004	17.31	0.294	10.606	0.130	0.711	0.0071	6.95	2.92	16020
18	245	518	5	6	10	0	12104	18.2	180.5	2.0	587.88	0.0004	0.2482	0.012	0.08198	0.06	0.045	3.870	6.203	1399.500	1806.6	0.004	18.30	0.310	11.209	0.137	0.751	0.0075	7.35	2.92	16931
19	258	546	5	6	11	0	12759	18.2	190.3	1.9	619.72	0.0004	0.2614	0.012	0.08639	0.07	0.047	4.080	6.539	1475.300	1906.9	0.004	19.29	0.327	11.816	0.144	0.792	0.0079	7.75	2.92	17848
20	271	574	5	6	11	0	13420	18.1	200.1	1.9	651.81	0.0005	0.2746	0.012	0.09084	0.07	0.050	4.291	6.877	1551.700	2008	0.005	20.28	0.344	12.428	0.152	0.833	0.0083	8.15	2.91	18772
21	280	593	5	6	12	0	13887	18.1	207.1	1.8	674.54	0.0005	0.2840	0.012	0.09399	0.07	0.052	4.440	7.117	1605.800	2079.6	0.005	20.99	0.356	12.861	0.157	0.862	0.0086	8.43	2.91	19426
22	285	604	5	6	12	0	14131	18.1	210.7	1.8	686.38	0.0005	0.2889	0.012	0.09563	0.07	0.053	4.518	7.242	1634.000	2116.9	0.005	21.36	0.362	13.087	0.160	0.877	0.0088	8.58	2.91	19767
23	289	614	5	6	12	0	14373	18.1	214.3	1.8	698.13	0.0005	0.2938	0.012	0.09726	0.07	0.053	4.596	7.366	1662.000	2153.9	0.005	21.72	0.368	13.311	0.163	0.892	0.0089	8.73	2.91	20105
24	294	624	5	6	12	0	14615	18.0	217.9	1.7	709.89	0.0005	0.2986	0.012	0.09889	0.07	0.054	4.673	7.490	1690.000	2190.9	0.005	22.09	0.374	13.535	0.165	0.907	0.0091	8.87	2.91	20444
25	299	634	5	6	12	0	14854	18.0	221.5	1.7	721.50	0.0005	0.3034	0.012	0.10049	0.07	0.055	4.749	7.613	1717.600	2227.4	0.005	22.45	0.380	13.757	0.168	0.922	0.0092	9.02	2.91	20778
26	304	645	5	6	12	0	15097	18.0	225.1	1.7	733.32	0.0005	0.3083	0.012	0.10213	0.07	0.056	4.827	7.737	1745.800	2264.6	0.005	22.82	0.387	13.982	0.171	0.937	0.0094	9.16	2.91	21118
27	308	655	5	6	12	0	15339	18.0	228.7	1.7	745.05	0.0005	0.3131	0.012	0.10376	0.07	0.057	4.904	7.861	1773.700	2301.5	0.005	23.18	0.393	14.206	0.173	0.952	0.0095	9.31	2.91	21456
28	313	665	5	6	13	0	15580	18.0	232.3	1.6	756.79	0.0005	0.3180	0.012	0.10538	0.07	0.058	4.982	7.985	1801.600	2338.4	0.005	23.55	0.399	14.429	0.176	0.967	0.0097	9.46	2.91	21794
29	318	675	5	6	13	0	15818	18.0	235.9	1.6	768.36	0.0005	0.3228	0.012	0.10699	0.07	0.059	5.058	8.107	1829.200	2374.8	0.005	23.91	0.405	14.650	0.179	0.982	0.0098	9.60	2.91	22127
30	322	686	5	6	13	0	16061	17.9	239.5	1.6	780.17	0.0005	0.3276	0.012	0.10862	0.07	0.060	5.136	8.232	1857.300	2411.9	0.005	24.28	0.411	14.875	0.182	0.997	0.0100	9.75	2.90	22467
31	327	696	5	6	13	0	16302	17.9	243.1	1.6	791.88	0.0005	0.3325	0.012	0.11025	0.07	0.061	5.213	8.355	1885.200	2448.7	0.005	24.64	0.417	15.098	0.184	1.012	0.0101	9.90	2.90	22804
32	332	706	5	6	13	0	16543	17.9	246.7	1.5	803.60	0.0005	0.3373	0.012	0.11187	0.08	0.062	5.290	8.479	1913.100	2485.4	0.006	25.00	0.423	15.322	0.187	1.027	0.0103	10.04	2.90	23141
33	336	716	6	6	13	0	16781	17.9	250.2	1.5	815.15	0.0005	0.3421	0.012	0.11347	0.08	0.062	5.366	8.601	1940.600	2521.7	0.006	25.36	0.430	15.542	0.190	1.041	0.0104	10.19	2.90	23473
34	341	727	6	7	14	0	17024	17.9	253.9	1.5	826.95	0.0005	0.3470	0.012	0.11511	0.08	0.063	5.443	8.725	1968.700	2558.7	0.006	25.73	0.436	15.767	0.192	1.057	0.0106	10.34	2.90	23813
35	346	737	6	7	14	0	17265	17.9	257.5	1.5	838.65	0.0005	0.3518	0.012	0.11673	0.08	0.064	5.520	8.849	1996.600	2595.4	0.006	26.09	0.442	15.990	0.195	1.072	0.0107	10.48	2.90	24150
36	350	747	6	7	14	0	17506	17.8	261.0	1.4	850.36	0.0005	0.3566	0.012	0.11835	0.08	0.065	5.598	8.972	2024.400	2632.1	0.006	26.46	0.448	16.213	0.198	1.086	0.0109	10.63	2.90	24487
37	355	757	6	7	14	0	17743	17.8	264.6	1.4	861.87	0.0005	0.3614	0.012	0.11995	0.08	0.066	5.673	9.094	2051.800	2668.2	0.006	26.82	0.454	16.433	0.201	1.101	0.0110	10.77	2.90	24818
38	359	767	6	7	14	0	17985	17.8	268.2	1.4	873.65	0.0005	0.3663	0.012	0.12158	0.08	0.067	5.751	9.218	2079.900	2705.1	0.006	27.18	0.460	16.658	0.203	1.116	0.0112	10.92	2.90	25157
39	364	778	6	7	14	0	18225	17.8	271.8	1.4	885.34	0.0005	0.3711	0.012	0.12320	0.08	0.068	5.828	9.341	2107.700	2741.6	0.006	27.55	0.466	16.880	0.206	1.131	0.0113	11.06	2.90	25492
40	368	788	6	7	15	0	18465	17.8	275.4	1.3	897.03	0.0005	0.3759	0.012	0.12482	0.08	0.069	5.905	9.465	2135.500	2.78E+03	0.006	27.91	0.473	17.103	0.209	1.146	0.0115	11.21	2.90	25827
41	372	798	6	7	15	0	18700	17.8	278.9	1.3	908.51	0.0005	0.3806	0.012	0.12641	0.08	0.070	5.980	9.586	2162.900	2.81E+03	0.006	28.27	0.479	17.322	0.211	1.161	0.0116	11.35	2.89	26156

Table 5-2. Predictions of average annual concentrations for lost seepage combined form the Pyrite Pond and Pyrite Tailings

	Ca	Mg	Na	K	Cl	HCO_3	SO_4	Si	F	NO_3-N	Al	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Se	Ag	Tl	Zn	pH	TDS
Year	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.	mg/L
1	121	41	69	46	32	2	670	12.9	3.4	2.4	2.34	0.0009	0.005556	0.015	0.00106	0.20	0.001	0.043	0.067	4.936	0.01	0.000	0.21	0.136	0.121	0.016	0.010	0.0004	0.21	6.45	1007
2	188	63	104	73	49	0	1086	17.3	6.0	3.0	5.57	0.0014	0.006919	0.016	0.00177	0.29	0.002	0.084	0.133	17.626	0.025226	0.000	0.43	0.226	0.236	0.032	0.020	0.0007	0.42	5.73	1613
3	221	68	111	82	54	0	1245	18.2	6.8	3.8	7.17	0.0018	0.007211	0.016	0.00208	0.32	0.003	0.106	0.172	24.629	0.03127	0.001	0.63	0.267	0.295	0.051	0.029	0.0009	0.68	5.62	1844
4	247	69	110	91	59	0	1354	18.6	7.5	4.2	8.71	0.0029	0.007869	0.016	0.00240	0.33	0.005	0.130	0.217	31.209	0.036572	0.001	0.91	0.322	0.361	0.079	0.040	0.0016	1.07	5.54	2005
5	253	65	106	100	62	0	1374	18.9	8.0	4.1	9.54	0.0046	0.008151	0.016	0.00257	0.33	0.006	0.145	0.247	34.383	0.039122	0.001	1.11	0.378	0.402	0.101	0.047	0.0030	1.35	5.50	2040
6	263	63	103	113	66	0	1413	19.0	8.3	3.9	10.35	0.0059	0.008503	0.015	0.00273	0.33	0.008	0.158	0.274	37.350	0.041428	0.001	1.30	0.445	0.440	0.124	0.055	0.0041	1.61	5.48	2104
7	286	62	103	131	72	0	1483	19.1	8.3	3.8	10.45	0.0067	0.008421	0.015	0.00274	0.34	0.009	0.163	0.290	37.926	0.041729	0.001	1.47	0.531	0.457	0.149	0.061	0.0044	1.90	5.47	2223
8	309	61	105	149	78	0	1541	19.0	8.0	3.8	10.04	0.0072	0.008049	0.015	0.00263	0.36	0.010	0.162	0.297	36.663	0.040627	0.001	1.60	0.610	0.456	0.171	0.066	0.0045	2.14	5.49	2326
9	330	61	107	164	84	0	1590	19.0	7.7	3.8	9.49	0.0075	0.007614	0.015	0.00250	0.37	0.011	0.160	0.299	34.951	0.039226	0.001	1.69	0.677	0.451	0.191	0.070	0.0045	2.34	5.50	2417
10	345	61	108	174	88	0	1631	19.0	7.6	3.8	9.33	0.0077	0.007447	0.015	0.00245	0.38	0.012	0.160	0.304	34.407	0.038709	0.001	1.77	0.722	0.453	0.205	0.073	0.0045	2.48	5.51	2487
11	355	61	109	181	90	0	1669	19.0	7.7	3.9	9.46	0.0079	0.007499	0.015	0.00248	0.39	0.012	0.163	0.312	35.080	0.039253	0.001	1.84	0.754	0.463	0.217	0.076	0.0045	2.58	5.50	2547
12	363	62	110	186	92	0	1716	19.0	8.0	3.9	10.16	0.0080	0.007929	0.015	0.00262	0.39	0.013	0.171	0.328	37.755	0.041281	0.001	1.91	0.780	0.488	0.226	0.079	0.0045	2.67	5.48	2616
13	369	63	111	190	94	0	1749	19.0	8.2	3.9	10.64	0.0080	0.008217	0.015	0.00272	0.40	0.013	0.176	0.339	39.633	0.042714	0.001	1.96	0.798	0.505	0.233	0.081	0.0045	2.72	5.46	2665
14	373	64	111	193	95	0	1785	19.0	8.6	3.9	11.49	0.0081	0.008727	0.015	0.00290	0.40	0.013	0.185	0.354	42.501	0.044822	0.001	2.01	0.809	0.530	0.239	0.083	0.0045	2.75	5.44	2714
15	376	65	111	195	96	0	1814	19.0	8.8	3.9	12.12	0.0081	0.009096	0.015	0.00302	0.40	0.013	0.191	0.365	44.626	0.046378	0.001	2.05	0.819	0.549	0.244	0.085	0.0045	2.78	5.42	2753
16	381	66	112	197	97	0	1844	19.0	9.1	4.0	12.75	0.0082	0.009463	0.015	0.00315	0.40	0.014	0.197	0.377	46.704	0.047862	0.001	2.09	0.830	0.569	0.250	0.087	0.0045	2.82	5.41	2796
17	384	67	112	199	98	0	1867	19.0	9.3	4.0	13.11	0.0082	0.009676	0.015	0.00322	0.40	0.014	0.201	0.385	48.055	0.048843	0.001	2.13	0.840	0.581	0.255	0.089	0.0045	2.86	5.40	2828
18	388	68	112	201	98	0	1900	19.0	9.6	4.0	13.96	0.0082	0.010157	0.015	0.00338	0.41	0.014	0.209	0.399	50.554	0.050582	0.001	2.18	0.848	0.605	0.259	0.091	0.0045	2.91	5.38	2872
19	391	69	113	203	99	0	1925	19.0	9.9	4.0	14.53	0.0083	0.010480	0.015	0.00349	0.41	0.014	0.215	0.410	52.315	0.051805	0.001	2.22	0.856	0.622	0.262	0.093	0.0045	2.95	5.37	2906
20	393	69	113	204	100	0	1948	19.0	10.1	4.0	15.12	0.0083	0.010810	0.015	0.00360	0.41	0.015	0.220	0.420	54.061	0.053001	0.001	2.26	0.863	0.640	0.265	0.094	0.0046	3.00	5.36	2938
21	396	70	113	206	100	0	1962	19.0	10.2	4.0	15.32	0.0084	0.010930	0.015	0.00365	0.41	0.015	0.223	0.425	54.844	0.053551	0.001	2.29	0.870	0.647	0.267	0.095	0.0046	3.03	5.35	2958
22	398	71	113	207	101	0	1988	19.0	10.5	4.0	16.09	0.0084	0.011347	0.015	0.00378	0.41	0.015	0.229	0.436	56.786	0.054837	0.001	2.33	0.876	0.667	0.268	0.097	0.0045	3.06	5.34	2993
23	400	71	113	208	101	0	2007	19.0	10.7	4.0	16.51	0.0084	0.011579	0.015	0.00386	0.41	0.015	0.234	0.443	57.934	0.055596	0.001	2.36	0.883	0.679	0.269	0.098	0.0045	3.09	5.34	3018
24	402	72	114	210	102	0	2026	19.0	10.9	4.0	16.98	0.0084	0.011833	0.015	0.00395	0.41	0.015	0.238	0.450	59.150	0.056393	0.001	2.40	0.889	0.691	0.270	0.099	0.0045	3.12	5.33	3044
25	405	72	114	211	102	0	2038	19.0	10.9	4.0	17.15	0.0084	0.011928	0.015	0.00398	0.42	0.015	0.240	0.454	59.744	0.056796	0.001	2.42	0.896	0.697	0.271	0.100	0.0045	3.14	5.33	3062
26	406	73	114	212	103	0	2063	19.0	11.3	4.0	17.98	0.0084	0.012370	0.015	0.00413	0.42	0.015	0.247	0.466	61.693	0.05806	0.001	2.46	0.900	0.718	0.271	0.102	0.0045	3.17	5.32	3094
27	407	74	114	212	103	0	2078	19.0	11.4	4.0	18.43	0.0084	0.012611	0.015	0.00421	0.42	0.015	0.251	0.472	62.810	0.05879	0.001	2.49	0.902	0.730	0.271	0.103	0.0045	3.19	5.31	3113
28	408	74	114	213	103	0	2093	19.0	11.6	3.9	18.93	0.0084	0.012876	0.014	0.00430	0.42	0.016	0.256	0.479	64.002	0.059564	0.001	2.52	0.905	0.742	0.271	0.104	0.0045	3.20	5.31	3132
29	409	75	114	213	103	0	2100	19.0	11.7	3.9	19.08	0.0084	0.012968	0.014	0.00433	0.42	0.016	0.257	0.482	64.549	0.059937	0.001	2.53	0.907	0.747	0.272	0.104	0.0045	3.20	5.30	3141
30	409	76	114	213	103	0	2122	19.0	12.0	3.9	19.98	0.0084	0.013435	0.014	0.00449	0.42	0.016	0.265	0.494	66.491	0.061179	0.001	2.57	0.908	0.768	0.273	0.106	0.0045	3.20	5.30	3168
31	409	76	114	213	103	0	2134	19.0	12.2	3.9	20.45	0.0084	0.013684	0.014	0.00457	0.42	0.016	0.269	0.500	67.587	0.061887	0.001	2.59	0.908	0.780	0.274	0.106	0.0045	3.20	5.29	3182
32	409	77	114	213	103	0	2145	19.0	12.4	3.9	20.99	0.0084	0.013962	0.014	0.00466	0.42	0.016	0.273	0.507	68.762	0.062642	0.001	2.60	0.907	0.792	0.275	0.107	0.0045	3.19	5.29	3195
33	408	77	114	212	103	0	2147	19.0	12.5	3.9	21.14	0.0084	0.014054	0.014	0.00469	0.42	0.016	0.274	0.509	69.280	0.062999	0.001	2.60	0.904	0.796	0.275	0.107	0.0045	3.17	5.28	3196
34	407	78	114	211	102	0	2166	19.0	12.9	3.8	22.12	0.0084	0.014553	0.014	0.00486	0.42	0.016	0.282	0.520	71.232	0.064234	0.001	2.63	0.899	0.818	0.274	0.108	0.0045	3.16	5.27	3217
35	406	78	114	210	102	0	2175	19.0	13.1	3.8	22.63	0.0083	0.014819	0.014	0.00495	0.42	0.016	0.286	0.526	72.334	0.064941	0.001	2.64	0.895	0.829	0.274	0.109	0.0045	3.15	5.27	3225
36	405	79	114	209	102	0	2185	19.0	13.3	3.8	23.21	0.0083	0.015117	0.014	0.00505	0.41	0.016	0.290	0.533	73.520	0.065696	0.001	2.65	0.890	0.842	0.273	0.109	0.0045	3.15	5.26	3236
37	404	79	114	208	101	0	2187	19.0	13.4	3.8	23.35	0.0083	0.015203	0.014	0.00508	0.41	0.016	0.291	0.535	74.008	0.066025	0.001	2.65	0.887	0.846	0.272	0.109	0.0045	3.14	5.26	3237
38	404	80	114	208	101	0	2210	19.0	13.8	3.8	24.41	0.0083	0.015730	0.014	0.00525	0.41	0.016	0.300	0.548	75.976	0.067243	0.001	2.69	0.884	0.870	0.272	0.111	0.0046	3.14	5.25	3263
39	404	81	114	207	101	0	2222	19.0	14.0	3.8	24.96	0.0083	0.016010	0.014	0.00535	0.41	0.016	0.304	0.555	77.091	0.06794	0.001	2.71	0.883	0.882	0.271	0.112	0.0046	3.15	5.25	3277
40	404	82	114	207	101	0	2236	19.0	14.2	3.8	25.59	0.0083	0.016325	0.014	0.00545	0.41	0.016	0.309	0.562	78.290	6.87E-02	0.001	2.73	0.882	0.896	0.271	0.112	0.0046	3.15	5.25	3294
41	404	82	114	207	101	0	2241	19.0	14.3	3.8	25.72	0.0083	0.016408	0.014	0.00548	0.41	0.016	0.310	0.564	78.745	6.90E-02	0.001	2.733	0.883	0.900	0.271	0.113	0.0046	3.15	5.24	3299

Table 5-3. Predictions of average annual concentrations for lost seepage combined from the Scavenger Pond and Scavenger Tailings

	Ca	Mg	Na	K	Cl	HCO_3	SO_4	Si	F	NO_3-N	Al	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Se	Ag	Tl	Zn	pH	TDS
Year	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.	mg/L
1	188	56	112	74	51	20	894	17.2	2.5	2.2	0.41	0.0013	0.0021581	0.016	0.000085	0.31	0.000	0.004	0.004	0.171	0.001703	0.0004	0.02	0.218	0.006	0.024	0.004	0.0005	0.22	7.79	1410
2	218	62	124	86	58	20	1014	18.8	2.8	3.0	0.56	0.0016	0.0013251	0.017	0.000049	0.34	0.001	0.007	0.010	0.196	0.001722	0.0005	0.07	0.264	0.011	0.035	0.006	0.0006	0.33	7.79	1598
3	243	62	124	92	61	19	1077	19.0	2.7	4.0	0.55	0.0021	0.0007559	0.017	0.000045	0.35	0.002	0.014	0.024	0.198	0.001724	0.0005	0.22	0.294	0.026	0.055	0.012	0.0008	0.59	7.78	1696
4	269	60	122	102	65	19	1131	19.2	2.7	4.5	0.48	0.0032	0.0004273	0.017	0.000038	0.36	0.004	0.023	0.047	0.199	0.001727	0.0007	0.45	0.352	0.049	0.086	0.021	0.0015	0.99	7.76	1788
5	271	54	116	110	68	18	1108	19.3	2.6	4.3	0.47	0.0050	0.0002492	0.017	0.000037	0.35	0.005	0.029	0.063	0.199	0.001727	0.0009	0.62	0.406	0.065	0.108	0.027	0.0030	1.26	7.76	1765
6	277	50	111	121	70	18	1106	19.3	2.6	4.0	0.44	0.0064	0.0001745	0.017	0.000038	0.35	0.007	0.034	0.077	0.199	0.001728	0.0010	0.76	0.469	0.079	0.129	0.032	0.0041	1.49	7.76	1774
7	297	48	110	139	76	18	1164	19.3	2.6	3.9	0.39	0.0070	0.0001323	0.017	0.000040	0.36	0.008	0.039	0.093	0.199	0.001731	0.0011	0.92	0.551	0.095	0.153	0.039	0.0044	1.76	7.75	1873
8	317	48	111	154	82	17	1224	19.3	2.5	3.9	0.36	0.0075	0.0001067	0.016	0.000041	0.37	0.009	0.042	0.105	0.200	0.001733	0.0011	1.06	0.624	0.108	0.174	0.044	0.0045	1.98	7.73	1975
9	334	48	112	167	86	17	1279	19.3	2.5	3.9	0.33	0.0078	0.0000906	0.016	0.000042	0.38	0.010	0.045	0.116	0.201	0.001736	0.0011	1.17	0.683	0.118	0.191	0.048	0.0045	2.17	7.73	2066
10	346	48	113	176	89	17	1317	19.3	2.4	3.9	0.31	0.0079	0.0000794	0.016	0.000042	0.39	0.011	0.047	0.123	0.201	0.001737	0.0012	1.25	0.722	0.125	0.203	0.051	0.0045	2.29	7.72	2130
11	355	48	114	182	92	17	1346	19.3	2.4	3.9	0.30	0.0081	0.0000719	0.016	0.000043	0.40	0.011	0.049	0.129	0.201	0.001739	0.0012	1.30	0.751	0.131	0.213	0.054	0.0045	2.39	7.71	2176
12	363	48	114	188	94	17	1371	19.3	2.4	4.0	0.29	0.0082	0.0000669	0.016	0.000043	0.40	0.011	0.050	0.134	0.201	0.00174	0.0011	1.35	0.777	0.136	0.223	0.055	0.0045	2.46	7.71	2218
13	370	48	115	193	96	16	1391	19.3	2.4	4.0	0.28	0.0082	0.0000630	0.016	0.000043	0.41	0.012	0.050	0.137	0.202	0.001741	0.0011	1.38	0.797	0.139	0.231	0.057	0.0044	2.51	7.71	2252
14	374	48	115	196	97	16	1405	19.2	2.4	4.0	0.27	0.0083	0.0000596	0.016	0.000043	0.41	0.012	0.051	0.140	0.202	0.001742	0.0011	1.39	0.812	0.142	0.238	0.058	0.0044	2.54	7.70	2275
15	378	48	115	199	98	16	1417	19.2	2.4	4.0	0.27	0.0083	0.0000567	0.016	0.000043	0.41	0.012	0.051	0.142	0.202	0.001742	0.0011	1.41	0.825	0.144	0.244	0.059	0.0044	2.57	7.70	2295
16	382	48	116	202	99	16	1431	19.2	2.4	4.1	0.26	0.0084	0.0000543	0.016	0.000043	0.41	0.012	0.052	0.145	0.202	0.001743	0.0011	1.43	0.837	0.147	0.251	0.060	0.0044	2.60	7.70	2318
17	386	49	116	204	100	16	1442	19.2	2.4	4.1	0.26	0.0084	0.0000521	0.016	0.000043	0.42	0.012	0.052	0.147	0.202	0.001744	0.0011	1.45	0.847	0.149	0.256	0.061	0.0044	2.63	7.70	2337
18	389	49	116	206	101	16	1452	19.2	2.4	4.1	0.26	0.0085	0.0000503	0.016	0.000043	0.42	0.013	0.052	0.150	0.202	0.001744	0.0011	1.46	0.855	0.151	0.260	0.062	0.0044	2.67	7.70	2352
19	392	49	116	207	101	16	1459	19.2	2.4	4.1	0.25	0.0085	0.0000485	0.016	0.000044	0.42	0.013	0.053	0.152	0.202	0.001744	0.0011	1.48	0.863	0.153	0.263	0.062	0.0044	2.70	7.70	2365
20	394	49	117	209	102	16	1466	19.2	2.4	4.1	0.25	0.0086	0.0000470	0.016	0.000044	0.42	0.013	0.053	0.153	0.203	0.001745	0.0011	1.50	0.869	0.155	0.265	0.063	0.0044	2.73	7.69	2376
21	396	49	117	210	102	16	1473	19.2	2.3	4.1	0.25	0.0086	0.0000455	0.016	0.000044	0.42	0.013	0.053	0.155	0.203	0.001745	0.0011	1.51	0.876	0.156	0.267	0.064	0.0044	2.76	7.69	2387
22	398	49	117	212	103	16	1481	19.2	2.3	4.1	0.25	0.0086	0.0000444	0.016	0.000045	0.42	0.013	0.054	0.156	0.203	0.001746	0.0011	1.53	0.883	0.158	0.268	0.064	0.0043	2.79	7.69	2400
23	401	49	117	214	104	16	1489	19.2	2.3	4.1	0.24	0.0086	0.0000432	0.016	0.000045	0.42	0.013	0.054	0.157	0.203	0.001746	0.0011	1.54	0.891	0.159	0.270	0.065	0.0043	2.82	7.69	2413
24	403	49	118	215	104	16	1496	19.2	2.3	4.1	0.24	0.0086	0.0000424	0.016	0.000045	0.43	0.013	0.054	0.158	0.203	0.001746	0.0011	1.56	0.898	0.160	0.271	0.065	0.0043	2.84	7.69	2426
25	405	49	118	217	105	16	1503	19.2	2.3	4.1	0.24	0.0086	0.0000413	0.016	0.000046	0.43	0.013	0.055	0.159	0.203	0.001747	0.0011	1.58	0.904	0.161	0.271	0.066	0.0043	2.86	7.69	2437
26	406	49	118	218	105	16	1509	19.2	2.3	4.1	0.24	0.0086	0.0000404	0.016	0.000046	0.43	0.014	0.055	0.160	0.203	0.001747	0.0011	1.59	0.908	0.162	0.272	0.066	0.0042	2.88	7.69	2445
27	407	49	118	218	106	16	1512	19.2	2.3	4.0	0.24	0.0086	0.0000397	0.016	0.000046	0.43	0.014	0.055	0.161	0.203	0.001747	0.0011	1.60	0.911	0.163	0.272	0.066	0.0042	2.89	7.69	2451
28	408	49	118	219	106	16	1515	19.2	2.3	4.0	0.24	0.0086	0.0000387	0.016	0.000047	0.43	0.014	0.056	0.161	0.203	0.001747	0.0011	1.61	0.914	0.163	0.272	0.066	0.0042	2.89	7.69	2455
29	409	49	118	219	106	16	1517	19.2	2.3	4.0	0.24	0.0087	0.0000379	0.016	0.000047	0.43	0.014	0.056	0.161	0.203	0.001747	0.0011	1.62	0.917	0.164	0.273	0.067	0.0042	2.89	7.69	2459
30	409	49	118	220	106	16	1518	19.2	2.3	4.0	0.24	0.0087	0.0000372	0.016	0.000047	0.43	0.014	0.056	0.162	0.203	0.001747	0.0011	1.62	0.918	0.164	0.274	0.067	0.0042	2.88	7.69	2461
31	409	49	118	220	106	16	1518	19.2	2.3	4.0	0.23	0.0087	0.0000365	0.016	0.000047	0.43	0.014	0.056	0.162	0.203	0.001748	0.0011	1.62	0.918	0.164	0.276	0.067	0.0043	2.87	7.69	2461
32	409	49	118	219	106	16	1516	19.2	2.3	4.0	0.24	0.0087	0.0000361	0.016	0.000047	0.43	0.014	0.056	0.161	0.203	0.001747	0.0011	1.62	0.917	0.164	0.276	0.067	0.0043	2.85	7.69	2458
33	407	49	118	219	106	16	1513	19.2	2.3	3.9	0.24	0.0087	0.0000359	0.016	0.000047	0.43	0.013	0.055	0.161	0.203	0.001747	0.0011	1.61	0.913	0.163	0.276	0.066	0.0043	2.83	7.69	2452
34	406	49	118	217	105	16	1509	19.2	2.3	3.9	0.24	0.0086	0.0000357	0.016	0.000047	0.43	0.013	0.055	0.160	0.203	0.001747	0.0011	1.60	0.908	0.162	0.275	0.066	0.0043	2.80	7.69	2445
35	405	49	118	216	105	16	1504	19.2	2.3	3.9	0.24	0.0086	0.0000356	0.016	0.000047	0.43	0.013	0.055	0.159	0.203	0.001747	0.0011	1.59	0.903	0.162	0.275	0.066	0.0043	2.79	7.69	2438
36	403	49	118	215	104	16	1498	19.2	2.3	3.9	0.24	0.0086	0.0000399	0.016	0.000049	0.43	0.013	0.055	0.158	0.203	0.001747	0.0011	1.58	0.897	0.161	0.273	0.065	0.0042	2.76	7.69	2428
37	403	49	118	215	104	16	1500	19.2	2.3	3.9	0.24	0.0086	0.0000321	0.016	0.000045	0.43	0.013	0.055	0.158	0.203	0.001747	0.0011	1.58	0.896	0.161	0.273	0.065	0.0043	2.76	7.69	2429
38	403	49	118	214	104	16	1498	19.2	2.3	3.9	0.24	0.0086	0.0000333	0.016	0.000046	0.43	0.013	0.054	0.157	0.203	0.001746	0.0011	1.57	0.893	0.160	0.273	0.065	0.0042	2.75	7.69	2426
39	402	49	118	214	104	16	1495	19.2	2.3	3.9	0.24	0.0085	0.0000371	0.016	0.000049	0.42	0.013	0.054	0.157	0.203	0.001746	0.0011	1.57	0.891	0.160	0.272	0.065	0.0042	2.75	7.69	2421
40	401	49	117	213	104	16	1492	19.2	2.3	3.9	0.24	0.0085	0.0000423	0.01586	0.000051	0.42	0.0131	0.0542	0.1567	0.203	1.75E-03	0.0011	1.565	0.88902	0.15962	0.27133	0.06461	0.00423	2.74	7.69	2417
41	400	49	117	213	104	16	1489	19.1	2.3	3.87	0.242	0.008510	0.0000472	0.015865	0.000053	0.42	0.01303	0.0541	0.1564	0.203	1.75E-03	1.1E-03	1.6E+00	8.9E-01	1.6E-01	2.7E-01	6.4E-02	4.2E-03	2.7E+00	7.69	2412

Table 5-4 Predictions of average annual concentrations for Surplus Water

	Ca	Mg	Na	K	Cl	HCO_3	SO_4	Si	F	NO_3-N	Al	Sb	As	Ba	Be	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Mo	Ni	Se	Ag	Tl	Zn	pH	TDS
Year	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	s.u.	mg/L
1	206	63	123	80	56	14	1002	18.6	2.9	2.2	0.33	0.0014	2.46E-03	0.017	0.00022	0.34	0.001	0.012	0.018	0.208	0.001773	0.00048	0.06	0.239	0.029	0.026	0.006	0.0006	0.25	7.62	1561
2	231	64	121	90	60	6	1098	18.8	2.9	4.3	0.12	0.0018	1.96E-03	0.017	0.00058	0.34	0.002	0.037	0.058	0.689	0.003497	0.00046	0.27	0.299	0.092	0.050	0.014	0.0007	0.52	6.99	1694
3	293	65	119	92	63	2	1281	18.9	3.4	5.6	0.43	0.0033	0.0028	0.016	0.00091	0.36	0.006	0.070	0.125	6.357	0.013174	0.0008	0.78	0.332	0.179	0.102	0.034	0.0014	1.32	6.17	1953
4	291	57	110	117	73	2	1263	19.1	3.8	4.8	0.69	0.0055	0.0033	0.016	0.00107	0.35	0.008	0.085	0.160	9.554	0.016861	0.0010	1.06	0.469	0.225	0.137	0.044	0.0032	1.70	6.06	1954
5	240	44	94	110	64	2	1047	19.1	3.6	3.4	0.51	0.0086	0.0028	0.017	0.00093	0.32	0.008	0.077	0.149	5.848	0.01251	0.0013	0.99	0.459	0.205	0.133	0.041	0.0065	1.59	6.21	1636
6	315	54	104	152	81	1	1399	19.1	5.5	3.7	1.65	0.0081	0.0052	0.016	0.00170	0.36	0.011	0.123	0.238	22.935	0.029104	0.0013	1.51	0.654	0.341	0.186	0.062	0.0052	2.25	5.83	2164
7	343	58	106	171	88	1	1563	19.0	6.7	3.7	2.50	0.0082	0.0069	0.015	0.00226	0.38	0.012	0.153	0.293	35.161	0.047382	0.0013	1.78	0.745	0.430	0.210	0.072	0.0049	2.54	5.60	2403
8	370	64	107	187	94	0	1758	19.0	8.5	3.8	4.66	0.0082	0.0095	0.015	0.00313	0.39	0.013	0.196	0.371	50.785	0.2396	0.0013	2.10	0.826	0.560	0.232	0.079	0.0046	2.83	5.08	2675
9	384	70	108	190	97	0	1909	19.0	10.3	3.8	6.58	0.0080	0.0121	0.015	0.00397	0.40	0.014	0.237	0.441	65.754	0.66368	0.0013	2.35	0.852	0.682	0.246	0.082	0.0043	3.01	4.80	2872
10	381	69	108	188	96	0	1892	19.0	10.1	3.9	6.42	0.0082	0.0119	0.015	0.00392	0.40	0.014	0.234	0.438	64.751	0.6238	0.0013	2.33	0.842	0.676	0.249	0.082	0.0045	2.99	4.79	2847
11	390	77	108	190	98	0	2077	19.0	12.9	3.9	9.19	0.0081	0.0157	0.014	0.00516	0.40	0.015	0.293	0.536	86.677	1.5772	0.0013	2.63	0.870	0.849	0.263	0.083	0.0044	3.14	4.58	3082
12	392	81	107	190	99	0	2172	19.0	14.5	4.0	10.84	0.0079	0.0178	0.014	0.00587	0.40	0.016	0.325	0.589	99.175	2.3314	0.0013	2.75	0.878	0.946	0.270	0.083	0.0044	3.14	4.53	3201
13	395	85	109	189	99	0	2244	19.0	15.7	4.1	11.94	0.0078	0.0192	0.014	0.00633	0.40	0.016	0.346	0.623	107.110	2.848	0.0012	2.83	0.878	1.008	0.277	0.083	0.0043	3.13	4.47	3291
14	388	80	107	188	98	0	2136	19.0	14.3	3.9	10.47	0.0082	0.0172	0.014	0.00569	0.40	0.015	0.316	0.575	96.098	2.1098	0.0012	2.65	0.869	0.921	0.279	0.083	0.0047	3.02	4.51	3152
15	404	90	108	190	100	0	2386	19.0	17.7	4.0	14.07	0.0080	0.0219	0.014	0.00725	0.40	0.017	0.390	0.699	123.170	4.0911	0.0012	3.05	0.895	1.140	0.294	0.083	0.0044	3.25	4.35	3470
16	409	95	108	188	100	0	2487	19.0	19.3	4.0	15.76	0.0080	0.0240	0.014	0.00795	0.40	0.017	0.424	0.755	135.260	5.1171	0.0013	3.24	0.898	1.239	0.297	0.084	0.0045	3.38	4.30	3595
17	408	94	108	187	100	0	2478	19.0	19.2	4.0	15.65	0.0082	0.0238	0.014	0.00789	0.40	0.018	0.422	0.753	134.250	5.0236	0.0013	3.25	0.893	1.233	0.293	0.084	0.0046	3.46	4.29	3583
18	411	98	108	186	100	0	2562	18.9	20.6	3.9	17.00	0.0083	0.0257	0.014	0.00850	0.40	0.018	0.451	0.801	144.740	5.9316	0.0014	3.41	0.898	1.319	0.292	0.084	0.0047	3.62	4.20	3687
19	411	102	107	184	100	0	2663	18.9	22.4	3.7	18.89	0.0083	0.0281	0.014	0.00930	0.40	0.019	0.490	0.862	158.460	7.2994	0.0015	3.61	0.902	1.429	0.288	0.084	0.0048	3.71	4.17	3809
20	410	104	107	184	100	0	2690	18.9	22.9	4.1	19.46	0.0083	0.0287	0.014	0.00953	0.40	0.019	0.501	0.876	162.350	7.6863	0.0015	3.66	0.904	1.458	0.280	0.084	0.0049	3.70	4.17	3842
21	417	117	107	182	101	0	2968	18.9	27.3	3.9	23.99	0.0080	0.0347	0.014	0.01151	0.40	0.020	0.595	1.025	196.210	11.443	0.0016	4.13	0.923	1.728	0.278	0.084	0.0047	3.88	4.04	4187
22	421	129	106	177	101	0	3236	18.9	31.7	3.6	28.55	0.0077	0.0408	0.013	0.01353	0.40	0.020	0.690	1.176	230.680	15.573	0.0017	4.59	0.930	2.003	0.275	0.085	0.0046	4.04	3.90	4514
23	422	134	106	175	101	0	3346	18.9	33.5	3.7	30.48	0.0075	0.0433	0.013	0.01437	0.40	0.021	0.730	1.238	245.080	17.417	0.0018	4.78	0.932	2.116	0.272	0.085	0.0046	4.07	3.89	4648
24	424	137	106	174	101	0	3403	18.9	34.4	3.8	31.42	0.0076	0.0445	0.013	0.01476	0.40	0.021	0.749	1.268	251.850	18.437	0.0018	4.90	0.933	2.172	0.272	0.085	0.0046	4.12	3.91	4720
25	425	138	106	173	101	0	3419	18.9	34.6	3.6	31.62	0.0076	0.0448	0.013	0.01486	0.40	0.021	0.754	1.277	253.460	18.613	0.0018	4.94	0.933	2.186	0.271	0.085	0.0047	4.14	3.90	4738
26	419	117	110	181	101	0	2958	18.9	26.9	3.6	23.51	0.0079	0.0340	0.014	0.01130	0.41	0.019	0.588	1.007	192.700	10.959	0.0017	4.16	0.916	1.699	0.262	0.084	0.0046	3.82	4.00	4175
27	414	115	108	181	101	0	2915	18.9	26.5	3.8	23.13	0.0081	0.0335	0.014	0.01113	0.40	0.019	0.579	0.993	189.720	10.641	0.0017	4.12	0.916	1.675	0.261	0.084	0.0048	3.76	4.03	4120
28	416	120	107	180	101	0	3029	18.9	28.4	3.8	25.17	0.0080	0.0361	0.014	0.01201	0.40	0.019	0.620	1.059	204.800	12.442	0.0016	4.29	0.923	1.795	0.274	0.084	0.0048	3.71	4.01	4261
29	414	113	108	182	101	0	2888	18.9	26.1	3.4	22.73	0.0082	0.0329	0.014	0.01093	0.40	0.018	0.568	0.980	186.500	10.293	0.0014	4.03	0.915	1.650	0.292	0.084	0.0049	3.50	4.06	4086
30	410	107	108	181	100	0	2754	18.9	23.9	3.1	20.47	0.0083	0.0300	0.014	0.00996	0.40	0.018	0.521	0.906	169.970	8.351	0.0013	3.77	0.899	1.517	0.303	0.084	0.0050	3.30	4.06	3917
31	401	102	109	181	98	0	2618	18.9	21.9	3.1	18.41	0.0082	0.0272	0.014	0.00906	0.40	0.017	0.476	0.830	154.550	6.741	0.0012	3.47	0.880	1.386	0.296	0.084	0.0050	3.09	4.14	3743
32	378	95	110	166	93	0	2378	19.0	19.0	3.3	15.42	0.0077	0.0232	0.014	0.00772	0.39	0.015	0.409	0.715	131.630	4.4631	0.0011	2.99	0.794	1.190	0.276	0.083	0.0048	2.69	4.24	3422
33	351	90	110	148	88	0	2187	19.0	17.2	3.0	13.49	0.0073	0.0207	0.014	0.00688	0.38	0.013	0.365	0.636	116.890	3.0566	0.0010	2.62	0.701	1.060	0.254	0.082	0.0047	2.34	4.30	3155
34	336	89	107	131	78	0	2119	19.0	17.0	3.5	13.15	0.0068	0.0203	0.014	0.00675	0.36	0.012	0.356	0.617	114.660	2.6622	0.0009	2.47	0.622	1.033	0.238	0.082	0.0045	2.13	4.27	3037
35	309	87	106	108	71	0	1980	19.0	16.1	3.2	12.10	0.0062	0.0189	0.014	0.00630	0.35	0.010	0.330	0.567	106.840	1.8642	0.0008	2.20	0.510	0.957	0.209	0.082	0.0043	1.82	4.34	2828
36	287	86	103	89	60	0	1892	19.0	15.9	2.4	11.76	0.0057	0.0185	0.014	0.00616	0.33	0.009	0.320	0.543	104.430	1.4662	0.0008	2.04	0.420	0.925	0.178	0.082	0.0041	1.62	4.38	2679
37	236	84	97	53	47	0	1694	17.8	14.9	1.4	10.50	0.0047	0.0181	0.015	0.00611	0.29	0.007	0.296	0.494	99.629	0.90911	0.0007	1.73	0.255	0.858	0.113	0.072	0.0038	1.23	4.52	2362
38	197	85	98	30	40	0	1578	17.8	14.9	1.1	10.18	0.0039	0.0179	0.015	0.00604	0.28	0.005	0.281	0.459	97.823	0.62833	0.0009	1.46	0.137	0.819	0.045	0.060	0.0036	0.86	4.58	2175
39	179	86	97	17	38	0	1561	17.7	15.7	1.0	11.21	0.0037	0.0192	0.015	0.00640	0.26	0.004	0.292	0.477	103.730	0.73332	0.0014	1.47	0.085	0.857	0.027	0.060	0.0037	0.77	4.55	2132
40	175	87	97	10	36	0	1569	17.6	15.7	1.0	11.60	0.0036	0.0287	0.015	0.00657	0.26	0.004	0.298	0.486	106.250	7.52E-01	0.0027	1.49	0.054	0.875	0.019	0.060	0.0037	0.75	4.57	2132
41	174	88	97	6	35	0	1581	17.5	15.7	0.9	11.95	0.0036	0.0361	0.015	0.00683	0.26	0.004	0.302	0.493	107.970	7.05E-01	0.0040	1.51	0.038	0.889	0.016	0.061	0.0037	0.75	4.58	2141

6 REFERENCES

Cravotta, C.A., D.L. Parkhurst, B. Means, R. McKenzie, H. Morris, and W. Arthur (2010) A geochemical module for “AMDTreat” to compute caustic quantity, effluent quality, and sludge volume. 2010 National Meeting of the American Society of Mining and Reclamation, Pittsburgh, PA Bridging Reclamation, Science and the Community June 5 - 11, 2010. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, Kentucky.

Enchemica (2018) Water Chemistry Inputs for Operational Models of Tailings Circuit Solute Chemistry. Draft Technical Memo from T. Eary (Enchemica) to V. Peacey (Resolution Copper), July 18, 2018.

KCB (2018) DEIS Design for Alternative 4 – Silver King Filtered, Draft Technical Memorandum, Klohn Crippen Berger, May 4, 2018.

Parkhurst, D.L. and Appelo, C.A.J. (2013) Description of Input and Examples for PHREEQC Version 3 – A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations. U.S. Geological Survey Techniques and Methods, Book 6, Chapter A43, 497 p, available only at http://pubs.usgs.gov/tm/06/a43.

Duke (2017) Geochemical Reactivity of Unsaturated Pyrite Tailings. Memo from K. Duke (Duke HydroGeochem) to H. Gluski (Resolution) and M. Wickham (Wickham GeoGroup), March 3, 2017.

RESOLUTION
COPPER

102 Magma Heights – P.O. Box 1944
Superior, AZ 85173
Tel.: 520.689.9374
Fax: 520.689.9304

July 20, 2018

Ms. Mary Rasmussen
US Forest Service
Supervisor's Office
2324 East McDowell Road
Phoenix, AZ 85006-2496

Subject: Response to Analysis Data Request #1 – Request for Analysis of Tailings Seepage – Item #2 Tailings Solute Modeling.

Dear Ms. Rasmussen,

In partial response to your letter dated March 8, 2018, the following documents are attached as requested:

2. **Tailings Solute Modeling**: It is our understanding that the water balance and geochemical modeling for tailings solute is being updated, specific to each alternative tailings storage facility, and including specific analysis of oxidation potential of the embankment. There is an expectation that modeling would cover both operational and post-closure time frames.

Request: RCM to provide USFS with block cave geochemical modeling.

RCM Response: As requested, please see the attached technical memorandums by Enchemica dated July 17, 2018 for the following tailing storage facilities (TSF):

- *Alternative 2 - Near West Modified Proposed Action: Prediction of Operational Tailings Circuit Solute Chemistry*
- *Alternative 3 - Near West Modified Proposed Action – Thin Lift/PAG Cell: Prediction of Operational Tailings Circuit Solute Chemistry*
- *Alternative 4 - Silver King Filtered: Prediction of Operational Tailings Circuit Solute Chemistry*
- *Alternative 5 - Peg Leg: Prediction of Operational Tailings Circuit Solute Chemistry*
- *Alternative 6 - Skunk Camp: Prediction of Operational Tailings Circuit Solute Chemistry*
- *Common Inputs Common to All Operational Models of Tailings Circuit Solute Chemistry*

Overall, there are no substantive differences in predictive solute chemistry for the alternative TSF sites with the exception of Alternative 4 (Silver King). The solute balances are useful tools for TSF alternatives comparison, but it is also worth noting that the model likely over predicts solute chemistry due to several conservative assumptions:

1. No mitigations have been applied to the water chemistry
2. Water from the block cave mine, which has the poorest water quality and highest solute load, has first priority to meet the water demand at the West Plant (concentrator).
3. Makeup water needed at the end of the operational period are sourced from the Pyrite Pond and water from the block cave. The decrease in the amount of freshwater makeup results in less dilution of the combined effects of evaporation and inflow of chemical loads from the block cave.

Once a selected TSF has been identified, additional mitigation approaches may be incorporated as needed.

Sincerely,

Vicky Peacey,

Senior Manager, Environment, Permitting and Approvals; Resolution Copper Company, as Manager of Resolution Copper Mining, LLC

Cc: Ms. Mary Morissette; Senior Environmental Specialist; Resolution Copper Company

Enclosure(s)

Technical Memorandum by Enchemica (2018), *Alternative 2 - Near West Modified Proposed Action: Prediction of Operational Tailings Circuit Solute Chemistry*

Technical Memorandum by Enchemica (2018), *Alternative 3 - Near West Modified Proposed Action – Thin Lift/PAG Cell: Prediction of Operational Tailings Circuit Solute Chemistry*

Technical Memorandum by Enchemica (2018), *Alternative 4 - Silver King Filtered: Prediction of Operational Tailings Circuit Solute Chemistry*

Technical Memorandum by Enchemica (2018), *Alternative 5 - Peg Leg: Prediction of Operational Tailings Circuit Solute Chemistry*

Technical Memorandum by Enchemica (2018), *Alternative 6 - Skunk Camp: Prediction of Operational Tailings Circuit Solute Chemistry*

Technical Memorandum by Enchemica (2018), *Common Inputs Common to All Operational Models of Tailings Circuit Solute Chemistry*