Enchemica

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

TECHNICAL MEMORANDUM

TO: Vicky Peacey, Resolution Copper

FROM: Ted Eary, Enchemica

DATE: July 17, 2018

SUBJECT: Alternative 2 - Near West Modified Proposed Action: 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 2.

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 included 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 1-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 2 was developed by KCB. 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 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 four sources of water for ore processing:

- **Reclaim water**: For the first 9 years of operation, excess water from the Scavenger Pond will be pumped to the Pyrite Pond. Excess water in the Pyrite Pond will be pumped to West Plant as reclaim. After 9 years, the scavenger pond will be eliminated and reclaim will be pumped from the Pyrite Pond. The reclaim flows are 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 beyond the flow 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. Freshwater makeup is generally the largest water source for ore processing followed by reclaim water, block cave sump water, and ore moisture. At certain times the model indicates low flows of overflow water, such as near the end of mining when the available water as reclaim water and block cave sump water are exceed what would be needed for ore processing at the West Plant.

Each of the makeup water sources has a different chemical composition. The details about the chemical compositions of makeup water are provided in Enchemica (2018).

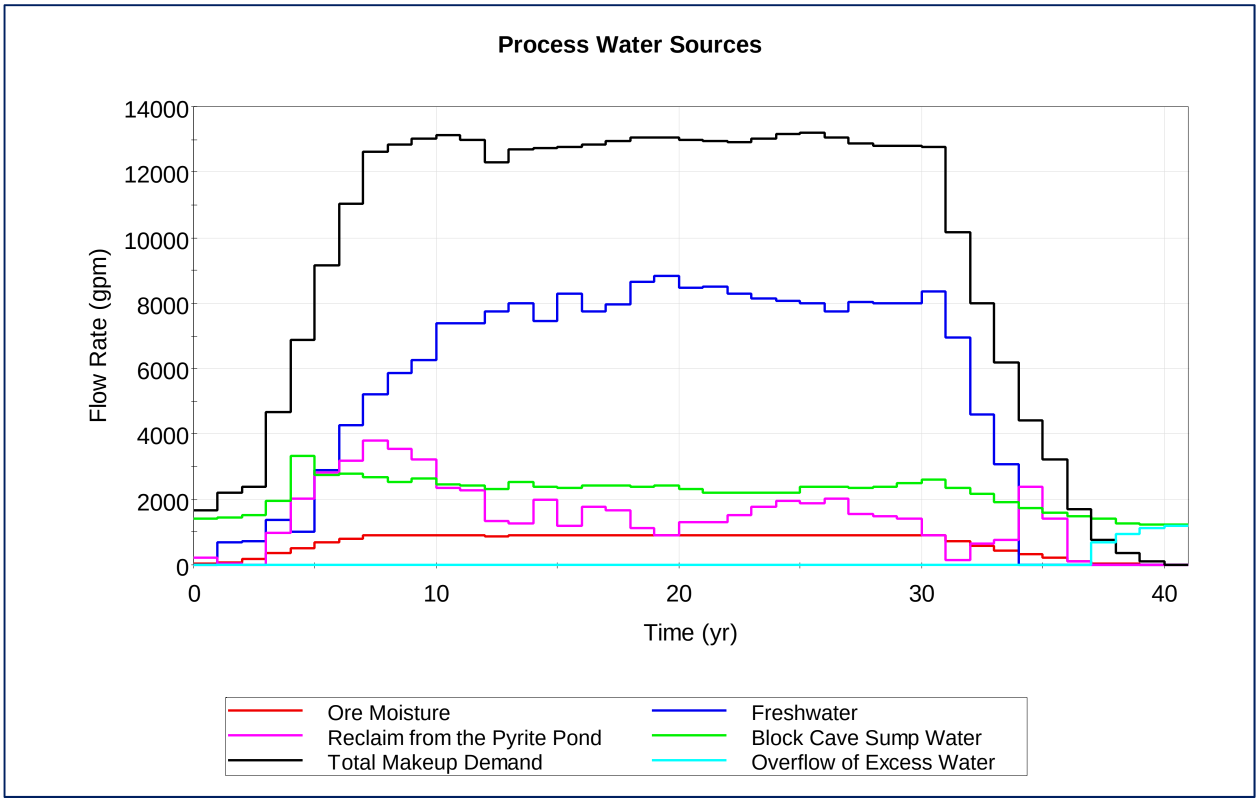

Figure 3-1. Simulation results for process water sources

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 six locations where PHREEQC is applied to produced equilibrated water chemistries:
  - **West Plant**: mixture of water entering the Plant
  - **Pyrite Pond**: storage of water over the pyrite tailings used for reclaim to the West Plant
  - **Scavenger Pond**: this pond only exists for the first 10 years before merging with the Pyrite Pond
  - **Embankment**: water contained in the pore space of the embankment
  - **Seepage Collection Ponds**: the water balance lumps all seepage collections ponds into a single water reservoir. Predictions of water chemistry are made for this single reservoir.
  - **Lost Seepage**: seepage from scavenger and pyrite tailings that bypasses seepage collection systems and is lost to the underlying foundation. 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.

- Equilibrated water chemistries are multiplied by flow rates to move chemical loads through the water distribution system.

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: Seepage Collection Ponds
- Table 5-3: Embankment
- Table 5-4: Lost Seepage

5.1 Lost Seepage

Examples of model results are shown in Figure 5-1 for Lost Seepage as average annual concentrations for the 41-year operational mine life. Lost Seepage represents flows from deposited tailings that bypass collection systems and enter the bedrock foundation. The following observations are made for Lost Seepage water chemistry based on the model predictions:

- Figure 5-1a - pH: The pH is predicted to range between about 7.7 and 7.9 for the entirety of the 41-year operational mine life.
- Figure 5-1b – major anions: Sulfate is the dominant anion at concentrations from 960 to 2400 mg/L. Chloride is next in importance with concentrations from 85 to 300 mg/L followed by HCO_3 at concentrations from 18 to 22 mg/L, NO_3-N at concentrations from 3.5 to 8.8 mg/L, and F at concentrations from 2.4 to 2.7 mg/L.
- Figure 5-1c – divalent metals: Zinc is predicted to have the highest concentrations, ranging between 0.6 and 3.6 mg/L. Copper concentrations are predicted to be relatively constant at about 0.2 to 0.3 mg/L due to equilibrium with malachite. Concentrations of the other divalent metals are not limited by solubility. Nickel and cobalt are predicted to range from 0.1 to 0.3 mg/L. Cadmium and lead are predicted to be less than 0.016 and 0.003 mg/L, respectively.
- Figure 5-1d: anionic metals and metalloids: Molybdenum concentrations are the highest for this group at concentrations from 0.4 to 1.2 mg/L. Selenium is next at concentrations from 0.1 to 0.35 mg/L. Arsenic concentrations lower but variable at concentrations less than 0.002 mg/L.

The trends shown in Figure 5-1 are due to the following factors:

- Concentrations of most solutes start out lowest during the early years due to low rates of ore production and a relatively higher amount of freshwater makeup during the initial period of operation.
- Most solutes show a jump in concentrations at years 9 to 10. These increases are due to the end of reclaim from the Scavenger Pond to the Pyrite Pond and beginning of operation of the single Pyrite Pond.
- Concentrations of most solutes increase during the early years of operations due to evaporation and then tend to remain relatively constant (years 10 to 30) as the ratio of freshwater makeup balances the evaporative losses.
- Concentrations of most solutes predicted to increase slowly toward the end of operations. The increases are due to a decrease in the amount of freshwater makeup needed at the end of the operational period because much of the water requirement for ore processing can be satisfied by reclaim 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.

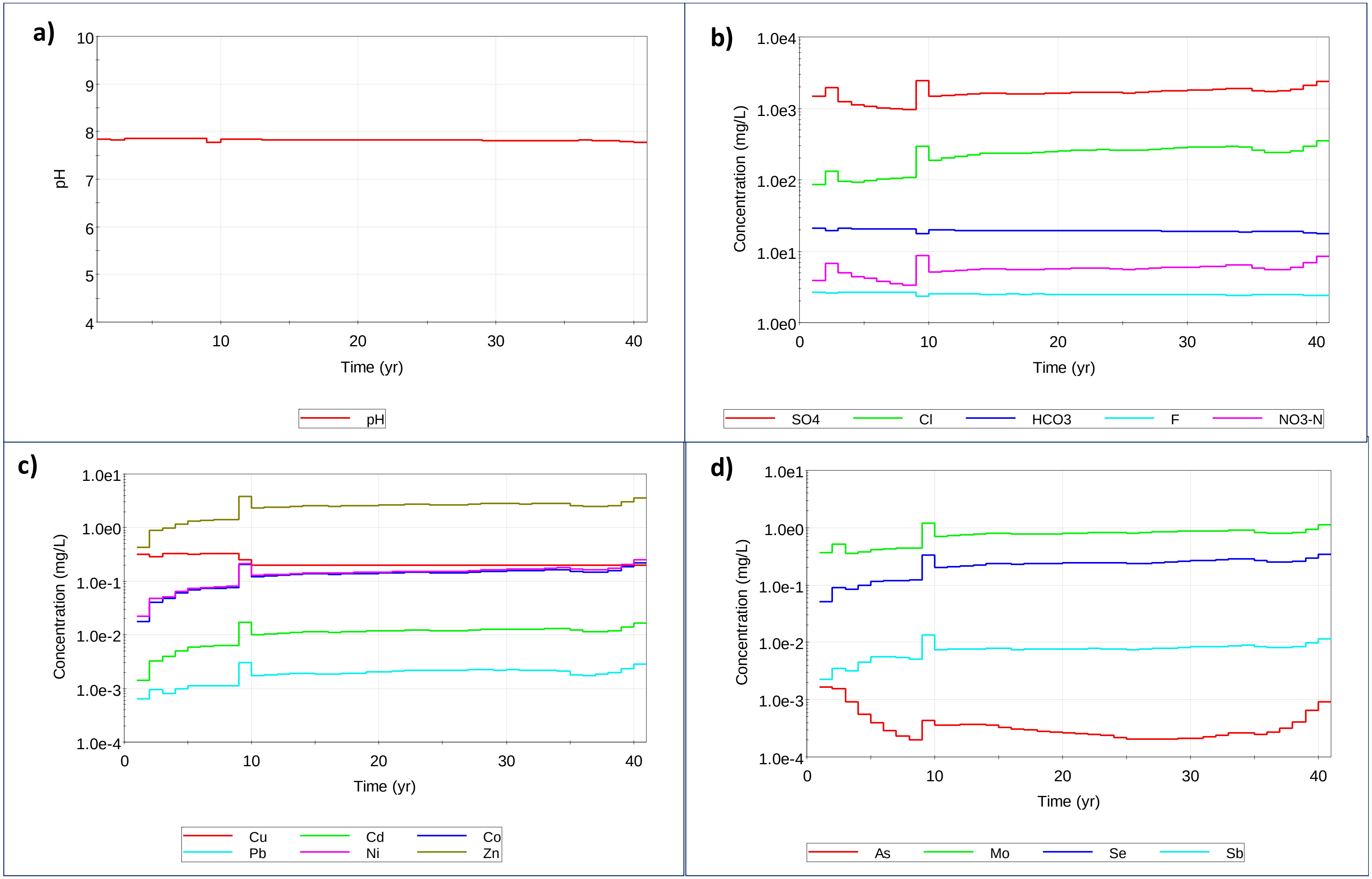

Figure 5-1. Predictions of average annual concentrations in Lost Seepage for a) pH, b) major anions, c) divalent metals, and d) anionic metals and metalloids

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	249	68	141	96	59	25	1154	15.1	2.5	4.0	0.90	0.0020	0.00175	0.016	0.00054	0.24	0.002	0.012	0.022	0.195	0.001718	0.0005	0.20	0.292	0.025	0.049	0.010	0.0008	0.24	7.90	1803
2	298	85	174	118	83	24	1405	19.2	2.7	4.6	0.70	0.0023	0.00251	0.016	0.00033	0.42	0.002	0.012	0.018	0.195	0.001719	0.0006	0.15	0.359	0.022	0.052	0.010	0.0009	0.41	7.87	2203
3	346	94	196	131	108	23	1579	19.3	2.6	6.3	0.60	0.0030	0.00238	0.016	0.00031	0.51	0.003	0.021	0.036	0.196	0.00172	0.0008	0.33	0.415	0.040	0.079	0.017	0.0012	0.80	7.85	2498
4	351	88	189	131	119	23	1539	19.3	2.6	6.4	0.58	0.0039	0.00172	0.016	0.00026	0.50	0.005	0.030	0.057	0.196	0.00172	0.0010	0.55	0.439	0.062	0.104	0.025	0.0018	1.18	7.85	2461
5	300	68	155	119	109	24	1268	19.3	2.6	5.3	0.70	0.0053	0.00109	0.016	0.00018	0.42	0.006	0.034	0.068	0.195	0.001718	0.0012	0.67	0.431	0.072	0.115	0.029	0.0032	1.34	7.86	2063
6	292	62	145	124	111	24	1209	19.4	2.6	4.8	0.71	0.0065	0.00066	0.017	0.00015	0.41	0.007	0.038	0.079	0.195	0.001718	0.0013	0.78	0.472	0.083	0.130	0.033	0.0042	1.52	7.87	1987
7	283	58	141	126	119	24	1158	19.4	2.6	4.4	0.73	0.0063	0.00051	0.017	0.00013	0.39	0.007	0.040	0.084	0.195	0.001718	0.0013	0.84	0.492	0.088	0.136	0.034	0.0040	1.60	7.87	1929
8	282	56	141	130	127	24	1143	19.4	2.6	4.2	0.73	0.0062	0.00038	0.017	0.00012	0.39	0.007	0.042	0.088	0.195	0.001718	0.0013	0.88	0.514	0.092	0.143	0.036	0.0037	1.67	7.87	1923
9	289	58	147	137	138	24	1169	19.3	2.6	4.2	0.70	0.0062	0.00033	0.017	0.00012	0.40	0.008	0.044	0.093	0.195	0.001718	0.0014	0.94	0.545	0.098	0.152	0.038	0.0036	1.77	7.87	1980
10	335	67	172	161	167	23	1360	19.3	2.6	4.8	0.58	0.0071	0.00034	0.016	0.00014	0.47	0.009	0.052	0.112	0.196	0.00172	0.0016	1.13	0.648	0.117	0.182	0.045	0.0040	2.11	7.85	2306
11	357	73	190	174	189	22	1459	19.3	2.5	5.1	0.53	0.0075	0.00036	0.016	0.00016	0.51	0.010	0.057	0.121	0.196	0.00172	0.0018	1.22	0.699	0.127	0.199	0.049	0.0041	2.29	7.84	2485
12	367	76	199	179	202	22	1503	19.3	2.5	5.3	0.51	0.0075	0.00036	0.016	0.00017	0.52	0.011	0.059	0.126	0.196	0.001721	0.0018	1.26	0.724	0.132	0.209	0.051	0.0041	2.36	7.83	2570
13	374	78	207	184	213	22	1537	19.3	2.5	5.4	0.50	0.0076	0.00037	0.016	0.00018	0.54	0.011	0.060	0.129	0.196	0.001721	0.0018	1.29	0.741	0.135	0.216	0.052	0.0040	2.40	7.83	2637
14	383	81	215	189	223	22	1578	19.3	2.5	5.5	0.49	0.0077	0.00037	0.016	0.00019	0.56	0.011	0.062	0.132	0.197	0.001721	0.0019	1.31	0.762	0.139	0.224	0.054	0.0041	2.45	7.83	2713
15	394	83	222	194	232	22	1622	19.3	2.5	5.7	0.47	0.0079	0.00036	0.016	0.00020	0.57	0.011	0.064	0.137	0.197	0.001722	0.0019	1.35	0.786	0.144	0.234	0.055	0.0041	2.52	7.83	2792
16	394	84	224	195	235	22	1624	19.3	2.5	5.7	0.47	0.0078	0.00033	0.016	0.00020	0.57	0.011	0.064	0.138	0.197	0.001722	0.0019	1.35	0.788	0.145	0.237	0.056	0.0040	2.53	7.83	2800
17	382	82	219	188	232	22	1575	19.3	2.5	5.5	0.49	0.0075	0.00030	0.016	0.00020	0.56	0.011	0.063	0.134	0.196	0.001721	0.0019	1.31	0.763	0.141	0.232	0.054	0.0039	2.46	7.83	2723
18	387	83	223	191	237	22	1596	19.3	2.5	5.6	0.48	0.0076	0.00029	0.016	0.00020	0.57	0.011	0.064	0.138	0.197	0.001722	0.0019	1.34	0.774	0.145	0.237	0.055	0.0039	2.52	7.83	2762
19	388	84	225	191	241	22	1600	19.3	2.5	5.5	0.48	0.0076	0.00028	0.016	0.00020	0.57	0.012	0.064	0.139	0.197	0.001722	0.0019	1.35	0.776	0.146	0.238	0.056	0.0038	2.55	7.83	2774
20	391	85	229	193	247	22	1615	19.3	2.5	5.6	0.47	0.0076	0.00027	0.016	0.00021	0.58	0.012	0.065	0.140	0.197	0.001722	0.0020	1.37	0.783	0.147	0.239	0.056	0.0038	2.59	7.83	2805
21	397	87	234	196	253	22	1642	19.3	2.5	5.7	0.46	0.0077	0.00026	0.016	0.00022	0.59	0.012	0.067	0.142	0.197	0.001722	0.0021	1.39	0.797	0.150	0.242	0.057	0.0039	2.64	7.83	2854
22	402	88	238	199	258	22	1664	19.3	2.5	5.8	0.46	0.0077	0.00026	0.016	0.00022	0.60	0.012	0.068	0.144	0.197	0.001722	0.0021	1.42	0.809	0.152	0.244	0.058	0.0038	2.68	7.82	2894
23	407	89	242	202	263	22	1687	19.3	2.5	5.8	0.45	0.0078	0.00025	0.016	0.00023	0.61	0.012	0.069	0.146	0.197	0.001722	0.0022	1.45	0.821	0.154	0.246	0.059	0.0038	2.72	7.82	2936
24	406	89	242	202	263	22	1683	19.3	2.5	5.8	0.45	0.0077	0.00024	0.016	0.00023	0.60	0.012	0.069	0.146	0.197	0.001722	0.0022	1.45	0.820	0.154	0.244	0.058	0.0037	2.71	7.82	2930
25	401	88	239	200	261	22	1663	19.3	2.5	5.7	0.46	0.0075	0.00022	0.016	0.00022	0.60	0.012	0.068	0.144	0.197	0.001722	0.0022	1.44	0.811	0.152	0.240	0.058	0.0036	2.68	7.82	2897
26	397	87	236	197	258	22	1642	19.3	2.5	5.6	0.46	0.0074	0.00021	0.016	0.00022	0.59	0.012	0.068	0.142	0.197	0.001722	0.0021	1.43	0.801	0.151	0.236	0.057	0.0036	2.65	7.83	2862
27	401	88	239	199	260	22	1660	19.3	2.5	5.6	0.46	0.0075	0.00020	0.016	0.00022	0.60	0.012	0.069	0.144	0.197	0.001722	0.0022	1.46	0.810	0.153	0.238	0.058	0.0036	2.68	7.82	2892
28	413	91	246	206	269	22	1712	19.2	2.5	5.8	0.44	0.0078	0.00021	0.016	0.00024	0.61	0.012	0.071	0.149	0.197	0.001722	0.0022	1.51	0.837	0.158	0.245	0.060	0.0038	2.75	7.82	2981
29	421	93	251	210	275	22	1746	19.2	2.5	5.9	0.43	0.0079	0.00021	0.016	0.00025	0.63	0.013	0.072	0.152	0.197	0.001723	0.0022	1.54	0.854	0.161	0.252	0.061	0.0038	2.79	7.82	3041
30	427	94	255	213	279	22	1772	19.2	2.5	5.9	0.42	0.0081	0.00021	0.016	0.00026	0.64	0.013	0.073	0.154	0.197	0.001723	0.0022	1.57	0.865	0.164	0.259	0.062	0.0039	2.80	7.82	3085
31	435	96	261	216	285	21	1807	19.2	2.5	6.0	0.41	0.0082	0.00021	0.016	0.00028	0.65	0.013	0.074	0.157	0.197	0.001723	0.0022	1.59	0.880	0.168	0.266	0.063	0.0040	2.82	7.81	3145
32	434	97	263	216	287	21	1809	19.2	2.5	6.0	0.41	0.0082	0.00023	0.016	0.00030	0.65	0.013	0.074	0.156	0.197	0.001723	0.0022	1.58	0.875	0.167	0.267	0.062	0.0040	2.77	7.81	3151
33	443	99	267	219	290	21	1846	19.2	2.5	6.2	0.40	0.0084	0.00024	0.016	0.00033	0.66	0.013	0.075	0.159	0.197	0.001724	0.0022	1.59	0.887	0.171	0.273	0.063	0.0042	2.79	7.81	3209
34	455	102	273	224	295	21	1899	19.2	2.4	6.4	0.39	0.0087	0.00026	0.016	0.00036	0.68	0.013	0.076	0.163	0.197	0.001724	0.0022	1.63	0.906	0.176	0.282	0.064	0.0043	2.83	7.81	3294
35	460	101	271	224	289	21	1913	19.2	2.4	6.4	0.38	0.0088	0.00027	0.016	0.00038	0.68	0.013	0.075	0.164	0.198	0.001724	0.0021	1.64	0.906	0.178	0.285	0.065	0.0044	2.82	7.80	3305
36	430	93	246	206	258	21	1775	19.2	2.5	5.8	0.42	0.0083	0.00025	0.016	0.00038	0.62	0.012	0.068	0.153	0.197	0.001723	0.0018	1.52	0.832	0.166	0.264	0.060	0.0042	2.58	7.81	3052
37	419	90	235	197	241	22	1727	19.3	2.5	5.5	0.44	0.0081	0.00027	0.016	0.00042	0.60	0.012	0.064	0.147	0.197	0.001723	0.0017	1.45	0.788	0.161	0.252	0.057	0.0042	2.46	7.82	2952
38	424	92	238	197	243	22	1752	19.2	2.5	5.6	0.43	0.0081	0.00032	0.016	0.00050	0.61	0.012	0.065	0.148	0.197	0.001723	0.0018	1.47	0.786	0.164	0.250	0.057	0.0042	2.48	7.82	2991
39	442	97	249	205	255	21	1829	19.2	2.4	5.9	0.41	0.0084	0.00040	0.016	0.00063	0.63	0.012	0.067	0.156	0.197	0.001724	0.0020	1.56	0.818	0.175	0.257	0.059	0.0044	2.59	7.81	3122
40	508	111	287	236	295	21	2106	19.2	2.4	7.0	0.35	0.0097	0.00064	0.015	0.00089	0.73	0.014	0.078	0.183	0.198	0.001726	0.0024	1.84	0.939	0.209	0.294	0.067	0.0050	3.00	7.79	3589
41	553	131	336	277	347	20	2371	19.1	2.4	8.4	0.30	0.0114	0.00092	0.015	0.00123	0.85	0.016	0.091	0.220	0.199	0.001727	0.0028	2.23	1.106	0.255	0.345	0.079	0.0057	3.54	7.78	4064

Table 5-2. Predictions of average annual concentrations for the Seepage Collection Ponds

	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	275	78	160	107	70	24	1302	17.9	2.6	3.8	0.71	0.0021	0.0023	0.016	0.00039	0.35	0.001	0.010	0.017	0.195	0.001714	0.0006	0.15	0.323	0.021	0.047	0.009	0.0009	0.30	7.87	2031
2	300	86	175	119	86	24	1408	19.3	2.7	4.6	0.69	0.0023	0.0022	0.016	0.00028	0.44	0.002	0.012	0.019	0.195	0.001719	0.0006	0.16	0.364	0.023	0.053	0.010	0.0009	0.44	7.87	2214
3	344	92	192	128	108	23	1551	19.3	2.6	6.1	0.61	0.0030	0.0019	0.016	0.00028	0.50	0.003	0.022	0.040	0.196	0.00172	0.0008	0.37	0.408	0.044	0.082	0.018	0.0012	0.87	7.85	2457
4	319	78	169	119	110	23	1378	19.2	2.6	5.9	0.66	0.0038	0.0015	0.016	0.00024	0.45	0.005	0.029	0.056	0.196	0.001719	0.0010	0.55	0.404	0.061	0.100	0.024	0.0018	1.16	7.86	2215
5	289	64	147	116	104	24	1213	19.3	2.6	5.1	0.73	0.0055	0.0010	0.017	0.00018	0.41	0.006	0.034	0.068	0.195	0.001718	0.0012	0.67	0.423	0.072	0.114	0.028	0.0034	1.33	7.87	1977
6	279	58	138	120	107	24	1150	19.3	2.7	4.6	0.74	0.0063	0.0007	0.017	0.00015	0.39	0.007	0.037	0.077	0.195	0.001718	0.0012	0.76	0.456	0.081	0.126	0.032	0.0041	1.48	7.87	1895
7	277	56	137	124	116	24	1128	19.3	2.7	4.2	0.75	0.0062	0.0005	0.017	0.00014	0.38	0.007	0.039	0.082	0.195	0.001718	0.0013	0.82	0.483	0.087	0.134	0.034	0.0039	1.57	7.87	1881
8	280	56	140	129	126	24	1135	19.4	2.6	4.1	0.73	0.0062	0.0004	0.017	0.00013	0.39	0.007	0.041	0.087	0.195	0.001718	0.0013	0.88	0.512	0.092	0.142	0.036	0.0037	1.67	7.87	1910
9	288	57	146	136	137	24	1163	19.4	2.6	4.1	0.71	0.0062	0.0004	0.017	0.00013	0.40	0.008	0.044	0.093	0.195	0.001718	0.0014	0.94	0.541	0.097	0.151	0.038	0.0036	1.76	7.87	1969
10	257	50	130	122	125	23	1029	17.1	2.6	3.6	0.74	0.0054	0.0003	0.017	0.00012	0.35	0.007	0.039	0.084	0.195	0.001717	0.0012	0.85	0.489	0.088	0.138	0.034	0.0030	1.60	7.86	1752
11	266	53	138	127	137	23	1070	16.6	2.6	3.7	0.70	0.0055	0.0003	0.017	0.00013	0.37	0.007	0.042	0.089	0.196	0.001718	0.0013	0.90	0.513	0.093	0.146	0.036	0.0030	1.68	7.86	1831
12	269	55	143	130	145	23	1085	16.3	2.6	3.8	0.70	0.0055	0.0003	0.017	0.00013	0.38	0.008	0.042	0.091	0.196	0.001718	0.0013	0.91	0.522	0.095	0.150	0.037	0.0030	1.70	7.86	1865
13	267	55	144	129	148	23	1079	15.9	2.6	3.8	0.71	0.0053	0.0003	0.017	0.00013	0.38	0.008	0.042	0.090	0.195	0.001718	0.0013	0.90	0.520	0.095	0.151	0.037	0.0028	1.69	7.86	1860
14	266	55	146	129	152	23	1077	15.7	2.6	3.8	0.72	0.0053	0.0003	0.017	0.00013	0.38	0.008	0.042	0.090	0.195	0.001718	0.0013	0.90	0.520	0.095	0.153	0.037	0.0028	1.68	7.86	1864
15	270	56	149	131	156	23	1093	15.6	2.6	3.8	0.70	0.0053	0.0003	0.017	0.00014	0.39	0.008	0.043	0.092	0.196	0.001718	0.0013	0.91	0.529	0.097	0.157	0.037	0.0028	1.70	7.86	1893
16	270	56	151	131	158	23	1096	15.4	2.6	3.8	0.69	0.0053	0.0003	0.017	0.00014	0.39	0.008	0.043	0.093	0.196	0.001718	0.0013	0.91	0.531	0.098	0.160	0.037	0.0027	1.70	7.86	1901
17	268	56	151	130	160	23	1088	15.3	2.6	3.8	0.70	0.0052	0.0003	0.017	0.00014	0.39	0.008	0.043	0.093	0.196	0.001718	0.0013	0.91	0.527	0.098	0.160	0.037	0.0027	1.70	7.86	1892
18	271	57	153	132	163	23	1100	15.3	2.6	3.8	0.68	0.0052	0.0003	0.017	0.00015	0.39	0.008	0.044	0.094	0.196	0.001718	0.0013	0.92	0.533	0.099	0.163	0.038	0.0027	1.73	7.85	1914
19	272	57	154	132	165	23	1103	15.3	2.6	3.8	0.68	0.0052	0.0003	0.017	0.00016	0.39	0.008	0.044	0.095	0.196	0.001718	0.0013	0.93	0.534	0.100	0.163	0.038	0.0026	1.75	7.85	1921
20	267	57	153	130	164	23	1086	15.1	2.6	3.8	0.70	0.0051	0.0003	0.017	0.00015	0.39	0.008	0.044	0.094	0.196	0.001718	0.0013	0.92	0.525	0.099	0.161	0.038	0.0026	1.73	7.85	1895
21	265	57	153	129	165	23	1078	15.0	2.6	3.7	0.70	0.0051	0.0002	0.017	0.00015	0.39	0.008	0.044	0.093	0.196	0.001718	0.0013	0.91	0.522	0.099	0.159	0.037	0.0025	1.72	7.86	1884
22	264	57	153	128	165	23	1072	14.8	2.6	3.7	0.71	0.0050	0.0002	0.017	0.00015	0.38	0.008	0.043	0.093	0.196	0.001718	0.0014	0.91	0.520	0.098	0.158	0.037	0.0025	1.72	7.86	1876
23	263	56	152	128	165	23	1068	14.7	2.6	3.7	0.71	0.0049	0.0002	0.017	0.00015	0.38	0.008	0.043	0.093	0.196	0.001718	0.0014	0.91	0.518	0.098	0.156	0.037	0.0024	1.71	7.86	1869
24	263	57	153	128	166	23	1069	14.6	2.6	3.7	0.70	0.0049	0.0002	0.017	0.00016	0.38	0.008	0.044	0.093	0.196	0.001718	0.0014	0.92	0.519	0.098	0.155	0.037	0.0024	1.72	7.85	1871
25	263	57	153	128	166	23	1068	14.6	2.6	3.6	0.70	0.0049	0.0002	0.017	0.00016	0.38	0.008	0.044	0.093	0.196	0.001718	0.0014	0.92	0.519	0.098	0.155	0.037	0.0024	1.72	7.85	1872
26	261	56	152	127	166	23	1063	14.5	2.6	3.6	0.70	0.0048	0.0002	0.017	0.00015	0.38	0.008	0.044	0.092	0.196	0.001718	0.0014	0.92	0.517	0.097	0.153	0.037	0.0023	1.71	7.85	1862
27	266	57	155	130	169	23	1083	14.7	2.6	3.7	0.68	0.0049	0.0002	0.017	0.00016	0.39	0.008	0.044	0.094	0.196	0.001718	0.0014	0.95	0.527	0.100	0.156	0.038	0.0024	1.74	7.85	1898
28	271	59	158	133	173	22	1104	14.8	2.6	3.7	0.66	0.0050	0.0002	0.017	0.00017	0.40	0.008	0.045	0.096	0.196	0.001719	0.0014	0.97	0.538	0.102	0.158	0.038	0.0024	1.78	7.85	1935
29	273	59	159	133	174	22	1112	14.8	2.6	3.8	0.65	0.0050	0.0002	0.017	0.00017	0.40	0.008	0.046	0.097	0.196	0.001719	0.0014	0.98	0.542	0.103	0.160	0.039	0.0024	1.78	7.84	1947
30	269	58	157	132	172	22	1098	14.7	2.6	3.7	0.66	0.0050	0.0002	0.017	0.00018	0.39	0.008	0.045	0.096	0.196	0.001719	0.0014	0.97	0.535	0.102	0.158	0.038	0.0024	1.75	7.84	1924
31	265	57	155	129	169	22	1079	14.5	2.5	3.6	0.66	0.0049	0.00023	0.017	0.00020	0.39	0.008	0.044	0.094	0.196	0.001719	0.0014	0.96	0.524	0.101	0.156	0.037	0.0024	1.71	7.84	1890
32	244	53	142	118	155	23	990	13.7	2.6	3.3	0.73	0.0045	0.0002	0.017	0.00020	0.35	0.007	0.040	0.086	0.196	0.001718	0.0012	0.88	0.479	0.093	0.144	0.034	0.0022	1.55	7.85	1737
33	228	49	133	110	144	23	924	13.2	2.6	3.1	0.80	0.0042	0.0002	0.017	0.00018	0.33	0.007	0.038	0.080	0.195	0.001717	0.0011	0.81	0.446	0.086	0.134	0.032	0.0020	1.44	7.86	1623
34	220	47	128	106	139	23	890	12.9	2.6	3.0	0.82	0.0041	0.0002	0.017	0.00017	0.32	0.006	0.036	0.077	0.195	0.001717	0.0011	0.78	0.429	0.083	0.130	0.031	0.0020	1.38	7.86	1564
35	215	46	124	103	134	23	865	12.7	2.5	2.9	0.83	0.0040	0.0002	0.017	0.00017	0.31	0.006	0.035	0.075	0.195	0.001717	0.0010	0.75	0.416	0.080	0.127	0.030	0.0019	1.33	7.86	1520
36	211	45	121	101	131	23	852	12.5	2.5	2.8	0.83	0.0039	0.0002	0.017	0.00016	0.30	0.006	0.034	0.074	0.195	0.001717	0.0010	0.74	0.408	0.079	0.125	0.029	0.0019	1.30	7.85	1495
37	205	44	117	98	125	22	826	12.2	2.5	2.7	0.83	0.0038	0.0002	0.017	0.00016	0.29	0.006	0.033	0.071	0.196	0.001717	0.0010	0.71	0.394	0.076	0.121	0.028	0.0019	1.25	7.85	1447
38	199	42	113	94	121	22	800	12.0	2.4	2.6	0.83	0.0037	0.0002	0.017	0.00015	0.28	0.006	0.032	0.069	0.196	0.001717	0.0009	0.69	0.381	0.074	0.117	0.027	0.0018	1.21	7.84	1402
39	194	41	109	91	117	21	779	11.7	2.4	2.6	0.80	0.0036	0.0002	0.016	0.00019	0.28	0.005	0.031	0.067	0.196	0.001717	0.0009	0.68	0.368	0.073	0.113	0.026	0.0018	1.17	7.83	1362
40	190	40	106	89	113	21	761	11.5	2.3	2.5	0.78	0.0035	0.0003	0.016	0.00022	0.27	0.005	0.030	0.066	0.196	0.001718	0.0009	0.67	0.358	0.073	0.110	0.026	0.0017	1.14	7.82	1330
41	187	40	104	87	111	21	748	11.4	2.3	2.5	0.77	0.0034	0.0003	0.016	0.00024	0.26	0.005	0.029	0.066	0.196	0.001718	0.00086	0.66	0.351	0.073	0.108	0.025	0.0017	1.12	7.82	1308

Table 5-3. Predictions of average annual concentrations for the Embankment

	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	251	71	146	98	63	24	1184	16.8	2.6	3.2	0.77	0.0019	0.00161	0.016	0.00031	0.31	0.001	0.009	0.016	0.194	0.001711	0.0005	0.13	0.295	0.018	0.043	0.008	0.0008	0.26	7.87	1850
2	272	77	159	107	79	24	1272	19.0	2.8	4.0	0.72	0.0021	0.00147	0.016	0.00019	0.39	0.001	0.011	0.017	0.195	0.001718	0.0006	0.14	0.331	0.020	0.049	0.009	0.0008	0.41	7.86	2007
3	297	77	163	108	93	23	1322	19.2	2.7	5.1	0.66	0.0027	0.00127	0.016	0.00017	0.42	0.003	0.021	0.036	0.196	0.001719	0.0007	0.34	0.349	0.039	0.074	0.017	0.0011	0.80	7.85	2102
4	311	75	164	116	108	22	1339	18.6	2.6	5.5	0.63	0.0037	0.00105	0.016	0.00017	0.44	0.005	0.029	0.055	0.196	0.001719	0.0010	0.54	0.398	0.059	0.099	0.024	0.0018	1.15	7.84	2154
5	280	62	142	113	101	23	1173	19.0	2.7	4.7	0.71	0.0054	0.00068	0.017	0.00012	0.39	0.006	0.033	0.066	0.195	0.001718	0.0011	0.65	0.414	0.070	0.112	0.028	0.0034	1.30	7.86	1913
6	269	56	133	116	103	23	1105	18.6	2.7	4.2	0.74	0.0061	0.00042	0.017	0.00010	0.37	0.006	0.036	0.074	0.195	0.001718	0.0012	0.73	0.443	0.078	0.122	0.031	0.0040	1.43	7.86	1822
7	259	52	128	116	110	24	1050	18.1	2.7	3.8	0.78	0.0058	0.00031	0.017	0.00009	0.36	0.007	0.037	0.077	0.195	0.001717	0.0012	0.77	0.455	0.081	0.126	0.032	0.0036	1.48	7.87	1756
8	255	51	127	118	116	24	1028	17.8	2.7	3.6	0.79	0.0056	0.00024	0.017	0.00008	0.35	0.007	0.038	0.080	0.195	0.001717	0.0012	0.80	0.469	0.083	0.130	0.033	0.0033	1.52	7.87	1735
9	254	50	128	120	122	24	1022	17.6	2.7	3.5	0.79	0.0054	0.00020	0.017	0.00008	0.35	0.007	0.039	0.082	0.195	0.001717	0.0012	0.83	0.481	0.085	0.134	0.034	0.0031	1.56	7.87	1737
10	266	52	135	127	132	24	1068	17.4	2.7	3.7	0.75	0.0056	0.00018	0.017	0.00008	0.37	0.007	0.041	0.088	0.195	0.001718	0.0013	0.89	0.512	0.091	0.144	0.036	0.0031	1.67	7.87	1821
11	278	56	145	134	145	24	1119	16.9	2.7	3.8	0.72	0.0057	0.00019	0.017	0.00009	0.39	0.008	0.044	0.093	0.195	0.001718	0.0013	0.94	0.539	0.097	0.154	0.038	0.0031	1.76	7.87	1916
12	284	58	152	138	155	24	1148	16.6	2.6	3.9	0.71	0.0058	0.00019	0.017	0.00010	0.40	0.008	0.045	0.096	0.195	0.001718	0.0014	0.96	0.556	0.100	0.160	0.039	0.0031	1.81	7.87	1974
13	285	59	156	138	161	24	1154	16.4	2.7	4.0	0.71	0.0057	0.00019	0.017	0.00010	0.41	0.008	0.046	0.097	0.195	0.001718	0.0014	0.96	0.559	0.101	0.163	0.039	0.0030	1.81	7.87	1992
14	286	60	159	139	166	24	1162	16.2	2.7	4.0	0.71	0.0057	0.00020	0.017	0.00011	0.41	0.008	0.046	0.097	0.195	0.001718	0.0014	0.96	0.563	0.102	0.166	0.040	0.0030	1.81	7.87	2011
15	293	61	164	143	172	24	1192	16.2	2.6	4.1	0.69	0.0058	0.00020	0.017	0.00011	0.42	0.008	0.047	0.100	0.195	0.001718	0.0014	0.99	0.580	0.105	0.173	0.041	0.0030	1.86	7.87	2066
16	297	63	168	146	177	24	1211	16.2	2.6	4.2	0.67	0.0058	0.00019	0.017	0.00011	0.43	0.009	0.048	0.102	0.195	0.001718	0.0014	1.00	0.589	0.107	0.178	0.042	0.0030	1.89	7.86	2101
17	293	62	167	143	177	24	1195	16.0	2.6	4.1	0.69	0.0057	0.00018	0.017	0.00012	0.43	0.008	0.048	0.101	0.195	0.001718	0.0014	0.99	0.581	0.106	0.177	0.041	0.0029	1.87	7.87	2077
18	295	62	168	144	179	24	1200	16.1	2.6	4.1	0.68	0.0057	0.00017	0.017	0.00012	0.43	0.009	0.048	0.103	0.195	0.001718	0.0014	1.00	0.584	0.107	0.178	0.042	0.0029	1.89	7.87	2088
19	293	62	168	143	180	24	1195	16.0	2.6	4.1	0.69	0.0056	0.00017	0.017	0.00012	0.43	0.009	0.048	0.103	0.195	0.001718	0.0014	1.00	0.581	0.107	0.178	0.042	0.0029	1.90	7.87	2082
20	291	62	169	142	182	24	1188	15.9	2.6	4.1	0.69	0.0056	0.00016	0.017	0.00012	0.43	0.009	0.048	0.103	0.195	0.001718	0.0015	1.00	0.577	0.107	0.177	0.041	0.0028	1.90	7.87	2074
21	292	63	170	143	184	24	1192	15.9	2.6	4.1	0.69	0.0056	0.00016	0.017	0.00012	0.43	0.009	0.048	0.103	0.195	0.001718	0.0015	1.00	0.580	0.108	0.177	0.042	0.0028	1.92	7.87	2084
22	294	63	172	144	187	24	1201	15.8	2.6	4.1	0.69	0.0056	0.00015	0.017	0.00013	0.43	0.009	0.049	0.104	0.195	0.001718	0.0015	1.02	0.585	0.109	0.177	0.042	0.0028	1.93	7.87	2101
23	296	64	174	145	189	24	1212	15.8	2.6	4.1	0.68	0.0056	0.00015	0.017	0.00013	0.44	0.009	0.050	0.105	0.195	0.001719	0.0016	1.03	0.590	0.110	0.178	0.042	0.0028	1.96	7.86	2121
24	299	65	176	147	192	24	1223	15.9	2.6	4.2	0.67	0.0056	0.00014	0.017	0.00013	0.44	0.009	0.050	0.105	0.195	0.001719	0.0016	1.04	0.597	0.111	0.179	0.043	0.0027	1.97	7.86	2142
25	301	65	178	148	194	24	1232	15.9	2.6	4.2	0.66	0.0056	0.00014	0.017	0.00013	0.44	0.009	0.051	0.106	0.195	0.001719	0.0016	1.06	0.601	0.112	0.179	0.043	0.0027	1.99	7.86	2158
26	302	66	178	149	195	24	1236	15.9	2.6	4.2	0.66	0.0056	0.00013	0.017	0.00013	0.45	0.009	0.051	0.107	0.195	0.001719	0.0016	1.07	0.604	0.112	0.179	0.043	0.0027	2.00	7.86	2166
27	303	66	179	149	196	23	1240	16.0	2.6	4.2	0.66	0.0056	0.00013	0.017	0.00013	0.45	0.009	0.051	0.107	0.195	0.001719	0.0016	1.08	0.606	0.113	0.179	0.043	0.0027	2.01	7.86	2173
28	304	66	180	150	197	23	1247	16.0	2.6	4.2	0.65	0.0056	0.00012	0.017	0.00013	0.45	0.009	0.052	0.108	0.195	0.001719	0.0016	1.09	0.610	0.113	0.179	0.044	0.0027	2.02	7.86	2184
29	306	67	181	151	198	23	1255	16.0	2.6	4.2	0.65	0.0057	0.00012	0.017	0.00014	0.45	0.009	0.052	0.108	0.195	0.001719	0.0016	1.10	0.615	0.114	0.181	0.044	0.0027	2.02	7.86	2198
30	308	67	182	152	200	23	1262	16.0	2.6	4.2	0.64	0.0057	0.00012	0.017	0.00014	0.45	0.009	0.052	0.109	0.195	0.001719	0.0016	1.11	0.618	0.115	0.183	0.044	0.0028	2.02	7.86	2211
31	309	67	183	152	200	23	1266	16.0	2.6	4.2	0.64	0.0058	0.00012	0.017	0.00014	0.46	0.009	0.052	0.109	0.195	0.001719	0.0016	1.11	0.620	0.115	0.184	0.044	0.0028	2.01	7.86	2217
32	308	67	183	152	201	23	1266	15.9	2.6	4.2	0.64	0.0058	0.00012	0.017	0.00014	0.46	0.009	0.052	0.109	0.195	0.001719	0.0016	1.11	0.619	0.115	0.185	0.044	0.0028	2.00	7.86	2217
33	309	68	184	152	201	23	1268	16.0	2.6	4.2	0.64	0.0058	0.00012	0.017	0.00015	0.46	0.009	0.052	0.109	0.195	0.001719	0.0016	1.10	0.619	0.115	0.186	0.044	0.0028	1.99	7.86	2221
34	310	68	184	153	202	23	1274	16.0	2.6	4.2	0.64	0.0058	0.00012	0.017	0.00015	0.46	0.009	0.052	0.109	0.196	0.001719	0.0016	1.11	0.620	0.116	0.187	0.044	0.0028	1.99	7.86	2230
35	313	68	186	154	202	23	1285	16.1	2.6	4.3	0.63	0.0059	0.00012	0.017	0.00015	0.46	0.009	0.053	0.110	0.196	0.001719	0.0016	1.11	0.624	0.117	0.189	0.045	0.0029	2.00	7.86	2248
36	316	69	187	155	203	23	1297	16.2	2.6	4.3	0.62	0.0059	0.00012	0.017	0.00015	0.47	0.009	0.053	0.111	0.196	0.001719	0.0016	1.12	0.629	0.118	0.191	0.045	0.0029	2.01	7.86	2266
37	317	69	187	155	203	23	1301	16.2	2.6	4.3	0.62	0.0059	0.00012	0.017	0.00015	0.47	0.009	0.053	0.111	0.196	0.001719	0.0016	1.12	0.630	0.118	0.191	0.045	0.0029	2.01	7.86	2273
38	317	69	187	155	203	23	1302	16.2	2.6	4.3	0.62	0.0060	0.00012	0.017	0.00015	0.47	0.009	0.053	0.111	0.196	0.001719	0.0016	1.12	0.629	0.118	0.191	0.045	0.0029	2.01	7.86	2274
39	317	69	187	155	202	23	1302	16.2	2.6	4.3	0.62	0.0060	0.00012	0.017	0.00015	0.47	0.009	0.053	0.111	0.196	0.001719	0.0016	1.12	0.629	0.118	0.191	0.045	0.0029	2.01	7.86	2273
40	317	69	187	155	202	23	1302	16.2	2.6	4.3	0.62	0.0060	0.00012	0.017	0.00016	0.47	0.009	0.053	0.111	0.196	0.001719	0.0016	1.12	0.629	0.118	0.191	0.045	0.0029	2.01	7.86	2273
41	317	69	187	155	202	23	1302	16.2	2.6	4.3	0.62	0.0060	0.00013	0.017	0.00016	0.47	0.009	0.053	0.111	0.196	0.001719	0.0016	1.12	0.628	0.118	0.191	0.045	0.0029	2.01	7.86	2273

Table 5-4. Predictions of average annual concentrations for Lost Seepage (NS=no seepage flow)

	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	309	89	180	122	85	21	1464	19.2	2.7	3.9	0.96	0.0023	0.00163	0.016	0.00021	0.45	0.001	0.011	0.018	0.314	0.001717	0.0006	0.15	0.371	0.022	0.051	0.009	0.0009	0.43	7.91	2288
3	426	118	245	164	133	20	1972	19.2	2.6	6.8	1.59	0.0035	0.00156	0.015	0.00033	0.63	0.003	0.023	0.041	0.285	0.001727	0.0010	0.37	0.516	0.048	0.091	0.019	0.0014	0.89	7.81	3101
4	288	71	152	106	96	21	1247	18.9	2.7	5.0	1.02	0.0032	0.00091	0.017	0.00020	0.40	0.004	0.025	0.048	0.325	0.001721	0.0008	0.46	0.355	0.052	0.085	0.021	0.0014	0.98	7.93	2000
5	264	59	134	103	94	21	1110	18.5	2.6	4.4	0.99	0.0045	0.00056	0.017	0.00016	0.37	0.005	0.029	0.060	0.325	0.001721	0.0010	0.59	0.373	0.064	0.100	0.025	0.0027	1.17	7.95	1805
6	260	55	130	110	98	21	1078	18.5	2.7	4.2	1.02	0.0057	0.00039	0.017	0.00015	0.36	0.006	0.033	0.070	0.321	0.00172	0.0011	0.69	0.415	0.074	0.114	0.028	0.0036	1.34	7.96	1771
7	251	51	124	110	101	21	1025	17.9	2.7	3.8	1.05	0.0055	0.00029	0.017	0.00013	0.35	0.006	0.034	0.073	0.323	0.00172	0.0011	0.72	0.425	0.077	0.118	0.029	0.0035	1.38	7.96	1701
8	246	49	122	111	106	21	994	17.4	2.7	3.5	1.08	0.0054	0.00023	0.017	0.00012	0.34	0.006	0.035	0.075	0.324	0.00172	0.0011	0.75	0.435	0.079	0.121	0.030	0.0033	1.42	7.97	1666
9	237	47	119	111	109	20	957	16.7	2.7	3.4	1.09	0.0051	0.00020	0.018	0.00013	0.33	0.006	0.035	0.076	0.324	0.00172	0.0011	0.76	0.437	0.080	0.122	0.030	0.0030	1.42	7.98	1618
10	571	126	319	297	297	17	2448	19.1	2.4	8.8	2.81	0.0135	0.00043	0.015	0.00028	0.87	0.017	0.095	0.203	0.256	0.001735	0.0030	2.06	1.182	0.214	0.330	0.083	0.0079	3.85	7.72	4108
11	358	73	190	174	189	20	1466	19.3	2.5	5.1	0.54	0.0075	0.00036	0.016	0.00016	0.51	0.010	0.057	0.122	0.197	0.00172	0.0018	1.23	0.702	0.127	0.200	0.049	0.0041	2.30	7.89	2494
12	368	76	199	180	202	20	1508	19.3	2.5	5.3	0.51	0.0076	0.00036	0.016	0.00017	0.53	0.011	0.059	0.126	0.197	0.00172	0.0018	1.27	0.726	0.132	0.209	0.051	0.0041	2.37	7.89	2577
13	375	79	207	184	213	20	1543	19.3	2.5	5.4	0.50	0.0076	0.00037	0.016	0.00018	0.54	0.011	0.061	0.129	0.197	0.00172	0.0018	1.29	0.743	0.136	0.216	0.052	0.0040	2.41	7.88	2644
14	384	81	216	189	223	20	1584	19.3	2.5	5.6	0.49	0.0077	0.00037	0.016	0.00019	0.56	0.011	0.062	0.133	0.197	0.00172	0.0019	1.32	0.764	0.139	0.225	0.054	0.0041	2.46	7.88	2720
15	395	84	223	195	232	19	1628	19.3	2.5	5.7	0.47	0.0079	0.00036	0.016	0.00020	0.57	0.011	0.064	0.137	0.197	0.00172	0.0019	1.35	0.788	0.144	0.235	0.055	0.0041	2.53	7.88	2800
16	395	84	224	195	236	19	1630	19.3	2.5	5.7	0.47	0.0078	0.00033	0.016	0.00020	0.58	0.011	0.064	0.138	0.197	0.00172	0.0019	1.36	0.790	0.145	0.238	0.056	0.0041	2.54	7.88	2808
17	383	82	220	189	233	20	1580	19.3	2.5	5.5	0.49	0.0075	0.00031	0.016	0.00020	0.56	0.011	0.063	0.135	0.197	0.00172	0.0019	1.32	0.765	0.142	0.233	0.054	0.0039	2.47	7.88	2731
18	388	83	223	191	238	20	1602	19.3	2.5	5.6	0.48	0.0076	0.00029	0.016	0.00020	0.57	0.011	0.064	0.138	0.197	0.00172	0.0019	1.34	0.776	0.145	0.237	0.055	0.0039	2.53	7.88	2770
19	389	84	226	192	242	20	1606	19.3	2.5	5.6	0.48	0.0076	0.00028	0.016	0.00021	0.57	0.012	0.064	0.139	0.197	0.00172	0.0019	1.35	0.778	0.146	0.238	0.056	0.0038	2.56	7.88	2782
20	392	85	230	193	247	20	1621	19.3	2.5	5.6	0.48	0.0076	0.00027	0.016	0.00021	0.58	0.012	0.065	0.140	0.197	0.00172	0.0020	1.37	0.785	0.148	0.240	0.056	0.0038	2.59	7.88	2813
21	398	87	235	197	253	19	1649	19.3	2.5	5.7	0.47	0.0077	0.00026	0.016	0.00022	0.59	0.012	0.067	0.143	0.197	0.00172	0.0021	1.40	0.799	0.150	0.243	0.057	0.0039	2.64	7.88	2862
22	403	88	239	200	258	19	1671	19.3	2.5	5.8	0.46	0.0078	0.00026	0.016	0.00022	0.60	0.012	0.068	0.145	0.197	0.00172	0.0021	1.42	0.811	0.152	0.245	0.058	0.0038	2.68	7.87	2903
23	408	90	243	203	263	19	1694	19.3	2.5	5.8	0.45	0.0078	0.00025	0.016	0.00023	0.61	0.012	0.069	0.147	0.197	0.00172	0.0022	1.45	0.823	0.155	0.247	0.059	0.0038	2.72	7.87	2945
24	407	89	243	202	264	19	1690	19.3	2.5	5.8	0.45	0.0077	0.00024	0.016	0.00023	0.61	0.012	0.069	0.146	0.197	0.00172	0.0022	1.45	0.822	0.154	0.245	0.059	0.0038	2.72	7.87	2939
25	402	88	240	200	262	19	1670	19.3	2.5	5.7	0.46	0.0076	0.00022	0.016	0.00022	0.60	0.012	0.069	0.145	0.197	0.00172	0.0022	1.45	0.813	0.153	0.241	0.058	0.0037	2.69	7.87	2906
26	398	87	237	198	258	19	1649	19.3	2.5	5.6	0.46	0.0075	0.00021	0.016	0.00022	0.59	0.012	0.068	0.143	0.197	0.00172	0.0022	1.44	0.803	0.151	0.237	0.057	0.0036	2.66	7.88	2871
27	402	88	239	200	261	19	1667	19.3	2.5	5.7	0.46	0.0076	0.00020	0.016	0.00022	0.60	0.012	0.069	0.144	0.197	0.00172	0.0022	1.46	0.813	0.153	0.238	0.058	0.0036	2.69	7.87	2901
28	414	91	247	206	269	19	1719	19.3	2.5	5.8	0.44	0.0078	0.00021	0.016	0.00024	0.62	0.012	0.071	0.149	0.197	0.00172	0.0022	1.52	0.839	0.158	0.246	0.060	0.0038	2.76	7.87	2990
29	422	93	252	211	275	19	1753	19.3	2.5	5.9	0.43	0.0080	0.00021	0.016	0.00025	0.63	0.013	0.072	0.152	0.198	0.001721	0.0022	1.55	0.856	0.162	0.253	0.061	0.0038	2.80	7.86	3051
30	428	94	256	213	280	19	1779	19.3	2.5	6.0	0.42	0.0081	0.00021	0.016	0.00026	0.64	0.013	0.073	0.155	0.198	0.001721	0.0022	1.57	0.868	0.165	0.260	0.062	0.0039	2.81	7.86	3095
31	436	96	262	217	286	19	1814	19.3	2.5	6.0	0.41	0.0083	0.00021	0.016	0.00028	0.65	0.013	0.074	0.157	0.198	0.001721	0.0022	1.59	0.883	0.168	0.267	0.063	0.0040	2.82	7.85	3156
32	436	97	263	216	288	19	1817	19.3	2.5	6.1	0.41	0.0083	0.00023	0.016	0.00030	0.65	0.013	0.074	0.157	0.198	0.001721	0.0022	1.58	0.878	0.168	0.268	0.063	0.0040	2.78	7.85	3161
33	444	99	268	219	291	19	1854	19.2	2.5	6.2	0.40	0.0085	0.00024	0.016	0.00033	0.67	0.013	0.075	0.159	0.198	0.001721	0.0022	1.60	0.889	0.171	0.274	0.063	0.0042	2.80	7.84	3220
34	457	102	274	225	296	19	1907	19.2	2.4	6.4	0.39	0.0087	0.00026	0.016	0.00036	0.68	0.013	0.076	0.163	0.198	0.001722	0.0022	1.63	0.909	0.176	0.283	0.065	0.0043	2.84	7.83	3305
35	461	102	272	225	290	19	1921	19.2	2.4	6.4	0.39	0.0089	0.00027	0.016	0.00038	0.68	0.013	0.075	0.165	0.198	0.001723	0.0021	1.64	0.909	0.178	0.286	0.065	0.0044	2.83	7.82	3317
36	431	93	246	207	259	19	1783	19.3	2.5	5.8	0.42	0.0083	0.00025	0.016	0.00038	0.63	0.012	0.068	0.153	0.198	0.00172	0.0018	1.52	0.834	0.167	0.265	0.060	0.0042	2.59	7.85	3063
37	420	90	235	197	241	19	1733	19.3	2.5	5.5	0.44	0.0081	0.00027	0.016	0.00043	0.60	0.012	0.065	0.147	0.198	0.001721	0.0017	1.46	0.790	0.162	0.253	0.057	0.0042	2.47	7.86	2961
38	425	92	239	198	243	19	1760	19.3	2.5	5.6	0.43	0.0082	0.00032	0.016	0.00050	0.61	0.012	0.065	0.149	0.198	0.001721	0.0018	1.48	0.789	0.164	0.251	0.057	0.0043	2.49	7.86	3000
39	443	97	250	206	256	19	1836	19.2	2.4	5.9	0.42	0.0085	0.00040	0.016	0.00063	0.64	0.012	0.068	0.157	0.198	0.001723	0.0020	1.56	0.820	0.175	0.258	0.059	0.0044	2.60	7.83	3132
40	510	112	287	236	296	18	2115	19.2	2.4	7.0	0.35	0.0097	0.00064	0.015	0.00089	0.73	0.014	0.078	0.184	0.199	0.001729	0.0024	1.85	0.942	0.209	0.295	0.067	0.0050	3.01	7.77	3601
41	553	131	337	278	349	18	2378	19.1	2.4	8.4	0.30	0.0114	0.00092	0.015	0.00124	0.85	0.016	0.092	0.221	0.199	0.001734	0.0028	2.23	1.110	0.255	0.346	0.079	0.0058	3.56	7.73	4075

6 REFERENCES

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

KCB (2018) DEIS Design for Alternative 3A – Near West Modified Proposed Action (Modified Centerline Embankment – "wet") Final Report, Prepared for Resolution Copper Mining; Prepared by Klohn Crippen Berger, June 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.

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*