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TECHNICAL MEMORANDUM

TO: Vicky Peacey, Resolution Copper

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DATE: July 17, 2018

SUBJECT: Alternative 5 - Peg Leg: 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 5.

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 0.2-day time step was used. Both the water balance and PHREEQC calculations are conducted at each time step. A 0.2-day timestep was found to be short enough prevent potential mass transfer warnings from occurring during simulations.

3 WATER BALANCE

A model of the water balance for Alternative 5 was developed by Golder. The boundaries of the Golder water balance model included the West Plant, tailings storage facility (TSF), and seepage collection systems. The TSF components include storage of pyrite tailings in four discrete cells and scavenger tailings in the main portion of the TSF. Details of the TSF design are provided in Golder (2018).

3.1 Makeup Water

The Golder 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. The Golder model does not indicate the specific sources for makeup water. Consequently, the makeup sources were defined while altering the Golder model to include the chemical balance. The sources of water for ore processing are:

- **Reclaim water**: Excess water pumped from the Reclaim Water Tank. Sources of water entering the Reclaim Water Tank include:
    - Reclaim from the PAG ponds
    - Reclaim from the NPAG Pond
    - Pumping from the Seepage Collection Ponds.

  These flows are provided by the Golder 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 water from the Reclaim Water Tank, 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. It is assumed the excess water would be managed as either a discharge (if water quality is acceptable) or evaporated.

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).

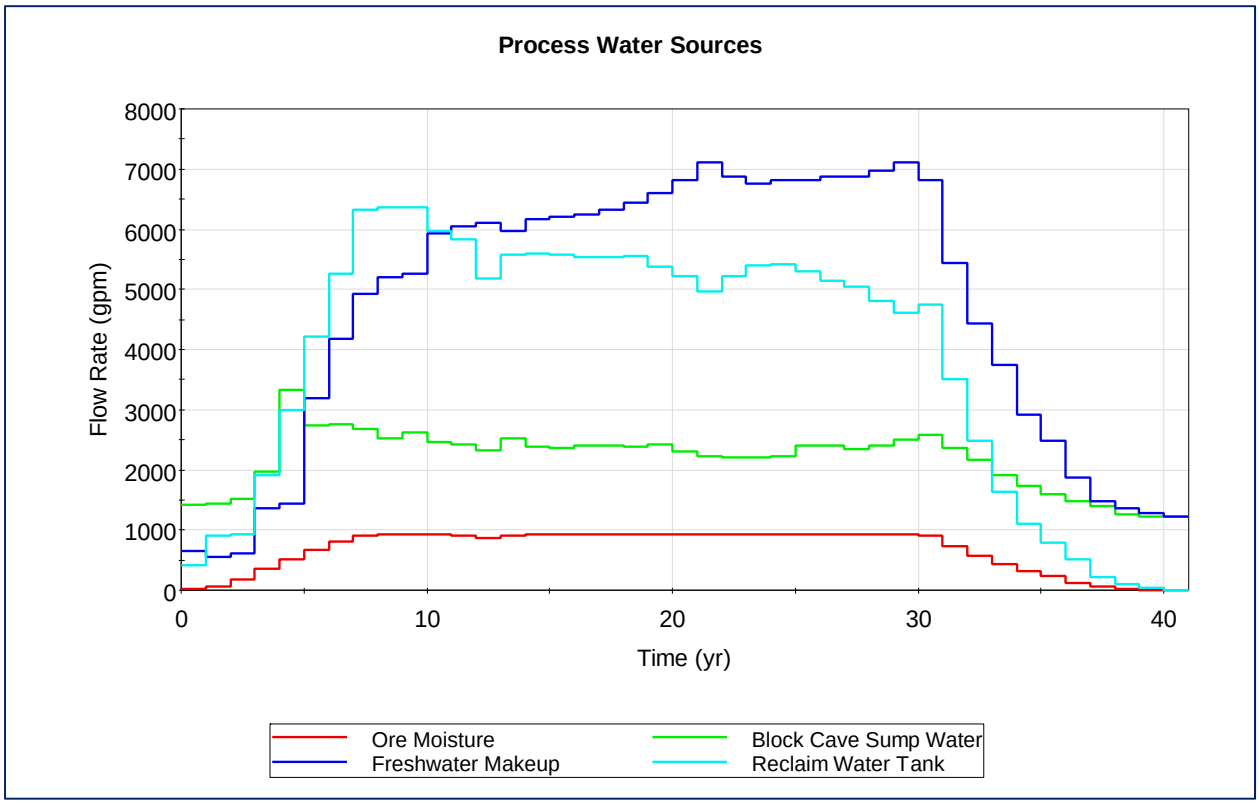

Figure 3-1. Simulation results for process water sources

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 four locations where PHREEQC is applied to produced equilibrated water chemistries:
    - **West Plant**: mixture of water entering the Plant
    - **Embankment**: water contained in the pore space of the TSF 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 water exiting the TSF and entering the downgradient groundwater system. The water balance model includes three main routes for seepage loss:
        - From the PAG ponds tailings deposited in cells
        - From the NPAG dam, ponds, and deposited tailings
        - From the Seepage Collection Ponds

  - To simplify the simulations of the water chemistry of lost seepage, the flows from the three seepage routes were mixed together and equilibrated. The water balance model includes an estimation of the recovery rate of lost seepage through the operation of pump-back systems that would send recovered water to the Reclaim Water Tank. The water chemistry for the recovered water was assumed to be the same as that calculated from the mixing of the three sources of Lost Seepage. The potential effects of recovering natural groundwater along with seepage were not included in the water chemistry simulations.
- Reactions and mixing of Lost Seepage with groundwater in flow paths downgradient of the TSF were 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: Lost Seepage
- Table 5-2: Embankment

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. The following observations for the Lost Seepage water chemistry:

- Figure 5-1a - pH: The pH is predicted to range between about 7.2 and 7.8 for the entirety of the 41-year operational mine life.
- Figure 5-1b – major anions: Sulfate is the dominant anion at concentrations from 500 to 1100 mg/L. Chloride is next in importance with concentrations from 40 to 190 mg/L followed by HCO_3 at concentrations from 17 to 27 mg/L, nitrate-N at concentrations from 1.5 to 4.8 mg/L, and fluoride at concentrations from 1.6 to 3.4 mg/L.
- Figure 5-1c – divalent metals: Zinc is predicted to have the highest concentrations, ranging between 0.1 and 1.5 mg/L. Copper concentration range up to 4.5 mg/L. Copper is predicted to increase at about year 37. This increase is due to the prediction of the increase in the solubility of malachite related to the decrease in pH that occurs at year 37 (Figure 5.1a). Nickel and cobalt are predicted to range from 0.02 to 0.3 mg/L. Concentrations of cadmium and lead are predicted to be less than 0.01 and 0.002 mg/L, respectively.
- Figure 5-1d: anionic metals and metalloids: Molybdenum concentrations are the highest for this group at concentrations from 0.1 to 0.7 mg/L. Selenium is next at concentrations from 0.01 to 0.21 mg/L. Arsenic concentrations lower but variable at concentrations from 0.0004 to 0.01 mg/L.

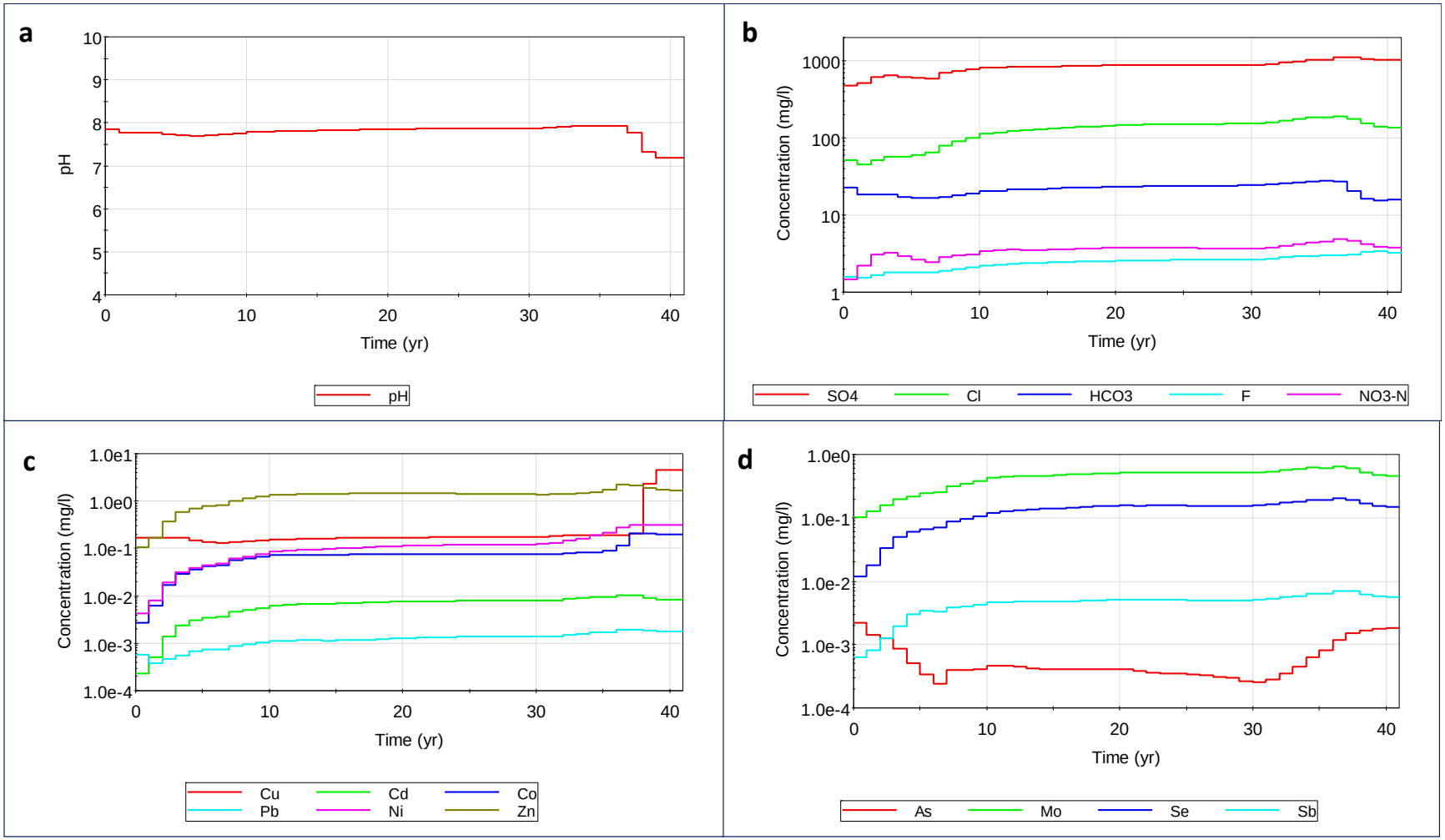

Figure 5-1. Predictions of average annual concentrations in Lost Seepage for a) pH, b) major anions, c) divalent metals, and d) anionic metals and metalloids

Table 5-1. Predictions of average annual concentrations for Lost Seepage

	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	101	34	76	37	52	23	481	9.5	1.6	1.5	0.24	0.0006	0.002226	0.013	0.000092	0.183	0.000	0.003	0.003	0.168	0.001719	0.0006	0.0173	0.104	0.004	0.012	0.002	0.0003	0.10	7.85	805
2	110	34	72	42	45	19	511	10.1	1.6	2.2	0.40	0.0008	0.001431	0.011	0.000107	0.186	0.001	0.005	0.006	0.166	0.001727	0.0004	0.0521	0.126	0.008	0.018	0.003	0.0003	0.17	7.77	838
3	140	38	81	50	52	19	618	11.3	1.7	3.1	0.53	0.0012	0.001237	0.012	0.000120	0.216	0.001	0.010	0.017	0.169	0.001728	0.0005	0.1600	0.159	0.019	0.033	0.008	0.0005	0.37	7.77	1007
4	154	37	82	57	57	19	649	11.9	1.8	3.3	0.63	0.0019	0.000854	0.012	0.000107	0.222	0.002	0.015	0.029	0.171	0.001727	0.0006	0.2855	0.194	0.031	0.050	0.012	0.0009	0.59	7.77	1064
5	149	33	76	60	57	17	617	11.9	1.8	2.9	0.66	0.0030	0.000511	0.012	0.000084	0.214	0.003	0.018	0.036	0.151	0.001635	0.0007	0.3578	0.220	0.039	0.060	0.015	0.0019	0.71	7.73	1020
6	148	31	75	64	60	17	605	11.8	1.8	2.6	0.64	0.0034	0.000337	0.012	0.000074	0.211	0.003	0.020	0.042	0.137	0.00139	0.0007	0.4128	0.242	0.044	0.067	0.017	0.0022	0.79	7.71	1011
7	146	30	74	65	64	17	592	11.2	1.8	2.4	0.62	0.0033	0.000243	0.012	0.000068	0.206	0.004	0.021	0.044	0.129	0.001247	0.0007	0.4442	0.254	0.047	0.071	0.018	0.0020	0.83	7.70	998
8	171	36	88	80	80	17	697	11.6	1.9	2.9	0.58	0.0038	0.000392	0.012	0.000141	0.244	0.005	0.026	0.056	0.136	0.00126	0.0009	0.5689	0.314	0.061	0.087	0.022	0.0023	1.03	7.72	1180
9	179	38	95	88	90	18	736	11.9	2.0	3.0	0.61	0.0040	0.000391	0.013	0.000162	0.261	0.005	0.028	0.062	0.142	0.001295	0.0010	0.6382	0.348	0.068	0.097	0.024	0.0023	1.14	7.74	1255
10	184	41	102	95	99	19	767	12.1	2.1	3.1	0.64	0.0042	0.000406	0.013	0.000188	0.279	0.006	0.031	0.067	0.147	0.00133	0.0010	0.7026	0.378	0.075	0.107	0.026	0.0024	1.24	7.76	1318
11	191	45	115	107	113	20	822	12.5	2.2	3.4	0.68	0.0047	0.000465	0.014	0.000236	0.310	0.006	0.035	0.072	0.155	0.001387	0.0011	0.7727	0.426	0.087	0.121	0.029	0.0026	1.36	7.78	1425
12	190	46	118	109	118	21	826	12.4	2.3	3.5	0.69	0.0047	0.000458	0.014	0.000251	0.316	0.006	0.036	0.073	0.156	0.001397	0.0011	0.7837	0.437	0.090	0.126	0.029	0.0025	1.38	7.79	1440
13	192	48	123	114	124	21	843	12.5	2.4	3.6	0.72	0.0048	0.000451	0.014	0.000267	0.327	0.007	0.037	0.074	0.161	0.001437	0.0012	0.8013	0.456	0.094	0.132	0.030	0.0025	1.41	7.81	1476
14	190	48	123	114	126	22	838	12.3	2.4	3.5	0.74	0.0048	0.000416	0.015	0.000267	0.328	0.007	0.037	0.074	0.162	0.001452	0.0012	0.7979	0.459	0.095	0.135	0.030	0.0025	1.40	7.81	1473
15	189	49	125	116	128	22	838	12.2	2.4	3.5	0.75	0.0048	0.000406	0.015	0.000275	0.331	0.007	0.037	0.074	0.163	0.001463	0.0011	0.8021	0.465	0.097	0.138	0.031	0.0025	1.40	7.82	1478
16	189	49	127	117	131	22	844	12.2	2.4	3.6	0.77	0.0048	0.000403	0.015	0.000289	0.335	0.007	0.038	0.074	0.165	0.001476	0.0011	0.8155	0.473	0.100	0.142	0.031	0.0025	1.42	7.83	1491
17	189	50	129	120	135	22	852	12.2	2.5	3.6	0.78	0.0049	0.000403	0.015	0.000305	0.341	0.007	0.039	0.075	0.166	0.001492	0.0012	0.8281	0.482	0.103	0.146	0.032	0.0025	1.45	7.83	1509
18	190	51	132	122	138	23	860	12.2	2.5	3.7	0.79	0.0049	0.000408	0.015	0.000324	0.347	0.007	0.040	0.076	0.168	0.001503	0.0012	0.8343	0.492	0.107	0.150	0.032	0.0025	1.47	7.84	1527
19	190	52	134	124	141	23	866	12.2	2.5	3.7	0.80	0.0050	0.000408	0.015	0.000334	0.352	0.007	0.040	0.076	0.169	0.001512	0.0012	0.8341	0.500	0.110	0.153	0.033	0.0025	1.48	7.84	1542
20	189	53	136	126	144	23	871	12.1	2.5	3.8	0.80	0.0051	0.000405	0.015	0.000336	0.357	0.008	0.041	0.076	0.170	0.001518	0.0013	0.8310	0.507	0.112	0.155	0.033	0.0025	1.48	7.85	1553
21	189	54	139	127	146	23	875	12.1	2.6	3.8	0.81	0.0051	0.000403	0.015	0.000334	0.361	0.008	0.042	0.077	0.170	0.001524	0.0013	0.8256	0.513	0.115	0.156	0.034	0.0025	1.47	7.85	1564
22	188	54	139	127	147	23	873	12.0	2.6	3.8	0.82	0.0051	0.000382	0.016	0.000323	0.361	0.008	0.042	0.076	0.171	0.001529	0.0013	0.8121	0.514	0.115	0.156	0.034	0.0025	1.46	7.85	1563
23	188	54	140	128	149	24	876	12.0	2.6	3.8	0.84	0.0051	0.000357	0.016	0.000320	0.363	0.008	0.042	0.076	0.173	0.001546	0.0013	0.8103	0.517	0.117	0.156	0.034	0.0025	1.45	7.86	1570
24	187	55	141	128	150	24	876	11.9	2.6	3.8	0.84	0.0050	0.000350	0.016	0.000318	0.364	0.008	0.042	0.076	0.173	0.001551	0.0014	0.8072	0.519	0.118	0.156	0.034	0.0024	1.44	7.86	1572
25	187	55	142	129	151	24	877	11.9	2.6	3.8	0.85	0.0050	0.000344	0.016	0.000318	0.365	0.008	0.043	0.076	0.174	0.001556	0.0014	0.8069	0.521	0.119	0.156	0.034	0.0024	1.44	7.87	1575
26	187	55	142	129	152	24	877	11.9	2.6	3.7	0.85	0.0050	0.000337	0.016	0.000318	0.366	0.008	0.043	0.076	0.174	0.001558	0.0014	0.8070	0.522	0.120	0.156	0.034	0.0024	1.43	7.87	1577
27	186	55	143	129	153	24	876	11.8	2.6	3.7	0.85	0.0050	0.000324	0.016	0.000316	0.366	0.008	0.043	0.076	0.174	0.001558	0.0014	0.8070	0.523	0.121	0.155	0.034	0.0024	1.42	7.87	1577
28	185	55	142	129	153	24	873	11.8	2.6	3.7	0.85	0.0050	0.000309	0.016	0.000314	0.366	0.008	0.043	0.076	0.174	0.001554	0.0014	0.8047	0.522	0.120	0.155	0.034	0.0024	1.41	7.87	1572
29	185	55	143	129	153	24	872	11.8	2.6	3.7	0.86	0.0050	0.000298	0.016	0.000310	0.366	0.008	0.043	0.075	0.174	0.001557	0.0014	0.8028	0.522	0.121	0.155	0.034	0.0024	1.40	7.87	1572
30	185	55	143	129	154	24	874	11.8	2.6	3.7	0.87	0.0050	0.000264	0.016	0.000302	0.367	0.008	0.043	0.076	0.175	0.001571	0.0014	0.7999	0.523	0.122	0.156	0.034	0.0024	1.39	7.87	1576
31	185	56	144	130	155	24	875	11.8	2.7	3.7	0.87	0.0050	0.000254	0.016	0.000301	0.368	0.008	0.043	0.075	0.176	0.001578	0.0014	0.7972	0.524	0.123	0.157	0.035	0.0024	1.38	7.87	1578
32	188	58	148	133	159	25	898	12.0	2.7	3.8	0.90	0.0052	0.000284	0.017	0.000314	0.378	0.008	0.044	0.077	0.180	0.001615	0.0014	0.8087	0.538	0.131	0.163	0.035	0.0024	1.39	7.89	1619
33	195	62	157	141	168	26	946	12.5	2.8	4.0	0.93	0.0056	0.000353	0.017	0.000350	0.401	0.009	0.047	0.080	0.186	0.001663	0.0015	0.8397	0.569	0.147	0.173	0.037	0.0026	1.43	7.91	1706
34	198	66	164	147	174	27	978	12.7	2.9	4.2	0.96	0.0058	0.000449	0.017	0.000397	0.417	0.009	0.048	0.082	0.191	0.001699	0.0016	0.8662	0.589	0.163	0.181	0.038	0.0027	1.46	7.92	1766
35	200	72	174	156	184	27	1024	12.9	3.0	4.5	0.98	0.0063	0.000624	0.018	0.000463	0.440	0.009	0.051	0.083	0.194	0.00172	0.0017	0.8954	0.620	0.192	0.192	0.039	0.0029	1.51	7.93	1848
36	199	74	174	156	183	28	1032	12.9	3.0	4.5	0.99	0.0064	0.000801	0.018	0.000591	0.439	0.010	0.050	0.090	0.194	0.00172	0.0017	1.0063	0.615	0.213	0.192	0.039	0.0029	1.70	7.93	1857
37	203	83	186	167	192	27	1104	13.0	3.0	4.8	0.95	0.0071	0.001184	0.017	0.001660	0.464	0.010	0.053	0.116	0.194	0.001719	0.0020	1.8306	0.651	0.277	0.205	0.040	0.0031	2.22	7.93	1976
38	207	83	174	158	177	20	1108	13.2	3.1	4.6	0.70	0.0069	0.001509	0.017	0.004132	0.430	0.0101	0.0483	0.2089	0.203	0.001763	0.0020	2.3106	0.605	0.318	0.192	0.037	0.0029	2.12	7.77	1945
39	209	77	153	139	154	16	1062	13.2	3.3	4.1	0.74	0.0062	0.001660	0.018	0.004474	0.375	0.0091	0.0417	0.2068	2.335	0.005454	0.00184	2.27470	0.527	0.320	0.169	0.034	0.0025	1.89	7.32	1832
40	212	73	141	128	140	15	1036	13.3	3.4	3.9	0.83	0.0058	0.001785	0.018	0.004632	0.341	0.0084	0.0377	0.2024	4.551	0.008039	0.00177	2.23700	0.479	0.319	0.154	0.032	0.0023	1.75	7.18	1768
41	212	71	137	123	137	16	1022	13.3	3.3	3.8	0.84	0.0056	0.001853	0.018	0.004552	0.331	0.0082	0.0364	0.1973	4.604	0.008108	0.00174	2.18200	0.461	0.312	0.149	0.030	0.0022	1.69	7.19	1741

Table 5-2. 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	157	53	115	59	75	29	758	15.5	2.4	2.7	0.34	0.0010	0.00364	0.018	0.00015	0.29	0.000	0.004	0.004	0.180	0.001715	0.0008	0.02	0.168	0.005	0.019	0.003	0.0004	0.17	7.96	1254
2	174	53	111	68	70	28	803	16.6	2.5	4.2	0.67	0.0013	0.00243	0.018	0.00020	0.29	0.001	0.008	0.011	0.194	0.001719	0.0006	0.09	0.204	0.013	0.031	0.006	0.0005	0.29	7.95	1317
3	210	55	117	74	76	26	909	17.3	2.5	5.1	0.82	0.0020	0.00213	0.018	0.00021	0.32	0.002	0.017	0.029	0.194	0.001717	0.0007	0.29	0.236	0.032	0.055	0.013	0.0008	0.64	7.92	1481
4	218	51	112	81	81	26	904	17.0	2.6	4.9	0.96	0.0030	0.00139	0.018	0.00018	0.31	0.004	0.024	0.046	0.194	0.001717	0.0008	0.46	0.284	0.049	0.077	0.019	0.0015	0.92	7.91	1488
5	215	47	108	88	82	25	881	17.7	2.7	4.3	1.05	0.0048	0.00090	0.018	0.00015	0.31	0.005	0.028	0.056	0.194	0.001717	0.0010	0.56	0.329	0.060	0.091	0.023	0.0031	1.08	7.91	1463
6	217	45	109	95	90	25	880	17.0	2.7	3.9	1.01	0.0052	0.00063	0.018	0.00015	0.31	0.005	0.030	0.064	0.194	0.001716	0.0011	0.64	0.363	0.069	0.102	0.025	0.0034	1.20	7.90	1476
7	223	45	112	101	100	25	895	16.4	2.8	3.7	0.98	0.0050	0.00049	0.018	0.00015	0.31	0.006	0.033	0.070	0.195	0.001717	0.0011	0.70	0.393	0.075	0.110	0.027	0.0031	1.29	7.90	1516
8	221	45	112	103	105	25	885	15.7	2.7	3.5	0.96	0.0048	0.00039	0.018	0.00014	0.31	0.006	0.033	0.072	0.195	0.001716	0.0011	0.73	0.407	0.077	0.113	0.028	0.0028	1.33	7.89	1509
9	217	43	110	102	107	25	862	15.1	2.7	3.3	0.97	0.0045	0.00033	0.018	0.00013	0.30	0.006	0.033	0.072	0.194	0.001716	0.0011	0.74	0.408	0.078	0.114	0.028	0.0026	1.34	7.89	1479
10	213	43	109	102	109	25	847	14.6	2.7	3.2	0.97	0.0044	0.00030	0.018	0.00013	0.29	0.006	0.033	0.073	0.193	0.001716	0.0011	0.74	0.408	0.078	0.115	0.029	0.0024	1.34	7.89	1460
11	209	42	108	101	110	25	831	14.2	2.7	3.1	0.99	0.0043	0.00027	0.018	0.00013	0.29	0.006	0.033	0.073	0.193	0.001716	0.0011	0.74	0.405	0.078	0.116	0.029	0.0023	1.33	7.89	1438
12	205	41	108	100	111	25	815	13.9	2.7	3.0	1.02	0.0041	0.00026	0.018	0.00013	0.29	0.006	0.033	0.072	0.192	0.001716	0.0010	0.73	0.401	0.078	0.116	0.028	0.0022	1.31	7.90	1416
13	202	41	107	99	111	25	803	13.6	2.7	3.0	1.04	0.0040	0.00024	0.018	0.00013	0.28	0.006	0.032	0.072	0.192	0.001716	0.0010	0.72	0.398	0.077	0.117	0.028	0.0021	1.29	7.90	1399
14	200	41	106	98	111	25	793	13.4	2.7	3.0	1.04	0.0039	0.00023	0.018	0.00013	0.28	0.006	0.032	0.071	0.191	0.001716	0.0010	0.71	0.394	0.077	0.117	0.028	0.0020	1.27	7.90	1383
15	198	40	106	97	111	25	786	13.2	2.7	2.9	1.04	0.0039	0.00022	0.018	0.00013	0.28	0.006	0.032	0.071	0.191	0.001716	0.0009	0.70	0.393	0.077	0.119	0.028	0.0020	1.26	7.90	1373
16	196	40	105	97	111	25	780	13.0	2.7	2.9	1.04	0.0038	0.00021	0.018	0.00013	0.27	0.006	0.031	0.071	0.191	0.001716	0.0009	0.70	0.391	0.077	0.120	0.028	0.0019	1.25	7.90	1364
17	195	40	105	96	111	25	775	12.8	2.7	2.9	1.05	0.0038	0.00020	0.018	0.00013	0.27	0.006	0.031	0.071	0.190	0.001716	0.0009	0.70	0.389	0.077	0.120	0.028	0.0019	1.25	7.89	1357
18	194	40	104	96	111	25	770	12.7	2.7	2.8	1.05	0.0038	0.00019	0.018	0.00013	0.27	0.006	0.031	0.072	0.190	0.001716	0.0009	0.70	0.387	0.078	0.120	0.028	0.0019	1.26	7.90	1350
19	193	39	104	95	111	25	766	12.6	2.7	2.8	1.06	0.0037	0.00019	0.018	0.00013	0.27	0.006	0.031	0.072	0.190	0.001716	0.0009	0.70	0.385	0.078	0.119	0.028	0.0018	1.27	7.90	1344
20	192	39	104	95	112	25	763	12.5	2.7	2.8	1.07	0.0037	0.00018	0.018	0.00013	0.27	0.006	0.031	0.072	0.191	0.001716	0.0009	0.70	0.384	0.078	0.119	0.028	0.0018	1.27	7.90	1339
21	192	39	104	94	112	25	760	12.5	2.7	2.8	1.09	0.0037	0.00018	0.018	0.00013	0.27	0.006	0.031	0.071	0.191	0.001716	0.0010	0.70	0.383	0.078	0.117	0.027	0.0018	1.27	7.90	1336
22	190	39	104	94	112	25	754	12.3	2.7	2.8	1.10	0.0036	0.00017	0.018	0.00013	0.27	0.006	0.031	0.071	0.191	0.001716	0.0010	0.70	0.380	0.077	0.116	0.027	0.0017	1.27	7.90	1328
23	189	39	104	93	112	25	750	12.2	2.7	2.7	1.11	0.0036	0.00017	0.018	0.00013	0.27	0.006	0.031	0.070	0.191	0.001716	0.0010	0.70	0.378	0.077	0.114	0.027	0.0017	1.26	7.90	1322
24	189	39	104	93	113	25	749	12.2	2.7	2.7	1.11	0.0035	0.00016	0.018	0.00014	0.27	0.006	0.031	0.070	0.191	0.001716	0.0010	0.71	0.378	0.077	0.113	0.027	0.0017	1.26	7.90	1321
25	188	39	104	93	113	25	748	12.1	2.7	2.7	1.11	0.0035	0.00016	0.018	0.00014	0.27	0.006	0.031	0.070	0.192	0.001716	0.0010	0.71	0.378	0.077	0.112	0.027	0.0016	1.26	7.90	1319
26	188	39	104	93	113	25	747	12.1	2.7	2.7	1.12	0.0035	0.00015	0.018	0.00014	0.26	0.006	0.031	0.070	0.192	0.001716	0.0010	0.71	0.377	0.077	0.111	0.027	0.0016	1.25	7.90	1319
27	188	39	104	93	113	25	748	12.1	2.8	2.7	1.12	0.0035	0.00015	0.018	0.00014	0.27	0.006	0.032	0.070	0.193	0.001716	0.0010	0.72	0.377	0.077	0.110	0.027	0.0016	1.25	7.90	1320
28	188	39	104	93	113	25	747	12.1	2.8	2.7	1.13	0.0035	0.00015	0.018	0.00014	0.27	0.006	0.032	0.070	0.193	0.001716	0.0010	0.72	0.376	0.077	0.110	0.027	0.0016	1.25	7.91	1318
29	187	39	104	93	113	25	744	12.1	2.8	2.7	1.14	0.0035	0.00015	0.018	0.00014	0.26	0.006	0.031	0.069	0.193	0.001716	0.0010	0.72	0.375	0.077	0.110	0.027	0.0016	1.23	7.91	1315
30	187	39	104	92	113	25	742	12.0	2.8	2.7	1.14	0.0035	0.00014	0.018	0.00014	0.26	0.005	0.031	0.069	0.193	0.001716	0.0010	0.72	0.374	0.077	0.111	0.027	0.0016	1.22	7.91	1312
31	187	39	104	92	113	25	742	12.1	2.8	2.6	1.15	0.0035	0.00014	0.018	0.00014	0.26	0.005	0.031	0.069	0.194	0.001716	0.0010	0.71	0.373	0.077	0.112	0.027	0.0016	1.20	7.91	1311
32	186	39	104	92	113	25	739	12.1	2.8	2.6	1.16	0.0035	0.00014	0.018	0.00014	0.26	0.005	0.031	0.068	0.194	0.001716	0.0009	0.71	0.371	0.076	0.113	0.026	0.0017	1.18	7.91	1306
33	184	39	103	90	112	26	731	12.0	2.8	2.6	1.21	0.0034	0.00016	0.018	0.00014	0.26	0.005	0.030	0.067	0.194	0.001716	0.0009	0.69	0.364	0.074	0.112	0.026	0.0017	1.14	7.92	1292
34	181	38	102	88	110	26	718	11.9	2.8	2.6	1.29	0.0034	0.00021	0.019	0.00013	0.26	0.005	0.029	0.065	0.194	0.001717	0.0009	0.66	0.353	0.072	0.110	0.025	0.0016	1.10	7.93	1271
35	177	38	101	85	109	27	704	11.8	2.8	2.5	1.32	0.0033	0.00030	0.019	0.00013	0.25	0.005	0.029	0.063	0.194	0.001717	0.0009	0.63	0.341	0.069	0.107	0.024	0.0016	1.06	7.94	1249
36	174	38	100	82	107	27	692	11.7	2.7	2.5	1.31	0.0032	0.00042	0.019	0.00012	0.25	0.005	0.028	0.060	0.194	0.001718	0.0009	0.61	0.330	0.067	0.105	0.024	0.0016	1.02	7.94	1228
37	170	38	100	80	107	27	681	11.6	2.7	2.5	1.29	0.0031	0.00054	0.019	0.00012	0.25	0.005	0.027	0.059	0.193	0.001718	0.0009	0.59	0.320	0.065	0.102	0.023	0.0016	0.98	7.94	1210
38	168	37	99	79	106	28	672	11.4	2.6	2.5	1.26	0.0031	0.00064	0.019	0.00012	0.25	0.005	0.026	0.057	0.192	0.001718	0.0009	0.58	0.312	0.063	0.100	0.022	0.0016	0.96	7.94	1196
39	166	37	99	77	105	28	664	11.3	2.6	2.5	1.24	0.0030	0.00069	0.020	0.00012	0.24	0.004	0.026	0.056	0.191	0.001718	0.0009	0.57	0.307	0.062	0.098	0.022	0.0015	0.94	7.95	1183
40	164	37	98	76	104	28	657	11.2	2.6	2.5	1.23	0.0030	0.00072	0.020	0.00012	0.24	0.004	0.026	0.055	0.189	0.001718	0.0009	0.56	0.303	0.061	0.097	0.022	0.0015	0.93	7.95	1170
41	162	36	97	75	103	28	650	11.1	2.6	2.5	1.21	0.0030	0.00072	0.020	0.00012	0.24	0.004	0.025	0.055	0.187	0.001718	0.0009	0.55	0.299	0.061	0.096	0.021	0.0015	0.92	7.95	1158

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 17, 2018.

Golder (2018) Alternative 7 – Solute Memo Input Parameters and Dust Management. Technical Memorandum, From J. Pilz (Golder) to Anita Marks (Resolution), May 4, 2018, Golder Associates, Inc., Salt Lake City, UT.

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.

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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*