TECHNICAL MEMO

TO: Resolution Copper – Groundwater Modeling Workgroup

FROM: WSP – Gustavo Meza-Cuadra & Doug Oliver

SUBJECT: Responses to Regional Model Queries

DATE: February 13, 2018

Following the Resolution Copper Groundwater Modeling Workgroup held on January 16th, SWCA forwarded an email communication detailing the questions from the U.S. EPA on January 25th (email provided in Appendix A). This memo provides responses to EPA's comments and supporting information.

Questions and Responses

Item #2: Quantify the flow out from Drain (DRN) cells within the reaches of the model and compare these values to the enchanced recharge applied in the stream reach.

EPA comment: These figures depict a losing surface water system (i.e. groundwater levels lower than streambed, recharge magnitudes larger than discharge values, net downward flow). We know this to be true about most arid systems a priori. We also know that hydrologic timing is extremely important to GDEs, but that information is not available from this type of graphical depiction.

- What time-period(s) are depicted here? Are these averaged values?

Response: Areal recharge rates shown in Figure A-1 of WSP's January 9th memo are steady state. Drain discharge rates shown in Figure A-2 are from the final stress period of the calibration period (EOY 2016).

- Consider providing a timeseries or table of both recharge and discharge, and qualitatively analyzing the reasonableness the relative timing of both processes.

Response: Table A presents drain discharge rates for the period 1998-2016 parsed out for each stream reach (see Figure A for reach location numbering corresponding to numbers in Table A). As mentioned above, recharge is steady state, but drain discharge rates are not. However, because recharge is steady state, most of the discharge flows are also relatively constant through time.

Item #4: Present the calibration contours at the end of the calibration period (EOY 2016)

EPA comment: I interpreted this question to be a request for more of a "residual heatmap" of calibration errors. It appears that WSP provided a head contour of the calibrated model. Both would are useful…consider contouring RMSE and presenting a figure.

Response: Figure B is a heatmap of the calibration errors for the targets in the Apache Leap Tuff. The circle diameter is proportional to the magnitude of errors with blue representing overestimates (modeled heads

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greater than measured values) and red representing underestimates (modeled heads lower than measured values).

Item #5: Present a figure with the gaining reaches (i.e., flows to DRN cells), in Devils Canyon, versus the measured flows from surveys conducted by M&A.

EPA comment: It does not appear that WSP has fully addressed this issue. Figures A-1, A-2, A-3 show model recharge boundary conditions, and modeled flows, as well as overlaid perennial reaches. #5 is more akin to a residual analysis where modeled flow volumes and fluxes were compared to observed data.

- How do modeled discharges compare to observed values?
    - Is there adequate data to answer this question?
    - For cases where most of the GW discharge is likely being consumed by ET, riparan veg cover may act as a proxy
- Spatially, the areas of highest drain flow do not correspond very well with M&A's continuously saturated reaches. This is problematic considering that actual in-stream flow "is expected to be only a fraction of the quantity discharging to the drains."
    - By extension, even where drain flows are non-zero and the area is mapped as a perennial reach, the drain flow would have to be much higher than the observed base flow to maintain perennial flow. Are the modeled flows high enough--given the other "built-in" losses--to support base flow in reaches where drain flows and perennial reaches overlap?

Response: Data from the Surface Water Baseline Addendum: Upper Queen Creek, Devils Canyon, and Mineral Creek Watersheds (M&A, 2017) were compared to model-predicted values. M&A has performed occurrence surveys along Devils Canyon since 2003 to identify the presence of water. Continuously saturated reaches were identified between DC 9.1 and DC 7.5 and between DC 6.1 and DC 5.4 (distances are in kilometers upstream of the confluence with Mineral Creek). These reaches are supported by groundwater discharge from the Apache Leap Tuff. Within these two reaches, two monitoring locations have a relatively long and continuous record: DC 8.8 (2004-2016; ~3.5 years missing) and DC 5.5 (2003-2016; ~1.5 years missing). Data from these locations have been evaluated to identify base flow. Figure C shows the measurement points and the continuously saturated reaches as well as the drain cells within the model representing the creek.

Flows from the DRN output in the model were compared to the measured base flow for monitoring stations DC 8.8 and DC 5.5. See the table below for comparison. The median daily base flow (for the entire period of record) for DC 8.8 was 118 gpm (0.264 cfs), and compares favorably with the model-predicted discharge for drain cells in this reach, which sum to 164 gpm . The median daily base flow (for the entire period of record) for DC 5.5 was 39 gpm (0.088 cfs) and compares favorably with the model-predicted discharge for drain cells in reach 97, which sum to 45 gpm. The drains also implicitly represent evapotranspiration, so should be greater than the measured flow values. Because the groundwater model is using steady-state recharge, seasonal variations are not simulated.

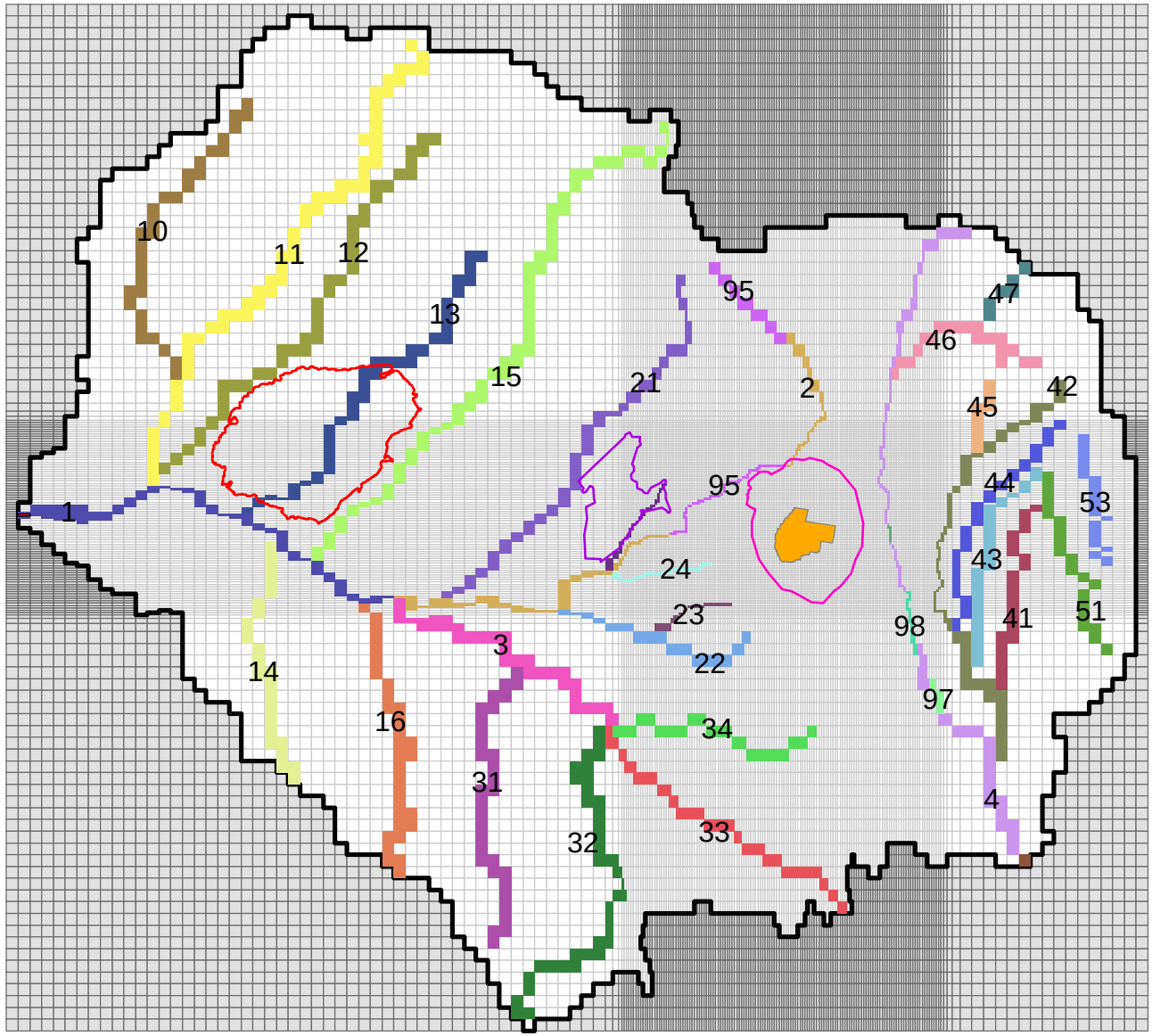
Monitoring station	DC 5.5	DC 8.8
Median daily base flow (gpm)	39	118
Model Reach #	97	98
Predicted drain flow (gpm)	45	164

Item 6: Present the steady state water balance at the beginning of the historical model (stress period 1) representing pre-1910 conditions (before mine dewatering commenced).

EPA comment: It appears that in the steady-state run, recharge is balanced by discharge from drains.

- Are the drains in the #6 Table the same drains that are active during the 2016 period?
    - Drains were added to simulate mine workings, so presumably drain flows would have increased, but Response #1 Table for the 2016 period has a slightly lower drain outflow flux.

      Response: The drains used to simulate discharge to surface streams pre-1910 (listed in the table under response 6 of WSP's January 9th memo) are the same as those used at the end of the historical model at EOY 2016 (listed in the table under response 1 of the January 9th memo). Flow to the underground workings was modeled with the Fractured Well (FWL) package, so is not combined with the drain flows shown. As a result, drain flow rates are lower at EOY 2016 (1,115 gpm) relative to pre-1910 (1,325 gpm) because water levels were reduced by dewatering from 1910 to 2016 and no additional dewatering flows are included in these numbers (dewatering reported separately).



N

1:175,000

0 0.5 1 2 3
Miles

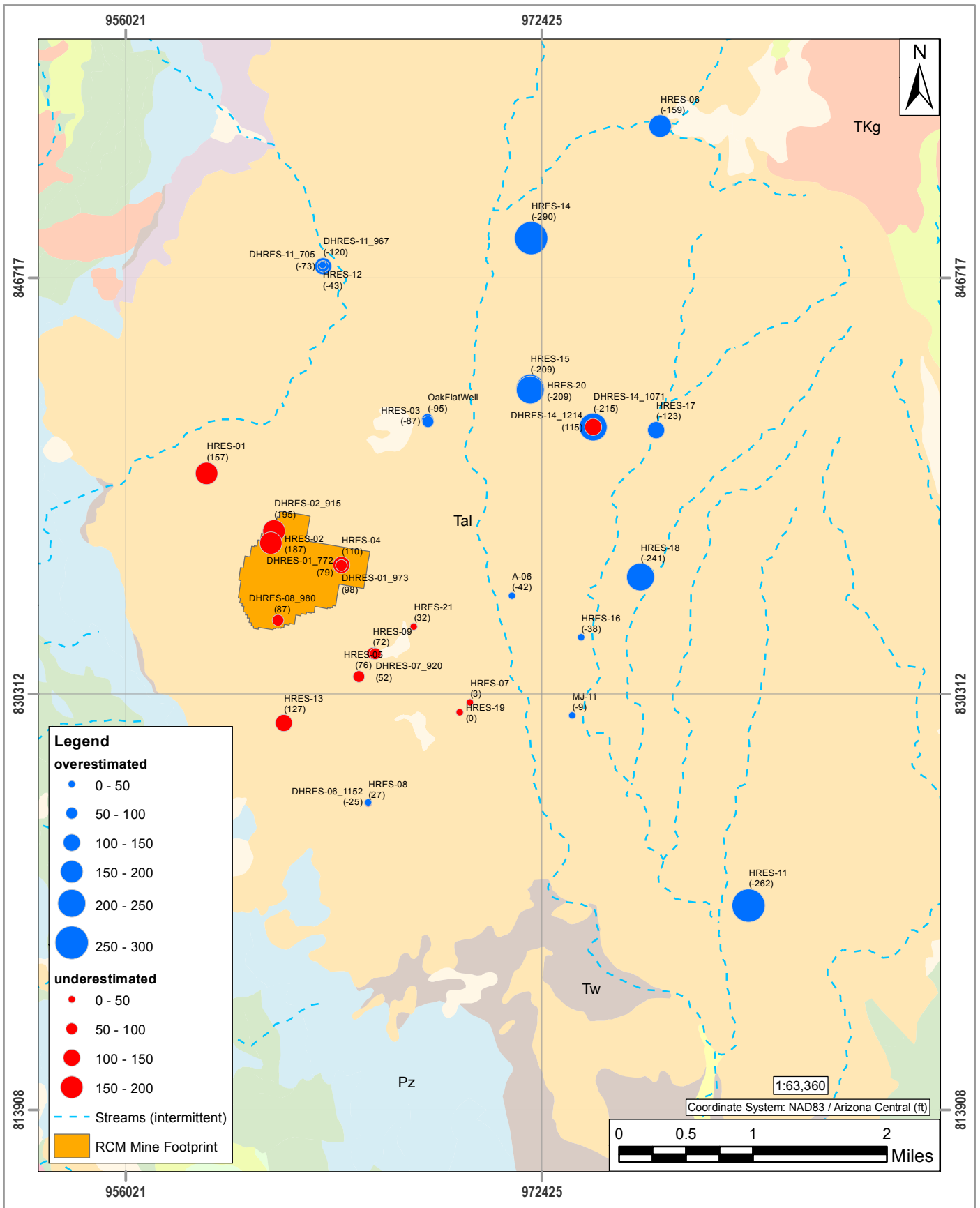
Coordinate System: NAD 1983
2011 StatePlane Arizona Central
FIPS 0202 Ft IntlTransverse Mercator

wsp

Model Drain Reaches

PROJECT:	Regional Groundwater Model		FIGURE #: A
CLIENT:	Resolution Copper		PROJECT #: 31400968
DRAWN:	CDM	CHECKED: GM	DATE: February 2018

Document Path: J:\Resolution\31400680 Model Update 2017\500_Deliverables\Draft Report\Figures\mxd\Figure 3.3 - Boundary Conditions (V10.2).mxd



Apache Leap Tuff Calibration Residuals (EOY 2016)

PROJECT:	Regional Groundwater Model		FIGURE #: B
CLIENT:	Resolution Copper		PROJECT #: 31400968
DRAWN:	GM	CHECKED: DO	DATE: February 2018

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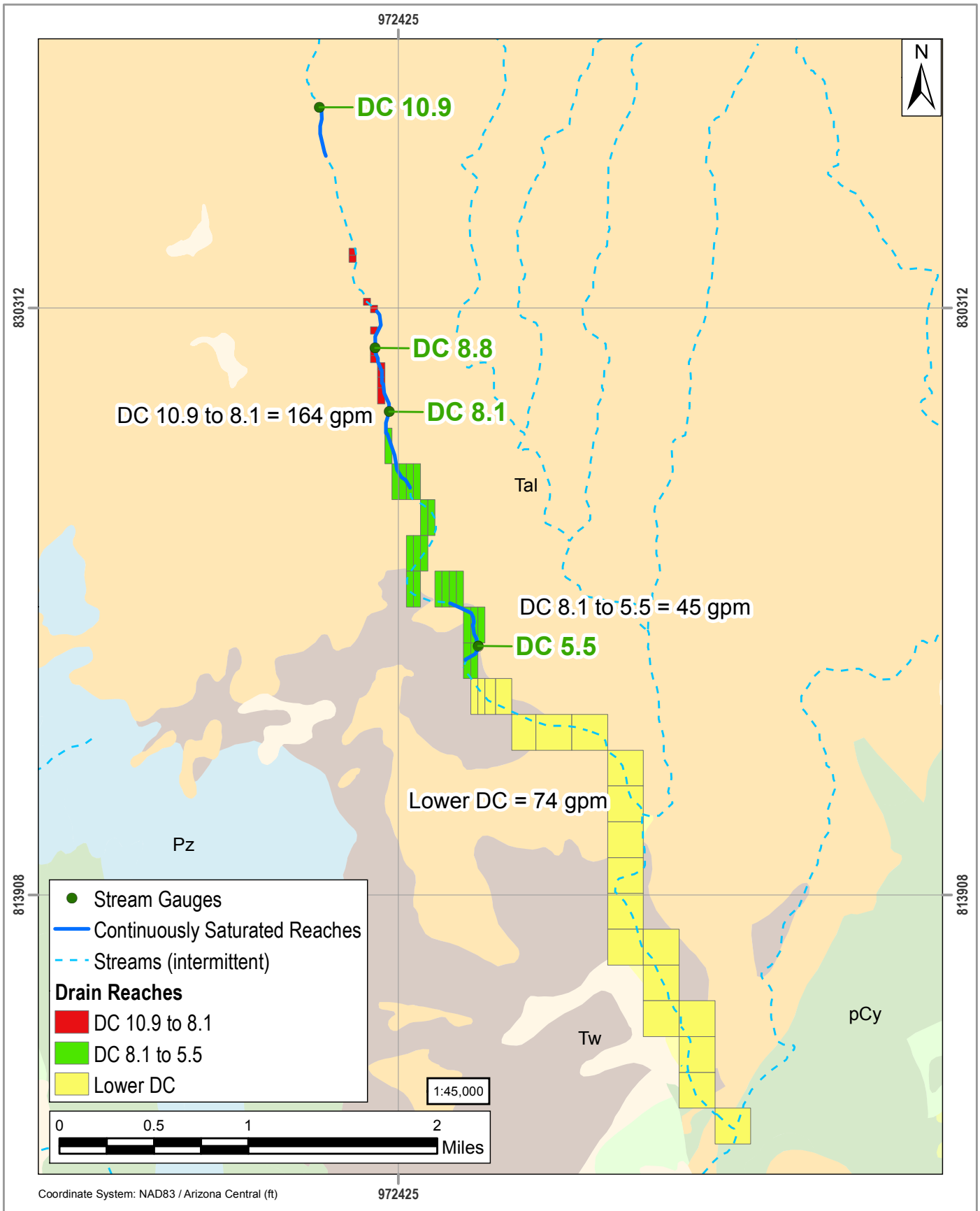

Devils Canyon Drain Flow

PROJECT:	Regional Groundwater Model	FIGURE #:	C
CLIENT:	Resolution Copper	PROJECT #:	31400968.001
DRAWN:	CP	CHECKED: DO	DATE: February 2018

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Table A: Drain Reach Flow Rates - Historical Model 1998-2016

**All flows are in gpm*

		1	2	3	4	5	10	11	12	13	14	15	16	21	22	24	25	31	32	33	34	42	51	95	97	98
Time (d)	Date	Lower Queen Creek	Upper Queen Creek	Arnett Creek	Devils Canyon	Mineral Creek	Millsite Canyon	Hewitt Canyon	Roblas Canyon	Bear Tank Canyon	Reymert Wash	Potts-Whitford Canyon	Alamo Canyon	Silver King Wash	Pacific Canyon	Cross Canyon	Superior Wash	Telegraph Canyon	Wood Canyon	Upper Arnett Creek	Kane Spring Canyon	Rawhide Canyon	Section 13 Canyon	Historical Queen Creek	Devils Creek 5.5	Devils Creek 8.8
31	6/1/1998	-117	-43	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
61	7/1/1998	-53	-43	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
92	8/1/1998	-90	-43	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
123	9/1/1998	-89	-43	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
153	10/1/1998	-48	-43	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
184	11/1/1998	-85	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
214	12/1/1998	-80	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
245	1/1/1999	-85	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
276	2/1/1999	-86	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
304	3/1/1999	-59	-44	-15	-277	-3	-13	-32	-12	-22	-1	-44	-5	-4	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
335	4/1/1999	-89	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
365	5/1/1999	-76	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
396	6/1/1999	-85	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
426	7/1/1999	-34	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
457	8/1/1999	-50	-44	-15	-277	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
488	9/1/1999	-50	-44	-16	-276	-3	-13	-32	-13	-22	-1	-44	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
518	10/1/1999	-54	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
549	11/1/1999	-50	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
579	12/1/1999	-73	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
610	1/1/2000	-52	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
641	2/1/2000	-52	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
670	3/1/2000	-35	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
701	4/1/2000	-49	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
731	5/1/2000	-58	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
762	6/1/2000	-49	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
792	7/1/2000	-48	-45	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
823	8/1/2000	-52	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
854	9/1/2000	-52	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
884	10/1/2000	-51	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
915	11/1/2000	-52	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
945	12/1/2000	-80	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
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1035	3/1/2001	-53	-46	-16	-276	-3	-13	-32	-12	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
1066	4/1/2001	-51	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
1096	5/1/2001	-80	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
1127	6/1/2001	-48	-46	-16	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
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1522	7/1/2002	-51	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
1553	8/1/2002	-48	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-4	-27	-11	0	-72	-168	0	-16	-137
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1706	1/1/2003	-50	-48	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-27	-11	0	-72	-168	0	-16	-137
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1796	4/1/2003	-50	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-27	-11	0	-72	-168	0	-16	-137
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1918	8/1/2003	-47	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
1949	9/1/2003	-47	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
1979	10/1/2003	-34	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2010	11/1/2003	-40	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2040	12/1/2003	-34	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2071	1/1/2004	-40	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2102	2/1/2004	-46	-47	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2131	3/1/2004	-48	-48	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2162	4/1/2004	-34	-48	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2192	5/1/2004	-51	-48	-17	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2223	6/1/2004	-46	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2253	7/1/2004	-51	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2284	8/1/2004	-50	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2315	9/1/2004	-49	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2345	10/1/2004	-51	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2376	11/1/2004	-46	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2406	12/1/2004	-73	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2437	1/1/2005	-46	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2468	2/1/2005	-42	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2496	3/1/2005	-41	-48	-18	-276	-3	-13	-32	-12	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2527	4/1/2005	-34	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2557	5/1/2005	-40	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2588	6/1/2005	-50	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2618	7/1/2005	-34	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2649	8/1/2005	-50	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2680	9/1/2005	-50	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2710	10/1/2005	-80	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2741	11/1/2005	-48	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2771	12/1/2005	-54	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2802	1/1/2006	-42	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2833	2/1/2006	-43	-48	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2861	3/1/2006	-59	-48	-18	-276	-3	-13	-32	-12	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2892	4/1/2006	-40	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2922	5/1/2006	-51	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2953	6/1/2006	-52	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
2983	7/1/2006	-48	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
3014	8/1/2006	-48	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
3045	9/1/2006	-52	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
3075	10/1/2006	-80	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
3106	11/1/2006	-40	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-11	0	-72	-168	0	-16	-137
3136	12/1/2006	-34	-49	-18	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3167	1/1/2007	-48	-49	-18	-276	-3	-13	-32	-13	-22	-1	-45	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3198	2/1/2007	-49	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3226	3/1/2007	-53	-49	-19	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3257	4/1/2007	-51	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3287	5/1/2007	-51	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137

3318	6/1/2007	-42	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3348	7/1/2007	-76	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3379	8/1/2007	-42	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3410	9/1/2007	-48	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3440	10/1/2007	-34	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3471	11/1/2007	-50	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3501	12/1/2007	-34	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3532	1/1/2008	-49	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3563	2/1/2008	-50	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3592	3/1/2008	-67	-49	-19	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3623	4/1/2008	-48	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3653	5/1/2008	-76	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3684	6/1/2008	-42	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3714	7/1/2008	-34	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3745	8/1/2008	-42	-49	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
3776	9/1/2008	-53	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3806	10/1/2008	-34	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3837	11/1/2008	-51	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3867	12/1/2008	-54	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3898	1/1/2009	-51	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3929	2/1/2009	-51	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3957	3/1/2009	-53	-50	-19	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
3988	4/1/2009	-40	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4018	5/1/2009	-34	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4049	6/1/2009	-49	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4079	7/1/2009	-34	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4110	8/1/2009	-56	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4141	9/1/2009	-48	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4171	10/1/2009	-34	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4202	11/1/2009	-49	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4232	12/1/2009	-52	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4263	1/1/2010	-53	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4294	2/1/2010	-42	-50	-19	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4322	3/1/2010	-46	-50	-20	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4353	4/1/2010	-49	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4383	5/1/2010	-37	-50	-20	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4414	6/1/2010	-51	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4444	7/1/2010	-80	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4475	8/1/2010	-50	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4506	9/1/2010	-50	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4536	10/1/2010	-34	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4567	11/1/2010	-40	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4597	12/1/2010	-68	-50	-20	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4628	1/1/2011	-66	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4659	2/1/2011	-49	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	-1	-16	-137
4687	3/1/2011	-50	-50	-20	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4718	4/1/2011	-42	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4748	5/1/2011	-82	-50	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4779	6/1/2011	-34	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4809	7/1/2011	-42	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4840	8/1/2011	-42	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4871	9/1/2011	-34	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4901	10/1/2011	-88	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4932	11/1/2011	-41	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4962	12/1/2011	-76	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
4993	1/1/2012	-46	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5024	2/1/2012	-40	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5053	3/1/2012	-73	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5084	4/1/2012	-59	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5114	5/1/2012	-53	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5145	6/1/2012	-46	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5175	7/1/2012	-34	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5206	8/1/2012	-46	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5237	9/1/2012	-34	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5267	10/1/2012	-80	-51	-20	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5298	11/1/2012	-50	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5328	12/1/2012	-75	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5359	1/1/2013	-47	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5390	2/1/2013	-47	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5418	3/1/2013	-51	-51	-20	-277	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5449	4/1/2013	-47	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5479	5/1/2013	-39	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5510	6/1/2013	-50	-51	-20	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5540	7/1/2013	-63	-51	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5571	8/1/2013	-50	-51	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5602	9/1/2013	-47	-51	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5632	10/1/2013	-82	-51	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5663	11/1/2013	-56	-51	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5693	12/1/2013	-66	-52	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5724	1/1/2014	-52	-52	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5755	2/1/2014	-34	-52	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5783	3/1/2014	-49	-52	-21	-277	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5814	4/1/2014	-54	-52	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5844	5/1/2014	-61	-52	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5875	6/1/2014	-40	-51	-21	-277	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5905	7/1/2014	-49	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5936	8/1/2014	-34	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5967	9/1/2014	-42	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
5997	10/1/2014	-83	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6028	11/1/2014	-42	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6058	12/1/2014	-48	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6089	1/1/2015	-47	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6120	2/1/2015	-47	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6148	3/1/2015	-68	-51	-21	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6179	4/1/2015	-40	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6209	5/1/2015	-54	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6240	6/1/2015	-34	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6270	7/1/2015	-58	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6301	8/1/2015	-51	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6332	9/1/2015	-50	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6362	10/1/2015	-66	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6393	11/1/2015	-34	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6423	12/1/2015	-34	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
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6485	2/1/2016	-50	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6514	3/1/2016	-35	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
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6575	5/1/2016	-66	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6606	6/1/2016	-50	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6636	7/1/2016	-66	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137

6667	8/1/2016	-34	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6698	9/1/2016	-40	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6728	10/1/2016	-84	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6759	11/1/2016	-41	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6789	12/1/2016	-52	-51	-21	-276	-3	-13	-32	-13	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137
6820	1/1/2017	-71	-51	-21	-276	-3	-13	-32	-12	-22	-1	-46	-5	-5	0	0	0	-5	-28	-12	0	-72	-168	0	-16	-137

Oliver, Douglas

From:	Chris Garrett <cgarrett@swca.com>
Sent:	Thursday, January 25, 2018 3:59 PM
To:	Gluski, Heather (RC); Donna Morey; Rasmussen, Mary C -FS; DeAnne Rietz; Joe Frank (EXT); Gabriele Walser HydroGeo; Laurie Brandt #EXTERNAL#; Nick Enos; Michael Henderson; jknight@usgs.gov; Meza-Cuadra, Gustavo; Congdon, Roger D -FS; Stroope, Timothy L -FS; Olsen, Gregory S -FS; jgurrieri@fs.fed.us; Bret C. Esslin; James Wells; Victoria Boyne; KELLY, PATRICKJ; James Ruff; Oliver, Douglas; magirl@usgs.gov; Wickham, Matt (G&I); Todd Keay; Charles Coyle; cameo.flood@tetratech.com; Morissette, Mary (RC); Jim Butler; Peacey, Victoria (RC); Timothy Bayley
Subject:	Resolution GW Modeling - Additional follow-up action items

Hi all –

Following the groundwater meeting, we received some additional thoughts from EPA that lend themselves to action items. I'm circulating those here for RCM/WSP to take into account as they prepare follow-up documentation prior to the next groundwater modeling workgroup meeting (2/13). I am taking the liberty of adding my interpretation of whether these are simple clarifications or requests for additional output.

Item #2: Quantify the flow out from Drain (DRN) cells within the reaches of the model and compare these values to the enhanced recharge applied in the stream reach.

EPA comment: These figures depict a losing surface water system (i.e. groundwater levels lower than streambed, recharge magnitudes larger than discharge values, net downward flow). We know this to be true about most arid systems *a priori*. We also know that hydrologic timing is extremely important to GDEs, but that information is not available from this type of graphical depiction.

- What time-period(s) are depicted here? Are these averaged values? [CLARIFICATION REQUESTED]
- Consider providing a timeseries or table of both recharge and discharge, and qualitatively analyzing the reasonableness the relative timing of both processes. [ADDITIONAL OUTPUT REQUESTED]

Item #4: Present the calibration contours at the end of the calibration period (EOY 2016)

EPA comment: I interpreted this question to be a request for more of a "residual heatmap" of calibration errors. It appears that WSP provided a head contour of the calibrated model. Both would are useful…consider contouring RMSE and presenting a figure. [ADDITIONAL OUTPUT REQUESTED]

Item #5: Present a figure with the gaining reaches (i.e., flows to DRN cells) in Devils Canyon, versus the measured flows from surveys conducted by M&A.

EPA comment: It does not appear that WSP has fully addressed this issue. Figures A-1, A-2, A-3 show model recharge boundary conditions, and modeled flows, as well as overlaid perennial reaches. #5 is more akin to a residual analysis where modeled flow volumes and fluxes were compared to observed data.

- How do modeled discharges compare to observed values?
  - Is there adequate data to answer this question? [CLARIFICATION REQUESTED]
  - For cases where most of the GW discharge is likely being consumed by ET, riparan veg cover may act as a proxy [See Chris comment]
- Spatially, the areas of highest drain flow do not correspond very well with M&A's continuously saturated reaches. This is problematic considering that actual in-stream flow "is expected to be only a fraction of the quantity discharging to the drains."

- By extension, even where drain flows are non-zero and the area is mapped as a perennial reach, the drain flow would have to be much higher than the observed baseflow to maintain perennial flow. Are the modeled flows high enough--given the other "built-in" losses--to support baseflow in reaches where drain flows and perennial reaches overlap? [See Chris comment]

Chris comment: There's a lot packed into this EPA comment, and it ties in with one major concern I heard at the meeting. I believe two of the action items already assigned were related to this (#4 and #7 below). I'll try to restate this all as a general concern, which I think I heard at the meeting: It feels like we don't yet have any method or comparison that gives us comfort that the drain/recharge components used in the groundwater model match the real world. We ideally need some way to come at this question using available real-world data. [ADDITIONAL OUTPUT REQUESTED]

Item 6: Present the steady state water balance at the beginning of the historical model (stress period 1) representing pre-1910 conditions (before mine dewatering commenced).

EPA comment: It appears that in the steady-state run, recharge is balanced by discharge from drains.

- Are the drains in the #6 Table the same drains that are active during the 2016 period? [CLARIFICATION REQUESTED]
  - Drains were added to simulate mine workings, so presumably drain flows would have increased, but Response #1 Table for the 2016 period has a slightly lower drain outflow flux. [CLARIFICATION REQUESTED]

Thanks everyone – and note that we've scheduled more time for the next meeting on 2/13 so we can discuss these more thoroughly than in January

- C

From: Chris Garrett
Sent: Tuesday, January 16, 2018 3:50 PM
To: 'Gluski, Heather (RC)' <Heather.Gluski@riotinto.com>; Donna Morey <dmorey@swca.com>; 'Rasmussen, Mary C -FS' <mcrasmussen@fs.fed.us>; DeAnne Rietz <drietz@swca.com>; Joe Frank (EXT) <jfrank@hydrogeo.com>; 'Gabriele Walser HydroGeo' <gwalser@hydrogeo.com>; Laurie Brandt #EXTERNAL# <lbrandt@dowl.com>; 'Nick Enos' <NEnos@bgcengineering.ca>; Michael Henderson <mhenderson@bgcengineering.ca>; 'jknight@usgs.gov' <jknight@usgs.gov>; 'gustavo.meza-cuadra@wsp.com' <gustavo.meza-cuadra@wsp.com>; 'Congdon, Roger D -FS' <rcongdon@fs.fed.us>; 'Stroope, Timothy L -FS' <timothylstroope@fs.fed.us>; 'Olsen, Gregory S -FS' <golsen@fs.fed.us>; 'jgurrieri@fs.fed.us' <jgurrieri@fs.fed.us>; 'Bret C. Esslin' <bcesslin@azwater.gov>; 'James Wells' <JWells@everettassociates.net>; Victoria Boyne <vboyne@swca.com>; 'KELLY, PATRICKJ' <kelly.patrickj@epa.gov>; 'James Ruff' <JRuff@azgfd.gov>; 'Oliver, Douglas' <douglas.oliver@wsp.com>; 'magirl@usgs.gov' <magirl@usgs.gov>; 'Wickham, Matt (G&I)' <Matt.Wickham1@riotinto.com>; 'Todd Keay' <tkeay@elmontgomery.com>; Charles Coyle <ccoyle@swca.com>; 'cameo.flood@tetratech.com' <cameo.flood@tetratech.com>; 'Morissette, Mary (RC)' <Mary.Morissette@riotinto.com>; 'Jim Butler' <JButler@parsonsbehle.com>; 'Peacey, Victoria (RC)' <Victoria.Peacey@riotinto.com>; 'Timothy Bayley' <tbayley@elmontgomery.com>
Subject: Springs catalog & GW meeting action items

Hi all –

Thank you all for joining the meeting today. Two follow-up items:

Springs Catalog

Donna reminded me that the springs catalog actually is posted on the public-facing website, and it can be easily downloaded: http://www.resolutionmineeis.us/documents/montgomery-westland-seep-spring-catalog-20171003

I believe the Resolution catalog contains 24 springs, with substantial detail included for each. By contrast, the springs database that the NEPA team created internally to support the alternatives process contains over 1,000 springs. But…that database also covers a much, much bigger area including all the way down to the Peg Leg alternative. If you compare apples-to-apples, the NEPA team database probably contains about 36 springs within the same area looked at in the Resolution catalog. However, the NEPA spring database contains almost no information whatsoever about each spring except a location. We fully expect that many springs captured in the NEPA lsit are seasonal seeps supported by local precip, not groundwater.

The Resolution catalog represents the most complete look at the major springs that actually have persistent water, support riparian vegetation, and are within the area expected to be impacted by mine dewatering. We can't rule out that there aren't some additional seeps in the area, but the catalog should serve as a solid base to guide the GDE list.

Action Items

1. Forest Service/SWCA – Continue internal discussions about submittal of raw model files
2. Forest Service/SWCA – Research the best way to obtain and incorporate the Anderson & Woessner reference
3. Forest Service/SWCA – Incorporate spring information into the GDE list, and expand the GDE document to incorporate more supporting data to justify inclusion
4. RCM/WSP – Produce tables to quantify drain and recharge cell graphical depictions that were provided
5. Forest Service/SWCA – Background task: if available, bring forward any pertinent, adjacent information from Pinto Valley or Carlotta.
6. RCM – Provide suggestion of reports that reference pumping tests or other useful information to support interpretation of Apache Leap Tuff/Whitetail Conglomerate hydraulic properties, and specifically anisotropy
7. RCM – For discussion next meeting, consider data sources that allow a reality check on model drain/recharge values (Ones mentioned in the meeting today as possibilities: water balance, baseflow separation work, WestLand surveys)

Hopefully that captured the action items discussed. If I missed one, or even if there is an additional question we didn't get to that you feel would be worth investigating, please email me to let me know.

Thanks!

- C

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SWCA
ENVIRONMENTAL CONSULTANTS