Test Number	#1
Participants	Brad Carr, Eva Smith, Danial Ciraula; Justin Bowen; Chau Ha; Tessa Ray-Cozzens; Matthew Elliot; Ye Zhang
Location	Blair Wallis road (FS 705); Buford, Wyoming
Name	BW7 constant-rate pumping test
Weather condition	High: 60F; low 40F; Cloudy in the am; afternoon thunderstorm with strong wind; given this time of the year and historical WL monitoring data, infiltration of rain to the water table is likely insignificant due to low soil moisture content and high ET in the overlying unsaturated zone.
Discharge point	Into the wetland north of the well field. Next & future test will send water to wetland downstream from BW4, which was not in communication with BW7 during the 2017 44-hr test.
WL 1-day prior (Stephanie)	Stephanie will send data this week.
WL before test (Chau Ha)	Pumping Test 09/11/19. Weather: Cloudy DTW Before PumpingTest Well | Time | DTW | Note 1 | 9:51 | 14.11 | From top of metal casing, at red marker 6 | 10:04 | 14.555 | From top of metal casing, at red marker 7 | 9:42 | 12.84 | From top of the blue casing. No marker 8 | 10:12 | 14.1 | From top of metal casing, at red marker 9 | 10:17 | 13.6 | From top of metal casing, at red marker
Start time of test	9/11/2019; 11:16:40
Target rate	5~6 gpm; Next & future test on BW7 will target at 3 gpm.
Duration	5 hours
Purpose	• Dewatering the unconfined fractured rock to create a large cone of de-saturation; • Seismic and ERT surveys to monitor & detect saturation change; • Determine connection between fractured bedrock & Blair Creek streamflow; • Collect drawdown data among BW 1, 6, 7, 8, 9 to determine the strength of inter-well connectivity with BW7.
Flow Rate (gpm) Daniel Ciraula & Justin Bowen Both 8-gallone graded bucket and inline flowmeter used; Comparison of bucket with inline flowmeter yielded a similar rate.	Wellhead flow valve rule: use small step (<1/10 of a full turn); turn right to constrict the flow ("righty tighty"); turn left to increase flow. Next time, please write down both elapsed time (using a stopwatch) & the absolute time: Bucket test: *min:sec* (elapsed time since start of test) – Daniel "Time to fill" bucket TIME FLOW RATE (gpm) 7- 8:05 11:24 7.9 15- 16:28 11:42 5.5 30- 31:36 11:47 5.0 60- 61:52 12:17 4.3 64- 65:48 12:21 4.4 120- 125:55 13:17 1.4 130- 131:42 13:27 4.7 Inline flowmeter reading at the BW7 wellhead: Elapsed *min:sec* TIME FLOW RATE (gpm) ~70 min 12:27 6.45 rain started 83:49 12:41 5.49 rain stopped at 80 min elapsed time TIME - FLOW RATE (gpm) - Justin & Ye 13:42 6.6 13:45 5.7 13:50 5.2 14:00 2.9 14:10 2.7 14:30 2.82 14:55 2.75 15:15 2.66 15:22 4.62 15:33 5.12

	3 minute interruption flow rate is 0 Let's write down the exact time flow stopped. 3-more interruptions flow rate is 0 16:06 - 5.33 2 minute interruption flow rate is 0 2-3 minute interruptions flow rate is 0
BW7 drawdown (Chau Ha) *"Min" is the elapsed time since the start of pumping test*	
Monitoring well drawdown	Chau Ha: ('Time' is absolute time)

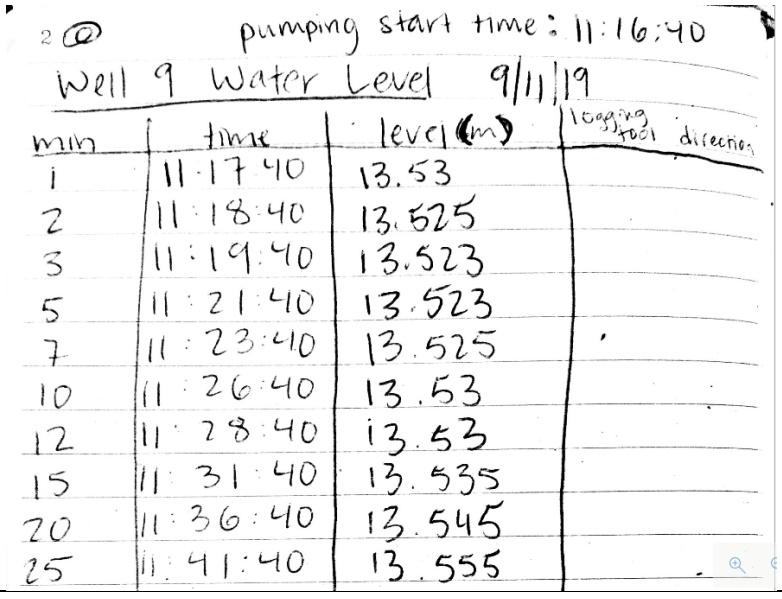
BW 7 Water Drawdown Information

Min	Time	DTW	Notes
1	11:17	13.755	
2	11:18	14.1	
3	11:19	14.305	
5	11:21	14.745	
7	11:23	15.04	
10	11:26	15.59	
12	11:28	15.555	
15	11:31	15.79	
20	11:36	16.165	
25	11:41	16.51	
30	11:46	16.88	
40	11:56	17.315	
50	12:06	17.78	
60	12:16	18.055	
75	12:31	22.315	@12:24: flowrate reduced
90	12:46	26.105	
120	13:17	21.365	@13:20: flowrate reduced again
150	13:47	26.15	
180	14:17	20.695	
240	15:18	17.77	15:20: 17.00; 15:52: 17.695
300	16:21	17.76	Pump died

Observed Wells Drawdown Information

Time	BW1	Time	BW6	Time	BW8
15:36	14.11	15:43	14.59	15:41	14.435

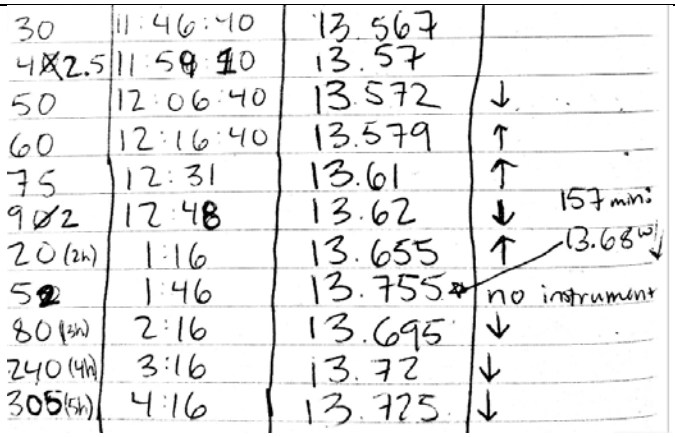
Eva Smith: ('min' is elapsed time since pump turns on)



2 pumping start time: 11:16:40

Well 9 Water Level 9/11/19

min	time	level (m)	logging tool direction
1	11:17:40	13.53	
2	11:18:40	13.525	
3	11:19:40	13.523	
5	11:21:40	13.523	
7	11:23:40	13.525	
10	11:26:40	13.53	
12	11:28:40	13.53	
15	11:31:40	13.535	
20	11:36:40	13.545	
25	11:41:40	13.555	

	
Transducer Data	Will be downloaded after the next well test & WL recovery.
Water Chemistry	Clear water mostly throughput the test; cloudy water was observed from time to time, which likely damaged the inline flowmeter (which stopped working ~ 1 hr after the test started). 1:11 pm: pH = 7.4; Oakyon meter: TDS = 190 ppm; 9.5 C; water sample taken in bottle
Comments	A constant pumping rate was ***not*** maintained throughout the test duration. Similar to the 2017 test, pumping rate varies, from 6 to 3 gpm, and it was difficult to maintain a constant rate. Generator malfunctioned & stopped after ~4:15 hours of pumping; adding fuel and restarting did not fix the problem: it died repeatedly even with a full fuel tank. Suspected reason for failure according to Brad: the Champion brand of generator "does not like low fuel level". For future test, generator needs close monitoring. Minor glowing debris— in-line flowmeter (situated at the pumping well head) killed again. Throughout the rest of the test, bucket test has to be used at the discharge point for flow rate monitoring. In future test, we need to check the fuel level in generator every 3 hours (Matt). It's also important to have walki talki among test participants. Minimum of 3 persons to monitor the well test: person 1 at pumping wellhead for DTW; person 2 at pumping wellhead to monitor generator & the flow rate valve; person 3 at discharge point to measure flow rate using a bucket test and communicate with 2 using a walki talki (3 must tell 2 to increase or decrease flow rate, test the actual rate, and feedback to 2). During logging of a monitoring well, a 4th person needs to take manual DTW at the logging borehole where transducer is taken out.

Test Number	#2
Participants	Brad Carr, Chau Ha; Ye Zhang
Location	Blair Wallis road (FS 705); Buford, Wyoming
Name	BW7 step drawdown test after the (failed) pumping test the week prior
Discharge point	Set towards BW4, further east of BW1. Because BW4 is hydraulically isolated from BW1 and the rest of the bedrock wells.

WL before test (Chau Ha)

DTW Before Test			Notes
BW1	9:34	14.135	Deeper than 09/11/19 : 2 cm
BW6	9:31	14.565	Deeper than 09/11/19 : 1 cm
BW7	9:26	12.965	Deeper than 09/11/19 : 1 cm
BW8	9:42	14.21	Deeper than 09/11/19 : 10 cm
BW9	9:37	13.704	Deeper than 09/11/19 : 10 cm

Start time of test	9/18/2019; 10:05
Target rate	3 gpm
Duration	8 hours
Purpose	• Determine the appropriate pumping rate.

Flow Rate (gpm)Ye Zhang & Chau Ha

8-gallon bucket test

Time	Min.Sec	Min	GPM	Notes
10:10	220	2.333333	3.43	
10:16	300	3	2.67	
10:21	352	3.866667	2.07	
10:26	336	3.6	2.22	
10:29	148	1.8	4.44	
10:33	201	2.016667	3.97	
10:36	205	2.083333	3.84	
10:40	215	2.25	3.56	
10:44	216	2.266667	3.53	
10:48	222	2.366667	3.38	
10:53	230	2.5	3.20	
10:57	222	2.366667	3.38	
11:08	220	2.333333	3.43	
11:54	235	2.583333	3.10	
12:17	243	2.716667	2.94	
12:30	255	2.916667	2.74	
12:50	249	2.816667	2.84	
13:01	253	2.883333	2.77	
13:09	301	3.016667	2.65	
13:18	248	2.8	2.86	Inc
13:24	153	1.883333	4.25	Inc
13:34	141	1.683333	4.75	
13:45	151	1.85	4.32	
14:05	202	2.033333	3.93	
14:22	202	2.033333	3.93	
14:38	208	2.133333	3.75	
14:53	208	2.133333	3.75	
15:22	211	2.183333	3.66	A
15:52	216	2.266667	3.53	A|B

16:02	218	2.3	3.48	B
16:17	219	2.316667	3.45	
16:40	226	2.433333	3.29	
16:53	224	2.4	3.33	
17:10	218	2.3	3.48	
17:30	212	2.2	3.64	
17:35	129	1.483333	5.39	
17:43	131	1.516667	5.27	
17:58	142	1.7	4.71	
18:21	233	2.55	3.14	
18:33	220	2.333333	3.43	
18:40	233	2.55	3.14	
18:48	230	2.5	3.2	

BW7 drawdown (Chau Ha)

"Min" is the elapsed time since the start of pumping test

Time	Min	DTW	Note
10:05	1	13.61	1st rate
	2	13.684	
	3	13.96	
	4	14.015	
	5	14.04	
	6	14.05	
	7	14.06	
	8	14.06	
	9	14.095	
	10	14.09	
	11	14.08	
	12	14.04	
	13	14.039	
	14	14.02	
	15	14	
	16	14.005	
	17	14.005	
	18	13.995	
	19	13.995	
	20	13.985	
	30	14.505	
	40	14.795	
	50	14.955	
	60	15.09	
	70	15.245	
	80	15.361	
	90	15.41	
	100	15.49	
	110	15.455	
	120	15.425	
	136	15.38	
	140	15.345	

	150	15.28	
	160	15.185	
	174	15.195	
	180	15.18	
13:14	190	15.27	
13:18	1	15.245	2nd rate
	2	15.28	
	3	15.245	
	5	15.515	
	6	15.48	
	7	15.798	
	8	15.85	
	9	16.16	
	10	16.13	
	11	16.21	
	12	16.375	
	13	16.5	
	14	16.62	
	15	16.73	
	16	16.84	
	17	16.93	
	18	17.01	
	19	17.085	
	20	17.155	
	21	17.22	
	22	17.305	
	23	17.365	
	24	17.45	
	25	17.52	
	28	17.725	
	29	17.775	
	30	17.83	
	40	19.07	
	50	20.355	
	60	21.165	
	70	21.69	
	80	22.115	
	90	22.56	
	106	23.045	
	110	23.09	
	120	23.175	
	130	23.26	
	141	23.315	
	150	23.22	
	160	23.135	

	170	23.05	
	180	22.97	
	190	22.93	
	205	22.9	
	217	22.915	
	235	22.95	
	254	23.19	
	270	28.32	
	283	28.32	
	306	26.32	
	318	26.11	

Monitoring well drawdown

Chau Ha

Monitoring Wells				
BW1	11:37	14.135	11:57	14.13
BW6	11:37	14.59	11:57	14.59
BW8	11:40	14.378	11:59	14.393
BW9	11:41	13.733	12:00	13.74

Transducer Data

Will be downloaded after the next well test & WL recovery.

Water Chemistry

Comments

Water discharged was clear throughout the test.

Before the step test, WL in all 5 wells (BW 1, 6, 7, 8, 9) were measured. They were compared to their **pre-test** levels on last Wed (i.e., 9/11 test that ended after 5 hrs). For 3 wells, WL is 1 cm lower; for 2 wells, WL is 10 cm lower. Thus, WL has not changed significantly. The water table decline is expected for this time of the year, as most rainfall could not infiltrate to bedrock to contribute to GW recharge due to the dry unsaturated zone after a long dry summer. And, in my view, the decline is likely due to **lateral GW flow** because the water table is tilted in Blair, creating a natural gradient to drive lateral flow. The lateral GW flow in this hillslope likely contributes and sustains base-flow in nearby streams. Finally, though ET may contribute to water table decline as well, the site is pretty exposed with few vegetation other than grasses (they are dry and yellow in color and not likely contributing much ET). Overall, the pre-test water table and moisture condition for the next pumping test is likely similar to the one surveyed on 9/10.

Couldn't maintain a constant rate throughout the test. The most stable rate observed is around 3.0 gpm.

Test Number	#3
Participants	Chau Ha, Matt Elliot, Stephanie Phillips, Eva Smith, Daniel Ciraula, Tessa Ray-Cozzens, Ye Zhang
Location	Blair Wallis road (FS 705); Buford, Wyoming
Name	BW7 48-Hour Pumping Test
Discharge point	Set towards BW4, further east of BW1. Because BW4 is hydraulically isolated from BW1 and the rest of the bedrock wells.

WL before test (Chau Ha)

DTW Before Test		
BW1	9:31	13.105
BW6	9:34	14.585
BW7	9:18	13.105
BW8	9:26	14.338
BW9	9:29	13.825

Start time of test	9/20/2019; 10:00:00
Target rate	~3.5 gpm
Duration	47.35 hours
Purpose	• Dewatering the unconfined fractured rock to create a large cone of de-saturation; • Seismic and ERT surveys to monitor & detect saturation change; • Determine connection between fractured bedrock & Blair Creek streamflow; • Collect drawdown data among BW 1, 6, 7, 8, 9 to determine the strength of inter-well connectivity with BW7.

Flow Rate (gpm) Daniel Ciraula & Justin Bowen

8-gallone graded bucket used;

Wellhead flow valve rule: use small step (<1/10 of a full turn); turn right to constrict the flow ("righty tighty"); turn left to increase flow.

Time	Elapsed Time	Min	Min/Sec	Min	Rate	Notes
10:03	0:03:00	0003	218	2.30	3.48	
10:07	0:07:00	0007	105	1.08	1.85	Fills 2 Gals
10:10	0:10:00	0010	152	1.87	4.29	
10:14	0:14:00	0014	210	2.17	3.69	
10:21	0:21:00	0021	213	2.22	3.61	
10:26	0:26:00	0026	217	2.28	3.50	
10:32	0:32:00	0032	219	2.32	3.45	
10:36	0:36:00	0036	213	2.22	3.61	
10:43	0:43:00	0043	214	2.23	3.58	
10:56	0:56:00	0056	250	2.83	2.82	
11:07	1:07:00	0067	319	3.32	2.41	
11:12	1:12:00	0072	227	2.45	3.27	
11:27	1:27:00	0087	200	2.00	4.00	
11:34	1:34:00	0094	226	2.43	3.29	
11:51	1:51:00	0111	227	2.45	3.27	
11:59	1:59:00	0119	228	2.47	3.24	
12:35	2:35:00	0155	480	5.33	1.50	
12:50	2:50:00	0170	239	2.65	3.02	
13:10	3:10:00	0190	234	2.57	3.12	
13:20	3:20:00	0200	259	2.98	2.68	
13:33	3:33:00	0213	212	2.20	3.64	
13:45	3:45:00	0225	214	2.23	3.58	
14:06	4:06:00	0246	226	2.43	3.29	

14:15	4:15:00	0255	231	2.52	3.18	
14:31	4:31:00	0271	216	2.27	3.53	
14:40	4:40:00	0280	217	2.28	3.50	
14:54	4:54:00	0294	220	2.33	3.43	
15:10	5:10:00	0310	224	2.40	3.33	
15:26	5:26:00	0326	310	3.17	2.53	
15:33	5:33:00	0333	306	3.10	2.58	
15:39	5:39:00	0339	205	2.08	3.84	
15:45	5:45:00	0345	236	2.60	3.08	
15:51	5:51:00	0351	239	2.65	3.02	
15:56	5:56:00	0356	243	2.72	2.94	
16:02	6:02:00	0362	151	1.85	4.32	
16:06	6:06:00	0366	215	2.25	3.56	
16:25	6:25:00	0385	237	2.62	3.06	
16:41	6:41:00	0401	239	2.65	3.02	
17:03	7:03:00	0423	255	2.92	2.74	
17:09	7:09:00	0429	214	2.23	3.58	
17:30	7:30:00	0450	215	2.25	3.56	Small rain @ 5:35
17:51	7:51:00	0471	222	2.37	3.38	
18:18	8:18:00	0498	216	2.27	3.53	
18:47	8:47:00	0527	227	2.45	3.27	
20:10	10:10:00	0610	246	2.77	2.89	
20:33	10:33:00	0633	208	2.13	3.75	
21:50	11:50:00	0710	226	2.43	3.29	
22:05	12:05:00	0725	209	2.15	3.72	
1:10	15:10:00	0910	211	2.18	3.66	21-Sep
1:35	15:35:00	0935			3.78	
4:25	18:25:00	1105			3.84	
9:02	23:02:00	1382	143	1.72	4.66	
9:40	23:40:00	1420	120	1.33	6.00	
10:10	24:10:00	1450	222	2.37	3.38	
10:32	24:32:00	1472	217	2.28	3.50	
12:53	26:53:00	1613	328	3.47	2.31	
13:44	27:44:00	1664	222	2.37	3.38	
14:48	28:48:00	1728	204	2.07	3.87	maintained long
15:16	29:16:00	1756	222	2.37	3.38	
15:50	29:50:00	1790	300	3.00	2.67	
16:02	30:02:00	1802	240	2.67	3.00	
20:15	34:15:00	2055	213	2.22	3.61	
21:55	35:55:00	2155	204	2.07	3.87	22-Sep
3:53	41:53:00	2513	210	2.17	3.69	
9:35	47:35:00	2855	211	2.18	3.66	

BW7 drawdown (Chau Ha)

Time	Min	DTW	Notes
10:01	1	13.585	

"Min" is the elapsed time since the start of pumping test

10:02	2	13.78	
10:03	3	13.845	
	5	13.865	
	7	13.81	
	10	14.05	
	12	14.26	
	15	14.475	
	20	14.645	
	25	14.825	
	30	14.985	
	40	15.29	
	50	15.58	
	75	15.255	
	90	15.18	
	120	16.06	
	150	15.81	
	180	15.79	
	240	17.47	
	300	20.088	
	360	19.87	
	420	20.27	
	480	23.18	
	600	23.11	
	720	26.14	
	910	26.12	
	935	26.485	
	1097	26.08	
	1105	26.35	
	1440	45.69	
	1800	43.66	
	2160	40.86	
	2520	40.4	
	2855	48.06	

Monitoring well drawdown

9/20/2019	BW1	15:35	14.125	17:27	14.15	18:50	14.13
9/20/2019	BW6	15:35	14.64	17:26	14.655	18:50	14.674
9/20/2019	BW8	15:35	14.707	17:21	14.76	18:50	14.803
9/20/2019	BW9	15:35	13.965	17:23	14.013	18:50	14.503
9/21/2019	BW1	9:18	14.14				
9/21/2019	BW6	9:18	14.685				
9/21/2019	BW8	9:18	14.969				
9/21/2019	BW9	9:18	14.185				
9/26/2019	BW1	14:06	14.06				

	9/26/2019	BW6	12:48	14.596			
	9/26/2019	BW8*	13:00	14.955			
	9/26/2019	BW9	8:45	14.15			
	9/26/2019	BW7	11:30	13.232			

Transducer Data	Stephanie have downloaded the transducers (BW 1, 6, 7, 8, 9) and reset them to 15 min monitoring.
Water Chemistry	Clear water mostly throughput the test 2:22 pm: pH = 7; Oakyon meter: TDS = 163 ppm; 10.5 C; water sample taken in bottle
Comments	Water discharged was clear throughout the test. Before the pumping test, WL in all 5 wells (BW 1, 6, 7, 8, 9) were measured. The pre-pumping DTW of all wells were essentially similar to those measured in the step test two days prior. We tried to maintain a constant rate of 3.0 gpm, but the actual rate varied throughout the test. At some points, the rate jumped to 6 gpm while at some other points it went down to less than 2 gpm. The exact reason is unknown but can be due to the fracture network. The rate became more stable later on during the test, fluctuating around 3.5 gpm, though still going down to less than 3 gpm sometimes. The BW7 DTW correlated with the pumping rate: when the rate was high, dtw increased and vice versa. The **max drawdown** was 34.955m. After the pump was turned off for the seismic survey to take place, the **water level recovered 19.06 m** right after the seismic survey (about 3 hours). The last DTW reading is 48.06 m at 3.66gpm. The DTW before the test is 13.105m Thus, we have a max drawdown of 48.06-13.105 = 34.96m. I believe the number 29m I told Brad is the DTW right after the seismic survey, so the water level recovery was 19.06m.