

UPDATED ASSESSMENT OF EFFECTS OF STUMP LAKE WATER ELEVATION ON GROUND-WATER ELEVATION, FLOW AND CHEMISTRY IN TOLNA COULEE, NELSON COUNTY, NORTH DAKOTA: 2009

To address concerns over Stump Lake waters, or ground water influenced by Stump Lake elevations potentially breaching the divide in Tolna Coulee, the North Dakota State Water Commission provided a report (Schuh 2007) analyzing the ground-water flow system in Tolna Coulee. In that report, two analytical tools were used: 1. Water-table gradients within the Coulee were used to determine the direction of flow; and 2. A comparison of trends in ground-water chemistry was used to discern possible Stump Lake influence on water quality. Results of both indicated no influence of Stump Lake waters on ground-water elevations or chemistry in Tolna Coulee ground water. Locations of well sites used for water samples and water-table elevation measurements are shown on Figure 1.



Figure 1. Locations of Tolna Coulee observation wells in Township 151, Range 61, Section 19.

Water-Table Indicators

In 2007, water levels were measured on 4/26, 7/25, 8/23, and 10/15. Water-elevations for Tolna Coulee wells indicated that: 1. The highest water levels for all measurements were at the East Johnson Crossing (USBLM 151-061-19ACA); and 2. there have been no substantial changes in ground-water elevations or directions of flow between 11/6/07 and 9/2/09. From the East Johnson Crossing, and to a lesser degree from the West Johnson Crossing (USBLM 151-061-19BDB) water flows eastward toward Stump Lake and southwestward down Tolna Coulee. Because the ground-water gradient is toward Stump Lake, it is very unlikely that flow from Stump Lake would be affecting ground water in Tolna Coulee. In June of 2007, Stump Lake Elevations equalized with those of East Devils Lake and have approximately stabilized at 1446.8 feet above mean sea level (amsl). The ground-water elevation of the well located nearest Stump Lake (East Section Line: USBLM 151-061-19AAD) was about 7 feet above the elevation of Stump Lake in November of 2007, and the land surface elevation was approximately 9 feet above the elevation of Stump Lake. At the highest measured elevation (USBLM 151-061-19ACA), both ground-water levels and the surface elevation were more than 11 feet above the elevation of Stump Lake. Water levels showed no substantial changes in ground-water elevations, gradients or directions of flow that would indicate possible influence from changes in Stump Lake elevations.

In 2009 Water Levels were measured on 9/2/2009. Water levels were lower than previous years at well sites (USBLM 151-061-19ACA, -19BDB, and -19CCC) in late 2008 than in previous years. The Stump Lake elevation increased by about three feet. As in previous measurements, water-table gradients were toward Stump Lake from the

Coulee in the northeast direction, and southwestward from the coulee. This would indicate that ground-water flow through the divide is unlikely.

One difference is that the stump lake water elevation is, for the first time, above the elevation of ground water at well site 151-061-19CCC. While the overall gradient would be favorable for flow if there were a confined high permeability hydraulic connection, the high head and predominant flow direction TOWARD Stump Lake in the intervening high land would prevent the flow of Stump Lake water to SE Section 19 unless the connection is hydraulically isolated from any pressure influence of ground water in the high land. In addition, there is no evidence that a ground-water connection exists. If isolated underflow were occurring it would eventually be indicated by changes in water chemistry.

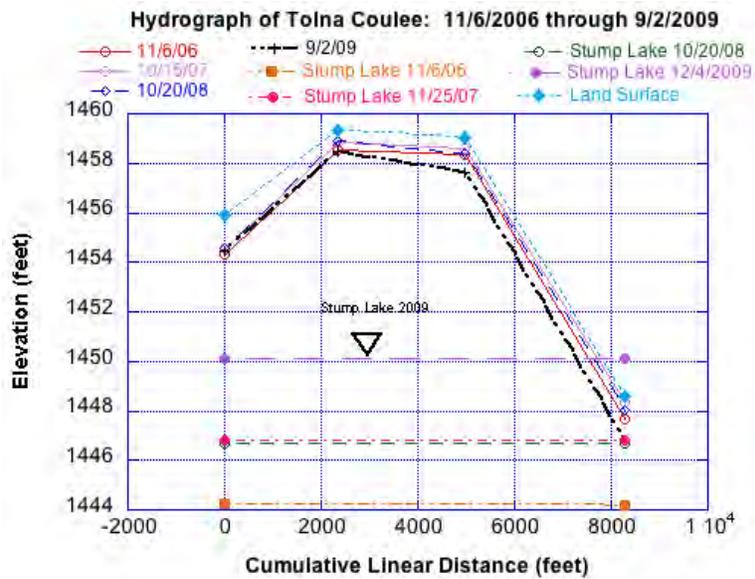


Figure 2. Stump Lake water elevation, and water-table elevations at ground-water measurement sites in Tolna Coulee from 2006 through 2009.

Principle Water-Chemistry Indicators

In the initial report (Schuh, January 2007), it was determined that the best chemical indicator of changing ground-water chemistry from Stump Lake water would be the sodium-adsorption ratio (SAR). Additional indicators would be increasing specific conductance (EC), total dissolved solids (TDS), and sulfate concentrations. Chemical indicators of Stump Lake influence on water chemistry in 2007 were all negative. An updated summary of water chemistry for Stump Lake, including 2009 data, is on Table 2. Ground water chemistry data is on Table 3. Site locations from Table 3 are identified with the map on Figure 1 using a key on Table 1. Specific conductance (EC) and dissolved solids (TDS) have increased at well site 151-061-19CCC. However, the increases represent increased calcium and bicarbonate, rather than sodium and sulfate, as would be expected from Stump Lake water. A more likely cause for the change is local surface runoff. Increasing sodium adsorption ratio (SAR) was cited as the best indicator of influent Stump Lake water. The SAR at well site 151-061-19CCC has decreased slightly, indicating that Stump Lake water is not likely affecting well site 151-061-19CCC.

Table 1. Site Location Descriptions for Tables 2 and 3.

Location (USBLM)	Name (Fig. 1)
15106120AAB	Stump Lake
15106119AAD	East Section Line
15106119ACA	East Johnson Crossing
15106119BDB	West Johnson Crossing
15106119CCC	Southwest Corner

Table 2. General chemistry for water samples collected from Stump Lake from 2006 through 2009.

Location	Date	EC Field	EC Lab	Ph Field	Ph Lab	Si	Ca	Mg	K	Na	F	HCO ₃	CO ₃	SO ₄	Cl	NO ₃	TDS_ Calc.	SAR
15106120AAB	10/22/06	6310	6820		8.46		126	246	76.4	1160	0.22	529	21	2990	545	0.89	4230	13.8
15106120AAB	4/25/07	6030	6280		8.18		112	215	87.3	1050	3	540	<1	2530	445	<0.09	3890	13.4
15106120AAB	8/22/07	6300	6580	6.94	8.45		117	242	86.2	1210	0.19	533	20	2550	451	0.4	4080	14.7
15106120AAB	10/14/07	5590	6610		8.63		124	253	94.6	1130	0.18	501	40	2740	478	0.27	4100	13.4
15106120AAB	5/26/08	6400	6600		8.69	9.98	120	248	91.6	1180	0.2	452	62	2710	482	<0.09	4090	14.1
15106120AAB	8/18/08	6400	6630		8.56	8.76	130	253	97.5	1180	0.18	509	32	2710	471	<0.09	4110	13.9
15106120AAB	5/19/09	5850	6300		8.55	11	127	225	88.9	1070	0.22	488	37	2560	455	0.35	3910	13.2

Table 3. General Chemistry for water samples from monitoring wells in Tolna Coulee: 2006 through 2009.

Location	Date	EC Field	EC Lab	Ph Field	Ph Lab	TDS_ Calc.	Si mg/L	Ca mg/	Mg mg/	K mg/	Na mg/	F mg/	HCO ₃ mg/	SO ₄ mg/	Cl mg/	NO ₃ mg/	SAR
15106119A	6/28/06	534	556	8.39	8.39	298	19.2					0.165	312	26.8	6.8		0.18
15106119AAD	9/7/06	1176	1260	8.63	7.37	781		196	56.5	1.3	7.6	0.184	428	360	9.73	0.35	0.12
15106119AAD	10/23/06	1136	1200		7.33	744		187	52.4	<1	7.1	0.177	413	355	9.13	0.18	0.12
15106119AAD	4/26/07	1097	1130		7.94	701		163	58.3	3.27	39.1	0.099	381	313	8.35	0.44	0.67
15106119AAD	8/23/07	1180	1250	7.65	7.63	775		186	57.5	<1	9.4	0.164	412	353	8.56	0.22	0.15
15106119AAD	10/15/07	1162	1250		7.86	775		190	58.8	1.01	7.3	0.147	421	371	8.88	<0.09	0.12
15106119AAD	5/27/08	1117	1160		7.13	719	25.4	179	54.7	<1	5.8	0.12	394	333	9.42	0.44	0.1
15106119AAD	10/20/08	1140	1180		7.75	732	31.8	198	60	1.25	7.3	0.132	371	355	8.34	0.18	0.12
15106119AAD	5/19/09	1025	1100		7.87	682	25.8	170	52.9	<1	6.1	0.134	362	316	8.75	0.97	0.1
15106119ACA	9/7/06	621	653	8.5	7.36	405		86.5	26.1	3.02	10.3	0.221	400	22.1	8.38	0.09	0.25
15106119ACA	10/23/06	593	618		7.52	383		86.7	24.2	1.99	6.6	0.237	387	20.9	7.62	0.18	0.16
15106119ACA	4/26/07	526	490		8.13	304		62.1	19.9	3.02	7.1	0.241	299	16.9	6.45	0.13	0.2
15106119ACA	8/23/07	553	574	8.32	8.21	356		84.8	26.5	2.03	7.6	0.211	347	16.7	6.08	0.44	0.18
15106119ACA	10/15/07	550	578		8.21	358		85.4	26	2.3	6	0.204	351	20	6.36	0.13	0.15
15106119ACA	5/27/08	555	575		7.34	356	31.6	80.9	25.3	2.41	6	0.187	350	20.6	7.06	0.35	0.15
15106119ACA	8/19/08	565	553	8.48	7.98	343	38	89.9	28.3	2.19	7	0.189	329	23	6.91	<0.09	0.16
15106119ACA	10/20/08	588	603		8.23	374	38.5	77.7	31	2.97	8.7	0.17	357	22.3	7.41	0.18	0.21
15106119ACA	5/19/09	575	598		8.1	371	33.1	88.6	27.8	2.04	6.7	0.166	368	16.7	7.97	0.27	0.16
15106119BDB	9/7/06	1277	1350	8.21	7.27	837		191	56.6	6.61	30.7	0.2	912	15.1	17.2	0.09	0.5
15106119BDB	10/23/06	1277	1350		7.24	837		201	52	5.76	27	0.141	919	9.92	18.7	0.18	0.44
15106119BDB	4/26/07	1332	1380		7.26	856		176	53.1	7.23	35.2	0.095	905	8.57	17.3	<0.09	0.6
15106119BDB	8/23/07	1305	1370	7.98	7.53	849		186	56.4	6.36	34.5	0.153	897	25.9	15.2	0.35	0.57
15106119BDB	10/15/07	1276	1370		7.75	849		198	59.1	6.86	30.6	0.12	884	36.3	15.8	<0.09	0.49
15106119BDB	5/27/08	1311	1360		7.02	843	33.5	199	57.1	6.27	28.3	0.103	899	24.2	16	0.62	0.45
15106119BDB	8/19/08	1327	1390	7.41	7.24	862	46.2	228	57.5	7.48	35.7	0.094	881	26.4	15.1	0.71	0.55
15106119BDB	10/20/08	1257	1280		7.67	794	38.1	201	61.1	6.83	31.2	0.121	821	29.6	14.9	<0.09	0.49
15106119BDB	5/19/09	1314	1400		7.27	868	35.9	216	62.3	6.24	29.2	0.101	897	29.3	14.7	0.31	0.45
15106119CCC	9/7/06	792	832	8.74	7.41	516		100	31.9	3.51	34	0.213	505	42.9	3.3	0.4	0.76
15106119CCC	10/23/06	855	895		7.24	555		125	37.1	3.06	17.1	0.208	568	37.8	3.68	<0.09	0.34
15106119CCC	4/26/07	845	862		7.28	534		101	36	3.88	39	0.213	541	40.7	3.02	<0.09	0.85
15106119CCC	8/23/07	907	951	8.25	7.14	590		128	41.7	3.36	20.7	0.206	595	28.6	2.89	0.31	0.41
15106119CCC	10/15/07	880	938		7.08	582		130	42.2	3.66	18	0.215	578	32.6	3.23	<0.09	0.35
15106119CCC	5/27/08	947	968	7.93	7.54	600	29.8	139	44.7	3.56	16.7	0.162	637	29.1	3.57	<0.09	0.31
15106119CCC	8/19/08	936	986		7.83	611	31.8	151	48.7	3.41	18.8	0.157	627	28.2	3.63	<0.09	0.34
15106119CCC	10/20/08	931	975		7.68	604	31.5	139	45.5	3.9	19.8	0.165	608	27.5	3.51	<0.09	0.37
15106119CCC	5/19/09	1080	1150		7.82	713	31.5	147	53.2	3.82	18.3	0.145	739	25.3	4.9	<0.09	0.33

Citations

Schuh, W.M., January, 2007. Assessment of effects of Stump Lake water elevation on ground-water elevation, flow, and chemistry in Tolna Coulee: Nelson County, North Dakota. SWC Project No. 416-1. 31 pp.

Schuh, W.M. 2007. Review of Water Quality Assessments for the North Dakota National Guard Camp Grafton (South Unit), Eddy County, North Dakota: 1986 through 2006). Water Resources Investigation No. 40. North Dakota State Water Commission. 86 pp.