APPENDIX B

Alternative Scenarios for Increased Water Demand in the Deer Creek Watershed

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The water demand projections presented in the main body of this study are based on population growth gleaned from county census estimates and from increases in commercial and industrial water use derived from an analysis of potential changes in land use to meet zoning. While useful for estimating increases in water demand given the current character and composition of the watershed, the analyses do not account for the potential increase in water use associated with emerging trends that are not immediately evident from census and zoning data.

The most influential of these trends are: (1) growth of Aberdeen Proving Ground (APG) in conjunction with the federal Base Realignment and Closure (BRAC) effort, and the military and civilian population growth it entails; (2) conversion of agricultural land from uses with lower-intensity water use to land uses with relatively higher-intensity water use, such as nurseries; and (3) development of commercially zoned land to relatively high water use purposes, such as golf courses. The potential increase in water demand in the Deer Creek Watershed associated with these three trends are assessed in the next three sections, and assessed cumulatively in a fourth section.

APPENDIX B1

Population and Water Demand Projections Associated with BRAC

The report entitled *Aberdeen Proving Ground BRAC Impacts on Seven Jurisdictions* (Sage Policy Group, 2007) uses estimates of jobs per household and household size to project increases in households and population attributable to BRAC changes at APG. The APG BRAC report provides baseline (without BRAC), low-, mid-, and high-case population projections for 2007, 2012, and 2017 for seven jurisdictions (including York, Harford, and Baltimore Counties), as well as a total for all seven. To incorporate estimated BRAC impacts on population, as reported in the APG BRAC document, the differences between the percent population increases under the baseline condition and the BRAC mid-case projection scenario were calculated for Harford, York, and Baltimore Counties for the 2007, 2012, and 2017 populations. The BRAC-related percent increases were then added to the percent increases extracted from the data provided by the respective counties for 2010, 2015, 2020, and 2025. Since the population projection years did not match up exactly between the two data sources, the BRAC-related percent increases for 2012 were added to the county percent increases for 2010. The BRAC-related percent increases for 2017 were added to the county percent increases for 2020. The median values of the BRAC-related percent increases between 2012 and 2017 were added to the county percent increases for 2015. The BRAC-related percent increases for 2017 also were added to the county percent increases for 2025, since the APG BRAC document did not contain projections beyond 2017.

Using the 2005 county-derived populations as a benchmark, the sum of the appropriate BRAC-related and county-projected percent population increases were applied to calculate population projections for 2010, 2015, 2020, and 2025 that reflect both county projections and APG BRAC report estimates. To apply the sum of the appropriate BRAC-related and county-projected percent increases, reported in the APG BRAC document by county, to each subwatershed, the subwatersheds were broken out by percent composition of each county and assigned percent increases accordingly.

Population projections associated with BRAC, in 5-year increments for each subwatershed, can be seen in Table B-1. The total 25-year projected population increase for the Deer Creek Watershed (2000 to 2025) is approximately 28 percent, as compared to 24 percent without including BRAC-related impacts (Table 22). Projected increases for individual subwatersheds range from about 12 percent to 41 percent when BRAC population projections are incorporated, as opposed to 5 percent to 35 percent without including BRAC projections. The lowest projected growth value corresponds to the Little Deer Creek subwatershed, as is also the case when BRAC population projections are not included in the analysis. The greatest projected growth is in the South Stirrup - North Stirrup subwatershed, near the northwestern extent of Bel Air, while the greatest projected growth without consideration of BRAC-related impacts is in the Deer Creek headwaters, near Shrewsbury. As compared to the population projections in Table 20 of this report, the population projections that incorporate BRAC impacts presented below are larger at the watershed, county, and subwatershed scales. The most substantial population increases are projected to occur in the Harford County portion of the watershed, which constitutes more than 80 percent of the total watershed area. The period of time between 2005 and 2010 is when the most pronounced increase in population growth is projected to occur as a result of BRAC impacts.

Table B-1. Population Projections (with BRAC Population Projections)

ID	Location	2000*	2005	2010	2015	2020	2025	10-Year Growth*	25-Year Growth*	2000 to 2025 Percentage Growth
	By County									
	Harford County	24,332	25,421	28,681	29,876	30,610	31,011	4,349	6,679	27.4%
	York County	16,139	17,476	17,295	18,319	19,234	21,034	1,156	4,895	30.3%
	Baltimore County	1,170	1,323	1,413	1,427	1,437	1,449	243	279	23.9%
	By Subwatershed									
1	Cool Branch Run	472	477	530	548	558	565	59	93	19.8%
2	Stout Bottle Branch - Cabbage Run	1,980	2,102	2,389	2,463	2,538	2,513	409	533	26.9%
3	Thomas Run	3,113	3,407	3,876	4,046	4,129	4,159	763	1,046	33.6%
4	Mill Brook	736	749	847	889	920	946	111	210	28.6%
5	Hollands Branch	397	421	467	482	490	495	69	97	24.5%
6	UNT at Thomas Bridge Rd	588	620	713	754	781	801	125	213	36.2%
7	Saint Omer Branch	2,238	2,304	2,549	2,621	2,658	2,677	311	439	19.6%
8	Deer Creek – Mid	772	790	875	900	908	917	103	145	18.7%
9	South Stirrup - North Stirrup Run	1,808	1,931	2,240	2,383	2,479	2,548	432	740	40.9%
10	Rock Hollow - Kellogg - Gladden Branches	2,306	2,373	2,687	2,813	2,891	2,946	381	640	27.7%
11	UNT south of Falling Branch	76	80	91	96	99	101	15	25	32.5%
12	UNT west of Falling Branch	40	42	48	51	53	54	8	14	34.6%
13	Little Deer Creek	2,531	2,500	2,736	2,792	2,817	2,829	205	298	11.8%
14	Falling Branch	547	572	638	666	683	695	92	148	27.1%
15	Big Branch	648	676	747	775	792	804	99	156	24.0%
16	Island - Jackson - Plumtree Branches	2,821	3,021	3,374	3,507	3,594	3,656	554	836	29.6%
17	Ebaugh's Creek	6,859	7,566	6,926	7,339	7,710	8,441	67	1,582	23.1%
18	Deer Creek Headwaters	9,708	10,394	10,910	11,526	12,076	13,149	1,201	3,441	35.4%
19	Graveyard Creek	177	187	213	223	230	235	36	58	33.1%
20	Hopkins Branch	413	424	467	480	486	490	55	78	18.8%
21	Tobacco Run	2,276	2,378	2,708	2,846	2,933	2,992	432	716	31.5%
22	Buck Branch - Elbow Branch	1,130	1,199	1,353	1,412	1,449	1,474	223	344	30.4%
23	UNT east of Hollands Branch	6	6	7	7	8	8	1	2	25.7%
	Deer Creek Watershed Total	**41,640**	**44,220**	**47,390**	**49,622**	**51,282**	**53,494**	**5,750**	**11,853**	**27.6%**

** From 2000 Census Data.*

The 10- and 25-year population growth projections that include BRAC-related impacts were incorporated into the analyses presented in Tables B-2 through B-5 as additional, residential population demands. The tables represent groundwater balances for average year conditions and drought year conditions for the years 2010 and 2025. These results are also illustrated graphically on Figure B-1. Many of the trends evident in the water demand projection data that does not incorporate BRAC population projections (Tables 23-26) are also evident when BRAC-related impacts are included. As expected, the number of subwatersheds with an allocation deficit is greater for drought years than for average years. The number also increases from 2010 to 2025, reflecting increases in demand. Under average conditions, the allocated water resources do not indicate any deficits during 2010 and a deficit only for the Hopkins Branch subwatershed in 2025.

More significantly, under 2010 and 2025 drought conditions, several of the subwatersheds show an allocation deficit. The allocation deficits are concentrated in the lower portion of the watershed and in the headwaters. This primarily reflects: (1) growth in an area having aquifers with relatively low recharge rates; and (2) growth in an area having minimal upgradient contributing recharge area. Under drought conditions in 2010, it is expected that five subwatersheds will show allocation deficits of as much as 150 million gallons over the year (0.64 cubic feet per second [cfs]), which equates to the quantity of water used by more than 3,600 people. Although presented as an annual analysis, the deficits are likely to manifest during the summer months, as they did over the watershed as a whole (Table 14, Figure 24) and for the three test subwatersheds (Tables 18, 19, and 20; Figures 26, 27, and 28). Under drought conditions in 2025, eight subwatersheds show deficits in the range of 18 to 316 million gallons over the year (0.08 cfs to 1.34 cfs).

As compared to the water demand projections (without BRAC impacts) incorporated into the analyses presented in Tables 23, 24, 25, and 26, and Figure 30, the water demand analyses (with BRAC impacts) reflected in Tables B-2 through B-5 and Figure B-1 are not dramatically different. The values for population supported do, however, decrease for 2010 and 2025 average and drought years, as a result of the incorporation of BRAC population projections, but not by more than 1,650 people under average conditions and 2,000 people under drought conditions for the entire watershed. On a subwatershed scale, decreases in population served as a result of BRAC-related impacts are more pronounced in subwatersheds located within Harford County since, according to the APG BRAC document, it is the county in which population projections are predicted to increase the most as a result of BRAC. The number of subwatersheds with an allocation deficit, during both average and drought years, is the same for the water demand projections with and without BRAC-related impacts, with the exception of the Hollands Branch subwatershed, which is projected to experience a deficit of four people served under drought conditions in 2010 as a result of BRAC.

With regard to the unavailability of Deer Creek at Darlington during a repeat of the 2002 drought, the increased water demand projected to accompany BRAC by 2025 would increase the duration of the time the flow is below the passby threshold by an additional 3 days to 176 days.

Table B-2. Water Allocation, 2010 Population, Average Precipitation (with BRAC Population Projections)

ID	Subwatershed	Average Base Flow (cfs)	Existing Permitted Ground-water Withdrawals (cfs)	Existing Un-permitted Ground-water Withdrawals (cfs)	Aberdeen Permit Passby (cfs)	Change in Percent Future Impervious Area (%)	Reduction for Future Impervious Area (cfs)	Reduction for Municipal/ Commercial (cfs)	Additional Residential Population[1] (cfs)	Residual Ground-water Resources (cfs)	Surplus/ Deficit Population Supported (people)
1	Cool Branch Run	1.91	-0.01	-0.05	-0.78	1.08	-0.02	-0.31	-0.01	0.73	5,889
2	Stout Bottle Branch - Cabbage Run	7.39	-0.12	-0.16	-2.27	1.73	-0.13	-0.39	-0.05	4.28	34,564
3	Thomas Run	6.26	-0.05	-0.17	-2.55	0.47	-0.03	-0.39	-0.09	2.98	24,066
4	Mill Brook	3.60	-0.03	-0.10	-1.47	0.47	-0.02	-0.31	-0.01	1.66	13,450
5	Hollands Branch	2.60	-0.03	-0.07	-1.06	0.47	-0.01	-0.08	-0.01	1.34	10,846
6	UNT at Thomas Bridge Rd	4.45	-0.28	-0.09	-1.37	0.33	-0.01	-0.08	-0.02	2.60	21,008
7	Saint Omer Branch	10.07	-0.06	-0.24	-3.53	0.74	-0.07	-0.39	-0.04	5.74	46,350
8	Deer Creek - Mid	5.40	-0.01	-0.11	-1.66	0.33	-0.02	0.00	-0.01	3.59	28,966
9	South Stirrup - North Stirrup Run	6.68	-0.01	-0.14	-2.05	0.54	-0.04	-0.15	-0.05	4.23	34,184
10	Rock Hollow - Kellogg - Gladden Branches	12.75	-0.23	-0.27	-3.92	0.21	-0.03	-0.31	-0.05	7.95	64,201
11	UNT south of Falling Branch	0.64	-0.01	-0.01	-0.20	2.80	-0.02	0.00	0.00	0.40	3,250
12	UNT west of Falling Branch	0.39	0.00	-0.01	-0.12	2.80	-0.01	0.00	0.00	0.25	2,003
13	Little Deer Creek	14.65	-0.02	-0.31	-4.50	0.20	-0.03	-0.23	-0.03	9.53	76,951
14	Falling Branch	6.60	-0.01	-0.14	-2.03	2.80	-0.18	-0.39	-0.01	3.84	31,008
15	Big Branch	8.15	0.00	-0.17	-2.51	2.62	-0.21	-0.23	-0.01	5.02	40,529
16	Island - Jackson - Plumtree Branches	29.59	-0.18	-0.62	-9.10	0.22	-0.07	-0.23	-0.07	19.33	156,145
17	Ebaugh's Creek	7.05	-0.65	0.00	-2.17	2.42	-0.17	-0.39	-0.01	3.66	29,597
18	Deer Creek Headwaters	17.68	-0.55	0.00	-5.44	4.06	-0.72	-0.77	-0.15	10.06	81,229
19	Graveyard Creek	1.24	-0.01	-0.03	-0.51	0.47	-0.01	0.00	0.00	0.68	5,520
20	Hopkins Branch	1.76	-0.01	-0.05	-0.72	0.47	-0.01	-0.70	-0.01	0.27	2,200
21	Tobacco Run	6.15	-0.16	-0.17	-2.51	1.08	-0.07	-0.08	-0.05	3.12	25,191
22	Buck Branch - Elbow Branch	7.90	-0.01	-0.22	-3.22	0.05	0.00	0.00	-0.03	4.42	35,722
23	UNT east of Hollands Branch	0.04	0.00	0.00	-0.02	0.47	0.00	0.00	0.00	0.02	187
	Entire Watershed	**162.94**	**-2.44**	**-3.14**	**-53.67**	**1.00**	**-1.63**	**-5.42**	**-0.71**	**95.69**	**773,057**

[1] Calculated at 80 gpd per person.

Table B-3. Water Allocation, 2010 Population, Drought Conditions (with BRAC Population Projections)

ID	Subwatershed	Average Base Flow (cfs)	Existing Permitted Ground-water Withdrawals (cfs)	Existing Un-permitted Ground-water Withdrawals (cfs)	Aberdeen Permit Passby (cfs)	Change in Percent Future Impervious Area (%)	Reduction for Future Impervious Area (cfs)	Reduction for Municipal/ Commercial (cfs)	Additional Residential Population[1] (cfs)	Residual Ground-water Resources (cfs)	Surplus/ Deficit Population Supported (people)
1	Cool Branch Run	0.94	-0.01	-0.07	-0.78	1.08	-0.02	-0.31	-0.01	-0.26	-1,477
2	Stout Bottle Branch - Cabbage Run	3.67	-0.12	-0.22	-2.27	1.73	-0.13	-0.39	-0.07	0.47	2,699
3	Thomas Run	3.10	-0.05	-0.24	-2.55	0.47	-0.03	-0.39	-0.13	-0.29	-1,650
4	Mill Brook	1.78	-0.03	-0.14	-1.47	0.47	-0.02	-0.31	-0.02	-0.20	-1,126
5	Hollands Branch	1.29	-0.03	-0.10	-1.06	0.47	-0.01	-0.08	-0.01	0.00	-4
6	UNT at Thomas Bridge Rd	2.21	-0.28	-0.13	-1.37	0.33	-0.01	-0.08	-0.02	0.31	1,807
7	Saint Omer Branch	4.99	-0.06	-0.34	-3.53	0.74	-0.07	-0.39	-0.05	0.55	3,158
8	Deer Creek - Mid	2.68	-0.01	-0.16	-1.66	0.33	-0.02	0.00	-0.02	0.81	4,687
9	South Stirrup - North Stirrup Run	3.31	-0.01	-0.20	-2.05	0.54	-0.04	-0.15	-0.07	0.78	4,528
10	Rock Hollow - Kellogg - Gladden Branches	6.32	-0.23	-0.37	-3.92	0.21	-0.03	-0.31	-0.07	1.39	8,026
11	UNT south of Falling Branch	0.32	-0.01	-0.02	-0.20	2.80	-0.02	0.00	0.00	0.07	427
12	UNT west of Falling Branch	0.19	0.00	-0.01	-0.12	2.80	-0.01	0.00	0.00	0.05	284
13	Little Deer Creek	7.26	-0.02	-0.43	-4.50	0.20	-0.03	-0.23	-0.04	2.01	11,580
14	Falling Branch	3.27	-0.01	-0.19	-2.03	2.80	-0.18	-0.39	-0.02	0.45	2,606
15	Big Branch	4.04	0.00	-0.24	-2.51	2.62	-0.21	-0.23	-0.02	0.83	4,799
16	Island - Jackson - Plumtree Branches	14.67	-0.18	-0.87	-9.10	0.22	-0.07	-0.23	-0.10	4.13	23,844
17	Ebaugh's Creek	3.49	-0.65	0.00	-2.17	2.42	-0.17	-0.39	-0.01	0.11	619
18	Deer Creek Headwaters	8.76	-0.55	0.00	-5.44	4.06	-0.72	-0.77	-0.21	1.08	6,225
19	Graveyard Creek	0.62	-0.01	-0.05	-0.51	0.47	-0.01	0.00	-0.01	0.04	233
20	Hopkins Branch	0.87	-0.01	-0.07	-0.72	0.47	-0.01	-0.70	-0.01	-0.64	-3,672
21	Tobacco Run	3.05	-0.16	-0.24	-2.51	1.08	-0.07	-0.08	-0.07	-0.07	-429
22	Buck Branch - Elbow Branch	3.91	-0.01	-0.31	-3.22	0.05	0.00	0.00	-0.04	0.34	1,964
23	UNT east of Hollands Branch	0.02	0.00	0.00	-0.02	0.47	0.00	0.00	0.00	0.00	10
	Entire Watershed	**80.77**	**-2.44**	**-4.40**	**-53.67**	**1.00**	**-1.63**	**-5.42**	**-0.99**	**11.98**	**69,140**

[1] Calculated at 112 gpd per person.

Table B-4. Water Allocation, 2025 Population, Average Precipitation (with BRAC Population Projections)

ID	Subwatershed	Average Base Flow (cfs)	Existing Permitted Ground-water Withdrawals (cfs)	Existing Un-permitted Ground-water Withdrawals (cfs)	Aberdeen Permit Passby (cfs)	Change in Percent Future Impervious Area (%)	Reduction for Future Impervious Area (cfs)	Reduction for Municipal/ Commercial (cfs)	Additional Residential Population[1] (cfs)	Residual Ground-water Resources (cfs)	Surplus/ Deficit Population Supported (people)
1	Cool Branch Run	1.91	-0.01	-0.05	-0.78	1.08	-0.02	-0.62	-0.01	0.42	3,354
2	Stout Bottle Branch - Cabbage Run	7.39	-0.12	-0.16	-2.27	1.73	-0.13	-0.77	-0.07	3.88	31,314
3	Thomas Run	6.26	-0.05	-0.17	-2.55	0.47	-0.03	-0.77	-0.13	2.56	20,658
4	Mill Brook	3.60	-0.03	-0.10	-1.47	0.47	-0.02	-0.62	-0.03	1.34	10,850
5	Hollands Branch	2.60	-0.03	-0.07	-1.06	0.47	-0.01	-0.15	-0.01	1.26	10,193
6	UNT at Thomas Bridge Rd	4.45	-0.28	-0.09	-1.37	0.33	-0.01	-0.15	-0.03	2.51	20,296
7	Saint Omer Branch	10.07	-0.06	-0.24	-3.53	0.74	-0.07	-0.77	-0.05	5.33	43,097
8	Deer Creek - Mid	5.40	-0.01	-0.11	-1.66	0.33	-0.02	0.00	-0.02	3.58	28,924
9	South Stirrup - North Stirrup Run	6.68	-0.01	-0.14	-2.05	0.54	-0.04	-0.31	-0.09	4.04	32,626
10	Rock Hollow - Kellogg - Gladden Branches	12.75	-0.23	-0.27	-3.92	0.21	-0.03	-0.62	-0.08	7.61	61,443
11	UNT south of Falling Branch	0.64	-0.01	-0.01	-0.20	2.80	-0.02	0.00	0.00	0.40	3,240
12	UNT west of Falling Branch	0.39	0.00	-0.01	-0.12	2.80	-0.01	0.00	0.00	0.25	1,998
13	Little Deer Creek	14.65	-0.02	-0.31	-4.50	0.20	-0.03	-0.46	-0.04	9.28	74,983
14	Falling Branch	6.60	-0.01	-0.14	-2.03	2.80	-0.18	-0.77	-0.02	3.44	27,826
15	Big Branch	8.15	0.00	-0.17	-2.51	2.62	-0.21	-0.46	-0.02	4.78	38,597
16	Island - Jackson - Plumtree Branches	29.59	-0.18	-0.62	-9.10	0.22	-0.07	-0.46	-0.10	19.06	153,988
17	Ebaugh's Creek	7.05	-0.65	0.00	-2.17	2.42	-0.17	-0.77	-0.20	3.09	24,957
18	Deer Creek Headwaters	17.68	-0.55	0.00	-5.44	4.06	-0.72	-1.55	-0.43	9.00	72,740
19	Graveyard Creek	1.24	-0.01	-0.03	-0.51	0.47	-0.01	0.00	-0.01	0.68	5,498
20	Hopkins Branch	1.76	-0.01	-0.05	-0.72	0.47	-0.01	-1.39	-0.01	-0.43	-3,448
21	Tobacco Run	6.15	-0.16	-0.17	-2.51	1.08	-0.07	-0.15	-0.09	3.01	24,283
22	Buck Branch - Elbow Branch	7.90	-0.01	-0.22	-3.22	0.05	0.00	0.00	-0.04	4.41	35,601
23	UNT east of Hollands Branch	0.04	0.00	0.00	-0.02	0.47	0.00	0.00	0.00	0.02	187
	Entire Watershed	**162.94**	**-2.44**	**-3.14**	**-53.67**	**1.00**	**-1.63**	**-10.83**	**-1.47**	**89.52**	**723,206**

[1] Calculated at 80 gpd per person.

Table B-5. Water Allocation, 2025 Population, Drought Precipitation (with BRAC Population Projections)

ID	Subwatershed	Average Base Flow (cfs)	Existing Permitted Ground-water Withdrawals (cfs)	Existing Un-permitted Ground-water Withdrawals (cfs)	Aberdeen Permit Passby (cfs)	Change in Percent Future Impervious Area (%)	Reduction for Future Impervious Area (cfs)	Reduction for Municipal/ Commercial (cfs)	Additional Residential Population[1] (cfs)	Residual Ground-water Resources (cfs)	Surplus/ Deficit Population Supported (people)
1	Cool Branch Run	0.94	-0.01	-0.07	-0.78	1.08	-0.02	-0.62	-0.02	-0.57	-3,297
2	Stout Bottle Branch - Cabbage Run	3.67	-0.12	-0.22	-2.27	1.73	-0.13	-0.77	-0.09	0.06	342
3	Thomas Run	3.10	-0.05	-0.24	-2.55	0.47	-0.03	-0.77	-0.18	-0.72	-4,165
4	Mill Brook	1.78	-0.03	-0.14	-1.47	0.47	-0.02	-0.62	-0.04	-0.52	-3,011
5	Hollands Branch	1.29	-0.03	-0.10	-1.06	0.47	-0.01	-0.15	-0.02	-0.08	-478
6	UNT at Thomas Bridge Rd	2.21	-0.28	-0.13	-1.37	0.33	-0.01	-0.15	-0.04	0.22	1,274
7	Saint Omer Branch	4.99	-0.06	-0.34	-3.53	0.74	-0.07	-0.77	-0.08	0.14	798
8	Deer Creek - Mid	2.68	-0.01	-0.16	-1.66	0.33	-0.02	0.00	-0.02	0.81	4,645
9	South Stirrup - North Stirrup Run	3.31	-0.01	-0.20	-2.05	0.54	-0.04	-0.31	-0.13	0.58	3,327
10	Rock Hollow - Kellogg - Gladden Branches	6.32	-0.23	-0.37	-3.92	0.21	-0.03	-0.62	-0.11	1.04	5,982
11	UNT south of Falling Branch	0.32	-0.01	-0.02	-0.20	2.80	-0.02	0.00	0.00	0.07	417
12	UNT west of Falling Branch	0.19	0.00	-0.01	-0.12	2.80	-0.01	0.00	0.00	0.05	279
13	Little Deer Creek	7.26	-0.02	-0.43	-4.50	0.20	-0.03	-0.46	-0.05	1.76	10,148
14	Falling Branch	3.27	-0.01	-0.19	-2.03	2.80	-0.18	-0.77	-0.03	0.05	317
15	Big Branch	4.04	0.00	-0.24	-2.51	2.62	-0.21	-0.46	-0.03	0.59	3,402
16	Island - Jackson - Plumtree Branches	14.67	-0.18	-0.87	-9.10	0.22	-0.07	-0.46	-0.14	3.85	22,222
17	Ebaugh's Creek	3.49	-0.65	0.00	-2.17	2.42	-0.17	-0.77	-0.27	-0.54	-3,128
18	Deer Creek Headwaters	8.76	-0.55	0.00	-5.44	4.06	-0.72	-1.55	-0.60	-0.08	-478
19	Graveyard Creek	0.62	-0.01	-0.05	-0.51	0.47	-0.01	0.00	-0.01	0.04	211
20	Hopkins Branch	0.87	-0.01	-0.07	-0.72	0.47	-0.01	-1.39	-0.01	-1.34	-7,712
21	Tobacco Run	3.05	-0.16	-0.24	-2.51	1.08	-0.07	-0.15	-0.12	-0.20	-1,159
22	Buck Branch - Elbow Branch	3.91	-0.01	-0.31	-3.22	0.05	0.00	0.00	-0.06	0.32	1,843
23	UNT east of Hollands Branch	0.02	0.00	0.00	-0.02	0.47	0.00	0.00	0.00	0.00	10
	Entire Watershed	**80.77**	**-2.44**	**-4.40**	**-53.67**	**1.00**	**-1.63**	**-10.83**	**-2.05**	**5.51**	**31,789**

[1] Calculated at 112 gpd per person.

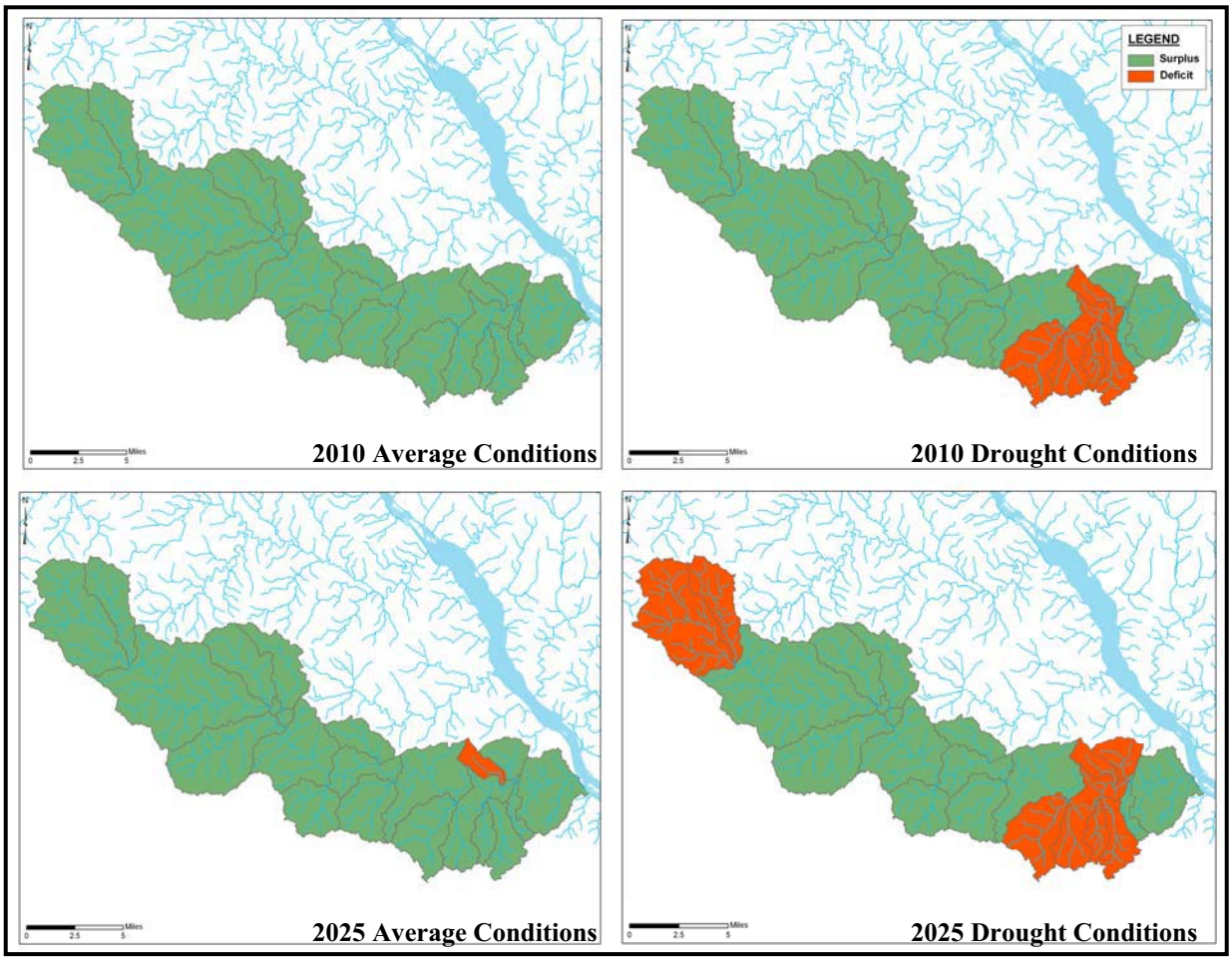

Figure B-1. Twenty-Five-Year Projected Water Allocation Surplus/Deficit by Subwatershed (with BRAC Population Projections)

APPENDIX B2

Agricultural Land Use Conversion Projections

Agricultural activities are the predominant type of land use in the Deer Creek Watershed, occupying roughly 60 percent of the total land area. However, several areas of the watershed are undergoing (or expected to undergo) rapid growth and development, most of which will consume land currently used for agricultural purposes. The analysis performed for this study incorporated estimates for the change in water use associated with the conversion of land to commercial and residential use. Excluded from the analysis were areas in the watershed designated as under permanent agricultural easement. Each of the jurisdictions in the watershed has agricultural preservation programs, and the program in Harford County has been particularly successful, with more than 40,500 acres under permanent easement. While such areas were excluded from the analysis of conversion to commercial or residential uses and the associated increases in water use, no consideration was given to conversion from one agricultural use to another. Conversions of this nature can be important because new uses can be much more water-intensive than current uses. For example, the conversion of pasture land to a vineyard is likely to require processing water and may demonstrate increased use of groundwater by the deep roots of grapevines, as compared to field grasses. Another example is the conversion of livestock lands to horticultural uses such as nurseries.

Consultation with stakeholders in the watershed revealed that certain trends within the agricultural community may be worth investigation. Specifically, horse-related activities seem likely to decline with the diminished importance of horseracing in Maryland, while growth is apparent in the nursery industry. Conversion of a preserved agricultural tract from horse farming to nursery activities is likely to result in an increase in water use. Based on research, SRBC staff estimates that typical horse-related operations require 12 gallons per animal per day, while nurseries may use up to 27,000 gallons per acre per day.

Data are available on the nature of the agricultural land under permanent easement and on the nature of horse farms in Harford County, which is the predominant horse-related area in the Deer Creek Watershed and the area where conversion from horsing to nursery is most likely to occur.

Agricultural Preservation: The table below shows the acres of agricultural land that under permanent easement, by jurisdiction, in the Deer Creek Watershed. The map on Figure B-2 shows the agricultural land in Harford County and the location of permanent easements on that land; the easements are located predominantly in the Deer Creek Watershed. About 40 percent of the agricultural land in the watershed is under permanent easement, representing about 24 percent of the total land area in the watershed.

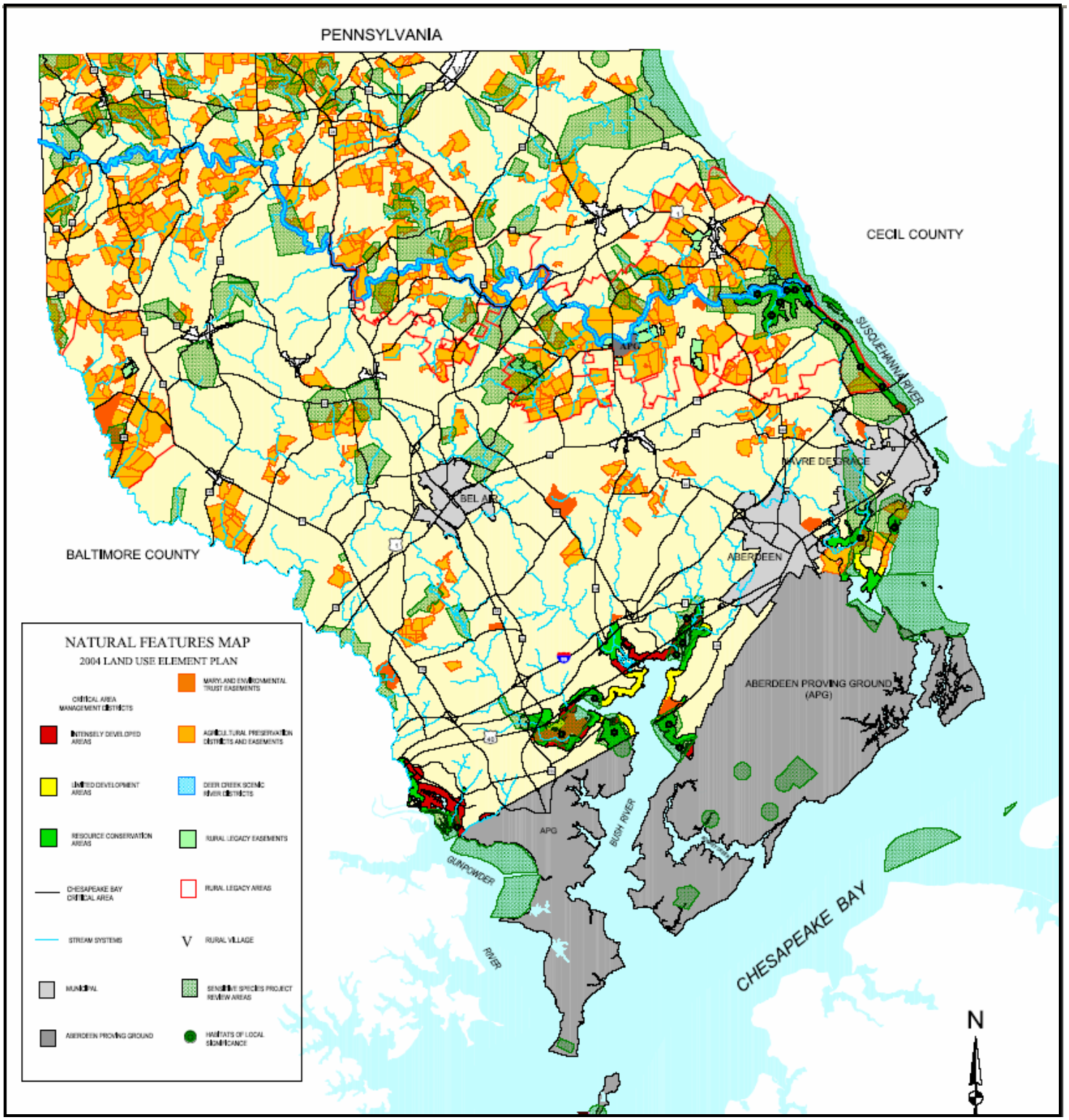

Figure B-2. Natural Land Features of Harford County, Maryland (Harford County, 2004)

Horse Husbandry: Data from the 2002 Maryland Equine Census on the horse industry in Maryland indicate that Harford County ranks in the top five counties in Maryland in terms of number of horses, number of equine facilities, and in acreage devoted to horse-related activities. Statewide, approximately 41 percent of horses are associated with the racing industry. Data were not reported for the number of horses associated with racing on a county-by-county basis; however, the average value per horse in Harford County is substantially higher than the statewide average, which suggests that higher-valued racing breeds likely account for a greater portion of the horse population in Harford County than in the state as a whole. For the purposes of this exercise, 50 percent of the horse population in Harford County is assumed to be associated with racing, for a total of 3,484 animals. Using the county average of 2.5 acres per horse, 8,710 acres in the county are estimated to be associated with horseracing. This is important information because, as a result of a suspected decline in Maryland's racing industry, some of that acreage may convert from horseracing to other uses, such as nursery operations, and water demand would change accordingly. It is assumed that draft and recreational horse husbandry will not be affected by trends in racing, and that the number of such horses will remain unchanged.

Nursery Operations: Horticulture is a significant industry in Maryland, and particularly so in the central region comprised of Baltimore, Carroll, Frederick, Harford, Howard, Montgomery, and Washington Counties. According to the 2003 Maryland Horticulture Industry Economic Profile, nearly 40 percent of the state's horticulture acreage is located in the central region. The seven counties contained 6,123 acres in horticulture, for an average of 875 acres in each county. Based on the results of the profile, the industry is expected to show growth. Over the course of this study's time frame, it was assumed that 20 percent growth (an added 175 acres) could occur, given that agricultural land is expected to be available as a result of the decrease in horse operations.

Conclusion: The potential increase in water use as a result of conversion of agricultural land from horse operations to nurseries is the difference between the current estimated water use for horses and the projected water need for nursery operations.

At 12 gallons per horse, operations related to horse racing use an estimated 41,808 gallons per day (gpd) in the Deer Creek Watershed. If it is assumed that the population of horses in racing operations diminishes by half, water use would decline by 20,904 gpd, and an estimated 4,355 acres would become available for other agricultural purposes. If it is assumed that one-quarter of the acreage stays in horsing as draft or recreational operations, there would be no net change in water use, and 5,226 gpd usage will still occur on those acres. If the projected horticulture growth of 175 acres occurs on the converted acreage, a new water demand of 4,725,000 gallons will be created on that land. Finally, it is assumed that the remaining 3,091 acres formerly involved in the horse racing industry would revert to pasture, be developed into vineyards, or be put to another agricultural use that does not require more water than what is delivered by nature in the form of precipitation. Thus, the net change in water demand for agricultural lands used in horse husbandry is an additional 4,709,322 gpd. Such an increase, equivalent to 7.25 cfs, would increase the duration that Deer Creek is unavailable at Darlington by an additional 31 days, to 204 total days, should 2002 drought conditions recur in 2025 with the projected change in horse and nursery operations.

APPENDIX B3

Water Demand Projections Associated with Commercial Development

Estimates for commercial water use and growth were made for the basic analysis of this study, as presented in the main body of this report. The estimates were consistent with generally accepted standard rates of water use for commercial development, which are based on the water used for purposes such as retail, light industrial facilities, and other small business enterprises or institutions. Water use associated with these commercial facilities was assumed to total up to 100,000 gpd for the purposes of the water use projections in this study. However, it is possible that more water-intensive uses also may develop in the watershed, golf courses being of particular interest.

Anecdotal evidence suggests that many residents of Maryland travel to southern Pennsylvania for golfing due to lack of golf courses in northern Maryland. An inventory of golfing facilities in Harford County, Maryland, and York County, Pennsylvania, confirms that of about a dozen golf courses in Harford County, all but one are located in the southeast part of the county near the population centers of Bel Air, Havre de Grace, and Aberdeen. To compete with the several courses in southern York County for the patronage of residents of northern Harford County, it is conceivable that one or more additional golf courses will develop in the Deer Creek Watershed. To demonstrate the impact such development could have on the availability of water resources along Deer Creek, SRBC staff assessed the water use of two new 18-hole courses.

To estimate the potential water use by two new golf courses in the Deer Creek Watershed, SRBC staff accessed records of the courses already existing in the Susquehanna River Basin. SRBC regulates more than 200 golf courses, and their water use – particularly for newer courses – usually greatly exceeds the 100,000 gpd assumed for typical commercial development in this study's basic analysis. Most newer courses irrigate not only tees and greens, but also fairways, which dramatically increases water use. Based on monitoring reports from such courses, SRBC staff assumed that two new courses in Harford County would use 300,000 gpd each when irrigating. Thus, an additional 600,000 gpd, or nearly 1 cfs, would be withdrawn from the waters of Deer Creek and consumed. That amount of additional water use by itself is not sufficient to impact Deer Creek, but when combined with current and projected water use, has the potential to accelerate and prolong the period of time that Deer Creek is unavailable to meet withdrawals. Using the 2002 drought conditions as a reference, the additional water use for golf course irrigation would increase the unavailability at Darlington by 3 additional days, for a total of 176 days.

APPENDIX B4

Cumulative Impact of Projected Water Demand Increases

The main body of this report showed the estimated impact of expected population and water use growth in the Deer Creek Watershed, and the previous sections in this appendix presented estimates for the impacts of growth in the residential (due to BRAC), agricultural, and commercial sectors. Each sector has the potential to realize significant impacts to the water resources of Deer Creek, and although they are based only on assumptions, all the associated increase in water demand could reasonably occur. It is useful to estimate the cumulative impact of all these developments should they all happen to occur through the 2025 time frame of this study. The additional water demand would be nearly 23 cfs; Figure B-3 below shows the affect on Deer Creek at Darlington, assuming a direct gallon-for-gallon reduction to streamflow during a repeat of conditions seen during the 2002 drought. The duration of days below the passby threshold would increase from the 130 days actually experienced in 2002 to 207 days considering the increased demand in 2025.

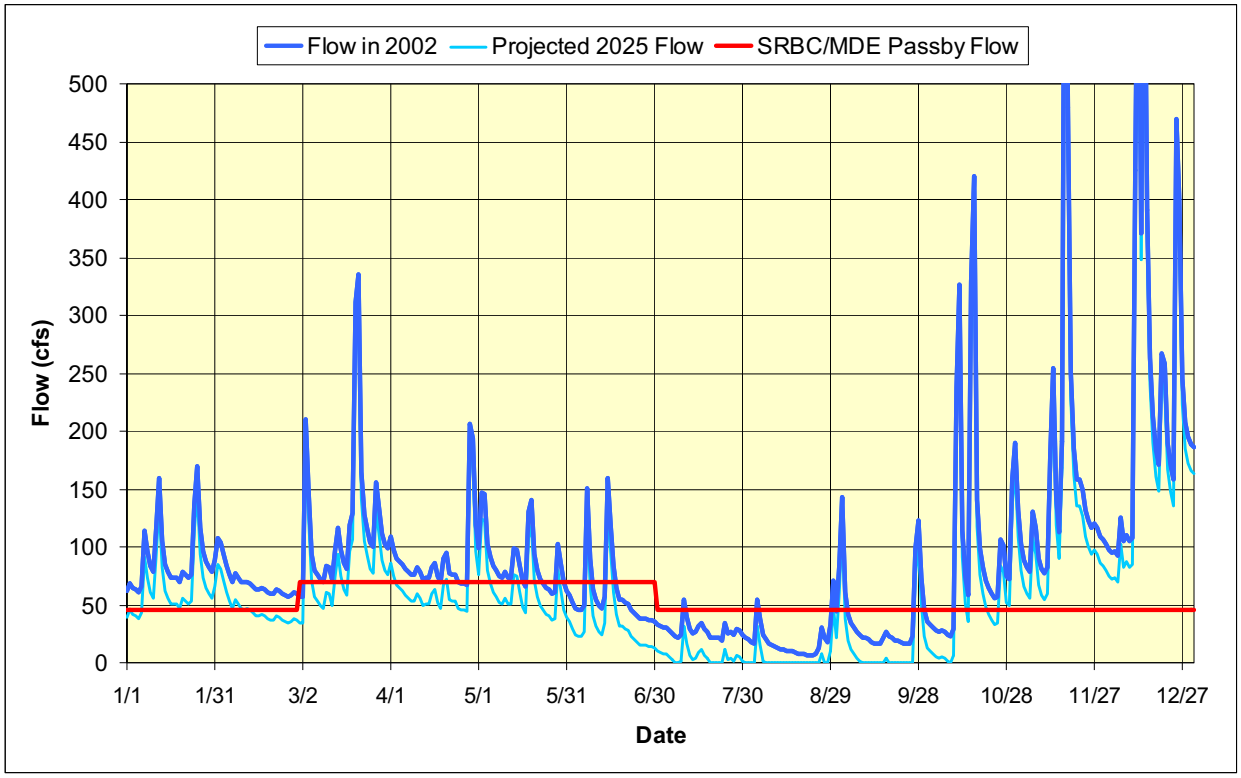

Figure B-3. Cumulative Impact of Potential Increases in Water Demand