Appendix: Repeated Water Level Measurements

There have been several areas where accurate water level measurements have been taken many years apart other than at dedicated monitoring wells. These situation have arisen when local town or village water supplies were studied. It is rare that return measurements are taken after a hydrostudy has been completed.

Village of Waterford: In 2021, water level data was collected at 67 of the wells in the village. Data were compared to the initial depth to water from the driller's reports and from the data collected in 2006 when a study of water supply for the elementary school was conducted. Because of the complexity of geology and pumping history, there were wells where the water level rose over time and those where the levels declined. Water levels declined from initial measurement to 2021 in 22 (54%) and increased in 19 (46%) of the 41 readings whereas water levels declined from 2006 to 2021 initial measurement in 17 (55%) and increased in 14 (45%) of the 31 readings. The median water level decline from initial measurement to 2021 was 17 feet and the median water level declined from 2006 to 2021 was 22 feet. Only 14 wells have reported values from initial to 2021 and 2006 to 2021 with mixed results. Overall the change over the decades has been a decline of almost 20 feet.

Data are reported in the Tetra Tech 2022 report In Table 1. A few values were corrected (NA (Rev)) and selected columns presented here.

WellID	DTW_May_2021	DTW_Spring_2006	DTW_Driller	Differencein DTWfrom2006to2021_Corrected	Differencein DTWfromInitialDateto2021_Corrected
Not known	25	NM	NA	NA	NA
WWIN-1973-0176	44	NM	NA	NA	NA
WWIN-1970-0104	45	NM	NA	NA	NA
Baptist Church	32	NM	NA	NA	NA
WWIN-2001-0911	194	NM	NA	NA	NA
WWIN-1978-0185	90	NM	NA	NA	NA
WWIN-1984-0167	16	NM	NA	NA	NA
Not known	77	NM	NA	NA	NA
WWIN-1982-0124	79	NM	NA	NA	NA
WWIN-1111-0018	14	NM	NA	NA	NA
WWIN-1983-0114	60	NM	NA	NA	NA
WWIN-1986-0327	92	NM	NA	NA	NA
WWIN-1962-0083	NM	25	NA	NA	NA
WWIN-2010-0061	128	NM	45	NA	83.2
WWIN-1999-0178	101	NM	28	NA	73.2
WWIN-2010-0066	169	NM	100	NA	69.1
WWIN-1981-0173	78	NM	18	NA	59.9
WWIN-1987-0365	81	NM	25	NA	56.0
WWIN-2012-0017	95	NM	40	NA	55.1
WWIN-2002-0436	72	NM	17	NA	54.7
WWIN-2001-0530	104	NM	80	NA	24.3
WWIN-2010-0049	115	NM	100	NA	15.2
WWIN-2011-0053	83	NM	70	NA	13.4
WWIN-1989-0337	72	NM	60	NA	11.7
WWIN-1981-0168	16	NM	8	NA	7.6
WWIN-1992-0236	67	NM	61	NA	5.6
WWIN-1986-0342	19	NM	15	NA	3.8
WWIN-2000-0182	42	NM	40	NA	1.8
WWIN-2018-0118	13	NM	15	NA	-1.6

WWIN-2001-0737	30	NM	32	NA	-2.5
WWTS-2011-0008	54	NM	60	NA	-6.4
WWIN-1991-0191	50	NM	58	NA	-8.4
WWIN-1981-0169	92	NM	110	NA	-18.4
WWIN-2010-0166	77	NM	100	NA	-23.4
WWIN-1980-0148	67	NM	109	NA	-42.4
WWIN-1986-0343	16	NM	80	NA	-64.4
WWIN-2018-0002	272	NM	400	NA	-127.6
WWIN-1993-0267	212	162	12	50	199.6
WWIN-2001-0393	139	106	50	33	89.2
WWIN-1988-0529	20	8	NA	12	NA
WWIN-1986-0340	86	76	NA	10	NA
WWIN-1988-0525	36	28	NA	8	NA
WWIN-1979-0160	97	89	NA	8	NA
WWIN-1982-0125	83	75	NA	8	NA
WWIN-1988-0524	34	28	NA	6	NA
WWIN-1981-0198	43	38	NA	5	NA
WWIN-1981-0171	14	12	NA	2	NA
WWIN-1981-0174	92	90	62	2	29.5
WWIN-1998-0117	30	28	40	2	-9.7
WWIN-1964-0097	42	41	NA	1	NA
WWIN-1990-0404	117	116	85	1	31.6
WWIN-1995-0229	26	25	30	1	-4.0
WWIN-1998-0116	30	29	40	1	-9.7
WWIN-1998-0115	27	26	40	1	-13.4
WWIN-1983-0115	17	18	NA	-1	NA
WWCO-1986-0325	NM	3	8.82	NA (Rev)	-8.8
WWIN-1987-0361	32	36	NA	-4	NA
WWIN-1991-0155	61	69	69	-8	-7.7
WWNC-1965-0080	16	26	NA	-10	NA
WWIN-1957-0069	14	25	NA	-11	NA
WWCO-1989-0329	NM	12	17	NA (Rev)	-17.0
WWIN-1980-0150	163	177	NA	-14	NA
WWCO-1989-0330	NM	14	NA	NA (Rev)	NA (Rev)
WWIN-1956-0076	82	107	NA	-25	NA
WWIN-1986-0341	208	249	NA	-41	NA
WWIN-1989-0336	NM	60	18	NA (Rev)	-18.0
WWIN-1992-0159	92	152	64	-61	27.5
WWIN-1996-0267	98	237	50	-139	48.4
WWIN-1986-0338	107	246	NA	-139	NA (Rev)
WWIN-1988-0528	37	227	NA	-190	NA
WWIN-1974-0153	31	244	NA	-213	NA
WWIN-1986-0339	32	262	22	-230	10.4
WWIN-1999-0179	NM	284	80	NA (Rev)	-80.0
WWIN-1973-0307	NM	425	25	NA (Rev)	-25.0

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The Tetra Tech report provides maps of the data as well as computer simulations and other information beyond the scope of this appendix.

The key take away is that when repeated measurements (2006 and 2021) are compared, the is an overall decline in the water table with a median value of 22 feet Additional when using the less reliable driller-reports depth to water (different set of well pairs), there is a median decline of 17 feet.

Tetra Tech, 2022. "Groundwater Resource Evaluation Waterford, Virginia, March 17, 2022" https://lfportal.loudoun.gov/LFPortalInternet/0/edoc/563140/03-31-22%20FINAL%20Waterford%20Feasibility%20Study%20w%20Appendices.pdf

(Projects\Loudoun_County_Hydrogeology\Waterford_Groundwater_Evaluation_2022)

Middleburg: In 2022 water level data collected from 2004 to 2005 were compared with field data collected in 2022 at the same well. Over that time period town wells rates changed and new production wells were added. Some wells showed an increase in the water table elevation, but most wells displayed a lower water table elevation due to the increased pumping of town wells. One well recovered 200 feet. Water table declines of more than 85 feet were observed in 6 of the 19 wells.

Reference:

Tetra Tech, 2022. "Groundwater Recharge Study Report, Middleburg, VA , DRAFT Report – June 24, 2022" (*Obtained by email request to Town of Middleburg 8/14/2025 Danny Davis*)
(Loudoun_County_B_and_D\Groundwater_Monitoring\Middleburg_Groundwater)

The chart below provides details of the change in water table in response to growth in Middleburg.

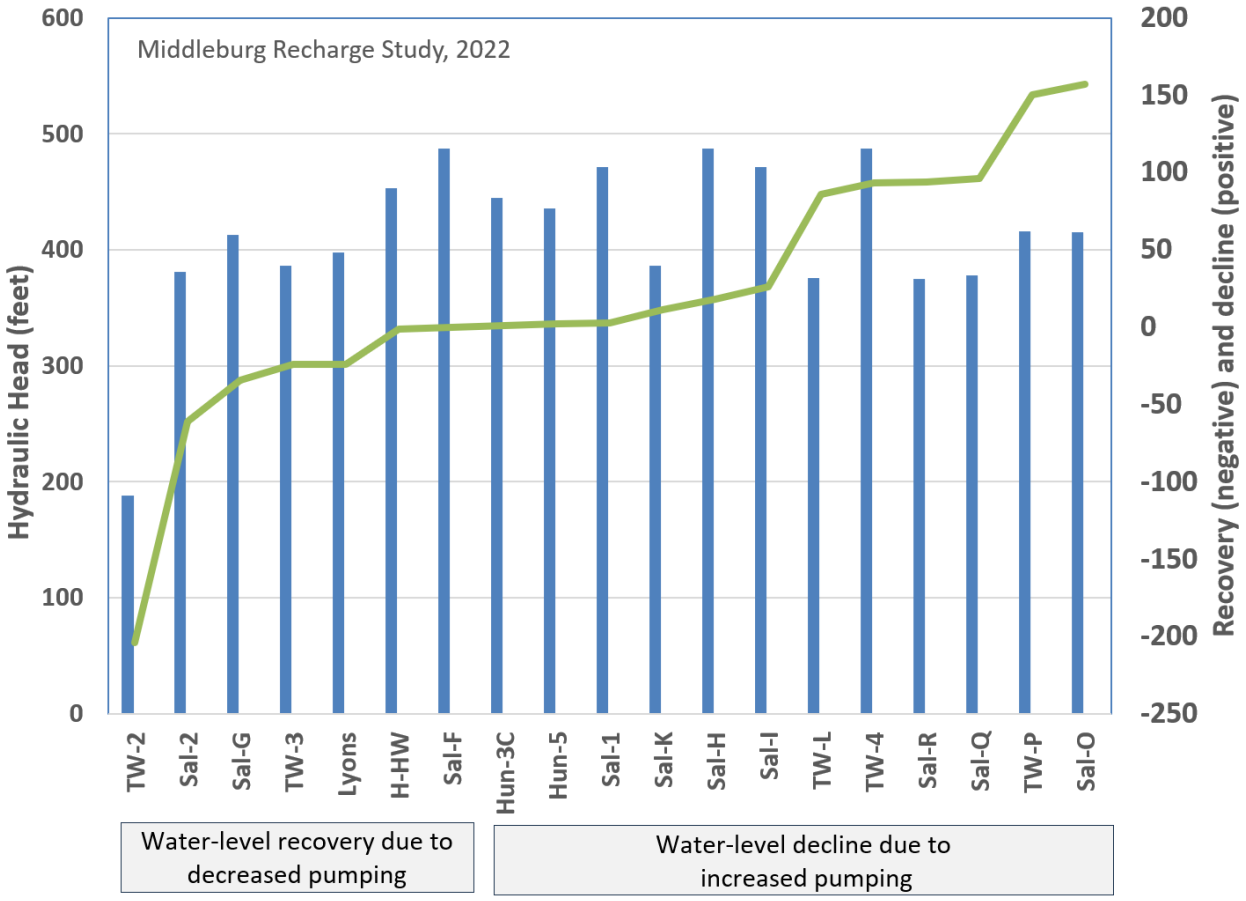
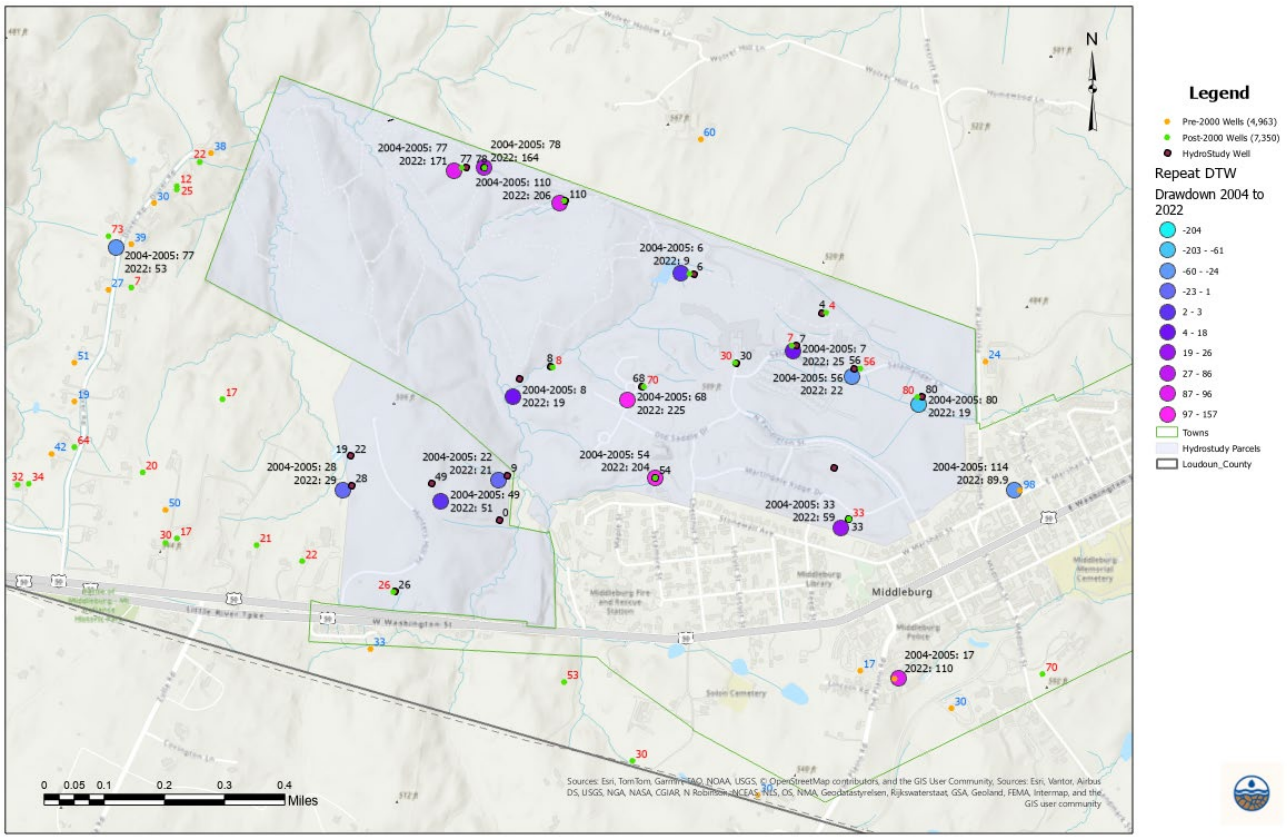


Table 3 (Modified from Tetra Tech)

Well ID	Drill Date	Drawdown (feet) from 2004-2005 to 2022	DTW in 2022 (feet)	DTW in 2004-2005 (feet)	Estimated Ground Surface (feet>MSL)	Hydraulic Head in 2004-2005 (feet>MSL)	Hydraulic Head in 2022 (feet>MSL)	Comments
TW-2	7/13/1971	-204	38	242	430	188	392	Water-level recovery due to decreased pumping rate.
Sal-2	3/20/2003	-61	19	80	461	381	442	Water-level recovery due to decreased pumping rate at TW-2.
Sal-G	11/4/2003	-34	22	56	469	413	447	Water-level recovery due to decreased pumping rate at TW-2.
TW-3	12/12/1986	-24	89.90	114	500	386	410	Water-level recovery due to decreased pumping rate.
Lyons	1982	-24	53	77	475	398	422	No apparent drawdown due to Town pumping.
H-HW	1/0/1900	-1	21	22	475	453	454	No apparent drawdown due to Town pumping.
Sal-F	5/29/2003	0	4	4	491	487	487	
Hun-3C	3/27/1996	1	29	28	473	445	444	No apparent drawdown due to Town pumping.
Hun-5	5/31/1996	2	51	49	485	436	434	No apparent drawdown due to Town pumping.
Sal-1	6/6/2003	3	9	6	477	471	468	
Sal-K	10/13/2003	11	19	8	394	386	375	
Sal-H	6/4/2003	18	25	7	494	487	469	
Sal-I	8/14/2003	26	59	33	504	471	445	
TW-L	12/2/2003	86	164	78	454	376	290	Drawdown due to new pumping.
TW-4	8/18/1994	93	110	17	504	487	394	Drawdown due to new pumping.
Sal-R	12/11/2003	94	171	77	452	375	281	Fracture connection to TW-L; could hear water flow in Sal-R when pumping TW-L.
Sal-Q	11/5/2003	96	206	110	488	378	282	Hydraulic connection to TW-L.
TW-P	8/25/2003	150	204	54	470	416	266	Drawdown due to new pumping.
Sal-O	9/9/2003	157	225	68	483	415	258	Drawdown observed when TW-4 began pumping; apparently impacted by pumping at TW-4, TW-L, and TW- P.

Nonzero water table changes were mapped and the change in water table colorized. Additional wells (depth to water labelled), either from driller static values or from hydrostudies. There is a zone in the central region (magenta) where water table has declined 100+ in two decades as caused by town well rate increases.



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The key take away is that when repeated measurements are taken several years apart, there is localized decline in the water table measuring many tens of feet.