

Appendix E

Revisions to April 2005 Nutrient and DO High-Flow TMDL for Christina River Basin

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On April 8, 2005, the Region III (Philadelphia, PA) office of the Environmental Protection Agency (EPA) established Total Maximum Daily Loads (TMDLs) for nutrients and dissolved oxygen (DO) under high-flow conditions for the portions of the Christina River Basin listed on the Clean Water Act Section 303(d) lists for the Commonwealth of Pennsylvania and the State of Delaware. Additional information has become available for CSO and NPDES discharges that prompted this revision to the April 2005 TMDLs. The updated information is described in this appendix.

E.1 Event Mean Concentrations for Wilmington CSO Discharges

Following the establishment of the Christina River Basin nutrient and DO high-flow TMDLs, the City of Wilmington and Delaware DNREC completed a storm-monitoring program. The goal of the storm-monitoring program was to collect nutrient and bacteria data from four storm events to establish characteristic concentrations for the CSO discharges in the City of Wilmington. Two storm events had been completed prior to the April 2005 TMDL. After April 2005, the monitoring data from two additional storm events were available. This proposed TMDL revision incorporates data from additional storm events to establish updated total nitrogen (TN), total phosphorus (TP), and total organic carbon (TOC) event mean concentrations (EMCs) for the Wilmington CSO discharges as shown in Table E-1.

Table E-1. Revised EMCs for TN, TP, and TOC City of Wilmington CSOs

CSO ID	EMC April 2005 TMDL (mg/L)			EMC for Revised TMDL (mg/L)		
	TN	TP	TOC	TN	TP	TOC
CSO 4b	2.966	0.310	6.92	2.619	0.334	11.94
CSO 25	2.947	0.618	21.70	2.928	0.655	20.58
CSO 3	4.451	0.690	12.63	7.591	1.041	15.84
All other CSOs	4.451	0.690	12.63	2.753	0.339	15.68

The data from the individual storm events are summarized in Tables E-2, E-3, and E-4. The revised event mean concentrations were calculated using an arithmetic mean of all data associated with a given CSO. For the April 2005 TMDL, data from the 11th Street Pumping Station were used to establish EMCs for CSO3 and all other CSOs except for CSO 4b, and CSO 25. For the revised TMDL, data from the 11th Street Pumping Station was used to establish the EMC for CSO 3 only. The EMCs for the other CSOs were calculated as the arithmetic mean from the combined storm monitoring data of CSO 4b and CSO 25.

Stormwater runoff sometimes exhibits high pollutant concentrations during the initial stages of a storm. This is referred to as the “first flush”. Examination of the CSO storm monitoring data in Tables E-2, E-3, and E-4 did not indicate any strong first-flush tendency. Larger concentrations were just as likely to occur several hours into the storm event rather than at the beginning. Also, in many of the storms, the concentrations were relatively constant over time. Due to the absence of any definitive evidence in the monitoring data, the first-flush phenomenon was not included in this analysis. Event-mean concentrations were considered appropriate for characterizing the mass loadings from the CSO outfalls.

Table E-2. Storm monitoring data for CSO 4b

Date	Time	CBOD20 mg/L 80087	CBOD5 mg/L 80082	DOC mg/L 00681	TOC mg/L 00680	NH3-N mg/L 00610	NOxN mg/L 00630	TKN mg/L 00625	TN mg/L ****	DOrthP mg/L 00671	TP mg/L 00665	TSS mg/L 00530
10/27/2003	11:40	14.62	11.70	6.6	9.1	0.362	0.969	1.400	2.369	0.004	0.238	298
10/27/2003	12:10	13.60	5.82	2.9	3.7	0.137	0.248	0.275	0.248	0.020	0.320	278
10/27/2003	12:40	10.20	5.64	6.1	6.2	0.189	0.502	0.644	0.502	0.100	0.219	195
10/27/2003	13:10	14.48	7.85	5.9	7.1	0.238	0.831	1.080	1.911	0.126	0.270	177
10/27/2003	13:40	13.98	7.65	6.8	8.3	0.244	1.070	1.210	2.280	0.141	0.219	75
10/27/2003	14:10	13.50	10.60	7.3	8.9	0.238	1.290	1.370	2.660	0.159	0.216	32
12/17/2003	09:00	16.20	9.20	4.9	6.8	0.403	0.627	2.650	3.277	0.203	0.388	35
12/17/2003	09:30	16.10	8.65	4.7	6.2	0.480	0.855	2.790	3.645	0.180	0.382	34
12/17/2003	10:00	23.80	12.80	6.8	8.4	4.520	1.210	4.830	6.040	0.222	0.546	25
12/17/2003	10:30	16.20	10.60	5.9	6.1	0.504	1.360	3.060	4.420	0.192	0.416	17
12/17/2003	11:00	12.10	8.18	5.5	6.0	0.486	1.710	2.610	4.320	0.138	0.306	19
12/17/2003	11:30	10.60	6.86	5.0	6.2	0.357	1.970	1.950	3.920	0.112	0.194	19
11/4/2004	13:33	25.10	13.10	22.9	24.4	0.206	0.391	1.250	1.641	0.308	0.489	174
11/4/2004	14:03	28.40	15.20	18.3	20.2	0.154	0.337	0.937	1.274	0.256	0.376	31
11/4/2004	14:33	27.40	15.00	20.6	22.8	0.145	0.540	1.060	1.600	0.268	0.386	14
11/4/2004	15:03	24.50	15.60	22.2	23.5	0.113	0.748	1.080	1.828	0.250	0.314	11
11/4/2004	15:33	23.60	13.60	22.5	29.1	0.197	0.710	1.870	2.580	0.218	0.407	27
EMC		17.90	10.47	10.29	11.94	0.528	0.904	1.769	2.619	0.170	0.334	86

Table E-3. Storm monitoring data for CSO 25

Date	Time	CBOD20 mg/L 80087	CBOD5 mg/L 80082	DOC mg/L 00681	TOC mg/L 00680	NH3-N mg/L 00610	NOxN mg/L 00630	TKN mg/L 00625	TN mg/L ****	DOrthP mg/L 00671	TP mg/L 00665	TSS mg/L 00530
10/27/2003	11:00	13.88	13.88	11.8	14.4	0.325	0.516	1.270	1.786	0.234	0.296	32
10/27/2003	11:30	14.76	14.76	10.3	11.6	0.294	0.503	1.050	1.553	0.286	0.397	33
10/27/2003	12:00	7.83	5.36	3.8	4.3	0.136	0.215	0.392	0.215	0.113	0.178	51
10/27/2003	12:30	12.14	12.14	70.5	80.0	0.421	0.634	3.070	3.704	1.870	1.620	39
10/27/2003	13:30	14.10	14.10	10.6	11.6	0.352	0.820	1.900	2.720	0.249	0.450	26
10/27/2003	14:00	14.26	14.26	10.8	12.0	0.455	1.160	2.480	3.640	0.354	0.642	15
12/17/2003	08:45	15.00	9.48	6.3	6.6	0.350	0.547	1.850	2.397	0.202	0.102	27
12/17/2003	09:15	28.30	19.60	9.1	10.2	0.500	0.839	3.140	3.979	0.317	0.296	22
12/17/2003	09:45	28.76	28.76	40.8	44.6	3.720	1.030	5.500	6.530	1.560	1.580	14
11/4/2004	13:20	28.50	14.90	15.4	18.3	0.476	0.272	1.990	2.262	0.277	0.505	42
11/4/2004	13:50	27.74	15.30	14.0	15.2	0.559	0.315	2.220	2.535	1.000	1.100	39
11/4/2004	14:20	28.00	14.10	17.2	19.1	0.606	0.422	2.630	3.052	0.385	0.637	19
11/4/2004	14:50	26.10	15.10	16.4	19.6	0.712	0.513	3.180	3.693	0.436	0.706	16
EMC		19.95	14.75	18.24	20.58	0.685	0.599	2.359	2.928	0.560	0.655	29

Table E-4. Storm monitoring data for CSO 3 (11th Street Pumping Station)

Date	Time	CBOD20 mg/L 80087	CBOD5 mg/L 80082	DOC mg/L 00681	TOC mg/L 00680	NH3-N mg/L 00610	NOxN mg/L 00630	TKN mg/L 00625	TN mg/L ****	DOrthP mg/L 00671	TP mg/L 00665	TSS mg/L 00530
10/27/2003	11:20	11.76	11.76	23.5	29.6	4.040	0.467	7.250	7.717	0.262	1.470	454
10/27/2003	11:50	10.88	10.88	9.5	11.9	3.070	1.100	3.820	4.920	0.433	0.520	71
10/27/2003	12:10	10.88	10.88	7.7	9.6	1.520	0.545	1.450	1.995	0.202	0.357	166
10/27/2003	12:50	12.98	9.02	4.6	5.8	2.200	0.517	1.400	1.917	0.003	0.366	144
10/27/2003	13:20	11.82	11.82	13.9	15.3	1.720	0.646	0.964	1.610	0.167	0.289	104
10/27/2003	13:50	11.66	11.66	6.8	8.5	2.340	0.753	1.880	0.753	0.311	0.420	106
12/17/2003	08:50	82.32	29.30	8.5	10.4	3.040	0.682	6.790	7.472	0.157	1.160	143
12/17/2003	09:20	26.50	13.80	5.3	6.3	4.520	0.732	4.880	0.732	0.129	0.630	86
12/17/2003	09:50	29.60	15.40	6.0	8.2	1.650	0.820	4.900	5.720	0.004	0.632	91
12/17/2003	10:20	20.80	14.30	6.7	9.1	3.530	0.842	4.670	5.512	0.019	0.645	73
12/17/2003	10:50	42.40	23.70	7.3	11.3	2.940	1.200	5.910	7.110	0.004	0.883	106
12/17/2003	11:20	82.05	82.05	21.4	25.5	1.150	1.140	6.810	7.950	0.341	0.909	64
11/4/2004	13:25	26.82	13.58	20.1	22.6	4.340	0.460	23.200	23.660	0.007	3.400	553
11/4/2004	13:55	30.00	13.70	16.0	23.2	3.080	0.463	12.300	12.763	0.210	1.650	189
11/4/2004	14:25	29.50	12.96	15.6	20.0	2.780	0.506	10.600	11.106	0.182	1.130	181
11/4/2004	14:55	24.36	13.40	14.6	21.5	3.140	0.430	12.600	13.030	0.274	1.470	122
11/4/2004	15:25	20.70	12.40	16.7	21.2	3.050	0.533	11.200	11.733	0.605	1.480	128
11/4/2004	15:55	23.50	12.80	20.9	25.2	2.800	0.630	10.300	10.930	0.644	1.320	104
EMC		28.25	17.97	12.51	15.84	2.828	0.693	7.274	7.591	0.220	1.041	160

E.2 Summary of Annual Baseline and TMDL CSO Nitrogen and Phosphorus Loads

A summary of the baseline and TMDL CSO nitrogen and phosphorus annual average loads grouped by EFDC model grid cell location is presented in Table E-5. The locations of the CSO discharges and the EFDC model grid cells are shown in Figure E-1. Note that CSO 31 discharges to Shellpot Creek, which flows into the Delaware River and is outside the Christina River Basin, therefore it is not included in the CSO load totals for the baseline and TMDL columns in Table E-5. The following CSOs were assigned zero flow (i.e., 100% load reduction) for the TMDL allocation: 4b, 4c, 4f, 12, 14, 15, 18, 20, and Rockford Road (RR).

Table E-5. Baseline and TMDL average annual loads for CSOs grouped by EFDC grid cell

Location (subbasin)	EFDC Cell [I,J]	CSO ID numbers	Baseline (kg/yr)	TMDL (kg/yr)	Reduction
Total Nitrogen					
Little Mill Creek (C05)	[44,55]	27, 28	683.6	162.1	76.3%
Little Mill Creek (C05)	[45,55]	29	267.5	63.5	76.3%
Christina River (C09)	[52,13]	5, 6, 7, 11, 12, 13, 30	1055.2	363.2	65.6%
Christina River (C09)	[53,13]	9a, 10, 14, 15, 16, 17	1057.4	229.6	78.3%
Christina River (C09)	[55,13]	9c	52.2	2.6	95.1%
Brandywine Cr. (B34)	[54,16]	18	0.4	0.0	100.0%
Brandywine Cr. (B34)	[54,17]	3, 4a, 4b, 4c, 4d, 19, 20, 21a, 21b, 21c	2210.1	398.2	82.0%
Brandywine Cr. (B34)	[54,18]	4e, 4f, 22b, 22c, 23, 24	262.1	261.0	0.4%
Brandywine Cr. (B34)	[54,20]	25, 26	1643.6	839.9	48.9%
Brandywine Cr. (B34)	[54,21]	RR	60.6	0.0	100.0%
Shellpot Creek - CSO 31*	[57,15]	31	258.8	182.1	29.6%
Total Average Annual Nitrogen Load			7292.7	2319.9	68.2%
Total Phosphorus					
Little Mill Creek (C05)	[44,55]	27, 28	115.7	27.4	76.3%
Little Mill Creek (C05)	[45,55]	29	45.3	10.6	76.6%
Christina River (C09)	[52,13]	5, 6, 7, 11, 12, 13, 30	178.5	61.7	65.4%
Christina River (C09)	[53,13]	9a, 10, 14, 15, 16, 17	178.9	38.7	78.4%
Christina River (C09)	[55,13]	9c	8.8	0.4	95.8%
Brandywine Cr. (B34)	[54,16]	18	0.0	0.0	0.0%
Brandywine Cr. (B34)	[54,17]	3, 4a, 4b, 4c, 4d, 19, 20, 21a, 21b, 21c	328.9	60.2	81.7%
Brandywine Cr. (B34)	[54,18]	4e, 4f, 22b, 22c, 23, 24	44.9	44.5	0.8%
Brandywine Cr. (B34)	[54,20]	25, 26	333.6	161.7	51.5%
Brandywine Cr. (B34)	[54,21]	RR	10.2	0.0	100.0%
Shellpot Creek - CSO 31*	[57,15]	31	43.8	30.7	30.0%
Total Average Annual Phosphorus Load			1244.7	405.2	67.4%

*CSO31 not included in total CSO load since it discharges outside of Christina River Basin

these types of small discharges. This change in nitrogen loading from the small residence discharges had negligible impact on receiving water quality.

Table E-6. List of updated NPDES information for Christina River Basin

NPDES Permit	HSPF subbasin	Name	Description of Change
PA0012416	B03	PA American Water (Rock Run)	New owner (previously owned by Coatesville)
PA0011568-001	B05	ISG Plate LLC (Sucker Run, W. Br. Brandywine Cr.)	New owner (previously owned by Lukens Steel)
PA0011560-016	B05	ISG Plate LLC (Sucker Run, W. Br. Brandywine Cr.)	New owner (previously owned by Lukens Steel)
PA0055492	B10	Andrew and Gail Woods (Indian Run)	New owners (previously owned by John and Jane Topp)
PA0051365	B11	PA American Water (E. Br. Brandywine Cr.)	New owner (previously owned by West Chester Area Municipal Authority)
PA0026531	B13	Downingtown Area WWTP (E. Br. Brandywine Cr.)	Flow increase from 7.134 to 7.500 mgd
PA0244031	B16	Chadds Ford Township (Brandywine Cr.)	Replaces PA0047252 (Pantos Corp.). Flow increase from 0.07 to 0.15 mgd
PA0055085	B16	Nancy Winslow (Brandywine Cr.)	Active during 1994-98 calibration period. No longer exists.
PA0036161	B20	Lincoln Crest MHP (Buck Run)	Active during 1994-98 calibration period. No longer exists.
PA0053937	B29	William and Patricia Kratz (Broad Creek)	New owners (previously owned by Ralph and Gayla Johnson)
PA0056952	W04	Sun Company, Inc. (E. Br. White Clay Cr.)	Active during 1994-98 calibration period. No longer exists.
PA0052019	W04	Avon Grove Trailer Court (E. Br. White Clay Cr.)	Active during 1994-98 calibration period. No longer exists.
PA0029343	W06	Chatham Acres (E.Br. White Clay Cr.)	Active during 1994-98 calibration period. No longer exists.
PA0057720-001	R01	Sunny Dell Foods, Inc. (W. Br. Red Clay Cr.)	Flow increase from 0.05 to 0.072 mgd