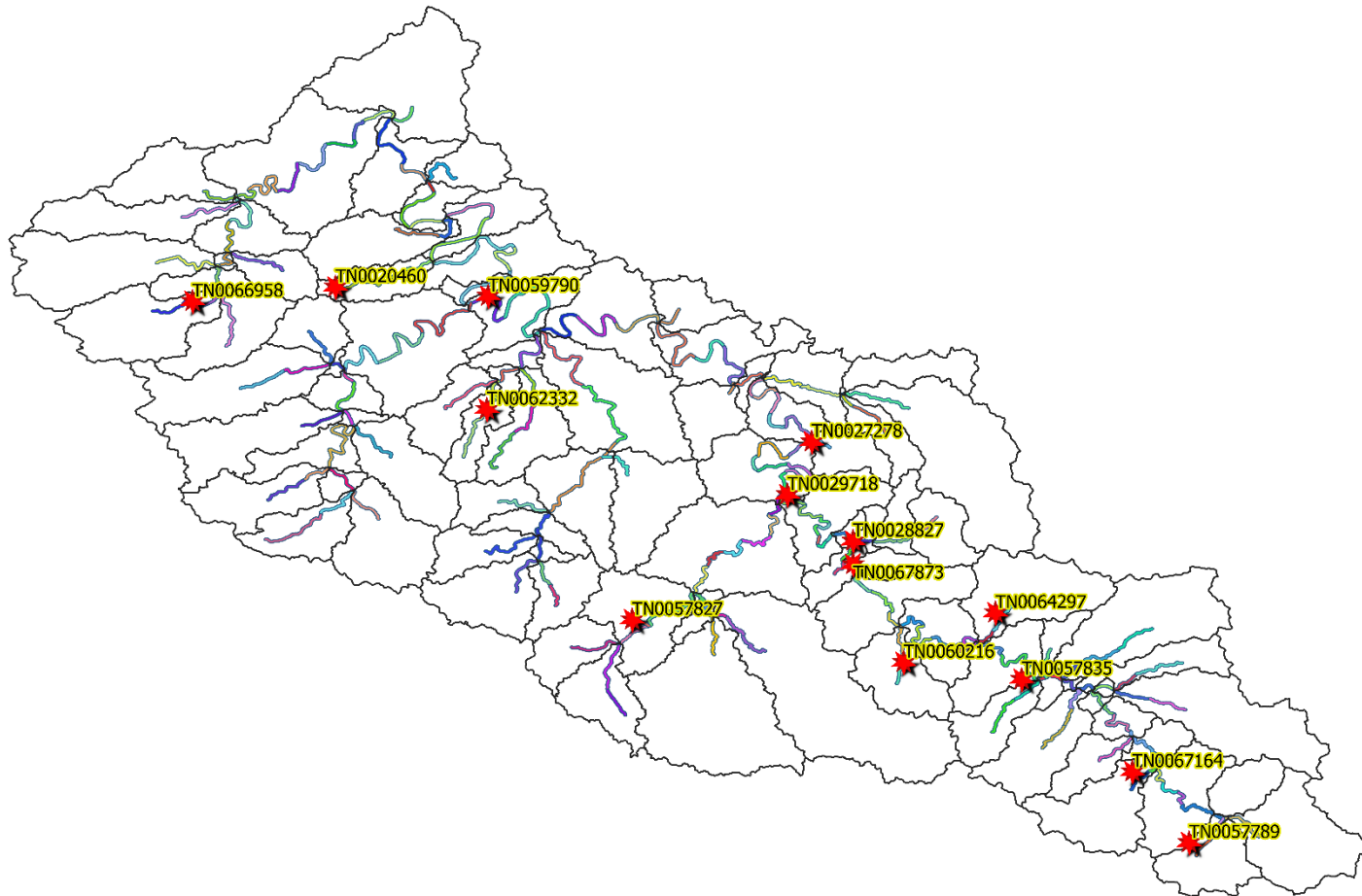


Overview of NPDES point source processing

Harpeth River water quality model

J. Davis
02/25/2021

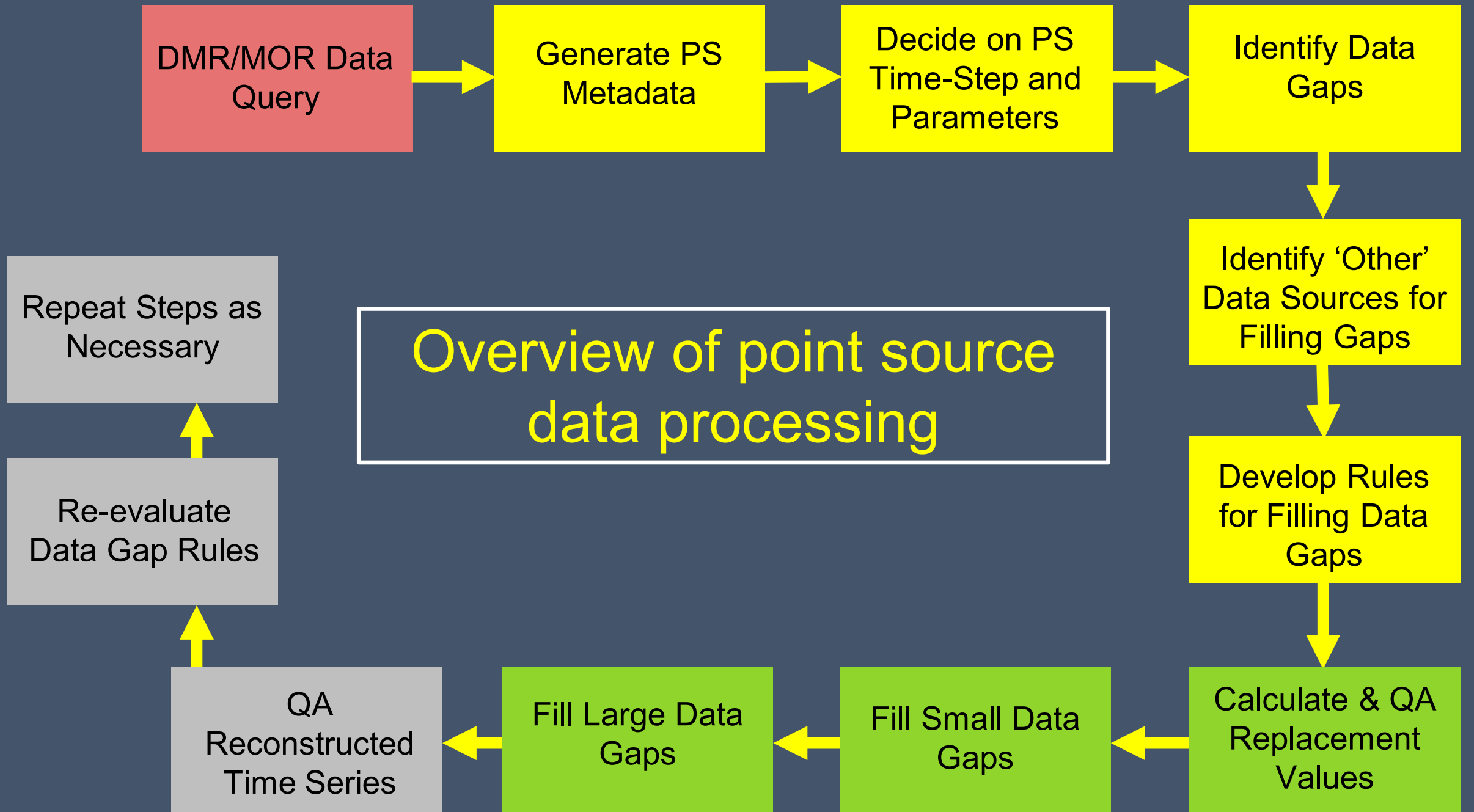
Point source locations



- 14 NPDES facilities included
 - DMR source for many facilities
 - Franklin/Goose Creek had MOR data
- Model period: 01/01/11 to 12/31/19
 - 2 facilities shutdown prior to 2019

Permit	Stat Code	Station Name	Station Type	Permit End
TN0020460	WhBluff	White Bluff STP	MunicMinor	
TN0027278	CartwrCrk	Cartwright Creek STP	MunicMinor	
TN0028827	Franklin	Franklin STP	MunicMajor	
TN0029718	BerryChap	Berry's Chapel Utility STP	MunicMinor	
TN0057789	EaglevHS	Eagleville HS	School	11/1/2015
TN0057827	HillsbroES	Hillsboro ES	School	
TN0057835	PageSchl	Page School	School	
TN0059790	KingstnSpr	Kingston Springs STP	MunicMinor	
TN0060216	GooseCrk	Goose Creek Inn	Subdivision	6/1/2018
TN0062332	Fairvw	Fairview STP	MunicMinor	
TN0064297	TrintyES	Trinity ES	School	
TN0066958	Dickson	Dickson STP	MunicMajor	
TN0067164	ColGrvES	College Grove ES	School	
TN0067873	OakvwES	Oakview ES	School	

MOR = Monthly operating report (Daily data from facility)
DMR = Discharge monitoring report (Monthly data from ICIS)



Point source parameters

- Many facilities missing water quality data
- Reconstructed 13 parameters
 - Flow (WASP: m³/sec; LSPC: ft³/sec)
 - TP, PO₄, & ORGP (mg/L)
 - TN, NH₃, NO₂ + NO₃, & ORGN (mg/L)
 - Temperature (deg C)
 - DO (mg/L)
 - CBOD (mg/L)
 - TSS (mg/L)
- Nondetects replaced with ½ RL
- Used measured values when available
 - MOR records prioritized over DMR records
 - Back-calculated subspecies when required constituents measured
- Data gaps of ≤ 3 records linearly interpolated
- Gaps > 3 records filled using replacement values
 - Averages calculated based on measured values or other suitable data
- All schools, except Trinity ES, shutdown during summer (summer discharge flow = 0)
- Reconstructed data reviewed by TDEC

Permit	Stat_Code	Date	CBOD (mg/L)
TN0029718	BerryChap	1/31/2014	2.2
TN0029718	BerryChap	2/28/2014	2.067
TN0029718	BerryChap	3/31/2014	1.933
TN0029718	BerryChap	4/30/2014	1.8
TN0029718	BerryChap	5/31/2014	2
TN0029718	BerryChap	6/30/2014	2.1
TN0029718	BerryChap	7/31/2014	2.6
TN0029718	BerryChap	8/31/2014	2.9
TN0029718	BerryChap	9/30/2014	3.2
TN0029718	BerryChap	10/31/2014	3.3
TN0029718	BerryChap	11/30/2014	2.5
TN0029718	BerryChap	12/31/2014	2.4
TN0029718	BerryChap	1/31/2015	3
TN0029718	BerryChap	2/28/2015	3

Point source data sources

Permit	Stat_Code	TP (mg/L)	NH3 (mg/L)	CBOD (mg/L)	DO (mg/L)	Flow (MGD)	TSS (mg/L)	NH3_TN_Ratio	NOX_TN_Ratio	ORGN_TN_Ratio	TKN_TN_Ratio	PO4_TP_Ratio	ORGP_TP_Ratio	WTEMP (degC)
TN0020460	WhBluff	Permit Appl	DMR	DMR	DMR	DMR	DMR	Permit Appl	Permit Appl	Permit Appl	Permit Appl	FF Minor	FF Minor	General
TN0027278	CartwrCrk	DMR	DMR	DMR	DMR	DMR	DMR	DMR	Permit Appl	Permit Appl	Permit Appl	FF Minor	FF Minor	General
TN0028827	Franklin*	MOR	MOR	MOR	MOR	MOR	MOR	MOR	MOR	MOR	MOR	FF Major	FF Major	General
TN0029718	BerryChap	DMR	DMR	DMR	DMR	DMR	DMR	DMR	Permit Appl	Permit Appl	Permit Appl	FF Minor	FF Minor	General
TN0057789	EaglevLHS	TDEC cal	Permit Values	Permit Values	Permit Values	Similar Harpeth School	Permit Values	TDEC cal	FF School	FF School	FF School	FF School	FF School	General
TN0057827	HillsbroES	Nutrient Report	Permit Appl	Nutrient Report	Permit Values	Nutrient Report	Permit Appl	Nutrient Report	FF School	FF School	FF School	FF School	FF School	General
TN0057835	PageSchl	Nutrient Report	Permit Appl	Nutrient Report	Permit Values	Nutrient Report	Permit Appl	Nutrient Report	FF School	FF School	FF School	FF School	FF School	General
TN0059790	KingstnSpr	Permit Appl	DMR	DMR	DMR	DMR	DMR	Permit Appl	2010 Permit Appl	2010 Permit Appl	2010 Permit Appl	FF Minor	FF Minor	General
TN0060216	GooseCrk	similar facility	MOR	MOR	MOR	MOR	MOR	Similar facility	Similar facility	Similar facility	Similar facility	Similar facility	Similar facility	General
TN0062332	Fairvw	DMR	DMR	DMR	DMR	DMR	DMR	DMR	Permit Appl	Permit Appl	Permit Appl	FF Minor	FF Minor	General
TN0064297	TrintyES	Nutrient Report	Permit Appl	Nutrient Report	Permit Values	Est. Flow	Permit Appl	Nutrient Report	FF School	FF School	FF School	FF School	FF School	General
TN0066958	Dickson	DMR	DMR	DMR	DMR	DMR	DMR	DMR	Permit Appl	Permit Appl	Permit Appl	FF Major	FF Major	General
TN0067164	ColGrvES	Nutrient Report	Permit Appl	Nutrient Report	Permit Values	Est. Flow	Permit Appl	Nutrient Report	FF School	FF School	FF School	FF School	FF School	General
TN0067873	OakvwES	2011-2012 event	Permit Appl	2011-2012 event	Permit Values	2011-2012 event	Permit Appl	2011-2012 event	FF School	FF School	FF School	FF School	FF School	General

* Franklin calculated monthly avg by year; all others calculated monthly averages across all years

Color Coding	
DMR values	
MOR Values	
Average ratios based on permit applications for that facility	
Average values based on Nutrient Report submitted with permit application (2018 or 2019)	
Average ratios based only on 2010 permit application for that facility due to negative ratio of OrgN/TN in 2015 permit application	
Est. Flow - Flow meters inaccurate (Source Nutrient Report)	
Values based on 2011-2012 sample event (Source Harpeth School.xlsx TDEC spreadsheet)	
Permit Values based on TDEC's Harpeth School.xlsx (permit values)	
Values based on 95% values calculated by TDEC (Source Harpeth School.xlsx TDEC spreadsheet)	
Flows value based on average flow of TN0067873	
Default values based on Floyds Fork School - KY0076732 (TP and subspecies from field samples; NH/TN and nitrogen subspecies based on combination of field sample and DMR data)	
Global average from Cherrytree Apartments in Floyd's Fork (KY0076741); Nitrogen subspecies from the outfall of Cherrytree Apartments	
Default value based on Tetra Tech Model for Floyds Fork (Major Munic)	
Default value based on Tetra Tech Model for Floyds Fork (Minor Munic)	
Default value based on general modeling assumptions	

Month-by-year replacement table

Permit	Stat_Code	Year	Month	Perm_Month_Year	FLOW	CBOD	DO	TSS	WTEMP	NH3	TP	NH3_TN_Ratio	NOX_TN_Ratio	ORGN_TN_Ratio	TKN_TN_Ratio	PO4_TP_Ratio	ORGP_TP_Ratio
TN0028827	Franklin	2011	1	TN0028827_1_2011	9.62774	1.19758	10.31734	1.22581	15	0.09265	0.79294	0.03272	0.75346	0.21383	0.24654	0.98036	0.01964
TN0028827	Franklin	2011	2	TN0028827_2_2011	10.69365	1.18953	10.48987	1.12823	15	0.04442	0.69884	0.02647	0.70402	0.26951	0.29598	0.87650	0.12350
TN0028827	Franklin	2011	3	TN0028827_3_2011	9.61621	1.32500	10.30968	1.15726	15	0.04063	0.71238	0.01732	0.71385	0.26883	0.28615	0.85845	0.14155
TN0028827	Franklin	2011	4	TN0028827_4_2011	9.58642	1.17750	9.88208	1.15417	25	0.04685	0.76138	0.03185	0.61959	0.34857	0.38041	0.93908	0.06092
TN0028827	Franklin	2011	5	TN0028827_5_2011	7.57681	1.10927	9.39516	1.13710	25	0.03609	1.01774	0.01909	0.61714	0.36361	0.38286	0.95061	0.04939
TN0028827	Franklin	2011	6	TN0028827_6_2011	7.35500	1.26271	8.89375	1.47500	25	0.17034	1.58244	0.02676	0.58109	0.39216	0.41891	0.77399	0.22601
TN0028827	Franklin	2011	7	TN0028827_7_2011	7.20415	1.19476	8.77137	1.44355	25	0.07486	1.11988	0.03488	0.60786	0.35726	0.39214	0.85086	0.14914
TN0028827	Franklin	2011	8	TN0028827_8_2011	6.50605	1.19556	8.67661	1.21371	25	0.04875	0.98313	0.02255	0.60146	0.37599	0.39854	0.86577	0.13423
TN0028827	Franklin	2011	9	TN0028827_9_2011	6.45729	1.13354	8.78625	1.30417	25	0.05407	1.13964	0.02494	0.62119	0.35387	0.37881	0.95223	0.04777
TN0028827	Franklin	2011	10	TN0028827_10_2011	6.57355	1.46694	9.25242	1.31855	15	0.08868	1.53145	0.03907	0.57876	0.38217	0.42124	0.84239	0.15761
TN0028827	Franklin	2011	11	TN0028827_11_2011	7.28021	1.42125	9.79000	1.34583	15	0.14972	1.57407	0.05758	0.67074	0.27168	0.32926	0.92374	0.07626
TN0028827	Franklin	2011	12	TN0028827_12_2011	9.38472	1.19173	9.93911	1.25000	15	0.09185	0.71174	0.04698	0.69591	0.25711	0.30328	0.83414	0.16586
TN0028827	Franklin	2012	1	TN0028827_1_2012	9.03871	0.85323	10.03226	1.22581	15	0.32419	0.70200	0.02482	0.71503	0.26015	0.28497	0.98036	0.01964
TN0028827	Franklin	2012	2	TN0028827_2_2012	7.15621	0.81724	10.27931	1.10345	15	0.05103	1.24500	0.02487	0.65707	0.31806	0.34293	0.87650	0.12350
TN0028827	Franklin	2012	3	TN0028827_3_2012	8.52323	0.64839	9.95484	1.16129	15	0.03032	1.12500	0.01109	0.69774	0.29117	0.30226	0.85845	0.14155
TN0028827	Franklin	2012	4	TN0028827_4_2012	5.10367	0.57333	9.44667	1.16667	25	0.01100	1.14250	0.00872	0.47016	0.52112	0.52984	0.93908	0.06092
TN0028827	Franklin	2012	5	TN0028827_5_2012	5.23581	0.65161	9.30323	1.09677	25	0.03935	1.25600	0.02124	0.51985	0.45891	0.48015	0.95061	0.04939
TN0028827	Franklin	2012	6	TN0028827_6_2012	2.65467	0.85167	8.90333	1.26667	25	0.05200	2.15000	0.02488	0.43853	0.53659	0.56147	0.77399	0.22601
TN0028827	Franklin	2012	7	TN0028827_7_2012	4.21032	0.73548	8.40968	1.09677	25	0.04774	1.54400	0.01916	0.74290	0.23794	0.25710	0.85086	0.14914
TN0028827	Franklin	2012	8	TN0028827_8_2012	4.36387	0.86452	8.29677	1.12903	25	0.06387	1.14900	0.03135	0.53385	0.43479	0.46615	0.86577	0.13423
TN0028827	Franklin	2012	9	TN0028827_9_2012	5.09200	1.12167	8.57000	1.36667	25	0.13133	1.35000	0.06087	0.57880	0.36033	0.42120	0.95223	0.04777
TN0028827	Franklin	2012	10	TN0028827_10_2012	5.22419	2.02258	9.03871	1.35484	15	0.37677	1.65200	0.22085	0.22330	0.55585	0.77670	0.84239	0.15761
TN0028827	Franklin	2012	11	TN0028827_11_2012	5.52100	1.97667	9.64000	1.36667	15	0.62333	1.72825	0.29584	0.48425	0.21991	0.51575	0.92374	0.07626
TN0028827	Franklin	2012	12	TN0028827_12_2012	8.47806	0.90806	9.69032	1.32258	15	0.16839	1.16975	0.14672	0.63417	0.21911	0.35930	0.83414	0.16586
TN0028827	Franklin	2013	1	TN0028827_1_2013	13.06516	0.77258	9.93548	1.19355	15	0.05097	0.95900	0.02525	0.82093	0.15382	0.17907	0.98036	0.01964

- Franklin STP and Goose Creek had MOR daily records
 - Reduced need for default values
- Calculated for all months/years, even when not used

Monthly replacement table: Other facilities

Permit	Stat_Code	Month	Perm_Month	FLOW	CBOD	DO	TSS	WTEMP	NH3	TP	NH3_TN_Ratio	NOX_TN_Ratio	ORGN_TN_Ratio	TKN_TN_Ratio	PO4_TP_Ratio	ORGP_TP_Ratio
TN0020460	WhBluff	1	TN0020460_1	0.30830	5.21889	8.51556	6.26667	15	0.21699	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	2	TN0020460_2	0.44943	5.12000	8.35750	6.42750	15	0.09921	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	3	TN0020460_3	0.39800	5.60444	8.09667	5.25222	15	0.11276	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	4	TN0020460_4	0.37254	5.26956	7.42889	5.90889	25	0.08104	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	5	TN0020460_5	0.29690	5.78250	7.31875	4.76875	25	0.06689	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	6	TN0020460_6	0.25400	6.86889	6.96889	5.98222	25	0.06000	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	7	TN0020460_7	0.26100	6.85333	6.84556	5.62333	25	0.07068	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	8	TN0020460_8	0.22552	5.85556	6.96556	6.10556	25	0.07418	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	9	TN0020460_9	0.22363	7.04556	7.03500	5.69556	25	0.09526	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	10	TN0020460_10	0.23625	5.68125	7.38625	6.60000	15	0.10214	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	11	TN0020460_11	0.27160	5.46111	7.95778	6.78889	15	0.05740	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	12	TN0020460_12	0.32884	4.93111	8.38556	4.98889	15	0.05608	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0020460	WhBluff	Global	TN0020460_Global	0.30144	5.81568	7.60827	5.86552	20	0.09110	3.11667	0.00859	0.92535	0.06606	0.07465	0.57	0.43
TN0027278	CartwrCrk	1	TN0027278_1	0.51180	3.04000	7.30000	5.48000	15	0.43000	0.69200	0.08064	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	2	TN0027278_2	0.63520	6.40000	7.10000	5.62000	15	0.28000	1.03400	0.06564	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	3	TN0027278_3	0.51360	3.38000	7.18000	4.14000	15	0.29000	0.54000	0.06174	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	4	TN0027278_4	0.52380	6.02000	6.64000	5.18000	25	0.56400	0.92400	0.13140	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	5	TN0027278_5	0.30780	4.72000	6.58000	3.16000	25	0.71000	0.83200	0.13288	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	6	TN0027278_6	0.30140	5.84000	6.36000	3.70000	25	0.49000	1.19600	0.11380	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	7	TN0027278_7	0.29460	2.94000	6.50000	3.40000	25	0.39600	0.94800	0.09424	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	8	TN0027278_8	0.25240	2.40000	6.42000	3.58000	25	0.72200	1.13600	0.11989	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	9	TN0027278_9	0.26600	4.26000	6.38000	4.18000	25	0.57200	1.74600	0.10947	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	10	TN0027278_10	0.28940	2.84000	6.74000	3.86000	15	0.36600	1.05600	0.06227	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	11	TN0027278_11	0.39900	3.36000	6.86000	4.34000	15	0.38400	1.00000	0.07864	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	12	TN0027278_12	0.51550	7.58333	7.20000	5.90000	15	0.45000	1.49600	0.06840	0.73283	0.21022	0.26717	0.57	0.43
TN0027278	CartwrCrk	Global	TN0027278_Global	0.40275	4.45082	6.77869	4.40328	20	0.47082	1.05085	0.09350	0.73283	0.21022	0.26717	0.57	0.43
TN0029718	BerryChap	1	TN0029718_1	0.20911	2.72222	8.42222	4.47778	15	0.18111	2.98222	0.09361	0.02884	0.85644	0.97116	0.57	0.43
TN0029718	BerryChap	2	TN0029718_2	0.18950	3.03750	8.31250	4.16250	15	0.07875	2.51000	0.06214	0.02884	0.85644	0.97116	0.57	0.43
TN0029718	BerryChap	3	TN0029718_3	0.15888	2.56250	7.96250	3.47500	15	0.08750	2.77250	0.09063	0.02884	0.85644	0.97116	0.57	0.43

- Example of typical monthly replacement table
- Replacement values based on DMR/MOR values (white fill) when available
 - Calculated for all months, even when not used

Adjusting subspecies ratios

Original Data

Permit	Date	NH3	TN	NOX	ORGN	TKN	NH3_TN Ratio	NOX_TN Ratio	ORGN_TN Ratio	TKN_TN Ratio
Facility A	7/1/2013	0.200								
Facility A	7/2/2013	0.060	1.810	0.410	1.340	1.400	0.033	0.227	0.740	0.773
Facility A	7/3/2013	0.200	1.900				0.105	0.483	0.492	0.517
Facility A	7/4/2013	0.100								

If use uncorrected ratios, sum equals 1.08

	Measured DMR Ratios		Default Ratios		Correction Factor		DMR-Corrected Ratios
NH ₃ / TN Ratio	0.105		0.062		NA		0.105
NO _x / TN Ratio	NA	X	0.483		0.918	=	0.443
ORGN / TN Ratio	NA	X	0.492		0.918	=	0.452
TKN / TN Ratio	NA	+	0.105		0.452	=	0.557

Sum of corrected ratios equals 1.0

Data source / sampling frequency can differ among subspecies

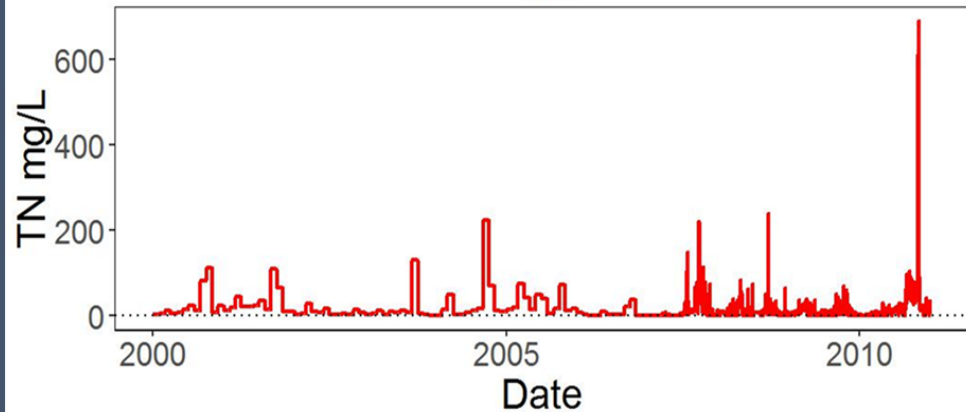
Adjust nitrogen subspecies default ratios based on measured NH₃/TN ratios for each record

$$\text{Calculate Corr. Fact.} = (1 - \text{NH}_3/\text{TN Ratio}_{\text{DMR}}) / (\text{NO}_x/\text{TN Ratio}_{\text{Default}} + \text{ORGN}/\text{TN Ratio}_{\text{Default}})$$

Basically, subtract portion of TN that is NH₃, then split remainder between NO_x and ORGN based on default subspecies ratios

Reconstructed TN capped

Hypothetical TN w/o cap



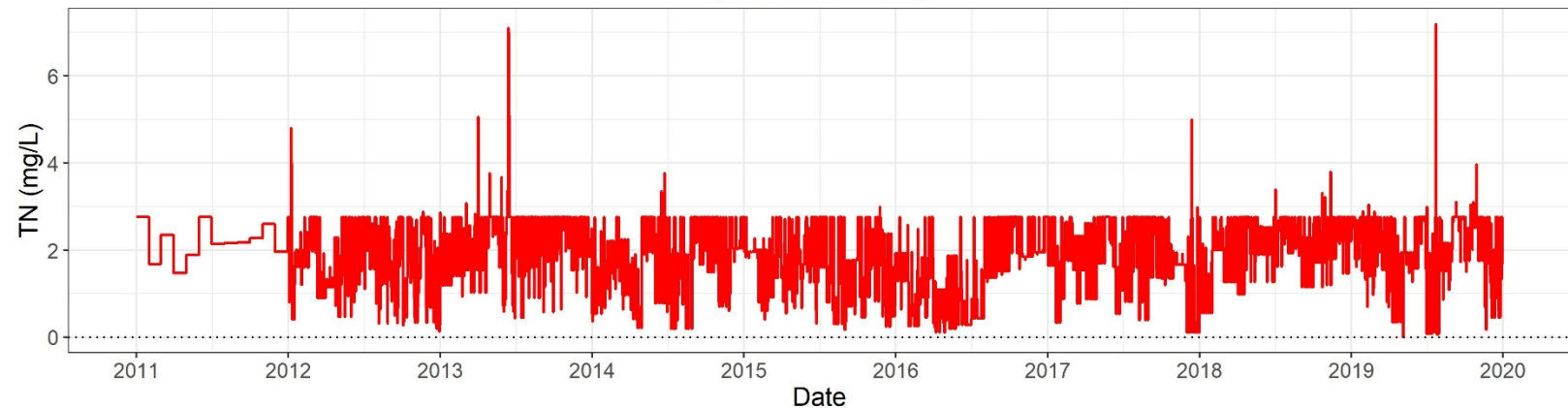
Permit	Station Code	TN Cap (95% Percentile; mg/L)	Data Source
TN0020460	WhBluff	44.05	Based on 95% percentiles of daily max values in DMR/MOR data
TN0027278	CartwrCrk	9.17	95% percentiles of DMR/MOR
TN0028827	Franklin	2.7593125	95% percentiles of DMR/MOR
TN0029718	BerryChap	2.8825	95% percentiles of DMR/MOR
TN0057789	EaglevIHS	62.9	Based on 95% percentile of permit TN values
TN0057827	HillsbroES	74.25	Based on 95% percentile of permit TN values
TN0057835	PageSchl	99.13	Based on 95% percentile of permit TN values
TN0059790	KingstnSpr	49.1	Based on 95% percentiles of daily median values in DMR/MOR data
TN0060216	GooseCrk	26.11	Based on 95% percentile TN value from comparable permit (KY0076741)
TN0062332	Fairvw	11.27	95% percentiles of DMR/MOR
TN0064297	TrintyES	93.33	Based on 95% percentile of permit TN values
TN0066958	Dickson	5.96	95% percentiles of DMR/MOR
TN0067164	ColGrvES	95.775	Based on 95% percentile of permit TN values
TN0067873	OakvwES	62.9	Based on 95% percentile of permit TN values for TN0057789

Dividing NH_3 by NH_3/TN ratio
can result in unreasonably
high TN concentrations

Developed cutoff for
reconstructed TN values

Measured values unchanged

TN
Facility: Franklin
(TN0028827)



Questions