Mining Existing Databases as an Alternative to EPA's Mandatory Section 308 National Study of Nutrient Removal and Secondary Technologies

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On September 16, 2016, the U.S. Environmental Protection Agency published a draft National Study of Nutrient Removal and Secondary Technologies: POTW Screener Questionnaire. The purpose of this survey is summarized as follows: "EPA's Office of Water is conducting a nationwide study to evaluate the nutrient removals and related technology performance by different types of publicly owned treatment works (POTWs)" (EPA, 2016a, 2016b).

In an open letter to POTWs, EPA's Director of the Office of Science and Technology highlights the significance of nutrient pollution and the intent of the national study to provide information about realistic and achievable nutrient reduction strategies (EPA, 2016c). EPA case studies on implementing low cost modifications to reduce nutrient discharges are cited. EPA believes that in order to provide statistically representative information on low cost nutrient removal practices, that basic information on all municipal treatment plants in the nation must be gathered. EPA plans to follow the screener survey with selection of a statistically representative sample of treatment plants from the national population for further study.

Nutrients are an important water quality issue nationally that warrant further investigation and analysis. However, conduct of mandatory national survey of all POTWs may reveal less information on nutrient removal than is currently available from existing data sources. Further, existing data sources may provide the opportunity to narrow the focus on a smaller population of POTWs to better understand the potential for low cost operational optimization efforts to reduce effluent nutrient levels.

This report explores mining data from existing EPA databases as an alternative to conducting a new survey of wastewater utilities to assess secondary treatment and nutrient removal. The ability to extract effluent data from existing information available in on-line databases is illustrated with the presentation of the results of database queries. Analysis of the information available in existing databases shows that effluent nutrient data is available from only a relatively small number of POTWs compared to the very large number of total POTWs nationwide.

Making Sense of Nutrient Surveys from Utilities

Making sense of the data received from a large survey of nearly 30,000 utilities nationwide presents a number of challenges, not the least of which is analyzing the large amount of data that would need to be compiled and interpreted. Using legal authorities to mandate survey responses has the potential for the information gathered to be less useful than it might otherwise be. Cooperative efforts where the utilities are involved in gathering and analyzing the data may produce more useful, representative, and reliable information.

Finding the best way to analyze the responses and then use that information to draw relevant conclusions about the potential for existing secondary treatment facilities to accomplish some level of nutrient removal is challenging. Experience in conducting surveys of a much smaller number of facilities in order to make an assessment of opportunities for nutrient removal enhancements by optimization provides some insights. Accurately assessing plant loadings is a critical aspect of any such evaluation because underloaded facilities may exhibit a nutrient removal ability in the interim, that cannot be maintained when influent flows and loadings reach the full intended design capacity.

It is important to understand existing treatment discharge objectives/limits because descriptors like secondary treatment, advanced treatment, etc. do not provide a complete portrayal of site specific circumstances at any facility. Individual facilities are unique and they are, for the most part, focused on compliance with existing discharge permit limits. Any additional effort for process optimization, sidestream treatment, or other nutrient removal performance enhancements may, or may not, be a reflection of the existing secondary treatment capacity to reduce nutrient discharges.

Data Mining: Available Databases

EPA maintains discharge monitoring report (DMR) databases that may be capable of providing an initial "first screen" on a national level for a census of POTWs. Mining this database initially seems to be a more expeditious way to meet EPA's objective to "characterize the universe of POTWs in the U.S." (EPA 2016a). A significant amount of potentially relevant information is available in existing EPA databases that more than likely has not been analyzed to the degree that it might to address EPA questions regarding nutrient removal and secondary technologies.

A screening exercise has been conducted to identify the level of effort likely required to analyze existing databases and compare that with the likely level of effort forecasted to conduct an entirely new nationwide survey. The existing online databases explored were as follows: EPA Envirofacts PCS-ICIS, EPA ECHO, and EPA CWNS.

- EPA Envirofacts PCS-ICIS
    - This search allows retrieval of selected data from the Permit Compliance System (PCS) and Integrated Compliance Information System (ICIS) databases in Envirofacts regarding facilities registered with the federal enforcement and compliance (FE&C) and holding National Pollutant Discharge Elimination System (NPDES) permits.
    - https://www3.epa.gov/enviro/facts/pcs-icis/search.html
    - Approximate number of facilities: 367,000
- EPA ECHO
    - EPA's Enforcement and Compliance History Online (ECHO) website can be used to search for facilities to assess their compliance with environmental regulations, such as NPDES permits.
    - https://echo.epa.gov/
    - Approximate number of facilities: 205,000
- EPA CWNS
    - EPA's Clean Watersheds Needs Survey (CWNS) is an assessment of capital investment needed nationwide for publicly-owned wastewater collection and treatment facilities to meet the water quality goals of the Clean Water Act.

- https://www.epa.gov/cwns
- Approximate number of facilities: 27,000

For this initial investigation, the effort required to download and analyze some of the largest wastewater facilities in the U.S. was assessed. Specifically, this effort attempted to characterize the treatment process train and effluent quality from existing facilities, including BOD, ammonia, total nitrogen and total phosphorus. Table 1 summarizes the information gathered in an initial on-line database query effort for the 50 largest U.S. POTWs. The ECHO database was used to download effluent data. This was performed individually for each wastewater facility. This required a multiple step process to search for the data, download the data, ground truth and make sense of the data, and average the effluent concentration data for the summary in Table 1.

Table 1. Summary Information from Exploration of Online Databases for Large Wastewater Facilities

NPDES Permit Number[A]	Authority[A]	Facility Name[A]	Location[A]	Treatment Level[A]	Unit Process[A,1]	CWNS Flow[A] (mgd)	Average Flow[B,2] (mgd)	Average BOD5[B,2] (mg/L)	Average Ammonia[B,2] (mg/L)	Average TN[B,2] (mg/L)	Average TP[B,2] (mg/L)
IL0028053	Chicago MWRDGC	Stickney	Cicero, IL	Advanced	Biosolids Thickening, Gravity	1200	928	228	1.8	8.2	0.9
MI0022802	Detroit Board of Water Co	Detroit	Detroit, MI	Advanced	Chemical Addition (Polymer)	730	Not found				
NJ0021016	Passaic Valley SC	Passaic	Newark, NJ	Secondary	Biosolids Wet Air Oxidation	600	Not found				
CA0109991	City of LA Bureau of San.	Hyperion	Playa Del Rey, CA	Secondary	Biosolids Anaerobic Digestion, Other	512	87	322	41.0	--	6.8
NV0021261	Clark Co. WRD	SCOP	Las Vegas, NV		Phosphorus Removal, Biological	400	41	211	9.8	--	0.2
MA0103284	MWRA	MWRA	Boston, MA	Secondary	Biosolids Thickening, Gravity	390	143	33	28.7	--	--
DC0021199	DCWASA	Blue Plains	WA, DC	Advanced	Biosolids Chemical Addition (Polymer)	370	102	32	0.5	9.5	0.6
CA0053813	LACSD	Joint WPCP	Carson, CA	Secondary	Clarification, Secondary	330	180	162	42.1	--	3.4
IL0028061	Chicago MWRDGC	Calumet	Chicago, IL	Advanced	Biosolids Thickening, Gravity	313	319	124	0.7	9.9	3.0
NY0026204	NYCDEP	Newtown	New York, NY	Secondary	Biosolids Thickening, Gravity	284	216	68	15.9	23.7	3.5
PA0025984	Allegheny Co. San. Auth.	ALCOSAN	Pittsburgh, PA	Secondary	Activated Sludge, Conventional	280	217	6	1.4	--	--
Unknown	MDWASD	MDWASD	Miami, FL	Advanced	Biosolids Thickening, Gravity	279	122	78	--	22.1	1.7
NY0026131	NYCDEP	Wards Island	New York, NY	Advanced	Biosolids Thickening, Gravity	272	205	40	8.5	15.5	2.5
PA0026671	Philadelphia Water Dept.	PWD	Philadelphia, PA	Secondary	Activated Sludge, Conventional	244	223	5	22.4	--	0.4
CA0107409	City of San Diego MWD	Point Loma	San Diego, CA	Advanced	Clarification, Intermediate	240	144	245	36.9	--	--
AZ0020559	City of Phoenix	91st Ave	Phoenix, AZ	Secondary	Biosolids Thickening, Gravity	230	85	91	1.8	--	3.6
IL0028088	Chicago MWRDGC	Northside	Skokie, IL	Advanced	Biosolids Thickening, Gravity	227	314	115	1.4	10.2	1.5
CA0077682	SCRSD	Sac Regional	Elk Grove, CA	Secondary	Clarification, Secondary	218	142	127	35.3	--	3.3
CA0110604	Orange Co. SD	OCSD No. 2	Fountain Valley, CA	Secondary	Clarification, Secondary	200	109	216	32.9	--	5.9
LA0038091	New Orleans WB	East Bank	New Orleans, LA	Secondary	Biosolids Incineration (Other)	200	106	22	--	--	--
NY0026191	NYCDEP	Hunts Point	Bronx, NY	Advanced	Biosolids Thickening, Gravity	191	121	41	10.1	15.8	3.2
TX0096172	City of Houston	69th Street	Houston, TX	Advanced	Clarification, Secondary	187	122	10	5.5	--	--
NY0028410	Buffalo Sewer Authority	Bird Island	Buffalo, NY	Secondary	Activated Sludge, Conventional	180	123	65	6.3	--	1.5
TX0047295	City of Forth Worth	Village Creek	Fort Worth, TX	Advanced	Filter, Mixed Media	179	116	3	0.7	--	--
PA0026689	Philadelphia Water Dept.	PWD NE	Philadelphia, PA	Secondary	Activated Sludge, Conventional	177	212	6	7.2	--	0.5
CA0110604	Orange Co. SD	OCSD No. 1	Fountain Valley, CA	Secondary	Clarification, Secondary	170	109	216	32.9	--	5.9
NY0026247	NYCDEP	North River	New York, NY	Secondary	Biosolids Thickening, Gravity	169	114	60	20.5	23.1	4.3
CA0037842	City of San Jose ESD	SJ/SC WPCP	San Jose, CA	Advanced	Activated Sludge, Conventional	167	97	3	0.7	18.4	1.3
MD0021555	City of Baltimore DPW	Back River	Baltimore, MD	Advanced	Biosolids Thickening, Gravity	164	88	4	0.7	7.9	0.2
TX0022802	Trinity RA	Central	Dallas, TX	Advanced	Filter, Mixed Media	162	155	2	0.8	--	--
NV0021261	Clark Co. WRD	CCWRDAWT	Las Vegas, NV	Advanced	Disinfection, UV Radiation	160	103	2	0.1	--	0.1
NJ0020141	Middlesex County UA	Middlesex	Sayreville, NJ	Advanced	Biosolids Thickening, Gravity	160	?	?	?	?	?
MN0029815	Met. Council ES	Metropolitan	St Paul, MN	Advanced	Chemical Addition (Polymer)	155	190	150	12.2	33.4	2.2
TX0047830	City of Dallas	Central	Dallas, TX	Advanced	Activated Sludge, Extended Aeration	150	114	5	1.4	--	--
OH0024741	Columbus Div. S&D	Southerly	Lockbourne, OH	Advanced	Biosolids Incineration (Other)	146	121	88	0.3	--	1.1
NY0026689	Westchester County DEF	Yonkers	Yonkers, NY	Secondary	Biosolids Land Application (Spreading)	145	61	67	22.0	--	--
PA0026662	Philadelphia Water Dept.	PWD SE	Philadelphia, PA	Secondary	Activated Sludge, Conventional	142	112	9	10.2	--	0.3
OH0024651	NEORSD	Southerly	Cuyahoga Heights, OH	Advanced	Clarification, Secondary	135	196	60	0.2	--	0.2
IA0044130	Des Moines WRF	Metro WRA	Des Moines, IA	Secondary	Biosolids Mech. Dewatering (Filter Press)	134	?	?	?	?	?
NY0026158	NYCDEP	Bowery Bay	Astoria, NY	Advanced	Biosolids Thickening, Gravity	132	106	56	14.4	24.1	3.8
OH0025461	MSD of Greater Cincinnati	Mill Creek	Cincinnati, OH	Secondary	Clarification, Secondary	130	180	145	4.0	--	0.4

OR0026905	City of Portland	Columbia Blvd	Portland, OR	Secondary	Biosolids Anaerobic Digestion, Other	128	128	111	38.4	--	--
TX0077801	City of San Antonio	Dos Rios	San Antonio, TX	Advanced	Clarification, Secondary	125	151	12	3.0	--	--
NY0027081	Onondaga Co. Dept. D&S	Metro Syracuse	Syracuse, NY	Advanced	Biosolids Anaerobic Digestion, Other	123	52	31	11.6	--	4.8
WA0029581	City of Seattle	King Co. South	Renton, WA	Secondary	Clarification, Secondary	122	70	195	23.0	--	3.0
TN0020575	Nashville Dept. of WSS	Central	Nashville, TN	Advanced	Disinfection, UV Radiation	122	126	92	4.9	--	--
NY0026166	NYCDEP	Owls Head	Brooklyn, NY	Secondary	Biosolids Thickening, Gravity	119	93	78	16.5	22.5	3.7
OH0024643	NEORSD	Easterly	Cleveland, OH	Advanced	Clarification, Secondary	115	116	66	1.7	--	0.5
PR0023728	PRASA	Bayamon	Catano, PR	Primary	Sedimentation, Primary	114	49	75	--	--	--
CA0037702	East Bay MUD	East Bay	Oakland, CA	Secondary	Biosolids Aerobic Digestion, Air	110	67	198	46.2	56.5	4.4
TX0047848	City of Dallas	Southside	Dallas, TX	Advanced	Clarification, Secondary	110	68	3	0.5	--	--
NY0026182	NYCDEP	Coney Island	Brooklyn, NY	Advanced	Biosolids Thickening, Gravity	110	87	68	16.1	24.8	3.7
TN0020711	City of Memphis	Maynard Stiles	Memphis, TN	Advanced	Biosolids Mech. Dewatering (Filter Press)	108	95	196	24.8	55.8	9.9
CA0053911	CSD of LA Co.	San Jose Creek	Whittier, CA	Secondary	Biosolids Thickening, Gravity	100	40	310	1.0	8.3	0.8

[A]Source is CWNS database. [B]Source is ECHO database.

[1]"Unit Process" is described as the treatment technologies present or proposed for a facility but does not appear to contain reliable or useable information regarding the facility design.

[2]Parameters full names: Flow, in conduit or thru treatment plant, BOD, carbonaceous [5 day, 20 C], Nitrogen, ammonia total [as N], Nitrogen, total [as N], Phosphorus, total [as P]

Database Queries

The initial data mining effort was followed by a second effort to determine whether or not the process of analyzing the effluent data could be automated by conducting database queries. The annual data files were downloaded from the EPA Echo Database and stored locally. The 2016 Echo Database has about 12 million records for more than 84,000 NPDES permitted discharges. Of those, about 30,000 are for wastewater treatment facilities. The original files were maintained and queried within MySQL. The large file size required parsing down to smaller, more manageable datasets to analyze in ACCESS.

Effluent Nutrient Data Available in Existing Databases

There is a large amount of facility data available on wastewater flows, BOD, TSS, ammonia, nitrogen, and phosphorus in the existing databases. Database queries were used to extend the summary of the large facilities in Table 1 to explore effluent quality data in greater depth. Table 2 summarizes effluent quality for select parameters for the years 2015 and 2016. A subset of key effluent parameters was selected for the summary presented in Table 2, including BOD, ammonia, total nitrogen, and total phosphorus.

The general wastewater facility information in Table 2 is taken from EPA's Clean Watersheds Needs Survey (CWNS). The effluent data for 2015 and 2016 is taken from the Echo Database. The effluent data can be extracted by year and by individual facility. The data can also be extracted for multi-year periods for statistical analysis such as short and long term averages, trending, etc. Table 2 illustrates the data available for a limited number of large facilities for two years. Later in this report, queries are used for the entire Echo database to analyze effluent quality for nutrients in the format of EPA's POTW Screener Questionnaire.

Table 2. Summary of Select Effluent Quality Data for Large Wastewater Facilities for 2015 and 2016

NPDES Permit Number[A]	Authority[A]	Facility Name[A]	2015[B]				2016[B]			
			Average BOD5 (mg/L)	Average Ammonia (mg/L)	Average TN (mg/L)	Average TP (mg/L)	Average BOD5 (mg/L)	Average Ammonia (mg/L)	Average TN (mg/L)	Average TP (mg/L)
IL0028053	Chicago MWRDGC	Stickney	2.7	0.5	8.3	0.65	2.4	0.4	8.3	0.83
MI0022802	Detroit Board of Water Co	Detroit	7.6	8.2	--	--	15.0	6.1	--	--
NJ0021016	Passaic Valley SC	Passaic	--	--	--	--	--	--	--	--
CA0109991	City of LA Bureau of San.	Hyperion	16.5	44.7	--	--	19.5	44.2	--	--
NV0021261	Clark Co. WRD	SCOP	--	--	--	--	--	--	--	--
MA0103284	MWRA	MWRA	6.0	26.7	--	--	33.0	30.4	--	--
DC0021199	DCWASA	Blue Plains	27.5	0.3	10.3	--	27.9	--	8.1	--
CA0053813	LACSD	Joint WPCP	3.7	41.2	--	--	4.2	44.1	--	--
IL0028061	Chicago MWRDGC	Calumet	2.6	0.3	10.6	3.87	2.4	0.1	9.4	1.43
NY0026204	NYCDEP	Newtown	11.5	12.9	18.6	2.91	12.3	--	18.5	2.35
PA0025984	Allegheny Co. San. Auth.	ALCOSAN	4.0	1.7	--	--	10.0	1.6	--	--
Unknown	MDWASD	MDWASD	--	--	--	--	--	--	--	--
NY0026131	NYCDEP	Wards Island	3.7	5.1	8.7	1.76	6.3	--	8.8	1.43
PA0026671	Philadelphia Water Dept.	PWD	4.7	20.7	--	0.32	4.5	22.2	--	0.35
CA0107409	City of San Diego MWD	Point Loma	66.4	--	--	--	121.1	--	--	--
AZ0020559	City of Phoenix	91st Ave	1.3	--	--	--	2.3	--	--	--
IL0028088	Chicago MWRDGC	Northside	2.6	0.7	12.0	1.63	2.2	0.6	9.0	1.43
CA0077682	SCRSD	Sac Regional	7.3	35.9	--	--	8.9	36.5	--	--
CA0110604	Orange Co. SD	OCSD No. 2	5.2	22.5	--	--	9.6	22.6	--	--
LA0038091	New Orleans WB	East Bank	18.8	--	--	--	16.0	--	--	--
NY0026191	NYCDEP	Hunts Point	2.0	2.8	8.3	2.23	3.9	--	6.2	2.46
TX0096172	City of Houston	69th Street	7.9	3.7	--	--	9.0	4.7	--	--
NY0028410	Buffalo Sewer Authority	Bird Island	12.8	--	--	0.77	14.5	--	--	0.85
TX0047295	City of Forth Worth	Village Creek	2.1	0.2	--	--	2.0	0.2	--	--
PA0026689	Philadelphia Water Dept.	PWD NE	6.8	7.6	--	0.49	4.5	5.9	--	0.46
CA0110604	Orange Co. SD	OCSD No. 1	5.2	22.5	--	--	9.6	22.6	--	--
NY0026247	NYCDEP	North River	9.6	16.2	21.1	3.42	6.9	--	21.7	3.27
CA0037842	City of San Jose ESD	SJ/SC WPCP	2.2	0.6	19.0	1.22	2.9	0.7	17.0	1.08
MD0021555	City of Baltimore DPW	Back River	2.0	0.6	7.5	0.10	2.0	0.1	8.6	0.10
TX0022802	Trinity RA	Central	1.4	0.3	--	--	1.3	0.7	--	--
NV0021261	Clark Co. WRD	CCWRDAWT	--	--	--	--	--	--	--	--
NJ0020141	Middlesex County UA	Middlesex	--	--	--	--	--	--	--	--
MN0029815	Met. Council ES	Metropolitan	2.8	8.5	--	0.30	3.6	8.5	21.4	0.30
TX0047830	City of Dallas	Central	3.5	0.4	--	--	3.2	0.3	--	--
OH0024741	Columbus Div. S&D	Southerly	13.0	0.9	--	0.63	27.7	0.5	--	2.26
NY0026689	Westchester County DEF	Yonkers	13.5	20.6	--	--	10.8	0--	--	--
PA0026662	Philadelphia Water Dept.	PWD SE	9.4	9.7	--	0.21	11.9	9.3	--	0.28
OH0024651	NEORSD	Southerly	17.4	0.1	--	0.40	7.9	0.2	--	0.70
IA0044130	Des Moines WRF	Metro WRA	--	--	--	--	--	--	--	--
NY0026158	NYCDEP	Bowery Bay	3.6	6.5	12.9	2.80	5.9	--	13.3	2.70
OH0025461	MSD of Greater Cincinnati	Mill Creek	79.0	--	--	--	100.1	--	--	--

OR0026905	City of Portland	Columbia Blvd	14.1	39.2	--	--	14.0	--	--	--
TX0077801	City of San Antonio	Dos Rios	2.0	0.4	--	--	2.1	0.3	--	--
NY0027081	Onondaga Co. Dept. D&S	Metro Syracuse	3.1	5.5	--	0.63	3.2	--	--	0.84
WA0029581	City of Seattle	King Co. South	10.1	1.6	--	2.84	4.5	19.7	--	2.29
TN0020575	Nashville Dept. of WSS	Central	0.2	2.6	--	--	43.2	--	--	--
NY0026166	NYCDEP	Owls Head	11.7	15.9	21.4	2.22	14.9	--	23.2	2.62
OH0024643	NEORSD	Easterly	39.2	1.1	--	0.37	36.7	0.8	--	0.48
PR0023728	PRASA	Bayamon	76.7	--	--	--	82.5	--	--	--
CA0037702	East Bay MUD	East Bay	133	46.5	55.5	3.68	13.0	43.7	53.7	4.25
TX0047848	City of Dallas	Southside	2.3	0.2	--	--	1.9	0.2	--	--
NY0026182	NYCDEP	Coney Island	11.9	14.0	18.6	2.36	14.1	--	19.1	2.61
TN0020711	City of Memphis	Maynard Stiles	37.5	23.6	33.7	7.83	32.7	25.1	39.6	6.01
CA0053911	CSD of LA Co.	San Jose Creek	42.	1.0	--	--	--	1.2	--	--
[A]Source is CWNS database. [B]Source is ECHO database.										

Sources of Wastewater Facility Information for the Questionnaire

EPA's POTW Screener Questionnaire consists of 24 questions in the following categories:

- Section A Eligibility Confirmation
- Section B POTW Identification
- Section C POTW Operations and Treatment Characteristics

Wastewater facility information is available from a number of existing sources including NPDES permits, permit Fact Sheets, and the databases identified above: EPA Envirofacts PCS-ICIS, EPA ECHO, and EPA CWNS. A comparison of the questions in the EPA screener survey with data available in these sources is summarized in Table 3. Facility NDPES permits and Fact Sheets contain at least some of the general information required to complete the screener questionnaire. The on-line databases appear to have the numerical information needed for flows and effluent quality for BOD, ammonia, and nutrients. Of the 24 questions in the screener questionnaire, the databases have information to address C.11, C.21, C.23, and C.24 in the current EPA survey.

Table 3. Matrix of POTW Screener Questions Compared to Existing Sources of Information

Question	Sources				
	NPDES Permit	NPDES Fact Sheet	ECHO	Envirofacts PCS-ICIS	CWNS
A.1 Municipal Facility Yes/No	Possibly	Possibly	Possibly	Likely	Possibly
A.2 Ownership? POTW	Possibly	Possibly	Possibly	Likely	Possibly
A.3 Surface Water Discharge? Yes/No	Possibly	Possibly	Possibly	Unlikely	Possibly
B.4 Facility Name	Unlikely	Unlikely	Unlikely	Possibly	Unlikely
B.5 Mailing Address	Unlikely	Unlikely	Unlikely	Possibly	Unlikely
B.6 Physical Location	Unlikely	Unlikely	Unlikely	Possibly	Unlikely
B.7 Contact	Unlikely	Possibly	Possibly	Unlikely	Likely
B.8 Facility Registry Service (FRS) ID	Unlikely	Unlikely	Likely	Unlikely	Unlikely
B.9 NPDES ID	Likely	Likely	Likely	Likely	Likely
C.10.a Population	Unlikely	Unlikely	Unlikely	Unlikely	Likely
C.10.b Seasonal Population	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
C.11.a Design Capacity Flow	Unlikely	Possibly	Unlikely	Possibly	Possibly
C.11.b Peak Design Capacity Flow	Unlikely	Possibly	Unlikely	Unlikely	Unlikely
C.11.c Average Flow	Unlikely	Possibly	Likely	Unlikely	Possibly
C.11.d Peak Flow	Unlikely	Possibly	Likely	Unlikely	Unlikely
C.12 Wastewater Contributions	Unlikely	Possibly	Unlikely	Unlikely	Possibly
C.13 Collection Systems	Unlikely	Possibly	Unlikely	Unlikely	Unlikely
C.14 Sources received (“pre-treatment”)	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
C.15 Inflow and Infiltration	Unlikely	Possibly	Unlikely	Unlikely	Unlikely
C.16 Treatment Works Technologies	Unlikely	Likely	Unlikely	Unlikely	Possibly
C.17 Design Temperatures	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
C.18 Heated?	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
C.19 Design and Operation Objectives	Unlikely	Likely	Unlikely	Unlikely	Unlikely
C.20 Historical and Future Changes	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
C.21 BOD and TSS removal requirement	Likely	Likely	Possibly	Unlikely	Unlikely
C.22.a Outfall Identification	Likely	Likely	Unlikely	Unlikely	Unlikely
C.22.b Outfall Flow	Unlikely	Likely	Likely	Unlikely	Unlikely
C.23.a Ammonia Monitoring Locations	Likely	Likely	Possibly	Unlikely	Unlikely
C.23.b Ammonia Concentrations	Unlikely	Likely	Likely	Unlikely	Unlikely
C.24.a Nutrient Monitoring Locations	Likely	Likely	Possibly	Unlikely	Unlikely
C.24.b Nutrient Concentrations	Unlikely	Likely	Likely	Unlikely	Unlikely
Likely – High certainty in ability to accurately answer this question using this source. Possibly – Potential to answer this question using this source but the accuracy may be low. Unlikely – Little to no ability to accurately answer this question using this source.					

Additional data sources may be useful in addressing all of the POTW screener questions. The information in NPDES permits, Fact Sheets, and databases might be combined to complete the entire screener with the following facility specific information:

- Wastewater utility web site
- Facility Plan

- Pretreatment Report
- NPDES Permit Applications
- EPA Facility Registry Service (FRS): Wastewater Treatment Plants : https://catalog.data.gov/dataset/epa-facility-registry-service-frs-wastewater-treatment-plants
- Fed Center:
- https://www.fedcenter.gov/assistance/myfacility/

Table 4 summarizes the POTW Screener Questionnaire and identifies additional sources of information.

Table 4. Potential Sources of Information to Complete POTW Screener Questions

Question	Information Sources		
	NPDES Permit or Fact Sheet	Online Databases	Other Information Sources and Comments
A.1 Municipal Facility? Yes/No	Possibly	Likely	Simple. No additional information necessary.
A.2 Ownership? POTW?	Possibly	Likely	Simple. No additional information necessary.
A.3 Surface Water Discharge? Yes/No	Possibly	Possibly	Facility contact
B.4 Facility Name	Unlikely	Possibly	Facility website or contact
B.5 Mailing Address	Unlikely	Possibly	Facility website or contact
B.6 Physical Location	Unlikely	Possibly	Facility website or contact
B.7 Contact	Possibly	Possibly	Facility website or contact
B.8 Facility Registry Service (FRS) ID	Unlikely	Likely	NPDES Permit
B.9 NPDES ID	Likely	Likely	NPDES Permit
C.10.a Service Population	Unlikely	Likely	Facility Plan
C.10.b Seasonal Population	Unlikely	Unlikely	Facility contact
C.11.a Design Capacity Flow	Possibly	Possibly	Facility Plan
C.11.b Peak Design Capacity Flow	Possibly	Unlikely	Facility Plan
C.11.c Average Flow 2016	Possibly	Possibly	Facility contact. Query databases.
C.11.d Peak Flow	Possibly	Likely	Facility contact. Query databases.
C.12 Wastewater Contributions	Unlikely	Possibly	Facility contact. Facility Plan.
C.13 Collection Systems	Unlikely	Unlikely	Facility contact
C.14 Industrial/Commercial Sources	Unlikely	Unlikely	Facility contact. Pretreatment Report.
C.15 Inflow and Infiltration	Unlikely	Unlikely	Facility contact. Facility Plan.
C.16 Treatment Works Technologies	Unlikely	Possibly	Facility contact. Facility Plan.
C.17 Design Temperatures	Unlikely	Unlikely	Facility contact. Facility Plan.
C.18 Heated?	Unlikely	Unlikely	Facility contact. Facility Plan.
C.19 Design and Operation Objectives	Unlikely	Unlikely	Facility contact. Facility Plan.
C.20 Historical and Future Changes	Unlikely	Unlikely	Facility contact. Facility Plan.
C.21 BOD and TSS removal requirement	Likely	Possibly	Query databases
C.22.a Outfall Identification	Likely	Unlikely	NPDES Permit
C.22.b Outfall Flow	Unlikely	Likely	Query databases
C.23.a Ammonia Monitoring Locations	Likely	Possibly	Query databases
C.23.b Ammonia Concentrations	Unlikely	Likely	Query databases
C.24.a Nutrient Monitoring Locations	Likely	Possibly	Query databases
C.24.b Nutrient Concentrations	Unlikely	Likely	Query databases
Likely – High certainty in ability to accurately answer this question using this source. Possibly – Potential to answer this question using this source but the accuracy may be low. Unlikely – Little to no ability to accurately answer this question using this source.			

POTW Screener Questionnaire Trials

Trials in completing the EPA POTW Screener Questionnaire were conducted for three facilities of varying size. Technical staff with knowledge of the individual facilities used readily available data sources to track the time required to complete the questionnaire. Wastewater facilities with capacities ranging from 6 mgd, to more than 200 mgd, were used in the trials. A summary of the findings from the trials is presented in Table 5.

EPA has estimated that the reporting and recordkeeping burden for the questionnaire is estimated to average 3.5 hours per response for 90 percent of utilities and 1.5 hours for 10 percent of facilities (Federal Register, 2016). The three time trials fell into the range identified by EPA. However, there were some questions that presented difficulty in the trials and were not completed, or completed with some difficulty. Interestingly, the challenging questions were common in the three facilities and may be of limited significance to the key focus of the survey on nutrients. The most difficult questions were the following:

- C.12 Wastewater Contributions
- C.13 Collection Systems
- C.14 Industrial/Commercial Sources
- C.15 Inflow and Infiltration

Table 5. Time Trials with EPA's POTW Screener Questionnaire

Facility	Capacity, mgd	Time Required, hours	Comments
A	6	About 2 hours	• Relatively Easy o Eligibility Confirmation (Section A) o POTW Identification (Section B) • Moderately Easy o Population: checked Census data o Flow: Facility Plan and Discharge Monitoring Reports (DMRs) o Outfall: Facility Plan o Effluent nutrient concentrations: DMRs • Moderately Difficult o Collection systems and sources: Facility Plan o Treatment technologies: Facility plan o Design and operations objectives: Facility plan • Difficult o Wastewater contributions: Best estimate o Monitoring locations: Unclear what to report
B	26	About 1 hour with gaps remaining. Estimated to require an additional 2 hours to track	• Relatively Easy o For items related to NPDES permit numbers and outfall ID, state correspondence was referenced o Treatment technology o Effluent quality

		down information.	• Moderately Easy
			  o Population: Best guess
			  o Design Capacity Flows: Best guess
			  o Average Flows: Effluent flowmeter
			  o Wastewater Contributions:
			  ▪ Residential: Best guess
			  ▪ Commercial: Best guess
			  ▪ Industrial: Known for a single large industry
			  ▪ Septage: Known based on deliveries
			• Moderately Difficult
			  o Collection System Contributions
			  ▪ Called account billing staff with inquiries
			  o Industrial/Commercial Contributions:
			  ▪ Called pretreatment staff with inquiries
			• Difficult
			  o Infiltration/Inflow
			  ▪ Confused about wet weather questions
			  ▪ Reviewed I/I Report

C	220	About 2 hours with gaps remaining. Estimated to require an additional 2 hours to gather and analyze effluent data.	• Relatively Easy
			  o Addressed many parts of questionnaire with the following:
			  ▪ Facility Plan
			  ▪ NPDES Permit Application
			  ▪ LIMS/SCADA Database
			• Moderately Difficult
			  o Question 8: What is an FRS ID number?
			  ▪ Couldn't find and ultimately had to query EPA database.
			  o Question 12: Wastewater contribution percentages were difficult to track down.
			  ▪ Categories included in the NPDES Permit Application didn't quite match what is requested in the survey questionnaire.
			  o Question 13 Collection System: Similar to problems addressing Question 12
			• Difficult
			  o Question 14 Industrial/Commercial
			  ▪ This took a significant amount of time to read through the Pretreatment program documents to decipher which SIU's matched which

			categories in the survey questionnaire. o Question 15 Infiltration/Inflow ▪ An average day for inflow is a strange number; should be a maximum day value?

Use of Database Queries to Complete Screener Questionnaire

Table 6 summarizes the 2016 available data from the 2016 Echo Database to address select questions in the EPA's POTW Study Screener. There is a large amount of facility data available on wastewater flows, BOD, TSS, ammonia, nitrogen, and phosphorus in the database. The summary in Table 6 illustrates the extent of the data available and a preliminary effort to summarize the effluent nutrient data nationally. For example, from a query of the 2016 Echo database, there are 1,658 facility records with effluent total nitrogen data. Of those, 275 facilities report effluent TN < 4 mg N/L, 325 facilities report values of 4 to 8 mg N/L, 298 facilities report values of 8 to 12 mg N/L and 619 facilities report values of >12 mg N/L. There are 3,956 facility records with effluent total phosphorus data. Of those, 643 facilities report effluent TP < 0.3 mg P/L, 1,114 facilities report values of 0.3 to 1 mg P/L, 1,775 facilities report values of 1 to 4 mg P/L, and 404 facilities report values > 4mg P/L.

Table 6. Select Questions from EPA's POTW Study Screener and Available Data in Existing Databases

2016 POTW Study Screener Questionnaire		**Source of Data and Records Available**
Question Number	**Question**	
C.11	*"What are the design capacity, average daily and respective peak flows (MGD) of your treatment works in 2016? Do not include additional capacity used for primary treatment only."*	
	Average Flow Daily	2016 Echo Database Query 8,731 Facility Records with Average Flows from 0.1 to 726 mgd
	Peak Flow	2016 Echo Database Query 8,731 Facility Records with Peak Flows from 0 to 1,402 mgd
C.21	*"Does your treatment works have biochemical oxygen demand (BOD) and/or total suspended solids (TSS) percent removal provisions in its permit?* ☐ *Yes* ☐ *No"*	
	Record Number facilities with BOD and/or TSS limits	2016 Echo Database Query 10,613 Facility Records with BOD and TSS Limits
C.23	*"Indicate in Table 5 if and where your treatment works monitors for ammonia. If your treatment works does not monitor for ammonia, please select 'No' for all responses."*	
	Average 2016 Ammonia Concentrations	2016 Echo Database Query 7,151 Facility Records with Effluent Ammonia Data Ranges Records

<table>
<tr><td></td><td></td><td><0.1 mg/L 315
0.1 - <1 mg/L 3,425
1 - 3 mg/L 1,417
>=3 mg/L 1,435
No Value 559</td></tr>
<tr><td rowspan="3">C.24</td><td colspan="2">“Indicate in Table 7 if and where your treatment works monitors for nutrients other than ammonia. If your treatment works does not monitor for any of the additional nutrients, please select ‘No’ for all responses”.</td></tr>
<tr><td>Average 2016 Total Nitrogen (TN) Concentrations</td><td>2016 Echo Database Query
1,658 Facility Records with Effluent Total Nitrogen Data
<u>Ranges</u> <u>Records</u>
<4 mg/L 275
4 - <8 mg/L 325
8 - <12 mg/L 298
>=12 mg/L 619
No Value 141</td></tr>
<tr><td>Average 2016 Total Phosphorus (TP) Concentrations</td><td>2016 Echo Database Query
3,956 Facility Records with Effluent Total Phosphorus Data
<u>Ranges</u> <u>Records</u>
<0.3 mg/L 643
0.3 - <1 mg/L 1114
1 - <4 mg/L 1775
>=4 mg/L 404
No Value 0</td></tr>
</table>

Lessons Learned in Conducting Wastewater Surveys

A summary of lessons learned has been prepared from experiences gained in surveying more than 30 wastewater discharges to a large estuary. The purpose of the survey was to gather information for use in evaluating potential optimization and upgrade opportunities to reduce nutrient discharges. This information may be valuable to others planning to conduct similar evaluations on a watershed basis. Furthermore, this experience may provide valuable insights on potential challenges that may be encountered while compiling and analyzing the nationwide survey results.

A summary of the top lessons learned from this experience is as follows:

1) Getting the plant loadings correct is key to understanding current conditions and establishing a basis for further analysis. When little nutrient monitoring information is available, such as when plants sample infrequently and there’s limited data (for example only sample 1X/month), the basis for analysis is tenuous.

2) The perception of the purpose for gathering the survey information and how it will be used is influential and may shape the responses and accuracy of the information received. Experience has shown that it takes on average 2 to 3 phone calls, or direct contacts with individual treatment plants, to illicit complete responses, sort out questions, and address details of the survey.
3) It's important to understand existing treatment objectives because descriptors like Secondary Treatment vs. Advanced Treatment do not tell the whole story of the process configuration. Some plants are comprised of portions of advanced treatment and portions secondary. Also, the treatment processes and configuration may change seasonally.
4) The structure of discharge permit effluent limits may influence the information gathered in a survey. Averaging periods and Load v. Concentration based limits, etc. impact on how a plant operates, and consequently on the effluent performance data.
5) Reclamation and reuse complicate effluent quantities. In some cases, the effluent flows are significantly reduced from influent flows. Reuse applications also make a difference in the sense that in some cases the reclaimed water comes back to the facility. For example, reclaimed water used for power plant cooling water is returned to the treatment plant in concentrated form, sometimes with different nutrients or nutrient speciation.
6) Individual facilities are very unique. Even after requesting historical plant performance data, compiling it, and spending a day with each individual facility, there are still numerous communication exchanges required to fully understand the effluent data and develop individual nutrient reduction strategies.
7) Individual facility operational histories and personal preferences may limit what modifications can be done to existing facilities to reduce nutrient discharges. Options such as "splitting the plant into two" with one side reducing nutrients and the other side maintaining secondary treatment, may be a viable optimization strategy, but may be unacceptable to some. It may be important to develop a metric for the willingness to change and/or improve to do new things, such as nutrient removal, in order to evaluate the potential for optimization efforts.
8) The decision to implement opportunities for nutrient reduction may be challenging for plant managers. The costs for potential nutrient optimization efforts may not be insignificant. Modifications may result in facility changes that are inconsistent with long term objectives such as plans for future upgrades, treatment capacity reserved for future growth, or capacity allocated to existing (industrial or residential) customers that needs to be preserved.
9) Most plant operations are primarily focused on meeting existing discharge limits. Some utilities may be reluctant to pursue nutrient optimization for a number of reasons, including existing treatment process challenges, aversion to risks, avoidance of distractions, diversion from prime compliance objectives, resource limitations, etc.

Conclusions and Recommendations

A great deal of existing information is available in on-line databases to address at least some of the questions most pertinent to secondary treatment and effluent nutrient concentrations in EPA's POTW

Screener Questionnaire. This information can be queried and facility specific data for effluent BOD, ammonia, nitrogen, and phosphorus can be analyzed without conducting a new nationwide survey. Further, analysis of the existing databases has revealed that effluent nutrient data is available from only a relatively small number of POTWs compared to the very large number of total POTWs nationwide. Compiling information for the entire POTW Screener Questionnaire for the facilities that actually have effluent nutrient data might be undertaken by other approaches that do not require a mandatory survey using Section 308 authority.

The analysis presented in this report demonstrates that the large Echo Database can be downloaded and queried to extract treatment plant effluent monitoring data as numerical fields for individual facilities. There is a large amount data on ammonia, nitrogen species, and phosphorus in the database for POTWs that actually have that data. One of the interesting findings is that while the 2016 Echo Database includes more than 84,000 NPDES permitted discharges, and about 30,000 of those are for wastewater treatment facilities, there are far fewer facilities with nutrient data (<4,000).

The questions in EPA's POTW Study Screener Questionnaire related to effluent concentrations have been analyzed with queries of the 2015 and 2016 Echo Database. Screener questions C.11, C.21, C.23, and C.24 address flow, BOD, nitrogen and phosphorus and can be addressed now using queries of existing databases. For example, from a query of the 2016 Echo database, there are 1,658 facility records with effluent total nitrogen data. Grouping the nitrogen data into EPA's ranges from the Screener Questionnaire, there are 275 facilities reporting effluent TN < 4 mg/L, 325 facilities reporting 4 to 8 mg/L, 298 facilities reporting 8 to 12 mg/L and 619 facilities reporting >12 mg/L. There are 3,956 facility records with effluent total phosphorus data. Grouping the phosphorus data into EPA's ranges from the Screener Questionnaire, there are 643 facilities reporting effluent TP < 0.3 mg/L, 1,114 facilities reporting 0.3 to 1 mg/L, 1,775 facilities reporting 1 to 4 mg/L, and 404 facilities reporting > 4mg/L.

There are far fewer facilities with nutrient data available compared to the total number of approximately 30,000 POTWs nationwide. The 2016 Echo Database has 7,151 facility records with effluent ammonia data. Further, there are less than 4,000 facilities with phosphorus data and less than 2,000 facilities with nitrogen data. Alternative approaches to gathering the information requested in EPA's POTW Study Screener Questionnaire from existing sources may be more viable with a smaller number of facilities that warrant investigation. Narrowing the investigation to the smaller number of facilities that actually have effluent nutrient data allows time and resources to be focused on the most relevant considerations related to nutrients. Especially if it is recognized in advance that reconciling the details and analyzing the information will require clarifications that cannot be gathered in a survey in order to achieve the broader objective of more fully understanding secondary treatment and nutrient removal.

It may be more difficult to use existing database sources to address the more general questions in the Screener Questionnaire, such as treatment process descriptions and design capacities. Generally, the Fact Sheet or Statement of Basis that supports the NPDES permit will have the Permit Writers' analysis of a treatment plant and be a good source of this type of facility design information. NPDES permits and Fact Sheets are commonly, but not always, available on-line. Permit application packages can also be useful sources of facility information, although they are seldom available on-line. The Permit Compliance System (PCS) and Integrated Compliance Information System (ICIS) databases may also have some of this information. Completing all of the Screener Questionnaire may require review of individual facility

site specific information such as wastewater utility web sites, facility plans, pretreatment reports, infiltration/inflow studies, NPDES permit applications, etc.

It is recommended that consideration be given to utilizing existing sources of information and focused wastewater utility information review, and contacts as needed, to compile the information sought in the POTW Screener Questionnaire for the facilities that actually have effluent nutrient data. Mining of existing databases can be used to rapidly gather and analyze effluent quality data for the limited number of facilities that actually have nutrient data available. This will reduce the number of facilities to evaluate, can be undertaken expeditiously, and avoids the need for a new mandatory survey. In this way, investigators can move more expeditiously to the subsequent steps of further exploring secondary treatment and nutrient removal where the analysis can be focused on the most relevant considerations and move beyond the general information in the POTW Screener Questionnaire.

References

EPA (2016a) National Study of Nutrient Removal and Secondary Technologies: POTW Screener Questionnaire, September 16, 2016. https://www.epa.gov/sites/production/files/2016-09/documents/potw-screener-questionnaire_v7_09-15-2016.pdf

EPA (2016b) National Study of Nutrient Removal and Secondary Technologies webpage. https://www.epa.gov/eg/national-study-nutrient-removal-and-secondary-technologies

EPA (2010c) Elizabeth Southerland, Director, Office of Science and Technology, Letter to POTW dated October 20, 2016.

Federal Register (2016) Proposed Collection; Comment Request; Proposed Information Collection Request for the National Study of Nutrient Removal and Secondary Technologies: Publicity Owned Treatment Works (POTW) Screener Questionnaire, 81 (181) 64151 – 64153. September 19, 2016.