Delaware County Regional Water Quality Control Authority (DELCORA)
CSO Long Term Control Plan Update

Alternatives Evaluation Approach Report (Final)

April 2016

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REPORT SIGNATURE COVER SHEET

Signature of this cover signifies agreement with the content of the DELCORA Alternatives Evaluation Report.

I certify under penalty of law that the document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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REVISION CONTROL

REV. NO.	DATE ISSUED	PREPARED BY	DESCRIPTION OF CHANGES

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Section 1 Introduction

1.1 Background

The Delaware County Regional Water Quality Control Authority (DELCORA) is a municipal wastewater authority that owns, operates and maintains collection systems that serve approximately a half-million people in southeastern Pennsylvania, including 42 municipalities in Delaware and Chester Counties. DELCORA operates a Combined Sewer System (CSS) that is comprised of sewer sections that accept both stormwater and sanitary wastewater, which is treated at DELCORA's Western Regional Treatment Plant (WRTP).

On August 17, 2015, a Consent Decree was lodged in the United States District Court for the Eastern District of Pennsylvania that requires DELCORA to complete and submit a revised and updated Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) to the United States Environmental Protection Agency (USEPA or EPA) and the Pennsylvania Department of Environmental Protection (PADEP or DEP).

1.2 Purpose

As part of the Long Term Control Plan Update (or "LTCPU"), the Consent Decree requires DELCORA (in coordination with the USEPA and PADEP) to propose what approach to the Long Term Control Plan Alternative Evaluation (i.e., the "Presumption Approach" or the "Demonstration Approach") is appropriate for the each of DELCORA's receiving waters, and to submit a written explanation to the USEPA and PADEP for review and approval. The three water bodies that receive overflows from DELCORA's CSS include the Delaware River, Chester Creek and Ridley Creek.

DELCORA is in the process of developing the LTCPU for its Combined Sewer System, and the purpose of this report is to meet the requirement in the Consent Decree for the submission of a written explanation of DELCORA's Alternatives Evaluation Approach to the USEPA and PADEP, while also addressing those requirements from USEPA's "Combined Sewer Overflow Control Policy," April 1994 and also considering the "Combined Sewer Overflows Guidance for Long-Term Control Plan," September 1995 (CSO Guidance Document). Determination of the use of the Presumption or Demonstration Approach is important because it can potentially affect the development of the CSO control alternatives.

Section 2 Regulatory Framework

There are various documents that discuss the Alternatives Evaluation Approach that may be taken for the development of a long term control plan. These documents are discussed in further detail in this Section.

2.1 Consent Decree Requirements

The Consent Decree requires DELCORA to complete and submit a LTCPU to the USEPA and PADEP for review and approval. Section V.A.13 of the Consent Decree ("Alternatives Evaluation Approach") specifically requires that:

> *"Within nine (9) months after the Date of Lodging, DELCORA shall propose, in coordination with the EPA and PADEP and in accordance with Section II.C.4 of the CSO Control Policy, what approach to LTCP Alternative Evaluation (i.e., Presumption or Demonstration) is appropriate for each of DELCORA's Receiving Waters, and to submit a written explanation of such determination to Plaintiffs for review and approval pursuant to Section VI (Review and Approval of Submittals)."*

The Consent Decree further states that:

> *"Use of the Presumption Approach will be allowed only where EPA and PADEP each agree that the specific presumption(s) to be used in a particular water body are reasonable pursuant to Section II.C.4.a of the CSO Control Policy".*

2.2 USEPA's CSO Control Policy Requirements

Section II.C.4 of the USEPA's CSO Control Policy states that the long term CSO control plan should adopt one of the following two approaches for CSO controls sufficient to meet CWA requirements: 1) the Presumption Approach, and 2) the Demonstration Approach.

2.2.1 Presumption Approach from USEPA's CSO Control Policy

Sub-section II.C.4.a of the USEPA's CSO Control Policy (Presumption Approach) states that:

> *"A program that meets any of the criteria listed below would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA, provided the permitting authority determines that such presumption is reasonable in light of the data and analysis conducted in the characterization, monitoring, and modeling of the system and the consideration of sensitive areas... These criteria are provided because data and modeling of wet weather events*

> *often do not give a clear picture of the level of CSO controls necessary to protect WQS."*

Under the Presumption Approach, CSO controls proposed in the LTCPU are presumed to protect water quality in the receiving water bodies if the Combined Sewer System achieves any of the following three criteria:

i. *"No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment specified below; or*

ii. *The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or*

iii. *The elimination or removal of no less than the mass of the pollutants identified as causing water quality impairment through the sewer system characterization, monitoring, and modeling effort, for the volumes that would be eliminated or captured for treatment under the paragraph ii above."*

"Minimum treatment," as noted in Item "*i*" above, is defined in Sub-section II.C.4.a of the CSO Control Policy as:

- *"Primary Clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification.);*

- *Solids and floatables disposal; and*

- *Disinfection of effluent, if necessary, to meet WQS, protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary."*

2.2.2 Demonstration Approach from USEPA's CSO Control Policy

Sub-section II.C.4.b of the USEPA's CSO Control Policy (Demonstration Approach) states that:

> *"A permittee may demonstrate that a selected control program, though not meeting the criteria specified in II.C.4.a. above is adequate to meet the water quality-based requirements of the CWA."*

Under the Demonstration Approach, the municipality would be required to successfully demonstrate compliance with each of the following criteria from the CSO Control Policy:

i. *"The planned control program is adequate to meet WQS and protect designated uses, unless WQS or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;*

ii. *The CSO discharges remaining after implementation of the proposed control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribution to their impairment. Where WQS are not met in part because of natural background conditions or pollution sources other than CSO discharges, a total maximum daily load, including a waste load allocation and a load allocation or other means should be used to apportion pollutant loads;*

iii. *The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and*

iv. *The planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are determined to be necessary to meet WQS or designated uses."*

2.3 USEPA's CSO Guidance for Long-Term Control Plan Requirements

The USEPA's CSO Guidance for Long-Term Control Plan (or "CSO Guidance Document") states that the Demonstration Approach and the Presumption Approach are the two general approaches to attainment of WQS, and that these two approaches provide municipalities with targets for CSO controls that achieve compliance with the Clean Water Act, particularly the protection of designated uses.

Section 1.3 of the CSO Guidance Document states:

> *"Permittees should develop long-term control plans (LTCPs) for controlling CSOs. A permittee may use one of two approaches: 1) demonstrate that its plan is adequate to meet the water quality-based requirements of the CWA ("demonstration approach"), or 2) implement a minimum level of treatment (e.g., primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise ("presumption approach")."*

Section 2.6.2.1 states that:

> *"Under the CSO Control Policy, a municipality should develop an LTCP that adopts either the demonstration or the presumption approach to attainment of*

WQS. The demonstration approach is based on adequately demonstrating that the selected CSOs will provide for the attainment of WQS, including designated uses in the receiving water. The presumption approach does not explicitly call for analysis of receiving water impacts. The presumption approach usually involves at least screening-level models of receiving water impacts, however, because the approach will not apply if the NPDES permitting authority determines that the LTCP will not result in attainment of CWA requirements."

2.3.1 Presumption Approach from USEPA's CSO Guidance for LTCP

For the Presumption Approach, Section 3.2.1 of the USEPA's CSO Guidance Document states that:

"If the data collected by a community do not provide "...a clear picture of the level of CSO controls necessary to protect WQS", the presumption approach may be considered. Use of the presumption approach is contingent, however, on the municipality presenting sufficient data to the NPDES permitting authority to allow the agency to make a reasonable judgment that WQS will probably be met with a control plan that meets one of the three presumption criteria."

Furthermore, the CSO Guidance Document states:

"Use of the presumption approach does not release municipalities from the overall requirement that WQS be attained. If data collected during system characterization suggest that use of the presumption approach cannot be reasonably expected to result in attainment of WQS, the municipality should be required to use the demonstration approach instead. Furthermore, if implementation of the presumption approach does not result in attainment of WQS, additional controls beyond those already implemented might be required."

2.3.2 Demonstration Approach from USEPA's CSO Guidance for LTCP

For the Demonstration Approach, Section 3.2.1 of the USEPA's CSO Guidance Document states that:

"Generally, if sufficient data are available to demonstrate that the proposed plan would result in an appropriate level of CSO control, then the demonstration approach will be selected. The demonstration approach is particularly appropriate where attainment of WQS cannot be achieved through CSO control alone, due to the impacts of non-CSO sources of pollution. In such cases, an appropriate level of CSO control cannot be dictated directly by existing WQS but must be defined based on water quality data, system performance modeling, and economic factors."

The Demonstration Approach is consistent with the total maximum daily load (TMDL) development approach and may be used in the TMDL process where the WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs. Section 3.2.1.1 of the CSO Guidance Document states:

> *"the demonstration approach encourages the development of total maximum daily loads and/or the use of a watershed approach throughout the LTCP process. In conducting the existing baseline water quality assessments as part of the system characterization, for example, the specific pollutants causing nonattainment of WQS, including existing or designated uses, would be identified, and then the sources of these pollutants could be identified and loads apportioned and quantified."*

2.4 Comparison of the Two Approaches

The following table summarizes the major differences between the Presumption Approach and the Demonstration Approach.

Table 2-1: Comparison of the Two Approaches

Item	Presumption Approach	Demonstration Approach
Criteria	• Meet one of three criteria and compliance is **presumed**: 1) No more than an average of 4-6 overflow events per year; 2) 85% capture (by volume) 3) Elimination or removal of the mass of pollutants, identified as causing water quality impairment.	• Number of CSO events, flow or pollutant loading limited by a proposed CSO system Waste Load Allocation which will comply with Water Quality Standards (WQS). • Relies on data collection and model simulation to **demonstrate** that the proposed LTCP results in meeting the current WQS and designated uses.
Monitoring Data Collection	• Flow metering of the collection system and/or water quality sampling of CSOs.	• Flow metering of the collection system and water quality sampling of CSOs **and** receiving water bodies.
Modeling	• Combined sewer system (CSS) hydrologic and hydraulic (H&H) model.	• CSS H&H Model **and** Receiving Water Quality Model(s).
Pollutant Sources Evaluated	• Only CSOs.	• The contributing pollutant sources in the watershed including urban stormwater, agricultural (if any), wildlife, etc.

The Demonstration Approach takes a holistic watershed based approach to understand the pollutant sources and their relative contributions, so that appropriate level of controls can be cost-effectively applied to each pollutant source instead of focusing on just the CSOs. The

Demonstration Approach can help to understand where the current CSO program is in terms of meeting the WQS and demonstrate the impact of future WQS changes on the CSO controls. Under the Demonstration Approach, the permittee must document that their CSO control program is adequate to meet the water quality-based requirements of the CWA.

Use of the Presumption Approach for a particular water body is only allowed when approved by the USEPA and PADEP and each agree that the specific presumption(s) to be used in a particular water body are reasonable pursuant to Section II.C.4.a of the CSO Control Policy.

Certain tasks must be completed regardless if the Presumption or Demonstration Approach is used, such as system characterization, sewer and GIS mapping, and the evaluation of alternatives. However, it is to be noted that the study phase for the Demonstration Approach also requires water quality sampling and water quality modeling of the receiving waters.

Section 3 CSO System Description

3.1 Background of DELCORA's Facilities

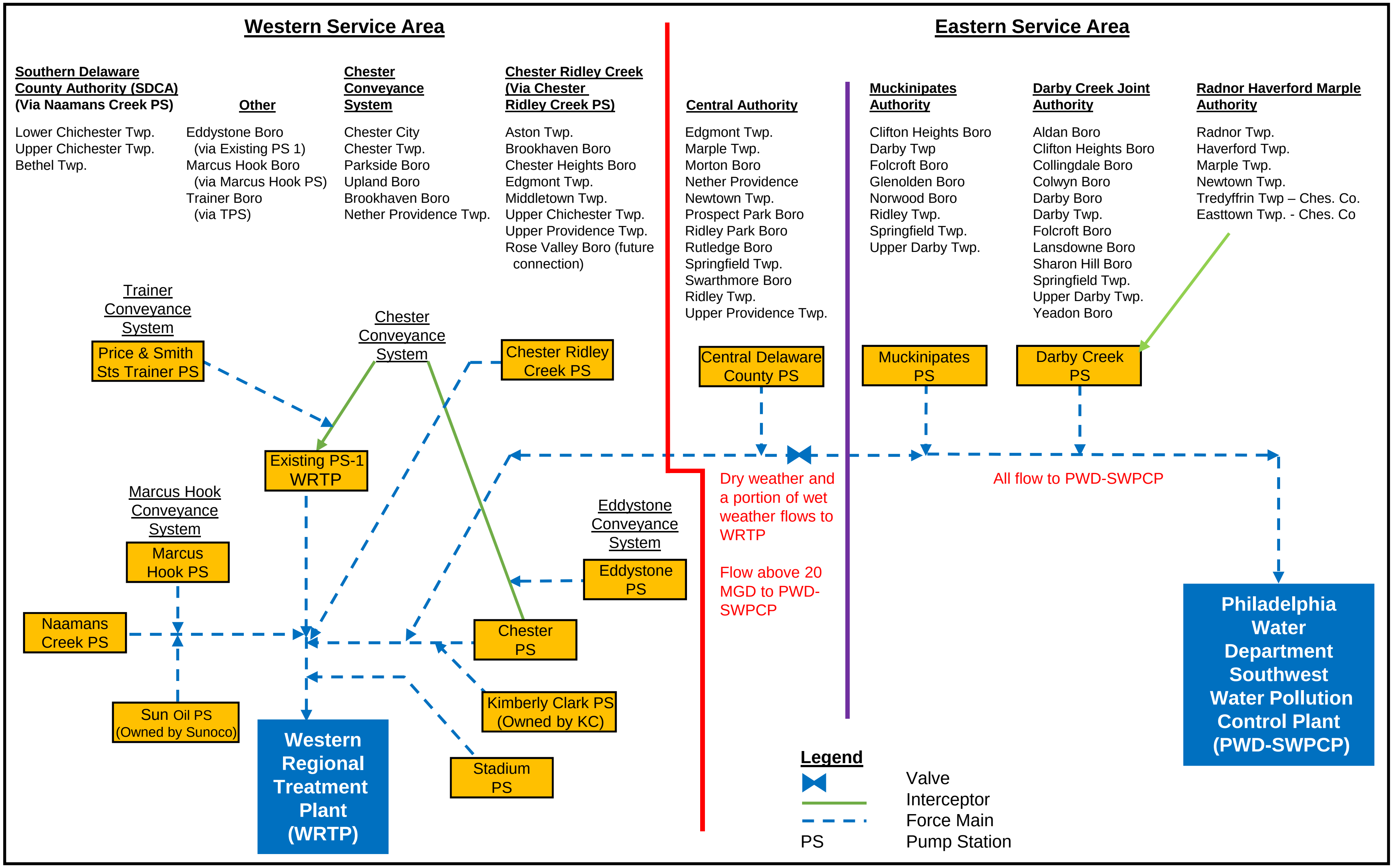
The Delaware County Regional Water Quality Control Authority is responsible for the safe collection, transmission, treatment and disposal of approximately 65 million gallons per day (MGD) of wastewater generated in southeastern Pennsylvania. DELCORA's facilities serve residential, commercial, institutional, and industrial customers in Delaware County. DELCORA owns and operates an extensive system of pump stations, force mains and sewers that provide the core infrastructure for the transmission of wastewater to treatment facilities in Delaware County and the City of Philadelphia as shown diagrammatically in Figure 3-1. The total service area served by DELCORA, as shown on Figure 3-2, is approximately 82,977 acres which illustrates that DELCORA serves a significant and widespread portion of Delaware County.

The combined sewer area simulated in DELCORA's existing Hydrologic and Hydraulic (H&H) model is located within the City of Chester and consists of a drainage area of approximately 1,510 acres. It comprises approximately half of Chester City's serviced area. To support the service area, DELCORA owns and operates over 129 miles of separate and combined sewers. Included in the 129 miles of sewers are: 11.7 miles of an interceptor system; 3,209 manholes; and twenty-five (25) combined sewer outfall regulators controlling storm overflows.

Historically, DELCORA has characterized its service areas as the "Eastern" and "Western." The Western Service Area wastewater is treated at DELCORA's Western Regional Treatment Plant, located at 3201 W. Front Street in Chester, Pennsylvania. The WRTP treats all wastewater from Southern Delaware County Authority, Marcus Hook Borough, Trainer Borough, Upland Borough, Parkside Borough, Eddystone Borough, Chester Township and the City of Chester as well as a portion of the wastewater from Brookhaven Borough and Nether Providence Township.

The Eastern Service Area discharges to the Philadelphia Water Department's Southwest Water Pollution Control Plant (PWDSWPCP). In 2002, DELCORA completed the installation of a force main that connects the Eastern Service Area's Central Delaware Pump Station (CDPS) to the Chester Force Main. This connection allows DELCORA to send flow from the CDPS to the WRTP. Flows above 20 MGD are directed to the PWDSWPCP. As such, dry weather flows and a portion of the wet weather flows (total flow less than 20 MGD) from the Central Delaware County Authority in the Eastern Service Area are discharged to the WRTP.

There are a total of 26 combined sewer overflows with 25 discharge points listed in DELCORA's existing National Pollutant Discharge Elimination System (NPDES) Permit. Under its NPDES Permit No. PA0027103, issued and administered by the Pennsylvania Department of Environmental Protection, DELCORA is authorized to discharge from the Western Regional Treatment Plant (#001), four storm water outfalls at the WRTP (#028-031),



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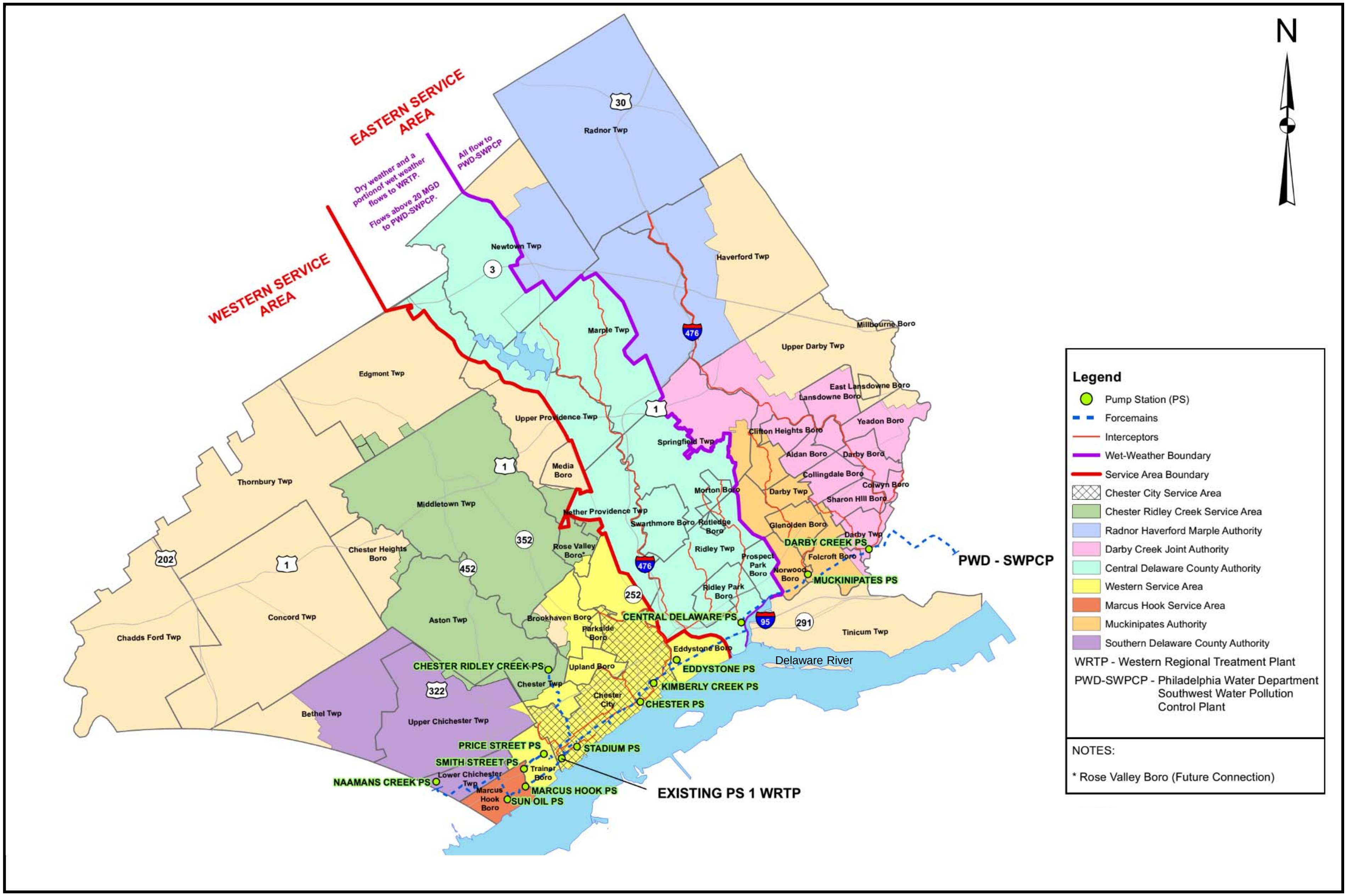
WESTON SOLUTIONS
Restoring Resource Efficiency

Figure 3-1
DELCORA'S CONVEYANCE SYSTEM



CSO Long-Term Control Plan Delaware County Regional Water Quality Control Authority	GREELEY AND HANSEN	Figure 3-2 DELCORA'S SERVICE AREA

and from 26 combined sewer overflow outfalls (#002-#026, #032, #033) that ultimately discharge to the Delaware River, Chester Creek and/or Ridley Creek. CSOs #009 and #010 both discharge at CSO #009.

3.2 City of Chester CSO System

As noted in Section 3.1, the combined portion of DELCORA's sewer system is located within the City of Chester (City) and it comprises approximately half of the City's serviced area. The combined wastewater/stormwater system in the City of Chester is complicated by the fact that parts of the system are owned, operated and maintained by two governmental entities, the City and DELCORA. DELCORA owns, operates and maintains the parts of the system that convey wastewater, such as the street sewers, collectors, interceptors, CSO regulators and CSO outfalls. The City owns, operates and maintains the inlets, stormwater-only sewers that connect to the combined sewer system and any stormwater-only outfalls. The City is also responsible for the maintenance and cleaning of the streets, planning, zoning, and development controls.

The Chester CSO system contains 26 permitted outfalls as listed in Table 3-1 that discharge to three receiving water bodies; the Delaware River, Chester Creek and Ridley Creek. Figure 3-3 depicts the locations of CSO regulators and outfalls that are DELCORA's responsibility.

Table 3-1: Permitted CSOs in the City of Chester

Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Delaware River	002	Front and Booth	39°49'30"N	75°23'31"W
Delaware River	003	Front and Highland	39°49'34"N	75°23'11"W
Delaware River	004	Front and Haves	39°50'36"N	75°23'07"W
Delaware River	005	Front and Townsend	39°49'46"N	75°22'53"W
Delaware River	007	Delaware and Reaney	39°49'51"N	75°22'45"W
Delaware River	008	2nd and Tilghman	39°50'05"N	75°22'22"W
Delaware River	009	2nd and Lloyd	39°50'14"N	75°22'10"W
Delaware River(1)	010	5th and Pusey	39°50'26"N	75°22'19"W
Delaware River	011	2nd and Parker	39°50'26"N	75°21'54"W
Delaware River	013	2nd and Welsh	39°50'37"N	75°21'17"W
Delaware River	014	3rd and Upland	39°50'50"N	75°21'05"W
Delaware River	032	2nd and Avenue of The States	39°50'34"N	75°21'25"W
Chester Creek	012	2nd and Edgmont	39°50'42"N	75°21'38"W
Chester Creek	019	14th and Crozer Hospital	39°51'24"N	75°21'54"W
Chester Creek	020	Kerlin and Finland	39°51'24"N	75°22'27"W
Chester Creek	021	9th and Sproul	39°51'08"N	75°21'49"W
Chester Creek	022	6th and Sproul	39°50'56"N	75°21'47"W
Chester Creek	023	3rd and Edgmont	39°50'45"N	75°21'42"W

Name of Receiving Stream	CSO Outfall	Interceptor/CSO Regulator Location	Latitude	Longitude
Chester Creek	024	3rd and Dock	39°50'44"N	75°21'43"W
Chester Creek	025	5th and Penn	39°50'49"N	75°21'50"W
Chester Creek	026	7th and Penn	39°50'58"N	75°21'55"W
Ridley Creek	015	4th and Melrose	39°51'03"N	75°20'48"W
Ridley Creek	016	8th and McDowell	39°51'15"N	75°20'53"W
Ridley Creek	017	9th and Campbell	39°51'16"N	75°20'51"W
Ridley Creek	018	Sun Drive and Hancock Street	39°51'47"N	75°20'57"W
Ridley Creek	033	Elkington Boulevard and Ridley Creek	39°52'22"N	75°22'29"W

Notes:

(1) CSO Outfall 010 discharges to the Delaware River through CSO Outfall 009.

Figure 3-3 and Table 3-2 also provide a sewer system characterization and illustrate the breakdown of each outfall and how each drainage area has combined sewers and separate sewers. Figure 3-4 is a schematic of the Chester CSO system and shows the outfalls and the interceptors that are connected to each CSO.

3.3 CSO System Modeling

Since 1997, DELCORA has conducted annual modeling of the CSO system using the USEPA's Storm Water Management Model (SWMM) to estimate overflows to its receiving waters. SWMM is a dynamic rainfall-runoff model for "single-event" or "continuous" simulations of runoff quantity and quality from primarily urban areas. The model simulates the time-varying process of rainfall onto land surfaces, the conversion of rainfall to infiltration, evaporation, or surface runoff, and the routing of mixed stormwater runoff and sanitary sewage through the collection system. DELCORA's SWMM is also referred to in this report as the Hydrologic and Hydraulic (H&H) model.

Section 2.6.1 (Combined Sewer System Modeling) of the USEPA's CSO Guidance for Long-Term Control Plan states that:

> *"The primary objective of CSS modeling is to understand the hydraulic response of the CSS to a variety of precipitation and drainage area inputs. CSS modeling can also be used to predict pollutant loadings to receiving waters. Once the model is calibrated and verified, it can be used for numerous applications that support CSO planning efforts, including (EPA, 1995d):*

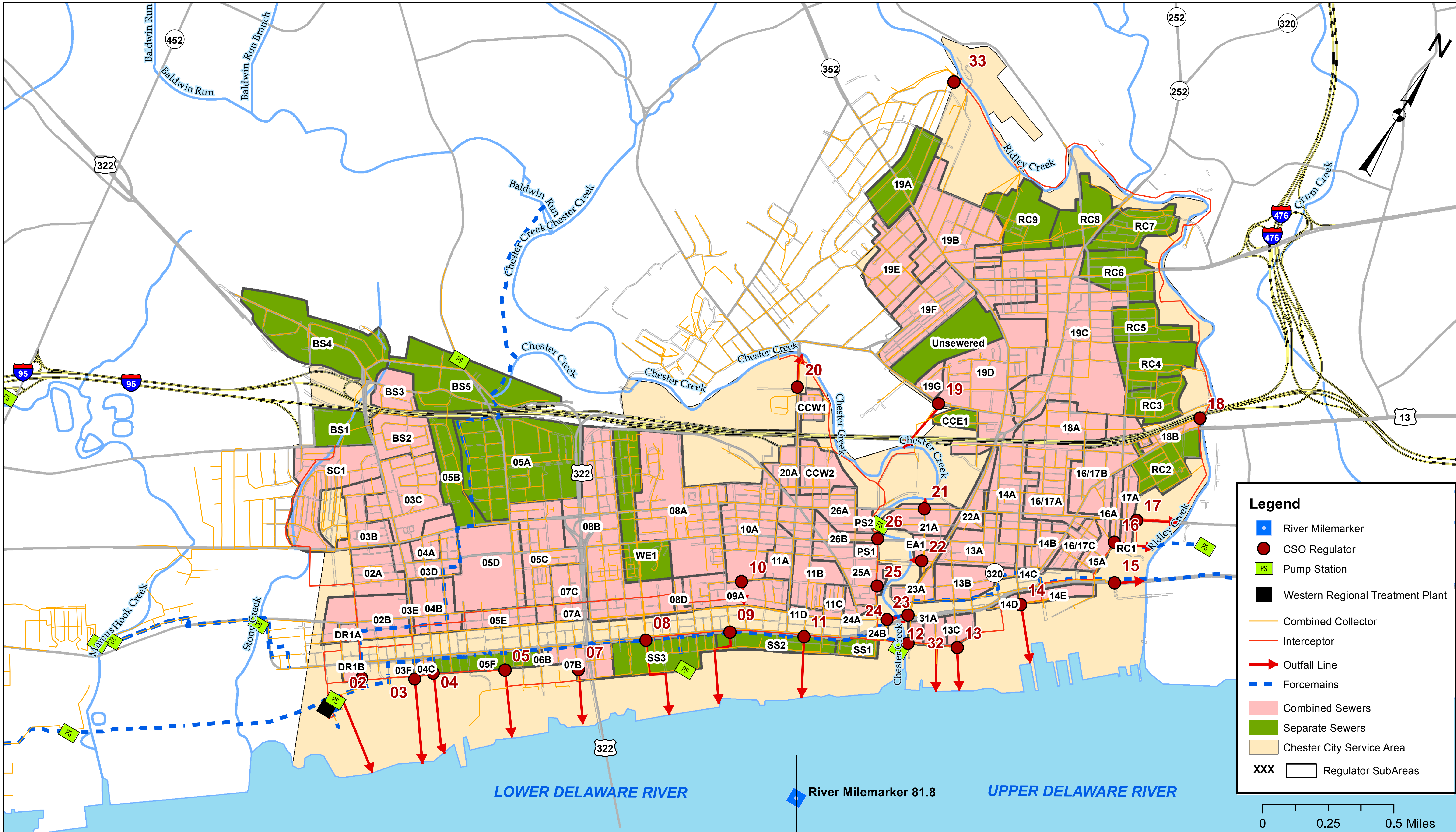


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Figure 3-3
Location of Regulators and Combined Sewer Outfalls With Drainage Areas

Table 3-2: Subarea Type and Size

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
2	02A	CSS	20.7
	02B	CSS	31.7
	02C	CSS	0.3
			52.7
3	03A	Separate	12.8
	03B	CSS	21.9
	03C	CSS	46.5
	03D	CSS	18.5
	03E	CSS	2.9
			102.5
4	04A	CSS	10.8
	04B	CSS	22.6
	04C	CSS	2.5
	04D	Separate	1.0
			36.8
5	05A	Separate	97.4
	05B	Separate	26.4
	05C	CSS	32.0
	05D	CSS	29.1
		Unsewered	32.1
	05E	CSS	28.6
			245.7
6	Converted to Regulator 7 subareas		
7	07A	CSS	12.8
	07B	CSS	18.5
	07C	CSS	16.3
			47.6
8	08A	CSS	83.2
	08B	CSS	90.2
	08C	Separate	9.8
	08D	CSS	3.8
			187.0

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
9	09A	CSS	29.3
10	10A	CSS	46.6
11	11A	CSS	11.8
	11B	CSS	31.4
	11C	CSS	6.3
	11D	CSS	2.5
			52.0
12	12A	CSS	3.3
13	13A	CSS	25.3
	13B	CSS	19.7
	13C	CSS	7.2
			52.1
14	14A	CSS	41.4
	14B	CSS	11.8
	14C	CSS	10.5
	14D	CSS	2.4
			66.1
15	15A	CSS	8.6
	15B	Separate	4.1
			12.7
16	16A	CSS	6.9
16/17	16/17A	CSS	36.4
	16/17B	CSS	41.4
	16/17C	CSS	17.2
			95.0
17	17A	CSS	7.6
18	18A	CSS	27.2
	18B	CSS	4.8
			32.1

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
19	19A	Separate	30.7
	19B	CSS	73.5
	19C	CSS	138.2
	19D	CSS	71.5
	19E	CSS	36.3
	19F	CSS	38.7
	19G	CSS	6.1
			395.0
20	20A	CSS	12.8
21	21A	CSS	18.3
22	22A	CSS	17.3
23	23A	CSS	9.1
24	24A	CSS	6.1
25	25A	CSS	23.7
26	26A	CSS	18.3
	26B	CSS	8.6
			26.9
31	31A	CSS	5.9
Stoney Creek Collector	SC1	CSS	49.1
Booth Street Inteceptor	BS1	Separate	18.4
	BS2	CSS	22.2
	BS3	CSS	14.3
	BS4	Separate	63.2
	BS5	Separate	60.3
			178.4
West End Interceptor	WE1	Separate	39.7
Delaware River Interceptor	DR1	CSS	5.8

CSO Regulator/ Interceptor	Subarea	Collection System Type	Area (ac)
2nd Street Interceptor	SS1	Separate	7.1
	SS2	Separate	19.0
	SS3	Separate	30.4
			56.5
Penn Street Interceptor	PS1	CSS	2.9
	PS2	CSS	3.4
			6.3
Chester Creek West Interceptor	CCW1	CSS	18.9
	CCW2	CSS	6.2
			25.1
Chester Creek East Interceptor	CCE1	Separate	6.9
Edgmont Avenue Interceptor	EA1	CSS	3.8
Ridley Creek Interceptor	RC1	CSS	2.2
	RC2	Separate	24.7
	RC3	Separate	19.2
	RC4	Separate	27.7
	RC5	Separate	21.4
	RC6	Separate	27.2
	RC7	Separate	23.9
	RC8	Separate	25.1
	RC9	Separate	31.6
	RC10	CSS	7.7
			210.7
		CSS	**1,506.1**
		Separate	**632.4**
TOTAL			**2,138.5**

NOTE: CSS = Combined Sewer System

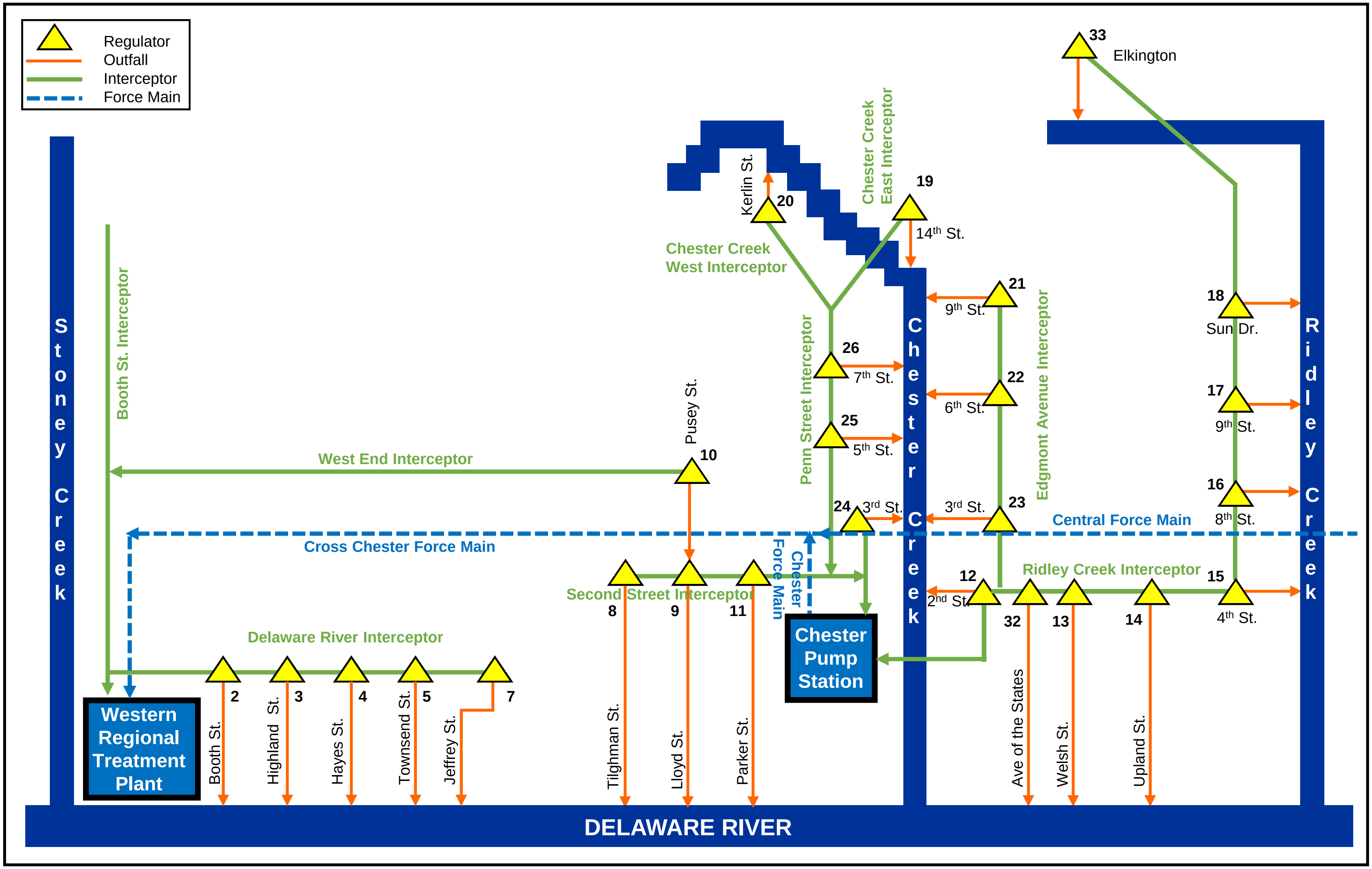

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Figure 3-4
SCHEMATIC OF CHESTER CSO SYSTEM

- *To predict overflow occurrence, volume, and, in some cases, quality for rain events other than those which occurred during the monitoring phase. These can include a storm event of large magnitude (long recurrence period) or numerous storm events over an extended period of time.*

- *To predict the performance of portions of the CSS that have not been extensively monitored.*

- *To develop CSO statistics, such as annual number of overflows and percent of combined sewage captured in response to the presumption approach of the CSO Control Policy.*

- *To optimize CSS performance as part of NMC implementation. In particular, modeling can assist in locating storage opportunities and hydraulic bottlenecks and demonstrate that system storage and flow to the POTW are maximized.*

- *To evaluate and optimize control alternatives, from simple controls described under the NMC to more complex controls proposed in a municipality's LTCP. An example of a simple control would be to raise weir heights to increase in-line storage. The model can be used to evaluate the resulting reductions in CSO volume and frequency."*

The original DELCORA H&H model was developed and calibrated for the 1999 LTCP. The model was set up to simulate monthly CSO discharges in EPA SWMM 5.0, and it is used to estimate the frequency and volume of CSO overflows in the City of Chester and to evaluate long-term strategies for minimizing CSO overflows. The model uses data from the rain gauge located at the WRTP and is supplemented with data from a gauge at the Central Delaware Pump Station. The current model has been updated and expanded over the years to account for changes in the CSO system, but it has not been re-calibrated. Updating and additional calibration and validation of the SWMM model will occur in a subsequent task as part of the requirements of DELCORA's Consent Decree.

Monthly Reports of CSO Modeling using the SWMM are provided to the PADEP as part of DELCORA's Annual Municipal Wasteload Management Report (Chapter 94 Report), and are also provided monthly with the PADEP electronic Discharge Monitoring Report (e-DMR). For the purposes of this report, a run of the existing H&H model was performed using the typical hydrologic period established for DELCORA's CSO LTCPU. The typical hydrologic period was previously determined to be the 3-year period from 1994 – 1996, as detailed in the "Typical Hydrologic Period Report" submitted to the USEPA in November 2015. The hydrologic period from 1994 – 1996 contains a wet year (1996 with 52.1 inches), a dry year (1995 with 31.6 inches) and a year close to average conditions (1994 with 44.9 inches).

A series of monthly simulations of the existing H&H model was executed to estimate the overflow frequency, duration and volume to each of the three receiving water bodies (the Delaware River, Chester Creek and Ridley Creek) as well as the percent volume captured for treatment. The model was run in continuous mode for each month for the 1994 – 1996 period. Evaporation was not included in the simulation since it does not affect the model in a meaningful way, and may cause underreporting of CSO discharges in some cases. It is also to be noted that the snowfall recorded at the rain gauges was simulated in SWMM as rainfall and since peak runoff from snowmelt is typically lower than from rainfall, the SWMM model simulates a conservative estimate of CSO overflows.

The outputs from the H&H model run for the typical hydrologic period are summarized in Table 3-3. Based on the model results for the 1994 – 1996 typical hydrologic period, Table 3-3 indicates that:

- Only four (4) of the 25 outfalls (i.e., #012, 024, 032 and 033) are currently estimated by the model to have had less than 4-6 annual overflow events, which is a prime requirement for use of the Presumption Approach. The next lowest number of overflow events is shown to occur at CSO #020, for which the model indicates an annual average of 21 overflow events. All of the remaining outfalls are shown to have to an annual average of 25 or more overflow events.

- The response of certain regulators (i.e., #002, 003, 004, 005, 007, 008, 009, 011, 013, 015, 017, 018, 019, 022 and 025) is sensitive to even the smallest amounts of precipitation. The model indicates that these outfalls had the highest frequency of discharges.

- The Delaware River received overflows from 11 of the 25 discharge points in the CSS, which was approximately 50% of the total annual average overflow volume and accounted for approximately 49% of the overall number of discharge events.

- The Ridley Creek received overflows from 5 of the 25 discharge points in the CSS, which was approximately 12% of the total annual average overflow volume and accounted for approximately 23% of the overall number of discharge events.

- The Chester Creek received overflows from 9 of the 25 discharge points in the CSS, which was approximately 38% of the total annual average overflow volume and accounted for approximately 28% of the overall number of discharge events.

- The existing H&H model estimates that the percentage of the combined flow treated at the wastewater treatment plant was approximately 61% for the 1994 - 1996 period, which is significantly less than the 85% capture rate for treatment required for use of the Presumption Approach.

A bar chart is also included below Table 3-3 that graphically illustrates the information in the table. The chart shows the large gap that exists between the modeled number of overflow events for the typical hydrologic period, and the limit prescribed for use of the Presumption Approach of only 4-6 overflow events per year.

Table 3-3: H&H Model Results for Typical Hydrologic Period (1994 - 1996)

Annual Overflow Frequency (Occurrence)

		Western Chester City Service Area						Central Chester City Service Area												Eastern Chester City Service Area								
		DELAWARE RIVER						DELAWARE RIVER			CHESTER CREEK									DELAWARE RIVER			RIDLEY CREEK					
	Rainfall	#002	#003	#004	#005	#006	#007	#008	#009	#011	#012	#019	#020	#021	#022	#023	#024	#025	#026	#013	#014	#032	#015	#016	#017	#018	#033	Max
1/1/1994	45	80	76	44	72	0	74	76	48	50	3	93	21	43	51	30	5	65	26	54	31	2	46	32	97	93	5	97
1/1/1995	31	62	60	37	58	0	60	61	39	39	1	80	13	31	40	23	4	53	17	44	24	1	37	26	83	80	2	83
1/1/1996	52	88	83	56	83	0	84	84	57	58	1	112	28	52	59	36	5	79	32	64	38	1	56	42	115	112	3	115
Average	43	77	73	46	71	0	73	74	48	49	2	95	21	42	50	30	5	66	25	54	31	1	46	33	98	95	3	98

Typical Year Overflow Volume (MG)

	Rainfall	#002	#003	#004	#005	#006	#007	#008	#009	#011	#012	#019	#020	#021	#022	#023	#024	#025	#026	#013	#014	#032	#015	#016	#017	#018	#033	Annual Total
1/1/1994	45.0	67.0	52.9	14.6	56.7	0.0	28.7	96.9	27.1	20.7	0.2	272.5	2.5	6.5	7.6	2.5	0.5	13.3	5.8	26.1	15.4	0.1	2.4	17.9	51.0	27.6	0.4	862
1/1/1995	31.4	44.3	34.1	8.3	36.9	0.0	18.7	61.9	16.6	12.1	0.0	182.1	0.8	3.5	4.5	1.1	0.1	8.5	2.0	16.2	7.0	0.0	1.2	7.6	36.5	18.6	0.0	554
1/1/1996	52.1	78.8	62.2	16.0	67.5	0.0	33.9	112.8	30.9	23.2	0.0	318.0	1.4	6.7	8.6	2.0	0.1	15.8	3.4	30.4	13.1	0.0	2.4	14.1	62.0	32.1	0.0	988
Average	42.8	63.4	49.7	13.0	53.7	0.0	27.1	90.6	24.9	18.7	0.1	257.5	1.6	5.6	6.9	1.9	0.2	12.6	3.7	24.2	11.8	0.0	2.0	13.2	49.8	26.1	0.1	801

WWTP Treated Wet Weather Volume (Assuming max WWTP flow at 105.54 MGD, and plant DWF at 7.01 MGD)

1994	634	MG
1995	481	MG
1996	743	MG
Average	620	MG

Notes:
1. Modeled was test run for June, July and August, 2014, the results are in line with Weston's 2014 report.
2. The model only include the Chester City Service Area, it does not include flows from the other service areas and the Central Delaware PS.
3. Modeled max flow to the WWTP is only 86.64 MGD, less than the plant record of 105.54 MGD
4. We checked Regulator #08 set up in the model and the drawing, they are different.
5. The "Percent of Combined Flow Treated by WWTP" is estimated based on precipitation inter-event time (IET) of 12 hr.
6. CSO #006 has been separated and no longer discharges combined storm/wastewater flow.
7. CSO #010 discharges to the Delaware River through CSO #009.

Total Overflow

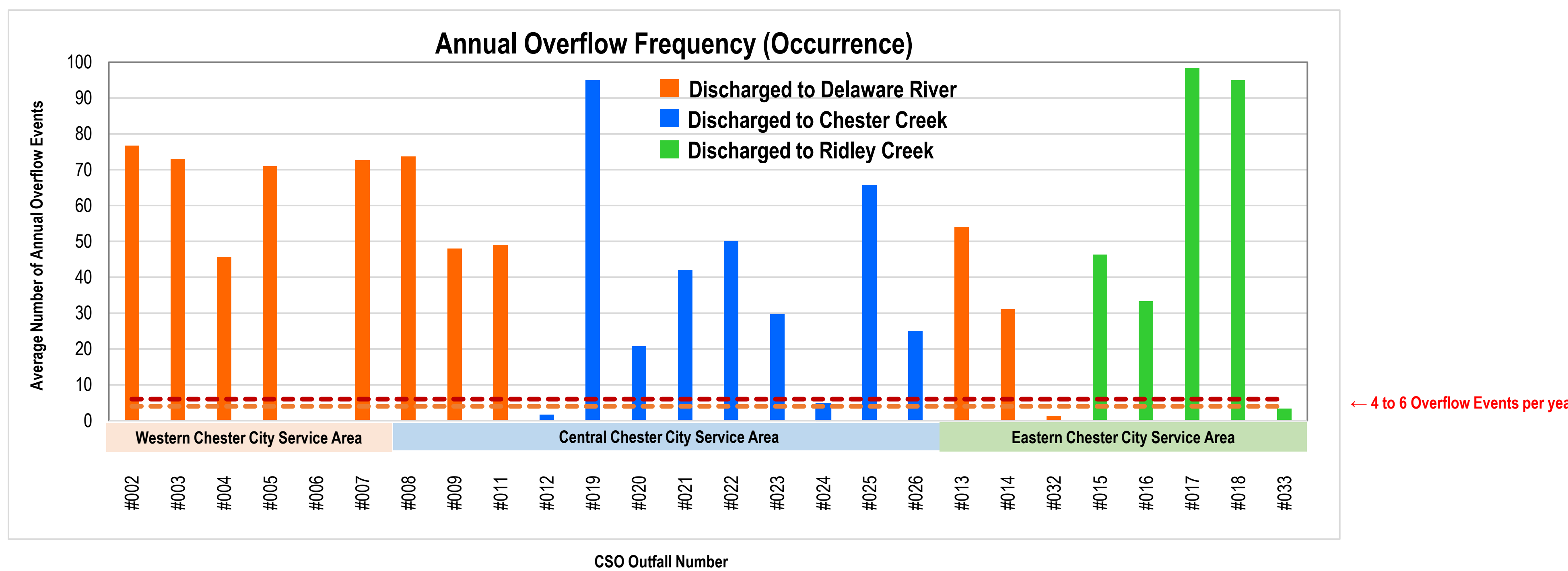
1994	862	MG
1995	554	MG
1996	988	MG
Average	801	MG

Percent of Wet Weather Flow Treated by WWTP

1994	42%
1995	47%
1996	43%
Average	44%

Percent of Combined Flow Treated by WWTP

1994	59%
1995	64%
1996	59%
Average	61%



Section 4 Characterization of Receiving Water Bodies

In order to select the Presumption Approach or the Demonstration Approach, it is necessary to understand the existing condition of the receiving water bodies. Use of the Presumption Approach is contingent on the municipality presenting sufficient data to make a reasonable judgment that the water quality standards in the receiving water body will presumably be met with a control plan that meets one of the three presumption criteria (see Section 2.2.1). The Demonstration Approach is appropriate where attainment of water quality standards cannot be achieved through CSO controls alone, due to the impacts of background conditions or pollution sources other than CSOs.

For the characterization of receiving water bodies, Section 2.6.2 (Receiving Water Modeling) of the USEPA's CSO Guidance Document states that:

> *"Under the CSO Control Policy, a municipality should develop an LTCP that adopts either the demonstration or the presumption approach to attainment of WQS. The demonstration approach is based on adequately demonstrating that the selected CSOs will provide for the attainment of WQS, including designated uses in the receiving water. The presumption approach does not explicitly call for analysis of receiving water impacts. The presumption approach usually involves at least screening-level models of receiving water impacts, however, because the approach will not apply if the NPDES permitting authority determines that the LTCP will not result in attainment of CWA requirements."*

In February 2016, DELCORA submitted to the USEPA its "Identification of Sensitive Areas and Pollutants of Concern Report" as a requirement of the Consent Decree. The report reviewed the impairment status of each of the three receiving water bodies and identified parameters associated with CSOs that are exceeding the water quality standards as "Pollutants of Concern".

Figure 4-1 (from the Identification of Sensitive Areas and Pollutants of Concern Report) shows the Non-Attaining and TMDL streams and river within the area impacted by DELCORA's CSO discharges, as determined from the 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report. The location of each of DELCORA's CSOs for each of the water bodies is shown in the figure.

CSO Long Term Control Plan Update
Delaware County Regional Water
Quality Control Authority

GREELEY AND HANSEN

Figure 4-1

Non-Attaining and TMDL Streams/River
Within DELCORA's Service Area

Section 5 Selection of the Presumption or Demonstration Approach for Each of DELCORA's Receiving Waters

The development of an LTCPU allows for either the Presumption Approach or the Demonstration Approach to be utilized. DELCORA's approach is to establish the most reliable CSO Program that meets the Consent Decree requirements, the USEPA's CSO Policy and Guidance Document, and the applicable water quality standards.

5.1 Methodology Used in this Study

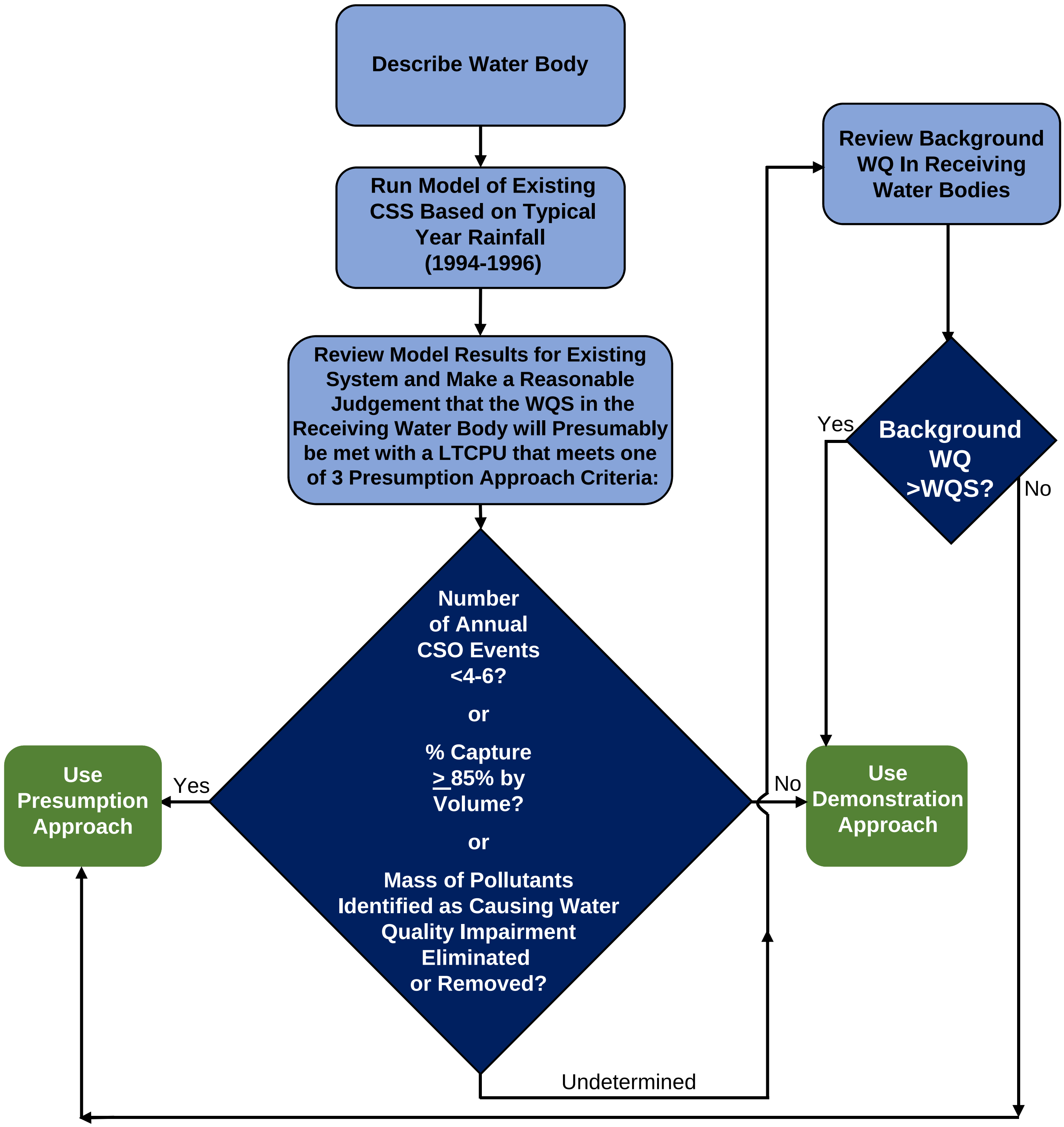
A flowchart was created to help illustrate the decision-making methodology used to assist in determining the recommended Alternatives Evaluation Approach for each of DELCORA's three receiving water bodies. This flowchart is presented in Figure 5-1.

The flowchart emphasizes two main decision making steps that lead to the recommendation of either the Demonstration or Presumption Approach, and these decision making steps are shown as dark blue diamonds. The primary decision step is to make a reasonable judgement that after all of the future CSO controls have been installed (1) will the annual average number of overflow events be less than 4 - 6 events, or (2) will the annual average percent capture for treatment of the combined wastewater be greater than or equal to 85%, or (3) for the volumes that would be eliminated or captured for treatment under item "(2)" will the mass of pollutants identified as causing water quality impairment be eliminated or removed? An answer of "Yes" to any one of these three questions is required for use of the Presumption Approach.

The results from the H&H model run for the typical hydrologic period of 1994 – 1996 were used to estimate the annual average number of overflow events per outfall, and the average percentage of the combined flow treated at the WWTP. The existing H&H model is not able to estimate if the mass of pollutants identified as causing water quality impairment will be eliminated or removed for the volumes that would be eliminated or captured for treatment, and therefore no determination can be made on that specific question at this time.

It was concluded that if the H&H model (Section 3.3) shows substantially more than 4 - 6 annual overflow events per outfall for the CSOs or if significantly less than 85% of the combined flow is shown to be captured for treatment, it will likely not be economically justifiable to install the full range of CSO control measures needed to meet the overflow frequency requirements of the Presumption Approach, and the Demonstration Approach will be favored. This determination is based on the use of Best Professional Judgement.

If it cannot be determined from the H&H model results as to whether the future CSO controls will likely be able to meet the annual number of overflow events or the percent capture rate for the Presumption Approach, then the flowchart indicates a secondary decision making step in



LEGEND

CSS	=	Combined Sewer System
CSO	=	Combined Sewer Overflow

Figure 5-1
METHODOLOGY FLOWCHART FOR THE ALTERNATIVES EVALUATION APPROACH

which the existing water quality of the receiving water bodies is reviewed and compared to the applicable water quality standards. This determination is required since use of the Presumption Approach is contingent on the municipality presenting sufficient data to make a reasonable judgment that water quality standards will probably be met with a control plan that meets one of the three presumption criteria.

If the review of the background concentrations of those parameters typically associated with CSOs in the receiving water bodies are less than the applicable water quality standards, then the flow chart indicates that the Presumption Approach can be considered. However, if the background concentrations for those parameters are above the applicable water quality standards, then the Demonstration Approach should be used.

A review of the methodology flowchart was performed for each of the three receiving water bodies and is described in the following sub-sections.

5.1.1 Delaware River

Eleven (11) of DELCORA's 25 CSO outfalls discharge to the Delaware River. The H&H model run for the typical hydrologic period shown in Table 3-3 estimates that the Delaware River received discharges from these 11 outfalls accounting for approximately 50% of the total annual average overflow volume from the CSS, and approximately 49% of the overall number of discharge events.

Table 3-3 indicates that 10 of the 11 outfalls to the Delaware River had substantially more than the 4 – 6 annual overflow events that are the target for using the Presumption Approach. Only CSO #032 is shown to have had less than 4 – 6 annual overflows. Of the 10 CSOs that were modeled to overflow more than 4 - 6 times a year, the model estimates that all 10 of them had at least 31 annual overflow events and five of the outfalls are modeled as having had more than 71 overflow events.

Following the methodology described in the flowchart, the answers to the questions in the first decision making step indicate that the **Demonstration Approach** is the most appropriate to be used for the CSO discharges to the Delaware River.

5.1.2 Chester Creek

Nine (9) of DELCORA's 25 CSO outfalls discharge to the Chester Creek. The H&H model run for the typical hydrologic period of 1994 – 1996 shown in Table 3-3 estimates that the Chester Creek received discharges from these 9 outfalls accounting for approximately 38% of the total annual average overflow volume from the CSS, and approximately 28% of the overall number of discharge events.

Table 3-3 indicates that 7 of the 9 outfalls to the Chester Creek had substantially more than the 4 – 6 annual overflow events that are the target for using the Presumption Approach. Only CSOs #012 and #024 are shown to have had less than 4 – 6 overflows. Of the 7 CSOs that were modeled to overflow more than 4-6 times a year, the model estimates that all 7 of them had at least 21 or more annual overflow events and four of the outfalls are modeled as having had more than 42 overflow events.

Following the methodology described in the flowchart, the answers to the questions in the first decision making step indicate that the **Demonstration Approach** is the most appropriate to be used for the CSO discharges to the Chester Creek.

5.1.3 Ridley Creek

Five (5) of DELCORA's 25 CSO outfalls discharge to the Ridley Creek. The H&H model run for the typical hydrologic period of 1994 – 1996 shown in Table 3-3 estimates that the Chester Creek received discharges from these 5 outfalls accounting for approximately 12% of the total annual average overflow volume from the CSS, and approximately 23% of the overall number of discharge events.

Table 3-3 indicates that 4 of the 5 outfalls to the Ridley Creek had substantially more than the 4 – 6 annual overflow events that are the target for using the Presumption Approach. Only CSOs #033 is shown to have had less than 4 – 6 overflows. Of the four CSOs that were modeled to overflow more than 4- 6 times a year, the model estimates that all four of them had at least 33 or more annual overflow events and two of the outfalls are modeled as having had more than 95 overflow events.

Following the methodology described in the flowchart, the answers to the questions in the first decision making step indicate that the **Demonstration Approach** is the most appropriate for the CSO discharges to the Ridley Creek.

Section 6 Recommendations

It is recommended that the Demonstration Approach be utilized for the Delaware River, Chester Creek and Ridley Creek.

The Demonstration Approach relies on data collection and model simulation to demonstrate that the proposed LTCPU will meet applicable water quality standards and designated uses, and it provides a reliable tool to identify, evaluate and compare the selection and recommendation of the CSO control measures to be installed.

In addition to flow metering of the combined sewer system and water quality sampling of the CSOs to help refine and calibrate the H&H Model for the collection system, the Demonstration Approach requires a water quality model be developed for the Delaware River, Chester Creek and Ridley Creek. Water quality sampling of the receiving water bodies will be required to calibrate the water quality model and to identify and quantify the contributing pollutant sources in the watersheds other than CSOs.

The Demonstration Approach will be a better predictor than the Presumption Approach of actual resulting water quality at the end of the LTCPU program, and use of the Demonstration Approach will allow DELCORA to make more informed decisions regarding the long term control plan update investments that will result in compliance with the applicable water quality-based requirements.

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