APPENDIX 5-4
Characterization of Pollutant Loads Technical Memorandum

D R A F T

June 30, 2016

City of Lakewood

Integrated Wet Weather Improvement Plan
Characterization of Pollutant Loads
Technical Memorandum

June 2016

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EXECUTIVE SUMMARY

Lakewood's NPDES permit requires "*adequate characterization*" of the sewer system to allow for "*volume and frequency of sewage discharges as well as pollutant concentrations/loads discharged*." The volume and frequency of sewage discharges was submitted in a Technical Memorandum in June 2014 to both the Ohio EPA and the USEPA Region 5. Pollutant characterization was done by modeling pollutants as an enhancement to its Storm Water Management Model (SWMM) hydrologic model developed for the hydraulic characterization. The objective of modeling pollutants is to characterize their concentrations in:

1. Untreated Overflows
2. Wastewater Treatment Plant (WWTP) influent on dry and wet days

This characterization will enable comparison of long term control alternatives to provide the most cost-effective improvement to the water quality of Lake Erie.

Pollutants added to the SWMM model include total suspended solids (TSS), carbonaceous biological oxygen demand (CBOD), total phosphorous (TP), and *Escherichia coli* (*E. coli*) bacteria. Typical concentrations of these pollutants in sewage were calculated from five years of WWTP Discharge Monitoring Reports. Pollutants in stormwater runoff were modeled using SWMM's buildup and washoff equations. The SWMM pollutant equations were calibrated with data from five samplers with attached flow meters. Details of the process to set up the model and calibrate it are described within this report.

After setting up and calibrating the model parameters to calculate pollutant loadings, SWMM was run with a typical year of rainfall. Output from the typical year analysis serves as the basis for calculating pollutant reductions of future improvements. The following table shows the amount of flow and pollutants in a typical year currently treated by the Lakewood WWTP and Northeast Ohio Regional Sewer District and the amount of untreated flow discharged through the City's outfalls. In addition to the total flows treated and discharged, the table also shows the percentages of flow and pollutants captured for treatment by the collection system during precipitation events on a system-wide annual average basis (wet weather capture).

City of Lakewood
SWMM Typical Year Flow and Pollutant Loadings

	Flow (MGal)	CBOD (lbs)	*E. coli* (cfu)	TP (lbs)	TSS (lbs)
WWTP Influent	2,787	1,843,662	2.06E+18	70,000	2,747,213
To NEORSD	398	27,142	3.04E+16	1,030	40,469
Lakewood Outfalls	577	30,720	2.30E+16	1,129	56,356
Total Quantity Treated	3,185	1,870,804	2.09E+18	71,030	2,787,682
Percentage of Total Flow Captured for Treatment	**83.2%**	**98.2%**	**98.8%**	**98.3%**	**97.8%**
Percentage of Wet Weather Flow Captured for Treatment	**73.1%**	**94.3%**	**96.0%**	**94.4%**	**93.2%**

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CHAPTER 1 – INTRODUCTION

1.1 OBJECTIVE

After submittal of the Lakewood Storm Water Management Model (SWMM) to the United States Environmental Protection Agency (USEPA), the City of Lakewood (City) began work to add pollutant loadings to the model. Pollutants added to the model include total suspended solids (TSS), carbonaceous biological oxygen demand (CBOD), total phosphorous (TP), and *Escherichia coli* (*E. coli*) bacteria. The objective of modeling pollutants is to characterize their concentrations in:

1. Untreated Overflows
2. Wastewater Treatment Plant (WWTP) influent on dry and wet days

This characterization will enable comparison of wet weather improvement alternatives to provide the most cost-effective improvement to the water quality of Lake Erie.

1.2 POLLUTANT SOURCES

SWMM has the following six methods to add pollutants to the hydrologic model:

1. Dry Weather Flow (DWF) – In the Lakewood hydrologic model, SWMM's DWF parameter was used to model daily input of normal sewage flow. Average concentrations of pollutants in sewage are input values for all DWF. The DWF flows are multiplied by these concentrations to calculate pollutant loadings into junction nodes.
2. Rainfall Dependent Infiltration and Inflow (RDII) – Average concentrations of pollutants in RDII are input values applied to all RDII. The RDII flows are multiplied by these concentrations to calculate pollutant loadings into junction nodes.
3. Subcatchment Runoff – Pollutants are deposited and accumulate on subcatchment land during dry weather. These pollutants are then washed off the land during wet weather. SWMM has four equations available to calculate buildup and three equations available to calculate washoff. These equations are developed for different land use types (i.e. residential, commercial, industrial, etc.). In the Lakewood pollutant model, subcatchment buildup/runoff parameters are calibrated using flow meter and sampling data for four types of land use:

    a. Low-Density Residential
    b. Medium-Density Residential
    c. High-Density Residential
    d. Commercial/Industrial

    A fifth type of land use, Open Space, uses 50% of the calibrated Medium Density Residential values.

4. Rainfall – Average concentrations of pollutants in rainfall are available in SWMM. If used, the rainfall volumes are multiplied by these values. In sewer studies, such concentrations are generally not significant compared to other sources. For the Lakewood model, rainfall pollutants were considered to be included in the Subcatchment Runoff and RDII values.
5. Direct Flow - In the Lakewood model, SWMM's Direct Flow parameter was used in the hydrologic model to represent dry weather infiltration of groundwater. Concentrations of pollutants in groundwater are generally not significant compared to sewage. For the Lakewood pollutant model, Direct Flow pollutants were considered to be included in the DWF values.
6. Groundwater – The use of Aquifers and Groundwater equations are an alternative method of modeling pipe joint infiltration in the hydrologic model. Average concentrations of pollutants in Groundwater are data input values. The Groundwater flows are multiplied by these values. For the Lakewood model, the Groundwater function was not used in lieu of Direct Flow. If it had been used, pollutant concentrations would be considered not significant compared to sewage, and therefore included in the sewage values.

This report details the development of the pollutant model using pollutants in sewage, RDII and subcatchment runoff.

1.3 ORGANIZATION OF THIS REPORT

Chapters 2 through 4 describe the analysis used to develop pollutant parameters. Chapter 2 analyzes DWF parameters. Chapter 3 analyzes RDII parameters. Chapter 4 analyzes Subcatchment buildup and washoff parameters.

Chapter 5 analyzes dry weather sewage flow. It describes the development of the diurnal sewage flow pattern, and it presents the results of sampling and testing for *E. coli.*

Chapter 6 analyzes a typical year of rainfall and calculates pollutant loadings to the WWTP. It also presents the quantity of pollutants discharged to NEORSD and to Lake Erie from Lakewood outfalls.

CHAPTER 2 – DRY WEATHER FLOW POLLUTANTS

2.1 INTRODUCTION

Dry weather flow has two components: sewage and groundwater. Sewage is highly polluted while groundwater is much cleaner. Sewage is composed of human waste and household wastes. It has high concentrations of the pollutants being modeled: CBOD, *E. coli*, TP and TSS. Groundwater originates with rainfall that soaks into pervious areas, and percolates down to the water table. Within the water table, the rainfall slowly flows laterally through the soil and into defective sewer pipes and manholes (sewer studies term this groundwater infiltration as opposed to the surface infiltration term used by hydrologists). As the rain water soaks into the ground, the soil filters out solids. As it travels through the soil, vegetation absorbs nutrients and biological action breaks down bacteria that were picked up on the surface. Usually, within twenty feet of the surface, the water is significantly cleaner. As a result of these actions, the groundwater that infiltrates into the sewers is much cleaner than the sewage portion of the dry weather flow. For the model, pollutant loadings are applied to the sewage portion of dry weather flow and include any pollutants that might be in groundwater.

On a year round basis, the daily flow rate of sewage is more consistent than groundwater. In the clay soils of Lakewood, the sewer trenches act as French drains and control the water table. In the spring, groundwater infiltration rates are higher as snow melt and spring rains raise the water table. In the summer and fall, the water table falls and flow rates decrease as vegetation and evaporation assimilate a significant portion of the rainfall. Groundwater flow rates vary seasonally; however, dry day pollutant loadings at the WWTP are fairly consistent from month to month. This consistency is another justification for assigning pollutants to sewage only.

For the Lakewood model, the groundwater and sewage are both hydraulically entered at junction nodes. Sewage is hydraulically entered using the “DWF” parameter. Groundwater is hydraulically entered using SWMM’s “Direct” parameter. Pollutants are introduced into the model as concentrations within DWF. These concentrations are calculated from the influent data as measured and reported by the WWTP.

2.2 SEWAGE FLOW CALCULATIONS

The portion of the WWTP flow attributable to sewage was calculated from water billing records. Monthly billed water consumption for the years from 1998 to 2010 was entered into a spreadsheet. Figure 2-1 is a graph of the average monthly water usage billings. The graph does not add non-billed water (i.e. fire stations and City Hall) and does not subtract normal water usage not returned to the sewer (i.e. cooking, home humidifiers, etc. – these tend to cancel each other out). There is a noticeable increase in summer months due to non-sewage generating water consumption (i.e. car and house washing, lawn and garden sprinkling, etc.). Excluding the extraordinary summer water demand, the average daily consumption for the 13 years was calculated to be 4.409 MGD. However, Lakewood has experienced a drop in water consumption. The reason for the drop in consumption is beyond the scope of this study;

however it may be due to rising water rates, water conservation practices, declining population, and/or economic impacts. Figure 2-2 is a graph of total yearly water billings (excluding the extraordinary summer water demand). An Excel trendline was applied to the values. The equation for the trendline was used to calculate a water consumption of 3.693 MGD for 2011. This 3.693 MGD value is comparable to the average daily consumption of 3.256 MGD billed from September 2010 to May 2011.

The model has some flow that is not tributary to the Lakewood WWTP. A portion of southwest Lakewood discharges to Northeast Ohio Regional Sewer District (NEORSD) near Riverside Drive @ Fischer Road. A portion of southeast Lakewood discharges to NEORSD at the intersection of Berea Road with West 117th Street. During wet weather, a third area on the east side of Lakewood discharges to NEORSD on West 117th Street near Edgewater Drive. These three locations discharge a total of 0.165 MGD of sewage to NEORSD. An additional flow of 0.060 MGD has been found as illicit connections to the sewers (since rectified). These flows are not tributary to the WWTP, and they reduce average daily influent flow to 3.031 MGD.

$$3.256 \text{ MGD} - (0.165 + 0.060) \text{ MGD} = 3.031 \text{ MGD}$$

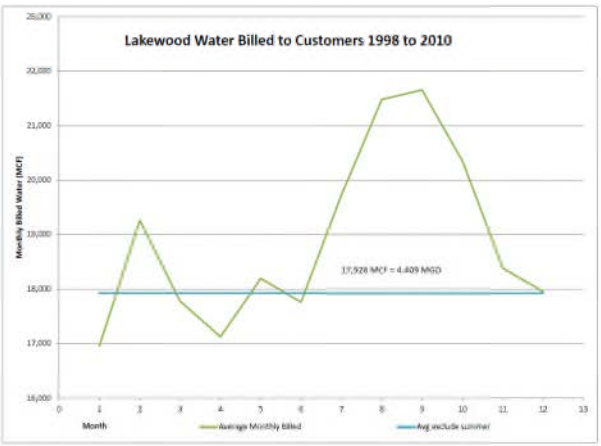


Figure 2-1 Average Monthly Water Usage Billed (MCF – 1,000 cubic feet)

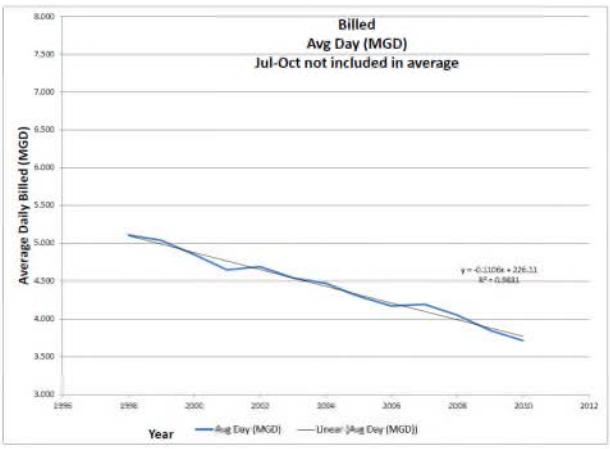


Figure 2-2 Yearly Water Billings (MGD – million gallons per day)

2.3 SEWAGE LOADINGS – CBOD, TP AND TSS

Daily wastewater treatment plant (WWTP) influent concentrations of CBOD, TP and TSS were entered into a spreadsheet from data reported in the monthly DMRs. The data for years 2010 to 2014 were input. All the days had flow and rainfall data. The WWTP generally measured concentrations of TSS five days a week, CBOD four days a week and TP two days a week. These influent flows and concentrations were used to calculate the daily influent loadings within the spreadsheet.

The data was sorted from lowest to highest flow to determine dry and wet day conditions.

- Dry day flow is composed of sewage and groundwater with all the pollutants coming from the sewage. A review of the rain and flow data indicated that flows rose after rainfall and sometimes stayed elevated on following days. Flows were also elevated in winter and spring due to snow melt. After removing days with rainfall and the subsequent wet days, the spreadsheet data was sorted by flow and examined to determine a flow that could confidently be considered as dry weather. After excluding possible snow melt values that occurred in winter months, the examination found that non-rain affected flows were generally less than 5.7 MGD. As a result, spreadsheet data were classified as dry day values when the total flow was 5.7 MGD or less.

- Wet day flow is composed of sewage, groundwater and rainfall dependent infiltration and inflow (RDII). Since rainfall is needed to wash off pollutants into RDII, the daily values were classified as wet days when rainfall was recorded.

- Days with greater than 5.7 MG but no rainfall were classified as in-between days and not used for dry weather pollutant concentrations.

Pollutant loadings were calculated for the dry days that were sampled. The spreadsheet totaled the loadings for the five years of DMR data and counted the number of days that were tested. Sewage concentrations were calculated as the total loadings divided by the total volume of sewage flow. With parts per million (ppm) being equivalent to milligrams per liter (mg/l), the general form of the equation is:

(Total lbs / (8.34 lb/gal)) / (3.031 MG/day x number of days sampled) = concentration (mg/l)

The average concentrations of these pollutants in Lakewood sewage are shown in Table 2-1.

2.4 SEWAGE CONCENTRATIONS – *E. COLI*

E. coli is not sampled in the influent flow to the WWTP. The *E. coli* concentration shown in Table 2-1 is based on concentrations calculated in Appendix B – Sampler E.

Table 2-1
City of Lakewood
Yearly WWTP Influent Sewage Loads and Concentrations on Dry Days, 2010-2014

Pollutant	CBOD	*E. coli*	TP	TSS
Pollutant Concentration Calculations				
Total loading (lbs)	2,028,004	n/a	40,808	3,880,474
Number of days sampled	454	n/a	240	589
Sewage volume (MG)	1376	n/a	727	1785
Sewage concentration (mg or cfu)/l	177	4.43×10^8	6.73	261

2.5 YEARLY SEWAGE POLLUTANT LOADINGS

The sewage concentrations of pollutants were used to calculate total yearly loadings from sewage. These yearly pollutant loadings to the WWTP are based on the current 3.031 MGD of sewage reaching the WWTP. The general form of the yearly loading equation is as follows:

(3.031 MG/day) x (365 days/year) x (concentration mg/l) x (8.34 lb/gal) = Total lbs/year

These yearly loadings in Lakewood sewage are shown in Table 2-2. The yearly *E. coli* loading is also based calculations in Appendix B – Sampler E.

Table 2-2
City of Lakewood
Yearly WWTP Influent Sewage Loadings

Pollutant	CBOD	*E. coli*	TP	TSS
	(lbs)	(cfu)	(lbs)	(lbs)
Yearly sewage loading (lbs or cfu)	1,630,000	1.09×10^{18}	62,100	2,405,000

The values in Table 2-2 are less than the total typical year values shown in the Executive Summary because they are only the sewage portion of the total yearly loadings.

CHAPTER 3 – RAINFALL DEPENDENT INFILTRATION AND INFLOW POLLUTANTS

3.1 INTRODUCTION

Rainfall Dependent Infiltration and Inflow (RDII) is flow that quickly enters a sewer collection system when rainfall occurs. In areas with older sewers, RDII may infiltrate into defective sewer joints. Roof downspouts are modeled as RDII if they are directly connected to the sewer. In the Lakewood SWMM model, the RDII flow is introduced into the sewer at junction nodes. Hydraulically, RDII is introduced as an additional equation separate from Direct Flow and DWF. The RDII represents runoff from roofs and leaking joints that are directly or indirectly connected to the sewer.

Since RDII is associated with runoff, it picks up pollutants as it flows down the roofs. These pollutants are introduced into the SWMM model as average concentrations in RDII. These average concentrations are applied to the RDII throughout the runoff period. Pollutant concentrations are applied to all RDII sources regardless of the type of land use. The values for RDII concentrations are calculated from WWTP DMRs and flow sampling.

3.2 CBOD, TP AND TSS

The same five years (2010 to 2014) of Lakewood WWTP DMRs were analyzed to determine the values of CBOD, TP and TSS in the wastewater on wet days. The wet days were considered to be any day with rainfall. Influent pollutant loadings were calculated using influent flows and concentrations. The RDII pollutant loadings were the net increase in the pollutant loadings after subtracting the portion that comes from sewage. The RDII concentrations are calculated by dividing this net increase in pollutant loading by the net increase in flow volume and then converting to milligrams per liter (mg/l). The general equation for calculating the concentrations is as follows:

$$\text{concentration} = \frac{(\text{Total Wet Weather Pounds} - \text{Pounds of Dry Weather Portion}) \div 8.34\ \text{lb/gal}}{\text{Total wet weather flow (MG)} - \text{Dry Weather Flow Portion (MG)}}$$

The concentration units in the above equation are gallons per million gallons (gal/MG) which is equivalent to parts per million (ppm) or milligrams per liter (mg/l).

Because of the different frequencies of influent pollutant sampling, the number of wet days had to be counted separately for each pollutant to calculate the associated DWF pounds and DWF volume. Table 3-1 lists the wet day volumes and loadings for the five years of DMR data.

Table 3-1
Lakewood Wet Day Influent Pollutants

	CBOD			TP			TSS		
Year	Wet Day Load (lbs)	Wet Day Flow (MG)	Num-ber of Wet Days	Wet Day Load (lbs)	Wet Day Flow (MG)	Num-ber of Wet Days	Wet Day Load (lbs)	Wet Day Flow (MG)	Num-ber of Wet Days
2010	390,477	760	78	8,251	469	43	710,468	949	95
2011	523,538	1,429	88	9,256	716	43	1,152,581	1,733	110
2012	322,216	765	65	6,680	431	37	774,028	966	85
2013	360,255	779	66	6,879	387	35	756,916	949	82
2014	508,883	870	86	10,743	467	44	851,604	1,033	104
Total	2,105,369	4,603	383	41,809	2,470	202	4,245,597	5,630	476
DWF	1,710,849	1,161		34,347	612		3,136,003	1,443	
Net	394,520	3,442		7,462	1,858		1,109,594	4,187	
Concentration(mg/l)		**13.7**			**0.48**			**31.8**	

3.3 *E. COLI*

The concentration of *E. coli* in runoff from medium density residential land (see Appendix B – Sampler D) is used for *E. coli* in RDII. The Sampler D flow weighted average value of 4.53×10^5 cfu per 100 ml is used for the SWMM RDII input value 4.53×10^6 cfu/liter.

3.4 COMPARISON TO NSQD VALUES

The calculated pollutant concentrations were compared to average values in the University of Alabama's National Stormwater Quality Database (NSQD), Version 4.02, (March 17, 2015). The NSQD average BOD5 value for stormwater is 12 mg/l. Other studies have found that BOD values average 16% higher than CBOD values. The CBOD value in the model is 32% higher (13.7*1.16÷12-*100=32%) compared to NSQD. The *E. coli* value of 453,000 cfu/100ml is 56 times higher than the NSQD average of 8,033 cfu/100ml. The higher *E. coli* concentration may be due to higher density housing and associated higher pet waste buildup as compared to the NSQD study. Since similar high *E. coli* concentrations were measured in the other sampled locations, its value was considered appropriate. The Total Phosphorous concentration of 0.48 mg/l is comparable compared to the NSQD average Total Phosphorous concentration for stormwater of 0.42 mg/l. The TSS concentration of 31.8 mg/l is significantly lower compared to the NSQD TSS concentration for stormwater of 134 mg/l. Although there are differences between NSQD and RDII calculated values, the calculated concentrations were used in the SWMM model as initial values when calibrating the model to a typical year of rainfall.

CHAPTER 4 – SUBCATCHMENT RUNOFF POLLUTANTS

4.1 INTRODUCTION

In SWMM, surface water is modeled as runoff from pervious and impervious surfaces within a defined area known as a subcatchment. Hydrologic flow rates are calculated and merged together in the hydraulic model of the collection system. The input parameters used to calculate the volume of runoff do not consider the pollutants on the surface of the land

As water runs off the surfaces in the subcatchment, it picks up pollutants. Different land uses have different amounts of pollutants building up on the ground between storms. For example, a fast food parking lot collects CBOD (from food litter) and bacteria (from scavenger birds) but little TSS from disturbed ground. Residential properties have TSS from ground disturbing activities and bacteria from pet waste. SWMM allows for different pollutant buildup rates depending on the land use. When it rains these pollutants are washed off into the sewer system and flow to the WWTP. SWMM allows for different washoff rates depending on the land use and type of pollutant.

This chapter details the development of the pollutant buildup and washoff equations for the Lakewood SWMM model. Flow meters and samplers were used to measure the runoff rates and pollutant concentrations in the sewers from four subcatchments which represented different land uses. Washoff loadings were calculated from the flow data and pollutant analysis of the samples. Buildup and washoff equations were chosen from SWMM's available options. Finally, a trial and error method was used to develop the appropriate coefficients to use in the buildup and washoff equations.

4.2 LAND USE CALCULATIONS

Lakewood's pollutants are modeled in the following five types of land use (% is of total land in the Lakewood SWMM model).

1. 20% Low-density residential – Single and two-family residential properties with land area greater than ¼ acre in size.
2. 60% Medium-density residential – Single and two-family residential properties with land area less than ¼ acre in size.
3. 5 % High-density residential – Properties classified as apartments.
4. 10% Commercial/Industrial – Properties with large impervious areas. In addition to commercially and industrially used properties, this group also includes properties listed as institutional (municipal, schools and churches), highway, and active recreation areas.
5. 5% Open Space – Properties with large pervious areas. This group includes the following types of land uses broken down by percentage of total open space
    a. passive green space 78%
    b. railroads 13%
    c. utility 9%

Several subcatchments outside Lakewood were included for the hydraulic portion of the model only. These subcatchments are tributary to NEORSD's Northwest Interceptor sewer which carries some of the pollutants from the three connection points described in Section 2.2. No pollutants are calculated for the non-Lakewood flow into the interceptor.

For each Lakewood subcatchment in the model, a percentage was calculated for each type of land use. The Cuyahoga County Auditor's database of Lakewood properties was downloaded and sorted by land use. For one and two family residential properties, the data was further sorted by lot size. Several lot sizes were examined to determine a break point between low-density and medium-density residential land. A break point of ¼ acre resulted in 75% of the residential land being medium-density and the remaining 25% being low-density. GIS was used to assign the properties to their respective land use designations. Thiessen polygon capability was used to extend the property lines to the center of the street. The revised acreages were totaled for each type of land use within each subcatchment. Appendix A is a summary table with the acreage of each subcatchment and the percentage of each land use type within the subcatchment. The final step was to enter the fractional value of each type of land use into the model.

4.3 SUBCATCHMENT RUNOFF MEASUREMENTS

Five flow meter/samplers were used to collect pollutant loadings from the different land uses. The samplers were configured to take up to eight discrete samples when activated by a flow depth sensor. The flow meters measured the flow in the sewers and also recorded the time each sample was taken. The meter/ samplers were in the sewers from July 17, 2015 to September 30, 2015.

4.3.1 SAMPLER AND FLOW METER LOCATIONS

Aerial photographs and local knowledge were used to select representative subcatchments for four different land uses. The Lakewood sewer maps were then used to refine the selection to choose areas that had a good meter/sampling locations carrying the runoff out of the subcatchments. A fifth meter was placed in a sewer to collect sewage samples from a medium-density residential area to develop a diurnal flow pattern and to measure *E. coli* concentrations in sewage. The locations chosen for the meter/samplers are shown in the following aerial photos (Figures 4-1 to 4-5).

Figure 4-1	Land Use Description	Diameter (inches)	Model ID	Location
Site A	Low-density Residential	30	002T3741	Lake, west of intersection with Clifton & Forest

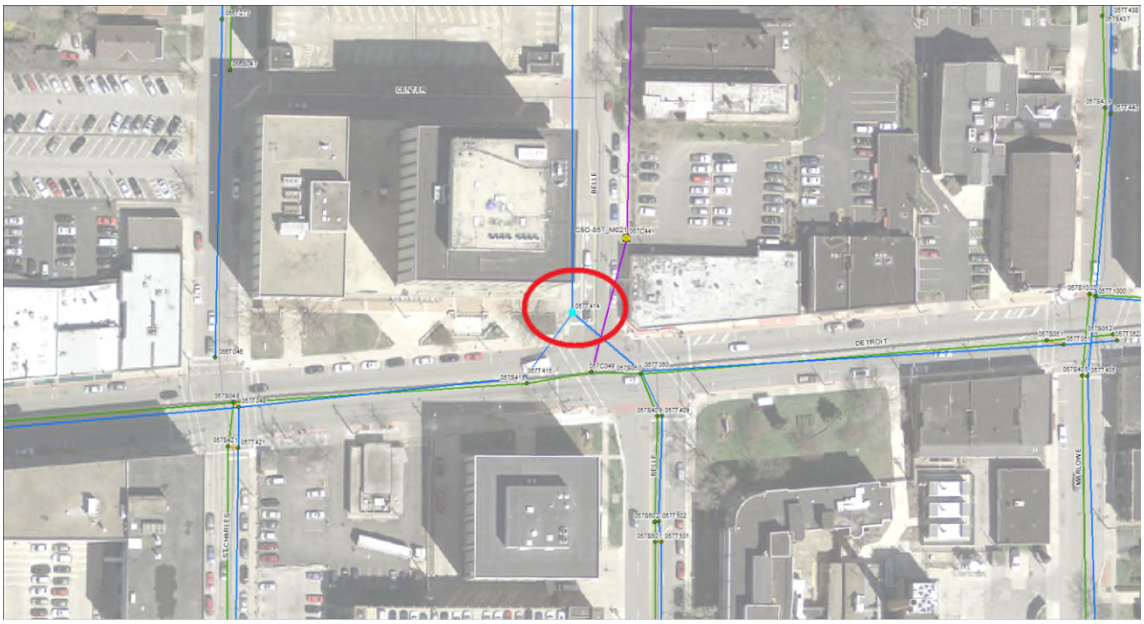


Figure 4-2	Land Use Description	Diameter (inches)	Model ID	Location
Site B	Commercial	60	057T414	Intersection of Detroit & Belle

Figure 4-3	Land Use Description	Diameter (inches)	Model ID	Location
Site C	High-density Residential	48	059T4120	Edgewater, west of W.117th St.

Figure 4-4	Land Use Description	Diameter (inches)	Model ID	Location
Site D	Medium-density Residential	36	052T074	Hilliard & Eldred

Figure 4-5	Land Use Description	Size (inches)	Model ID	Location
Site E	Medium-density Residential	10	052S075	Hilliard & Eldred

The flow meters associated with the samplers recorded flow rates which were used to calculate pollutant loadings. The flow rates were calculated as area of flow (based on depth) times the velocity of flow (using ultrasonic Doppler technology). CT performed a QA/QC analysis of the flow data (described below) prior to calculating pollutant loadings.

4.3.2 QA/QC OF DEPTH READINGS

There are several potential problems with depth readings. First, depth sensors sometimes send an anomalous value to memory (i.e. a single 5-minute reading that jumps from normal depth to a very high value then back to normal depth). These depths are replaced with the average of the before and after readings. Second, the sensor may experience hysteresis (where after a rain event the normal depth is consistently higher or lower). These depth values are adjusted by a constant value that adjusts the post event water levels to prior values. Third, the depth sensors can experience drift (where the normal levels slowly increase or decrease from actual values). These depth values are adjusted by applying a uniformly increasing or decreasing value that is based on observed actual depths during site visits. After correcting the meter depth values, the data is ready for the velocity QA/QC procedures.

4.3.3 QA/QC OF VELOCITY READINGS

There are several potential problems with velocity readings in sewers. First, velocity sensors do not always record a velocity due to the relative clearness of the water (not enough particles to reflect back an ultrasonic signal). Second, the turbulence of the flow sometimes causes the velocity sensors to record a negative value. Third, at low depths, the velocity sensor does not pick up an accurate value. Fourth, in any large set of depth-velocity data points there are some velocity values outside the normal range (outliers). Fifth, the velocity sensor is sometimes blinded by debris. These problems are fixed by the QA/QC analysis described below.

The QA/QC of velocity uses an Excel spreadsheet to correct velocity problems. First, the raw date/time, adjusted depth, raw velocity and raw flow data are entered into the spreadsheet. The data is then sorted by depth to capture all readings where there was flow in the sewer. Zero depth readings that have a velocity are temporarily set aside. Depth readings that have negative velocities are also temporarily set aside. Readings that have depth and velocity are placed in an Excel scattergraph. A preliminary polynomial equation is fit to these points using the Excel trendline function and forcing a 0,0 intercept. Outlier readings are removed from the dataset as are the many readings with very low depths or velocities. Outliers were determined by visually inspecting the plotted data and removing extremes, defined as data points that were more than 50% off the trendline. A final scattergraph and third order trendline is prepared from the remaining points in the dataset. The equation for the trendline is then used to calculate velocities for depth data that did not have a velocity. Points with negative velocities are examined relative to the context of other data points at that time. If the negative velocity appears to be an anomaly, the equation is used to calculate a positive value. Finally, the equation is reversed to calculate depths for data points that have a velocity and no depth.

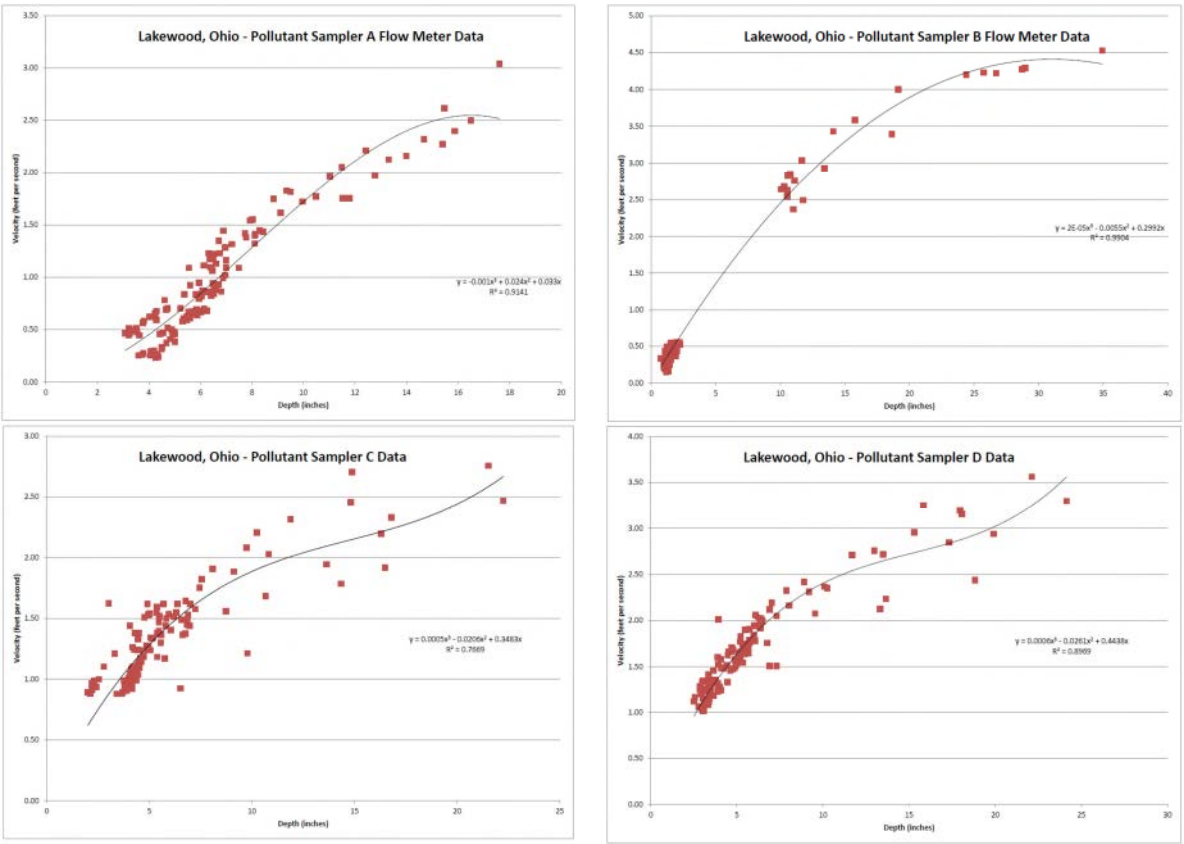
Table 4-1 is a summary of the number of data points taken by the flow meters at the sampler locations.

Table 4-1
Lakewood Samplers – Categories of Flow Meter Data

Sampler with Flow Meter	Number of Readings				
	Depth with Zero Velocity	Velocity with Zero Depth	Depth with Negative Velocities	Readings used for Preliminary Scattergraph	Readings used for Final Scattergraph
A	2143	0	10	258	143
B	1893	0	0	295	118
C	3963	1	16	771	226
D	256	0	71	205	125
E	504	11	2	821	9

4.3.4 TRENDLINE EQUATIONS

The scattergraphs for Samplers A through D are shown below:



The trendline equations for velocity based on depth in the above scattergraphs are:

Meter A - Velocity = - 0.00100 depth^3 + 0.0240 depth^2 + 0.0330 depth
Meter B - Velocity = + 0.00002 depth^3 – 0.0055 depth^2 + 0.2992 depth
Meter C - Velocity = + 0.00050 depth^3 – 0.0206 depth^2 + 0.3483 depth
Meter D - Velocity = + 0.00060 depth^3 – 0.0261 depth^2 + 0.4438 depth
Meter E - Insufficient number of points to confidently prepare a trendline

The above equations were used to calculate velocities for the zero values and the temporarily ignored readings.

4.4 SWMM CHANGES FOR POLLUTANT CALIBRATION

Several changes were made to simplify the SWMM model and decrease run times for pollutant calibration.

1. Prepared rainfall and climate files for sampling time period. Downloaded rainfall data in 5-minute increments to better model short duration high intensity periods of rainfall.

2. Ran the model for the sampling time period and downloaded flow and depth time series for the manholes downstream of the samplers. Converted the manholes downstream of the sampler locations to outfalls and applied the time series to the outfall to match flow depths to the full model.
3. Stripped out subcatchments, conduits, outfalls and nodes not contributing to a flow meter.
4. Ran the stripped down model for the time period. This reduced the runtime from 3 hours to 75 seconds.
5. Converted link 057T547_057T547A from a vortex valve to a 12-inch orifice. This decreased the flow routing continuity error from -52% to -0.03%.

Additional changes were made to the subcatchments tributary to the sampler/meters. These changes and additional notes specific to the sampled areas are described in the following subsections. The parameter names as used by SWMM are shown in italics.

4.4.1 METER SITE A

Initially, Site A runoff volume in SWMM was 30% of the metered volume. This was due to some subcatchment settings which reduced the runoff to the sewers. To better compare SWMM pollutant loadings to metered and sampled loadings, the following adjustments were made to the subcatchment data:

1. Doubled the subcatchment width to cut the flow path length in half. This better models a subcatchment with a street in the middle and runoff coming in from both sides.
2. *% Routed* (to pervious) decreased from 50% to 30% (this is a reduction in the amount of sidewalks, patios, driveways, etc.) that drain onto grassy areas.
3. *% Zero Impervious* increased from 50% to 80% (this is the percentage that does not have puddles after the rain event).
4. Moved the outlet of subcatchment S002T3741 from 002T3741 to 002T3740 to include its runoff with the sample/metered data.

4.4.2 METER SITE B

Site B is a mixture of commercial and medium density residential subcatchments. There are five commercial subcatchments, three mixed commercial/medium-density residential, and six medium-density residential subcatchments tributary to the sampler/meter. Site D was calibrated first and its buildup and washoff parameters used for the residential portions of the subcatchments. The remaining pollutant loadings were then used to develop the commercial parameter values.

Initially, Site B had more runoff in SWMM compared to the metered data. The model had a high percentage of the commercial area connected to the sewer as RDII. The commercial subcatchments also had the impervious area with a high percentage flowing onto pervious land. Changes to the model include:

1. For the commercial subcatchments:
   a. Changed the rain gauge for subcatchments S057T047 and S057T048 from RG_Lincoln to RG_Fire_1. This is the rain gauge for all the other subcatchments in area B.
   b. Changed the *% Routed* from pervious to *Outlet*. This directs impervious runoff directly into the sewer instead of onto grass.
   c. Doubled the ground slope to create steeper rising and falling hydrograph limbs.
2. For the medium density subcatchments:
   a. Decreased *% Impervious* of each subcatchment by 7%.
   b. Doubled the ground slope to create steeper rising and falling hydrograph limbs.

4.4.3 METER SITE C

Initially, Site C had no runoff in SWMM for any rainfall less than 1-year storm. Consequently, there was no runoff in the model during the metering/sampling period. Since the flow meter measured wet weather flow increases, subcatchment parameter changes were made to the model. These changes include:

1. *% Impervious* increased from 40% to 60% to reflect more parking area and the high density large buildings.
2. *% Zero Impervious* increased from 25% to 50% to reflect fewer puddles on roofs and parking areas
3. *D Store Impervious* (the depth of puddles in impervious areas) decreased from 0.137 inches to 0.070 inches to reflect shallower puddles.
4. *% Routed* (flow routed from impervious area to pervious area) decreased from 100% to 25% to reflect drainage systems for the parking areas and roofs.

4.4.4 METER SITE D

Initially, Site D had more runoff in SWMM compared to the metered data. The model had an average 23% of the impervious area connected to the sewer as RDII. This would include mostly roofs and other sources that do not flow onto pervious areas. The remaining impervious area needed to have a higher percentage flowing onto pervious land. Changes to the model include:

1. Decreased *% Impervious* from 70% to 37%
2. Increase *% Routed* (impervious to pervious) from 20% to 50%
3. Increased *% Impervious* with no storage from 55% to 75%

4.5 POLLUTANT BUILDUP AND WASHOFF IN SUBCATCHMENTS

Pollutants accumulate on the ground until rainfall washes them off and into the collection system. In the Lakewood SWMM model, the buildup accumulations are measured in pounds per acre, and washoff is also calculated in pounds per acre but then converted to a concentration in the runoff. Development of buildup and washoff equations is detailed in the following sections.

4.5.1 POLLUTANT BUILDUP EQUATION

Four options are available in SWMM to model pollutant buildup[1]. One option would use a time series if actual buildup data were available. This option was eliminated because there were no measurements available of buildup over time for the four types of land use. Three other options are buildup equations that are graphed in Figures 4-6 to 4-8.

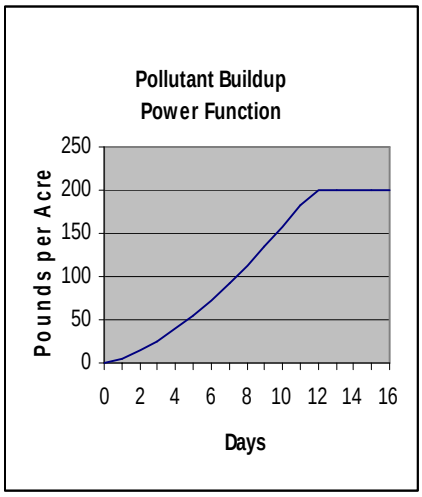


Figure 4-6 Power Function

Power Function - pollutants build up slowly at first, then more rapidly after a few days to a maximum value.

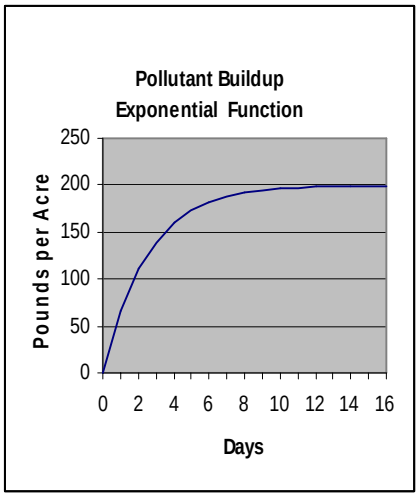


Figure 4-7 Exponential Function

Exponential Function – pollutants build up very rapidly in the first few days, then the buildup slows down to a maximum value

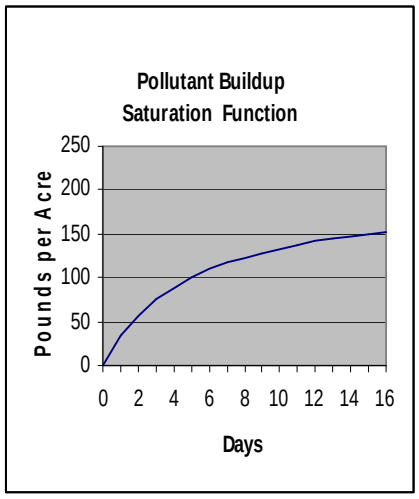


Figure 4-8 Saturation Function

Saturation Function –pollutant buildup is initially more rapid, then it tapers as the quantity approaches a maximum value.

All three equations were evaluated for each pollutant in the model. In Lakewood's residential areas, the pollutants accumulate from wildlife deposits, pet deposits, residential activity (lawn cutting and gardening), construction activity, and windblown dust and debris. Eventually, residents will take action to reduce the amount of pollutants on their property, thus there should be a maximum value. The buildup is fairly steady, and the saturation function was chosen to represent buildup of the pollutants in the model.

In the SWMM manual, the general form of the saturation equation is:

$$\text{Buildup (lbs per acre)} = C1 \text{ (lbs per acre)} * \text{Days} / (C2 + \text{Days})$$

[1] Lewis A. Rossman, Storm Water Management Model, User's Manual Version 5.1 - Hydrology, EPA/600/R-14/413b, US EPA Office of Research and Development, (September 2015), pp. 65-66.

The constant C1 is the maximum possible buildup and C2 is the number of days to reach half the value. Initial maximum values were calculated from the quantity of pollutants washed off and sampled. The number of days to half saturation was determined by trial and error in conjunction with development of the washoff equation.

4.5.2 POLLUTANT WASHOFF EQUATION

Rainfall washes the remaining pollutants off the ground and into the collection system. The SWMM manual provides three (3) equations[2] to model rain induced pollutant washoff. All three algorithms will track the quantity of pollutants washed off until no more are remaining on the ground.

1. Event Mean Concentration - washoff is proportional to runoff. The concentration of pollutants in the washoff does not change. The sampling data does not support this method. First flush (high concentrations) were observed in the data set.
2. Rating Curve - washoff is proportional to runoff raised to a power. A more intense rain will wash pollutants off faster. This equation does not account for the quantity of pollutants on the ground.
3. Exponential – washoff is proportional to the product of runoff raised to a power and to the amount of buildup remaining. Not only will a more intense rain wash pollutants off faster, but if there are more pollutants on the ground, there will be more in the washoff. This equation was selected as intuitively being more representative of the actual washoff process.

In the SWMM manual, the form of the exponential washoff equation is

$$\text{Washoff} = C1 * \text{runoff rate (inches/hour)}^{C2} * \text{pollutant buildup (lbs)}$$

The C1 and C2 constants in this equation are different from those in the buildup equation. By trial and error and in conjunction with the buildup equations, the final values for these C1 and C2 constants were determined for the four pollutants (refer to Table 4-3).

4.5.3 STREET SWEEPING

SWMM uses street sweeping to remove pollutants once they are on the ground. SWMM's street sweeping routine removes a portion of these pollutants based on the frequency and extent of the sweeping (SWMM parameter names are shown in italics). Lakewood generally sweeps the main arterials every two weeks and residential streets every four weeks (the line labeled *Interval* in Table 4-2). The commercial and high-density land uses are generally located on arterial streets, and low-density and medium-density housing are mostly located on the residential streets. The sweeping season runs from late spring after the snow season until fall when the city switches to leaf pickup.

[2] Lewis A. Rossman, Storm Water Management Model, User's Manual Version 5.1 - Hydrology, EPA/600/R-14/413b, US EPA Office of Research and Development, (September 2015), pp. 66-67.

Lakewood had 500 cubic yards of sweepings in 2013 and 750 cubic yards in 2014. At 1.3 tons per cubic yard of sweepings[3], the weights for the two years are 650 and 975 tons respectively. Based on an average moisture content of 11%,[4] and converting from tons to pounds, the dry weight of the sweepings is 1,160,000 and 1,740,000 pounds in 2013 and 2014 respectively. These values will be compared to SWMM calculated values in the output report file for a typical year.

The following calculations determined street sweeping parameters for the four land uses in the Lakewood SWMM model pollutant calibration areas. The length of the streets multiplied by their width is the acreage available to sweepers. This acreage divided by the total subcatchments acreage is the fraction available to sweepers (the line labeled *Availability* in Table 4-2). Sweeping was set to be 90% effective (the line labeled *Cleaning Effic.* in Table 4-2) in removing the buildup of pollutants from the *Availability* area. Table 4-2 lists the data used to calculate the street sweeping parameters. The area tributary to Sampler B is a mixture of commercial and residential properties – for the Table 4-2 commercial land use column, only the commercial properties were used for the calculations.

Table 4-2
City of Lakewood
SWMM Street Sweeping Data

	Low-Density Residential	Commercial	High-Density Residential	Medium-Density Residential
Sweeping Season	4/15 to 10/15	4/15 to 10/15	4/15 to 10/15	4/15 to 10/15
Interval (days)	28	14	14	28
Meter/Sampler ID	A	B	C	D
Total area (acres)	25.78	23.97	30.1	44.56
Street area (acres)	3.02	4.13	1.81	3.96
Availability	0.12	0.18	0.06	0.09
Cleaning Effic.	90%	90%	90%	90%

With these parameters, SWMM calculated 1,200 pounds of pollutants being removed by street sweeping in the typical year analysis. This poundage is less than the total reported by Lakewood because their sweepings include gross solids (litter and other solid waste) that are not included in the model. Because this SWMM calculated value is less than the City's historical experience, the 90% efficiency of sweeping was not changed.

[3] University of Massachusetts, Boston, *Case study: Saving Money through Alternative Disposal of Street Sweeping Debris, Town of Natick, Massachusetts, (June 2, 2019),* http://www.umb.edu/editor_uploads/images/centers_institutes/center_collins_mgmt/Casestudy-StreetSweepingDebrisManagement.06.02.09.pdf

[4] Sukalyan Sengupta, et.al., *Processing and Reuse of Street Sweepings and Catch Basin Cleanings*, University of Massachusetts, Dartmouth, Street Sweeping (On Site), (July 9, 2007), http://www.trb-adc60.org/downloads/S.%20Sengupta%20_%20K.%20Leach.pdf

4.6 CALIBRATING BUILDUP AND WASHOFF COEFFICIENTS

The previous sections detail the process of developing the buildup and runoff equations. The equations for pollutants in subcatchment runoff were calibrated by graphing the SWMM pollutant loadings with the measured loadings from the sampling data. The final coefficient values are presented in Table 4-3 and the calibration graphs are in Appendix C. The acreage listed in Table 4-3 is the percentage of land that can be swept (streets) from Table 4-2.

Table 4-3
SWMM Buildup and Washoff Coefficients

	CBOD	*E. coli*	TP	TSS
Area A – Low-density Residential: Sweep 28 days, 90% efficiency, 12% of the acreage				
Buildup Equation	Saturation	Saturation	Saturation	Saturation
Max per acre – C1	3.25	6.9×10^{11}	0.13	26
Days to ½ - C2	10	10	14	10
Washoff Equation	Exponential	Exponential	Exponential	Exponential
Coefficient – C1	6	10	5	5
Exponent – C2	0.5	0.5	0.5	0.5
Area B – Commercial/Industrial: Sweep 14 days, 90% efficiency, 18% of the acreage				
Buildup Equation	Saturation	Saturation	Saturation	Saturation
Max per acre – C1	6.10	1.4×10^{12}	0.15	13.7
Days to ½ - C2	10	6	14	10
Washoff Equation	Exponential	Exponential	Exponential	Exponential
Coefficient – C1	6	10	5	5
Exponent – C2	0.5	0.5	0.5	0.5
Area C – High-density Residential: Sweep 14 days, 90% efficiency, 6% of the acreage				
Buildup Equation	Saturation	Saturation	Saturation	Saturation
Max per acre – C1	0.79	1.41×10^{11}	0.051	15.1
Days to ½ - C2	10	10	14	10
Washoff Equation	Exponential	Exponential	Exponential	Exponential
Coefficient – C1	6	10	5	5
Exponent – C2	0.5	0.5	0.5	0.5
Area D – Medium-density Residential: Sweep 28 day, 90% efficiency, 9% of the acreage				
Buildup Equation	Saturation	Saturation	Saturation	Saturation
Max per acre – C1	0.70	2.5×10^{10}	0.03	9.6
Days to ½ - C2	10	10	14	10
Washoff Equation	Exponential	Exponential	Exponential	Exponential
Coefficient – C1	6	10	5	7
Exponent – C2	0.5	0.5	0.5	0.5

The additional land use type, Open Space, did not have calibrated buildup and washoff equations. No sampling was performed to calibrate Open Space pollutant equations – ½ the Medium-density Residential values were used to provide for surface pollution from wildlife and passive recreation.

Table 4-3 (Continued)
SWMM Buildup and Washoff Coefficients

	CBOD	*E. coli*	TP	TSS
Open Space: Sweep 0 days, 0% efficiency, 0% of the acreage				
Buildup Equation	Saturation	Saturation	Saturation	Saturation
Max per acre – C1	0.35	1.25×10^{10}	0.015	4.8
Days to ½ - C2	10	10	14	10
Washoff Equation	Exponential	Exponential	Exponential	Exponential
Coefficient – C1	6	10	5	5
Exponent – C2	0.5	0.5	0.5	0.5

CHAPTER 5 – SEWAGE FLOW ANALYSIS

5.1 INTRODUCTION

Meter Site E was a sewage sampling and metering site. The metering and sampling at this location had two purposes:

1. Measure *E. coli* concentrations in the incoming residential sewage.
2. Establish a diurnal flow pattern for dry days.

This chapter details the analysis of the flow metering and sampling data.

5.2 *E. COLI* CONCENTRATIONS

Sampler E was used to measure the dry weather pollutant concentrations in sewage. These samples were important to acquire data because *E. coli* is not a tested WWTP influent parameter. The sampler was programmed to collect discrete samples at 1 to 2 hour intervals. The 1-hour intervals were set for the higher flow periods of morning and evening, and the 2-hour interval for the middle of the day and middle of the night. The sampler was installed at 10:15 a.m. on July 27, 2015. Lakewood sewer crew collected the samples at 10:15AM on July 28, 2015 and delivered them to an outside laboratory for analysis. Seventeen samples were drawn into separate bottles. Middle of the night sample numbers 11, 12, and 13 all had minimal amounts of water, so they were combined and labeled as E11.

The fifteen samples were cultured and *E. coli* colonies counted. The *E. coli* values were placed in a spreadsheet and averaged three ways. The results are as follows:

1. 3.51×10^7 cfu/deciliter – a straight average of the 15 values.
2. 3.66×10^7 cfu/deciliter – a weighted average wherein the concentration was multiplied by the flow rate at that time with the sum divided by the total flow.
3. 2.6×10^7 cfu/deciliter - the geometric mean of the 15 values.

Although the EPA uses a geometric mean for water quality monitoring at public beaches, the weighted average was used for the SWMM model as being more conservative. This weighted average was divided by the sewage fraction of the total flow (82.7%) to calculate the SWMM input value of 4.43×10^8 cfu/l.

The average daily sewage flow of 3.031 MGD was multiplied by the concentration and conversion factors to calculate a total yearly cfu loading currently reaching the WWTP in the sewage portion of the influent. The concentration and yearly loading are shown in Table 2-2.

5.3 DIURNAL FLOW PATTERN

As shown in Table 4-1, the flow meter did not work well during the original metering period in July through September (only 9 readings were available for the final scattergraph). The location was metered again from October 13, 2015 to October 20, 2015 to obtain sewage flow data on dry days. Two dry days, October 17 and October 18 were graphed in the spreadsheet, and shown as Figure 5-1. The metered depths and velocities are shown as the two jagged lines on the upper and lower portion of the graph. Smoother lines were made for depth, velocity and flow by calculating a 35-minute moving average of the metered values. This graph shows a classic diurnal sewage flow pattern. This data was used to create the diurnal hourly flow pattern for sewage in the SWMM pollutant calibration model for Meter Site E.

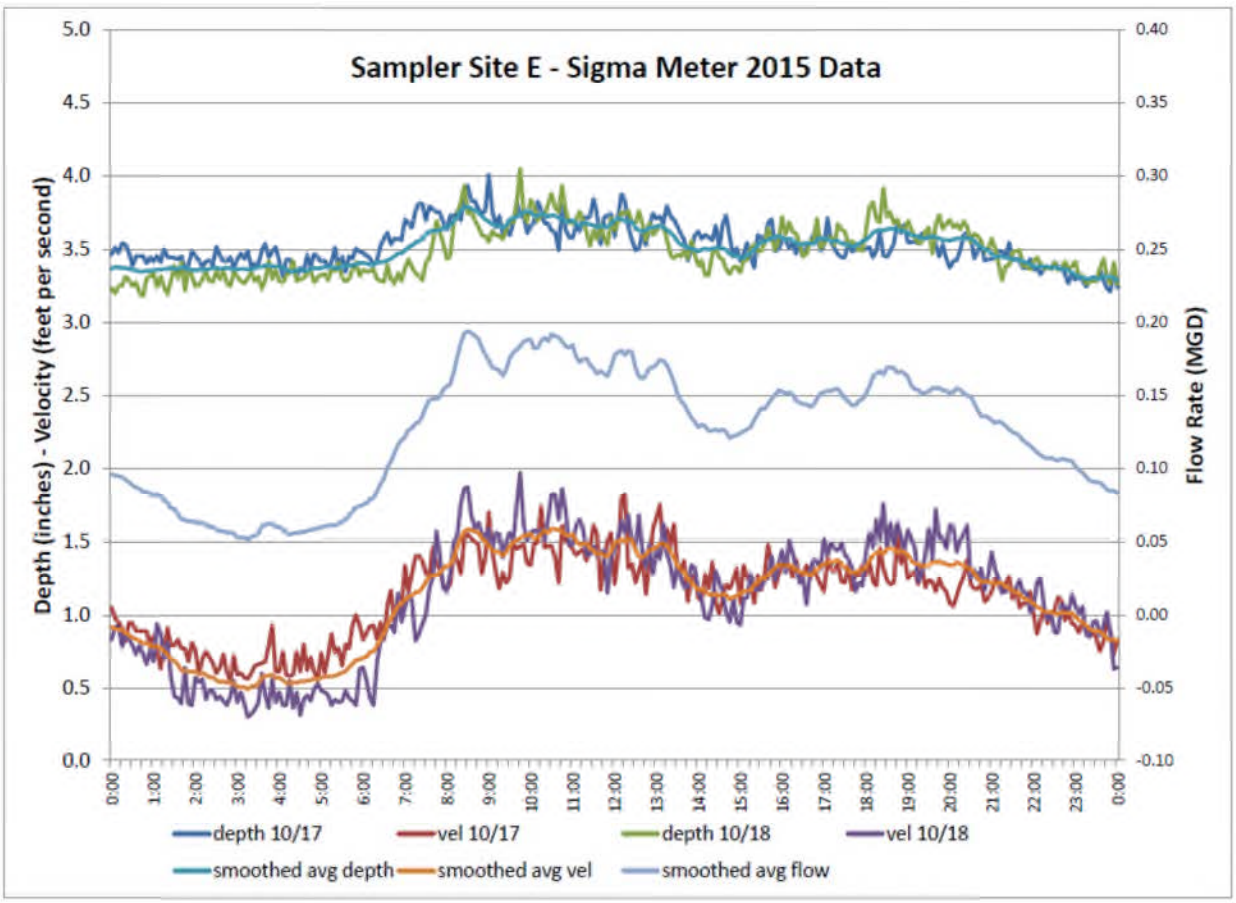


Figure 5-1 Diurnal Flow Pattern

The diurnal flow pattern was converted to the hourly sewage flow pattern shown in Table 5-1. This pattern was used in the pollutant calibration model to vary the sewage flows during the day.

The calculations to achieve the hourly sewage flow pattern are as follows:

1. The hourly flows for the 17th and 18th were averaged.
2. The infiltration rate of 0.011 MGD was subtracted from each average. (See the bottom of Appendix B – Sampler E, total flow 0.062 MGD – sewage flow 0.051 MGD.)
3. The daily flow of 0.115 MGD is the average of the 24 hourly averages
4. The hourly fraction of the daily flow is each (hourly average – infiltration) ÷ daily flow
5. The average of the hourly fractions is 1.000 which shows that they are normalized.

Table 5-1
Hourly Sewage Flow Pattern

Hour	Hourly Average Flow Rate (MGD)	Hourly Average – Infiltration (MGD)	Hourly Fraction Of Daily Flow
0:00	0.098	0.087	0.754
1:00	0.082	0.071	0.611
2:00	0.064	0.053	0.455
3:00	0.053	0.042	0.364
4:00	0.060	0.049	0.425
5:00	0.060	0.049	0.425
6:00	0.075	0.064	0.555
7:00	0.122	0.111	0.958
8:00	0.156	0.145	1.257
9:00	0.174	0.163	1.413
10:00	0.189	0.178	1.538
11:00	0.185	0.174	1.504
12:00	0.178	0.167	1.443
13:00	0.171	0.160	1.387
14:00	0.128	0.117	1.014
15:00	0.124	0.113	0.979
16:00	0.153	0.142	1.226
17:00	0.153	0.142	1.226
18:00	0.151	0.140	1.213
19:00	0.163	0.152	1.313
20:00	0.152	0.141	1.218
21:00	0.133	0.122	1.057
22:00	0.113	0.102	0.884
23:00	0.101	0.090	0.780
Daily Flow>		**0.115**	
Average Hourly Factors>			**1.000**

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CHAPTER 6 – TYPICAL YEAR POLLUTANT LOADINGS

6.1 INTRODUCTION

The Lakewood SWMM model was run to simulate flows and pollutant loadings in a typical year. The purpose of the run was to establish a baseline to compare the effectiveness of improvements to the WWTP and collection system on Lake Erie water quality.

6.2 TYPICAL YEAR RAINFALL AND CLIMATOLOGY

The model used the typical year of rainfall as submitted to U.S. EPA. The basis for the typical year was 1977 rainfall at Hopkins Airport because of the size and number of storms during that year. That year had 35.48 total inches of rain, to which 2.04 inches were added to reflect recent increases in yearly rainfall. The typical year used in the model has 37.52 inches of rainfall. The rain events include:

1. No storm events greater than a 1-year storm
2. A 1-year 1-hour storm
3. A 6-month 1-hour storm
4. A 4-month 1-hour storm
5. A 3-month 1-hour storm
6. Remaining storms are less than a 3-month storm

Rainfall is broken down into 15 minute increments to enable the model to calculate peak flow rates from smaller subcatchments that have short times of concentration.

In addition to rainfall, a climatology input file was prepared. This climatology file uses data from 1977 to match wet weather days. The climate file contains daily values for:

1. High Temperature
2. Low Temperature
3. Wind Speed

SWMM uses daily high and low temperatures to differentiate between rain and snow. It uses wind speed in its snow melt calculations. SWMM also uses the temperatures to calculate evaporation rates throughout the year. All these daily values are in the climate file.

6.3 POLLUTANT MODELING

The Lakewood model was enhanced to include SWMM capabilities of modeling pollutant loads. Typical DWF and RDII concentrations as calculated in Chapters 2 and 3 were assigned to the four modeled pollutants. Buildup and washoff coefficients as calculated in Chapter 4 were assigned to the four pollutants for the five types of land use.

6.4 AVERAGE YEARLY WWTP FLOWS AND LOADINGS

Table 6-1 lists the yearly rainfall, and WWTP influent flow and pollutant loadings from 2010 to 2014. The total flow values are as reported in the DMRs. Daily pollutant loadings are calculated from DMR influent concentrations. Because pollutants are not sampled every day, the yearly loadings are extrapolated values based on the number days that influent concentration was sampled. The days not tested are assumed to contain a similar proportion of wet and dry weather as the days tested. The general equation for extrapolating loadings is as follows:

Measured lbs / Number of days tested x 365 days/year = Extrapolated lbs/year

The 5-year average pollutant loadings are shown at the bottom of Table 6-1. Since influent *E. coli* is not measured, there is no data for that column. The average values are also shown excluding year 2011 because of its extremely high total rainfall.

Table 6-1
Lakewood WWTP - Yearly Influent to WWTP (2010-2014)

Year	Rainfall (inches)	Total Flow (MG)	CBOD Extrapolated (lbs)	*E. coli* (cfu)	TP Extrapolated (lbs)	TSS Extrapolated (lbs)
2010	30.42	2,520	1,699,793	n/a	64,191	2,323,305
2011	60.95	3,793	1,745,619	n/a	65,368	2,834,474
2012	37.65	2,570	1,590,437	n/a	63,509	2,638,742
2013	34.02	2,721	1,793,740	n/a	68,452	2,839,658
2014	34.51	2,730	1,956,179	n/a	71,687	2,653,134
Average	**39.51**	**2,867**	**1,757,154**	**n/a**	**66,641**	**2,657,863**
Exclude 2011	***34.15***	***2,635***	***1,760,037***	***n/a***	***66,960***	***2,613,710***

The 4-year average pollutant loadings to the WWTP (excluding year 2011) are similar to the 5-year average loadings. This indicates the increased total flow for 2011 is composed of relatively clean groundwater and diluted runoff (the pollutants having already been washed off).

6.5 SWMM TYPICAL YEAR MODEL FLOW PATTERNS

The spreadsheet used to calculate average yearly loadings was expanded to calculate monthly sewage, monthly infiltration and daily flow patterns. For the years 2010 to 2014, the dry day sewage portion of the flow was averaged by month and by weekday. The water consumption spreadsheet calculated the monthly sewage portion of the flows. The monthly dry weather infiltration was calculated by subtracting the sewage portion of the flows from monthly averages. Table 6-2 shows the average monthly sewage flows and their ratio to the yearly average. Table 6-3 shows the average monthly infiltrations and their ratio to the yearly average. Table 6-4 shows the dry day daily sewage variations and their ratio to the weekly average. These ratios were input into the SWMM program as monthly and daily time patterns.

Table 6-2
Lakewood WWTP
Monthly Sewage Discharge Pattern

Month	5-Year Average Dry Day Sewage (MGD)	Monthly Fraction of Yearly Average Sewage
January	3.255	1.074
February	3.007	0.992
March	2.895	0.955
April	3.076	1.015
May	3.004	0.991
June	3.031	1.000
July	3.031	1.000
August	3.031	1.000
September	3.031	1.000
October	3.107	1.025
November	3.037	1.002
December	2.867	0.946
Monthly Average	**3.031**	**1.000**

Table 6-3
Lakewood WWTP
Monthly Infiltration Pattern

Month	5-Year Average Dry Day Infiltration (MGD)	Monthly Fraction of Yearly Average Infiltration
January	1.645	0.902
February	2.031	1.114
March	2.443	1.340
April	2.123	1.165
May	1.946	1.068
June	2.048	1.123
July	1.780	0.977
August	1.548	0.849
September	1.237	0.678
October	1.410	0.773
November	1.664	0.913
December	2.001	1.098
Monthly Average	**1.823**	**1.000**

Table 6-4
Lakewood WWTP
Daily Sewage Flow Pattern

	5-Year Average Dry Day Flow (MGD)	Daily Fraction Of Average Flow
Sunday	4.804	1.040
Monday	4.683	1.012
Tuesday	4.668	0.990
Wednesday	4.624	0.996
Thursday	4.653	0.997
Friday	4.663	0.985
Saturday	4.678	0.980
Daily Average	**4.682**	**1.000**

For the 2011 calibrated SWMM model, diurnal sewage flow patterns were developed from the 2011 flow metering data. Hourly flow data on dry days were entered into a spreadsheet. Multiple weekdays and weekend days were selected and the hourly flows were averaged to

determine diurnal weekday and weekend patterns for each flow meter. Seventeen of these individual meter flow patterns were aggregated to develop citywide diurnal flow patterns for the typical year pollutant model. Table 6-5 presents the weekday pattern and Table 6-6 presents the weekend pattern. The weekday pattern is typical in that flow peaks at 08:00 (8:00 a.m.) and again at 21:00 (9:00 p.m.). The weekend pattern has a later morning flow peak at 11:00 a.m. and no definitive evening peak.

Table 6-5
Lakewood Metered Sewage
Weekday Hourly Discharge Pattern

Hour	18-Meter Average Hourly Sewage (MGD)	Hourly Fraction of Average Daily Sewage
0:00	0.908	0.902
1:00	0.794	0.789
2:00	0.690	0.686
3:00	0.629	0.625
4:00	0.623	0.620
5:00	0.677	0.673
6:00	0.884	0.878
7:00	1.253	1.245
8:00	1.323	1.315
9:00	1.168	1.161
10:00	1.183	1.176
11:00	1.089	1.082
12:00	1.047	1.040
13:00	1.055	1.048
14:00	1.040	1.034
15:00	0.991	0.985
16:00	1.032	1.025
17:00	1.046	1.039
18:00	1.107	1.100
19:00	1.153	1.146
20:00	1.153	1.146
21:00	1.168	1.160
22:00	1.128	1.121
23:00	1.011	1.004
Weekday Average	**1.006**	**1.000**

Table 6-6
Lakewood Metered Sewage
Weekend Hourly Discharge Pattern

Month	18-Meter Average Hourly Sewage (MGD)	Hourly Fraction of Average Daily Sewage
0:00	0.922	0.928
1:00	0.781	0.786
2:00	0.652	0.656
3:00	0.642	0.646
4:00	0.614	0.618
5:00	0.586	0.590
6:00	0.665	0.669
7:00	0.793	0.798
8:00	0.998	1.004
9:00	1.209	1.217
10:00	1.245	1.253
11:00	1.367	1.375
12:00	1.342	1.350
13:00	1.306	1.313
14:00	1.204	1.212
15:00	1.164	1.171
16:00	1.118	1.125
17:00	1.081	1.088
18:00	1.074	1.081
19:00	1.032	1.038
20:00	1.053	1.060
21:00	1.054	1.061
22:00	0.977	0.983
23:00	0.972	0.978
Weekend Average	**0.994**	**1.000**

6.6 SWMM TYPICAL YEAR RESULTS

Lakewood has its WWTP outfall and 33 sewer outfalls. In addition to these outfalls, 13% of Lakewood's combined sewage is discharged to the Northeast Ohio Regional Sewer District (NEORSD). These outfalls discharge pollutants from overflows within the collection system. For the typical year of rainfall, PCSWMM calculates the total flow volume and pollutant quantity discharged at each outfall. The Lakewood model was run for the conditions:

1. Typical Year rainfall = 37.52 inches
2. Average dry day flow = 6.283 MGD
3. Evaporation turned on.
4. Ponding allowed at surcharged manholes

The 6.283 MGD average dry day flow is composed of 3.693 MGD sewage and 2.590 MGD infiltration. Table 6-7 lists the resulting discharges for this scenario. The calculated values are divided into three groups: the loadings influent to the WWTP, the portion of Lakewood's sewage and runoff that flows to NEORSD, and the total of all Lakewood outfalls.

Table 6-7
City of Lakewood
SWMM Calculated Flows and Loadings

	Flow (MG)	CBOD (lbs)	*E. coli* (cfu)	TP (lbs)	TSS (lbs)
Typical Year Scenario					
WWTP Influent	2,787	1,843,662	2.06E+18	70,000	2,747,213
To NEORSD	398	27,142	3.04E+16	1,030	40,469
Lakewood outfalls	577	30,720	2.30E+16	1,129	56,356
Total Generated	**3,762**	**1,901,524**	**2.12E+18**	**72,159**	**2,844,038**

For this scenario, Table 6-8 shows the typical year flows to each individual outfall, the WWTP, and to the NEORSD connection points described in Section 2.2. For outfall 052NEORSD (which is outside the Lakewood corporate limits), Table 6-8 shows only the Lakewood generated flow and pollutant values.

Table 6-8
Lakewood Sewer Outfalls
SWMM Typical Year Flows and Loadings

SWMM Model Outfall ID	Flow (MG)	CBOD (lbs)	*E. coli* (cfu)	TP (lbs)	TSS (lbs)
Lakewood Outfalls					
002LEWS1070	15.249	1,380.4	1.03E+15	50.8	2,529.9
002LEWS1195	6.354	492.0	4.75E+14	18.4	820.9
002LEWS1210	0.086	0.1	9.77E+09	0.0	0.6
002LEWS1215	0.891	1.3	2.55E+11	0.0	11.2
002LEWS1220	0.088	2.6	2.88E+12	0.1	3.9
002LEWS1230	0.400	0.2	5.27E+09	0.0	2.1
002LEWS1285	0.000	0.0	0.00E+00	0.0	0.0
002LEWS1295	14.125	111.2	1.14E+14	4.2	254.9
002RRES1145	53.356	1,063.1	7.71E+14	38.8	2,042.3
002RRES1150	0.000	0.0	0.00E+00	0.0	0.0
002SRRES1065	2.058	1.7	3.14E+11	0.1	14.8
052NEORSD	1.829	1.3	2.65E+11	0.0	10.0
052RRES1160	173.514	10,734.7	7.66E+15	393.6	19,893.5
052RRES1165B	0.410	0.5	1.27E+11	0.0	1.4
052RRES1180	1.878	13.6	4.62E+12	0.5	31.1
052RRES1185	4.638	14.3	4.72E+12	0.3	32.6
052RRES1215	3.692	2.5	5.53E+11	0.1	13.8
052T01	0.742	0.3	5.30E+10	0.0	2.7
053RRWS1200	3.229	345.0	2.62E+14	12.7	620.6
054RRES1140	16.335	55.8	2.13E+13	1.9	140.8
055LEWS1225	1.850	6.5	5.55E+12	0.2	14.0
056LEWS1140	25.700	655.4	5.25E+14	24.2	1,189.1
056LEWS1145	3.323	85.9	7.82E+13	3.2	149.4
056LEWS1180	12.498	938.7	6.53E+14	34.4	1,742.4
057LEWS1130	15.417	56.2	2.49E+13	1.8	149.7
057LEWS1135	2.366	244.9	1.60E+14	8.9	464.7
058LEWS1110	1.856	34.3	1.45E+13	1.2	76.1
059ALEWS1040	123.668	10,218.2	7.74E+15	376.0	18,557.8
059LEWS1005	0.232	0.2	4.05E+10	0.0	3.5
059LEWS1035	59.232	2,482.9	2.61E+15	93.5	3,912.6
059LEWS1045	5.544	628.8	2.99E+14	22.6	1,282.0
059LEWS1050	1.448	3.6	7.43E+11	0.1	29.2
059LEWS1055_1060	23.366	1,017.7	4.67E+14	36.5	2,130.8
CSO002	1.920	126.2	9.68E+13	4.7	227.4
WWTP Influent					
053WWTP	93.991	81,177.9	9.12E+16	3,083.2	120,597.6
WWTP	2,692.646	1,762,483.6	1.97E+18	66,916.3	2,626,615.5
NEORSD Influent					
059C33	293.441	1.0	2.12E+16	709.4	27,577.4
059C4	92.410	1,924.2	2.16E+15	73.0	2,912.7
Southwest Lakewood	12.170	6,540.8	7.05E+15	247.5	9,979.3

6.7 COMPARISON OF SWMM TYPICAL YEAR TO AVERAGE WWTP INFLUENT FLOWS

One validation check of the calibrated SWMM model is to compare its output to the Lakewood WWTP influent flow quantities. Table 6-9 shows this comparison. SWMM Typical-year Influent values are from Table 6-7 Average Typical Year Scenario. The 4-yr DMR Influent values are from Table 6-1 and based on the average yearly WWTP influent flow and loadings as calculated from DMR data. Table 6-9 shows SWMM influent flow to be 10% higher than the DMR data, which is due to the higher total rainfall. SWMM's pollutant loadings are also higher than the DMR data due to extra RDII having constant pollutant concentrations. SWMM's yearly WWTP influent *E. coli* loading (2.06E+18cfu from Table 6-7) is not shown in Table 6-9 because there are no measured influent concentrations in the DMR data.

Table 6-9
City of Lakewood
SWMM versus WWTP DMR Influent Flows and Loadings

	Total Rainfall (inches)	Flow (MG)	CBOD (lbs)	TP (lbs)	TSS (lbs)
SWMM Typical-year Influent	37.52	2,787	1,843,662	70,000	2,747,213
4-yr DMR Influent	34.15	2,635	1,760,037	66,960	2,613,710
SWMM to DMR Ratio	110%	106%	105%	105%	105%

6.8 POLLUTANT CAPTURE PERCENTAGES

The percentage of pollutants captured is a value that can be used to evaluate WWTP and collection system improvement alternatives. One version of this number is percentage capture of typical year total pollutant loadings. Another version is percentage capture of typical year wet weather pollutant loadings. These two values are described in the following sections.

6.8.1 TYPICAL YEAR CAPTURE PERCENTAGE OF TOTAL POLLUTANT LOADINGS

These values combined with the WWTP's effectiveness in removing pollutants can be used to calculate the total pollutant loadings discharged to Lake Erie. Improvement alternatives can be analyzed to determine their ability to further reduce pollutants. A cost benefit ratio ($ per additional pound of pollutant removed) for each alternative can then be calculated to determine a relative ranking of system improvement alternatives. (Cost benefit ratios are not a part of the pollutant model; however, the data for typical year total pollutant loadings are presented herein as the baseline for comparisons.)

The values to calculate typical year capture percentages have previously been calculated. Table 6-7 lists the typical year flows to the WWTP influent and to NEORSD. These treated flows are summed in Table 6-10. Added to that sum is the total flow and loadings discharged at the Lakewood outfalls to give the total Lakewood generated flows and

loadings. The treated values divided by the total generated values gives the percentage of flows and pollutants treated.

Table 6-10
City of Lakewood
Typical Year Total Pollutant Loading Treatment Percentages

	Flow (MG)	CBOD (lbs)	*E. Coli* (lbs)	TP (lbs)	TSS (lbs)
WWTP+NEORSD Treated	3,525	1,924,515	2.16E+18	73,072	2,866,695
Total Lakewood Generated	4,236	1,959,339	2.18E+18	74,354	2,929,993
Capture Percentage	83.2%	98.2%	98.8%	98.3%	97.8%

6.8.2 WET WEATHER POLLUTANT CAPTURE PERCENTAGE

This value is the pollutant loading to Rocky River and Lake Erie during wet weather. Collection system improvement alternatives can be analyzed to determine their ability to capture pollutants for treatment by NEORSD or the WWTP. A cost benefit ratio ($ per additional pound of pollutant captured) for each alternative can then be calculated to determine a relative ranking of collection system improvement alternatives.

The values to calculate typical year wet weather capture percentages are based on output from the SWMM model. The model was run for the typical year with rainfall turned on, and then run again with rainfall turned off (dry weather). The dry weather flow is the sewage portion of the wet weather flow for a given time slot. Flow rate and pollutant concentrations were downloaded from the WWTP and NEORSD capture points. This data was entered into an excel spreadsheet in 15-minute time slots. A wet weather event was considered to have started when both of the following two conditions were met:

1. Precipitation had occurred within the previous two hours
2. Total typical year captured flow rate exceeded total dry weather flow rate for the corresponding time slot by at least 0.4 MGD. (After some wet weather events the wet minus dry flow rate difference takes some time to stabilize. The wet minus dry difference was -0.387 MGD at its lowest. To eliminate error caused by this flow rate instability at the end of a wet weather event, the value of 0.4 MGD was chosen as the cut-off point for the storm.)

The wet weather event was considered to have ended when typical year captured flow rate returned to within 0.4 MGD of dry weather flow rate for the corresponding time slot. These two conditions resulted in 150 wet weather events on 118 wet days (a new day was not counted if the event spanned midnight, but was counted if the event lasted more than 24 hours).

For each wet weather time slot, treated pollutant loadings were calculated for the specific wet weather flow volume and pollutant concentration. The sum of all the time slots is the total treated wet weather flow and loadings.

The sum of these treated flows is shown in the first line of Table 6-11. The second line shows the total flow and loadings discharged at the Lakewood outfalls. The sum of these two values is the total Lakewood generated wet weather flows and loadings. The captured values divided by the total generated values gives the percentage of flows and pollutants captured.

Table 6-11
City of Lakewood
Typical Year Wet Weather Pollutant Loading Treatment Percentages

	Flow (MG)	CBOD (lbs)	*E. Coli* (lbs)	TP (lbs)	TSS (lbs)
WWTP+NEORSD Treated	1,541	497,408	5.35E+17	18,813	761,643
Discharge to Lakewood Outfall	568	30,208	2.24E+16	1,110	55,601
Total Lakewood Wet Weather	2,109	527,616	5.57E+17	19,922	817,243
Wet Weather Capture Percentage	**73.1%**	**94.3%**	**96.0%**	**94.4%**	**93.2%**

6.9 RECOMMENDED FURTHER ACTION

Further pollutant calibration is not proposed at this time, because the historical DMR data is not tied to rainfall intensity. Instead, the following actions should be incorporated to keep the pollutant model updated:

1. Run the pollutant model with future actual rainfall intensities. Compare SWMM loadings to the WWTP DMR loadings.
2. Continue to monitor water consumption. With increased use of water saving devices, future sewage flow volumes may continue to decrease.
3. Monitor population trends. Although flow volumes may decrease, if population remains constant pollutant loadings from sewage will remain constant. As a result, influent concentrations will increase. Since SWMM uses influent concentrations for sewage, this monitoring will be necessary to possibly adjust sewage concentrations.
4. Use overflow monitoring to refine SWMM input parameters. Since these overflows discharge to Lake Erie and Rocky River, comparing the model's calculated values to these metered values will be important to confirm the characterization of the collection system.

With the current pollutant model, a plan of improvements to the treatment plant and collection system can be developed to cost-effectively improve the water quality of Lake Erie and Rocky River. Future updates to the pollutant model can confirm whether Lakewood is remaining on the best course of improvements, or if alternative plans should be considered.

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APPENDIX A

LAND USE PERCENTAGES

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APPENDIX A – LAND USE PERCENTAGES

A.1 Introduction

The SWMM model was developed to calculate pollutants from runoff from the following five types of land use:

1. Low-density residential – Single and two-family residential properties with land area greater than ¼ acre in size.
2. Medium-density residential – Single and two-family residential properties with land area less than ¼ acre in size.
3. High-density residential – Properties classified as apartments.
4. Commercial/Industrial – Properties with large impervious areas. In addition to commercially and industrially used properties, this group also includes properties listed as institutional (municipal, schools and churches), highway, and active recreation areas.
5. Open Space – Properties with large pervious areas. This group includes the following types of land uses broken down by percentage of total open space
    a. passive green space 78%
    b. railroads 13%
    c. utility 9%

For each Lakewood subcatchment in the model, a percentage was calculated for each type of land use within that subcatchment. The Cuyahoga County Auditor's database of Lakewood properties was downloaded and sorted by land use. For one and two family residential properties, the data was further sorted by lot size. Lot sizes were examined to determine a break point between low-density and medium-density residential land. A break point of ¼ acre resulted in 75% of the residential land being medium-density and the remaining 25% being low-density. GIS was used to assign the properties to their respective land use designations. Thiessen polygon capability was used to extend the property lines to the center of the street. The revised acreages were totaled for each type of land use within each subcatchment. This appendix lists all the subcatchments within the model, their acreages and the percentage of the acreage classified to each of the five land uses.

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Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S002C026A	002C026A	1.192		88.5%		11.5%	
S002C029A	002C029A	3.310		79.2%		20.8%	
S002C039A	002C039A	2.322		93.7%		6.3%	
S002C124	002C124	2.155	88.9%	11.1%			
S002C1421	002C1421	3.803	85.1%	14.9%			
S002C169	002T169	0.806	22.5%	77.5%			
S002C170	002C170	1.012		100.0%			
S002C179	002C179	0.953		100.0%			
S002C181	002C181	0.427		100.0%			
S002C185	002C185	0.774	0.1%	99.9%			
S002C187	002C187	1.338	53.2%	43.3%		3.5%	
S002C189	002C189	1.371	59.6%	40.4%			
S002C191	002C191	1.099		100.0%			
S002C192	002C192	1.275		100.0%			
S002C193	002C193	2.536	58.2%	41.8%			
S002C195	002C195	1.704	17.8%	82.2%			
S002C198	002C198	3.201	84.9%	15.1%			
S002C210	002C210	0.788	11.4%	88.6%			
S002C214	002C214	2.022	96.6%	3.4%			
S002C219	002C219	1.993	16.2%	83.8%			
S002C238A	002C238A	2.485	16.8%	83.2%			
S002C240A	002C240A	2.572	37.5%	62.5%			
S002C241	002C241	1.899	14.0%	86.0%			
S002C255	002C255	0.820	33.6%	65.6%			0.8%
S002C260	002C260	3.135	25.6%	58.0%	16.4%		
S002C3646	002C3646	5.516		94.8%		5.2%	
S002C3648	002C3648	5.131		100.0%			
S002C3651	002C3651	6.518		100.0%			
S002C3691	002C3691	2.533		91.5%		8.5%	
S002C3693	002C3693	4.352		100.0%			
S002C3695	002C3695	7.027		100.0%			
S002C3697	002C3697	1.541		77.4%		22.6%	
S002C3804	002C3804	1.840	66.5%	33.5%			
S002C3895	002C3895	1.236	15.1%	84.9%			
S002C3897	002C3897	2.463	12.5%	87.5%			
S002C3906	002C3906	3.357	62.3%	37.7%			
S002C3941	002C3941	2.152	62.6%	37.4%			
S002C3943	002C3943	3.137	90.7%	9.3%			
S002C3945	002C3945	1.043		93.1%		6.9%	
S002C3946	002C3946	1.002		100.0%			
S002C3947	002C3947	1.392		80.7%			19.3%
S002C3948	002C3948	1.292		100.0%			
S002C3949	002C3949	1.498		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S002C3951	002C3951	0.877		100.0%			
S002C4049	002C4049	1.371			83.0%	17.0%	
S002C4418	002C4418	0.612		33.9%	34.7%	31.4%	
S002C4422	002C4422	2.223	15.6%	84.4%			
S002C4433	002C4433	5.578	1.9%	98.1%			
S002C9980	002C9980	1.080		100.0%			
S002S252	002S252	2.387	4.0%	6.6%	3.5%	12.8%	73.2%
S002S4066	002S4066	1.968		100.0%			
S002S4425	002S4425	1.225				100.0%	
S002S4426	002S4426	1.335	17.8%	3.0%		79.2%	
S002T015	002T015	7.522		95.9%		4.1%	
S002T017	002T017	4.358		86.8%		13.2%	
S002T019	002T019	5.134		100.0%			
S002T021	002T021	2.832		100.0%			
S002T024	002T024	0.912				100.0%	
S002T026	002T026	2.350			42.5%	57.5%	
S002T027	002T027	2.366			0.2%	99.8%	
S002T028	002T028	0.779				100.0%	
S002T029	002T029	2.970		3.7%	55.7%	40.6%	
S002T030	002T030	2.638		1.6%	13.6%	84.8%	
S002T031	002T031	1.818		11.7%	0.1%	88.3%	
S002T032	002T032	1.860		0.2%		99.8%	
S002T035	002T035	2.056		93.4%		6.6%	
S002T036	002T036	6.093		0.9%		99.0%	
S002T038	002T038	1.440		4.9%		95.1%	
S002T039	002T039	1.865		0.2%		99.8%	
S002T040	002T040	2.310		1.6%		98.4%	
S002T041	002T041	1.005		0.3%		99.7%	
S002T043	002T043	1.086		0.1%	1.0%	98.9%	
S002T044	002T044	1.406		4.3%	0.9%	94.8%	
S002T046	002T046	1.296			25.8%	74.2%	
S002T048	002T048	1.383				100.0%	
S002T049	002T049	3.693		32.7%		67.3%	
S002T053	002T053	1.386		100.0%			
S002T054	002T054	1.392		100.0%			
S002T055	002T055	1.253		100.0%			
S002T056	002T056	0.996	53.2%	46.8%			
S002T057	002T057	1.210	81.3%	18.5%			0.1%
S002T070	002T070	2.898		38.0%	45.2%	16.7%	
S002T075	002T075	3.577	20.9%	76.8%	2.3%		
S002T078	002T078	1.127		88.2%	11.8%		
S002T080	002T080	2.328		99.9%			0.1%
S002T082	002T082	2.342		100.0%			
S002T084	002T084	2.392		44.2%	25.3%	30.5%	
S002T090	002T090	2.749		22.3%	2.3%	75.4%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S002T092	002T092	1.571			12.7%	87.3%	
S002T094	002T094	1.024			97.4%	2.6%	
S002T103	002T103	1.711	100.0%				
S002T106	002T106	2.977	100.0%				
S002T107	002T107	2.593	100.0%				
S002T110	002T110	2.902	47.6%	46.3%		6.1%	
S002T1102	002T1102	1.441		80.4%		19.6%	
S002T114	002T114	4.607	87.8%	12.2%			
S002T116	002T116	1.498	78.4%	21.6%			
S002T1201	002T1201	3.017	75.6%	24.4%			
S002T123	002T123	4.319	18.4%	81.6%			
S002T1301	002T1301	2.599	49.5%	50.5%			
S002T1303	002T1303	4.228	18.4%	81.6%			
S002T1306	002T1306	3.770	80.7%	19.3%			
S002T1308	002T1308	1.511	100.0%				
S002T131	002T131	2.409	29.5%	70.5%			
S002T1313	002T1313	3.693	99.7%	0.3%			
S002T1318	002T1318	1.383	78.0%	22.0%			
S002T1319	002T1319	2.403	99.7%	0.3%			
S002T132	002T132	2.223		59.0%	12.4%	28.6%	
S002T1322	002T1322	1.347	98.5%	1.5%			
S002T1322A	002T1322	0.169	100.0%				
S002T1324	002T1324	1.079	16.9%	83.1%			
S002T1326	002T1326	1.058	99.3%	0.7%			
S002T1328	002T1328	1.326	59.4%	40.6%			
S002T1330	002T1330	1.820	0.5%	99.5%			
S002T138	002T138	1.357		100.0%			
S002T139	002T139	2.630	0.1%	62.4%	20.4%		17.2%
S002T1403	002T1403	3.678	87.0%	13.0%			
S002T1408	002T1408	2.422	27.2%	72.7%	0.1%		
S002T141	002T141	2.320	10.9%	67.3%			21.8%
S002T1410	002T1410	1.424	48.1%	51.9%			
S002T1417	002T1417	1.972	1.4%	63.8%	34.8%		
S002T1419	002T1419	2.837		100.0%			
S002T1423	002T1423	2.487	81.1%	18.9%			
S002T1429	002T1429	1.090	25.8%	74.2%			
S002T143	002T143	4.140	1.0%	98.9%		0.1%	
S002T1431	002T1431	2.219	60.1%	39.9%			
S002T145	002T145	1.248		100.0%			
S002T147	002T147	0.866		96.3%	3.7%		
S002T166	002T166	1.777	11.5%	88.5%			
S002T173	002T173	1.077	26.2%	73.8%			
S002T175	002T175	1.246	43.2%	56.8%			
S002T184	002T184	1.247	0.2%	99.8%			
S002T184A	002T184	1.918		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S002T186	002T186	1.064	6.3%	29.4%		64.3%	
S002T196	002T196	0.675	18.0%	82.0%			
S002T2000	002T2000	1.198	24.6%	75.4%			
S002T205	002T205	0.403	45.9%	54.1%			
S002T207	002T207	2.346	94.6%	5.4%			
S002T2106	002T2106	5.403	12.4%	87.6%			
S002T2107	002T2107	4.616		100.0%			
S002T2109	002T2109	3.721		100.0%			
S002T2115	002T2115	0.992				100.0%	
S002T2122	002T2122	5.354		100.0%			
S002T2124	002T2124	2.445		100.0%			
S002T2126	002T2126	2.564		100.0%			
S002T2131	002T2131	1.468		37.9%		62.1%	
S002T2149	002T2149	2.381		65.9%	10.4%	23.7%	
S002T2151	002T2151	2.956		100.0%			
S002T2154	002T2154	5.113		100.0%			
S002T216	002T216	1.784	5.4%	94.6%			
S002T2162	002T2162	3.090	7.2%	37.1%		55.7%	
S002T2164	002T2164	3.547	56.6%	43.4%			
S002T2165	002T2165	3.552	45.8%	38.6%			15.6%
S002T2167	002T2167	4.506	57.0%	43.0%			
S002T2169	002T2169	6.122	49.9%	31.9%		18.2%	
S002T217	002T217	1.739	98.1%	1.9%			
S002T2173	002T2173	2.062		100.0%			
S002T230	002T230	2.169	72.2%	27.8%			
S002T236	002T236	1.175	0.7%	99.3%			
S002T242	002T242	1.276	41.6%	58.4%			
S002T251	002T251	6.133		6.0%	25.5%	68.5%	
S002T253	002T253	1.813	0.4%	37.2%	26.9%		35.5%
S002T256	002T256	0.939		83.3%			16.7%
S002T257	002T257	3.119	0.1%	1.9%		98.0%	
S002T3587	002T3587	3.452		100.0%			
S002T3589	002T3589	2.969		100.0%			
S002T3593	002T3593	3.802		100.0%			
S002T3595	002T3595	2.031		84.5%	8.0%	7.5%	
S002T3602	002T3602	2.532		75.4%	5.8%	18.8%	
S002T3603	002T3603	3.510		100.0%			
S002T3606	002T3606	2.536		100.0%			
S002T3610	002T3610	4.339		100.0%			
S002T3620	002T3620	3.527		65.7%		34.3%	
S002T3622	002T3622	5.141		100.0%			
S002T3624	002T3624	5.865		100.0%			
S002T3626	002T3626	5.211		90.6%		9.4%	
S002T3632	002T3632	7.086		96.5%	2.2%	1.3%	
S002T3637	002T3637	6.294		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S002T3641	002T3641	3.364		100.0%			
S002T3643	002T3643	1.574		53.1%		46.9%	
S002T3654	002T3654	2.345		92.5%	3.8%		3.8%
S002T3655	002T3655	2.685		100.0%			
S002T3656	002T3656	2.200		100.0%			
S002T3657	002T3657	2.560		100.0%			
S002T3658	002T3658	2.878		100.0%			
S002T3661	002T3661	2.914	11.5%	79.9%		8.5%	
S002T3664	002T3664	4.543		97.9%		2.1%	
S002T3667	002T3667	3.496		100.0%			
S002T3673	002T3673	5.711	4.5%	91.9%	3.6%		
S002T3675	002T3675	2.352		93.6%		6.4%	
S002T3677	002T3677	4.359		100.0%			
S002T3680	002T3680	4.872		100.0%			
S002T3689	002T3689	1.770		91.9%		8.1%	
S002T3702	002T3702	5.927		100.0%			
S002T3704	002T3704	3.364		93.2%		6.8%	
S002T3705	002T3705	0.941		15.2%	54.5%	30.2%	
S002T3728	002T3728	2.059	100.0%				
S002T3732	002T3732	3.170	64.7%	17.6%		17.7%	
S002T3735	002T3735	1.791	100.0%				
S002T3741	002T3741	4.252	94.6%	5.4%			
S002T3744	002T3744	4.406	97.9%	2.1%			
S002T3749	002T3749	0.877	100.0%				
S002T3766	002T3766	3.188	89.3%	10.7%			
S002T3770	002T3770	5.759	100.0%				
S002T3772	002T3772	1.189	77.8%	22.2%			
S002T3779	002T3779	1.835	55.7%	44.3%			
S002T3829	002T3829	4.607	91.1%	8.9%			
S002T3836	002T3836	5.142	100.0%				
S002T3840	002T3840	7.498	92.9%	7.1%			
S002T3846	002T3846	3.725	84.0%	16.0%			
S002T3848	002T3848	8.079	90.6%	9.4%			
S002T3867	002T3867	2.158	82.0%	18.0%			
S002T3869	002T3869	2.324	100.0%				
S002T3870	002T3870	3.047	79.5%	20.5%			
S002T3873	002T3873	2.991	100.0%				
S002T3875	002T3875	3.236	81.8%	18.2%			
S002T3880	002T3880	1.269	0.1%	99.9%			
S002T3883	002T3883	1.503		100.0%			
S002T3889	002T3889	1.372	1.4%	98.6%			
S002T3908	002T3908	2.512	29.2%	70.8%			
S002T3922	002T3922	1.959		82.8%	5.6%	11.6%	
S002T3923	002T3923	1.521		92.6%			7.4%
S002T3924	002T3924	1.655		82.5%			17.5%

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S002T3925	002T3925	1.368		100.0%			
S002T3926	002T3926	1.448		100.0%			
S002T3927	002T3927	1.485	14.1%	79.7%	6.2%		
S002T3929	002T3929	1.885	0.1%	50.0%		49.9%	
S002T3930	002T3930	1.319		99.9%			
S002T3932	002T3932	2.799		91.6%			8.4%
S002T3934	002T3934	2.669		100.0%			
S002T3953	002T3953	0.812	24.3%	22.6%	16.4%	36.7%	
S002T3954	002T3954	0.969		70.8%	29.2%		
S002T3955	002T3955	0.789		100.0%			
S002T3956	002T3956	0.753		71.7%			28.3%
S002T3957	002T3957	0.787		100.0%			
S002T3958	002T3958	0.782		100.0%			
S002T3959	002T3959	0.786		100.0%			
S002T3960	002T3960	0.779		100.0%			
S002T3961	002T3961	1.507		100.0%			
S002T3963	002T3963	2.025	8.5%	62.8%	19.9%	8.8%	
S002T3964	002T3964	1.149		96.7%	3.3%		
S002T3965	002T3965	1.207		36.0%	35.8%		28.2%
S002T3966	002T3966	2.233		93.9%			6.1%
S002T3967	002T3967	1.454		100.0%			
S002T3968	002T3968	1.682	14.3%	85.7%			
S002T3969	002T3969	1.902	1.0%	99.0%			
S002T3974	002T3974	1.231		64.7%	26.1%	9.2%	
S002T3979	002T3979	2.074		70.1%	15.3%		14.6%
S002T3981	002T3981	1.780		92.2%			7.8%
S002T3982	002T3982	1.424		100.0%			
S002T3984	002T3984	2.477	5.0%	95.0%			
S002T3986	002T3986	0.549		86.7%		13.3%	
S002T3987	002T3987	0.684		99.2%	0.3%	0.4%	
S002T3988	002T3988	1.762		99.9%			0.1%
S002T3990	002T3990	1.304		73.2%			26.8%
S002T3991	002T3991	1.422		100.0%			
S002T3992	002T3992	1.378		100.0%			
S002T3994	002T3994	1.862		100.0%			
S002T4002	002T4002	1.236		100.0%			
S002T4004	002T4004	0.993		100.0%			
S002T4005	002T4005	0.425		100.0%			
S002T4020	002T4020	2.381		100.0%			
S002T4022	002T4022	2.235		100.0%			
S002T4025	002T4025	2.270		94.9%	5.1%		
S002T4026	002T4026	1.206		100.0%			
S002T4028	002T4028	0.864		99.9%			0.1%
S002T4031	002T4031	1.760		56.0%		44.0%	
S002T4033	002T4033	1.797		99.0%	0.3%	0.8%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S002T4037	002T4037	1.584		100.0%			
S002T4043	002T4043	1.868		86.4%			13.6%
S002T4064	002T4064	1.477	27.4%	59.8%		12.8%	
S002T4065	002T4065	1.472	48.4%	51.6%			
S002T4152	002T4152	5.207	65.6%	34.4%			
S002T4157	002T4157	1.871	60.0%	40.0%			
S002T4171	002T4171	4.103	100.0%				
S002T4227	002T4227	1.695	22.4%	77.6%			
S002T4228	002T4228	2.798	3.2%	96.8%			
S002T4232	002T4232	2.359		100.0%			
S002T4233	002T4233	2.081	1.6%	98.4%			
S002T4235	002T4235	2.101	100.0%				
S002T4243	002T4243	1.256	41.3%	58.7%			
S002T4250	002T4250	4.193	68.1%	31.9%			
S002T4254	002T4254	2.311	92.6%	7.4%			
S002T4259	002T4259	1.667	31.2%	68.8%			
S002T4278	002T4278	7.253	94.8%	5.2%			
S002T4300	002T4300	1.363		19.8%	70.2%	10.0%	
S002T4301	002T4301	2.550		77.2%	16.9%	5.9%	
S002T4304	002T4304	1.002		50.9%	3.7%	45.4%	
S002T4306	002T4306	3.304		57.7%	32.7%	9.6%	
S002T4307	002T4307	3.313		100.0%			
S002T4309	002T4309	2.311		95.2%		4.8%	
S002T4315	002T4315	5.742		56.8%	18.4%	24.8%	
S002T4317	002T4317	2.528	0.9%	79.2%	19.9%		
S002T4320	002T4320	2.255	15.5%	84.1%	0.4%		
S002T4322	002T4322	1.249		100.0%			
S002T4324	002T4324	3.827		76.4%	23.6%		
S002T4394	002T4394	4.951		95.5%	4.5%		
S002T4395	002T4395	3.654		100.0%			
S002T4414	002T4414	2.922		99.4%		0.6%	
S002T4416	002T4416	0.683		2.0%	2.5%	95.5%	
S002T4424	002T4424	2.897		73.4%		26.6%	
S002T4426	002T4426	6.455		100.0%			
S002T4428	002T4428	1.745	3.5%	96.5%			
S002T4651	002T4651	1.683				100.0%	
S002T685	002T685	0.939		100.0%			
S002T725	002T725	2.578	99.5%	0.5%			
S002T767	002T767	2.418	51.5%	48.5%			
S002T9984	002T9984	0.985	79.2%	20.8%			
S002T9988	002T9988	1.440		100.0%			
S0059C015	059C015	4.912	4.7%	95.3%			
S0059T011	059T011	1.391	26.8%	46.3%	26.9%		
S0059T014	059T014	3.030	33.4%	24.2%		42.5%	
S052C1133	052C1133	0.470		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052C1138	052C1138	2.590		100.0%			
S052C1143	052C1143	1.240		100.0%			
S052C1148	052C1148	1.090		100.0%			
S052C1150	052C1150	1.170		100.0%			
S052S103	052S103	0.720		9.1%		90.9%	
S052S1060	052S1060	1.430		100.0%			
S052S1072	052S1072	1.670		100.0%			
S052S1076	052S1076	3.860		22.0%		78.0%	
S052S1080	052S1080	2.950		100.0%			
S052S1081	052S1081	2.300		81.7%		18.3%	
S052S1171	052S1171	1.150	60.1%	39.9%			
S052S1173	052S1173	1.050		100.0%			
S052S1178	052S1178	1.390		100.0%			
S052S1257	052S1257	1.850		100.0%			
S052S1258	052S1258	1.720		100.0%			
S052S1259	052S1259	1.530		100.0%			
S052S1260	052S1260	1.340		100.0%			
S052S1261	052S1261	1.730		100.0%			
S052S1262	052S1262	2.370		95.6%		4.4%	
S052S1492	052S1492	1.610	98.9%	1.1%			
S052S3419	052S3419	1.460		0.7%		99.3%	
S052S4615	052S4615	1.820		57.3%		42.7%	
S052T003	052T003	2.520	77.4%	22.6%			
S052T006	052T006	2.800	0.7%		79.7%	19.7%	
S052T007	052T007	2.330		11.3%	43.7%	45.0%	
S052T008	052T008	2.900		21.8%	16.6%	61.5%	
S052T009	052T009	2.480		12.2%	40.1%	47.7%	
S052T010	052T010	3.790	7.7%	17.7%	26.0%	48.6%	
S052T011	052T011	2.010		1.2%	18.4%	59.1%	21.4%
S052T012	052T012	1.800			44.8%	55.2%	
S052T013	052T013	1.880		1.3%	27.0%	71.6%	
S052T014	052T014	1.720		0.6%		99.4%	
S052T014A	052T014	1.390		100.0%			
S052T015	052T015	1.630		1.4%		98.6%	
S052T016	052T016	1.400		15.9%		84.1%	
S052T017	052T017	2.750			28.8%	71.2%	
S052T018	052T018	1.320		100.0%			
S052T019	052T019	1.400		21.6%		78.4%	
S052T021	052T021	2.000		0.5%	28.7%	70.8%	
S052T023	052T023	4.390		4.3%		95.7%	
S052T024	052T024	3.100		1.8%	34.1%	64.2%	
S052T025	052T025	3.780		0.8%	34.0%	65.1%	
S052T026	052T026	3.680		7.0%	5.2%	87.7%	
S052T027	052T027	2.130		20.0%	33.9%	46.2%	
S052T028	052T028	2.510		1.5%	26.4%	72.1%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052T029	052T029	2.120		19.4%	7.2%	73.4%	
S052T032	052T032	0.220				100.0%	
S052T036	052T036	1.400	70.0%	30.0%			
S052T037	052T037	1.910	92.1%	7.9%			
S052T039	052T039	2.180	17.7%	82.3%			
S052T040	052T040	1.870	100.0%				
S052T041	052T041	1.410	79.7%	20.3%			
S052T043	052T043	1.860	30.6%	62.5%			6.9%
S052T046	052T046	1.020		100.0%			
S052T048	052T048	1.790		100.0%			
S052T049	052T049	1.700		100.0%			
S052T050	052T050	1.200	35.1%	64.9%			
S052T051	052T051	1.360	14.0%	86.0%			
S052T052	052T052	0.950		100.0%			
S052T053	052T053	1.610	0.2%			99.8%	
S052T055	052T055	1.870		66.2%		33.8%	
S052T056	052T056	1.350	9.8%	90.2%			
S052T058	052T058	1.670	47.4%	52.6%			
S052T060	052T060	4.070	21.6%	78.4%			
S052T064	052T064	1.260	16.1%	83.9%			
S052T066	052T066	1.620	22.4%	77.6%			
S052T068	052T068	2.220	61.3%	38.7%			
S052T074	052T074	0.960	1.1%	98.9%			
S052T080	052T080	1.450	5.6%	40.4%		54.0%	
S052T081	052T081	1.110	49.2%	34.6%		16.1%	
S052T083	052T083	2.110		10.2%	35.3%	54.6%	
S052T092	052T092	0.590		11.4%		88.6%	
S052T095	052T095	1.530		87.6%		12.4%	
S052T096	052T096	1.330		91.8%		8.2%	
S052T097_2	052T097	0.760		58.8%		41.2%	
S052T098	052T098	0.970		100.0%			
S052T099	052T099	0.520		31.8%		68.2%	
S052T101	052T101	2.270	11.5%	54.0%		34.5%	
S052T102	052T102	0.980		100.0%			
S052T1047	052T1047	1.160		0.1%		99.9%	
S052T1049	052T1049	2.240		99.9%		0.1%	
S052T105	052T105	0.910		93.4%		6.6%	
S052T1050	052T1050	1.960		100.0%			
S052T1051	052T1051	2.360		100.0%			
S052T1052	052T1052	1.800		100.0%			
S052T1053	052T1053	2.230		100.0%			
S052T1054	052T1054	1.960		100.0%			
S052T1055	052T1055	1.950		100.0%			
S052T1058	052T1058	2.040		100.0%			
S052T1059	052T1059	2.130		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052T105A	052T105	0.420		100.0%			
S052T106	052T106	0.890		100.0%			
S052T1061	052T1061	1.210		100.0%			
S052T1062	052T1062	2.130		100.0%			
S052T1064	052T1064	2.500		100.0%			
S052T1065	052T1065	2.770		99.9%		0.1%	
S052T1068	052T1068	1.220		100.0%			
S052T1069	052T1069	2.390		100.0%			
S052T1070	052T1070	2.720		100.0%			
S052T1077	052T1077	1.340		100.0%			
S052T1078	052T1078	0.980		100.0%			
S052T1079	052T1079	0.510		100.0%			
S052T108	052T108	2.330		100.0%			
S052T1082	052T1082	3.130		100.0%			
S052T1083	052T1083	2.300		100.0%			
S052T1086	052T1086	0.970		100.0%			
S052T1087	052T1087	1.240		77.8%		22.2%	
S052T1088	052T1088	1.100		64.2%		35.8%	
S052T1089	052T1089	1.700		88.1%		11.9%	
S052T109	052T109	0.830		100.0%			
S052T1090	052T1090	1.900		100.0%			
S052T1092	052T1092	0.500		100.0%			
S052T1093	052T1093	0.400		100.0%			
S052T1094	052T1094	1.510		100.0%			
S052T1096	052T1096	2.600		100.0%			
S052T1098	052T1098	3.210		88.3%	11.4%	0.3%	
S052T110	052T110	0.920		100.0%			
S052T1101	052T1101	1.100		100.0%			
S052T1103	052T1103	1.850		100.0%			
S052T1105	052T1105	2.460		100.0%			
S052T1106	052T1106	1.970		100.0%			
S052T111	052T111	1.200		100.0%			
S052T1110	052T1110	2.330		73.0%		27.0%	
S052T1111	052T1111	2.290		100.0%			
S052T1112	052T1112	1.660		100.0%			
S052T1113	052T1113	1.880		100.0%			
S052T1115	052T1115	1.130		100.0%			
S052T1117	052T1117	2.290		100.0%			
S052T1118	052T1118	0.760		100.0%			
S052T112	052T112	0.730		100.0%			
S052T1122	052T1122	1.400		65.6%		34.4%	
S052T1124	052T1124	1.450		100.0%			
S052T1126	052T1126	2.120		100.0%			
S052T1128	052T1128	1.390		100.0%			
S052T113	052T113	0.200		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052T1130	052T1130	1.490		75.0%	25.0%		
S052T1135	052T1135	0.910		100.0%			
S052T1137	052T1137	1.010		100.0%			
S052T114	052T114	0.890		100.0%			
S052T1141	052T1141	1.150		100.0%			
S052T1146	052T1146	0.830		100.0%			
S052T1147	052T1147	1.030		100.0%			
S052T1149	052T1149	1.370		92.1%	7.9%		
S052T114A	052T114	0.830		100.0%			
S052T1151	052T1151	1.460		100.0%			
S052T1152	052T1152	1.690		100.0%			
S052T1153	052T1153	1.720		100.0%			
S052T1156	052T1156	2.080		100.0%			
S052T1157	052T1157	2.320		100.0%			
S052T1158	052T1158	2.770		74.1%	14.7%	11.2%	
S052T1159	052T1159	2.420		100.0%			
S052T116	052T116	1.890		100.0%			
S052T1160	052T1160	2.900		100.0%			
S052T1161	052T1161	2.790		100.0%			
S052T1162	052T1162	3.370		100.0%			
S052T1163	052T1163	3.360		100.0%			
S052T1164	052T1164	2.310		100.0%			
S052T1165	052T1165	1.730		100.0%			
S052T1168	052T1168	1.830		100.0%			
S052T116A	052T116	1.410		100.0%			
S052T117	052T117	2.130		100.0%			
S052T1174	052T1174	0.670		100.0%			
S052T1176	052T1176	0.770		100.0%			
S052T1177	052T1177	1.610		100.0%			
S052T1179	052T1179	1.890		100.0%			
S052T117A	052T117	1.360		100.0%			
S052T118	052T118	0.510		100.0%			
S052T1181	052T1181	3.230		100.0%			
S052T1184	052T1184	1.950		100.0%			
S052T1187	052T1187	1.550		100.0%			
S052T1190	052T1190	1.960		100.0%			
S052T1191	052T1191	1.390		100.0%			
S052T1194	052T1194	2.450	14.2%	85.8%			
S052T1196	052T1196	3.320		100.0%			
S052T1198	052T1198	2.470		100.0%			
S052T1199	052T1199	0.930		100.0%			
S052T120	052T120	0.560		100.0%			
S052T1201	052T1201	1.340		100.0%			
S052T1203	052T1203	1.490		100.0%			
S052T1205	052T1205	2.560		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052T1206	052T1206	0.700		100.0%			
S052T121	052T121	0.660		100.0%			
S052T1216	052T1216	1.430		100.0%			
S052T1218	052T1218	1.670		100.0%			
S052T122	052T122	1.160		100.0%			
S052T1220	052T1220	2.060	17.4%	71.8%	10.7%	0.2%	
S052T1221	052T1221	2.480		100.0%			
S052T1222	052T1222	3.720		100.0%			
S052T1223	052T1223	2.030		100.0%			
S052T1224	052T1224	3.040		100.0%			
S052T1225	052T1225	2.480		100.0%			
S052T1226	052T1226	2.230		100.0%			
S052T1228	052T1228	1.950		100.0%			
S052T123	052T123	1.000		100.0%			
S052T1230	052T1230	3.470		100.0%			
S052T1231	052T1231	2.560		100.0%			
S052T1233	052T1233	2.400		100.0%			
S052T1234	052T1234	2.220		100.0%			
S052T1235	052T1235	1.470		87.9%		12.1%	
S052T1236	052T1236	2.050		76.0%		24.0%	
S052T1237	052T1237	2.290		100.0%			
S052T1238	052T1238	1.870		100.0%			
S052T124	052T124	0.570		100.0%			
S052T1240	052T1240	1.980		100.0%			
S052T1241	052T1241	1.720		100.0%			
S052T1242	052T1242	2.400		100.0%			
S052T1243	052T1243	1.830		100.0%			
S052T1245	052T1245	1.660		100.0%			
S052T125	052T125	1.310		100.0%			
S052T126	052T126	0.570		100.0%			
S052T1263	052T1263	3.250		93.3%	6.4%	0.2%	
S052T1264	052T1264	3.010		100.0%			
S052T1265	052T1265	2.280		100.0%			
S052T1266	052T1266	1.830		100.0%			
S052T1267	052T1267	1.780		100.0%			
S052T1269	052T1269	2.300		89.3%		10.7%	
S052T127	052T127	0.940		100.0%			
S052T1270	052T1270	2.980		100.0%			
S052T1271	052T1271	2.950		100.0%			
S052T1272	052T1272	3.230	11.3%	88.7%			
S052T1273	052T1273	2.060	7.0%	63.6%		29.4%	
S052T1278	052T1278	1.910		82.0%		18.0%	
S052T1279	052T1279	1.260		99.8%		0.2%	
S052T128	052T128	1.800		100.0%			
S052T1280	052T1280	0.490		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052T1284	052T1284	2.050		98.7%		1.3%	
S052T1285	052T1285	2.190		100.0%			
S052T1286	052T1286	2.510		100.0%			
S052T1289	052T1289	1.490		100.0%			
S052T129	052T129	0.620		100.0%			
S052T1290	052T1290	2.050		100.0%			
S052T1291	052T1291	1.950		100.0%			
S052T1294	052T1294	2.320		100.0%			
S052T1295	052T1295	2.050		100.0%			
S052T1296	052T1296	1.790		100.0%			
S052T1297	052T1297	1.420	0.1%	99.9%			
S052T1298	052T1298	2.990	27.5%	72.5%			
S052T130	052T130	1.180		100.0%			
S052T1300	052T1300	1.782		100.0%			
S052T1301	052T1301	2.069		100.0%			
S052T1302	052T1302	2.807		100.0%			
S052T1303	052T1303	3.125		100.0%			
S052T131	052T131	0.980		100.0%			
S052T132	052T132	0.550		100.0%			
S052T133	052T133	1.150		100.0%			
S052T134	052T134	1.140		0.1%	19.7%	80.2%	
S052T135	052T135	0.880		100.0%			
S052T136	052T136	0.690		99.7%		0.3%	
S052T1368	052T1368	1.400		0.2%	16.3%	83.5%	
S052T137	052T137	1.250		100.0%			
S052T138	052T138	0.820		99.8%	0.2%		
S052T139	052T139	1.080	37.2%	28.3%	19.5%	14.9%	
S052T140	052T140	0.480		100.0%			
S052T1401	052T1401	3.430		0.7%	10.4%	89.0%	
S052T1403	052T1403	1.740		0.9%	21.8%	77.3%	
S052T141	052T141	2.090		0.9%		99.1%	
S052T1410	052T1410	2.040			0.1%	99.9%	
S052T145	052T145	14.800		7.8%		92.2%	
S052T146	052T146	0.940		100.0%			
S052T1461	052T1461	2.390	71.4%	27.2%			1.5%
S052T147	052T147	2.150		100.0%			
S052T1471	052T1471	1.710	96.5%	2.6%			1.0%
S052T1478	052T1478	1.990	84.4%	13.9%			1.7%
S052T148	052T148	1.870		99.0%		1.0%	
S052T1484	052T1484	2.600	36.6%	63.4%			
S052T1488	052T1488	1.930	68.3%	31.5%			0.2%
S052T149	052T149	4.297		99.2%		0.8%	
S052T1494	052T1495	1.299	42.3%	57.7%			
S052T150	052T150	1.360		90.9%		9.1%	
S052T151	052T151	1.379		75.1%		24.9%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052T1513	052T1513	0.854	99.4%	0.6%			
S052T1521	052T1521	1.495		100.0%			
S052T1526	052T1526	0.609		100.0%			
S052T1537	052T1537	1.735		100.0%			
S052T1538	052T1538	1.620		100.0%			
S052T1540	052T1540	0.780	0.4%	99.6%			
S052T1542	052T1542	0.980		100.0%			
S052T1543	052T1543	2.600		100.0%			
S052T1544	052T1544	2.700	0.4%	99.6%			
S052T1545	052T1545	2.230	57.8%	42.2%			
S052T1546	052T1546	2.790		100.0%			
S052T1546A	052T1546	1.870		100.0%			
S052T1548	052T1548	3.610		92.0%		8.0%	
S052T1549	052T1549	1.990		91.2%		8.8%	
S052T1559	052T1559	1.200		31.9%		68.1%	
S052T157	052T157	2.670	38.6%	59.4%			2.0%
S052T2002	052T2002	1.237	48.3%	51.6%			0.1%
S052T2004	052T2004	1.070			100.0%		
S052T2005	052T2005	10.950	0.9%	0.4%		92.8%	5.9%
S052T2007	052T2007	1.240		1.5%		98.5%	
S052T2008	052T2008	8.270		0.2%	4.4%	95.5%	
S052T3002	052T3002	1.560	41.4%	58.6%			
S052T3467	052T3467	1.830	39.4%	60.6%			
S052T3469	052T3469	1.230	37.7%	62.3%			
S052T3470	052T3470	1.370	15.0%	85.0%			
S052T3473	052T3473	1.800		100.0%			
S052T3476	052T3476	2.000		100.0%			
S052T3478	052T3478	2.000		100.0%			
S052T3481	052T3481	3.230		100.0%			
S052T3485	052T3485	2.490	34.8%	65.2%			
S052T3486	052T3486	1.660	45.4%	54.6%			
S052T3487	052T3487	1.270		100.0%			
S052T3490	052T3490	2.440		100.0%			
S052T3494	052T3494	2.500		100.0%			
S052T3495	052T3495	2.310		100.0%			
S052T3497	052T3497	3.080		94.1%	5.9%		
S052T3498	052T3498	2.030	15.9%	84.1%			
S052T3502	052T3502	5.370	61.6%	29.2%	9.2%		
S052T4403	052T4403	1.395	50.5%	49.5%			
S052T4439	052T4439	0.749	4.5%	95.5%			
S052T4440	052T4440	0.870		100.0%			
S052T4441	052T4441	1.452		100.0%			
S052T4442	052T4442	1.351		100.0%			
S052T4445	052T4445	2.243		100.0%			
S052T4446	052T4446	1.237	0.1%	99.9%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S052T4449	052T4449	0.931		100.0%			
S052T4450	052T4450	2.147		100.0%			
S052T4582	052T4582	0.750		85.1%	14.9%		
S052T4585	052T4585	1.900		89.8%	10.2%		
S052T4588	052T4588	0.960		75.1%		24.9%	
S052T4590	052T4590	1.130		100.0%			
S052T4592	052T4592	1.280		88.7%		11.3%	
S052T4593	052T4593	1.520	57.7%	22.2%		20.0%	
S052T4597	052T4597	2.700		8.6%		91.4%	
S052T4600	052T4600	1.950		65.0%		35.0%	
S052T4601	052T4601	2.050		83.0%		17.0%	
S052T4602	052T4602	1.770		100.0%			
S052T4603	052T4603	2.210		100.0%			
S052T4604	052T4604	1.370		100.0%			
S052T4605	052T4605	2.150		100.0%			
S052T4606	052T4606	3.360		100.0%			
S052T4609	052T4609	0.480		100.0%			
S052T4635	052T4635	0.850		100.0%			
S053C008	053C008	5.664		5.8%	86.0%	8.0%	0.3%
S053C009	053C010	0.688		81.6%	0.1%	18.3%	
S053C011	053C011	0.726		81.1%	18.9%		
S053C012	053C012	0.809		100.0%			
S053C013	053C013	0.353		99.7%	0.3%		
S053C3521	053C3521	0.815		94.8%		5.2%	
S053C3525	053C3525	1.247		76.1%		23.9%	
S053C3528	053C3528	1.369		57.4%		42.6%	
S053C3529	053C3529	1.232		100.0%			
S053C3544	053C3544	0.481		100.0%			
S053T014	053T014	0.523		0.7%	99.3%		
S053T015	053T015	0.256		100.0%			
S053T016	053T016	0.555		100.0%			
S053T017	053T017	1.458			57.8%	41.7%	0.5%
S053T018	053T018	1.378		0.1%	2.2%	97.8%	
S053T3507	053T3507	1.699			54.5%	45.5%	
S053T3510	053T3510	3.613			8.9%	91.1%	
S053T3513	053T3513	1.987		0.2%	56.7%	43.2%	
S053T3533	053T3533	1.770		83.0%	17.0%		
S053T3534	053T3534	1.636		58.9%	41.1%		
S053T3536	053T3536	2.928		11.2%	37.1%	51.7%	
S053T3538	053T3538	1.771		98.2%		1.8%	
S053T3539	053T3539	1.490		100.0%			
S053T3541	053T3541	0.630		100.0%			
S053T3546	053T3546	1.613		60.3%	39.7%		
S053T3547	053T3547	0.448		27.3%	63.1%	9.6%	
S053T4333	053T4333	2.044		0.2%	0.1%	99.7%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S053T4339	053T4339	1.633		0.3%	65.4%	34.3%	
S053T4340	053T4340	1.618			100.0%		
S053T4342	053T4342	1.804		0.5%	28.9%	70.6%	
S053T4343	053T4343	1.066		0.4%	25.2%	74.4%	
S055C001	055C001	1.127	11.8%	88.2%			
S055C008	055C672	5.086	46.3%	53.7%			
S055C010	055C010	3.106	11.0%	89.0%			
S055C011	055C011	1.922	14.0%	86.0%			
S055C012	055C012	1.797	0.3%	99.7%			
S055C014	055C014	1.708		100.0%			
S055C015	055C015	1.355	4.9%	78.9%	5.4%	10.8%	
S055C700	055C700	2.447	11.6%	88.4%			
S055C701	055C701	2.224		100.0%			
S055C702	055C702	2.627		81.6%			18.4%
S055C705	055C705	1.906		100.0%			
S055C706	055C706	1.603		91.9%		8.1%	
S055T005	055T005	0.615	0.2%	99.8%			
S056C013	056C013	3.444	1.4%	27.0%	71.6%		
S056C014	056C014	0.934	0.2%	99.8%			
S056C019	056C019	0.768		8.5%	91.5%		
S056C035	056C035	0.525		100.0%			
S056C117	056C117	0.757		100.0%			
S056C1300	056C1300	1.513	51.0%	49.0%			
S056C1301	056C1301	0.344		100.0%			
S056C194	056C194	3.826	7.9%	36.4%	55.7%		
S056C195	056C195	1.751	0.6%	99.2%	0.2%		
S056C280	056C280	1.321		95.8%			4.2%
S056C281	056C281	0.851		100.0%			
S056C284A	056C284A	0.519	88.0%	12.0%			
S056C285	056C285	1.806		100.0%			
S056C289	056C289	0.794		33.2%		66.8%	
S056C296	056C296	4.104		99.9%		0.1%	
S056C297	056C297	7.772		100.0%			
S056C304	056C304	2.998		100.0%			
S056C305	056C305	3.633		93.7%		6.3%	
S056C307	056C307	4.861		99.7%		0.3%	
S056C318	056C318	4.946		100.0%			
S056C320	056C320	2.758		84.9%		15.1%	
S056C325	056C325	4.479		88.9%		11.1%	
S056C490	056C490	0.443	90.4%	9.6%			
S056C557	056C557	0.779		100.0%			
S056C898	056C898	3.509	26.9%	46.2%	26.9%		
S056C899	056C899	0.546	10.3%		89.7%		
S056C912	056C912	0.737	41.4%	58.6%			
S056C913	056C913	1.017	59.1%	40.9%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S056C914	056C914	1.763	52.1%	47.9%			
S056C917	056C917	0.422		100.0%			
S056C918	056C918	0.945	86.0%	14.0%			
S056C918A	056C918	0.423		100.0%			
S056C919	056C919	0.901	66.6%	33.2%		0.2%	
S056S032	056S032	1.129		100.0%			
S056S2143	056S2143	1.598	1.7%	56.2%	42.0%		
S056S810	056S810	4.602	2.6%	71.3%		26.0%	0.1%
S056T017	056T017	3.962	15.2%	66.0%	18.8%		
S056T023	056T023	2.384		81.8%	18.2%		
S056T024	056T024	2.568		43.2%	56.8%		
S056T028	056T028	1.923		66.6%	33.4%		
S056T030	056T030	4.613		99.4%	0.6%		
S056T034	056T034	4.050		100.0%			
S056T038	056T038	3.789		17.2%		82.8%	
S056T040	056T040	4.455	11.3%	41.0%		38.1%	9.6%
S056T049	056T049	2.452		2.1%		97.9%	
S056T050	056T050	2.739				100.0%	
S056T052	056T052	1.756				100.0%	
S056T055	056T055	5.600		12.1%		87.9%	
S056T058	056T058	1.176		95.2%	4.8%		
S056T060	056T060	3.478	30.9%	69.1%			
S056T061	056T061	3.851		99.4%		0.6%	
S056T064	056T064	4.807	11.2%	74.8%	3.9%	10.1%	
S056T101	056T101	1.030	68.7%	31.3%			
S056T115	056T115	1.494		100.0%			
S056T190	056T190	2.003		76.2%	23.8%		
S056T191	056T191	3.449	2.8%	68.8%	28.4%		
S056T2133	056T2133	2.282		78.7%		21.3%	
S056T2134	056T2134	2.575		100.0%			
S056T2136	056T2136	3.176		79.6%	4.2%		16.2%
S056T2137	056T2137	2.266		100.0%			
S056T2138	056T2138	2.069	8.4%	46.5%		45.0%	
S056T2138A	056T2138	2.693		100.0%			
S056T235	056T235	1.772		89.0%			11.0%
S056T239	056T239	2.765		100.0%			
S056T253	056T253	4.638		67.1%		28.7%	4.2%
S056T264	056T264	5.643		95.8%			4.2%
S056T296	056T296	4.566	4.1%	74.4%		14.8%	6.7%
S056T299	056T299	6.715		100.0%			
S056T303	056T303	1.549		100.0%			
S056T309	056T309	3.742		0.2%		99.8%	
S056T311	056T311	2.464		24.3%	32.6%	43.0%	
S056T313	056T313	1.788		73.0%	5.0%	22.0%	
S056T331	056T331	2.316	22.8%	26.4%	50.5%	0.3%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S056T334	056T334	1.870	13.5%	65.9%		20.6%	
S056T335	056T335	1.325		1.4%		98.6%	
S056T540	056T540	1.436		93.6%		6.4%	
S056T541	056T541	1.534		96.6%		3.4%	
S056T542	056T542	1.023		100.0%			
S056T542A	056T542A	1.115		100.0%			
S056T543	056T543	1.340		100.0%			
S056T545	056T545	1.097		100.0%			
S056T547	056T547	1.476		100.0%			
S056T548	056T548	1.101		100.0%			
S056T550	056T550	1.481		100.0%			
S056T554	056T554	1.704		100.0%			
S056T789	056T789	7.790		95.4%			4.6%
S056T792	056T792	6.715		90.9%			9.1%
S056T793	056T793	7.976		100.0%			
S056T801	056T801	5.793	5.1%	66.5%		16.8%	11.7%
S056T804	056T804	8.008		100.0%			
S056T806	056T806	0.126		100.0%			
S056T813	056T813	1.699		79.4%			20.6%
S056T820	056T820	2.770		100.0%			
S056T837	056T837	6.131		94.6%	2.4%		3.1%
S056T895	056T895	1.297	17.6%	82.4%			
S056T897	056T897	4.276	34.2%	60.9%	4.9%		
S056T900	056T900	2.131		40.3%	59.7%		
S057C005	057C005	1.448	37.7%	62.1%	0.2%		
S057C007	057C007	3.052	30.8%	69.2%			
S057C013	057C013	2.104	14.5%	85.5%			
S057C013A	057C013A	1.394	23.8%	76.2%			
S057C015	057C015	2.134	33.4%	66.6%			
S057C018	057C018	1.538	37.4%	62.6%			
S057C020	057C020	2.397	19.4%	79.8%		0.8%	
S057C021	057C021	2.151		100.0%			
S057C022	057C022	1.136		100.0%			
S057C023	057C023	1.772		44.4%		55.6%	
S057C024	057C024	3.041	0.1%	90.8%	9.2%		
S057C025	057C025	2.500	30.8%	69.2%			
S057C278	057C278	1.940		81.7%			18.3%
S057C279	057C279	1.764	77.8%	22.2%			
S057C282	057C282	1.784	90.1%	9.9%			
S057C286	057C286	3.761	90.9%	9.1%			
S057C442	057C442	1.615		8.9%	25.2%	65.9%	
S057C443	057C443	1.168		98.8%	1.2%		
S057T009	057T009	1.987		46.7%	53.3%		
S057T010	057T010	2.756	15.3%	84.7%			
S057T014	057T014	1.877		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S057T016	057T016	2.794	2.9%	97.1%			
S057T029	057T029	2.539	2.2%	47.1%		50.6%	
S057T030	057T030	2.586		85.9%		14.1%	
S057T031	057T031	1.149		100.0%			
S057T031A	057T031	1.144		100.0%			
S057T032	057T032	1.390		100.0%			
S057T036	057T036	1.797	20.3%	28.0%	0.1%	51.6%	
S057T047	057T047	1.628		2.8%		97.2%	
S057T048	057T048	1.999				100.0%	
S057T053	057T053	1.004			8.4%	91.6%	
S057T054	057T054	0.562		0.4%	0.4%	99.2%	
S057T1000	057T1000	1.854			25.9%	74.1%	
S057T370	057T370	4.998	99.4%	0.6%			
S057T372	057T372	4.534	98.8%	1.2%			
S057T375	057T375	8.429	80.4%	19.6%			
S057T379	057T379	7.185	47.0%	29.2%	4.1%	14.5%	5.2%
S057T400	057T400	0.693		41.2%		58.8%	
S057T405	057T405	4.138		47.2%		52.8%	
S057T409	057T409	5.960		28.8%		71.2%	
S057T414	057T414	5.489				100.0%	
S057T421	057T421	4.786		22.6%		77.4%	
S057T426	057T426	3.155	0.4%	99.6%			
S057T427	057T427	3.025	0.5%	99.5%			
S057T430	057T430	2.791	0.3%	88.9%			10.8%
S057T431	057T431	5.799			83.8%	11.6%	4.6%
S057T431A	057T431	3.714		73.1%	5.0%	18.7%	3.1%
S057T448	057T448	3.768		100.0%			
S057T452	057T452	2.162	15.2%	74.6%			10.2%
S057T457	057T457	9.026		99.7%		0.2%	
S057T469	057T469	3.457		99.0%	1.0%		
S057T471	057T471	5.418		100.0%			
S057T473	057T473	5.250		100.0%			
S057T474	057T474	2.595		100.0%			
S057T475	057T475	0.775		49.8%	11.8%	38.3%	
S057T477	057T477	5.069		99.6%		0.4%	
S057T480	057T480	7.072		100.0%			
S057T481	057T481	2.904		89.5%		10.5%	
S057T485	057T485	7.732	8.5%	89.1%	1.4%	1.0%	
S057T489	057T489	10.155		100.0%			
S057T511	057T511	10.302		98.5%		1.5%	
S057T514	057T514	5.960		100.0%			
S057T517	057T517	4.249		71.2%		28.8%	
S057T535	057T535	6.334		96.6%		3.4%	
S057T539	057T539	4.570		100.0%			
S057T547	057T547	4.151		23.7%	11.1%	65.2%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S057T552	057T552	2.071				100.0%	
S057T580	057T580	2.037	16.1%	83.7%	0.2%		
S057T601	057T601	2.339		91.2%		8.8%	
S057T603	057T603	4.496		100.0%			
S057T609	057T609	3.379		91.9%			8.1%
S057T610	057T610	2.504		100.0%			
S057T611	057T611	2.644		85.4%		14.6%	
S057T612	057T612	2.109		100.0%			
S057T613	057T613	2.151		100.0%			
S057T614	057T614	4.214		89.6%			10.4%
S057T617	057T617	5.092		96.1%			3.9%
S057T618	057T618	2.755		100.0%			
S057T621	057T621	2.725		42.2%	41.9%		15.9%
S057T630	057T630	3.753		100.0%			
S057T632	057T632	2.037		100.0%			
S057T635	057T635	1.906		100.0%			
S057T636	057T636	1.938		100.0%			
S057T637	057T637	2.511		43.9%		56.1%	
S057T638	057T638	4.039		76.9%	14.9%	2.7%	5.5%
S057T657	057T657	2.443			96.4%	3.6%	
S057T739	057T739	4.766		3.0%	87.6%	6.2%	3.2%
S058C002	058C002	3.021	77.6%	22.4%			
S058C004	058C004	3.601	57.2%	42.8%			
S058C004A	058C004	3.714	55.3%	23.8%		20.9%	
S058C005	058C005	3.754	75.2%	24.8%			
S058C006	058C006	6.198	72.5%	9.2%		18.2%	
S058C008	058C008	0.684		100.0%			
S058T014	058T014	7.428	1.8%	4.8%	0.3%	83.3%	9.9%
S059AC001	059AC001	1.524	99.1%	0.9%			
S059AC001A	059AC001	0.979	98.5%	1.5%			
S059AC001B	059AC001	0.839	99.8%	0.2%			
S059AC001C	059AC001	3.333	100.0%				
S059AC001D	059AC001	2.428	81.4%	18.6%			
S059AC001E	059AC001	1.012	56.2%	43.8%			
S059AC017	059AC017	1.063			0.2%	99.8%	
S059AC046A	059AC046A	0.850		16.0%	23.8%	60.3%	
S059AC1013	059AC1013	0.538		78.9%		21.1%	
S059AC1013A	059AC1013	0.586		99.0%		1.0%	
S059AC1015	059AC1015	1.302		100.0%			
S059AC1015A	059AC1015	1.323		98.2%		1.8%	
S059AC1017	059AC1017	0.684		83.0%		17.0%	
S059AC1017A	059AC1017	0.760		72.9%		27.1%	
S059AC1017B	059AC1017	1.543		99.7%		0.3%	
S059AC1017C	059AC1017	1.540		100.0%			
S059AC1020	059AC1020	2.974		90.6%	8.2%	1.2%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S059AC1021	059AC1021	1.992		99.7%		0.3%	
S059AC1023	059AC1023	2.838		0.4%		99.6%	
S059AC1023A	059AC1023	3.502		67.3%		32.7%	
S059AC1034	059AC1034	2.993		92.2%	7.8%		
S059AC1310	059AC1310	0.386		99.9%			
S059AC1310A	059AC1310	0.197		43.3%	56.7%		
S059AC3001	059AC3001	1.756		59.1%	16.0%	24.8%	
S059AC3002	059AC3002	2.152	17.0%	83.0%			
S059AC3003	059AC3003	2.331	49.6%	50.4%	0.1%		
S059AC3005	059AC3005	2.246		24.6%	75.4%		
S059AC898	059AC898	1.772	17.6%	60.1%	10.3%	11.9%	
S059AC898A	059AC898	1.582	0.1%	99.9%			
S059AC899	059AC899	2.879		100.0%			
S059AC900	059AC900	2.618		100.0%			
S059AC901	059AC901	1.494	0.2%	99.8%			
S059AC902	059AC902	2.775	11.9%	88.1%			
S059AC903	059AC903	2.502		100.0%			
S059AC904	059AC904	2.270		100.0%			
S059AC905	059AC905	1.921		92.6%		7.4%	
S059AC908	059AC908	1.970		98.2%	1.8%		
S059AC909	059AC909	1.250		100.0%			
S059AC910	059AC910	3.510		100.0%			
S059AC911	059AC911	3.234	5.1%	94.9%			
S059AC912	059AC912	2.762	8.3%	91.7%			
S059AC914	059AC914	1.220		100.0%			
S059AC914A	059AC914	0.470		100.0%			
S059AC916	059AC916	0.465	18.6%	81.4%			
S059AC916A	059AC916	1.228	41.6%	58.4%			
S059AC971	059AC971	1.376		100.0%			
S059AC972	059AC972	3.350		100.0%			
S059AC975	059AC975	3.610		96.2%		3.8%	
S059AC977	059AC977	1.680		100.0%			
S059AC978	059AC978	2.170		94.1%	5.9%		
S059AS3006	059AS3006	2.133	13.6%	60.6%	25.8%		
S059AST0RE	059AST0RE	5.406		4.5%		95.5%	
S059AT003	059AT003	4.649	99.5%	0.5%			
S059AT006A	059AT006A	1.648	6.8%	93.1%		0.2%	
S059AT006AB	059AT006A	1.908	47.9%	51.6%	0.4%		
S059AT007	059AT007	1.967	29.9%	18.2%	51.9%		
S059AT012	059AT012	1.286		100.0%			
S059AT016	059AT016	2.350		17.8%	1.7%	80.5%	
S059AT018	059AT018	2.730		2.3%	15.0%	82.6%	
S059AT021	059AT021	2.710		3.5%		96.5%	
S059AT022	059AT022	2.950		0.6%	6.1%	93.3%	
S059AT024	059AT024	1.980		45.3%	0.3%	54.4%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S059AT025	059AT025	2.100		0.2%	23.1%	76.8%	
S059AT026	059AT026	2.750		0.3%	23.6%	76.1%	
S059AT027	059AT027	2.300	15.6%	1.8%	17.5%	65.2%	
S059AT029	059AT029	2.190	0.2%		52.0%	47.8%	
S059AT030	059AT030	1.846			28.6%	71.4%	
S059AT031	059AT031	0.966			10.5%	89.5%	
S059AT1000	059AT1000	2.150		98.6%		1.4%	
S059AT1001	059AT1001	2.580		92.6%		7.4%	
S059AT1004	059AT1004	3.829		98.9%		1.1%	
S059AT1011	059AT1011	3.729		0.2%		99.8%	
S059AT1013	059AT1013	1.848				100.0%	
S059AT1014	059AT1014	0.596		93.8%		6.2%	
S059AT1018	059AT1018	1.092		94.4%		5.6%	
S059AT1039	059AT1039	2.820		99.9%		0.1%	
S059AT1041	059AT1041	1.891		99.7%		0.3%	
S059AT1043	059AT1043	2.093		100.0%			
S059AT1046	059AT1046	1.909		100.0%			
S059AT1311	059AT1311	0.964	0.1%	27.6%	71.6%	0.7%	
S059AT876	059AT876	3.090		95.8%		4.2%	
S059AT878	059AT878	3.290		100.0%			
S059AT880	059AT880	4.070		91.3%			8.7%
S059AT884	059AT884	2.504	2.0%	70.2%		21.4%	6.3%
S059AT884A	059AT884	6.554			0.5%	99.4%	0.1%
S059AT885	059AT885	4.771	4.4%	22.7%	26.0%	46.9%	
S059AT888	059AT888	2.420		59.1%		40.9%	
S059AT891	059AT891	2.600		100.0%			
S059AT913	059AT913	1.230		100.0%			
S059AT915	059AT915	1.235	0.6%	99.4%			
S059AT920	059AT920	3.995		96.1%		3.9%	
S059AT921	059AT921	2.890		100.0%			
S059AT922	059AT922	2.890		100.0%			
S059AT924	059AT924	3.670	2.7%	97.3%			
S059AT925	059AT925	2.410	12.0%	88.0%			
S059AT926	059AT926	2.520	41.7%	58.3%			
S059AT927	059AT927	2.440	54.2%	18.0%	25.6%	2.0%	
S059AT930	059AT930	3.665		95.7%		4.3%	
S059AT932	059AT932	4.430		100.0%			
S059AT933	059AT933	3.580		100.0%			
S059AT935	059AT935	3.120	15.0%	85.0%			
S059AT936	059AT936	0.750		100.0%			
S059AT937	059AT937	2.230	17.3%	82.7%			
S059AT940	059AT940	2.940	23.1%	76.9%			
S059AT942	059AT942	1.390		100.0%			
S059AT945	059AT945	4.050		100.0%			
S059AT946	059AT946	2.900		100.0%			

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S059AT948	059AT948	4.840		56.7%		43.3%	
S059AT950	059AT950	2.010		100.0%			
S059AT956	059AT956	3.190		95.7%	4.3%		
S059AT958	059AT958	3.000		100.0%			
S059AT960	059AT960	3.640		100.0%			
S059AT962	059AT962	3.680	11.6%	88.4%			
S059AT963	059AT963	4.520	24.9%	75.1%			
S059AT969	059AT969	2.741		99.9%		0.1%	
S059AT983	059AT983	2.620		99.9%	0.1%		
S059AT984	059AT984	1.920		100.0%			
S059AT985	059AT985	1.920		100.0%			
S059AT986	059AT986	2.190		99.8%		0.2%	
S059AT987	059AT987	2.470		100.0%			
S059AT989	059AT989	2.660		100.0%			
S059AT989A	059AT989	3.280		94.5%		5.5%	
S059AT993	059AT993	11.808		29.5%		70.4%	
S059AT995	059AT995	9.400		36.9%		63.1%	
S059AT999	059AT999	3.890		99.0%		1.0%	
S059BC010	059BC010	10.877	90.4%	9.4%		0.2%	
S059BT005	059BT005	2.157	83.4%	16.6%			
S059BT011	059BT011	2.979	19.2%	52.7%		28.1%	
S059BT013	059BT013	1.160		100.0%			
S059BT745	059BT745	3.028	67.3%	32.7%			
S059BT751	059BT751	1.979	77.2%	22.8%			
S059BT753	059BT753	3.054	93.0%	7.0%			
S059C0001	059C0001	3.821		1.0%		99.0%	
S059C0004	059C0004	1.398		2.5%		97.5%	
S059C0005	059C0005	3.856	34.9%	60.7%	4.4%		
S059C0009	059C0009	2.627	33.7%	51.2%	15.1%		
S059C0011	059C0011	5.082	7.9%	0.2%	78.8%	13.1%	
S059C0015	059C0015	2.665		10.8%	89.2%		
S059C0019	059C0019	2.912			99.9%	0.1%	
S059C0026	059C0026	1.279		26.6%	73.3%	0.1%	
S059C0028	059C0028	2.274		2.5%	13.2%	84.3%	
S059C0032	059C0032	2.744		9.0%	91.0%		
S059C0035	059C0035	3.073		19.6%	79.4%	1.0%	
S059C0040	059C0040	2.266		100.0%			
S059C0043	059C0043	1.189		0.7%	60.1%	39.2%	
S059C0044	059C0044	0.963		38.2%	1.1%	60.7%	
S059C0046	059C0046	2.777		10.2%	14.1%	75.6%	0.1%
S059C0047	059C0047	2.617			1.1%	98.9%	
S059C0051	059C0051	4.876	0.7%	12.0%	7.1%	80.2%	
S059C0052	059C0052	3.192	17.2%	6.8%	0.8%	75.1%	
S059C0053	059C0053	1.790		19.9%	17.3%	62.8%	
S059C0055	059C0055	1.756		72.2%		27.8%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S059C0057	059C0057	3.734	1.6%	19.3%	33.3%	45.8%	
S059C0058	059C0058	1.788	0.1%	35.3%		64.6%	
S059C0059	059C0059	5.036		0.1%		99.9%	
S059C0061	059C0061	1.036		100.0%			
S059C0062	059C0062	0.212		97.2%	0.6%	2.2%	
S059C0063	059C0063	0.378	1.8%	48.4%	49.8%		
S059C0064	059C0064	0.968		100.0%			
S059C0065	059C0065	0.940		85.8%	14.2%		
S059C0067	059C0067	1.825		80.9%		19.1%	
S059C0068	059C0068	0.863	0.1%	96.9%	3.1%		
S059C0069	059C0069	0.885	42.3%	1.7%		56.0%	
S059C0070	059C0070	1.671		13.4%		86.5%	
S059C0072	059C0072	0.703		99.8%		0.2%	
S059C0073	059C0073	1.157		99.8%		0.2%	
S059C0073A	059C0073A	2.591			0.2%	99.8%	
S059C0074A	059C0074A	1.906		0.8%	7.4%	91.9%	
S059C0075	059C0075	2.358				100.0%	
S059C0076	059C0076	3.904		2.6%	17.9%	79.5%	
S059C0076A	059C0076A	1.977		1.1%	1.2%	97.6%	
S059C0077	059C0077	18.169		81.8%	1.2%	15.7%	1.3%
S059C0077A	059C0077A	1.795		0.4%		99.6%	
S059C0079	059C0079	1.685		0.2%	5.7%	94.1%	
S059C0079A	059C0079A	1.093		100.0%			
S059C0080	059C0080	2.229		0.8%	33.7%	65.5%	
S059C0080A	059C0080A	1.262		100.0%			
S059C0081	059C0081	1.695			22.0%	78.0%	
S059C0081A	059C0081A	1.105		100.0%			
S059C0082	059C0082	1.029		100.0%			
S059C0082A	059C0082A	1.168		100.0%			
S059C0083	059C0083	0.891		100.0%			
S059C0083A	059C0083A	1.168		100.0%			
S059C0084	059C0084	0.924		99.9%		0.1%	
S059C0085	059C0085	15.804		0.1%		93.0%	6.9%
S059C0088	059C0088	0.757		100.0%			
S059C0089	059C0089	1.025		50.6%	26.8%	22.7%	
S059C0090	059C0090	1.032		87.4%	0.1%	12.5%	
S059C0091	059C0091	1.032		54.6%		45.4%	
S059C0092	059C0092	0.705		100.0%			
S059C0093	059C0093	0.693		100.0%			
S059C0097	059C0097	1.272		53.9%		41.6%	4.5%
S059C010	059C010	11.353	49.9%	15.2%	16.1%	18.7%	
S059C1009	059C1009	3.818		5.3%		94.7%	
S059C1020	059C1020	9.807	0.3%	0.1%	99.7%		
S059C2002	059C2002	2.621		93.4%		6.6%	
S059C2003	059C2003	2.616		100.0%			

S059C2004	059C2004	2.606	100.0%	
S059C2006	059C2006	1.970	100.0%	
S059C2007	059C2007	2.305	100.0%	
S059C2008	059C2008	2.650	100.0%	
S059C2009	059C2009	2.292	100.0%	
S059C2012	059C2012	2.151	100.0%	
S059C2013	059C2013	2.416	100.0%	
S059C2014	059C2014	2.440	100.0%	
S059C2015	059C2015	2.143	100.0%	
S059C2016	059C2016	2.158	100.0%	
S059C2017	059C2017	2.166	99.8%	0.2%
S059C2020	059C2020	1.297	100.0%	
S059C2021	059C2021	1.730	100.0%	
S059C2022	059C2022	1.952	100.0%	
S059C2023	059C2023	1.483	100.0%	
S059C2024	059C2024	2.003	100.0%	
S059C2025	059C2025	2.048	100.0%	
S059C2026	059C2026	1.701	100.0%	
S059C2032	059C2032	1.855	100.0%	
S059C2033	059C2033	1.722	100.0%	
S059C2034	059C2034	1.970	100.0%	
S059C2035	059C2035	1.448	100.0%	
S059C2036	059C2036	1.608	100.0%	
S059C2037	059C2037	1.950	100.0%	
S059C2038	059C2038	1.746	99.7%	0.3%
S059C2042	059C2042	2.262	99.9%	0.1%
S059C2043	059C2043	2.510	100.0%	
S059C2044	059C2044	2.066	100.0%	
S059C2045	059C2045	2.324	100.0%	
S059C2046	059C2046	1.668	100.0%	
S059C2050	059C2050	1.868	100.0%	
S059C2051	059C2051	2.391	100.0%	
S059C2052	059C2052	2.145	100.0%	
S059C2053	059C2053	1.555	100.0%	
S059C2055	059C2055	2.087	100.0%	
S059C2056	059C2056	1.598	99.9%	0.1%
S059C2060	059C2060	1.743	100.0%	
S059C2061	059C2061	1.649	100.0%	
S059C2062	059C2062	2.492	100.0%	
S059C2063	059C2063	1.869	100.0%	
S059C2064	059C2064	1.849	100.0%	
S059C2065	059C2065	2.212	100.0%	
S059C2066	059C2066	1.739	99.6%	0.4%
S059C2071	059C2071	2.604	99.6%	0.4%
S059C2072	059C2072	2.562	99.7%	0.3%
S059C2073	059C2073	1.726	100.0%	
S059C2074	059C2074	1.997	100.0%	
S059C2075	059C2075	1.977	100.0%	
S059C2076	059C2076	1.389	99.6%	0.4%

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S059C2082	059C2082	1.879		100.0%			
S059C2083	059C2083	2.067		100.0%			
S059C2090	059C2090	1.165		98.2%	1.8%		
S059C2092	059C2092	1.442		27.3%	49.6%	8.1%	14.9%
S059C2098	059C2098	1.765		88.2%	11.8%		
S059C3003	059C3003	2.644		55.1%		44.9%	
S059C3004	059C3004	2.715		99.7%		0.3%	
S059C3006	059C3006	2.385		99.7%	0.3%		
S059C3007	059C3007	1.320		90.3%		9.7%	
S059C3010	059C3010	3.911		100.0%			
S059C3011	059C3011	5.077		96.6%	3.4%		
S059C3017	059C3017	1.878		100.0%			
S059C3018	059C3018	2.155		100.0%			
S059C3019	059C3019	2.314		100.0%			
S059C3020	059C3020	1.108		100.0%			
S059C3022	059C3022	1.649		100.0%			
S059C3023	059C3023	2.166		100.0%			
S059C3024	059C3024	2.173		100.0%			
S059C3025	059C3025	1.446	0.1%	99.9%			
S059C3026	059C3026	1.453		100.0%			
S059C3029	059C3029	1.691		87.8%	12.0%	0.2%	
S059C3030	059C3030	1.946		99.4%		0.6%	
S059C3031	059C3031	1.981		100.0%			
S059C3035	059C3035	5.917		42.3%	3.4%	46.1%	8.1%
S059C3040	059C3040	2.391		85.0%		15.0%	
S059C3046	059C3046	4.247		34.7%		65.3%	
S059C3050	059C3050	1.494		37.8%	9.0%	53.2%	
S059C3057	059C3057	3.164		87.5%	12.5%		
S059C3058	059C3058	3.575	8.5%	76.0%	11.5%	4.0%	
S059C3059	059C3059	3.915	1.3%	95.9%		2.8%	
S059C3060	059C3060	2.720		85.6%	14.4%		
S059C3061	059C3061	3.443	0.2%	88.3%	11.5%		
S059C3074	059C3074	3.412		99.3%	0.7%		
S059C3077	059C3077	2.372		100.0%			
S059C3081	059C3081	2.303		100.0%			
S059C3083	059C3083	2.564		86.0%	13.8%	0.2%	
S059C3087	059C3087	2.390		57.8%		42.2%	
S059C3089	059C3089	1.882		54.6%		45.4%	
S059C3090	059C3090	1.993		44.4%		51.5%	4.1%
S059C3093	059C3093	4.228		53.1%	7.0%	33.0%	6.9%
S059C3101	059C3101	2.318		100.0%			
S059C3102	059C3102	1.866		100.0%			
S059C3103	059C3103	1.747	0.4%	86.9%	12.7%		
S059C3104	059C3104	2.076		94.5%	5.5%		
S059C3105	059C3105	2.880		99.9%	0.1%		

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S059C3108	059C3108	2.086		94.3%	5.7%		
S059C3109	059C3109	1.520		100.0%			
S059C3110	059C3110	1.172		99.6%	0.4%		
S059C3111	059C3111	1.392		100.0%			
S059C3112	059C3112	1.631		100.0%			
S059C3113	059C3113	1.872		99.9%	0.1%		
S059C3119	059C3119	2.744	7.2%	82.9%	9.0%	0.9%	
S059C3120	059C3120	3.171		86.1%	13.9%		
S059C3122	059C3122	2.435		99.8%	0.2%		
S059C3123	059C3123	2.596		66.0%	34.0%		
S059C3126	059C3126	1.570		92.4%	6.1%	1.5%	
S059C3126A	059C3126	3.118		69.0%	30.3%	0.7%	
S059C3129	059C3129	3.159		70.7%		29.3%	
S059C3131	059C3131	3.328		85.1%	14.0%	0.9%	
S059C3132	059C3132	2.676		72.4%	27.1%	0.5%	
S059C3135	059C3135	3.385		27.1%	49.7%	23.2%	
S059C3139	059C3139	0.846		64.1%	34.3%	1.6%	
S059C3140	059C3140	2.061		92.3%	6.9%	0.7%	
S059C3141	059C3141	1.407		80.9%		0.2%	18.8%
S059C3142	059C3142	3.492		87.4%	12.5%	0.1%	
S059C3143	059C3143	4.014	7.1%	42.6%	29.9%		20.3%
S059C3144	059C3144	5.784	11.9%	36.4%	47.1%		4.6%
S059C3149	059C3149	2.297	0.1%	99.8%	0.1%		
S059C3171	059C3171	2.260		78.0%	12.6%	9.3%	
S059C3176	059C3176	7.577			52.3%	35.6%	12.1%
S059C4096	059C4096	1.793		80.4%	19.6%		
S059C4100	059C4100	2.567		27.9%	38.4%	33.7%	
S059C4101	059C4101	1.809		30.8%	69.1%	0.1%	
S059C4102	059C4102	3.234		81.2%	10.0%	8.7%	
S059C4127	059C4127	2.056			99.5%	0.4%	
S059C4129	059C4129	2.898	11.6%	28.9%	53.5%	6.0%	
S059C4132	059C4132	4.935	6.2%	1.4%	60.6%	31.7%	
S059C4212	059C4212	5.932		0.1%	0.2%	94.1%	5.6%
S059C4225	059C4225	8.842		2.2%	11.3%	86.5%	
S059C4473	059C4473	0.927		75.2%		24.8%	
S059C4474	059C4474	2.158		89.0%	10.5%	0.5%	
S059C4478	059C4478	3.612		75.8%	24.2%		
S059C4482	059C4482	1.276		100.0%			
S059C4483	059C4483	1.514		82.3%		17.7%	
S059C4489	059C4489	1.625		100.0%			
S059C4490	059C4490	1.663		100.0%			
S059C4494	059C4494	2.428				100.0%	
S059C4499	059C4499	1.917		0.9%		99.1%	
S059C4507	059C4507	1.377		15.0%		85.0%	
S059C4510	059C4510	5.475		20.7%	5.2%	74.1%	

Subcatchment Name	Tributary To Node	Area (acres)	Low Density Residential	Medium Density Residential	High Density Residential	Commer-cial	Open Space
S059C4523	059C0081	22.841			0.1%	96.2%	3.7%
S059C4542	059C4542	42.974				85.8%	14.2%
S059C4563	059C4563	4.032		57.1%		42.9%	
S059C842A	059C842A	4.178	8.3%	84.5%		2.4%	4.8%
S059S3013	059S3013	4.372	6.8%	93.2%			
S059S3014	059S3014	4.838	13.8%	81.2%		5.1%	
S059T001	059T001	4.707			100.0%		
S059T017	059T017	3.553	50.2%	2.2%	47.5%		
S059T030	059T030	7.114		0.1%		96.5%	3.4%
S059T038	059T038	2.030		49.1%	21.7%	29.2%	
S059T041	059T041	1.273		98.8%	0.7%		0.5%
S059T042	059T042	1.127		60.7%		39.3%	
S059T071	059T071	2.115		3.7%	48.9%	47.4%	
S059T1006	059T1006	0.728		87.0%	13.0%		
S059T2085	059T2085	1.517		100.0%			
S059T2086	059T2086	1.545		97.2%	2.8%		
S059T2087	059T2087	1.696		66.1%	12.8%		21.1%
S059T2088	059T2088	1.445		100.0%			
S059T2089	059T2089	1.150		88.8%	11.2%		
S059T2096	059T2096	4.442		50.1%	49.9%		
S059T2097	059T2097	1.568		72.8%			27.2%
S059T3065	059T3065	3.627		91.9%	8.1%		
S059T3066	059T3066	2.865		94.4%	5.6%		
S059T3067	059T3067	2.210		100.0%			
S059T3068	059T3068	2.839	11.9%	77.9%	10.3%		
S059T3069	059T3069	2.848		94.4%	5.6%		
S059T3070	059T3070	3.187		99.7%	0.2%	0.1%	
S059T4107	059T4107	6.939			100.0%		
S059T4112	059T4112	11.086			99.8%	0.1%	
S059T4118	059T4118	7.367	7.5%		79.4%	13.0%	
S059T811	059T811	2.029		90.1%	9.9%		
S059T812	059T812	1.236	1.0%	98.8%	0.2%		
S059T813	059T813	1.316		95.3%	4.7%		
S059T815	059T815	2.131		99.7%	0.3%		
S059T816	059T816	1.344	12.5%	57.8%			29.7%
S059T819	059T819	1.518		91.5%			8.5%
S059T823	059T823	11.850		15.8%		79.4%	4.8%
S059T825	059T825	2.108	0.1%	99.9%			
S059T828	059T828	2.121		100.0%			
S059T830	059T830	2.273		91.1%			8.9%
S059T832	059T832	2.411		12.4%	70.1%	17.5%	
S059T849	059T849	3.785	29.0%	54.4%			16.6%
S059T892	059T892	3.810		100.0%			

APPENDIX B

FLOW AND POLLUTANT CONCENTRATIONS
SAMPLERS A-E

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APPENDIX B – FLOW AND POLLUTANT CONCENTRATIONS SAMPLERS A-E

B.1 Introduction

Five flow meters/samplers were installed to collect characterization data for the pollutant model. Four samplers collected runoff from the following types of land use:

A. Low density residential property (properties greater than 0.25 acre)
B. Commercial/Industrial properties
C. High density residential property (apartments and high-rise buildings)
D. Medium density residential (single family and duplexes on lots less than 0.25 acre)

Samplers A through D were programmed to start when the depth of flow reached one inch and to continue sampling every 15 minutes during the wet weather event until 8 samples were collected. The following pages list the dates that samples were collected and the concentrations of the four pollutants being modeled: Carbonaceous Biochemical Oxygen Demand (CBOD), Total Phosphorous (TP), and Total Suspended Solids (TSS) all as measured in milligrams per liter (mg/l) and Escherichia coli (*E. coli*) as measured in colony forming units per deciliter cfu/dl (a deciliter is 1/10 of a liter or 100 milliliters).

The target was to collect eight samples at each site from five rain events. Many runoff events lasted less than the 2 hours of 1-inch flow necessary to collect samples. Batteries died at some sites, so the sampling period was extended to include one additional storm. Site C had an equipment malfunction and only four storms were sampled. Site D had one storm where insufficient liquid was drawn to run all the tests, so only CBOD was analyzed. The dates, sample numbers and pollutant concentrations are listed on the following pages.

The fifth flow meter/sampler was installed for a week in a medium density residential area sewer to measure an hourly flow pattern and pollutant concentrations in sewage on a dry day.

A. Medium density residential sewage

Sampler E was programmed to collect separate samples at discreet times. Samples were taken every hour during the morning and evening peak flow periods. During off-peak periods, the samplers activated every other hour. During the night, an insufficient amount of flow was collected for each of samples 11, 12 and 13. These three samples were combined, analyzed, and reported in the 3:00 am time slot.

B.2 Pollutant Loadings

Pollutant loadings were calculated for each sample. Since the flow meters were programmed to measure the flow rate every five minutes, for samplers A-D, three flow rate readings (before, during and after the sampling) were averaged to calculate the total volume of flow associated with each sample. For sampler E, average hourly flow rates were calculated and used to determine flow volumes. The flow volume times the sample concentration and appropriate unit conversion factors were used to calculate the loadings. The equations are as follows:

lbs Pollutant	= # Gallons	x 8.34 lb/gal	x Concentration	x 1 liter/1,000,000 mg
Number of CFU	= # Gallons	x 3.7853 liter/gal	x Concentration	x 10 deciliter/liter

A flow weighted average concentration is shown on the following pages. A flow weighted average is used for the model as being more conservative than geometric means even though geometric means for *E. coli* are used for Lake Erie water quality at beaches.

Sampler A
Lake, west of intersection with Clifton & Forest
Low Density Residential

Flow Volume (Gallons)	Date & Sample #	Sample CBOD (mg/l)	Sample *E. coli* (cfu/dl)	Sample TP (mg/l)	Sample TSS (mg/l)	Sampler Washoff Loading CBOD (pounds)	Sampler Washoff Loading *E. coli* (cfu)	Sampler Washoff Loading TP (pounds)	Sampler Washoff Loading TSS (pounds)
3,237	8/03 - #1	20	115,600	2.5	1250	0.540	1.42E+10	0.067	33.744
58,858	8/03 - #2	26	1,004,000	1.11	233	12.763	2.24E+12	0.545	114.374
67,700	8/03 - #3	13	250,000	0.56	68	7.340	6.41E+11	0.316	38.394
43,833	8/03 - #4	14	650,000	0.55	32	5.118	1.08E+12	0.201	11.698
11,339	8/03 - #5	12	570,000	0.44	24	1.135	2.45E+11	0.042	2.270
17,942	8/03 - #6	9	880,000	0.39	18	1.347	5.98E+11	0.058	2.693
11,114	8/03 - #7	9	270,000	0.37	16	0.834	1.14E+11	0.034	1.483
7,918	8/03 - #8	10	240,000	0.36	16	0.660	7.19E+10	0.024	1.057
2,549	8/11 - #1								
228,469	8/11 - #2	29	432,000	0.85	152	55.257	3.74E+12	1.620	289.625
363,477	8/11 - #3	10	112,000	0.38	95	30.314	1.54E+12	1.152	287.983
68,930	8/11 - #4	9	96,000	0.46	43	5.174	2.50E+11	0.264	24.720
8,653	8/11 - #5	20	2,200,000	0.96	63	1.443	7.21E+11	0.069	4.546
257	8/11 - #6								
124	8/11 - #7								
95	8/11 - #8								
432,384	8/18 - #1	20	30,800	1.03	527	72.122	5.04E+11	3.714	1900.404
225,072	8/18 - #2	30	4,800,000	1.20	120	56.313	4.09E+13	2.253	225.252
7,335	8/18 - #3	27	5,000,000	0.76	54	1.652	1.39E+12	0.046	3.304
20,697	8/18 - #4	25	4,200,000	0.63	16	4.315	3.29E+12	0.109	2.762
31,474	8/18 - #5	22	4,200,000	0.64	27	5.775	5.00E+12	0.168	7.087
1,232	8/18 - #6	32	3,160,000	0.56	23	0.329	1.47E+11	0.006	0.236
114	8/18 - #7	47	2,960,000	0.70	31	0.045	1.27E+10	0.001	0.029
23	8/18 - #8	30	4,200,000	0.57	25	0.006	3.67E+09	0.000	0.005
934	9/04 - #1								
2,054	9/04 - #2								
4,886	9/04 - #3	9	90,090	0.41	101	0.367	1.67E+10	0.017	4.115
7,202	9/04 - #4	12	350,000	0.28	39	0.721	9.54E+10	0.017	2.342
6,861	9/04 - #5	67	960,000	1.04	245	3.834	2.49E+11	0.060	14.019
9,464	9/04 - #6	16	545,000	0.40	68	1.263	1.95E+11	0.032	5.367
8,049	9/04 - #7	9	467,000	0.23	23	0.604	1.42E+11	0.015	1.544
5,613	9/04 - #8	9	460,000	0.25	21	0.421	9.77E+10	0.012	0.983
1,113	9/14 - #1								
78,314	9/14 - #2	18	7,840,000	2.27	306	11.757	2.32E+13	1.483	199.861
278,223	9/14 - #3	73	590,000	0.77	123	169.388	6.21E+12	1.787	285.407
134,453	9/14 - #4	33	2,000,000	0.87	109	37.004	1.02E+13	0.976	122.226
41,161	9/14 - #5	35	380,000	0.75	88	12.015	5.92E+11	0.257	30.209
7,358	9/14 - #6	23	142,000	0.60	28	1.411	3.96E+10	0.037	1.718
5,946	9/14 - #7	9	88,900	0.57	23	0.446	2.00E+10	0.028	1.140
5,691	9/14 - #8	9	310,000	0.47	17	0.427	6.68E+10	0.022	0.807
			Weighted Average Concentrations			**27**	**1.24E+06**	**0.84**	**196**
						mg/l	cfu/dl	mg/l	mg/l

Sampler B
on Bell just north of Detroit
Mix of Commercial and Medium Density Residential

Flow Volume (Gallons)	Date & Sample #	Sample CBOD (mg/l)	Sample *E. coli* (cfu/dl)	Sample TP (mg/l)	Sample TSS (mg/l)	Sampler Washoff Loading CBOD (pounds)	Sampler Washoff Loading *E. coli* (cfu)	Sampler Washoff Loading TP (pounds)	Sampler Washoff Loading TSS (pounds)
250	8/03 - #1	102	177,800	1.51	220	0.213	1.68E+09	0.003	0.459
8,869	8/03 - #2	89	880,000	3.07	432	6.583	2.95E+11	0.227	31.955
10,299	8/03 - #3	31	1,235,600	0.90	102	2.663	4.82E+11	0.077	8.761
16,318	8/03 - #4	50	1,120,000	0.52	60	6.805	6.92E+11	0.071	8.166
14,031	8/03 - #5	58	457,800	0.45	30	6.787	2.43E+11	0.053	3.511
15,899	8/03 - #6	40	488,900	0.31	20	5.304	2.94E+11	0.041	2.652
12,845	8/03 - #7	30	48,890	0.56	18	3.214	2.38E+10	0.060	1.928
15,063	8/03 - #8	27	88,900	0.28	10	3.392	5.07E+10	0.035	1.256
3,623	8/11 - #1	34	144,000	0.87	194	1.027	1.97E+10	0.026	5.862
1,568	8/11 - #2	124	30,400,000	3.10	342	1.622	1.80E+12	0.041	4.473
45,232	8/11 - #3	30	47,200,000	0.78	126	11.317	8.08E+13	0.294	47.532
289,849	8/11 - #4	9	368,000	0.47	114	21.756	4.04E+12	1.136	275.577
48,594	8/11 - #5	11	440,000	0.55	116	4.458	8.09E+11	0.223	47.012
6,022	8/11 - #6	19	4,900,000	0.61	76	0.954	1.12E+12	0.031	3.817
839	8/11 - #7								
209	8/11 - #8								
24,647	8/18 - #1	48	38,500	0.49	134	9.867	3.59E+10	0.101	27.545
127,603	8/18 - #2	26	380,000	0.52	103	27.669	1.84E+12	0.553	109.614
70,296	8/18 - #3	24	370,000	0.59	94	14.070	9.85E+11	0.346	55.109
29,102	8/18 - #4	27	1,000,000	0.53	42	6.553	1.10E+12	0.129	10.194
35,617	8/18 - #5	24	76,900	0.34	55	7.129	1.04E+11	0.101	16.338
23,904	8/18 - #6	11	192,000	0.37	44	2.193	1.74E+11	0.074	8.772
10,032	8/18 - #7	14	92,300	0.45	27	1.171	3.51E+10	0.038	2.259
4,288	8/18 - #8								
2,150	8/25 - #1	19	7,840	0.39	89	0.341	6.38E+08	0.007	1.596
4,324	8/25 - #2	175	148,000	3.78	340	6.311	2.42E+10	0.136	12.262
4,850	8/25 - #3	22	125,000	0.71	48	0.890	2.30E+10	0.029	1.942
510	8/25 - #4								
62	8/25 - #5								
20	8/25 - #6								
7	8/25 - #7								
5	8/25 - #8								
728	9/04 - #1	65	1,280,000	1.31	148	0.395	3.53E+10	0.008	0.899
5,951	9/04 - #2	15	440,000	0.41	45	0.745	9.91E+10	0.020	2.234
14,277	9/04 - #3	9	400,000	0.30	31	1.072	2.16E+11	0.036	3.691
10,677	9/04 - #4	9	128,000	0.23	23	0.801	5.17E+10	0.020	2.048
14,173	9/04 - #5	9	152,000	0.19	24	1.064	8.15E+10	0.022	2.837
11,093	9/04 - #6								
910	9/04 - #7								
188	9/04 - #8								
			Weighted Average Concentrations			**21** mg/l	**2.85E+06** cfu/dl	**0.53** mg/l	**95** mg/l

Sampler C
Edgewater west of W. 117th St.
High Density Residential

Flow Volume (Gallons)	Date & Sample #	Sample CBOD (mg/l)	Sample *E. coli* (cfu/dl)	Sample TP (mg/l)	Sample TSS (mg/l)	Sampler Washoff Loading CBOD (pounds)	Sampler Washoff Loading *E. coli* (cfu)	Sampler Washoff Loading TP (pounds)	Sampler Washoff Loading TSS (pounds)
161	8/03 - #1	58	9,000,000	3.15	189	0.078	5.48E+10	0.004	0.254
2,265	8/03 - #2	44	4,800,000	1.24	90	0.831	4.12E+11	0.023	1.700
5,545	8/03 - #3	15	1,950,000	0.59	15	0.694	4.09E+11	0.027	0.694
7,663	8/03 - #4	10	2,050,000	0.48	15	0.639	5.95E+11	0.031	0.959
5,983	8/03 - #5	11	260,000	0.45	10	0.549	5.89E+10	0.022	0.499
7,502	8/03 - #6	9	431,100	0.36	5	0.563	1.22E+11	0.023	0.313
5,449	8/03 - #7	9	130,000	0.38	10	0.409	2.68E+10	0.017	0.454
6,509	8/03 - #8	9	2,550,000	0.90	5	0.489	6.28E+11	0.049	0.271
13	8/18 - #1								
22,158	8/18 - #2								
83,523	8/18 - #3								
	8/18 - #4								
	8/18 - #5								
	8/18 - #6								
	8/18 - #7								
	8/18 - #8								
1,535	8/25 - #1	12	578	1.14	13	0.154	3.36E+07	0.015	0.166
8,237	8/25 - #2	39	34,000	1.12	107	2.679	1.06E+10	0.077	7.351
4,001	8/25 - #3	9	31,400	0.30	23	0.300	4.76E+09	0.010	0.768
2,331	8/25 - #4	9	15,700	0.23	7	0.175	1.39E+09	0.004	0.136
1,741	8/25 - #5	9	23,500	0.31	4	0.131	1.55E+09	0.005	0.058
1,105	8/25 - #6	9	7,840	0.28	5	0.083	3.28E+08	0.003	0.046
711	8/25 - #7								
648	8/25 - #8								
1,246	9/04 - #1	107	1,440,000	2.49	1450	1.112	6.79E+10	0.026	15.071
8,147	9/04 - #2	12	260,000	2.10	2690	0.815	8.02E+10	0.143	182.782
11,063	9/04 - #3	16	440,000	0.56	508	1.476	1.84E+11	0.052	46.871
8,729	9/04 - #4	9	42,000	0.29	135	0.655	1.39E+10	0.021	9.828
7,506	9/04 - #5	9	23,400	0.23	109	0.563	6.65E+09	0.014	6.823
11,722	9/04 - #6	9	46,000	0.24	165	0.880	2.04E+10	0.023	16.130
5,934	9/04 - #7	9	42,000	0.17	35	0.445	9.43E+09	0.008	1.732
3,007	9/04 - #8	9	46,000	0.18	15	0.226	5.24E+09	0.005	0.376
33,317	9/11 - #1	9	210,000	0.68	93	2.501	2.65E+11	0.189	25.842
59,179	9/11 - #2	9	97,800	0.32	76	4.442	2.19E+11	0.158	37.510
27,114	9/11 - #3	9	133,000	0.35	49	2.035	1.37E+11	0.079	11.080
9,105	9/11 - #4								
4,452	9/11 - #5								
3,533	9/11 - #6								
3,793	9/11 - #7								
3,106	9/11 - #8								
		Weighted Average Concentrations				**7** mg/l	**2.39E+05** cfu/dl	**0.33** mg/l	**120** mg/l

Sampler D
Hilliard @ Eldred
Medium Density Residential

Flow Volume (Gallons)	Date & Sample #	Sample CBOD (mg/l)	Sample *E. coli* (cfu/dl)	Sample TP (mg/l)	Sample TSS (mg/l)	Sampler Washoff Loading CBOD (pounds)	Sampler Washoff Loading *E. coli* (cfu)	Sampler Washoff Loading TP (pounds)	Sampler Washoff Loading TSS (pounds)
711	8/03 - #1	20	380,000	1.73	310	0.119	1.02E+10	0.010	1.838
2,958	8/03 - #2	45	7,100,000	1.90	215	1.110	7.95E+11	0.047	5.303
5,541	8/03 - #3	30	977,800	1.24	205	1.386	2.05E+11	0.057	9.473
7,799	8/03 - #4	12	270,000	0.72	75	0.780	7.97E+10	0.047	4.878
8,253	8/03 - #5	9	200,000	0.53	40	0.619	6.25E+10	0.036	2.753
7,658	8/03 - #6	12	195,000	0.56	20	0.766	5.65E+10	0.036	1.277
7,113	8/03 - #7	9	115,000	0.44	30	0.534	3.10E+10	0.026	1.780
4,486	8/03 - #8	9	105,000	0.55	25	0.337	1.78E+10	0.021	0.935
39,664	8/11 - #1	20	32,000	0.65	335	6.616	4.80E+10	0.215	110.816
49,381	8/11 - #2	12	384,000	0.46	130	4.942	7.18E+11	0.189	53.539
52,399	8/11 - #3	10	352,000	0.47	92	4.370	6.98E+11	0.205	40.205
16,340	8/11 - #4	11	224,000	0.54	78	1.499	1.39E+11	0.074	10.629
4,813	8/11 - #5	32	940,000	0.92	126	1.284	1.71E+11	0.037	5.057
1,742	8/11 - #6	23	640,000	0.82	93	0.334	4.22E+10	0.012	1.351
575	8/11 - #7					0.000	0.00E+00	0.000	0.000
34	8/11 - #8					0.000	0.00E+00	0.000	0.000
1,871	8/25 - #1	75				1.171	0.00E+00	0.000	0.000
1,542	8/25 - #2	46				0.592	0.00E+00	0.000	0.000
1,472	8/25 - #3					0.000	0.00E+00	0.000	0.000
309	8/25 - #4					0.000	0.00E+00	0.000	0.000
16	8/25 - #5					0.000	0.00E+00	0.000	0.000
6	8/25 - #6					0.000	0.00E+00	0.000	0.000
2	8/25 - #7					0.000	0.00E+00	0.000	0.000
132	8/25 - #8					0.000	0.000	0.000	0.000
1,867	9/04 - #1					0.000	0.00E+00	0.000	0.000
4,144	9/04 - #2	59	1,040,000	1.48	200	2.039	1.63E+11	0.051	6.913
5,909	9/04 - #3	27	560,000	0.99	132	1.331	1.25E+11	0.049	6.505
6,726	9/04 - #4	25	254,000	0.55	58	1.402	6.47E+10	0.031	3.253
6,977	9/04 - #5	26	196,000	0.53	76	1.513	5.18E+10	0.031	4.422
6,222	9/04 - #6	22	980,000	0.36	50	1.142	2.31E+11	0.019	2.595
3,799	9/04 - #7	21	400,000	0.42	37	0.665	5.75E+10	0.013	1.172
1,509	9/04 - #8					0.000	0.00E+00	0.000	0.000
12,293	9/11 - #1	33	3,500,000	2.35	148	3.383	1.63E+12	0.241	15.173
31,154	9/11 - #2	23	370,000	0.89	211	5.976	4.36E+11	0.231	54.824
38,195	9/11 - #3	16	210,000	0.41	102	5.097	3.04E+11	0.131	32.492
29,164	9/11 - #4	12	169,000	0.36	58	2.919	1.87E+11	0.088	14.107
11,868	9/11 - #5	11	107,000	0.38	50	1.089	4.81E+10	0.038	4.949
5,800	9/11 - #6	10	310,000	0.41	42	0.484	6.81E+10	0.020	2.032
3,926	9/11 - #7	13	470,000	0.50	41	0.426	6.99E+10	0.016	1.343
3,348	9/11 - #8	13	1,090,000	0.47	38	0.363	1.38E+11	0.013	1.061
		Weighted Average Concentrations				**17**	**4.53E+05**	**0.61**	**124**
						mg/l	cfu/dl	mg/l	mg/l

Sampler E
Hilliard @ Eldred
Medium Density Residential Sewage

Time	Average Hourly Flow Rate (MGD)	Sample CBOD (mg/l)	Sample *E. coli* (cfu/dl)	Sample TP (mg/l)	Sample TSS (mg/l)	Pollutant Loading CBOD (pounds)	Pollutant Loading *E. coli* (cfu)	Pollutant Loading TP (pounds)	Pollutant Loading TSS (pounds)
10:15	0.187								
11:15	0.175	270	1.7E+07	5.39	292	34.0	9.71E+12	0.68	36.7
12:15	0.178								
13:15	0.174	290	3.4E+07	6.58	464	35.4	1.88E+13	0.80	56.6
14:15	0.129								
15:15	0.127	360	3.7E+07	6.26	692	32.0	1.49E+13	0.56	61.4
16:15	0.152								
17:15	0.153	166	8.0E+07	3.69	246	17.6	3.85E+13	0.39	26.1
18:15	0.163	168	3.2E+07	4.49	220	9.5	8.22E+12	0.25	12.5
19:15	0.154	198	3.9E+07	4.68	354	10.6	9.48E+12	0.25	19.0
20:15	0.155	198	3.9E+07	4.68	354	10.7	9.53E+12	0.25	19.0
21:15	0.132	260	7.2E+07	4.32	178	11.9	1.50E+13	0.20	8.2
22:15	0.109	410	5.0E+06	4.68	428	15.6	8.61E+11	0.18	16.2
23:15	0.097	219	4.5E+07	4.77	224	14.6	1.36E+13	0.32	14.9
0:15	0.095								
1:15	0.081								
2:15	0.063								
3:15	0.053	102	2.7E+07	4.26	64	8.9	1.07E+13	0.37	5.6
4:15	0.056								
5:15	0.061								
6:15	0.079	197	5.4E+06	6.82	236	9.6	1.19E+12	0.33	11.5
7:15	0.128	183	7.0E+06	8.31	198	8.1	1.41E+12	0.37	8.8
8:15	0.166	373	1.8E+07	9.47	818	21.5	4.70E+12	0.55	47.1
9:15	0.168	233	6.9E+07	5.93	189	13.6	1.83E+13	0.35	11.0
Average	**0.126**	**241.8**	**3.51E+07**	**5.62**	**330.5**				
Weighted Average		**240.6**	**3.66E+07**	**5.55**	**336.6**				
Geometric Mean			**2.60E+07**		Total Load	253.4	1.75E+14	5.84	354.6

SWMM total flow	0.062	MGD
SWMM sewage flow	0.051	MGD
sewage portion of total flow	82.7	%
sewage cfu concentration per 100ml	4.43E+07	cfu/dl

2011 sewage flow (MGD)	3.031
Yearly cfu Loading	1.85E+19

B.3 Sewage Loadings

Sampler E collected 24 hours of sanitary flow. Samples were collected hourly during the morning and evening peak flows, less often throughout the rest of the day. Average and flow weighted averages had similar values. A geometric mean *E. coli* value was also calculated. The more conservative weighted average was used to calculate the sewage concentration ($3.66 \times 10^7 \div 82.7\% = 4.43 \times 10^7$ cfu/dl).

As shown in Section 2.2 the average sewage flow rate reaching the WWTP is 3.031 MGD. This flow rate for 365 days and the sewage concentration were used to calculate the yearly *E. coli* loading using the equation in Section A.2. This value was used in Chapter 6 for comparison to the SWMM output.

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APPENDIX C

GRAPHS OF

SWMM POLLUTANT LOADINGS

VERSUS

METERS A-D MEASURED LOADINGS

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APPENDIX C – SWMM POLLUTANT LOADINGS VERSUS METERS A-D MEASURED LOADINGS

C.1 Introduction

Four flow meters/samplers were installed to collect runoff characterization data for the pollutant model from the following types of land use:

A. Low density residential property (properties greater than 0.25 acre)
B. Commercial/Industrial properties
C. High density residential property (apartments and high-rise buildings)
D. Medium density residential (single family and duplexes on lots less than 0.25 acre)

The collected runoff samples were analyzed for four pollutants: Carbonaceous Biochemical Oxygen Demand (CBOD), Total Phosphorous (TP), and Total Suspended Solids (TSS) all as measured in milligrams per liter (mg/l) and *Escherichia coli* (*E. coli*) as measured in colony forming units per deciliter cfu/dl (a deciliter is 1/10 of a liter or 100 milliliters). Appendix B shows the pollutant concentrations, flow volumes and calculated 15-minute pollutant loadings for these four parameters.

C.2 SWMM Output versus Sampled Data

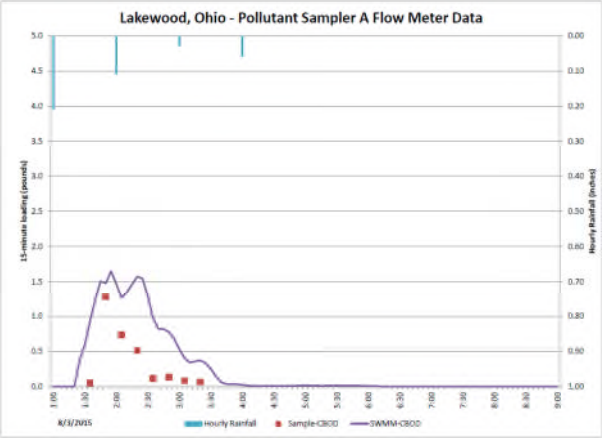
SWMM calculates pollutant concentrations in runoff. These concentrations are based on buildup and washoff equations within the SWMM programming capabilities. For the Lakewood pollutant model the SWMM concentrations were converted to 15-minute loadings, and the loadings were graphed as continuous lines on the following pages. The 15-minute pollutant loadings from the meter/sampler data are shown as discrete points on the same graphs.

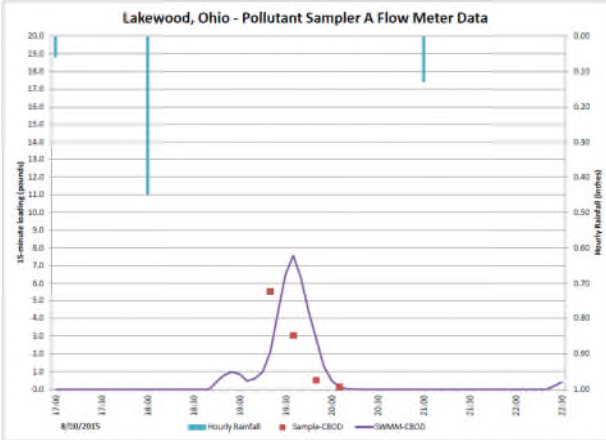
The SWMM buildup and wash off parameters were calibrated to have SWMM output model the loadings from the meters/samplers. Buildup parameters were calibrated to have the total SWMM loadings closely match total meter/sampler loadings. The sampled data showed a first flush effect where the majority of the pollutants were washed off within the first hour. The SWMM washoff parameters were calibrated to have the SWMM loadings match this first flush effect.

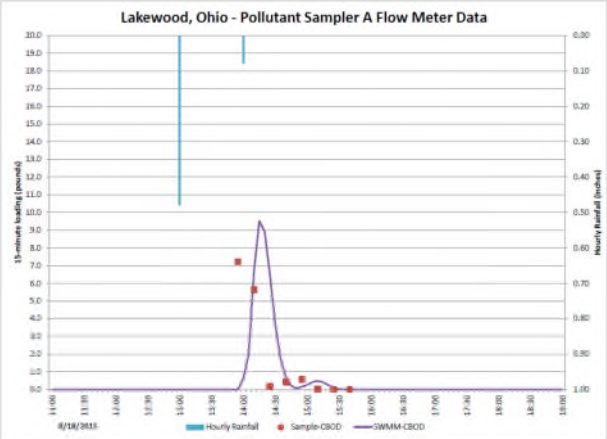
On any given rain event, SWMM output may be more or less than the measured quantities. This is due to the variability of human activity as compared to the structured SWMM buildup equations. CBOD and *E. coli* variations can be influenced inconsistently by pet waste deposition and food litter. TP variations can be influenced when homeowners or lawn care companies apply fertilizer. TSS variations can be influenced by mud tracked onto streets from construction activity. To allow for this variability, greater emphasis was placed on matching the total SWMM pollutant loadings to the metered/sampled loadings as compared to pollutant concentrations.

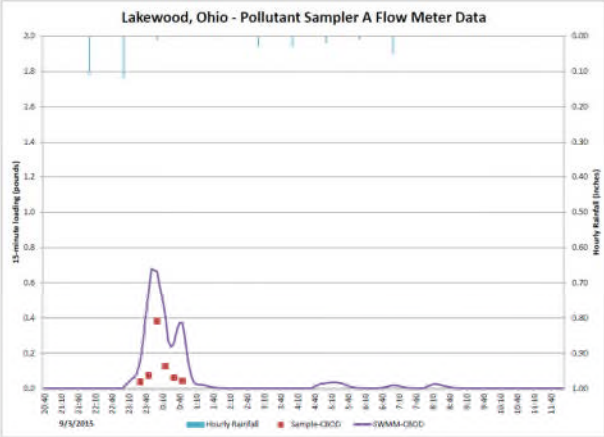
Notes:
1. Because *E. coli* is plotted on a logarithmic scale, rainfall could not be plotted. Refer to the other pollutant graphs for hourly rainfall data.
2. Hourly rainfall is graphed at the beginning of the hour and may have occurred closer to the pollutant runoff than when it appears on the graph.

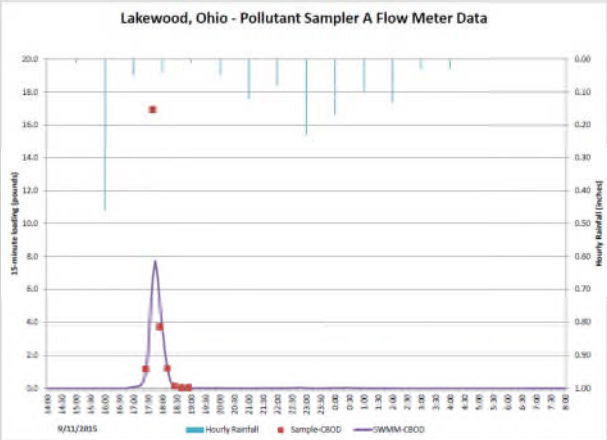
Area A – Low Density Residential - CBOD



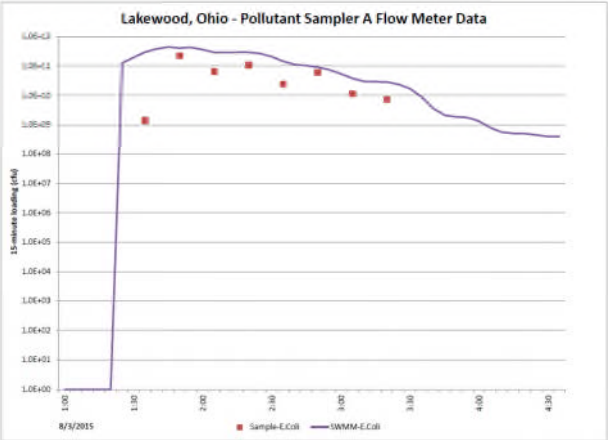


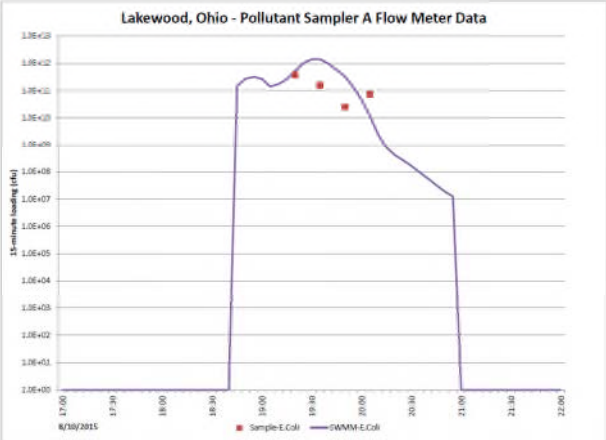


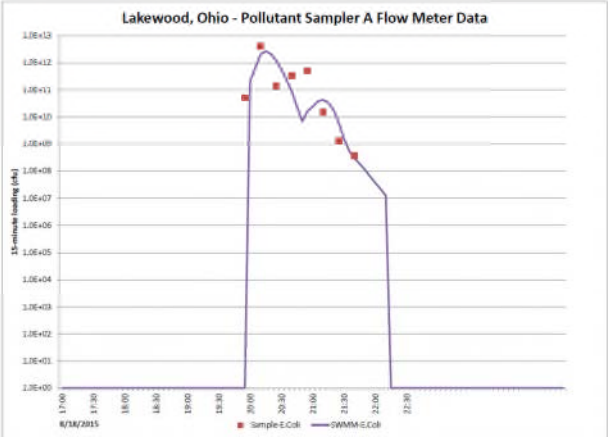


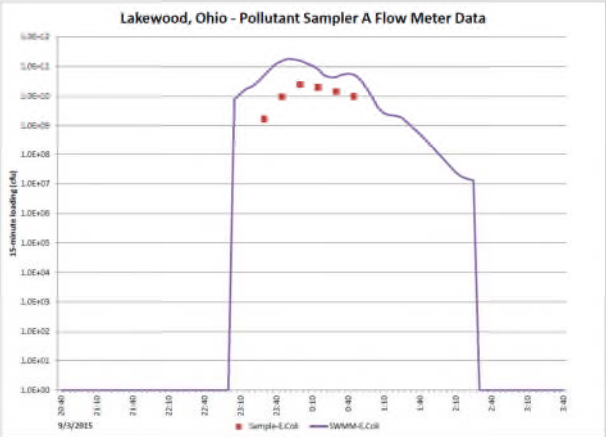


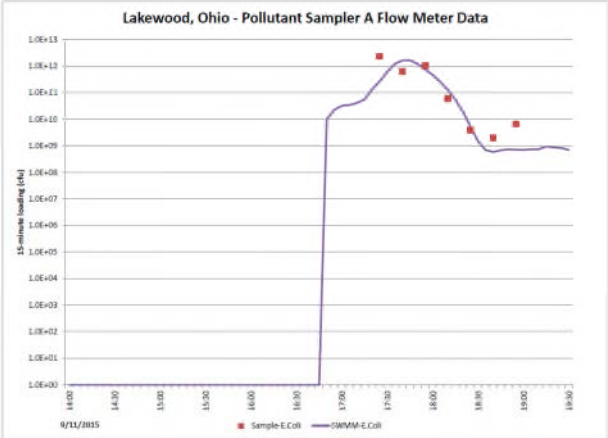
Area A – Low Density Residential – *E. coli*











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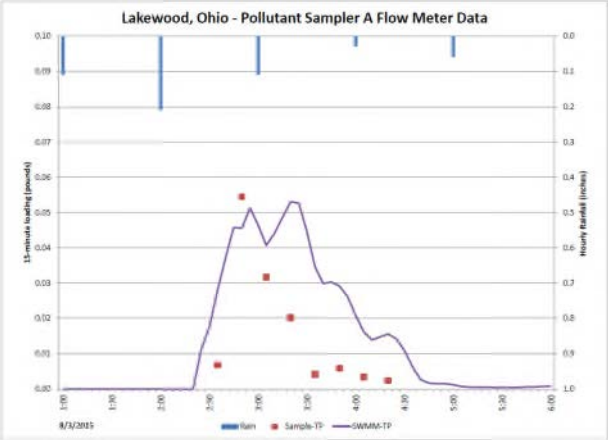
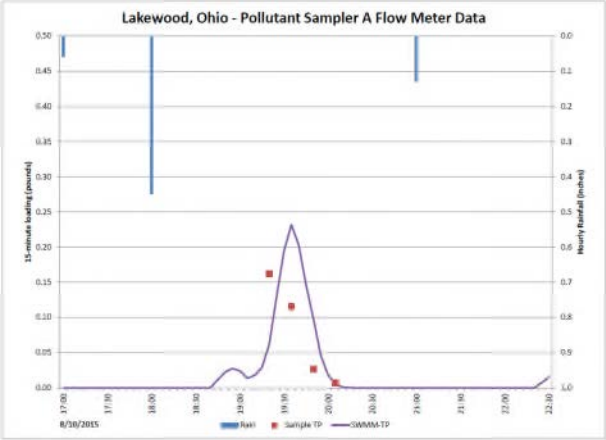
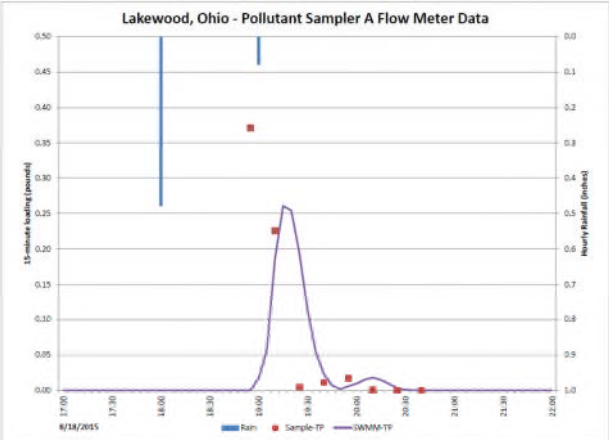
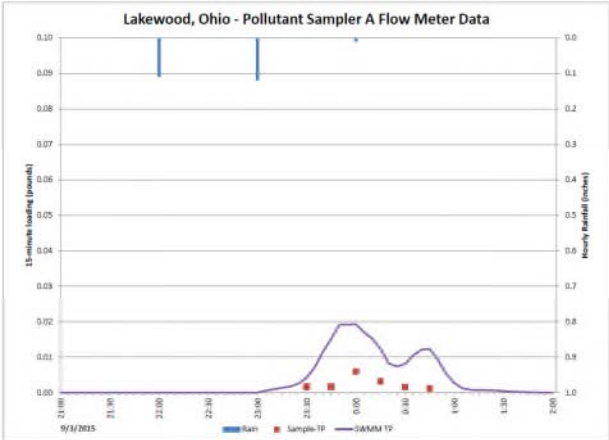
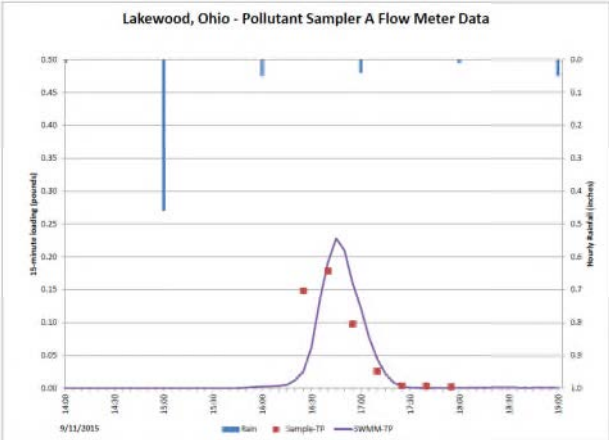


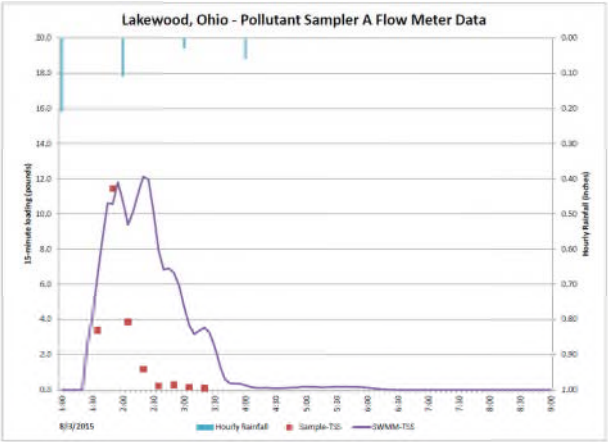


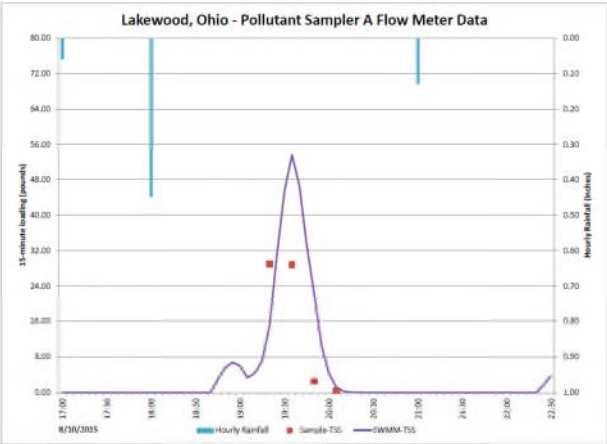


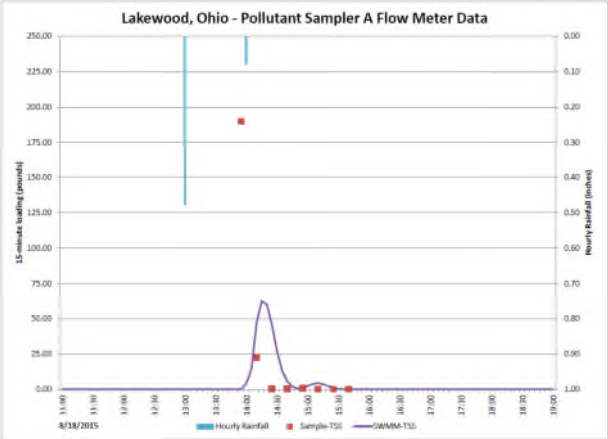


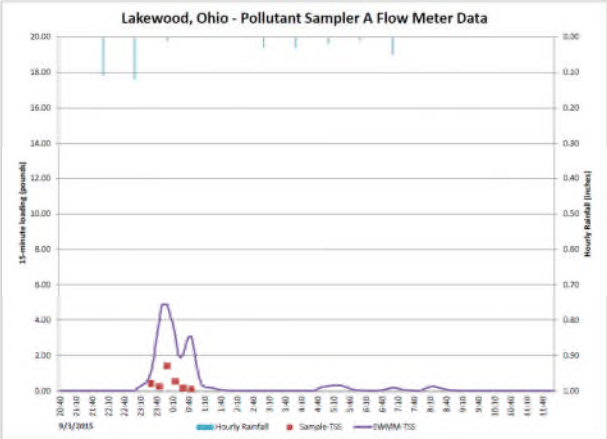


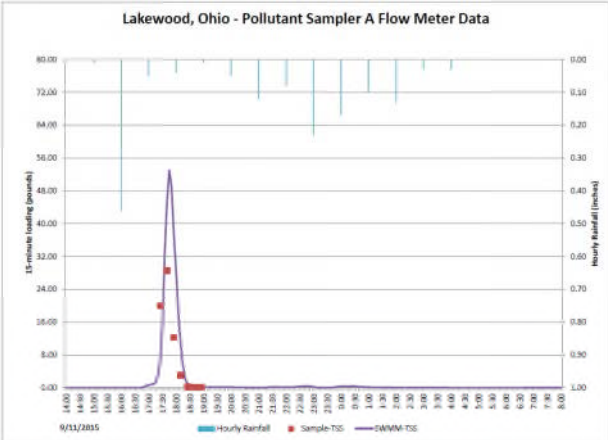
Area A – Low Density Residential - TSS



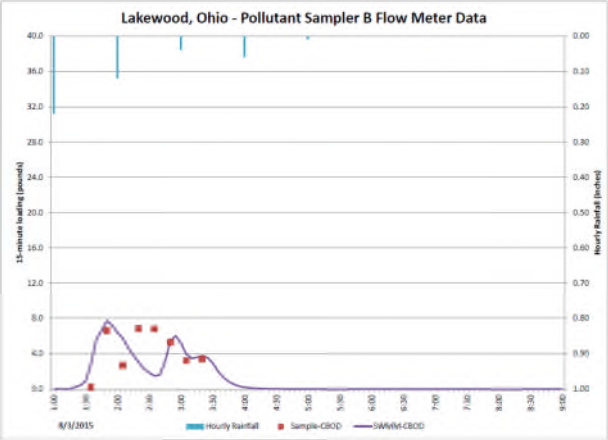


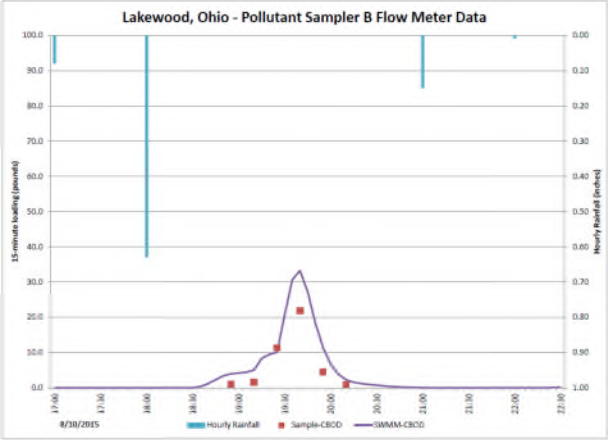


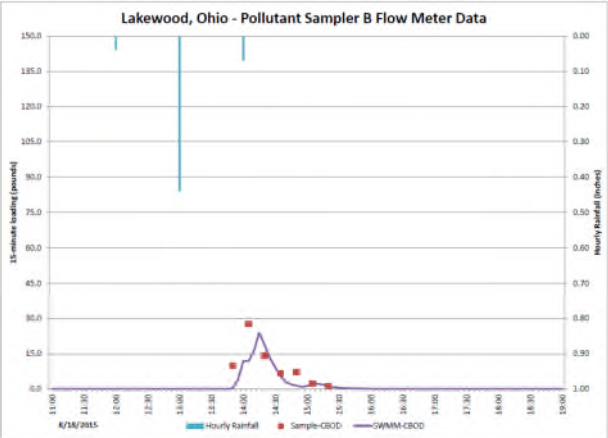


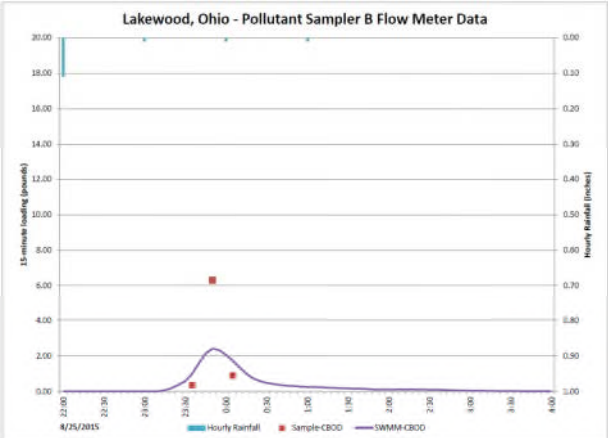


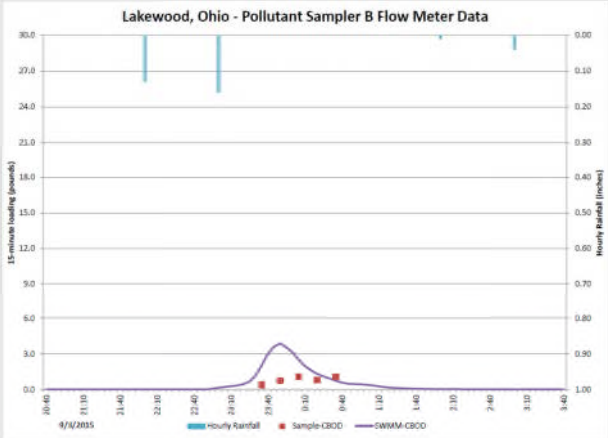
Area B – Commercial - CBOD



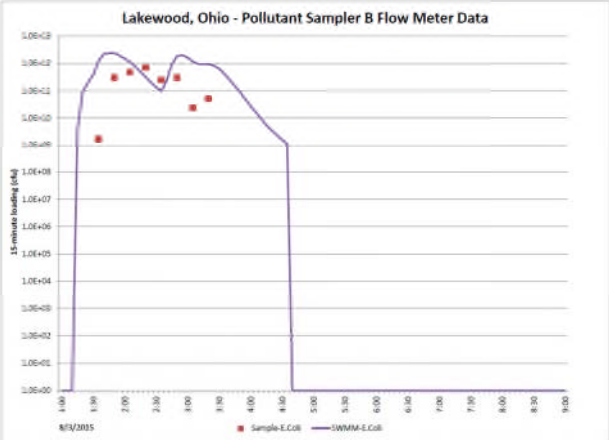


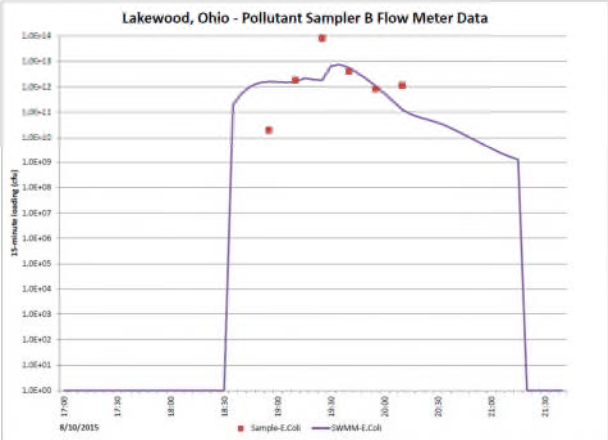


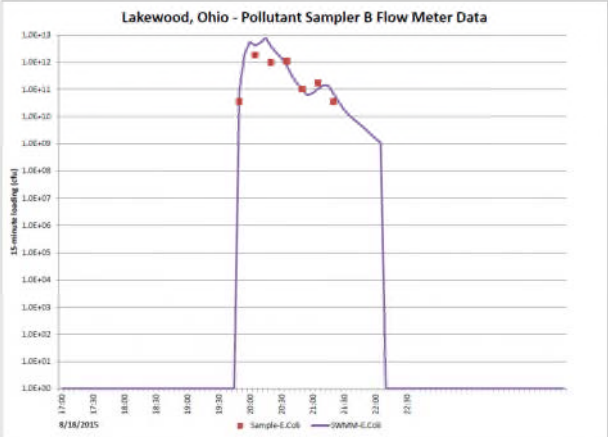


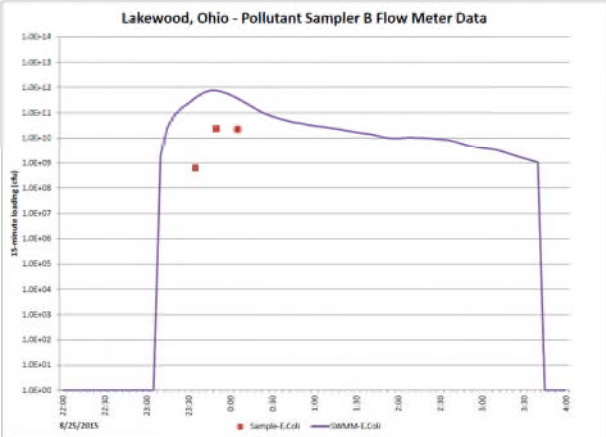


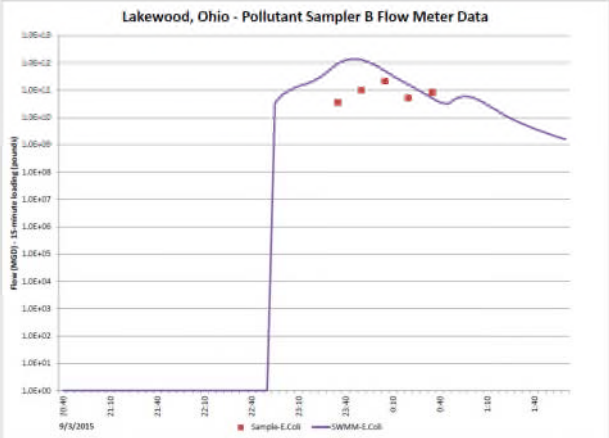
Area B – Commercial – *E. coli*



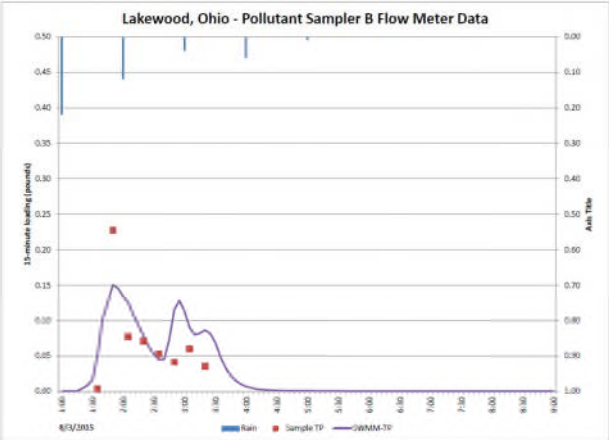


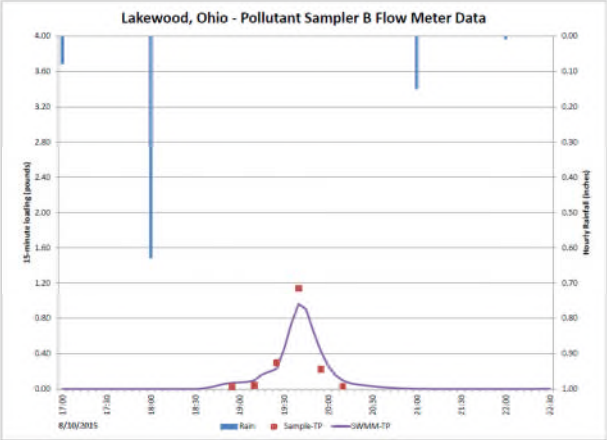


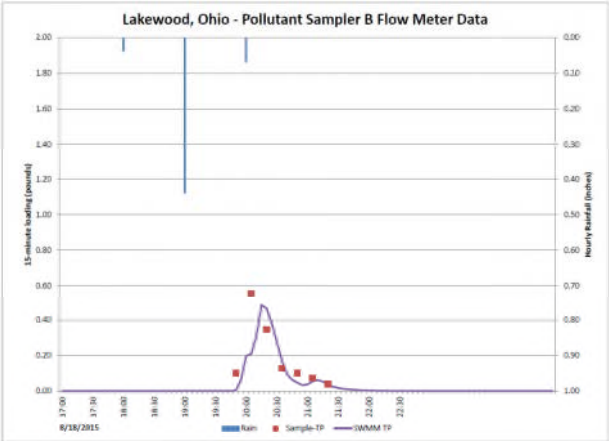


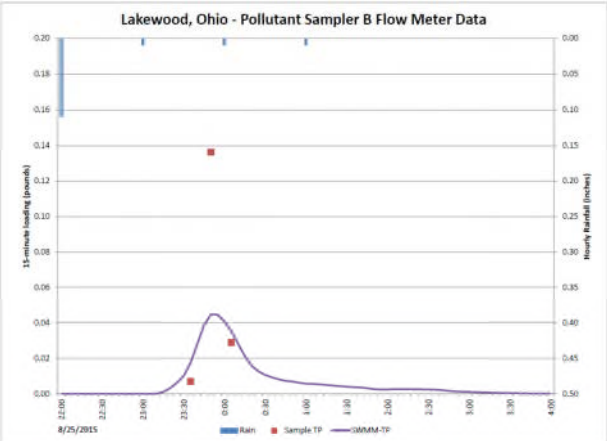


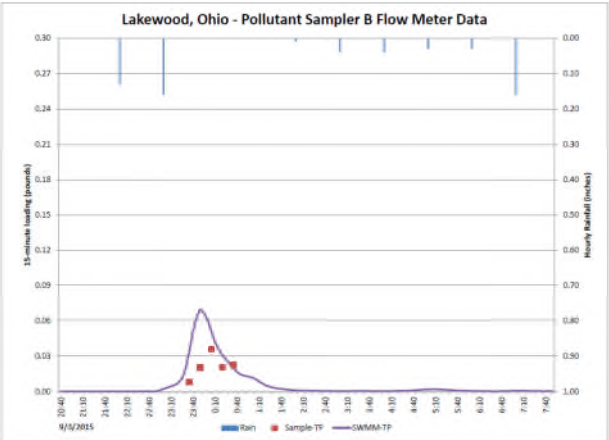
Area B – Commercial - TP











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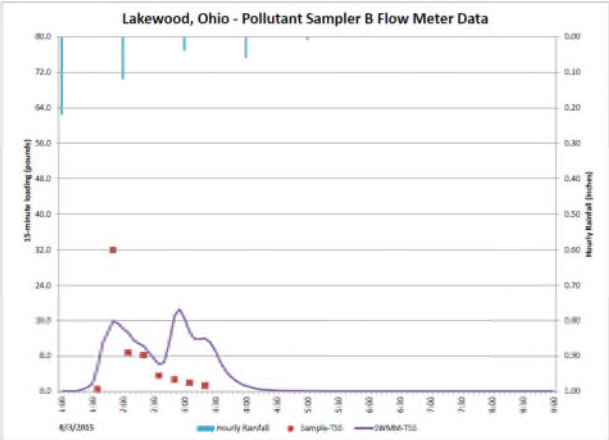
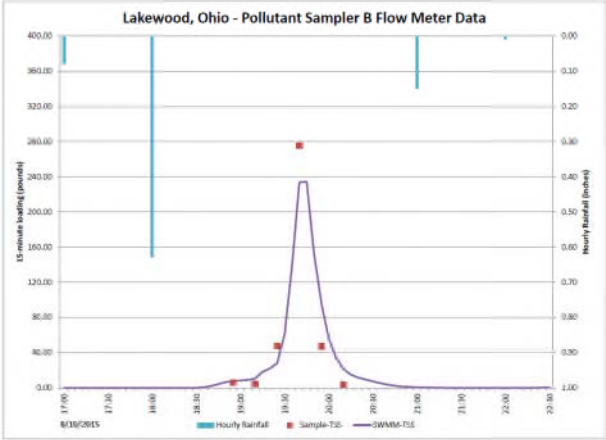
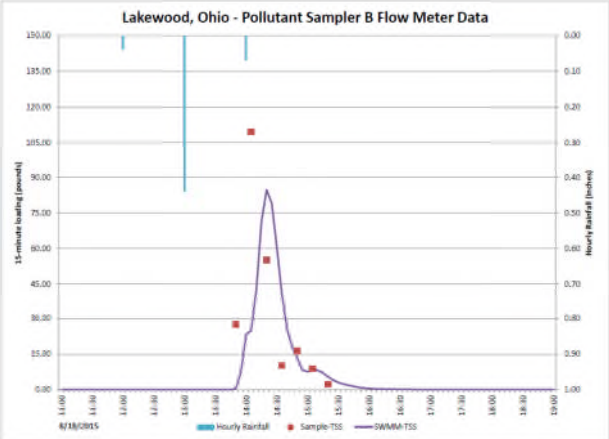
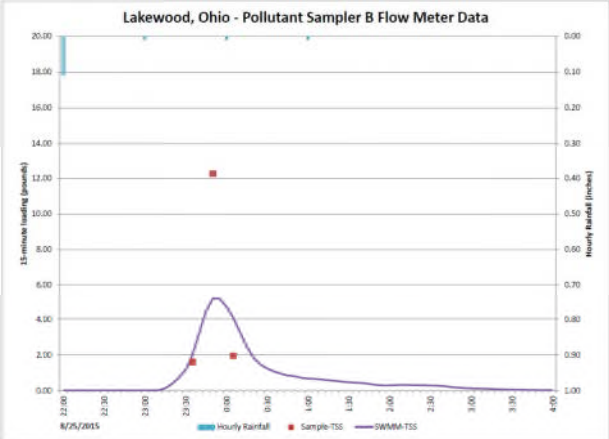
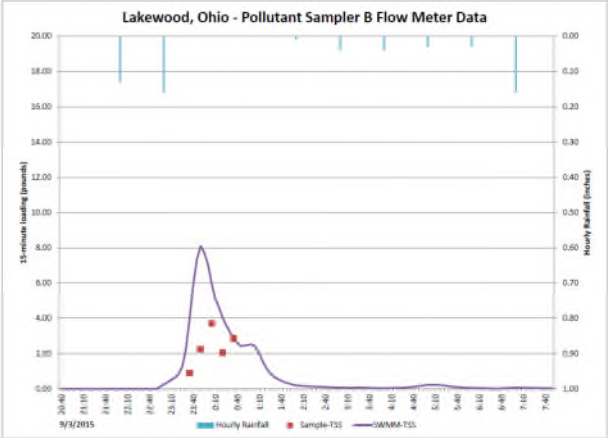
Area B – Commercial - TSS











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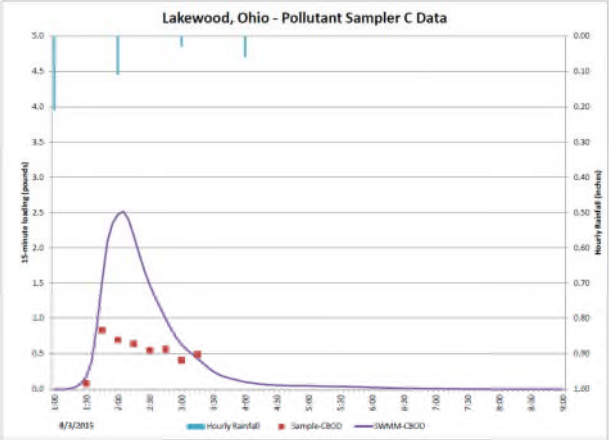
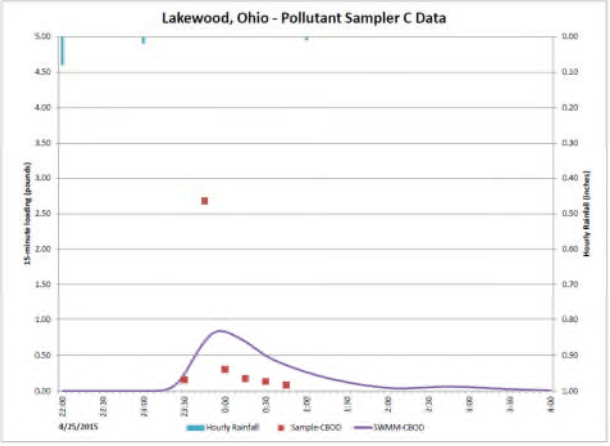
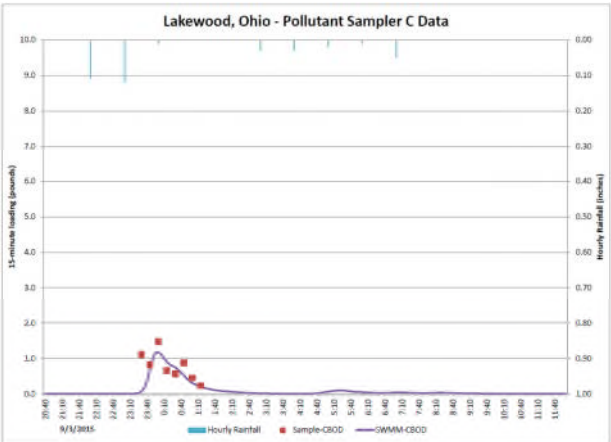
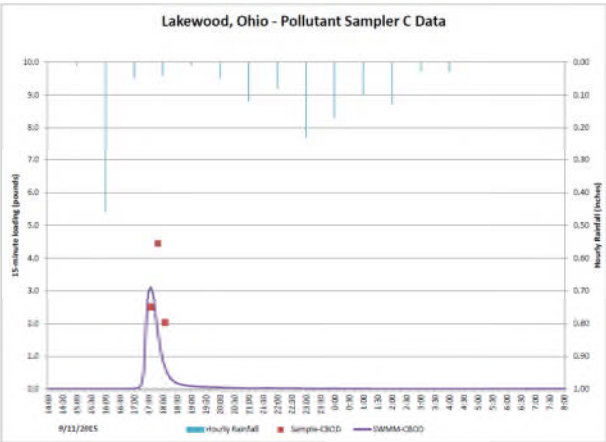
Area C – High Density Residential - CBOD

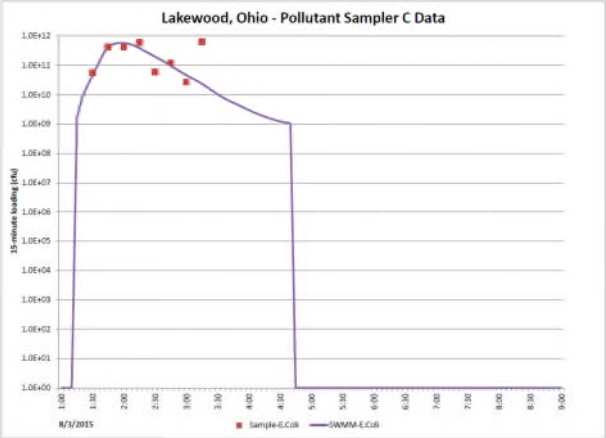


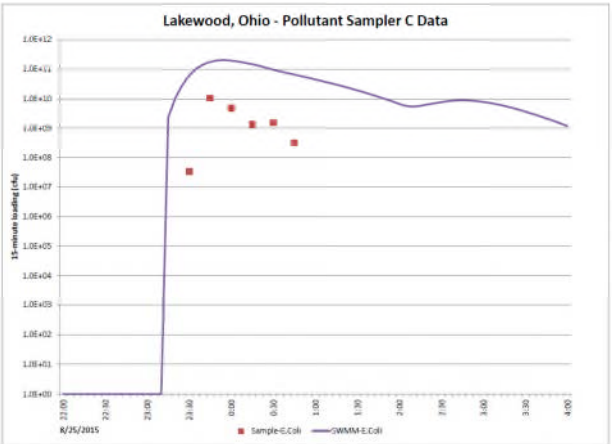


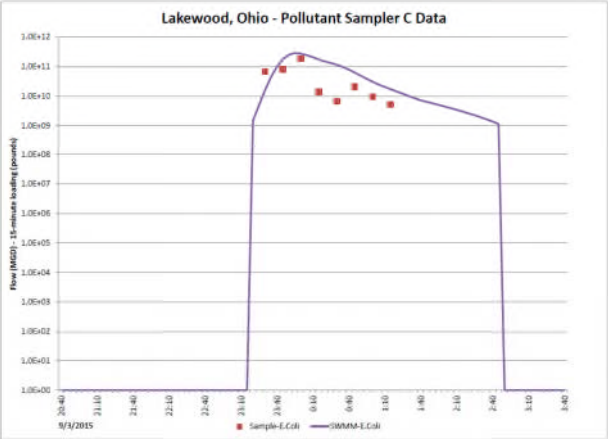


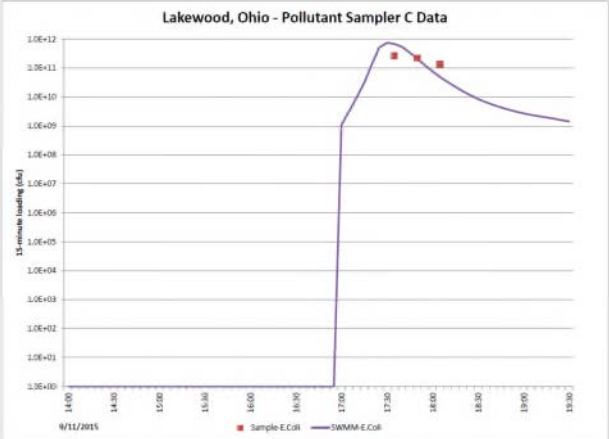


Area C – High Density Residential – *E. coli*

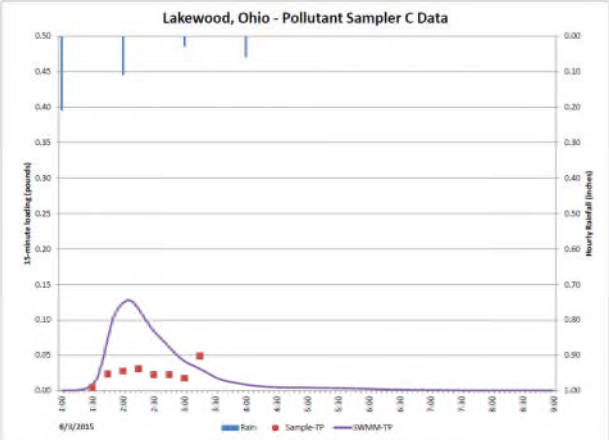


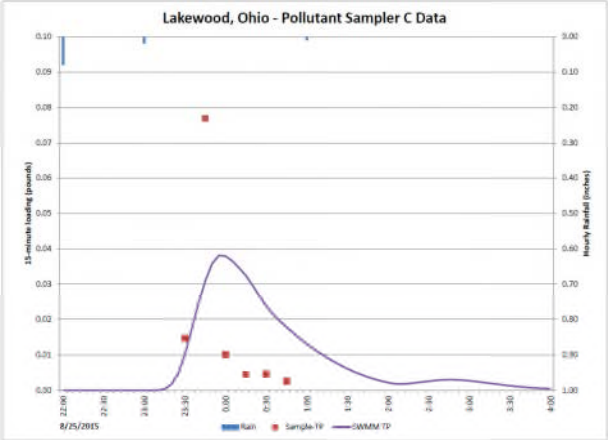


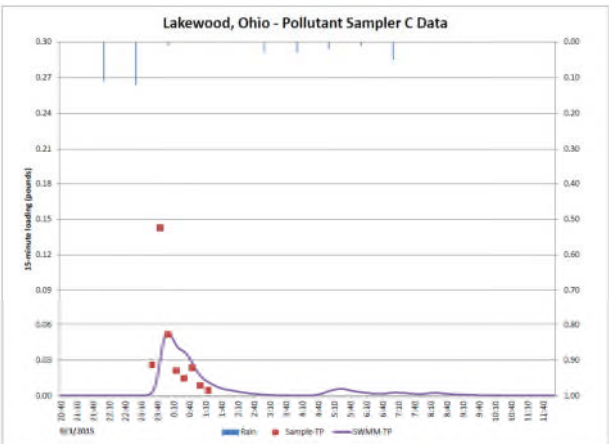


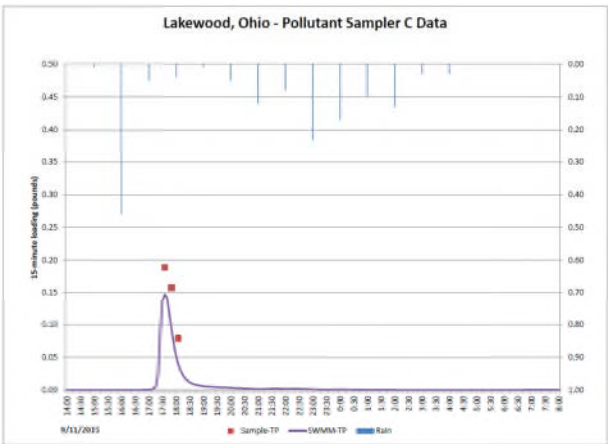


Area C – High Density Residential - TP

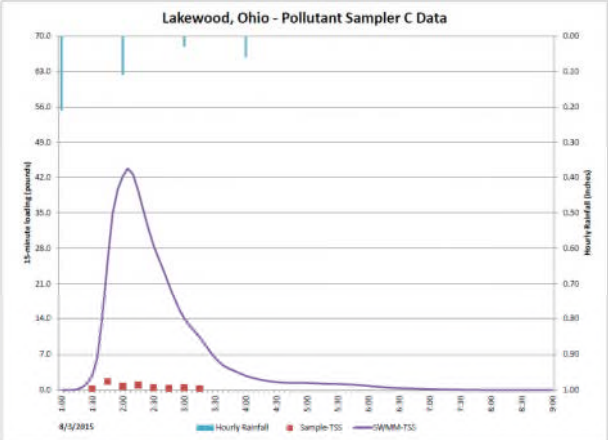


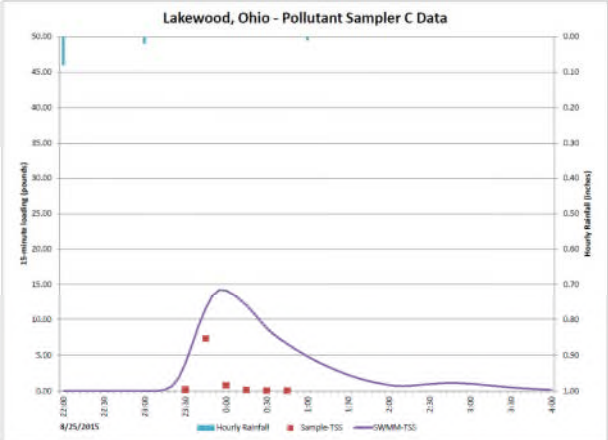


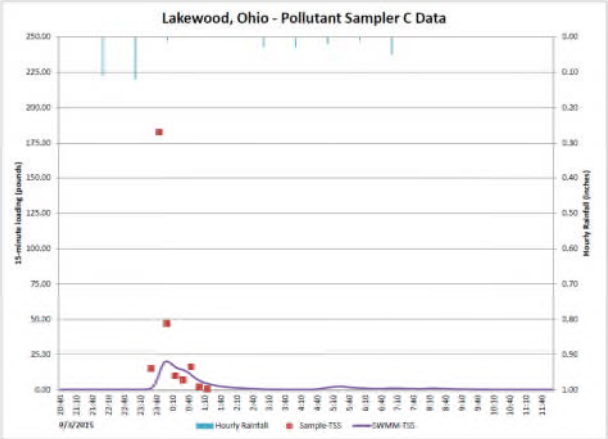


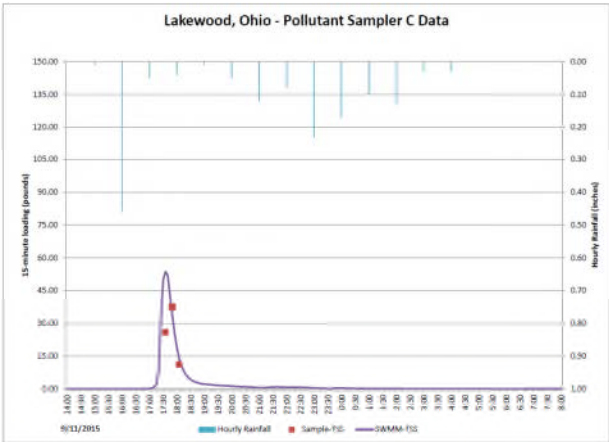


Area C – High Density Residential - TSS

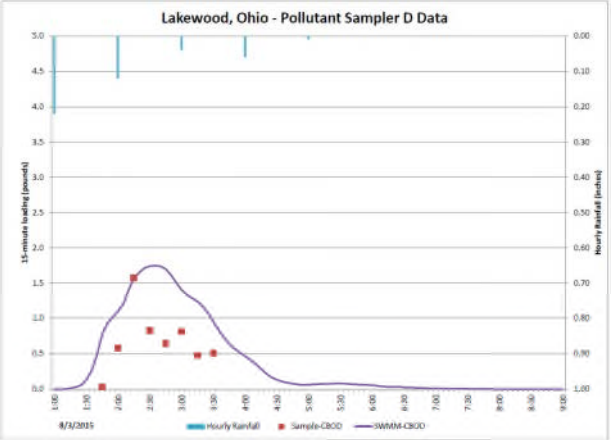


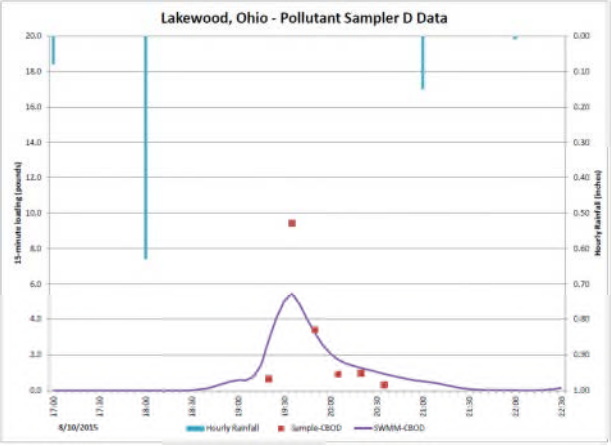


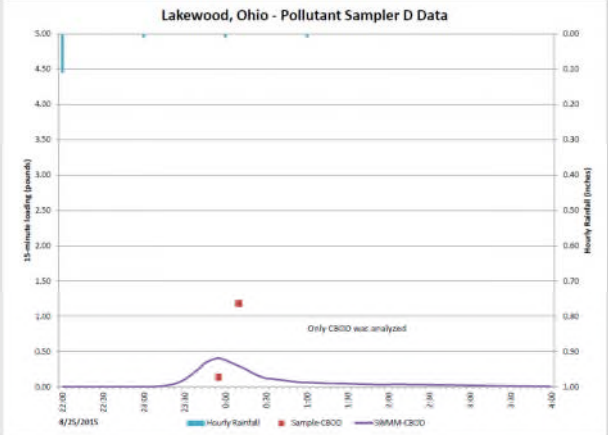


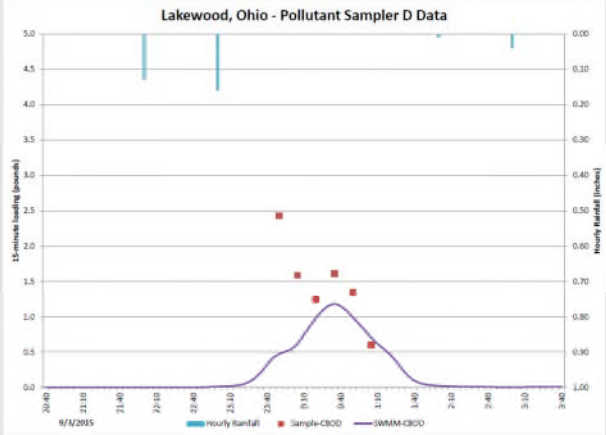


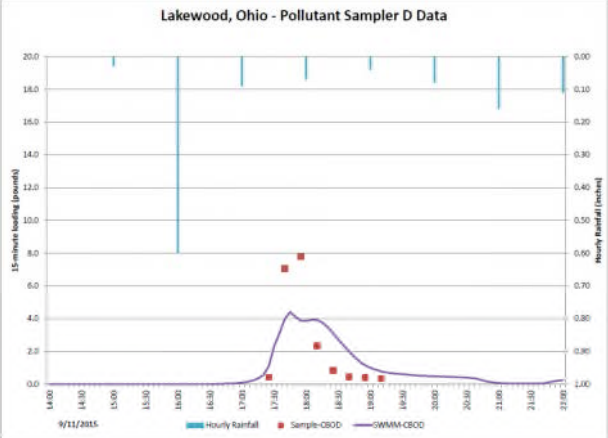
Area D – Medium Density Residential - CBOD



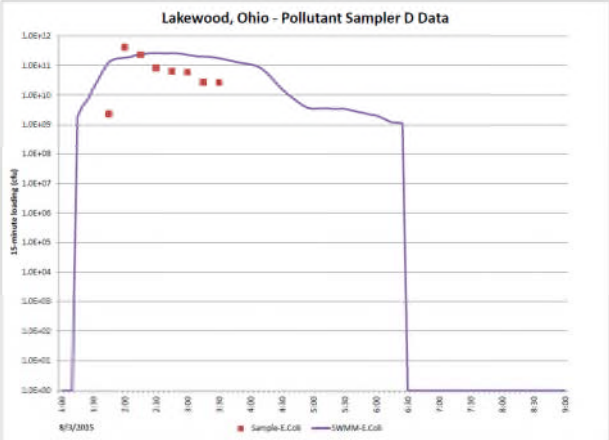


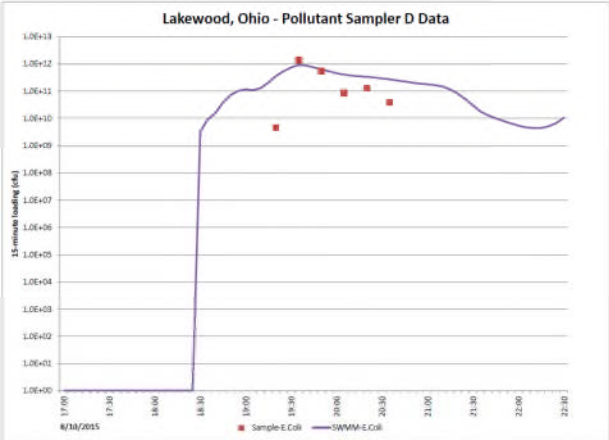


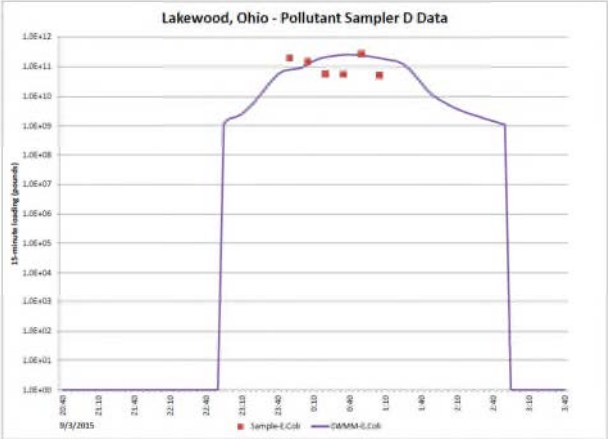


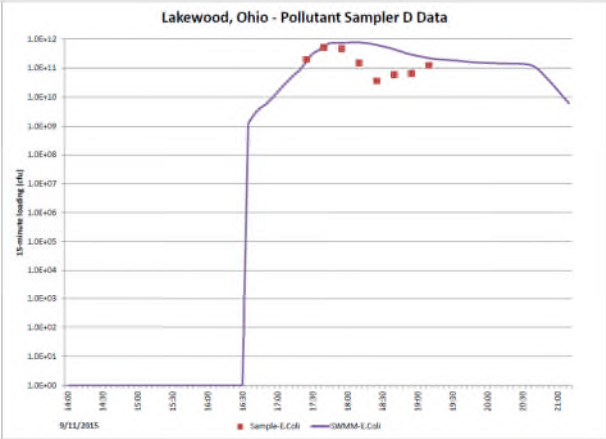


Area D – Medium Density Residential – *E. coli*

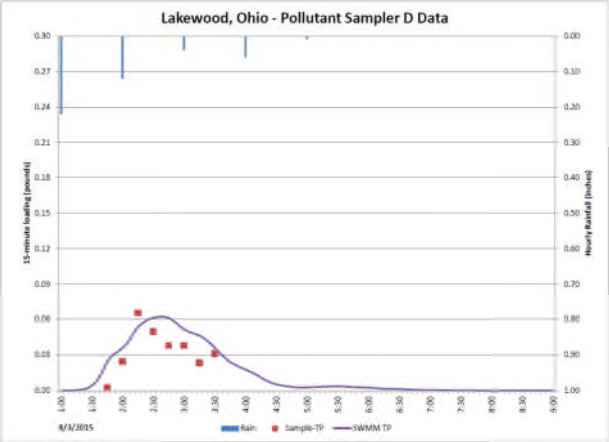


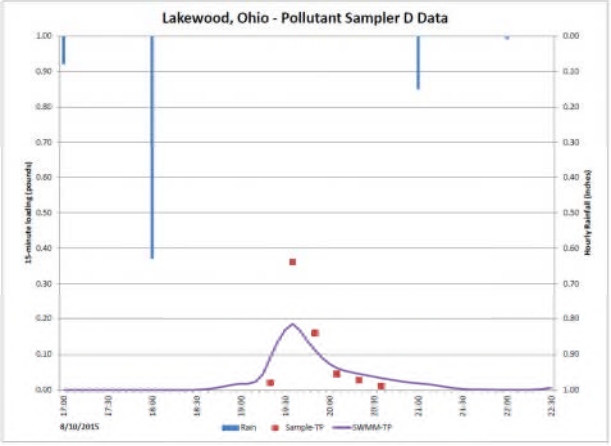


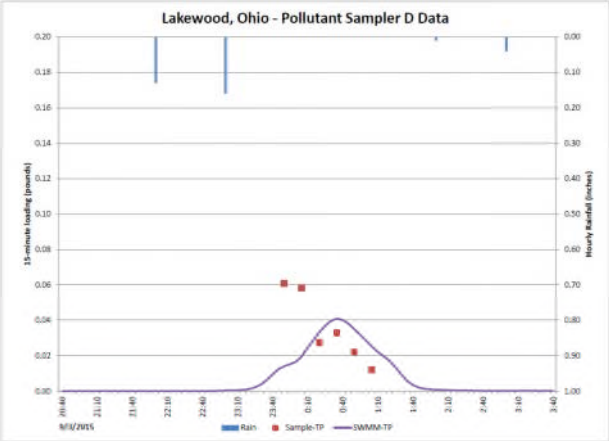


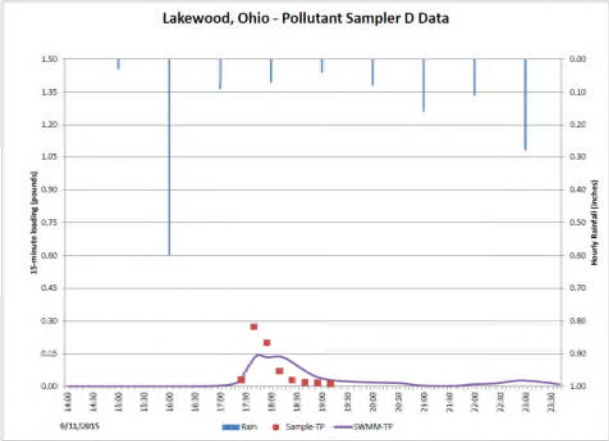


Area D – Medium Density Residential - TP

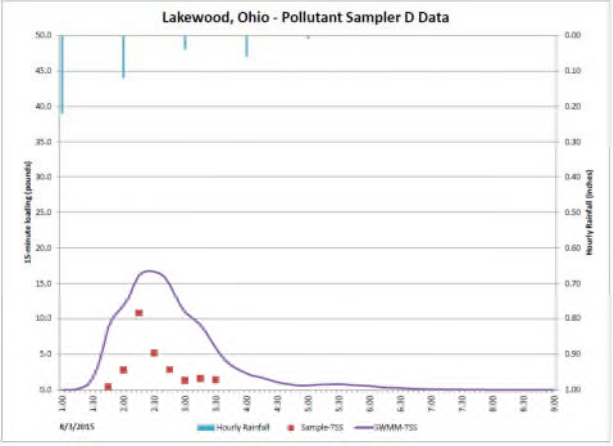


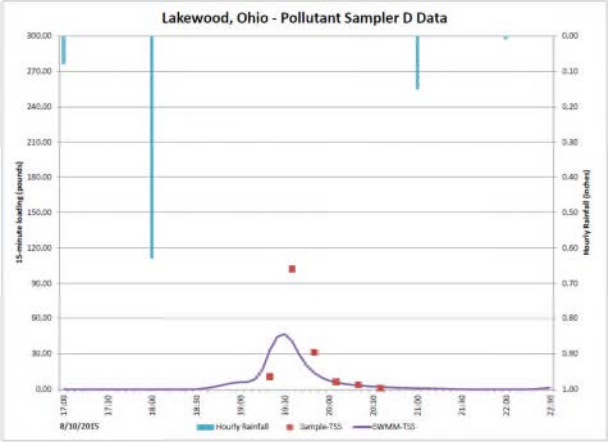


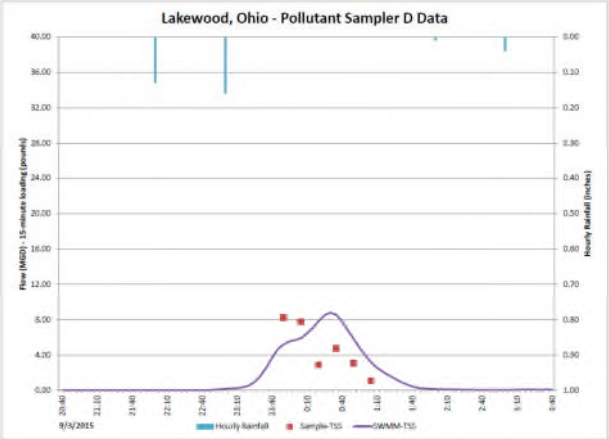


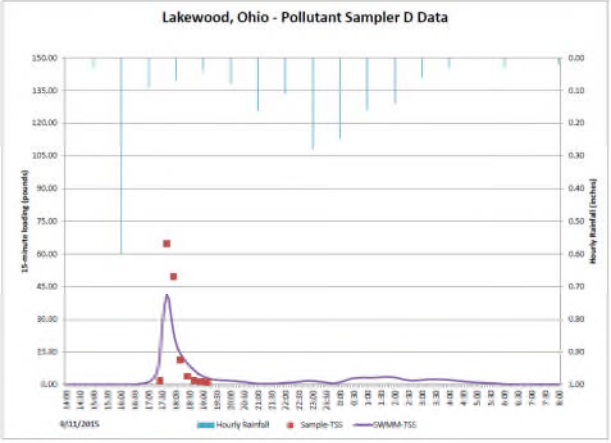


Area D – Medium Density Residential - TSS









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APPENDIX 5-5
Model Update Log

Revision Date	Revision Decription:	Location	Object Name	Outfall Area	Revision Completed By
1/7/2015	Manhole separation, EAP Project - REMOVE WEIR	Cannon and West Clifton	002S251, 002T251	002	LCH
1/7/2015	Manhole separation, EAP Project - REMOVE WEIR	Webb and south side of Clifton Blvd.	002T167, 002C167A	002D	LCH
1/7/2015	Manhole separation, EAP Project - add 10" from 002S258 to 002C260, remove weir	Southeast side of Clifton and West Clifton	002S258, 002T258	002	LCH
1/14/2015	Manhole separation per Thoreau Ave manhole separation EAP-4 and EAP-6 plans	Thoreau just south of railroad	059T842,059C842	059	LCH
1/30/2015	Revised rim and invert elevation	Edgewater, west of Wilbert	059BC006A	059B	LCH
1/30/2015	Removed offset on conduit	Lake Erie and Homewood	002T1301_002LEWS1070	002G	LCH
1/30/2015	Change pipe size at the outlet on Nicholson	Nicholson at Lake Erie	059AC001_059BLEWS1040	059A/059B	LCH
1/30/2015	Change outfall designation at the end of Nicholson to LEWS 1040	Nicholson at Lake Erie	059ALEWS1041	059A	LCH
1/30/2015	Move baseline flow to upstream side of wier	Wilbert and Cliff	059BS012/059BS02A	059B	LCH
1/30/2015	Move baseline flow to upstream manhole	Gold Coast overflow	059S001/059C01A	059	LCH
1/30/2015	Remove leaping wier from manhole, replace with 8" bottom orifice	Grace at Detroit	059AT897_059AS897	059A	LCH
1/30/2015	Remove overflow from sanitary to storm, EAP Project	Clifton in front of Emerson School	057T037	059B/057	LCH
2/25/2015	Added over/under manhole	Delaware btw Glenbury and McKinley	052S1280/052T1280	052	LCH
2/25/2015	Remove conduits btw 052T1281/052S1281 and 052T1280/052S1280	Delaware btw Glenbury and McKinley	052T1281/052S1281	052	LCH
2/25/2015	Adjusted invert depths per sketch	Delaware btw Woodward and Eldred	052S1276/052T1276	052	LCH
2/25/2015	Added manhole at the intersection and connected Atkins sanitary to this location	Hilllard and Atkins Intersection	052S072	052	LCH
3/17/2015	Moved average value data from storm (002T4044) to sanitary (002S4044)	Shaw	002T4044/002S4044	002D	LCH
3/17/2015	Moved average value data from stm (059AT024) to sanitary (059AS047)	Detroit and Elber	059AT024/059AS047	059A	LCH
4/14/2015	Updates subcatchments shapes for 053-054	053/054		053/054	LCH
4/16/2015	Changed invert plate to open and update depths on sanitary and storm	Elbur at Madison	T953_059AS953, 059AT953, 059A	059A	LCH
4/16/2015	Changed weir offset, height and length	West Clifton and Detroit (SW corner)	002S1401_002S1400	002	LCH
4/16/2015	Updated depths on manholes	West Clifton and Detroit	002S1401, 002T1400	002	LCH
4/16/2015	Updates pipe sizes	West Clifton and Detroit	1400_002C4418, 002T1419_002T	002	LCH
4/16/2015	Changed weir offset, height and length	1484 West Clifton	002S1415_002T1414	002	LCH
4/16/2015	Updated depths on manholes	1484 West Clifton	002S1415, 002T1414	002	LCH
4/16/2015	Updates pipe sizes	1484 West Clifton	1414_002T1419, 002T1417_002T	002	LCH
4/16/2015	Changed weir offset, height and length	1488 West Clifton	002S1418_002T1417	002	LCH
4/16/2015	Updated depths on manholes	1488 West Clifton	002S1418, 002T1417	002	LCH
4/17/2015	Updates manhole depths	West Clifton and Detroit (SE corner)	002S4416, 002T4416	002	LCH
4/17/2015	Changed weir offset, height and length and added a second weir for notch in weir	West Clifton and Detroit (SE corner)	4416_002T4416, 002S4416_002T4	002	LCH
4/17/2015	Update pipe sizes	West Clifton and Detroit (SE corner)	4416_002C4418, 002T4414_002T	002	LCH
4/17/2015	Updates manhole depths	1429 West Clifton	002S4414, 002T4414	002	LCH
4/17/2015	Changed weir offset, height and length	1429 West Clifton	002S4414_002T4414	002	LCH
4/17/2015	Update pipe sizes	1429 West Clifton	002T4412_002T4414	002	LCH
4/17/2015	Updates manhole depths	1459 West Clifton	002S4412, 002T4412	002	LCH
4/17/2015	Changed weir offset, height and length and added a second weir	1459 West Clifton	4412_002T4412, 002S4412_002T4	002	LCH
4/17/2015	Update pipe sizes	1459 West Clifton	002T1408_002T4412	002	LCH
4/17/2015	Updates manhole depths	1491 West Clifton	002S1409, 002T1408	002	LCH
4/17/2015	Changed weir offset and height	1491 West Clifton	002S1409_002T1408	002	LCH
4/17/2015	Removed weir and offset outfall pipe	Edgewater btw Homewood and Wilburt	059BC006	002	LCH
4/21/2015	Updated coordinates for manhole	Rockway at Detroit	002C032A	002C	LCH
4/21/2015	Updated coordinates for manhole	Larchmont at Detroit	002C029A	002C	LCH
8/13/2015	Updated coordinates, elevations and manhole designations for manholes on the storm outfall sewer	Lakewood Park	7T344(057C342), 057T348(057C34	057	LCH
8/13/2015	Added a manhole in Lakewood park, update storm sewer sizes from Belle at RR to outfall	Lakewood Park, Belle Street	057T344A	057	LCH
8/20/2015	Subcatchment S002T4392 was not assigned to a node. Was assigned to 002T4394 and renamed to S002T4394	Spring garden	S002T4392	002	LCH
8/20/2015	Node 059AS047 - Time pattern needs to be 059_M039(obs)_Hourly (the zero in 059 was missing)	Detroit and Elber	059AS047	059A	LCH
10/26/2015	Re assigned subcatchment S059T011 to 059BT011	Clifton btw Jackson Nicholson	S059T011	059B	LCH
10/26/2015	Renamed Subcatchment S059T011 to S059BT011	Clifton btw Jackson Nicholson	S059T012	059B	LCH
10/26/2015	Re assigned subcatchment S059AT006A to 059AT006A	Nicholson at Clifton	S059AT006A	059A	LCH
10/26/2015	Delete duplicate subcatchment	Nicholson at Clifton	S059AT006A	059A	LCH
10/26/2015	Re assigned subcatchment S059T006 to 059AT006A	Clifton at Nicholson	S059T006	059A	LCH
10/26/2015	Renamed Subcatchment S059T006 to S059AT006AB	Clifton at Nicholson	S059AT006AB	059A	LCH
10/26/2015	Move average value at 059T011 to 059S010	Clifton at Donald	059S010	059	LCH
10/26/2015	Change invert of 052T4597 to 735.38	Lakewood Heights Blvd. btw Warren and Carabel	052T4597	052	LCH
10/26/2015	Change invert of 052T4598 to 734.24	Lakewood Heights Blvd. btw Warren and Carabel	052T4598	052	LCH
10/26/2015	Change invert of 052T4600 to 733.75	Lakewood Heights Blvd. btw Warren and Carabel	052T4600	052	LCH
10/26/2015	Change invert of 052T4601 to 732.72	Lakewood Heights Blvd. btw Warren and Carabel	052T4601	052	LCH
10/26/2015	Change invert of 052T4602 to 731.66	Lakewood Heights Blvd. btw Warren and Carabel	052T4602	052	LCH
10/26/2015	Change invert of 052T4603 to 730.52	Lakewood Heights Blvd. btw Warren and Carabel	052T4603	052	LCH
10/26/2015	Change invert of 052T4604 to 729.37	Lakewood Heights Blvd. btw Warren and Carabel	052T4604	052	LCH
10/26/2015	Change invert of 052T4605 to 728.22	Lakewood Heights Blvd. btw Warren and Carabel	052T4605	052	LCH
10/26/2015	Change invert of 052T4606 to 727.07	Lakewood Heights Blvd. btw Warren and Carabel	052T4606	052	LCH
10/26/2015	Change invert of 052T4609 to 725.28	Lakewood Heights Blvd. btw Warren and Carabel	052T4609	052	LCH
10/26/2015	Change inlet offset on 059AS055A_059AS055 to 0.05	Detroit and Waterbury	059AS055A_059AS055	059A	LCH
10/26/2015	Change outlet offset for 059C01A_059S001 to 12.95	Gold Coast overflow	059C01A_059S001	059	LCH
10/26/2015	Changed height to 7.7', offset to 0.5' and length to 4' for 002S190_002T190	North side of Clifton west of Webb Rd.	002S190_002T190	002D	LCH
10/26/2015	Changed invert for 002C3906 to 624.2	Erie Cliff cul-de-sac	002C3906	002	LCH

Revision Date	Revision Decription:	Location	Object Name	Outfall Area	Revision Completed By
10/26/2015	Changed invert for 002C240A to 624.5	Erie Cliff at interceptor	002C240A	002	LCH
10/26/2015	Changed invert for 002C240 to 624.6	Erie Cliff at interceptor	002C240	002	LCH
10/26/2015	Moved 057T444 to N664047.024, E2161059.748, Rim 660.84, Inv. 654.13	Belle at railroad	057T444	057	LCH
10/26/2015	Inlet offset on weir 059T030_059S030 is 0.9'	North end of City Hall service yard	059T030_059S030	059	LCH
10/26/2015	Rename Outfall 052T1499 to 052S1499	Ogontz and Riverside	052T149	052	LCH
10/26/2015	Remove weir 059T030_059S030	Back of City Hall at Thoreau	059T030_059S030	059	LCH
10/29/2015	Reversed weir 002S184_002T184, changed inlet offset to 1.7	Clifton and Brockley	002S184_002T184	002	LCH
10/29/2015	Reversed weir 002S1407_002T1406, changed inlet offset to 0.511	west side of West Clifton south of railroad	002S1407_002T1406	002	LCH
10/29/2015	Reversed weir 002S188_002T188, changed inlet offset to 3.2 and height to 11.7	South side of Clifton Boulevard at Lakeland	002S188_002T188	056	LCH
10/29/2015	Reversed weir 002S190_002T190, changed inlet offset to 0.3	North side of Clifton Boulevard west of Webb	002S190_002T190	002	LCH
10/29/2015	Reversed weir 002S190_002T190, changed inlet offset to 0.7	Southwest corner of Clifton Blvd and West Clifton	002S264_002T264	002	LCH
10/29/2015	Reversed weir 002S4414_002T4414, changed inlet offset to 0.7	East side of West Clifton Blvd	002S4414_002T4414	002	LCH
10/29/2015	Changed rim elevation to 716 for 052S045	Riverside at I-90	052S045	052	LCH
10/29/2015	Reversed weir 053C009_053C009A, changed inlet offset to 1.75	Graber Alley at Scenic	053C009_053C009A	053	LCH
10/29/2015	Reversed weir 055C003_055C003A, changed inlet offset to 0.4	At Interceptor btw Maple Cliff and Kenneth	055C003_055C003A	055	LCH
10/29/2015	Reversed weir 056C490_056C490B, changed inlet offset to 0.8	On Edgewater at 056 overflow	056C490_056C490B	056	LCH
10/29/2015	Reversed weir 057S009_057T009, changed inlet offset to 3.7	Clifton at Belle	057S009_057T009	057	LCH
10/29/2015	Reversed weir 057S010_057T010, changed inlet offset to 4.9	Clifton at Belle	057S010_057T010	057	LCH
10/29/2015	Reversed weir 058C001A_058C001B, changed inlet offset to 0.6	Clifton at Belle	058C001A_058C001B	058	LCH
10/29/2015	Add new sanitary and improvements per Webb Road EAP-4 and EAP-6 plans	Webb btw Clifton and Lake		002	LCH
10/29/2015	Add new sanitary sewers and separation on Edgewater btw Abbeyshire and Cliffdale	Edgewater		056	LCH
11/3/2015	Update 057T547_057T547A with curve information	Warren south of Detroit	057T547_057T547A	057	LCH
11/9/2015	Reassign 002T3659_002T3661 to the correct inlet and outlet nodes	Lauderdale	002T3659_002T3661	002C	LCH
12/22/2015	Update manholes, invert plates, conduits and subcatchments associated with Mars beginning at Delaware to Madison	Mars btw Delaware and Madison		052	LCH
1/5/2016	Update manholes, conduits, orifice and wier at node 002C216 and 002C261A	Clifton and West Clifton	002C261, 002C261A	002	LCH
1/5/2016	Updated S002T143 (one corner was incorrect)	Webb btw Woodford and Shaw	S002T143	002D	LCH
1/6/2016	Updated Westerly Interceptor based on plans to include additional sewer and adding regional subcatchments as well as better slope and wieir control information. Includes updates of all interconnections with Lakewood along 117th.	Lakewood Heights and Berea from Bunts to 117th and 117th from Berea to Edgewater	Various	059C	CPR
1/6/2016	Updated Northwest Interceptor based on plans to include additional sewer and adding regional subcatchments as well as better slope and wieir control information. Update includes hydrobrakes from NEORSD data and updates of all interconnections with Lakewood along 117th.	Lorain/Rocky River to Rocky River/Fischer to Lakewood Heights/Bunts to Berea/117th to 117th/Lake	Various	059C	CPR
1/22/2016	Update sewers, nodes and subcatchments along Fischer, Ogontz and the intersection of Fischer and Riverside	Fischer, Ogontz and Riverside		052	LCH
3/10/2016	Added Pollutants (CBOD, E.coli, TotPhos,and TSS) and initial Land Use percentages	Entire Model	See Pollutants and Land Uses tables	all	PWK
3/23/2016	Added Open Space land use and Modified Land Use percentages based on Auditor's parcel land use file	Entire Model	See Pollutants and Land Uses tables	all	PWK
4/13/2016	Disconnected sanitary sewer from combined sewer at 055C671 and created new O/U MH 002S671, Created new storm connection from 002T671 to 055C671 with V-notch weir between the storm and combined.	Lake Ave. at Hall Ave.	002S671	002	RHG
4/13/2016	Corrected weir link by reversing direction. Correct link is from 058C001A to 058C001B	Edgewater btw Roy and Kirtland	058C001A, 058C001B	058	RHG
4/13/2016	Corrected depth on MH 057T570 from 0 to 18.68	Clifton at Whippoorwill	057T570	057	RHG
4/13/2016	Eliminated MH 002S1407 and MH 002T1406. Connected sanitary conduit from 002S095 to 002S253. Connected storm conduit from 002T094 to 002S252.	West Clifton south of Railroad on west side of street	002T094_002S252, 002S095_002S253	002	RHG
4/13/2016	Deleted weir between 057S009 and 057T009. This weir represented a missing MH cover on the inner manhole that could allow and overflow. The cover was found to be in place.	NE corner of Clifton and Belle	057S009, 057T009	057	RHG
4/13/2016	Deleted weir between 057C010 and 057T010. This weir represented a missing MH cover on the inner manhole that could allow and overflow. The cover was put in place by CT crew on March 24, 2016.	N side of Clifton at Marlowe	057C010, 057T010	057	RHG
4/15/2016	Changed orifice sizes on Summit between Detroit and Lake to reflect missing invert plates. MH 002T2167 had 6" pipe connected between springline of storm and sanitary to reflect WPA era relief ports.	Summit from Detroit to Lake	002T2162_002S2162, 002T2165_002S2165, 002T2164_002S2164, 002T2167_002S2167, 002T2168_002S2168, 002T186_002S186, 002T196_002S196	002	RHG
4/20/2016	Added PS for private resident at 13474 Edgewater Drive	Cliff Drive west of Wilbert	059BS012B	059B	RHG
4/21/2016	Modified PS input flow pattern to weekend only	Cliff Drive west of Wilbert	PS_13474_Edgewater	059B	PWK
5/9/2016	Updated Edgewater interceptor to include AMCO segmented pipe cross section	Lake and 117th to CSO-058		059 A and C	CPR
5/9/2016	Updated Detroit to include proper egg shaped pipe cross section	Hopkins to 117th		059C	CPR
5/9/2016	Updated Madison with proper egg shaped pipe cross section and modified slopes based on historical drawings to better fit flow meter results	Bunts to 117th		059C	CPR
5/9/2016	Updated Lewis and Madison overflow inlet offset to 0.7 ft. and pipe to a #5 egg shape	Lewis and Madison	059S078A_059AT1375	059C/059A	CPR
5/9/2016	Updated Elbur and Madison overflow weir to 2.55 ft.	Elbur and Madison	059C0076A_059C0076AA	059C/059A	CPR
5/9/2016	Increased pipe coefficient to achieve proper overflow calibration at Elbur	Elbur and Madison	059C0076A_059C0077A	059C	CPR
5/9/2016	Increased pipe coefficient to achieve proper overflow calibration at Lewis and backwater conditions at Madison and Dowd	Madison and Robin	059C4507_059C0079	059C	CPR
5/9/2016	Increased pipe coefficient to achieve proper calibration backwater conditions at Madison and Coutant	Madison and 117th	059C4494_059C0002	059C	CPR
5/9/2016	Subcatchment S059C0085 split and southern portion added to Subcatchment S059C4563	Bramely and Clarence/Halstead	S059C0085 and S059C4563	059C	CPR
5/9/2016	All subcatchments draining to Madison were modified based on calibration to flow meters	All Streets draining to and along Madison	Various	059C	CPR
5/9/2016	Madison Park subcatchment and Industrial Park south of it had imperious area updates to better detail their runoff impacts beyond the general calibration values	Clarence to Halstead South of Madison	S059C0077 and S059C0085	059C	CPR

Revision Date	Revision Decription:	Location	Object Name	Outfall Area	Revision Completed By
5/10/2016	Removed small weir representing missing brick in main weir at CSO1145E	Detroit and West Cliffton	002S4416_002T4416A	002	CPR
5/12/2016	5/9/16 update overwrote Landuse values during data subcatchment push. Landuse data has been put back in	Madison East end Subcatchments	Various	059C	CPR
5/13/2016	Updated Madison subcatchments to use 1977 RG file	Madison East end Subcatchments	Various	059C	CPR
5/13/2016	Updated time patterns to include WQ calibration GWI completed by Phil	Model Patterns		All	CPR
6/1/2016	Reverse flow direction of Weir for CSO 54 hold weir invert elevation	Scenic and Detroit	053C009_053C009A	054	CPR
6/1/2016	Reverse flow direction of Weir for CSO 55 hold weir invert elevation	Edgewater West of Maplecliff	055C003_055C003A	055	CPR
6/1/2016	Reverse flow direction of Weir for CSO 56B hold weir invert elevation	Edgewater West of Rosalie	056C490_056C490B	056B	CPR
6/1/2016	Reverse flow direction of Weir for 002 hold weir invert elevation	Cliffton and Lakeland LEWS1180-A	002S188_002T188	002	CPR
6/1/2016	Updated storm from Lakeland and Cliffton to Outfall (includes 1 combined at end) to No.6 Egg (Some segmented tile and some brick)	Cliffton and Lakeland North to outfall	Various	056	CPR
6/1/2016	Reverse flow direction of Weir for 002 hold weir invert elevation	Cliffton south of Detroit RRES1145-F	002S4414_002T4414	002	CPR
6/1/2016	Weir is removed due to being bulkheaded off between storm and sewer	Cliffton and Brockley RRES1195-B	002S184_002T184	002	CPR
6/1/2016	Added vertice to sanitary to expose it from under storm	Thoreau just south of Cliffton	059S850_0059C015	059B	CPR
6/1/2016	Weir is removed due to televising showing no manholes at this location	West Cliffton south of Detroit RRES1145-B	002S1420_002T1419	002	CPR
6/1/2016	Manhole description revised to indicate televising shows no manhole. Manhole left in model due to other inflow inputs on it.	West Cliffton south of Detroit RRES1145-B	002S1420	003	CPR
6/1/2016	Manhole description revised to indicate televising shows no manhole. Manhole left in model due to other inflow inputs on it.	West Cliffton south of Detroit RRES1145-B	002T1419	004	CPR
6/1/2016	Changed storm sewer to combined. Combined comes in US and DS low flows go to sanitary underneath	Hilliard and Victoria	056T061_056T058	056	CPR
6/1/2016	Modified orifice size	Hilliard and Victoria	056T058_056S058	056	CPR
6/9/2016	Delete overflow pipe from Halstead to Thrush	Halstead and Thrush	059C3006_059C3095	059C	CPR
7/25/2016	Added Outfall Line from node: Outfall_Head_Chamber to Diffuser_Outfall_3 and others	Treatment Plant to Lake	Outfall_Head_Chamber	PLANT	MRD
7/25/2016	Changed various pipe tags, including NEORSD pipes and incorrect pipes noted by Bob	Various	Various	Various	MRD
7/27/2016	Deleted link 056C915_056C490	Stemming from Edgewater b/w Leedale and Rosalie	056C915_056C490	056A, 056B	MRD
7/27/2016	Deleted link 056C1301_056C284A	Stemming from Edgewater b/w Leedale and Rosalie	056C1301_056C284A	056A, 056B	MRD
7/27/2016	Deleted 056C1301_056C1302, Deleted node 056C1302	Stemming from Edgewater b/w Leedale and Rosalie	056C1302	056A, 056B	MRD
7/27/2016	Connected 056C1302_056C490A to 056C1301	Stemming from Edgewater b/w Leedale and Rosalie	056C1301	056A, 056B	MRD
7/27/2016	Deleted weir 056C915_056C915A and connected 056C915A_056LEWS1145 to 056C915, deleted node 056C915A	Stemming from Edgewater b/w Leedale and Rosalie	056C915A	056A, 056B	MRD
7/27/2016	Converted several pipe tags from com to stm (southeast of 056C490C, and west of 056T915)	Stemming from Edgewater b/w Leedale and Rosalie	056C490C	056A, 056B	MRD
10/12/2016	Updated Thoreau from Tracks north to Cliffton to show sanitary over or beside storm conditions	Tracks to Cliffton	Various	059	CPR
10/12/2016	Removed duplicate conduit	Cliffton from 30 west of Hall to Edwards	055C010A_002C195	055,002	CPR
10/12/2016	Removed duplicate manhole	Cliffton from 30 west of Hall to Edwards	055C010A	055,002	CPR
10/12/2016	Reduced conduit size to 8"	West Cliffton and Sloan	002C249_002C4049	002	CPR
10/12/2016	Increased conduit size to 21"	West Cliffton and RR Bridge	002T252_002T253	002	CPR
10/12/2016	Converted wier to 6" bottom orifice with 1.4 ft offset	West Cliffton and RR Bridge	002S1405_002T1404	002	CPR
10/12/2016	Added to represent sanitary weir pipe blocking storm sewer hydraulics	West Cliffton and RR Bridge	002T252A	002	CPR
10/12/2016	Modified storm sewer to connect to 002T252A	West Cliffton and RR Bridge	002T094_002T252A	002	CPR
10/12/2016	Added weir to represent blocked storm sewer flow into sanitary sewer	West Cliffton and RR Bridge	002T252A_002S252	002	CPR
10/12/2016	Modified san sewer to flow into 002S252 instead of 002S253	West Cliffton and RR Bridge	002S095_002S252	002	CPR
10/12/2016	Removed duplicate pipe routed to wrong manhole	West Cliffton South of Sloan	002C4049_002T094	002	CPR
10/12/2016	Reduced conduit size to 8"	West Cliffton and Sloan	002C4049_002S095	002	CPR
10/12/2016	Added new Manhole north of 002C4049	West Cliffton South of Sloan	002C4050	002	CPR
10/12/2016	Increased conduit size to 8"	Clarence south of Detroit	059AT1311_059AC1310	002	CPR
10/20/2016	Changed sewer type south of Sloane on the west side of W Cliffton from Combined to Sanitary	West Cliffton South of Sloan	Various	002	CPR
10/20/2016	Changed sewer type south of Detroit on the west side of Clarence from Storm to Combined	Clarence south of Detroit	Various	002	CPR
3/7/2017	Changed sewer type to "INT" for the following conduits to extend the interceptor 059C0017_059S003, 059C0022_059C0017, 059C1034_059C0022, 059C4109_059C3160, 059C4114_059C4109, 059S003_059C4114	Edgewater and W 117th	Various See Description	n/a	MD as advised by CPR
3/20/2017	Master Model Run				CPR
11/1/2017	Model archived for next model update				CPR
11/2/2017	Changed outlet offset from 22 feet to 0 feet.	W. Clifton south of railroad at overflow RRES 1145-N	002S095_002S252	RRES 1145	RHG
11/2/2017	Changed conduit diameter from 24" to 8"	Erie Cliff at interceptor downstream of overflow regulator	002C240A_002C239	LEWS 1215	RHG
11/2/2017	Changed model label from LEWS 1035-A to LEWS 1035	CSO 059 chamber at Carlyle	059S001_059C1020	LEWS 1035 (059)	RHG
11/2/2017	Reduced pipe from 4.69 egg to 1.25 round, raised offset from 0 to 3.5 feet	CSO 059 chamber at Carlyle	059C01A_059C001	LEWS 1035 (059)	RHG
11/2/2017	Raised manhole invert from 614.71 to 616.45	CSO 059 chamber at Carlyle	059C01A	LEWS 1035 (059)	RHG
11/2/2017	Raised manhole invert from 612.85 to 614.7	CSO 059 chamber at Carlyle	059S001	LEWS 1035 (059)	RHG
11/2/2017	Reduced outlet offset from 11.09 to 9.35 feet	CSO 059 chamber at Carlyle	059S002_059C01A	LEWS 1035 (059)	RHG
11/2/2017	Reduced inlet offset from 11.1 to 9.35, reduced outlet offset from 12.95 to 11.1 feet	CSO 059 chamber at Carlyle	059C01A_059S001	LEWS 1035 (059)	RHG
11/2/2017	Changed model label from LEWS 1035-B to LEWS 1035-A	Thoreau at Clifton	Orifice 0059T014_0059S014	LEWS 1035 (059)	RHG
11/2/2017	Invert plate was removed. Increased orifice from 1.0 x 0.25 to 2.2 x 0.9 feet	Thoreau at Clifton	Orifice 0059T014_0059S014	LEWS 1035 (059)	RHG
11/2/2017	Reduced pipe size from 2.5 to 1.25 feet	Thoreau at Clifton	059T015_059T014	LEWS 1035 (059)	RHG

Revision Date	Revision Decription:	Location	Object Name	Outfall Area	Revision Completed By
11/2/2017	Increased size from 1.25 to 1.667 feet, raised outlet offset from 0 to 0.19 feet	Nicholson at Cliff	059BS853_059BS852	LEWS 1040	RHG
11/2/2017	Raised outlet offset from 0 to 0.01 feet	Nicholson at Cliff	059BS855_059BS852	LEWS 1040	RHG
11/2/2017	Increased length from 2 to 3.333 feet, raised offset from 0.8 to 0.86 feet	Nicholson at Cliff	weir 059BS852_059BS852A	LEWS 1040	RHG
11/2/2017	Lowered manhole invert from 618.934 to 618.347	Nicholson at Cliff	059BS852A	LEWS 1040	RHG
11/2/2017	Added manhole 059T1310 just north of 059AC1310, invert 670.44, depth 8.73 feet	Detroit at Clarence	none	LEWS 1040	RHG
11/2/2017	Changed inlet to 059T1310, changed name, reduced inlet offset from 2 to 0 feet, changed color to blue	Detroit at Clarence	059AC1310_059AT030	LEWS 1040	RHG
11/2/2017	Changed outlet to 059T1310, changed name, reducde outlet offset from 5 to 2.44 feet, changed color to blue	Detroit at Clarence	059AT1311_059AC1310	LEWS 1040	RHG
11/2/2017	Added weir 059AC1310_059T1310, length 2.5 feet, inlet offset 1.97 feet	Detroit at Clarence	none	LEWS 1040	RHG
11/2/2017	Changed color from purple to blue	Detroit at Clarence	Storm lines south of 059AT1311	LEWS 1040	RHG
11/2/2017	Changed column title in this spreadsheet from CSO Area to Outfall Area, changed outfall descriptions to LEWS ####, RRES ####, or RRWS ####, (permitted CSO number)	All			RHG
11/3/2017	Lowered manhole invert from 674.325 feet to 672.335 feet	Grace 200 feet south of Detroit	059AT897	LEWS 1040	RHG
11/3/2017	Lowered outlet offset from 0.5 feet to 0.19 feet, increase Geom1 from 2 feet to 3 feet	Grace 200 feet south of Detroit	059AC898_059AT897	LEWS 1040	RHG
11/3/2017	Raised inlet offset from 4 feet to 5.2 feet	Detroit Avenue 260 feet east of Elbur	059AS050_059AT025	LEWS 1040	RHG
11/3/2017	Reduced Roughness from 0.015 to 0.011	Detroit Avenue 260 feet east of Elbur	059AS050_059AS052	LEWS 1040	RHG
11/3/2017	Reduced Roughness from 0.015 to 0.011	Detroit Avenue 260 feet east of Elbur	059AS049_059AS050	LEWS 1040	RHG
11/3/2017	Lowered inlet offset from 4.1 feet to 2.76 feet, lowered outlet offset from 7.5 feet to 1.83, roughness to 0.011	Detroit Avenue at Elbur	059AS047_059AT024	LEWS 1040	RHG
11/3/2017	Raised outlet offset from 0 feet to 0.02 feet	Detroit Avenue at Elbur	059AS046_059AS047	LEWS 1040	RHG
11/3/2017	Reduced Roughness from 0.015 to 0.011	Detroit Avenue at Elbur	059AS048_059AS049	LEWS 1040	RHG
11/3/2017	Reduced Roughness from 0.015 to 0.011	Detroit Avenue at Elbur	059AS047_059AS048	LEWS 1040	RHG
11/3/2017	Reduced Roughness from 0.015 to 0.011	Detroit Avenue at Elbur	059AS046_059AS047	LEWS 1040	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 1.11 feet	Wyandotte south of Detroit Avenue	059AC978_059AC046A	LEWS 1040	RHG
11/3/2017	Raised manhole invert from 671.235 feet to 672.185 feet	Wyandotte south of Detroit Avenue	059AC046B	LEWS 1040	RHG
11/3/2017	Lowered inlet offset from 0.5 feet to 0.0 feet	Wyandotte south of Detroit Avenue	059AC046B_059AT023	LEWS 1040	RHG
11/3/2017	Raised weir inlet offset from 0.5 feet to 1.59 feet	Wyandotte south of Detroit Avenue	Weir 059AC046A_059AC046B	LEWS 1040	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.05 feet	Madison at Lewis	059C0077A_059C0078A	LEWS 1040	RHG
11/3/2017	Raised outlet offset from 2.2 feet to 2.27 feet	Madison at Lewis	059C2041_059C0078A	LEWS 1040	RHG
11/3/2017	Raised inlet offset from 0.7 feet to 0.73 feet	Madison at Lewis	059S078A_059AT1375	LEWS 1040	RHG
11/3/2017	Lowered the manhole invert from 718.212 to 717.70	Elbur north of Madison	059AT953	LEWS 1040	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.01 feet	Elbur north of Madison	059C0076AA_059AT953	LEWS 1040	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.02 feet	Wilbert Dr north end (Cliff Dr)	059BS852_059BS012A	LEWS 1045	RHG
11/3/2017	Raised outlet offset from 0.45 feet to 1.38 feet	Wilbert Dr north end (Cliff Dr)	059BS012B_059BS012A	LEWS 1045	RHG
11/3/2017	Raised inlet offset from 0.58 feet to 0.60 feet	Wilbert Dr north end (Cliff Dr)	weir 059BS012A_059BS012	LEWS 1045	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.40 feet	Edgewood between Homewood and Wilbert	059BC010_059BC006	LEWS 1055	RHG
11/3/2017	Raised inlet offset from 0.1 feet to 0.31 feet	Edgewood between Homewood and Wilbert	059BC006A_059BT1003	LEWS 1055	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.07 feet	Detroit @ Parkwood	059AS044_059AS045	LEWS 1055	RHG
11/3/2017	Raised outlet offset from 5.32 feet to 7.05 feet	Detroit @ Parkwood	059AS989_059AS045	LEWS 1055	RHG
11/3/2017	Lowered inlet offset from 7.2 feet to 6.26 feet; Lowered outlet offset from 5.3 feet to 4.5 feet	Detroit @ Parkwood	059AS045_059AT022	LEWS 1055	RHG
11/3/2017	Changed Outlet node from 059AC036 to 059AC036A; raised outlet offset from 0.0 to 0.50 feet	Detroit @ Robinwood	059AC1017_059AC036	LEWS 1055	RHG
11/3/2017	Changed from orifice to weir 059AC036A_059AC036; length 1.5 feet, inlet offset 0.45 feet	Detroit @ Robinwood	Orifice 059AC036_059AC036A	LEWS 1055	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.02 feet	Cedarwood and Blossom Park	059AC1034_059AC1036	LEWS 1055	RHG
11/3/2017	Lowered inlet offset from 0.1 feet to 0.07 feet	Cedarwood and Blossom Park	059AC1036A_059AT1037	LEWS 1055	RHG
11/3/2017	Lowered weir offset from 0.6 feet to 0.37 feet, reduced length from 2 to 1.5 feet	Cedarwood and Blossom Park	weir 059AC1036_059AC1036A	LEWS 1055	RHG
11/3/2017	Moved overflow pipe from 002S769_002T1301 to 002S766_002T767, inlet offset 0.5 feet, outlet offset 3 feet	Homewood north end	002S769_002T1301	LEWS 1070	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.04 feet	Homewood north end	002S769_002S766	LEWS 1070	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.04 feet	Clifton @ Whipporwill	057C024_057C023	LEWS 1070	RHG
11/3/2017	Lowered inlet offset from 0.25 feet to 0.17 feet	Clifton @ Whipporwill	057C023_057T570	LEWS 1070	RHG
11/3/2017	Changed label from LEWS 1110-A to LEWS 1110	CSO-058	Label	LEWS 1110 (058)	RHG
11/3/2017	Decreased size from 2.5 to 2.0 feet; raised outlet offset from 0.0 feet to 0.05 feet	Edgewater between Roy Dr and Kirtland Ln	058C003_058C001A	LEWS 1110 (058)	RHG
11/3/2017	Raised weir offset from 0.6 feet to 0.77 feet; increased length from 4 to 4.17 feet	Edgewater between Roy Dr and Kirtland Ln	weir 058C001A_058C001B	LEWS 1110 (058)	RHG
11/3/2017	Decreased size from 2.5 to 2.0 feet	Edgewater between Roy Dr and Kirtland Ln	058C001B_058LEWS1110	LEWS 1110 (058)	RHG
11/3/2017	Removed label LEWS 1130-B (overflow was removed)	Clifton & Marlow	Label	LEWS 1130	RHG
11/3/2017	Removed label LEWS 1130-A (overflow was removed)	Clifton & Belle (NE corner)	Label	LEWS 1130	RHG
11/3/2017	Lowered the manhole invert from 632.892 to 632.582	Clifton & Belle (SE corner)	057C012A	LEWS 1130	RHG
11/3/2017	Raised outlet offset from 0.0 feet to 0.31 feet	Clifton & Belle (SE corner)	057C286_057C012A	LEWS 1130	RHG
11/3/2017	Lowered outlet offset from 3.9 feet to 3.59 feet	Clifton & Belle (SE corner)	057C012A_057C011	LEWS 1130	RHG
11/3/2017	Raised weir offset from 1.0 feet to 1.87 feet	Clifton & Belle (SE corner)	weir 057C012A_057C012	LEWS 1130	RHG
11/3/2017	Raised the manhole invert from 632.892 to 633.81	Clifton & Belle (SE corner)	057C012	LEWS 1130	RHG
11/3/2017	Lowered inlet offset from 1.0 feet to 0.0 feet	Clifton & Belle (SE corner)	057C012_057C163	LEWS 1130	RHG
11/3/2017	Changed label from LEWS 1135-A to LEWS 1135	CSO-057	Label	LEWS 1135 (057)	RHG
11/3/2017	Deleted this orifice (it does not exist)	Lakewood Park	orifice 057T001_057S001	LEWS 1135 (057)	RHG
11/3/2017	Changed the orifice to a weir, length 5.50, inlet offset 2.11 feet, coeff 3.33	Lakewood Park	orifice 057T001_057S001A	LEWS 1135 (057)	RHG
11/3/2017	Changed size from 0.9 x 1.0 to 0.75 x 1.667 feet, lowered inlet offset from 1.0 to 0.0	Lakewood Park	orifice 057T001_057S001B	LEWS 1135 (057)	RHG
11/3/2017	Lowered inlet offset from 2.0 feet to 1.76 feet	Lakewood Park	057T001_057C343	LEWS 1135 (057)	RHG
11/3/2017	Changed conduit label from 056C490C_056C898 to 056C490C_056C490	Edgewater between Leedale and Rosalie	056C490C_056C898	LEWS 1150 (056B)	RHG
11/3/2017	Lower outlet offset from 0.5 feet to 0.2 feet	Edgewater between Leedale and Rosalie	056C490C_056C490	LEWS 1150 (056B)	RHG

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11/3/2017	Raised the inlet offset from 1.1 feet to 1.2 feet	Edgewater between Leedale and Rosalie	weir 056C490_056C490B	LEWS 1150 (056B)	RHG
11/3/2017	Lowered the invert from 614.821 to 614.301	Edgewater between Leedale and Rosalie	056C490B	LEWS 1150 (056B)	RHG
11/3/2017	**NOTE: Model reflects anticipated post construction condition on Edgewater, not as of this date. The existing combined sewer has not been converted to a storm sewer only. NOTE: 11/7/17 revision revertyed model back to pre-construction condition.**	Edgewater between Leedale and Rosalie	CSO 056B	LEWS 1150 (056B)	RHG
11/3/2017	Lowered the invert from 672.332 to 670.232	Elmwood @ Detroit	056C289	LEWS 1150 (056B)	RHG
11/3/2017	Raised the outlet offset from 0.0 feet to 2.1 feet	Elmwood @ Detroit	056C307_056C289	LEWS 1150 (056B)	RHG
11/3/2017	Raised the inlet offset from 1.0 feet to 1.46 feet	Elmwood @ Detroit	056C289_056T050	LEWS 1150 (056B)	RHG
11/3/2017	Raised the inlet offset from 0.0 feet to 0.04 feet, change the pipe size from 1.5 feet to 0.667 feet	Mars @ Detroit	056C295_056S049	LEWS 1150 (056B)	RHG
11/3/2017	Lowered inlet offset from 2 feet to 0.66 feet, change the pipe size from 2.0 feet to 1.667 feet	Mars @ Detroit	056C295_056T049	LEWS 1150 (056B)	RHG
11/3/2017	Lowered the outlet offset from 0.5 feet to 0.0 feet	Mars @ Detroit	056C296_056C295	LEWS 1150 (056B)	RHG
11/3/2017	Raised the outlet offset from 0.0 feet to 0.10 feet	Victoria north of Hilliard	056S063_056S058	LEWS 1150 (056B)	RHG
11/3/2017	Moved label LEWS1150-E from Hilliard Ave to this orifice	Victoria north of Hilliard	orifice 056T058_056S058	LEWS 1150 (056B)	RHG
11/3/2017	Raised the outlet offset from 0.0 feet to 0.21 feet	Victoria north of Hilliard	056T063_056T058	LEWS 1150 (056B)	RHG
11/3/2017	Raised the manhole invert from 620.78 to 620.82	Clifton @ Lakeland	002T188	LEWS 1180	RHG
11/3/2017	Changed the shape from 2.5 circular to custom 4.38 (same as outlet pipe); raised outlet offset from 0.0 to 0.18 feet	Clifton @ Lakeland	056T2139_002T188	LEWS 1180	RHG
11/3/2017	Raised inlet offset from 5.40 to 5.66	Clifton @ Lakeland	weir 002S188_002T188	LEWS 1180	RHG
11/3/2017	Reduced the size from 2.5 to 2.0 feet	Clifton @ Lakeland	002S188_056S2143	LEWS 1180	RHG
11/3/2017	Added new storm outfall at the cliff and named it LEWS 1190. This is a new outfall number.	Summit @ Edgewater	LEWS 1190	LEWS 1190	RHG
11/3/2017	Increased roughness from 0.013 to 0.024; size from 1 foot to 2 feet, decreased inlet offset from 11.3 to 10.43	Summit @ Edgewater	002C244_002C241	LEWS 1190	RHG
11/3/2017	There is a hump in the pipe. Add a pseudo manhole 70 feet downstream, invert 616.60	Summit @ Edgewater	LEWS1190-PSEUDO	LEWS 1190	RHG
11/3/2017	Changed outlet node from 002T9987 to LEWS1190-PSEUDO, outlet offset 0	Summit @ Edgewater	002C244_LEWS1190-PSEUDO	LEWS 1190	RHG
11/3/2017	Added new 24" cmp from LEWS1190-PSEUDO to outfall LEWS1190	Summit @ Edgewater	LEWS1190-PSEUDO_LEWS1190	LEWS 1190	RHG
11/3/2017	Changed name to 002C244_LEWS1190-PSEUDO	Summit @ Edgewater	002C244_LEWS1190-PSEUDO	LEWS 1190	RHG
11/3/2017	Decreased outlet offset from 10.76 to 10.54	Summit @ Edgewater	002S245_002C244	LEWS 1190	RHG
11/3/2017	Decreased outlet offset from 9.60 to 6.67	Summit @ Edgewater	002S243_002C244	LEWS 1190	RHG
11/6/2017	Lowered manhole invert from 621.541 to 621.36	Forest Cliff north end	002T242	LEWS 1210	RHG
11/6/2017	Raised outlet offset from 0.0 feet to 0.01 feet	Forest Cliff north end	002T3911_002T242	LEWS 1210	RHG
11/6/2017	Decreased length from 7.8 feet to 4.0 feet, raised inlet offset from 2 feet to 2.04 feet	Forest Cliff north end	weir 002S242_002T242	LEWS 1210	RHG
11/6/2017	Raised weir height from 0.5 feet to 7.761 feet	Forest Cliff north end	weir 002S242_002T242	LEWS 1210	RHG
11/6/2017	Raised manhole invert from 624.51 to 624.67	Erie Cliff north end	002C240	LEWS 1215	RHG
11/6/2017	Decreased size from 2.0 feet to 0.667 feet	Erie Cliff north end	002C240A_002C239	LEWS 1215	RHG
11/6/2017	Raised outlet offset from 0.0 feet to 0.02 feet	Erie Cliff north end	002C219_002C240A	LEWS 1215	RHG
11/6/2017	Raised inlet offset from 0.7 feet to 0.81 feet	Erie Cliff north end	weir 002C240A_002C240	LEWS 1215	RHG
11/6/2017	Lowered manhole invert from 624.457 to 624.217	Edgewater btwn Kenneth and Maple Cliff	055C003A	LEWS 1225 (055)	RHG
11/6/2017	Raised outlet offset from 0.40 feet to 1.04 feet	Edgewater btwn Kenneth and Maple Cliff	055T005_055C003A	LEWS 1225 (055)	RHG
11/6/2017	Raised inlet offset from 0.60 feet to 1.30 feet; reduce length from 3 feet to 2.42 feet	Edgewater btwn Kenneth and Maple Cliff	weir 055C003_055C003A	LEWS 1225 (055)	RHG
11/6/2017	Raised inlet offset from 0.80 feet to 0.90 feet	Edgewater btwn Webb and Kenneth	weir 002C232_002C232A	LEWS 1285A	RHG
11/6/2017	Increased size from 1.0 foot to 1.25 feet, raised outlet offset from 0.0 feet to 0.16 feet	Maple Cliff north end	002C3897_002C238A	LEWS 1220	RHG
11/6/2017	Raised outlet offset from 0.0 feet to 0.32 feet	Maple Cliff north end	002C222_002C238A	LEWS 1220	RHG
11/6/2017	Raised inlet offset from 0.33 feet to 1.12 feet	Maple Cliff north end	weir 002C238A_002C238	LEWS 1220	RHG
11/6/2017	Increased size from 0.833 feet to 1.0 feet	Lake Ave btwn Webb and Kenneth	002C206_002T207	LEWS 1295	RHG
11/6/2017	Raised outlet offset from 0.0 feet to 0.11 feet	Lake Ave btwn Webb and Kenneth	002C203_002C206	LEWS 1295	RHG
11/6/2017	Raised manhole invert from 626.08 to 626.60	Lake Ave btwn Webb and Kenneth	002C206A	LEWS 1295	RHG
11/6/2017	Raised inlet offset from 0.50 feet to 0.91 feet	Lake Ave btwn Webb and Kenneth	weir 002C206_002C206A	LEWS 1295	RHG
11/6/2017	Raised outlet offset from 0.0 feet to 0.22 feet	Lake Avenue @ Webb	002C3943_002C197	LEWS 1295	RHG
11/6/2017	Raised inlet offset from 0.50 feet to 0.54 feet	Lake Avenue @ Webb	weir 002C197_002S197A	LEWS 1295	RHG
11/6/2017	Raised outlet offset from 0.0 feet to 0.16 feet	Edwards Avenue @ Clifton Blvd	002C179_002C178	LEWS 1295	RHG
11/6/2017	Raised outlet offset from 5.20 feet to 5.30 feet	Edwards Avenue @ Clifton Blvd	002S3969_002C178	LEWS 1295	RHG
11/6/2017	Lowered inlet offset from10.2 feet to 7.58 feet	Edwards Avenue @ Clifton Blvd	002C178_002T177	LEWS 1295	RHG
11/6/2017	Raised outlet offset from 52 feet to 61.76	West Clifton @ Detroit Avenue SW corner	002S1401_002C247	RRES 1145	RHG
11/6/2017	Raised outlet offset from 0 feet to 0.24 feet	West Clifton @ Detroit Avenue SW corner	002S1420_002S1401	RRES 1145	RHG
11/6/2017	Raised outlet offset from 0.82 feet to 0.90 feet, rename from 002S1400 to 002**T**1400	West Clifton @ Detroit Avenue SW corner	weir 002S1401_002S1400	RRES 1145	RHG
11/6/2017	Raised manhole invert from 666.74 feet to 666.84 feet	West Clifton @ Detroit Avenue SW corner	002T1400	RRES 1145	RHG
11/6/2017	Raised outlet offset from 0 feet to 0.06 feet	West Clifton @ Detroit Avenue SW corner	002T1419_002T1400	RRES 1145	RHG
11/6/2017	Lowered weir inlet offset from 1.02 feet to 0.88 feet, lengthened from 3.5 feet to 3.83 feet	1460 West Clifton	weir 002S1415_002T1414	RRES 1145	RHG
11/6/2017	Lowered weir inlet offset from 0.6 feet to 0.34 feet	1488 West Clifton	weir 002S1418_002T1417	RRES 1145	RHG
11/6/2017	Lowered manhole invert from 676.5 feet to 675.42 feet	1488 West Clifton	002T1417	RRES 1145	RHG
11/7/2017	Raised weir inlet offset from 0.66 feet to 0.72 feet, reduced length from 4 feet to 3 feet	West Clifton @ Detroit Avenue SE corner	weir 002S4416_002T4416	RRES 1145	RHG
11/7/2017	Raised outlet offset from 0 feet to 0.19 feet	West Clifton @ Detroit Avenue SE corner	002T4414_002T4416	RRES 1145	RHG
11/7/2017	Raised outlet offset from 0 feet to 0.24 feet	West Clifton @ Detroit Avenue SE corner	002S4414_002S4416	RRES 1145	RHG
11/7/2017	Raised manhole invert from 667.82 feet to 667.86 feet	West Clifton @ Detroit Avenue SE corner	002T4416	RRES 1145	RHG
11/7/2017	Raised weir inlet offset from 0.8 feet to 0.81 feet, reduced length from 3.5 feet to 2.875 feet	1429 West Clifton	weir 002S4414_002T4414	RRES 1145	RHG
11/7/2017	Raised manhole invert from 669.59 feet to 669.62 feet	1429 West Clifton	002T4416	RRES 1145	RHG
11/7/2017	Raised weir inlet offset from 2.05 feet to 2.07 feet, increased length from 2 feet to 2.25 feet	1459 West Clifton	weir 002S4412_002T4412	RRES 1145	RHG
11/7/2017	Raised weir inlet offset from 1.05 feet to 5.05 feet (after wall is raised), reduced length from 2 feet to 1.75 feet	1459 West Clifton	weir 002S4412_002T4412A	RRES 1145	RHG
11/7/2017	Raised outlet offset from 0 feet to 0.05 feet	1459 West Clifton	002T1408_002T4412	RRES 1145	RHG

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11/7/2017	Changed subcatchment outlet from 002T4414 to 002T4412	1459 West Clifton	S002T4414	RRES 1145	RHG
11/7/2017	Lowered manhole invert from 671.50 feet to 671.46 feet	1459 West Clifton	002T4412	RRES 1145	RHG
11/7/2017	Lowered weir inlet offset from 0.86 feet to 0.72 feet	1491 West Clifton	weir 002S1409_002T1408	RRES 1145	RHG
11/7/2017	Raised manhole invert from 676.84 feet to 677.10 feet	1491 West Clifton	002T1408	RRES 1145	RHG
11/7/2017	Increased outlet offset from 0 feet to 1.48 feet	Clifton Place at Detroit Avenue	002C4421_002C026A	RRES 1145	RHG
11/7/2017	Increased pipe size from 1.5 feet to 2.0 feet, reduced inlet offset from 1.5 feet to 1.19 feet	Clifton Place at Detroit Avenue	002C026A_002T026	RRES 1145	RHG
11/7/2017	Reduced pipe size from 0.833 feet to 0.667 feet	Clifton Place at Detroit Avenue	002C026A_002S026	RRES 1145	RHG
11/7/2017	Lowered manhole invert from 667.782 feet to 666.302 feet	Clifton Place at Detroit Avenue	002C026A	RRES 1145	RHG
11/7/2017	Increased outlet offset from 2 feet to 2.44 feet	Rockway at Detroit Avenue	002C4432_002C029A	RRES 1145	RHG
11/7/2017	Decreased inlet offset from 4.4 feet to 2.44 feet	Rockway at Detroit Avenue	002C029A_002T029	RRES 1145	RHG
11/7/2017	Raised invert from 669.426 to 669.566	1421 Spring Garden	002S4392	RRES 1145	RHG
11/7/2017	Changed the outlet node to 002S4392, lowerer the outlet offset from 5.4 to 0, increased size 1.0 to 1.5 feet	1421 Spring Garden	002T4393_002C4392	RRES 1145	RHG
11/7/2017	Raised the outlet offset from 0 to 2.28, increased size 0.667 to 0.833 feet	1421 Spring Garden	002S4393_002S4392	RRES 1145	RHG
11/7/2017	Increased size 1.0 to 1.5 feet	1421 Spring Garden	002S4392_002S4391	RRES 1145	RHG
11/7/2017	Increased size 1.0 to 1.5 feet	1421 Spring Garden	003S4391_002S4360A	RRES 1145	RHG
11/7/2017	Increased size 0.833 to 1.5 feet	1421 Spring Garden	002S4360A_002S4360	RRES 1145	RHG
11/7/2017	Increased size 0.833 to 1.5 feet	1421 Spring Garden	002S4360_002S030	RRES 1145	RHG
11/7/2017	Decreased length from 4 to 1.5 feet, decreased inlet offset from 0.6 to 0.59 feet	1421 Spring Garden	weir 002S4392_002C4392	RRES 1145	RHG
11/7/2017	Changed conduit name from 00**3**S4391_002S4360A to 00**2**S4391_002S4360A	1421 Spring Garden	003S4391_002S4360A	RRES 1145	RHG
11/7/2017	Decreased size from 0.833 to 0.667 feet	Larchmont at Detroit Avenue	002C032A_002S032	RRES 1145	RHG
11/7/2017	Raised inlet offset from 1.1 to 1.14 feet	Larchmont at Detroit Avenue	002C032A_002T032	RRES 1145	RHG
11/7/2017	Raised outlet offset from 0.3 to 1.27 feet	Larchmont at Detroit Avenue	002C3697_002C032A	RRES 1145	RHG
11/7/2017	Decreased size from 0.833 to 0.667 feet	Wagar at Detroit Avenue	002C039A_002S039	RRES 1145	RHG
11/7/2017	Increased size 1.5 to 2 feet, decreased inlet offset from 0.7 to 0.62 feet	Wagar at Detroit Avenue	002C039A_002T039	RRES 1145	RHG
11/7/2017	Decreased size from 1.5 to 1.25 feet, decreased outlet offset from 4.4 to 2.67 feet	Wagar at Detroit Avenue	002C3651_002C039A	RRES 1145	RHG
11/7/2017	Decrease size from 1.75 to 1.667 feet	West Clifton south of RR	002T252_002T253	RRES 1145	RHG
11/7/2017	Move the CSO label RRES 1145-N to here from north of the RR	West Clifton south of RR		RRES 1145	RHG
11/7/2017	Add new MH 002S252E just east of 002S252, Inv. 637.816, depth 5.3	West Clifton south of RR	new 002S252E	RRES 1145	RHG
11/7/2017	Changed weir 002T252A_002S252 to 002T252A_002S252E; length 1.5; inlet offset 1.63	West Clifton south of RR	weir 002T252A_002S252	RRES 1145	RHG
11/7/2017	Added new weir 002S252E_002T252; length 1.5, inlet offset 0.65	West Clifton south of RR	weir 002S252E_002T252	RRES 1145	RHG
11/7/2017	Added new orifice 002T252A_002T252; type side; width 1.0; height 0.25; coeff 0.966	West Clifton south of RR	orifice 002T252A_002T2525	RRES 1145	RHG
11/7/2017	Decreased size from 1.0 to 0.833; changed outlet to 002S252E	West Clifton south of RR	002S1405_002S252	RRES 1145	RHG
11/7/2017	Increased size from 1.75 to 1.767	West Clifton south of RR	002T252_002T253	RRES 1145	RHG
11/7/2017	Added conduit 002S252E_002S252; Geom1 0.833; length 3	West Clifton south of RR	002S252E_002S252	RRES 1145	RHG
11/7/2017	Moved the CSO label RRES 1145-O to here from south of the RR	West Clifton north of RR		RRES 1145	RHG
11/7/2017	Reduced length from 50 feet to 10 feet, increased outlet offset from 2 feet to 4.5 feet	West Clifton north of RR	002S253_002C253	RRES 1145	RHG
11/7/2017	Decreased outlet offset from 22 to 13.35 feet	West Clifton north of RR	002S252_002S253	RRES 1145	RHG
11/7/2017	Decrease outlet offset from 21.5 to 20.90 feet	West Clifton north of RR	002T252_002T253	RRES 1145	RHG
11/7/2017	Changed conduit name from 002S1405_002S252 to 002S1405_002S252**E**	1285 West Clifton	002S1405_002S252	RRES 1145	RHG
11/7/2017	Raised outlet offset from 0.0 feet to 0.04 feet	1285 West Clifton	002T251_002T1404	RRES 1145	RHG
11/7/2017	Changed from weir to 0.5 ft horizontal (bottom) orifice, inlet offset from 1.2 to 5.49 feet	1232 West Clifton - Horace Mann Elementary	weir 002S4064_002T4064	RRES 1145	RHG
11/7/2017	Reduced the length from 4 to 3.17 feet, increase inlet offset from 1.2 to 1.39 feet	1253-55 West Clifton	weir 002S4062_002T4062	RRES 1145	RHG
11/7/2017	Reduced the length from 4 to 3.5 feet	West side of W. Clifton 75 ft south of Clifton	weir 002S265_002T265	RRES 1145	RHG
11/7/2017	Increased outlet offset from 0.0 to 0.08 feet	West side of W. Clifton 75 ft south of Clifton	002S4068_002S265	RRES 1145	RHG
11/7/2017	Reduced the length from 4 to 3 feet; lowered invert offset from 1.2 to 0.82 feet	1186 West Clifton	weir 002S4068_002T1410	RRES 1145	RHG
11/7/2017	Increased outlet offset from 0.0 to 0.04 feet	1186 West Clifton	002S4066_002S4068	RRES 1145	RHG
11/7/2017	Lowered invert elevation from 631.956 to 631.896	1186 West Clifton	002T1410	RRES 1145	RHG
11/7/2017	Lower invert offset from 1.2 to 0.82 feet	1214 West Clifton	weir 002S4066_002T4066	RRES 1145	RHG
11/7/2017	Raised invert elevation from 633.646 to 633.666	1214 West Clifton	002T4066	RRES 1145	RHG
11/7/2017	Redirected the subcatchment outlet from manhole 002S4066 to manhole 002T4066	1214 West Clifton	S002S4066	RRES 1145	RHG
11/7/2017	Lowered invert offset from 3.6 to 3.46 feet, reduced length from 8 to 4 feet	West Clifton at Clifton Blvd SW corner	weir 002S264_002T264	RRES 1145	RHG
11/7/2017	Lowered invert elevation from 627.682 to 627.332	West Clifton at Clifton Blvd SW corner	002T264	RRES 1145	RHG
11/7/2017	Deleted this conduit	Hilliard at Olive	052S090_052S086	RRES 1165 (052)	RHG
11/7/2017	Changed color from green to blue, increased size from 1 to 2 feet, lowered inlet offset from 0.9 to 0.71 feet	Hilliard at Olive	052SMeter006_052T086	RRES 1165 (052)	RHG
11/7/2017	Increased outlet offset from 0 to 0.39 feet	Hilliard at Olive	052T093_052SMeter006	RRES 1165 (052)	RHG
11/7/2017	Decreased the inlet offset from 0.3 to 0.17 feet	Hilliard at Olive	052SMeter006_052T091	RRES 1165 (052)	RHG
11/7/2017	RRES 1165-B	Change label from RRES 1165-A to RRES 1165-B	Label	RRES 1165 (052)	RHG
11/7/2017	Reduce outlet offset from 0.3 to 0.1 feet	WWTP entrance drive	053C004_053C002	RRWS 1200 (053)	RHG
11/7/2017	Reduce inlet offset from 1.4 to 1.18 feet	WWTP entrance drive	053C002_053S001	RRWS 1200 (053)	RHG
11/7/2017	Changed junction name to 053C001	WWTP entrance drive	053S001	RRWS 1200 (053)	RHG
11/7/2017	Added conduit 056T915_056C490; GEOM1 0.667; Inlet offset 0 (Separation project incomplete)	Edgewater between Leedale and Rosalie	056T915_056C490	LEWS 1155 (056A)	RHG
11/7/2017	Added junction 056T915B for outfall meter location	Edgewater between Leedale and Rosalie	056T915B	LEWS 1155 (056A)	RHG
11/7/2017	Added new weir 056T915_056T915B; length 4, inlet offset 1.21, coeff 3.33	Edgewater between Leedale and Rosalie	056T915_056T915B	LEWS 1155 (056A)	RHG
11/7/2017	Changed conduit from blue to magenta to reflect incomplete separation	Edgewater between Cliffdale and Leedale	056T912_056C490	LEWS 1155 (056A)	RHG
11/7/2017	Raise invert offset from 0 to 0.1	Edgewater between Leedale and Rosalie	056C1300_056T915	LEWS 1155 (056A)	RHG
11/7/2017	Added junction 056T1301B for overflow meter location	Edgewater between Leedale and Rosalie	056T1301B	LEWS 1150 (056B)	RHG

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11/7/2017	Added new weir, length 4, inlet offset 1.02, coeff 3.33 (Need field confirmation of dimensions of weir and effluent pipes)	Edgewater between Leedale and Rosalie	056T1301_056T1301B	LEWS 1150 (056B)	RHG
11/7/2017	Added existing 10" conduit from combined to interceptor (Separation project incomplete). Existing 10" blinds into interceptor, junction 056C284A used to represent connection.	Edgewater between Leedale and Rosalie	056T1301_056C284A	LEWS 1150 (056B)	RHG
11/7/2017	Changed conduit from blue to magenta to reflect incomplete separation	Edgewater between Abbieshire and Rosalie	056T918_056C490C	LEWS 1150 (056B)	RHG
11/7/2017	Changed conduit from blue to magenta to reflect incomplete separation	Edgewater between Abbieshire and Rosalie	056T1301_056C284A	LEWS 1150 (056B)	RHG
11/7/2017	Added WWTP to model	WWTP	Numerous	WWTP Outfall and 002	RHG
12/12/2017	Added West End aerial sewer and modified sewers on Scenic Street to reflect eliminaiton of CSO 054	Scenic Street to WWTP	Numerous	CSO 054	RHG
12/22/2017	Added missing 18" conduit	Edgewater between Sylvan and Leedale	056S_SEP1C_056C_SEP1D	CSO 056	RHG
1/18/2018	Lowered CSO-002 weir offset from 8 to 6.9 based on 1987 construction plans (also next 4 items)	WWTP influent head chamber	CSO-002	002	PWK
1/18/2018	Added CSO-002 overflow chamber just west of INFL-HEAD, inv=599.4, depth 12.27	WWTP influent head chamber	002-overflow	002	PWK
1/18/2018	Changed CSO-002 outlet node to 002-overflow	WWTP influent head chamber	002-overflow	002	PWK
1/18/2018	Added CSO-002 drop chamber just east of Outfall_Head_Chamber, inv=584.98, depth=19.82	WWTP influent head chamber	002-drop	002	PWK
1/18/2018	Added 30.04 feet of 42-inch pipe from head chamber wall to wall of CSO-002 drop chamber, n=0.013	WWTP influent head chamber	overflow-to-drop	002	PWK
1/18/2018	Added 5.5 feet of 42-inch pipe from wall CSO-002 drop chamber to wall outfall head chamber, n=0.013	WWTP outfall head chamber	drop-to-head_chamber	002	PWK
1/18/2018	un-checked report input summary	whole model	simulation options	all	PWK
1/18/2018	Added manhole 059T014A just north of 059T014, invert 640.055, depth 8 feet	LEWS 1035-A	059T014A	LEWS 1035 (059)	PWK
1/18/2018	Changed inlet node of 059T014_059T013 to 059T014A	LEWS 1035-A	059T014_059T013	LEWS 1035 (059)	PWK
1/18/2018	Added weir 059T014_059T014A, transverse, height 7.44, length 2.5, inlet offset 0.55 (forces dry flow through invert plate)	LEWS 1035-A	059T014_059T014A	LEWS 1035 (059)	PWK
1/18/2018	Added manhole 056T061A just south of 056T061, invert 696.935, depth 8.6 feet	LEWS 1150-E	056T061A	LEWS 056	PWK
1/18/2018	Changed 056C318_056T061 outlet node to 056T061A	LEWS 1150-E	056C318_056T061	LEWS 056	PWK
1/18/2018	Changed 056T061_056S061 inlet node to 056T061A	LEWS 1150-E	056T061_056S061	LEWS 056	PWK
1/18/2018	Added 1 foot of 48-inch pipe from 056T061 to 056T061A, n=0.015, inlet offset=0.2 (forces dry flow through invert plate)	LEWS 1150-E	056T061A_056T061	LEWS 056	PWK
1/18/2018	Added manhole 002T207A just northeast of 002T207, invert 622.517, depth 10.5 feet	LEWS 1295-A	002T207A	002	PWK
1/18/2018	Changed 002C206_002T207 outlet node to 002T207A	LEWS 1295-A	002C206_002T207	002	PWK
1/18/2018	Changed 002T207_002S207 inlet node to 002T207A	LEWS 1295-A	002T207_002S207	002	PWK
1/18/2018	Added 1 foot of 20-inch pipe from 002T207A to 002T207, n=0.015, inlet offset=0.25 (forces dry flow through invert plate)	LEWS 1295-A	002T207A_002T207	002	PWK
1/18/2018	Climate capabilities added (for evaporation and snow)	whole model	Numerous	all	PWK
1/18/2018	Snowpack added	whole model	Numerous	all	PWK
1/18/2018	Reduced ADF based on Pollutant analysis of 5 years of WWTP DMRs and 15 years of water consumption	whole model	Numerous	all	PWK
1/18/2018	Infiltration changed to modified Green-Ampt and Soil map overlays	whole model	Numerous	all	PWK
1/18/2018	Interceptor "n" values reduced from 0.015 to 0.013 to better model overflows at CSO-002	whole length of interceptor	Numerous	all	PWK
1/19/2018	Changed storm sewer size from 12" to 18" per City investigation	Lake Avenue	056T900_056C898	056	RHG
1/19/2018	Added Typ Yr 1977 Climate.dat and Typ Yr with 5-yr and 10-yr 6-hr storms.dat to Master Model_files folder	whole model	Climate and Rain Gauge files	all	PWK
1/19/2018	Set initial depth at Begin_Diffuser to 23 feet to match lake level	north end Webb Road	Begin_Diffuser	Diffusers	PWK
1/23/2018	Deleted unused flow patterns - updated (removed outliers) and normalized remaining flow patterns	whole model	Numerous	all	PWK
1/23/2018	Changed all baseline flow patterns to normalized GWI flow pattern based on 5 years of DMR data	whole model	Numerous	all	PWK
1/23/2018	Further reduced sewage production from 3.693 MGD to 3.559 MGD based on updated water consumption data trend	whole model	Numerous	all	PWK
1/24/2018	Adjested the R of RTK factors for non-calibrated months (1-5 and 9-12) to the averages of the calibrated months	whole model	Numerous	all	PWK
1/26/2018	lowered 053C002 5 feet (589.93 to 584.93) to model a wet well to enable pumping 053C002 sewage to the WWTP	WWTP	053C002	053WWTP	PWK
1/26/2018	Raised outlet offset of 053C004_053C002 from 0.1 to 5.1	WWTP	053C004_053C002	053WWTP	PWK
1/26/2018	Raised inlet offset of 053C002_053C001 from 1.18 to 6.18	WWTP	053C002_053C001	053WWTP	PWK
1/26/2018	Raised inlet offset of 053C002_053WWTP from 0.0 to 5.0	WWTP	053C002_053WWTP	053WWTP	PWK
1/26/2018	Added 053C002N as the pump influent manhole invert 584.00 depth 13 feet	WWTP	053C002N	053WWTP	PWK
1/26/2018	added a pseudo pipe from 053C002 to the pump influent node 053C002N Length 10, Rough 0.015, offsets 0, size 0.667	WWTP	053C002_053C002N	053WWTP	PWK
1/26/2018	Added 053P002 as the pump, Inlet Node 053C002N, Outlet Node InfluentMixingChamber, Ideal Pump *, start & stop 0.0	WWTP	053P002	053WWTP	PWK
1/26/2018	Raised invert of PS_13474_Edgewaterfrom 0 to 610, raised sewage from 0.003 to 0.001, updated patterns	north end Wilbert Dr	PS_13474_Edgewater	Lews 1045-A	PWK
1/26/2018	changed Startup depth from 0 to 2, changed Shutoff depth from 0 to 0.5	north end Wilbert Dr	Sub_Pump	Lews 1045-A	PWK
1/26/2018	Found John Kelly's site visit notes foe CSO-002 width 6.6, height 2.73, inlet offset 8.4	WWTP head chamber	CSO-002	002	PWK
1/30/2018	Added junction Infl_Head_Eff just south of INFL-HEAD invert 597.99, depth 13.68	WWTP head chamber	Infl_Head_Eff	Diffusers	PWK
1/30/2018	Added conduit INFL-HEAD to Infl_Head_Eff, length 8,size rough 0.013, offsets 0, **Flow Limit 35,** size 7 to limit flow here	WWTP head chamber	INFL-HEAD_Infl_Head_Eff	Diffusers	PWK
1/30/2018	Lowered invert of INFL-HEAD-A from 598 to 597.99	WWTP head chamber	INFL-HEAD-A	Diffusers	PWK
1/30/2018	Lowered invert of IFHOR from 598 to 597.99	WWTP head chamber	IFHOR	Diffusers	PWK
1/30/2018	Lowered invert of INFL-HEAD-B from 598 to 597.99	WWTP head chamber	INFL-HEAD-B	Diffusers	PWK
1/30/2018	Reduced IFHOR_InfluentMixingChamber Flow Limit from 40 to 0	WWTP	IFHOR_InfluentMixingChamber	Diffusers	PWK
1/30/2018	Artifically raised depth of InfluentMixingChamber from 8.5 to 13.5	WWTP	InfluentMixingChamber	Diffusers	PWK
1/29/2018	Changed name C24 to Clar4_InfChan	WWTP	Clar4_InfChan	Diffusers	PWK
1/29/2018	Changed name C25 to Clar3_InfChan	WWTP	Clar3_InfChan	Diffusers	PWK
1/29/2018	Changed name C26 to Clar2_InfChan	WWTP	Clar2_InfChan	Diffusers	PWK
1/29/2018	Changed name C27 to Clar1_InfChan	WWTP	Clar1_InfChan	Diffusers	PWK
1/29/2018	Changed name C28 to Clar5_InfChan	WWTP	Clar5_InfChan	Diffusers	PWK
1/29/2018	Changed name C28 to Clar6_InfChan	WWTP	Clar6_InfChan	Diffusers	PWK
1/29/2018	Changed 6 names to Final_clarifier _channel 1-6 and outlet offsets from0.82 to 0.81	WWTP	Final_clarifier _channel(s) 1-6	Diffusers	PWK
1/30/2018	Changed 6 Clar(1-6)_EffTroughInTank junctions depths from 1.568 to 2.67 to match top of effluent channels	WWTP	Clar(1-6)_EffTroughInTank	Diffusers	PWK
1/29/2018	Changed 6 Clar(1-6)_EffChanStart junctions depths from 2.59 to 3.49 to match top of effluent channels	WWTP	Clar(1-6)_EffChanStart	Diffusers	PWK
1/29/2018	Lowered invert of FinalClarify_EffChnlAtTankWal from 591.92 to 591.91 and raised depth from 2.76 to 3.5	WWTP	FinalClarify_EffChnlAtTankWal	Diffusers	PWK
1/29/2018	Lowered invert of EffluentOutletChnl from 591.92 to 590.64 and raised depth tp 5,27 to match ChlorineInflChnl	WWTP	EffluentOutletChnl	Diffusers	PWK

Revision Date	Revision Decription:	Location	Object Name	Outfall Area	Revision Completed By
1/29/2018	Lowered invert of BarScreenEnd from 590.64 to 590.63 and raised Depth from 5.27 to 5.28	WWTP	BarScreenEnd	Diffusers	PWK
1/29/2018	Lowered invert of BarScreenInChannel from 590.64 to 590.63 and raised Depth from 5.27 to 5.28	WWTP	BarScreenInChannel	Diffusers	PWK
1/29/2018	Changed ChlorInfChnl2 outlet offset from 7.409 to 7.38	WWTP	ChlorInfChnl2	Diffusers	PWK
1/29/2018	Changed OldChlorineTankStart invert from 583.23 to 583.24 and kept depth at 12.68	WWTP	OldChlorineTankStart	Diffusers	PWK
1/29/2018	Changed 3 junctions UVChnl(1-3)Step inverts from 590.72 to 590.71 and depth raised from 5.19 to 5.20	WWTP	UVChnl(1-3)Step	Diffusers	PWK
1/29/2018	Changed 3 names to UV_channel_exit 1-3 and depth kept at 4.44	WWTP	UV_channel_exit(s) 1-3	Diffusers	PWK
1/29/2018	Changed 3 junctions UVChnl1ALStart inverts from 590.7 to 591.45 and depth lowered from 5.19 to 4.46	WWTP	UVChnl1ALStart	Diffusers	PWK
1/29/2018	Changed name C1 to UV_effluent_channel	WWTP	UV_effluent_channel	Diffusers	PWK
1/29/2018	Changed Effluent_Chamber depth from 5.16 to 6.56 to match tops of other channels	WWTP	Effluent_Chamber	Diffusers	PWK
1/29/2018	Changed name C2 to 36_inch_4th_sect	WWTP outfall	36_inch_4th_sect	Diffusers	PWK
1/29/2018	Changed name C3 to36_inch_2nd_sect	WWTP outfall	36_inch_2nd_sect	Diffusers	PWK
1/29/2018	Changed name C4 to 36_inch_3rd_sect	WWTP outfall	36_inch_3rd_sect	Diffusers	PWK
1/29/2018	Changed name C5 to 30_inch_1st_sect	WWTP outfall	30_inch_1st_sect	Diffusers	PWK
1/29/2018	Changed name C6 to 30_inch_2nd_sect	WWTP outfall	30_inch_2nd_sect	Diffusers	PWK
1/29/2018	Changed name C7 to 30_inch_3rd_sect	WWTP outfall	30_inch_3rd_sect	Diffusers	PWK
1/29/2018	Changed name C8 to 30_inch_4th_sect	WWTP outfall	30_inch_4th_sect	Diffusers	PWK
1/29/2018	Changed name C9 to WWTP_outfall_1	WWTP outfall	WWTP_outfall_1	Diffusers	PWK
1/29/2018	Changed name C10 to WWTP_outfall_2	WWTP outfall	WWTP_outfall_2	Diffusers	PWK
1/29/2018	Changed name C11 to WWTP_outfall_3	WWTP outfall	WWTP_outfall_3	Diffusers	PWK
1/29/2018	Changed name C12 to WWTP_outfall_4	WWTP outfall	WWTP_outfall_4	Diffusers	PWK
1/29/2018	Changed name C13 to WWTP_outfall_5	WWTP outfall	WWTP_outfall_5	Diffusers	PWK
1/29/2018	Changed name C14 to WWTP_outfall_6	WWTP outfall	WWTP_outfall_6	Diffusers	PWK
1/29/2018	Changed name C15 to WWTP_outfall_7	WWTP outfall	WWTP_outfall_7	Diffusers	PWK
1/29/2018	Changed name C16 to WWTP_outfall_8	WWTP outfall	WWTP_outfall_8	Diffusers	PWK
1/29/2018	Changed name C17 to WWTP_outfall_9	WWTP outfall	WWTP_outfall_9	Diffusers	PWK
1/29/2018	Changed name C18 to WWTP_outfall_10	WWTP outfall	WWTP_outfall_10	Diffusers	PWK
1/29/2018	Changed name C19 to WWTP_outfall_11	WWTP outfall	WWTP_outfall_11	Diffusers	PWK
1/29/2018	Changed name C20 to WWTP_outfall_12	WWTP outfall	WWTP_outfall_12	Diffusers	PWK
1/29/2018	Changed name C36 to 053C009_WWTP-WE1	Scenic Ave	053C009_WWTP-WE1	RRES1140	PWK
1/29/2018	Changed name C37 to 002T207A_002T207	Lake Ave btwn Webb and Kenneth	002T207A_002T207	LEWS 1295	PWK
1/29/2018	Changed name C38 to 053C002_053C002N	WWTP west side	053C002_053C002N	RRWS 1200 (053)	PWK
1/29/2018	Renamed outfall 052T01 to 052RRES1220	Former outfall 052T01	052RRES1220	052RRES1220	PWK
1/29/2018	Renamed outfall 056LEWS1145 to 056LEWS1155	Former outfall 056LEWS1145	056LEWS1155	056LEWS1155	PWK
1/29/2018	Renamed outfall 056LEWS1140 to 056LEWS1150	Former outfall 056LEWS1140	056LEWS1150	056LEWS1150	PWK
1/29/2018	Renamed outfall LEWS1190 to 002LEWS1190	Former outfall LEWS1190	002LEWS1190	002LEWS1190	PWK
1/29/2018	Renamed outfall 059C4 to 059C4NEORSD	Former outfall 059C4	059C4NEORSD	059C4NEORSD	PWK
1/29/2018	Renamed outfall 059C33 to 059C33NEORSD	Former outfall 059C33	059C33NEORSD	059C33NEORSD	PWK
1/30/2018	Renamed subcatchment S2 to ClevelandSouthArea_3 (It's adjacent to ClevelandSouthArea_2)	South of I-90	ClevelandSouthArea_3	059C33NEORSD	PWK
1/31/2018	Renamed junction 052S4614 to 052T4614	Lakewood Hts Blvd near Olive Ave	052T4614	RRES 1165 (052)	PWK
1/31/2018	Renamed junction 052S4615 to 052T4615	Lakewood Hts Blvd near Olive Ave	052T4615	RRES 1165 (052)	PWK
1/31/2018	Renamed junction 052S4617 to 052T4617	Lakewood Hts Blvd near Olive Ave	052T4617	RRES 1165 (052)	PWK
1/31/2018	Renamed junction 052S103 to 052T103	Lakewood Hts Blvd near Olive Ave	052T103	RRES 1165 (052)	PWK
2/1/2018	052T103_052T4617 changed tag from SAN to STM	Lakewood Hts Blvd near Olive Ave	052T103_052T4617	RRES 1165 (052)	PWK
2/1/2018	052T4617_052T4615 changed tag from SAN to STM	Lakewood Hts Blvd near Olive Ave	052T4617_052T4615	RRES 1165 (052)	PWK
2/1/2018	052T4615_052T4614 changed tag from SAN to STM	Lakewood Hts Blvd near Olive Ave	052T4615_052T4614	RRES 1165 (052)	PWK
2/1/2018	05T4614_052T105 changed tag from SAN to STM	Lakewood Hts Blvd near Olive Ave	05T4614_052T105	RRES 1165 (052)	PWK
1/31/2018	Added Junction 052S4614, invert 724.368, depth 8.193	Lakewood Hts Blvd near Olive Ave	052S4614	RRES 1165 (052)	PWK
1/31/2018	Added Junction 052S4615, invert 724.61, depth 7.497	Lakewood Hts Blvd near Olive Ave	052S4615	RRES 1165 (052)	PWK
1/31/2018	Added Junction 052S4617, invert 725.074, depth 6.587	Lakewood Hts Blvd near Olive Ave	052S4617	RRES 1165 (052)	PWK
1/31/2018	Added Junction 052S103, invert 725.392, depth 5.9	Lakewood Hts Blvd near Olive Ave	052S103	RRES 1165 (052)	PWK
1/31/2018	Added san conduit 052S103_052S4617, tag san, length 170.591, roughness 0.015, offsets 0, geom1 0.667	Lakewood Hts Blvd near Olive Ave	052S103_052S4617	RRES 1165 (052)	PWK
1/31/2018	Added san conduit 052S4617_052S4615, tag san, length 246.262, roughness 0.015, offsets 0, geom1 0.667	Lakewood Hts Blvd near Olive Ave	052S4617_052S4615	RRES 1165 (052)	PWK
1/31/2018	Added san conduit 052S4615_052S4614, tag san, length 132.556, roughness 0.015, offsets 0, geom1 0.667	Lakewood Hts Blvd near Olive Ave	052S4615_052S4614	RRES 1165 (052)	PWK
1/31/2018	Added san conduit 05S4614_052S105, tag san, length 140.226, roughness 0.015, offsets 0, geom1 0.667	Lakewood Hts Blvd near Olive Ave	05S4614_052S105	RRES 1165 (052)	PWK
1/31/2018	Added stm conduit 052T4615_052C104, tag stm, length 142, roughness 0.015, offsets 0, geom1 1.0	Olive Ave	052T4615_052C104	RRES 1165 (052)	PWK
1/31/2018	Moved inflows from former 052T103 to 052S103 direct 0.000487 GWI, dry 0.001177 052_Monthly_M002F Sewage_Daily 052_Hourly_WD_M002F 052_Hourly_WE_M002F, RDII M002F 0.72 ac	Lakewood Hts Blvd near Olive Ave	052S103	RRES 1165 (052)	PWK
1/31/2018	Moved inflows from former 052T4615 to 052S4615 direct 0.000487 GWI, dry 0.001177 052_Monthly_M002F Sewage_Daily 052_Hourly_WD_M002F 052_Hourly_WE_M002F, RDII M002F 1.82 ac	Lakewood Hts Blvd near Olive Ave	052S4615	RRES 1165 (052)	PWK
1/31/2018	Changed outlet from 002S252 to 002T252	West Clifton	S002S252	002	PWK
1/31/2018	Changed outlet from 059S3013 to 059T3013	Cohasset	S059S3013	LEWS 1040	PWK
1/31/2018	Changed outlet from 059S3014 to 059T3014	Cohasset	S059S3014	LEWS 1040	PWK
2/2/2018	Changed land use within subcatchments from fractional values to percentages - no effect on pollutant results	Citywide	all subcatchments	all	PWK
2/6/2018	Changed name of weir W2 to 059T014_059T014A	Clifton at Thoreau	059T014_059T014A	LEWS 1035 (059)	PWK
2/6/2018	Reduced orifice from 0.92x2.2 to 0.25x0.2 (overflow label needs to be moved south)	Victoria north of Hilliard	056T058_056S058	LEWS 1035 (059)	PWK
2/6/2018	Increased ed orifice from 0.25x0.2 to 0.92x2.2 to 0.25x0.2 (overflow label needs to be moved here)	Victoria at Hilliard	056T061_056S061	LEWS 1035 (059)	PWK
2/6/2018	Reversed direction and label	Victoria at Hilliard	056T061A_056T061	LEWS 1035 (059)	PWK

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2/6/2018	Raised outlet offset to enable pseudo sump in manhole	Victoria at Hilliard	056C318_056T061	LEWS 1035 (059)	PWK
2/16/2018	Raised initial depth from 0 to 24.59 (lake level) to prevent negative flow on startup	north end of WWTP outfall pipe	End_Diff_Junction	Diffusers	PWK
2/16/2018	Raised initial depth from 0 to 25.1 (lake level) to prevent negative flow on startup	north end of WWTP outfall pipe	Middle_Diff_Junction	Diffusers	PWK
2/16/2018	Raised initial depth from 23 to 25.84 (lake level) to prevent negative flow on startup	north end of WWTP outfall pipe	begin_Diff_Junction	Diffusers	PWK
2/16/2018	Raised initial depth from 0 to 21.1 (lake level) to prevent negative flow on startup	south end of WWTP outfall pipe	Outfall_Access_No_6	Diffusers	PWK
2/20/2018	Add pollutant X_Lakewood to all lakewood land uses final value 100 lb/acre, no buildup, washoff EMC 12.1, 1, 0, 0 to track Lakewood	Lakewood	Lakewood Subcatchments	Lakewood outfalls	PWK
2/20/2018	Add pollutant X_Cleveland subcatchmenta final value 100 lb/acre, no buildup, washoff EMC 12.1, 1, 0, 0 to track Cleveland runoff	Cleveland	Cleveland Subcatchments	Cleveland outfalls	PWK
2/20/2018	Add pollutant X_InfLak to all lakewood Direct Flow 0.1294919 mg/l, to track Lakewood infiltration (edited .inp file)	Lakewood	Lakewood junctions with Direct	Lakewood outfalls	PWK
2/20/2018	Add pollutant X_InfCle to all Cleveland Direct Flow 0.1312797 mg/l, to track Cleveland infiltration (edited .inp file)	Cleveland	Cleveland junctions with Direct	NEORSD outfalls	PWK
2/20/2018	Add pollutant X_RDII to all RDII, I/I Concen. = 0.1223316, to track Lakewood RDII (NEORSD ha none)	Lakewood	Lakewood junctions with Direct	Lakewood outfalls	PWK
2/20/2018	Add pollutant X_Sewage to all DWF Concen. = 0.127374, to track Lakewood sewage (NEORSD has none)	Lakewood	Lakewood junctions with Direct	Lakewood outfalls	PWK
2/21/2018	Unchecked pollutant modeling to reduce runtime when not analyzing pollutants	whole model	whole model	whole model	PWK
2/27/2018	Reduced Lakewood baseline values from a total of 3.373993 MGD to 2.590 MGD based on pollutant study	whole model	whole model	whole model	PWK
2/27/2018	Added newly discovered manhole 056T190E	Andrews at Clifton	056T190E	LEWS 1140	PWK
2/28/2018	Reduced RDII acreage to approximate rooftop area	whole model	whole model	whole model	PWK
2/28/2018	changed Detroit sanitary flows to run past Marlowe - outlet manhole from 057S1003 to 057S052	Detroit Ave at Marlow	057S053_057S1003	LEWS 1135	PWK
2/28/2018	changed Detroit storm flows to run past Marlowe - outlet manhole from 057T1000 to 057T052	Detroit Ave at Marlow	057T053_057T1000	LEWS 1130	PWK
2/28/2018	reduced Marlowe pipe size from 1.0 to 0.833 (plans indicate 10" pipe)	Marlow	057S405_057S1003	LEWS 1135	PWK
3/1/2018	Changed Outlet to the downstream junction 059C0012 (too much acreage for a 12-inch pipe)	Lake Rd at Cove	S059C010	059C4NEORSD	PWK
3/1/2018	Increased pipe size from 0.667 to 1 per the 1910 drawings (E-51)	Hird Avenue	059C3176_059C3173	059C4NEORSD	PWK
3/1/2018	increased size of orifice .2x.25 to .75x1.5 to prevent model flooding at this manhole which is inside the high school	Robinwood under the high school	059AT3007_059AS3010	LEWS 1040	PWK
3/1/2018	Deleted 10 orifices on Atkins, Deleware and Elbur pilot study area	Atkins, Deleware and Elbur	10 varius orifices	052RRES1160	PWK
3/2/2018	Changed tag from SAN to COM (following Arden changes based on Drawing A653)	Arden - west end relief project	052S115_052C1140	052RRES1160	PWK
3/2/2018	Changed tag from SAN to COM	Arden - beginning of west end relief project	052S114_052S115	052RRES1160	PWK
3/2/2018	Moved Subcatchment Outlet from 052T114 to new Arden relief sewer 052S114	Arden - beginning of west end relief project	052S114	052RRES1160	PWK
3/2/2018	Moved Subcatchment Outlet from 052T114 to new Arden relief sewer 052S115	Arden - beginning of west end relief project	052S115	052RRES1160	PWK
3/2/2018	Deleted Arden orfice between former invert plate manholes	Arden - beginning of west end relief project	052T114_052S114	052RRES1160	PWK
3/2/2018	increased size and shape from 1.0 to #6 Egg 4.23, decreased roughness from 0.015 to 0.013	Warren south of Madison	052T1099_052T023	052RRES1160	PWK
3/2/2018	increased size and shape from 1.0 to #6 Egg 4.23, decreased roughness from 0.015 to 0.013	Warren south of Madison	052T1101_052T1099	052RRES1160	PWK
3/2/2018	increased size and shape from 1.0 to #5 Egg 3.74, decreased roughness from 0.017 to 0.013	Warren south of Madison	052T1103_052T1101	052RRES1160	PWK
3/2/2018	increased size and shape from 1.0 to #5 Egg 3.74, decreased roughness from 0.017 to 0.013	Warren south of Madison	052T1105_052T1103	052RRES1160	PWK
3/2/2018	increased size and shape from 1.0 to #5 Egg 3.74, decreased roughness from 0.017 to 0.013	Warren south of Madison	052T1106_052T1105	052RRES1160	PWK
3/2/2018	increased size and shape from 1.0 to #5 Egg 3.74, decreased roughness from 0.017 to 0.013	Warren south of Madison	052T1108_052T1106	052RRES1160	PWK
3/2/2018	increased sewer size from 1.5 to 2.0 (based on Drawing A0036)	Clifton - French to Andrews	056T191_056C019	056LEWS1150	PWK
3/2/2018	changed pipe outlet Node from 056T253 to 056T254 (based on Drawing A0966)	Warren south of RR tracks	056T256_056S253	056LEWS1140	PWK
3/2/2018	changed subcatchment outlet Node from 056T253 to 056T254 (based on Drawing A0966)	Warren south of RR tracks	S056T253	056LEWS1140	PWK
3/2/2018	increased size from 0.833 to 1 based on meter install	Belle at Clifton Blvd	057C012A_057C011	056LEWS1135	PWK
3/6/2018	Changed all RDII acreages based on total rooftop area within tributary subcatchment	All junctions with RDII	All junctions with RDII	All	PWK
3/12/2018	increased orifice size from 0.1x0.1 to 2.2x0.9	1421 Waterbury Ave	059AT927_059AS927		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 2.2x0.9	1455 Waterbury Ave	059AT926_059AS926		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 2.2x0.9	1471 Waterbury Ave	059AT925_059AS925		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 2.2x0.9	1503 Waterbury Ave	059AT924_059AS924		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 2.2x0.9	1529 Waterbury Ave	059AT923_059AS923		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 0.7x0.1	1553 Waterbury Ave	059AT922_059AS922		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 0.5x0.5	13823 Clifton	057T031_057S031		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 0.7x0.1	1225 Hathaway Ave	057T612_057S612		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 0.7x0.1	1257 Hathaway Ave	057T613_057S613		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 2.2x0.9	1287 Hathaway Ave	057T614_057S614		PWK
3/12/2018	increased orifice size from 0.1x0.1 to 0.7x0.1	1319 Hathaway Ave	058T015_058S015		PWK
3/12/2018	increased orifice size from 0.25x0.2 to 2.2x0.9	Lewis north of Madison	059AT1375_059AS1375		PWK
3/12/2018	increased orifice size from 0.25x0.2 to 2.2x0.9	1661 Lewis Ave	059AT944_059AS944		PWK
3/12/2018	increased orifice size from 0.25x0.2 to 2.2x0.9	1635 Lewis Ave	059AT945_059AS945		PWK
3/12/2018	increased orifice size from 0.25x0.2 to 2.2x0.9	1605 Lewis Ave	059AT946_059AS946		PWK
3/12/2018	increased orifice size from 0.25x0.2 to 2.2x0.9	1575 Lewis Ave	059AT947_059AS947		PWK
3/12/2018	increased orifice size from 0.25x0.2 to 2.2x0.9	1575 Lewis Ave	059AT948_059AS948		PWK
3/12/2018	reduced orifice size from 0.75x0.75 to 0.5x0.5	15009 Athans Ave	052T1218_052S1218		PWK
3/12/2018	reduced orifice size from 0.75x0.75 to 0.5x0.5	15211 Athans Ave	052T1144_052S1144		PWK
3/12/2018	increased orifice size from 0.75x0.75 to 1x1, increaded discharge coefficient from 0.65 to 1.0	2116 Warren Rd	052T118_052S118		PWK
3/12/2018	decreased depth from 8 to 7, raised invert from 725.815 to 726.82	2116 Warren Rd	052S118		PWK
3/12/2018	decreased depth from 7 to 6, raised invert from 726.815 to 725.82	2116 Warren Rd	052T118		PWK
3/12/2018	decreased depth from 7.88 to 6.90, raised invert from 723.451 to 724.43	15009 Athans Ave	052S1218		PWK
3/12/2018	decreased depth from 11.012 to 8.80, raised invert from 720.715 to 722.93	15211 Athans Ave	052S1144		PWK
3/12/2018	raised outlet offset from 0.0 to 1.83	Athens Ave at Mars	052S1144_052C1143		PWK
3/29/2018	Added "overflow shed" attribute to subcatchments shapefile			all	MRD
3/29/2018	Added "overflow shed" attribute to nodes shapefile			all	MRD
3/30/2018	restored old weekend hourly patterns - SWMM nowuses either weekday or weekend (not weekend*weekday)	Whole model	all patterns	all	PWK

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5/25/2018	Updated RTK Sewershed Areas, RTK Loading nodes, RTK Unit Hydrographs, Subcatchment Total Areas, Subcatchments % Impervious, Subcatchment SubArea Routings, Subcatchment Percent Routed, Subcatchment Conductivity, & Rain Gauges	Whole Model	Many	All	MRD
7/5/2018	Corrected Unit Hydrograph Loading Nodes based upon 2 rain gauge spatial distribution (as per MD/KR/PK). Updated Rain Gauge Station ID's (as per MD/PK). Added subcatchment attribute for IWWIP Approach (as per MD). Updated mannings roughness to 0.015 for conduits along Madison to W. 117th connection (as per MD/BG).	Set up and Madison to W117th.	Many		MRD
11/29/2018	Corrected inlet offset of CSO-059 from 3.50 to 4.71 feet.	Edgewater east of Nicholson	059C001_059S001	LEWS 1035 (059)	PWK/MRD
11/29/2018	Corrected subcatchment outlet from Interceptor MH 056C284A to combined manhole 056T1301	North of Edgewater - at Rosalie	S056C284A	LEWS 1150	PWK/MRD
11/29/2018	Corrected depth of MH 002T024 from 0 to 20.6 feet	Detroit at West Clifton	002T024	002	PWK/MRD
11/29/2018	Corrected depth of MH 002T713 from 0 to 20 feet	Lake at Whippoowill	002T713	002	PWK/MRD
11/29/2018	Corrected depth of MH 057T018A from 0 to 14 feet	Clifton at Manor Park	057T018A	057	PWK/MRD
11/29/2018	corrected tag from STM to SAN	Detroit east of Cordova	002T037_002S036	002	PWK/MRD
11/29/2018	corrected tag from SAN to STM	Detroit east of Cordova	002S037_002T036	002	PWK/MRD
11/29/2018	corrected manhole label from 002T037 to 002S036	Detroit east of Cordova	002S036	002	PWK/MRD
11/29/2018	corrected manhole label from 002S037 to 002T036	Detroit east of Cordova	002T036	002	PWK/MRD
11/29/2018	Removed 1st run of storm north of Detroit (its sn only) deleted 002T158_002T3963, 002T158 and 002T158_002S158	Edwards Avenue north of detroit	002T158	002	PWK/MRD
11/29/2018	san side - inv 624.95, depth 8.3, dry weather 0.0002, all 4 san patterns	New MH Lake Ave just west of Lakeland	056S806W	056	PWK/MRD
11/29/2018	stm side - inv 625.01, depth 8.24, direct 0.0002, pattern GWI	New MH Lake Ave just west of Lakeland	056T806W	056	PWK/MRD
11/29/2018	height 6.66, length 4, inlet offset 0.64, dischage coef 3.31, end contract 0	New MH Lake Ave just west of Lakeland	056T806W_056S806W	056	PWK/MRD
	Lake Avenue Phase 1 36-inch storm sewer added based on17-0541 design plans, as follows:				PWK/MRD
11/29/2018	MH on existing 36-inch storm sewer south treelawn - inv 627.42, depth 13.83	Lake Avenue 837 feet east of Parkside Dr	057TL01	57	PWK/MRD
11/29/2018	MH westbound travel lane - inv 627.02, depth 13.62	Lake Avenue 777 feet east of Parkside Dr	057TL02	57	PWK/MRD
11/29/2018	MH westbound travel lane - inv 625.82, depth 14.25	Lake Avenue 501 feet east of Parkside Dr	057TL03	57	PWK/MRD
11/29/2018	MH westbound travel lane - inv 624.32, depth 14.90	Lake Avenue 152 feet east of Parkside Dr	057TL04	57	PWK/MRD
11/29/2018	MH westbound travel lane - inv 622.90, depth 15.48	Lake Avenue 178 feet west of Parkside Dr	057TL05	57	PWK/MRD
11/29/2018	MH east side Lakewood Park 55 feet north of Lake Ave - inv 622.61, depth 15.29	Lakewood Park	057TL05A	57	PWK/MRD
11/29/2018	MH east side Lakewood Park 333 feet north of Lake Ave - inv 621.36, depth 14.44	Lakewood Park	057TL06	57	PWK/MRD
11/29/2018	MH east side Lakewood Park 390 feet north of Lake Ave - inv 620.95, depth 14.85	Lakewood Park	057TL07	57	PWK/MRD
11/29/2018	MH east side Lakewood Park 679 feet north of Lake Ave - inv 619.63, depth 14.17	Lakewood Park	057TL08	57	PWK/MRD
11/29/2018	MH east side Lakewood Park 922 feet north of Lake Ave - inv 618.53, depth 13.27	Lakewood Park	057TL09	57	PWK/MRD
11/29/2018	MH east side Lakewood Park 1,100 feet north of Lake Ave - inv 617.94, depth 12.06	Lakewood Park	057TL10	57	PWK/MRD
11/29/2018	MH east side Lakewood Park 1,186 feet north of Lake Ave - inv 617.55, depth 11.20	Lakewood Park	057TL11	57	PWK/MRD
11/29/2018	add existing MH east side Lakewood Park 1,198 feet north of Lake Ave - inv 610.40, depth 18.70	Lakewood Park	057TL12	57	PWK/MRD
11/29/2018	76 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	Lake Avenue east of Parkside Dr	057TL01_057TL02	57	PWK/MRD
11/29/2018	277 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	Lake Avenue east of Parkside Dr	057TL02_057TL03	57	PWK/MRD
11/29/2018	350 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	Lake Avenue east of Parkside Dr	057TL03_057TL04	57	PWK/MRD
11/29/2018	330 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	Lake Avenue east of Parkside Dr	057TL04_057TL05	57	PWK/MRD
11/29/2018	48 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	Lake Avenue east of Parkside Dr	057TL05_057TL05A	57	PWK/MRD
11/29/2018	289 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	east side of Lakewood Park	057TL05A_057TL06	57	PWK/MRD
11/29/2018	77 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	east side of Lakewood Park	057TL06_057TL07	57	PWK/MRD
11/29/2018	307 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	east side of Lakewood Park	057TL07_057TL08	57	PWK/MRD
11/29/2018	251\ feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	east side of Lakewood Park	057TL08_057TL09	57	PWK/MRD
11/29/2018	124 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	east side of Lakewood Park	057TL09_057TL10	57	PWK/MRD
11/29/2018	73 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	east side of Lakewood Park	057TL10_057TL11	57	PWK/MRD
11/29/2018	20 feet of 36-inch pipe, Tag STM, n=0.013, inlet offset 0, outlet offset 0.1, geom1 3	east side of Lakewood Park	057TL11_057TL12	57	PWK/MRD
11/29/2018	add new conduit C2, inlet 057T344A, outlet 057TL12Tag STM, length 101, n 0.015, rect closed, geom1 4, geom2 5	Lakewood park	C2	57	PWK/MRD
11/29/2018	change inlet of 057T344A_057LEWS1130 to 057TL12	Lakewood park	057TL12_057LEWS1130	57	PWK/MRD
11/29/2018	changed subcatchment S058C004A outlet to new pipe - changed 058C004 to 057TL01	Lake Avenue 837 feet east of Parkside Dr	057TL01	57	PWK/MRD
11/29/2018	changed subcatchment S058C004 outlet to new pipe - changed 058C004 to 057TL02	Lake Avenue 837 feet east of Parkside Dr	057TL02	57	PWK/MRD
11/29/2018	changed subcatchment S058C002 outlet to new pipe - changed 058C002 to 057TL03	Lake Avenue 837 feet east of Parkside Dr	057TL03	57	PWK/MRD
11/29/2018	Change conduit name C2 to 057T344A_057TL12	Lakewood park	057T344A_057TL12	57	PWK/MRD
11/29/2018	Change outlet offset from 0.7 to 0.36, change roughness from 0.01 to 0.015	Lake Ave west of Hall	055C673_055C671	57	PWK/MRD
11/29/2018	Change Tag from STM to COM	Lake Ave west of Hall	055C003_055C671	57	PWK/MRD
11/29/2018	Change name to 055C671_055T671, Type to Transverse, Length 0.8,Inlet offset from 1.75 to 2.16, Height to 6	Lake Ave west of Hall	W1	055	PWK/MRD
11/29/2018	Change Geom1 from 1.667 to 1.0	Lake Ave west of Hall	002T669_002T671	055	PWK/MRD
11/29/2018	Change invert from 625.8 to 626.98, depth from 9.1 to 8.06	Lake Ave west of Hall	002T671	055	PWK/MRD
11/29/2018	Change invert from 625.8 to 625.48, depth from 10 to 9.56	Lake Ave west of Hall	002S671	055	PWK/MRD
11/29/2018	Change Tag from COM to STM	Edgewater east of Kenneth	055T005_055C003A	055	PWK/MRD
11/29/2018	Change Tag from COM to SAN	Edgewater east of Kenneth	055S005_055T004	055	PWK/MRD
11/29/2018	Delete orifice - the storm pipe is under the sanitary pipe	Spring Garden	002T006_002S006	002	PWK/MRD
11/29/2018	Delete orifice - the storm pipe is under the sanitary pipe	Spring Garden	002T4396_002S4396	002	PWK/MRD
11/29/2018	Delete orifice - the storm pipe is under the sanitary pipe	Spring Garden	002T4395_002S4395	002	PWK/MRD
11/29/2018	Delete orifice - the storm pipe is under the sanitary pipe	Spring Garden	002T4394_002S4394	002	PWK/MRD
11/29/2018	Delete orifice - the storm pipe is under the sanitary pipe	Spring Garden	002T4393_002S4393	002	PWK/MRD
11/29/2018	switch manhole inverts - the storm pipe is under the sanitary pipe	Spring Garden	Multiple		PWK/MRD
11/29/2018	Inteceptor shape correction - Use AMCO sewer shape	Interceptor	onduits from INFL-HEAD to 059C00	002	PWK/MRD
11/29/2018	Change interceptor roughness - Use 0.012	Interceptor	onduits from INFL-HEAD to 059C00	002	PWK/MRD

Revision Date	Revision Decription:	Location	Object Name	Outfall Area	Revision Completed By
11/29/2018	Change tag from STM to COM	Btw Kenneth & Maple Cliff	055C003_055C671	055	PWK/MRD
11/29/2018	rename pipe 056C915A_056LEWS1145 to 056C915A_056LEWS1155		056C915A_056LEWS1145	056	PWK/MRD
11/29/2018	Revise orifice 056T058_056S058 to .75x .75		056T058_056S058	056	PWK/MRD
11/29/2018	Change length of 056C284A_056C490A to 23.25'		056C284A_056C490A	INT	PWK/MRD
11/29/2018	Change length of 057S001_056C285A to 1088		057S001_056C285A	INT	PWK/MRD
11/29/2018	Interceptor slope correction to 0.001 including preservation of connector pipe elevations	from plant to w117th	Multiple	INT	PWK/MRD
11/29/2018	Using LEWS1070a site install sheet and overflow calculation survey measurements, updated sanitary line lengths/elevations & overflow elevation (MD TO RELOCATE OF PIPE TO NORTI		Multiple	LEWS1070a	PWK/MRD
11/29/2018	Robinwood to Alameda Sanitary along Detroit change manning's n to 0.013	Detroit from Robinwood to Alameda	Multiple	1040	MRD/RHG
11/29/2018	Remove 48" sewer 056T061A_056T061. Connect existing sewer and top of orifice to MH 056T061.	Victoria/Hilliard	Multiple	1150	MRD/RHG
11/29/2018	Add manhole 052S1548A, and manhole 052T1548A, and orifice , 418.12 feet west of 052S1548.	Lakewood Heights Boulevard	Multiple	052	MRD
11/30/2018	Weekend House Changes: Start = 0', Stop = 0', Weir inlet offset @ RRES1145-A = 0.68', Decrease PrivateResidenceWeekend pattern magnitude values to 150.		Multiple	RRES1145A	MRD
12/2/2018	As per #180174 sewer videos, no active connections. Change 055T007_055C008 change tag to STM		055T007_055C008	055	MRD
12/2/2018	As per #180174 sewer videos, no active connections. Change 055T006_055T007 Tag to STM		055T006_055T007	055	MRD
12/2/2018	As per #180174 sewer videos, no active connections. Change 055T006_002T664 tag to STM		055T006_002T664	055	MRD
12/2/2018	As per #180174 sewer videos, no active connections. Change 055T009_055C008 tag to STM		055T009_055C008	055	MRD
12/2/2018	002S197A_002T200 change tag to STM, and name to002T197A_002T200	Webb @ Lake Ave	002S197A_002T200	002	MRD/RHG
12/2/2018	002S1425_002S197A change tag to STM and name to 002T1425_002T197A	Webb @ Lake Ave	002S1425_002S197A	002	MRD/RHG
12/2/2018	002S197A change name to 002T197A	Webb @ Lake Ave	002S1425_002S197A	002	MRD/RHG
12/3/2018	Relocate Average Value, Pattern 1, Pattern 2, Pattern 3, & Pattern 4 from Node 002T197A to node 002S168A	Webb @ Lake Ave	002T197A	002	MRD/RHG
12/3/2018	Resolve madison storm false dwf pass thru. Add inlet offset of 0.1 to conduit 052T006_052T003.	Madison @ Riverside	052T006_052T003	052	MRD/PWK

APPENDIX 5-6
Design Storm Derivation
Duration and Temporal Distribution

City of Lakewood, Ohio
Integrated Wet Weather Improvement Plant, Phase 2

Design Storm Derivation
Duration and Temporal Distribution

Based on communications with US EPA evaluations of CSOs and SSOs in the 5-year, 10-year and 20-year events were performed. The duration and temporal distribution is defined based on Time of Concentration and first quartile distribution.

A total time of concentration was calculated from typical year values in the Lakewood SWMM model. The longest flow path starts at the south end of Bunts Rd, flows north to Madison Ave, east to W. 117th St, north to Edgewater Dr, west along the interceptor to Webb Dr, South to Clifton Blvd, west to West Clifton Blvd, south to the WWTP Influent Mixing Chamber.

Overland sheet flow:

Overland flow time was calculated from TR-55 for the subcatchment tributary to the south end of the pipe, S059C0079A. The equation below calculates an overland travel time, T_t, of 0.06 hours.

$$T_t = \frac{0.007\,(n\,L)^{0.8}}{(P_2)^{0.5}\,s^{0.4}}$$

n -Manning's friction factor = 0.013 (from the model)
L – Flow length = 256 feet (from the model)
P_2 – 2-year 24-hour rain = 2.50 inches (Huff and Angel)
s – slope = 0.0148 feet/foot (from the model)

Shallow concentrated flow:

Overland flow discharges to a street gutter where it becomes shallow concentrated flow. For this subcatchment, the water has 200 feet of gutter flow before it reaches a catch basin. From the SWMM model, the ground slope for the length (284.28 feet) from junction 059C0079A (Rim Elev. = 752.009) to junction 059C2009 (Rim Elev. = 747.758) is

$$S = \frac{752.009-747.758}{284.28} = 0.0150 \text{ ft/ft}$$

From Figure 3-1 in the TR-55 manual, this slope will produce an average velocity of 2.5 feet per second. This velocity will produce a travel time of 284.28 feet ÷ 2.5 fps = 113.7 seconds or 0.03 hours.

Open channel flow:

From the catch basin to the WWTP, the SWMM program calculates the travel time through the sewer pipes as open channel flow. It calculates a maximum velocity for each segment of pipe along the previously described longest flow path. For each segment, the length was divided by its maximum velocity to calculate the travel time within the segment. Appendix-A lists each individual pipe segment along this path. The total open channel travel time is 2.00 hours.

Time of concentration:

The time of concentration T_c is the sum of the individual times for overland sheet flow, shallow concentrated flow, and open channel flow. These values as calculated above are 0.06 hours, 0.03 hours, and 2.00 hours respectively. This total is:

$$\mathbf{T_c} = 0.06 + 0.03 + 2.00 = 2.09 \text{ hours (Note: a 2-hour } T_c \text{ was used for design)}$$

Design storm 2-hour rainfalls:

Two reference sources were compared to determine design storm rainfall quantities. Table-1 shows rainfall amounts for the published return periods. The NOAA values are from the referenced website and are for Lakewood from Atlas 14, Volume 2, Version 3.

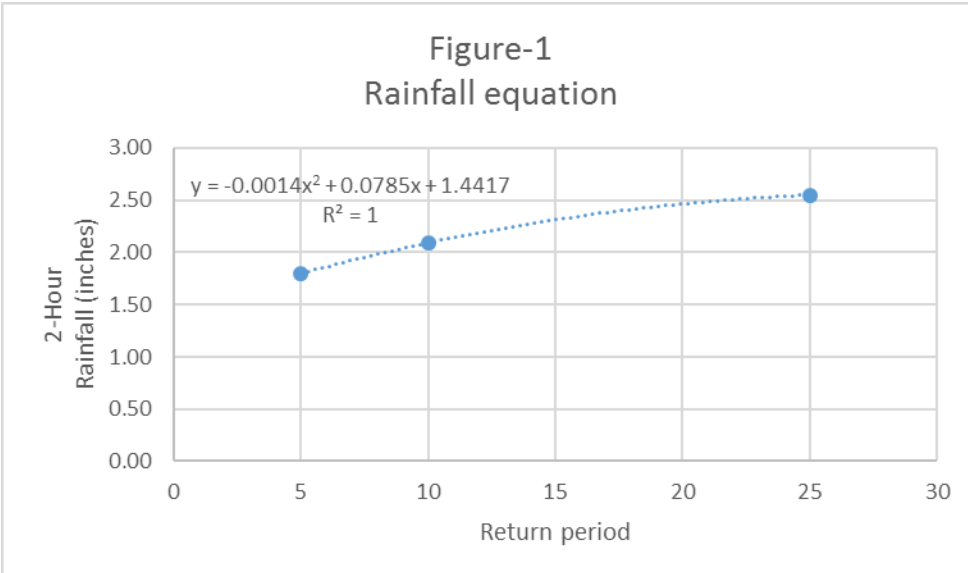
Table-1 Rainfall Amounts for 2-Hour rain events

Return period (yr)	1	2	5	10	25	50	100
NOAA[1]	1.14	1.39	1.76	2.06	2.48	2.83	3.18
Huff and Angel[2]	1.18	1.45	1.80	2.09	2.55	2.96	3.42

The Huff and Angel values were selected for the design storm as being slightly more conservative. To develop a 20-year 2-hour rainfall amount, a scattergraph of the 5, 10 and 25 year values was prepared and a 2 degree polynomial trendline was applied. Figure 1 shows the equation for the trendline. Plugging a 20-year value into the equation gives a 20-year 2-hour rainfall of 2.45 inches.

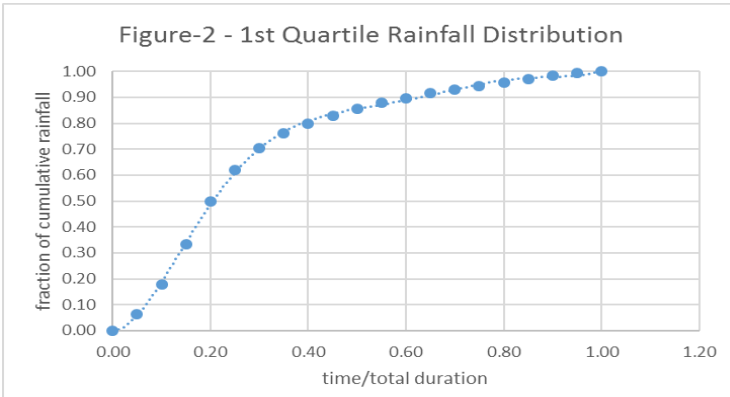
[1] Geoffrey M. Bonnin, et. Al., Precipitation-Frequency Atlas of the United States, Volume 2 Version 3, (NOAA revised 2006) https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?lat=41.4845&lon=-81.7783&data=depth&units=english&series=pds

[2] Huff and Angel, Rainfall Frequency Atlas of the Midwest, (Midwestern Climate Center, 1992), p. 135



Design storm temporal distribution:

Figure-2 is a graph of the tabular data for a Huff 1st quartile rain event.[3] A 6 degree polynomial trendline was fit to the data to allow for interpolation between each 5% data point.



Design storm duration:

With a T_c of 2.09 hours, the trendline values were used to create a 2-hour unit hyetograph. The SWMM model calculated flows for the three rainfall events. Figure-2 is a graph of the flow rates along the West Clifton Avenue portion of the Lakewood interceptor sewer.

H:\2017\170105\REPORTS\Design Storm\Design Storm Derivation.Doc

[3] Alan A. Smith, Hydrological Theory, http://www.alanasmith.com/theory-Derivation-Huff-Storm.htm

APPENDIX 5-7
Validation Model Results

City of Lakewood - Existing Conditions Model 12-03-2018 - Model Validation

CSOs (Permit # if applicable)	Reporting Link	Modeled Activations	Modeled Volume (MG)	Metered Activations	Metered Volume	Modeled Volume As % of Metered Volume	Assessment	Analysis Period
LEWS 1035 (059)	059S001_059C1020	38	10.22	46	9.43	108%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1035-A	059T014_059T014A	9	0.30	21	0.26	112%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1040-A	059BS852_059BS852A	2	0.00	2	0.0	-	n/a	01/01/2018 - 10/30/2018
LEWS 1040-B	059AC1310_059T1310	27	1.50	27	1.50	100%	n/a	01/01/2018 - 10/30/2018
LEWS 1040-C	059AT897_059AT031	31	1.39	47	1.10	127%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1040-D	059AS050_059AT025	0	0.00	12	0.08	-	Poor	01/01/2018 - 10/30/2018
LEWS 1040-E	059AS047_059AT024	52	10.13	61	13.70	74%	Fair	01/01/2018 - 10/30/2018
LEWS 1040-F	059AC046A_059AC046B	13	1.09	34	0.97	113%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1040-G	059S078A_059AT1375	42	7.87	66	5.36	147%	Fair	01/01/2018 - 10/30/2018
LEWS 1040-H	059C0076A_059C0076AA	4	0.52	22	0.85	61%	Fair	01/01/2018 - 10/30/2018
LEWS 1045-A	059BS012A_059BS012	29	3.31	21	3.46	96%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1055-A	059BC006A_059BT1003	40	16.10	67	11.14	144%	Fair	01/01/2018 - 10/30/2018
LEWS 1055-C	059AS045_059AT022	37	3.45	40	3.16	109%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1055-D	059AC036_059AC036A	34	3.56	44	4.75	75%	Fair	01/01/2018 - 10/30/2018
LEWS 1055-E	059AC1036_059AC1036A	9	0.03	1	0.00	-	Poor	01/01/2018 - 10/30/2018
LEWS 1070-A	002S766_002T767	54	6.02	54	6.02	100%	n/a	01/01/2018 - 10/30/2018
LEWS 1070-B	057C023_057T570	55	0.79	62	0.42	190%	Poor	01/01/2018 - 10/30/2018
LEWS 1110 (058)	058C001A_058C001B	0	0.00	13	0.90	0%	Poor	8/22/2018 - 10/30/2018
LEWS 1130-C	057C012A_057C012	5	0.52	67	1.00	52%	Fair	01/01/2018 - 10/30/2018
LEWS 1135 (057)	057T001_057C343	43	4.20	63	4.96	85%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1150 (056B)	056C490_056C490B	42	37.27	53	31.61	118%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1150-A	056T1301_056T1301B	5	0.29	0	0.00	-	Poor	01/01/2018 - 10/30/2018
LEWS 1150-B	056S020_056T020	8	0.34	0	0.00	-	Poor	01/01/2018 - 10/30/2018
LEWS 1150-C	056C289_056T050	32	0.92	33	0.83	110%	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1150-D	056C295_056T049	13	0.40	34	0.64	63%	Fair	01/01/2018 - 10/30/2018
LEWS 1150-E	056T058_056T313	68	2.73	53	0.90	303%	Poor	5/1/2018 - 10/30/2018
LEWS 1155 (056A)	056T915_056T915B	32	3.42	47	5.98	57%	Fair	01/01/2018 - 10/30/2018
LEWS 1180-A	002S188_002T188	4	0.23	4	0.23	100%	n/a	01/01/2018 - 10/30/2018
LEWS 1195-A	002C244_LEWS1190-PSEUDO	5	0.74	13	1.35	55%	Fair	01/01/2018 - 10/30/2018
LEWS 1210-A	002S242_002T242	4	0.09	4	0.09	-	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1215-A	002C240A_002C240	3	0.03	15	0.10	32%	Poor	01/01/2018 - 10/30/2018
LEWS 1220-A	002C238A_002C238	9	0.14	6	0.06	-	Poor	01/01/2018 - 10/30/2018
LEWS 1225 (055)	055C003_055C003A	27	2.68	44	4.83	56%	Fair	01/01/2018 - 10/30/2018
LEWS 1285-A	002C232_002C232A	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
LEWS 1295-A	002T207A_002T207	5	0.08	8	0.03	-	Poor	01/01/2018 - 10/30/2018
LEWS 1295-B	002C197_002S197A	10	0.02	7	0.01	-	Poor	01/01/2018 - 10/30/2018
LEWS 1295-C	002C178_002T177	1	0.00	5	0.03	-	Poor	01/01/2018 - 10/30/2018
RRES 1145-A	002S1401_002T1400	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-C	002S1415_002T1414	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-D	002S1418_002T1417	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-E	002S4416_002T4416	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-F	002S4414_002T4414	0	0.00	1	0.00	-	Poor	01/01/2018 - 10/30/2018
RRES 1145-G	002S4412_002T4412	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-H	002S1409_002T1408	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-I	002C026A_002T026	0	0.00	10	0.12	0%	Poor	01/01/2018 - 10/30/2018
RRES 1145-J	002C029A_002T029	55	2.04	48	2.40	85%	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-K	002T4392_002T4360A	0	0.00	9	0.02	-	Poor	01/01/2018 - 10/30/2018
RRES 1145-L	002C032A_002T032	16	0.55	9	0.23	237%	Poor	01/01/2018 - 10/30/2018
RRES 1145-M	002C039A_002T039	18	1.02	56	2.21	46%	Poor	01/01/2018 - 10/30/2018
RRES 1145-N	002S252E_002T252	7	0.12	43	1.28	10%	Poor	01/01/2018 - 10/30/2018
RRES 1145-O	002S253_002T253	1	0.02	2	0.04	-	Fair	01/01/2018 - 10/30/2018
RRES 1145-P	002S1405_002T1404	0	0.00	75	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-R	002S4064_002T4064	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-S	002S4062_002T4062	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018

City of Lakewood - Existing Conditions Model 12-03-2018 - Model Validation

CSOs (Permit # if applicable)	Reporting Link	Modeled Activations	Modeled Volume (MG)	Metered Activations	Metered Volume	Modeled Volume As % of Metered Volume	Assessment	Analysis Period
RRES 1145-T	002S265_002T265	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-U	002S4068_002T1410	0	0.00	1	0.00	-	Poor	01/01/2018 - 10/30/2018
RRES 1145-V	002S4066_002T4066	0	0.00	0	0.00	-	Meets WaPUG	01/01/2018 - 10/30/2018
RRES 1145-W	002S264_002T264	0	0.00	3	0.03	-	Poor	01/01/2018 - 10/30/2018
RRES 1160-A	052SMeter006_052T091	65	3.98	204	2.78	143%	Fair	1/1/2018 - 7/1/2018
RRES 1165-B (052)	052S005_052T004	0	0.00	60	0.02	-	Poor	01/01/2018 - 10/30/2018
RRWS 1200 (053)	053C002_053C001	0	0.00	2	0.00	-	Poor	01/01/2018 - 10/30/2018
WWTP OUTFALL (002)	CSO-002	37	49.87	40	43.39	115%	Meets WaPUG	01/01/2018-07/31/2018 & 8/27/2018-10/31/2018

*Note: Activation threshold 0.010 MGD was used in determining events.
*Note: 6 hour interevent time was used in determining events based upon flow hydrographs
These events were totaled using PCSWMM because of meter site adjustments during the monitoring period.
No Meter Data Available or Very poor data quality. Meter Statistics set to = Model Statistics.

APPENDIX 6-1
Lakewood WWTP
Treatment Data Evaluation

6055 Rockside Woods Boulevard, Suite 350
Independence, OH 44131

Phone: 216-606-1300
Fax: 216-606-1350

Technical Memorandum

Prepared for: Files

Project Title: Lakewood, OH WWTP Treatment Evaluation

Project No.: 153281

Technical Memorandum

Subject: Lakewood, OH WWTP Treatment Data Evaluation

Date: February 28, 2019

To: Andy Lukas

From: Shawn Loew

Copy to: Eric Dunn

Prepared by: Shawn Loew, P.E.
Name and Title, License No., Expiration

Reviewed by: Andy Lukas, Vice President
Name and Title

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Section 1: Objective

The objective of this technical memorandum is to document the treatment efficiency of the Lakewood, OH WWTP by calculating the daily and average monthly percent removal of carbonaceous biological oxygen demand 5-day (CBOD5) and total suspended solids (TSS) for the years of 2017 and 2018.

Section 2: Sources

The daily and average monthly percent removals of CBOD5 and TSS were calculated directly from the monthly Daily Discharge Monitoring Reports submitted by the City of Lakewood to the Ohio EPA for the years of 2017 and 2018. The city is required by its NPDES permit to report a 24-hour composite concentration of CBOD5 5-day and TSS each day for influent and final effluent locations. Not all days have reported values as the NPDES permit does not require the City to monitor on days when "the plant is not normally staffed (Saturdays, Sundays, and Holidays)."

Section 3: Methodology

The daily percent removal of a pollutant was calculated by dividing the daily effluent value by the daily influent value and subtracting that quotient from 1. For example, if the daily influent value is 50 milligrams per liter (mg/L) and the daily effluent value is 2 mg/L, the percent removal would be calculated as 1 – 2/50, or 96%.

The average monthly percent removal of a pollutant was calculated by performing the same calculation on the average daily influent and the average daily effluent values for that pollutant for that month.

Section 4: Results

The average monthly percent removals of CBOD5 and TSS for the Lakewood WWTP are presented in Table 1. The NPDES permit effluent limits for CBOD5 are 15.0 mg/L monthly and 23.0 weekly, and the TSS limits are 20.0 mg/L monthly and 30.0 mg/L weekly.

As shown in the Table, the average monthly removal of CBOD5 varies from 94.4% to 98.5%, while the average monthly removal of TSS varies from 84.1% to 94.8% for the years of 2017 and 2018. The 2-year average CBOD5 removal efficiency was 97.4%, and the TSS removal efficiency over this same period was 92.0%.

The daily influent and effluent values from which the average monthly values were calculated in addition to the daily percent removals for each pollutant are presented in Appendix A.

Table 1. Lakewood WWTP Average Monthly Percent Removals of CBOD5 and TSS							
Month	Daily Average Flow Rate (mgd)	Average CBOD5 (mg/L)		Average TSS (mg/L)		Average Monthly Removal	
		Influent	Effluent	Influent	Effluent	CBOD	TSS
January 2017	10.12	50.65	2.09	57.38	6.05	95.9%	89.5%
February 2017	7.82	80.40	3.42	94.79	13.00	95.7%	86.3%
March 2017	6.85	73.50	4.12	85.43	7.10	94.4%	91.7%
April 2017	7.33	70.20	2.93	89.05	14.20	95.8%	84.1%
May 2017	7.88	71.78	2.72	92.32	9.86	96.2%	89.3%
June 2017	4.61	119.29	1.88	185.15	9.65	98.4%	94.8%
July 2017	5.24	95.94	1.79	118.81	9.48	98.1%	92.0%
August 2017	3.83	140.56	2.25	193.52	16.09	98.4%	91.7%
September 2017	3.61	136.06	2.50	210.00	13.37	98.2%	93.6%
October 2017	4.58	109.22	1.63	164.18	10.00	98.5%	93.9%
November 2017	6.67	99.06	3.00	130.10	13.50	97.0%	89.6%
December 2017	4.41	128.79	4.62	145.41	18.18	96.4%	87.5%
January 2018	7.03	86.83	2.13	112.82	8.68	97.5%	92.3%
February 2018	9.12	53.36	1.75	94.50	7.06	96.7%	92.5%
March 2018	9.21	73.19	2.26	114.60	9.85	96.9%	91.4%
April 2018	9.08	84.50	1.63	108.90	6.10	98.1%	94.4%
May 2018	8.50	76.06	1.54	85.05	7.10	98.0%	91.7%
June 2018	5.89	96.73	1.62	104.60	8.10	98.3%	94.2%
July 2018	547	87.06	2.62	137.82	10.73	97.0%	92.2%
August 2018	4.44	107.3	2.04	174.55	10.45	98.1%	94.0%
September 2018	5.16	101.87	2.31	141.32	10.58	97.7%	92.5%
October 2018	5.92	107.00	1.94	170.91	9.95	98.2%	94.2%
November 2018	9.41	55.80	1.89	87.53	7.05	96.6%	91.9%
December 2018	6.45	74.50	2.02	89.65	6.25	97.3%	93.0%

Attachment A: 2017 and 2018 Daily CBOD5 and TSS Percent Removals by Month

JANUARY 2017

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2	90	63	1.3	4	98.6%	93.7%
3	41	41	2.9		92.9%	
4	57	51	2.9	5	94.9%	90.2%
5	76	56	1.5	6	98.0%	89.3%
6				4		
7						
8		100		6		94.0%
9		76		6		92.1%
10	51	146	3	4	94.1%	97.3%
11	56	83	2.9	10	94.8%	88.0%
12	35	33	1.7	6	95.1%	81.8%
13						
14						
15						
16	64	50	1.6	8	97.5%	84.0%
17	56	105	3.1	5	94.5%	95.2%
18	51	37	1.8	5	96.5%	86.5%
19	51	39	1.2	4	97.6%	89.7%
20						
21						
22		51		4		92.2%
23	24	32	1.5	4	93.8%	87.5%
24	23	26	1.7	6	92.6%	76.9%
25	50	28	2.2	9	95.6%	67.9%
26	47	30	2.2	7	95.3%	76.7%
27						
28						
29		56		4		92.9%
30	52	50	1.4	8	97.3%	84.0%
31	37	52	2.6	12	93.0%	76.9%
Average	50.6	57.4	2.1	6.0	95.9%	89.5%

FEBRUARY 2017

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	48	35	1.7	15	96.5%	57.1%
2	63	84	3.3	13	94.8%	84.5%
3						
4						
5		182		10		94.5%
6	110	193	2.6	15	97.6%	92.2%
7	29	62	4.7	19	83.8%	69.4%
8	52	43	3	7	94.2%	83.7%
9	84	60	3.5	20	95.8%	66.7%
10						
11						
12		95		12		87.4%
13		86		15		82.6%
14	82	89	4	10	95.1%	88.8%
15	100	114	4.6	20	95.4%	82.5%
16	71	59	2.6	19	96.3%	67.8%
17						
18						
19						
20	86	81	2.5	11	97.1%	86.4%
21	80	89	3.1	8	96.1%	91.0%
22	130	140	3.5	11	97.3%	92.1%
23	100	151	3.9	14	96.1%	90.7%
24						
25						
26		41		4		90.2%
27	71	67	4.6	12	93.5%	82.1%
28	100	130	3.7	12	96.3%	90.8%
Average	80.4	94.8	3.4	13.0	95.7%	86.3%

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	46	103	2.6	9	94.3%	91.3%
2	58	46	1	6	98.3%	87.0%
3						
4						
5		72		6		91.7%
6	74	140	3	6	95.9%	95.7%
7	34	79	2	4	94.1%	94.9%
8	36	56	3	11	91.7%	80.4%
9	67	61	2	10	97.0%	83.6%
10						
11						
12						
13	77	200	4	2	94.8%	99.0%
14	78	52	4	2	94.9%	96.2%
15	74	58	11	5	85.1%	91.4%
16	116	78	15	5	87.1%	93.6%
17						
18						
19		69		7		89.9%
20	78	64	5.8	12	92.6%	81.3%
21	150	80	3.9	11	97.4%	86.3%
22	120	116	4.5	13	96.3%	88.8%
23	96	102	3.2	10	96.7%	90.2%
24						
25						
26		78		4		94.9%
27	44	162	2.4	5	94.5%	96.9%
28	56	51	2	3	96.4%	94.1%
29	85	81	3.2	9	96.2%	88.9%
30	34	46	1.5	9	95.6%	80.4%
31						
Average	73.5	85.4	4.1	7.1	94.4%	91.7%

APRIL 2017

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2		61		10		83.6%
3	34	37	3	27	91.2%	27.0%
4	34	33	1.8	5	94.7%	84.8%
5	90	134	1.3	6	98.6%	95.5%
6	50	67	3.6	15	92.8%	77.6%
7						
8						
9		73		14		80.8%
10	81	87	2.1	11	97.4%	87.4%
11	100	148	2.6	13	97.4%	91.2%
12	90	101	2.6	8	97.1%	92.1%
13						
14						
15						
16		56		6		89.3%
17	87	78	3	16	96.6%	79.5%
18	87	106	2	10	97.7%	90.6%
19	94	247	8.6	89	90.9%	64.0%
20	28	27	2.4	3	91.4%	88.9%
21						
22						
23		60		4		93.3%
24	69	90	3.2	12	95.4%	86.7%
25	57	74	2.9	7	94.9%	90.5%
26	80	137	2	11	97.5%	92.0%
27	72	97	2.9	10	96.0%	89.7%
28						
29						
30		68		7		89.7%
Average	70.2	89.1	2.9	14.2	95.8%	84.1%

MAY 2017

Day	Influent	Effluent	% Removal

	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	34	47	2.6	10	92.4%	78.7%
2	37	51	1.8	5	95.1%	90.2%
3	76	75	1.4	8	98.2%	89.3%
4	30	34	2.3	6	92.3%	82.4%
5						
6						
7		36		8		77.8%
8	36	40	1.7	8	95.3%	80.0%
9	51	66	2.2	5	95.7%	92.4%
10	93	120	2.4	15	97.4%	87.5%
11	55	54	2.1	5	96.2%	90.7%
12						
13						
14		76		12		84.2%
15	110	90	3.3	8	97.0%	91.1%
16	97	97	3	14	96.9%	85.6%
17	120	177	5	15	95.8%	91.5%
18	100	139	5.2	15	94.8%	89.2%
19						
20						
21		124		10		91.9%
22		142		14		90.1%
23	110	134	2.9	10	97.4%	92.5%
24	86	194	2.1	5	97.6%	97.4%
25	38	57	4.1	16	89.2%	71.9%
26						
27						
28						
29	74	97	2.9	10	96.1%	89.7%
30	70	113	1.8	9	97.4%	92.0%
31	75	68	2.1	9	97.2%	86.8%
Average	71.8	92.3	2.7	9.9	96.2%	89.3%

JUNE 2017

Day	Influent	Effluent	% Removal

	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	150	163	3.1	13	97.9%	92.0%
2						
3						
4		226		11		95.1%
5	120	118	2.7	11	97.8%	90.7%
6	140	156	2	6	98.6%	96.2%
7	120	165	3.3	7	97.3%	95.8%
8	110	171	1.3	8	98.8%	95.3%
9						
10						
11		315		5		98.4%
12	140	205	1.7	10	98.8%	95.1%
13	120	228	1.3	6	98.9%	97.4%
14	130	368	1.3	13	99.0%	96.5%
15	82	74	1.4	10	98.3%	86.5%
16						
17						
18		290		12		95.9%
19	74		1.9		97.4%	
20	140	155	2	5	98.6%	96.8%
21	98	87	1.9	7	98.1%	92.0%
22	110	111	1.9	9	98.3%	91.9%
23						
24						
25		152		6		96.1%
26	100	127	1	13	99.0%	89.8%
27	114	156	1.3	10	98.9%	93.6%
28	140	254	1.4	16	99.0%	93.7%
29	140	182	2.5	15	98.2%	91.8%
30						
Average	119.3	185.2	1.9	9.7	98.4%	94.8%

JULY 2017

Day	Influent	Effluent	% Removal

	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2		67		8		88.1%
3	88		1.8		98.0%	
4	94	82	1.4	6	98.5%	92.7%
5	140	146	1.2	5	99.1%	96.6%
6	140	153	2.4	18	98.3%	88.2%
7						
8						
9		146		10		93.2%
10	30	41	1.4	8	95.3%	80.5%
11	27	41	2.5	8	90.7%	80.5%
12	60	88	1.6	6	97.3%	93.2%
13	16	34	1	6	93.8%	82.4%
14						
15						
16		57		4		93.0%
17	33	34	1.9	6	94.2%	82.4%
18	69	95	1	6	98.6%	93.7%
19	74	146	2.5	20	96.6%	86.3%
20	130	204	3	16	97.7%	92.2%
21						
22						
23		135		8		94.1%
24	140	144	1.4	12	99.0%	91.7%
25	130	166	1.6	9	98.8%	94.6%
26	160	143	1.9	10	98.8%	93.0%
27	160	183	2	12	98.8%	93.4%
28						
29						
30		192		11		94.3%
31	140	198	1.9	10	98.6%	94.9%
Average	95.9	118.8	1.8	9.5	98.1%	92.0%

AUGUST 2017

Day	Influent	Effluent	% Removal

	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	150	212	2	14	98.7%	93.4%
2	150	257	2.2	18	98.5%	93.0%
3	130	161	2.7	16	97.9%	90.1%
4						
5						
6		150		10		93.3%
7	120	165	1.1	9	99.1%	94.5%
8	130	168	1.2	12	99.1%	92.9%
9	150	242	2.3	12	98.5%	95.0%
10	150	291	1.4	14	99.1%	95.2%
11						
12						
13		205		18		91.2%
14	140	176	2	13	98.6%	92.6%
15	170	203	1.6	10	99.1%	95.1%
16	150	202	3	18	98.0%	91.1%
17	210	312	2	15	99.0%	95.2%
18						
19						
20		180		20		88.9%
21	150	158	3.7	22	97.5%	86.1%
22	70	150	2.1	17	97.0%	88.7%
23	130	172	2.2	12	98.3%	93.0%
24	160	172	2.2	12	98.6%	93.0%
25						
26						
27		184		22		88.0%
28		180		22		87.8%
29	120	190	2.5	21	97.9%	88.9%
30	100	125	2.8	21	97.2%	83.2%
31	150	196	3.5	22	97.7%	88.8%
Average	140.6	193.5	2.3	16.1	98.4%	91.7%

SEPTEMBER 2017

Day	Influent	Effluent	% Removal

	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2						
3						
4	184	263	2.3	16	98.8%	93.9%
5	49	85	1.2	8	97.6%	90.6%
6	72	101	1.2	4	98.3%	96.0%
7	32	24	1.4	4	95.6%	83.3%
8						
9						
10		176		10		94.3%
11	180	213	2.3	10	98.7%	95.3%
12	140	270	1.4	7	99.0%	97.4%
13	150	309	3.5	21	97.7%	93.2%
14	140	328	3.4	21	97.6%	93.6%
15						
16						
17		208		9		95.7%
18	160	245	2.9	11	98.2%	95.5%
19	160	192	2.5	14	98.4%	92.7%
20	160	243	2.9	18	98.2%	92.6%
21	130	258	4.4	20	96.6%	92.2%
22						
23						
24		196		15		92.3%
25	160	195	3.1	13	98.1%	93.3%
26	160	216	3.5	20	97.8%	90.7%
27	150	216	2.6	17	98.3%	92.1%
28	150	252	1.4	16	99.1%	93.7%
29						
30						
Average	136.1	210.0	2.5	13.4	98.2%	93.6%

OCTOBER 2017

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS

1		237		14		94.1%
2	180	247	1.6	12	99.1%	95.1%
3	140	268	1.6	16	98.9%	94.0%
4	110	252	2	9	98.2%	96.4%
5	50	81	1.4	5	97.2%	93.8%
6						
7						
8		189		6		96.8%
9	48	108	2.1	10	95.6%	90.7%
10	100	130	1	6	99.0%	95.4%
11	84	184	1	4	98.8%	97.8%
12	67	93	1	5	98.5%	94.6%
13						
14						
15		105		5		95.2%
16	120	125	1.9	11	98.4%	91.2%
17	130	152	1.4	9	98.9%	94.1%
18	150	164	1.8	16	98.8%	90.2%
19	160	250	2.4	20	98.5%	92.0%
20						
21						
22		169		13		92.3%
23	140	275	1.6	8	98.9%	97.1%
24	94	134	2	13	97.9%	90.3%
25	100	144	1.8	11	98.2%	92.4%
26	95	116	1.1	8	98.8%	93.1%
27						
28						
29		47		10		78.7%
30	78		2.3		97.1%	
31	120	142	1.3	9	98.9%	93.7%
Average	109.2	164.2	1.6	10.0	98.5%	93.9%

NOVEMBER 2017

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	96	106	1.3	6	98.6%	94.3%

2	33	29	1.8	5	94.5%	82.8%
3						
4						
5		95		10		89.5%
6	20	23	1.4	7	93.0%	69.6%
7	26	40	1	2	96.2%	95.0%
8	61	73	1.6	9	97.4%	87.7%
9	100	158	2.6	16	97.4%	89.9%
10						
11						
12		169		14		91.7%
13	130	167	4.5	20	96.5%	88.0%
14	130	197	4.6	25	96.5%	87.3%
15	200	392	4.9	19	97.6%	95.2%
16	110	127	4.7	21	95.7%	83.5%
17						
18						
19		37		9		75.7%
20	41	60	2.1	10	94.9%	83.3%
21	98	83	2.7	12	97.2%	85.5%
22						
23						
24						
25						
26		99		16		83.8%
27	120	135	4.4	22	96.3%	83.7%
28	120	132	3.2	15	97.3%	88.6%
29	150	186	2.7	9	98.2%	95.2%
30	150	294	4.5	23	97.0%	92.2%
Average	99.1	130.1	3.0	13.5	97.0%	89.6%

DECEMBER 2017

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2						

3		185		24		87.0%
4	120	157	4	15	96.7%	90.4%
5	110	202	3.2	9	97.1%	95.5%
6	130	183	2	8	98.5%	95.6%
7	110	138	2	10	98.2%	92.8%
8						
9						
10		158		12		92.4%
11	130	123	2.3	13	98.2%	89.4%
12	110	146	2.8	11	97.5%	92.5%
13	200		3.7		98.2%	
14	140	232	4.6	20	96.7%	91.4%
15						
16						
17		188		24		87.2%
18						
19	100	137	6.1	27	93.9%	80.3%
20	180	161	8.8	25	95.1%	84.5%
21	130	137	7	30	94.6%	78.1%
22						
23						
24						
25		52		8		84.6%
26	83	47	6.4	20	92.3%	57.4%
27	120	105	4	21	96.7%	80.0%
28	140	121	7.8	32	94.4%	73.6%
29						
30						
31						
Average	128.8	145.4	4.6	18.2	96.4%	87.5%

JANUARY 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	180	119	3	12	98.3%	89.9%
2	200	193	1.9	7	99.1%	96.4%
3	100	185	2.7	14	97.3%	92.4%

4	120	188	3.5	12	97.1%	93.6%
5						
6						
7		96		7		92.7%
8		116		18		84.5%
9	100	191	3.6	12	96.4%	93.7%
10	100	210	4.8	17	95.2%	91.9%
11	56	96	1.6	8	97.1%	91.7%
12						
13						
14						
15	68	62	1.2	4	98.2%	93.5%
16	110	115	1.6	7	98.5%	93.9%
17	110	120	1.4	6	98.7%	95.0%
18	86	82	1.8	10	97.9%	87.8%
19						
20						
21		246		13		94.7%
22	21	32	1.4	7	93.3%	78.1%
23	41	82	2.8	9	93.2%	89.0%
24	48	42	1.6	4	96.7%	90.5%
25	68	76	1.5	6	97.8%	92.1%
26						
27						
28		50		3		94.0%
29	46	54	1	2	97.8%	96.3%
30	53	68	1.3	8	97.5%	88.2%
31	56	59	1.7	5	97.0%	91.5%
Average	86.8	112.8	2.1	8.7	97.5%	92.3%

FEBRUARY 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	57	62	1.5	8	97.4%	87.1%
2						
3						
4		73		4		94.5%

5	83	77	2	3	97.6%	96.1%
6	63	100	1.8	12	97.1%	88.0%
7	93	142	1.6	5	98.3%	96.5%
8	89	173	2.2	8	97.5%	95.4%
9						
10						
11		252		12		95.2%
12		239		11		95.4%
13	100	182	2.7	11	97.3%	94.0%
14	34	53	2.1	5	93.8%	90.6%
15						
16						
17						
18						
19	24	38	2.4	6	90.0%	84.2%
20	27	32	2	6	92.6%	81.3%
21	18	26	1.9	9	89.4%	65.4%
22	30	54	1	4	96.7%	92.6%
23						
24						
25		37		8		78.4%
26	26	51	1.1	3	95.8%	94.1%
27	48	62	1.2	11	97.5%	82.3%
28	55	48	1	1	98.2%	97.9%
Average	53.4	94.5	1.8	7.1	96.7%	92.5%

MARCH 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	28	100	4	20	85.7%	80.0%
2						
3						
4		90		11		87.8%

5	54	103	1.6	16	97.0%	84.5%
6	81	118	2	11	97.5%	90.7%
7	94	136	2.5	6	97.3%	95.6%
8	47	50	1	5	97.9%	90.0%
9						
10						
11		107		5		95.3%
12	47	44	1	2	97.9%	95.5%
13	75	110	1	6	98.7%	94.5%
14	53	80	4.8	20	90.9%	75.0%
15	79	84	2.4	8	97.0%	90.5%
16						
17						
18		167		10		94.0%
19	76	98	1.4	4	98.2%	95.9%
20	120	174	2.6	8	97.8%	95.4%
21	83	92	2	15	97.6%	83.7%
22	110	233	2.6	12	97.6%	94.8%
23						
24						
25		155		8		94.8%
26	140	176	3.2	13	97.7%	92.6%
27	60	147	2.8	11	95.3%	92.5%
28	24	28	1.3	6	94.6%	78.6%
29						
30						
31						
Average	73.2	114.6	2.3	9.9	96.9%	91.4%

APRIL 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1		82		10		87.8%
2	83	91	1.6	4	98.1%	95.6%
3	26	62	2	6	92.3%	90.3%
4	22	54	1	7	95.5%	87.0%
5						

6						
7						
8		136		6		95.6%
9	110	140	2.1	12	98.1%	91.4%
10	120	200	1.9	5	98.4%	97.5%
11	130	226	2.1	9	98.4%	96.0%
12	74	99	1.4	5	98.1%	94.9%
13						
14						
15		32		4		87.5%
16	22	23	1.9	12	91.4%	47.8%
17	34	30	1.3	3	96.2%	90.0%
18	72	50	1.4	7	98.1%	86.0%
19	74	92	1.6	5	97.8%	94.6%
20						
21						
22		134		2		98.5%
23	130	169	1.2	5	99.1%	97.0%
24	150	173	1.7	2	98.9%	98.8%
25	85	101	1.6	4	98.1%	96.0%
26	120	131	1.9	9	98.4%	93.1%
27						
28						
29		105		4		96.2%
30	100	157	1.3	7	98.7%	95.5%
Average	84.5	108.9	1.6	6.1	98.1%	94.4%

MAY 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	67	106	1.2	3	98.2%	97.2%
2	110	122	2.1	15	98.1%	87.7%
3	38	87	1.9	7	95.0%	92.0%
4						
5						
6		62		6		90.3%

7	69	66	1.4	3	98.0%	95.5%
8	100	92	1.2	5	98.8%	94.6%
9	130	123	1.8	4	98.6%	96.7%
10	67	74	2	4	97.0%	94.6%
11						
12						
13		26		6		76.9%
14	25	28	1.8	5	92.8%	82.1%
15	62	88	2.5	11	96.0%	87.5%
16	64	57	1.2	3	98.1%	94.7%
17	81	78	1.6	10	98.0%	87.2%
18						
19						
20		29		4		86.2%
21						
22	13	20	1.3	8	90.0%	60.0%
23	41	39	1	6	97.6%	84.6%
24	44	54	1	3	97.7%	94.4%
25						
26						
27						
28	110	133	1.5	10	98.6%	92.5%
29		35		13		62.9%
30	82		1		98.8%	
31	190	382	1.6	16	99.2%	95.8%
Average	76.1	85.1	1.5	7.1	98.0%	91.7%

JUNE 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2						
3		184		12		93.5%
4	61	92	1.1	7	98.2%	92.4%
5	130	214	2.5	12	98.1%	94.4%
6	150	233	2	12	98.7%	94.8%
7	100	133	1.6	5	98.4%	96.2%

8						
9						
10		214		9		95.8%
11	54	35	1.2	3	97.8%	91.4%
12	87	139	1	10	98.9%	92.8%
13	94	136	1	4	98.9%	97.1%
14	130	136	1.5	8	98.8%	94.1%
15						
16						
17		165		6		96.4%
18	170	314	1	8	99.4%	97.5%
19	20	36	2.3	4	88.5%	88.9%
20	52	59	1.1	6	97.9%	89.8%
21	88	126	1	8	98.9%	93.7%
22						
23						
24		111		4		96.4%
25	102	122	2	7	98.0%	94.3%
26	112	170	3	18	97.3%	89.4%
27	101	122	2	10	98.0%	91.8%
28		71		9		87.3%
29						
30						
Average	96.7	140.6	1.6	8.1	98.3%	94.2%

JULY 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1		96		16		83.3%
2		90		5		94.4%
3	130		1.7		98.7%	
4	140	121	1.7	5	98.8%	95.9%
5	29	47	1.9	10	93.4%	78.7%
6						
7						
8		100		6		94.0%

9	85	66	2.1	9	97.5%	86.4%
10	73	104	3.2	12	95.6%	88.5%
11	120	176	3.4	24	97.2%	86.4%
12	130	256	2.4	12	98.2%	95.3%
13						
14						
15		181		12		93.4%
16	39	168	2.6	3	93.3%	98.2%
17	80	88	2.1	15	97.4%	83.0%
18	110	200	2.3	4	97.9%	98.0%
19	120	292	3.2	12	97.3%	95.9%
20						
21						
22		180		10		94.4%
23	24	32	4.8	18	80.0%	43.8%
24	17	30	1	7	94.1%	76.7%
25	89	121	2	8	97.8%	93.4%
26	71	173	3.7	14	94.8%	91.9%
27						
28						
29		117		12		89.7%
30	93	164	3.9	11	95.8%	93.3%
31	130	230	2.6	11	98.0%	95.2%
Average	87.1	137.8	2.6	10.7	97.0%	92.2%

AUGUST 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	120	166	2.8	10	97.7%	94.0%
2						
3						
4						
5		84		8		90.5%
6	80	114	1	15	98.8%	86.8%
7	60	137	1	6	98.3%	95.6%
8	62	48	1	4	98.4%	91.7%
9	120	183	1	6	99.2%	96.7%

10						
11						
12		223				
13	100	140	1	6	99.0%	95.7%
14	130	196	1.8	10	98.6%	94.9%
15	120	189	1.3	7	98.9%	96.3%
16	160	206	1.6	10	99.0%	95.1%
17						
18						
19		220		17		92.3%
20	160	214	2.9	13	98.2%	93.9%
21	44	88	2.4	7	94.5%	92.0%
22	58	78	1.5	8	97.4%	89.7%
23	120	134	4.4	12	96.3%	91.0%
24						
25						
26		211		10		95.3%
27		252		8		96.8%
28	200	418	2.6	16	98.7%	96.2%
29	76	190	3.6	24	95.3%	87.4%
30			2.8	12		
31						
Average	107.3	174.6	2.0	10.5	98.1%	94.0%

SEPTEMBER 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2						
3	200	220	2.2	14	98.9%	93.6%
4	130	171	2.4	11	98.2%	93.6%
5	81	100	1.8	7	97.8%	93.0%
6						
7						
8						
9		81		18		77.8%
10	20	28	1	6	95.0%	78.6%

11	22	42	1	4	95.5%	90.5%
12	79	122	1.7	8	97.8%	93.4%
13	110	141	2.6	10	97.6%	92.9%
14						
15						
16		203		16		92.1%
17	180	246	4.8	16	97.3%	93.5%
18	190	262	3.5	14	98.2%	94.7%
19	190	308	4.5	15	97.6%	95.1%
20	170	252	3.6	18	97.9%	92.9%
21						
22						
23		95		7		92.6%
24	73	141	1.3	5	98.2%	96.5%
25	30	26	1.5	2	95.0%	92.3%
26	11	22	1.5	12	86.4%	45.5%
27	42	89	1.2	8	97.1%	91.0%
28						
29						
30		136		10		92.6%
Average	101.9	141.3	2.3	10.6	97.7%	92.5%

OCTOBER 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	110	182	1.9	14	98.3%	92.3%
2	82	128	2.6	11	96.8%	91.4%
3	97	168	2.9	19	97.0%	88.7%
4	110	226	3.3	20	97.0%	91.2%
5						
6						
7		85		6		92.9%
8	120	228	1	6	99.2%	97.4%
9	110	194	2.4	12	97.8%	93.8%
10	100	272	2.9	10	97.1%	96.3%
11	130	234	3.1	8	97.6%	96.6%

12						
13						
14		100		13		87.0%
15	95		1.1		98.8%	
16	150	197	1.8	22	98.8%	88.8%
17	130	250	2.7	9	97.9%	96.4%
18	120	226	1.3	12	98.9%	94.7%
19						
20						
21		111		4		96.4%
22	110	161	1	9	99.1%	94.4%
23	160	248	1.9	5	98.8%	98.0%
24	110	114	1.5	5	98.6%	95.6%
25	190	405	1.5	10	99.2%	97.5%
26						
27						
28		95		10		89.5%
29	23	38	1.8	7	92.2%	81.6%
30	39	34	1.1	5	97.2%	85.3%
31	47	64	1	2	97.9%	96.9%
Average	107.0	170.9	1.9	10.0	98.2%	94.2%

NOVEMBER 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1	40	37	2.5	8	93.8%	78.4%
2						
3						
4		24		4		83.3%
5	28	36	1	1	96.4%	97.2%
6	22	30	1	2	95.5%	93.3%
7	49	64	1	4	98.0%	93.8%
8	60	78	1	4	98.3%	94.9%
9						
10						
11		176		6		96.6%
12	110	262	1.6	7	98.5%	97.3%

13	77	110	2.2	16	97.1%	85.5%
14	130	226	4.2	17	96.8%	92.5%
15	57	87	4.1	14	92.8%	83.9%
16						
17						
18		47		3		93.6%
19	49	71	1.3	3	97.3%	95.8%
20	24	30	1.6	9	93.3%	70.0%
21						
22						
23						
24						
25		136		8		94.1%
26	24	21	2.1	9	91.3%	57.1%
27	51	94	2.3	10	95.5%	89.4%
28	58	71	1.5	4	97.4%	94.4%
29	58	63	1	5	98.3%	92.1%
30						
Average	55.8	87.5	1.9	7.1	96.6%	91.9%

DECEMBER 2018

Day	Influent		Effluent		% Removal	
	CBOD5	TSS	CBOD5	TSS	CBOD5	TSS
1						
2		28		2		92.9%
3	35	30	1.5	2	95.7%	93.3%
4	57	30	1.2	3	97.9%	90.0%
5	67	78	1.2	2	98.2%	97.4%
6	82	155	2.2	8	97.3%	94.8%
7						
8						
9		205		10		95.1%
10	73	84	2	9	97.3%	89.3%
11	120	145	2.5	13	97.9%	91.0%
12	110	110	2.4	9	97.8%	91.8%
13		165		6		96.4%

14						
15						
16		42		16		61.9%
17		119		2		98.3%
18		91		9		90.1%
19	78	102	3	14	96.2%	86.3%
20	59	51	2	6	96.6%	88.2%
21						
22						
23		28		2		92.9%
24						
25		32		1		96.9%
26	82	93	2	8	97.6%	91.4%
27	93	63	2	1	97.8%	98.4%
28						
29						
30		142		2		98.6%
31	38		2.2		94.2%	
Average	74.5	89.7	2.0	6.3	97.3%	93.0%

APPENDIX 7-1
Discharge Performance Analysis

City of Lakewood - IWWIP PH 2 - Discharge Performance Analysis																					
						Wet Weather Discharge | Million Gallons | During Simulation															
DESCRIPTION OF CONTROL FACILITIES:		Existing System				4/TY Facilities		3/TY Facilities		2/TY Facilities		1/TY Facilities		0/TY Facilities		2 Yr Facilities		5 Yr Facilities		10 Yr Facilities	
DESCRIPTION OF RAINFALL ANALYSIS:						Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		2 year storm		5 year storm		10 year storm	
LOCATION	OPTION	Sum of Top 5 Pk Rain Events (MG)	2 Year (MG)	5 Year (MG)	10 Year (MG)	Sum of Top 5 Pk Rain Events (MG)	Cost ($M)	Sum of Top 5 Pk Rain Events (MG)	Cost ($M)	Sum of Top 5 Pk Rain Events (MG)	Cost ($M)	Sum of Top 5 Pk Rain Events (MG)	Cost ($M)	Sum of Top 5 Pk Rain Events (MG)	Cost ($M)	2 Year (MG)	Cost ($M)	5 Year (MG)	Cost ($M)	10 Year (MG)	Cost ($M)
RRES 1160-1165	A	46.5	12.0	15.8	18.2	COMP	22.00	COMP	23.00	NA	See 0/TY	NA	See 0/TY	41.49	65.73	10.78	72.73	13.79	72.74	18.80	76.58
RRES 1160-1165	B	46.5	12.0	15.8	18.2	30.54	81.40	29.76	81.80	29.75	95.32	29.75	101.50	27.16	132.40	7.20	120.88	9.65	132.45	11.79	138.23
LEWS 1040	A	25.3	6.4	8.6	10.5											3.66	87.28	4.72	106.88	5.64	121.98
LEWS 1040	B	25.3	6.4	8.6	10.5											NA	NA	5.26	41.45	6.17	43.10
LEWS 1040	C	25.3	6.4	8.6	10.5											3.65	25.39	4.77	31.30	NA	NA
LEWS 1045	A	0.7	0.1	0.2	0.2											0.00	1.53	0.00	2.11	0.00	2.31
LEWS 1035	A	6.5	1.9	2.8	3.4	1.87	2.15	1.30	2.92	0.97	3.44	0.36	4.98	0.00	8.08	0.84	6.53	1.26	8.24	1.65	9.65
LEWS 1195	A	5.2	0.1	0.3	0.4											0.00	0.61	0.00	0.61	0.00	0.61
LEWS 1070	A	4.2	1.2	1.6	2.0											0.93	1.62	1.32	1.66	1.66	1.70
LEWS 1070	B	4.2	1.2	1.6	2.0											1.04	1.31	1.48	1.35	1.88	1.35
RRES 1145	A	13.7	4.2	5.9	7.1											4.18	29.96	5.60	30.00	6.81	30.37
RRES 1145	B	13.7	4.2	5.9	7.1											3.69	63.58	5.02	63.58	6.15	67.92
LEWS 1180	A	4.3	1.5	2.0	2.5											0.80	19.64	1.15	19.71	1.44	19.84
LEWS 1150-1155	A	10.0	3.4	4.0	4.6	1.45	18.34	1.24	18.34	2.06	18.34	2.47	18.34	4.55	18.34	3.41	23.33	4.14	24.00	4.62	25.23
LEWS 1150-1155	A	1.1	0.4	0.5	0.6	0.17		0.15		0.23		0.25		0.43		0.30		0.39		0.50	
LEWS 1150-1155	B	10.0	3.4	4.0	4.6											3.21	See 1040 Tunnel	3.84	See 1040 Tunnel	4.39	See 1040 Tunnel
LEWS 1150-1155	B	1.1	0.4	0.5	0.6											0.39		0.50		0.60	
LEWS 1130	A	8.4	2.8	3.9	4.9	12.42	14.43	12.42	15.13	12.42	15.13	12.42	16.70	12.42	17.30	3.59	18.72	4.65	18.72	5.51	23.15
LEWS 1135	A	1.2	0.2	0.2	0.2	0.31		0.14		0.14		0.01		0.00		0.00		0.00		0.00	
LEWS 1130	B	8.4	2.8	3.9	4.9									14.77	30.09	3.59	30.09	4.65	30.64	5.51	30.64
LEWS1135	B	1.2	0.2	0.2	0.2									0.10		0.01		0.01		0.01	
LEWS 1295	A	3.5	1.31	2.2	3.2											1.33	1.43	2.19	1.88	3.11	1.96
LEWS 1285	A	0.0	0.0	0.0	0.0											0.00		0.00		0.00	
LEWS 1055-1060	A	8.3	0.7	0.7	6.2											1.18	17.49	1.89	17.76	5.44	17.89
LEWS 1055-1060	B	8.3	0.7	0.7	6.2											2.13	See 1040 Tunnel	1.08	See 1040 Tunnel	3.23	See 1040 Tunnel
LEWS 1225	A	1.1	0.4	0.6	0.8	4.12	4.40	4.12	4.40	4.12	4.40	4.12	4.40	4.12	4.40	0.77	4.40	0.97	4.40	1.14	4.40
LEWS 1110	A	0.0	0.0	0.1	0.1	0.00	0.001	0.00	0.001	0.00	0.001	0.00	0.001	0.00	0.07	0.00	0.07	0.00	0.07	0.00	0.08
LEWS 1210	A	0.2	0.1	0.1	0.1											0.16	0.56	0.23	0.56	0.21	0.56
LEWS 1215	A	0.2	0.03	0.06	0.10											0.02	0.44	0.04	0.44	0.06	0.45
LEWS 1215	B	0.2	0.03	0.06	0.10											0.02	0.07	0.04	0.07	0.06	0.07
LEWS 1215	C	0.2	0.03	0.06	0.10											0.03	0.45	0.05	0.45	0.07	0.45
LEWS 1220	A	0.0	0.0	0.0	0.1											0.00	0.32	0.00	0.32	0.00	0.32

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City of Lakewood - IWWIP PH 2 - Discharge Performance Analysis — **Wet Weather Discharge | CBOD (pounds) | During Simulation**

DESCRIPTION OF CONTROL FACILITIES:		Existing System				4/TY Facilities		3/TY Facilities		2/TY Facilities		1/TY Facilities		0/TY Facilities		2 Yr Facilities		5 Yr Facilities		10 Yr Facilities	
DESCRIPTION OF RAINFALL ANALYSIS:						Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		2 year storm		5 year storm		10 year storm	
LOCATION	OPTION	Sum of Top 5 Pk Rain Events (lbs)	2 Year (lbs)	5 Year (lbs)	10 Year (lbs)	Sum of Top 5 Pk Rain Events (lbs)	Cost ($M)	Sum of Top 5 Pk Rain Events (lbs)	Cost ($M)	Sum of Top 5 Pk Rain Events (lbs)	Cost ($M)	Sum of Top 5 Pk Rain Events (lbs)	Cost ($M)	Sum of Top 5 Pk Rain Events (lbs)	Cost ($M)	2 Year (lbs)	Cost ($M)	5 Year (lbs)	Cost ($M)	10 Year (lbs)	Cost ($M)
RRES 1160-1165	A	2839	703	844	933	COMP	22.00	COMP	23.00	1371	See 0/TY	1371	See 0/TY	1371	65.73	445	72.73	538	72.74	692	76.58
RRES 1160-1165	B	2839	703	844	933	772	81.40	701	81.80	701	95.32	701	101.50	418	132.40	101	120.88	127	132.45	161	138.23
LEWS 1040	A	1564	319	389	447											36	87.28	44	106.88	73	121.98
LEWS 1040	B	1564	319	389	447											NA	NA	137	41.45	157	43.10
LEWS 1040	C	1564	319	389	447											33	25.39	43	31.30	NA	NA
LEWS 1045	A	64	16	22	24											0	1.53	0	2.11	0	2.31
LEWS 1035	A	158	74	92	109	79	2.15	58	2.92	45	3.44	19	4.98	0	8.08	7	6.53	9	8.24	11	9.65
LEWS 1195	A	383	10	23	29											0	0.61	0	0.61	0	0.61
LEWS 1070	A	277	65	77	87											46	1.62	57	1.66	64	1.70
LEWS 1070	B	277	65	77	87											48	1.31	60	1.35	69	1.35
RRES 1145	A	495	142	188	220											140	29.96	181	30.00	225	30.37
RRES 1145	B	495	142	188	220											41	63.58	57	63.58	73	67.92
LEWS 1180	A	436	118	141	159											12	19.64	16	19.71	19	19.84
LEWS 1150-1155	A	366	109	127	147	37	18.34	33	18.34	49	18.34	51	18.34	81	18.34	59	23.33	70	24.00	79	25.23
LEWS 1150-1155	A	0	0	0	0	6		5		8		8		14		10		12		14	
LEWS 1150-1155	B	366	109	127	147											97	See 1040 Tunnel	116	See 1040 Tunnel	133	See 1040 Tunnel
LEWS 1150-1155	B	0	0	0	0											12		14		17	
LEWS 1130	A	53	27	43	55	79	14.43	79	15.13	79	15.13	79	16.70	79	17.30	19	18.72	23	18.72	27	23.15
LEWS 1135	A	101	16	17	18	34.8		15.9		15.7		1.9		0		0		0		0	
LEWS 1130	B	53	27	43	55									327	30.09	69	30.09	84	30.64	96	30.64
LEWS1135	B	101	16	17	18									0		0		0		0	
LEWS 1295	A	82	29.9	43	55											29	1.43	40	1.88	51	1.96
LEWS 1285	A	0	0	0	0											0	0.00	0	0.00	0	0.00
LEWS 1055-1060	A	141	13	11	84											30	17.49	34	17.76	56	17.89
LEWS 1055-1060	B	141	13	11	84											12	See 1040 Tunnel	11	See 1040 Tunnel	42	See 1040 Tunnel
LEWS 1225	A	55	27	36	43	233	4.40	233	4.40	233	4.40	233	4.40	233	4.40	47	4.40	58	4.40	66	4.40
LEWS 1110	A	0	2	4	6	0	0.001	0	0.001	0	0.001	0	0.001	0	0.07	0	0.07	0	0.07	0	0.08
LEWS 1210	A	2	1	1	1											4	0.56	6	0.56	5	0.56
LEWS 1215	A	1	0.2	0.3	0.5											0.1	0.44	0.2	0.44	0.2	0.45
LEWS 1215	B	1	0.2	0.3	0.5											0.1	0.07	0.2	0.07	0.2	0.07
LEWS 1215	C	1	0.2	0.3	0.5											0.2	0.45	0.3	0.45	0.3	0.45
LEWS 1220	A	1	2	3	3											0	0.32	0	0.32	0	0.32

NOTES: (1) COMP = only available through composite run analysis - See Chapter 8. (2) NA = The particular alternative was not applied or appropriate for the respective level of control. (3) This table represents a planning level point in time analysis. Alternatives considered may produce stormwater only values at the discharge point. These values have been shaded blue. These values may also report higher values than those of existing conditions in the event that invert plates are closed and more stormwater (volume and/or pollutants) is discharged through the outfall pipe. (4) Some values may contain some amount of sewage when discharging during the typical year because they are permitted CSOs. These volumes and pollutants should be considered as possible CSO. These values have been shaded orange. Further analysis of alternatives selected for composite modeling are explained in Chapter 8 with CBOD as contributed by sewage being the primary point of analysis.

City of Lakewood - IWWIP PH 2 - Discharge Performance Analysis																					
												Wet Weather Discharge | e. Coli (CFU) | During Simulation									
DESCRIPTION OF CONTROL FACILITIES:		Existing System				4/TY Facilities		3/TY Facilities		2/TY Facilities		1/TY Facilities		0/TY Facilities		2 Yr Facilities		5 Yr Facilities		10 Yr Facilities	
DESCRIPTION OF RAINFALL ANALYSIS:						Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		Typical Year 5 Events		2 year storm		5 year storm		10 year storm	
LOCATION	OPTION	Sum of Top 5 Pk Rain Events (CFU)	2 Year (CFU)	5 Year (CFU)	10 Year (CFU)	Sum of Top 5 Pk Rain Events (CFU)	Cost ($M)	Sum of Top 5 Pk Rain Events (CFU)	Cost ($M)	Sum of Top 5 Pk Rain Events (CFU)	Cost ($M)	Sum of Top 5 Pk Rain Events (CFU)	Cost ($M)	Sum of Top 5 Pk Rain Events (CFU)	Cost ($M)	2 Year (CFU)	Cost ($M)	5 Year (CFU)	Cost ($M)	10 Year (CFU)	Cost ($M)
RRES 1160-1165	A	1E+15	3E+14	3E+14	3E+14	COMP	22.00	COMP	23.00	2.07E+14	See 0/TY	2.07E+14	See 0/TY	2.07E+14	65.73	6.66E+13	72.73	8.06E+13	72.74	1.05E+14	76.58
RRES 1160-1165	B	1E+15	3E+14	3E+14	3E+14	2.02E+14	81.40	2.02E+14	81.80	2.40E+14	95.32	6.38E+13	101.50	2.02E+14	132.40	1.51E+13	120.88	1.90E+13	132.45	2.75E+13	138.23
LEWS 1040	A	9E+14	2E+14	2E+14	2E+14											5.46E+12	87.28	6.65E+12	106.88	1.83E+13	121.98
LEWS 1040	B	9E+14	2E+14	2E+14	2E+14													2.05E+13	41.45	2.35E+13	43.10
LEWS 1040	C	9E+14	2E+14	2E+14	2E+14											5.64E+12	25.39	7.07E+12	31.30		
LEWS 1045	A	5E+13	1E+13	2E+13	2E+13											0.00E+00	1.53	0.00E+00	2.11	0.00E+00	2.31
LEWS 1035	A	1E+14	5E+13	5E+13	6E+13	5.42E+13	2.15	3.60E+13	2.92	2.70E+13	3.44	9.94E+12	4.98	0.00E+00	8.08	2.04E+12	6.53	2.78E+12	8.24	3.16E+12	9.65
LEWS 1195	A	3E+14	6E+13	6E+13	7E+13											5.91E+13	0.61	6.51E+13	0.61	6.87E+13	0.61
LEWS 1070	A	2E+14	4E+13	5E+13	5E+13											2.97E+13	1.62	3.37E+13	1.66	3.59E+13	1.70
LEWS 1070	B	2E+14	4E+13	5E+13	5E+13											3.05E+13	1.31	3.51E+13	1.35	3.76E+13	1.35
RRES 1145	A	3E+14	7E+13	8E+13	9E+13											4.73E+13	29.96	6.50E+13	30.00	8.49E+13	30.37
RRES 1145	B	3E+14	7E+13	8E+13	9E+13											8.33E+12	63.58	1.16E+13	63.58	1.53E+13	67.92
LEWS 1180	A	3E+14	7E+13	8E+13	8E+13											4.73E+12	19.64	5.74E+12	19.71	6.70E+12	19.84
LEWS 1150-1155	A	2E+14	4E+13	5E+13	5E+13	5.63E+12	18.34	5.10E+12	18.34	7.54E+12	18.34	7.86E+12	18.34	1.22E+13	18.34	8.80E+12	23.33	1.06E+13	24.00	1.19E+13	25.23
LEWS 1150-1155	A	0E+00	0E+00	0E+00	0E+00	8.46E+11		8.23E+11		1.20E+12		1.25E+12		2.07E+12		1.45E+12		1.80E+12		2.10E+12	
LEWS 1150-1155	B	0E+00	4E+13	5E+13	5E+13											3.86E+13	See 1040 Tunnel	4.48E+13	See 1040 Tunnel	4.89E+13	See 1040 Tunnel
LEWS 1150-1155	B	0E+00	0E+00	0E+00	0E+00											4.04E+12		4.63E+12		5.08E+12	
LEWS 1130	A	1E+13	1E+13	2E+13	2E+13	1.52E+13	14.43	1.52E+13	15.13	1.52E+13	15.13	1.52E+13	16.70	1.52E+13	17.30	2.82E+12	18.72	3.42E+12	18.72	4.21E+12	23.15
LEWS 1135	A	8E+13	1E+13	1E+13	1E+13	4.43E+12		4.45E+12		4.46E+12		4.46E+12		4.48E+12		0.00E+00		0.00E+00		0.00E+00	
LEWS 1130	B	1E+13	1E+13	2E+13	2E+13									5.01E+13	30.09	1.05E+13	30.09	8.65E+12	30.64	1.47E+13	30.64
LEWS 1135	B	8E+13	1E+13	1E+13	1E+13									0.00E+00		0.00E+00		0.00E+00		0.00E+00	
LEWS 1285-1295	A	4E+13	1E+13	2E+13	2E+13											1.35E+13	1.43	1.05E+13	1.88	2.26E+13	1.96
LEWS 1285-1295	A	0E+00	0E+00	0E+00	0E+00											0.00E+00	0.00	0.00E+00	0.00	0.00E+00	0.00
LEWS 1055-1060	A	6E+13	5E+12	4E+12	3E+13											4.50E+12	17.49	5.14E+12	17.76	8.49E+12	17.89
LEWS 1055-1060	B	6E+13	5E+12	4E+12	3E+13											2.74E+12	See 1040 Tunnel	2.78E+12	See 1040 Tunnel	1.50E+13	See 1040 Tunnel
LEWS 1225	A	2E+13	7E+12	9E+12	1E+13	3.55E+13	4.40	3.55E+13	4.40	3.55E+13	4.40	3.55E+13	4.40	3.55E+13	4.40	7.29E+12	4.40	9.20E+12	4.40	1.05E+13	4.40
LEWS 1110	A	0E+00	7E+11	1E+12	1E+12	0.00E+00	0.001	0.00E+00	0.001	0.00E+00	0.001	0.00E+00	0.001	0.00E+00	0.07	0.00E+00	0.07	0.00E+00	0.07	0.00E+00	0.08
LEWS 1210	A	2E+11	1E+11	2E+11	2E+11											5.78E+11	0.56	8.55E+11	0.56	7.63E+11	0.56
LEWS 1215	A	2E+11	2E+10	5E+10	8E+10											2.27E+10	0.44	2.77E+10	0.44	3.24E+10	0.45
LEWS 1215	B	2E+11	2E+10	5E+10	8E+10											2.27E+10	0.07	2.77E+10	0.07	3.24E+10	0.07
LEWS 1220	A	4E+11	6E+11	9E+11	1E+12											0.00E+00	0.32	0.00E+00	0.32	0.00E+00	0.32

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APPENDIX 7-2
Alternatives Evaluation for CSO 052

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Technical Memorandum

Prepared for: Files

Project Title: Lakewood, OH Integrated Wet Weather Improvement Plan, Phase 2

Project No.: 153281

Technical Memorandum

Subject: Management Alternatives Evaluation for CSO 052

Date: February 28, 2019

To: Andy Lukas

From: Dan Davis

Copy to: Eric Dunn

Prepared by: Dan Davis, P.E.
Vice President

Reviewed by: Bryan Rogne
Wet Weather Specialist

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Section 1: Introduction

The purpose of this Technical Memorandum (TM) is to provide an evaluation of alternative management approaches to address typical year discharges from CSO 052. The different approaches include a range of treatment and storage options over different discharge frequency conditions. The area shown in Figure 1-1 directly to the east of the Lakewood Wastewater Treatment Plant (LWWTP) is assumed to be available for these facilities. The currently planned 35 mgd ballasted flocculation (ACTIFLO) facility is shown. The following sections summarize the evaluation results.

Figure 1-1. General location of existing and potential treatment facilities

Section 2: CSO 052 Modeled Flows

Brown and Caldwell (BC) obtained an updated copy of the collection system model from CT consultants in December 2018 for the purposes of reviewing and evaluating flow conditions for CSO 052. The analysis associated with this TM focused on the discharge from CSO 052 only. The model results used in this analysis are based on a version that may have been updated in the Integrated Wet Weather Improvement Plan (IWWIP) and may result in slight differences between this TM and the IWWIP.

As described in the following subsection, the peak flow rates and volumes were identified using the typical year model flows from the collection system.

2.1 Typical Year Model Data

The collection system model is based on PCSWMM and predicts flows for the hydrologic and hydraulic components of the Lakewood collection system. The model simulates the typical year flows based on precipitation from 1977. Previous work by others defined the typical year conditions used for this evaluation. Figure 2-1 depicts the general overview of the model, the general location of CSO 052 and the LWWTP.

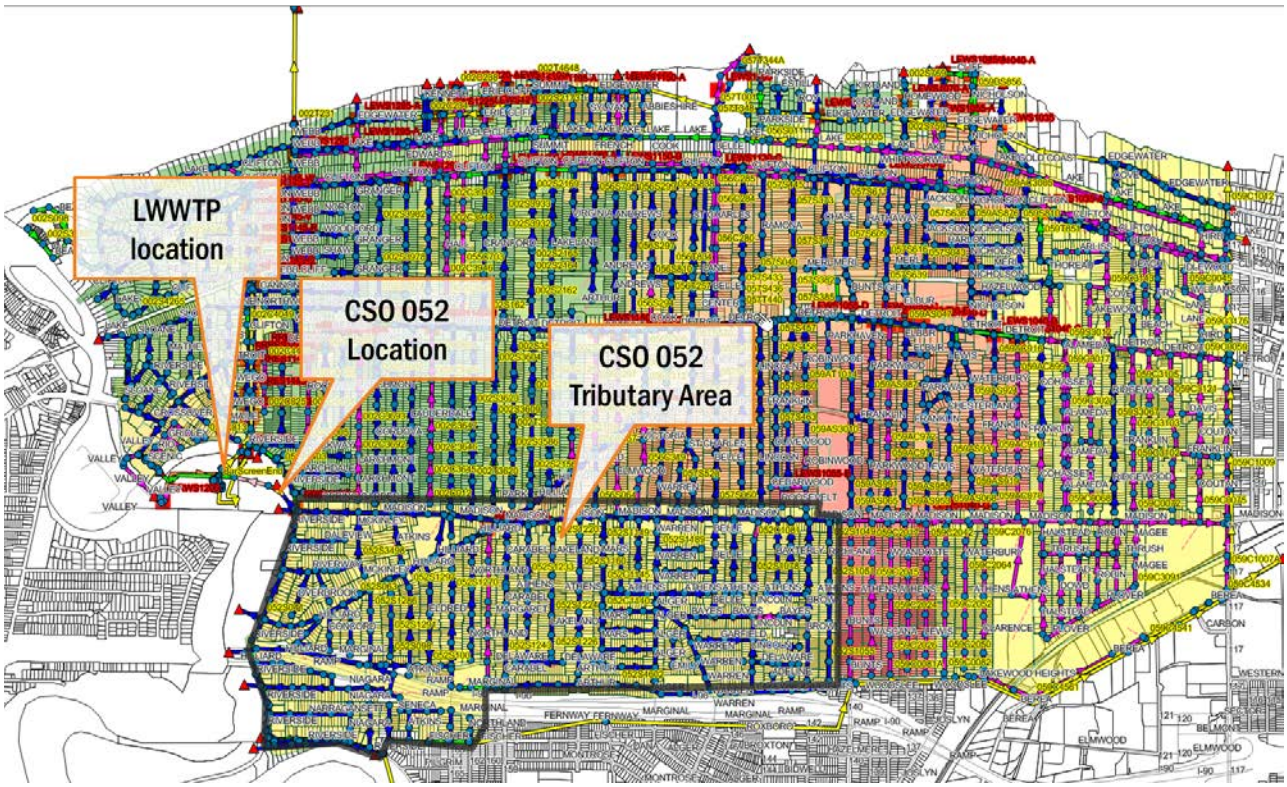


Figure 2-1. Modeled sewer system overview

The existing CSO 052 outfall consists of an 85-inch x 75-inch elliptical storm sewer that discharges directly to the Rocky River.

The typical year hydrograph shown in Figure 2-2 illustrates the resulting discharge from CSO 052 based on the modeled typical year rainfall. The conduit selected in the model is conduit 052T006_052T003.

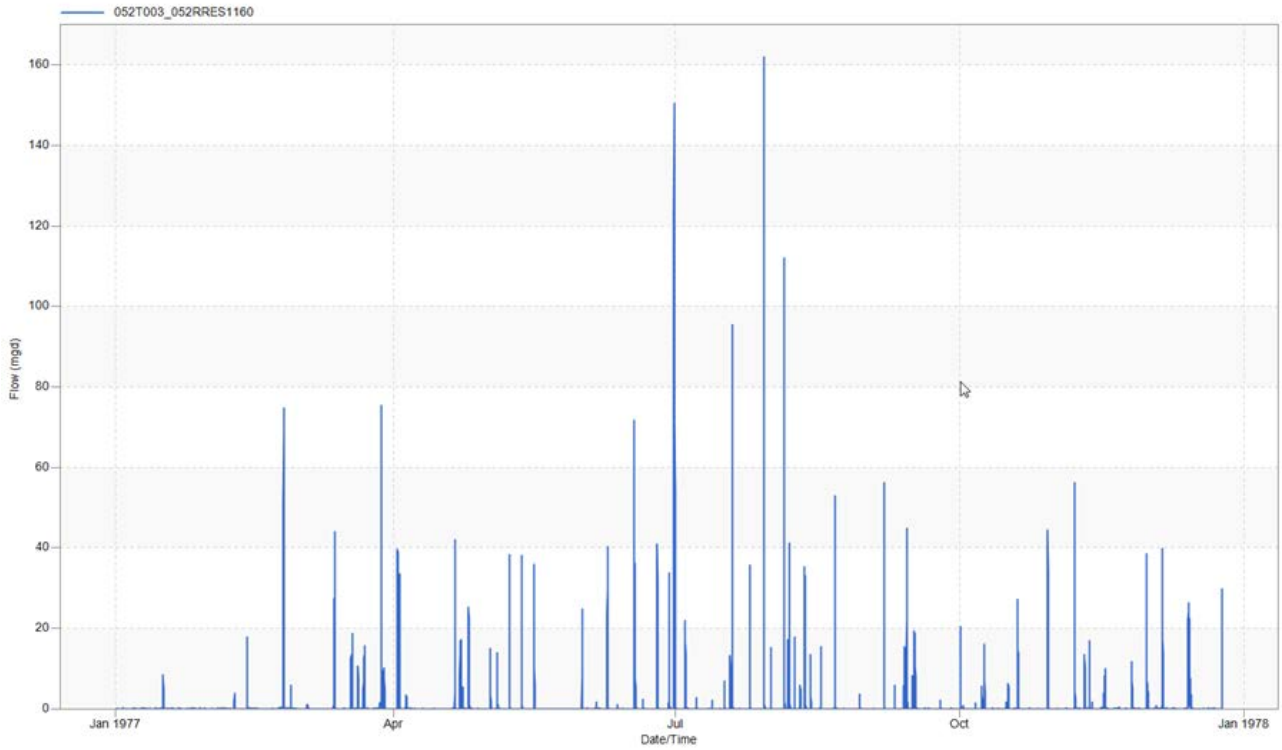


Figure 2-2. Typical year hydrograph for CSO 052

Table 2-1 summarizes the 5 largest ranked peak flows and event volumes based on the model results. It is important to note that the peak flow values do not coincide with the event volumes reported below. The typical year data were analyzed to identify the peak and volume criteria as separate analyses. For example, the peak flow event of 75 mgd does not represent an event volume of 6.1 MG.

Table 2-1. Summary of Peak Flows and Discharged Volumes by Event

Peak Flow Ranking	Peak Flow (mgd)
Largest	162
2nd Largest	150
3rd Largest	112
4th Largest	95
5th Largest	75
Event Volume Ranking	**Volume (MG)**
Largest	14.4
2nd Largest	9.6
3rd Largest	7.7
4th Largest	6.4
5th Largest	6.1

The development of the various CSO treatment approaches presented in the next section is based on the values presented in Table 2-1 to compare various levels of control.

CSO 052 Management Approaches

A number of CSO management approaches were developed to broadly assess alternatives that would provide varying levels of control. The approaches evaluated are outlined below, and the implementation of each to obtain the various treatment levels outlined in Table 2-1 is discussed in the following subsections.

- ACTIFLO (Ballasted Flocculation)
- Chemically Enhanced Primary Treatment (CEPT) and High Rate Disinfection (HRD)
- Retention Treatment Basin (RTB)
- High Rate Disinfection (HRD)
- Storage

For each management approach, the facilities were sized to accommodate the 2nd through the 5th largest events as summarized in Table 2-1. The volumes in Table 2-1 were used for the storage approaches, while the remaining treatment approaches were based on peak flows. An approximate layout for the 5th largest event has been developed. In addition, a comparison of pollutant loading and estimated cost has been developed for each approach and event. For each approach, flows greater than the peak flow or volume criteria shown in Table 2-1 are assumed to be discharged untreated to the Rocky River. For each of the treatment approaches, a new permitted outfall would be required for the treated flows.

Based upon review of modeled pollutant concentration data for CSO 052, it was observed that modeled pollutant concentrations appear relatively low and may not be as amendable to higher levels of treatment using chemically enhanced approaches. These types of technologies may result in poorer performance when subjected to very dilute conditions. Additional sampling during wet weather would be necessary to address this concern.

2.2 Aerial Sewer Crossing for CSO 052 Conveyance

Since each approach includes a facility located on the other side of the Rocky River, on the east side of the LWWTP, it is necessary to convey flow from CSO 052 to the site adjacent to the plant. Due to the much higher elevation of CSO 052 located across the river, an aerial sewer crossing was assumed for all alternatives. The sewer was sized with a 48-inch diameter at a slope that would allow the peak flow to be conveyed while maintaining a peak velocity less than 15 feet per second. A second barrel is required to convey the 3rd largest and greater events. Due to the significant difference in elevation from the invert of CSO 052 at the top of the slope on the east side of the river (approximately 634) and the ground surface elevation in the vicinity of the LWWTP (approximately 600), a 16-foot drop structure was assumed on the east side of the river to lower the alignment before crossing the river. Once the flow is dropped, a jack and bore of approximately 200-LF was assumed to “daylight” the sewer from the cliff face before the alignment continues on piers and an aerial bridge across the river to the LWWTP.

2.3 Ballasted Flocculation/ACTIFLO and UV Disinfection

The City is currently about to begin construction on an ACTIFLO high-rate treatment facility next to the LWWTP for the treatment of CSO 002 located just upstream of the plant influent. The treatment process begins with fine screening and grit removal. ACTIFLO is a proprietary, high-rate physical-chemical treatment process that involves the use of a ballast material (microsand) to aid in settling of flocculated solids. The

ballast material provides a medium to more rapidly settle the flocculated solids and results in a reduced footprint compared with conventional clarification. The process uses two chemicals including a coagulant and a flocculent in conjunction with ballast material to improve settling. It is assumed that flows remaining in the facility following a wet weather event would be dewatered and returned to the LWWTP for full secondary treatment.

The project about to begin construction will include UV disinfection and is anticipated to treat a peak flow of 35 mgd. The bid results include an estimated cost of approximately $22M. This CSO 052 treatment approach assumes that the currently proposed facility could be expanded to accommodate the higher peak flows presented in Table 2-1.

Figure 3-1 shows the general layout of the facility as currently proposed to treat 35 mgd, as well as the approximate facility size to treat the 5th largest event (75 mgd). Flows in excess of peak treatment rates would be discharged untreated to the Rocky River.

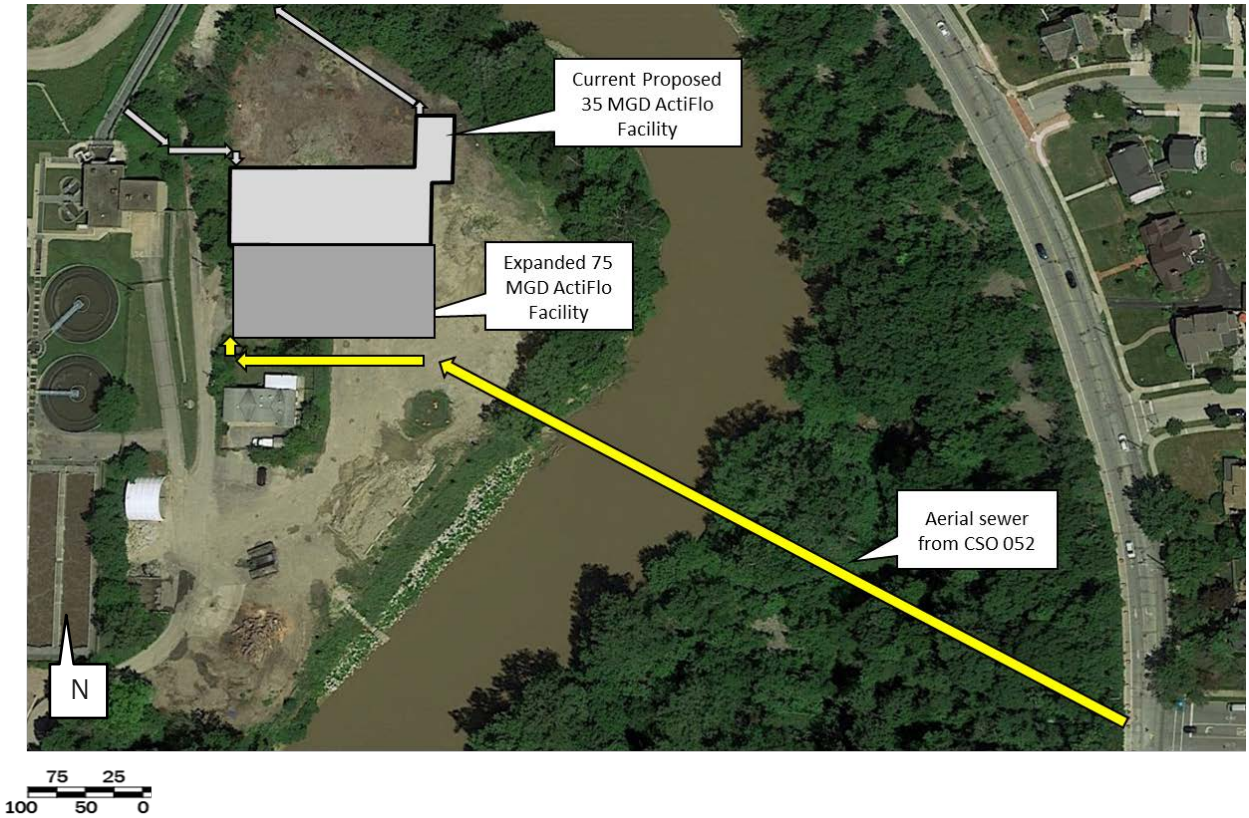


Figure 3-3. Expanded ACTIFLO conceptual layout to treat 75 mgd

2.4 Chemically Enhanced Primary Treatment (CEPT) and High Rate Disinfection (HRD)

CEPT is similar to ACTIFLO in that they both use a two chemical process to accomplish coagulation and flocculation of solids in wastewater. However, CEPT does not include a ballast media to aid in the settling process. It is nonproprietary and does not requiring purchase of equipment from a specific supplier.

CEPT has been available for decades in the wastewater industry and most recently has been tested in pilot and full-scale applications for the North East Ohio Regional Sewer District at three of its wastewater treatment plants. It has been shown to be highly effective at surface overflow rates (SORs) as high as 10,000 gallons per day per square foot (gpd/sf). These recent results were the basis for sizing the CEPT approach for CSO 052.

The treatment process begins with screening and grit removal. CEPT then provides a flow-through treatment scheme that is followed by disinfection. Disinfection treatment could include either UV or high-rate disinfection (HRD), however, for this analysis it is assumed that high-rate disinfection using liquid sodium hypochlorite is used. Dechlorination would be achieved prior to discharge. Any flows remaining in the facility following a wet weather event would be dewatered and returned to the LWWTP for full secondary treatment. Flows in excess of peak treatment rates would be discharged untreated to the Rocky River. Figure 3-2 shows the approximate facility size to treat the 5th largest event (75 mgd).

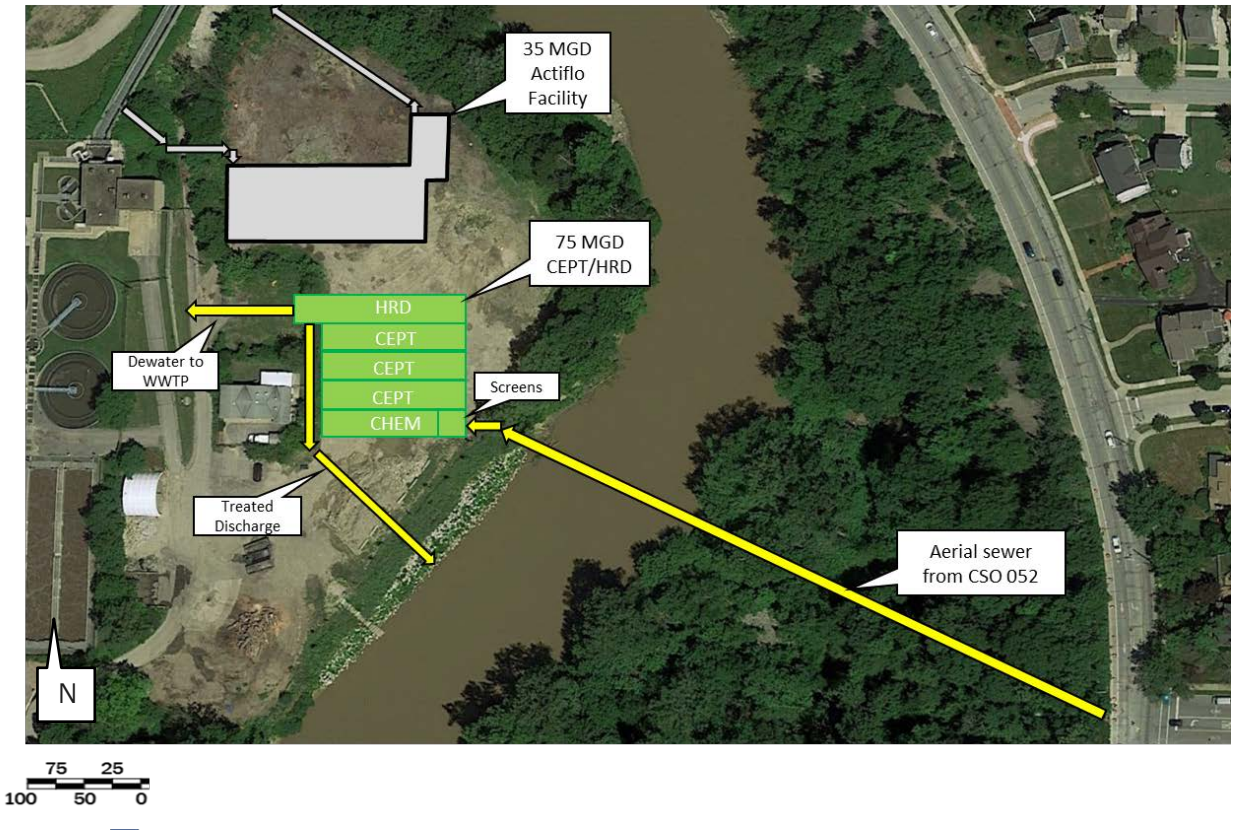


Figure 3-4. CEPT/HRD conceptual layout to treat 75 mgd

2.5 Retention Treatment Basin (RTB)

The RTB is a flow-through treatment approach that provides a combination of storage and treatment for CSO flows. For the purposes of this evaluation it is assumed that approximately 20 minutes of settling and disinfection is accomplished at the peak flow condition. Disinfection is assumed to be achieved through the use of liquid sodium hypochlorite injected before flows enter the RTB, followed by dechlorination prior to river discharge. It is assumed that the RTB will achieve the equivalent to primary treatment based on an average of wet weather events over a typical year. Any flows remaining in the facility following a wet weather event would be dewatered and returned to the LWWTP for full secondary treatment. Flows in excess of peak treatment rates would be discharged untreated to the Rocky River. Figure 3-3 shows the approximate facility size to treat the 5th largest event (75 mgd).

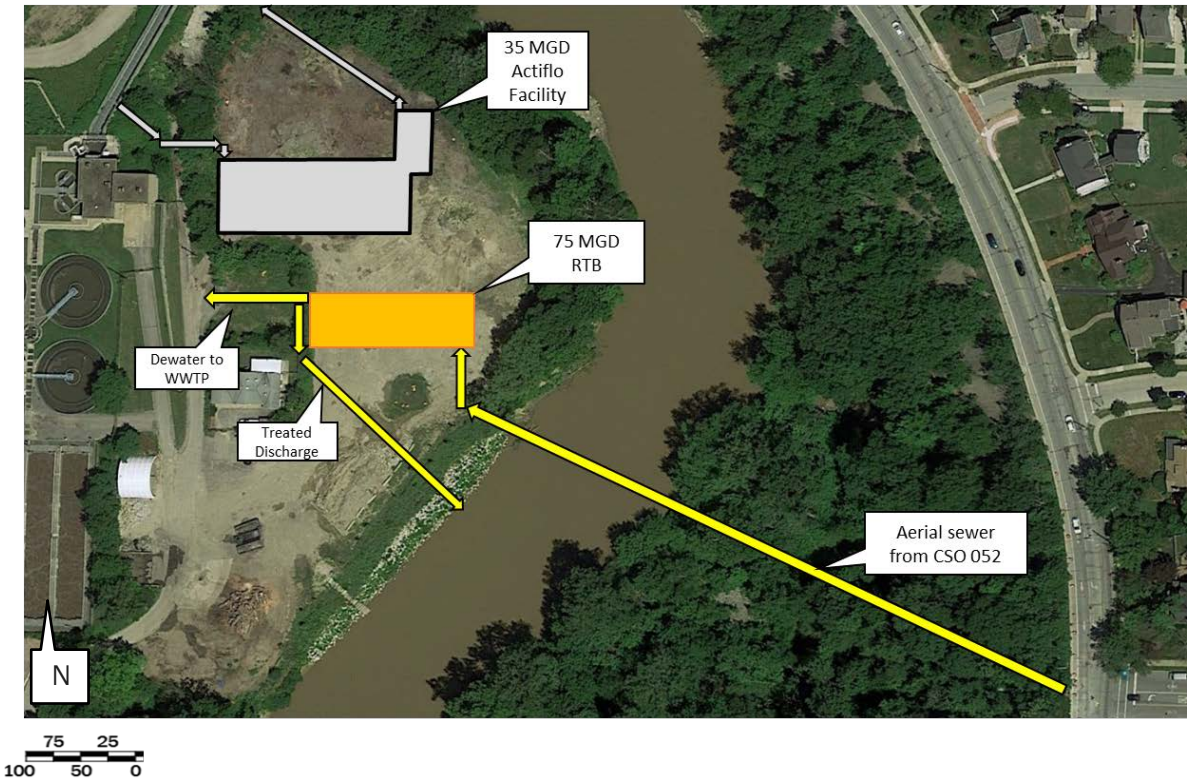


Figure 3-5. RTB conceptual layout to treat 75 mgd

2.6 High Rate Disinfection (HRD)

This treatment approach includes the use of liquid sodium hypochlorite for a contact time of approximately 10 minutes followed by dechlorination prior to river discharge. Any flows remaining in the facility following a wet weather event would be dewatered and returned to the LWWTP for full secondary treatment. Flows in excess of peak treatment rates would be discharged untreated to the Rocky River. Figure 3-4 shows the approximate facility size to treat the 5th largest event (75 mgd).

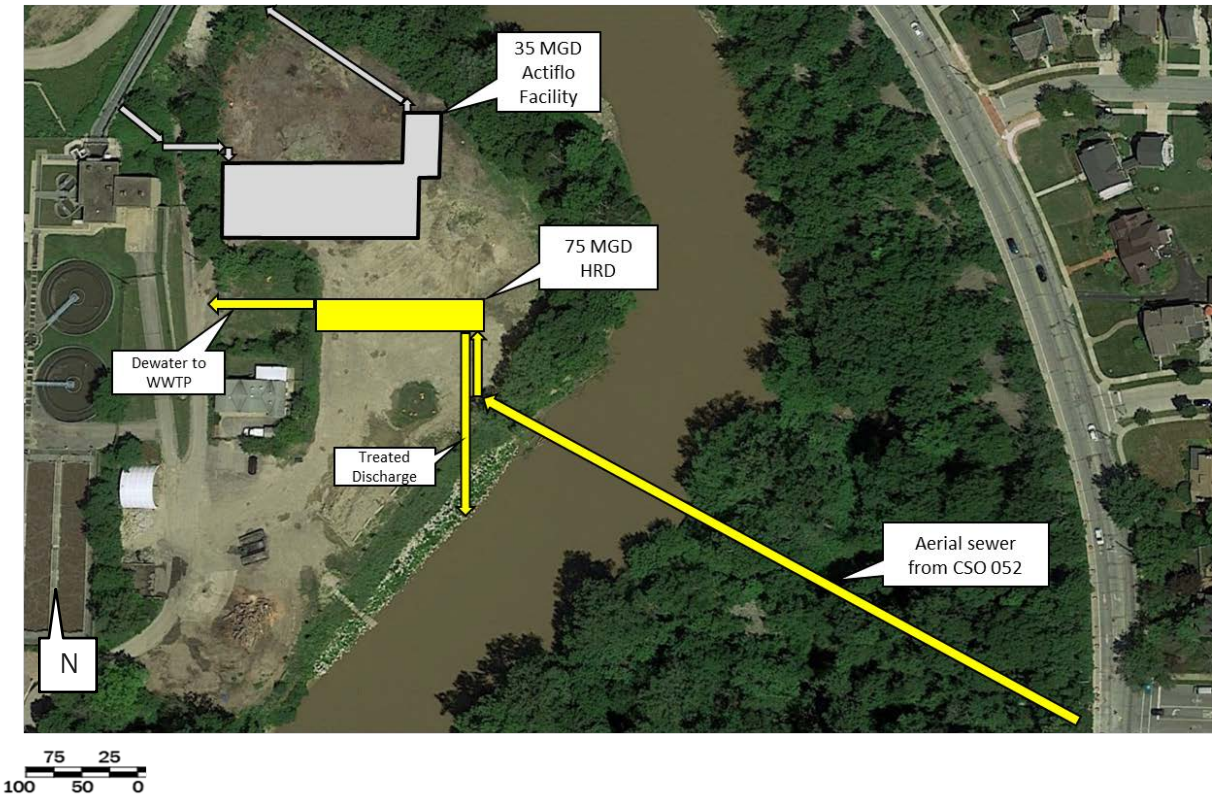


Figure 3-6. HRD Conceptual Layout to Treat 75 mgd

2.7 Storage

Both above and below ground storage were considered for this analysis. For each approach, it is assumed that once the storage is full, flows would be discharged untreated to the Rocky River. The differences in storage approaches relate to costs of construction and tank visibility. Above ground storage would be elevated above the ground surface from 20 to 40 feet depending on how it is sized and constructed. It is assumed that both above and below ground storage would be uncovered. A storage alternative provides the least amount of operational complexity since there would not be any chemical feed and storage facilities that would need to be considered.

Both the above and below ground storage approaches store volumes up to the criteria identified in Table 2-1. Following each wet weather event, stored flow is dewatered to the LWWTP influent for full secondary treatment. The storage facility would then utilize automatic flushing to remove solids that dropped out during the basin filling process.

Figure 3-5 shows the approximate facility size to treat the 5th largest event (75 mgd) in three storage tanks with storage heights of approximately 30 feet each.

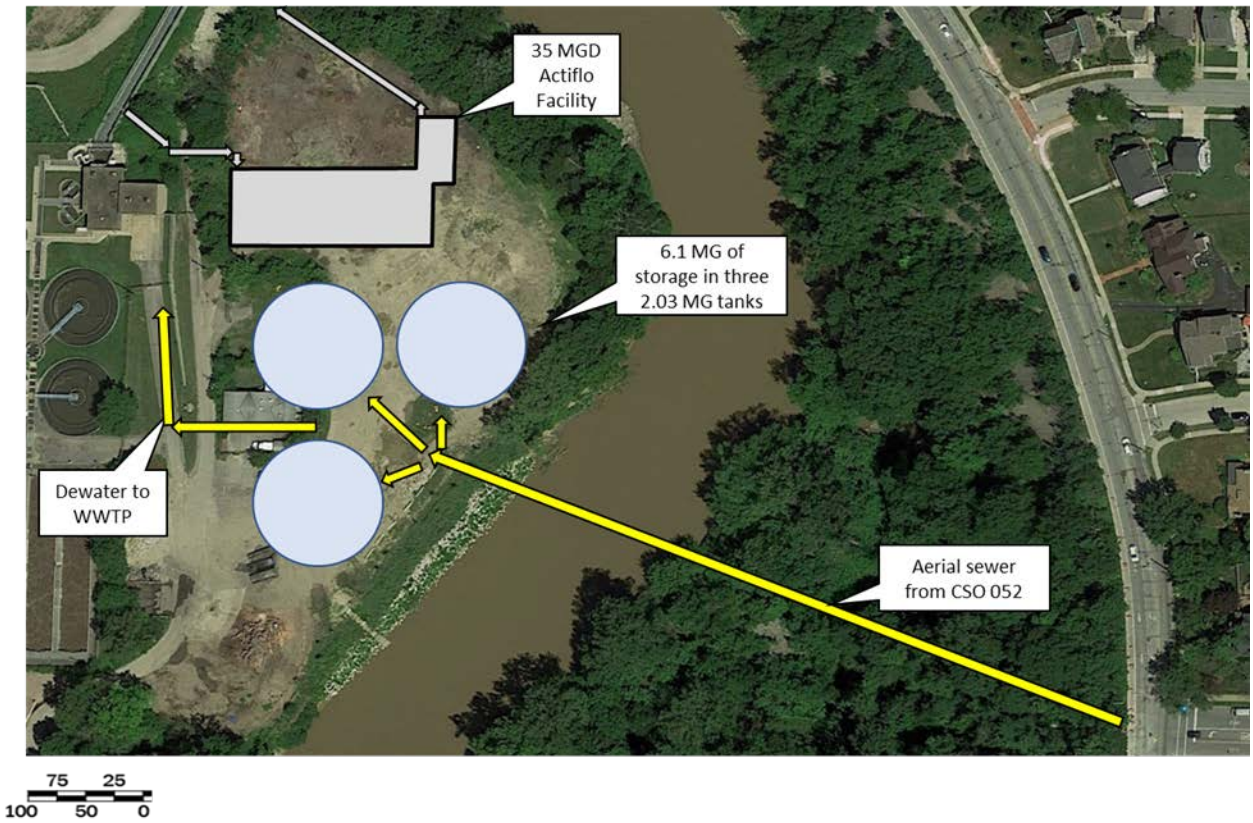


Figure 3-7. Storage Conceptual Layout to Treat 75 mgd

Section 3: Pollutant Loading Projections

An evaluation of pollutant loading resulting from each of the approaches described above was conducted to estimate the annual discharge of TSS, CBOD and *E. Coli*. For each CSO management approach, the parameters were developed by utilizing the PCSWMM output for flow and pollutant concentrations over the modeled typical year. Except for the storage approach, each approach provides both a treatment and storage component depending on the size of the event.

During each event, flow enters the facility and if the event volume is greater than the storage associated with that particular approach it will be discharged as treated effluent up to the design peak treatment rate (not including storage). Following each wet weather event, any captured/stored volume of CSO that remains in the facility would be dewatered back to the LWWTP for full secondary treatment. These captured volumes are included in the reduced pollutant loadings for each approach. As there is no treatment component for the storage approach, pollutant loadings are only reduced by the captured storage volume. Table 4-1 summarizes the volume capture for each treatment approach during the typical year. The volume capture varies significantly with CEPT and disinfection providing the smallest annual capture of 21% for the 5th largest event while storage provides the largest volume capture at 90% capture for the same event.

Figure 4-1 shows the volume capture comparison by approach.

Table 4-1. Summary of Annual Volume Capture by Treatment Approach				
Untreated Events	4	3	2	1
Peak Flow Rate (mgd)	75	95	112	150
ACTIFLO Storage (MG)	0.63	0.79	0.94	1.25
ACTIFLO Volume Capture	21%	26%	30%	38%
CEPT/HRD Storage (MG)	1.94	2.45	2.89	3.88
CEPT/HRD Volume Capture	51%	59%	65%	75%
RTB Storage (MG)	1.04	1.32	1.56	2.08
RTB Volume Capture	32%	39%	44%	54%
HRD Storage (MG)	0.62	0.79	0.93	1.25
HRD Volume Capture	21%	26%	30%	38%
Storage (MG)	6.1	6.4	7.7	9.6
Storage Volume Capture	90%	91%	94%	97%

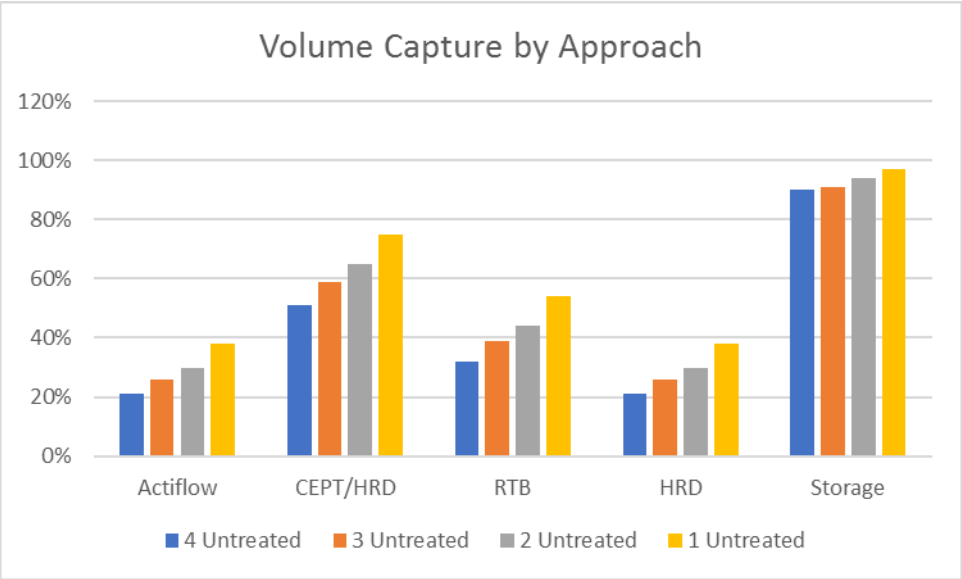


Figure 4-1. Volume Capture by approach

Table 4-2 and Figures 4-1, 4-2, and 4-3 show the estimated amount of TSS, CBOD, and E. Coli discharged respectively by each approach during the typical year. As indicated on each figure, the model estimated a typical year average discharge of approximately 19,540 lbs of TSS, 9,750 lbs of CBOD and 9.5 x 10^{15} bacteria counts without any consideration of treatment and/or storage. The storage approach results in the lowest TSS and CBOD pollutant loading discharged due to the large storage volumes that capture most of the CSO during the typical year.

Table 4-2. Summary of Annual Pollutant Discharge by Treatment Approach				
Untreated Events	4	3	2	1
Peak Flow Rate (mgd)	75	95	112	150
TSS (lbs)	Existing modeled discharge 19,543			
ACTIFLO	3,045	2,564	2,289	1,844
CEPT/HRD	2,641	1,983	1,592	975
RTB	7,338	6,334	5,679	4,535
Disinfection	11,510	10,531	9,845	8,559
Storage	1,885	1,707	1,075	581
CBOD (lbs)	Existing modeled discharge 9,750			
ACTIFLO	2,671	2,362	2,169	1,832
CEPT/HRD	1,792	1,386	1,134	726
RTB	5,309	4,643	4,193	3,391
Disinfection	6896	6339	5941	5185
Storage	940	852	536	290
E. Coli (counts)	Existing modeled discharge 5.43 x 10^{15}			
ACTIFLO	2.16E+14	1.15E+14	6.79E+13	5.13E+12
CEPT/HRD	2.16E+14	1.15E+14	6.77E+13	4.92E+12
RTB	2.16E+14	1.16E+14	6.81E+13	5.24E+12
Disinfection	2.16E+14	1.16E+14	6.82E+13	5.41E+12
Storage	5.59E+14	5.05E+14	3.2E+14	1.72E+14

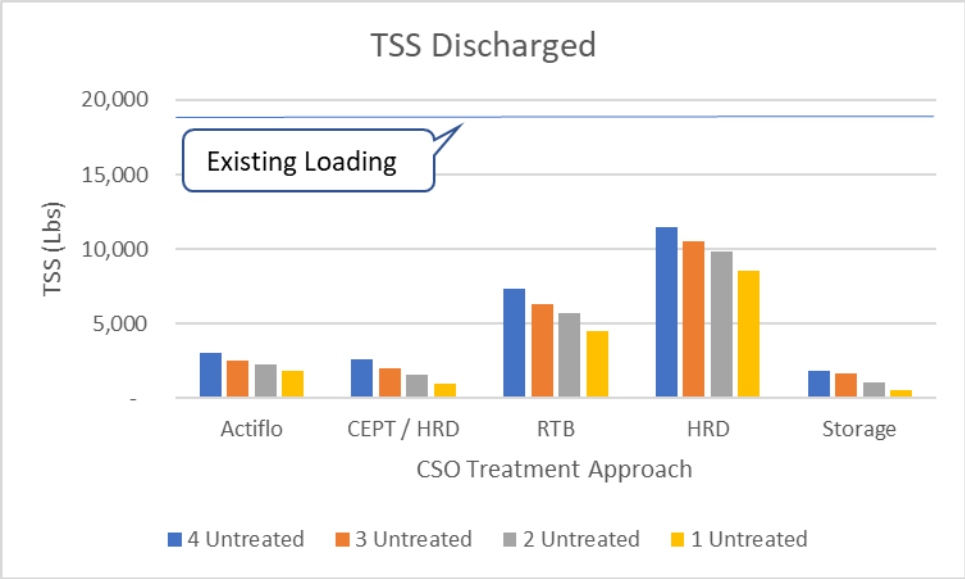


Figure 4-2. TSS Discharged by Approach

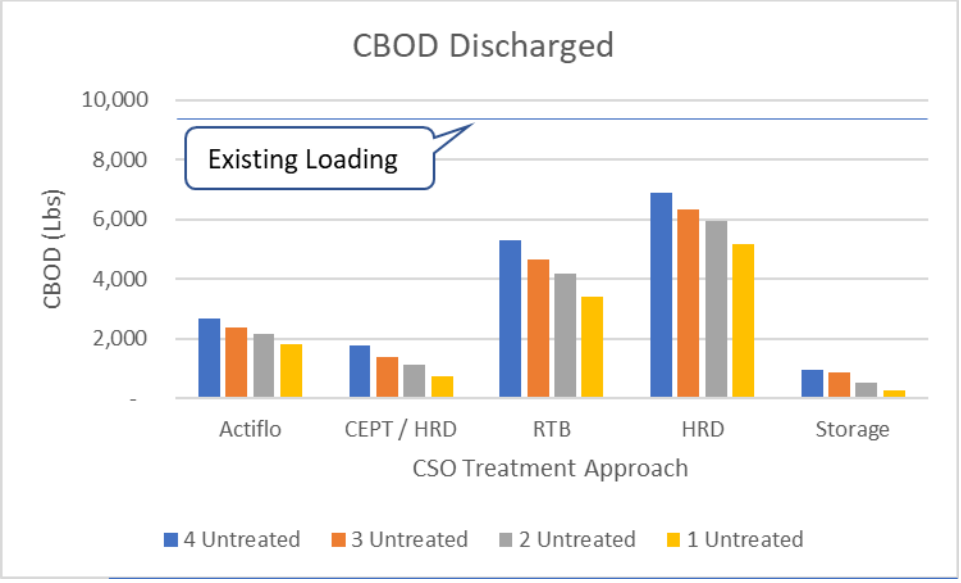


Figure 4-3. CBOD Discharged by Approach

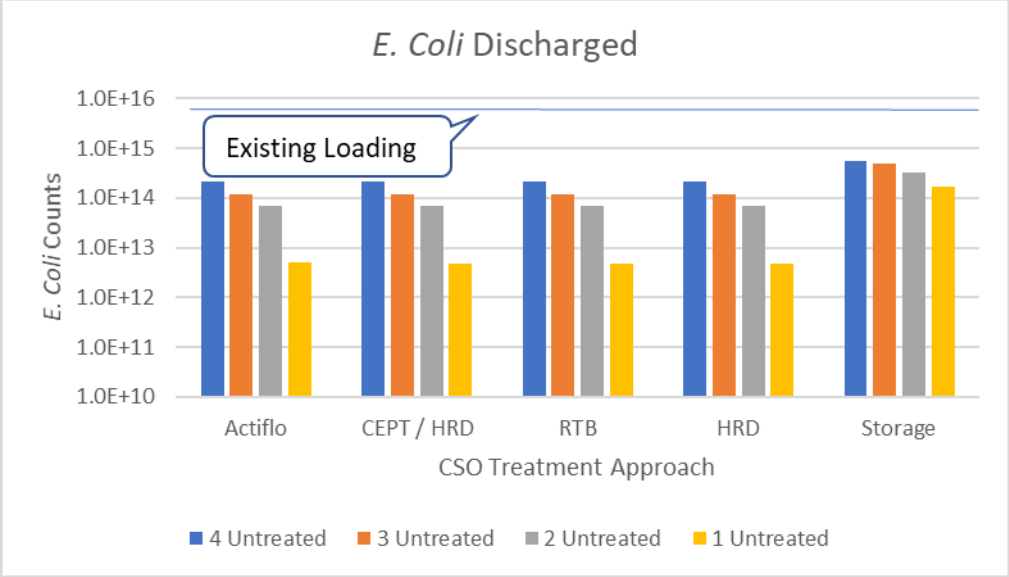


Figure 4-4. *E. Coli* Discharged by Approach

Section 4: Costs

Planning level project capital and present worth costs were estimated for each alternative, as described in this section. Costs were adjusted to January 2019 conditions. Present worth costs were estimated for each alternative by applying an annual operations and maintenance (O&M) cost across a 20-year service life with an interest rate of 2.5%. Additional assumptions employed to determine the costs for each alternative are described in Attachment A.

4.1 Aerial Sewer Crossing for CSO 052 Conveyance

Project capital costs for the aerial sewer crossing were estimated based on bid tabs for similar projects in both Ohio and South Carolina. Costs were calculated for a peak flow of 60 MGD and 150 MGD and scaled linearly for the other peak flow scenarios.

O&M costs for the aerial sewer were assumed to be negligible.

4.2 Ballasted Flocculation/ACTIFLO and UV Disinfection

Project capital costs for the ACTIFLO alternative were estimated based on the cost of the 35 mgd facility planned to be constructed on the site of the LWWTP. The project cost was estimated in dollars ($) per mgd and multiplied by the required peak flow to generate a cost for each scenario.

To calculate the present worth cost, an annual O&M cost was estimated based on an O&M curve in the EPA Manual of Combined Sewer Overflow Control for sedimentation with chemical treatment.

4.3 Chemically Enhanced Primary Treatment (CEPT) and High Rate Disinfection (HRD)

Project capital costs for the CEPT and HRD alternative were estimated based on the 100% design costs for another similar facility designed in Ohio. The project cost was estimated in dollars ($) per mgd and multiplied by the required peak flow to generate a cost for each scenario.

To calculate the present worth, an annual O&M cost was estimated based on an O&M curve in the EPA Manual of Combined Sewer Overflow Control for sedimentation with chemical treatment.

4.4 Retention Treatment Basin (RTB)

Project capital costs for the RTB alternative were estimated based on the 100% design costs for another similar facility designed in Ohio. The project cost was estimated in dollars ($) per mgd and multiplied by the required peak flow to generate a cost for each scenario.

To calculate the present worth, an annual O&M cost was estimated based on an O&M curve in the EPA Manual of Combined Sewer Overflow Control for disinfection.

4.5 High Rate Disinfection (HRD)

Project capital costs for the disinfection alternative were estimated based on the 100% design costs for another similar facility designed in Ohio. The project cost was estimated in dollars ($) per mgd and multiplied by the required peak flow to generate a cost for each scenario.

To calculate the present worth, an annual O&M cost was estimated based on an O&M curve in the EPA Manual of Combined Sewer Overflow Control for disinfection.

4.6 Storage

Project capital costs for the above ground storage alternative were estimated based on recent cost estimates. The project cost was estimated in dollars ($) per gallon and multiplied by the required storage tank size to generate a cost for each scenario.

Project capital costs for the below ground storage alternative were estimated based on a cost curve in the EPA Manual of Combined Sewer Overflow Control for storage. The project cost was estimated in dollars ($) for each scenario.

To calculate the present worth, an annual O&M cost was estimated based on an O&M curve in the EPA Manual of Combined Sewer Overflow Control for screening for both above and below ground storage.

Table 5-1 provides the project cost summary for each scenario and approach in millions of dollars ($M), while Figure 5-1 depicts a graphical summary.

Table 5-1. Project Cost Summary ($M)

Scenario	Above Ground Storage	HRD	RTB	Below Ground Storage	CEPT/HRD	ACTIFLO
4 Events per TY	22	19	25	41	48	53
3 Events per TY	23	23	32	43	60	66
2 Events per TY	28	27	37	50	71	77
1 Event per TY	34	35	48	60	94	103

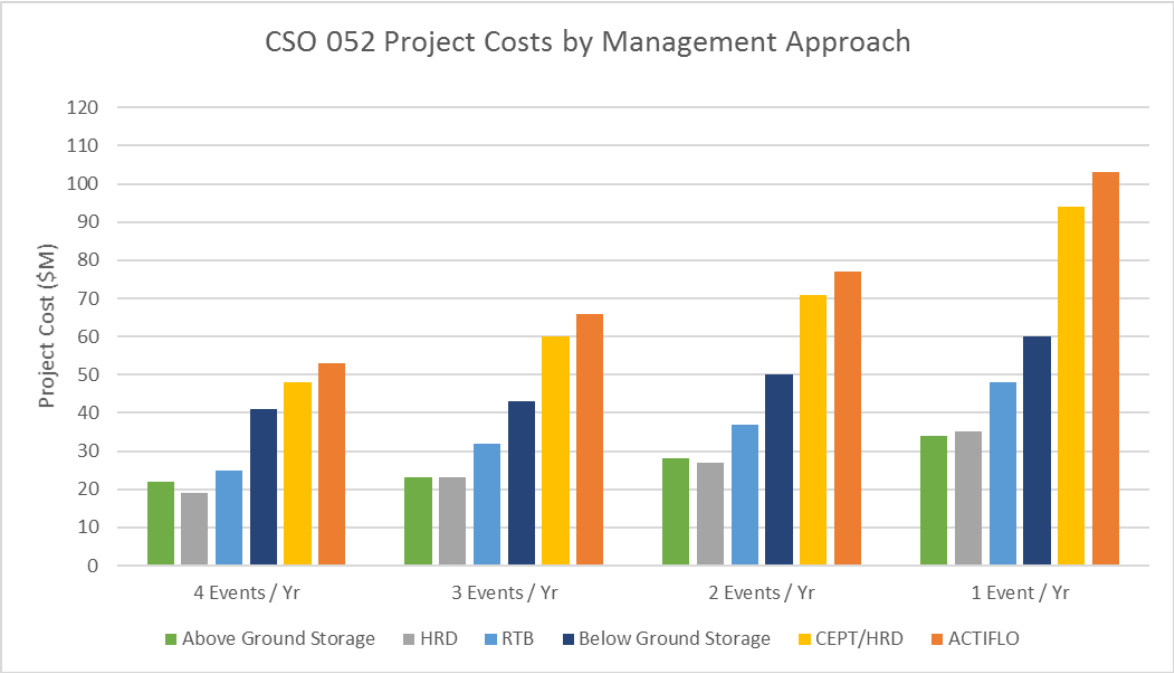


Figure 5-1. Project Cost Summary ($M)

Table 5-2 provides the present worth cost summary for each scenario and approach in millions of dollars ($M), while Figure 5-2 depicts a graphical summary.

Table 5-2. Present Worth Cost Summary ($M)						
Scenario	Above Ground Storage	HRD	RTB	Below Ground Storage	CEPT/HRD	ACTIFLO
4 Events per TY	23	24	31	42	55	61
3 Events per TY	24	29	39	44	68	75
2 Events per TY	29	34	44	51	79	89
1 Event per TY	36	43	56	62	104	114

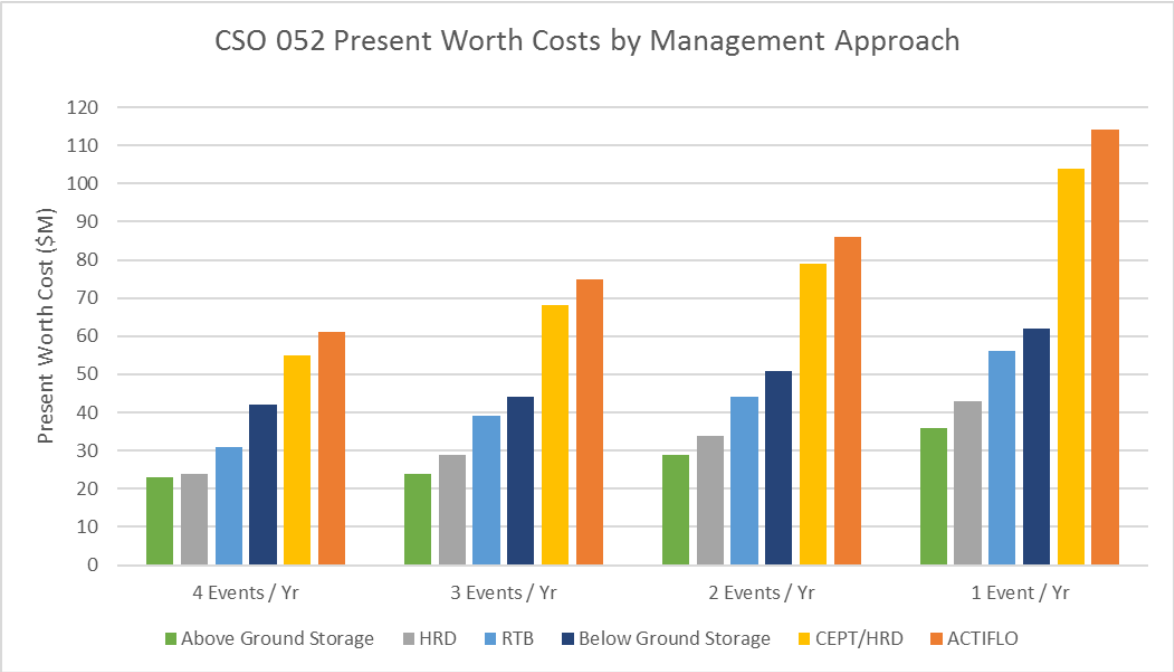


Figure 5-2. Present Worth Cost Summary ($M)

Section 5: Conclusions

A wide range of alternatives have been evaluated in this TM to address discharges from CSO 052. Two comparisons have been conducted including pollutant loadings and costs (project capital and present worth) for each alternative. The following conclusions have been identified as a result of these evaluations:

- The storage alternatives result in a facility that is the most simple to operate since it does not include disinfection treatment facilities
- The storage alternatives result in the greatest volume capture over a typical year compared with treatment alternatives
- The storage alternatives result in significantly reduced loadings for both TSS and CBOD compared with the treatment alternatives
- The storage alternatives result in greater discharge of bacteria compared with other alternatives, however, it only occurs one to four times in a typical year whereas treatment scenarios are discharging during numerous events throughout the typical year
- Project capital cost for above ground storage is the least compared with all other alternatives, with the exception of HRD at only the lowest control scenario
- Present worth cost comparisons results in above ground storage as the least cost alternative.
- The model results used in this analysis are based on a version that may have been updated in the IWWIP and may result in slight differences between this TM and the IWWIP

Based on these conclusions, above ground storage is considered the most cost-effective alternative when considering CSO 052.

APPENDIX 9-1
Public Participation Documents

ATTACHMENT 9-1: PUBLIC PARTICIPATION DOCUMENTS

Public Participation Documents 1
- Public Engagement Summaries From Phase 1 2
- Handouts Given at Phase 1 Public Meetings 8
- Social Media Posts 60
- Newspaper Articles 73
- Media Monitoring Emails to Clean Water Lakewood Task Force 85
- Informational flyer 88
- Phase 2 Public Engagement 91
  - October 23, 2018 Powerpoint 91
  - Answers to the questions asked during the October 23, 2018 meeting: 101
  - November 15, 2018 Powerpoint 106
  - Summary Report from November 15, 2018 Public Meeting 116
  - December 4, 2018 Powerpoint 132
  - January 16, 2019 Open House Meeting Posters 147
  - Summary Report from January Public Meeting 151
- Community Engagement Plan 156
- Lakewood Life Newsletter, Fall 2018 174
- Letter from 3rd Grader 181

PUBLIC ENGAGEMENT SUMMARIES FROM PHASE 1

Meeting Date: July 15, 2015, Number of people in attendance: 20
Meeting Topic: Introduction & Overview
Goal: To give an overview of the challenges Lakewood faces regarding overflows
Summary

- Lakewood faces regulatory requirements that involve a variety of infrastructure, policy, and land management solutions. Clean Water Lakewood will help to evaluate various water infrastructure improvement alternatives based on the working group's suggestions, reflecting the community's criteria and values.

- Combined sewer overflows
    - During dry weather, sewer transports all of the wastewater to a sewage treatment plant, where it is treated and then discharged to a water body.
    - During periods of heavy precipitation, the wastewater volume can exceed the capacity of the sewer system or treatment plant. For this reason, sewer system is designed to overflow and discharge excess wastewater directly to waterways.

- CSOs are a major water pollution concern for approximately 772 cities in the U.S. that have combined sewer systems (EPA, 2014).

- With the passage of the Clean Water Act in 1972, such overflows and other discharges must be controlled to make water fishable and swimmable, among other uses.

- US EPA and Ohio EPA have mandated that Lakewood capture, treat or remove the millions of gallons of overflow that happen every year.

- As with the original investments in the City, Lakewood must invest in its infrastructure so that it meets the demands of Lakewood's second century, and for the benefit of human and environmental health.

- Introductions around the room. People stated why they were interested in joining Clean Water Lakewood and a bit about their background.

- Explained our meeting structure and discussion expectations: mostly about being respectful.

- Listed communications they can expect from us, including media monitoring emails regarding stormwater and CSOs.

- List of common acronyms and definitions provided.
- All members given a 3-ring binder with background info, and each subsequent handout is meant to be added to binder.

Meeting Date: August 11, 2015, Number of people in attendance: 18
Meeting Topic: Tour of Lakewood's Waste Water Treatment Plant (WWTP) and Nearby Overflow Site
Goal: To learn how a sewage treatment plant works, and to gain an understanding of where the overflows discharge when it rains.
Summary

- Tour led by Bill Crute, the Division Manager. Plant treats an average of 7.85 million gallons of sewage water a day, and consistently meets all state water discharge permits.

- Overall the cost to collect all of the waste water and manage the sewer system is estimated to cost $6.7 million in 2015. The cost to run the waste water treatment plant is estimated at $4.5 million for 2015.

- In Lakewood, we have more than 875,000 feet (166 miles) of pipe, which includes 393,500 feet of sanitary sewer, 133,500 feet of combined sewer and the rest is storm.

- Rainfall and stormwater can overwhelm the sewers and dramatically increase the volume reaching the plants, leading to overflows.

- A map of the plant was provided. We reviewed: headworks, grit removal chambers, primary clarifying, secondary treatment, UV disinfection, and sludge processing.

- Reviewed information on CSOs and volume of overflows Lakewood has in a typical year. Included maps of the 55 outflow pipes leading to the lake or river from Lakewood, and 2) CSO sewersheds of Lakewood. Some overflow pipes were visible from the treatment plant, and those were discussed.

- Lakewood removing two permitted CSOs that discharge into Rocky River

- By November of 2016, there will be a new pipe spanning across the river and leading into the sewage treatment plant to treat this combined flow.

- Defined gray infrastructure as referring to man-made, constructed assets, like tunnels and storm drains. Various types of gray infrastructure were included as graphics with basic descriptions in the handout

Meeting date: August 26, 2015, Number of people in attendance: 19
Meeting Topic: Tour of Watershed Stewardship Center at West Creek Reservation
Goal: Learning and interacting with the green infrastructure at the Watershed Stewardship Center. We also hope to learn about the effectiveness and maintenance of some of these options.
Summary

- The Watershed Stewardship Center is located in Parma. Center opened in 2013. Jennifer Grieser, focusing on Urban Watersheds for the Cleveland Metroparks, led the tour as well as an overview of results from a local green infrastructure study.

- Education on hydrologic cycle; discussed post-urban and pre-urban hydrographs.

- Impervious surfaces associated with suburban and urban land uses alter the amount of water going into each of the above three pathways. The biggest change is a reduction in the volume of water seeping into the ground, resulting in an increased volume going to our surface water. This has implications for water quality in Lake Erie, affecting habitat for fish and wildlife as well as drinking water for humans.

- Development commonly eliminates natural green areas that once absorbed and filtered stormwater, the result is downstream flooding, erosion, and increases in various types of pollution; including: pet waste, fertilizers, salt, and sediment.

- In Lakewood, about 65% of the land area is covered by impervious surfaces including areas devoted to houses, driveways, streets, sidewalks and parking lots, resulting in a significant amount of surface water runoff during storms.

- Parts of Lakewood are serviced by a one-pipe system, carrying both storm water and sanitary waste. During rain events, the pipe capacity is overwhelmed, causing a combination of sewage and storm water to drain into Lake Erie, potentially violating the Clean Water Act and our Ohio EPA discharge permit (NPDES).

- Some solutions to remediate these discharges include green infrastructure, or on-site actions that can be taken to capture rainwater after it has hit the ground but before it flows to the sewer.

- Tables, graphics and definitions were included for the following: permeable pavements, retention basin/stormwater pond, green roof, bioretention, rain garden, rain barrels, infiltration trenches and basins, and filtration. Tables included information on green infrastructure common in urban areas, and green infrastructure processes that main serve to reduce volume.

Meeting Date: September 15, 2015, Number of people in attendance: 21
Meeting Topic: Part 1: Clean Water Act Policy Introduction; Part 2: Understanding Source Control on Private Property via Inflow and Infiltration
Goals: 1) to learn about the NPDES permit and why Lakewood has one and 2) to learn how homeowners play a role in reducing the volume of water going into the sanitary sewer unnecessarily.
Summary
Part 1: CWA overview

- The Clean Water Act (CWA) establishes the structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.
- The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained.
- EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls discharges from point sources (pipes). Individual homes that are connected to a municipal system do not need an NPDES permit; however, industrial and municipal pipe discharges must obtain permits if their discharges go directly to surface waters.
- Lakewood is in compliance with their effluent from the wastewater treatment plant (WWTP), but our combined sewage and stormwater overflows need to be reduced.
- Summary of Lakewood's NPDES permit requirement in Part I,C:
    1. Characterize the sewer and stormwater system
    2. Monitor and record all overflows
    3. Create an integrated plan that addresses overflows
    4. Install high rate treatment at the sewage treatment plant to deal with wet weather flows
    5. Analyze alternatives to bring overflows into compliance
    6. Bring overflow discharges into compliance with the Clean Water Act

Part 2: How does an individual's property affect sewer overflows?

- When individuals have roof drains or foundation drains connected to the sanitary sewer line, groundwater and rainwater are adding unnecessary water to the sewer system.
- Additionally, when sewer pipes on the individual's property are cracked, ground water leaches in, adding another source of unnecessary water to the treatment plant's load.
- We estimate that 50% or more of inflow and infiltration comes from leaking house laterals and improperly connected roof and foundation drains.
- To test this hypothesis, 102 homes on Atkins and Eldred Avenues were investigated to see if their homes are improperly connected, and if their pipes are cracked and broken. Nearly all of the homes had some broken or improperly connected pipes. The City is paying a contactor to fix these issues. After all the 102 homes are properly connected, flows will be re-measured and compared to pre-construction flows, to determine if a significant reduction has occurred due to correct connections.
- Infiltration, inflow, and the homeowner's role were discussed.
- Infographic depicting sources of infiltration and inflow was provided.

Meeting Date: October 20, 2015, Number of people in attendance: 17
Meeting Topic: Comparing Green and Grey Infrastructure
Goal: Understanding the advantages and disadvantages of various infrastructure options for addressing combined sewer overflows.
Summary

- Definitions of common green and grey infrastructure investments were provided. Terms included were: bioretention, street planters, pervious pavements, sand/infiltration filter, tree planting, downspout disconnection, green roofs, blue roofs, rain harvesting, sewer

separation, storage tunnels, source control, high rate treatment, and upgrades to waste water treatment plant.

- The following questions were posed to the group:
    - What are some advantages of green infrastructure? What about for grey infrastructure?
    - What are disadvantages of each?
    - Where do you see risks and uncertainties?
    - What benefits might come out of green infrastructure that won't show up in the modeling?
    - How might investing in grey infrastructure meet the needs of Lakewood differently compared to green infrastructure?
    - What other information do you need to know to help make a decision?

- A table of green and grey infrastructure control strategies was provided to them that had the following information:
    - Name and photo of control strategy
    - Relative cost (range in cost from $-$$$$, as a relative scale)
    - Pros and Cons
    - Life cycle and maintenance (range from 1-4, with 4 being the most labor intensive, a simple relative scale)

- A PowerPoint presentation was given that reviewed branded programs that other communities have created to help reduce combined sewer overflows. Cities discussed include:
    - Milwaukee
    - Baltimore
    - Chicago
    - Seattle
    - NYC
    - Menomonee River Valley
    - Portland, OR

Meeting Date: November 17, 2015, Number of people in attendance: 18
Meeting Topic: Integrated Planning Process and Lakewood's Vision for the Future
Goal: Assign small teams of 4 or 5 individuals to look at a specific area of Lakewood and apply the integrated planning process to determining what they think might work best in terms of green and grey infrastructure.
Summary

- In 2011 EPA wrote a memo encouraging integrated planning approach to waste and stormwater obligations.

- Lakewood citizens just recently went through a community vision process and we are using that as our same vision. Part of Lakewood's vision was "Community Wellness", and specifically, adopting environmental best practices.

- Currently, the city is undertaking data collection to ensure they have identified all of their overflows and measuring flows on all of those sites. Our vision is to reduce all of these overflows to be in compliance with the CSO policy.

- Broke into four breakout groups that were each neighborhoods or streets of Lakewood, specifically

- Each breakout group brainstormed through the vision, goal, and objective process, including items specific to stormwater management like green and grey infrastructure options.

- Discussion continued with factors to consider when developing a plan for managing CSOs, such as:
    - Community and institutional support for green infrastructure, specifically noting the importance of buy-in from community and local government
    - Realistic ideas for the potential of green infrastructure implementation after understanding the physical factors on the landscape, as well as regulatory and social factors

Meetings from December-March:

A total of eight meetings were held, two meetings with each of the breakout groups.

We first met with each breakout group to solicit their modeling preferences and then we met again to review the results of the modeling. All preferences and modeling results were provided to the larger group in the April meeting, and provided further below, as well as in Attachment H.

The breakout group meeting schedule was as follows:

Breakout Group Meeting Schedule

Breakout Group	Soliciting Modeling Preferences Meeting Date	Reviewing Modeling Results Meeting Date
Larchmont Ave	December 15	February 16
Lake Ave	December 16	February 17
Birdtown	January 19	March 15
Parkwood	January 20	March 16

Summary of task force modeling requests

Larchmont, between Detroit and Madison	Lake, between Homewood and Estill
● permeable pavement on sidewalks and driveway aprons ● bioretention in tree lawns ● south-end of Larchmont rerouted to Franklin sewers	● permeable pavement on sidewalk ● bioretention in tree lawns ● downspout disconnection ● detention basin (now replaced with a storm sewer bypassing a combined sewer)

Birdtown: Madison to the north, Plover to the south, Halstead to the east and Magee to the west	**Parkwood, between Detroit and Madison**
● bioretention on vacant lots, at the school, as bumpouts, in tree lawns, including area west of Birdtown ● green roof garages ● permeable pavement at Madison Park ● sewer separation ● routing flow to NEORSD or a detention basin ● 24" combined relief pipe at pinch point on Madison	● downspout disconnection ● public and private infilitration and inflow improvements such as relining or replacing laterals and public sewer, new manholes to bypass over/under access plates ● upsizing Detroit Ave sanitary sewer to 4 ft diameter (currently 1 ft) ● upsizing Detroit and Nicholson sanitary sewer to 4 ft (currently 1 ft)

Meeting Date: April 19, 2016, Number of people in attendance: 25
Meeting Topic: Modeling Results and Discussion
Goal: Review public preferences and report on modeling results
Summary:

- Using the preferences suggested by the breakout groups, models were created for each of the focus areas: Larchmont, Lake, Parkwood, and Birdtown.

- In order to evaluate the green infrastructure ideas brought up by this group, a series of models were developed for comparison purposes. A "typical year" of rainfall is what was used in this modeling exercise.

- The results produced from this modeling study are not intended to be exact. The results should be used to identify if the suggested approaches are practical and the approximate levels of overflow improvements that might be expected.

- Results from the meetings are included in Attachment H.

HANDOUTS GIVEN AT PHASE 1 PUBLIC MEETINGS

The following are copies of the handouts provided during public meetings.

CLEAN WATER LAKEWOOD

Rebuilding the Pipeline for Our Future

2016 Integrated Wet Weather Improvement Plan; Resource Binder

Cover of Clean Water Lakewood Resource Binder, all members had their own binder.

Below are acronyms and definitions Clean Water Lakewood Task Force may come across in our meetings or in the literature.

Acronyms and Abbreviations	
BAT	Best Available Technology
BID	Business Improvement District
BMP	Best Management Practice
CIP	Capital Improvement Plan
CWA	Clean Water Act
HRT	High-Rate Treatment
EMC	Event Mean Concentration
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
I/I	Inflow/Infiltration
IWWIP	Integrated Wet Weather Improvement Plan
LID	Low Impact Development
LTCP	Long Term Control Plan
MG	Million Gallons
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
NEDO	Northeast District Office of Ohio EPA
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
OEPA	Ohio Environmental Protection Agency
POC	Pollutant of Concern
RDI/I	Rainfall-Derived Inflow and Infiltration
SWMM	Storm Water Management Model
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps Of Engineers
USEPA	U.S. Environmental Protection Agency
WWT	Wastewater Treatment
WWTP	Wastewater Treatment Plant

Definitions

Combined Sewer: a sewer designed to transport sanitary, industrial, and storm flows.

Dry Weather Flow (DWF): base flow rates not resulting from wet weather conditions.

Edgewater Interceptor: the main interceptor in the City of Lakewood, interceptor flow originates at 117th and Edgewater Drive, goes west to Webb Road, then south to Clifton, west to West Clifton, then south to the WWTP (waste water treatment plant).

Infiltration/Inflow (**I/I**): causes dilution in sanitary sewers. Dilution of sewage decreases the efficiency of treatment, and may cause sewage volumes to exceed design capacity. Although inflow is technically different from infiltration, it may be difficult to determine which is causing dilution problems in inaccessible sewers. The USEPA defines the term infiltration/inflow as combined contributions from both.

Infiltration: Groundwater entering sanitary sewers through defective pipe joints and broken pipes is called infiltration. Pipes may leak because of careless installation; or they may be damaged after installation by ground movement, heavy vehicle traffic on roadways above the sewer, careless construction practices in nearby trenches, or degradation of the sewer pipe materials. In general, volume of leakage will increase over time (The Environmental Dictionary, 1995).

Inflow: Water entering sanitary sewers from inappropriate connections is called inflow. Typical sources include sump pumps, roof drains, cellar drains, and yard drains where urban features prevent surface runoff, and storm drains are not conveniently accessible or identifiable. Inflow tends to peak during precipitation events, and causes greater flow variation than infiltration (The Environmental Dictionary, 1995).

Invert Plate: A removable cast iron plate that is installed at each manhole of an over/under sewer system to prevent mixing stormwater and sanitary sewage.

Inform / Influence Projects: Programmatic elements that engage and educate partners and the broader public in making sustainable decisions that provide water quantity and quality benefits. Examples include forming partnerships with educational institutions or community thought leaders to create highly visible projects within the community.

Integrated Wet Weather Improvement Plan (IWWIP)– Later branded "Clean Water Lakewood: Rebuilding the Pipeline for Our Future" that is focused on meeting the requirements in the City's NPDES permit for controlling untreated sewage overflows.

NPDES Permit: (National Pollutant Discharge Elimination System) The permit issued by the Ohio EPA regulating point discharges into water bodies.

Urban: An area where the majority of land use is marked by a high density of created structures and developments. It is also marked by a high population density. A high population den-

sity consists of core census block groups or blocks that have a population density of at least 1,000 people per square mile and surrounding census blocks that have an overall density of at least 500 people per square mile (https://ask.census.gov). Lakewood has approximately 9,400 peopl per square mile.

Sanitary Sewer: a sewer intended to transport sanitary and/or industrial wastes.

Storm Sewer: a sewer intended to transport surface runoff and drainage due to wet weather events (rain, sleet, snow melt).

Wet Weather Flow (WWF): flow generated by wet weather events such as rainfall or snow-melt.

Working Group Meeting #1
July 15, 2015 at 7PM

Introductory Meeting

Roster of members as of July 13, 2015

Ynes	Arocho
Connie	Bilowski
Glenn	Coyne
Byron	Crampton
T.	Dziak
John	Ehrnfelt
Bill	Fraunfelder
Jim	Gagan
Babette	Gowda
Jerry	Gubani
Jim	Hostacky
Ron	Hudak
John	Kilgore
Zuzanna	Kurowska
Cole	Mellino
Katelyn	Milius
Michelle	Nochta
Dana	Paul
Jim	Rambasek
Jeralyn	Saleet
Stuart	Sayler
Jeannie	Smith
Jan	Snow
Mike	Stewart
Allison	Urbanek
Patrick	Wadden

Please email Julia (jlazar@ct.consultants.com) with a sentence about yourself. Eventually there will be a website for this project on onelakewood.com with all of this information listed on the website.

This is a diverse working group of residents, business owners, and home owners assembled to help identify the best paths forward for water infrastructure in Lakewood. This group is focusing on facilitating best-practice solutions for sewage overflows.

Please, talk to others about these meetings. You can be both a megaphone – spreading information out to your fellow citizens as well as a reporter– gathering input and relaying back to the group the comments and opinions you have heard.

Brief Statement of the Challenge

The city is currently faced with multiple regulatory requirements that will involve a variety of infrastructure, policy, and land management solutions.

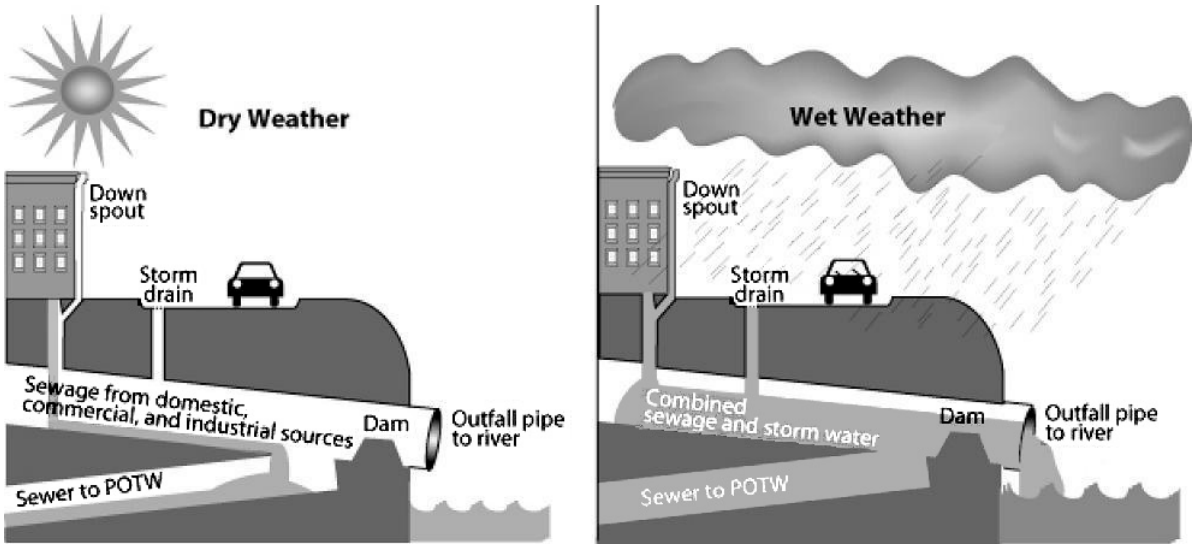
CT Consultants will work with the City and this working group to evaluate various water infrastructure improvement alternatives based on the working group's suggestions, reflecting the community's criteria and values.

Why do we have sewage overflows?

Lakewood has sewer systems that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. During dry weather, our sewer system transports all of the wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume can exceed the capacity of the sewer system or treatment plant. For this reason, our sewer system is designed to overflow and discharge excess wastewater directly to nearby waterways—Rocky River and Lake Erie.

These types of overflows are a major water pollution concern for the approximately 772 cities in the U.S. that have combined sewer systems (EPA, 2014).With the passage of the Clean Water Act in 1972, such overflows and other discharges must be controlled or eliminated in order to make water fishable and swimmable, among other uses.

To resolve this problem, US EPA and Ohio EPA have mandated that Lakewood capture, treat or remove the millions of gallons of overflow that happen every year. As with the original investments in the City, Lakewood must invest in its infrastructure so that it meets the demands of Lakewood's second century, and for the benefit of human and environmental health.



Expectation of this Working Group

1) Help communicate and engage with the community to work on public awareness of this issue
2) Develop green and grey infrastructure alternative suggestions for CT to model, that reflect community values and priorities
3) Evaluate model results and to suggest top feasible alternatives for consideration

Resource People for this Working Group:

1) Robert H. Greytak, PE, bgreytak@ctconsultants.com, Engineer and Program Facilitator at CT Consultants, focus areas include water and waste water.
2) Kristin M. Hopkins, AICP, khopkins@ctconsultants.com, Planner and Lead Program Facilitator at CT Consultants, focusing on urban planning and community supported decision making.
3) Joyce M. Bond, RLA, jbond@ctconsultants.com, Landscape Architect and Program Facilitator at CT Consultants, focus area includes: green infrastructure.
4) Julia G. Lazar, PhD, jlazar@ctconsultants.com, Scientist and Program Facilitator at CT Consultants, applied researcher in industry, government, and academia; focus includes pollution transformations, hydrology, and scientific communication.
5) Louis L. McMahon, JD, lmcmahon@mdllp.net, Environmental Lawyer hired by City of Lakewood focusing on Clean Water Act compliance, partner at McMahon DeGulis LLP
6) Joseph J. Beno, PE, joe.beno@lakewoodoh.net, Director of Public Works, Lakewood
7) Mark K. Papke, PE, mark.papke@lakewoodoh.net, City Engineer, Lakewood
8) Shannon C. Strachan, JD, shannon.strachan@lakewoodoh.net, Assistant to the Mayor, Lakewood
9) Brian Shields, brian.shields@lakewoodoh.net, Project Manager, Lakewood
10) Bryce Sylvester, AICP, bryce.sylvester@lakewoodoh.net, City Planner, Lakewood
11) Ermelindo Gomes, Ohio EPA, erm.gomes@epa.ohio.gov ,330-963-1196, Environmental Engineer

Meeting Ground Rules

Group members are expected to respect the opinions of team members, have meaningful conversations, and provide constructive insight by:

- Everyone participating – all viewpoints are important
- Using active listening
- Avoiding side bar conversations – one person speaks at a time so everyone can hear
- Brainstorming without editing; all ideas are good ideas
- Respecting everyone's time by being concise, succinct with comments
- Turning off cell phones

Meetings are open to the public

- Opportunity for observers to comment will be provided at the end of the process, when feasible plans are developed
- Regular updates and meeting notes will be provided on the City's website

Meeting Structure:

- Meetings start promptly at 7PM
- Meetings will be a combination of learning, brainstorming and discussion
- When meeting materials are distributed ahead of time, participants are expected to review the materials and arrive prepared to participate in discussions
- Each meeting will begin with a summary of the concepts and discussion from the last meeting
- Meetings are open for public listening and at the end of each meeting there will be 5 minutes for public comment. Additionally index cards and a box will be provided at the meetings so if the public didn't get a chance to ask their question they can write it out, including their contact information, and one of the Resource Colleagues will get back to them. Comments can also be submitted directly to working group individuals, or to resource members, or to the City of Lakewood.

Facilitated Discussion means:

- Systemic approach to discussion, so that all voices are heard
- Can't always ask questions – might need to write down for later
- Won't necessarily debate issues to closure
- Discussion on some issues may need to be deferred, or may need more research between meetings

Meeting Date and Time

Meeting the 3rd Tuesday of every month, starting at 7PM.

Communication you can expect from us

Two email updates a month for the first 6-8 weeks sharing news and tweets from that week regarding stormwater, green infrastructure, sewage over flows in other municipalities, etc. We consider this helpful in broadening everyone's awareness. Please feel free to pass this information on to others in the community.

What you can expect at our next meetings

We will spend the first few monthly meetings going over background information, providing educational resources for understanding the problem and discussing possible solutions.

Specifically, the next two meetings will be field trips: one to show you the sewage treatment plant and one which focuses on green infrastructure.

Tuesday, August 11th we meet at Lakewood Municipal Waste Water Treatment plant, 1699 Cleveland Metro Park Dr, at 7PM. We will gain an understanding of how a treatment plant works, and how it has evolved over time. We will also look at one overflow site right near the plant, which overflows into Rocky River.

Wednesday, August 26th we meet at the Watershed Stewardship Center to learn about green infrastructure options, 2277 W Ridgewood Dr, Parma, OH 44134. The tour starts at 7pm sharp, please arrive a few minutes early.

After that, we plan to have our September, October, and November meetings at the University of Akron, Lakewood campus, multi-use room.

December, January, and February meetings may be held at City Hall depending on auditorium availability.

Tour of Lakewood's Waste Water Treatment Plant (WWTP) and an Overflow Site

Refresher Question: Why was this working group formed?

Goal of this meeting: To learn how a sewage treatment plant works, and to gain an understanding of where the overflows discharge when it rains.

Some might say the most important facility in Lakewood is our treatment plant. This plant treats an average of 7.85 million gallons of sewage water a day, and consistently meets all state water discharge permits. Bill Crute, the Division Manager, has been working at this plant for 45 years. He, along with a crew of about 22 people, makes sure the plant is running efficiently on an hourly basis.

In the USA there are 800,000 miles of sewage collection systems (networks of pipes) according to the EPA. This does not include private home laterals that connect to these systems, which would add an additional 500,000 miles of pipes.

In Lakewood, we have more than 875,000 feet (166 miles) of pipe, which includes 393,500 feet of sanitary sewer, 348,000 feet of storm sewer, and 133,500 feet of combined sewer. Lakewood has a sewered area of approximately 3,100 acres, 500 of those acres are serviced by combined sewers (Facility Plan for the City of Lakewood, 1978).

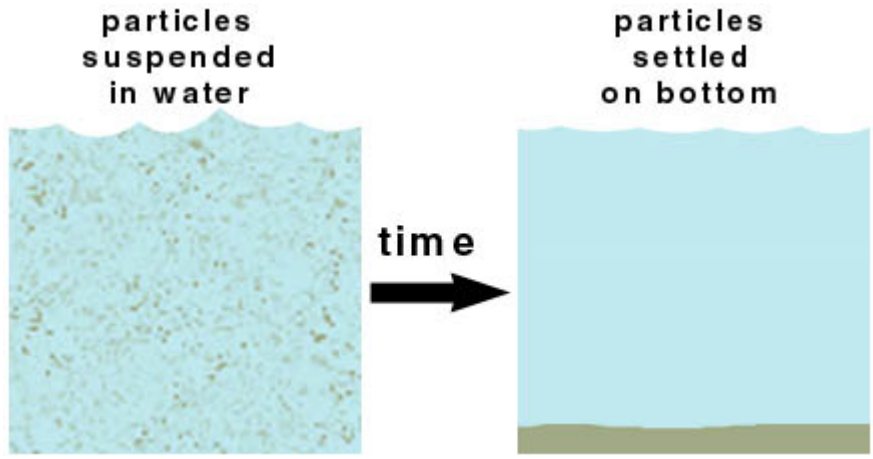
Large storms overwhelm sewers and dramatically increase the volume reaching the plant, often leading to overflows.

Part 1: Touring the Plant

Preliminary Treatment
Goal of the headworks is to remove anything larger than ½ inch, things like: trash, rocks, rags and cans. Influent screens filter out large debris. This prevents pipes and pumps in the plant from getting clogged. The trash that is removed is landfilled.

Grit removal chamber
Water flows slowly, and heavier grit falls to bottom, lighter organics float. Rake runs across bottom of tank, sweeping grit away.

Primary Treatment/ Primary Clarifier
Goal: start to separate water from solids.



http://www.chemistry.wustl.edu/~edudev/LabTutorials/Water/PublicWaterSupply/images/sedimentation.jpg

Primary treatment relies on physical separation methods—sedimentation is done via gravity. Other solids are screened out. Average detention time in these tanks is 2 hours.

Waste water comes up through center of the circular settling tank, water sits in this tank for a few hours, becoming very still. 60-70% of solids falls to bottom and is removed. Oil and grease form film on top and are skimmed off. Cleaner water flows over weirs as solids settle out.

There is a rotating arm that brings solids from the bottom of the clarifier into a hopper in the center, and the hopper is connected to a pipe that brings it to the sludge (biosolids) treatment process, located on site.

Secondary Treatment
This process removes solids and nutrients like nitrogen and phosphorous (N&P). N&P are important to remove for the health of Rocky River and Lake Erie as they promote algae growth, and can lead to low oxygen zones in the water.

Nutrients are also a valuable resource, particularly for agriculture, and these nutrients can be recovered through sludge processing.

Aeration tank is the first part of secondary treatment—it relies on biological science, not physical separation.

Blowers distribute oxygen via pipes into aeration basin. Oxygen is used by bacteria; they feed on the solids and reduce their volume as well as reduce nutrient concentrations.

Secondary clarification is similar to primary clarification, in the sense that the solids settle out and are sent to biosolids treatment. These solids are called “activated sludge”. Some of the activated sludge is sent back to aeration tank to keep bacteria counts high enough to continuously eat up the solids.

UV Disinfection

This removes bacteria that would cause illness. When bacteria are exposed to UV light, they are rendered incapable of reproducing and therefore they are short-lived.

Water is now free of solids, grit, and microorganisms and is considered clean enough for use in: cooling systems, irrigation, or firefighting.

Sludge Processing
Sludge is put into an anaerobic digester and different species of bacteria reduce pathogens and volatiles, as well as produce methane as a byproduct. This methane (natural gas) can be a great energy source and Lakewood uses this energy to run their boilers as well as heat their buildings in the winter. They are hoping to one day also use the methane produced by the digesters for electricity.

The sludge is squeezed between two belts so that all the water is squeezed out; the removed water is sent back to the headworks. Approximately 5000 wet tons of biosolids are produced annually.
Part 2: Where are the overflows?

Lakewood has sewer systems that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe, as well as a unique system involving “over-under” sewers intermingled with combined sewers. Most of the time, our sewer system transports all of the wastewater to a sewage treatment plant, where it is treated and then discharged to Lake Erie.

During periods of heavy rainfall or snowmelt, however, the wastewater volume can exceed the capacity of the sewer system or treatment plant. For this reason as well as to guard against basement flooding, our sewer system was designed to overflow and discharge excess wastewater directly to nearby waterways—Rocky River and Lake Erie.

In a typical year Lakewood discharges over 15 million gallons of sewage mixed with stormwater to Lake Erie and Rocky River. This is equivalent to 4.4 million water bottles of waste released every day.

This June was an incredibly wet month and 51 million gallons overflowed just in that month.

b)

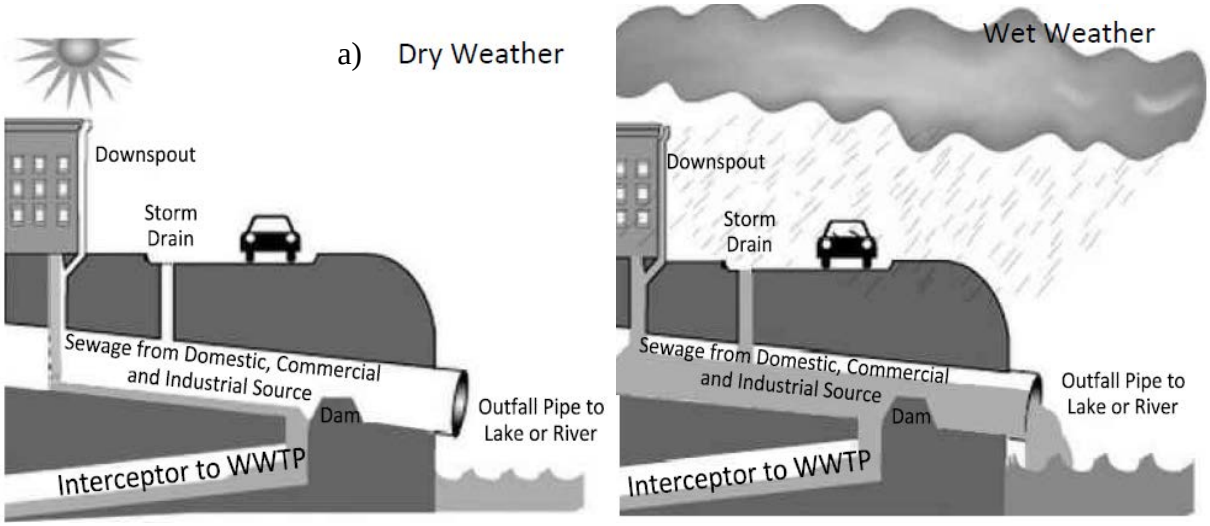


Figure 1. a) During dry weather, sewage and commercial wastes do not cause overflows. The waste flows into an interceptor pipe to the waste water treatment plant. b) During wet weather, sewage, commercial wastes and stormwater mix and overwhelm the system. Due to the surge in volume, not all waste gets to the interceptor and therefore it is released to the nearest water body.

Attached you will find two additional maps; 1) shows the 55 outflow pipes leading to the lake or the river from Lakewood, and 2) shows the CSO sewersheds of Lakewood.

Lakewood is making progress on reducing overflows and is in the process of removing two permitted CSOs that discharge into Rocky River.

One is overflow RRES 1140, which we can see from the bridge, the other is right near the sewage treatment plant, RRWS 1205, which acts as a release if too much water is going into the treatment plant influent pipe.

The pipe you can see from the bridge is going to remain, but it will only release stormwater, rather than combined sewage and stormwater.

By November of 2016, you will see a new pipe spanning across the river and leading into the sewage treatment plant (Figure 2), this is so that the combined sewage and stormwater from the West End neighborhood, does not discharge to the river, but instead goes through the pipe for treatment. This is expected to cost about $5 million, and half of this is covered by state grant and loan money.

Figure 2. Rendering of new pipe spanning Rocky River leading to the WWTP.

Overall the cost to collect all of the waste water

water treatment plant is estimated
at $4,480,745 for 2015. These numbers were
taken from the 2015 Estimate of Expenses Report:
http://www.onelakewood.com/pdf/Finance%20Reports/2015_Lakewood_Comprehensive_Budget.pdf, page 152 and 156, respectively.

What is grey infrastructure?
A general term referring to man-made, constructed assets, like tunnels and storm drains.

Examples are below:

Storage Tunnels: brings large volume of water into storage tunnel during rain event and then that water gets pumped to WWTP when they have capacity to treat it.

http://www.waterworld.com/content/dam/etc/medialib/new-lib/waterworld/print-articles/volume-28/issue%208/parsons-tunnel-interior-1208ww.jpg
Sewer Separation: separates the storm and sanitary sewers so that all overflows going into river and lake are just stormwater, not storm mixed with sewage

http://www.severinotrucking.com/images/gallery/12/lg_Lincoln%20Ave%202010%20-%201%20%2869%29.JPG

high rate treatment: increasing the capacity that the treatment plant can handle by using technology and chemicals that settle the solids and disinfect the water in minimal time

http://vertassets.blob.core.windows.net/image/67a33121/67a33121-b234-4d63-9c86-b1ddda114e88/actiflomem.jpg

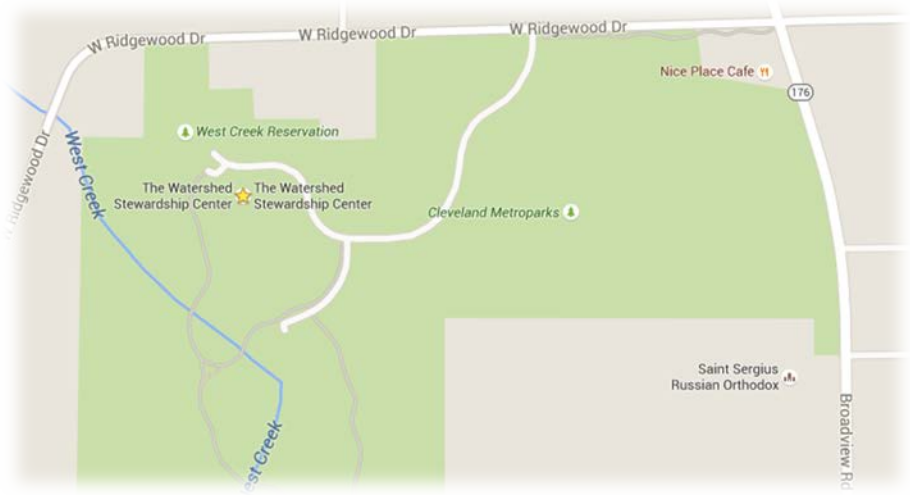
Working Group Meeting #3
August 26, 2015

Tour of Watershed Stewardship Center at West Creek Reservation

Refresher Question: When does the waste water treatment plant have trouble treating all of the water flowing into the sewer system? Why?
Goal of today's meeting: Learning and interacting with the green infrastructure at the Watershed Stewardship Center. We also hope to learn about the effectiveness and maintenance of some of these options.

The Watershed Stewardship Center is located in Parma at 2277 West Ridgewood Drive, just west of Broadview Road. This Center opened in 2013 and was made possible through a partnership between the West Creek Conservancy, Cleveland Metroparks and Northeast Ohio Regional Sewer District.

Jennifer Grieser, Senior Natural Resources Manager, focusing on Urban Watersheds for the Cleveland Metroparks, will be giving us a tour as well as an overview of results from a neighborhood green infrastructure study on Parkhaven Dr. and Klusner Ave in Parma. Please drive by those roads to get a glimpse of what the rain gardens, biorentention, and rain barrels look like and if it is something you see working Lakewood.

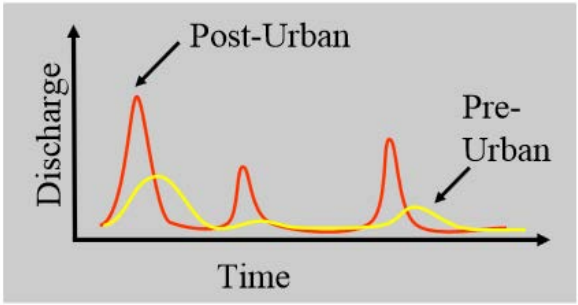


The Water Cycle

The water cycle, or hydrologic cycle, is a continuous exchange of water between land, water bodies, and the atmosphere. 97% of the earth's water is stored in the oceans, and only a fraction of the remaining water is usable freshwater, making Lake Erie an incredibly valuable natural resource.

When it rains, the water follows three major paths: 1) evaporation or returning the water to the atmosphere, 2) percolating into the ground and/or taken up by plant roots, and 3) traveling to surface waters like lakes, rivers, and eventually oceans.

Impervious surfaces associated with suburban and urban land uses alter the amount of water going into each of the above three pathways. The biggest change is a reduction in the volume of water seeping into the ground, resulting in an increased volume going to our surface water. This has implications for water quality in Lake Erie, affecting habitat for fish and wildlife as well as drinking water for humans.



This hydrograph to the left shows peak stormwater discharges in an urban watershed (red line) and in a less developed watershed (yellow line). In watersheds with large amounts of impervious cover, there is a larger volume of water and a faster rate of water discharge, leading to flooding and degraded water quality. http://www.coastal.ca.gov/nps/watercyclefacts.pdf

Lakewood's Water Cycle

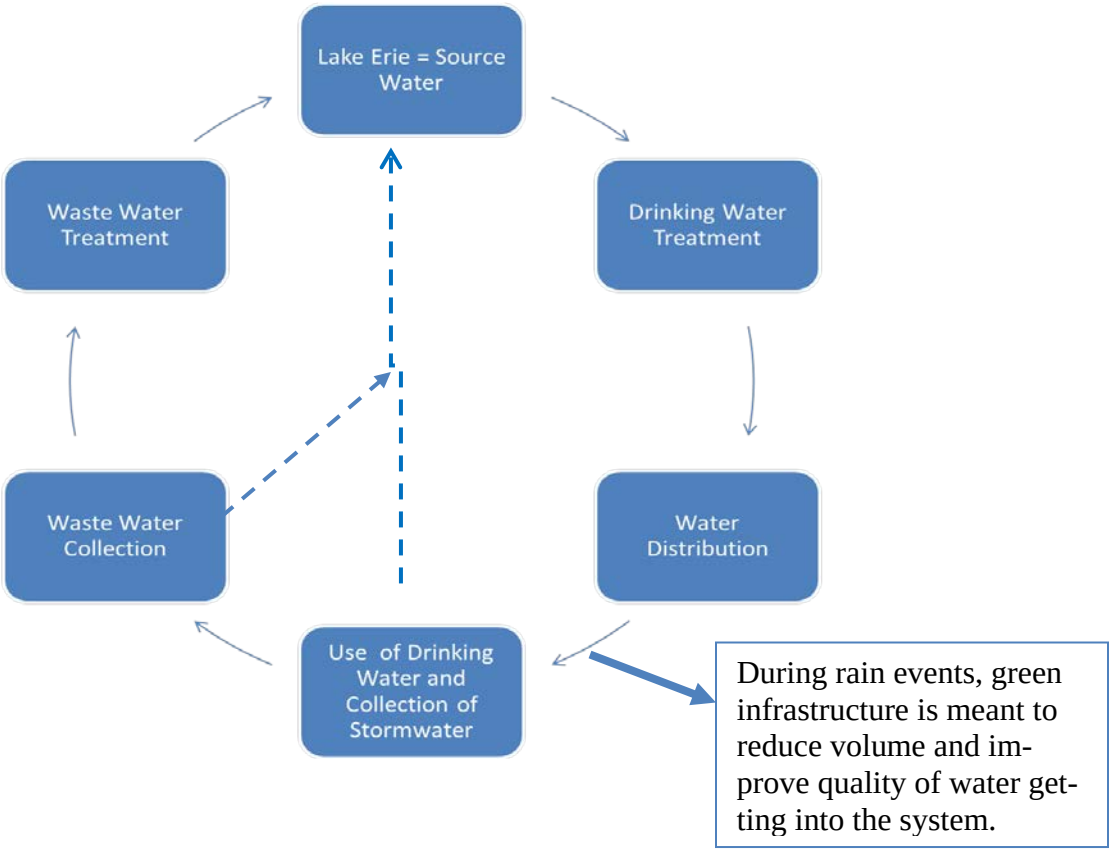
Development commonly eliminates natural green areas that once absorbed and filtered stormwater, the result is downstream flooding, erosion, and increases in various types of pollution; including: pet waste, fertilizers, salt, and sediment.

In Lakewood, about 65% of the land area is covered by impervious surfaces including areas devoted to houses, driveways, streets, sidewalks and parking lots, resulting in a significant amount of surface water runoff during storms.

Parts of Lakewood are serviced by a one-pipe system, carrying both storm water and sanitary waste. During rain events, the pipe capacity is overwhelmed, causing a combination of sewage and storm water to drain into Lake Erie, potentially violating the Clean Water Act and our Ohio EPA discharge permit (NPDES).

Some solutions to remediate these discharges include green infrastructure, which are on-site actions that can be taken by both public and private property owners to capture rainwater after it has hit the ground but before it flows to the sewer.

The figure below shows a simplified version of Lakewood's urban water cycle.



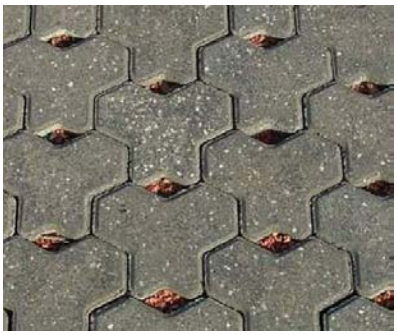
Adapted from http://voices.nationalgeographic.com/files/2014/03/urban-water-cycle.png
Green Infrastructure at the Watershed Stewardship Center in Parma
Definitions adapted from the Minnesota Stormwater Manual, 2015.

Permeable pavements
Permeable pavements allow stormwater runoff to filter through surface voids into an underlying stone reservoir for temporary storage and/or infiltration. Depending on the soil below the permeable pavement, pervious pavement can remove pollutants. The most commonly used permeable pavement surfaces are pervious concrete, porous asphalt, and permeable interlocking concrete pavers.

Permeable pavements have been used for areas with light traffic at commercial and residential sites to replace traditional impervious surfaces in low-speed roads, alleys, parking lots, driveways, sidewalks, plazas, and patios.

All permeable pavements have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer, optional underdrains and geotextile over uncompacted soil subgrade.

From a hydrologic perspective, permeable pavement is designed to manage rainfall landing directly on the permeable pavement surface. Permeable pavement surfaces may accept runoff contributed by adjacent impervious areas such as driving lanes or rooftops. Runoff from vegetated areas often has sediment loads, and therefore must be directed elsewhere as sediment accelerates permeable pavement surface clogging.



Stormwater pond/retention basin

Stormwater ponds are constructed stormwater management practices, not natural ponds. They can contain a permanent pool and temporary storage for water quality control and runoff quantity control. When maintained properly, stormwater ponds can be an important aesthetic feature. If you have more land you can put in a stormwater wetland, which can be larger, have more vegetative growth and have greater water quality benefits. The Stewardship Center has a stormwater wetland, not a pond.

http://www.drainagedoctor.com/Images/stormwater%20pond.jpg

Green roof

A rooftop treatment practice where a thin planting media is established on roof surfaces and then planted with hardy, low–growing vegetation. Green roofs can reduce quantity of runoff as well as improve quality of runoff with proper management.

Bioretention

Bioretention is a water quality and quantity control process. Bioretention provides opportunity for runoff infiltration, filtration, storage, and water uptake by vegetation.

Bioretention areas are suitable stormwater treatment practices for all land uses, as long as the contributing drainage area is appropriate for the size of the facility. Common bioretention opportunities include landscaping islands, cul-de-sacs, parking lot margins, commercial setbacks, open space, rooftop drainage and street-scapes (i.e., between the curb and sidewalk). Bioretention, when designed with an underdrain and liner, is also a good design option for treating potential stormwater hotspots.

Bioretention is extremely versatile because of its ability to be incorporated into landscaped areas. The versatility of the practice also allows for bioretention areas to be frequently employed as stormwater retrofits.

http://www.stormwaterpartners.com/lid/images/TitleBioretention.jpg

http://www.ence.umd.edu/~apdavis/Bioinstallations.htm

Rain garden

Rain gardens are a form of bioretention and can have positive effects on both quantity and quality of runoff. Rain gardens are meant to be something that an individual can install themselves—digging it by hand, while other forms of bioretention require heavy machinery and more engineering, including drainage pipes underneath the soil. Rain gardens typically have no subsurface pipes for drainage.

Rain barrels

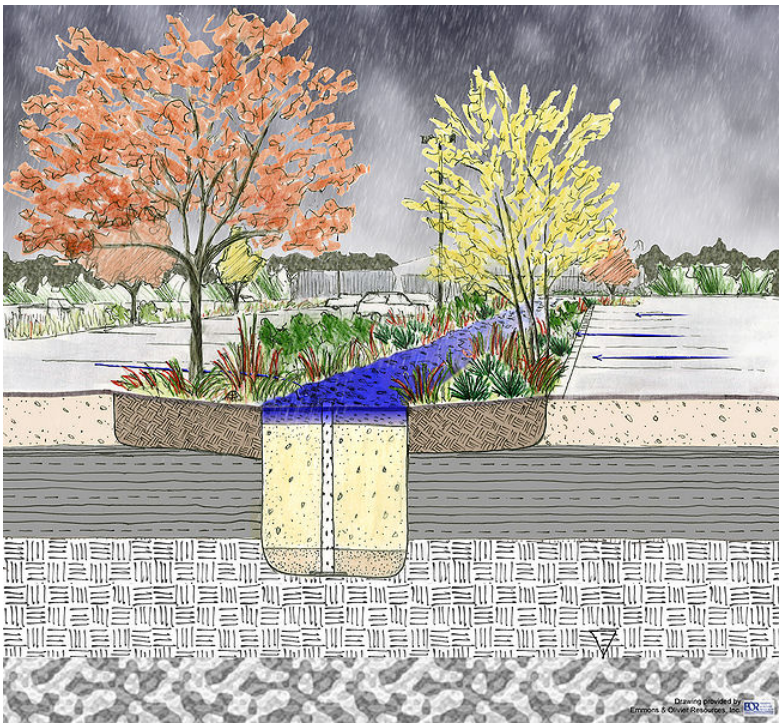
A container used to collect and store rainwater that is usually placed below the downspout of a roof gutter. The collected water is used to water the landscape.

https://stevenrhorn.files.wordpress.com/2014/06/rain-barrel.jpg

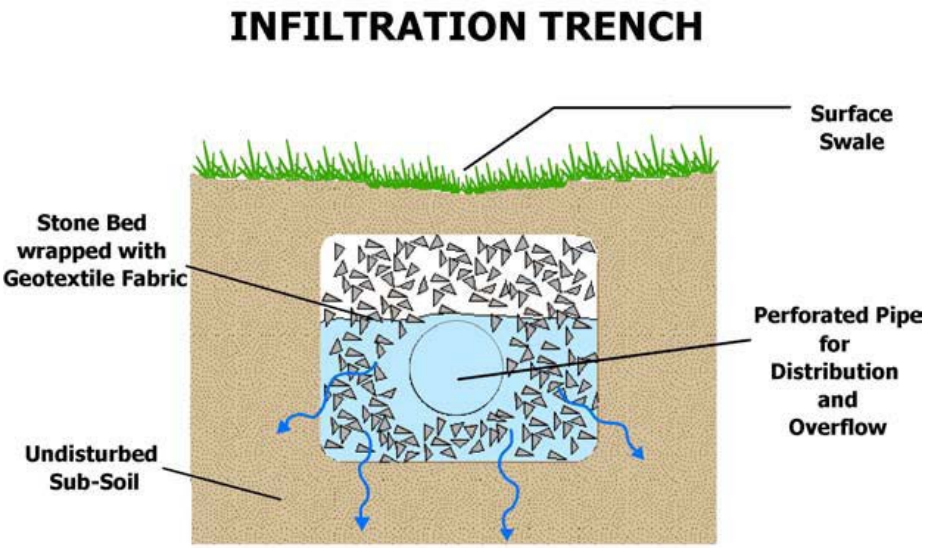
Other examples of green infrastructure that aren't shown at the Watershed Stewardship Center:

Infiltration trenches and basins

Infiltration practices treat urban stormwater runoff as it flows through a filtering medium and into underlying soil, where it may eventually percolate into groundwater. The filtering media is typically coarse-textured and may contain organic material. They are designed for reducing run-off volume and pollutants.



Source: Minnesota Stormwater Manual, 2013



http://www.temple.edu/ambler/csc/t-vssi/images/survey_BMP/diagrams/infilt_trench_large.jpg

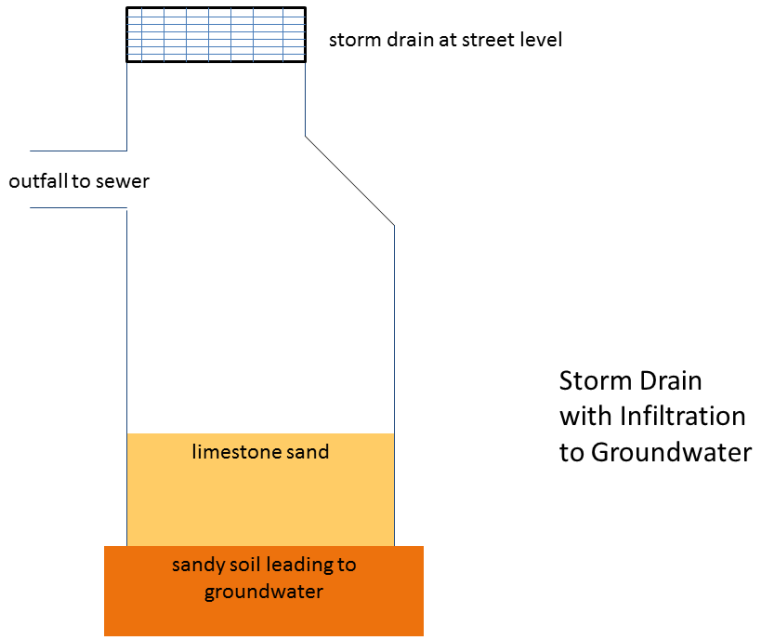
Filtration

Filtration practices treat urban stormwater runoff as it flows through a filtering medium, such as sand or an organic material. They are generally used on small drainage areas (5 acres or less) and are primarily designed for pollutant removal.

Media (sand) filters

Surface (vegetative) flow (grass channels, dry or wet swales, filter strips)
Combination media/vegetative filters

The below example is an illustration of what is behind the Drug Mart and Quaker Steak and Lube Parking Lot in Lakewood:



Questions to consider asking while on this tour:
How successful was the stormwater pilot study in Parma?
What is the maintenance required for some of these practices?
Do you have any cost data available? Maintenance cost vs. construction/installation cost?
What do you think is your most effective green infrastructure practice? Why?
Is there any green infrastructure that has not been as successful as you imagined? Or has been most problematic?
What are the tools needed to make green infrastructure successful?
Do you think grey infrastructure is more reliable than green?
Do neighbors find green infrastructure unpleasant to look at since it sometimes has the over-grown and unmaintained look?
Does green infrastructure work in the winter?

Green Infrastructure Practices Common in Urban Areas

Green Infrastructure Practice	Description
Disconnection	Disconnection refers to the practice of directing runoff from impervious areas such as roofs or parking lots onto pervious areas such as lawns or vegetative strips, rather than directly into storm drains.
Rain Harvesting	Rain harvesting systems collect runoff from rooftops and convey it to a cistern tank where the water is available for uses that do not depend on potable water, like irrigation.
Rain Gardens	Rain gardens are shallow depressions filled with an engineered soil mix that supports vegetative growth. They are designed to store and infiltrate captured runoff, and retain water for plant uptake. They are commonly used on individual home lots to capture roof runoff.
Green Roofs	Green roofs (also known as vegetated roofs or ecoroofs) are vegetated detention systems placed on roof surfaces that capture and temporarily store rainwater in a soil medium. They typically have a waterproof membrane, a drainage layer, and a lightweight growing medium populated with plants that absorb and evaporate water
Infiltration Trench	Infiltration trenches are gravel-filled excavations that are used to collect runoff from impervious surfaces and infiltrate the runoff into the native soil. Some systems are designed to filter runoff and reduce clogging by routing water across grassed buffer strips.
Street Planters	Street planters are typically placed along sidewalks or parking areas. They consist of concrete boxes filled with an engineered soil that supports vegetative growth. Beneath the soil is a gravel bed that provides additional storage as the captured runoff infiltrates into the existing soil below. Street planters also can be designed with underdrains to avoid ponding on sites with inadequate infiltration capacity.
Porous Pavement	Permeable pavement and paver systems are excavated areas filled with gravel and paved over with a permeable concrete or asphalt mix. They may also be overset with a layer of pavers. Rainfall passes through the pavement or pavers into the gravel storage layer below where it can infiltrate at natural rates into the site's native soil.

Source:
http://water.epa.gov/infrastructure/greeninfrastructure/upload/Greening_CSO_Plans.PDF

Below is a summary table of volume reduction practices and BMPs associated with each process. Some BMPs occur in more than one process. Notice that many of the processes mimic natural processes in the hydrologic cycle, infiltration (percolating into ground), evaporation & plant uptake, conveyance (streams and rivers), storage (lakes and oceans).

Process	Best Management Practice/Green Infra-structure	Comments
infiltration (percolating into the ground)	low impact development/better site design	includes: reduced street and sidewalk width, less curb and gutter drainage, shared pavement, scattered bioretention
	trench or basin	must be properly engineered, put in proper soils, and adequately maintained
	perforated sub-surface pipes, tanks, and storage systems	expensive, but effective and space-saving
	disconnected imperviousness	includes rooftop drains and road/parking surfaces
	pervious/porous pavement	includes a number of paving and block methods, or parking on rein-forced grass surfaces
	bioretention (if it contains infiltration)	some bioretention are designed to infiltration
evapo-transpiration (evapora-tion+plant uptake)	bioretention (rain gardens)	exposes runoff water to plant roots for uptake; can be under-drained and still effective
	vegetated swales	provides water a chance to soak into the ground and be filtered as it flows
	wetland/pond storage	combination of standing surface water and vegetative root exposure yields volume reductions
	vegetated drainage corridor	connecting numerous features increases opportunities for volume reduction
	recessed road/ parking garage	routing paved surface runoff to vegetated sump areas keeps it out of receiving water
storage	rain barrel/cistern	small-scale runoff collectors keep water around for later re-use or slow release
	rooftop (possibly including green roof)	storage on a roof prevents water from leaving the site; combining with vegetation (engineered green roof) has additional benefits
	wetland/pond storage	combination of standing surface water and vegetative root exposure yields volume reductions

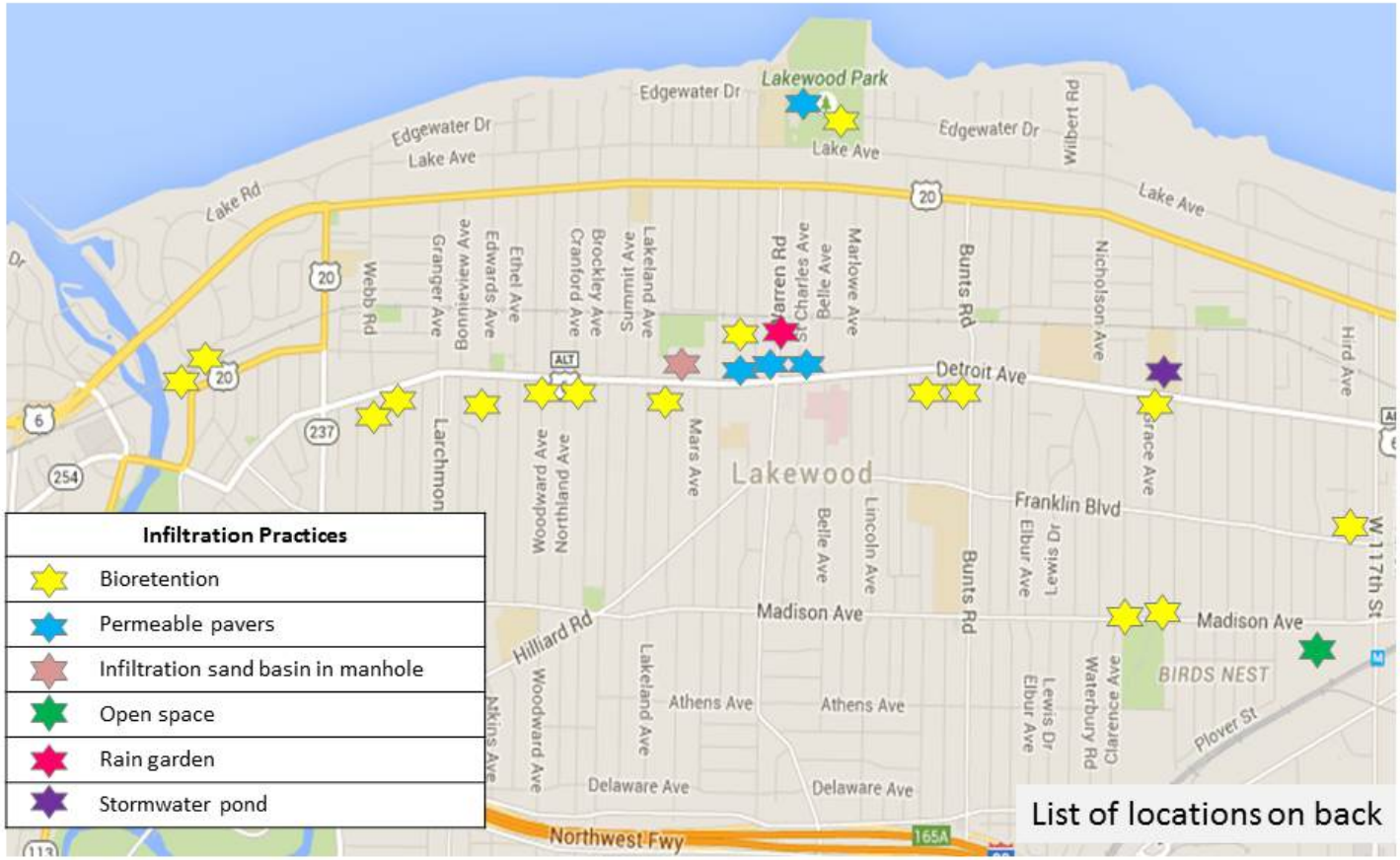
conveyance	vegetated swales	provides water a chance to soak into the ground and be filtered as it flows
	filter strips/buffers	variation of vegetated swale with side-slope protection
diversion	landscaping/better site design	diverts stormwater runoff before it reaches storm drain

Adapted from: Minnesota Storm Water Manual, 2015: http://stormwater.pca.state.mn.us/index.php/Volume_reduction_practices

Map of Green Infrastructure in Lakewood, OH

Commercial and City Owned Land

Complete as of July 2015



Infiltration Practices in Lakewood		
Corresponding to Green Infrastructure Map of Lakewood		
Bioretention	Permeable Pavers	Infiltration Basin
Beck Center	Parking lots A,B,C downtown	Discount Drug Mart on Detroit & Cohasset
Bob Evans	Small path at Lakewood Park	
CVS on Detroit		
Discount Drug Mart near Lakeland		
Dunkin on both Detroit and 117th		
GetGo		
Madison Park		
New condos on Sloane		
Parking lots A,B,C		
Rite Aid		
YMCA		
Lakewood Park		
Open Space	Rain Garden	Stormwater Pond
Graphtech	Behind First Federal	Garfield Middle School

Working Group Meeting #4
September 15, 2015

Clean Water Act Policy

Introduction & Grey vs Green Comparison Discussion

Refresher Question: What was the central goal of the green infrastructure we saw last month?

Goal of this meeting: What is an NPDES permit and why does Lakewood have one?

Note: Erm Gomes will be starting this meeting with an introduction of his work at OEPA, specifically as it relates to NPDES permits.

Part 1: History and Summary of the Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972.

EPA has set water quality standards for all contaminants in surface waters. Under the CWA, EPA has implemented pollution control programs such as setting wastewater discharge standards for industry and municipalities.

The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained.

EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls discharges from point sources (pipes). Individual homes that are connected to a municipal system do not need an NPDES permit; however, industrial and municipal pipe discharges must obtain permits if their discharges go directly to surface waters.

Lakewood is in compliance with their effluent from the wastewater treatment plant (WWTP), but our combined sewage and stormwater overflows need to be reduced to no greater than 4 occurrences per year.

Adapted from: http://www2.epa.gov/laws-regulations/summary-clean-water-act

Summary of Lakewood's NPDES permit requirement in Part I.C.

- Characterize the sewer and stormwater system
- Monitor and record all overflows into Lake Erie and Rocky River
- Create an integrated plan that addresses overflows from combined sewers and interconnected pipes
- Install high rate treatment at the sewage treatment plant to deal with high volume, wet weather flows
- Analyze alternatives that Lakewood expects to implement to bring overflows into compliance
- Bring overflow discharges into compliance with the Clean Water Act to minimize human and environmental health impacts

Lakewood's NPDES Permit Deadlines

Deadline	Ohio EPA Requirement
September 2014	New NPDES Permit Issued
September 2016	Design specifications of High Rate Treatment (HRT) due to OEPA, as well as feasible alternatives plan created
March 2018	Submit a permit to install HRT plan, and any other measure decided on, and begin construction within 6 months of permit being approved
March 2019	Alternatives analysis and plan for dealing with overflows
September 2022	Construction of measures and HRT are complete, and there is a significant reduction in CSOs

Part 2: Grey and Green Comparison Discussion Questions

What are some advantages of green infrastructure? Advantages of grey infrastructure?

What are some disadvantages of each?

Where do you see risks and uncertainties?
(thoughts to be used if people don't participate: risks that green won't work, won't be maintained, grey is seen as more of a "sure thing," green can only be relied upon for smaller storms, although grey infrastructure is generally expected to be exceeded during large storms, both need lots of maintenance and can be expensive)

What benefits might come out of green infrastructure that won't show up in the modeling?
(thoughts to be used if people don't participate: air quality, real estate value, decreased heat island effect, carbon sequestration, habitat for native plants, birds, insects, reduction in pollutant runoff, public health-more people recreating outdoors)

How might investing in grey infrastructure meet the needs of Lakewood differently compared to investing in green infrastructure?
(thoughts to be used if people don't participate: would grey and green investments appreciate or depreciate similarly?)

CT will be writing notes on a whiteboard or large note pad for all to see and add to the discussion. The below chart might be useful for individual's own notes.

Advantages of Green Infrastructure	Disadvantages of Green Infrastructure

Advantages of Grey Infrastructure	Disadvantages of Grey Infrastructure

Working Group Meeting #5
October 20, 2015

Discussion: Comparing Green and Grey Infrastructure

Refresher Question: How do homeowners play a role in reducing the volume of water going into the sanitary sewer unnecessarily?

Goal of today's meeting: Understanding the advantages and disadvantages of various infrastructure options for addressing combined sewer overflows.
Definitions of common grey and green infrastructure investments.

Rain gardens/bioretention: shallow depressions filled with an engineered soil mix that supports vegetative growth. They are designed to store and infiltrate captured runoff and retain water for plant uptake.

Street Planters/tree boxes: these consist of curbed openings or concrete boxes filled with an engineered soil to support plantings. Beneath the soil is a gravel bed that provides storage as the captured runoff infiltrates into the soil below.

Pervious pavements: pavements with properties that allow stormwater runoff to filter through surface voids into an underlying stone reservoir for temporary storage and/or infiltration.

Sand/infiltration filter: water flows through sand and either into groundwater or into pipe. They are primarily designed for pollutant removal.

Tree planting: tree planting provides for canopy interception and evaporation of rainwater along with evapotranspiration and transpiration of groundwater which provide for improvements in the health of the watershed system.

Downspout disconnect: a practice of directing runoff from impervious roof areas onto pervious areas rather than directly into storm drains.

Green roofs: vegetated detention systems placed on roof surfaces that capture and temporarily store rainwater in a soil medium.

Blue roofs: non-vegetated detention systems placed on roof surfaces that capture and temporarily store rainwater

Rain harvesting: rain harvesting systems collect runoff from rooftops and convey it to a tank where water is available for use.

Sewer separation: separating the combined single pipe system into separate sanitary and stormwater flows. This includes manhole separation in over/under systems with invert plates.

Storage tunnel/interceptor: deep tunnel system to capture and store combined stormwater and sewage that later gets pumped to treatment plant when capacity is available.

Source Control: policies and measures to reduce the volume of "clean" water entering the sanitary sewer system from inflow and infiltration.

High rate treatment: technology that can clarify and treat water to certain standards at a rate much faster than a waste water treatment plant.

Upgrades to wastewater treatment plant: increasing capacity of plant to remove solids, nutrients, and bacteria before releasing to the lake.

Grey and Green Comparison Discussion Questions

What are some advantages of green infrastructure? Advantages of grey infrastructure?

What are some disadvantages of each?

Where do you see risks and uncertainties?

What benefits might come out of green infrastructure that won't show up in the modeling?

How might investing in grey infrastructure meet the needs of Lakewood differently compared to investing in green infrastructure?

What other information do you need to know to help make a decision?
Stakeholders will be writing notes on a whiteboard for all to see and add to the discussion. The chart below might be useful for individual's own notes.

Advantages of Green Infrastructure	Disadvantages of Green Infrastructure

Advantages of Grey Infrastructure	Disadvantages of Grey Infrastructure

Resources and Web Links

Chicago's Green Alley Program
http://www.cityofchicago.org/city/en/depts/cdot/provdrs/street/svcs/green_alleys.html

Milwaukee's Menomonee River Valley Industrial Site
http://city.milwaukee.gov/AreaPlans/MenomoneeValley.htm#.Vgwt1E1FCJB

Baltimore's National Aquarium
http://www.aqua.org/care/conservation-initiatives/floating-wetland-island

Seattle's Street Edge Alternatives (SEA Streets)
http://www.seattle.gov/util/EnvironmentConservation/Projects/GreenStormwaterInfrastructure/CompletedGSIProjects/StreetEdgeAlternatives/index.htm

Portland's Grey to Green Program
http://www.portlandoregon.gov/bes/47203

New York's Green Infrastructure Program
http://www.nyc.gov/html/dep/html/stormwater/using_green_infra_to_manage_stormwater.shtml

http://water.epa.gov/infrastructure/greeninfrastructure/upload/Greening_CSO_Plans.PDF

http://www2.epa.gov/sites/production/files/2015-04/documents/green_infrastructure-om_report.pdf

http://www.cnt.org/sites/default/files/publications/CNT_Value-of-Green-Infrastructure.pdf

http://www.cityofchicago.org/content/dam/city/progs/env/ChicagoGreenStormwaterInfrastructureStrategy.pdf

CITY OF LAKEWOOD

GREEN AND GREY INFRASTRUCTURE CONTROL STRATEGIES

TOOL BOX

CLEAN WATER LAKEWOOD

Rebuilding the Pipeline for Our Future

October 2015

Green Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
Rain gardens/Bioretention	$ - $$$	– Increased risk of groundwater pollution if there is not adequate separation between bioretention facilties and groundwater table; – High groundwater may impede proper functioning; + Good for areas less than 2 acres, various land areas; + Reduces temperature, suspended solids, metals; – Requires ongoing maintenance.	
Street Planters	$$ - $$$	+ Reduced runoff/volume, pollutants, water temperatures; – Need adequate separation from groundwa-ter table; + Can be used in sidewalks, curbside, and within roads in urban areas; + Runoff conveyed by sheet flow or curb cuts; – Requires regular maintenance and trash removal; – Utility interferences could impact cost.	
Pervious Pavement	$$$	– Should not be used in areas of potential groundwater contamination; + Reduces suspended solids; + Reduces runoff volumes; + Filters solids and removes them in the sub-pavement layers; + Buffers water temperatures; + Reduces use of winter salt applications.	

$ - Least expensive to $$$$ very expensive

- Least maintenance to most maintenance

"+" - Considered to be a "pro" for this Control Strategy

"-"- Considered to be a "con" for this Control Strategy

Green Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
Sand/Infiltration Filter	$	+ Water flows through sand or gravel and either into groundwater or a pipe, or into storage ; – Needs frequent maintenance depending on location; + Useful on smaller sites; – Prone to sediment clogging.	
Tree Planting	$	+ Intercepts rainfall, helps increase infiltration and ability of soil to store water; + Provides shade, reduces wind speed,; + Releases water into atmosphere; + Absorbs air pollutants, reduces energy consumption; – Poorly chosen trees can affect powerlines, broken limbs incurs clean-up costs, requires maintenance; – Leaves need to be cleaned up to prevent storm sewer clogging.	
Downspout Disconnect	$	+ Reduces stormwater in the sewer system; + Minimal maintenance and cost; – Need positive drainage around the down-spout discharge to ensure stormwater does not pool; – Policies and controls need to be in place and implemented to ensure compliance.	

$ - Least expensive to $$$$ very expensive

- Least maintenance to most maintenance

"+" - Considered to be a "pro" for this Control Strategy

"- "- Considered to be a "con" for this Control Strategy

Green Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
Green Roofs	$$$$	+ Stores large amounts of water in growing media; + Reduces amount of solar radiation; + Reduces roof surface temperature; – Limited amount of plant choices; – Greater weight on roof; – Need for irrigation and drainage system requiring energy, water, materials; – Higher capital and maintenance cost;	
Blue Roofs	$$$$	+ Non-vegetated detention systems placed on roofs that capture and temporarily store rainwater, slowly releasing to the sewer system; + Provides for evaporation; + Less costly than green roofs; – Greater weight on roof.	
Rain Harvesting	$$	+ Reduces stormwater runoff by capturing rainfall where it lands—reduces flooding and erosion; + Reduce water treatment needs—reduces irrigation costs; + Used for non-drinking purposes; + Easy to maintain; – Unpredictable rainfall levels; – Initial moderate cost; – Roofs may seep chemicals into water;	

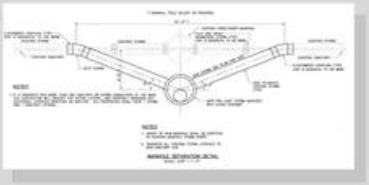
$ - Least expensive to $$$$ very expensive

- Least maintenance to most maintenance

"+" - Considered to be a "pro" for this Control Strategy

"-"- Considered to be a "con" for this Control Strategy

Grey Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
 Sewer Separation	$$$	+ Reduction in basement and street flooding; + Reduction in CSO and resulting biological impacts to receiving waters; + Possible cost savings related to incidental infrastructure upgrades performed under the same project; – Extensive construction impacts.	
Storage Tunnels	$$$$	+ Existing sewer system can remain in place; + Effective CSO reduction without increases to stormwater discharges; – High initial cost for construction; – Moderate to high construction impacts depending on the location; – On-going cost of maintaining the pumping station, cleaning, maintaining volume; – Fixed volume can be regularly exceeded.	
Source Control	$$	+ Relatively inexpensive, though costs can vary widely; + Can reduce the likelihood of sewer backup into structures; + Multiple solutions and technologies available from which to choose; – Can be intrusive on private property owners; – Can reduce the level of service of storm sewers.	

$ - Least expensive to $$$$ very expensive

- Least maintenance to most maintenance

"+" - Considered to be a "pro" for this Control Strategy

"- "- Considered to be a "con" for this Control Strategy

Grey Infrastructure Control Strategies

Stormwater Control Strategy	Relative Cost	Pros/Cons	Life Cycle/Maintenance
High Rate Treatment	$$$	+ Small footprint requires reduced space; + Competitively low cost when compared to WWTP upgrades; – Does not treat all nutrients; – Requires trained personnel to run and maintain with an increased cost to the City.	
Waste WaterTreatment Plant Upgrades	$$$$	– Costs vary, but are relatively high for any infrastructure improvement; – Space requirements may be substantial. + Nutrient treatment; + High pollutant removal.	

$ - Least expensive to $$$$ very expensive

- Least maintenance to most maintenance

"+" - Considered to be a "pro" for this Control Strategy

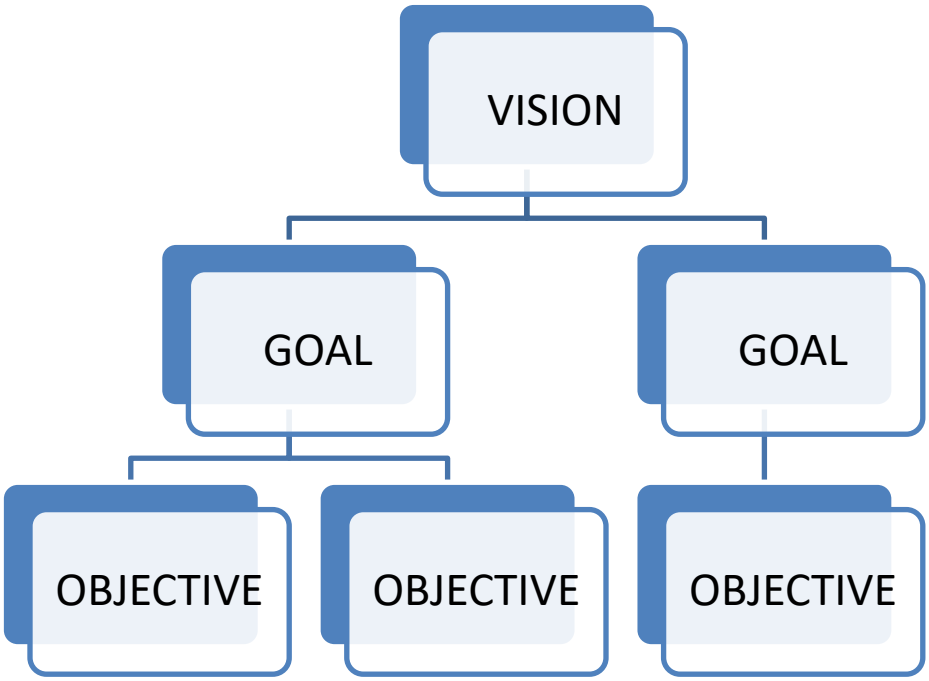
"- "- Considered to be a "con" for this Control Strategy

Working Group Meeting #6
November 17, 2015

Discussion: Integrated Planning Process and Lakewood's Vision for the Future

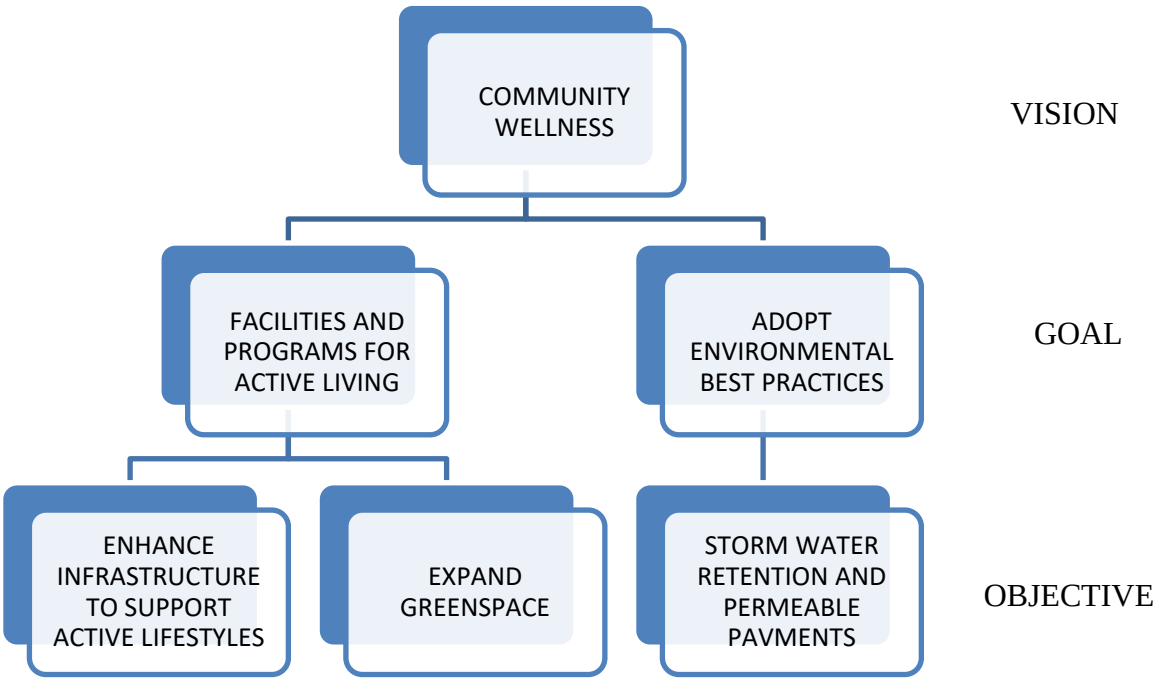
Refresher Question: What does Integrated Planning Framework mean?

Goal of today's meeting: For small teams to look at a specific area of Lakewood and apply the Integrated Planning process to determine what they think might work best in terms of green and grey infrastructure.
The Planning Process



Lakewood Community Vision – a Picture of the Future

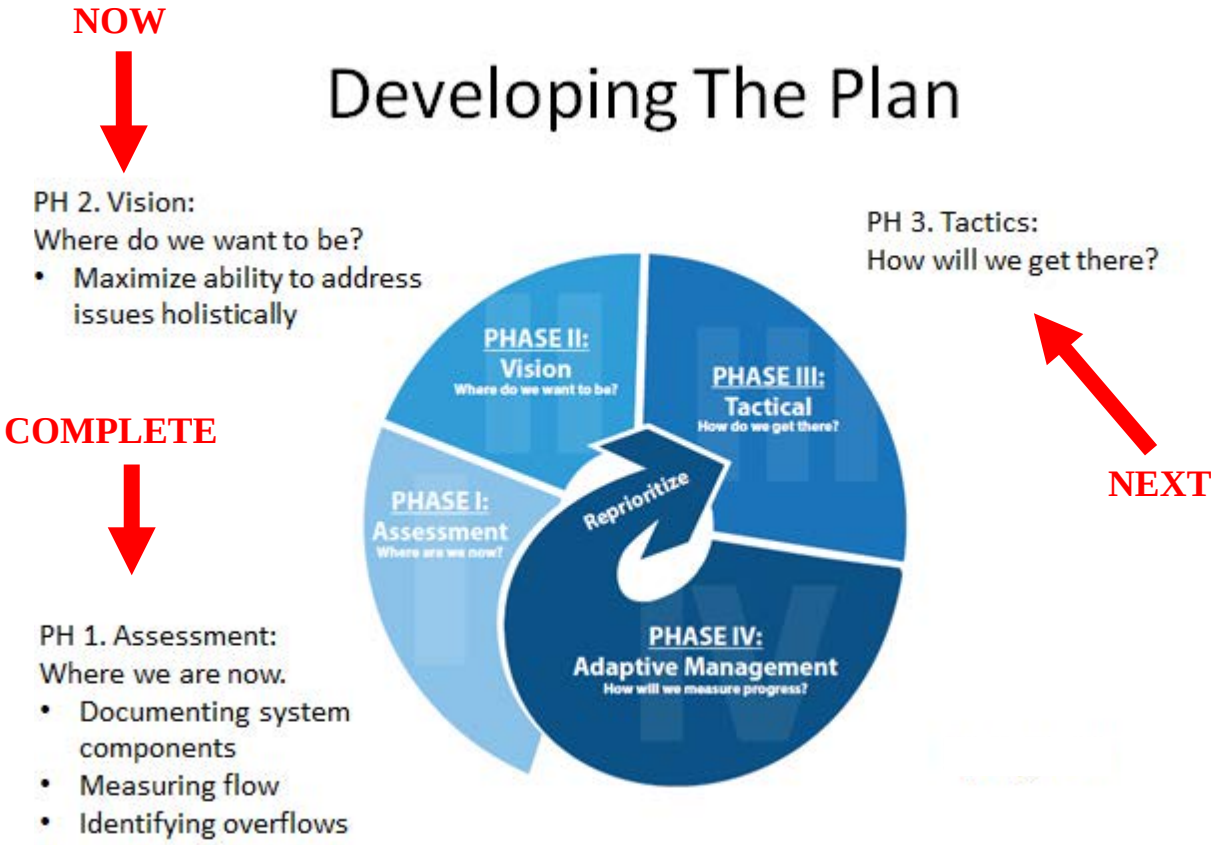
The City recently undertook a community planning process that resulted in the adoption of Lakewood Community Vision. This document is a picture of the desired future for the City of Lakewood in six areas: Commercial Development, Community Wellness, Education & Culture, Housing, Mobility and Safety. This Stakeholders Group will use the objectives for Community Wellness identified by the Lakewood community to help frame the strategies that will be tested as part of the IWWIP. Below is that portion of the Community Vision organized in a hierarchy chart representing Vision, Goal and Objective.



Please see the City website for a look at the entire visioning documents:
http://www.onelakewood.com/search/?k=vision+for+the+future

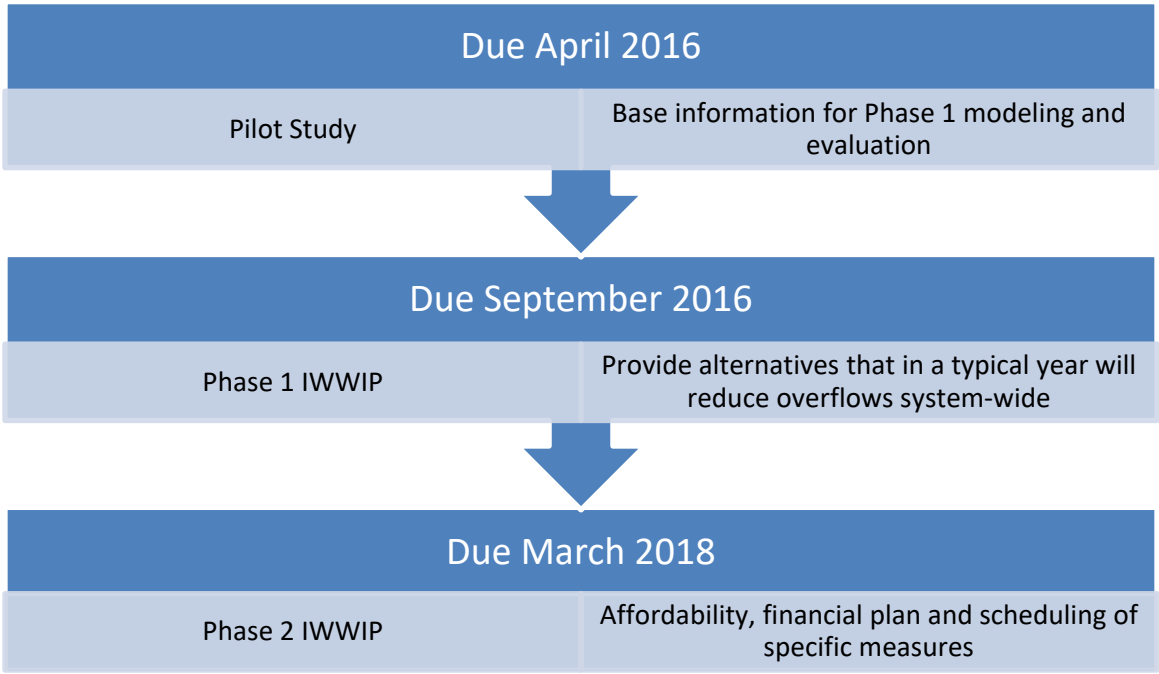
IWWIP – Planning for Sustainability

In October 2011, EPA's Office of Water (OW) and Office of Enforcement and Compliance Assurance (OECA) issued a joint memo encouraging EPA Regions to assist their state and local partners in pursuing an integrated planning approach to Clean Water Act (CWA) waste and stormwater obligations. The memo identifies green infrastructure as one comprehensive solution that can improve water quality and provide other benefits that enhance the vitality of communities. Please take the time to visit the EPA website:.
http://www2.epa.gov/green-infrastructure/integrating-green-infrastructure-federal-regulatory-programs



Summary Timeline

Below is a summary timeline of the specific IWWIP requirements in Lakewood's permit.



EPA Supports Integrated Planning and Green Infrastructure
The overarching goal for the IWWIP is CSO reduction. But integrated planning allows us to look at options beyond just single purpose projects/solutions. Also, green infrastructure practices, in conjunction with grey infrastructure practices, have been evaluated as being more cost-effective than grey infrastructure practices alone. Green infrastructure also delivers other environmental, social and economic benefits.

Deciding How to Use GI in CSO Plans – Factors to Consider
Any proposal for the incorporation of green infrastructure into a Long Term Control Plan (LTCP) should include, at a minimum, robust analyses in the following two areas:

Community and Institutional Support for Green Infrastructure The municipality or sewer authority responsible for implementing the LTCP should solicit initial buy-in from the community and relevant governmental entities.

2. Realistic Potential for Green Infrastructure Implementation The municipality or sewer authority responsible for implementing the LTCP should adequately investigate local factors that may limit the implementation of green infrastructure, including physical factors (e.g. soils, topography and land availability), regulatory factors (e.g. codes and ordinances), and social and institutional factors.

Factors to consider when evaluating the degree of green infrastructure implementation potential within a catchment should minimally include:

Soil characteristics. Many green infrastructure practices rely on infiltration as a means of stormwater dissipation. Areas with very tight soils (e.g., clay soils not conducive to infiltration of water) will reduce the infiltration potential of many green infrastructure measures. In some situations it may be appropriate to amend soils to enhance storage and infiltration, and to promote plant growth.

Land Use and Ownership. Since impervious cover tends to vary across land use type, parcel-level land use data can help estimate green infrastructure potential. Detailed land use data can also determine what types of green infrastructure approaches are most appropriate for a given catchment.

Local Buy-in. Will landowners be receptive or resistant to green infrastructure practices in the neighborhood or on their property? Drawing on the knowledge and experience of community leaders, as well as key groups such as home owner associations, land trusts, etc., will help inform outreach strategies.

Topography. Green infrastructure practices should ideally be located on slopes of less than 5%. GIS software can help identify and map steeper slopes, as well as areas with low infiltration potential (i.e., poorly drained soils).

Financing and Institutional Factors. What incentives would effectively encourage property owners to construct and maintain green infrastructure practices? Do codes and ordinances require green practices at existing sites or redevelopment sites?

Redevelopment Rate. Some localities require new and re- development to meet onsite retention standards. If this is the case, the CSO authority may use redevelopment rates to predict degree of new green infrastructure installation over time. If mandatory requirements do not exist, communities may consider incentives that encourage developers to install green infrastructure.

Green Infrastructure on Private Property. Privately-owned properties such as corporate campuses or shopping malls can be good locations for green infrastructure practices in terms of the availability of space and/or the location in a sewer shed. However, implementing green infrastructure on private property as part of a CSO control plan presents special challenges. Questions can arise as to who is responsible for maintenance, as wells as whether the sewer authority has the right to come onto the property for inspections or maintenance.

April 19, 2016

Modeling Results and Discussion

Goal of meeting: to review public preferences and report on modeling results

Summary of previous meetings: Since December we have been meeting in small groups to solicit public preferences and to share the results. At this meeting each group will share their results and understanding with the larger Clean Water Lakewood group.
Study Areas and Preferences

Larchmont, between Detroit and Madison ● permeable pavement on sidewalks and drive-way aprons ● bioretention in tree lawns ● south-end of Larchmont rerouted to Franklin sewers	Lake, between Homewood and Estill ● permeable pavement on sidewalk ● bioretention in tree lawns ● downspout disconnection ● detention basin (now replaced with a storm sewer bypassing a combined sewer)
Birdtown: Madison to the north, Plover to the south, Halstead to the east and Magee to the west ● bioretention on vacant lots, at the school, as bumpouts, in tree lawns, including area west of Birdtown ● green roof garages ● permeable pavement at Madison Park ● sewer separation ● routing flow to NEORSD or a detention basin ● 24” combined relief pipe at pinch point on Madison	Parkwood, between Detroit and Madison ● downspout disconnection ● public and private infilitration and inflow im-provements such as relining or replacing laterals and public sewer, new manholes to bypass over/under access plates ● upsizing Detroit Ave sanitary sewer to 4 ft di-ameter (currently 1 ft) ● upsizing Detroit and Nicholson sanitary sewer to 4 ft (currently 1 ft)

Currently in a typical year of rainfall there is the following number of overflow events in each of the study areas:

Study Area	# of overflows
Larchmont	14
Lake	9
Birdtown	103
Parkwood	64

Remember, to meet EPA CSO Policy there can be no more than 4 overflow events in a typical year.

Larchmont Results

Model	*Estimated # of over-flows	*Estimated total volume released in overflow (MG)	†Estimated # of overflows includ-ing Detroit sewer at full capacity	†Estimated total volume released in overflow (MG)
Existing conditions	2	0.101	14	0.96
With permeable pavement on sidewalk and driveway aprons	0	0	5	0.281
Bioretention in tree lawns or as bump-outs	2	0.007	4	0.309
Both permeable pavement and bioretention	0	0	4	0.052
Redirecting South end of Larchmont to Franklin	0	0	9	0.520

*The two columns highlighted in grey are only including water coming off of Larchmont Ave.
†The two columns highlighted in blue account for the sanitary sewer on Detroit Ave being at full capacity, as it currently is during rain events.

Interpreting results

The overflows from Larchmont can be brought into compliance or eliminated based on the green infrastructure this group suggested, when the Detroit sewer is not taken into account.

When Detroit sewer is taken into account the model suggests using both permeable pavement and bioretention should result in 4 overflows per year.

It is likely that the Detroit sewer would not be at full capacity if substantial areas of green infrastructure were installed upstream of where Larchmont intersects Detroit.

Lake Avenue Modeling Results

Model	Estimated # of overflows	Estimated total volume released in overflow (MG)
Existing conditions model	9	2.293 (mostly storm flow)
Existing conditions with storm bypass	2	0.092 (combined flow)
Permeable pavement on sidewalk with underground storage, with storm bypass	0	0
Bioretention in tree lawns, with storm bypass	0	0
Both permeable pavement and bioretention, with storm bypass	0	0

Interpreting results

To meet the EPA standards you can have no more than 4 overflow events during a typical year.

Under existing conditions without the stormwater bypass there are 9 overflows a year.
The overflows from Lake Ave can be brought into compliance with the stormwater bypass. The green infrastructure reduces overflows beyond what is required by federal policy.

If you did not have the stormwater bypass, and only green infrastructure, the model predicts 7-8 overflows per year, which is not in compliance with federal policy.

The existing conditions model does not contain the detail necessary to confirm which downspouts are connected and/or plugged since comprehensive field studies have not been conducted in this area. On-going construction efforts in other locations in Lakewood have shown storm downspouts and/or laterals to be blocked by debris. Once a blockage is in place, the system typically will:

- Release flow to the public sewers more slowly
- Potentially back up/overflow on to pervious/impervious areas around the house as if the downspout were splash disconnected. If the downspouts were cleaned and remain connected to the sanitary sewer it is possible that an increase in the number of overflow events would occur.
- If downspouts were cleaned and connected it is expected to result in an increase in the number of overflow events.

Birdtown Modeling Results

Model	Estimated # of overflows at Elbur and Madison	Estimated total volume released at Elbur and Madison (MG)	Estimated total volume released at Madison and W117th
Existing conditions	103	54.3	312.9
Bioretention at school	103	54.3	312.3
Bioretention on vacant lots	103	54.3	312.2
Curbside bioretention	103	54.3	306.5
Fire hydrant bump-out bioretention	103	54.3	312.3
Green roof garages	103	54.3	300.0
Permeable pavement at Madison Park	103	54.3	312.1
Green Infrastructure composite run (not including GI west of Birdtown)	103	54.3	292.0
Sewer separation	103	54.3	260.7
Curbside bioretention west of Birdtown	99	46.1	302.9
Additional 24” combined pipe on Madison	70	26.8	339.8
Combination of above 2 runs	18	4.1	345.2

Model	Estimated # of overflows at 059	Total volume released at 059 during wet weather events (MG)
Existing conditions	61	57.9
Diverting to NEORSD	4	0.8
15 MG detention basin in Gold Coast	4	1.1

Interpreting results

Green infrastructure in Birdtown does not reduce the number of overflows or the volume of water at the intersection of Elbur and Madison.

This is due to the layout of the system, including some bottle necks, and the fact that there is already a large volume of water in the system upstream of Birdtown.

Model shows green infrastructure can reduce volume of water entering 117th at Madison from 312.9 MG (existing conditions) to 292.0 MG (composite run), which is a 6.7% difference.

The combination of implementing curbside bioretention upstream of Elbur and Lewis overflows, as well as adding a 24 inch pipe to reduce a bottleneck on Madison, significantly reduces overflows, although it still results in greater than 4 overflows per year.

Overflow 059 is in compliance (≤4 overflows per year) in the following two scenarios:

- Diverting 117th flows to NEORSD. This includes flows East of Lewis and south of Edgewater.
- Creating a 15 MG detention basin, 2.5 acre footprint, and has a 25 MGD pump station. This would need to be placed in the Gold Coast area.

Parkwood Results

Model	Sanitary Sewer Peak Flow (MGD)	Sanitary Flow as % of Sanitary Sewer Capacity*	Storm Sewer Peak Flow (MGD)	Storm Flow as % of Storm Sewer Capacity*
Existing conditions	0.75	96%	6.6	97%
Disconnected downspouts	0.70	89%	7.3	107%
Public & private sewer improvements: downspout disconnection, lateral lining, manhole separation, public sewer repair	0.14	18%	8.2	120%

*percentage representative of largest storm event in a typical year

Model	Number of Overflow Events	Total Volume of Overflows (MG)
Existing Conditions	64	7.32
Detroit & Nicholson 4 ft. diameter sanitary sewer	0	0

Interpreting results

When sanitary flow decreases, storm flow increases dues to that water now being directed or indirectly connected to storm sewers.

It would be recommended that homeowners have sump pumps installled to prevent basement flooding when storm sewer surcharges.

Upsizing Detroit and Nicholson sanitary sewers has the greatest impact at reducing overflows at Detroit and Parkwood but:

- There are still many overflows occurring up and downstream of this site, even with the increased diameter pipe.
- The sewage conveyed by the 4 ft. will likely overflow at CSO 059A (Nicholson and Edgewater) resulting in a net overflow reduction of zero.

If the public and private sewer improvements are applied to Blossom Park, Bunts, Elbur, Lewis, Chesterfield, and Waterbury and the green infrastructure initiatives from the Larchmont study group are applied to Robinwood, Wyandotte, Clarence and Grace, modeling should show the 7 overflows along Detroit Avenue in CSO Area 059A would be deactivated in a typical year.

The existing conditions model does not contain the detail necessary to confirm which downspouts are connected and/or plugged since comprehensive field studies have not been conducted in this area. On-going construction efforts in other locations in Lakewood have shown storm downspouts and/or laterals to be blocked by debris. Once a blockage is in place, the system typically will:

- Release flow to the public sewers more slowly
- Potentially back up/overflow on to pervious/impervious areas around the house as if the downspout were splash disconnected. If the downspouts were cleaned and remain connected to the sanitary sewer it is possible that an increase in the number of overflow events would occur.

Background information on modeling
A master model of all sanitary and storm sewers in the City of Lakewood was created in 2014, and is currently used to help report expected overflows to the Ohio EPA. In order to evaluate the green infrastructure ideas brought up by this group, a series of models were developed for comparison purposes. These models needed to be calibrated against our larger city-wide model, to ensure that the results are reliable.

A “typical year” of rainfall is what was used in this modeling exercise. A typical year of rain was created by averaging rain intensity and frequency data from 1973-2006 collected at the Cleveland Hopkins International Airport.

It is important to remember that the results produced from this modeling study are not intended to be exact. The results should be used to identify if the suggested approaches are practical and the approximate levels of overflow improvements that might be expected.

SOCIAL MEDIA POSTS

The following posts are listed in chronological order, starting with the most recent posts. All posts were cross-posted on Facebook and Twitter.

City of Lakewood @LakewoodOhio · May 17

Dozens of residents braved the rain Saturday for a special tour of the Waste Water Treatment Plant #CleanWaterLKWD

2 7

City of Lakewood @LakewoodOhio · Apr 29

Bioretention, like the new gardens in Madison and Lakewood Park, are helpful to fish habitat news.wsu.edu/2016/04/12/hop … #1LKWD #cleanwaterLKWD

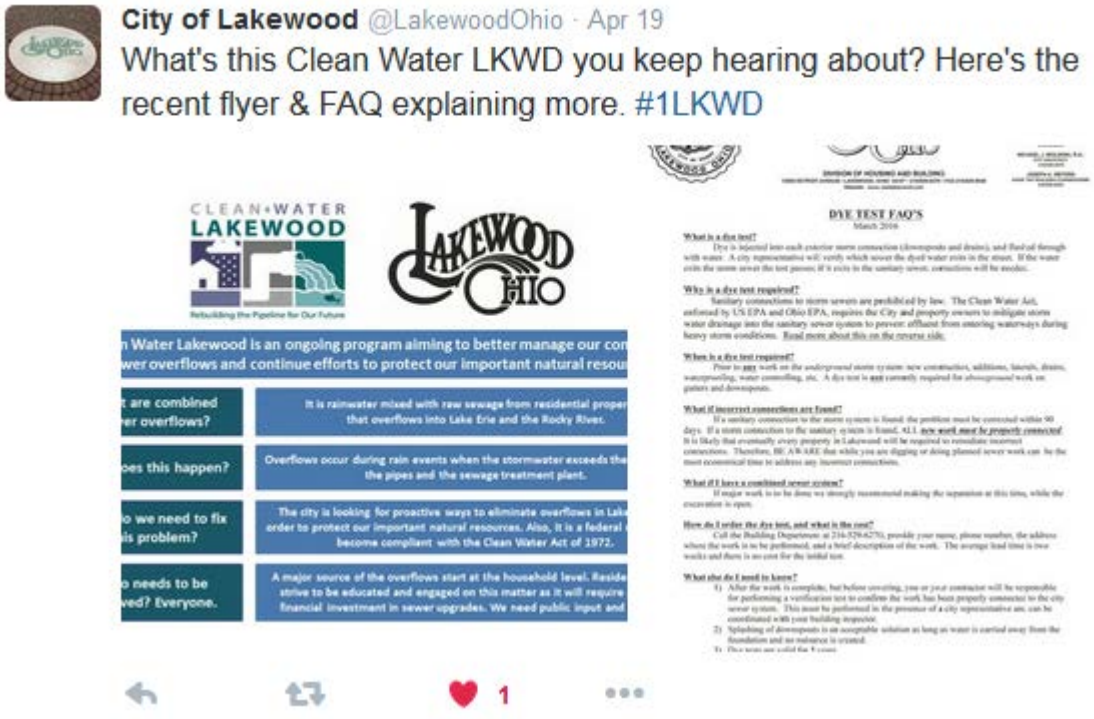
Hope for saving salmon lies in reducing stormwa...

SEATTLE, Wash. – Salmon exposed to toxic stormwater can die in a matter of hours. But preliminary new findings by Washington State University researchers suggest t...

news.wsu.edu

3 3

City of Lakewood @LakewoodOhio · Apr 26
Residents & contractors attended a seminar @ City Hall today to learn about city's #CleanWaterLKWD initiative #1LKWD
1
4


City of Lakewood @LakewoodOhio · Apr 19
What's this Clean Water LKWD you keep hearing about? Here's the recent flyer & FAQ explaining more. #1LKWD
CLEAN•WATER LAKEWOOD
Rebuilding the Pipeline for Our Future
LAKEWOOD OHIO
n Water Lakewood is an ongoing program aiming to better manage our con
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It is rainwater mixed with raw sewage from residential proper
that overflows into Lake Erie and the Rocky River.
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Overflows occur during rain events when the stormwater exceeds the
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The city is looking for proactive ways to eliminate overflows in Lake
order to protect our important natural resources. Also, it is a federal
become compliant with the Clean Water Act of 1972.
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ved? Everyone.
A major source of the overflows start at the household level. Reside
strive to be educated and engaged on this matter as it will require
financial investment in sewer upgrades. We need public input and
DYE TEST FAQ'S
1

City of Lakewood @LakewoodOhio · Apr 19
Clean Water Lakewood results to be discussed tonight @ 7pm in the City Hall Auditorium #1LKWD #CleanWaterLKWD

1

City of Lakewood @LakewoodOhio · Apr 12
This is the 39th consecutive year LKWD has received 'Tree City USA' status — the 2nd-longest streak in Ohio. bit.ly /1qGq0SL #1LKWD

5 6

City of Lakewood @LakewoodOhio · Apr 10
Lakewood's got NOTHING on Rio's overflow problems. read.bi /1NNO6F6 #1LKWD #CleanWaterLKWD

A 2016 Rio Olympics waterway has levels of viruses akin to raw se...
A bombshell Associated Press report detailed just how badly polluted Rio's waterways, which will host the 2016 Olympics, are.
businessinsider.com

1

City of Lakewood @LakewoodOhio · Apr 4
Reduce your runoff footprint: Rain Barrel Workshop set for April 6. bit.ly /24MOucE #1LKWD

2

City of Lakewood @LakewoodOhio · Mar 16
Can't wait to see Public Square with green infrastructure; maybe LKWD can get some ideas here #1LKWD #CleanWaterLKWD

8 15

City of Lakewood @LakewoodOhio · Mar 10
Copenhagen turning parks into ponds. LKWD's not looking at this idea, but still interesting. bit.ly/1SHcFVo #1LKWD #CleanWaterLKWD

1 View summary

City of Lakewood @LakewoodOhio · Mar 8

While @OhioEPA is encouraging urban tree canopy in Cleveland area, LKWD has planted more than 600 in past 2 years. bit.ly/1YtihCR

4 5 View summary

City of Lakewood @LakewoodOhio · Mar 8

Reduce your runoff footprint: Rain Barrel Workshop set for April 8. bit.ly/24MOucE #1LKWD #CleanWaterLKWD

1

City of Lakewood @LakewoodOhio · Mar 1

California no longer looking at stormwater as a nuisance, maybe we shouldn't either. #cleanwaterlakewood #1LKWD nyti.ms/1UcwJ1E

1 1 View summary

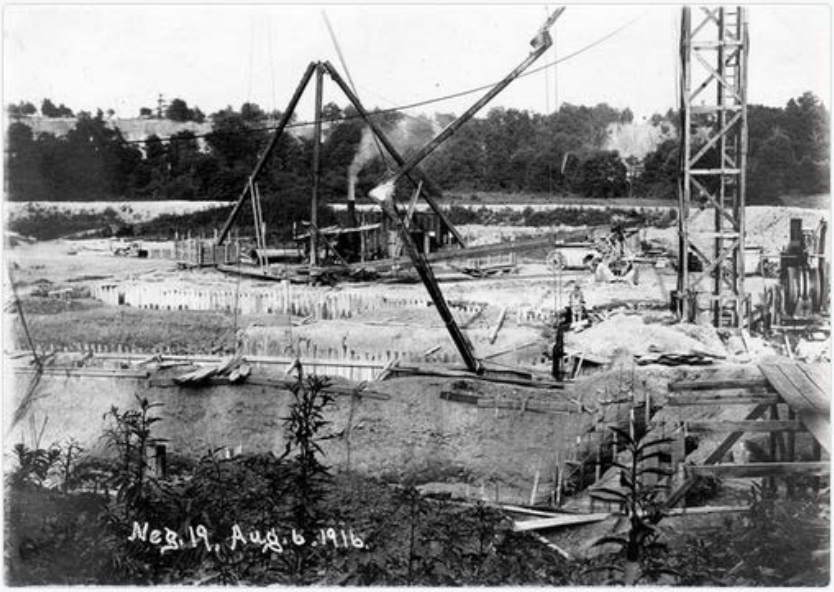
City of Lakewood @LakewoodOhio · Feb 25

Thinking about planting a tree in your yard? Get a reduced rate. bit.ly/1LHPwuU #1LKWD

4 1

City of Lakewood @LakewoodOhio · Feb 11

Throwback treatment plant on #ThrowbackThursday. If we only knew then what we know now. #CleanWaterLakewood



1 3

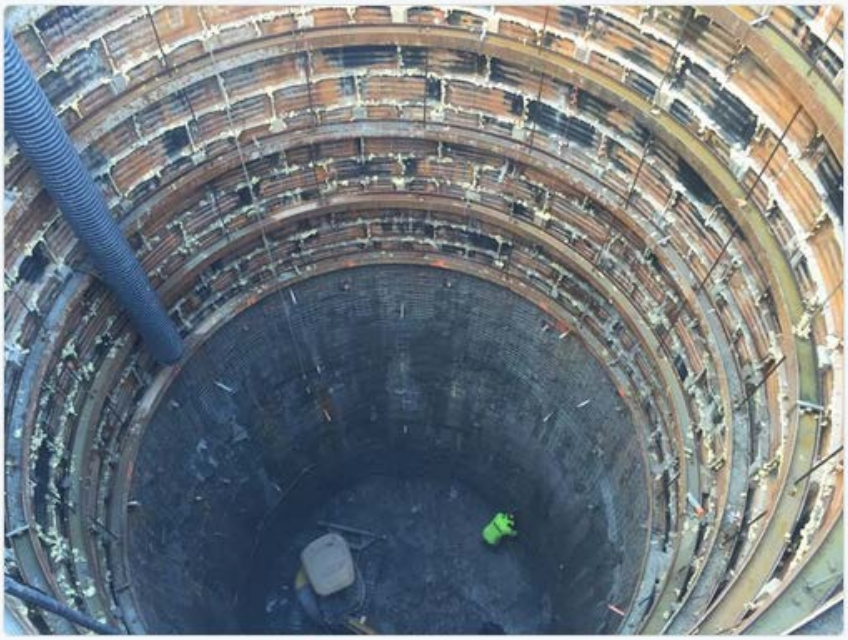
City of Lakewood @LakewoodOhio · Feb 11

When It's Raining In Lakewood: Where Does Your Rooftop Runoff Go? bit.ly/1nZxlel #CleanWaterLakewood

1

City of Lakewood @LakewoodOhio · Feb 8

This giant hole is part of the West End CSO Elimination Project, addressing LKWD's overflow into Rocky River. #1LKWD



4 7

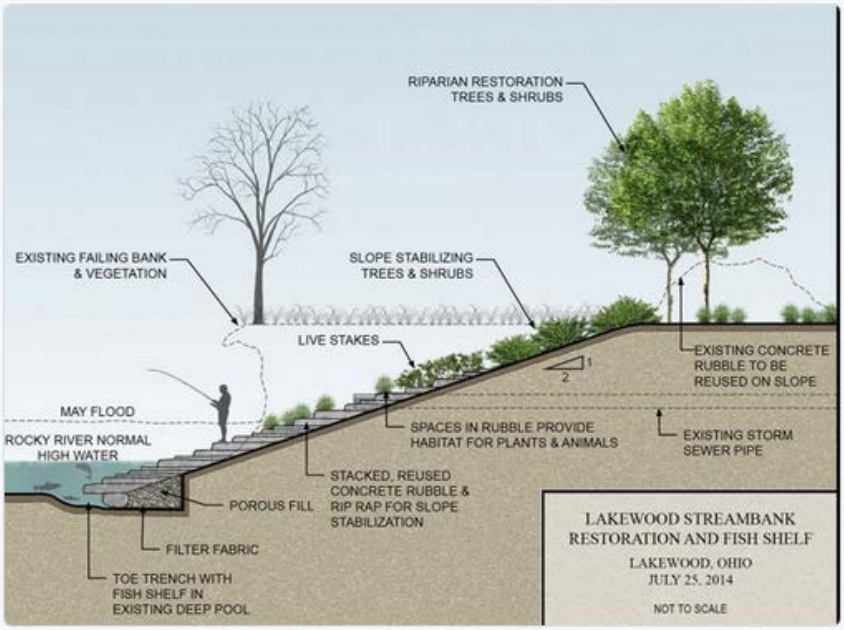
City of Lakewood @LakewoodOhio · Feb 5

.@CLE_State Urban Affairs is hosting a water photo contest titled: What does water mean to you? bit.ly/1Qg07yq #CleanWaterLKWD

1 1

City of Lakewood @LakewoodOhio · Feb 4

City hosting public forum TODAY to discuss Streambank Restoration Project. All are welcome. bit.ly/1P07iL2



2 5

City of Lakewood @LakewoodOhio · Jan 22

LKWD working to increase perviousness green infrastructure; retention via storage & capacity at the treatment plant. bit.ly /1P6sFOf

1 3 View media

City of Lakewood @LakewoodOhio · Jan 19

Clean Water Lakewood volunteers: Educated and engaged on overflows. bit.ly/1OnqrbV #1LKWD

City of Lakewood @LakewoodOhio · Jan 13
Investment in sewer projects spurs rate hike. bit.ly/1P8NF2L #1LKWD

1

City of Lakewood @LakewoodOhio · 17 Nov 2015
City of Lakewood planted hundreds of trees this fall. bit.ly/1NAgmVO #1LKWD

1 4

City of Lakewood @LakewoodOhio · 12 Sep 2015
From rustbelt to bluebelt. econ.st/1LX6Mic #CleanWaterLKWD #1LKWD

2 3 View summary

City of Lakewood @LakewoodOhio · 6 Sep 2015
The new environmentally friendly roof at LKWD City Hall. One of many "green" investments in your LKWD government.

6 4

City of Lakewood @LakewoodOhio · 29 Aug 2015

The Clean Water LKWD task force toured Green Infrastructure options in Parma earlier this week. #cleanwaterlakewood

City of Lakewood @LakewoodOhio · 2h

Clean Water Lakewood volunteers: Educated and engaged on overflows. bit.ly/1OnqrbV #1LKWD

City of Lakewood @LakewoodOhio · 27 Aug 2015

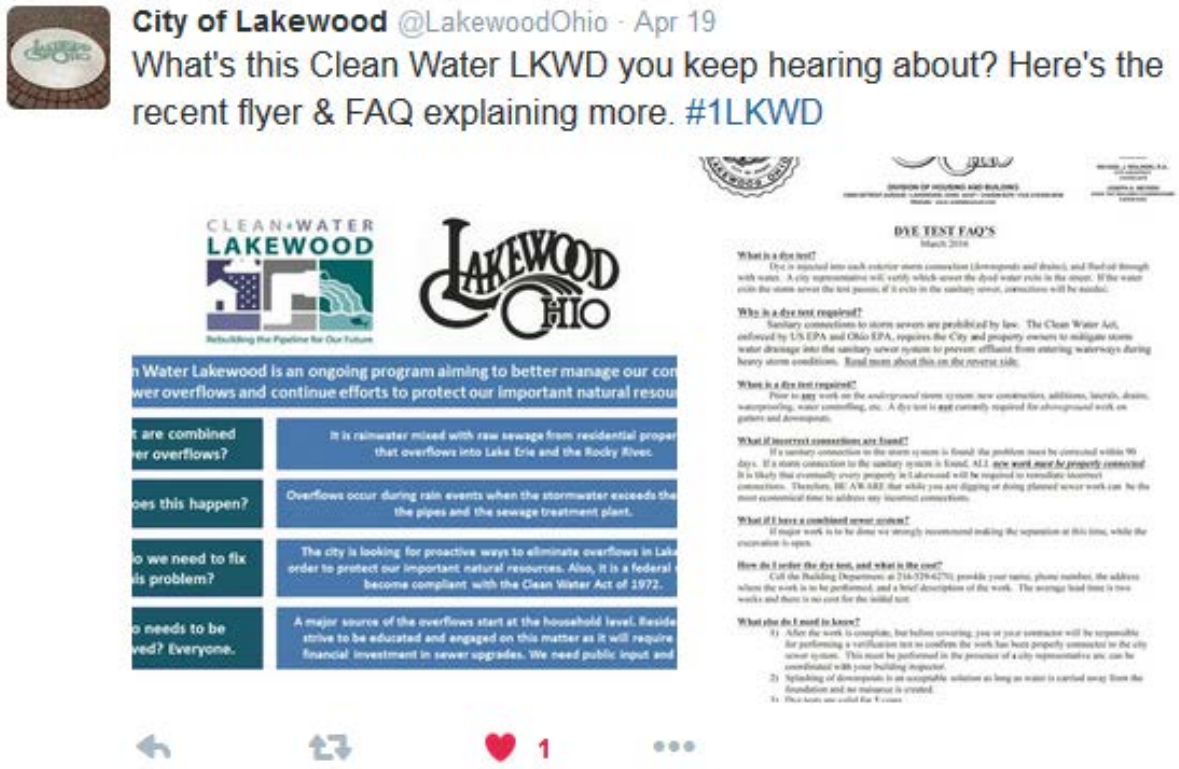
Clean Water LKWD group recently toured the Treatment Plant to better understand obstacles ahead #cleanwaterlakewood

3

City of Lakewood @LakewoodOhio · Apr 19

Clean Water Lakewood results to be discussed tonight @ 7pm in the City Hall Auditorium #1LKWD #CleanWaterLKWD

1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DIVISION OF HOUSING AND BUILDING
DYE TEST FAQ'S
March 2016
What is a dye test?
Why is a dye test required?
When is a dye test required?
What if incorrect connections are found?
What if I have a combined sewer system?
How do I order the dye test, and what is the cost?
What else do I need to know?
1

NEWSPAPER ARTICLES

December 19, 2018 *The Lakewood Observer Volume 14, Issue 24* Page 3

City

Costly Sewer Upgrades In Lakewood's Future

by Matt Kuhns

Lakewood will need to make expensive upgrades to the city's water and sewer infrastructure, to comply with the Clean Water Act.

Just how expensive those upgrades are, how soon they must be made, and how they can be paid for are all the subject of ongoing discussions between Lakewood and regulators.

The city's current ballpark estimate is $300 million to reach full compliance with Clean Water Act rules. That's a little over twice the entire proposed city budget for 2019. Under any realistic scenario, Lakewood will need a number of years to fund all of the necessary upgrades. City officials hope to negotiate as much time and flexibility as they can for the process.

Lakewood water rates are almost certain to rise for years to come, whatever terms the city reaches with regulators.

Beyond this, Mayor Mike Summers and other officials representing the city indicated that few details are settled, as of a December 4 public meeting. The city could fund future sewer system upgrades with rate increases or taxes or other fees, structured in a variety of ways.

Public input will have a role in determining those ways, as well as the schedule and rule framework for making upgrades. Under the Clean Water Act, Lakewood will have to eliminate nearly all untreated wastewater flows into Lake Erie—but the Environmental Protection Agency has considerable discretionary power in how it compels the city to comply with the Act.

Given the projected cost of upgrades compared with the size of Lakewood's budget, the EPA is negotiating with the city, with other federal and state agencies, and ultimately with the residents of Lakewood over how quickly the city can genuinely get into compliance.

The good news for residents is that, in addition to having some indirect say in these negotiations, the city has been building a case for flexibility.

While the Clean Water Act has been law since 1972, enforcement has been a decades-long process, only reaching local water systems for cities the size of Lakewood relatively recently. In the intervening decades, Lakewood has maintained its water and sewer infrastructure in general, though the larger challenge is that the system was built long before the Clean Water Act, and even when working as designed is noncompliant.

For at least a decade, the city has been implementing a variety of remedies, from underground pipes to "bioswales" outside of new construction to a pilot project for retrofitting existing homes.

City officials have expressed hope that these improvements—while considerably short of full Clean Water Act compliance—will demonstrate enough good faith that Lakewood receives a new operating permit without a consent decree which would take a lot of decision-making out of local hands.

The current permit expires in 2019, and public input will weigh on regulators' decisions. The next public discussion is planned for 7 p.m., January 16 in the Lakewood High School cafeteria. Visit onelakewood.com/cleanwaterlakewood for more information.

District to Renovate Taft for Curricular Expansion, Central Office Home

continued from page 1

The proposal calls for a renovation of Taft, which first opened in 1927 and had additions built in 1957 and 1970. The space will be configured to accommodate the relocation of the Central Office staff from the Board building at 1470 Warren Road, the expansion of the District's preschool program and partnership program with higher education institutions.

The District already has partnerships with the University of Akron and Tri-C. District officials are currently in discussions with two other institutions of higher learning that wish to partner with the District. These partnerships, as well as income generated through rental of a new flexible meeting space, will bring new revenue to the District that will help offset the cost of the renovation, which will be funded over 20 years.

Details of the preschool curricular programming will be developed over the next year with input from staff. Plans call for the renovation to be complete in time for Central Office staff to move into the building in January 2020

continued from page 5

Reduce Your Runoff Footprint: Rain Barrel Workshop Set for April 8
March 06, 2016
Colin McEwen

According to the Environmental Protection Agency, rain barrels save an average homeowner about 1,300 gallons of water during the peak summer months. Rain barrels can help capture some of that water — saving residents money and helping us all become better stewards of the environment.

The Cuyahoga County Soil and Water Conservation District and the city of Lakewood are hosting a rain barrel workshop at the Women's Pavilion at Lakewood Park at 6:30 p.m. Wednesday, April 6.

The workshop is designed to teach residents how to harvest rainwater for gardening and combatting storm water pollution.

Rain barrels are containers used to collect and store rainwater that would otherwise be lost to runoff and likely diverted to a storm drain. Collected water may then be used to water lawns and gardens.

"There are many ways that residents can be better stewards of the environment," said city engineer Mark Papke. "These rain barrels are just one very effective and affordable avenue for residents to make an impact."

A $60 fee includes instruction and all materials, including a 55-gallon barrel and a downspout diverter. With a large crowd expected, residents are required to register for the seminar, by calling the Cuyahoga County Soil and Water Conservation District at 216-524-6580, or registering online at www.cuyahogaswcd.or/events.

Registration is required by April 1.

For more information — or to register directly — call Rocky River Watershed Coordinator Jared Bartley at 216-524-6580, ext. 14, or check out the Clean Water Lakewood webpage.

It's Raining In Lakewood: Where Does Your Rooftop Runoff Go?

February 10, 2016
Colin McEwen

Lakewood, a city of homes with very little undeveloped property, may find the key to sewer improvements in our own backyards, driveways and roof drains.

When homes have roof drains or foundation drains connected to a sanitary sewer line, groundwater and rainwater add unnecessary water volume to the sewer system. Additionally, when sewer pipes on the individual's property are cracked, ground water leaches in, adding another source of unnecessary water to Lakewood wastewater treatment plant's load.

A significant volume of water in Lakewood's sanitary sewer system comes from private property. The sources include leaking house laterals and improperly connected roof and foundation drains. The city of Ann Arbor found that 70 to 90 percent of total sanitary sewer flow, in some portions of their system, was coming from footing drains during storm events, according to the city's 2001 Sanitary Sewer Overflow Prevention Study.

To quantify flow from private property, 102 homes in a pilot area on Delaware, Atkins and Eldred Avenues have been investigated to see if their homes are improperly connected, and if their pipes are cracked and broken. Nearly all of the homes in this pilot study had some broken or improperly connected pipes. After the homes are properly connected by this spring, flows going into storm and sewer drains will be re-measured and compared to pre-construction flows, to determine how significant of a reduction has occurred.

There are several overflow locations throughout the city.

Some of Lakewood's sewer overflows might be nearly eliminated if each property was connected so that their roofs and foundation drains were connected to the storm pipe, not the sanitary, and the property had sewer lines that weren't cracked. When planning home renovations you may also consider understanding the stormwater flow off of your property and ensuring proper connections.

Other ways homeowners can reduce the volume of water going into sanitary sewer lines is by:

- Installing low-flow showers, washers, dishwashers, and toilets
- During a rain event, don't add additional water into the sewer system; refrain from running dishwasher, clothes washer, or shower
- Add practices to your home where rain can infiltrate or be stored for later use (i.e. rain barrels, bio-swales and pervious pavement)

Residents interested in more information can visit the webpage or contact the Mayor's office: 529-6600; mayor@lakewood.oh.net.

Clean Water Lakewood Volunteers: Educated and Engaged On Overflows

January 15, 2016
Colin McEwen

Clean Water Lakewood: Rebuilding the Pipeline for Our Future, is a group of citizen volunteers committed to understanding Lakewood's sewer infrastructure to continue improvements and reduce wastewater overflows.

Lakewood's sewer system is a unique collection of types of pipes linked together over several decades. The system performs well in most conditions and Lakewood has been making sustained progress in implementing updates and new projects. Lakewood's unique system requires additional assessment and planning to select further improvements, which will include significant municipal investments over many years.

"Clean Water Lakewood volunteers bring a variety of perspective's and expertise to this important issue," said Shannon Strachan, Executive Assistant to the Mayor. "The group has met monthly since July, working toward suggesting infrastructure ideas to be considered for Lakewood."

Possibilities include combinations of increasing perviousness through green infrastructure, increasing retention via storage, eliminating cross-connections between storm and sanitary sewers, and increasing capacity at the waste water treatment plant.

The questions confronting Clean Water Lakewood are intricate, and connected to issues of development, land use, building codes and affordability. Consequently, meeting topics have included: the Clean Water Act of 1972, Lakewood's discharge permit requirements, EPA's Integrated Planning Framework, how private property can affect sewer overflows, and advantages & disadvantages of various infrastructure options.

Two field trips offered useful perspectives. First, the group toured Lakewood's Water Pollution Control Facility, and learned about Lakewood's high-performing treatment plant, as well as nearby combined sewer overflows, and the intended high rate treatment plant coming in the next 5-10 years. Led by William Crute, Division Manager of Lakewood's treatment plant, the field trip underscored the challenges of dealing with wet weather flow.

The second field trip was an interactive tour of the Watershed Stewardship Center in Parma. Jennifer Grieser, Area Manager of Urban Watersheds at the Cleveland Metroparks, led a tour of the green infrastructure installed around the premises to reduce stormwater runoff from impervious surfaces. Additionally, she spoke of maintenance required and pros and cons of the various options experienced during the few years it has been installed at the Center.

The work of this citizen group, as well as the City of Lakewood, is part of the development of Lakewood's Integrated Wet Weather Plan under Ohio EPA issued permit that is working to reduce wastewater overflows into Rocky River and Lake Erie. All meeting handouts and summaries are available at: http://www.onelakewood.com/cleanwaterlakewood under the sub heading "Meeting Summaries." The general public can offer comments by emailing the Mayor's Office at mayor@lakewoodoh.net or calling 529-6600.

http://www.onelakewood.com/clean-water-lakewood-volunteers-educated-and-engaged-on-overflows/

Clean Water Lakewood's Citizen Volunteers Tour 'Green and Gray' Infrastructure
September 25, 2015
Colin McEwen

A group of volunteer citizens committed to understanding Lakewood's water infrastructure in relation to wastewater overflows took a couple of evening field trips this summer.

The citizens are members of the city initiative Clean Water Lakewood: Rebuilding the Pipeline for Our Future, who also hosted their kickoff meeting in July.

William Crute, division manager of Lakewood's Waste Water Treatment Plant, and Mirko Kucinic, unit manager, led an Aug. 11 complete tour of the treatment plant, the nearby combined sewer overflows, and the intended high-rate treatment plant coming in the next five to 10 years.

The goal of the meeting was to understand how the treatment plant works, and when the facility has difficulty treating all of the water flowing through the sewer system.

A couple weeks later, the group toured the Watershed Stewardship Center in Parma. Jennifer Grieser, area manager of Urban Watersheds at the Cleveland Metroparks, led a tour of the green infrastructure installed around the premises to reduce stormwater runoff from impervious surfaces. Additionally, she talked about the maintenance required and pros and cons of the various options during the few years it has been installed at the Center.

The next several meetings will take place indoors, where the participants will discuss the issues with clean water entering our sanitary sewers, as well as compare various green and grey infrastructure options and what they see as advantages and disadvantages of each.

The city of Lakewood is working on a multi-year, multi-million-dollar plan to continue the city's progress under the 1972 Clean Water Act. The Ohio EPA approved a permit last year that will enable the city to improve the city's stormwater management and reduce wastewater overflows into the Rocky River and Lake Erie.

For some guidance in the process, the city established a volunteer-driven working group Clean Water Lakewood to help transform water infrastructure in Lakewood. The resident group will focus on facilitating best-practice solutions for wastewater overflows.

Lakewood's combined sewers are designed to take all wastewater to the treatment plant, which can process more than 30 million gallons per day. However, during storms, the volume of rainwater entering the combined sewer system can exceed both the capacity of the combined sewers and the treatment plant. The new agreement includes plans for sewer separation projects and wastewater treatment investments.

"No one more than the city of Lakewood desires to do our part to improve the cleanliness of our local watershed, especially our wonderful Lake Erie," said Lakewood Mayor Michael Summers.

New Study Begins At Waste Water Treatment Plant
Colin McEwen
Volume 11, Issue 14 06.23.2015
The Lakewood Observer

City of Lakewood officials are looking to increase capacity at the Lakewood wastewater treatment facility to treat a higher volume of flows during rain events.

Lakewood's combined sewers are designed to take all wastewater to the treatment plant, which can process a maximum hydraulic volume of 40 million gallons per day. However, during storms, the volume of rainwater entering the combined sewer system can exceed both the capacity of the combined sewers and the treatment plant, leading to overflows into Lake Erie and Rocky River.

Working to protect the city's water resources, Lakewood has implemented a pilot study of a high-rate treatment system. The high-rate system would be activated during storms when flows exceed treatment plant capacities. The high-rate system would reduce the quantity of untreated water being discharged to the river and lake.

The City of Lakewood selected Veolia's Actiflo, with technology that separates solids out of high volumes of water and settles them quickly into a sludge that can be properly disposed of.

If the pilot study is successful at cleaning Lakewood's wet weather flows to meet permit requirements, the system may be phased into the treatment plant in the next five years.

"Our goal is to decrease overflows that occur into the river and lake," said William Crute, division manager of the Lakewood Waste Water Treatment Plant. "This may be the most cost effective solution, as we look to stretch our treatment dollars while dramatically reducing pollution levels and achieving better water quality."

This pilot study is in a self-contained trailer that will be stationed on treatment plant grounds during the month of June for testing.

http://lakewoodobserver.com/read/2015/06/23/new-study-begins-at-waste-water-treatment-plant

City Of Lakewood Seeks Members For New 'Clean Water Lakewood' Advisory Group
Colin McEwen
06.23.2015
Volume 11, Issue 14, The Lakewood Observer

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enable the city to improve the city's stormwater management and reduce wastewater overflows into the Rocky River and Lake Erie.

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"No one more than the city of Lakewood desires to do our part to improve the cleanliness of our local watershed, especially our wonderful Lake Erie," said Lakewood Mayor Michael Summers.

"We hope to receive some guidance from our community's strong and diverse group of residents, business owners and thought leaders in Lakewood."

Anyone interested in participating in the Clean Water Lakewood working group is encouraged to call the mayor's office at 216-529-6093. The first meeting is slated to take place July 16.

http://lakewoodobserver.com/read/2015/06/23/city-of-lakewood-seeks-members-for-new-clean-water-lakewood

Work Wrapping Up On Madison Park 'Green Street' Project
Colin McEwen
5/26/2015
Volume 11, Issue 11, The Lakewood Observer

The project to enhance the entrance to Madison Park is coming to a close. Crews are expected to finish the work by June 1.

"Madison Park Green Street" includes the addition of decorative concrete pavement, plantings and benches that will also be installed near the pool entrance of Madison Park.

The comprehensive effort includes planting 18 trees, 69 shrubs, 649 perennials and ornamental grasses, 1,475 ground-cover plants, and 700 bulbs.

One of the ideas behind the "Madison Park Green Street" project is to improve the city's stormwater management and reduce combined sewer overflows into Rocky River and Lake Erie.

During storms, the volume of rainwater entering the combined sewer system can exceed both the capacity of the combined sewers and the treatment plant. Bio-retention catch basins — like those

installed at Madison Park's entrance — will help infiltrate stormwater into the ground rather than into a pipe.

"This project achieves a few very important objectives," said the city's public works director Joe Beno. "We're continuing our effort to be excellent stewards of the environment, while beautifying our park spaces and adding to the vibrancy of this important commercial corridor."

Once the project to resurface Madison Avenue is completed, designated bike lanes will be installed for each direction of traffic. To ensure the safety of bicyclists, the 28 angled spaces were removed and replaced with 14 parallel parking spaces.

Lakewood Continues Tree City USA Tradition

Colin McEwen
4.01.2015
Volume 11, Issue 7, The Lakewood Observer

For the 38th year, the Arbor Day Foundation has named the city of Lakewood a "Tree City USA" to honor the city's "commitment to effective urban forest management."

The Arbor Day Foundation — in cooperation with the National Association of State Foresters and the USDA Forest Service — sponsors the Tree City USA program.

"Trees clean the air, shade our homes, reduce energy costs, beautify our neighborhoods, improve storm water management and increase property values," said Mayor Michael Summers.

A long-standing Tree City USA award recipient in Northeast Ohio, Lakewood has consistently met the national standards required for the prestigious award.

The four standards of a Tree City USA include:

- A Tree Board or Department: Someone must be legally responsible for the care and management of the community's trees. This may be a volunteer tree board, a forestry department, or a professional forester or arborist.

- A Tree Care Ordinance: The tree ordinance must designate the establishment of a tree board or forestry department and give this body the responsibility for writing and implementing an annual community forestry work plan.
- A Community Forestry Program with an annual budget of at least $2 per capita.
- An Arbor Day Observance and Proclamation will take place this year, at a time/date to be determined.

According to the National Arbor Foundation, meeting the four standards for becoming a Tree City USA "tells visitors that here is a community that cares about its environment, and is also an indication to prospective businesses that the quality of life may be better in that community."

Summers said the city is proud to accept the recognition but added that there is still work ahead.

"A lot of our at-risk trees are in our backyards," he said. "The city has an opportunity to contribute, but residents and business owners can also help us grow our tree canopy; we've all got a role to play."

Among the city's goals is to increase the tree canopy by 10 percent, to 38.5 percent by the year 2035.

The city's forestry department and Lakewood Tree Task Force have developed a comprehensive strategy to improve the tree canopy and add diversity to the variety of species around the city.

In just two years, the organization has already helped plant dozens of trees at Madison and Lakewood parks, presented 19 recommendations to Lakewood City Council supporting tree legislation and worked with the city's forestry department to plant nearly 600 trees around Lakewood.

The city's strategy also includes an effort to prepare the city for climate change, add diversity to the urban forest, withstand pest infestations and storms, and add in trees with more fall colors. More trees also means less storm water runoff.

"Everyone benefits when elected officials, volunteers and committed citizens in communities like Lakewood make smart investments in urban forests," said Matt Harris, chief executive of the Arbor Day Foundation. "Trees bring shade to our homes and beauty to our neighborhoods, along with numerous economic, social and environmental benefits."

Investment in Sewer Projects Spurs Rate Hike

Colin McEwen
01.06.2015
Volume 11, Issue 1, The Lakewood Observer

Increases in water and sewer rates are expected to be the norm around Northeast Ohio this year — and during the next several years — as municipalities attempt to meet the challenges of an aging water and sewer infrastructure, while complying with EPA mandates. Lakewood is no different. On December 15, 2014, the city administration and Lakewood City Council agreed to increase water and sewer rates effective January 1, 2015. Customers will begin receiving bills with the new rates starting mid-January to early February.

Water rates will increase 10 cents, or 1.5%, over 2014 rates—from $6.24 per ccf to $6.34 per ccf, where one **ccf** is equal to 100 cubic feet or approximately 748 gallons.

- This slight increase is to support an automatic meter reading system that will be completed in 2015. The project has been completed in the eastern two thirds of the city, with approximately 6,000 residential meters remaining to be installed in the western third of the city.
- The $3.8 million project mentioned above is a new, wireless system which will not only replace the current outdated system, but will also result in more accurate measuring and real-time monitoring of water usage. This means that leaks can be detected and repaired faster for the City's water customers.
- Sections of Blossom Park, St. Charles, Summit, Athens and Woodward will be having new water mains installed during 2015.

Sewer rates will increase 5% over 2014 rates—from $4.72 per ccf to $4.96 per ccf.

- The sewer bill increase is required for the City of Lakewood to continue to develop and implement strategies for compliance with the regulations required by the Federal Clean Water Act of 1972.
- Lakewood's continued work with the EPA to develop an integrated wet weather improvement plan to eliminate combined sanitary and storm sewer overflows into Lake Erie and the Rocky River involves the City's measuring and modeling of its sewer system to develop appropriate, cost-effective and environmentally sound solutions to problems created by overflows.
- Projects underway in 2015 include West End Sewer Improvements, Edgewater Ave. Sewer Separation, and a Clean Water Pilot Study (southwestern section of Lakewood from Delaware to Hilliard and from Woodward to McKinley).

There is a special homestead exemption that reduces water and sewer bill charges for any homeowner who is 65 years of age or older—or is permanently disabled—with an income below $35,000 per year.

If you feel you may qualify, if you would like to set up monthly ACH payments, or if you have any other questions, please contact the **City of Lakewood's Division of Utility Billing at (216) 529-6820.**

New Downtown Parking Lots Part of an Effort to Improve Stormwater Management

Colin McEwen
9.30.2014
Volume 10, Issue 20, The Lakewood Observer

The recently finished parking lots in downtown Lakewood provide more than spaces for vehicles to park. They're also good for the environment.

The idea behind the improvements — at the two lots between St. Charles and Cook just north of Detroit Avenue — was to reduce stormwater runoff from the parking lot to the storm sewer.

"We wanted to capture the water, allow it to slowly drain into the ground instead of going into a catch basin and possibly affect the combined sewer overflow," said Joe Beno, the city's director of public works.

The city obtained a $150,000 storm-water improvement grant from the Ohio EPA's Surface Water Improvement Fund to help pay for the $400,000 project.

The concrete medians separating the lines of cars were ripped out, and replaced with a pervious paver drainage system. The project also included planting about a dozen new trees, as well as the addition of two bio-swales at the corners of the lots.

"This has a direct impact on the amount of water that goes into the overflow," added Beno. "This will reduce the amount of combined sewer overflow — and that's a good thing."

Most of the work was completed last year, but the contractor recently applied a final seal to the asphalt and raised a few of the pavers that settled during the past year.

In addition to new pavement, the two parking lots now have kiosks allowing motorists to pay for parking with a credit card, or by using an app on their cell phones. Additional signs will be added to aid with the visibility of the space numbers in the winter.

Improvements to the sidewalks and adjacent drive aprons are expected by the end of 2014; 10 additional lights are also being added to the lots.

MEDIA MONITORING EMAILS TO CLEAN WATER LAKEWOOD TASK FORCE

Below are the three separate media monitoring emails sent to the Clean Water Lakewood Task Force.

The goal of sending these emails was to get the Task Force engaged on the issue and understanding its context outside of Lakewood.

The first media monitoring email was sent on 8/4/2015.

Hello Clean Water Lakewood Working Group,

Approximately every 2 weeks for the next 6 weeks you will get an email with recent news articles in regards to either stormwater, green and grey infrastructure, sewage treatment plant upgrades, or combined sewer overflows. This is the first email.

Our next meeting starts at 7pm, August 11th at Lakewood's Waste Water Treatment Plant (1699 Cleveland Metro Park Drive).

Here are a few recent articles that may be of interest:

1) *AP Investigation: Filthy Rio Water a Threat to 2016 Olympics. This article states how the lack of sewage treatment affects Olympians training in Rio for next summer's games.*

2) *Northeast Ohio Regional Sewer District (NEORSD) posted a series of photos showing the waste water treatment network under our feet heading to the plant*

3) *Lakewood's Waste Water Treatment Plant launches pilot study to better manage overflows*

4) *Toronto and Calgary were hit with heavy flooding in 2013, forcing them to react with a new strategy*

Photos below are from twitter and may give you a good idea of some grey infrastructure before our tour of Lakewood's waste water treatment plant on August 11th.

1) *NEORSD shows a photo of their crew in one of their sewer tunnels. This gives you an idea of scale.*

2) Here is a photo that NEORSD tweeted of their sewer crews working on the Edgewater CSO flap gate:

Media Monitoring email sent to Clean Water Lakewood Volunteers on 8/17/2015

Hello Clean Water Lakewood Working Group,

Here is the 2nd installment of media monitoring. There are many varieties of green infrastructure that we will be learning about next Wednesday, August 26th at 7pm. We are meeting at the Watershed Stewardship Center in Parma (2277 W. Ridgewood Drive).

The first two articles detail two green infrastructure ideas other cities are working on.

1) *A New Playground in the Bronx Soaks Up the City's Problematic Storm Water*

2) *D.C.'s Polluted Rivers Are Getting a Green Makeover*

3) *Citizens Share Ideas for Lakewood's Downtown Development: Any redevelopment in Lakewood should consider opportunities of redeveloping in a way that also helps us meet our OEPA permit requirements through reducing: stormwater runoff, stress on Lakewood's sewer system, and/or combined sewer overflows. Make sure to click on the link to a pdf in this article, showcasing 3 development options up for discussion 6:30PM on Wednesday, August 19th at Univ of Akron, Lakewood campus.*

4) *In case you wanted to see another sewage treatment plant, NEORSD is hosting an open house on Saturday, September 19th which includes a plant and lab tour and several educational exhibitors to talk about water-related issues in Cleveland.*

Below is a photo from Twitter showing some green infrastructure installed in San Francisco.

Media Monitoring email sent to Clean Water Lakewood Volunteers on 9/10/2015.

Hello Clean Water Lakewood Working Group,

Below is the 3rd and final media monitoring email. Our goal was to start off the working group with a few recent articles every two weeks to keep us all informed of water news that relates either to this project or region. We hope you enjoyed them.

Here are three recent articles that emphasize the value of our water:

From rustbelt to bluebelt: Could water be the Midwest's ticket to economic rebirth? The Economist, Aug. 1, 2015. While this article doesn't specifically mention Cleveland, it certainly applies to this region.

Waukesha Plan for Lake Michigan Water Raises Worries. New York Times, Aug. 25, 2015. The 2008 Great Lakes Compact is being tested by a suburb of Milwaukee that hopes to divert water from Lake Michigan due to their aquifer being contaminated and running low.

Underground man-made cavern being turned into giant pump station to help clean Lake Erie. The Akron Beacon Journal, June 15, 2015. This article notes tunnels that Cleveland and Akron are working on in regards to their combined sewer overflow challenges.

We look forward to seeing you at our next meeting on ***September 15, at 7pm*** *at the University of Akron, Lakewood campus. I may be on maternity leave by that time; please note that Jennifer Brown (jbrown@ctconsultants.com) will be taking my place as email communicator for the next few meetings.*

INFORMATIONAL FLYER

This flyer was included with everyone's water bill during the spring of 2016. It was two-sided and its intended purpose was to help the community understand the Clean Water Lakewood initiative as well as to introduce them to the new dye-testing policy.

DIVISION OF HOUSING AND BUILDING
12650 DETROIT AVENUE • LAKEWOOD, OHIO 44107 • 216/529-6270 • FAX 216/529-6930
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DRU SILEY
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216/529-6634

MICHAEL J. MOLINSKI, R.A.
CITY ARCHITECT
216/529-6279

JOSEPH A. MEYERS
ASSISTANT BUILDING COMMISSIONER
216/529-6293

DYE TEST FAQ'S

February 2016

What is a dye test?

Dye is injected into each exterior storm connection (downspouts and drains), and flushed through with water. A city representative will verify which sewer the dyed water exits in the street. If the water exits the storm sewer the test passes, if it exits in the sanitary sewer, corrections will be needed.

Why is a dye test required?

The Environmental Protection Agency has mandated that the City mitigate storm water drainage into the sanitary sewer system to prevent effluent from entering waterways during heavy storm conditions. Sanitary connections to storm sewers are likewise prohibited. Read more about this on the reverse side.

When is a dye test required?

Prior to **any** work on the *underground* storm system: new construction, additions, laterals, drains, waterproofing, water controlling, etc. A dye test is **not** currently required for *aboveground* work on gutters and downspouts.

What if incorrect connections are found?

If a sanitary connection to the storm system is found, the problem must be corrected within 90 days. If a storm connection to the sanitary system is found, only ***new work must be properly connected***. The homeowner is encouraged to remediate all incorrect connections. Improper connections outside of the planned work area may be required to be capped or splashed at the direction of the City.

What if I have a combined sewer system?

If major work is to be done we strongly recommend making the separation at this time, while the excavation is open.

How do I order the dye test, and what is the cost?

Call the Building Department at 216-529-6270, provide your name, phone number, the address where the work is to be performed, and a brief description of the work. The average lead time is two weeks and there is no cost for the initial test.

What else do I need to know?

1) After the work is complete, but before covering, you or your contractor will be responsible for performing a verification test to confirm the work has been properly connected to the city sewer system. This must be performed in the presence of a city representative and can be coordinated with your Building Inspector.
2) Splashing of downspouts is an acceptable solution as long as water is carried away from the foundation and no nuisance is created.
3) Dye Tests are valid for 5 years.

CLEAN WATER LAKEWOOD

Rebuilding the Pipeline for Our Future

LAKEWOOD OHIO

Clean Water Lakewood is an ongoing program aiming to better manage our combined sewer overflows and continue efforts to protect our important natural resources.

What are combined sewer overflows?	It is rainwater mixed with raw sewage from residential properties that overflows into Lake Erie and the Rocky River.
Why does this happen?	Overflows occur during rain events when the stormwater exceeds the capacity of the pipes and the sewage treatment plant.
Why do we need to fix this problem?	The city is looking for proactive ways to eliminate overflows in Lakewood in order to protect our important natural resources. Also, it is a federal mandate to become compliant with the Clean Water Act of 1972.
Who needs to be involved? Everyone.	A major source of the overflows start at the household level. Residents should strive to be educated and engaged on this matter as it will require a sizable financial investment in sewer upgrades. We need public input and support.

You can learn more by visiting www.onelakewood.com/cleanwaterlakewood, calling the Mayor's office at 216-529-6093 or following the city of Lakewood on Twitter or Facebook.

PHASE 2 PUBLIC ENGAGEMENT
OCTOBER 23, 2018 POWERPOINT

October 23, 2018

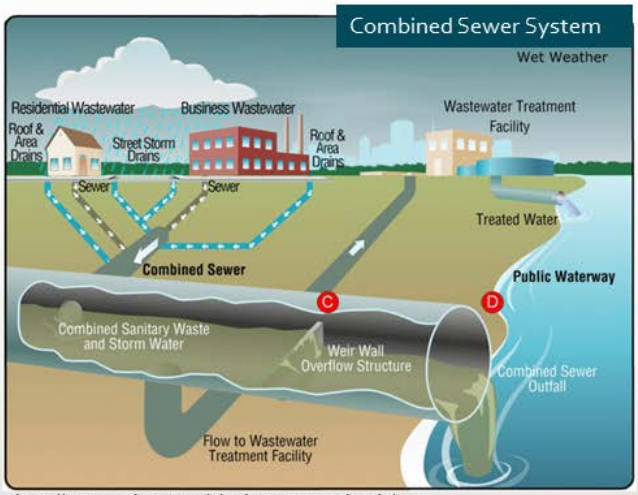
Clean Water Lakewood History

Clean Water Act (1972)

- Establishes structure for regulating discharges of pollutants into water
- Expands upon 1948 Federal Water Pollution Control Act
- Makes it unlawful to discharge any pollutant from a pipe into water unless a permit is obtained
- Establishes National Pollutant Discharge Elimination System (NPDES)
  - A permit program to control discharges from sources such as Lakewood's Wastewater Treatment Plant that discharge to Lake Erie

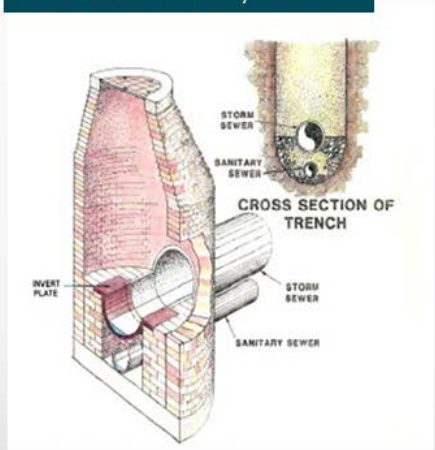
Lakewood has two types of sewers

Combined Sewer System



http://www.pgh20.com/gi-what-can-you-be-doing

"Over-Under" Sewer System



Lakewood's system

Lakewood's investments and efforts are ongoing

Date	Milestone
2002	Began developing sewer plan according to permit requirement
2006	Plan completed
2007-2009	Plan not officially approved; OEPA & USEPA asks for re-characterization study on Lakewood's sewers
2011-2014	Hydraulic and hydrologic sewer model developed
2014	New permit issued, requiring updated plan and a high-rate treatment facility at the treatment plant
2015	New plan submitted, Clean Water Lakewood key in plan creation
2016	Improvements worth $277 million estimated in plan; submitted & reviewed by OEPA & USEPA
2017-2018	Refinement of plan options, evaluation of additional alternatives, affordability
2019	Updated plan due to OEPA & USEPA
2022	High-rate treatment facility to be up and running

More must be done

Mark Delisio and Julia Lazar

More must be done

- Based on flow meter analysis we have refined all of our modeling for:
  - # of overflow occurrences
  - Water quality
  - Volume of overflow
- Following are maps showing ways we can prioritize sewersheds

Prioritization plan due in March 2019 will include:

- Evaluation of cost & effectiveness for various alternatives
- Recommended set of alternatives
- Implementation schedule
- Affordability analysis
  - City's financial capability assessment
  - Sewer rate study

Alternatives were examined and recommended by Clean Water Lakewood & included in 2016 plan submitted to EPA

- Since then alternatives were refined and additional alternatives analyzed
- Project ranking methodology developed. City evaluated alternatives based on:
  - Inconvenience to public
  - Reasonable price compared to other alternatives
  - Useful life
  - Does not increase risk of basement flooding
  - Integration with other projects
  - Willingness to invest in administrative & maintenance duties

Technology categories used to solve overflow problems

- **Green infrastructure**—increasing the ability for the land to infiltrate the water, vs having it runoff the impervious surface
- **Gray infrastructure**—building bigger pipes, storage basins, or treatment plants
- **Source control**—working to decrease the leakiness between the sanitary and stormwater systems

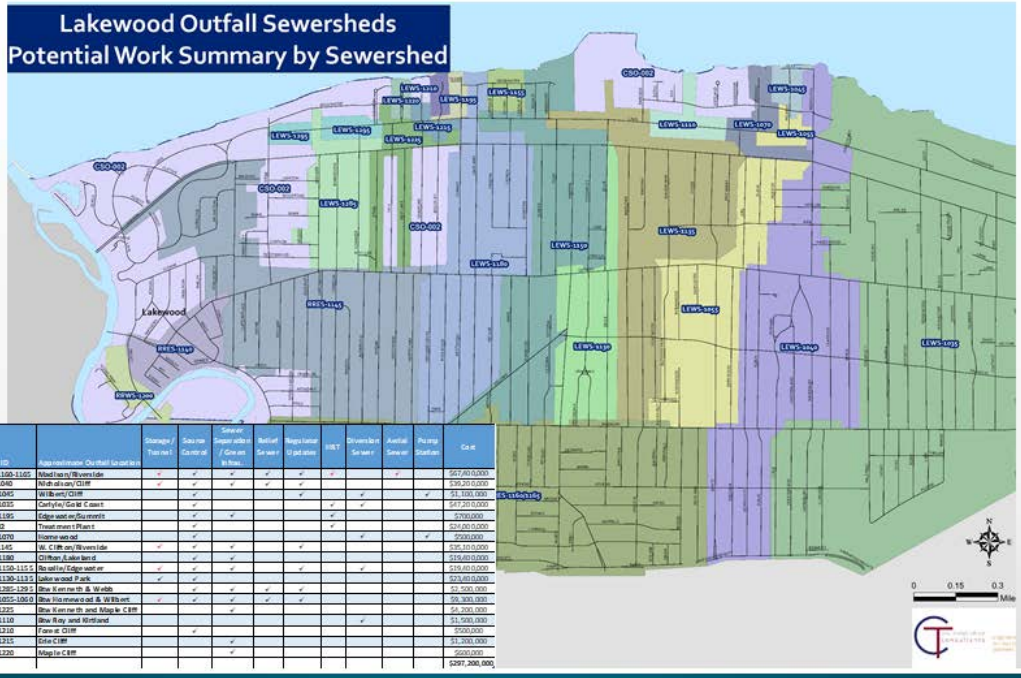
Lakewood is utilizing all three approaches in their planning.

Thorough analysis produced this list of possible projects

Oufall ID	Approximate Outfall Location	Storage/ Tunnel	Source Control	Sewer Separation / Green Infras.	Relief Sewer	Regulator Updates	HRT	Diversion Sewer	Aerial Sewer	Pump Station	Cost
RRES 1160-1165	Madison/Riverside	✓	✓	✓	✓	✓	✓		✓		$67,400,000
LEWS1040	Nicholson/Cliff	✓	✓	✓	✓	✓					$39,200,000
LEWS 1045	Wilbert/Cliff		✓			✓		✓		✓	$1,100,000
LEWS 1035	Carlyle/Gold Coast		✓				✓	✓			$47,200,000
LEWS 1195	Edgewater/Summit		✓	✓			✓				$700,000
CSO 002	Treatment Plant		✓				✓				$24,000,000
LEWS 1070	Homewood		✓					✓		✓	$500,000
RRES 1145	W. Clifton/Riverside	✓	✓	✓		✓					$35,100,000
LEWS 1180	Clifton/Lakeland		✓	✓							$19,400,000
LEWS 1150-1155	Rosalie/Edgewater	✓	✓	✓		✓		✓			$19,400,000
LEWS 1130-1135	Lakewood Park	✓	✓								$23,400,000
LEWS 1285-1295	Btw Kenneth & Webb		✓	✓	✓	✓					$2,500,000
LEWS 1055-1060	Btw Homewood & Wilbert	✓	✓	✓	✓	✓					$9,300,000
LEWS 1225	Btw Kenneth and Maple Cliff			✓							$4,200,000
LEWS 1110	Btw Roy and Kirtland							✓			$1,500,000
LEWS 1210	Forest Cliff		✓								$500,000
LEWS 1215	Erie Cliff			✓							$1,200,000
LEWS 1220	Maple Cliff			✓							$600,000
											$297,200,000

Red indicates further study needed & not included in cost.

Cost=100 year life cycle present worth value



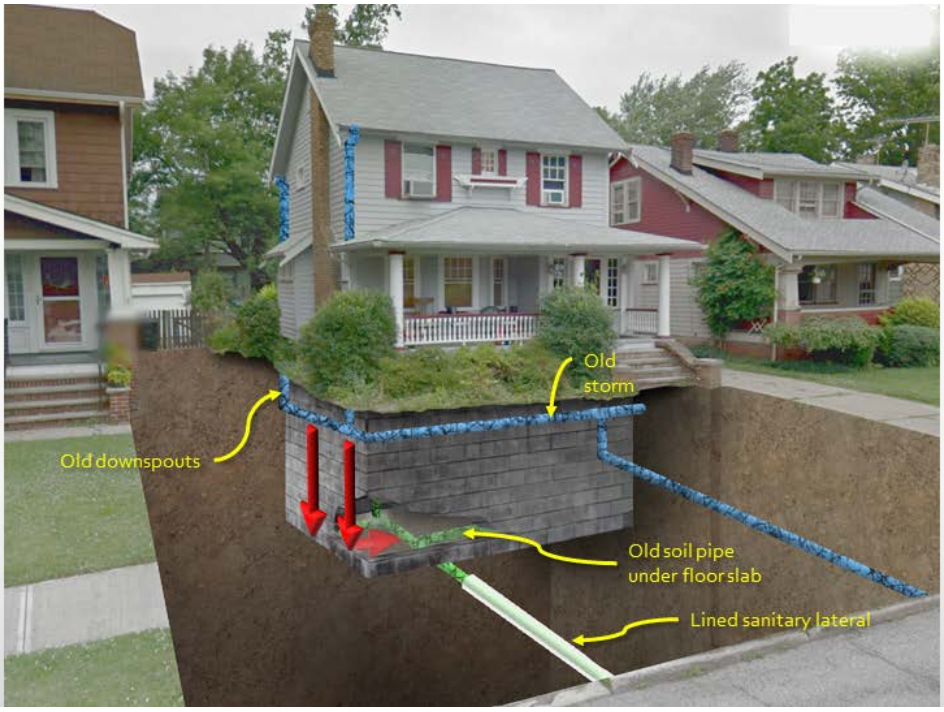
Private property is part of the solution

- Pilot study including 100 homes on Eldred, Atkins and Delaware Avenues
- Aimed to significantly reduce rain water from entering sanitary sewer
- Work done on sewers in the street as well as on private property

Manhole separation in pilot study

What have we learned from pilot study thus far?

- The old pipes are often cracked and clogged
- Cracked pipes cause interaction between the storm and sanitary laterals even after the clogs are flushed out
- Water from roofs most often ends up in sanitary sewer



What are contractors doing to remove this excess water?

Installing pipes along perimeter of home

- Cleaning laterals, relining as needed
- Replacing pipes along perimeter of house that receive stormwater only
- Connecting driveway drains to storm sewer
- Installing sump pump if needed

Questions we hope to answer with this study

- Are flows reduced enough to reduce overflows?
- If results show this as a success, how does the public perceive this work?
- Learning from the pilot study, what works best?
- Is this the least expensive way to solve some of our overflow problems?

Post-construction view

ANSWERS TO THE QUESTIONS ASKED DURING THE OCTOBER 23, 2018 MEETING:

Questions from October 23, 2018 Meeting:

1. How many houses in Lakewood have comingled storm and sanitary lines?

   There isn't a survey of every house, but based on experience and the pilot study there is a high percentage of houses that have a downspout or other storm water drain connected to the sanitary lateral, or other pathway from the storm lateral or footer drains that gets into the sanitary sewer under the house or out to the street.

   Approximately 3200 homes have combined sewers, where sanitary and storm water are conveyed to the public sewer through a single pipe. Some homes have separate storm and sanitary lines that join together as a single pipe at the property line.

   Approximately 7600 parcels have two separate laterals (mostly in a single trench), one sanitary and one storm, which convey water to the public sewers. The pilot study revealed that most storm laterals have a plugged trap which can force storm water into the sanitary system.

2. Is fixing the comingled lines a homeowner's responsibility? Yes

3. Did the NEORSD use integrated planning?

   The NEORSD's planning was done in 2011 prior to the advent of integrated planning. In addition, the NEORSD is a regional sewer district. Integrated planning was really created to be used at the local collection system level. The Lick Run project in Cincinnati was one of the first integrated planning projects and allowed the federal EPA to see the value of integrated planning at the local level. Instead of a big underground tunnel, Cincinnati was able to do surface planning and revitalization at the same time they contemplated the sewer infrastructure upgrades to meet its compliance obligations. This allowed Cincinnati to access outside money from ODOT money to rebuild roads, Brownfield dollars to clean up a foundry, money to rebuild water infrastructure all of which allowed private investment into a declining area.

   Integrated planning is a framework to create a plan.

4. What material are private property pipes in Lakewood typically made of?

   Most Lakewood homes are older so most of the underground pipes are made out of segmented clay tiles called Vitrified Clay Pipe (VCP). There are some iron pipes and the newer pipes are made out of PVC.

5. How much I/I was removed from the Pilot Project?

   Phase 2 of the pilot project is not complete yet, so full flow data is not available. Once construction is complete flow monitoring equipment will be installed and we will be able to collect flow data and analyze it to determine the full amount of reduction of storm water entering the sanitary sewers.

6. How many different watersheds are there in Lakewood and is there any storm water burden flowing into Lakewood from other cities or regions?

   Lakewood is in the Lake Erie and the Rocky River watersheds. However there are 15+ sewer sheds within Lakewood as shown on this map. (LINK TO THE SEWER SHED MAP) Generally we do not have southern storm or sanitary pipes coming into Lakewood sharing Lakewood's sewer pipes.

We do take some sewer flow from one city of Rocky River neighborhood; the sewage flow is small in nature and we charge the city of Rocky River for this service. Also, Cleveland's western interceptor may interact with Lakewood sewers. Gathering information and modeling that interaction is ongoing.

7. Can we shut off the valve to the NEORSD at 117th street?

   There is a western Cleveland interceptor that runs down 117th Street. In dry weather Lakewood may get some of that water, in wet weather Cleveland/NEORSD gets some Lakewood water. While we have considered overflow options such as working with NEORSD, we are focusing on the options the city has full control over. Cleveland and NEORSD would both have to be in agreement with Lakewood to utilize any pipes or systems belonging to them.

8. Fixing the current infrastructure ($150 million) also has some compliance factor in it, correct? (In response to the spreadsheet in the affordability section)

   Yes, there is overlap between maintaining/fixing current infrastructure and compliance.

9. Why does the 2% reduction in water consumption keep happening?

   We are seeing a 2% per year reduction in water consumption across the industry, not just in Lakewood. Why this is happening relates to: higher efficiency appliances, individual understanding of water conservancy, and lower density households (smaller families).

10. Will the affordability review encompass all costs/expenses of living in Lakewood not just the water and sewer bills? (i.e. real estate taxes, income taxes, school levies etc.)

    Yes. This presentation is focused on water and sewer billing/affordability, but the affordability study will encompass all costs of living in Lakewood such as schools, taxes and other utilities.

11. Is there a certain number of years within which we must have these upgrades/changes/increase in % of water treated?

    Yes, 15 – 100 years. As a city the more time we have the more affordable any solutions become. The city and the EPA will have differing opinions on what is the appropriate amount of time to effectuate change.

    - What about issuing Bonds? What about revolving loans from the state?

    Absolutely, we are considering all options and welcome creative thinking and options from the community as well. For example, the new HRT Plant is almost fully funded by Ohio Public Works (OPW) loans at 0% and Division of Environmental and Financial Assistance (DEFA) loans at 0-1%. But - we still have to pay it back.

12. When you looked at the median income numbers how did you handle all of the rental properties? Did you consider the Landlord's income or the tenants' income?

    The information was based on census data – whoever completed the census data at that address – typically that is the tenant. It is not a perfect science but it is in the information we have available to us.

13. As we review engineering options will there be a chart that includes the benefits and benefits v. costs of each option?

The engineering model is able to provide the benefits of a solution in terms of water captured/treated or pollutants removed or frequency of overflows. But it is important to get feedback from the community to understand what options they feel are important and rerun the model based on that feedback. The community may change its opinions or choose various options based on the cost, the inconvenience, the time involved, the interruption involved. The EPA and the community will have differing views with regard to all of these factors so as a city we need to determine what the most appropriate solutions are for our community and advocate for that plan with the EPA. As a community we want to propose the solution, we do not want the EPA to decide, but ultimately we both need to agree on a solution.

14. There are so many moving parts to this project. Do we know where we are going and where we want to be in 5, 10, 15 and 20 years? Do we know when we are done?

We want to continue to demonstrate our progress towards compliance. With the installation of the HRT system we will be at 88% capture and treatment of our water. We have worked hard to get there. Let's say we are thinking we want to get to 93% -- how do we get there? We are seeking time and flexibility to make these changes. Even if we have $300 M right now, we aren't confident that the engineering is that perfect or that there won't be engineering advancements and changes or new ideas and inventions in the future that would provide alternate or more efficient solutions. We want the flexibility and the time so we are executing the most affordable solutions with the highest effectiveness.

15. Have we taken a look at the cost of every percentage point of treated water gained and how much it will cost to gain every percent of treated water in the future?

Yes. There is definitely a point of diminishing returns where investing more money fails to advance the collection of more water to any great percent. For example for some of these options we could spend $70M and gain 3% more in collection and treatment of water. Later in the process we can spend $70M and gain only 0.5% in additional water collected and treated.

We have been meeting with the staffs of Senator Portman, Brown and Kaptur about this issue. They understand the important fact that Lakewood could spend $270M and we won't solve the biggest problem which is the runoff from the Maumee Valley. Even if Lakewood becomes pure we are not going to clean up the western basin of Lake Erie which is the big problem. For example if we would divert $100M from us to them it probably would have more impact, but we do not have that luxury.

16. Are we comparing ourselves with other communities?

Yes. The reason we are addressing this now is that it is our turn. We are not unique with having to deal with this EPA compliance issue. We need to think through this really well: cost efficiencies/affordability and effectiveness.

Milwaukee has completed their compliance plan and they are in the process of monitoring it and it is working well. Compliance planning is possible to be contemplated, created and constructed in a way a city wants, that is effective and supports EPA compliance at the state and federal level.

Seattle is a city that has done integrated planning. Seattle wanted to know what is the best investment for them – was it storm water control or CSO Control? The state wanted Seattle to focus on CSO controls. Seattle was however able to come to an agreement with the Federal and Washington State EPA to focus on projects with the greatest environmental benefit first, thereby making storm water projects a high

priority. They did not get rid of any obligations, but they were able to negotiate and prioritize the projects. They were able to spend the upfront money on the projects that mattered most to its community – to reduce the suspended solids and other contaminants being released into the local waterways. That is the way Lakewood wants to structure the plan for Lakewood – come up with the plan that prioritizes getting the biggest bang for the buck and focusing on the projects that mean the most to the community.

The financial burden is a big part of this. We need to take measured bites at this apple – it should be measured over an appropriate period of time. Looking at percent gain for specific improvements is a good way of looking at it. Need affordable levels of control.

We only want to make the next best investment for the foreseeable future. Need to negotiate a phased approach over ten year time. What is the priority we want to focus on in the next 10 years: frequency of flow; pounds of pollutants going into the water way – what is the best bang for the buck?

17. How do we become or beat Milwaukee?

Well the Milwaukee community is not done. The government may not push them much further but the community wants to start incorporating a large green infrastructure plan to capture even more water to prevent overflows in the future.

18. In the Pilot Project, what % of storm water is coming off of private property (homes) v. what is coming from the streets?

The average imperviousness of Lakewood's surface is about 60-70% in the city. The portion of roadways versus rooftops and driveways contributing to storm water run-off is: about equal, with 30% rooftop and driveway runoff and 30% runoff from streets.

19. Will there be financial models, spreadsheets and data we can review? Are there engineering models and data we can review?

Raftelis, a financial consultant for the city, has created a financial modeling tool which can take the financial costs/payments out 100 years on a project basis. You will have the opportunity to look at this model. We have serious affordability challenges. As a city we are working hard with our U.S. Senators to be an ally in this – do not ruin a city like Lakewood by making the community deal with onerous obligations based on affordability. What is common sense and what is impossible?

There will be engineering data available reflecting the engineering data the model produces.

20. Has there been an analysis of the current infrastructure's useful life so that projects can be identified to match that useful life so as not to waste opportunity?

Yes, but it can be improved. Part of our obligation is identification of and understanding of our assets. For asset identification and understanding we are talking about more than just our pipes, we are talking about all of our city assets: heavy equipment, buildings, parks and all city assets as a part of this.

Raftelis and Brown & Caldwell have been reviewing all of the water and sewer assets and coming up with a plan for maintenance and replacement based on useful life. We will be able to pair this information with potential projects for timing.

NOVEMBER 15, 2018 POWERPOINT

CLEAN WATER LAKEWOOD
Joint Task Force Meeting

November 15, 2018

Lakewood Women's Pavilion

Tonight's Agenda

- **Introduction/ Overview**
  - Mike Summers, Mayor of Lakewood
- **Workshop Overview / Exercise Instructions**
  - Melissa Elliott, Raftelis – Meeting Facilitator
- **Small Group Discussions: Round One, Two, Three & Four**
  - All participants
- **Wrap-up / Walk Through Workshop Input**
  - Melissa Elliott, Raftelis – Meeting Facilitator
- **Thank You / Next Steps**
  - Mike Summers, Mayor of Lakewood

Tonight's Objectives

Your role:

- **Provide input about the issues, plans and challenges**
- **Be a critical listener and thinker and express your opinion on behalf of your community tonight**
  - Provide feedback to improve future public meetings
  - Prepare yourself to help with future public meetings
  - Provide creative ideas to address conventional problems
- **Help narrow options for further Clean Water Lakewood community discussions**
  - **December 4 Community Conversations**
  - **January 16 Open House**

Clean Water Lakewood Team Members

City of Lakewood- Administration

Mark Papke, City Engineer
Joe Beno, Director of Public Works
Jennifer Pae, Finance Director
Kevin Butler, Law Director
Brian Shields, Project Manager
Katelyn Milius, Planner & Engineer
Shannon Strachan, Exec Ass't to Mayor
Mike Summers, Mayor
Justin McCaulley, Gov't Advocacy

CT Consultants, Inc.

Bob Greytek
Julia lazar
Mark Delisio
Craig Juday

McMahon & DeGulis, LLP

Lou McMahon

Raftelis, Inc.

Joe Crea
Melissa Elliott

Brown & Caldwell

Andy Lukas

Joining Us this Evening

- City Council Members
- Clean Water Lakewood Task Force
- Lakewood Resiliency Task Force
- Other City Boards & Commission Members
  - Audit, CAC BZA, ABR, Keep Lakewood Beautiful, Planning Commission
- Other City Administration
  - Alex Harnocz, City Planner, Liaison to Resiliency Task Force
- ReThink Advisors, Inc., Irwin M. Lowenstein
- Lakewood Residents

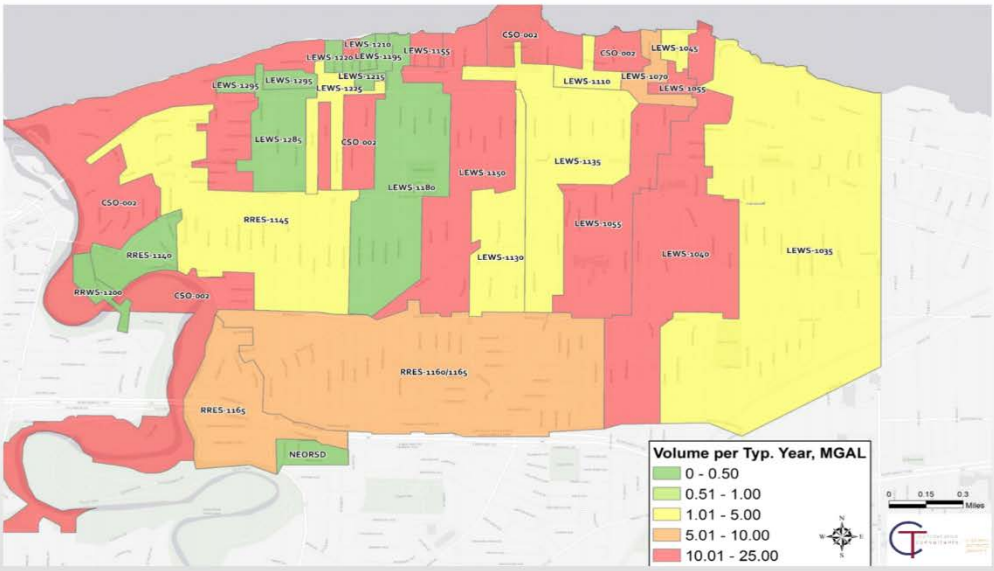
Workshop Overview / Exercise Instructions

Melissa Elliott
Meeting Facilitator

Round 1: Prioritize Outfalls

Phase 2 Report, Implementation Schedule

Overflow Volume



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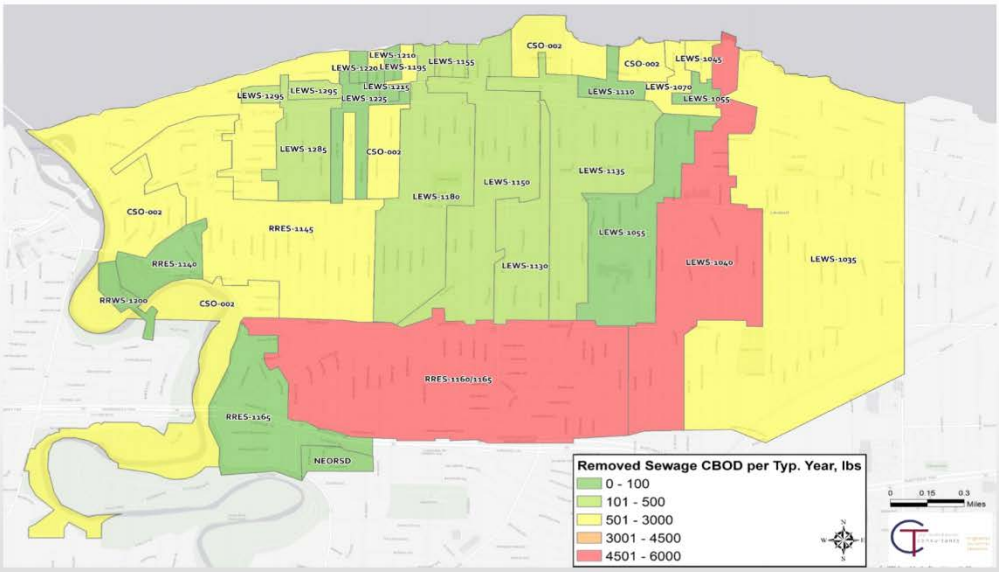
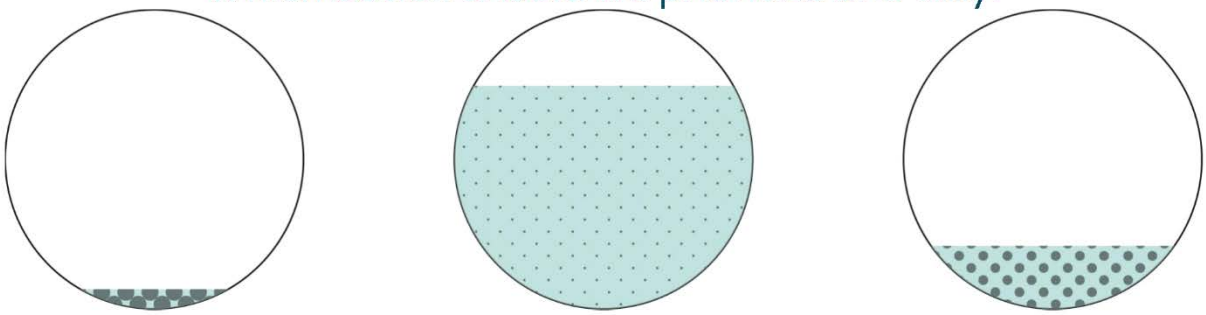


Which outfall should we prioritize and why?



Combined Outfall A:
Less Stormwater, More Sanitary Sewage

Low Gallons/Year

FOCUS ON POLLUTANT CONCENTRATION

Combined Outfall B:
Mostly Stormwater

Highest Gallons/Year

FOCUS ON VOLUME

Combined Outfall C:
Stormwater & Sanitary Sewage

Highest number of overflow events/Year

FOCUS ON FREQUENCY

Round 1: Prioritize Outfalls

1. Compare three outfalls that must be mitigated. Which outfall would you prioritize as the most important to work on and why?
   - Outfall A: High concentration of pollutants, minimal overflow volume
   - Outfall B: Low concentration of pollutants, but high overflow volume
   - Outfall C: Average concentration of pollutants, but overflows the most frequently
2. Given that we must prioritize our work, is it more important to make improvements to reduce pollutants flowing to Rocky River or to Lake Erie? Why?

Round 2: Integration and Disruption Trade-offs

Phase 2 Report, Recommended set of Alternatives

Relief Sewer
Construction
STOP

Storage Construction
KOMATSU

Round 2: Integration and Disruption Trade-offs

1. Should sewer work be integrated with other projects like street repaving or waterline work, or should sewer work be completed as swiftly as possible? Why?
2. What improvements can you think of that could be integrated with sewer work?
3. This work can be disruptive. What is your tolerance for traffic and parking impacts and private property access?

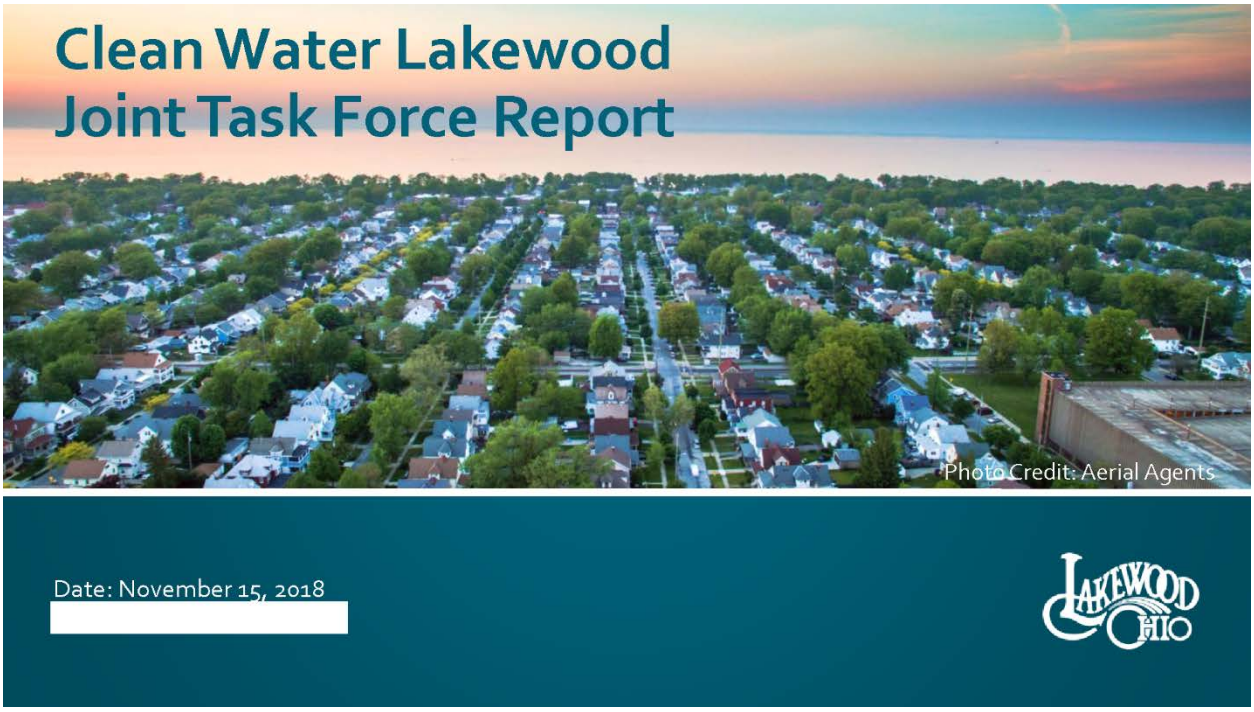
Round 3: Private Property Concerns

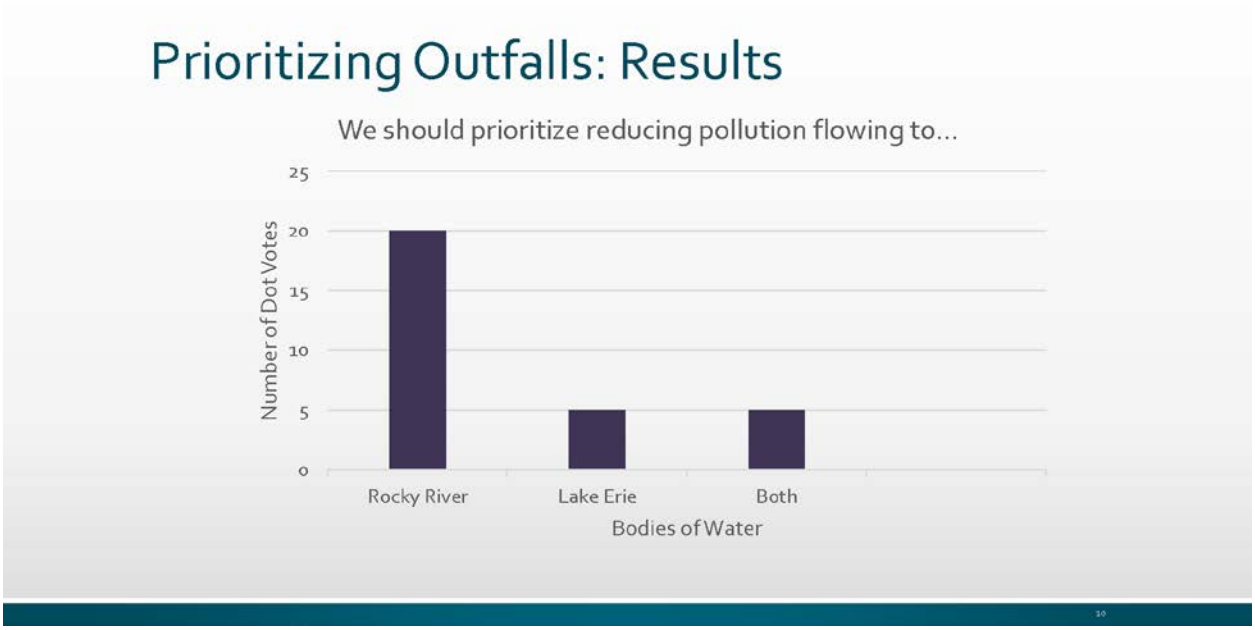
Phase 2 Report, Recommended set of Alternatives

Ongoing public engagement is key—our upcoming meetings include:

- ✓ Oct 23 at 6 pm taskforce workshop at City Hall
- ✓ Nov 15 at 6pm taskforce workshop at the Women's Pavilion
- Dec 4 at 6pm community conversations at Lakewood High School
- Jan 16 at 6pm community open house at Lakewood High School

SUMMARY REPORT FROM NOVEMBER 15, 2018 PUBLIC MEETING


Clean Water Lakewood
Joint Task Force Report
Photo Credit: Aerial Agents
Date: November 15, 2018
LAKEWOOD OHIO


Prioritizing Outfalls: Results
We should prioritize reducing pollution flowing to...
Number of Dot Votes
25
20
15
10
5
0
Rocky River
Lake Erie
Both
Bodies of Water

Prioritizing Outfalls: Requests for Additional Information

- Need more information on which options best protect the lake, cost and who will bear the burden?
- What is the volume flowing into the river vs. the lake today?
- Who has jurisdiction over the flow into Rocky River? Are there other stakeholders?
- Which outfall (river or lake) has the more significant impact on public health?
- How much pollution is upstream of Lakewood's river outflow location?
- What is the economic impact to the river vs. the lake?
- Are environmental ("green") solutions being explored? Are there vegetation solutions that can help manage volume?

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Activity 2.

Integration and Disruption Trade-offs

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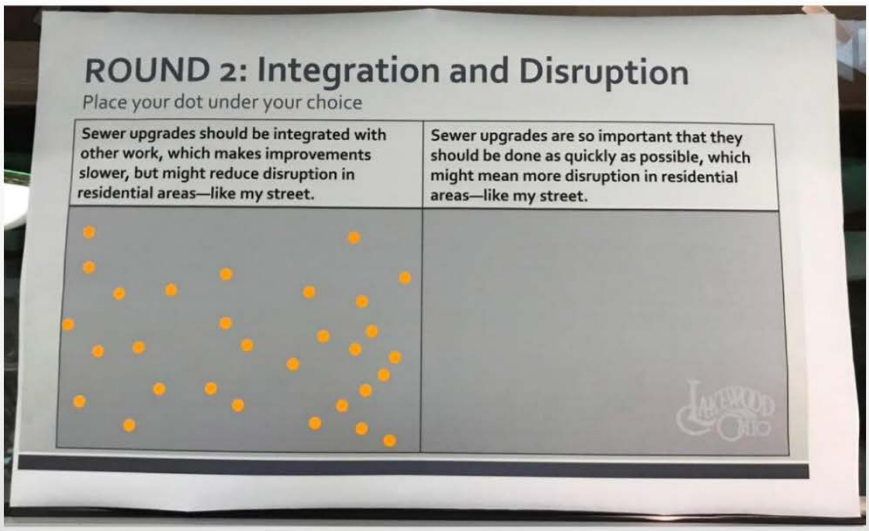
Integration and Disruption



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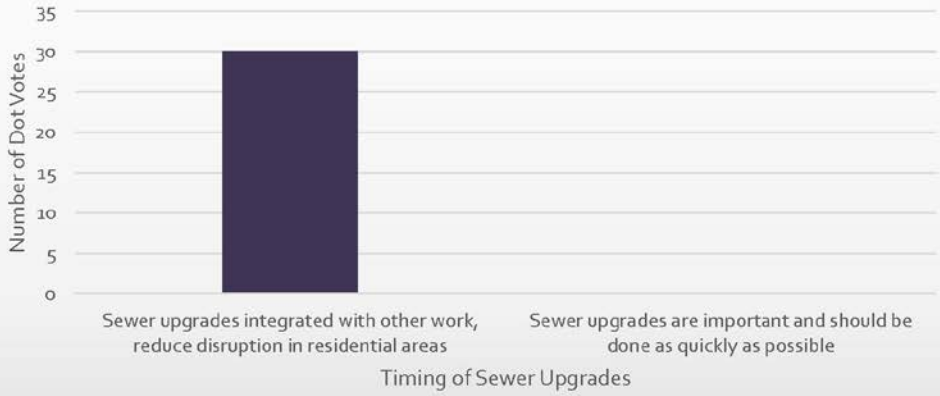
Integration and Disruption



Integration and Disruption
Participant Ideas for Work to Integrate with Sewer Projects

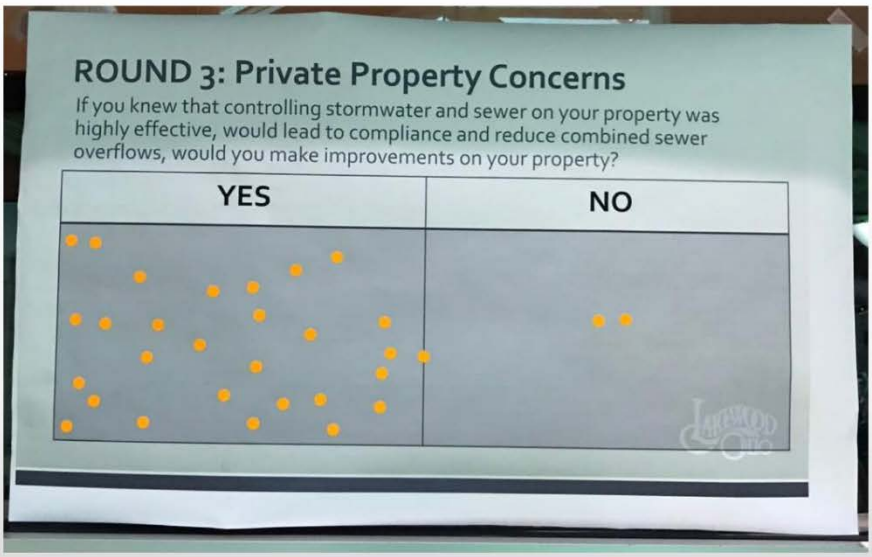
- Traffic calming measures
- Technology upgrades
- Implement a full street plan as part of doing these upgrades (bike lanes, green infrastructure, traffic improvements, paving, etc.)
- Add medians and landscaping as part of each project
- Use the opportunity to bury utility power lines and lay conduit/water lines, gas lines for future infrastructure
- Add sanitary stations for dog waste
- Add fiber optic cable
- Tree pits
- Improve bike and pedestrian lanes, sidewalks and infrastructure
- Introduce pervious materials/permeable surfaces
- Add bioswales
- Add park space on larger sites
- Don't remove trees unnecessarily
- Use federal dollars to assist businesses impacted by construction
- Implement minimum required by EPA to address issue.

15

Activity 3.
Private Property Concerns

16

Private Property Concerns



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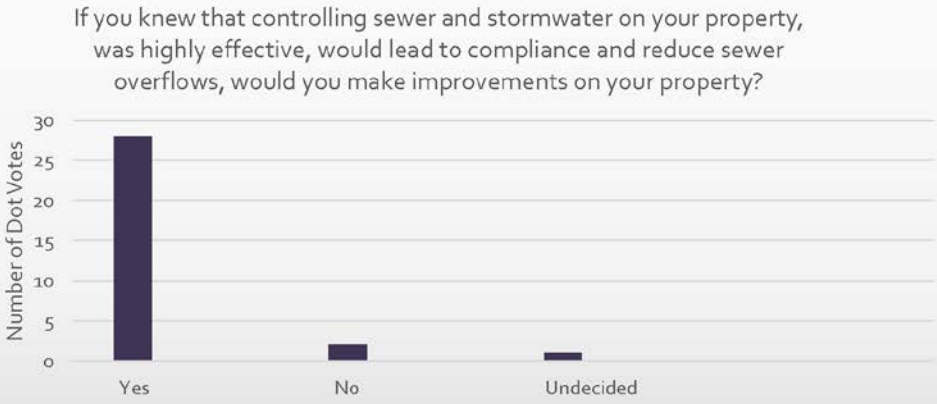
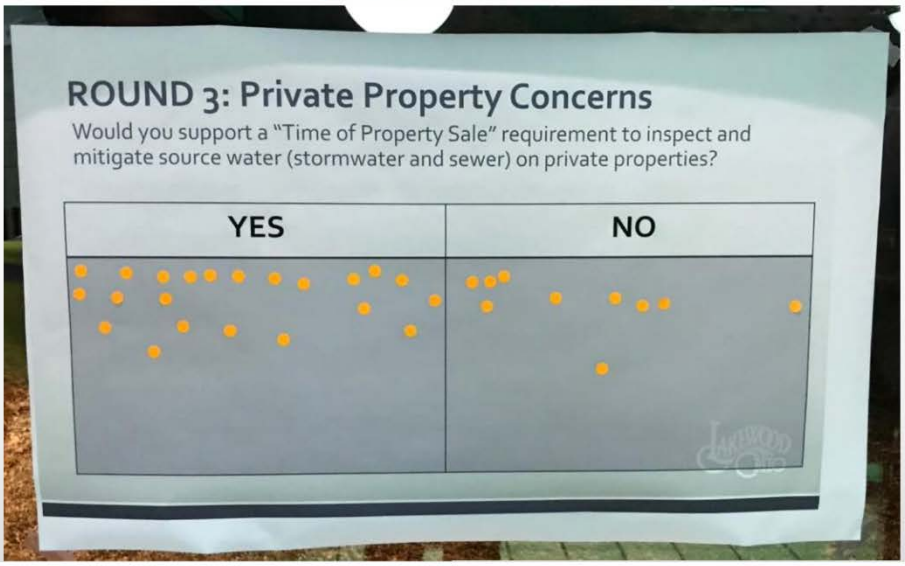
Private Property Concerns: Results



Private Property Concerns



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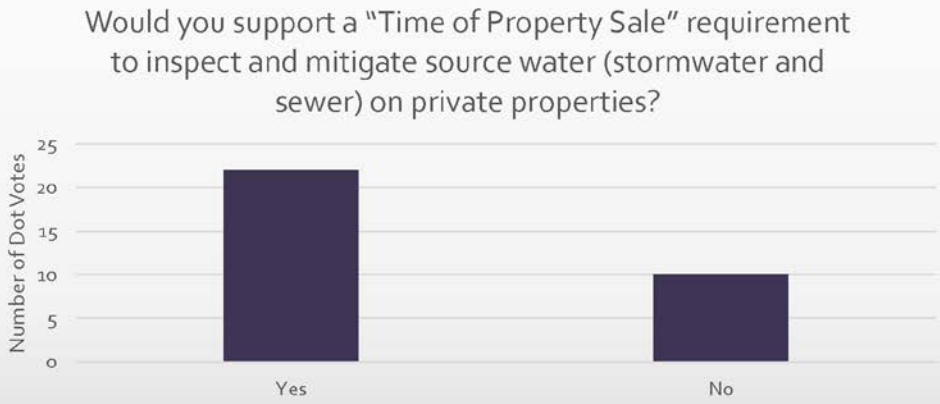
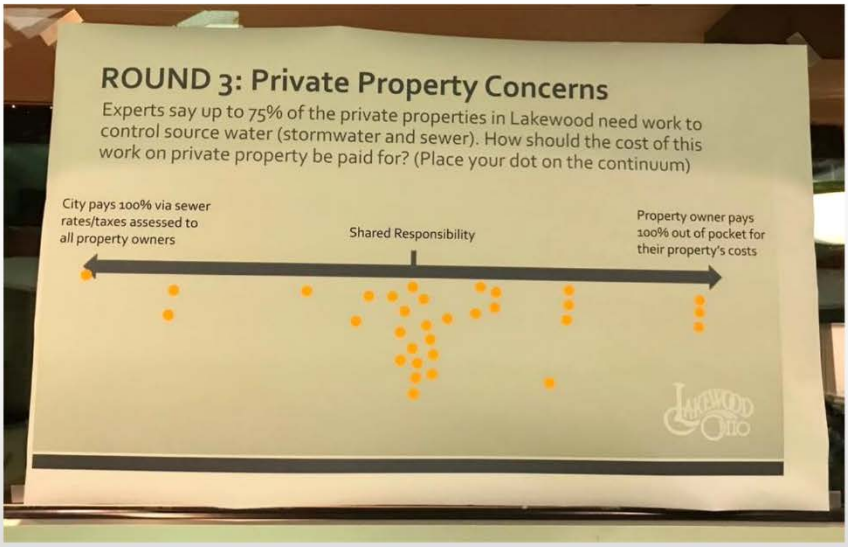
Clean Water Lakewood

- Clean Water Lakewood aims to better manage the City's combined sewer overflows and protect its natural resources to meet the requirements of the Clean Water Act.
- USEPA and Ohio EPA will require that Lakewood treat or mitigate millions of gallons of combined sewer overflow every year to protect Rocky River and Lake Erie.
- The City must invest in public infrastructure and find ways to help its residents and businesses fix private infrastructure that is contributing to the problem.

Private Property Concerns: Results



Private Property Concerns



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Private Property Concerns: Results

Experts say that up to 75% of private properties in Lakewood need work to control source water (stormwater and sewer). How should the cost of this work on private property be paid for?

Private Property Concerns: Additional Suggestions

- Do public work first
- Create an escrow account with the Water Department to start to pre-pay for costs so that the account stays with the property
- The 10K cost for upgrades on my property adds zero equity to my home so why should I do it?
- Why weren't rain barrels considered as an option in the evaluation of the issue?
- Have realtors/owners/sellers determine responsibility
- Attach projects to property tax to keep payments with the parcel
- Use municipal bonds to offer low interest loans for homeowners then use special association tax
- This country prioritizes profits, need to socialize losses – we all need to pay for this
- Could the county sell bonds to pay for this?
- Sharing costs with everyone punishes homeowners who have already made improvements
- Figure out how to help people who can't afford it
- The sale will artificially deflate home values in neighborhoods where this is a problem
- Incentives for getting it done – reduced water bills?
- Provide a list of approved contractors to make it easy
- What are the priorities of the private property owner?
- Is there federal/state assistance for this?

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Activity 4. Affordability

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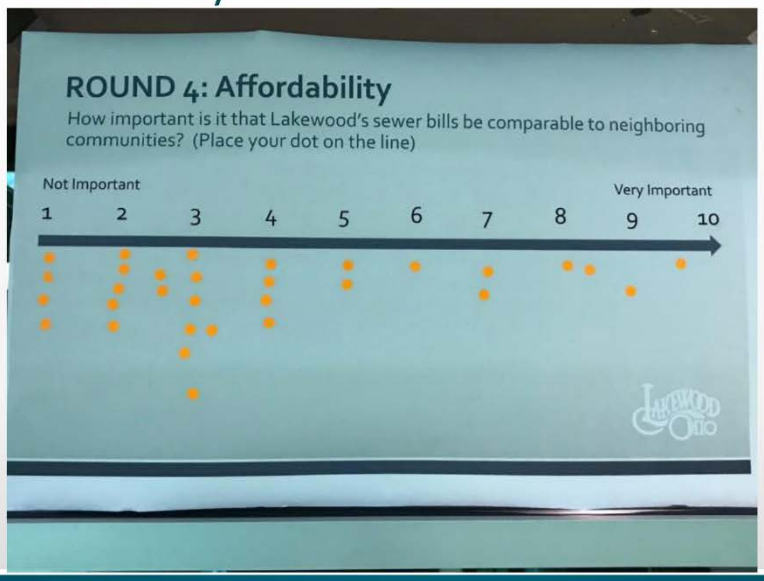
Affordability



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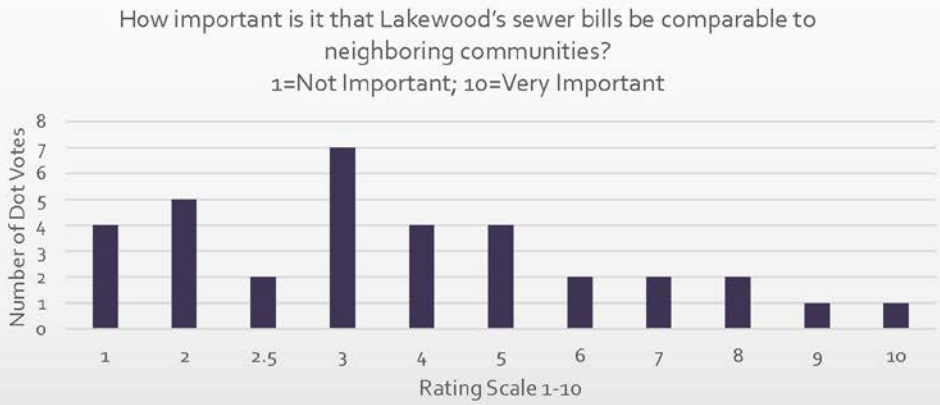
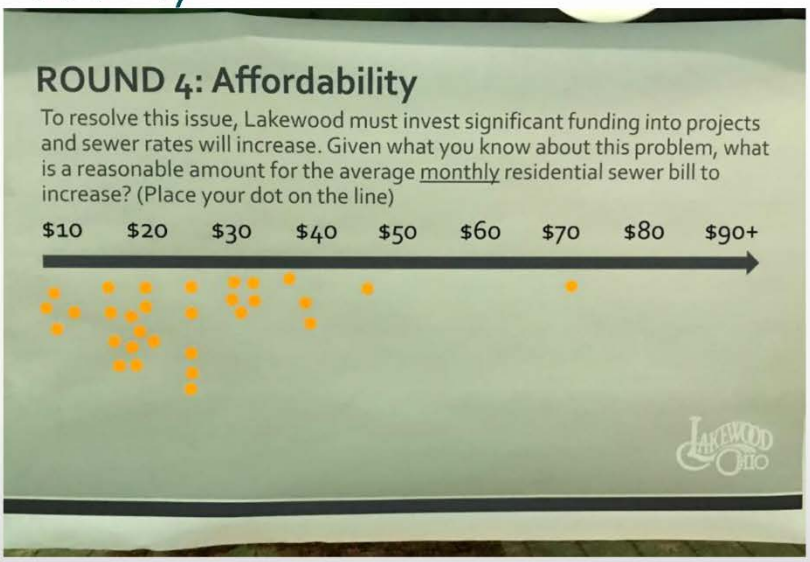
Affordability: Results



Affordability



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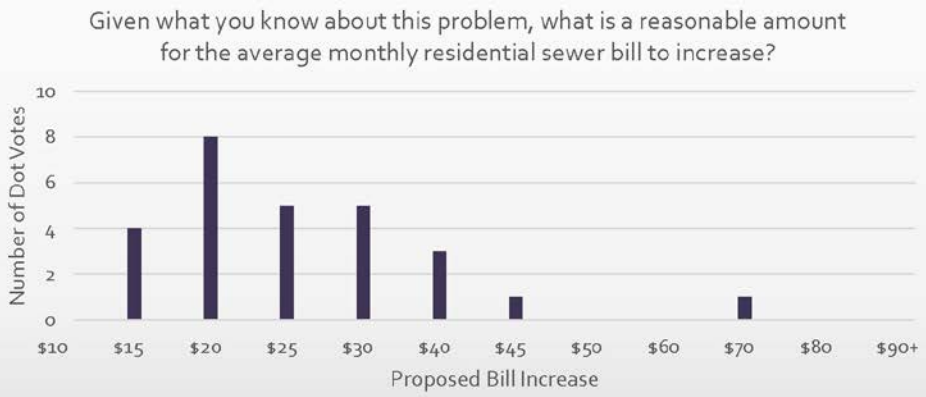
Affordability: Results



Affordability: Additional Suggestions

- Mandate commercial property source control over 10 years then do residential at point of sale
- Sewer rate increases are regressive. Figure out how to tie to income.
- When buying a house, no one considers how sewer rates compare across communities.
- Communication is key! Show people the info from the round 4 charts so they can put the increase in context
- Rates will need to be a factor of income
- We need a stormwater fee
- Could there be any incentives for lowering rates – impervious area, trees, rain barrels, etc.
- Gradual increase over time will go over better
- Do rates on graph of other cities include NEORSD for impervious surface area
- Special tax assessment to each property owner for their actual cost to eliminate. I and I and cross connections
- We have to clearly demonstrate what one is getting for the increased bill. Lakewood's W/S bills are high but that's because they are upgrading their 100 year old system.
- Any benefits we can advertise to make the increase in rates more acceptable?

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Community Outreach Goals

- To increase community awareness of the City's efforts to address regulatory, environmental and financial challenges related to combined sewer overflows.
- To advocate on behalf of residents and businesses to prioritize a solution that is the most affordable and least disruptive to the community.
- To provide a way for the community to engage and share in the City's concerns for affordability, public health and environment.

3

Key Themes

Prioritize high pollutant concentration areas and protect Rocky River.

Integrate sewer upgrades with other planned work and incorporate additional amenities (traffic calming measures, landscaping upgrades, burying utility lines).

Prefer shared responsibility between the City and private property owners for addressing combined sewer overflows.

Would expect between a $10-$40 increase on monthly residential bills to address this sewer overflow issue.

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Clean Water Lakewood Joint Task Force Report

Clean Water Lakewood - Joint Task Force

- Lakewood hosted two joint task force workshops on Oct 23 and Nov 15 to raise awareness and foster discussion about the issue and options for addressing it with some of Lakewood's residents.
- Attendees at these workshops were invited based on their participation in other city task forces and commissions.
  - Clean Water Lakewood Task Force
  - Lakewood Resiliency Task Force
  - Lakewood Planning Commission
  - Lakewood City Staff and Consultants

Joint Task Force Workshops

- October 23

  Participants were provided with presentations to provide background and establish a working knowledge of the issue.

- November 15

  Participants were guided through four activities to provide input on the following topics:

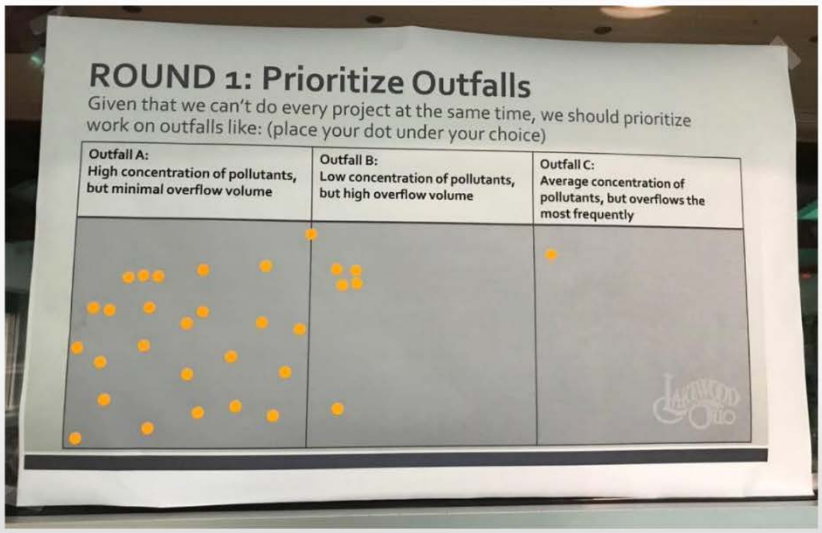
  - Prioritization of outfalls
  - Integration and disruption trade-offs
  - Private property concerns
  - Affordability

5

Activity 1.
Prioritizing Outfall Projects

6

Prioritizing Outfalls



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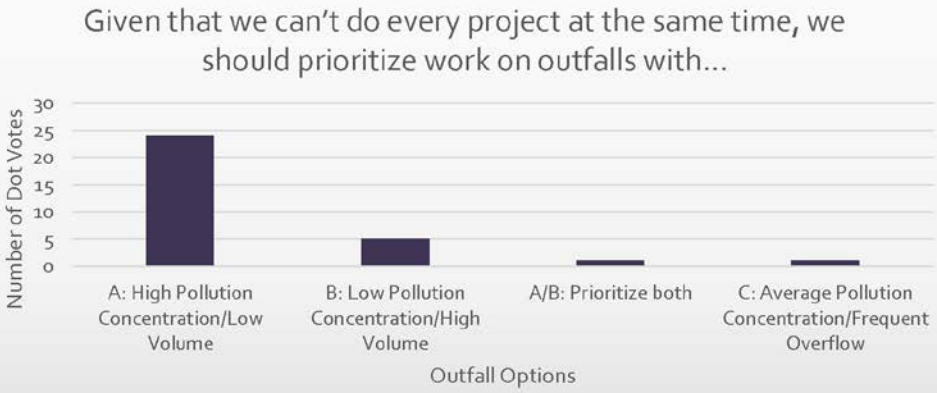
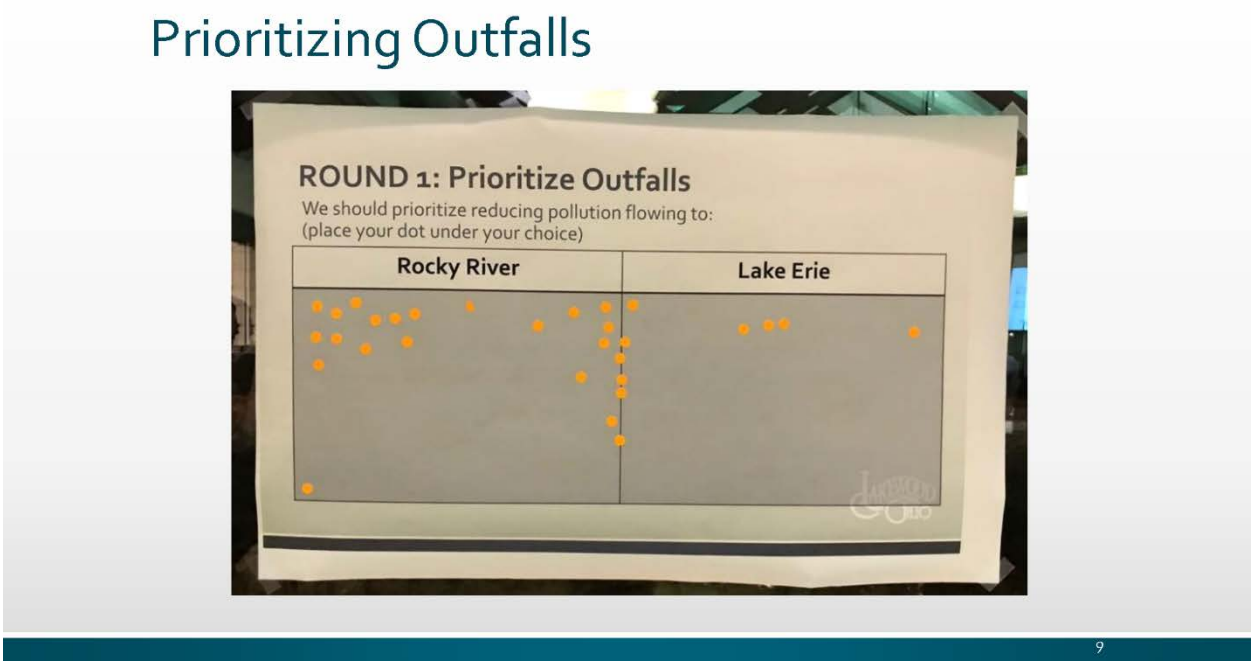
Prioritizing Outfalls: Results





DECEMBER 4, 2018 POWERPOINT

Tonight's Agenda

Welcome & Clean Water History – Mayor Summers

Community Input Exercise

Private Property Improvements – Brian Shields, PE, City of Lakewood

Community Input Exercise

Affordability Presentation – Joe Crea, Raftelis

Community Input Exercise

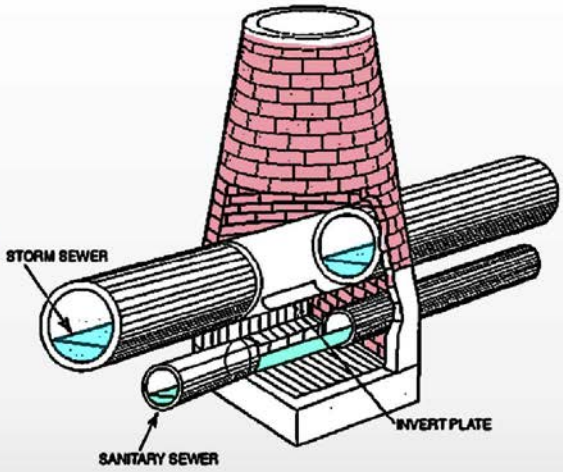
Facilitator – Melissa Elliott, Raftelis

Why are we here?

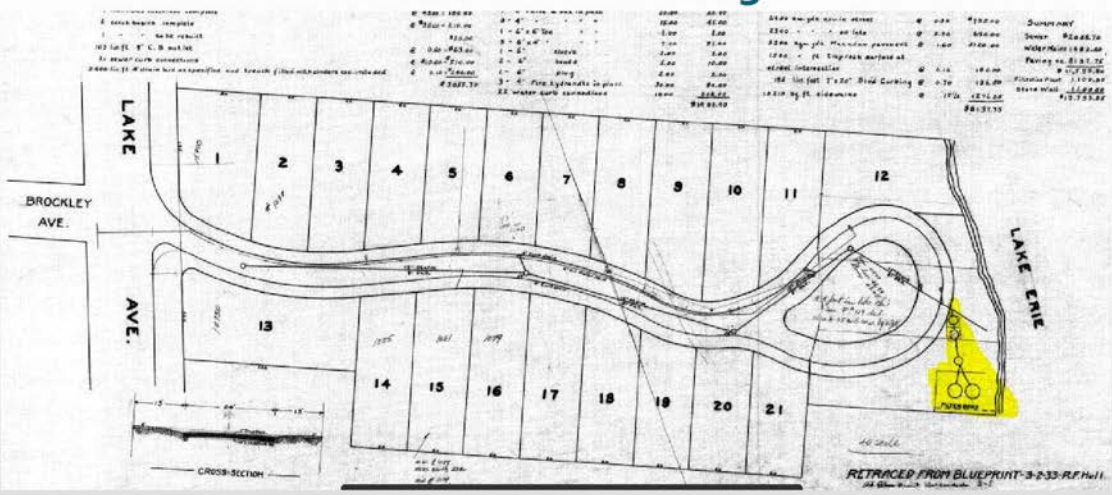
- Lakewood must come up with it's own plan to continue to sustain improvements *or a plan will be imposed upon Lakewood.*
  - **THERE IS NO ABILITY TO CHOOSE NOT TO ENGAGE**
  - **THERE IS NO ABILITY TO VOTE "PRESENT"**
  - **WE MUST CHOOSE A PLAN WE CAN AFFORD**
- Public input is critical to the process
  - Vital to the City to help develop a good plan
  - Persuasive to EPA and Courts

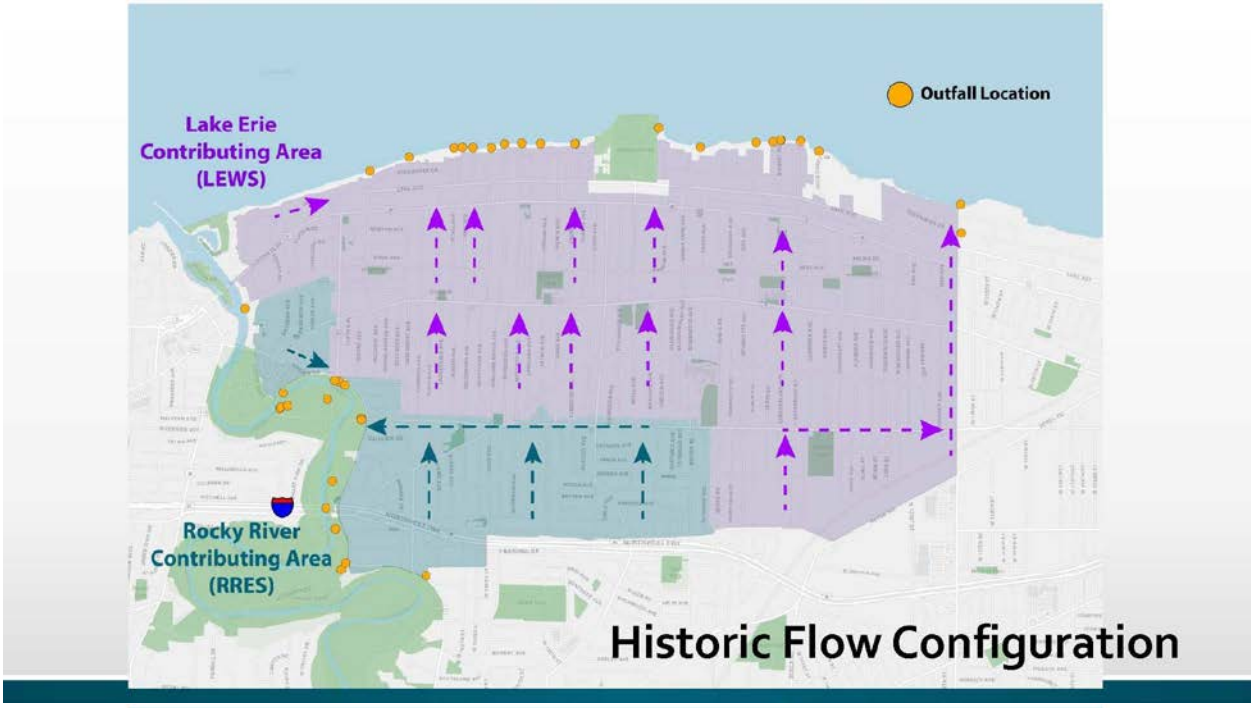
Lakewood's "Unique" Sewer System

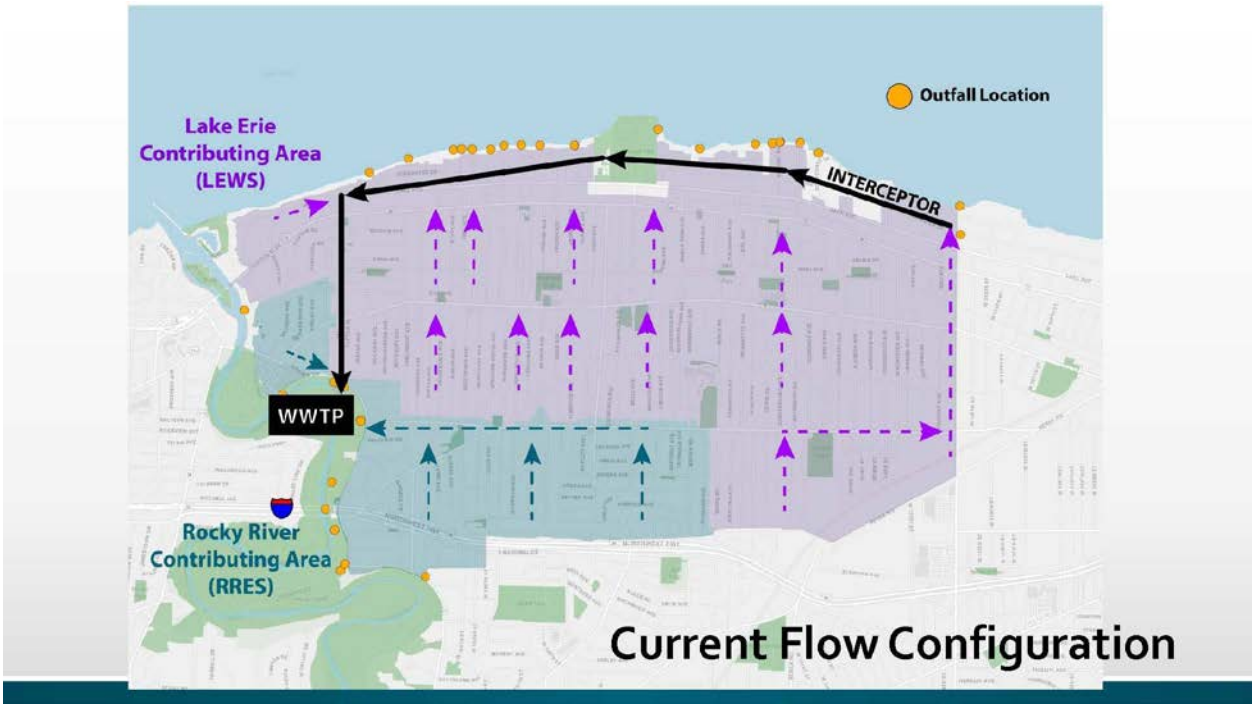
- It was not built as one system
- It's an amalgamation of many subsystems over many years
- Built in a pre-World War II environment
- Theory of "solution to pollution is dilution"
- Public health was the primary objective when it was created; environmentalism came later
- **Most Importantly: the system performed as designed**



1933 Forest Cliff- Filter Bed - End of Street before direct discharge

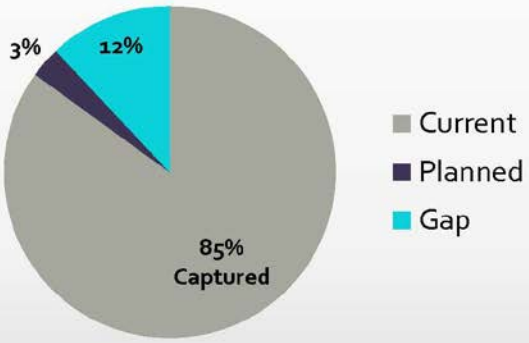



Outfall Location
Lake Erie
Contributing Area
(LEWS)
Rocky River
Contributing Area
(RRES)
Historic Flow Configuration


Outfall Location
Lake Erie
Contributing Area
(LEWS)
INTERCEPTOR
WWTP
Rocky River
Contributing Area
(RRES)
Current Flow Configuration

2018 Sewer System Performance:

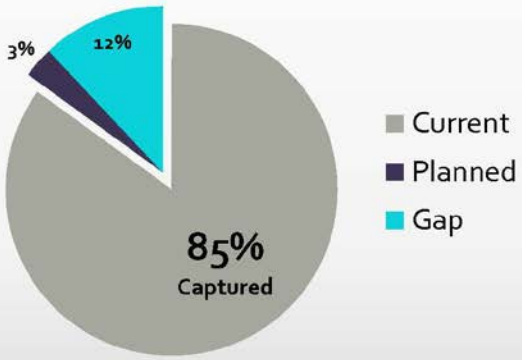
- Collects & treats 10x our average daily dry weather volumes of approx. 4 million gallons per day (MGD)
- Collects & treats **85 %** of all dry and wet weather volume
- Approved projects will take us to **88% of all dry and wet weather volume by 2023**



$60 Million Investments in the Past 10 Years

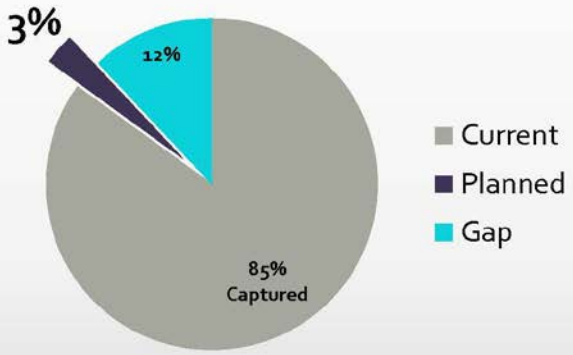
- Expanded the collection system
- Expanded the waste water treatment system
- Pilot Project: public & private property source control

In addition: Updated code to require stormwater control on any development that disturbs 8,000 sq. ft. or more



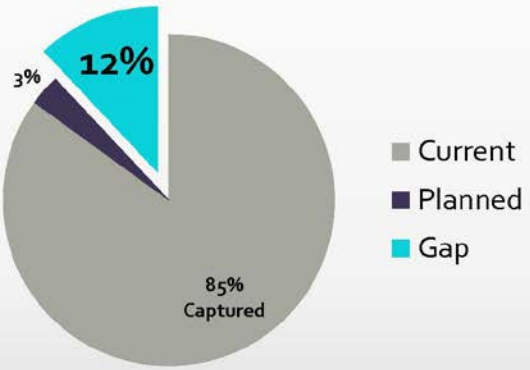
$23 Million High Rate Treatment

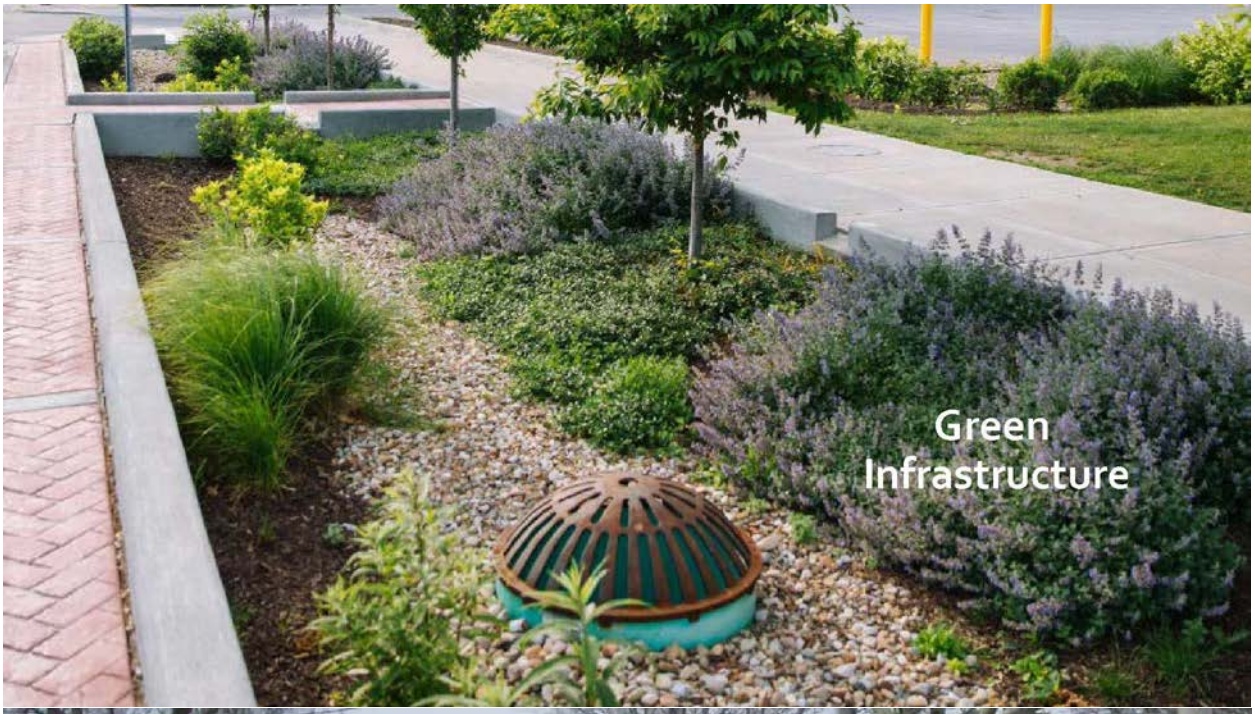
- New High Rate Treatment Plant (HRT) has been designed, funded, and bid
- HRT Facility is scheduled to go live in 2022
- **Total capture and treatment to 88%**



Technology categories considered for the integrated plan

- **Green infrastructure**—increasing the ability for the land to infiltrate the water, vs having it runoff the impervious surface
- **Gray infrastructure**—building bigger pipes, storage basins, or treatment plants
- **Source control**—working to decrease the leakiness between the sanitary and stormwater systems




Green
Infrastructure

Gray Infrastructure
Relief Sewer
Construction
STOP

Gray Infrastructure
Storage Construction

Public Source Control
Manhole Separation

Private Source Control

Water & Sewer Bill History

5.4% average annual increase since 2000
Industry average: approx. 6.5%

Affordability Today

- **Typical residential bill: approx. $81 per month**
- Original 2006 CSO-Only Plan Estimated Cost: $274 million (2006$)
  - Escalates to approximately $385 million in today's value
- Potential Integrated Plan total estimated costs (next 15-20 years)
  - Maintaining our existing facilities and infrastructure: $150 million
  - In progress High Rate Treatment Facility : $23 million
  - Other system improvements for compliance: estimated $300 million+

Estimated $323 million in total compliance costs

How Can We Fund This?

- Federal and State grants are not a reliable or sufficient option
- City residents and businesses will ultimately bear the responsibility
- Community economics will provide a limit to what we can ask from our residents
- **Affordability threshold will need to be defined**
  - Typical bill as percent of household income
  - Number of hours worked at minimum wage
  - Estimated number of at-risk residents

The Route Forward

- Lakewood must come up with it's own plan to continue to sustain improvements *or a plan will be imposed upon Lakewood.*
  - **THERE IS NO ABILITY TO CHOOSE NOT TO ENGAGE**
  - **THERE IS NO ABILITY TO VOTE "PRESENT"**
  - **WE MUST CHOOSE A PLAN WE CAN AFFORD**
- Public input is critical to the process
  - Vital to the City to help develop a good plan
  - Persuasive to EPA and Courts

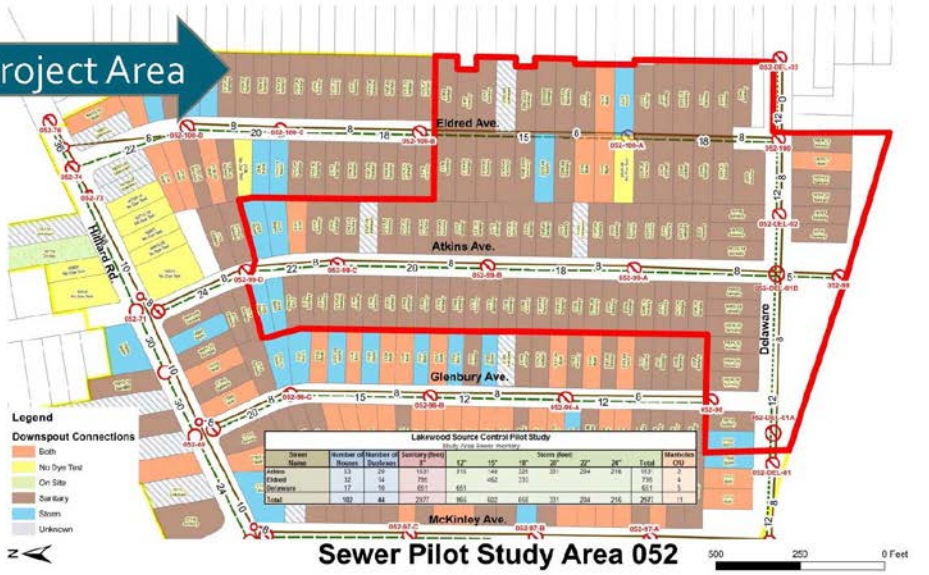
Private Property Source Control

Lakewood Clean Water Act Compliance Overview

Brian Shields, PE
City of Lakewood

Pilot Study Project Area

Inflow & Infiltration (I/I) removal from sources on **103 private properties** as well as public. sewers. The project area is tributary to CSO 052.



Affordability Considerations

Lakewood Clean Water Act Compliance Overview

Joe Crea
Raftelis

LAKEWOOD OHIO

Affordability Illustrated

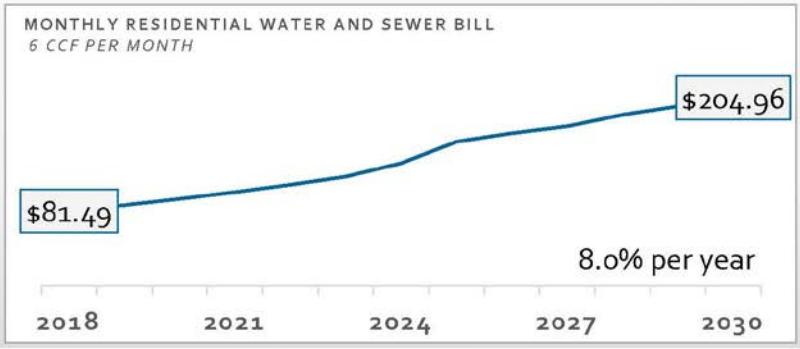
For Illustration Purposes Only– Subject to Ongoing Analysis

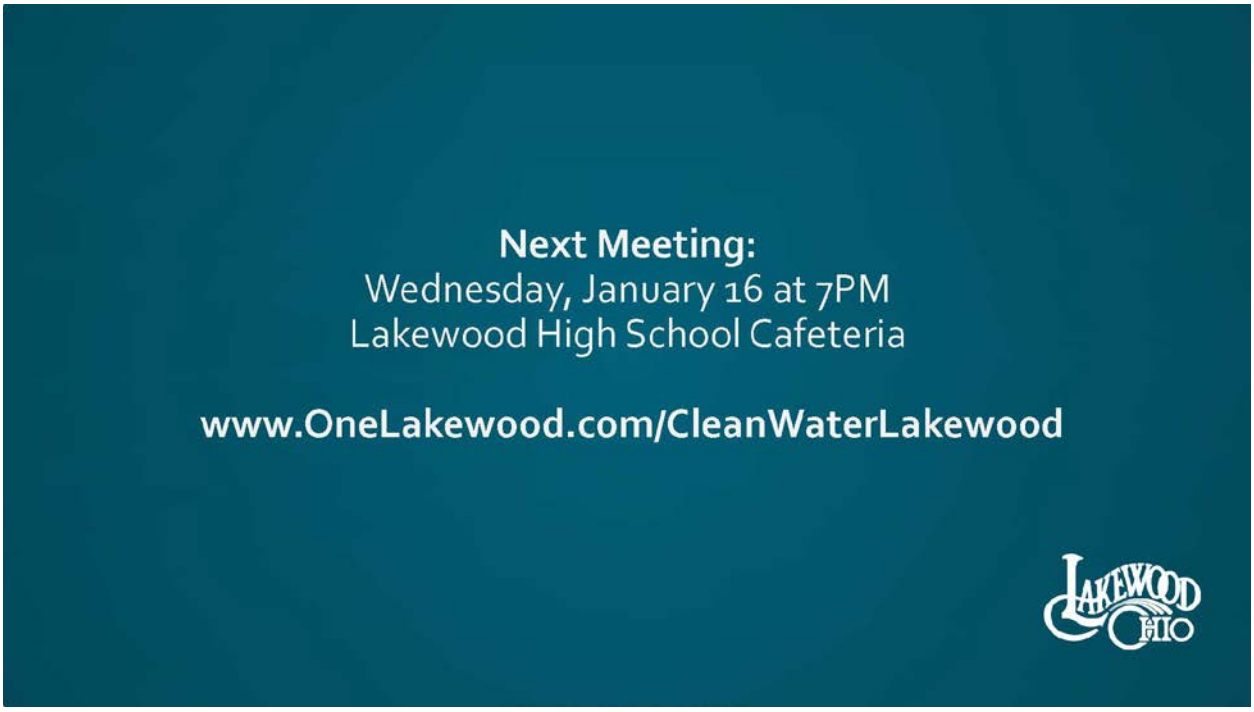
- $83 million spent from 2009 to 2023 to collect and treat 88% of all water
- Projected $150 million needed between 2019 and 2035 for asset management repair and rehabilitation
- Potential $300 million+ additional investment needed for compliance

Affordability Illustrated

For Illustration Purposes Only– Subject to Ongoing Analysis

Example impact of compliance costs ($275 million investment) and asset management repair and replacement ($150 million reinvestment) on typical customer water and sewer monthly bills through 2030

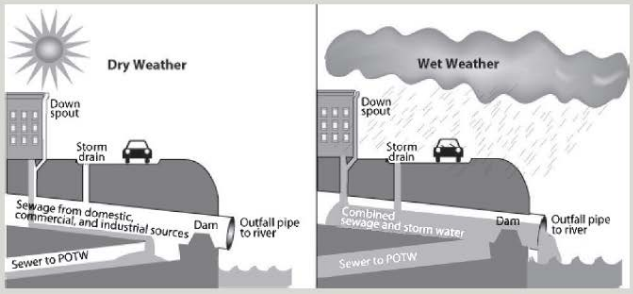



Next Meeting:
Wednesday, January 16 at 7PM
Lakewood High School Cafeteria
www.OneLakewood.com/CleanWaterLakewood
LAKEWOOD OHIO

JANUARY 16, 2019 OPEN HOUSE MEETING POSTERS

Clean Water Lakewood Orientation

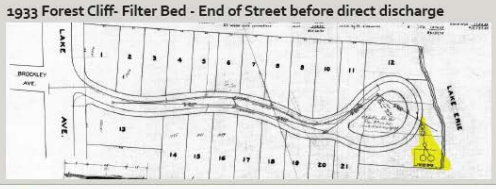
COMBINED SEWER OVERFLOWS



Lakewood's "Unique" Sewer System

- It was not built as one system
- It's an amalgamation of many subsystems over many years
- Built in a pre-World War II environment
- Public health was the primary objective when it was created; environmentalism came later
- Most Importantly: the system performed as designed

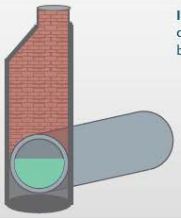
1933 Forest Cliff- Filter Bed - End of Street before direct discharge



SEWER TYPES- What does your house tie into?

COMBINED

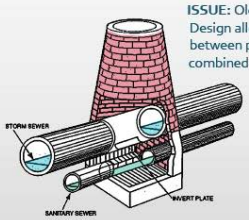
Single-pipe system that collects both storm water and sanitary water.



ISSUE: During large storm system overflows to Lake and River to protect basements from flooding.

OVER-UNDER

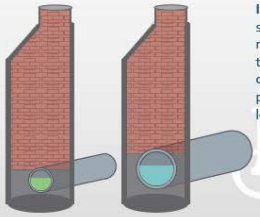
Two-pipe system that collects storm water in a pipe directly above a sanitary pipe. A plate is placed between the pipes that allowed access for maintenance.



ISSUE: Old invert plates leak. Design allows exchange of flow between pipes, acting more like a combined system.

SEPARATE

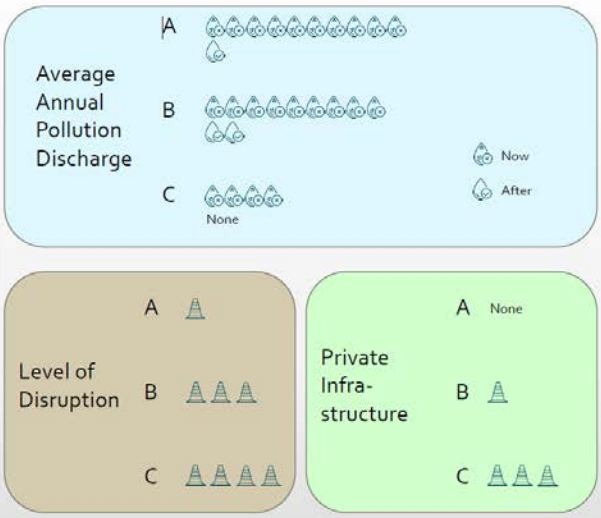
Two-pipe system that collects storm water in a pipe that is not connected to the sanitary system. There are two separate manholes.



ISSUE: Best practice for sewer design. System need to be maintained to ensure groundwater doesn't enter the sanitary pipe through cracks or leaking joints.

What Should Be Our Priority for the First Five Years?

Option	Outfalls	Solution	Level of Control
A	RRES1160	Storage Tank	4 per year
B	LEWS 1040, 1035, 1195	Storage Tank and Pipes	4 per year
C	RRES 1145, LEWS 1180, LEWS 1070	Public/Private Source Control and System modifications	2 year storm



CLEAN WATER LAKEWOOD ORIENTATION

Schedule and Roles

Date	Milestone
2002	Began developing sewer plan according to permit requirement
2006	Plan completed
2007-2009	Plan not officially approved; OEPA & USEPA asks for re-characterization study on Lakewood's sewers
2011-2014	Hydraulic and hydrologic sewer model developed. West End CSO Elimination project in design.
2014	New permit issued, requiring updated plan and a high-rate treatment (HRT) facility at the treatment plant
2015	New plan submitted, Clean Water Lakewood key in plan creation
2016	Improvements worth $277 million estimated in plan; submitted & reviewed by OEPA & USEPA.
2017-2018	Refinement of plan options, evaluation of additional alternatives, affordability. Completion of West End CSO Elimination project completed. Eliminating CSO-053 and 054. Completion Lake Ave. storm improvements to reduce CSO flow at CSO-058.
2019	Updated plan due to OEPA & USEPA. Begin HRT Construction.
2022	HRT Facility to be up and running

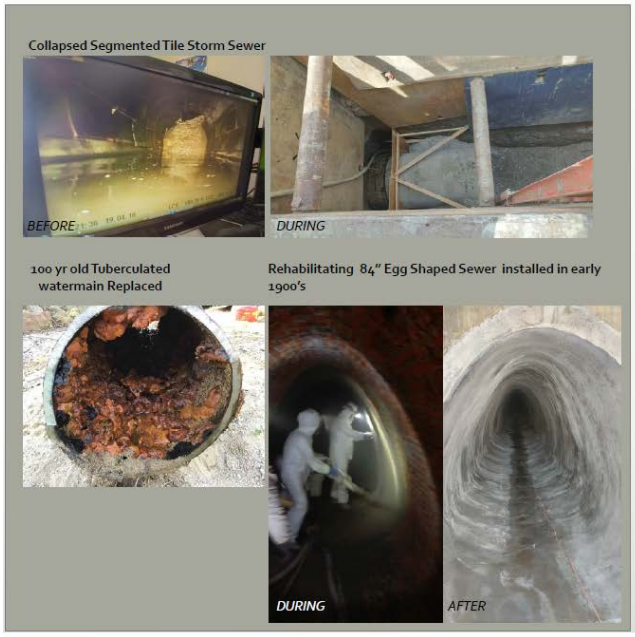
Who's involved?

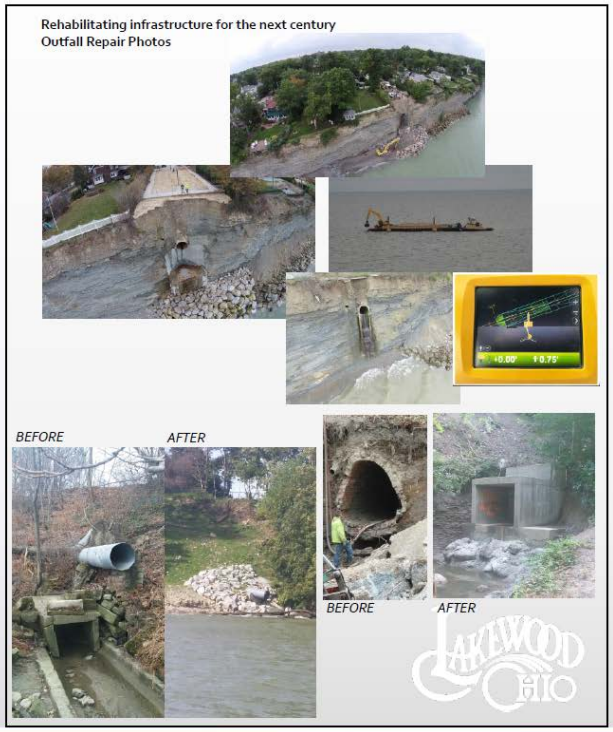
Ohio EPA & US EPA	Enforcing clean water laws like the Clean Water Act of 1972. Regulating Lakewood's Sewer Department operations with a permitting process in 2019.
City Hall	Communicating to Lakewood residents about Ohio and US EPA requirements. Coordinating city, resident, consultant and partner resources to comply with the Clean Water Act. Advocating affordability for residents to EPA.
Consultants	Guiding the creation of an affordable and sustainable overflow control plan to comply with EPA enforcement of the Clean Water Act.
OPWC and OWDA	Ohio Public Works Commission and EPA's Ohio Water Development Authority provide grants and loans awarded on project merit.
You	Getting informed and involved.

CLEAN WATER LAKEWOOD ORIENTATION

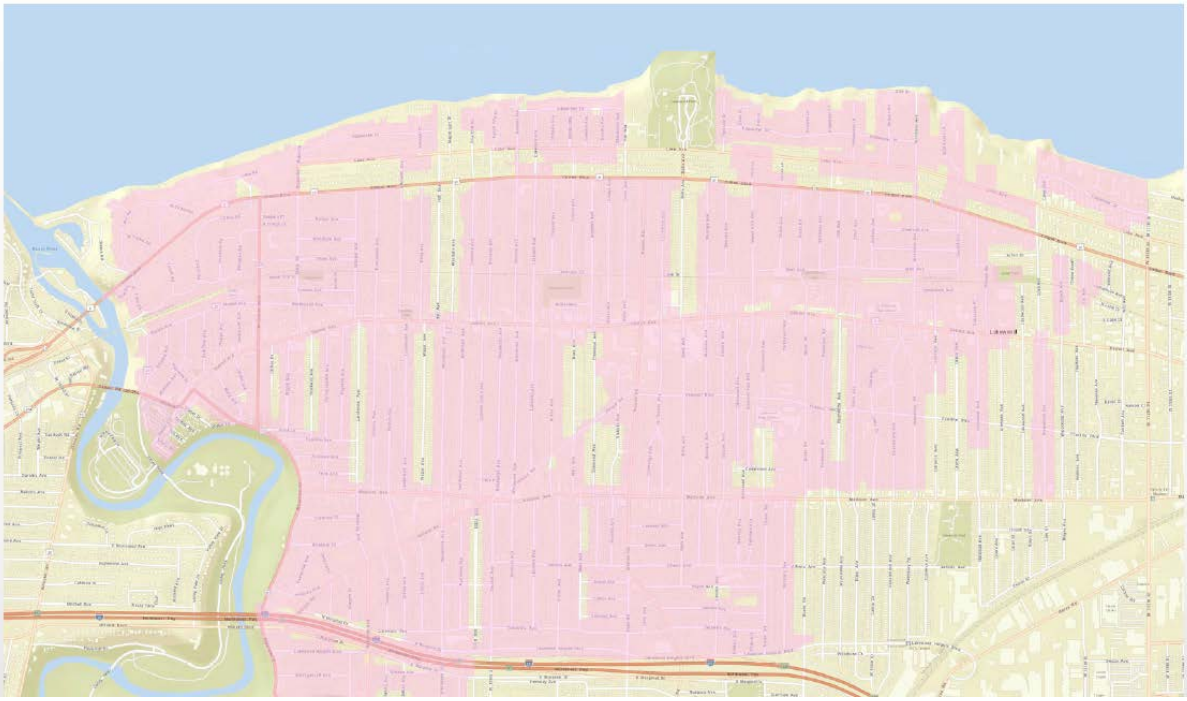
Existing System Rehabilitation/Replacement

An aging water and sewer system take a lot of time and investment to maintain. Below are photos of existing repair or replacement projects the City has completed. Inspections often find problem areas that are near failure and need to be replaced, but the City also responds to many emergency situations caused by aging pipes that have failed.





Clean Water Starts at My House
AREAS ELIGIBLE FOR SOURCE CONTROL



Clean Water Starts at My House
Pilot Study Images

Pilot study including 100 homes on Eldred, Atkins and Delaware Avenues
- Aiming to significantly reduce rain water from entering sanitary sewer
- Work is being done done on sewers in the street as well as on private property
- Aiming for atleast a 35% reduction in storm water entering sanitary pipe

What have we learned from pilot study thus far?
- The old pipes are often cracked and clogged
- Cracked pipes cause interaction between the storm and sanitary laterals even after the clogs are flushed out
- Water from roofs most often ends up in sanitary sewer

What is being done to remove excess water?
- Cleaning laterals, relining as needed
- Replacing pipes along perimeter of house that receive stormwater only
- Connecting driveway drains to storm sewer
- Installing sump pump if needed

Example of stormwater entering sanitary system

Installing pipes along perimeter of home

Construction on private property

Post-construction view

Manhole separation in pilot study

Nature Can Help Keep Lake Erie and the Rocky River Clean!

GREEN INFRASTRUCTURE

Commercial Green Infrastructure

Residential Green Infrastructure Examples

Tree Benefits

For every 5% of tree canopy cover added to a community, stormwater runoff is reduced by approximately 2%

– United States Forest Service

- Using USFS research, during a 1-inch rainstorm over 12 hours, the interception of rain by the canopy of the urban forest in Lakewood reduces surface runoff by about 12%.
- Trees slow stormwater runoff, decreasing the amount of stormwater storage needed and reduce the cost of water treatment.
- Lakewood's present tree canopy manages approximately 7 million cubic feet of stormwater, valued at $14 million using a conservative $2 per cubic foot stromwater retention capacity construction costs.

Percent Tree Canopy is 28.5% today.
Our goal is to increase it to 33.5% by 2035.

We need YOU to achieve our tree canopy goals!

Consider planting a tree in your yard this spring!

What does affordable mean to you?

RATE STRUCTURE

We are considering updating the rate structure (how you are charged for service) for 2019 – 2023 to include both a volumetric rate (existing) and a fixed fee (new) to meet these revenue needs. There are two options for adding a fixed fee.

Option 1.
Volumetric Rate + Fixed Monthly Charge

- Every customer pays the same amount per bill
- Can be broken into separate fixed charges
  - Billing charge (e.g. $2 per bill)
  - Compliance charge (e.g. $10 per bill)

Option 2.
Volumetric Rate + Impervious Area Charge

- A fixed monthly charge calculated based on the amount of impervious area on your property
  - Driveways
  - Rooftops
  - Sidewalks
  - Parking lots

Example

Sample Bills: *Illustrative Purposes Only*	Residential			Non-Residential	
	Apartment	*Typical House*	*Large House*	*Shopping Center Tenant*	*Parking Lot*
Current Structure					
Volumetric Charge	$ 43.91	$ 87.82	$ 175.63	$ 58.54	$ 0.00
Option 1: Volumetric Rate + Fixed Monthly Charge					
Fixed Fee	$ 5.00	$ 5.00	$ 5.00	$ 5.00	$ 0.00
Volumetric Charge	$ 39.87	$ 82.65	$ 165.21	$ 53.30	$ 0.00
Total Bill	$ 44.87	$ 87.65	$ 170.21	$ 58.30	$ 0.00
Difference from Current	2.2%	-0.2%	-3.1%	-0.4%	-
Option 2: Volumetric Rate + Impervious Area Charge					
Impervious Area Charge	$ 2.50	$ 5.00	$ 10.00	$ 10.00	$ 40.00
Volumetric Charge	$ 40.80	$ 83.54	$ 170.55	$ 48.85	$ 0.00
Total Bill	$ 43.30	$ 88.54	$ 180.55	$ 58.85	$ 40.00
Difference from Current	-1.4%	0.8%	2.8%	0.5%	-

Rate Structure Options

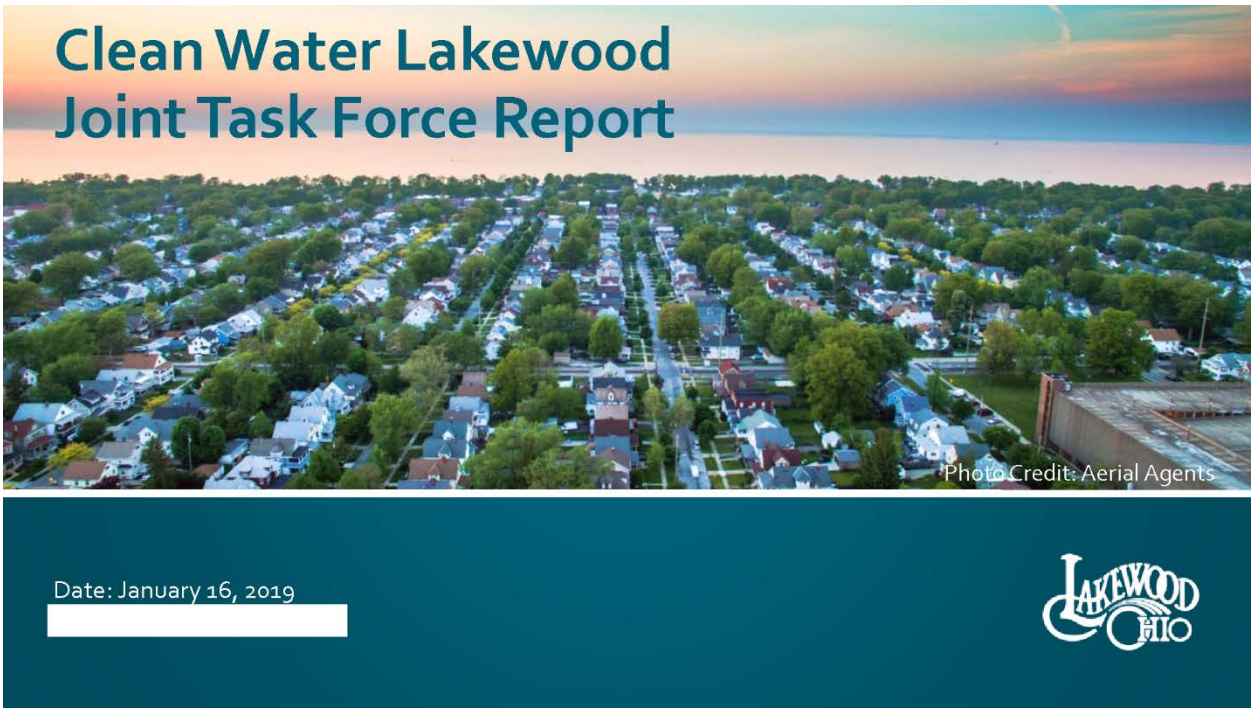
Option 1. Fixed Monthly Charge

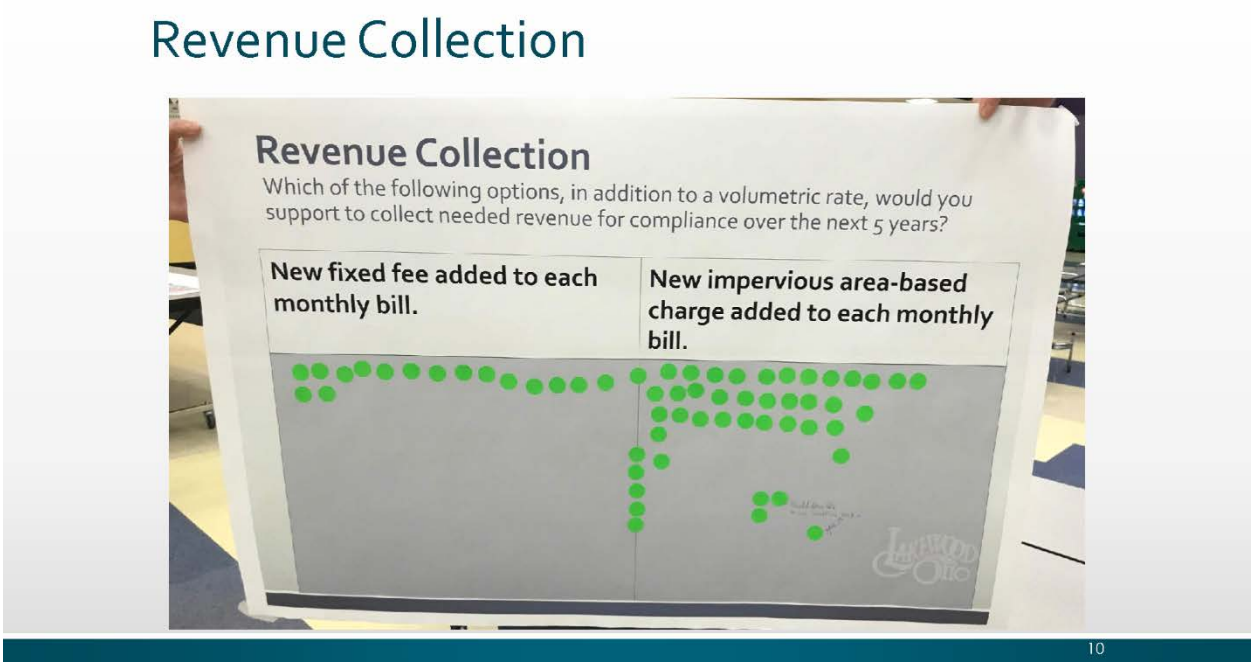
Benefits	Drawbacks
Simple to administer	Provides limited equity
Easy to understand	May impact low & fixed-income households the most
Can scale to program costs	Limits customer ability to control bill amount
Viewed favorably by investors	

Option 2. Impervious Area Charge

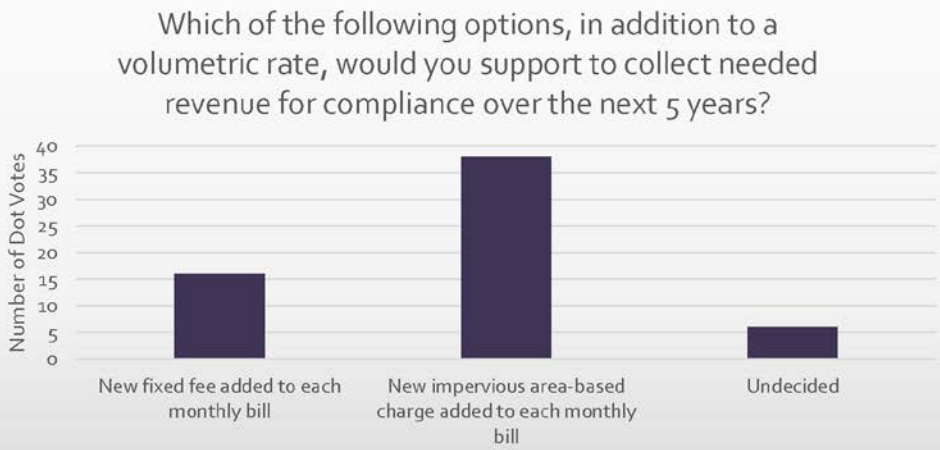
Benefits	Drawbacks
Most fair for wet-weather related costs	Difficult to implement
Includes non-utility customers (e.g. parking lots)	Can be hard to understand
Can scale to program costs	Greater administrative requirements
Consistent with regional trend (NEORSD)	May impact low & fixed income households

Summary Report from January Public Meeting





Revenue Collection: Results



Clean Water Lakewood

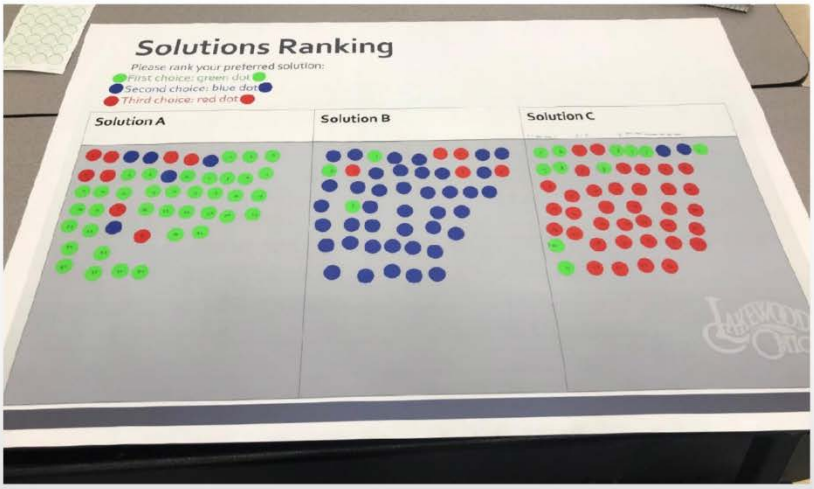
- Clean Water Lakewood aims to better manage the City's combined sewer overflows and protect its natural resources to meet the requirements of the Clean Water Act.
- USEPA and Ohio EPA will require that Lakewood treat or mitigate millions of gallons of combined sewer overflow every year to protect Rocky River and Lake Erie.
- The City must invest in public infrastructure and find ways to help its residents and businesses fix private infrastructure that is contributing to the problem.

Clean Water Lakewood Community Open House

- The City of Lakewood hosted a Community Open House on January 16 from 7 to 9 p.m. at the Lakewood High School Cafeteria. Participants stopped by at their convenience to visit information stations, talk to City staff and share their individual comments and questions.
- Goals of the Community Open House
  - Improve public understanding of the stormwater and sewer system and the City's response to Clean Water Act regulations
  - Inform the public by getting input on specific questions related to private property remediation and potential rate and affordability impacts
  - Explain complex points in an informal setting allowing for one-on-one discussion

3

Solutions Ranking



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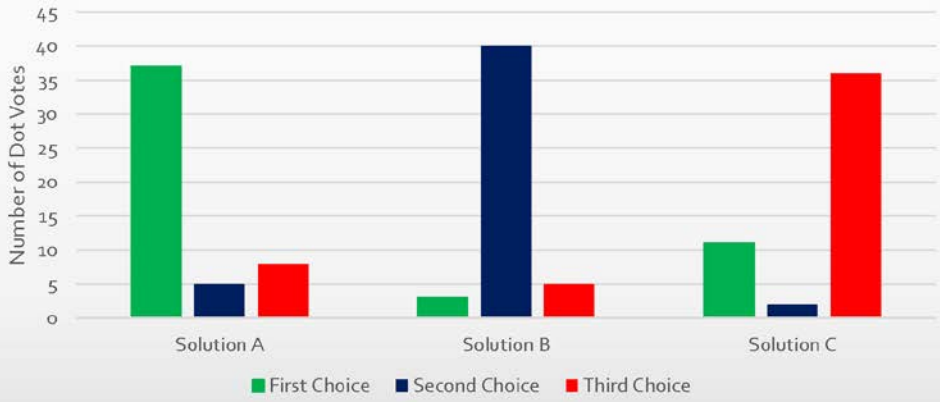
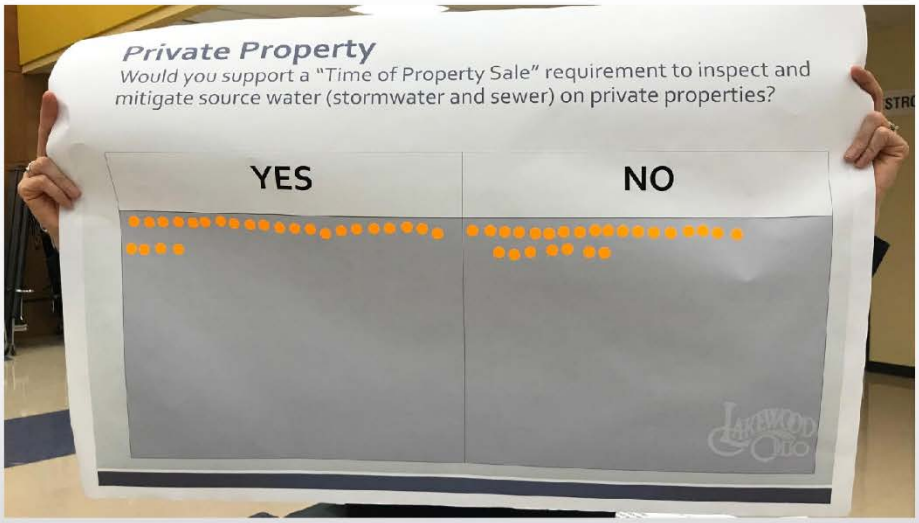
Solutions Ranking: Results



Private Property: Time of Sale



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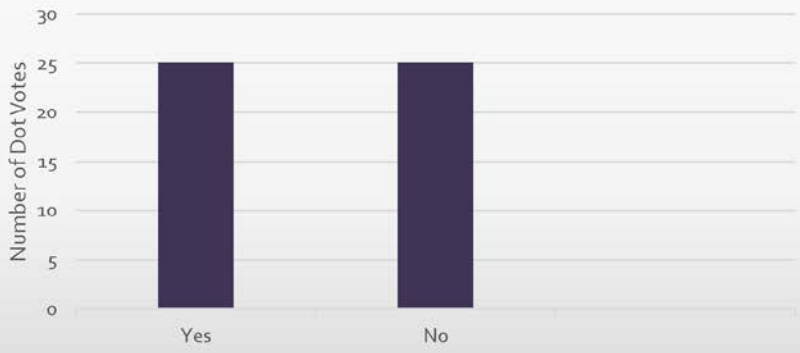
Private Property Time of Sale: Results

Would you support a "Time of Property Sale" requirement to inspect and mitigate source water (stormwater and sewer) on private properties?



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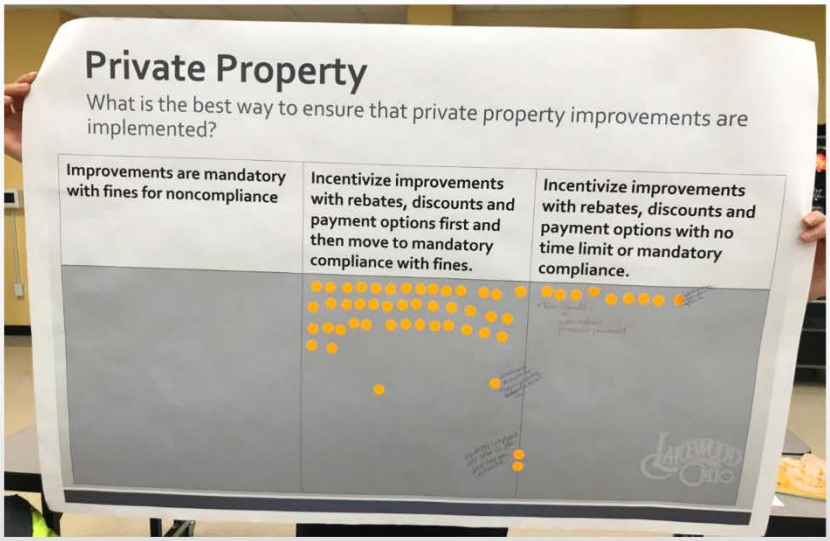
Private Property: Improvements



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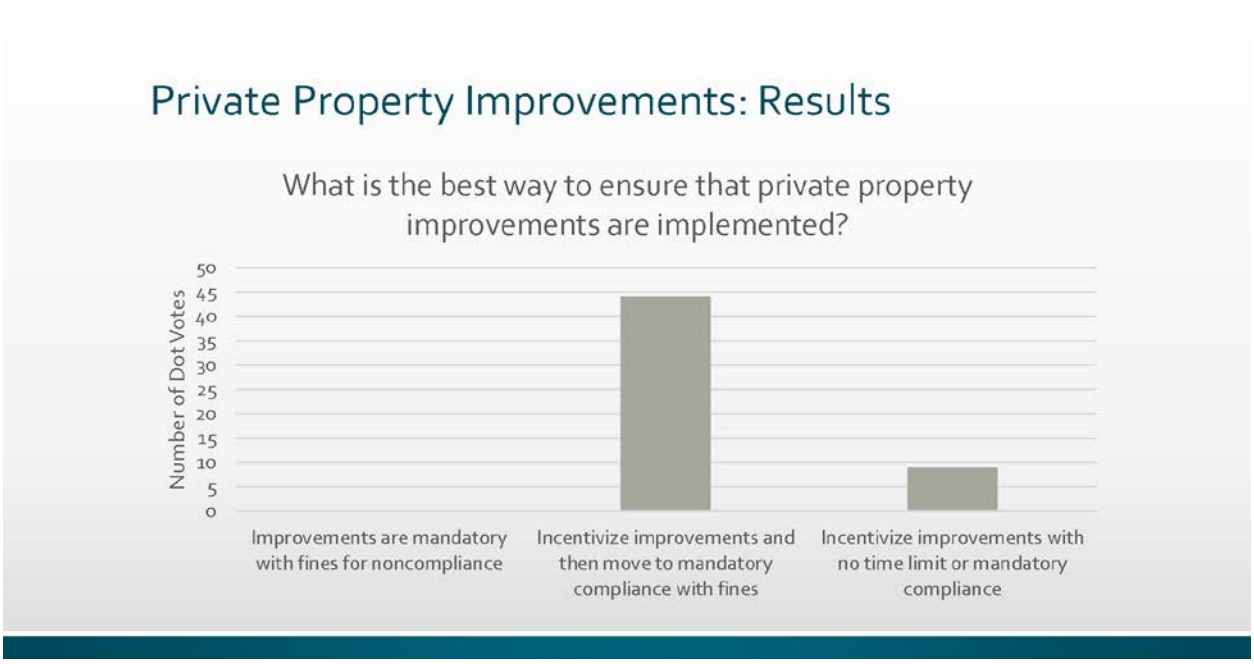

COMMUNITY ENGAGEMENT PLAN

Goals and Audiences

Goals

To elicit community preferences regarding overflow control approaches, program pace, and affordability.

To increase community awareness of the City's efforts to address regulatory, environmental and financial challenges related to combined sewer overflows.

To advocate on behalf of residents and businesses to prioritize a solution that is the most affordable and least disruptive to the community.

Stakeholder audiences

For this plan, stakeholders are individuals, groups, organizations or political entities that have an interest in the outcome of Clean Water Lakewood, and any potential regulatory, environmental and financial action that may be considered by the City and its regulators. Stakeholders may be directly or indirectly affected by the outcome of a decision related to Clean Water Lakewood. Internal stakeholders that work for and lead the City of Lakewood are also stakeholders.

For the City, the following stakeholder audiences have been identified as having a connection to the outcome of Clean Water Lakewood:

1. Single family residential customers
2. School communities
3. City Council
4. Neighborhood associations
5. Business community (includes commercial customers and top tier wastewater users)
6. City employees
7. City's boards, commissions, and task forces
8. Community organizations
9. Faith organizations

2

Public Participation Spectrum

Identifying the proper role of the public and the level of public participation is a critical component of developing effective engagement strategies. The City used the following public participation spectrum to define the public's role for the Joint Task Force workshops, Community Conversations, Open House and other outreach tactics. It is important to note that as the City moves forward with developing its Clean Water Lakewood response, the level of public participation will move to the left of the spectrum from Involve to Inform.

Clean Water Lakewood Public Participation Spectrum

	Inform	Consult	Involve	Collaborate	Empower
Goal	To provide balanced and objective information in a timely manner	To obtain feedback on analysis, issues, alternatives and decisions	To work with the public to make sure that concerns and needs are considered and understood	To partner with the public in each aspect of decision-making	To place the final decision-making in the hands of the public
Promise	"We will keep you informed."	"We will listen to and acknowledge your concerns."	"We will work with you to ensure your concerns and needs are directly reflected in the decisions made."	"We will look to you for advice and innovation and incorporate this in decisions as much as possible."	"We will implement what you decide."
	January Open House	December 4 Community Conversations	October 23 & Nov. 15 Joint Task Force Workshops		

Communication Channels

Lakewood has a well-defined outreach and communications program, relying primarily on its website, bill inserts, bill messaging, outreach events and social media to reach customers.

For this plan, the focus is on using these available channels and supplementing with active outreach to key stakeholder audiences to improve the chances of informing customers about the cost of service study and attaining the goals of this plan. The tactics listed for each channel below are provided to inform customers, engage stakeholders, and secure third-party support about Clean Water Lakewood response process, and drive awareness of the planned community engagement events.

Bill Inserts

Bill inserts can be sent in customers' monthly water bills.

Presentations

Certain stakeholder audiences have been identified in the stakeholder map as having the potential for a high level of interest in the cost of service study, while others may have a lower interest level, but be in positions where they are influential in their community. A presentation will be developed that is geared for these stakeholders and focuses on clear messages about why Clean Water Lakewood is important to the City and the need to invest in the sewer and storm water systems. The following stakeholder audiences would be appropriate targets to offer a presentation/briefing to:

- State legislators
- Community organizations
- School district
- Business community
- Some highly engaged neighborhood associations

Bill Messages

Lakewood's water bills are a primary channel to reach every customer. During the Clean Water Lakewood community engagement period leading up to March 1, 2019, bills can carry messages promoting the open house and directing customers to the web site for more information.

Website

Lakewood has developed an online news site that contains up-to-date news and event information. The intention is for this site to be a landing page for most customer information that is promoted through Lakewood's social media platforms.

Lakewood can take several actions related its website. 1) provide additional content so that stakeholders interested in understanding Clean Water Lakewood information can do so with easily to build upon the content that is already in place. This content is described in the Content Development section of this plan. 2) Thoroughly review onelakewood.com and ensure that outdated information is removed and links are active.

Payment Walk-Ins

Lakewood sees customers in person when they pay their bills. This is a "high-touch" interaction that can be used to provide information about Clean Water Lakewood and the need to invest in a secure clean water future. Invitations to the community conversations and open house events can also be provided at this time.

Direct Mail Postcard

As a point of contact to all current customers, a postcard can be developed to mail to every customer account to invite them to the customer conversations and community open house events and inform them of related Clean Water Lakewood information available on the website. Additional postcards can be provided to employees so they can provide them as they work and meet with customers.

Social Media

Lakewood has a social media presence on YouTube, Instagram, Twitter and Facebook. The City has an active presence on these social media platforms, contributing content several times a week. For this plan, we'll aim to incorporate an additional post per week to increase the promotion of content related to Clean Water Lakewood and to drive back to the website.

Events

Lakewood participates in community events at a wide variety of locations. Although the primary purpose has been to promote community stewardship, these events also offer an opportunity to engage with residents and consumers and provide them with a broader perspective on the sewer and stormwater system. Adding a display about how revenue from ratepayers is reinvested in the sewer or stormwater system and the future investments Lakewood has planned for Clean Water Lakewood may help signal context. Invitations to the community conversations and open house can also be distributed at these events.

Partner Agency Channels

As an investment in the community it serves, Lakewood has established positive relationships with several partner agencies and organizations including:

- School District
- Business Community
- Various Neighborhood Associations
- Community organizations

Each of these agencies and organizations has their own communication channels that, with permission, can be used to help communicate to Lakewood residents and businesses.

5

Communications Materials

Communications materials provide a home for the messages and content and are delivered through appropriate communication channels. The following is an outline of communication materials that can be developed for this plan:

Material	Description	Channels
FAQ's	Q&A that describes what Clean Water Lakewood is, and what water and sewer rates pay for	Open House Web Site Presentations Payment Walk-Ins Community Events Internal Communication
Infographics	• Graphic representation of the process for Lakewood's March 1, 2019 submittal • Graphic representation of the regulatory and project timeline (past and future) • Graphic representation of rate structure options • Graphic representation of what sewer/water rates pay for	Open House Web Site Presentations Payment Walk-Ins Community Events Social Media
Direct Mail	Invitation to Community Conversations and Open House	Post Card Copies for Payment Walk-Ins
Case Studies	Explanations of how residents and businesses are controlling source water on their properties	Open House Web Site Presentations
Presentation	Short, 10-15-minute presentation showing the Lakewood's infrastructure investment needs and providing context for Clean Water Lakewood	Presentations Partner Agencies Open House (looped) Internal Communication
Customer Service Talking Points	For use with customer-facing employees	Internal Communication

CITY OF LAKEWOOD CLEAN WATER LAKEWOOD COMMUNITY ENGAGEMENT PLAN

6

Joint Task Force Workshop - 1

The City of Lakewood will host a Joint Task Force Workshop on October 23 from 7 to 9 p.m. at the City Hall Auditorium. The focus of the Oct. 23 workshop is to help participants learn by discovery and exchange and bring them up to speed on the current state of the City's planned response in developing Clean Water Lakewood's overflow control plan (IWWIP Phase 2 Report). This workshop sets the stage for the Joint Task Force Workshop – 2 on Nov. 15 where workshop participants will focus on providing input that can feed directly into the decision-making process through facilitated exercises. The two workshops are designed to allow participants to "dig in" to this issue with others who are committed to the process and the Clean Water Lakewood efforts. It is expected that participants will have differing opinions, but what they produce will be used in the City's overflow control plan submittal, not just documented for the record.

Participants:

- Members of Clean Water Lakewood Task Force
- Members of Lakewood's Resiliency Task Force
- Members of Lakewood's Planning Commission
- Lakewood City Staff and IWWIP Phase 2 Report Consultants

Description:

At this workshop, participants will receive a briefing to ensure that all participants understand history and the current state of the City's response to managing combined sewer overflows and the current and potential future regulatory environment.

Workshop Goals:

- Raise awareness and impart information to Lakewood's most engaged citizens
- Foster discussion and progress on receiving community feedback on common ground related to Clean Water Lakewood options
- Get participants engaged in the project and in finding workable, sustainable recommendations

Preparation:

- Be clear about the purpose of the workshop and how the City will use the results.
- Make sure all attendees know they are coming to work and interact and not just listen to presentations and ask questions and make comments.
- The opening overview presentation is designed to ensure that everyone will get relevant and needed information that participants must have to do the assignments at the Nov. 15 workshop.
- Before finalizing all materials, review them with the project team. Hold a planning meeting for the project team prior to the workshop.

Implementation:

- Obtain participants agreement to the agenda, process and ground rules at the beginning.
- Explain how the Oct. 23 and Nov. 15 workshops are related and the goal for each.
- Show respect for all perspectives.
- Be clear about how the workshop results will get used in the process.

Documentation:

- Provide a record of the presentation, attendance, questions and answers, and any outstanding questions that need research
- Reach closure with the group on how ideas for information will be documented and used
- Later in the process show the public how the workshop results contributed to the decision process

Evaluation/Debrief:

- Ask participants for their views on how well the workshop met its objectives (use a comment form)
- After attendees have left, gather the staff and consultant team and ask:
  - What went well?
  - What could be improved?
  - Was anything confusing?
  - What are the major things we learned?
  - What action is needed for requests and/or questions asked by attendees?
  - How well did the event meet the objectives outlines in our plan?

RESOURCES:

Staffing:

- Content experts/resources:
- Main presenter(s):
- Greeter and room attendant (greets and signs in participants, handles any technical glitches, etc.):
- Note taker(s):

Equipment/Materials

- Laptop, projector and screen for presentation
- Maps at each table where appropriate (for ease of understanding)

Space and room:

- Tables and chairs throughout the room
- Sign-in table with name badges or name tents
- Refreshments as appropriate to reflect appreciation of the participants' time and effort

8

Joint Task Force Workshop - 2

The City of Lakewood will host a second Joint Task Force Workshop on November 15 from 5 to 7 p.m. at the City Hall Auditorium. The focus of the Nov. 15 workshop is to break into small groups assisted by assigned facilitators to share perspectives, identify issues, prioritize a list, and evaluate alternatives. The work of each group will be presented verbally at the end of the workshop.

This workshop builds on the Joint Task Force Workshop – 1. The two workshops are designed to allow participants to "dig in" to this issue with others who are committed to the process and the Clean Water Lakewood efforts. It is expected that participants will have differing opinions, but what they produce will be used in the City's overflow control plan submittal, not just documented for the record.

Participants:

- Members of Clean Water Lakewood Task Force
- Members of Lakewood's Resiliency Task Force
- Members of Lakewood's Planning Commission
- Lakewood City Staff and IWWIP Phase 2 Report Consultants

Description:

At this workshop, participants will break into small groups and work on pre-designed assignments assisted by a facilitator. At the end of the workshop the work of each group will be presented and is intended to be the basis for the Community Conversations event on Dec. 4.

Workshop Goals:

- Foster discussion and progress on receiving community feedback on common ground related to Clean Water Lakewood options
- Get participants engaged in the project and in finding workable, sustainable recommendations
- Narrow down options and seek input on disruption, equity and total cost tradeoffs.

Preparation:

- Be clear about the purpose of the workshop and how the City will use the results.
- Make sure all attendees know they are coming to work and interact and not just listen to presentations and ask questions and make comments.
- Carefully prepare workshop assignments; make the instructions clear and straight forward and provide appropriate support materials (handouts, maps, graphics).
- Design assignments to get useful information and products to meet the participation objectives.
- As assignments are designed it will be critical to understand how we will use the results in our decision-making process.
- Before finalizing all materials, review them with the project team. Hold a planning meeting for the project team prior to the workshop.
- Conduct an orientation meeting/training session during the day before this workshop to pass out a briefing sheet on the workshop process. This briefing sheet will clearly define each support person's role and the group exercises.
- Determine how we will document the results of small group efforts ahead of time.

Implementation:

- Obtain participants agreement to the agenda, process and ground rules at the beginning.
- Explain how the Oct. 23 and Nov. 15 workshops are related and the goal for each.
- Show respect for all perspectives.
- Be clear about how the workshop results will get used in the process.
- Provide clear directions for each exercise.
- Explain how small groups will report to the large group and ensure enough time to share their results.
- Have one or more staff people roam from group to group to assist.
- Come back together at the end so small groups can share results with the full group.
- Seek consensus and describe the next step, the Community Conversations event on Dec. 4, and seek out volunteers for that effort.

Documentation:

- Provide a record of small group results and any further processing by the full group.
- Reach closure with the group on how ideas for information will be documented and used
- Decide in advance how to handle documentation if particular interests appear to be missing or others show up in especially large numbers
- Later in the process show the public how the workshop results contributed to the decision process

Evaluation/Debrief:

- Ask participants for their views on how well the workshop met its objectives (use a comment form).
- After attendees have left, gather the staff and consultant team and ask:
  - What went well?
  - What could be improved?
  - Was anything confusing?
  - What are the major things we learned?
  - What action is needed for requests and/or questions asked by attendees?
  - How well did the event meet the objectives outlines in our plan?

RESOURCES:

Staffing:

- Content experts/resources:
- Main presenter(s):
- Greeter and room attendant (greets and signs in participants, handles any technical glitches, etc.):
- Note taker(s):

Equipment/Materials

- Laptop, projector and screen for presentation
- Maps at each table where appropriate (for ease of understanding)
- Flip charts and posters for each small group
- Small-group supplies as required for exercises: dots, sticky notes, wall to apply sticky notes, markers, pens, note cards, tape, etc.

Space and room:

- Round tables and chairs throughout the room or in nearby rooms
- Each table has needed supplies and materials
- Sign-in table with name badges or name tents
- Refreshments as appropriate to reflect appreciation of the participants' time and effort

Community Conversations

The purpose of the Community Conversations effort on Dec. 4 is to engage City of Lakewood residents and business owners in discussion about the City's compliance with the Clean Water Act. This forum is focused on obtaining input on a recommended approach to capture and treat discharges from Lakewood's combined storm and sanitary water that are released untreated to our watershed during large rain events.

There are three goals to achieve through this forum:

- Educate participants regarding Lakewood's challenge to update its stormwater and sewer systems to meet requirements of the Clean Water Act
- Identify areas of consensus regarding burden of private property improvements related to remediation
- Build understanding related to the need for a future revenue increases to accommodate public property improvements

Recruiting participants:
The City desires a large attendance base for this effort, and as such recruitment is important to accomplish this goal. The following is designed to maximize attendance:

- Offer an incentive to participate—such as a $20 Amazon gift card or a credit on the City water/sewer bill
- Require attendees to pre-register for the meeting online, this allows for a confirmation letter to be sent and a reminder to attend the event.

Publicize the meetings through:

- Direct invitations from the Mayor and City Council
- Direct invitations to all the City's boards, commissions, and task forces
- NextDoor
- Lakewood Life
- Website
- Direct invitations to stakeholder groups
- News Media
- City's Social Media
- Email to water/sewer customers
- Postcards to water/sewer customers
- Inclusion in neighborhood and school newsletters
- Direct invitation to youth groups (teens and young adults)
- Direct invitation to community and faith organizations

Meeting Format

Participants will be assigned to tables to ensure a gender balance. Each table has a facilitator and a recorder. The facilitator sits at the table to assist with the program, discussion and exercises. The recorder stands near the table with an easel pad to record comments or questions from participants.

At the beginning of the meeting an overview of the City's compliance with the Clean Water Act and the challenges of meeting the Act's regulatory requirements will be provided. Participants will be told how this forum will be used to update the City's response to regulators. Since a special focus of this forum is on the impact of these regulations

on property owners from the perspective of remediation needs and the city's future revenue needs this will be addressed in the presentation. The goals of the forum will be provided to the participants following the presentation.

The forum will focus on two main activities centered on private property owners' impact on Lakewood's Clean Water Act regulatory strategy and revenue needs for infrastructure investment to meet regulatory requirements.

To provide for anonymity and engaged participation in this setting it is recommended that a combination of interactive polling and true/false statements be used to help facilitate participant learning and to avoid having some vocal participants influence others.

The first part of the activity will include multiple-choice questions that can be projected onto a screen. Interactive polling is available through Microsoft PowerPoint and Poll Everywhere, which allows for live, real-time polls of audience members with questions embedded directly in the presentation. Participants can use their smartphone to access the poll. This software allows the facilitator to track the poll results by the number of responses received. When the poll is closed, the results are projected in a graph for all participants to see the results.

The second part of the activity will use true/false statements and participants will be asked to vote whether they believed the statements to be true or false and then discuss the results.

After this activity, staff/consultants will review the statements with participants, explaining why each statement was either true or false and providing examples of the City of Lakewood's involvement in each statement area.

After the two main activities, participants will hear a short presentation discussing the City's identification of 10 major projects intended to bring the City to a capture and treatment rate of 98% for all water in a typical year and a short discussion of the costs of these projects. This presentation will be followed by an open table discussion with a facilitated activity at each table designed to address the following questions:

- What had real meaning for you from what you've heard? What surprised you? What challenged you?
- What else do you think the City can do to protect against combined sewer overflows?
- What do you think property owners can do to minimize and remediate stormwater and sewer cross contamination at the individual property level?
- Given the need for revenue for future investments in infrastructure, how do you perceive this problem and the best solution?

REPORT OUT AND EVALUATIONS

Group facilitators will report out at the end of the session on the outcome of group activities by summarizing their tables' discussions from the true/false statements and/or ideas and suggestions resulting from the open table discussion. Meeting participants will be asked to participate in the Open House on Jan. 16.

At the end of the meeting, participants will be asked to complete an evaluation form for feedback on the meeting and process. Participants will be asked to rate five statements on a scale of 1 to 5 with 1 indicating no agreement and 5 indicating complete agreement. The five statements are:

- My time was well spent.
- I felt the City of Lakewood wanted my input.
- I would participate in this type of session again.
- The meeting structure allowed participants to provide feedback.
- I learned something about the City's regulatory requirements for combined sewer overflows.

Community Open House

The City of Lakewood will host a Community Open House on January 16 from 7 to 9 p.m. at the Lakewood High School Cafeteria. An open house is self-directed to a large degree. Participants stop by at their convenience and visit the information stations of greatest interest to them. They can talk to City staff members and share with staff their individual comments and questions. The following is an overview of what the open house entails and how the City can prepare for the event.

Goals of the Community Open House

- Improve public understanding of the stormwater and sewer system and the City's response to Clean Water Act regulations
- Inform the public by getting input on specific questions related to private property remediation and potential rate and affordability impacts
- Explain complex points in an informal setting allowing for one-on-one discussion

Timing

The open house is set to occur January 16 from 7 to 9 p.m. Attendees can arrive at any time during the open house.

Preparation

The City has identified the topics to include at the stations in the open house as the following…X. Specific staff and consultant team members need to be identified for each station and a "dry run" of the event will be conducted to test the materials and staff preparation in advance.

It will be important to promote the open house through all available channels. This accomplishes two goals: 1) it creates awareness of the event even for those that have no interest in attending; and 2) it helps drive participation for those that have a moderate to high level of interest in the topic.

Promotion

The following tactics are proposed to help build awareness of the open house:

- Direct invitations from the Mayor and City Council
- Direct invitations to all the City's boards, commissions, and task forces
- Lakewood Life
- Direct invitations to those that participated in the workshops and community conversation events
- NextDoor
- Direct invitations to stakeholder groups
- News Media
- City's Social Media
- Email to water/sewer customers
- Postcards to water/sewer customers
- Inclusion in neighborhood and school newsletters
- Direct invitation to youth groups (teens and young adults)
- Direct invitation to community and faith organizations
- Inclusion on the City's website
- Postcards mailed to every customer, and handed out to walk-in bill payers
- Inclusion on the customer's water bill

- Signs at the intersection closest to the open house location promoting community open house (consider use of lighted message boards)
- Request partner organizations help promote community open house
- Bill inserts
- Other community events

Implementation

- Setup team arrives early to arrange the room and stations
- Setup should be complete 45 minutes before scheduled start time
- Resource team arrives at least 45 minutes before the start for a briefing and walk-through of the displays and stations.
- Review station assignments with City staff and consultant team
- Spend a few minutes reviewing the key messages and providing tips for active listening
- Attendees are greeted as they arrive, asked to sign in and are briefly oriented to the event setup
- People move at their own pace, visiting one-on-one or in small groups with resource team members
- Attendees conclude at a comment station where they can sit down, complete comment forms and enjoy refreshments.

Documentation

- Comment forms that can be completed at the event help participants provide useful information by soliciting their input on specific topics.
- Alternatively, people can provide comments on a "paper comment wall" sticky notes or on a flip chart paper at each station.
- Attendee sign-in sheets provide a basis for building a mailing list.
- A written summary of the event can be included in the City's IWIPP Phase 2 Report

Tips

- Be ready for early arrivals.
- Need a contingency plan to accommodate large numbers of arrivals
- Ensure exhibits and displays are informative, but not persuasive in tone. They must be simple, clear and easy to read at a distance.
- Minimize technical language and jargon.
- Aerial photographs can be used to help attendees orient to their location (particularly helpful for the sewer/stormwater system overview station).
- Ensure the words "draft," "proposed," etc., are clearly presented at the financial/rates station. Allowing for a comment board with sticky notes at this station would also help portray that the City is seeking to consult with customers.
- Provide relevant handouts (general utility information, FAQ on Clean Water Lakewood and rate infographics).
- Media may be present, so ensuring that the designated City spokesperson is at the open house is critical.

Evaluation / Debrief

After attendees have departed, the resource team will gather to debrief on the following:

- What went well?

- Was anything confusing?
- What are the major things we learned?
- What action is needed for attendees' requests and/or questions?
- How well did the event meet the objectives we outlined?

Resources

A fine balance exists between too many and not enough staff. Each station needs at least one staff person (rates and engineering stations will have a staff person and a consultant because of the focus on this topic).

- Two floaters are necessary to walk the room and answer general questions or direct attendees.
- A greeter at the entrance manages sign-in and orients attendees to the event layout.
- City Council should be invited to attend.
- Name tags for all staff members, consultants and City Council should be provided.

Equipment

- Plenty of easels
- Comment box
- Signs identifying stations, refreshments, comment boxes, restrooms

Space and Room

A sample room set-up will be developed for this plan, subject to actual room dimensions, etc. There should be no fixed seating, although a few chairs for use when filling in a comment form, or for those that need a seat should be provided.

- A display and potentially a hand-out at each station, and a sign above each station identifying what the topic is.
- Tables and chairs by the refreshment and comment area.
- Arrange stations clockwise from the entrance (or to follow a logical flow).
- Provide trash and recycling bins near the refreshments
- Ensure tap water is available with the refreshments (do not provide bottled water)

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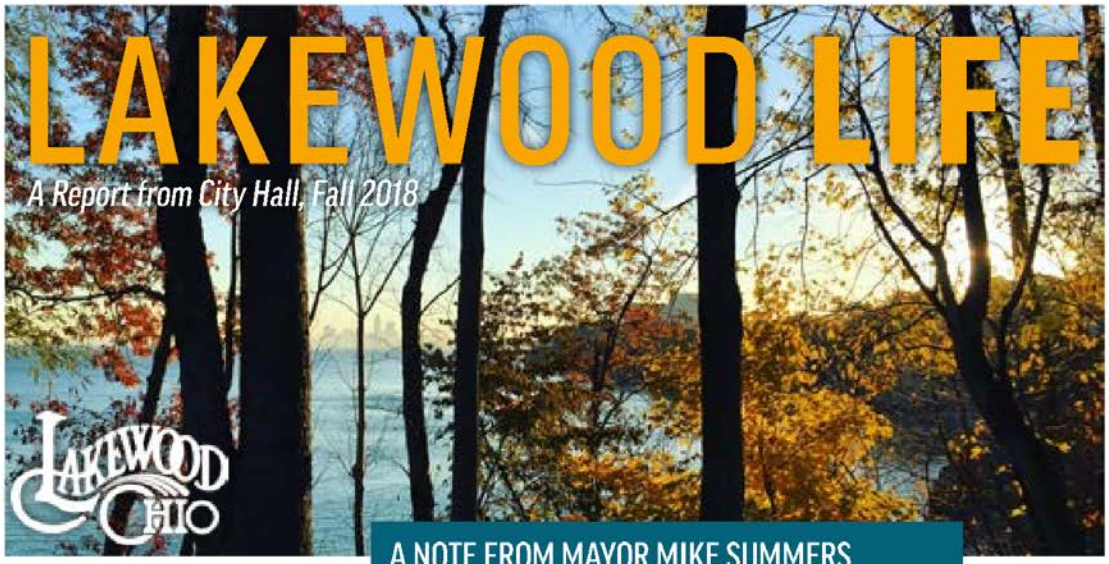
Timeline and Task List

Task Description	Assignment	Due Date
Review DRAFT Community Engagement Plan with City staff and provide feedback	City/Raftelis	Oct. 11
Finalize Community Engagement Plan	Raftelis	Oct. 16
Develop calendar of events October - February and add Clean Water Lakewood messaging and materials where appropriate	City	Oct. 19
Develop Clean Water Lakewood presentation for use with key stakeholder audiences	Raftelis	Oct. 30
Offer briefings/presentations to targeted stakeholders	City	Ongoing
Seek out partner agency communications on behalf of Clean Water Lakewood	City	Ongoing
Bill message/insert promoting community conversations and open house	City	Ongoing
Develop contact card for use with customer-facing and field staff	City	Nov. 9
Staff meetings/tailgate meetings to go over messaging, purpose of Clean Water Lakewood and community events	City	Nov. 9
Design direct mail postcard for all residents and businesses	Raftelis	Nov. 15
Mail postcard to residents and businesses/begin providing to walk-ins	City	Nov. 16
Develop FAQ document on Clean Water Lakewood	Raftelis/City	Oct. 30
Develop Fact Sheet/Infographic on Clean Water Lakewood	Raftelis/City	Oct. 30
Develop content calendar and assign stories	City/McCaulley & Co	Nov. 1
Research whether signs can be placed at intersection near open house	City	Nov. 15
Develop social media calendar to post content	City/McCaulley & Co	Nov. 1
Review onelakewood.com for outdated information and ensure consistency with Clean Water Lakewood messaging	City/McCaulley & Co	Nov. 1
Add website content providing context	City/McCaulley & Co	Ongoing

COMMUNITY ENGAGEMENT EVENTS	Assignment	Due Date 16
Joint Task Force Workshop – 1 Task Description		
Develop agenda	City/Raftelis	Oct. 12
Invite participants	City	DONE
Assign roles	City/Raftelis	Oct. 16
Develop presentations	Speakers	Oct. 19
Dry-run	All	Oct. 19
Create meeting materials/name tags/sign in sheets	City	Oct. 19
Conduct Workshop	All	Oct. 23
Develop summary report	Raftelis	Oct. 25
Joint Task Force Workshop – 2 Task Description	**Assignment**	**Due Date**
Develop agenda	City/Raftelis	Nov. 2
Develop small group exercises	Raftelis	Nov. 2
Invite participants	City	DONE
Assign roles	City/Raftelis	Nov. 2
Develop presentations	Speakers	Nov. 9
Dry-run	All	Nov. 15
Create meeting materials/name tags/sign in sheets	City	Nov. 14
Conduct Workshop	All	Nov. 15
Develop summary report	Raftelis	Nov. 17
Community Conversations – Task Description	**Assignment**	**Due Date**
Publicize meeting through channels described in plan	City	Nov. 16
Determine how to incentivize participation ($20 Amazon card, bill credit)	City	Nov. 16
Set up meeting registration on website	McCaulley & Co	Nov. 16
Determine A/V needs for meeting if real-time polling is used	City/Raftelis	Nov. 16
Assign staff as table facilitators and recorders	City/Raftelis	Nov. 29
Develop presentations and facilitated meeting format/discussion guide	City/Raftelis	Nov. 29
Create sign-in sheets/name tags	City	Dec. 3
Create table assignments	City	Dec. 3
Gather all materials	City	Dec. 3
Set up meeting room	City/Raftelis	Dec. 4
Purchase refreshments	City	Dec. 4
Develop input forms	Raftelis	Dec. 3
Summary report	Raftelis	Dec. 6
Open House – Task Description	**Assignment**	**Due Date**
Publicize meeting through channels described in plan	City	Jan. 4

Develop input method to match level of input desired by City	Raftelis	Jan. 4
Determine stations and develop displays	City/Raftelis/Brown and Caldwell	Jan. 4
Assign staff to set-up, resource and clean-up teams	City	Jan. 4
Create attendee sign-in sheets	City	Jan. 14
Assemble equipment	City	Jan. 14
Purchase refreshments	City	Jan. 16
Implement community open house	City/Raftelis	Jan. 16
Conduct debrief	City/Raftelis	Jan. 16
Develop summary report on open house	Raftelis	Jan. 20

LAKEWOOD LIFE NEWSLETTER, FALL 2018



INSIDE THIS ISSUE...

The Past, Present, and Future of Lakewood's Sewer System

Resiliency Update

Wastewater Treatment Plant Improvements

Fall Leaf Collection & Halloween Information

You're invited!

Community Meetings on the Clean Water Act: The Road Ahead for Lakewood

Tuesday, December 4, 2018
7 p.m.
Lakewood High School Cafeteria
&
Wednesday, January 16, 2019
7 p.m.
Lakewood High School Cafeteria

LKWD

A NOTE FROM MAYOR MIKE SUMMERS

This edition of Lakewood Life focuses on the challenges for Lakewood to comply with the Clean Water Act of 1972. Our unique 100-year-old sewer system performs as designed. It is powered by gravity, has protected us from waterborne diseases and minimized basement flooding.

I remain impressed with our 1910-1930 sewer system design and workmanship. However, as environmental stewards we appreciate the requirements of the Clean Water Act. We understand the importance of and the value we find in our Great Lake. Our system performs very well in dry weather circumstances, but in large rain storms our system fills up and discharges an untreated combination of storm and some sanitary water into Lake Erie. This is illegal under the Clean Water Act.

On March 1, 2019, Lakewood is required to submit an engineering plan that will capture and treat substantially all water in dry and wet weather circumstances. Reengineering our system requires significant measuring, monitoring and modeling to capture the full effect of needed changes. Like other communities, we face large costs, disruptive digging and higher sewer rates to effectuate a redesigned system.

We need your input now and ultimately your help to advocate what is best for our city to the regulators (the Ohio EPA and U.S. EPA). The regulators must agree with the city as to which solutions are selected for compliance. Because the national "one-size-fits-all approach" will not work in Lakewood, we need to stand together and explain our position to the regulators.

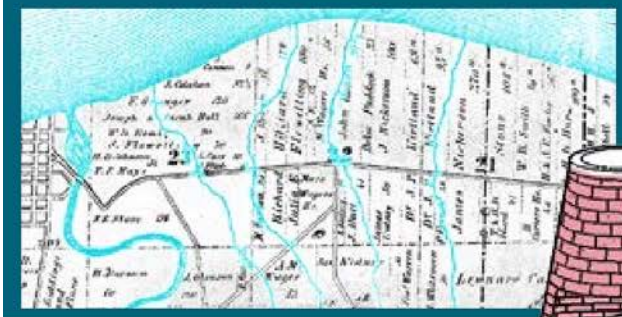
Please join me and invest your valuable time to become an informed advocate about this once in a century challenge. Details on how you can be instrumental in this process are found throughout this edition.

Read my full letter to council at the following link: https://bit.ly/2OSI0dp

EARLY 1900s

1852

Below: This early map of Lakewood shows four streams that flowed through the city to the lake before they were culverted for development and flood control.

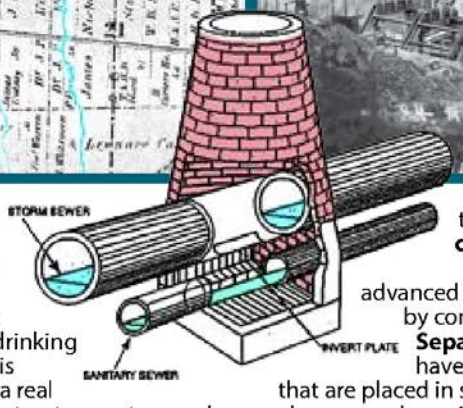


1930s

Left: Large combined interceptors were constructed to convey more flow to the wastewater treatment plant.

1916

Below: The construction of the wastewater treatment plant with the valley cliffs visible in the background.



In the early 1900s, governments were focused on health and sanitation. Outbreaks of diseases like typhoid and cholera spurred the development of hospitals, sanitary sewers and drinking water treatment. It was during this time that Lakewood experienced a real estate boom thanks in part to the streetcar system and the completion of the Detroit-Superior Bridge.

The earliest sewers built in Lakewood during this time were combined sewers. **Combined Sewers** are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. The next iteration of sewer design came in the form of **over-under sewers** (see graphic). These used a common trench and placed the storm sewer immediately above the sanitary sewer. In order to gain access the sanitary sewer for maintenance, metal invert plates were placed on the bottom of the manhole. These sewers were also designed to overflow during large rainfall events.

Lakewood's wastewater treatment plant was built in 1916 at the lowest point in Lakewood, the Rocky River Valley, but only served a portion of the city. The city's sewers were retrofitted in the 1930s to flow to an **interceptor** running along the lakefront and riverfront and directing more flow to the treatment plant. During periods of heavy rain or snow melt, our sewers were designed to release excess storm and sanitary water into the lake to avoid basement backups, causing **combined sewer overflows**.

As time went on, sewer design advanced to account for the problems created by combined and over-under sewers. **Separate sewer systems** are those that have both the storm and sanitary sewers that are placed in separate trenches. These sewers also age and require maintenance, but are the current standard for building sewers.

Lakewood is not alone in dealing with an aging system with a design that is no longer considered best practice. With the passage of the Clean Water Act in 1972, overflows in cities like ours across the country were required to be controlled in order to make public waters fishable and swimmable.

Did you know?

Lakewood had several streams that ran through the city (as shown on the map above). One of the streams ran through Lakewood Park, seen in the photo at left. Another flowed through the area of what is now (appropriately named) Waterbury Avenue.

LKWD

1972 - TODAY

CLEAN WATER LAKEWOOD

Rebuilding the Pipeline for Our Future

2016

Right: The construction of the aerial sewer shown in the photo addressed CSO 054 outfall, eliminating 3.5 million gallons of combined wastewater from entering the Rocky River.

2015

Above: The Clean Water Lakewood task force was put together in 2015 to help identify the best paths forward for water infrastructure in Lakewood.

The chart on the right shows percent capture of wastewater in Lakewood as projects have been implemented. The measurement started in 2003 when the hydraulic model was created.

- **2003** 79%
- **2011** 83% WWTP Expansion
- **2016** 85% Aerial Sewer & Lake Ave. Sewer
- **2021** 88% High-rate Treatment

Since the Clean Water Act's adoption, Lakewood has made substantial strides learning how our old patchwork sewer system operates – from our homes to our streets, and from our wastewater plant and to Lake Erie and the Rocky River. And we've implemented measures to protect those vital waters and achieve the spirit of the Clean Water Act sustainably and affordably.

Just since 2003 the city has spent $60 million to improve our sewer and wastewater system. Approved projects in process add an additional $23 million of improvement, including a high-rate treatment facility that will soon be constructed next to the wastewater plant.

These important projects have paid off and will continue to do so. Until 2006, the city's sewer system captured and treated 79 percent of all water – storm and sanitary – with the remaining 21 percent overflowing into the lake untreated as mostly rainwater and some sanitary water.

In 2011 the city invested $5 million in an expansion of the wastewater plant, which ultimately increased our rate of capturing and treating wastewater to 83 percent. In 2016 the city added the West End aerial sewer that eliminated a major overflow to the Rocky River, and in 2018 the city expanded the Lake Avenue sewer main that further increased the city's total wastewater capture and treatment to 85 percent. Projects in process will advance our capture-and-treatment percentage to 88 percent by 2021.

By comparison, communities nationwide are under federal orders requiring them to spend billions over decades with the goal of achieving 85 percent control – a level Lakewood has already surpassed.

All that is good news, but we know our work isn't done. The figures above reflect the enormity of the tasks ahead of us, not only to reach compliance with the Clean Water Act but also to do so without jeopardizing your financial well-being. You must play a role in the planning process that's before us. Read on to see how you can.

Who's involved?

OHIO EPA & U.S. EPA	Enforcing clean water laws like the Clean Water Act of 1972. Regulating Lakewood's Sewer Department operations with a permitting process in 2019.
CITY HALL	Communicating to Lakewood residents about Ohio EPA and U.S. EPA requirements. Coordinating city, resident, consultant, and partner resources to comply with the Clean Water Act. Advocating affordability for Lakewood residents to Ohio EPA and U.S. EPA.
CONSULTANTS	Guiding the creation of an affordable and sustainable overflow control plan to comply with Ohio EPA and U.S. EPA enforcement of the Clean Water Act.
YOU	Getting informed and involved. This challenge impacts every resident in the City of Lakewood and every choice we make will have a lasting impact. Join the community discussion on December 4th at Lakewood High School.

FUTURE

The city is creating a plan that will be submitted on March 1, 2019 which will propose future system improvements to achieve greater percent capture of wastewater.

2018

- **City Council Work Sessions**
  Council will gather to consider water and sewer rate increases necessary to implement the Integrated Wet Weather Improvement Plan
- **Stakeholder Meetings *(Clean Water Task Force/Resiliency Task Force/Planning Commission)***
  October 23rd, 2018 City Hall Auditorium 6:00 p.m.
  November 15th, 2018 Woman's Club Pavilion 6:00 p.m.
- **Community Round Table**
  December 4th, 2018 Lakewood H.S. Cafeteria 7:00 p.m.

2019

- **Open House**
  January 16th, 2019 Lakewood H.S. Cafeteria 7:00 p.m.
- **Submit the Plan**
  March 1st, 2019 Submit revised Integrated Wet Weather Improvement Plan to the U.S. and Ohio EPA

Once the plan is submitted, discussions will continue with the public and the Ohio and U.S. EPA throughout 2019 (including financing and our National Pollutant Discharge Elimination System permit).

Throughout the next year, our local elected officials and each of us as citizens will have a big role to play in Lakewood's future compliance with the Clean Water Act. The city's engineering and financial consultants have been busy over the last few years reviewing our current sewer infrastructure and the financial ability of the community to support the various sewer infrastructure options. The consultants have been working on optimizing alternatives that may include wastewater treatment plant upgrades, **green infrastructure** (using natural cycles such as infiltration and plants) and **grey infrastructure** (using pipes and storage).

As a community, we must prioritize what infrastructure projects we believe make the most sense for Clean Water Act compliance and are most affordable. We must also work with our state and federal regulators to ensure that they also agree on the solutions chosen for compliance.

While considering these new solutions we must not lose focus on the need to maintain investments in our current 2nd-century infrastructure plans. These plans involve improving our drinking water infrastructure, streets, century-old homes, parks and pools, and city buildings and equipment. The goal is to have an integrated plan that can combine multiple projects with the investments in the sewer system.

Beyond the public infrastructure projects, we must also acknowledge the need to consider how private improvements can be implemented within our community to help over time. For example, all new developments within the city are required to include stormwater controls. These requirements hold developers and contractors within the city to maintain the commitment we have to our waterways. Lake Erie is and will remain a valuable asset.

By making these tough decisions, we are preserving a future with access to clean drinking water, providing safe recreation opportunities, and ensuring the long-term health of our community.

Madison Park Green Infrastructure

RESILIENCY UPDATE

What is Resiliency? Resiliency is the ability of a system to absorb internal and external shocks – whether environmental, social, or economic. Purposeful planning with a focus on resiliency will address the local effects of climate change, globalization, population growth, overconsumption, housing insecurity, rising healthcare costs, and much more.

The Resiliency Task Force meets monthly to discuss long-range planning topics that have an impact on the City of Lakewood and its citizens. Each month, the task force hears from industry experts in a particular field who conduct a group discussion on the long-range challenges the city faces related to that topic. The task force then works to capture their thoughts on the topic and produce a "template" document. In addition to providing a synthesis of the group's notes, the template includes methods to measure progress, potential projects or policy changes identified, and partnerships the city must leverage to address the topic. To date, the Task Force has addressed energy, connectivity, housing, food, and waste. Meeting materials and draft template documents are available at:

www.onelakewood.com/resiliency

The public is invited and encouraged to attend all Resiliency Task Force meetings. On the evening of October 23rd, the Resiliency Task Force and Clean Water Task Force will hold a joint meeting on the topic of water, taking a deeper dive into the wastewater challenges explored in this issue of Lakewood Life. Join us!

Be on the lookout for future resiliency discussion topics including public spaces, culture & identity, economic development, engagement & inclusion, public safety, and more.

WASTEWATER TREATMENT PLANT IMPROVEMENTS

Lakewood's Wastewater Treatment Plant (WWTP) has undergone several improvement projects over the past few years and will continue to see investment in the future. The current WWTP treats all flow during dry weather and up to 40 million gallons/day during rainfall events. Many of the projects completed to date at the plant will save the city valuable resources by replacing energy intensive systems with energy-efficient systems. Other improvements allow the plant to treat more flows during rainfall events, preventing overflows into Lake Erie. The completed and planned project are as follows:

- The lights throughout the WWTP were recently replaced with energy efficient LED lights.
- New high-efficiency aeration blowers were installed. The blowers save about 1 million kWh of electricity per year. This means they will have a short payback period of about 8 years.
- The city is enhancing a large maintenance overhaul project on the plant's digesters to include using the methane gas produced there to generate 30 percent of the electricity needed to operate the plant.
- The new high-rate treatment addition will reduce combined sewer overflows to the lake by 16 million gallons per year by cleaning and disinfecting the water at a rate 20 percent faster than the standard treatment process.

Did you know? The upcoming high-rate treatment installation, working with the WWTP, can treat 70 million gallons per day. That's enough to fill Foster Pool at Lakewood Park 108 times!

LAKEWOOD OHIO

Lakewood City Hall
12650 Detroit Ave.
Lakewood, Ohio 44107

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FALL LEAF COLLECTION

Leaf collection will begin November 5th and continue through December 14th.

More information can be found at:
www.onelakewood.com/leaf-collection-begins-monday-november-5th/

The most challenging aspect of fall leaf collection – besides parked cars – is the delay in the onset of leaf drop. This causes a scenario in which the majority of the leaves do not completely fall from trees until the beginning of December, which may often coincide with early season snow falls – placing great demands on city crews. If this is the case this fall, please be patient with our crews as they try to do two important jobs at once!

HALLOWEEN

Trick-or-Treating will be held October 31st from 6:00 p.m. - 8:00 p.m.

Please be safe!

- Parents should encourage their trick-or-treaters to be especially careful after sunset. If escorting their children, parents should carry a flashlight as an additional safeguard.
- Residents giving out candy and treats can help prevent accidents by reminding children to be especially careful crossing streets and to walk up and down steps, instead of running.
- Halloween night drivers should be especially vigilant. Motorists should drive more cautiously and be prepared to stop.

LETTER FROM 3RD GRADER

October 26, 2018

Dear Mayor Summer's,

The trip to city hall was awesome, I learned so much when I was there! I can't believe hard it must be to rune a hole city. I never knew that the worst problem was the sewer, I always thought that the sewer were ok, but I guess I was wrong. I can't wait to see you again

Your Lakewood Citizen,
John grasso
Third grader at Lincoln Elementary

APPENDIX 10-1
Council Resolution

RESOLUTION NO. 9060-19 BY: Anderson, Bullock, George, Litten, O'Leary, O'Malley, Rader

A RESOLUTION to take effect immediately provided it receives the affirmative vote of at least two thirds of the members of council, or otherwise to take effect at the earliest period allowed by law, ratifying and endorsing the City's Integrated Wet Weather Improvement Plan, and especially the Priorities and Principles recited therein.

WHEREAS, after years of study under the integrated planning framework advanced by the federal government, the City has prepared an integrated plan to address and minimize combined sewer overflows into Lake Erie and Rocky River for the health, safety and welfare of Lakewood residents and for compliance with the federal Clean Water Act of 1972; and

WHEREAS, the plan, found within Phase 2 of the City's Integrated Wet Weather Improvement Plan, is due to the Ohio EPA on or about March 1, 2019; and

WHEREAS, Council has been involved in the planning of Phase 2 of the City's IWWIP, from participating in the public process to passing five years' worth of water and sewer rates in order to fund imminent improvements called for under the plan to adopting long-term capital strategies that permit the construction of a high-rate treatment facility among other improvements, and

WHEREAS, pursuant to the Constitution of the State of Ohio and the Ohio Revised Code, municipalities have the power of local self-government; and

WHEREAS, pursuant to the Constitution of the State of Ohio and the Ohio Revised Code, municipalities have the power to enact laws that are for the health, safety, welfare, comfort and peace of the citizens of the municipality; and

WHEREAS, as set forth in Section 2.12 of the Third Amended Charter of the city of Lakewood, this Council by a vote of at least two thirds of its members determines that this resolution is an emergency measure and that it shall take effect immediately, and that it is necessary for the immediate preservation of the public peace, property, health and safety, and to provide for the usual daily operation of municipal departments in that the City's IWWIP Phase 2 plan is due on or about March 1, 2019; now, therefore

BE IT RESOLVED BY THE CITY OF LAKEWOOD, OHIO:

Section 1. Council hereby ratifies and endorses the City's Integrated Wet Weather Improvement Plan, and especially the Priorities and Principles recited therein, in substantially the same form as the document attached as Exhibit A, as part of the City's overall Phase 2 submission to the Ohio EPA.

Section 2. It is found and determined that all formal actions of this Council concerning and relating to the passage of this resolution were adopted in an open meeting of this Council, and that all such deliberations of this Council and of any of its committees that resulted in such formal action were in meetings open to the public, in compliance with all legal requirements.

Section 3. This resolution is hereby declared to be an emergency measure necessary for the immediate preservation of the public peace, property, health, safety and welfare in the City and for the usual daily operation of the City for the reasons set forth and defined in the preamble to this resolution, and provided it receives the affirmative vote of at least two thirds of the members of Council, this resolution shall take effect and be in force immediately upon its adoption by the Council and approval by the Mayor, or otherwise it shall take effect and be in force after the earliest period allowed by law.

Adopted: 2/19/19

PRESIDENT

Maureen M Bach

CLERK

Approved: 2/20/19

MAYOR (ACTING)

I HEREBY CERTIFY THIS RESOLUTION NO. 9060-19 TO BE A TRUE COPY OF THE ORIGINAL.

Maureen M Bach

CLERK OF COUNCIL

EXHIBIT A

Integrated Wet Weather Improvement Plan

(*See following pages*)

INTEGRATED WET WEATHER IMPROVEMENT PLAN

PHASE 2

City of Lakewood, Ohio

February 19, 2019

NOTE

The material that follows is the City of Lakewood Integrated Wet Weather Improvement Plan, Phase 2. The full report includes technical and historical analyses found in other chapters and will be submitted by the NPDES permit deadline. The material that follows constitutes Chapter 10 of the full Phase 2 IWWIP report and submittal by the city.

CHAPTER 10 – LAKEWOOD'S INTEGRATED WET WEATHER IMPROVEMENT PLAN

Based on the investigations summarized and reported in the 2019 Phase 2 IWWIP report, the City of Lakewood adopts this Integrated Wet Weather Improvement Plan and schedule.

This IWWIP will achieve compliance with the Clean Water Act and Ohio law. This IWWIP complies with all requirements of 33 USC §1412(s) and EPA's June 2012 Integrated Municipal Stormwater and Wastewater Planning Approach Framework.

PRIORITIES AND PRINCIPLES

To achieve the environmental and public health goals of the Clean Water Act, Ohio law and the city's Community Vision, the City of Lakewood adopts these priorities and principles to guide the implementation of the IWWIP:

1. **Lakewood is committed to sustained sewer system improvement for the betterment of water resources, human health and the protection of economic vitality of the city.** The city's IWWIP priority is to reduce the discharge of pollutants to receiving waters. General stormwater management and general maintenance and operation will follow existing permits and plans.

   Control of Rocky River pollutant discharge via CSO 052 is prioritized higher than other overflows due to pollutant load, recreational use, and opportunity for significant cost-effective measures on city-owned property. Control of Lake Erie discharges are prioritized based on relative mass of pollutant loading.

2. **Capital projects should achieve the greatest water quality and public health improvement for the dollars spent.** Upgrades to the collection system, especially the modernization of over-under sewers, should be integrated with other infrastructure work, such as street repairs and water line renewal, in order to maximize cost efficiencies and minimize disruption.

3. **Basement backups are the worst water and sewer related outcome and reducing risk of backups is a priority.** Lakewood will not undertake any action under this IWWIP that knowingly increases the risk of basement backups during the normal level of service conditions. Lakewood will continue system monitoring and iterative modeling so that all improvements under this plan, including major capital projects as well as routine manhole separation and invert plate replacements, are documented and incorporated into ongoing analysis so that risk of backups is minimized.

4. **Consistent with the Clean Water Act and Integrated Planning, Adaptive Management of this IWWIP must be maintained.** Adaptive management is necessary to leverage land use changes, market opportunities, new technologies, changing affordability and access to non-local sources of infrastructure funding.

   In each five-year period, Lakewood will prepare an IWWIP update. As part of the update and at other times, Lakewood will receive and consider public input, consistent with the Integrated Planning Framework.

5. **All actions under the IWWIP must remain affordable and equitable.** The IWWIP must remain affordable for Lakewood's sensitive populations, especially the lowest quintiles. The IWWIP must remain predictable to protect affordability and sustain private investment. New rate structures and any systematic renewal of private infrastructure must be equitable.

With these priorities and principles guiding implementation, Lakewood's IWWIP and schedule are set forth below for the next five-year period, corresponding to the schedule for Lakewood's NPDES renewal schedule for 2019-2023. The projected five-year schedule for 2024-2028 is also listed. All remaining IWWIP large capital measures to be implemented after 2028 are prioritized.

Ongoing IWWIP Measures

The following IWWIP measures are applicable in all five-year periods:

1. Lakewood will continue its ongoing investment to renew existing infrastructure, at its WWTP and throughout the system, in an integrated and planned approach.

2. Lakewood will maximize land use opportunities and code enforcement for continued wet weather improvement and green infrastructure development, consistent with the Community Vision.

3. Lakewood will continue its ongoing investigation and iterative modeling and monitoring to optimize system performance, prioritize capital investments and minimize risks of basement backups.

4. Lakewood will perform periodic affordability analyses, no less than in every five-year period, to protect ratepayer affordability, especially the lowest quintiles of the population, in order to keep the program sustainable.

5. Lakewood will perform Adaptive Management review of this IWWIP no less than every five-year period in preparation for any five-year IWWIP update.

SCHEDULE

Lakewood adopts the following schedule of IWWIP measures:

1. **2019-2023**

   - Continue all ongoing activities.
   - Complete Atkins area private property pilot study and evaluate the cost-effectiveness and prioritization of any private infrastructure requirements.
   - Evaluate revised rate structure to include fixed-fee charge and/or impervious-surface charge and credit or incentive regime.
   - Complete West Clifton and other Regulator Improvement Projects.
   - Complete $23 million High-Rate Treatment Facility for control of CSO 002.
   - Complete design of Bundle 1: work for CSO 052 storage facility and aerial sewer.
   - Evaluate land use requirements for CSO 059 control measure and related land use opportunities and existing facility investment.
   - Complete IWWIP Update by December 31, 2022.

2. **2024-2028 (projected)**

   - Continue all ongoing activities (and any additional ongoing measures adopted in 2019-2023).
   - Construct Bundle 1: CSO 052 storage facility RRES 1160-1165: Aerial Sewer to Above Ground Storage at WWTP. Controlled to 4 untreated CSOs per typical year.
   - Complete design work for Bundle 2: CSO 059 and related interceptor overflow storage facilities.
   - Complete IWWIP Update by December 31, 2027.

3. Prioritized potential 5-year bundles of measures (exclusive of ongoing activities), subject to affordability limits

Bundle 2: CSO 059 and Homewood

- Construct LEWS 1040: Relief to Interceptor picking up all CSOs and manage at CSO 059. No overflow in 2-year storm event.
- Construct LEWS 1035 (CSO 059): Underground Tank Storage (storage to manage also LEWS 1040 and LEWS 1195 TBD). Controlled to 4 untreated CSOs per typical year.
- Construct LEWS 1195: Close off and convey more to Interceptor and manage at CSO 059. No overflow in 2-year storm event.
- Construct LEWS 1070: Source Control, Diversion Sewer, Pump Station, Storm Sewer. No overflow in 2-year storm event.
- Design Bundle 3: CSO 057 and Detroit Avenue/West Clifton.

Bundle 3: CSO 057 and Detroit Avenue/West Clifton

- Construct LEWS 1130-1135 (CSO 057): Belle Storage Tunnel, Lakewood Park Storage Basin. Controlled to 4 untreated CSOs per typical year.
- Construct RRES 1145: Source Control, Sewer Separation, Regulator Modification, Green Infrastructure. No overflow in 2-year storm event.
- Design Bundle 4: CSO 056A&B and Lakeland.

Bundle 4: CSO 056A&B and Lakeland

- Construct LEWS 1150 (CSO 056B)-1155 (CSO 056A): Source Control, Green Infrastructure, Relief Sewer, Regulator Modifications. Controlled to 0 untreated CSOs per typical year.
- Construct LEWS 1180: Source control, relief sewer, storm sewer. No overflow in 2-year storm event.
- Design Bundle 5: Remaining Minor Overflows.

Bundle 5: Remaining Minor Overflows

- Construct LEWS 1225 (CSO 055): Sewer separation. Overflow eliminated.
- Construct LEWS 1110 (CSO 058): Diversion sewer. Controlled to 4 untreated CSOs per typical year.
- Construct LEWS 1045: Bulkhead interceptor connection, add pump station to serve area. No overflow in 2-year storm event.
- Construct LEWS 1055-1060: Source Control, Green Infrastructure, Relief Sewer, Regulator Modification. No overflow in 2-year storm event.
- Construct LEWS 1285-1295: Relief Sewer, Regulator Modification. No overflow in 2-year storm event.
- Construct LEWS 1210: Source control. No overflow in 2-year storm event.
- Construct LEWS 1215: Regulator modification. No overflow in 2-year storm event.
- Construct LEWS 1220: Source control, Green Infrastructure. No overflow in 2-year storm event.