



MASSACHUSETTS WATER RESOURCES AUTHORITY

Charlestown Navy Yard
100 First Avenue, Building 39
Boston, MA 02129

Frederick A. Laskey
Executive Director

Telephone: (617) 242-6000
Fax: (617) 788-4899
TTY: (617) 788-4971

April 30, 2015

Todd J. Borci
Office of Environmental Stewardship
US EPA New England
5 Post Office Square
Suite 100 (OES 04-4)
Boston, MA 02109-3912

Kevin Brander, P.E.
Section Chief, Municipal Services Section
DEP Northeast Region Office
205B Lowell Street
Wilmington, MA 01887

Subject: CSO Discharge Estimates and Rainfall Analyses for Calendar Year 2014

Dear Mr. Borci and Mr. Brander:

Enclosed please find documentation of the Massachusetts Water Resources Authority's (MWRA) estimates of combined sewer overflow (CSO) discharges in its service area during calendar year 2014. MWRA is required to submit estimates of CSO activations and volumes for the previous calendar for the Alewife Brook/Upper Mystic River and the Lower Charles River/Charles Basin in accordance with conditions in the Variance Extensions for CSO Discharges to the Alewife Brook/Upper Mystic River and for CSO Discharges to the Lower Charles River/Charles Basin, issued by the Massachusetts Department of Environmental Protection in 2013 pursuant to the Massachusetts Surface Water Quality Standards at 314 CMR 4.00. The Variance Extensions authorize limited CSO discharges to the Alewife Brook/Upper Mystic River and the Lower Charles River/Charles Basin in conjunction with National Pollution Discharge Elimination System (NPDES) permits MA0103284, MA0101974, MA0101982, and MA0101192 issued to MWRA, the City of Somerville, the City of Cambridge, and the Boston Water and Sewer Commission (BWSC), respectively.

MWRA reports herewith its estimates of calendar year 2014 CSO activation frequency, total discharge duration and total discharge volume from each of the CSO outfalls within its service area that are addressed in MWRA's approved CSO Long-Term Control Plan (LTCP), not just those discharging to the Alewife Brook/Upper Mystic River or the Lower Charles River Basin. MWRA has also provided this information to the Boston Water and Sewer Commission (BWSC) and the cities of Cambridge, Chelsea and Somerville.

Table 10: Summary of 2014 and Typical Year Model Simulation Results and Comparison to Typical Year Long-Term CSO Control Plan

Table 10 presents estimated CSO activations, duration and volume at all CSO outfalls for storms during calendar year 2014. For most outfalls, the estimates were developed using the MWRA InfoWorks sewer system model by simulating each of the rainfall events in 2014 with storm-specific system operations. In support of these simulations, MWRA updated the model to account for new information and known changes to the system, including CSO projects and other system improvements that were completed during the year. The most significant model updates for 2014 reflect the following completed sewer system improvements and new information. These and less significant model updates are briefly listed at the bottom of Table 10, attached.

- In December 2014, the City of Chelsea permanently closed Outfall CHE002 to CSO discharges.
- BWSC attained substantial completion of Reserved Channel sewer separation Contract 3B in November 2012 and completed nearly all of the sewer separation work of Contract 4 by the end of 2014. (After a winter suspension of work, BWSC expects its contractor to attain substantial completion of Contract 4 in May 2015.) While as-built plans for these contracts are not yet available, MWRA has incorporated the designed improvements and related stormwater inflow estimates into its system model. These model adjustments lowered CSO discharges at outfalls BOS076, BOS078 and BOS079. In addition to completing the work of Contract 4, BWSC continues to perform additional inflow removal, including the disconnection of building downspouts, under its Contract 6 scheduled to be complete later this year.
- In response to a MWRA request, the City of Cambridge removed a 10-inch orifice plate that had limited the hydraulic capacity of the 18-inch dry weather connection at the CSO regulator tributary to Outfall CAM401B. Cambridge had installed the orifice plate as a temporary measure when it completed the interceptor connection relief and floatables control work at CAM401B and other Alewife Brook outfalls in 2010. Cambridge had intended to remove the orifice plate with completion of the CAM004 sewer separation project in December 2015. Modeling performed by MWRA showed that the orifice plate could be removed in advance of completion of sewer separation without significantly affecting hydraulic grade lines in the sewer system and would result in a net reduction in CSO at the various outfalls to Alewife Brook.
- MWRA adjusted the elevations of overflow weirs in the model at several CSO outfalls using new field measurements collected by BWSC, primarily increasing the modeled weir elevations to match the field verified levels.
- With new information from BWSC, MWRA adjusted the set points for operation of BWSC's Malden Street sluice gate that, when closed, shunts flow into the Union Park Detention/Treatment Facility. The adjustment lowers the model's prediction of treated discharges at Union Park.

At the outfalls associated with MWRA's four CSO treatment facilities, the discharge estimates (activation frequency, duration and volume) presented in Table 10 for calendar year 2014 storms are from recorded measurements at the facilities, not model predictions. These outfalls are MWR201 (Cottage Farm), MWR203 (Prison Point), MWR205 (Somerville-Marginal), and MWR215 (Union Park). The activation frequencies and durations in Table 10 for outfalls SOM007A/MWR205A (Somerville-Marginal high tide relief) and BOS019 are from data generated by MWRA depth sensors at the overflow weirs, but the estimated annual volumes at these two outfalls are from the model predictions. The following table compares the recorded CSO measurements to the model predictions for these facilities for the storms in 2014 and for Typical Year rainfall under 2014 and Recommended Plan system conditions.

CSO Discharge Measurements and Model Predictions

Facility	Measured in 2014		Model Predicted					
			2014 Storms		Typical Year		Recommended Plan	
	#	Volume	#	Volume	#	Volume	#	Volume
Cottage Farm	3	81.40	3	73.13	5	16.71	2	6.30
Prison Point	12	303.12	19	301.88	19	283.83	17	243.00
Somerville Marginal*	28**	91.83	19	59.79	18	61.28	39	60.58
Union Park	4	44.50	7	50.48	11	35.88	17	71.37
SOM007A/SOM205A	7	NM	5	5.11	2	1.79	3	3.48
BOS019	2	NM	2	1.53	2	0.30	2	0.58

Notes: Volumes are in million gallons. NM = not measured.

* All flow through CSO facility to outfalls MWR205 and SOM007A/MWR205A

** Gates were opened frequently on forecasted thunderstorms.

Table 10 also compares the results of the Typical Year simulation using end-of-year 2014 system conditions to the activation frequencies and annual volumes in the approved Long-Term Control Plan as defined in Exhibit B to the Second Stipulation of the United States and the Massachusetts Water Resources Authority on Responsibility and Legal Liability for Combined Sewer Overflow Control in the Federal District Court Order in the Boston Harbor Case (as amended in May 2008). This comparison allows a tracking of progress towards meeting the long-term control levels as MWRA and its CSO member communities continue to implement the LTCP.

Rainfall Summary Tables and Rainfall Intensity Comparison Graph

Table 1: Comparison of Frequency of Rain Events within Selected Ranges of Total Rainfall, Typical Year Versus 2014

Table 2: Comparison of Storms with Greater than 2 Inches of Total Rainfall, Typical Year Versus 2014

Table 3: Comparison of Storms with Peak Intensities Greater than 0.40 Inch/Hour, Typical Year Versus 2014

Figure 1: Rainfall Intensity Comparison: 2014 vs. Typical Year

Table 4: Comparison of model predicted CSO volumes for the ten largest storms in 2014 and the ten largest storms in the Typical Year

These rainfall comparisons were developed to be able to explain the magnitude of the estimated CSO discharges caused by 2014 rainfall relative to the predicted discharges for the Typical Year with 2014 system conditions. Table 1's presentation of total rainfall, number of storms and number of storms in each rainfall depth category suggests that 2014 was fairly "Typical." However, Table 2's presentation of storms with rainfall depth greater than 2 inches clearly shows that each of three storms in 2014 – March 29, October 22 and December 9 – exceeded the volume of rain in any of the storms in the Typical Year, which explains the higher CSO discharge volumes. The information in Table 4 shows that these three storms contributed much of the total CSO discharge volume in 2014.

Moving Toward LTCP Levels of Control

The following work is still underway to bring CSO discharges into conformance with the LTCP levels of control.

Alewife Brook: MWRA and the City of Cambridge continue to implement the two remaining LTCP projects that will control CSO discharges to the Alewife Brook: the CAM004 sewer separation project, by Cambridge, and the automated gate, floatables control and Rindge Avenue Siphon relief at MWR003 project, by MWRA. Both are well into construction and are on schedule to meet their respective completion milestones in the Federal Court's Schedule Seven.

Lower Charles River: The City of Cambridge's ongoing, long-term sewer separation work tributary to MWRA's North Charles Met and North Charles Relief sewers, including but not limited to the Western Avenue sewer separation project currently in construction, is predicted to reduce CSO discharges at outfalls CAM005 and CAM007 and at the Cottage Farm facility.

Downtown and Fort Point Channel: BWSC is continuing with sewer separation projects that are expected to further lower CSO discharges to the Dorchester Brook Conduit and the Roxbury Canal Conduit and lower hydraulic burden (backwater) within the New East Side Interceptor. In addition, BWSC has installed flow meters in systems related to these conduits, which MWRA can use to verify and possibly recalibrate the model predictions.

East Boston: The 2013 Typical Year discharge predictions are higher than LTCP levels at BOS003 and BOS014. BWSC plans to perform additional sewer separation in East Boston in the coming years. BWSC recently installed flow meters in East Boston, and MWRA intends to use the data to verify and possibly recalibrate model predictions.

Prison Point Facility: CSO discharge volume remains higher than the LTCP level at this facility. Overflows to the Prison Point facility are higher since the City of Somerville lowered the weir elevation at the SOM009 regulator following the extreme storm of July 10, 2010 that had caused serious flooding in Union Square. MWRA intends to reevaluate the long-term condition of the SOM009 weir.

Reserved Channel: While the four major Reserved Channel sewer separation contracts are complete or nearly complete, BWSC continues to perform work to disconnect building downspouts and otherwise further reduce stormwater inflow levels. Once the work is complete,

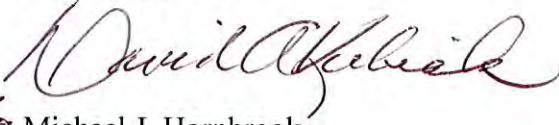
Todd J. Borci, EPA
Kevin Brander, P.E., DEP
April 30, 2015
Page 5

MWRA plans to coordinate with BWSC in reevaluating overflow weir elevations to minimize CSO to the Reserved Channel while protecting upstream systems.

I also want to point out that MWRA and the City of Chelsea continue to work collaboratively to identify and resolve the sources of differences between the City's metered overflow data and MWRA's model predictions at outfalls CHE002, CHE003, CHE004 and CHE008. MWRA conducted additional field investigations in cooperation with the City in 2014, which led to further model refinements, and the City replaced all of its overflow meters in December 2014. MWRA is already coordinating with the City to evaluate the new meter data against model predictions for storms in 2015.

Should you have questions about these results, please feel free to contact me, at 617-788-4359.

Very truly yours,


for Michael J. Hornbrook
Chief Operating Officer

CSO File: 1000.21

TABLE 10. SUMMARY OF 2014 AND TYPICAL YEAR MODEL SIMULATION RESULTS, AND COMPARISON TO TYPICAL YEAR LONG TERM CSO CONTROL PLAN

Outfall	2014 RAINFALL UNDER 2014 SYSTEM CONDITIONS			TYPICAL-YEAR RAINFALL UNDER 2014 SYSTEM CONDITIONS		TYPICAL-YEAR RAINFALL W/ LONG TERM CSO CONTROL PLAN	
	Activation Frequency	Duration (hrs)	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
ALEWIFE BROOK							
CAM001	2	3.09	0.20	2	0.08	5	0.19
CAM002	2	3.59	1.10	4	0.41	4	0.69
MWR003	2	5.84	2.37	5	1.17	5	0.98
CAM004	4	17.27	5.58	10	4.64	To be closed	N/A
CAM400	Closed	N/A	N/A	Closed	N/A	Closed	N/A
CAM401A	4	10.54	3.53	7	1.61	5	1.61
CAM401B	7	24.44	2.75	5	0.48	7	2.15
SOM001A	2	5.64	6.92	7	5.48	3	1.67
SOM001	Closed	N/A	N/A	Closed	N/A	Closed	N/A
SOM002A	Closed	N/A	N/A	Closed	N/A	Closed	N/A
SOM003	Closed	N/A	N/A	Closed	N/A	Closed	N/A
SOM004	Closed	N/A	N/A	Closed	N/A	Closed	N/A
TOTAL		70.43	22.45		13.89		7.29
UPPER MYSTIC RIVER							
SOM007A/MWR205A ⁽¹⁾	7	12.79	5.12	2	1.79	3	3.48
SOM007	Closed	N/A	N/A	Closed	N/A	Closed	N/A
TOTAL		12.79	5.12		1.79		3.48
MYSTIC/CHELSEA CONFLUENCE							
MWR205 (Somerville Marginal Facility) ⁽²⁾	28	91.63	91.83	18	61.28	39	60.58
BOS013	2	3.98	0.14	4	0.13	4	0.54
BOS014	2	5.13	1.60	4	0.53	0	0.00
BOS015	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS017	1	1.90	0.64	0	0.00	1	0.02
CHE002	0	0.00	0.00	0	0.00	4	0.22
CHE003	0	0.00	0.00	0	0.00	3	0.04
CHE004	0	0.00	0.00	0	0.00	3	0.32
CHE008	1	3.63	2.94	0	0.00	0	0.00
TOTAL		106.27	97.15		61.94		61.72
UPPER INNER HARBOR							
BOS009	1	2.19	0.32	3	0.10	5	0.59
BOS010	2	4.57	1.30	5	0.63	4	0.72
BOS012	2	3.86	0.27	7	0.55	5	0.72
BOS019 ⁽³⁾	2	11.97	1.52	2	0.30	2	0.58
BOS050	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS052	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS057	2	4.44	4.27	2	0.81	1	0.43
BOS058	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS060	1	0.66	0.01	1	0.02	0	0.00
MWR203 (Prison Point) ⁽⁴⁾	12	70.72	303.12	19	283.83	17	243.00
TOTAL		98.40	310.82		286.23		246.04
LOWER INNER HARBOR							
BOS003	4	14.14	10.46	8	5.42	4	2.87
BOS004	4	16.75	1.58	8	1.11	5	1.84
BOS005	0	0.00	0.00	0	0.00	1	0.01
BOS006 ⁽⁵⁾	Closed	N/A	N/A	Closed	N/A	4	0.24
BOS007 ⁽⁵⁾	Closed	N/A	N/A	Closed	N/A	6	1.05
TOTAL		30.88	12.04		6.54		6.01

TABLE 10. SUMMARY OF 2014 AND TYPICAL YEAR MODEL SIMULATION RESULTS, AND COMPARISON TO TYPICAL YEAR LONG TERM CSO CONTROL PLAN

Outfall	2014 RAINFALL UNDER 2014 SYSTEM CONDITIONS			TYPICAL-YEAR RAINFALL UNDER 2014 SYSTEM CONDITIONS		TYPICAL-YEAR RAINFALL W/ LONG TERM CSO CONTROL PLAN	
	Activation Frequency	Duration (hrs)	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
CONSTITUTION BEACH							
MWR207	Closed	N/A	N/A	Closed	N/A	Closed	N/A
TOTAL		N/A	N/A		N/A		N/A
FORT POINT CHANNEL							
BOS062	0	0.00	0.00	0	0.00	1	0.01
BOS064	2	5.03	0.60	1	0.04	0	0.00
BOS065	2	6.46	5.62	1	0.92	1	0.06
BOS068	1	1.91	0.11	0	0.00	0	0.00
BOS070							
BOS070/DBC	3	7.71	27.17	5	5.71	3	2.19
MWR215 (Union Park) ⁽⁴⁾	4	31.56	44.50	11	35.88	17	71.37
BOS070/RCC	4	7.30	1.47	6	0.94	2	0.26
BOS072	1	0.89	0.02	0	0.00	0	0.00
BOS073	1	1.61	0.08	0	0.00	0	0.00
TOTAL		62.46	79.57		43.48		73.89
RESERVED CHANNEL							
BOS076	16	61.29	9.75	6	1.55	3	0.91
BOS078	11	23.27	3.08	0	0.00	3	0.28
BOS079	7	11.78	0.50	0	0.00	1	0.04
BOS080	6	7.21	0.24	7	0.24	3	0.25
TOTAL		103.54	13.57		1.79		1.48
NORTHERN DORCHESTER BAY							
BOS081	0	0.00	0.00	0	0.00	0 / 25 year	N/A
BOS082	0	0.00	0.00	0	0.00	0 / 25 year	N/A
BOS083 ⁽⁶⁾	Closed	N/A	N/A	Closed	N/A	0 / 25 year	N/A
BOS084	0	0.00	0.00	0	0.00	0 / 25 year	N/A
BOS085	0	0.00	0.00	0	0.00	0 / 25 year	N/A
BOS086	0	0.00	0.00	0	0.00	0 / 25 year	N/A
BOS087	Closed	N/A	N/A	Closed	N/A	Closed	N/A
TOTAL		0.00	0.00		0.00		0.00
SOUTHERN DORCHESTER BAY							
BOS088/BOS089 (Fox Point)	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS090 (Commercial Point)	Closed	N/A	N/A	Closed	N/A	Closed	N/A
TOTAL		N/A	N/A		N/A		N/A
UPPER CHARLES							
BOS032	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS033	Closed	N/A	N/A	Closed	N/A	Closed	N/A
CAM005	2	5.47	3.69	3	1.38	3	0.84
CAM007	2	3.95	2.23	2	0.26	1	0.03
CAM009 ⁽⁷⁾	Closed	N/A	N/A	Closed	N/A	2	0.01
CAM011 ⁽⁷⁾	Closed	N/A	N/A	Closed	N/A	0	0.00
TOTAL		9.42	5.92		1.63		0.88

TABLE 10. SUMMARY OF 2014 AND TYPICAL YEAR MODEL SIMULATION RESULTS, AND COMPARISON TO TYPICAL YEAR LONG TERM CSO CONTROL PLAN

Outfall	2014 RAINFALL UNDER 2014 SYSTEM CONDITIONS			TYPICAL-YEAR RAINFALL UNDER 2014 SYSTEM CONDITIONS		TYPICAL-YEAR RAINFALL W/ LONG TERM CSO CONTROL PLAN	
	Activation Frequency	Duration (hrs)	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER CHARLES							
BOS028	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS042	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS049	Closed	N/A	N/A	Closed	N/A	Closed	N/A
CAM017	1	1.48	3.04	1	1.32	1	0.45
MWR010	0	0.00	0.00	0	0.00	0	0.00
MWR018	1	2.99	3.96	0	0.00	0	0.00
MWR019	1	2.23	1.38	0	0.00	0	0.00
MWR020	1	1.72	0.79	0	0.00	0	0.00
MWR021	Closed	N/A	N/A	Closed	N/A	Closed	N/A
MWR022	Closed	N/A	N/A	Closed	N/A	Closed	N/A
MWR201 (Cottage Farm) ⁽⁴⁾	3	16.90	81.40	5	16.71	2	6.30
MWR023	0	0.00	0.00	1	0.02	2	0.13
SOM010	Closed	N/A	N/A	Closed	N/A	Closed	N/A
TOTAL		25.31	90.56		18.06		6.88
NEPONSET RIVER							
BOS093	Closed	N/A	N/A	Closed	N/A	Closed	N/A
BOS095	Closed	N/A	N/A	Closed	N/A	Closed	N/A
TOTAL		N/A	N/A		N/A		N/A
BACK BAY FENS							
BOS046 ⁽⁸⁾	0	0.00	0.00	1	1.56	2	5.38
TOTAL		0.00	0.00		1.56		5.38
Total Treated			521		398		381
Total Untreated			111		37		28
GRAND TOTAL			632		435		410

- (1) Includes portion of flow treated at Somerville Marginal facility and separate stormwater entering the Somerville Marginal Conduit (outfall) downstream of the facility. Activation frequency and volume for 2014 rainfall are from MWRA depth sensor measurements and MWRA model
- (2) Volume represents all flow through the CSO treatment facility. Activation frequency and volume for 2014 rainfall are from MWRA facility records (measurements).
- (3) Activation frequency and volume for 2014 rainfall are from MWRA depth sensor measurements and MWRA model results, respectively.
- (4) Activation frequency and volume for 2014 rainfall are from MWRA facility records (measurements).
- (5) BWSC has permanently closed outfalls BOS006 and BOS007 in East Boston as part of sewer separation and development plans in the tributary areas, although the outfalls were assumed to remain active in the long-term CSO control plan.
- (6) CSO discharge at Outfall BOS083 was redirected to Outfall BOS084 with construction of the North Dorchester Bay Storage Tunnel.
- (7) The City of Cambridge closed outfalls CAM009 and CAM011 in November 2007, and continues to monitor upstream hydraulic effects.
- (8) Volumes represent model predicted total discharge at outfall BOS046, including Stony Brook Conduit stormwater and CSO contributions.

Key 2014 Model Updates

Revised Cottage Farm Brookline Connection gate control.
 Removed CAM401B 10" orifice plate at 18" DWF connection and corrected underflow baffle location.
 Adjusted weir elevations using BWSC field measurements at outfalls 003, 057, 065, 068, 070, and 073.
 Closed Chelsea outfall CHE002.
 Adjusted set points for Malden Street sluice gate at Union Park CSO Facility.
 Removed 10-inch connection between Prison Point DWF and storm wet wells.
 Incorporated BWSC Reserved Channel sewer separation contracts 3B and 4.

RAINFALL CHARACTERISTICS

TABLE 1. COMPARISON OF FREQUENCY OF RAIN EVENTS WITHIN SELECTED RANGES OF TOTAL RAINFALL, TYPICAL YEAR VERSUS 2014

Conditions	Total Rainfall (inches)	Total Number of Storms	Number of Storms by Volume				
			Volume < 0.25 inches	Volume 0.25 to 0.5 inches	Volume 0.5 to 1.0 inches	Volume 1.0 to 2.0 inches	Volume \geq 2.0 inches
Typical Year	46.8	93	49	14	16	8	6
MWRA Rain Gauges							
Ward Street	47.95	94	45	18	17	10	4
Columbus Park	49.1	85	40	14	19	8	4
Chelsea Creek	47.31	87	36	22	17	8	4
HF-1C	51.17	94	48	11	21	9	5
RG-WF-1	47.0	106	63	14	15	10	4
BWSC Rain Gauges							
Allston	43.22	76	31	20	11	10	4
Dorchester - Adam Street	46.99	88	44	18	12	10	4
Charlestown	43.8	82	36	18	14	10	4
Roslindale	46.9	88	46	14	13	11	4
Union Park	46.02	91	48	14	17	8	4
USGS Rain Gauge							
Fresh Pond	42.57	89	43	22	9	12	3

TABLE 2. COMPARISON OF STORMS WITH GREATER THAN 2 INCHES OF TOTAL RAINFALL, TYPICAL YEAR VERSUS 2014

Rain Gauge	Date	Duration (hours)	Total Rainfall (inches)	Average Intensity (inch/hour)	Peak Intensity (inch/hour)	Storm Recurrence Interval (24-hour)
Typical Year	12/11/1992	50	3.89	0.08	0.20	1y
	8/15/1992	72	2.91	0.04	0.66	3m
	9/22/1992	23	2.76	0.12	0.65	1y
	11/21/1992	84	2.39	0.03	0.31	3m
	5/31/1992	30	2.24	0.07	0.37	3m-6m
	10/9/1992	65	2.04	0.03	0.42	<3m
Ward Street Headworks (BO-DI-1)	12/9/2014	59.75	4.14	0.07	0.71	2-5y
	3/29/2014	46.25	3.44	0.07	0.40	6m-1y
	10/22/2014	47.5	3.23	0.07	0.52	1y
	7/4/2014	21.25	2.49	0.12	0.39	6m
Columbus Park Headworks (BO-DI-2)	12/9/2014	50.5	4.47	0.09	1.00	5y
	3/29/2014	47.25	4.04	0.09	0.47	2y
	10/22/2014	47	3.90	0.08	0.62	2-5y
	7/4/2014	19.0	2.72	0.14	0.50	6m-1y
Chelsea Creek Headworks (CH-BO-1)	12/9/2014	55.25	4.69	0.08	0.84	5-10y
	3/29/2014	47	4.35	0.09	0.50	2y
	10/22/2014	45.25	3.43	0.08	0.57	2y
	7/4/2014	18.5	2.39	0.13	0.38	6m

TABLE 3. COMPARISON OF STORMS WITH PEAK INTENSITIES GREATER THAN 0.40 INCHES/HOUR, TYPICAL YEAR VERSUS 2014

Rain Gauge	Date	Duration (hours)	Total Rainfall (inches)	Average Intensity (inch/hour)	Peak Intensity (inch/hour)	Storm Recurrence Interval (1-hour)
Typical Year	10/23/1992	4	1.18	0.29	1.08	1-2y
	8/11/1992	11	0.87	0.08	0.75	6m-1y
	8/15/1992	72	2.91	0.04	0.66	3m-6m
	9/22/1992	23	2.76	0.12	0.65	3m-6m
	5/2/1992	7	1.14	0.16	0.63	3m-6m
	9/9/1992	1	0.57	0.57	0.57	3m
	9/3/1992	13	1.19	0.09	0.51	< 3m
	6/5/1992	18	1.34	0.07	0.44	< 3m
	10/9/1992	65	2.04	0.03	0.42	< 3m
Ward Street Headworks (BO-DI-1)	7/28/2014	1.50	0.93	0.62	0.92	1-2y
	12/9/2014	59.75	4.14	0.07	0.71	6m
	7/30/2014	0.50	0.65	1.30	0.65	3-6m
	5/16/2014	16.75	1.11	0.07	0.54	< 3m
	7/14/2014	6.75	0.63	0.09	0.52	< 3m
	10/22/2014	47.50	3.23	0.07	0.52	< 3m
	7/16/2014	13.25	0.80	0.06	0.49	< 3m
	8/13/2014	16.75	1.42	0.08	0.46	< 3m
	7/3/2014	0.25	0.41	1.64	0.41	< 3m
	3/29/2014	46.25	3.44	0.07	0.40	< 3m
Columbus Park Headworks (BO-DI-2)	12/9/2014	50.50	4.47	0.09	1.00	1-2y
	10/6/2014	0.50	0.94	1.88	0.94	1-2y
	7/14/2014	6.50	0.78	0.12	0.63	3-6m
	6/10/2014	7.75	0.63	0.08	0.62	3-6m
	10/22/2014	47.00	3.90	0.08	0.62	3-6m
	8/31/2014	2.25	0.62	0.28	0.59	3-6m
	7/4/2014	19.00	2.72	0.14	0.50	< 3m
	3/29/2014	47.25	4.04	0.09	0.47	< 3m
	2/13/2014	21.25	1.71	0.08	0.44	< 3m
	7/16/2014	8.75	0.93	0.11	0.43	< 3m
5/16/2014	17.25	0.69	0.04	0.40	< 3m	

Rain Gauge	Date	Duration (hours)	Total Rainfall (inches)	Average Intensity (inch/hour)	Peak Intensity (inch/hour)	Storm Recurrence Interval (1-hour)
Chelsea Creek Headworks (CH-BO-1)	12/9/2014	55.25	4.69	0.08	0.84	6m-1y
	10/22/2014	45.25	3.43	0.08	0.57	3m
	6/26/2014	4.00	0.64	0.16	0.53	< 3m
	3/29/2014	47.00	4.35	0.09	0.50	< 3m
	6/19/2014	0.50	0.48	0.96	0.48	< 3m
	7/28/2014	2.00	0.50	0.25	0.48	< 3m
	7/16/2014	7.75	0.67	0.09	0.44	< 3m
	5/27/2014	13.50	0.62	0.05	0.40	< 3m

Table 4. Top Ten Storms Contributing the Most CSO

For 2014 Storms:

No.	Storm Event	CSO Volume By Storm		Cumulative CSO Volume	
		(MG)	% of Total CSO Discharged in 2014 (632 MG)	(MG)	% of Total CSO Discharged in 2014 (632 MG)
1	12/9/2014 Storm	295.50	46.7%	295.50	46.7%
2	10/22/2014 Storm	102.13	16.2%	397.63	62.9%
3	3/29/2014 Storm	59.38	9.4%	457.01	72.3%
4	7/28/2014 Storm	44.97	7.1%	501.98	79.4%
5	7/3/2014 Storm	43.52	6.9%	545.50	86.3%
6	11/26/2014 Storm	18.20	2.9%	563.70	89.2%
7	5/16/2014 Storm	14.01	2.2%	577.72	91.4%
8	11/17/2014 Storm	10.68	1.7%	588.40	93.1%
9	7/16/2014 Storm	9.80	1.6%	598.20	94.6%
10	8/13/2014 Storm	9.22	1.5%	607.42	96.1%

For the Typical Year Rainfall:

No.	Storm Event	CSO Volume By Storm		Cumulative CSO Volume	
		(MG)	% of Total CSO Discharged in Typical Year (434 MG)	(MG)	% of Total CSO Discharged in Typical Year (434 MG)
1	9/23/92	86.21	19.9%	86.21	19.9%
2	12/11/92	53.43	12.3%	139.64	32.2%
3	6/1/92	48.64	11.2%	188.28	43.4%
4	10/23/92	45.62	10.5%	233.90	53.9%
5	8/18/92	34.31	7.9%	268.22	61.9%
6	5/2/92	22.71	5.2%	290.92	67.1%
7	11/23/92	22.25	5.1%	313.17	72.2%
8	3/7/92	17.50	4.0%	330.67	76.3%
9	8/11/92	16.92	3.9%	347.59	80.2%
10	6/6/92	15.91	3.7%	363.50	83.8%