MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 18-22

TUNNEL AND RESERVOIR PLAN

MAINSTREAM TUNNEL SYSTEM

ANNUAL GROUNDWATER MONITORING REPORT

FOR 2017

July 2018

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

CECIL LUE-HING RESEARCH AND DEVELOPMENT COMPLEX
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Director of Monitoring and Research

July 31, 2018

Chief
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Illinois Environmental Protection Agency
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Dear Sir or Madam:

Subject: Tunnel and Reservoir Plan, Mainstream Tunnel System, Annual Groundwater Monitoring Report for 2017

Attached are three copies of the "Tunnel and Reservoir Plan, Mainstream Tunnel System, Annual Groundwater Monitoring Report for 2017."

Very truly yours,

Albert E. Cox
Environmental Monitoring and Research Manager
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AC:PS:cm
Attachment
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TUNNEL AND RESERVOIR PLAN, MAINSTREAM TUNNEL SYSTEM, ANNUAL GROUNDWATER MONITORING REPORT FOR 2017

Monitoring and Research Department
Edward W. Podczerwinski, Director

July 2018

TABLE OF CONTENTS

	Page
LIST OF TABLES	ii
LIST OF FIGURES	iii
LIST OF ABBREVIATIONS	iv
ANNUAL DATA FOR MONITORING AND OBSERVATION WELLS	1
Introduction	1
Modified Groundwater Monitoring Program	1
Summary of Data	4
Monitoring Wells	4
Observation Wells	4

LIST OF TABLES

Table No.		Page
1	Analysis of Chemical and Physical Parameters in Groundwater From Fill Event Monitoring Wells in the Mainstream Tunnel System of the Tunnel and Reservoir Plan During 2017 and Descriptive Statistics of Each of the Parameters	5
2	Analysis of Fecal Coliform in Groundwater From Fill Event Monitoring Wells in the Mainstream Tunnel System of the Tunnel and Reservoir Plan Sampled During 2017 and Its Descriptive Statistics	10
3	Analysis of Chemical and Physical Parameters and Fecal Coliform in Groundwater From Annual Sampling Wells in the Mainstream Tunnel System of the Tunnel and Reservoir Plan During 2017	13
4	Groundwater Elevations for Observation Wells OM-1 Through OM-23 in the Mainstream Tunnel System of the Tunnel and Reservoir Plan Measured During 2017	14

LIST OF FIGURES

Figure No.		Page
1	Map of the Monitoring Wells in the Mainstream Tunnel System	2
2	Map of the Observation Wells in the Mainstream Tunnel System	3
3	Minimum, Mean, and Maximum of Water Elevations for Observation Wells in the Mainstream Tunnel System of the Tunnel and Reservoir Plan Measured During 2017	15

LIST OF ABBREVIATIONS

°C	degrees Celsius
CCD	Chicago City Datum
CFU	colony forming units
Cl^-	chloride
District	Metropolitan Water Reclamation District of Greater Chicago
EC	electrical conductivity
FC	fecal coliform
ft	feet
hr	hour
IEPA	Illinois Environmental Protection Agency
L	liter
m	meter
mg	milligram
mS	millisiemens
NH_3-N	ammonia nitrogen
SO_4^{2-}	sulfate
TDS	total dissolved solids
Temp	temperature
TOC	total organic carbon

ANNUAL DATA FOR MONITORING AND OBSERVATION WELLS

Introduction

The monitoring and observation wells are located along the length of the Mainstream Tunnel System between Morton Grove and Hodgkins, Illinois (Figures 1 and 2). The elevations for the observation wells were measured monthly during 2017. The monitoring wells were sampled based on the modified groundwater monitoring program for the Metropolitan Water Reclamation District of Greater Chicago (District)'s Tunnel and Reservoir Plan (TARP) as briefly described below.

Modified Groundwater Monitoring Program

In a letter dated July 13, 2017, the Illinois Environmental Protection Agency (IEPA) accepted the modifications for the District's TARP groundwater monitoring program effective in January 2017 for a period of three years (2017 – 2019). Under the revised monitoring plan, nine wells (QM-61, -62, -63, -64, -65, -67, -68, -75, and -77), which had fecal coliform detected in 10 percent or more of samples during the period 1995 – 2013, will be sampled for four events of TARP tunnel fills, based on the water levels in the TARP following storm events (fill event-based). The criterion that triggers a fill event sampling is that the level of water in the TARP Mainstream tunnels reaches -150 ft Chicago City Datum (CCD). At each event, sampling is done weekly for three weeks. The samples collected during the first week of sampling are analyzed for all parameters in the original monitoring program, including: pH, temperature, electrical conductivity, total dissolved solids, hardness, ammonia, dissolved organic carbon, chloride, sulfate, and fecal coliform. However, the samples from the second and third week are analyzed for only fecal coliform.

The other 13 monitoring wells associated with the Mainstream Tunnel System are sampled once per year. These wells had fecal coliform detected in less than 10 percent of samples during the period 1995 – 2013.

In 1994, the termination of monitoring for wells QM-51, -52, -54, -55, -57, and -60 was approved by the IEPA (memorandum dated May 4, 1994). Monitoring well QM-59 has been dry since February 1995 and is no longer monitored. Monitoring wells QM-56 and QM-58 will be properly abandoned as indicated in the modified program. No samples were obtained from well QM-66 in 2017 due to well malfunction. Monitoring of observation well OM-17 was also discontinued with the approval of the IEPA (letter dated December 16, 2011).

FIGURE 1: MAP OF THE MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM

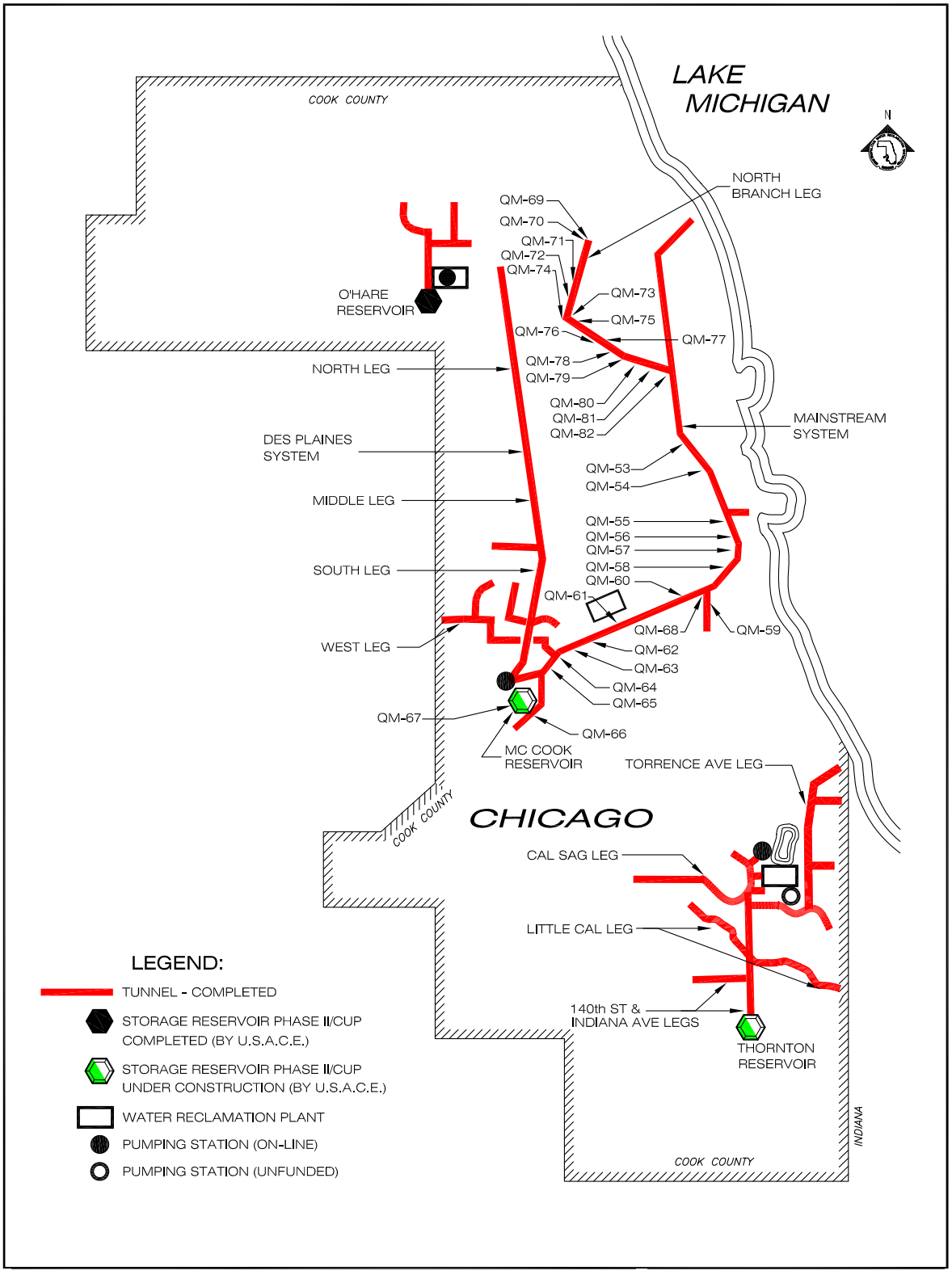
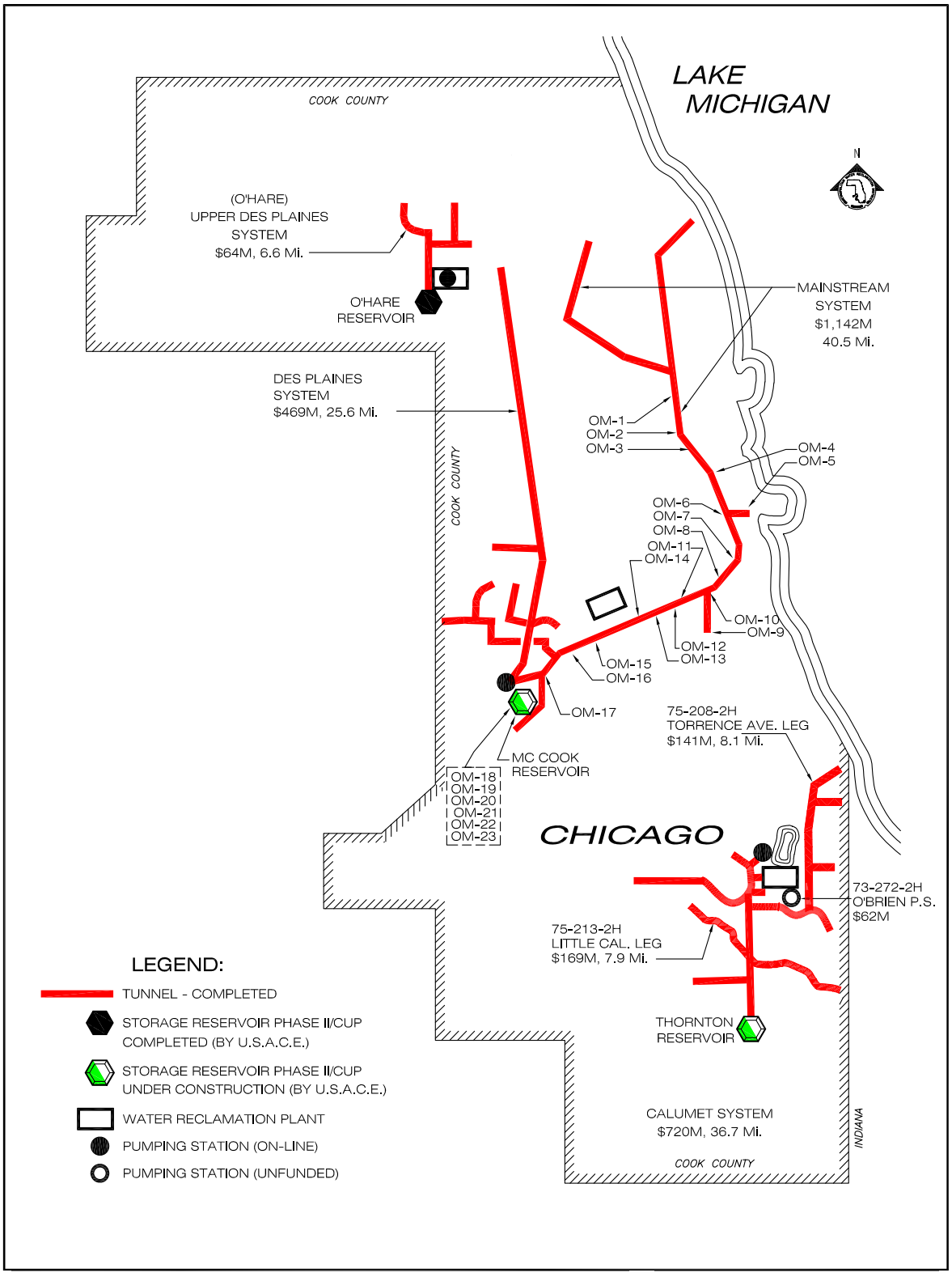


FIGURE 2: MAP OF THE OBSERVATION WELLS IN THE MAINSTREAM TUNNEL SYSTEM



Summary of Data

Monitoring Wells. The analytical data for groundwater sampled during 2017 from fill event-based monitoring wells QM-61 through QM-77 (except QM-66) along with descriptive statistics are presented in Table 1. Physical characteristics, such as elevation, groundwater temperature, and estimated time of recharge for each well between initial drawdown and sampling, are also included. The fecal coliform data for groundwater sampled during 2017 from these monitoring wells along with descriptive statistics are presented in Table 2. Fecal coliform (FC) counts in Wells QM-61, -62, -63, -64, -67 and -77 were much higher than expected at various times during the year. During the year, wells QM-62, -63 (2/7/17); QM-61, -64, -77 (2/24/17); and QM-65 (3/24/17) were decontaminated using the standard procedure. Significant reductions in FC counts were observed temporarily in two of these wells (QM-62 and -63). The analytical data for groundwater from the 13 wells sampled once per year are presented in Table 3.

Observation Wells. Measurement of groundwater elevations for observation wells OM-1 through -23 was attempted at the required frequencies (once/month) with a minor variation. No measurement was done in October due to a personnel shortage because the highest priority of sampling was placed on the fill event sampling of TARP wells. Several measurements were not taken as planned due to a number of factors limiting access to these wells (Table 4, Footnote 3). Adjusted elevations were calculated relative to the CCD (579.48 ft above mean sea level) at the intersection of Madison and State Streets (Table 4). The minimum, mean, and maximum values for each well were calculated and plotted to determine fluctuations in groundwater elevations during the year (Figure 3). Generally, these fluctuations appeared to be minimal throughout the year. However, there were significant fluctuations in groundwater elevations of 65, 101, 66, 134, and 49 ft in Wells OM-11, -16, -18, -20, and -23, respectively, which could indicate the possibility of exfiltration from the Mainstream tunnel during the year.

TABLE 1: ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS IN GROUNDWATER FROM FILL EVENT MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2017 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[1]	Recharge Time
				mS/m	mg/L						°C	ft	hr
QM-61	F1	01/20/17	8.8	64	540	2.0	<5	45	0.8	162	13.5	-133	<48
	F2	03/02/17	9.6	NRR[3]	246	<1.0	56	33	0.5	117	13.1	-150	<48
	F3	04/05/17	7.5	60	308	1.4	61	34	0.3	142	13.7	-167	<48
	F4	05/02/17	7.2	69	360	2.3	90	34	4.2	163	13.7	-131	<48
	F5	07/13/17	7.3	68	296	4.8	61	20	1.9	129	15.2	-140	<48
	F6	10/12/17	7.4	45	238	1.6	40	29	0.4	118	14.4	-149	<48
		Minimum	7.2	45	238	<1.0	<5	20	0.3	117	13.1	-167	
		Median	7.5	64	302	2.0	61	33	0.7	136	13.7	-145	
		Mean	8.0	61	331	2.4	62	32	1.4	139	13.9	-145	
		Maximum	9.6	69	540	4.8	90	45	4.2	163	15.2	-131	
		Standard deviation	1.0	10	111	1.4	18	8	1.5	21	0.8	-13	
		Coefficient of variation (%)	12	16	34	57	29	25	112	15	5.4	9	
QM-62	F1	01/20/17	7.0	87	526	3.5	169	53	1.0	178	13.5	-180	<48
	F2	03/03/17	7.2	59	372	1.0	49	82	0.4	184	11.8	-153	<48
	F3	04/05/17	6.4	70	356	1.1	51	49	0.5	179	13.6	-181	<48
	F4	05/03/17	6.8	69	480	2.5	96	57	1.8	235	14.1	-127	<48
	F5	07/14/17	7.3	58	260	1.4	60	20	0.6	156	15.4	-162	<48
	F6	10/13/17	6.8	61	366	1.0	51	73	0.3	180	13.9	-169	<48
		Minimum	6.4	58	260	1.0	49	20	0.3	156	11.8	-181	
		Median	6.9	65	369	1.3	56	55	0.6	180	13.8	-166	
		Mean	6.9	67	393	1.8	79	56	0.8	185	13.7	-162	
		Maximum	7.3	87	526	3.5	169	82	1.8	235	15.4	-127	
		Standard deviation	0.3	11	95	1.0	47	21	0.6	26	1.2	-20	
		Coefficient of variation (%)	4.7	16	24	59	60	38	71	14	8.5	13	

TABLE 1 (Continued): ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS IN GROUNDWATER FROM FILL EVENT IN MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2017 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[1]	Recharge Time
				mS/m				mg/L			°C	ft	hr
QM-63	F1	01/20/17	7.3	171	1,122	2.4	123	518	2.0	553	13.4	-129	<48
	F2	03/03/17	7.4	184	1,278	1.1	70	688	1.8	650	12.4	-145	<48
	F3	04/05/17	7.2	177	1,538	2.3	50	976	2.3	823	13.2	-168	<48
	F4	05/03/17	7.3	146	932	2.4	74	399	2.2	476	13.6	-90	<48
	F5	07/14/17	7.3	181	1,122	2.8	49	685	2.2	697	14.0	-145	<48
	F6	10/13/17	7.2	199	1,460	2.3	48	909	2.0	717	13.5	-132	<48
		Minimum	7.2	146	932	1.1	48	399	1.8	476	12.4	-168	
		Median	7.3	179	1,200	2.4	60	687	2.1	674	13.5	-139	
		Mean	7.3	176	1,242	2.2	69	696	2.1	653	13.4	-135	
		Maximum	7.4	199	1,538	2.8	123	976	2.3	823	14.0	-90	
		Standard deviation	0.1	18	229	0.6	29	221	0.2	124	0.5	-26	
		Coefficient of variation (%)	0.9	10	18	26	42	32	7.8	19	4.0	19	
QM-64	F1	01/20/17	7.6	75	418	1.2	58	44	1.9	201	13.9	-139	<48
	F2	03/02/17	8.8	NRR	334	<1.0	44	46	2.0	173	13.1	-150	<48
	F3	04/05/17	7.6	80	386	1.2	53	46	1.8	204	13.2	-170	<48
	F4	05/03/17	7.1	75	388	1.1	44	51	1.5	221	14.1	-126	<48
	F5	07/13/17	7.6	75	416	1.2	52	42	1.7	203	15.2	-140	<48
	F6	10/12/17	7.6	76	394	1.1	50	42	2.2	203	15.3	-152	<48
		Minimum	7.1	75	334	<1.0	44	42	1.5	173	13	-170	
		Median	7.6	75	391	1.2	51	45	1.9	203	14	-145	
		Mean	7.7	76	389	1.2	50	45	1.8	201	14	-146	
		Maximum	8.8	80	418	1.2	58	51	2.2	221	15	-126	
		Standard deviation	0.6	2.3	31	0.1	5.5	3.0	0.2	16	0.9	-15	
		Coefficient of variation (%)	7.4	3.1	7.8	4.7	11	7.0	13	7.7	6.7	10	

TABLE 1 (Continued): ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS IN GROUNDWATER FROM FILL EVENT IN MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2017 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[1]	Recharge Time
				mS/m			mg/L				°C	ft	hr
QM-65	F1	Not Sampled[2]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
	F2	Not Sampled	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND
	F3	04/05/17	7.3	127	708	2.8	108	136	5.7	279	13.3	-179	<48
	F4	05/03/17	7.2	135	750	2.3	115	131	5.7	304	13.4	-143	<48
	F5	07/14/17	7.4	135	674	3.1	111	134	5.4	312	15.2	-172	<48
	F6	10/13/17	7.2	149	764	3.1	169	150	4.3	351	14.4	-163	<48
		Minimum	7.2	127	674	2.3	108	131	4.3	279	13.3	-179	
		Median	7.3	135	729	3.0	113	135	5.5	308	13.9	-168	
		Mean	7.3	137	724	2.8	126	138	5.2	312	14.1	-164	
		Maximum	7.4	149	764	3.1	169	150	5.7	351	15.2	-143	
		Standard deviation	0.1	9.0	41	0.4	29	8.0	0.7	30	0.9	-15.6	
		Coefficient of variation (%)	1.5	7.0	5.7	13.4	23	6.0	13	9.6	6.4	9.5	
QM-67	F1	Not Sampled	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	F2	03/03/17	7.4	137	706	3.9	211	10	12	276	12.9	-183	<48
	F3	04/05/17	7.2	141	678	3.7	199	9.0	12	284	13.1	-181	<48
	F4	05/03/17	7.5	133	700	3.1	197	6.0	12	279	13.7	-180	<48
	F5	07/14/17	7.4	136	554	4.0	177	8.0	12	281	15.0	-195	<48
	F6	10/13/17	7.4	126	610	4.2	145	6.0	13	291	14.9	-184	<48
		Minimum	7.2	126	554	3.1	145	6.0	12	276	12.9	-195	
		Median	7.4	136	678	3.9	197	8.0	12	281	13.7	-183	
		Mean	7.4	135	650	3.8	186	8.0	12	282	13.9	-185	
		Maximum	7.5	141	706	4.2	211	10	13	291	15.0	-180	
		Standard deviation	0.1	6.0	66	0.4	26	2.0	0.4	5.7	1.0	-6.0	
		Coefficient of variation (%)	1.2	4.0	10	11	14	24	3.3	2.0	7.1	3.3	

TABLE 1 (Continued): ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS IN GROUNDWATER FROM FILL EVENT IN MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2017 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[1]	Recharge Time
				mS/m	----------	----------	----------	mg/L	----------	----------	°C	ft	hr
QM-68	F1	01/20/17	7.5	116	640	1.6	146	44	0.9	421	12.8	-125	<48
	F2	03/03/17	7.3	111	640	1.0	146	45	0.9	412	12.5	-133	<48
	F3	04/05/17	7.4	117	602	1.7	144	44	0.8	413	12.7	-128	<48
	F4	05/03/17	7.3	111	632	1.5	147	39	0.9	405	13	-120	<48
	F5	07/14/17	7.4	118	630	2.0	161	43	0.8	418	13.9	-125	<48
	F6	10/13/17	7.4	118	560	1.6	152	36	1.0	415	13.4	-159	<48
		Minimum	7.3	111	560	1.0	144	36	0.8	405	12.5	-159	
		Median	7.4	117	631	1.6	147	44	0.9	414	12.9	-127	
		Mean	7.4	115	617	1.6	149	42	0.9	414	13.1	-132	
		Maximum	7.5	118	640	2.0	161	45	1.0	421	13.9	-120	
		Standard deviation	0.1	3	31.4	0.3	6.3	3	0.1	5.5	0.5	-14.1	
		Coefficient of variation (%)	1.2	3	5.1	21	4.2	8	7.1	1.3	4.0	11	
QM-75	F1	01/20/17	8.0	37	216	1.0	13	10	0.3	65	11.4	-102	<48
	F2	03/03/17	7.9	37	208	1.0	12	10	0.3	63	11.6	-113	<48
	F3	04/06/17	8.0	37	210	1.1	14	11	0.2	61	11.5	-104	<48
	F4	05/04/17	8.1	35	204	1.0	13	10	0.4	62	11.5	-83	<48
	F5	07/19/17	8.2	37	204	1.0	12	11	0.2	63	12.1	-120	<48
	F6	10/19/17	8.2	36	234	1.2	12	10	0.3	66	12.7	-176	<48
		Minimum	7.9	35	204	1.0	12	10	0.2	61	11.4	-176	
		Median	8.1	37	209	1.0	13	10	0.3	63	11.6	-109	
		Mean	8.1	36	213	1.1	13	10	0.3	63	11.8	-116	
		Maximum	8.2	37	234	1.2	14	11	0.4	66	12.7	-83	
		Standard deviation	0.1	1.0	11	0.1	0.8	1.0	0.1	1.9	0.5	-31.8	
		Coefficient of variation (%)	1.6	2.0	5.3	8.0	6.4	5.0	20	2.9	4.3	27	

TABLE 1 (Continued): ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS IN GROUNDWATER FROM FILL EVENT IN MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2017 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[1]	Recharge Time
				mS/m	---------- mg/L ----------						°C	ft	hr
QM-77	F1	01/20/17	8.3	29	158	<1.0	11	5.0	<0.1	48	11.4	-135	<48
	F2	03/03/17	7.8	30	152	<1.0	10	10	<0.1	47	12	-174	<48
	F3	04/06/17	8.2	29	160	<1.0	12	5.0	0.1	47	11.5	-155	<48
	F4	05/04/17	8.3	30	168	<1.0	11	5.0	0.1	44	11.8	-81	<48
	F5	07/14/17	8.3	28	218	<1.0	10	5.0	<0.1	58	13.6	-184	<48
	F6	10/19/17	8.1	27	166	1.1	10	5.0	0.1	49	12.3	-86	<48
		Minimum	7.8	27	152	<1.0	10	5.0	<0.1	44	11.4	-184	
		Median	8.3	29	163	<1.0	11	5.0	<0.1	48	11.9	-145	
		Mean	8.2	29	170	<1.0	11	6.0	<0.1	49	12.1	-136	
		Maximum	8.3	30	218	1.1	12	10	0.1	58	13.6	-81	
		Standard deviation	0.2	1.0	24	0.04	0.8	2	0.01	4.8	0.8	-44	
		Coefficient of variation (%)	2.7	3.0	14	4.0	7.7	35	11	9.8	6.7	32.3	

[1]Relative to Chicago City Datum (579.48 ft above sea level) at intersection of Madison and State Streets.
[2]No sampling was done for the well at this event as the sampling was deferred to a later event.
[3]No reportable data due to equipment malfunction.

TABLE 2: ANALYSIS OF FECAL COLIFORM IN GROUNDWATER FROM FILL EVENT MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2017 AND ITS DESCRIPTIVE STATISTICS[1]

Well	Fill Event	Week 1 Sample Date	Week 1	Week 2	Week 3
			---------- CFU/100 mL ----------		
QM-61	F1	1/20/17	>20,000	16,000	1,300
	F2	3/2/17	67,000	860	230
	F3	4/5/17	1,500	140	29
	F4	5/2/17	100,000	2,200	5,800
	F5	7/13/17	>200,000	120,000	20,000
	F6	10/12/17	>200,000	34,000	8,300
		Minimum	1,500	140	29
		Median	83,500	9,100	3,550
		Mean[2]	44,759	5,085	1,424
		Maximum	>200,000	120,000	20,000
QM-62	F1	1/20/17	>166,000	5,700	220
	F2	3/3/17	15,000	690	76
	F3	4/5/17	1,000	1,100	60
	F4	5/3/17	>20,000	4,700	1,100
	F5	7/14/17	>45,000	29,000	>200,000
	F6	10/13/17	>200,000	37,000	>200,000
		Minimum	1,000	690	60
		Median	32,500	5,200	660
		Mean	27,664	5,286	1,880
		Maximum	>200,000	37,000	>200,000
QM-63	F1	1/20/17	>83,000	1,300	43
	F2	3/3/17	4	68	5
	F3	4/5/17	1,100	1,200	32
	F4	5/3/17	>20,000	1,400	1,200
	F5	7/14/17	>20,000	9,500	128,000
	F6	10/13/17	>73,000	34,000	>200,000
		Minimum	4	68	5
		Median	>20,000	1350	622
		Mean	4,692	1,906	772
		Maximum	>83,000	34,000	>200,000

TABLE 2 (Continued): ANALYSIS OF FECAL COLIFORM IN GROUNDWATER FROM FILL EVENT MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2017 AND ITS DESCRIPTIVE STATISTICS[1]

Well	Fill Event	Week 1 Sample Date	Week 1	Week 2	Week 3
			---------- CFU/100 mL ----------		
QM-64	F1	1/20/17	910	430	200
	F2	3/2/17	2,400	460	6
	F3	4/5/17	320	240	43
	F4	5/3/17	1,000	230	83
	F5	7/13/17	92	86	870
	F6	10/12/17	1,300	>20,000	32,000
		Minimum	92	86	6
		Median	955	335	142
		Mean	661	516	222
		Maximum	2,400	>20,000	32,000
QM-65	F1	Not Sampled[3]	NA	NA	NA
	F2	Not Sampled	NA	NA	NA
	F3	4/5/17	1	5	<1
	F4	5/3/17	17	12	12
	F5	7/14/17	140	29	170
	F6	10/13/17	630	1,300	11,000
		Minimum	1	5	<1
		Median	79	21	91
		Mean	35	39	69
		Maximum	630	1,300	11,000
QM-67	F1	Not Sampled	ND	ND	ND
	F2	3/3/17	4,300	1,700	2,200
	F3	4/5/17	2,400	1,100	770
	F4	5/3/17	510	910	6,500
	F5	7/14/17	2,600	6,700	4,400
	F6	10/13/17	>20,000	11,000	9,000
		Minimum	510	910	770
		Median	2,600	1,700	4,400
		Mean	3,072	2,628	3,372
		Maximum	>20,000	11,000	9,000

TABLE 2 (Continued): ANALYSIS OF FECAL COLIFORM IN GROUNDWATER FROM FILL EVENT MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2017 AND ITS DESCRIPTIVE STATISTICS[1]

Well	Fill Event	Week 1 Sample Date	Week 1	Week 2	Week 3
			---------- CFU/100 ml ----------		
QM-68	F1	1/20/17	<1	4	5
	F2	3/3/17	120	12	1
	F3	4/5/17	10	2	1
	F4	5/3/17	410	30	11
	F5	7/14/17	36	3	1
	F6	10/13/17	38	8	2
		Minimum	<1	2	1
		Median	37	6	1.5
		Mean	30	6	2
		Maximum	410	30	11
QM-75	F1	1/20/17	<1	11	<1
	F2	3/3/17	26	3	1
	F3	4/6/17	3	11	20
	F4	5/4/17	290	9	2
	F5	7/19/17	1	880	60
	F6	10/19/17	68	86	8
		Minimum	<1	3	<1
		Median	15	11	5
		Mean	11	25	5
		Maximum	290	880	60
QM-77	F1	1/20/17	4,000	930	52
	F2	3/3/17	13,000	840	95
	F3	4/6/17	680	82	2
	F4	5/4/17	1,900	1,600	2,300
	F5	7/14/17	>20,000	3,000	5,100
	F6	10/19/17	1,000	>20,000	110
		Minimum	680	82	2
		Median	2,950	1,265	103
		Mean	3,322	1,354	153
		Maximum	>20,000	>20,000	5,100

[1]For values less than minimum and greater than maximum reporting limits, the minimum and maximum reporting limits were used in calculation of descriptive statistics.
[2]Geometric mean calculated.
[3]No sampling was done for the well at this event as the sampling was deferred to a later event.

TABLE 3: ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS AND FECAL COLIFORM IN GROUNDWATER FROM ANNUAL SAMPLING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2017

Well	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[1]	Fecal Coliform
			mS/m	---------- mg/L ----------						^0C	ft	CFU/100 mL
QM-53	11/16/17	6.8	34	174	<1.0	15	39	<0.1	137	11.1	-55	<1
QM-69	09/13/17	8.1	50	288	1.0	35	39	0.9	145	11.9	-80	<1
QM-70	09/27/17	7.5	53	296	<1.0	47	56	0.6	156	13.5	-99	<1
QM-71	09/27/17	7.9	73	426	<1.0	122	73	0.5	193	11.9	-106	<1
QM-72	09/13/17	7.4	67	604	1.1	116	<5	0.4	191	12.9	-124	<1
QM-73	11/08/17	7.6	50	282	1.6	36	<5	0.3	142	11.7	-210	<1
QM-74	11/08/17	7.8	48	220	1.6	56	<5	0.2	98	11.4	-58	<1
QM-76	11/08/17	8.0	51	348	1.2	13	62	0.3	42	12.2	-231	1
QM-78	01/11/17	8.6	44	272	1.1	10	44	0.2	11	11.9	-196	<1
QM-79	01/11/17	8.4	44	284	<1.0	14	23	<0.1	14	11.3	-181	<1
QM-80	01/11/17	8.2	31	188	<1.0	13	7	<0.1	24	12.0	-175	<1
QM-81	11/16/17	8.1	42	184	1.0	21	10	0.1	29	12.0	-142	<1
QM-82	01/11/17	8.2	46	274	1.0	28	12	0.1	17	12.6	-206	<1

[1]Relative to Chicago City Datum (579.48 ft above sea level) at intersection of Madison and State Streets.

TABLE 4: GROUNDWATER ELEVATIONS FOR OBSERVATION WELLS OM-1 THROUGH OM-23 IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2017

Date[1]	Observation Well No. OM-1	OM-2	OM-3	OM-4	OM-5	OM-6	OM-7	OM-8	OM-9	OM-10	OM-11
	Elevation (ft)[2]										
01/23/17	-43.8	-36.7	-40.7	-83.6	-64.5	-35.4	-64.6	-50.2	-32.8	-26	-52.4
02/17/17	-47.8	-36.7	-41.7	-84.6	-66.5	-36.4	-61.6	-50.2	-35.8	-27	-54.4
03/31/17	-43.8	-32.7	-38.7	-80.6	-63.5	-35.4	-60.6	-48.2	-32.8	-24	10.6
04/27/17	-40.8	-41.7	-46.7	-84.6	-73.5	-40.4	-61.6	-55.2	-35.8	-27	-54.4
05/31/17	-46.8	-33.7	-39.7	-82.6	-65.5	-39.4	-60.6	-49.2	-35.8	-27	-52.4
06/30/17	-46.8	-33.7	-39.7	-83.6	-64.5	-39.4	-60.6	-49.2	-35.8	-27	-53.4
07/28/17	-47.8	NA[3]	-44.7	-85.6	-68.5	-37.4	-64.6	-51.2	-38.8	-28	-51.4
08/25/17	-44.8	-40.7	-45.7	-84.6	-66.5	-38.4	-63.6	-49.2	-33.8	-27	-54.4
09/15/17	-46.8	-33.7	-41.7	-84.6	-64.5	-39.4	-60.6	-49.2	-36.8	-27	-53.4
11/30/17	-44.8	-31.7	-38.7	-80.6	-65.5	-40.4	-59.6	-46.2	-33.8	-23	-51.4
12/08/17	-45.8	-29.7	-37.7	-82.6	-63.5	-42.4	-58.6	-47.2	-35.8	-22	-49.4

Date[1]	Observation Well No. OM-12[3]	OM-13[3]	OM-14	OM-15	OM-16	OM-18	OM-19	OM-20	OM-21	OM-22	OM-23
	Elevation (ft)[2]										
01/05/17	NA	NA	-65.8	-158	-120	-220	-82.5	-75.9	-76.9	-76.3	-211
02/03/17	NA	NA	-63.8	-158	-19	-218	-81.5	-95.9	-77.9	-80.3	-184
03/23/17	NA	NA	-62.8	-156	-118	-219	-80.5	-79	-78.9	-77.3	-211
04/14/17	NA	NA	-62.8	-148	-109	-185	-78.5	-72.9	-70.9	-72.3	-177
05/24/17	NA	NA	-64.8	-142	-107	-178	-80.5	-78.9	-71.9	-71.3	-223
06/16/17	NA	NA	-59.8	-145	-107	-183	-75.5	-82.9	-72.9	-72.3	-175
07/12/17	NA	NA	-65.8	-142	-108	-174	-84.5	-78.9	-71.9	-71.3	-223
08/18/17	NA	NA	-65.8	-146	-108	-238	-82.5	ND[4]	-87.9	-71.3	-223
09/06/17	NA	NA	-65.8	-146	-107	-240	-82.5	-106.9	-86.9	-74.3	-224
11/16/17	NA	NA	-66.8	-149	-111	-209	-79.5	-104.9	-76.9	-74.3	-184
12/13/17	NA	NA	-64.8	-145	-108	-237	-81.5	-104.9	-88.9	-71.3	-221

[1]Date measurements were taken.
[2]Relative to Chicago City Datum (579.48 ft above mean sea level) at intersection of State and Madison Streets.
[3]No reading. OM-12 inaccessible due to blockage by construction; OM-13 broken; OM-17 damaged in accident.
[4]ND: Not determined.

FIGURE 3: MINIMUM, MEAN, AND MAXIMUM WATER ELEVATIONS FOR OBSERVATION WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2017