

Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

***MONITORING AND RESEARCH
DEPARTMENT***

REPORT NO. 19-15

TUNNEL AND RESERVOIR PLAN

MAINSTREAM TUNNEL SYSTEM

ANNUAL GROUNDWATER MONITORING REPORT

FOR 2018

July 2019

Kari K. Steele
President
Barbara J. McGowan
Vice President
Frank Avila
Chairman of Finance
Cameron Davis
Kimberly Du Buclet
Marcelino Garcia
Josina Morita
Debra Shore
Maryana T. Spyropoulos

Metropolitan Water Reclamation District of Greater Chicago

CECIL LUE-HING RESEARCH AND DEVELOPMENT COMPLEX
6001 WEST PERSHING ROAD CICERO, ILLINOIS 60804-4112

Edward W. Podczerwinski, P.E.
Director of Monitoring and Research

July 26, 2019

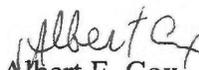
Chief
Bureau of Water
Illinois Environmental Protection Agency
P. O. Box 19276
Springfield, IL 62794-9276

Dear Sir or Madam:

Subject: Tunnel and Reservoir Plan, Mainstream Tunnel System, Annual
Groundwater Monitoring Report for 2018

Attached are three copies of the "Tunnel and Reservoir Plan, Mainstream Tunnel System,
Annual Groundwater Monitoring Report for 2018."

Very truly yours,


Albert E. Cox

Environmental Monitoring and Research Manager
Monitoring and Research Department

AC:OO:cm
Attachment

cc w/att: Ms. Sally K. Swanson (USEPA Region 5 - WC15J) - (2)
Mr. E. Podczerwinski
Dr. H. Zhang
cc w/o att: Mr. J. Murray
Mr. T. Conway

Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street Chicago, Illinois 60611-2803 (312) 751-5600

TUNNEL AND RESERVOIR PLAN, MAINSTREAM TUNNEL SYSTEM
ANNUAL GROUNDWATER MONITORING
REPORT FOR 2018

Monitoring and Research Department
Edward W. Podczewinski, Director

July 2019

TABLE OF CONTENTS

	<u>Page</u>
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

<u>Table No.</u>		<u>Page</u>
1	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 2018 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 2018 and Its Descriptive Statistics	10
3	Analysis of Chemical and Physical Parameters and Fecal Coliform in Groundwater From Annual Sampling of Wells in the Mainstream Tunnel System of the Tunnel and Reservoir Plan During 2018	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 2018	14

LIST OF FIGURES

<u>Figure No.</u>		<u>Page</u>
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 Water Elevations for Observation Wells in the Mainstream Tunnel System of the Tunnel and Reservoir Plan Measured During 2018	16

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 2018. 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 modified monitoring program, 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 2018 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

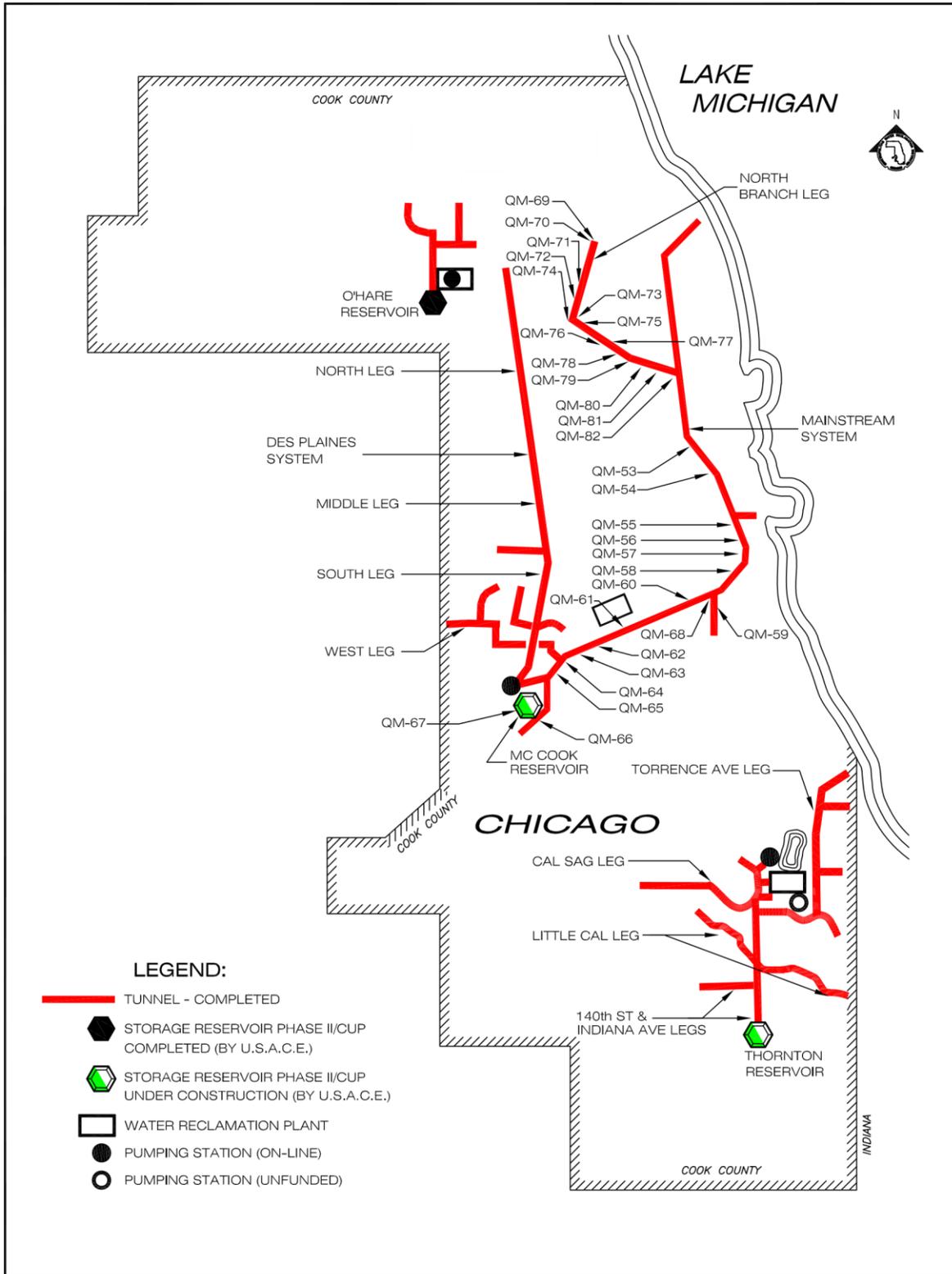
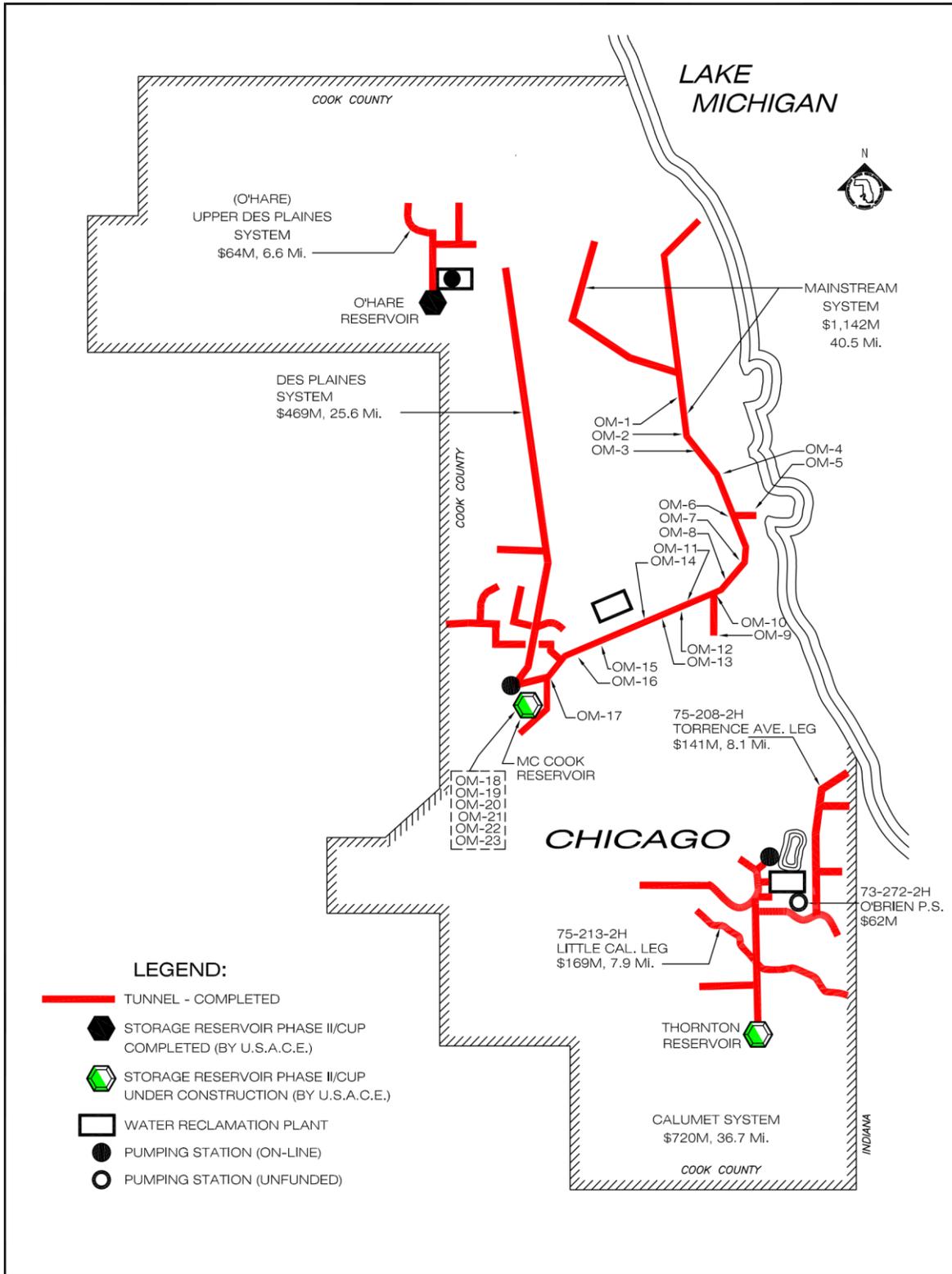


FIGURE 2: MAP OF THE OBSERVATION WELLS IN THE MAINSTREAM TUNNEL SYSTEM



Summary of Data

Monitoring Wells. The analytical data for groundwater sampled during 2018 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 2018 from these monitoring wells along with descriptive statistics are presented in Table 2. Fecal coliform (FC) counts in Wells QM-61, -62, -63, -67, and -77 were much higher than expected at various times during the year. During the year, no decontamination was done on any of the monitoring wells. 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 February, March, April, and July in OM-1 through -11, in December in OM-1 through -23, and in October in OM-12 through -23 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 61, 89, 168, 136, and 103 ft in Wells OM-11, -14, -15, -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 IN MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2018 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS¹

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N ²	Hardness	Temp	Water Elevation ³	Recharge Time
				mS/m	----- mg/L -----					°C	ft	hr	
QM-61	F1	02/21/18	7.0	107	558	2.6	243	34	0.7	186	13.0	-128	<4
QM-61	F2	04/18/18	7.0	76	400	1.3	95	23	0.6	163	13.5	-139	<4
QM-61	F3	05/14/18	7.7	58	328	1.5	66	NRR ⁴	0.8	124	14.4	-121	<4
QM-61	F4	09/06/18	7.3	58	172	3.0	58	17	0.9	117	13.8	-126	<4
QM-61	F5	10/12/18	7.5	36	660	2.2	37	18	0.9	94	13.5	-107	<4
		Minimum	7.0	36	172	1.3	37	17	0.6	94	13.0	-139	
		Median	7.3	58	400	2.2	66	20	0.8	124	13.5	-126	
		Mean	7.3	67	423	2.1	100	23	0.8	137	13.6	-124	
		Maximum	7.7	106	660	3.0	243	34	0.9	186	14.4	-107	
		Standard deviation	0.3	26	191	0.7	83	8	0.2	37	0.5	12	
		Coefficient of variation (%)	4	39	45	34	83	35	19	27	4	9	
QM-62	F1	02/22/18	7.8	80	660	2.6	272	45	1.5	217	13.4	-113	<48
QM-62	F2	04/19/18	7.9	73	374	1.6	106	26	1.0	162	13.8	-113	<48
QM-62	F3	05/17/18	7.8	57	332	3.1	89	NRR	1.4	140	14.7	-110	<48
QM-62	F4	09/06/18	6.9	61	276	2.7	54	28	1.1	144	14.9	-115	<48
QM-62	F5	10/10/18	7.6	62	288	1.9	44	31	0.8	168	14.7	-116	<48
		Minimum	6.9	57	276	1.6	44	26	0.8	140	13.4	-116	
		Median	7.8	62	332	2.6	89	29	1.1	162	14.7	-113	
		Mean	7.6	67	386	2.4	113	32	1.1	166	14.3	-113	
		Maximum	7.9	80	660	3.1	272	45	1.5	217	14.9	-110	
		Standard deviation	0.4	10	158	0.6	92	9	0.3	31	0.7	2	
		Coefficient of variation (%)	6	14	41	26	82	27	25	18	5	2	
QM-63	F1	02/22/18	7.6	190	1,046	2.8	186	379	1.9	497	13.6	-80	<48
QM-63	F2	04/19/18	7.4	199	1,804	3.4	57	1,132	2.6	991	14.2	-135	<48

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 2018 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS¹

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N ²	Hardness	Temp	Water Elevation ³	Recharge Time
				mS/m	----- mg/L -----					°C	ft	hr	
QM-63	F3	05/17/18	7.7	133	1,028	4.3	70	491	2.0	515	14.8	-92	<48
QM-63	F4	09/06/18	7.4	178	1,306	2.9	51	NRR	2.4	836	13.9	-99	<48
QM-63	F5	10/10/18	7.6	204	1,400	2.6	49	837	2.2	789	15.3	-96	<48
		Minimum	7.4	133	1,028	2.6	49	378	1.9	497	13.6	-135	
		Median	7.6	190	1,306	2.9	57	664	2.2	789	14.2	-96	
		Mean	7.5	181	1,317	3.2	83	710	2.2	726	14.4	-100	
		Maximum	7.7	204	1,804	4.3	186	1,132	2.6	991	15.3	-80	
		Standard deviation	0.1	29	317	0.7	58	343	0.3	214	0.7	21	
		Coefficient of variation (%)	2	16	24	21	71	48	13	29	5	21	
QM-64	F1	02/21/18	7.6	72	426	2.5	71	41	2.1	196	13.9	-125	<4
QM-64	F2	04/18/18	7.6	78	410	1.4	68	43	1.7	226	13.6	-140	<4
QM-64	F3	05/18/18	7.5	72	452	2.0	60	47	1.9	208	14.5	-112	<4
QM-64	F4	09/06/18	7.5	71	360	1.3	53	38	1.6	183	15.5	-125	<4
QM-64	F5	10/08/18	7.5	71	434	1.4	50	39	1.6	206	14.6	-119	<4
		Minimum	7.5	71	360	1.3	50	38	1.6	183	13.6	-140	
		Median	7.5	72	426	1.4	60	41	1.7	206	14.5	-125	
		Mean	7.5	73	416	1.7	60	42	1.8	204	14.4	-124	
		Maximum	7.6	78	452	2.5	71	47	2.1	226	15.5	-112	
		Standard deviation	0.1	3	35	0.5	9	4	0.2	16	0.7	10	
		Coefficient of variation (%)	1	4	8	30	15	9	13	8	5	8	
QM-65	F1	02/23/18	7.2	131	696	2.5	100	151	5.5	282	13.4	-124	<48
QM-65	F2	04/19/18	7.0	131	728	3.0	118	142	5.2	321	13.5	-153	<48
QM-65	F3	05/17/18	6.9	97	764	2.9	128	152	5.8	298	13.5	-122	<48
QM-65	F4	09/06/18	7.2	125	722	3.0	106	143	4.9	324	14.4	-140	<48
QM-65	F5	10/10/18	7.5	132	712	2.7	108	81	4.8	323	15.1	-139	<48

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 2018 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS¹

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N ²	Hardness	Temp	Water Elevation ³	Recharge Time	
				mS/m	----- mg/L -----					°C	ft	hr		
		Minimum	6.9	97	696	2.5	100	81	4.7	282	13.4	-153		
		Median	7.2	131	722	2.9	108	143	5.2	321	13.5	-139		
		Mean	7.2	123	724	2.8	112	134	5.2	310	14.0	-136		
		Maximum	7.5	132	764	3.0	128	152	5.7	324	15.1	-122		
		Standard deviation	0.2	15	25	0.2	11	30	0.4	19	0.7	13		
		Coefficient of variation (%)	3	12	3	8	10	22	8	6	5	9		
	QM-67	F1	02/22/18	7.2	77	760	4.0	211	15	14.4	314	14.0	-159	<48
	QM-67	F2	04/19/18	7.2	160	802	3.9	256	13	14.0	332	13.0	-159	<48
7	QM-67	F3	05/17/18	7.1	148	778	3.7	241	9	13.6	277	14.4	-167	<48
	QM-67	F4	09/06/18	7.2	129	668	4.1	166	11	13.7	253	14.1	-156	<48
	QM-67	F5	10/10/18	7.5	118	574	4.0	131	36	13.1	242	14.8	-156	<48
		Minimum	7.1	77	574	3.7	131	9	13.1	242	13.0	-167		
		Median	7.2	129	760	4.0	211	13	13.7	277	14.1	-159		
		Mean	7.2	126	716	3.9	201	17	13.7	284	14.1	-160		
		Maximum	7.5	160	802	4.1	256	36	14.4	332	14.8	-156		
		Standard deviation	0.1	32	94	0.2	52	11	0.5	39	0.7	5		
		Coefficient of variation (%)	2	25	13	4	26	66	3	14	5	3		
	QM-68	F1	02/22/18	7.5	65	618	1.8	154	38	1.1	413	13.6	-127	<48
	QM-68	F2	04/19/18	7.3	119	646	1.8	152	51	0.9	436	13.1	-132	<48
	QM-68	F3	05/17/18	7.2	112	702	2.5	146	56	0.9	386	14.0	-115	<48
	QM-68	F4	09/06/18	7.1	114	616	2.1	153	42	0.9	409	13.6	-126	<48
	QM-68	F5	10/10/18	7.4	120	652	2.0	144	50	0.9	405	13.4	-123	<48
		Minimum	7.1	65	616	1.8	144	38	0.9	386	13.1	-132		
		Median	7.2	114	646	2.0	152	50	0.9	409	13.6	-126		

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 2018 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS¹

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N ²	Hardness	Temp	Water Elevation ³	Recharge Time	
				mS/m	----- mg/L -----					°C	ft	hr		
		Mean	7.3	106	647	2.0	150	47	0.9	410	13.5	-124		
		Maximum	7.5	120	702	2.5	154	56	1.1	436	14.0	-115		
		Standard deviation	0.1	23	35	0.3	5	7	0.1	18	0.3	6		
		Coefficient of variation (%)	2	22	5	14	3	15	7	4	2	5		
∞	QM-75	F1	02/22/18	8.1	38	216	<1.0	14	9	0.3	70	11.9	-50	<48
	QM-75	F2	04/19/18	8.0	36	198	1.0	13	11	0.2	60	11.9	-77	<48
	QM-75	F3	05/17/18	8.0	37	240	1.0	14	11	0.3	62	12.3	-74	<48
	QM-75	F4	09/07/18	8.1	36	216	1.0	15	<10	<0.5	60	12.7	-60	<48
	QM-75	F5	10/11/18	8.1	34	222	1.0	12	<10	<0.5	60	12.1	-54	<48
			Minimum	8.0	34	198	<1.0	12	9	0.2	60	11.9	-77	
			Median	8.1	36	216	1.0	14	10	0.3	60	12.1	-60	
			Mean	8.1	36	218	1.0	14	10	0.4	62	12.2	-63	
			Maximum	8.2	38	240	1.0	15	12	<0.5	70	12.7	-50	
			Standard deviation	0.1	1	15	0.0	1	1	0.1	4	0.3	12	
			Coefficient of variation (%)	1	4	7	0	8	8	38	7	3	19	
	QM-77	F1	02/22/18	8.4	28	162	<1.0	12	<5	0.2	45	11.9	-78	<48
	QM-77	F2	04/19/18	8.3	26	134	<1.0	10	<5	0.2	42	11.9	-141	<48
	QM-77	F3	05/17/18	7.8	31	228	2.8	12	<5	0.1	45	12.1	-79	<48
	QM-77	F4	09/07/18	8.3	26	130	<1.0	10	<10	<0.5	41	13.0	-92	<48
QM-77	F5	10/11/18	8.6	25	138	<1.0	10	<10	<0.5	42	12.3	-84	<48	
		Minimum	7.8	25	130	<1.0	10	<5	0.1	41	11.9	-141		
		Median	8.3	26	138	1.0	10	<5	0.2	42	12.1	-84		
		Mean	8.3	27	158	1.4	11	<7	0.3	43	12.2	-95		

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 2018 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS¹

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N ²	Hardness	Temp	Water Elevation ³	Recharge Time
				mS/m	----- mg/L -----						°C	ft	hr
		Maximum	8.6	31	228	2.8	12	<10	<0.5	45	13.0	-78	
		Standard deviation	0.3	2	41	0.8	1	<3	0.2	2	0.5	26	
		Coefficient of variation (%)	3	9	26	59	10	39	62	4	4	28	

¹For values less than reporting limits, the reporting limits were used in calculation of descriptive statistics.

²Report limit changed to 0.5 mg/L in July 2018 due to the change in test equipment.

³Relative to Chicago City Datum (579.48 ft above sea level) at intersection of Madison and State Streets.

⁴NRR: No reportable result 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 2018 AND ITS DESCRIPTIVE STATISTICS¹

Well	Fill event	Week 1 Sample Date	Week 1	Week 2	Week 3
			-----CFU/100 mL-----		
QM-61	F1	02/21/18	76,000	37,000	17,000
	F2	04/18/18	1	3	<1
	F3	05/14/18	31	>20,000	1,100
	F4	09/06/18	>20,000	12,000	NRR ³
	F5	10/12/18	15,000	2,600	310
		Minimum	1	3	<1
		Median	15,000	12,000	705
		Mean ²	933	2,334	276
		Maximum	>20,000	37,000	17,000
	QM-62	F1	02/22/18	83,000	47,000
F2		04/19/18	18	5	6
F3		05/17/18	100,000	>200,000	720
F4		09/06/18	>20,000	6,000	800
F5		10/10/18	23,000	7,900	1,200
		Minimum	18	5	6
		Median	23,000	7,900	800
		Mean	9,277	4,673	466
		Maximum	100,000	>200,000	5,300
QM-63		F1	02/22/18	54,000	14,000
	F2	04/19/18	4	2	1
	F3	05/17/18	87,000	71,000	820
	F4	09/06/18	13,000	4,800	57
	F5	10/10/18	11,000	8,000	690
		Minimum	4	2	1
		Median	13,000	8,000	690
		Mean	4,851	2,380	178
		Maximum	87,000	71,000	5,600
	QM-64	F1	02/21/18	230	2,200
F2		04/18/18	10	<1	1
F3		05/18/18	1,800	660	420

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 2018 AND ITS DESCRIPTIVE STATISTICS¹

Well	Fill Event	Week 1 Sample Date	Week 1	Week 2	Week 3
-----CFU/100 mL-----					
	F4	09/06/18	100	4,300	NRR
	F5	10/08/18	34	830	140
		Minimum	10	<1	1
		Median	100	830	280
		Mean	107	349	85
		Maximum	1,800	4,300	870
QM-65	F1	02/23/18	33	780	86
	F2	04/19/18	<1	5	<1
	F3	05/17/18	520	2,000	33
	F4	09/06/18	110	99	45
	F5	10/10/18	49	440	65
		Minimum	<1	5	<1
		Median	49	440	45
		Mean	39	202	24
		Maximum	520	2,000	86
QM-67	F1	02/22/18	NRR	12,000	870
	F2	04/19/18	2,000	1,400	500
	F3	05/17/18	1,400	2,300	2,000
	F4	09/06/18	7,300	6,600	830
	F5	10/10/18	6,200	4,200	980
		Minimum	1,400	1,400	500
		Median	4,100	4,200	870
		Mean	3,355	4,036	933
		Maximum	7,300	12,000	2,000
QM-68	F1	02/22/18	NRR	38	170
	F2	04/19/18	<1	<1	NReq ⁴
	F3	05/17/18	2,700	1,900	60
	F4	09/06/18	<1	250	15
	F5	10/10/18	51	600	NRR

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 2018 AND ITS
DESCRIPTIVE STATISTICS¹

Well	Fill Event	Week 1 Sample Date	Week 1	Week 2	Week 3	
			----- CFU/100 mL -----			
		Minimum	<1	<1	15	
		Median	26	250	60	
		Mean	19	102	53	
		Maximum	2,700	1,900	170	
QM-75	F1	02/22/18	NRR	240	22	
	F2	04/19/18	NRR	<1	NReq	
	F3	05/17/18	370	230	16	
	F4	09/07/18	<1	<1	NReq	
	F5	10/11/18	<1	6	1	
			Minimum	<1	<1	1
			Median	1	6	16
			Mean	4	13	7
			Maximum	370	240	22
	QM-77	F1	02/22/18	2,900	250	970
F2		04/19/18	10	13	<1	
F3		05/17/18	6,000	2,500	120	
F4		09/07/18	3,800	590	7	
F5		10/11/18	3,400	330	38	
			Minimum	10	13	<1
			Median	3,400	330	38
			Mean	1,176	275	31
			Maximum	6,000	2,500	970

¹For values less than minimum and greater than maximum reporting limits, the minimum and maximum reporting limits were used in calculation of descriptive statistics.

²Geometric mean calculated.

³NRR: No reportable result due to QA/QC failure during laboratory analysis.

⁴NReq: Sampling is not required because fecal coliform was below reporting limit in the previous week.

TABLE 3: ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS AND FECAL COLIFORM IN GROUNDWATER FROM ANNUAL SAMPLING OF WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2018

Well	Sampled Date	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N ¹	Hardness	Temp	Water Elevation ²	Fecal Coliform
			mS/m				mg/L			°C	ft	CFU/100 mL
QM-53	12/11/18	7.8	25	186	<1.0	NA ³	NA	<0.5	119	11.8	-40	<1
QM-69	04/12/18	7.0	44	262	1.2	36	33	0.9	137	12.6	-23	<1
QM-70	04/12/18	7.6	46	300	1.6	48	50	0.4	151	12.0	-54	<1
QM-71	04/12/18	7.7	77	410	1.1	124	66	0.5	183	11.7	-64	<1
QM-72	08/15/18	7.5	63	352	1.1	118	<10	<0.5	188	11.9	-79	<1
QM-73	08/15/18	8.0	49	250	1.5	36	<10	<0.5	151	13.5	-163	<1
QM-74	08/15/18	8.1	45	252	1.6	55	<10	<0.5	105	13.2	-6	<1
QM-76	12/11/18	7.9	46	378	<1.0	12	109	<0.5	82	11.6	-194	1
QM-78	12/11/18	8.8	32	268	<1.0	11	43	<0.5	9	11.0	-192	<1
QM-79	12/11/18	8.8	33	256	<1.0	14	18	<0.5	19	11.1	-154	<1
QM-80	01/24/18	7.5	44	226	1.4	21	10	0.1	35	11.9	-113	<1
QM-81	12/11/18	8.1	29	218	<1.0	21	6	<0.5	33	12.5	-99	<1
QM-82	01/24/18	8.2	48	280	1.7	29	9	0.1	16	11.8	-186	<1

¹Report limit changed to 0.5 mg/L in July 2018 due to the change in test equipment.

²Relative to Chicago City Datum (579.48 ft above sea level) at intersection of Madison and State Streets.

³NA: Not analyzed due to samples being beyond holding time.

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 2018

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 -----										
01/19/18	-42.8	-29.7	-37.7	-79.6	-62.5	-41.4	-57.6	-45.2	-32.8	-24.0	-49.4
05/11/18	-40.8	-29.7	-35.7	-80.6	-61.5	-42.4	-59.6	-48.2	-34.8	-23.0	-48.4
06/22/18	NA ³	-28.7	-35.7	-80.6	-62.5	-43.4	-55.6	-43.2	-33.8	-23.0	10.6
08/03/18	NA	NA	-37.7	-80.6	-60.5	-46.4	-58.6	-48.2	-35.8	-23.0	-50.4
09/28/18	NA	NA	-35.7	-79.6	-65.5	-46.4	-54.6	-45.2	-32.8	-25.0	-49.4
10/26/18	-39.8	NA	NA	-79.6	-59.5	NA	-57.6	-46.2	NA	NA	-49.4
11/30/18	NA	NA	-34.7	-79.6	-59.5	-35.4	-57.6	-47.2	-32.8	-25.0	-50.4
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 -----										
01/09/18	NA	NA	-65.8	NA	-111	-212	-82.5	-108.9	-88.9	-75.3	-186
02/13/18	NA	NA	NA	NA	-109	-208	-79.5	-105.9	-83.9	-72.3	-183
03/16/18	NA	NA	-65.8	-136	-102	-199	-80.5	-89	-73.9	-72.3	-206
04/19/18	NA	NA	-52.8	-123	-104	-223	-81.5	-91.9	-77.9	-74.3	-156
05/04/18	NA	NA	-65.8	-143	-102	-225	-80.5	-94.9	-76.9	-73.3	-111
06/21/18	NA	NA	-66.8	-143	-104	-225	-85.5	-93.9	-77.9	-73.3	-114
07/20/18	NA	NA	-64.8	-142	-100	-217	-81.5	-92.9	-76.9	-72.3	-111
08/23/18	NA	NA	-64.8	-142	NA	-226	NA	27.1	-77.9	-75.3	-214

TABLE 4 (Continued): GROUNDWATER ELEVATIONS FOR OBSERVATION WELLS OM-1 THROUGH OM-23
IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2018

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 -----										
09/25/18	NA	NA	-62.8	-138	-96	-224	-79.5	-88.9	-74.9	-73.3	-210
11/09/18	NA	NA	-67.8	-136	-101	-210	-78.5	-92.9	-73.9	-70.3	-209

¹Date measurements were taken.

²Relative to Chicago city datum (579.48 ft above mean sea level) at intersection of State and Madison Streets.

³No reading: OM-12 inaccessible due to blockage by construction; OM-13 damaged by a truck and abandoned; OM-17 damaged in accident; other “no readings” due to gate locked, sinkhole, or overgrown vegetation.

FIGURE 3: MINIMUM, MEAN, AND MAXIMUM WATER ELEVATIONS FOR OBSERVATION WELLS IN THE MAINSTREAM TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2018

