Metropolitan Water Reclamation District of Greater Chicago

MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 16-20

TUNNEL AND RESERVOIR PLAN

CALUMET TUNNEL SYSTEM

ANNUAL GROUNDWATER MONITORING REPORT

FOR 2015

July 2016

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

TUNNEL AND RESERVOIR PLAN
CALUMET TUNNEL SYSTEM
ANNUAL GROUNDWATER MONITORING REPORT
FOR 2015

Monitoring and Research Department
Thomas C. Granato, Director

July 2016

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CFU	colony forming units
ft	feet
IEPA	Illinois Environmental Protection Agency
mL	milliliter
Cl^-	chloride
EC	electrical conductivity
FC	fecal coliform
L	liter
m	meter
mg	milligram
mS	millisiemens
NH_3-N	ammonia nitrogen
SO_4^{2-}	sulfate
TDS	total dissolved solids
TOC	total organic carbon

ANNUAL DATA FOR MONITORING AND OBSERVATION WELLS

Introduction

All monitoring and observation wells are located along the length of the Calumet Tunnel System. Four monitoring wells (QC-1, -2, -2-1, and -2-2) and 11 observation wells (OC-1 through OC-11) are located along the tunnel between Crawford Avenue and the Calumet Water Reclamation Plant. Seventeen monitoring wells (QC-3 through QC-19) are located between 140th Street and Indiana Avenue. Nine monitoring wells (QC-20 through QC-28) are positioned along Torrence Avenue, with the last nine monitoring wells (QC-29 through QC-37) along the Little Calumet River (Figures 1 and 2). Monitoring well QC-3 was abandoned with the approval of the Illinois Environmental Protection Agency (IEPA). Monitoring wells QC-1, -2, and QC-29 through QC-37 are sampled six times per year (IEPA memorandum dated July 9, 2004). Monitoring wells QC-2-1, -2-2, QC-4 through QC-7, and QC-9 through QC-28 are sampled three times per year (IEPA memoranda July 9, 2004, and February 23, 2006).

During 2015, all wells were sampled as scheduled, and the full number of samples were obtained. As expected, no samples were obtained from Wells QC-32, -33, -34, and -36, and only one sample was retrieved from Well QC-37. These wells are considered dry or intermittently dry. Their pumps were tested and classified as functional. Groundwater elevations in the monitoring wells were measured during each sampling event, while elevations in the observation wells were measured biweekly. The groundwater level in monitoring well QC-8-1 is no longer adequate for sampling. However, this well was converted to an observation well several years ago, and its groundwater elevations are still measured biweekly.

Summary of Data

Monitoring Wells. The analytical data for groundwater sampled during 2015 from monitoring wells QC-2 through QC-37 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. Fecal coliform counts for all wells, except QC-2 (maximum of 460 CFU/100 mL), were undetectable. Table 2 lists the descriptive statistics for groundwater data of monitoring wells QC-2 through QC-36 for the year 2015.

Observation Wells. Groundwater elevations for observation wells OC-1 through -11 were measured at the required frequencies. Adjusted elevations were calculated relative to the Chicago city datum (579.48 ft. above mean sea level) at the intersection of Madison and State Streets (Table 3). 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 or within expected ranges throughout the year in most wells. Notable fluctuations in groundwater elevations were evident at Wells OC-1, -4, -8, and -8-1 (31, 22, 27, and 49 ft, respectively) during June through September 2015.

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

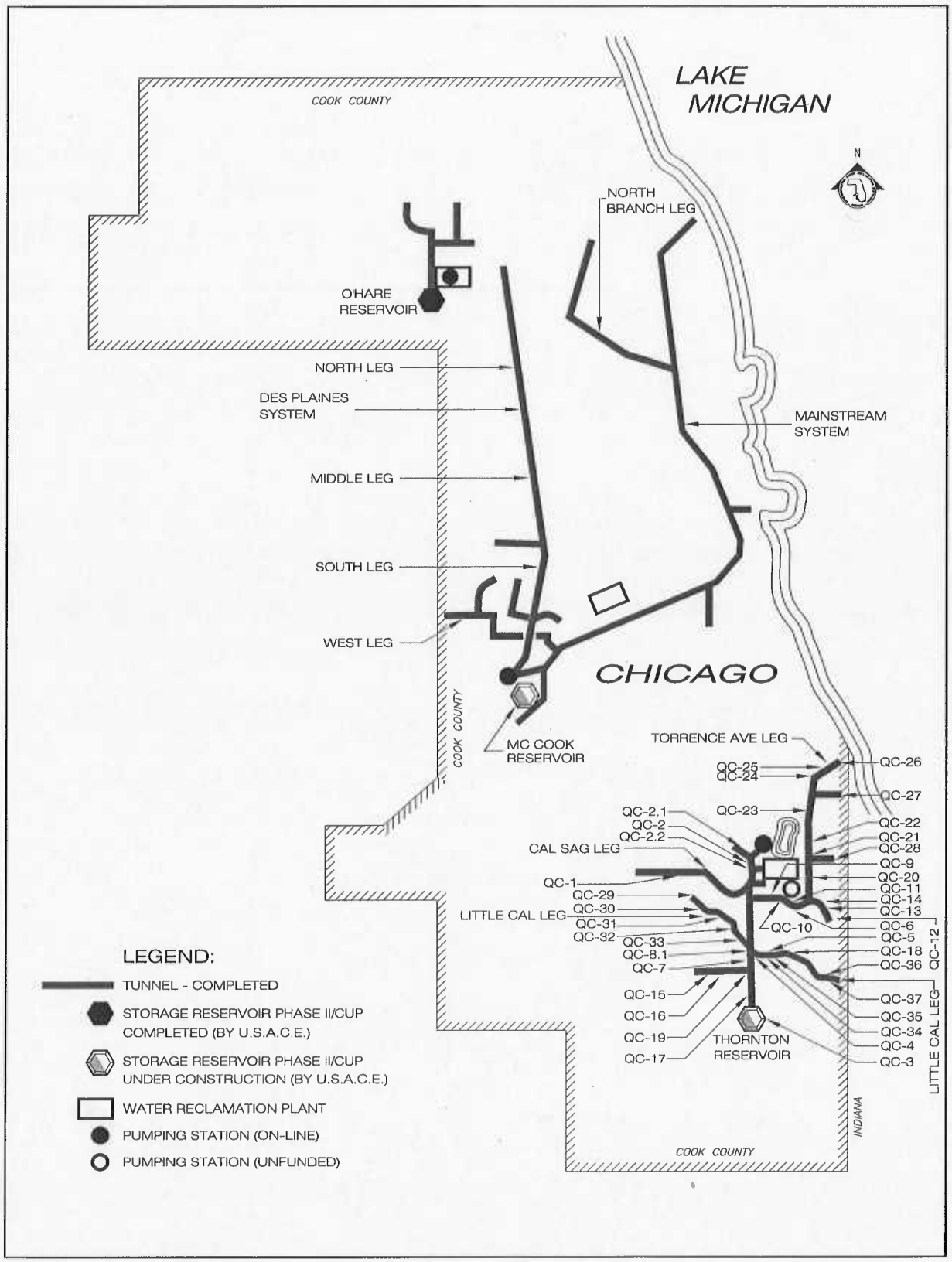

FIGURE 2: MAP OF OBSERVATION WELLS IN THE CALUMET TUNNEL SYSTEM

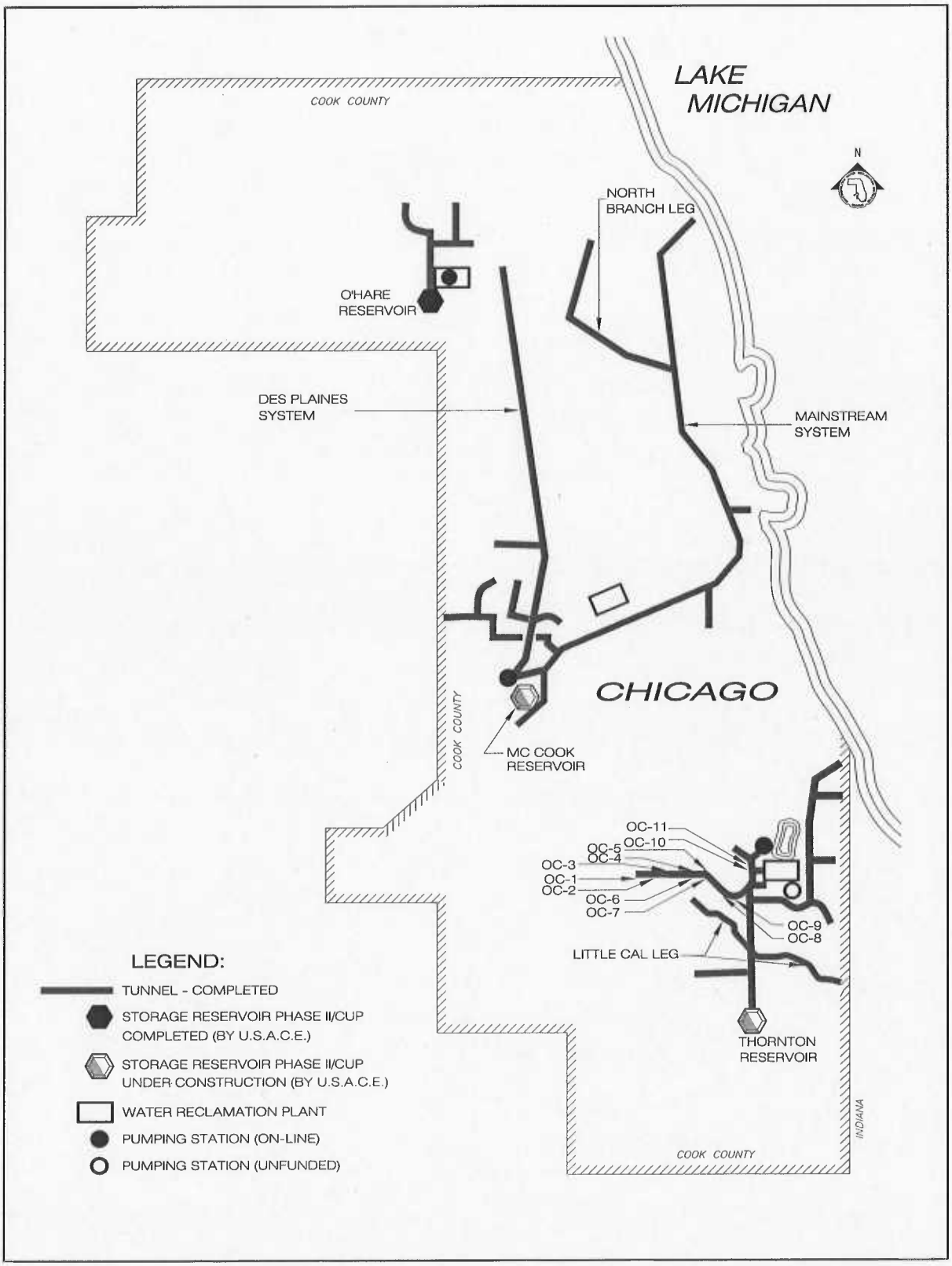

TABLE 1: ANALYSIS OF GROUNDWATER FROM MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2015

Well[1]	Date Sampled	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform	Temp.	Water Elevation[3]	Recharge Time
			mS/m	mg/L						CFU/100 mL	°C	ft	hr
QC-2	01/08/15	8.2	43	336	2	31	29	0.61	84	<1			
QC-2	03/19/15	8.2	41	334	2	30	29	0.35	85	<1	12.6	-259	<48
QC-2	04/23/15	8.0	42	352	2	30	27	0.32	83	<1	13.1	-280	<48
QC-2	07/16/15	8.1	61	338	1	32	26	0.43	91	360	14.1	-275	<48
QC-2	10/01/15	7.9	58	352	2	31	23	0.62	89	460	13.3	-264	<48
QC-2	10/21/15	8.0	60	346	1	30	21	0.45	86	83	14.2	-278	<48
QC-2-1	03/19/15	7.5	77	472	1	34	10	0.50	59	<1	12.0	-286	<48
QC-2-1	07/16/15	8.2	59	478	<1	33	12	0.59	64	<1	13.9	-285	<48
QC-2-1	10/21/15	8.1	86	496	1	34	<5	0.59	62	<1	14.0	-280	<48
QC-2-2	03/19/15	8.4	49	328	2	13	35	0.31	45	<1	12.2	-204	<48
QC-2-2	07/16/15	8.6	32	350	2	12	33	0.22	51	<1	14.3	-282	<48
QC-2-2	10/01/15	8.4	58	322	1	13	27	0.20	50	<1	14.2	-295	<48
QC-4	05/20/15	8.6	49	482	<1	10	15	0.14	11	<1	12.6	-232	<48
QC-4	08/12/15	8.7	70	408	<1	<10	12	0.17	11	<1	13.1	-234	<48
QC-4	11/04/15	8.6	58	404	<1	<10	18	0.11	11	<1	13.0	-230	<48
QC-5	05/20/15	8.6	66	606	1	39	12	0.11	8	<1	12.1	-217	<48
QC-5	08/12/15	8.7	91	518	1	39	12	0.15	9	<1	13.0	-208	<48
QC-5	11/04/15	8.7	88	518	1	40	14	0.10	8	<1	13.6	-206	<48
QC-6	05/20/15	8.6	54	532	2	14	6	0.32	16	<1	12.3	-202	<48
QC-6	08/12/15	8.5	74	430	2	14	8	0.33	17	<1	14.2	-205	<48
QC-6	11/04/15	8.7	72	440	1	14	11	0.28	16	<1	13.2	-206	<48

TABLE 1 (Continued): ANALYSIS OF GROUNDWATER FROM MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2015

Well[1]	Date Sampled	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform	Temp.	Water Elevation[3]	Recharge Time
			mS/m	mg/L						CFU/100 mL	°C	ft	hr
QC-7	05/20/15	8.4	48	448	2	10	<5	0.28	11	<1	12.5	-175	<48
QC-7	08/12/15	8.3	68	384	2	10	7	0.28	11	<1	14.5	-167	<48
QC-7	11/04/15	8.6	57	394	1	10	<5	0.24	11	<1	13.6	-166	<48
QC-9	03/19/15	8.1	37	310	1	<10	40	0.14	63	<1	12.6	-246	<48
QC-9	07/16/15	8.1	52	276	1	<10	38	0.31	66	<1	13.6	-241	<48
QC-9	12/10/15	8.0	52	296	<1	<10	35	0.15	62	<1	12.7	-252	<48
QC-10	05/20/15	8.3	47	464	<1	30	<5	0.12	12	<1	12.4	-174	<4
QC-10	11/24/15	8.6	64	382	<1	29	<5	<0.10	11	<1	12.5	-175	<4
QC-10	08/27/15	8.5	60	382	<1	29	5	0.11	11	<1	12.8	-173	<4
QC-11	02/04/15	8.8	33	264	<1	22	<5	0.22	21	<1	11.1	-222	<4
QC-11	08/10/15	8.3	23	230	<1	21	<5	0.12	27	<1	14.5	-198	<4
QC-11	12/02/15	8.1	44	280	<1	20	14	0.11	21	<1	12.5	-210	<4
QC-12	02/04/15	9.0	100	802	<1	37	296	0.88	151	<1	12.5	-233	<4
QC-12	08/10/15	8.0	134	834	<1	36	307	1.1	181	<1	14.2	-231	<4
QC-12	12/02/15	7.9	129	858	<1	35	280	2.13	174	<1	12.4	-222	<4
QC-13	03/26/15	8.2	68	406	<1	55	27	0.22	35	<1	12.5	-236	<48
QC-13	08/10/15	8.0	69	360	<1	58	23	0.19	35	<1	14.0	-235	<48
QC-13	12/02/15	8.1	67	398	<1	56	21	0.17	36	<1	11.9	-243	<48

TABLE 1 (Continued): ANALYSIS OF GROUNDWATER FROM MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2015

Well[1]	Date Sampled	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform	Temp.	Water Elevation[3]	Recharge Time
			mS/m	mg/L						CFU/100 mL	°C	ft	hr
QC-14	04/23/15	7.6	86	750	3	158	6	0.32	168	<1	12.9	-209	<48
QC-14	10/01/15	7.8	117	776	3	171	12	0.34	164	<1	13.4	-199	<48
QC-14	10/21/15	7.0	127	666	3	134	6	0.35	155	<1	13.9	-207	<48
QC-15	04/23/15	8.5	36	292	<1	12	<5	0.25	15	<1	12.6	-224	<48
QC-15	10/01/15	8.3	50	312	1	13	5	0.21	15	<1	12.9	-224	<48
QC-15	10/21/15	7.9	50	284	<1	13	<5	0.23	14	<1	13.5	-214	<48
QC-16	05/20/15	8.0	52	534	<1	23	76	<0.10	79	1	12.1	-266	<48
QC-16	08/12/15	8.1	85	496	<1	24	84	<0.10	92	<1	13.5	-264	<48
QC-16	11/19/15	8.0	39	486	<1	23	85	<0.10	93	<1	11.2	-255	<48
QC-17	04/23/15	7.9	56	488	<1	<10	180	0.28	161	<1	12.0	-203	<48
QC-17	09/03/15	8.3	70	488	<1	<10	179	0.31	174	<1	14.6	-210	<48
QC-17	10/21/15	7.6	74	492	<1	13	173	0.35	148	<1	13.2	-203	<48
QC-18	04/23/15	8.9	42	358	<1	<10	30	0.10	8	<1	12.1	-200	<48
QC-18	09/03/15	8.8	58	346	<1	<10	29	<0.10	13	<1	13.4	-198	<48
QC-18	10/21/15	8.3	61	340	<1	<10	28	0.11	6	<1	13.3	-199	<48
QC-19	05/14/15	9.0	46	390	<1	<10	136	0.29	96	<1	13.0	-142	<48
QC-19	08/27/15	8.5	32	420	3	<10	146	0.34	111	<1	13.1	-143	<48
QC-19	11/19/15	8.6	66	404	<1	<10	160	0.27	119	<1	11.3	-145	<48

TABLE 1 (Continued): ANALYSIS OF GROUNDWATER FROM MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2015

Well[1]	Date Sampled	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform	Temp.	Water Elevation[3]	Recharge Time
			mS/m	mg/L						CFU/100 mL	°C	ft	hr
QC-20	05/14/15	7.5	32	254	<1	18	<5	0.12	22	<1	13.0	-265	<48
QC-20	08/27/15	8.4	43	268	<1	18	<5	0.15	22	<1	14.8	-265	<48
QC-20	11/19/15	7.9	43	242	<1	17	6	0.10	21	<1	11.9	-263	<48
QC-21	05/14/15	8.0	40	338	2	17	6	0.16	38	<1	13.1	-257	<48
QC-21	08/27/15	7.9	55	346	4	16	9	0.10	31	<1	12.9	-256	<48
QC-21	11/19/15	8.0	51	308	1	17	7	<0.10	33	<1	12.0	-257	<48
QC-22	05/14/15	8.1	33	260	1	13	<5	0.22	42	<1	12.7	-261	<48
QC-22	08/27/15	8.4	41	276	2	13	5	0.28	41	<1	12.8	-263	<48
QC-22	11/19/15	7.8	43	270	1	13	44	0.21	44	<1	11.5	-258	<48
QC-23	05/14/15	9.0	41	324	<1	19	<5	<0.10	7	<1	13.0	-237	<48
QC-23	08/27/15	9.0	52	350	<1	18	5	0.11	9	<1	12.6	-237	<48
QC-23	11/19/15	9.0	42	300	<1	19	<5	<0.10	7	<1	11.8	-237	<48
QC-24	05/14/15	8.6	29	232	<1	30	<5	0.15	19	<1	12.9	-240	<48
QC-24	08/27/15	8.5	37	256	<1	26	<5	0.15	14	<1	12.7	-242	<48
QC-24	11/24/15	8.0	38	230	<1	24	<5	0.13	14	<1	12.2	-236	<48
QC-25	05/14/15	8.2	26	224	<1	13	5	0.14	29	<1	13.1	-239	<48
QC-25	08/27/15	7.9	33	246	<1	12	6	0.14	28	<1	13.6	-242	<48
QC-25	11/24/15	7.9	34	212	<1	12	<5	0.13	22	<1	12.6	-239	<48

TABLE 1 (Continued): ANALYSIS OF GROUNDWATER FROM MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2015

Well[1]	Date Sampled	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform	Temp.	Water Elevation[3]	Recharge Time
			mS/m	mg/L						CFU/100 mL	°C	ft	hr
QC-26	05/14/15	8.7	31	258	<1	11	<5	<0.10	7	<1	12.4	-229	<48
QC-26	08/27/15	8.1	41	312	<1	11	<5	0.12	6	<1	13.5	-229	<48
QC-26	11/24/15	7.8	41	256	<1	11	<5	<0.10	7	<1	12.2	-234	<48
QC-27	05/14/15	8.5	29	218	<1	30	<5	0.17	25	<1	13.2	-213	<48
QC-27	08/27/15	8.5	35	278	<1	30	<5	0.16	24	<1	13.2	-211	<48
QC-27	11/24/15	8.0	40	246	<1	29	<5	0.14	21	<1	12.6	-208	<48
QC-28	05/14/15	8.1	31	244	1	12	<5	<0.10	17	<1	13.1	-251	<48
QC-28	08/27/15	8.7	40	302	1	12	<5	<0.10	16	<1	13.4	-247	<48
QC-28	11/24/15	8.6	40	256	<1	12	<5	<0.10	17	<1	12.9	-246	<48
QC-29	01/08/15	7.3	118	978	1	190	213	0.78	425	<1	11.0	-55	<48
QC-29	03/25/15	7.3	59	744	1	163	195	0.68	312	<1	11.9	-50	<48
QC-29	06/03/15	7.0	125	802	1	170	173	0.76	380	<1	13.0	-51	<48
QC-29	09/03/15	7.0	144	940	2	183	205	0.78	430	<1	15.8	-54	<48
QC-29	10/22/15	6.4	144	902	1	176	187	0.74	411	<1	12.1	-58	<48
QC-29	12/17/15	7.6	124	862	1	167	186	0.65	413	<1	11.3	-51	<48
QC-30	01/08/15	8.2	47	428	<1	13	94	0.49	66	<1	9.1	-134	<48
QC-30	03/25/15	7.6	50	390	<1	12	98	0.29	76	<1	10.9	-140	<48
QC-30	06/03/15	8.1	57	394	<1	12	91	0.15	72	<1	13.5	-125	<48
QC-30	09/03/15	7.9	68	398	1	12	88	0.19	82	<1	14.4	-129	<48
QC-30	10/22/15	7.7	67	410	<1	12	95	0.41	69	<1	11.8	-128	<48
QC-30	12/17/15	8.1	65	408	<1	12	94	0.35	70	<1	11.1	-124	<48

TABLE 1 (Continued): ANALYSIS OF GROUNDWATER FROM MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2015

Well[1]	Date Sampled	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform	Temp.	Water Elevation[3]	Recharge Time
			mS/m	mg/L						CFU/100 mL	°C	ft	hr
QC-31	01/08/15	8.0	60	564	1	16	191	0.94	241	<1	11.1	-54	<48
QC-31	03/25/15	7.7	62	526	1	16	208	0.41	235	<1	12.0	-65	<48
QC-31	06/03/15	7.6	70	524	1	15	187	1.1	252	<1	13.1	-53	<48
QC-31	09/03/15	7.6	89	554	1	14	195	1.0	244	<1	13.7	-93	<48
QC-31	10/22/15	7.4	84	542	1	15	187	0.91	242	<1	12.4	-53	<48
QC-31	12/17/15	7.8	85	552	1	15	189	0.97	258	<1	11.7	-50	<48
QC-35	01/14/15	8.9	92	842	2	31	40	<0.10	25	<1	9.8	-154	<48
QC-35	03/26/15	8.6	89	870	1	32	35	<0.10	15	<1	11.9	-148	<48
QC-35	04/23/15	8.5	120	842	1	31	61	<0.10	19	<1	12.8	-151	<48
QC-35	10/22/15	8.4	131	858	1	32	36	<0.10	20	<1	13.0	-148	<48
QC-37	01/14/15	8.6	113	960	1	28	110	<0.10	17	<1	11.6	-128	<48

[1]No samples obtained from Wells QC-1, -32, -33, -34, and -36; considered intermittently or permanently dry; only one sample retrieved from QC-37.
[2]EC = electrical conductivity; TDS = total dissolved solids; TOC = total dissolved organic carbon.
[3]Relative to Chicago city datum (579.48 ft above mean sea level) at intersection of Madison and State Streets.

TABLE 2: DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-2	Minimum	7.9	41	334	1	30	21	0.32	83	<1
	Mean	8.1	51	343	1	31	26	0.46	86	15
	Maximum	8.2	61	352	2	32	29	0.62	91	460
	Std. Dev.	0.1	10	8	0.2	1	3	0.13	3	NA[4]
	Median	8.0	50	342	2	31	27	0.44	86	42
	Coeff. of Var. (%)	1.4	19	2	14	3	13	27	4	NA
QC-2-1	Minimum	7.5	59	472	1	33	10	0.50	59	<1
	Mean	7.9	74	482	1	34	11	0.56	62	<1
	Maximum	8.2	86	496	1	34	12	0.59	64	<1
	Std. Dev.	0.4	13	12	0.1	1	1	0.05	3	NA
	Median	8.1	77	478	1	34	11	0.59	62	<1
	Coeff. of Var. (%)	4.9	18	3	12	2	13	9.3	4	NA
QC-2-2	Minimum	8.4	32	322	1	12	27	0.20	45	<1
	Mean	8.5	46	333	2	13	31	0.24	49	<1
	Maximum	8.6	58	350	2	13	35	0.31	51	<1
	Std. Dev.	0.1	13	15	1	1	4	0.06	3	NA
	Median	8.4	49	328	2	13	33	0.22	50	<1
	Coeff. of Var. (%)	0.9	29	4	28	5	13	24	7	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-4	Minimum	8.6	49	404	<1	10	12	0.11	11	<1
	Mean	8.6	59	431	<1	10	15	0.14	11	<1
	Maximum	8.7	70	482	<1	10	18	0.17	11	1
	Std. Dev.	0.1	10	44	0.0	0	3	0.03	0	NA
	Median	8.6	58	408	<1	10	15	0.14	11	<1
	Coeff. of Var. (%)	0.9	17	10	0.0	0	18	21	0	NA
QC-5	Minimum	8.6	66	518	1	39	12	0.10	8	<1
	Mean	8.7	82	547	1	39	13	0.12	8	<1
	Maximum	8.7	91	606	1	40	14	0.15	9	<1
	Std. Dev.	0.1	14	51	0.2	1	1	0.03	1	NA
	Median	8.7	88	518	1	39	12	0.11	8	<1
	Coeff. of Var. (%)	1.0	17	9	18	1	9	22	7	NA
QC-6	Minimum	8.5	54	430	1	14	6	0.28	16	<1
	Mean	8.6	67	467	1	14	8	0.31	16	<1
	Maximum	8.7	74	532	2	14	11	0.33	17	<1
	Std. Dev.	0.1	11	56	0.2	0	3	0.03	1	NA
	Median	8.6	72	440	2	14	8	0.32	16	<1
	Coeff. of Var. (%)	1.2	16	12	10	0	30	8.5	4	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-7	Minimum	8.3	48	384	1	10	<5	0.24	11	<1
	Mean	8.4	58	409	2	10	6	0.27	11	<1
	Maximum	8.6	68	448	2	10	7	0.28	11	<1
	Std. Dev.	0.2	10	34	0.3	0	1	0.02	0	NA
	Median	8.4	57	394	2	10	5	0.28	11	<1
	Coeff. of Var. (%)	1.9	17	8	16	0	20	8.7	0	NA
QC-9	Minimum	8.0	37	276	1	<10	35	0.14	62	<1
	Mean	8.1	47	294	1	<10	38	0.20	64	<1
	Maximum	8.1	52	310	1	<10	40	0.31	66	<1
	Std. Dev.	0.1	9	17	0.2	0	3	0.10	2	NA
	Median	8.1	52	296	1	<10	38	0.15	63	<1
	Coeff. of Var. (%)	0.7	18	6	18	0	7	48	3	NA
QC-10	Minimum	8.3	47	382	<1	29	<5	0.11	11	<1
	Mean	8.5	57	409	<1	29	5	0.12	11	<1
	Maximum	8.6	64	464	<1	30	5	0.12	12	<1
	Std. Dev.	0.2	9	47	0.0	1	0.1	0.01	1	NA
	Median	8.5	60	382	<1	29	5	0.12	11	<1
	Coeff. of Var. (%)	1.8	16	12	0.0	2	3	6.1	5	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-11	Minimum	8.1	23	230	<1	20	<5	0.11	21	<1
	Mean	8.4	33	258	<1	21	8	0.15	23	<1
	Maximum	8.8	44	280	<1	22	14	0.22	27	<1
	Std. Dev.	0.4	11	26	0.0	1	5	0.06	3	NA
	Median	8.3	33	264	<1	21	5	0.12	21	<1
	Coeff. of Var. (%)	4.2	32	10	0.0	5	66	41	15	NA
QC-12	Minimum	7.9	100	802	<1	35	280	0.88	151	<1
	Mean	8.3	121	831	<1	36	294	1.4	169	<1
	Maximum	9.0	134	858	<1	37	307	2.1	181	<1
	Std. Dev.	0.6	18	28	0.0	1	14	0.67	16	NA
	Median	8.0	129	834	<1	36	296	1.1	174	<1
	Coeff. of Var. (%)	7.4	15	3	0.0	3	5	49	9	NA
QC-13	Minimum	8.0	67	360	<1	55	21	0.17	35	<1
	Mean	8.1	68	388	<1	56	24	0.19	35	<1
	Maximum	8.2	69	406	<1	58	27	0.22	36	<1
	Std. Dev.	0.1	1	25	0.0	2	3	0.03	1	NA
	Median	8.1	68	398	<1	56	23	0.19	35	<1
	Coeff. of Var. (%)	1.1	2	6	0.0	3	13	13	2	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-14	Minimum	7.0	86	666	3	134	6	0.32	155	<1
	Mean	7.4	110	731	3	154	8	0.34	162	<1
	Maximum	7.8	127	776	3	171	12	0.35	168	<1
	Std. Dev.	0.4	21	57	0.4	19	3	0.02	7	NA
	Median	7.6	117	750	3	158	6	0.34	164	<1
	Coeff. of Var. (%)	5.5	19	8	14	12	42	4.5	4	NA
QC-15	Minimum	7.9	36	284	1	12	<5	0.21	14	<1
	Mean	8.2	46	296	1	13	5	0.23	15	<1
	Maximum	8.5	50	312	1	13	5	0.25	15	<1
	Std. Dev.	0.3	8	14	0.0	1	0	0.02	1	NA
	Median	8.3	50	292	1	13	5	0.23	15	<1
	Coeff. of Var. (%)	4.0	18	5	0.0	5	0	8.7	4	NA
QC-16	Minimum	8.0	39	486	<1	23	76	<0.10	79	<1
	Mean	8.1	58	505	<1	23	82	<0.10	88	<1
	Maximum	8.1	85	534	<1	24	85	<0.10	93	<1
	Std. Dev.	0.1	24	25	0.0	1	5	0.00	8	NA
	Median	8.0	52	496	<1	23	84	<0.10	92	<1
	Coeff. of Var. (%)	0.8	40	5	0.0	2	6	0.00	9	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-17	Minimum	7.6	56	488	<1	<10	173	0.28	148	<1
	Mean	7.9	66	489	<1	11	177	0.31	161	<1
	Maximum	8.3	74	492	<1	13	180	0.35	174	<1
	Std. Dev.	0.4	10	2	0.0	2	4	0.04	13	NA
	Median	7.9	70	488	<1	13	179	0.31	161	<1
	Coeff. of Var. (%)	4.7	15	0.5	0.0	16	2	11	8	NA
QC-18	Minimum	8.3	42	340	<1	<10	28	0.10	6	<1
	Mean	8.7	54	348	<1	<10	29	0.11	9	<1
	Maximum	8.9	61	358	<1	<10	30	0.11	13	<1
	Std. Dev.	0.3	10	9	0.0	0	1	0.01	4	NA
	Median	8.8	58	346	<1	<10	29	0.11	8	<1
	Coeff. of Var. (%)	3.5	18	3	0.0	0	5	6.7	40	NA
QC-19	Minimum	8.5	32	390	<1	<10	136	0.27	96	<1
	Mean	8.7	48	405	2	<10	147	0.30	109	<1
	Maximum	9.0	66	420	3	<10	160	0.34	119	<1
	Std. Dev.	0.2	17	15	0.9	0	12	0.04	12	NA
	Median	8.6	46	404	1	<10	146	0.29	111	<1
	Coeff. of Var. (%)	2.7	36	4	60	0	8	12	11	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-20	Minimum	7.5	32	242	<1	17	<5	0.10	21	<1
	Mean	7.9	39	255	<1	18	5	0.12	22	<1
	Maximum	8.4	43	268	<1	18	6	0.15	22	<1
	Std. Dev.	0.5	6	13	0.0	1	1	0.03	1	NA
	Median	7.9	43	254	<1	18	6	0.12	22	<1
	Coeff. of Var. (%)	5.8	15	5	0.0	3	12	20	3	NA
QC-21	Minimum	7.9	40	308	1	16	6	0.10	31	<1
	Mean	8.0	49	331	2	17	7	0.13	34	<1
	Maximum	8.0	55	346	4	17	9	0.16	38	<1
	Std. Dev.	0.1	7	20	1	1	1	0.04	4	NA
	Median	8.0	51	338	2	17	7	0.13	33	<1
	Coeff. of Var. (%)	1.1	15	6	50	3	18	33	11	NA
QC-22	Minimum	7.8	33	260	1	13	5	0.21	41	<1
	Mean	8.1	39	269	1	13	25	0.24	42	<1
	Maximum	8.4	43	276	2	13	44	0.28	44	<1
	Std. Dev.	0.3	6	8	0.4	0	28	0.04	2	NA
	Median	8.1	41	270	1	13	25	0.22	42	<1
	Coeff. of Var. (%)	3.9	15	3	29	0	113	16	4	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-23	Minimum	9.0	41	300	<1	18	<5	0.11	7	<1
	Mean	9.0	45	325	<1	19	5	0.11	8	<1
	Maximum	9.0	52	350	<1	19	5	0.11	9	<1
	Std. Dev.	0.0	6	25	0.0	1	0	0.00	1	NA
	Median	9.0	42	324	<1	19	5	0.11	7	<1
	Coeff. of Var. (%)	0.3	13	8	0.0	3	0	0.00	15	NA
QC-24	Minimum	8.0	29	230	<1	24	<5	0.13	14	<1
	Mean	8.4	35	239	<1	27	<5	0.14	16	<1
	Maximum	8.6	38	256	<1	30	<5	0.15	19	<1
	Std. Dev.	0.3	5	14	0.0	3	0	0.01	3	NA
	Median	8.5	37	232	<1	26	<5	0.15	14	<1
	Coeff. of Var. (%)	3.8	15	6	0.0	11	0	8.1	18	NA
QC-25	Minimum	7.9	26	212	<1	12	5	0.13	22	<1
	Mean	8.0	31	227	<1	12	6	0.14	26	<1
	Maximum	8.2	34	246	<1	13	6	0.14	29	<1
	Std. Dev.	0.2	4	17	0.0	1	0.2	0.01	4	NA
	Median	7.9	33	224	<1	12	6	0.14	28	<1
	Coeff. of Var. (%)	2.1	13	8	0.0	5	3	4.2	14	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-26	Minimum	7.8	31	256	<1	11	<5	<0.10	6	<1
	Mean	8.2	38	275	<1	11	<5	0.10	7	<1
	Maximum	8.7	41	312	<1	11	<5	0.12	7	<1
	Std. Dev.	0.5	6	32	0.0	0	0	0.01	1	NA
	Median	8.1	41	258	<1	11	<5	0.10	7	<1
	Coeff. of Var. (%)	5.5	15	12	0.0	0	0	12	9	NA
QC-27	Minimum	8.0	29	218	<1	29	<5	0.14	21	<1
	Mean	8.3	35	247	<1	30	<5	0.16	23	<1
	Maximum	8.5	40	278	<1	30	<5	0.17	25	<1
	Std. Dev.	0.3	5	30	0.0	1	0	0.02	2	NA
	Median	8.5	35	246	<1	30	<5	0.16	24	<1
	Coeff. of Var. (%)	3.5	16	12	0.0	2	0	9.8	9	NA
QC-28	Minimum	8.1	31	244	1	12	<5	<0.10	16	<1
	Mean	8.5	37	267	1	12	<5	<0.10	17	<1
	Maximum	8.7	40	302	1	12	<5	<0.10	17	<1
	Std. Dev.	0.3	5	31	0.1	0	0	0.00	1	NA
	Median	8.6	40	256	1	12	<5	<0.10	17	<1
	Coeff. of Var. (%)	3.9	14	11	13	0	0	0.00	3	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-29	Minimum	6.4	59	744	1	163	173	0.65	312	<1
	Mean	7.1	119	871	1	175	193	0.73	395	<1
	Maximum	7.6	144	978	2	190	213	0.78	430	<1
	Std. Dev.	0.4	31	87	0.2	10	14	0.05	44	NA
	Median	7.1	125	882	1	173	191	0.75	412	<1
	Coeff. of Var. (%)	5.6	26	10	13	6	7	7.5	11	NA
QC-30	Minimum	7.6	47	390	<1	12	88	0.15	66	<1
	Mean	7.9	59	405	1	12	93	0.31	73	<1
	Maximum	8.2	68	428	1	13	98	0.49	82	<1
	Std. Dev.	0.3	9	14	0.0	0.41	3	0.13	6	NA
	Median	8.0	61	403	1	12	94	0.32	71	<1
	Coeff. of Var. (%)	3.4	16	3	0.0	3	4	41	8	NA
QC-31	Minimum	7.4	60	524	1	14	187	0.41	235	<1
	Mean	7.7	75	544	1	15	193	0.89	245	<1
	Maximum	8.0	89	564	1	16	208	1.1	258	<1
	Std. Dev.	0.2	13	16	0.1	1	8	0.24	8	NA
	Median	7.7	77	547	1	15	190	0.96	243	<1
	Coeff. of Var. (%)	2.5	17	3	9	5	4	27	3	NA

TABLE 2 (Continued): DESCRIPTIVE STATISTICS FOR GROUNDWATER DATA OF MONITORING WELLS QC-2 THROUGH QC-37 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN DURING 2015

Well[1]	Statistic	pH	EC[2]	TDS[2]	TOC[2]	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Fecal Coliform[3]
			mS/m	mg/L						CFU/100 mL
QC-35	Minimum	8.4	89	842	1	31	35	<0.10	15	<1
	Mean	8.6	108	853	1	32	43	<0.10	20	<1
	Maximum	8.9	131	870	2	32	61	<0.10	25	<1
	Std. Dev.	0.2	21	14	0.5	1	12	0.00	4	NA
	Median	8.5	106	850	1	32	38	<0.10	20	<1
	Coeff. of Var. (%)	2.3	19	2	36	2	28	0.00	21	NA

[1]No samples for Wells QC-1, -32, -33, -34, and -36; considered intermittently dry; QC-37 was not included because it had only one sample.
[2]EC = electrical conductivity; TDS = total dissolved solids; TOC = total dissolved organic carbon.
[3]Geometric mean calculated.
[4]Not applicable.

TABLE 3: GROUNDWATER ELEVATIONS FOR OBSERVATION WELLS OC-1 THROUGH OC-11 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2015

Date[1]	Observation Well No.											
	OC-1	OC-2	OC-3	OC-4	OC-5	OC-6	OC-7	OC-8	OC-8.1	OC-9	OC-10	OC-11
	Elevation (ft^2)											
01/09/15	-27	-23	-144	NA[3]	NA	-79	NA	NA	-217	-201	-207	-211
01/30/15	-30	-24	-151	-156	-150	-78	"	"	-226	-209	-212	-218
02/11/15	NA	-26	-159	NA	NA	-81	"	"	-223	-215	-217	-220
02/20/15	"	NA	-153	"	"	-77	"	"	-220	-212	-219	-215
03/10/15	"	-26	-157	"	"	-75	"	"	-223	NA	-220	-222
03/20/15	-29	-25	-153	-154	-149	-78	-204	"	-220	-206	-222	-223
04/02/15	-58	-26	-157	-162	NA	-75	-209	-181	-222	NA	-219	-222
04/17/15	-38	-25	-155	-153	-147	-80	-202	-204	-218	-209	-220	-225
05/15/15	-37	-25	-157	NA	NA	-73	NA	NA	-223	NA	-219	-221
05/29/15	-36	-23	-150	-151	-145	-85	-200	-206	-221	-212	-214	-222
06/12/15	-30	-22	-148	NA	-143	-82	-199	NA	-218	NA	-209	-219
06/29/15	NA	-25	-157	"	NA	-74	NA	"	-223	"	NA	NA
07/02/15	"	-23	-152	-145	"	-78	-195	"	-212	"	-211	-216
07/24/15	"	-21	-147	-141	-142	-76	NA	"	-221	-210	-212	-217
08/14/15	-38	-26	-160	-163	-146	-76	-210	-182	-261	-208	-221	-214
08/26/15	-39	-27	-161	-163	NA	-75	-210	NA	-217	-209	-219	-216
09/11/15	NA	-28	-158	-161	-144	-78	-209	-179	-254	-207	-222	-211
09/25/15	-37	-30	-158	-162	-151	-84	-210	-182	-254	-208	-222	-212
10/02/15	-35	-26	-160	-162	NA	-76	-208	NA	-219	-213	-220	NA
10/23/15	-39	-27	-160	-162	"	-74	-209	"	-257	NA	-221	-215
11/06/15	-39	-27	-161	-162	-151	-78	-209	"	-225	"	-221	-221
11/20/15	-37	-25	-156	-159	-150	-79	-208	-180	-223	-210	-222	-221
12/04/15	-38	-25	-152	-151	NA	-76	-199	NA	-223	-207	-217	-222
12/18/15	-37	-23	-151	-152	-149	-78	-201	-182	-221	-209	-215	-220

[1]Date measurements were taken.

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

[3]Wells inaccessible at various times due to heavy snow, locked gate, muddy road conditions, fallen trees, high weeds, and flooding.

FIGURE 3: MINIMUM, MEAN, AND MAXIMUM WATER ELEVATIONS FOR OBSERVATION WELLS OC-1 THROUGH OC-11 IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2015