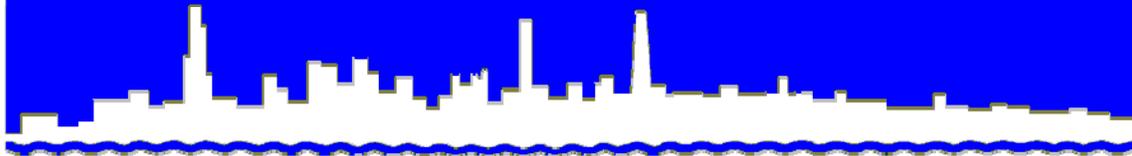


Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

*MONITORING AND RESEARCH
DEPARTMENT*

REPORT NO. 11-29

TUNNEL AND RESERVOIR PLAN

MAINSTREAM TUNNEL SYSTEM

2010 ANNUAL GROUNDWATER MONITORING REPORT

June 2011

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June 22, 2011

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

Dear Ms. Willhite:

Subject: Tunnel and Reservoir Plan, Mainstream Tunnel System, 2010 Annual
Groundwater Monitoring Report

Enclosed are three copies of "Tunnel and Reservoir Plan, Mainstream Tunnel System,
2010 Annual Groundwater Monitoring Report."

Very truly yours,

Thomas C. Granato, Ph.D.
Acting Director
Monitoring and Research

TCG:DGM:lf

Enclosures

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TUNNEL AND RESERVOIR PLAN
MAINSTREAM TUNNEL SYSTEM
2010 ANNUAL GROUNDWATER MONITORING REPORT

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2010 MONITORING RESULTS

Introduction

This report contains 2010 data for the Tunnel and Reservoir Plan Mainstream Tunnel System compiled from monitoring of groundwater level elevations in observation wells, and monitoring of groundwater quality in water quality monitoring wells. The observation wells are all sampled once every two months while the monitoring wells are sampled at varying frequency. Monitoring wells QM-53, QM-56, QM-58, QM-61, QM-66, QM-68 through QM-74, QM-76, QM-77, and QM-81 are sampled three times per year (Illinois Environmental Protection Agency [IEPA] memoranda July 9, 2004, and February 23, 2006). Monitoring wells QM-62 through QM-65, QM-67, QM-75, QM-78 through QM-80, and QM-82 are sampled six times per year (IEPA memorandum July 9, 2004). Sampling of water quality monitoring wells QM-51, QM-52, QM-54, QM-55, QM-57, and QM-60 was discontinued with the approval of the IEPA (memorandum dated May 4, 1994). Water quality monitoring well QM-59 has been dry since February 1995 and is no longer being monitored. The observation wells and water quality monitoring wells are located along the length of the Mainstream Tunnel between Morton Grove and Hodgkins.

Monitoring Data

Appendix AI contains a location map of observation wells OM-1 through OM-23 located along the Mainstream Tunnel System.

Table AII-1 in Appendix AII contains groundwater level elevation data for the year 2010 for observation wells OM-1 through OM-23 located along the Mainstream Tunnel System. Observation well OM-17 could not be monitored in 2010 due to damage to the well. The repairs to this well are currently under evaluation. Observation well OM-19 could not be monitored in 2010 because the well was inaccessible. The area surrounding the well was converted to native prairie land. The access issue has been resolved, and this well will be monitored in 2011. Table AII-1 also contains the yearly minimum, mean, and maximum water level elevations of each observation well.

Appendix AIII contains a location map of water quality monitoring wells QM-53 through QM-82 located along the Mainstream Tunnel System.

Tables AIV-1 and AIV-2 of Appendix AIV contain water quality data for the year 2010 pertaining to water quality monitoring wells QM-53, QM-56, QM-58, and QM-63 through QM-82 located along the Mainstream Tunnel System. Ten water quality parameters were monitored: chloride (Cl), conductivity (Cond.), fecal coliform (FC), hardness as CaCO₃ (Hard.), ammonia nitrogen (NH₃-N), pH, sulfate (SO₄), total dissolved solids (TDS), total organic carbon (TOC), and temperature (Temp.). Water elevation in each water quality monitoring well as measured at the time of sampling is also included in Table AIV-2. The recharge time after initial drawdown in each monitoring well prior to sampling is also provided in Table AIV-2.

All of the wells in the Mainstream system were visited for the required number of samples. However, in some instances the samples could not be collected for various reasons. Groundwater quality monitoring wells QM-56 and QM-58 could not be sampled during 2010 because construction in the area blocked access to both wells. Groundwater quality monitoring well QM-62 could not be sampled on May 13, 2010, July 22, 2010, August 19, 2010, October 14, 2010, and December 9, 2010, because the pump was inoperable. Groundwater quality monitoring well QM-64 could not be sampled on December 8, 2010, because heavy snow blocked access to the well. Groundwater quality monitoring well QM-65 could not be sampled November 17, 2010, because the pump was inoperable. Groundwater quality monitoring well QM-66 could not be sampled on May 20, 2010, and August 19, 2010, because there was insufficient water in the well to collect a sample. Groundwater quality monitoring well QM-79 could not be sampled on November 18, 2010, and December 9, 2010, because construction blocked access to the well. Groundwater quality monitoring well QM-82 could not be sampled during 2010 because the pump was inoperable. A work order has been issued to repair the pump.

Summary of Data

Observation Well Water Level Elevation Data. In [Figure 1](#), the 2010 groundwater level elevation data for observation wells OM-1 through OM-23 of the Mainstream Tunnel System except for OM-17 and OM-19 have been plotted. In this figure, minimum, mean, and maximum water level elevations of all the observation wells are plotted to show fluctuations in water level elevations during 2010. [Table AII-1](#) in [Appendix AII](#) contains the groundwater level elevation data for the year 2010 for the observation wells located in the Mainstream Tunnel System.

Water Quality Monitoring Well Data. [Tables 1](#) through [5](#) contain summary statistics of the water quality parameters for the year 2010 for water quality monitoring wells in the Mainstream Tunnel System. These statistics are computed from the 2010 data collected from each water quality monitoring well. The summary statistics include minimum, mean, maximum, standard deviation (Stdv.), median and coefficient of variation (COV) for eight of the nine water quality parameters analyzed during 2010. These eight water quality parameters are: chloride (Cl), conductivity (Cond.), hardness as CaCO₃ (Hard.), ammonia nitrogen (NH₃-N), pH, sulfate (SO₄), total dissolved solids (TDS), and total organic carbon (TOC). For fecal coliform (FC), the summary statistics include minimum, geometric mean (Geo. Mean), maximum, and median. The statistical analysis of the data was conducted using Microsoft[®] Excel functions.

FIGURE 1: 2010 MINIMUM, MEAN, AND MAXIMUM WATER LEVEL ELEVATIONS FOR THE MAINSTREAM TUNNEL SYSTEM OBSERVATION WELLS

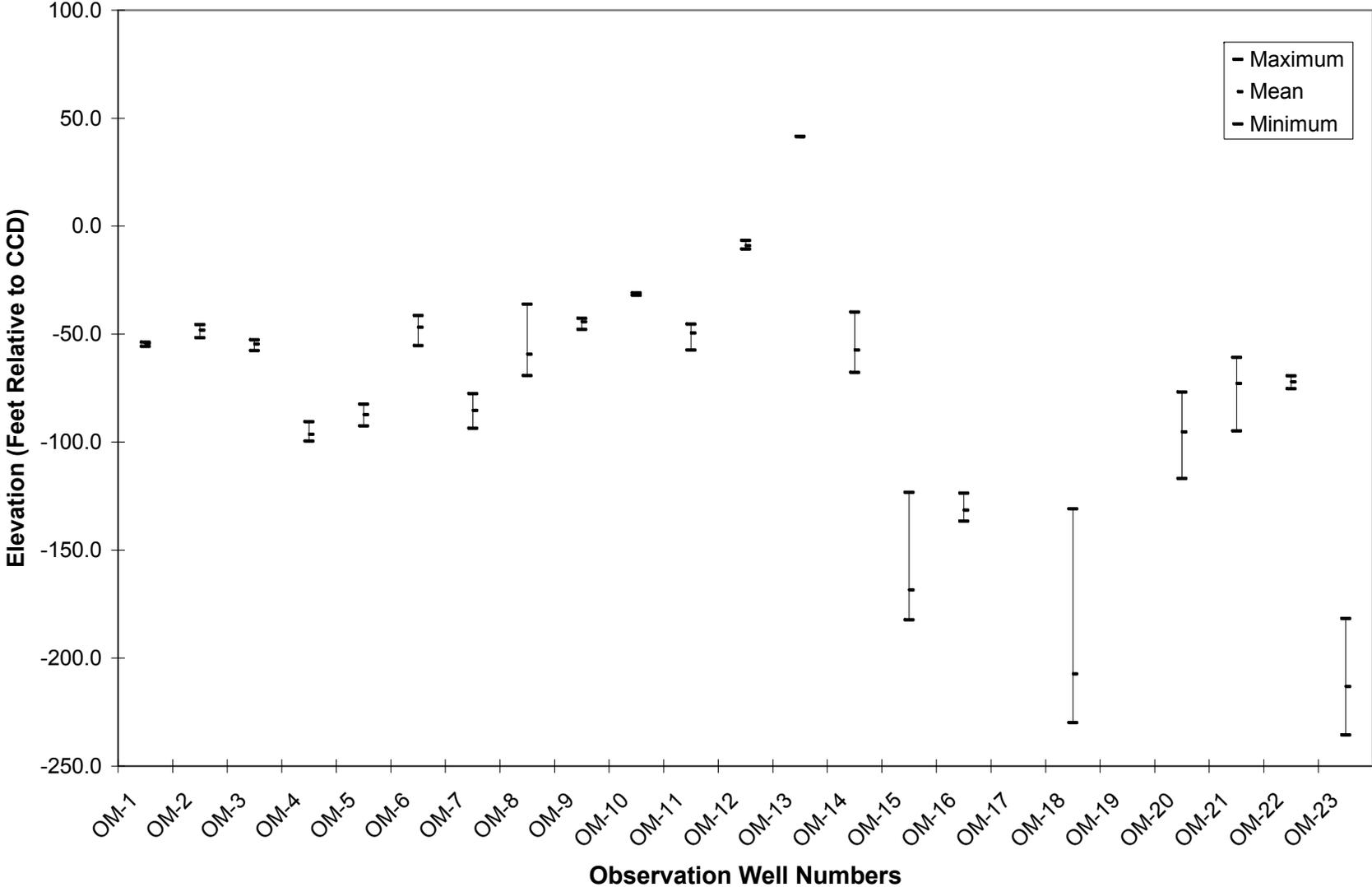


TABLE 1: SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-53 AND QM-61 THROUGH QM-64

Parameter ¹		Well Number				
		QM-53	QM-61	QM-62	QM-63	QM-64
Cl mg/L	Minimum	15	45	45	44	46
	Mean	15	85	45	47	69
	Maximum	15	151	45	52	132
	Stdv.	0	58	N/C ²	3	36
	Median	15	59	45	47	57
	COV	0	68	N/C	7	52
	FC cfu/100 mL	Minimum	1	1	2	1
	Geo. Mean	1	206	N/C	2	10
	Maximum	1	20,000	2	59	3,900
	Median	1	440	N/C	1	2
SO ₄ mg/L	Minimum	33.9	8.1	36.0	785.3	33.3
	Mean	35.2	21.9	36.0	837.6	39.8
	Maximum	36.5	35.7	36.0	871.2	46.9
	Stdv.	1.3	13.8	N/C	38.1	5.6
	Median	35.2	21.8	36.0	851.7	37.8
	COV	3.6	63.1	N/C	4.5	14.1
	NH ₃ -N mg/L	Minimum	0.06	0.37	0.49	1.73
Mean		0.07	0.84	0.49	3.30	1.82
Maximum		0.08	1.10	0.49	10.47	1.88
Stdv.		0.01	0.41	N/C	3.52	0.11
Median		0.07	1.06	0.49	1.94	1.86
COV		14.29	48.66	N/C	106.57	5.88
TOC mg/L		Minimum	1.0	1.3	1.4	2.1
	Mean	1.0	1.8	1.4	2.3	1.5
	Maximum	1.0	2.8	1.4	2.5	1.7
	Stdv.	0.0	0.9	N/C	0.1	0.1
	Median	1.0	1.3	1.4	2.3	1.4
	COV	0.0	48.1	N/C	6.4	9.4

TABLE 1 (Continued): SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-53 AND QM-61 THROUGH QM-64

Parameter ¹		Well Number				
		QM-53	QM-61	QM-62	QM-63	QM-64
TDS mg/L	Minimum	162	282	360	1,448	408
	Mean	194	367	360	1,597	480
	Maximum	234	502	360	1,682	682
	Stdv.	37	118	N/C	95	114
	Median	186	318	360	1,629	434
	COV	19	32	N/C	6	24
Hard. mg/L as CO ₃	Minimum	131	116	163	716	187
	Mean	138	135	163	861	203
	Maximum	142	151	163	928	217
	Stdv.	6	18	N/C	74	12
	Median	140	139	163	882	199
	COV	4	13	N/C	9	6
Cond. µmhos/cm	Minimum	185	345	396	740	402
	Mean	198	395	396	1,174	468
	Maximum	211	438	396	1,901	637
	Stdv.	13	47	N/C	513	98
	Median	199	401	396	971	430
	COV	7	12	N/C	44	21
pH unit	Minimum	7.5	6.9	7.7	6.9	7.6
	Mean	7.6	7.3	7.7	7.5	7.8
	Maximum	7.8	7.6	7.7	8.1	8.2
	Stdv.	0.1	0.4	N/C	0.4	0.2
	Median	7.7	7.5	7.7	7.5	7.7
	COV	1.7	5.4	N/C	5.0	3.1

¹For purpose of statistical evaluation, any value less than the appropriate limit of quantification (LOQ) was set equal to the value of the LOQ.

²N/C = No calculation due to single value.

TABLE 2: SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-65 THROUGH QM-69

Parameter ¹		Well Number				
		QM-65	QM-66	QM-67	QM-68	QM-69
Cl mg/L	Minimum	316	197	163	27	33
	Mean	403	197	213	28	34
	Maximum	485	197	267	29	35
	Stdv.	65	N/C ²	39	1	1
	Median	390	197	211	28	35
	COV	16	N/C	18	4	3
FC cfu/100 mL	Minimum	1	1	2	1	1
	Geo. Mean	1	N/C	173	2	1
	Maximum	1	1	1,200	8	1
	Median	1	N/C	280	1	1
SO ₄ mg/L	Minimum	158.1	132.8	2.1	32.1	37.7
	Mean	163.1	132.8	8.8	33.2	41.0
	Maximum	170.4	132.8	16.9	34.3	45.4
	Stdv.	4.8	N/C	6.2	1.1	4.0
	Median	161.2	132.8	8.7	33.3	40.1
	COV	2.9	N/C	69.7	3.3	9.7
NH ₃ -N mg/L	Minimum	10.46	2.04	8.91	0.31	0.88
	Mean	11.26	2.04	10.05	0.48	0.93
	Maximum	12.41	2.04	10.52	0.60	0.97
	Stdv.	1.03	N/C	0.59	0.15	0.05
	Median	10.53	2.04	10.26	0.52	0.94
	COV	9.16	N/C	5.90	31.42	4.93
TOC mg/L	Minimum	6.4	2.8	3.2	1.0	1.2
	Mean	7.0	2.8	3.6	1.0	1.3
	Maximum	7.6	2.8	4.3	1.1	1.4
	Stdv.	0.5	N/C	0.4	0.1	0.1
	Median	7.0	2.8	3.5	1.0	1.3
	COV	6.8	N/C	11.0	5.6	7.7

TABLE 2 (Continued): SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-65 THROUGH QM-69

Parameter ¹		Well Number				
		QM-65	QM-66	QM-67	QM-68	QM-69
TDS mg/L	Minimum	1,292	1,806	624	264	312
	Mean	1,451	1,806	742	311	322
	Maximum	1,586	1,806	850	340	332
	Stdv.	126	N/C	92	41	10
	Median	1,470	1,806	726	330	322
	COV	9	N/C	12	13	3
	Hard. mg/L as CO ₃	Minimum	426	9	224	187
Mean		530	9	259	193	145
Maximum		600	9	302	199	155
Stdv.		77	N/C	32	6	11
Median		555	9	245	192	145
COV		14	N/C	12	3	7
Cond. µmhos/cm		Minimum	1,115	3,035	685	332
	Mean	1,575	3,035	984	415	307
	Maximum	2,001	3,035	1,460	501	339
	Stdv.	396	N/C	270	84	34
	Median	1,621	3,035	908	412	311
	COV	25	N/C	27	20	11
	pH unit	Minimum	7.0	11.8	6.9	6.7
Mean		7.2	11.8	7.3	7.1	8.0
Maximum		7.7	11.8	7.6	7.7	8.1
Stdv.		0.3	N/C	0.3	0.5	0.2
Median		7.2	11.8	7.5	7.0	8.1
COV		4.0	N/C	4.1	7.6	3.0

¹For purpose of statistical evaluation, any value less than the appropriate limit of quantification (LOQ) was set equal to the value of the LOQ.

²N/C = No calculation due to single value.

TABLE 3: SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-70 THROUGH QM-74

Parameter ¹		Well Number				
		QM-70	QM-71	QM-72	QM-73	QM-74
Cl mg/L	Minimum	44	122	124	33	50
	Mean	47	125	128	35	51
	Maximum	50	129	134	37	52
	Stdv.	3	4	5	2	1
	Median	48	124	127	34	50
	COV	6	3	4	6	2
FC cfu/100 mL	Minimum	1	1	1	1	1
	Geo. Mean	1	1	1	1	1
	Maximum	1	2	1	1	2
	Median	1	1	1	1	1
SO ₄ mg/L	Minimum	50.2	33.5	2.0	2.0	2.0
	Mean	51.6	54.1	2.4	2.1	2.0
	Maximum	53.3	64.6	3.3	2.3	2.0
	Stdv.	1.6	17.9	0.7	0.2	0.0
	Median	51.3	64.2	2.0	2.1	2.0
	COV	3.1	33.0	30.6	8.0	0.0
NH ₃ -N mg/L	Minimum	0.35	0.41	0.32	0.28	0.19
	Mean	0.38	0.44	0.34	0.30	0.22
	Maximum	0.41	0.47	0.37	0.31	0.25
	Stdv.	0.03	0.03	0.03	0.02	0.03
	Median	0.39	0.43	0.34	0.30	0.23
	COV	7.97	7.00	7.33	5.15	13.68
TOC mg/L	Minimum	1.0	1.0	1.0	1.0	1.4
	Mean	1.0	1.0	1.0	1.2	1.4
	Maximum	1.0	1.0	1.0	1.3	1.5
	Stdv.	0.0	0.0	0.0	0.2	0.1
	Median	1.0	1.0	1.0	1.2	1.4
	COV	0.0	0.0	0.0	13.1	4.0

TABLE 3 (Continued): SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-70 THROUGH QM-74

Parameter ¹		Well Number				
		QM-70	QM-71	QM-72	QM-73	QM-74
TDS mg/L	Minimum	322	388	352	274	240
	Mean	334	453	396	331	305
	Maximum	348	538	448	440	418
	Stdv.	13	77	48	95	98
	Median	332	434	388	278	256
	COV	4	17	12	29	32
Hard. mg/L as CO ₃	Minimum	127	160	181	132	82
	Mean	143	181	205	147	95
	Maximum	152	201	217	166	105
	Stdv.	14	21	21	17	12
	Median	151	183	216	142	98
	COV	10	11	10	12	12
Cond. µmhos/cm	Minimum	280	370	331	287	280
	Mean	327	433	371	331	294
	Maximum	363	472	397	356	310
	Stdv.	42	55	36	38	15
	Median	337	456	386	349	292
	COV	13	13	10	12	5
pH unit	Minimum	7.8	6.8	6.9	7.7	7.9
	Mean	8.0	7.6	7.4	7.8	8.1
	Maximum	8.1	8.1	7.9	7.8	8.3
	Stdv.	0.1	0.7	0.5	0.1	0.2
	Median	8.0	8.0	7.3	7.8	8.0
	COV	1.9	9.5	6.8	1.1	2.8

¹For purpose of statistical evaluation, any value less than the appropriate limit of quantification (LOQ) was set equal to the value of the LOQ.

TABLE 4: SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-75 THROUGH QM-78

Parameter ¹		Well Number			
		QM-75	QM-76	QM-77	QM-78
Cl mg/L	Minimum	10	15	15	15
	Mean	15	15	16	15
	Maximum	16	15	22	15
	Stdv.	2	0	3	0
	Median	15	15	15	15
	COV	16	0	18	0
FC cfu/100 mL	Minimum	1	1	1	1
	Geo. Mean	4	1	1	77
	Maximum	2,600	1	1	6,400
	Median	1	1	1	70
SO ₄ mg/L	Minimum	2.7	17.7	37.9	2.0
	Mean	7.5	27.9	41.7	2.4
	Maximum	12.4	41.6	46.8	2.8
	Stdv.	3.3	12.3	3.5	0.4
	Median	7.6	24.5	40.6	2.5
	COV	43.3	44.1	8.3	15.9
NH ₃ -N mg/L	Minimum	0.22	0.27	0.04	0.04
	Mean	0.26	0.29	0.09	0.08
	Maximum	0.31	0.32	0.15	0.13
	Stdv.	0.03	0.03	0.04	0.05
	Median	0.27	0.27	0.08	0.08
	COV	12.40	10.07	42.34	54.11
TOC mg/L	Minimum	1.0	1.0	1.0	1.0
	Mean	1.0	1.1	1.0	2.3
	Maximum	1.0	1.2	1.0	3.4
	Stdv.	0.0	0.1	0.0	1.2
	Median	1.0	1.0	1.0	2.5
	COV	0.0	10.8	0.0	52.7

TABLE 4 (Continued): SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-75 THROUGH QM-78

Parameter ¹		Well Number			
		QM-75	QM-76	QM-77	QM-78
TDS mg/L	Minimum	208	286	290	164
	Mean	255	385	339	225
	Maximum	428	564	540	328
	Stdv.	85	156	99	90
	Median	224	304	299	182
	COV	33	40	29	40
Hard. mg/L as CO ₃	Minimum	59	23	8	38
	Mean	63	32	11	42
	Maximum	67	43	14	46
	Stdv.	3	10	2	4
	Median	63	31	11	42
	COV	5	31	19	10
Cond. µmhos/cm	Minimum	238	304	131	187
	Mean	270	317	316	200
	Maximum	307	331	401	211
	Stdv.	25	13	97	12
	Median	270	316	352	204
	COV	9	4	31	6
pH unit	Minimum	7.4	7.3	7.7	7.8
	Mean	7.9	8.1	8.6	8.0
	Maximum	8.4	9.0	9.1	8.2
	Stdv.	0.4	0.8	0.5	0.2
	Median	8.0	8.0	8.7	7.9
	COV	4.5	10.4	5.9	2.4

¹For purpose of statistical evaluation, any value less than the appropriate limit of quantification (LOQ) was set equal to the value of the LOQ.

TABLE 5: SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-79 THROUGH QM-81

Parameter ¹		Well Number		
		QM-79	QM-80	QM-81
Cl mg/L	Minimum	15	10	15
	Mean	17	14	18
	Maximum	19	15	19
	Stdv.	2	2	2
	Median	17	15	19
	COV	10	14	13
	FC cfu/100 mL	Minimum	1	1
Geo. Mean		1	1	1
Maximum		1	1	1
Median		1	1	1
SO ₄ mg/L	Minimum	13.5	2.0	10.4
	Mean	16.2	2.7	11.4
	Maximum	18.8	4.1	13.4
	Stdv.	2.4	0.9	1.7
	Median	16.3	2.3	10.5
	COV	14.9	33.9	15.1
NH ₃ -N mg/L	Minimum	0.03	0.02	0.05
	Mean	0.05	0.04	0.05
	Maximum	0.07	0.06	0.06
	Stdv.	0.02	0.01	0.01
	Median	0.06	0.05	0.05
	COV	32.53	35.33	10.83
TOC mg/L	Minimum	1.0	1.0	1.0
	Mean	1.0	1.0	1.2
	Maximum	1.0	1.0	1.5
	Stdv.	0.0	0.0	0.3
	Median	1.0	1.0	1.0
	COV	0.0	0.0	24.7

TABLE 5 (Continued): SUMMARY STATISTICS OF THE 2010 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM-79 THROUGH QM-81

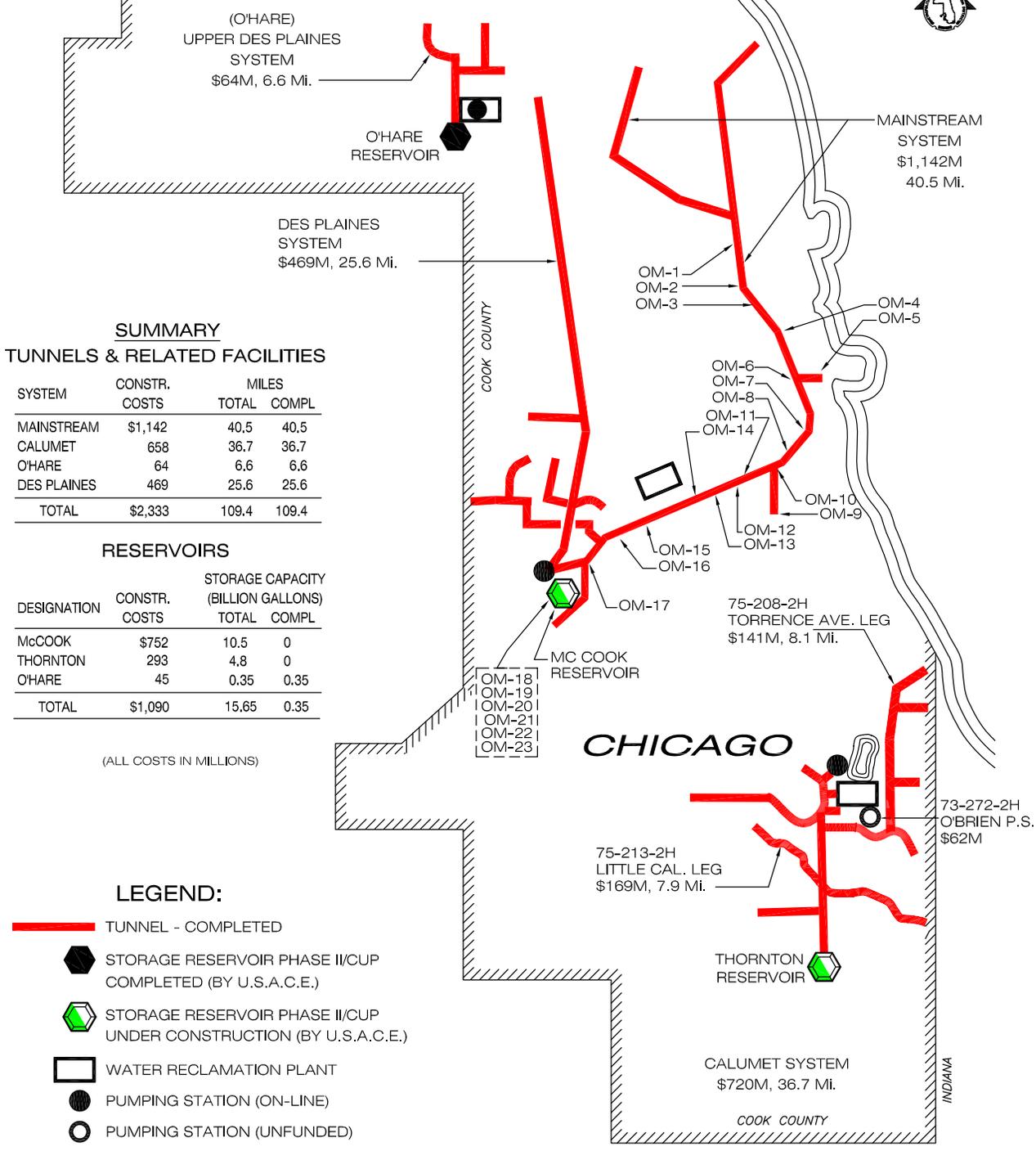
Parameter ¹		Well Number		
		QM-79	QM-80	QM-81
TDS mg/L	Minimum	294	186	222
	Mean	397	242	325
	Maximum	582	438	462
	Stdv.	131	99	124
	Median	355	196	290
	COV	33	41	38
	Hard. mg/L as CO ₃	Minimum	9	18
Mean		37	24	31
Maximum		114	44	32
Stdv.		51	10	1
Median		13	21	31
COV		139	41	2
Cond. µmhos/cm		Minimum	334	196
	Mean	368	249	314
	Maximum	393	323	387
	Stdv.	28	43	65
	Median	372	249	295
	COV	8	17	21
	pH unit	Minimum	8.0	7.5
Mean		8.7	8.2	8.2
Maximum		9.1	8.9	8.8
Stdv.		0.5	0.5	0.5
Median		8.9	8.2	8.0
COV		5.4	6.1	5.7

¹For purpose of statistical evaluation, any value less than the appropriate limit of quantification (LOQ) was set equal to the value of the LOQ.

APPENDIX AI

LOCATION MAP OF GROUNDWATER OBSERVATION WELLS
OM-1 THROUGH OM-23 IN THE MAINSTREAM TUNNEL SYSTEM

FIGURE AI-1



SUMMARY

TUNNELS & RELATED FACILITIES

SYSTEM	CONSTR. COSTS	MILES	
		TOTAL	COMPL.
MAINSTREAM	\$1,142	40.5	40.5
CALUMET	658	36.7	36.7
OHARE	64	6.6	6.6
DES PLAINES	469	25.6	25.6
TOTAL	\$2,333	109.4	109.4

RESERVOIRS

DESIGNATION	CONSTR. COSTS	STORAGE CAPACITY (BILLION GALLONS)	
		TOTAL	COMPL.
McCOOK	\$752	10.5	0
THORNTON	293	4.8	0
OHARE	45	0.35	0.35
TOTAL	\$1,090	15.65	0.35

(ALL COSTS IN MILLIONS)

LEGEND:

- TUNNEL - COMPLETED
- STORAGE RESERVOIR PHASE II/CUP COMPLETED (BY U.S.A.C.E.)
- STORAGE RESERVOIR PHASE II/CUP UNDER CONSTRUCTION (BY U.S.A.C.E.)
- WATER RECLAMATION PLANT
- PUMPING STATION (ON-LINE)
- PUMPING STATION (UNFUNDED)

**MAINSTREAM TUNNEL SYSTEM
LOCATION MAP OF
GROUNDWATER OBSERVATION WELLS**

METROPOLITAN WATER RECLAMATION
DISTRICT OF GREATER CHICAGO

APPENDIX AII

2010 GROUNDWATER LEVEL ELEVATION DATA FOR OBSERVATION WELLS
OM-1 THROUGH OM-23 IN THE MAINSTREAM TUNNEL SYSTEM

TABLE AII-1: 2010 GROUNDWATER LEVEL ELEVATION* DATA FOR OBSERVATION WELLS OM-1 THROUGH OM-23
IN THE MAINSTREAM TUNNEL SYSTEM

Date	Observation Well											
	OM-1	OM-2	OM-3	OM-4	OM-5	OM-6	OM-7	OM-8	OM-9	OM-10	OM-11	OM-12
1/15/10	-53.8	-51.7	-52.7	-99.6	-92.5	-41.4	-90.6	-69.2	-45.8	-32.0	-51.4	-6.7
3/19/10	-55.8	-45.7	-54.7	-97.6	-84.5	-47.4	-79.6	-62.2	-42.8	-31.0	-45.4	-9.7
5/14/10	-53.8	-50.7	-57.7	-98.6	-90.5	-44.4	-92.6	-68.2	-47.8	-31.0	-51.4	-10.7
7/23/10	**	-46.7	-55.7	-96.6	-83.5	-48.4	-78.6	-61.2	-42.8	-31.0	-46.4	-8.7
9/17/10	**	-48.7	-53.7	-90.6	-90.5	-55.4	-93.6	-59.2	-43.8	-31.0	-45.4	-9.7
11/19/10	**	-45.7	-53.7	-95.6	-82.5	-44.4	-77.6	-36.2	-42.8	-31.0	-57.4	-8.7
Minimum	-55.8	-51.7	-57.7	-99.6	-92.5	-55.4	-93.6	-69.2	-47.8	-32.0	-57.4	-10.7
Mean	-54.5	-48.2	-54.7	-96.4	-87.3	-46.9	-85.4	-59.4	-44.3	-31.2	-49.6	-9.0
Maximum	-53.8	-45.7	-52.7	-90.6	-82.5	-41.4	-77.6	-36.2	-42.8	-31.0	-45.4	-6.7

I-IV

TABLE AII-1 (Continued): 2010 GROUNDWATER LEVEL ELEVATION* DATA FOR OBSERVATION WELLS OM-1 THROUGH OM-23 IN THE MAINSTREAM TUNNEL SYSTEM

Date	Observation Well										
	OM-13	OM-14	OM-15	OM-16	OM-17	OM-18	OM-19	OM-20	OM-21	OM-22	OM-23
1/15/10	41.4	-60.8	-182.3	-136.7	***	-230.0	****	-102.9	-65.9	-75.3	-226.7
3/19/10	41.4	-67.8	-182.3	-134.7	***	-131.0	****	-116.9	-79.9	-75.3	-235.7
5/14/10	41.4	-39.8	-123.3	-123.7	***	-219.0	****	-85.9	-60.9	-71.3	-181.7
7/23/10	41.4	-57.8	-182.3	-130.7	***	-219.0	****	-101.9	-94.9	-69.3	-210.7
9/17/10	41.4	-59.8	-168.3	-131.7	***	-221.0	****	-87.9	-66.9	-69.3	-210.7
11/19/10	41.4	-58.8	-172.3	-131.7	***	-224.0	****	-76.9	-68.9	-72.3	-213.7
Minimum	41.4	-67.8	-182.3	-136.7	---	-230.0	---	-116.9	-94.9	-75.3	-235.7
Mean	41.4	-57.5	-168.5	-131.5	---	-207.3	---	-95.4	-72.9	-72.1	-213.2
Maximum	41.4	-39.8	-123.3	-123.7	---	-131.0	---	-76.9	-60.9	-69.3	-181.7

*Elevation in feet relative to Chicago City Datum.

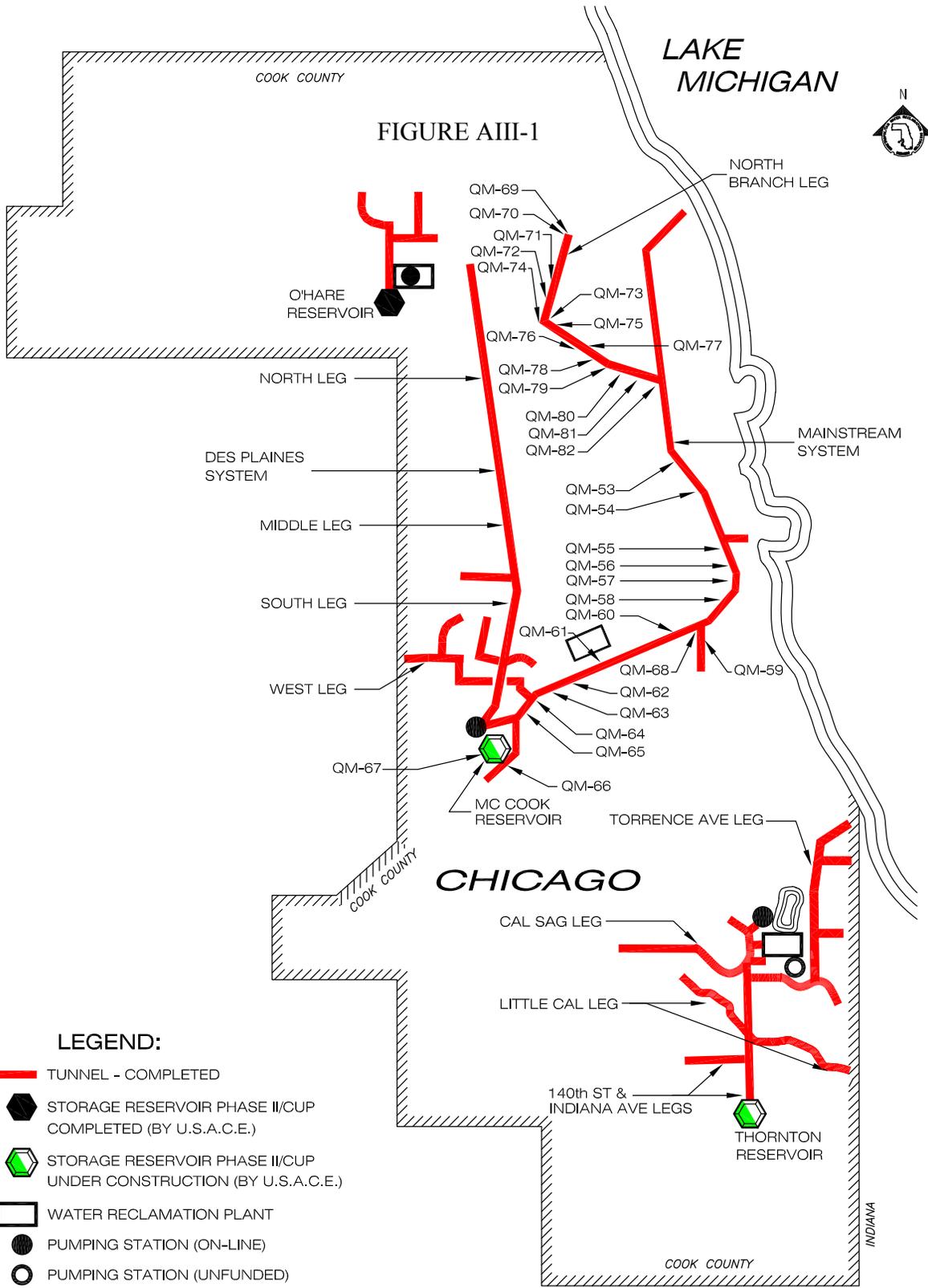
**Lock blocking access to well.

***Broken well head elevation cannot be measured.

****Unable to access well due to native prairie preservation.

APPENDIX AIII

LOCATION MAP OF GROUNDWATER QUALITY MONITORING WELLS
QM-53 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM



**MAINSTREAM TUNNEL SYSTEM
LOCATION MAP OF GROUNDWATER
QUALITY MONITORING WELLS**

METROPOLITAN WATER RECLAMATION
DISTRICT OF GREATER CHICAGO

APPENDIX AIV

2010 GROUNDWATER QUALITY MONITORING DATA FOR WELLS
QM-53 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

TABLE AIV-1: 2010 CHLORIDE, FECAL COLIFORM, SULFATE, AMMONIA NITROGEN, TOTAL ORGANIC CARBON, AND TOTAL DISSOLVED SOLIDS DATA FOR WATER QUALITY MONITORING WELLS QM-53 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Cl ¹ mg/L	FC ^{1,2} cfu/100 mL	SO ₄ ¹ mg/L	NH ₃ -N ¹ mg/L	TOC ¹ mg/L	TDS mg/L
QM-53	5/13/10	<15	<1	35.2	0.08	<1.0	234
QM-53	10/28/10	<15	<1	33.9	0.07	<1.0	162
QM-53	12/9/10	15	<1	36.5	0.06	<1.0	186
QM-56	5/13/10			Well could not be sampled			
QM-56	10/28/10			Well could not be sampled			
QM-56	12/9/10			Well could not be sampled			
QM-58	5/13/10			Well could not be sampled			
QM-58	10/28/10			Well could not be sampled			
QM-58	12/9/10			Well could not be sampled			
QM-61	3/29/10	151	<1	8.1	1.10	1.3	502
QM-61	8/5/10	59	>20,000	35.7	1.06	2.8	318
QM-61	9/9/10	45	440	21.8	0.37	1.3	282
QM-62	1/14/10	45	2	36.0	0.49	1.4	360
QM-62	5/13/10			Well could not be sampled			
QM-62	7/22/10			Well could not be sampled			
QM-62	8/19/10			Well could not be sampled			
QM-62	10/14/10			Well could not be sampled			
QM-62	12/9/10			Well could not be sampled			
QM-63	1/14/10	49	<1	857.4	1.98	2.3	1,604
QM-63	3/18/10	44	<1	846.1	1.91	2.2	1,518
QM-63	5/13/10	47	<1	870.6	1.96	2.5	1,682
QM-63	7/22/10	46	59	785.3	1.74	2.2	1,678
QM-63	10/14/10	44	<1	794.8	1.73	2.4	1,448
QM-63	11/17/10	52	<1	871.2	10.47	2.1	1,654
QM-64	3/29/10	59	<1	37.8	1.86	1.4	448
QM-64	8/5/10	46	3,900	46.9	1.63	1.7	428
QM-64	9/9/10	57	15	33.3	1.88	1.6	408
QM-64	10/26/10	132	1	36.9	1.88	1.4	682

TABLE AIV-1 (Continued): 2010 CHLORIDE, FECAL COLIFORM, SULFATE, AMMONIA NITROGEN, TOTAL ORGANIC CARBON, AND TOTAL DISSOLVED SOLIDS DATA FOR WATER QUALITY MONITORING WELLS QM-53 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Cl ¹ mg/L	FC ^{1,2} cfu/100 mL	SO ₄ ¹ mg/L	NH ₃ -N ¹ mg/L	TOC ¹ mg/L	TDS mg/L
QM-64	11/9/10	50	2	44.3	1.85	1.4	434
QM-64	12/8/10		Well could not be sampled				
QM-65	1/14/10	485	<1	158.1	12.41	7.6	1,586
QM-65	3/18/10	390	<1	160.6	12.36	7.3	1,552
QM-65	5/13/10	316	<1	161.2	10.46	7.0	1,292
QM-65	7/22/10	380	<1	165.1	10.52	6.4	1,356
QM-65	10/14/10	446	<1	170.4	10.53	6.7	1,470
QM-65	11/17/10		Well could not be sampled				
QM-66	3/18/10	197	<1	132.8	2.04	2.8	1,806
QM-66	5/20/10		Well could not be sampled				
QM-66	8/19/10		Well could not be sampled				
QM-67	1/14/10	185	260	12.8	8.91	3.4	680
QM-67	3/18/10	243	710	13.1	9.95	3.5	848
QM-67	5/20/10	267	200	4.6	10.43	3.5	850
QM-67	7/22/10	226	300	3.5	10.22	3.9	752
QM-67	10/14/10	195	2	2.1	10.29	3.2	700
QM-67	11/17/10	163	1,200	16.9	10.52	4.3	624
QM-68	3/18/10	29	<1	33.3	0.31	<1.0	264
QM-68	5/13/10	28	<1	32.1	0.52	1.1	330
QM-68	8/19/10	27	8	34.3	0.60	<1.0	340
QM-69	3/3/10	35	<1	37.7	0.94	1.3	322
QM-69	7/22/10	33	<1	45.4	0.97	1.2	312
QM-69	10/28/10	35	<1	40.1	0.88	1.4	332
QM-70	3/3/10	50	<1	51.3	0.39	1.0	322
QM-70	7/22/10	44	<1	53.3	0.41	<1.0	348
QM-70	10/28/10	48	<1	50.2	0.35	<1.0	332

TABLE AIV-1 (Continued): 2010 CHLORIDE, FECAL COLIFORM, SULFATE, AMMONIA NITROGEN, TOTAL ORGANIC CARBON, AND TOTAL DISSOLVED SOLIDS DATA FOR WATER QUALITY MONITORING WELLS QM-53 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Cl ¹ mg/L	FC ^{1,2} cfu/100 mL	SO ₄ ¹ mg/L	NH ₃ -N ¹ mg/L	TOC ¹ mg/L	TDS mg/L
QM-71	3/3/10	124	<2	33.5	0.43	1.0	434
QM-71	7/22/10	122	<1	64.2	0.47	<1.0	538
QM-71	10/28/10	129	<1	64.6	0.41	<1.0	388
QM-72	3/3/10	127	<1	3.3	0.34	<1.0	388
QM-72	7/22/10	124	<1	<2.0	0.37	<1.0	448
QM-72	10/28/10	134	<1	<2.0	0.32	1.0	352
QM-73	3/25/10	34	<1	2.3	0.28	1.2	278
QM-73	7/29/10	33	<1	2.1	0.31	1.0	440
QM-73	11/18/10	37	<1	<2.0	0.30	1.3	274
QM-74	3/25/10	50	<1	<2.0	0.25	1.5	240
QM-74	7/29/10	50	2	<2.0	0.19	1.4	418
QM-74	11/18/10	52	<1	<2.0	0.23	1.4	256
QM-75	1/21/10	<10	<1	5.6	0.27	<1.0	218
QM-75	3/25/10	<15	<1	7.2	0.26	<1.0	214
QM-75	7/29/10	16	2,600	2.7	0.31	<1.0	428
QM-75	10/28/10	16	<1	9.3	0.22	1.0	208
QM-75	11/18/10	<15	<1	8.0	0.27	<1.0	230
QM-75	12/9/10	<15	<1	12.4	0.23	<1.0	234
QM-76	5/20/10	<15	1	17.7	0.32	1.2	304
QM-76	7/29/10	<15	<1	41.6	0.27	<1.0	564
QM-76	12/9/10	<15	<1	24.5	0.27	<1.0	286
QM-77	3/25/10	<15	<1	<2.0	0.08	2.5	164
QM-77	5/20/10	<15	70	2.8	0.04	1.0	182
QM-77	7/29/10	<15	6,400	2.5	0.13	3.4	328
QM-78	1/21/10	22	<1	37.9	0.08	<1.0	302
QM-78	3/25/10	<15	<1	39.3	0.15	<1.0	294
QM-78	5/20/10	<15	<1	39.8	0.04	<1.0	310
QM-78	7/29/10	<15	<1	46.8	0.07	<1.0	540

TABLE AIV-1 (Continued): 2010 CHLORIDE, FECAL COLIFORM, SULFATE, AMMONIA NITROGEN, TOTAL ORGANIC CARBON, AND TOTAL DISSOLVED SOLIDS DATA FOR WATER QUALITY MONITORING WELLS QM-53 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Cl ¹ mg/L	FC ^{1,2} cfu/100 mL	SO ₄ ¹ mg/L	NH ₃ -N ¹ mg/L	TOC ¹ mg/L	TDS mg/L
QM-78	11/18/10	<15	<1	41.4	0.10	<1.0	296
QM-78	12/9/10	<15	<1	44.8	0.08	<1.0	290
QM-79	1/21/10	17	<1	17.6	0.03	<1.0	318
QM-79	3/25/10	<15	<1	13.5	0.05	<1.0	294
QM-79	5/27/10	19	<1	18.8	0.06	<1.0	392
QM-79	7/29/10	17	<1	15.0	0.07	<1.0	582
QM-79	11/18/10		Well could not be sampled				
QM-79	12/9/10		Well could not be sampled				
QM-80	1/21/10	<10	<1	2.5	<0.02	<1.0	196
QM-80	3/25/10	<15	<1	<2.0	0.04	<1.0	186
QM-80	5/27/10	<15	<1	2.1	0.03	<1.0	246
QM-80	7/29/10	<15	<1	3.5	0.05	<1.0	438
QM-80	11/18/10	15	<1	4.1	0.06	<1.0	196
QM-80	12/9/10	<15	<1	<2.0	0.05	<1.0	188
QM-81	3/25/10	<15	<1	10.5	0.05	<1.0	222
QM-81	5/27/10	19	<1	10.4	0.06	<1.0	290
QM-81	7/27/10	19	<1	13.4	0.05	1.5	462
QM-82	1/21/10		Well could not be sampled				
QM-82	3/25/10		Well could not be sampled				
QM-82	5/27/10		Well could not be sampled				
QM-82	7/27/10		Well could not be sampled				
QM-82	11/18/10		Well could not be sampled				
QM-82	12/9/10		Well could not be sampled				

¹The limit of quantification was 10 mg/L for Cl until January 31, 2010, then 15 mg/L from February 1, 2010, through December 31, 2010; 2.0 mg/L for SO₄; 0.02 mg/L for NH₃-N; 1.0 mg/L for TOC; and 40 mg/L for TDS. The detection limit for the FC analysis using the membrane filter method varies with actual sampling volume analyzed.

²Unfiltered samples, all others were filtered through 0.45 µm membrane.

TABLE AIV-2: 2010 HARDNESS, CONDUCTIVITY, pH, TEMPERATURE, ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM-51 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Hard. mg/L	Cond.1 μ hos/cm	pH ¹ Unit	Temp. °C	Elevation ² Feet	Recharge ³ Hours
QM-53	5/13/10	142	211	7.7	11.0	-39	<4
QM-53	10/28/10	140	199	7.5	11.3	-40	<4
QM-53	12/9/10	131	185	7.8	8.8	-41	<4
QM-56	5/13/10			Well could not be sampled			
QM-56	10/28/10			Well could not be sampled			
QM-56	12/9/10			Well could not be sampled			
QM-58	5/13/10			Well could not be sampled			
QM-58	10/28/10			Well could not be sampled			
QM-58	12/9/10			Well could not be sampled			
QM-61	3/29/10	151	438	7.5	12.2	-180	<4
QM-61	8/5/10	139	345	6.9	15.3	-111	<4
QM-61	9/9/10	116	401	7.6	13.5	-166	<4
QM-62	1/14/10	163	396	7.7	13.2	-199	<4
QM-62	5/13/10			Well could not be sampled			
QM-62	7/22/10			Well could not be sampled			
QM-62	8/19/10			Well could not be sampled			
QM-62	10/14/10			Well could not be sampled			
QM-62	12/9/10			Well could not be sampled			
QM-63	1/14/10	886	740	8.1	13.0	-187	<4
QM-63	3/18/10	928	1,720	7.5	13.0	-185	<4
QM-63	5/13/10	896	1,901	7.6	13.9	-211	<4
QM-63	7/22/10	716	741	7.5	16.0	-210	<4
QM-63	10/14/10	863	851	7.6	14.2	-214	<4
QM-63	11/17/10	878	1,090	6.9	12.1	-178	<4
QM-64	3/29/10	217	405	7.6	12.6	-168	<4
QM-64	8/5/10	187	466	7.7	16.5	-107	<4
QM-64	9/9/10	197	430	7.7	14.5	-176	<4
QM-64	10/26/10	199	402	8.2	14.5	-174	<4
QM-64	11/9/10	214	637	7.6	14.5	-171	<4
QM-64	12/8/10			Well could not be sampled			

TABLE AIV-2 (Continued): 2010 HARDNESS, CONDUCTIVITY, pH, TEMPERATURE, ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM-51 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Hard. mg/L	Cond.1 μ hos/cm	pH ¹ Unit	Temp. °C	Elevation ² Feet	Recharge ³ Hours
QM-65	1/14/10	600	1,230	7.0	13.0	-197	<48
QM-65	3/18/10	594	1,910	7.1	12.9	-191	<48
QM-65	5/13/10	474	2,001	7.7	13.5	-198	<48
QM-65	7/22/10	426	1,115	7.3	15.5	-202	<48
QM-65	10/14/10	555	1,621	7.2	13.7	-206	<48
QM-65	11/17/10			Well could not be sampled			
QM-66	3/18/10	9	3,035	11.8	13.4	-311	<48
QM-66	5/20/10			Well could not be sampled			
QM-66	8/19/10			Well could not be sampled			
QM-67	1/14/10	245	685	7.6	11.6	-160	<48
QM-67	3/18/10	302	1,460	7.5	13.5	-159	<48
QM-67	5/20/10	297	910	7.1	14.7	-149	<48
QM-67	7/22/10	224	906	7.5	15.7	-160	<48
QM-67	10/14/10	245	1,110	7.5	13.9	-163	<48
QM-67	11/17/10	242	835	6.9	12.9	-155	<48
QM-68	3/18/10	199	412	7.7	13.1	-135	<48
QM-68	5/13/10	192	501	6.7	13.0	-136	<48
QM-68	8/19/10	187	332	7.0	14.3	-127	<48
QM-69	3/3/10	145	271	8.1	10.0	-34	<48
QM-69	7/22/10	134	339	8.1	12.3	-34	<49
QM-69	10/28/10	155	311	7.7	10.9	-38	<48
QM-70	3/3/10	152	280	7.8	11.1	-65	<48
QM-70	7/22/10	127	363	8.0	12.1	-66	<49
QM-70	10/28/10	151	337	8.1	11.6	-61	<48
QM-71	3/3/10	183	370	6.8	10.7	-60	<48
QM-71	7/22/10	160	472	8.0	12.3	-63	<49
QM-71	10/28/10	201	456	8.1	11.6	-62	<48

TABLE AIV-2 (Continued): 2010 HARDNESS, CONDUCTIVITY, pH, TEMPERATURE, ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM-51 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Hard. mg/L	Cond.1 μ hos/cm	pH ¹ Unit	Temp. °C	Elevation ² Feet	Recharge ³ Hours
QM-72	3/3/10	216	331	7.3	10.5	-77	<48
QM-72	7/22/10	181	386	6.9	12.9	-81	<49
QM-72	10/28/10	217	397	7.9	12.8	-79	<48
QM-73	3/25/10	166	356	7.8	10.7	-165	<48
QM-73	7/29/10	132	349	7.7	14.2	-145	<48
QM-73	11/18/10	142	287	7.8	11.3	-167	<48
QM-74	3/25/10	105	310	8.3	10.8	-16	<48
QM-74	7/29/10	82	280	7.9	12.1	-26	<48
QM-74	11/18/10	98	292	8.0	11.2	-25	<48
QM-75	1/21/10	62	283	7.7	10.8	-70	<48
QM-75	3/25/10	67	263	8.4	10.4	-69	<48
QM-75	7/29/10	59	249	7.9	12.7	-62	<48
QM-75	10/28/10	65	278	8.0	12.1	-72	<48
QM-75	11/18/10	59	238	8.2	11.7	-72	<48
QM-75	12/9/10	64	307	7.4	10.4	-68	<48
QM-76	5/20/10	23	304	9.0	12.6	-181	<48
QM-76	7/29/10	43	331	8.0	13.9	-177	<48
QM-76	12/9/10	31	316	7.3	11.1	-184	<48
QM-77	3/25/10	46	211	8.2	12.7	-182	<48
QM-77	5/20/10	42	187	7.8	12.6	-181	<48
QM-77	7/29/10	38	204	7.9	15.1	-179	<48
QM-78	1/21/10	10	345	8.4	10.5	-155	<48
QM-78	3/25/10	11	366	9.1	11.1	-157	<48
QM-78	5/20/10	8	131	9.0	12.0	-154	<48
QM-78	7/29/10	14	360	8.6	14.0	-151	<48
QM-78	11/18/10	12	295	8.9	11.0	-160	<48
QM-78	12/9/10	10	401	7.7	10.7	-161	<48
QM-79	1/21/10	13	388	8.9	10.6	-148	<48
QM-79	3/25/10	12	355	8.9	10.7	-151	<48
QM-79	5/27/10	114	334	8.0	12.9	-148	<48

TABLE AIV-2 (Continued): 2010 HARDNESS, CONDUCTIVITY, pH, TEMPERATURE, ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM-51 THROUGH QM-82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	Hard. mg/L	Cond.1 μ hos/cm	pH ¹ Unit	Temp. °C	Elevation ² Feet	Recharge ³ Hours
QM-79	7/29/10	9	393	9.1	13.0	-133	<48
QM-79	11/18/10			Well could not be sampled			
QM-79	12/9/10			Well could not be sampled			
QM-80	1/21/10	21	255	8.9	11.0	-132	<48
QM-80	3/25/10	22	243	8.3	12.7	-133	<48
QM-80	5/27/10	19	223	7.9	12.9	-137	<48
QM-80	7/29/10	18	256	8.6	13.0	-136	<48
QM-80	11/18/10	44	196	8.1	11.6	-142	<48
QM-80	12/9/10	21	323	7.5	10.9	-135	<48
QM-81	3/25/10	32	295	8.0	12.0	-133	<48
QM-81	5/27/10	31	260	7.9	13.2	-136	<48
QM-81	7/27/10	31	387	8.8	13.2	-131	<48
QM-82	1/21/10			Well could not be sampled			
QM-82	3/25/10			Well could not be sampled			
QM-82	5/27/10			Well could not be sampled			
QM-82	7/27/10			Well could not be sampled			
QM-82	11/18/10			Well could not be sampled			
QM-82	12/9/10			Well could not be sampled			

¹Unfiltered samples, all others were filtered through 0.45 μ m membrane.

²Water level elevations are relative to Chicago City Datum.

³Refers to elapsed time after initial drawdown before the well recovered sufficiently for sampling.