

Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

***MONITORING AND RESEARCH
DEPARTMENT***

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MONITORING OF GROUNDWATER QUALITY UNDER TUNNEL FILLS

OVER THE YEARS FROM 2017–2019

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LIST OF ACRONYMS

Acronym	Meaning
BG	billion gallons
CCD	Chicago City Datum
CFU	colony forming unit
Cl ⁻	Chloride
CS	combined sewage
CSF	combined sewer flow
District	Metropolitan Water Reclamation District of Greater Chicago
EC	electrical conductivity
Elev.	water elevations
FC	fecal coliform
ft	feet
IEPA	Illinois Environmental Protection Agency
IQR	interquartile range
L	liter
M	meter
Majewski	Gloria Alitto Majewski
mg	milligrams
mL	milliliters
mS	millisiemens
NH ₃ -N	ammonia nitrogen
p	probability
r	correlation coefficient
SO ₄ ²⁻	sulfate
TARP	Tunnel and Reservoir Plan
TCR	Thornton Composite Reservoir
TDS	total dissolved solids
TOC	total organic carbon
UDP	Upper Des Plaines
USGS	United States Geological Survey
WRPs	water reclamation plants

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SUMMARY

In 2017, the groundwater monitoring program for wells associated with the Metropolitan Water Reclamation District of Greater Chicago's (District's) Tunnel and Reservoir Plan (TARP), Cook County, Illinois, was modified based on consultation and approval of the Illinois Environmental Protection Agency (IEPA). The modified monitoring program included a tunnel fill event-based sampling program for 25 (Tier 2) of the 106 TARP wells, defined as priority wells, for a study period of three years, and annual sampling for the remaining functional wells (Tier 1), defined as non-priority wells. In this three-year study with the modified monitoring program, groundwater quality parameters in samples collected from the 25 priority wells were analyzed to evaluate the impact of tunnel filling with combined sewer flow (CSF) on nearby groundwater quality. The criterion used to trigger fill event sampling is that the level of water in the TARP Mainstream tunnel reaches -150 feet (ft) Chicago City Datum (CCD). At each sampling event, groundwater samples were collected weekly for three weeks. The sampling was typically started one to three days after the criterion of a tunnel fill event is met. The samples collected during the first week of sampling were analyzed for all laboratory parameters in the original monitoring program, including total dissolved solids (TDS), hardness, ammonia nitrogen (NH₃-N), total organic carbon (TOC), chloride (Cl⁻), sulfate (SO₄²⁻), and fecal coliform (FC). However, the samples from the second and third weeks were analyzed for FC only. The four field parameters, groundwater elevation, pH, temperature, and electrical conductivity (EC), were measured at all three-weekly samplings. Values of the monitored groundwater quality parameters were compared with the Illinois Class I Groundwater Quality Standards as well as with the corresponding historic means (means of data collected during 1995–2013 monitoring on a fixed schedule) of water quality parameters at each well.

The percentage of samples collected that were within the groundwater quality standards was 99 percent for pH, 90 percent for TDS, 87 percent for Cl⁻, and 95 percent for SO₄²⁻. Thirteen percent of samples exceeded the groundwater quality standards for Cl⁻, and these occurred mainly at four wells. The observed high Cl⁻ concentrations could be associated with localized factors including winter salt application in the Chicago area. Over the three-year period, water quality chemistry parameters exhibited similar spatial and magnitude patterns to the historic values at most priority wells. With the observed minimal impact of TARP operations on groundwater chemistry, analysis of water chemistry at the priority wells once per year would be adequate for future monitoring, but FC were higher compared to the historic values and should be monitored more frequently.

The mean FC populations in this study period were generally higher than the corresponding historic means, suggesting that sampling under tunnel fill conditions could capture impacts of potential tunnel CSF exfiltration on groundwater. Also, there was a notable decrease in the frequency of FC detection in the wells along the Des Plaines and Mainstream tunnels in 2019 and in 2018 (Mainstream tunnel only) as compared to 2017. Such reduction in FC detection might be associated with the operation of McCook Reservoir Stage 1 (commencing in 2018), which provides additional storage for CSF, leading to possibly more diluted CSF stored in the tunnel system after storm events and decreased potential for exfiltration of CSF into the surrounding groundwater.

The data showed two patterns for FC population and detection frequency of the 25 priority wells and their change from week one to three. In the majority of the wells along the Upper Des Plaines (UDP) and Calumet tunnels, and in three wells (QD-29, QD-30, and QD-54) along the Des Plaines tunnel, the FC detection frequency and populations in samples were relatively low and tended to decrease over time following a tunnel fill. For all the wells along the Mainstream tunnel and the six wells along the Des Plaines tunnel, the FC detection frequency and population were relatively high, and there was little change over three weeks following a tunnel fill.

The FC was not detected in the majority of TARP non-priority wells (Tier 1) under annual sampling frequency but was detected once in eight different wells during this three-year period (2017–2019). The FC populations detected were very low, close to the detection limit (1 colony forming unit [CFU]/100 milliliters [mL]). However, FC was detected every year in well QD-57 along the Des Plaines tunnel, with the highest population of 85 CFU/100 mL in 2018. It is suggested this well be moved to the list of priority wells (Tier 2) in the future monitoring program.

Thus, to best capture the impact of tunnel CSF exfiltration on groundwater, it is suggested that in future monitoring the TARP priority wells (26 Tier 2 wells) be divided into four groups. Group I, including four wells along the Des Plaines tunnel (QD-29, QD-30, QD-54, and QD-57), will be sampled during the first week following a tunnel fill event. Group II, consisting of 15 wells, including nine wells in the Mainstream tunnel and the six remaining wells in the Des Plaines tunnel, will be sampled during week two following a fill event. The threshold for fill event sampling for Group I and II wells will still be the -150 ft CCD of water elevation in the Mainstream tunnel, and two events per year will be sampled. Group III includes all three wells along the Calumet tunnel, and sampling will be conducted at two times annually when the Thornton Composite Reservoir (TCR) fills. Group IV includes all four wells along the UDP tunnel, and sampling will be conducted at two fill events when the Gloria Alitto Majewski (Majewski) Reservoir fills. The functional non-priority wells (Tier 1) will continue to be sampled once per year.

INTRODUCTION

The District's TARP is designed as a solution to alleviate pollution of the Chicago area waterways, flooding, and the occasional local contamination of Lake Michigan during periods of heavy rainstorms. The District formally adopted the TARP in 1972 to comply with federal and state water quality standards in the 375-square-mile area that includes the city of Chicago and 51 suburban communities, most of which are serviced through combined sewer systems. The TARP consists of four tunnel segments: the Mainstream, Des Plaines, Calumet, and UDP Systems, which include 109 miles of tunnels ([Figure 1](#)). The tunnels terminate at three reservoirs: the Majewski Reservoir near O'Hare Airport, the TCR, and McCook Reservoir Stage 1. After a storm event, CSF collected in the tunnels and reservoirs is pumped to the District's water reclamation plants (WRPs) for treatment as capacity in the WRPs becomes available.

When the tunnels and reservoirs become filled with CSF due to major storms, the hydraulic pressure can cause exfiltration of CSF from the tunnels and reservoirs into the surrounding groundwater. In order to monitor the impact of the TARP operations on groundwater quality in the area, a network of groundwater monitoring wells (currently a total of 102 functional wells in operation) was installed adjacent to the four TARP tunnel segments over the years ([Figure 1](#)). The wells are sampled and analyzed for water quality parameters as required based on the TARP groundwater monitoring program approved by the IEPA.

In 2017, the TARP groundwater monitoring program was modified based on consultation with and approval of the IEPA (District letters to IEPA, December 23, 2016, and August 16, 2017; IEPA Approval letter, February 14, 2018, [Appendix A](#)). The modified monitoring program includes tunnel fill event-based sampling for 25 Tier 2 wells, which are defined as priority wells in this study, of the 110 functional TARP wells, identified in the August 16, 2017, letter to IEPA for a period of three years ([Table 1](#); [Figure 2](#)). The modified monitoring program is based on the recommendations in the 2015 United States Geological Survey (USGS) report entitled *Hydrogeology and Groundwater Quality at Monitoring Wells Installed for the Tunnel and Reservoir Plan System and Nearby Water-Supply Wells, Cook County, Illinois, 1995–2013*. Based on analysis of historic groundwater data from the TARP groundwater monitoring program, the USGS report recommended changing sampling from a fixed schedule to fill event-based monitoring for 23 wells, which showed a higher frequency (10 percent or greater) of detection of FC from 1995–2013. Two wells (QD-33 and QD-54) were placed on fill event-based monitoring by IEPA. The remaining TARP wells (85), which showed a lower frequency (less than 10 percent) of detection of FC, would be monitored at a frequency of once per year (Tier 1) (District letter to IEPA, August 16, 2017). The number of wells for fill event-based sampling in this study has always been 25. For the Tier 1 group, the number of wells changed from 85 in 2017 to 77 in 2019, as some of the wells in the group became unfunctional, and other wells were added to the group after being repaired. These changes were described in annual reports of the past three years.

This report presents a summary of the monitoring data of the groundwater quality of the 25 priority TARP monitoring wells over the three years from 2017–2019 under the modified monitoring program. It aims to utilize the collected data to examine the link between tunnel fill events and potential exfiltration, evaluate the effect of McCook Reservoir Stage 1 operation on exfiltration of CSF from the tunnels, and formulate future monitoring plans.

FIGURE 1: THE TUNNEL AND RESERVOIR PLAN SYSTEM AND ASSOCIATED MONITORING WELLS

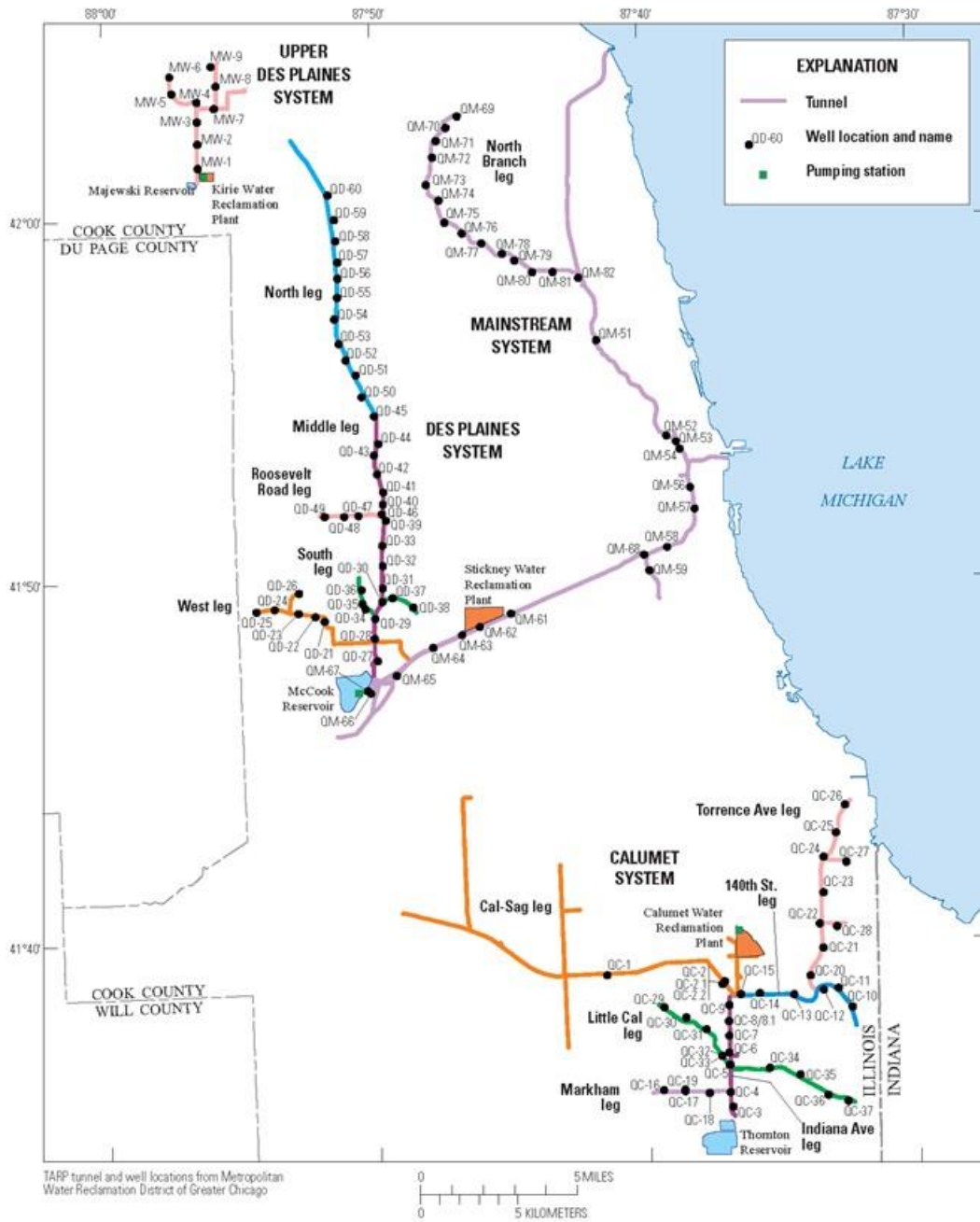
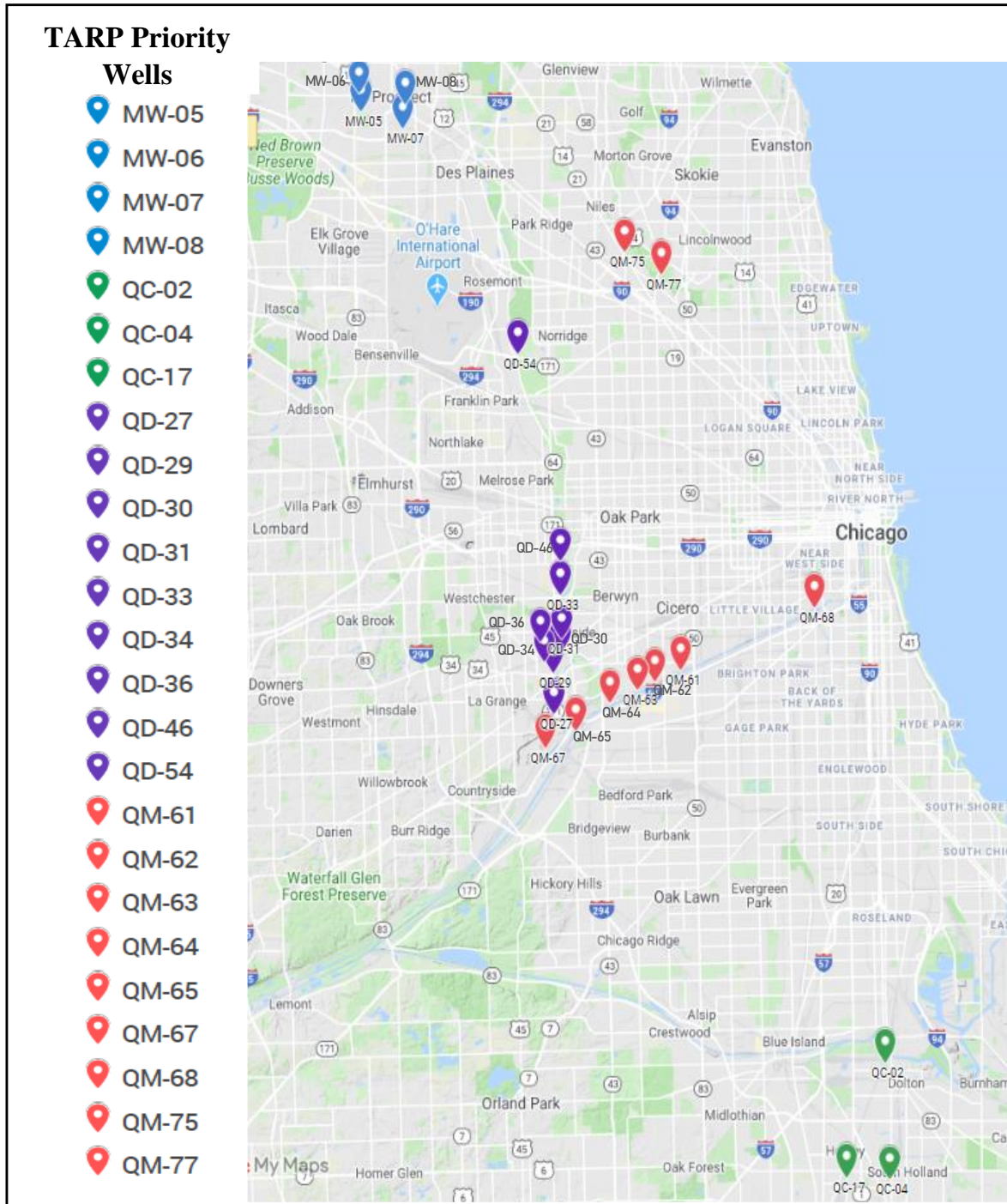


TABLE 1: LIST OF THE 25 TUNNEL AND RESERVOIR PLAN PRIORITY WELLS FOR
FILL EVENT-BASED MONITORING

Well ID	TARP System	Latitude	Longitude	Land Surface Elevation ¹ (ft CCD)
QD-27	Des Plaines	41°47'50.0"	-87°49'55.4"	32.0
QD-29	Des Plaines	41°48'59.2"	-87°49'59.8"	39.0
QD-30	Des Plaines	41°49'27.4"	-87°49'44.3"	33.4
QD-31	Des Plaines	41°49'49.9"	-87°49'42.7"	35.0
QD-33	Des Plaines	41°51'0.5"	-87°49'42.9"	44.0
QD-34	Des Plaines	41°49'15.6"	-87°50'20.5"	40.0
QD-36	Des Plaines	41°49'47.0"	-87°50'29.2"	40.0
QD-46	Des Plaines	41°51'52.1"	-87°49'42.3"	44.0
QD-54	Des Plaines	41°57'15.4"	-87°51'23.6"	46.8
QM-61	Mainstream	41°49'5.3"	-87°44'56.5"	17.2
QM-62	Mainstream	41°48'44.3"	-87°46'6.3"	19.5
QM-63	Mainstream	41°48'31.2"	-87°46'46.6"	10.1
QM-64	Mainstream	41°48'10.3"	-87°47'50.8"	13.8
QM-65	Mainstream	41°47'25.1"	-87°49'13.9"	12.6
QM-67	Mainstream	41°47'0.5"	-87°50'18.6"	24.1
QM-68	Mainstream	41°50'40.1"	-87°39'58.0"	17.1
QM-75	Mainstream	41°59'54.2"	-87°47'14.3"	41.0
QM-77	Mainstream	41°59'18.8"	-87°45'52.3"	31.0
MW-5	Upper Des Plaines	42°3'31.9"	-87°57'22.9"	88.4
MW-6	Upper Des Plaines	42°3'59.6"	-87°57'26.0"	93.6
MW-7	Upper Des Plaines	42°3'6.7"	-87°55'47.3"	73.7
MW-8	Upper Des Plaines	42°3'43.7"	-87°55'42.8"	77.8
QC-2	Calumet	41°38'50.0"	-87°37'14.0"	15.6
QC-4	Calumet	41°35'48.6"	-87°37'2.7"	24.1
QC-17	Calumet	41°35'51.1"	-87°38'42.9"	27.1

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

FIGURE 2: LOCATION OF THE TUNNEL AND RESERVOIR PLAN PRIORITY WELLS FOR THREE-YEAR FILL EVENT-BASED MONITORING



METHODS

Description of the Tunnel and Reservoir Plan System

The TARP systems include near-surface collecting structures, vertical drop shafts, deep tunnels, and combined sewer reservoirs. The TARP project construction began in 1975 and tunnel systems were completed in 2006. It includes a 109-mile network of deep tunnels 9 to 33 ft in diameter, bored into the lower part of the Niagaran dolomite formation of the Silurian shallow aquifer. The tunnels are lined with concrete and located 150 to 350 ft below ground. The total capacity of the tunnel system is 2.3 billion gallons (BG). The Mainstream part of the TARP tunnels, with a length of 40.5 miles and a capacity of 1.2 BG, terminates at the McCook Reservoir. Stage 1 of this reservoir began operating in January 2018, and Stage 2 is anticipated to be completed in 2029. The Des Plaines part of the TARP system, with a length of 25.6 miles and 0.4 BG capacity, also terminates at the McCook Reservoir. The UDP Tunnel System, with a length of 6.6 miles and a capacity of 0.07 BG, terminates at the Majewski Reservoir and was completed in 1998. The Calumet tunnel system, with a length of 36.7 miles and 0.63 BG capacity, terminates at the TCR, which began operating in 2015. The CSF collected in the TARP tunnel and reservoir systems is pumped to the Stickney, James C. Kirie, and Calumet WRPs as the capacity allows.

Revised Monitoring Program

Determinations of Sampling Threshold. The revised monitoring program required the determination of a threshold value of tunnel water elevation to be used as a trigger for fill event-based sampling. The fill event-based monitoring program was designed to sample all 25 wells for a minimum of four events per year; therefore, a tunnel water elevation threshold was selected to provide at least four fill events annually. Using the 2010–2016 TARP Mainstream tunnel water elevation data, the cumulative number of days during each year in which tunnel water elevations were at -50, -150, and -200 ft or higher CCD was calculated. On average, there were 21, 30, and 73 days per year, respectively, for the tunnel water elevations of -50, -150, and -200 ft CCD. On average, each fill event lasted for three to four days; thus, the potential number of fill events per year is 5–7, 7–10, and 18–24, respectively, for the -50, -150, and -200 ft CCD tunnel water elevations. Although the -50 ft CCD tunnel water elevations can give four fill events per year, a threshold of -150 ft CCD was selected to trigger fill event-based sampling to ensure that the requirement of four sampling events per year is accomplished with some operational flexibility (see detail in the August 16, 2017, letter to IEPA in [Appendix A](#)).

Priority Wells. The 25 priority wells ([Table 1](#) and [Figure 2](#)) were selected because these wells, except for two (QD-33 and QD-54), had a frequency of FC detection at 10 percent or more in samples during the monitoring period from 1995–2013. For this study period (January 2017–December 2019), according to the current monitoring program, these priority wells were to be sampled for at least four of TARP tunnel fill events annually based on the water levels in the TARP Mainstream tunnel following storm events (fill event-based). Out of these 25 priority wells, there are nine wells (QM-61, QM-62, QM-63, QM-64, QM-65, QM-67, QM-68, QM-75, and QM-77) located along the length of the Mainstream Tunnel between Morton Grove and Hodgkins, Illinois; nine wells (QD-27, QD-29, QD-30, QD-31, QD-33, QD-34, QD-36, QD-46, and QD-54) along

the Des Plaines Tunnel; four wells (MW-5, MW-6, MW-7, and MW-8) along the UDP Tunnel; and three wells (QC-2, QC-4, and QC-17) along the Calumet Tunnel.

Sampling. The information on levels of water in the tunnels is available through the District's dispatch personnel several times per day. For the 25 priority wells, the criterion that triggers a fill event sampling is that the level of water in the TARP Mainstream tunnel reaches -150 ft Chicago City Datum (CCD). At each sampling event, the collection of samples was started within three days and was carried out weekly for a period of three weeks. Sampling was conducted during a total of 16 fill events in the three-year period (six in 2017, five in 2018, and five in 2019). However, during the three-year study period, some of the wells had less than 16 sampling events due to well pump malfunction or dry well conditions (i.e., wells QC-2, QC-4, QC-17, QD-27, QD-30, QD-31, QD-33, QM-65, and QM-67). In some wells, samples from second or third week were used for the analysis of water chemistry parameters if the first week sampling was missed. For the non-priority TARP wells (Tier 1), samples were collected once per year on a fixed schedule.

Adequate well purging was performed prior to well sampling. For slow-recharging wells, 90 percent of the well volume is purged in the first day, and after 48 hours, 75 percent of the well volume is purged prior to well sampling. For fast-recharging wells, 150 percent of the well volume is purged prior to well sampling. Field measurements of pH, EC, temperature, and groundwater elevation were taken at each sampling. The TARP well samples were collected in one-gallon containers for water chemistry analysis. A separate sample for FC analysis was collected in 125-mL sterile plastic screw-top bottles containing sodium thiosulfate and ethylenediaminetetraacetic acid as a preservative. Samples were kept in an ice container until submitted to the laboratory.

Analysis. The samples collected during the first week of sampling were analyzed for groundwater quality parameters, according to the original monitoring program, including TDS, hardness, $\text{NH}_3\text{-N}$, TOC, Cl^- , SO_4^{2-} , and FC. However, the samples from the second and third weeks were only analyzed for FC. The sampling was halted for wells showing undetectable FC (<1 CFU/100 mL) in the previous week. The groundwater elevation, pH, temperature, and EC were measured in the field at every sampling. Over the three-year study period, a total of 1,047 groundwater samples was collected from the 25 wells, with 453 samples collected during the first week, and 594 samples collected during the second and third weeks of the monitoring events. The water chemistry analyses were conducted by the District's Analytical Laboratories Division, while FC analysis was conducted by the District's Analytical Microbiology Laboratory within six hours of sample collection.

An Extended Monitoring Study in 2019

A prolonged monitoring study (12 weeks) on the interactions among tunnel water elevation and groundwater elevation and fecal coliform in the downstream part of the tunnel system was conducted in four of the Mainstream wells (QM-61, QM-62, QM-63, and QM-67) after the tunnel fill triggered sampling on April 23, 2019, and the tunnel remained filled until the middle of June 2019 by several subsequent rain events. This extended monitor study offered an opportunity to evaluate the exfiltration potential associated with extended time of dewatering operations of combined sewage (CS) after the McCook Reservoir was connected to the Mainstream tunnel. The prolonged study also aimed to assess the role of other attributes controlling water and solute transport between the aquifer and the tunnel.

Tunnel Combined Sewer Flow Elevation Data

The Maintenance & Operations (M&O) Department prepares daily reports to document tunnel CSF elevation data at each of the TARP tunnel systems. The CSF elevation is reported in feet relative to CCD. Reports are dispatched several times daily to Monitoring and Research Department personnel. Average daily tunnel CSF elevation was calculated and used to evaluate the effect of tunnel and reservoir operation on the quality of the groundwater aquifer under the TARP system.

Data Analysis

Basic statistical summaries were performed for all groundwater quality data over three years (2017–2019) by individual well. For each fill event, there were data of three weekly measurements of groundwater elevation, pH, temperature, and EC, which were retrieved from field log sheets, three weekly analyses of FC, and one weekly analysis of all chemistry parameters except for pH and EC. The data summaries were presented in box and whisker plots (Helsel and Hirsch, 2002). The box represents the interquartile range (IQR) of the data distribution (the difference between the 75th and 25th percentiles). The ends of the whisker bars were the maximum or minimum of the observations, respectively. In this report, for any values less than minimum laboratory reporting limits and greater than maximum laboratory reporting limits, the minimum and maximum laboratory reporting limits, respectively, were used in the calculation of descriptive statistics. The FC was considered detected when the population was reported as 1 CFU/100 mL or greater. The frequency of samples detected for FC was calculated as the number of samples with detection of FC divided by the total number of samples scheduled. In this calculation, since wells that showed no detection of FC in week two were not sampled in week three, the FC in week three was considered below detection, which is in agreement with the basis of the modified monitoring plan. Correlation analysis was used to evaluate the relationship between tunnel water elevation and water quality variables. For correlation analyses, the degree of linearity between two variables was derived from the correlation coefficient (r) through Pearson's correlation analyses, and the significance was based on a probability (p)-value of less than 0.05. The mean of each groundwater quality parameter over the study period was compared with the mean of historic data (1995–2013) for wells using a simple t-test.

RESULTS AND DISCUSSION

Summary of Precipitation

Daily precipitation data from the Chicago Midway Airport weather station obtained from SC-ACIS was used in this report to represent the precipitation in the TARP area during the three-year period as the Midway Airport weather station is located in the middle of four TARP tunnels. Daily precipitation from January 1, 2017, through December 31, 2019, is presented in [Figure 3](#). Precipitation in 2018 was slightly lower compared to 2017 and 2019. The cumulative precipitation was 41.80, 39.25, and 41.25 inches for 2017, 2018, and 2019, respectively. The maximum daily precipitation was 5.20, 2.37, and 2.26 inches for 2017, 2018, and 2019, respectively. The number of days with average daily precipitation equal to 1.0 inch or more was ten days for 2017 and 2018 and eight days for 2019. Daily precipitation events that exceeded 1.0 inch represented less than three percent of the three-year precipitation days, and more than 86 percent of the daily precipitation events were less than 0.25 inches. Precipitation amounts and intensity affect the TARP tunnels' water levels and holding times ([Tables 2 and 3](#)).

Tunnel Water Elevation

Average daily tunnel water elevations relative to CCD for the UDP, Des Plaines, Mainstream, and Calumet tunnels are presented in [Figure 4](#) along with the start date of each fill event-based sampling. The monthly average water elevation in each tunnel system and monthly precipitation are summarized in [Table 2](#). The water levels in both the Des Plaines and Mainstream tunnels were highly variable over time compared to the UDP and Calumet tunnels. The daily water levels ranged from 34 to -293 ft CCD for the Des Plaines tunnel, and from 1.2 to -291 ft CCD for the Mainstream tunnel, with average daily means of -211 and -201 ft CCD, respectively. During the three-year period, the tunnel water elevation was higher than -150 ft CCD for a total of about 97 days (9 percent of the time) in the Des Plaines tunnel and for about 234 days (21 percent of the time) in the Mainstream Tunnel ([Table 3](#)). After a fill event, the dewatering duration to reach a tunnel water level of less than -150 ft CCD was shorter for the Des Plaines tunnel compared to the Mainstream tunnel system, mainly in 2018 and 2019 after the McCook Reservoir was in service ([Table 4](#)). The longest period at which the water was above -150 ft CCD was 44 continuous days at the Mainstream tunnel in 2019 (from April 29, 2019–June 12, 2019). This was due to an extremely wet period with approximately 14.5 inches of precipitation during the period of April through June 2019, and the construction of the connection between the McCook Reservoir and the Des Plaines tunnel consistently gave high priority to dewater the Des Plaines tunnel for a period of the time in 2019. The water level in the Calumet tunnel exceeded -150 ft CCD only nine days during the study period from May 28 to June 28, 2019. Tunnel water elevation in the UDP tunnels ranged from -73 to -36 ft CCD with an average of -68.1 ft CCD.

Groundwater Levels in the 25 Priority Wells

The groundwater levels in the TARP wells during 2017–2019 are spatially variable, but some overall patterns can be determined ([Figure 5](#)). Among the 25 priority wells, groundwater levels typically were highest in the UDP wells (above -50 ft CCD) and the lowest in the Calumet

FIGURE 3: DAILY AND CUMULATIVE PRECIPITATION DURING 2017–2019 RECORDED AT THE CHICAGO MIDWAY AIRPORT STATION, ILLINOIS

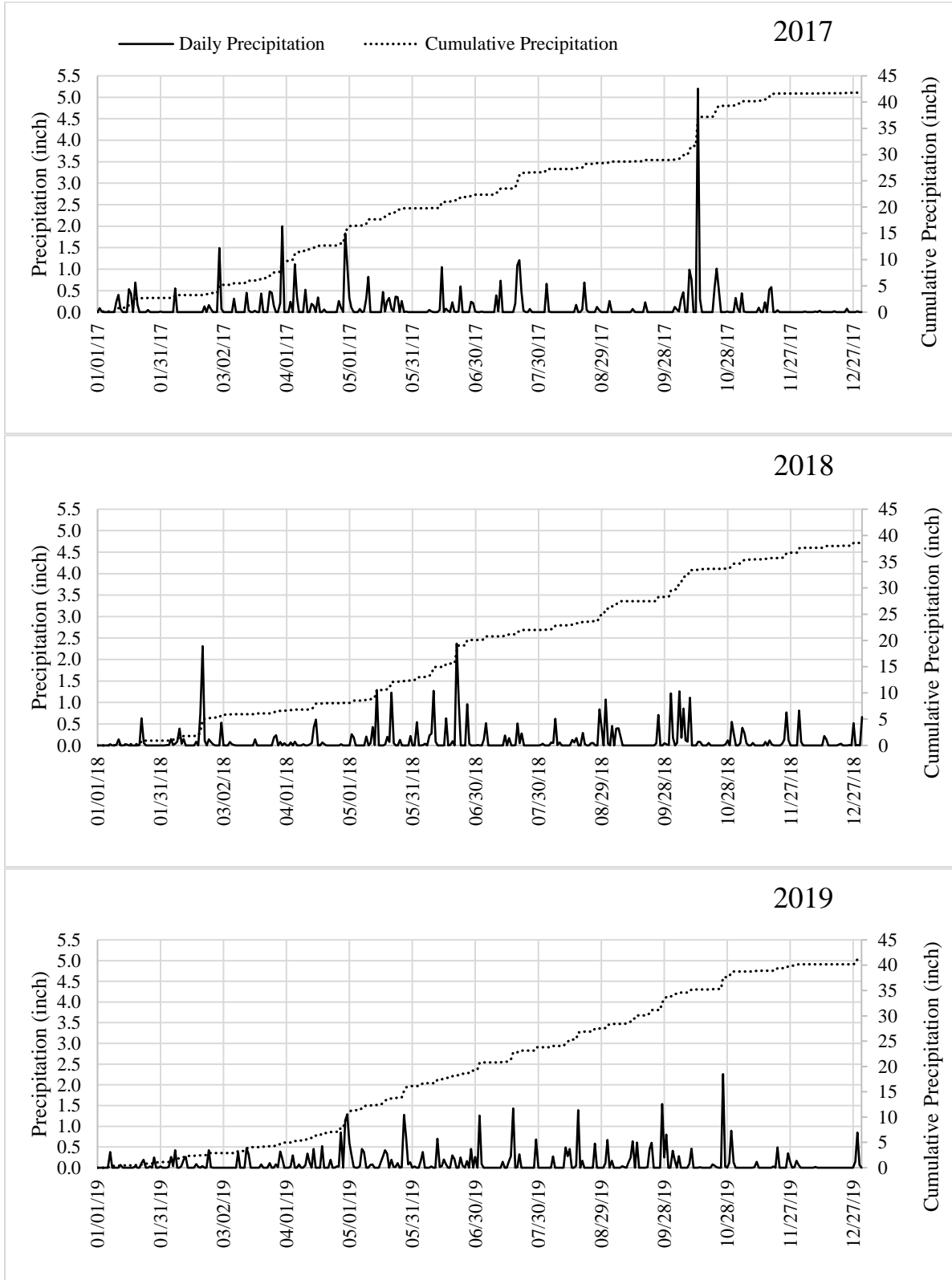


TABLE 2: MONTHLY AVERAGE WATER ELEVATION OF THE DES PLAINES, MAINSTREAM, CALUMET, AND UPPER DES PLAINES TUNNEL SYSTEMS AND MONTHLY PRECIPITATION

Year	Month	Water Elevation (ft) CCD ¹				Monthly Precipitation (inches)
		Des Plaines	Mainstream	Calumet	Upper Des Plaines	
2017	Jan	-180.03	-226.50	-291.42	-70.11	2.71
	Feb	-214.03	-253.32	-295.32	-71.17	2.40
	Mar	-197.94	-212.28	-264.74	-68.89	4.62
	Apr	-178.08	-190.53	-223.80	-62.55	6.27
	May	-174.19	-183.02	-219.81	-64.26	3.77
	Jun	-206.70	-229.01	-284.23	-70.17	2.60
	Jul	-167.47	-183.67	-286.90	-59.36	4.23
	Aug	-229.65	-238.48	-288.42	-71.67	1.80
	Sep	-225.66	-240.97	-287.83	-71.55	0.56
	Oct	-158.99	-165.87	-257.29	-64.97	10.34
	Nov	-214.42	-275.44	-276.57	-71.07	2.33
	Dec	-197.34	-279.35	-286.71	-71.94	0.17
2018	Jan	-231.96	-253.19	-289.45	-71.61	0.91
	Feb	-180.03	-183.56	-267.86	-64.13	4.39
	Mar	-231.32	-193.73	-276.26	-70.12	1.35
	Apr	-199.23	-200.55	-300.00	-69.52	1.43
	May	-154.82	-123.08	-299.71	-61.22	4.39
	Jun	-199.32	-174.37	-278.43	-60.49	7.60
	Jul	-231.29	-240.58	-288.52	-71.94	1.94
	Aug	-237.17	-249.41	-297.26	-68.02	4.00
	Sep	-214.58	-196.65	-295.87	-68.62	2.32
	Oct	-213.90	-155.34	-297.42	-70.20	6.26
	Nov	-235.99	-253.38	-298.67	-70.86	2.15
	Dec	-214.10	-233.90	-301.29	-66.39	2.51
2019	Jan	-262.91	-254.94	-301.87	-71.25	1.10
	Feb	-196.64	-136.34	-288.39	-66.41	1.81
	Mar	-222.45	-142.04	-296.29	-70.01	2.05
	Apr	-206.77	-177.24	-295.07	-69.07	5.43
	May	-161.14	-32.33	-178.87	-56.61	5.72
	Jun	-235.43	-167.10	-180.23	-70.32	3.33
	Jul	-264.87	-209.41	-241.13	-68.55	4.36
	Aug	-251.45	-172.67	-286.35	-71.91	3.79
	Sep	-224.47	-224.12	-287.83	-67.43	6.16
	Oct	-215.50	-123.44	-257.29	-65.88	5.00

TABLE 2 (Continued): MONTHLY AVERAGE WATER ELEVATION OF THE DES PLAINES, MAINSTREAM, CALUMET, AND UPPER DES PLAINES TUNNEL SYSTEMS AND MONTHLY PRECIPITATION

Year	Month	Water Elevation (ft) CCD ¹				Monthly Precipitation (inches)
		Des Plaines	Mainstream	Calumet	Upper Des Plaines	
	Nov	-219.03	-213.58	-268.29	-70.85	1.34
	Dec	-257.47	-261.58	-293.56	-71.32	1.16

¹Chicago City Datum (579.48 ft above sea level) at intersection of Madison and State Streets, in Chicago.

TABLE 3: NUMBER OF DAYS WATER ELEVATION IN THE DES PLAINES AND MAINSTREAM TUNNELS EXCEEDING THE -150 FEET CHICAGO CITY DATUM THRESHOLD DURING 2017, 2018, AND 2019¹

Year	Des Plaines	Mainstream
----- No. of days -----		
2017	39	37
2018	32	78
2019	26	119 ²
Total	97	234

¹Not relevant to the Calumet and Upper Des Plaines Tunnels, as the level of water at the Calumet Tunnel was generally kept at levels lower than -150 ft CCD, and the Upper Des Plaines tunnel is much higher than -150 ft CCD.

²The construction of the connection between the McCook Reservoir and the Des Plaines tunnel requires keeping the Des Plaines tunnel dry for a period of the time in 2019. Thus, the priority of dewatering was given to the Des Plaines tunnel consistently during that time, possibly resulting in more fill days for the Mainstream tunnel in 2019.

FIGURE 4: WATER ELEVATION IN THE UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS DURING 2017, 2018, AND 2019

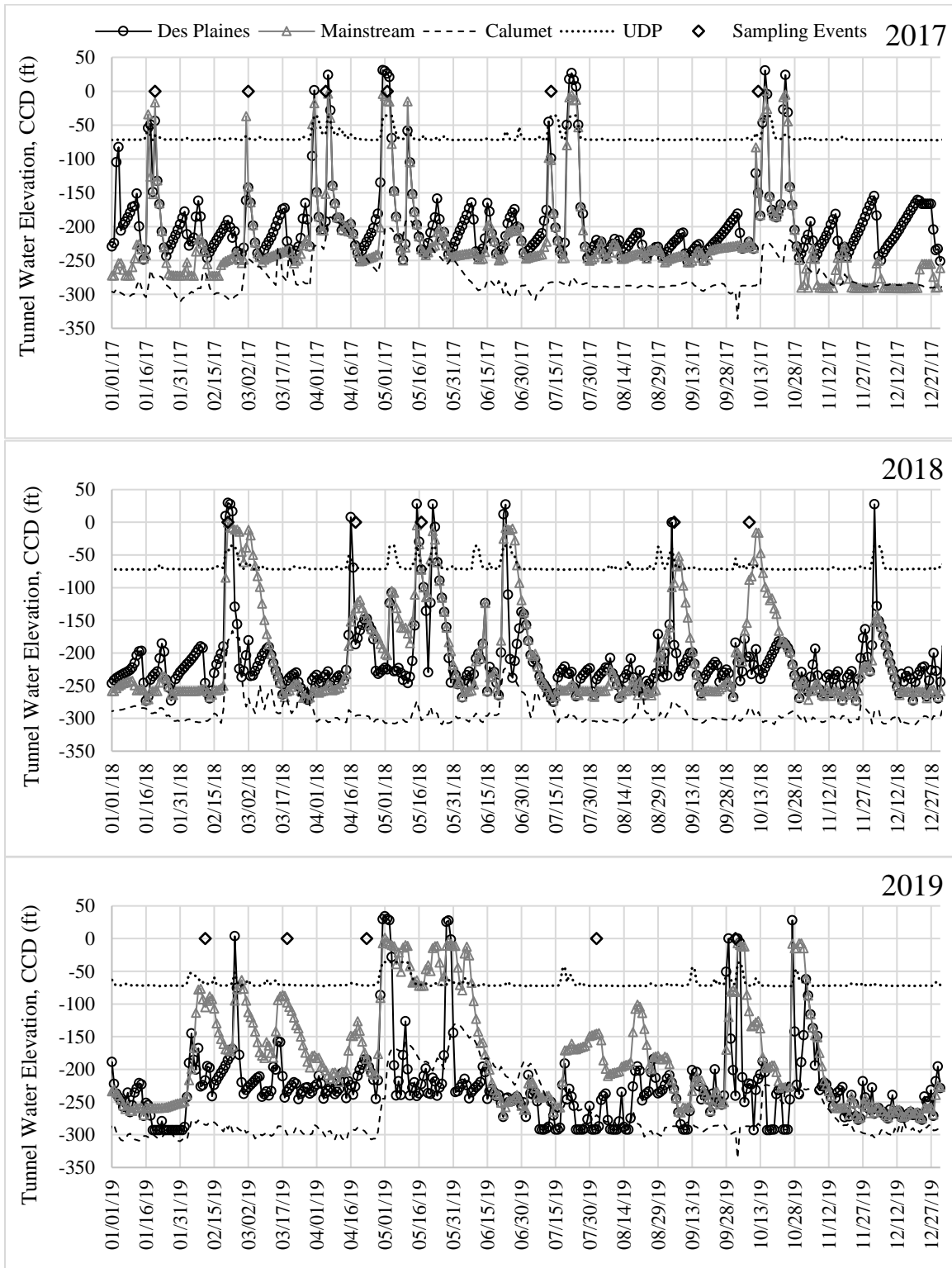
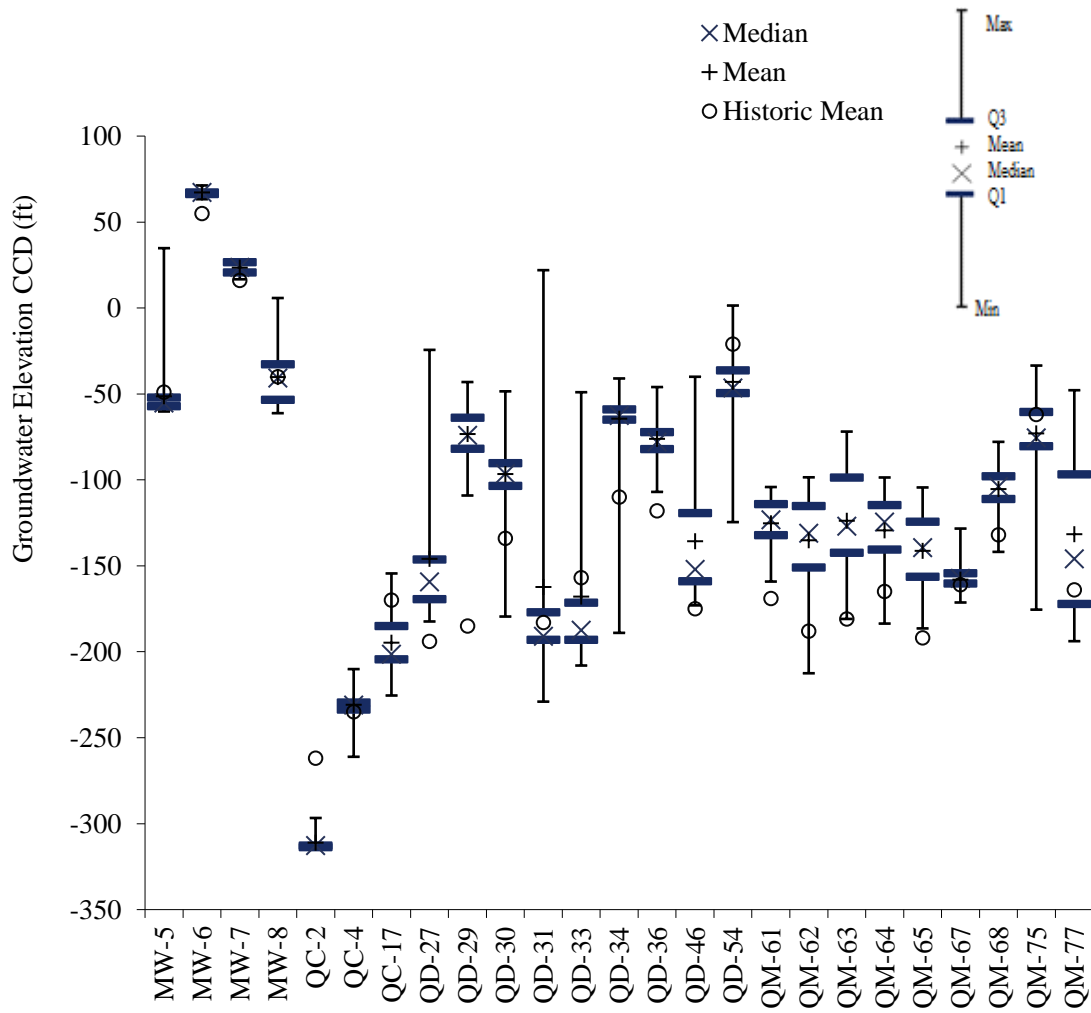


TABLE 4: NUMBER OF DAYS TO DEWATER THE DES PLAINES AND MAINSTREAM TUNNELS TO LEVELS LESS THAN -150 FEET CHICAGO CITY DATUM

Year	Des Plaines		Mainstream	
	Event Start	No. Days	Event Start	No. Days
2017	01/03/17	2	01/17/17	2
	01/17/17	5	01/20/17*	2
	03/02/17	1	03/01/17*	2
	03/30/17	3	03/30/17	3
	04/06/17	3	04/06/17*	3
	04/29/17	7	04/30/17	6
	05/11/17	2	05/11/17*	2
	07/12/17	2	07/12/17*	2
	07/20/17	6	07/20/17	6
	10/11/17	1	10/11/17*	2
	10/14/17	3	10/14/17	3
	10/23/17	4	10/22/17	4
2018	02/20/18	5	02/20/18*	18
	04/16/18	2	04/17/18*	7
	04/22/18	2	05/03/18	5
	05/03/18	2	05/14/18*	14
	05/15/18	5	06/14/18	1
	05/21/18	7	06/22/18	10
	06/14/18	1	09/04/18*	8
	06/22/18	3	10/08/18*	13
	06/30/18	2	12/03/18	2
	09/04/18	1		
	12/02/18	2		
2019	02/05/19	1	02/07/19*	11
	02/24/19	2	02/24/19	10
	04/29/19	6	03/14/19*	12
	05/10/19	1	04/16/19*	5
	05/28/19	4	04/29/19	44
	09/28/19	2	07/30/19*	5
	10/03/19	2	08/18/19	6
	10/27/19	2	09/29/19*	15
	11/01/19	5	10/27/19	11
	11/07/19	1		

*Indicating a fill event sampling that started on the same day or within a few days of the highlighted date.

FIGURE 5: RANGE, MEDIAN, AND MEAN OF GROUNDWATER LEVELS AT THE 25 PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN DURING 2017–2019 AND HISTORIC MEAN DURING 1995–2013



tunnel wells (below -160 ft CCD). Groundwater levels in the wells along the Mainstream and Des Plaines tunnels fall between those of the UDP and Calumet tunnels. A similar trend was documented based on evaluation of the historic data (1995–2013) in TARP groundwater monitoring reports (Kay, 2015 and Brose et al., 2016). Groundwater levels during this study period tended to be significantly higher compared with historic mean for many wells along the Mainstream tunnel (QM-61, QM-62, QM-63, QM-64, QM-65, and QM-77), Des Plaines tunnel (QD-27, QD-29, QD-30, QD-34, QD-34, and QD-46), Calumet tunnel (QC-4), and UDP tunnel (MW-6 and MW-7) (Figure 5). However, the groundwater levels at some of the other wells (QC-2, QC-17, and QD-54) were significantly lower than the historic mean for the period 1995–2013.

Groundwater Chemistry

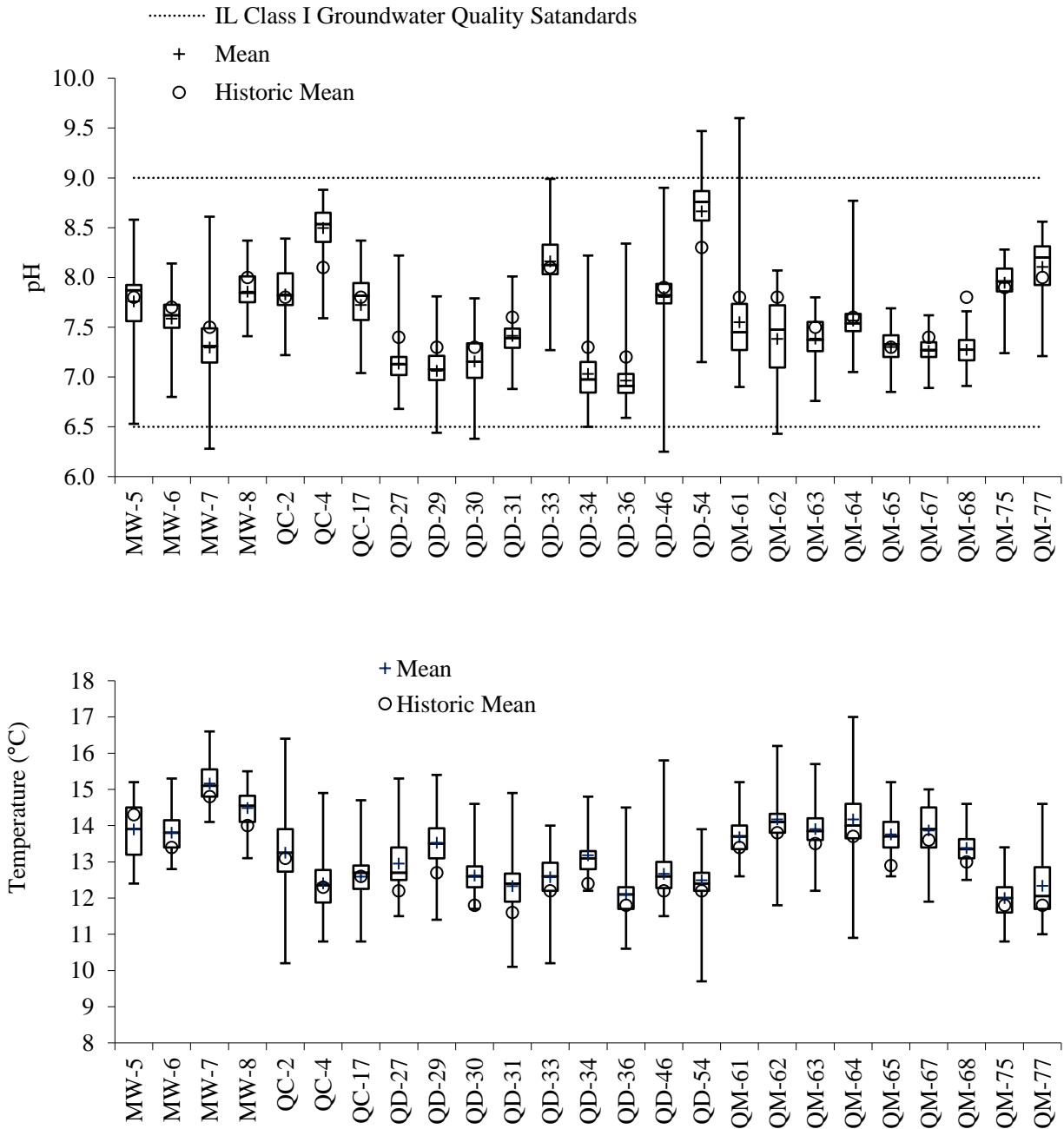
A summary of the groundwater quality data (pH, EC, TDS, TOC, Cl^- , SO_4^{2-} , $\text{NH}_3\text{-N}$, hardness, and temperature) for each of the 25 priority wells for the period 2017–2019 is presented in box and whisker plots in Figures 6 through 10. The raw data and associated descriptive statistics for these data are presented in Tables B-1 and B-2 of Appendix B, respectively. Presented data and the basic statistics analysis are based on up to three weeks monitoring data after each fill event sampling for pH, EC, temperature, and groundwater elevation, and one week (typically the first week) of sampling data for the rest of the water chemistry parameters (TDS, TOC, Cl^- , SO_4^{2-} , $\text{NH}_3\text{-N}$, and hardness). The values of the monitored parameters are compared with the Illinois Class I groundwater quality standards (Potable Resource Groundwater, Section 330, Part 620 of the Illinois Administrative Code) wherever applicable. Groundwater standards are applicable to only four of the water chemistry parameters (pH, TDS, Cl^- , and SO_4^{2-}). Historic means of water quality parameters for each well from 1995–2013 (Kay, 2015) were used as references to document changes in water quality in the study period.

pH. Over the three-year study period, pH values ranged from 6.25 to 9.6. The pH values in 99 percent of the samples collected from the 25 TARP priority wells were within the range of the Illinois Class I groundwater quality standard (6.5–9), as shown in Figure 6. There were only 14 samples with pH values slightly above or below the standard range in wells MW-7 along the UDP tunnel, QD-29, QD-30, QD-46, and QD-54 along the Des Plaines tunnel, and QM-75 and QM-77 along the Mainstream tunnel. Mean pH values were higher than historic mean values at five wells, QC-4, QD-33, QD-54, QM-75, and QM-77, but lower than or equal to the historic mean values at the rest of the monitored wells.

Temperature. Groundwater temperature at the 25 wells ranged between 9.7°C to 16.6°C (Figure 6). There was a small variability of temperature at the priority wells with coefficients of variation ranging from 3.5 percent to 10 percent. Groundwater temperature variability was directly related to the season with a slight increase of 1 to 2 degrees in the warmer months (April through October) compared to the colder months (January through March). Mean groundwater temperature values were higher than historic mean values at all Mainstream and Des Plaines tunnel wells, three UDP tunnel wells (MW-6, MW-7, and MW-8), and two Calumet tunnel wells (QC-2, and QC-4). Mean groundwater temperature data showed a similar spatial pattern to the historic mean of groundwater temperature in the monitored wells.

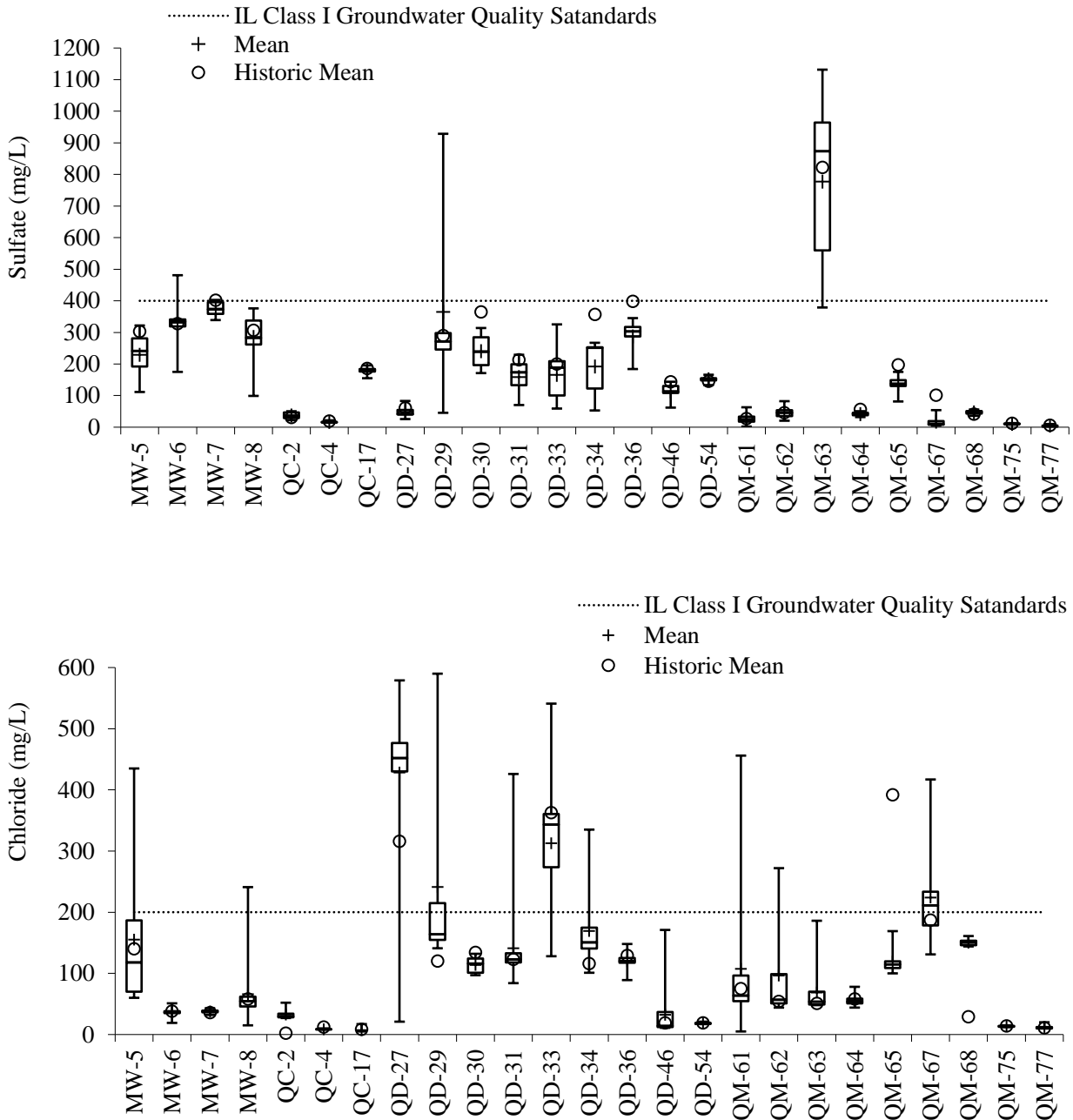
Chloride. Chloride concentrations in the TARP priority wells during the study period ranged from 5 mg/L at QC-17 (October 11, 2018) to 590 mg/L at QD-29 (May 3, 2017) (Figure

FIGURE 6: SUMMARY OF GROUNDWATER pH AND TEMPERATURE AT THE 25 PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN OVER THREE YEARS FROM 2017–2019



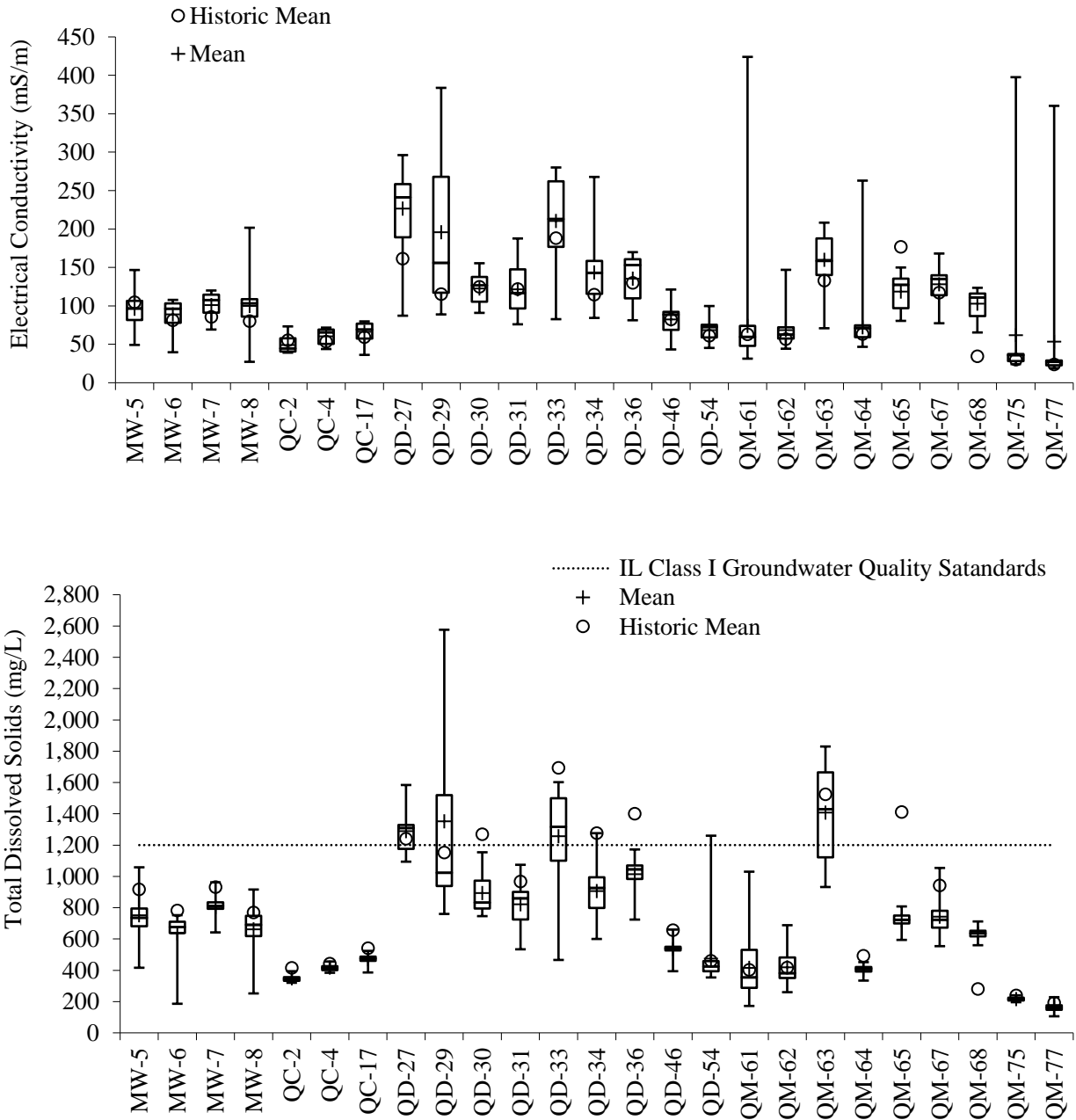
Note: For Box and Whisker plots, a line is drawn across the box at the median (-). The bottom of the box is at the first quartile (Q1), and the top is at the third quartile (Q3) value. The whiskers are the lines that extend from the top and bottom of the box to the lowest and highest observations. Historic mean refers to the mean value of data from 1995–2013.

FIGURE 7: SUMMARY OF GROUNDWATER SULFATE AND CHLORIDE AT THE 25 PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN OVER THREE YEARS FROM 2017–2019



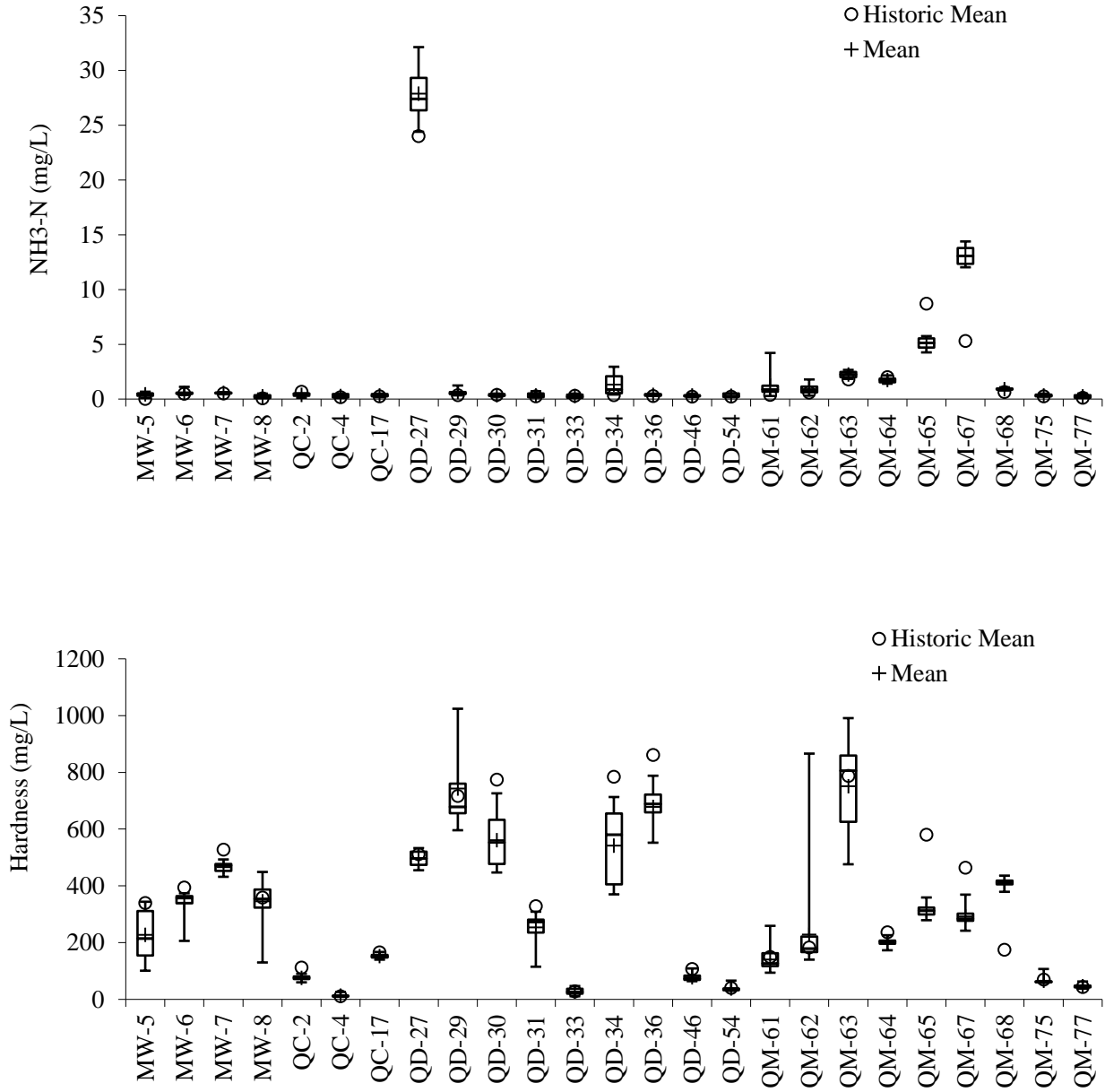
Note: For Box and Whisker plots, a line is drawn across the box at the median (-). The bottom of the box is at the first quartile (Q1), and the top is at the third quartile (Q3) value. The whiskers are the lines that extend from the top and bottom of the box to the lowest and highest observations. Historic mean refers to the mean value of data from 1995–2013.

FIGURE 8: SUMMARY OF GROUNDWATER ELECTRICAL CONDUCTIVITY AND TOTAL DISSOLVED SOLIDS AT THE 25 PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN OVER THREE YEARS FROM 2017–2019



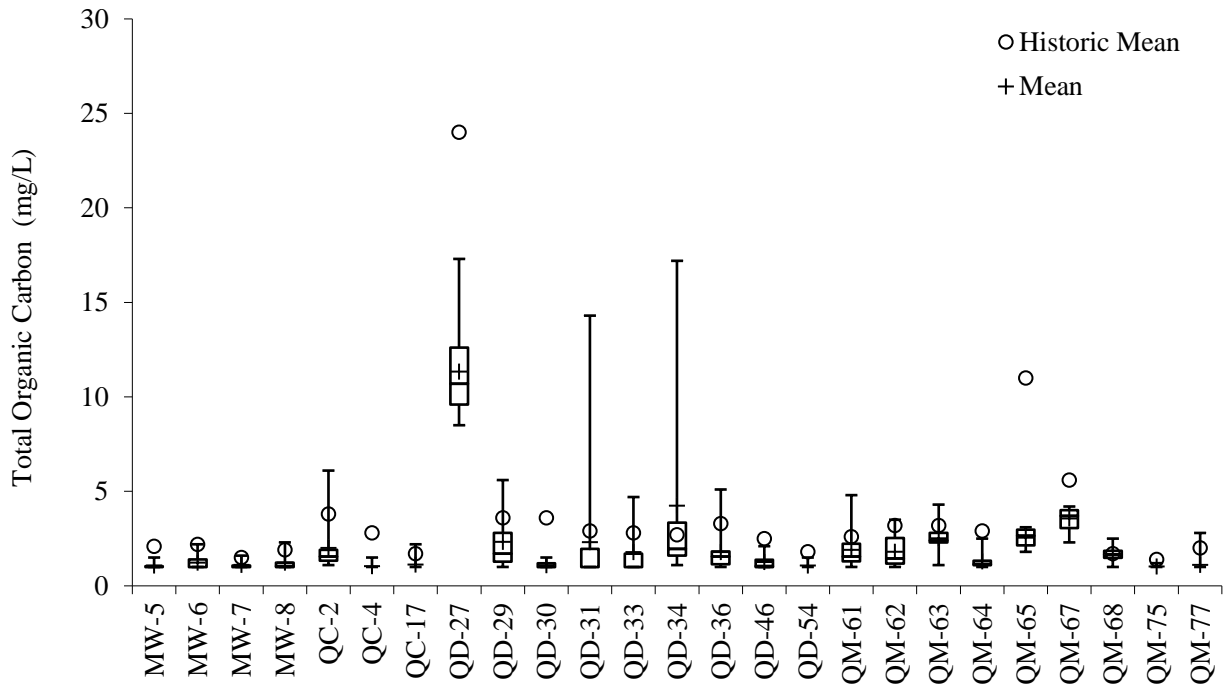
Note: For Box and Whisker plots, a line is drawn across the box at the median (-). The bottom of the box is at the first quartile (Q1), and the top is at the third quartile (Q3) value. The whiskers are the lines that extend from the top and bottom of the box to the lowest and highest observations. Historic mean refers to the mean value of data from 1995–2013.

FIGURE 9: SUMMARY OF GROUNDWATER AMMONIA AND HARDNESS AT THE 25 PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN OVER THREE YEARS FROM 2017–2019



Note: For Box and Whisker plots, a line is drawn across the box at the median (-). The bottom of the box is at the first quartile (Q1), and the top is at the third quartile (Q3) value. The whiskers are the lines that extend from the top and bottom of the box to the lowest and highest observations. Historic mean refers to the mean value of data from 1995–2013.

FIGURE 10: SUMMARY OF GROUNDWATER TOTAL ORGANIC CARBON AT THE 25 PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN OVER THREE YEARS FROM 2017–2019



Note: For Box and Whisker plots, a line is drawn across the box at the median (-). The bottom of the box is at the first quartile (Q1), and the top is at the third quartile (Q3) value. The whiskers are the lines that extend from the top and bottom of the box to the lowest and highest observations. Historic mean refers to the mean value of data from 1995–2013.

7). Among the analyzed samples for chloride over the three-year period, fifty samples (13 percent of the total samples), collected from 10 wells, exceeded the Illinois Class I groundwater quality standard (200 mg/L). The groundwater chloride exceedance mainly occurred in the winter months. The average Cl^- concentration during the winter months (January to April) for all wells was 128 mg/L compared with 99 mg/L for the rest of the sampling season (May to November). Compared to the historic mean, Cl^- mean concentrations were significantly higher at seven wells, MW-7, QC-2, QD-29, QD-34, QM-62, QM-63, and QM-68, but lower at six wells, QC-4, QC-17, QD-30, QD-36, QM-65, and QM-75. For the remaining 12 wells, there was no statistically significant difference in chloride mean values between this study and historic data.

Sulfate. Sulfate concentrations at the 25 priority wells ranged from 2 mg/L to 1,132 mg/L. Sulfate concentrations in TARP priority wells were below the groundwater quality standard (400 mg/L), except at wells MW-6, MW-7, QD-29, and QM-63 (Figure 7). Over the three-year monitoring period, only 18 samples (5 percent of the total samples) exceeded the limit for Illinois Class I groundwater quality standards (400 mg/L). Most of these samples were collected at well QM-63 with a mean concentration of 800 mg/L. This elevated level of groundwater SO_4^{2-} was likely attributable to the localized geologic formation because the mean value at this location was not statistically different from the historical mean value. Some samples showed anomalously high concentrations of SO_4^{2-} in wells MW-6 and MW-7 along the UDP tunnel and well QD-29 along the Des Plaines tunnel. Mean SO_4^{2-} concentrations were significantly lower than the corresponding historic means at wells MW-5 and MW-7 along the UDP tunnel, wells QC-4 and QC-17 along the Calumet tunnel, all Des Plaines wells except for wells QD-29 and QD-54, and all Mainstream wells except for wells QM-61, QM-62, and QM-63.

Total Dissolved Solids. The TDS in the 25 priority wells during the study period ranged from 106 mg/L in well QM-77 (March 21, 2019) to 2,576 mg/L in well QD-29 (May 3, 2017) (Figure 8). Out of the 25 priority wells, only four wells, three at the Des Plaines tunnel (QD-27, QD-29, and QD-33) and one at the Mainstream tunnel (QM-63), showed mean TDS concentrations higher than the Illinois Class I groundwater quality standard (1,200 mg/L). Only 10 percent of all samples collected during the study period exceeded the Illinois Class I groundwater quality standard for TDS. Compared with the historic mean TDS values, only three wells (QD-27, QD-29, and QM-68) showed higher mean TDS concentrations. Mean TDS concentrations were significantly lower than the historic means in 18 out of 25 priority wells, all UDP and Calumet tunnel wells, most Des Plaines tunnel wells (QD-30, QD-31, QD-33, QD-34, QD-36, and QD-46), and some Mainstream tunnel wells (QM-64, QM-65, QM-67, QM-75, and QM-77).

Electrical Conductivity. The EC in the 25 priority wells ranged from 19 to 424 millisiemens (mS)/meter (Figure 8). The lowest mean EC values were in wells QM-75 and QM-77 along the Mainstream tunnel, whereas higher mean EC values were in wells (QD-27, QD-29, and QD-33) along the upper part of the Des Plaines tunnel. Compared with the corresponding historic means, EC mean values were significantly higher in wells MW-7, QC-2, QD-27, QD-29, QD-34, QM-62, QM-63, and QM-68, and significantly lower in wells QC-2 and QM-65, and had no statistically significant difference in the remaining 15 wells.

Ammonia. Concentrations of $\text{NH}_3\text{-N}$ in the 25 priority wells ranged from 0.1 to 32 mg/L (Figure 9); however, most priority wells showed less than 1 mg/L. Ammonia concentrations ranged from 0.1 to 0.5 mg/L in the Calumet tunnel wells; 0.1 to 1.1 mg/L in the UDP tunnel wells; 0.1 to 3 mg/L in the Des Plaines tunnel wells, except for well QD-27 (24 to 32 mg/L); and less than 3

mg/L in the Mainstream tunnel wells, except for wells QM-65 (4 to 6 mg/L) and QM-67 (12 to 14 mg/L). Mean NH₃-N concentrations were higher in wells along the downstream part of the Mainstream tunnel compared to the upstream ones. In general, the concentrations of NH₃-N showed a similar pattern to the historic mean values except for three wells. Compared with the historic mean values, NH₃-N mean concentration (2017–2019) was higher in all priority wells except for wells QC-2 along the Calumet tunnel, QD-33 along the Des Plaines tunnel, QM-64 and QM-65 along the Mainstream tunnel.

Hardness. Hardness concentrations in the 25 priority wells during the study period ranged from 9 mg/L at QC-4 to 1,024 mg/L at QD-29 (Figure 9). Mean hardness concentrations generally showed a similar spatial pattern to the historic means. The mean concentrations of hardness during the study period were either significantly lower than or similar to the historic means for most wells. The mean hardness concentration was significantly higher compared to the historic mean only in well QM-68.

Total Organic Carbon. Mean TOC concentrations ranged from 1 to 4.2 mg/L for all wells except QD-27 (Figure 10). The TOC in QD-27 ranged from 1 to 17.3 mg/L. Higher concentrations of TOC were observed in the downstream parts of the Des Plaines and Mainstream tunnel wells compared with the rest of TARP priority wells. Mean TOC concentrations showed a similar pattern among the wells to the corresponding historic means. All TARP wells showed a significantly lower mean TOC concentrations compared with the corresponding historic mean except for wells QD-33, QD-34, and QM-68, in which the means were similar to the corresponding historic means.

Correlation Between Groundwater Quality Parameters and Tunnel Water Elevations

Correlation analysis was used to determine the effect of the TARP tunnel CSF level at each of the four tunnels on the groundwater level and groundwater quality parameters in each of the monitoring wells (Table 5 and Table B-3 of Appendix B). The groundwater level in the priority wells positively correlated with the tunnel CSF level at all wells except for QC-4 and QM-67. However, the positive correlations were statistically significant ($p < 0.05$) only in most of the Des Plaines and Mainstream tunnel wells, as shown in bold numbers in Table 5.

The correlation between groundwater chemistry parameters and tunnel CSF levels was mostly poor. There was no significant correlation ($p < 0.05$) between groundwater chemistry parameter monitored and the tunnel CSF level in all wells for EC, and significant correlation in less than 10 percent of the wells for pH and TDS, in 10 to 20 percent of the wells for TOC, Cl⁻, and hardness, and in 21 to 30 percent of the wells for NH₃-N and SO₄²⁻. Among eight water chemistry parameters monitored, SO₄²⁻ had a significant correlation found in the highest number of wells (28 percent). However, all the significant correlations for SO₄²⁻ were negative, which means that the SO₄²⁻ concentrations in these wells would decrease as tunnel water levels increase. The significant correlations varied spatially with the groundwater chemistry parameters, tunnel location, and individual wells.

TABLE 5: PEARSON CORRELATION COEFFICIENTS (R) BETWEEN EACH OF GROUNDWATER CHEMISTRY PARAMETERS/OTHER RELATED FACTORS AT UPPER DES PLAINES, CALUMET, DES PLAINES, AND MAINSTREAM PRIORITY WELLS AND COMBINED SEWER FLOW LEVEL IN THE TUNNEL

Well ID	pH ²	EC ²	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC Population ²	Temp. ²	Groundwater Elevation ²	Precipitation
MW-5	-0.11	-0.05	0.17	0.15	0.02	0.06	0.27	0.08	0.16	0.04	0.33	0.70¹
MW-6	0.24	-0.28	-0.14	0.30	-0.57	-0.57	-0.35	-0.42	0.44	0.04	0.08	0.56
MW-7	-0.19	-0.14	0.04	0.36	0.39	-0.27	-0.24	-0.08	0.34	0.11	0.33	0.67
MW-8	0.07	-0.21	-0.32	0.01	-0.09	-0.43	-0.10	-0.27	0.65	-0.03	0.28	0.64
QC-2	0.01	0.17	0.15	-0.15	0.07	-0.03	-0.55	0.33	0.25	0.03	0.30	0.80
QC-4	0.24	0.22	0.38	0.24	0.25	0.48	-0.49	-0.15	0.34	-0.09	-0.19	0.86
QC-17	0.10	0.33	0.10	0.10	-0.08	0.05	-0.51	0.23	0.24	-0.18	0.34	0.89
QD-27	-0.06	0.36	0.51	0.08	0.25	-0.01	-0.36	-0.09	0.43	0.06	0.95	0.64
QD-29	-0.08	-0.01	0.21	0.21	0.17	0.21	0.14	0.19	0.18	-0.03	0.16	0.62
QD-30	-0.13	0.25	0.13	0.13	-0.12	0.01	-0.35	-0.02	0.29	-0.10	0.60	0.70
QD-31	0.22	0.08	-0.07	0.54	0.44	-0.67	-0.33	-0.29	0.42	-0.09	0.94	0.71
QD-33	0.51	-0.17	-0.32	0.58	-0.26	-0.75	-0.46	-0.70	0.18	-0.02	0.80	0.65
QD-34	0.07	0.17	-0.39	0.80	0.56	-0.84	0.74	-0.79	0.58	-0.11	0.20	0.63
QD-36	-0.12	0.19	0.15	0.17	0.35	-0.03	-0.10	-0.16	0.24	-0.07	0.03	0.45
QD-46	0.16	0.09	0.20	0.47	0.66	-0.72	-0.36	0.14	0.24	0.03	0.71	0.63
QD-54	0.12	0.08	-0.22	-0.30	-0.24	-0.37	-0.65	-0.29	0.38	-0.15	0.56	0.67
QM-61	0.00	0.06	0.31	0.43	0.04	0.27	0.35	0.19	0.44	0.02	0.65	0.50
QM-62	0.08	0.24	0.34	0.80	0.52	-0.11	0.80	-0.34	0.30	-0.08	0.56	0.49
QM-63	0.18	-0.30	-0.53	0.27	0.62	-0.67	-0.21	-0.50	0.30	0.05	0.77	0.50
QM-64	-0.14	0.00	0.17	0.43	0.06	0.14	0.00	0.07	-0.05	0.03	0.65	0.50
QM-65	-0.16	-0.03	0.10	-0.02	-0.37	-0.08	0.42	-0.12	0.05	-0.04	0.66	0.55

TABLE 5 (Continued): PEARSON CORRELATION COEFFICIENTS (R) BETWEEN EACH OF GROUNDWATER CHEMISTRY PARAMETERS/OTHER RELATED FACTORS AT UPPER DES PLAINES, CALUMET, DES PLAINES, AND MAINSTREAM PRIORITY WELLS AND COMBINED SEWER FLOW LEVEL IN THE TUNNEL

Well ID	pH ²	EC ²	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC Population ²	Temp. ²	Groundwater Elevation ²	Precipitation
QM-67	0.06	0.04	-0.09	0.04	-0.22	-0.12	0.40	-0.19	-0.10	-0.15	-0.13	0.55
QM-68	0.17	-0.16	0.05	0.17	-0.32	-0.08	0.57	0.22	0.33	0.01	0.10	0.54
QM-75	0.20	0.06	0.16	-0.13	0.24	-0.51	0.20	0.31	0.24	-0.08	0.54	0.66
QM-77	0.46	-0.01	-0.13	0.05	0.02	0.19	0.12	0.03	0.14	-0.14	0.75	0.68

¹A bold number indicates the significant correlation at $p < 0.05$.

²Include data of three consecutive weekly samplings.

Fecal Coliform

Weekly Changes. Changes in the FC population and the percentage (frequency) of FC detection in samples collected in each of the three weekly samplings following a fill event are presented in [Figures 11](#) and [12](#). The frequency of FC detection in samples was relatively low in most of the wells along the UDP and Calumet tunnels and in wells QD-29, QD-30, and QD-54 along the Des Plaines tunnel, and it tended to decrease over time following a tunnel fill, particularly from week two to week three ([Figure 12](#)). However, the frequency of FC detection in samples was relatively high in nearly all wells along the Mainstream tunnel and in six wells along the Des Plaines tunnel, and in general, there is little difference in frequency of FC detection over time following a tunnel fill, as can be seen in [Figure 12](#). The FC populations in the samples collected from the 25 priority wells were generally low in wells located along the UDP and Calumet tunnels and three wells (QD-29, QD-30, and QD-54) along the Des Plaines tunnel, and high in wells associated with the Mainstream tunnel and six wells along the Des Plaines tunnel ([Figure 11](#)).

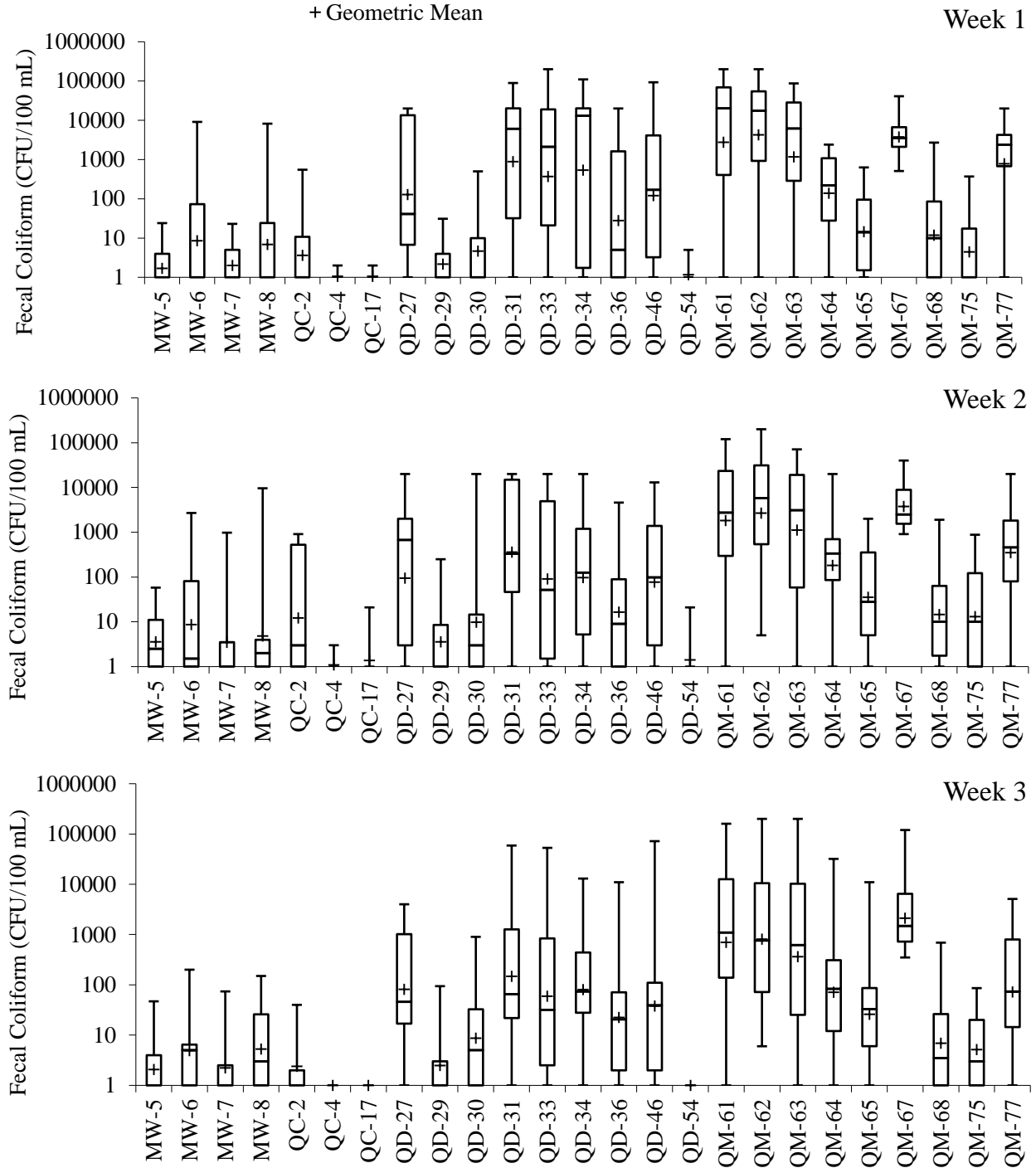
Tunnel CSF levels showed insignificant correlation ($p > 0.05$) with the population of FC in all the priority wells except for wells MW-8 and QD-34 ([Table 5](#)), when the data for the analysis included all the data from three consecutive weekly samplings. However, a high and significant positive correlation with the population of FC was found in wells MW-7 and MW-8 along the UDP tunnel and all three wells along the Calumet tunnel as well as QD-34, if only the first week data was included in the analysis (data not shown).

Comparison with Historic Means. Geometric means of FC populations were significantly higher in wells MW-8 and QC-2, all Des Plaines wells except for QD-54, and all Mainstream wells, but significantly lower in well QD-29, as compared to historic geometric means for the corresponding wells ([Figure 13](#)). As sampling for the wells along the Mainstream and Des Plaines tunnels in this three-year study was generally conducted following tunnel fills, these results suggest potential exfiltration associated with tunnel fill events.

Correlation Between Fecal Coliform and Water Chemistry. Correlation analysis was conducted to test the relation between the FC populations in the samples collected in the first week of sampling and the corresponding groundwater chemistry data from the same samples. The FC population showed weak or erratic correlation with groundwater chemistry parameters except for TOC ([Table 6](#)). There were significant positive correlations ($p < 0.05$) between the FC population and TOC in groundwater in about one third of the priority wells along the UDP, Des Plaines, and Mainstream tunnels.

Non-Priority Wells. Over the three years of sampling, FC was not detected (<1 CFU/100 mL) in most non-priority TARP wells under annual sampling frequency. The FC was occasionally detected in eight wells only once in each well during this three-year period (2017–2019) and the populations were very low, lower than 10 CFU/100 mL in seven of eight samples. The highest FC population detected in these eight wells was 12 CFU/100 mL in well QD-49 in 2019. However, FC was detected every year in well QD-57, with the highest at 85 CFU/100 mL in 2018.

FIGURE 11: GEOMETRIC MEAN AND DESCRIPTIVE STATISTICS FOR POPULATION OF FECAL COLIFORM AT THE TUNNEL AND RESERVOIR PLAN PRIORITY WELLS OVER THREE YEARS FROM 2017–2019



Note: For Box and Whisker plots, a line is drawn across the box at the median (-). The bottom of the box is at the first quartile (Q1), and the top is at the third quartile (Q3) value. The whiskers are the lines that extend from the top and bottom of the box to the lowest and highest observations.

FIGURE 12: WEEKLY VARIATIONS IN FREQUENCY OF FECAL COLIFORM DETECTIONS IN SAMPLES AT THE 25 TUNNEL AND RESERVOIR PLAN PRIORITY WELLS OVER THREE YEARS FROM 2017–2019

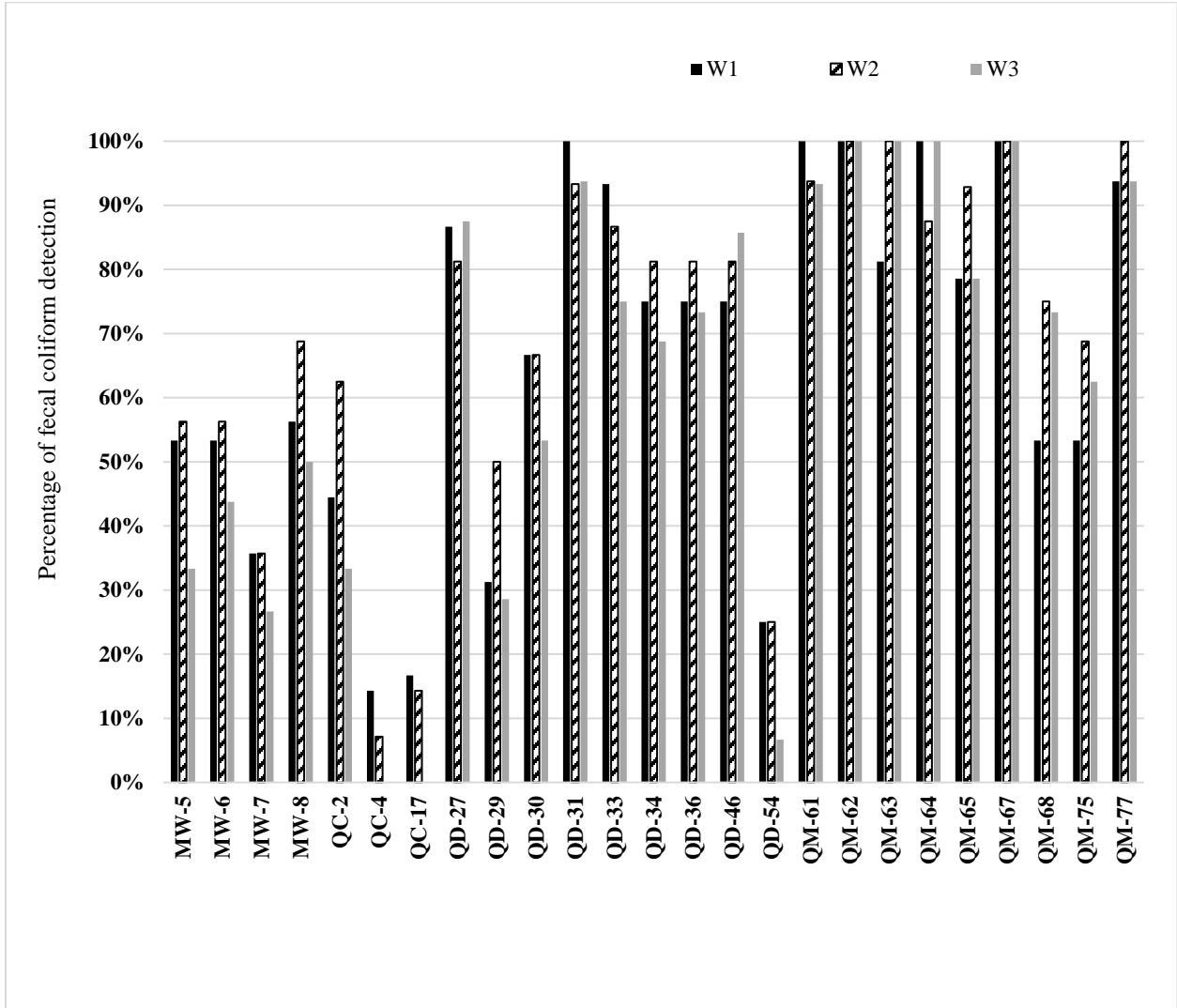
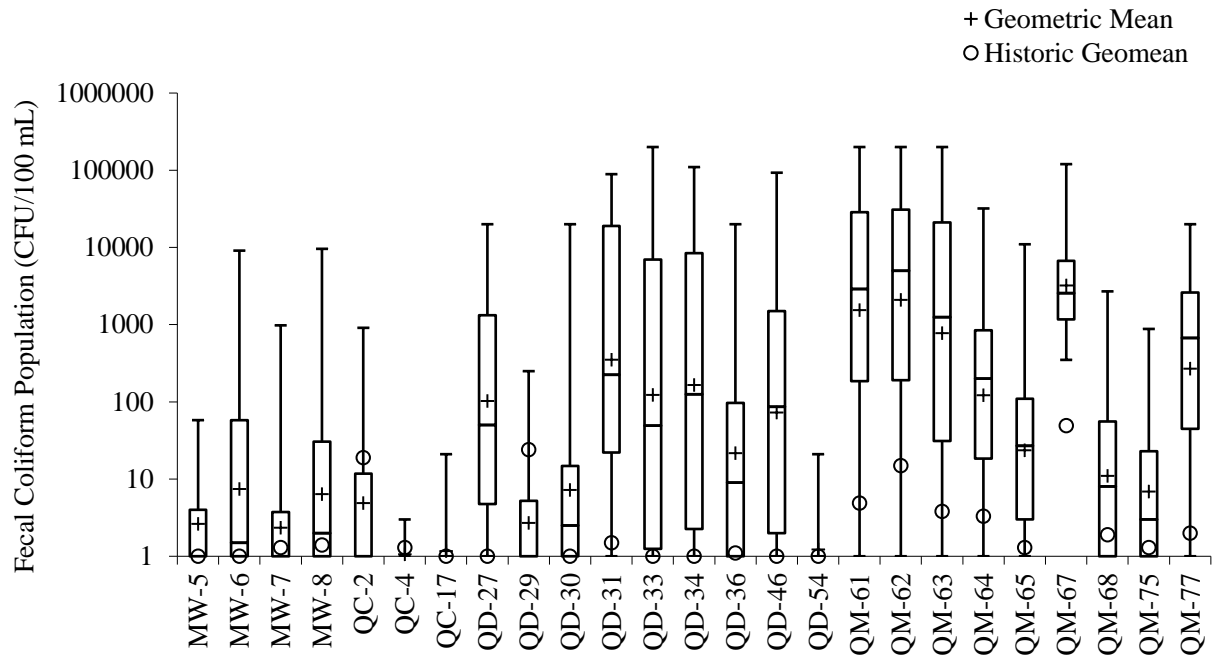


FIGURE 13: SUMMARY OF GROUNDWATER FECAL COLIFORM POPULATION AT THE 25 PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN OVER THREE YEARS FROM 2017–2019



Note: For Box and Whisker plots, a line is drawn across the box at the median (-). The bottom of the box is at the first quartile (Q1), and the top is at the third quartile (Q3) value. The whiskers are the lines that extend from the top and bottom of the box to the lowest and highest observations. Historic geomean refers to the geomean value of data from 1995–2013.

TABLE 6: PEARSON CORRELATION COEFFICIENTS (R) BETWEEN FECAL COLIFORM POPULATION IN GROUNDWATER FOR THE WEEK 1 SAMPLING AND EACH OF GROUNDWATER CHEMISTRY PARAMETERS/OTHER RELATED FACTORS AT UPPER DES PLAINES (MW), CALUMET (QC), DES PLAINES (QD), AND MAINSTREAM (QM) PRIORITY WELLS

Well ID	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	Temp	Groundwater Elevation	Tunnel Elev.	Precipitation
MW-5	0.30	-0.62¹	-0.19	0.05	-0.33	0.13	-0.14	-0.11	0.11	-0.11	0.08	0.07
MW-6	0.05	-0.52	-0.39	0.71	-0.66	-0.66	-0.31	-0.72	0.37	-0.04	0.45	0.23
MW-7	-0.26	-0.53	-0.13	0.81	0.44	-0.21	-0.15	-0.20	-0.14	0.21	0.73	0.39
MW-8	-0.12	-0.35	-0.26	-0.09	-0.10	-0.31	0.05	-0.17	-0.06	0.54	0.88	0.45
QC-2	-0.36	0.32	-0.21	-0.14	-0.07	-0.39	-0.54	0.35	-0.05	0.75	0.67	0.46
QC-4	-0.01	-0.10	0.02	0.40	0.16	0.10	-0.11	-0.05	-0.19	-0.10	0.56	0.70
QC-17	0.00	0.00	0.17	0.07	-0.13	0.06	-0.20	0.66	-0.17	0.15	0.56	0.71
QD-27	-0.19	0.32	0.41	-0.01	0.40	-0.08	-0.45	0.28	-0.04		0.42	0.16
QD-29	-0.05	-0.08	-0.05	-0.02	-0.27	0.05	-0.02	-0.08	-0.10	0.04	0.25	0.28
QD-30	-0.37	0.27	0.15	0.57	0.34	0.28	0.12	0.37	-0.12	-0.22	-0.04	-0.07
QD-31	0.35	0.22	-0.07	0.18	0.16	-0.27	-0.31	-0.11	-0.11	0.16	0.27	0.04
QD-33	0.27	-0.10	-0.09	0.52	-0.26	-0.21	-0.34	-0.31	0.20	-0.12	0.03	-0.18
QD-34	-0.27	0.45	-0.24	0.66	0.60	-0.59	0.60	-0.55	-0.22	0.09	0.57	0.42
QD-36	-0.19	0.18	-0.70	0.78	-0.12	-0.67	0.35	-0.61	0.84	-0.10	-0.08	0.04
QD-46	-0.09	0.16	-0.24	0.39	0.01	-0.12	-0.33	-0.16	-0.24	-0.06	-0.01	-0.16
QD-54	-0.09	0.10	-0.11	0.33	-0.23	-0.09	-0.16	0.61	0.44	0.07	0.03	0.25
QM-61	-0.13	0.09	-0.17	0.55	-0.04	0.16	0.21	0.04	0.53	-0.13	0.04	0.12
QM-62	-0.25	0.10	0.07	0.41	0.20	0.34	0.01	-0.22	-0.03	-0.46	0.16	0.23
QM-63	0.08	0.12	-0.62	0.46	0.49	-0.61	-0.66	-0.70	0.08	0.23	0.36	0.28
QM-64	0.48	0.57	-0.25	-0.08	-0.36	0.21	0.25	-0.34	-0.09	-0.03	-0.22	-0.05

TABLE 6 (Continued): PEARSON CORRELATION COEFFICIENTS (R) BETWEEN FECAL COLIFORM POPULATION IN GROUNDWATER FOR THE WEEK 1 SAMPLING AND EACH OF GROUNDWATER CHEMISTRY PARAMETERS/OTHER RELATED FACTORS AT UPPER DES PLAINES (MW), CALUMET (QC), DES PLAINES (QD), AND MAINSTREAM (QM) PRIORITY WELLS

Well ID	pH	EC	TDS	TOC	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	Temp	Groundwater Elevation	Tunnel Elev.	Precipitation
QM-65	-0.42	0.28	0.33	0.52	0.68	0.25	-0.11	0.25	0.24	0.01	-0.18	0.12
QM-67	-0.16	-0.52	-0.11	-0.06	-0.20	-0.25	-0.25	-0.12	0.39	0.17	-0.25	-0.24
QM-68	-0.36	0.13	0.44	0.57	-0.25	0.33	0.04	-0.43	0.40	0.26	0.21	0.13
QM-75	0.08	0.31	0.26	-0.02	-0.02	0.10	-0.17	-0.08	0.03	0.08	0.10	0.36
QM-77	-0.12	0.41	0.45	0.09	-0.32	0.36	-0.35	0.52	0.30	-0.23	-0.22	-0.07

¹A bold number indicates the significant correlation at p < 0.05.

Impact of Extended Tunnel Fill on Fecal Coliform Populations in Wells

An extended monitoring study (12 weeks), lasting from April 23, 2019, to July 24, 2019, was conducted at four priority wells along the Mainstream tunnel (QM-61, QM-62, QM-63, and QM-67) to further investigate the effect of an extended tunnel fill on FC populations in the nearby monitoring wells. These four wells were selected for this study because the frequency of FC detection observed in these wells was among the highest: at 100 percent of the time in QM-67 and QM-62, 96 percent of the time in QM-61, and 94 percent of the time in QM-63. As a result of the McCook Reservoir Stage 1 operation, an extremely wet spring in 2019, and limited treatment plant capacity for dewatering the tunnel and reservoir promptly, the Mainstream tunnel was filled with CSF at above -150 CCD level for 44 continuous days, from April 29, 2019, through June 11, 2019 (Table B-3 in Appendix B). The sampling at these four wells was triggered by a fill event caused by the rainfall on April 18, 2019, and continued for an extended period because of the prolonged tunnel fill caused by subsequent frequent rains from end of April to early June 2019.

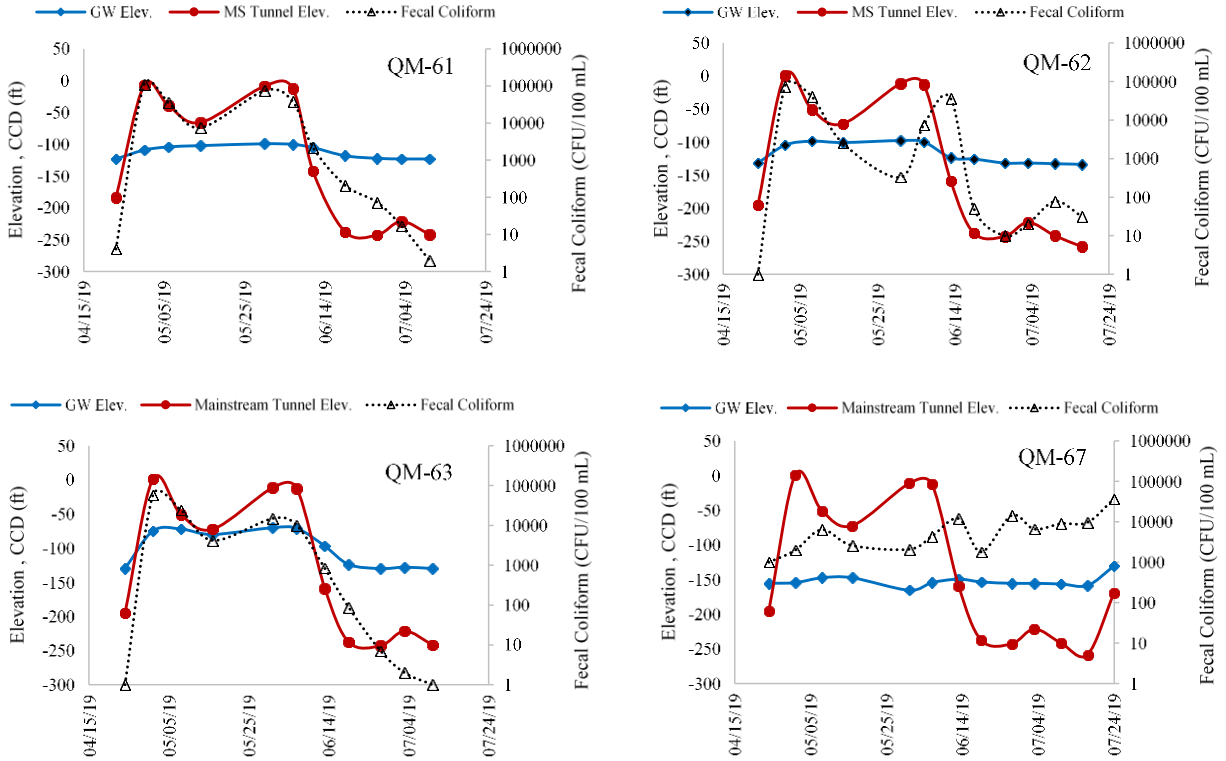
The FC populations, groundwater elevations in the wells at the sampling times and the corresponding water elevations in the tunnel from the extended monitoring study are presented in Figure 14. The FC populations followed the trend of tunnel water elevations (Elev.) closely in wells QM-61, QM-62, and QM-63, but showed a divergent, persistent pattern over time in well QM-67 (Figure 14). The data show that the FC population increase in response to tunnel water elevation increase could be instantaneous in the case of well QM-61 (fast recharge well <4 hours) or be delayed and deviated slightly in the case of wells QM-62 and QM-63 (slow recharge well <48 hours). This relationship is likely affected by the hydraulic conductivity of the aquifer geologic deposits and the hydraulic gradient between the water elevation in the tunnel and groundwater elevation in the aquifer. Notably, the groundwater elevation in these three wells increased when the tunnel water elevation exceeded the groundwater elevation, which is possibly the result of exfiltration, and decreased and leveled off likely to its background level when the tunnel water elevation dropped significantly below the groundwater elevation, which is the condition for possible infiltration.

However, the FC population in response to the change of tunnel water elevation in well QM-67 (slow recharge well <48 hours) was very different from the other three wells (Figure 14). The FC population increased slowly after a sharp increase in tunnel water elevation but continued to show a slightly increasing trend even after the tunnel water elevation decreased to a level much lower than the groundwater elevation. Unlike the other three wells in this extended monitoring study, the groundwater elevation in this well did not follow the general pattern of tunnel water elevation. In addition to the tunnel water elevation, other factors may also contribute to the elevated FC population and detection frequencies, including the permeability of geologic deposits around the monitoring wells, thickness of the unsaturated zone, groundwater recharge rate, intensity and duration of rainfall events, land-use activities around the monitoring wells, and tunnel conditions near the monitoring wells as well as FC population level in CSF in the tunnel. Therefore, the impact of extended tunnel fills on FC populations in nearby groundwater monitoring wells could be affected by many factors, as shown by different responses in the wells studied.

Impact of System-Wide Tunnel Fill

This three-year study was designed to sample the selected groundwater monitoring wells (priority wells) under the conditions that the tunnels were filled to a certain level and the potential

FIGURE 14: FECAL COLIFORM POPULATIONS IN THE FOUR WELLS IN RELATION TO COMBINED SEWER FLOW LEVELS IN THE MAINSTREAM TUNNEL AND GROUNDWATER ELEVATION DURING AN EXTENDED MONITORING STUDY IN 2019



for exfiltration from the tunnels to the surrounding groundwater aquifers would be the greatest based on hydraulic gradients. The threshold for fill event sampling for all priority wells in this study was based on the water elevation in the Mainstream tunnel at -150 ft Calumet. A single triggering signal was chosen under the assumption that all four tunnel systems would be filled when this threshold was reached due to a sizable rain. However, the study outcomes indicate that the spatial variation of precipitation and other factors caused the variation of tunnel fills in different tunnel systems. The Des Plaines and the Mainstream tunnels are served by the same pumping station and are designed to be connected to the same reservoir, the McCook Reservoir. As a result, the water elevation in the Des Plaines tunnel was generally similar to that in the Mainstream tunnel in 2017. However, in 2018 and 2019, because of the construction of the connecting tunnel between the Des Plaines tunnel and the McCook Reservoir and the sequence of dewatering operations determined by the M&O Department, the water elevations in these two tunnel systems were quite different, as shown in [Tables 3 and 4](#), particularly in 2019, although the fills of these two tunnel systems were relatively similar. As stated in the previous section, tunnel fill had noticeable impact on all the priority wells along the Mainstream tunnel and seven of nine priority wells along the Des Plaines tunnel with respect to FC populations and detection frequency, although the effect on the other water quality parameters showed no general trend. Because of the impact on FC populations in the priority wells of these two systems, it is warranted to continue to monitor these wells under tunnel fill conditions.

However, the Calumet and UDP tunnels are operated independently with their own pumping stations. Sometimes these two tunnel systems had different ranges of fills during this study period. Therefore, not all samples from the priority wells along the Calumet and UDP tunnels were collected under the tunnel filling conditions. These outcomes allowed us to compare the results between the samples collected under two different conditions. A t-test analysis was conducted to compare the FC population in samples collected from the UDP tunnel system under tunnel fill conditions (six times) and non-fill conditions (nine times). The result showed that the population of FC was higher for samples collected during tunnel fill, compared to non-fill, for one well (MW-8) only, and did not differ between the two groups (fill and non-fill) for the other three wells (MW-5, MW-6, and MW-7). It implies that during this study period most of the priority wells along the UDP tunnel were not negatively impacted with respect to FC populations by tunnel fills. The water elevations shown in [Figures 4 and 5](#) indicate that a tunnel fill could result in water elevation in the tunnel higher than that in the well for two wells (MW-5 and MW-8), but might still be lower than that in the well for the other two wells (MW-6 and MW-7). The impact of CSF on groundwater in MW-8 could be attributed to the exfiltration induced by a hydraulic gradient. However, the mixed impact on MW-5 seems to imply that the hydraulic gradient might not be a major factor causing FC detection in this well. Regardless of the mixed impact of tunnel fill on most of the priority wells along the UDP tunnel, it is probably warranted to monitor these wells under tunnel fill conditions in the future.

To capture tunnel fill conditions in this system, it appears that a local trigger needs to be developed for future monitoring of the priority wells along the UDP tunnel. The threshold for a fill event will be when the tunnel CSF is high enough to trigger a Majewski Reservoir fill. There were seven, nine, and five fill events at the Majewski Reservoir in 2017, 2018, and 2019, respectively. The change of threshold for a fill event to Majewski Reservoir fill will ensure that monitoring samples are always collected under tunnel fill conditions.

A similar comparison in FC population was done between samples collected under fill (four times) and non-fill (ten times) at the Calumet tunnel system and the results showed that FC

population tended to be higher in samples collected during tunnel fill, compared to the non-fill group, in one well (OC-2), but there was no difference between the two groups (fill and non-fill) in the other two wells (OC-4 and OC-17). According to the USGS report (Kay, 2015), OC-2 is located at the most downstream portion of the Calumet tunnel system and is also the deepest priority well in this system. Based on the water elevation in [Figures 4 and 5](#), it can be inferred that OC-2 had the lowest water elevation in its well and a tunnel fill condition would result in the greatest hydraulic gradient between water elevations in the tunnel and in the well, compared to the other two wells. The impact of tunnel fills on FC populations in OC-2 was likely attributable to exfiltration induced by tunnel fills. Although the impact of tunnel fills on the other two wells (OC-4 and OC-17) with respect to FC populations was mixed, more than 10 percent of FC detection in the first week of sampling ([Figure 12](#)) still warrants continual monitoring under tunnel fill conditions, particularly within the first week following a fill event.

The Calumet tunnel connects to the TCR and a water elevation increase in the tunnel leads to the fill of the TCR. For future monitoring, the threshold for fill event sampling for the Calumet tunnel wells will be when the tunnel CSF enters the TCR to raise water level in the reservoir to -280 ft CCD, the same threshold for TCR fill event sampling. There are generally more than four fill events at the TCR annually. This threshold would ensure that the monitoring samples are always collected under tunnel fill conditions.

Effect of McCook Reservoir Stage 1 on Exfiltration

One of the objectives of this three-year study was to evaluate how the completion of the McCook Reservoir Stage 1 affects the exfiltration of CSF from the Mainstream and Des Plaines tunnels to groundwater from storm events. The McCook Reservoir Stage 1 has been in operation since January 2018. The fill event sampling in 2017 was performed without the reservoir in service, while the fill event sampling in 2018 and 2019 for the 18 priority wells along the Des Plaines and Mainstream tunnels was conducted with CSF stored in the reservoir and tunnels when there was a fill. The evaluation was performed from two aspects: the change of water elevations in the tunnels and wells, from which the hydraulic gradient for exfiltration can be inferred, and the change of FC detection frequencies in the wells, which is a key indicator of exfiltration of CSF from the tunnels to the groundwater in the wells and can be driven by concentration gradient.

The annual mean water levels in the Des Plaines tunnel were -195 ft CCD in 2017, -212 ft CCD in 2018, and -227 ft CCD in 2019, based on data shown in [Table 2](#). The number of days that water elevation in the Des Plaines tunnel exceeded the -150 ft CCD threshold was 39, 32, and 26 for 2017, 2018, and 2019, respectively ([Table 3](#)). The results indicated that the annual mean water elevation in the tunnel in 2018 and 2019 decreased as compared to 2017. The lower tunnel water levels and fewer days of tunnel fills in 2018 and 2019 after the completion of the McCook Reservoir Stage 1 were primarily due to priority dewatering to a dry tunnel after rains for the construction of a connecting tunnel between the Des Plaines tunnel and the McCook Reservoir. The connecting tunnel is expected to be completed by 2021.

The annual mean water levels in the Mainstream tunnel were -223 ft CCD in 2017, -205 ft CCD in 2018, and -176 ft CCD in 2019, based on data shown in [Table 2](#). The number of days that the water elevation in the Mainstream tunnel exceeded the -150 ft CCD threshold was 37, 78, and 119 for 2017, 2018, and 2019, respectively ([Table 3](#)). The results indicated that the annual mean

water elevation in the tunnel in 2018 and 2019 increased as compared to 2017. This suggests that the water would be held longer in the Mainstream tunnel during 2018 and 2019 after the reservoir was in operation. This outcome was likely due to the following two main reasons: (1) more CSF was captured due to the increase in the storage capacity from the reservoir, which is evidenced by the dramatic increase in the capture of CSF by the Des Plaines and Mainstream tunnels as well as the reservoir after its completion, 36.6 BG in 2017 (before the reservoir), 58.1 BG in 2018, and 54.5 BG in 2019 (after the reservoir), according to the M&O Department Monthly Operating Reports; (2) the priority of tunnel dewatering was given to the Des Plaines tunnel, so the dewatering of the Mainstream tunnel was delayed. The tunnel fills during this study period may not be normal due to the construction of the connecting tunnel. However, the extended fills in the Mainstream tunnel allowed us to examine its impact. The following discussion will focus on the nine priority wells along the Mainstream tunnel.

The annual average groundwater elevations in each of the nine priority wells along the Mainstream tunnel during the study period of 2017 to 2019 are presented in [Table 7](#). The groundwater elevation in a well was measured each time the well was sampled for groundwater quality including both chemistry parameters and FC and the number of measurements could vary from 12 to 16 depending on the conditions at each well. The groundwater elevations in the wells generally increased as the tunnel water elevations and days of tunnel fill increased in 2018 and 2019, compared to 2017. The increase in groundwater elevation in the wells appeared to be linked to the hydraulic gradient caused by a tunnel fill, as shown in [Figure 14](#) for wells QM-61, QM-62, and QM-63. However, besides exfiltration of CSF from the tunnel, many other factors could influence the groundwater elevation in a well, as evidenced in [Figure 14](#) for well QM-67.

The annual frequency of FC detection in samples in each of the three sampling years (2017, 2018, and 2019) for each of the priority wells are presented in [Figure 15](#). Seven of the nine priority wells along the Mainstream tunnels showed a decreased frequency of FC detection from 2017 to 2018 and 2019, while two wells, QM-62 and QM-67, had no change in FC detection frequency, as 100 percent FC detection was observed in all three years. Although the 2019 spring/early summer was very wet, the majority of the wells at the Mainstream and Des Plaines Tunnels showed the lowest FC detection frequencies over the three years. Such reductions in FC detection were likely due to the operation of the McCook Reservoir Stage 1 since the beginning of 2018.

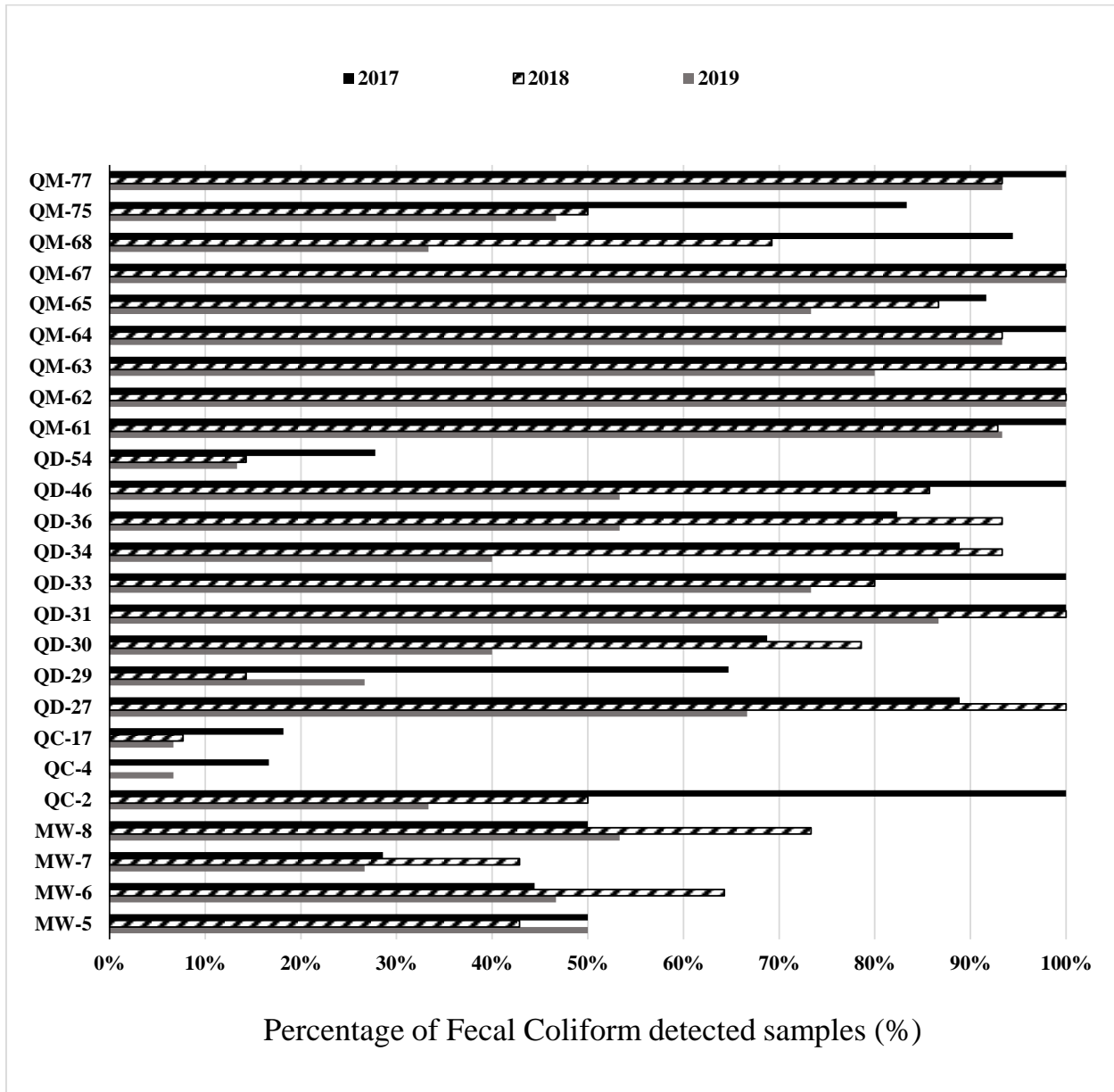
Despite the increase in water elevations in the tunnel and days of tunnel fill because of the operation of the McCook Reservoir Stage 1 and the increase in water elevation in the well as a result of extended tunnel fills, the general trend of mean FC detection frequency and population in the wells along the Mainstream tunnel was actually decreasing from 2017 to 2019 ([Figure 15](#) and [Table 7](#)). It is possible that with the increase in storage capacity from the McCook Reservoir operation, more storm water in the collection areas entered the system, resulting in the dilution of FC in CSF. This may account for decreasing trend in FC detection and population in the wells along the Mainstream tunnel, although there was no data of FC in CSF being collected over the three-year study period.

TABLE 7: ANNUAL MEAN GROUNDWATER ELEVATIONS AND GEOMETRIC MEAN OF FECAL COLIFORM POPULATIONS IN THE PRIORITY WELLS ALONG THE MAINSTREAM TUNNEL DURING THE STUDY PERIOD FROM 2017–2019¹

Well ID	Mean Groundwater Elevation in Well (CCD)			Geomean of FC in Well (CFU/100mL)		
	2017	2018	2019	2017	2018	2019
QM-61	-137	-121	-114	6,870	914	405
QM-62	-152	-133	-119	6,502	2,724	262
QM-63	-142	-119	-107	1,904	1,272	125
QM-64	-147	-122	-117	423	153	24
QM-65	-154	-140	-133	45	58	4
QM-67	-159	-158	-147	3,008	1,969	4,678
QM-68	-124	-124	-113	7	40	4
QM-75	-78	-70	-71	11	7	3
QM-77	-140	-130	-126	882	217	71

¹Including data collected only from the first three weekly sampling.

FIGURE 15: YEARLY VARIATIONS IN FREQUENCY OF FECAL COLIFORM DETECTIONS IN SAMPLES AT THE 25 TUNNEL AND RESERVOIR PLAN PRIORITY WELLS OVER THREE YEARS FROM 2017–2019



CONCLUSIONS

The data from the three-year fill event-based monitoring study for the 25 priority wells indicated that the levels of groundwater chemistry parameters for most samples were within the Illinois Class I groundwater standards. In the majority of the 25 priority wells, the mean concentrations of these parameters in the samples collected under tunnel fill conditions during this study were similar to the historic mean concentrations in the samples collected on a fixed schedule in 1995 to 2013. This implies that TARP operations have minimal impact on groundwater quality with respect to these parameters.

The FC populations were detected in nearly all the priority wells with varying detection frequency following tunnel fill events and showed some positive, but insignificant correlation with the tunnel water elevation for most wells. However, the mean FC populations in most wells were higher than the corresponding historic means, suggesting that fill events have some impact on FC levels in these monitoring wells. The results of extended fill event monitoring conducted in 2019 during the study period indicated that the FC populations would gradually decrease to a very low level in most wells after the water elevation in the tunnel dropped.

Since the operation of the McCook Reservoir Stage 1 in 2018, the days that the tunnels were filled by CSF were increased significantly in the Mainstream tunnel, but decreased in the Des Plaines tunnel, likely due to the construction of a connecting tunnel to the McCook Reservoir and prompt dewatering to keep the tunnel dry for construction. The operation of the McCook Reservoir Stage 1 caused a general increase in groundwater elevation in the priority wells along the Mainstream tunnel due to extended tunnel fills, but a decrease in the FC detection frequency and mean populations in most of the wells was observed.

It appears that having one trigger for fill event sampling in all four tunnel systems is likely insufficient. The results from this study indicated that only 40 and 30 percent of sampling events were performed under true tunnel fill conditions in the UDP and Calumet tunnel systems, respectively, even though the impact on groundwater quality between fill and non-fill conditions was not significantly different.

For the 25 priority wells, FC detection frequency and populations were generally low in wells located along the UDP and Calumet tunnels and three wells (QD-29, QD-30, and QD-54) along the Des Plaines tunnel, and high in the wells associated with the Mainstream tunnel and six of the wells along the Des Plaines tunnel. The FC was occasionally detected in non-priority wells (Tier 1) with populations always lower than 100 CFU/100 mL. However, FC detection was observed in one well, QD-57, every year during the three-year period, even though the highest population detected was only 85 CFU/100 mL in this well.

PROPOSED FUTURE MONITORING PLAN

It is proposed that future monitoring of TARP wells to be conducted at least two (2) times per year for 26 *Tier 2* wells, which consist of 25 priority wells monitored and one (1) non-priority well (QD-57) that was identified with FC detection every year in the three-year study, using fill event-based monitoring, and once per year for 76 *Tier 1* wells. All TARP groundwater monitoring wells for the tunnel systems including discontinued wells (Tier 3) that were approved by the IEPA and became dry in the past three years are presented in [Table 8](#).

Based on the frequency of detection and population levels of FC, it is suggested that the 26 TARP *Tier 2* wells be divided into four groups.

- Group I wells, consisting of a total of four (4) wells in the Des Plaines tunnel system (QD-29, QD-30, QD-54, and QD-57), showed a lower frequency of detection and a relatively low level of FC population, and FC population tended to decrease from week one to week three following tunnel fill events. Since FC detections and populations in Group I wells tend to decrease over time following a tunnel fill, performing the monitoring within the first week following a fill event will provide a chance to capture the highest levels of FC population associated with the fill event. Therefore, it is suggested that Group I wells be sampled during the first week following a tunnel fill event. The threshold for a fill event will still be the -150 ft CCD of water elevation in the Mainstream tunnel.
- Group II consists of 15 wells, which includes nine (9) wells in the Mainstream tunnel system and remaining six (6) wells in the Des Plaines tunnel system. This group of wells showed a higher frequency of detection and populations of FC, which did not change significantly after week one following a tunnel fill event. Since the levels of FC population in Group II wells tend to remain relatively unchanged over time following tunnel fills, the sampling can be conducted during week two. The threshold for a fill event will still be the -150 ft CCD of water elevation in the Mainstream tunnel.
- Group III includes all three (3) wells along the Calumet tunnel, and sampling will be done during two TCR fill events annually. The FC detection frequencies and populations in this group of wells were similar to Group I wells. Therefore, it is recommended that the Group I monitoring schedule also be used for Group III wells.
- Group IV includes all four (4) wells along the UDP tunnel, and sampling will be conducted during two Majewski Reservoir fill events. The FC detection frequencies and populations in this group of wells were similar to Group I wells. It is recommended that the Group I monitoring schedule also be used for Group IV wells.

This grouping of wells and monitoring schedule will allow better capture of tunnel fill events in all *Tier 2* wells after implementation of fill event-based sampling to monitor the impact

of tunnel fill on surrounding groundwater quality. This proposed monitoring plan will also allow a more even distribution of deployment of District personnel and other resources to conduct the monitoring program more efficiently.

Since levels of groundwater chemistry parameters for samples collected under fill events were generally within the Illinois Class I groundwater standards and similar to historic mean values, analysis of chemistry parameters for samples collected from one of the two events is considered sufficient. It is suggested that chemistry parameters be analyzed in one of the two sampling events annually, at the first sampling event of a year. Analysis of FC will be performed once for each of the two sampling events annually.

TABLE 8: LIST OF ALL TUNNEL AND RESERVOIR PLAN GROUNDWATER MONITORING WELLS FOR THE TUNNELS AS OF DECEMBER 2019

System	<u>Tier 1</u> (76 wells)	<u>Tier 2</u> (26 wells) ¹	<u>Tier 3</u> (19 Wells, Discontinued)
Mainstream	QM-53, QM-69, QM-70, QM-71, QM-72, QM-73, QM-74, QM-76, QM-78, QM-79, QM-80, QM-81, QM-82	QM-61, QM-62, QM-63, QM-64, QM-65, QM-67, QM-68, QM-75, QM-77	QM-51 ² , QM-52 ² , QM-54 ² , QM-55 ⁴ , QM-56, QM-57 ⁴ , QM-58, QM-59 ³ , QM-60 ⁴ QM-66 ³
Calumet	QC-2.1, QC-2.2, QC-5, QC-6, QC-7, QC-9, QC-10, QC-11, QC-12, QC-13, QC-14, QC-15, QC-16, QC-18, QC-19, QC-20, QC-21, QC-22, QC-23, QC-24, QC-25, QC-26, QC-27, QC-28, QC-29, QC-30, QC-31, QC-35	OC-2, QC-4, QC-17	QC-1 ⁵ , QC-3 ⁵ , QC-8 ⁵ QC-8.1 ⁵ (became observation well), QC-32, QC-33, QC-34, QC-36, QC-37
Des Plaines	QD-21, QD-22, QD-23, QD-24, QD-25, QD-26, QD-28, QD-32, QD-35, QD-37, QD-38, QD-39, QD-40, QD-41, QD-42, QD-43, QD-44, QD-45 ⁶ , QD-47, QD-48, QD-49, QD-50, QD-51, QD-52, QD-53, QD-55, QD-56, QD-58, QD-59, QD-60	QD-27, QD-29, QD-30, QD-31, QD-33, QD-34, QD-36, QD-46, QD-54, QD-57	
Upper Des Plaines	MW-1, MW-2, MW-3, MW-4, MW-9	MW-5, MW-6, MW-7, MW-8	

¹Well QD-57 will be moved from Tier 1 to Tier 2 since it has shown FC detection in the past three years.

²The IEPA approved discontinued wells QM-51, QM-52, and QM-54 were mistakenly listed in Tier 1 in the August 16, 2017, letter to IEPA.

³Wells QM-59 and QM-66 were functional in the August 16, 2017, letter to IEPA, now they became dry.

⁴Wells were already approved by the IEPA for termination in a May 4, 1994, memorandum.

⁵QC-1, QC-3, QC-8 (discontinued wells) and QC-8.1 (reused as observations well) were mistakenly listed in Tier 1 in the 2017 letter to IEPA.

⁶QD-45 was missed out in the list of the August 16, 2017, letter to IEPA.

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APPENDIX A

LETTERS

BOARD OF COMMISSIONERS
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Metropolitan Water Reclamation District of Greater Chicago

CECIL LUE-HING RESEARCH AND DEVELOPMENT COMPLEX
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Thomas C. Granato, Ph.D., BCES
Director of Monitoring and Research

December 23, 2016

Richard P. Cobb, P.G.
Deputy Manager
Division of Public Water Supplies
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62794

Dear Mr. Cobb:

Subject: Modifications for the Metropolitan Water Reclamation District of Greater Chicago Tunnel and Reservoir Plan Groundwater Monitoring Program

The Metropolitan Water Reclamation District of Greater Chicago (District) requests a modification of the Tunnel and Reservoir Plan (TARP) groundwater monitoring program. The modifications proposed were based on a United States Geological Survey (USGS) evaluation of TARP historical groundwater monitoring data and hydrogeology of the region (Report 2015-5186 "Hydrogeology and Groundwater Quality at Monitoring Wells Installed for the Tunnel and Reservoir Plan System and Nearby Water Supply Wells, Cook County, Illinois, 1995-2013),"¹ and the need for the District to make resources available for additional TARP groundwater monitoring with the Thornton Composite Reservoir, completed in 2015, and Phase I of the McCook Reservoir, scheduled for completion in 2017. The monitoring reduction is also based on meetings and other communications with your staff related to information in the aforementioned USGS report and other information on the TARP system.

The revised monitoring program is based on the frequency of detections of fecal coliform in groundwater sampled during the 1995-2013 period. The data showed that most of the 123 wells (83 wells) had fecal coliform detection in less than ten percent of the samples collected during the period (Tier 1 wells). There were a total of 23 wells having fecal coliform detection in ten percent or more of the samples collected during the period (Tier 2 wells). Most of the wells in Tier 2 are located in the lower part of the each tunnel system (closer to the reservoirs). There are also 17 wells that have not yielded samples consistently over many years (Tier 3). A total of 123 wells for four TARP tunnel systems that are classified in three tiers are shown in Table 1.

¹ pubs.usgs.gov/sir/2015/5186/sirz0155/86.pdf

Subject: Modifications for the Metropolitan Water Reclamation District of Greater Chicago Tunnel and Reservoir Plan Groundwater Monitoring Program

The revised monitoring plan is proposed for a study period of three years and will consist of three groups of wells, as shown in Table 2 based on the three tiers as follows:

Group 1 Wells – This group includes 81 wells in Tier 1. These wells will be sampled once per year and analyzed for the set of parameters analyzed currently.

Group 2 Wells – This group includes 25 wells, 23 in Tier 2 plus two wells from Tier 1 which showed a few spikes in fecal coliform during the monitoring period. This group of wells will be sampled more frequently according to an event-based monitoring outlined below.

Group 3 Wells – This group includes the 17 wells in Tier 3. The monitoring for this group of wells will be abandoned as they are no longer able to draw sample from the groundwater consistently.

Monitoring Program for Group 2 Wells:

The objectives of the monitoring program for the Group 2 wells are to:

1. Obtain data to better evaluate the correlation between tunnel fill events and exfiltration of combined sewer flow (CFS) water from the tunnels into the groundwater.
2. Evaluate how the completion of the McCook Phase 1 reservoir in 2017 affects exfiltration of CFS from the Mainstream and Des Plaines tunnels to groundwater during storm events.
3. Determine a future monitoring plan that will be needed on some wells.

The monitoring for the Group 2 wells will be based on water levels in the TARP tunnels associated with storm events. The criteria for a fill event that will trigger event-based monitoring will be based on the level of water in the TARP tunnels. To establish the criteria for each tunnel system, data on the level of water in the tunnels over the past five years will be evaluated to determine the tunnel water elevations that occur a maximum of about 12 times per year. This is based on the assumption that when the tunnel is filled to this elevation, the groundwater around the tunnel below this elevation has a high potential to be impacted by the tunnel water due to pressure of water in the tunnel, and that the pressure increases from the higher to the lower parts of the tunnels.

Subject: Modifications for the Metropolitan Water Reclamation District of Greater Chicago Tunnel and Reservoir Plan Groundwater Monitoring Program

The elements of the monitoring program for the Group 2 wells during the study period are as follows:

- Based on the fill event criteria established for each tunnel system, event-based monitoring of the Group 2 wells will be performed up to 12 events per year. However, because the 25 wells are distributed over wide geographic distances, the amount of time required to sample each well, and the other event-based monitoring associated with the TARP reservoirs, it is impractical to sample all 25 wells in one week. Therefore, for each fill event, 8 to 10 affected wells will be sampled. The wells sampled at each event will be alternated such that each well will be sampled during at least four events per year.
- At each event, sampling will be done weekly during the first three weeks following the fill event, as soon as weather conditions and scheduling of other TARP reservoir event-based monitoring allow. The three-week period is selected because based on the USGS report, which estimates that any exfiltration of CFS from the tunnel to groundwater and release back to the tunnel due to tunnel fill events occurs over a period of two to four weeks. The samples collected during the first week of sampling will be analyzed for all parameters in the current monitoring program. However, the samples from the second and third week will be analyzed for only fecal coliform and other field measurements (pH, conductivity, and temperature). In any well, if fecal coliform counts in the samples from the first and second weeks are non-detectable, the third sampling will not be done.
- At storm events resulting in water reaching the fill event tunnel elevation criteria of the individual tunnels, all Group 2 wells located at the position below the criteria elevation will be considered as potentially affected by the event and therefore, earmarked for sampling. In scheduling sampling during an event, the affected wells located at upper part of the tunnels will be given highest priority because the likelihood of these wells being affected is less compared to wells in the lower part of the tunnels and the water in the tunnel near these wells will decrease faster due to pumping or receding.
- If any of the Group 2 wells had no fill events by the end of the third quarter of the year, the wells will be sampled once for the year and analyzed for all parameters.

Subject: Modifications for the Metropolitan Water Reclamation District of Greater Chicago Tunnel and Reservoir Plan Groundwater Monitoring Program

This sampling scheme for the Group 2 wells is expected to generate a maximum of about 300 samples per year. Together with the 81 samples from the Group 1 wells, this modified monitoring program will generate a maximum of 381 samples per year. The 381 samples per year will represent an approximate 24 percent reduction in monitoring compared to approximately 500 samples currently collected per year. The number of samples could be lower if the number of fill events occurring in some wells were less than the maximum of four events for the year. Also, the number of samples could be lower if sampling is not done for any well during the third week following the fill event due to non-detectable levels of fecal coliform in samples collected during the first and second week.

We will begin this revised monitoring program on January 1, 2017. This monitoring program may run for up to three-years from January 2017 through December 2019. At the end of the three-year period, a report evaluating the data generated and addressing the objectives of the study period will be prepared. The report will be submitted to IEPA by July 31, 2020. However, we would like to meet with IEPA periodically during this period to assess and adjust this plan according to study findings and monitoring burdens that materialize from the reservoirs coming on line.

Please contact Dr. Albert Cox at (708) 588-4068 if you have any questions on this request.

Very truly yours,



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

TCG:HZ:AC:kq

Attachments

cc: Mr. S. Alan Keller, IEPA

Dr. H. Zhang

Dr. A. Cox

Dr. G. Tian

Dr. D. Brose

TABLE 1: WATER QUALITY MONITORING WELLS IN THE MAINSTREAM, CALUMET, DES PLAINES, AND UPPER DES PLAINES TUNNEL SYSTEMS OF THE TUNNEL AND RESERVOIR PLAN

Tier 1 - No Exceedance of Fecal Coliform (83)¹			
--- Mainstream ---	--- Calumet ---	--- Des Plaines ---	Upper Des --- Plaines ---
QM51, QM52, QM53, QM54, QM55, QM56, QM57, QM59, QM60, QM66, QM69, QM70, QM71, QM72, QM73, QM74, QM76, QM78, QM79, QM80, QM82	QC2.1, QC2.2, QC3, QC5, QC6, QC7, QC8, QC8.1, QC9, QC10, QC11, QC12, QC13, QC14, QC15, QC16, QC18, QC19, QC20, QC21, QC22, QC23, QC24, QC25, QC26, QC27, QC28, QC29, QC30, QC31, QC35,	QD21, QD22, QD23, QD24, QD25, QD26, QD28, QD32, QD33, QD35, QD37, QD38, QD39, QD40, QD41, QD42, QD44, QD48, QD50, QD51, QD52, QD54, QD56, QD57, QD59, QD60	MW1, MW2, MW3, MW4, MW9
Tier 2 - Exceedances of Fecal Coliform (23)			
QM61, QM62, QM63, QM64, QM65, QM67, QM68, QM75, QM77	QC2, QC4, QC17	QD27, QD29, QD30, QD31, QD34, QD36, QD46	MW5, MW6, MW7, MW8
Tier 3 - Wells to Discontinue (17)²			
QM55, QM57, QM58, QM60, QM81	QC1, QC32, QC33, QC34, QC36, QC37	QD43, QD47, QD49, QD53, QD55, QD58	

¹Exceedances defined as having fecal coliform detected in 10 percent or more of samples during the period 1995-2013 as identified in Kay, R.T. 2015. Hydrogeology and groundwater quality at monitoring wells installed for the Tunnel and Reservoir Plan System and nearby water-supply wells, Cook County, Illinois, 1995-2013: U.S. Geological Survey Scientific Investigations Report 21015-5186, 347p.

²Wells are dry or inaccessible.

**TABLE 2: GROUPS OF WATER QUALITY MONITORING WELLS IN THE
MAINSTREAM, CALUMET, DES PLAINES, AND UPPER DES PLAINES
TUNNEL SYSTEMS OF THE TUNNEL AND RESERVOIR
PLAN FOR THE PROPOSED MONITORING PROGRAM**

Group 1 – Monitored once per year (81)			
--- Mainstream ---	--- Calumet ---	--- Des Plaines ---	Upper Des --- Plaines ---
QM51, QM52, QM53, QM54, QM55, QM56, QM57, QM59, QM60, QM66, QM69, QM70, QM71, QM72, QM73, QM74, QM76, QM78, QM79, QM80, QM82	QC2.1, QC2.2, QC3, QC5, QC6, QC7, QC8, QC8.1, QC9, QC10, QC11, QC12, QC13, QC14, QC15, QC16, QC18, QC19, QC20, QC21, QC22, QC23, QC24, QC25, QC26, QC27, QC28, QC29, QC30, QC31, QC35,	QD21, QD22, QD23, QD24, QD25, QD26, QD28, QD32, , QD35, QD37, QD38, QD39, QD40, QD41, QD42, QD44, QD48, QD50, QD51, QD52, , QD56, QD57, QD59, QD60	MW1, MW2, MW3, MW4, MW9
Group 2 – Event-based monitoring (25)			
QM61, QM62, QM63, QM64, QM65, QM67, QM68, QM75, QM77	QC2, QC4, QC17	QD27, QD29, QD30, QD31, QD33 ¹ , QD34, QD36, QD46, QD54 ¹	MW5, MW6, MW7, MW8
Tier 3 - Wells to be Discontinued (17)²			
QM55, QM57, QM58, QM60, QM81	QC1, QC32, QC33, QC34, QC36, QC37	QD43, QD47, QD49, QD53, QD55, QD58	

¹These are Tier 1 placed in Group 2 as per IEPA.

²Wells are dry or inaccessible.

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Edward W. Podczerwinski, P.E.

Acting Director of Monitoring and Research

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August 16, 2017

Mr. Richard P. Cobb, P.C.
Deputy Division Manager
Division of Public Water Supplies
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, IL 62794

Dear Mr. Cobb:

Subject: Monitoring Program Modifications for the Metropolitan Water Reclamation District of Greater Chicago Tunnel and Reservoir Plan

Thank you for your letter of July 13, 2017, informing the Metropolitan Water Reclamation District of Greater Chicago (District) that the Illinois Environmental Protection Agency (IEPA) accepts the modifications for the District's Tunnel and Reservoir Plan Groundwater Monitoring Program effective in January 2017. Below are the questions raised in your letter and our responses to them:

1. Wells QM55, QM57, and QM60 are included in Mainstream Group 1, which are scheduled to be sampled once a year. These wells are also included in the Tier 3 well list. Sampling of the Tier 3 wells was scheduled to be discontinued due to sampling problems. Will wells QM55, QM57, and QM60 be renovated so that samples can be taken from them on a consistent basis?

Wells (QM55, QM57, and QM60) were mistakenly included in these lists. All three wells were already approved by the IEPA for termination of monitoring in a May 4, 1994, memorandum. We have removed these wells from the lists.

2. When will the evaluation of all the Tier 3 monitoring wells be completed to determine if the wells can be rehabilitated for future use or will need to be properly abandoned?

We have completed evaluation and repairs for Tier 3 wells. Eight of the wells have been rehabilitated (QM81, QC1, QD43, QD47, QD49, QD53, QD55, and QD58), and are added to the Tier 1 list. The following six wells could not be rehabilitated and, therefore, will be properly abandoned:

Subject: Monitoring Program Modifications for the Metropolitan Water Reclamation District of Greater Chicago Tunnel and Reservoir Plan

- QM58 – This well is inaccessible because it is located on the property of a private business which is now closed and secured by a locked gate.
- QM32, QC33, QC34, QC36, and QC37 – These wells are dry and do not yield samples

Furthermore, Well QM56 was previously listed in Tier 1. The well cannot be repaired because it is located on a river bank, and it cannot be accessed by the heavy equipment needed to repair it. Thus, Well QM56 has been moved to Tier 3 from Tier 1 and will be properly abandoned.

With this revision to the list of wells, the Tier 3 list consists of seven wells. The revised lists of three tiers of wells are attached ([Attachment 1](#)).

3. Provide the fill criteria (water elevation in the tunnel) that will trigger the event-based monitoring for each tunnel system and the documentation of the evaluation process used to analyze the five years of the water level information to establish the fill criteria for each tunnel system.

In the letter of December 23, 2016, to the IEPA, we indicated that up to 12 events per year are needed to complete four rounds of sampling of 25 Tier 2 wells, as only 8 to 10 wells could be sampled for each event with just one crew of technicians. Since we were able to mobilize additional staff for the moment, we could complete the sampling of all 25 wells for each fill event. Thus, we analyzed data on the tunnel water elevations for the years from 2010 – 2016 for the Mainstream tunnel to determine the criterion (tunnel water elevation) that could provide the opportunity of four fill events per year. We compared the cumulative days over a year in which tunnel water elevations were at -50, -150, and -200 ft Chicago City Datum (CCD). On average, there were 30 days per year for the tunnel water elevation at -150 ft CCD; thus, this tunnel water level (-150 ft CCD) is used as the criterion that will trigger the event-based sampling for each tunnel system. The detailed analysis is attached ([Attachment 2](#)).

4. The District indicates the monitoring system may run for up to (emphasis added) three years. The District will need to clarify that the monitoring program will run for three years.

The District will run the modified monitoring program for three years. We believe that the three-year period will provide sufficient data to understand how tunnel fill events impact the quality of groundwater.

Subject: Monitoring Program Modifications for the Metropolitan Water Reclamation District of Greater Chicago Tunnel and Reservoir Plan

5. Monitoring results must be provided to the Illinois EPA annually in a hard copy and electronically.

The District will submit to the IEPA all annual reports in a hard copy and electronically.

If you have any questions, please contact Dr. Guanglong Tian of my staff at (708) 588-4201.

Very truly yours,



Edward W. Podczerwinski, P.E.
Acting Director
Monitoring and Research Department

EWP:HZ:GT:cm

Attachments

cc: Mr. S. Alan Keller, IEPA/Dr. H. Zhang
Dr. A. Cox/Dr. G. Tian/Dr. P. Lindo/Dr. D. Brose

Attachment 1

WATER QUALITY MONITORING WELLS IN THE MAINSTREAM, CALUMET, DES PLAINES, AND UPPER DES PLAINES TUNNEL SYSTEMS OF THE TUNNEL AND RESERVOIR PLAN ACCORDING TO REVISED MONITORING PLAN AS OF AUGUST 2017¹

Tier 1 - No Exceedance of Fecal Coliform (87)²

--- Mainstream ---	--- Calumet ---	--- Des Plaines ---	---Upper Des Plaines ---
QM51, QM52, QM53, QM54, QM59, QM66, QM69, QM70, QM71, QM72, QM73, QM74, QM76, QM78, QM79, QM80, QM81, QM82	QC1, QC2.1, QC2.2, QC3, QC5, QC6, QC7, QC8, QC8.1, QC9, QC10, QC11, QC12, QC13, QC14, QC15, QC16, QC18, QC19, QC20, QC21, QC22, QC23, QC24, QC25, QC26, QC27, QC28, QC29, QC30, QC31, QC35	QD21, QD22, QD23, QD24, QD25, QD26, QD28, QD32, QD33, QD35, QD37, QD38, QD39, QD40, QD41, QD42, QD43, QD44, QD47, QD48, QD49, QD50, QD51, QD52, QD53, QD54, QD55, QD56, QD57, QD58, QD59, QD60	MW1, MW2, MW3, MW4, MW9

Tier 2 - Exceedances of Fecal Coliform (23)

QM61, QM62, QM63, QM64, QM65, QM67, QM68, QM75, QM77	QC2, QC4, QC17	QD27, QD29, QD30, QD31, QD34, QD36, QD46	MW5, MW6, MW7, MW8
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Tier 3 - Wells to Discontinue (7)³

QM56, QM58	QC32, QC33, QC34, QC36, QC37		
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¹QM55, QM57, and QM60 listed in in both Tier 1 and Tier 3 of the previous Table 1 (see letter of December 23, 2016 to IEPA) have been deleted because they were terminated for monitoring in 1994 per IEPA approval.

²Exceedances defined as having fecal coliform detected in 10 percent or more of samples during the period 1995-2013 as identified in Kay, R.T. 2015. Hydrogeology and groundwater quality at monitoring wells installed for the Tunnel and Reservoir Plan System and nearby water-supply wells, Cook County, Illinois, 1995-2013: U.S. Geological Survey Scientific Investigations Report 21015-5186, 347p.

³Wells are dry or inaccessible.

**DETERMINATION OF A TUNNEL-WATER ELEVATION THRESHOLD
FOR EVENT-BASED SAMPLING OF THE METROPOLITAN WATER
RECLAMATION DISTRICT OF GREATER CHICAGO'S TUNNEL AND
RESERVOIR PLAN**

BACKGROUND

Based on consultation with the Illinois Environmental Protection Agency (IEPA), the Metropolitan Water Reclamation District of Greater Chicago (District) developed a rainfall event-based sampling program for the Tunnel and Reservoir Plan (TARP) groundwater monitoring program, effective January 1, 2017. The revised sampling program is based on the findings of the 2016 U.S. Geological Survey (USGS) report *Hydrogeology and Groundwater Quality at Monitoring Wells Installed for the Tunnel and Reservoir Plan System and Nearby Water-Supply Wells, Cook County, Illinois, 1995-2013*. The USGS evaluated the TARP groundwater monitoring system and proposed that sewage-impacted water exfiltrated from the TARP tunnels to groundwater during extreme rainfall events. The revised monitoring program, which is accepted by the IEPA, requires the determination of a threshold value for tunnel-water elevation to be used as a trigger for event-based sampling.

METHODS

The 2016 USGS report did not evaluate how precipitation and tunnel-water elevations relate with observed exfiltration events from the tunnels; therefore, water elevation data for the Mainstream tunnel system and rainfall data for the period 2010 - 2016 were evaluated. Tunnel-water elevation data were available for the Mainstream tunnel but not for all tunnel systems; therefore, this analysis focuses only on tunnel fill events in the Mainstream tunnel. Daily total rainfall data were available from the National Oceanic and Atmospheric Administration's (NOAA) Climate Data Online database. The data corresponds to a NOAA weather station located at Midway Airport, which is within the Mainstream tunnel's service area. The tunnel system can fill quickly during a heavy rainfall event but would be expected to fill slowly with runoff from snow melt; therefore, only rainfall was analyzed. Snowfall and snowmelt events were omitted from the data evaluation.

RESULTS

Total monthly rainfall, mean monthly rainfall, and total annual rainfall for 2010 - 2016 evaluation period are presented in [Table 1](#). The mean rainfall for January was 1.8 in, which is the least reported for any month. The mean rainfall for May and June were 5.7 and 5.8 in, which were the wettest months in the period. Annual rainfall in the period ranged from 32 - 52 in. The greatest amount of rainfall in any month was June 2014 with 11 in. Rain fell in all months during the 2010 - 2016.

Attachment 2

TABLE 1: TOTAL MONTHLY RAINFALL, MEAN MONTHLY RAINFALL, AND TOTAL ANNUAL RAINFALL, INCHES, FROM 2010 - 2016 AT MIDWAY AIRPORT, CHICAGO, ILLINOIS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2010	1.1	1.6	1.7	3.8	6.8	7.9	9.2	3.5	1.7	2.2	2.5	2.8	45
2011	0.71	3.5	2.3	5.7	5.3	7.4	5.4	3.9	3.9	2.2	3.7	2.5	47
2012	2.2	1.4	2.2	2.6	4.3	1.1	3.8	6.1	1.6	3.2	1.0	2.1	32
2013	3.2	2.6	2.2	8.0	6.5	3.1	2.2	2.5	1.9	5.7	2.9	1.5	42
2014	3.2	2.4	2.3	3.5	6.1	11	5.5	9.0	3.1	4.0	1.4	0.93	52
2015	1.6	1.9	0.81	3.4	4.6	8.4	2.5	3.8	6.2	1.8	4.9	6.3	46
2016	1.0	1.3	3.3	3.3	5.9	2.5	8.2	5.8	2.4	4.6	2.2	1.5	42
Monthly Mean	1.8	2.1	2.1	4.3	5.7	5.8	5.3	4.9	3.0	3.4	2.7	2.5	

There were numerous days in the 2010 - 2016 evaluation period where the reported tunnel elevation was full or nearly full on days with little to no rainfall (Figure 1). This can be explained by a lag time between rainfall and dewatering the tunnels following rainfall events. For example, a rainfall event that began on May 10 and concluded on May 13, 2010, resulted in a total rainfall of 1.8 in. The tunnel-water elevation reported for May 10 when the rainfall began was nearly empty, elevation = -248 ft Chicago City Datum (CCD), but nearly full (elevation = -0.73 ft CCD) on May 13 (Figure 2). The tunnel was then dewatered from May 13 - 16; therefore, on May 14 and 15, the tunnel-water elevations were -10 and -156 ft CCD, respectively, but there was no reported rainfall on those days.

To account for this lag, a cumulative rainfall value was calculated for each date, which was a sum of the previous five days of rainfall. A scatter plot of tunnel-water elevation and five-day cumulative rainfall results in fewer occurrences of a nearly full tunnel when there was no reported rainfall in the previous five days (Figure 3). The cluster of points below -150 ft CCD, when there was less than half an inch of rainfall in the previous five days, is likely due to low-intensity wet-weather events and the natural drainage pattern of water migrating from the aquifer into the tunnel as discussed in the 2016 USGS report.

There were 2,133 days in the 2010 - 2016 rainfall data with a five-day cumulative precipitation greater than zero. Of these, 207 days (10 percent of the time period) had tunnel-water elevations greater than -150 ft CCD (Figure 4). Tunnel-water elevation was at -200 ft CCD or lower for 1,673 days (78 percent of the time period). Overall, these data indicate that most cumulative rainfall events are less than two inches, and tunnel-water elevation is lower than -150 ft CCD on most days.

The District's event-based monitoring program will sample all 25 high priority wells for a minimum of four events per year; therefore, a tunnel-water elevation threshold should be met at least four times annually. This criteria can be met with a tunnel-water elevation threshold of -150 ft CCD (Table 2). By selecting a threshold of -150 ft CCD for initiating sampling, the four sampling events per year requirement should easily be met while also ensuring the tunnel system is full enough to induce exfiltration.

TABLE 2: NUMBER OF DAYS ABOVE MAINSTREAM TUNNEL-WATER ELEVATION THRESHOLDS FROM 2010 - 2016

Year	Tunnel-Water Elevation		
	-50	-150	-200
2010	9	12	39
2011	21	28	67
2012	5	7	23
2013	24	29	54
2014	34	68	129
2015	21	27	135
2016	32	42	64

SUMMARY

Daily total precipitation and Mainstream tunnel-water elevation data are not well correlated due to variations in rainfall intensity and capacity of the stormwater and sewer systems; however, understanding the response of the tunnel system to rainfall is improved by using a five-day cumulative rainfall value. An examination of 2010 - 2016 data for the Mainstream tunnel-water elevation and rainfall at Midway Airport demonstrated that the tunnel regularly fills to approximately -150 ft CCD due to low-intensity rainfall events and the natural drainage pattern of groundwater migrating from the aquifer to the tunnel. A tunnel-water elevation threshold value of -150 ft CCD for the Mainstream tunnel would ensure sampling from high-intensity rainfall events that result in full or nearly full tunnels across the TARP tunnel system and ensure enough sampling days are available for the event-based sampling protocol.

FIGURE 1: MAINSTREAM TUNNEL-WATER ELEVATION AND TOTAL DAILY RAINFALL AT MIDWAY AIRPORT, CHICAGO, ILLINOIS, 2010 - 2016

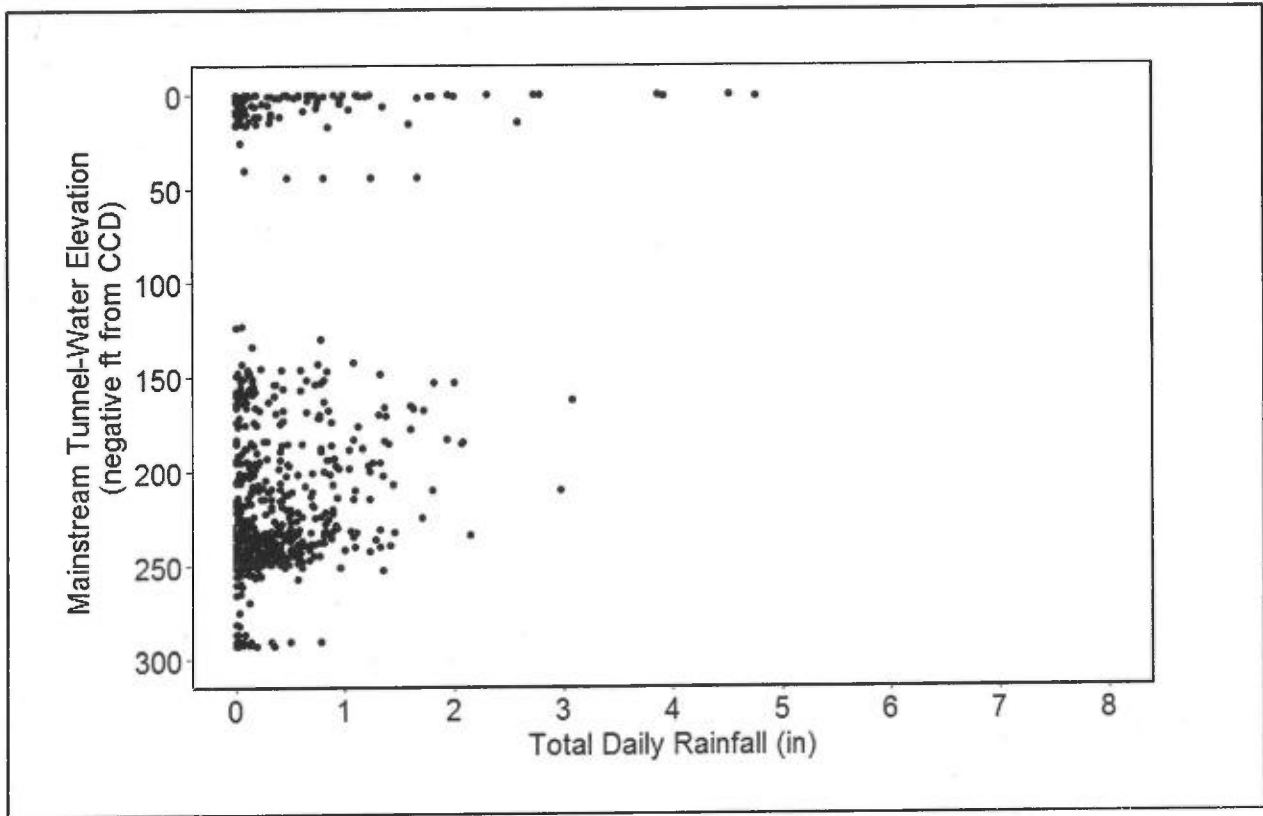


FIGURE 2: MAINSTREAM TUNNEL-WATER ELEVATION AND CUMULATIVE RAINFALL AT MIDWAY AIRPORT, CHICAGO, ILLINOIS, MAY 9 - 16, 2010

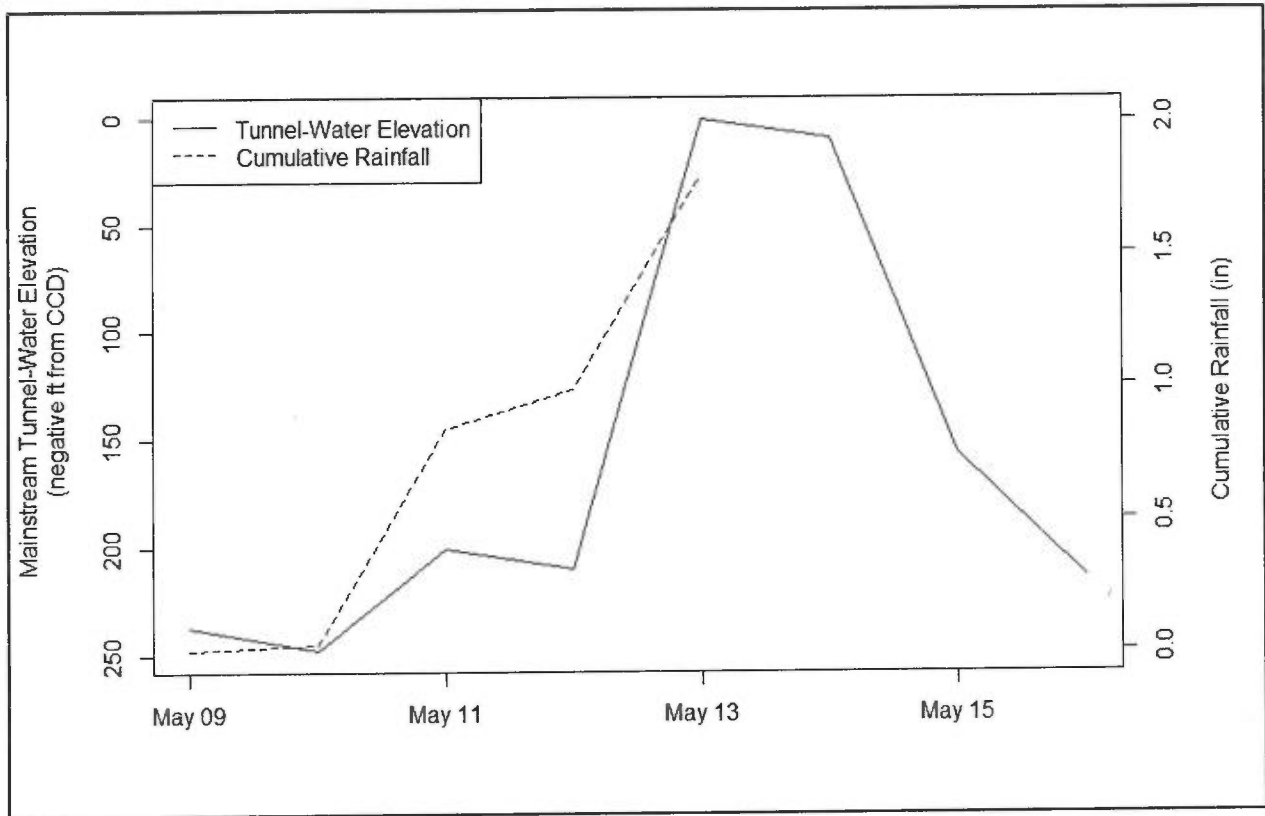


FIGURE 3: MAINSTREAM TUNNEL-WATER ELEVATION AND FIVE-DAY CUMULATIVE RAINFALL AT MIDWAY AIRPORT, CHICAGO, ILLINOIS, 2010 - 2016

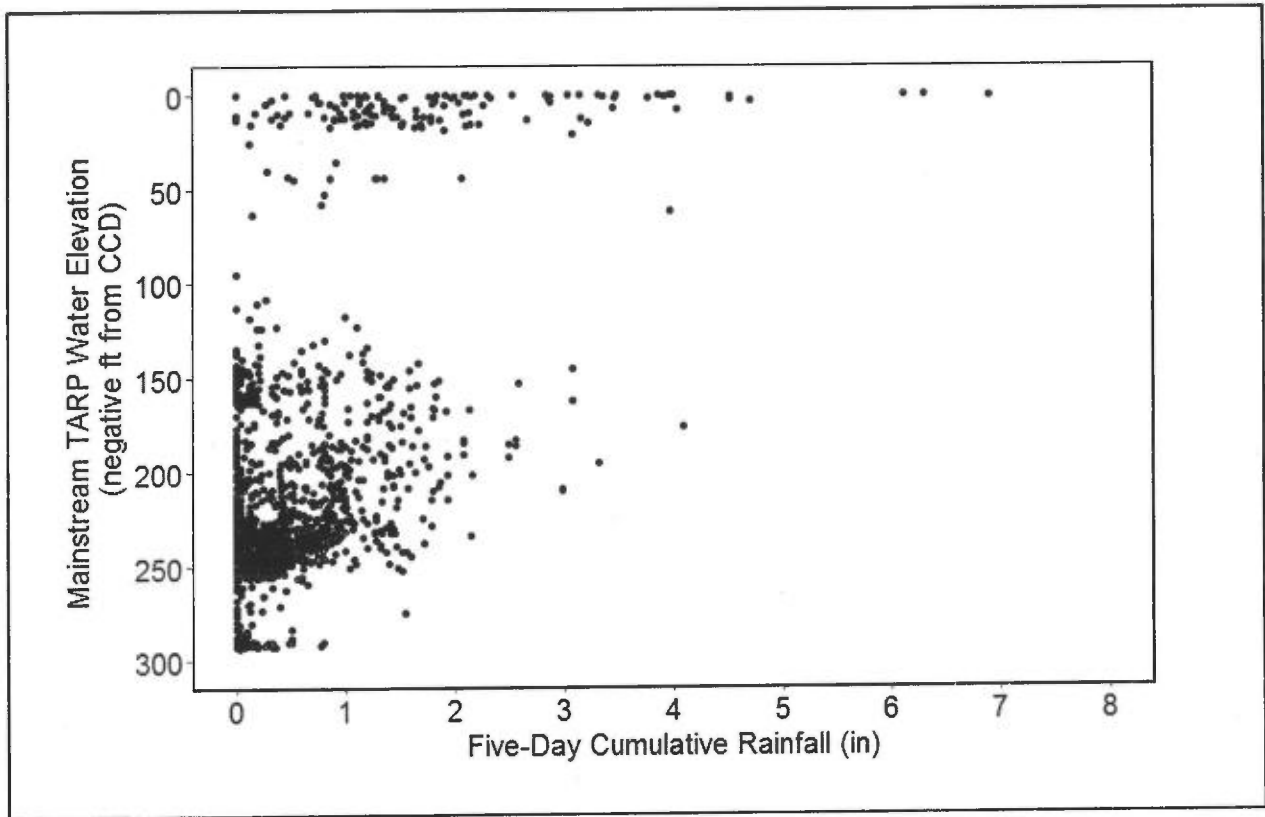
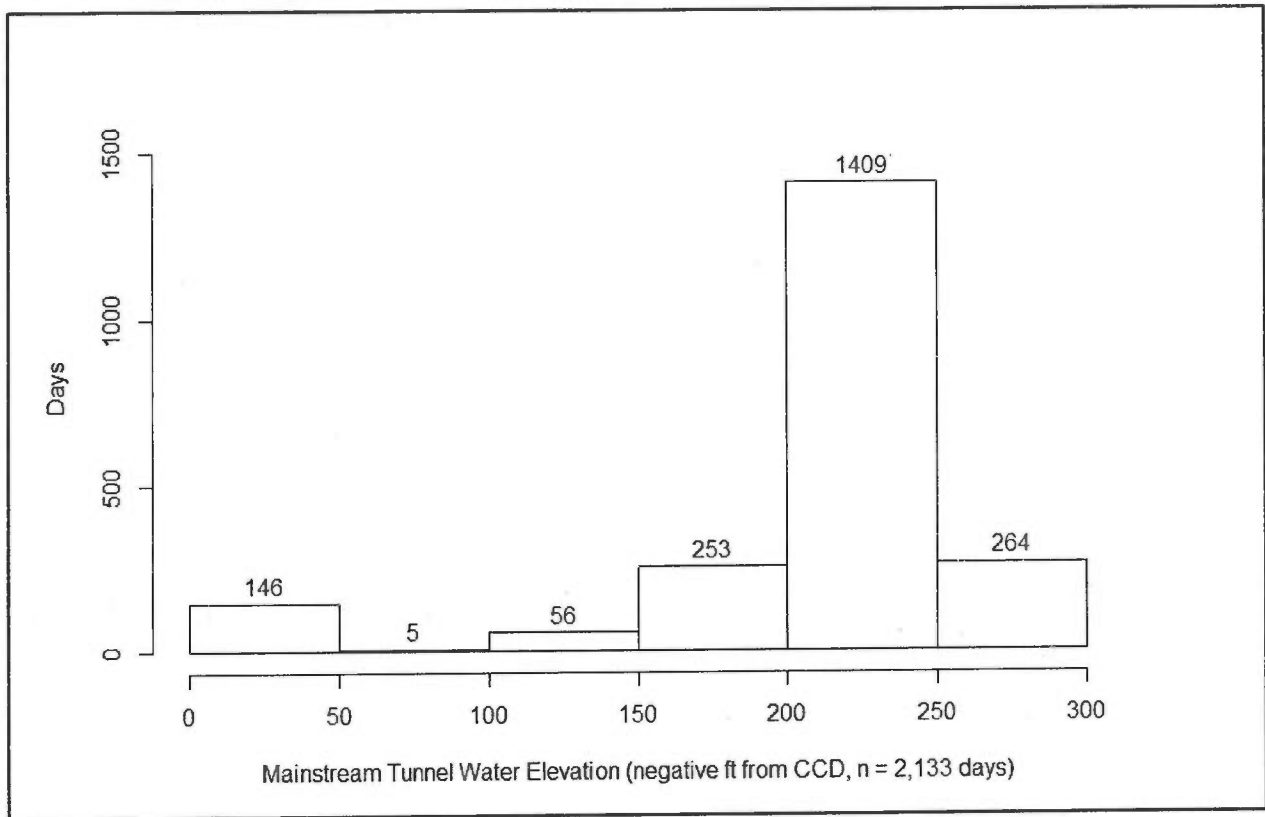


FIGURE 4: FREQUENCY OF MAINSTREAM TUNNEL-WATER ELEVATION ON DAYS WITH FIVE-DAY CUMULATIVE RAINFALL GREATER THAN ZERO FROM 2010-2016





ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

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BRUCE RAUNER, GOVERNOR

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DIRECTOR OF M&R

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OF M&R, CHGO.

February 14, 2018

Edward W. Podczewinski, P.E. Acting Director Monitoring and Research
Metropolitan Water Reclamation District of Greater Chicago
101 East Erie Street
Chicago, IL 60611-3154

Re: Monitoring Program Modifications for the Metropolitan Water Reclamation District of Greater Chicago (District) Tunnel and Reservoir Plan (TARP): Upper Des Plaines, Des Plaines, Calumet and Mainstream Tunnel Systems

Dear Mr. Podczewinsk

The Illinois Environmental Protection Agency (Illinois EPA) has completed its review of the letter dated August 16, 2017 which provided additional information regarding the District's December 23, 2016 request to modify the TARP tunnel system groundwater monitoring plan. The Illinois EPA approves the District's Modifications for the Upper Des Plaines, Des Plaines, Calumet and Mainstream tunnel systems. The District has noted that this monitoring plan commenced operation on January 1, 2017 and will be operated through December 31, 2019. The District is required to continue operating this modified monitoring plan for the Upper Des Plaines, Des Plaines, Calumet and Mainstream tunnel systems after December 31, 2019 unless additional modifications to the plan are approved by the Illinois EPA.

If you have any further questions or would like to discuss the information above, contact Bill Buscher 217-785-4787.

Sincerely,

Richard P. Cobb, P.G.
Deputy Manager, Division of Public Water Supplies
Bureau of Water

CC: Amy Dragovich
Bill Buscher
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APPENDIX B

TABLES

TABLE B-1: DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ²	TDS ²	TOC ²	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC ²	Temp.	GWE ^{2,3}	Recharge
					mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 mL	°C	ft	Time hr
QC-2	04/06/17	1	1	7.5	58	330	1.4	29	25.03	0.12	83	550	12.6	-296.69	<48
QC-2	04/14/17	1	2	7.9	61	—	—	—	—	—	—	700	14.6	-301.69	<48
QC-2	11/02/17	4	3	7.6	73	394	1.9	52	50.43	0.47	82	40	13.4	-304.69	<48
QC-2	05/16/18	3	1	8.1	57	344	2	30	NA ⁴	0.12	60	<1	12.9	-301.69	<48
QC-2	09/13/18	4	1	7.2	39	342	1.9	27	22.24	<0.50	68	4	16.4	-313.69	<48
QC-2	09/27/18	4	3	7.5	40	—	—	—	—	—	—	<1	13.4	-313.69	<48
QC-2	10/11/18	5	1	8.1	63	352	1.7	28	46.37	<0.50	74	14	13.6	-313.69	<48
QC-2	10/18/18	5	2	8.0	62	—	—	—	—	—	—	910	13.2	-314.69	<48
QC-2	10/25/18	5	3	7.3	61	—	—	—	—	—	—	<1	13.3	-313.69	<48
QC-2	02/13/19	1	1	8.1	41	320	6.1	28	29	<0.50	77	<1	10.2	-313.69	<48
QC-2	02/21/19	1	2	7.9	43	—	—	—	—	—	—	<1	11.5	-313.69	<48
QC-2	03/21/19	2	1	7.8	40	326	1.3	31	46	<0.50	72	1	11.7	-312.69	<48
QC-2	03/28/19	2	2	8.0	42	—	—	—	—	—	—	<1	12.9	-312.69	<48
QC-2	04/03/19	2	3	7.7	40	—	—	—	—	—	—	<1	12.7	-312.69	<48
QC-2	04/25/19	3	1	7.8	45	338	1.2	29	49	<0.3	72	<1	13.4	-312.69	<48
QC-2	05/02/19	3	2	7.8	44	—	—	—	—	—	—	5	12	-313.69	<48
QC-2	05/09/19	3	3	7.7	47	—	—	—	—	—	—	2	14	-313.69	<48
QC-2	08/01/19	4	1	7.9	45	384	1.1	35	36	<0.3	90	<1	14.3	-312.69	<48
QC-2	08/07/19	4	2	7.7	48	—	—	—	—	—	—	<1	15.5	-312.69	<48
QC-2	10/01/19	5	1	8.1	43	358	1.4	36	31	0.49	78	<1	13	-312.69	<48
QC-2	10/08/19	5	2	8.2	41	—	—	—	—	—	—	4	14.1	-312.69	<48
QC-2	10/15/19	5	3	8.4	40	—	—	—	—	—	—	46	12.8	-312.69	<48
QC-4	04/06/17	1	1	8.8	71	422	<1.0	10	21.73	<0.1	14	<1	11.6	-234.08	<48
QC-4	04/14/17	1	2	8.7	70	—	—	—	—	—	—	<1	12.7	-261.08	<48
QC-4	05/04/17	2	1	8.7	65	446	<1.0	8	16.63	0.15	10	1	11.8	-229.08	<48

B-1

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QC-4	05/11/17	2	2	8.6	69	—	—	—	—	—	—	<1	12.2	-226.08	<48
QC-4	05/18/17	2	3	8.6	64	—	—	—	—	—	—	<1	14.2	-224.08	<48
QC-4	08/03/17	3	1	8.7	69	404	—	8	15.4	<0.1	10	<1	13.4	-230.08	<48
QC-4	08/08/17	3	2	8.6	70	—	—	—	—	—	—	<1	13.2	-231.08	<48
QC-4	10/19/17	4	1	8.8	72	428	1.5	9	18.47	0.16	12	2	12.6	-230.08	<48
QC-4	10/26/17	4	2	8.5	68	—	—	—	—	—	—	<1	12.2	-231.08	<48
QC-4	11/02/17	4	3	8.9	70	—	—	—	—	—	—	<1	12.4	-245.08	<48
QC-4	02/28/18	1	1	8.5	67	422	<1.0	8	14.45	0.21	10	<1	12	-239.08	<48
QC-4	03/08/18	1	2	8.7	70	—	—	—	—	—	—	<1	11.7	-241.08	<48
QC-4	04/20/18	2	1	8.4	70	408	<1.0	8	17.85	0.16	12	<1	11.9	-232.08	<48
QC-4	04/27/18	2	2	8.3	51	—	—	—	—	—	—	<1	11.9	-230.08	<48
QC-4	05/16/18	3	1	8.7	65	422	<1.0	8	NA	0.12	9	<1	13	-231.08	<48
QC-4	05/24/18	3	2	8.4	52	—	—	—	—	—	—	<1	13.1	-232.08	<48
QC-4	09/13/18	4	1	8.4	68	448	<1.0	8	16.88	<0.50	10	<1	14.9	-230.08	<48
QC-4	09/20/18	4	2	8.6	67	—	—	—	—	—	—	<1	13.1	-232.08	<48
QC-4	10/11/18	5	1	8.4	68	400	<1.0	8	15.6	<0.50	12	<1	12.3	-232.08	<48
QC-4	10/18/18	5	2	8.5	68	—	—	—	—	—	—	<1	12.4	-232.08	<48
QC-4	02/13/19	1	1	8.2	51	400	<1.0	10	14	<0.50	18	<1	11.7	-213.08	<48
QC-4	02/21/19	1	2	8.8	51	—	—	—	—	—	—	<1	11.6	-231.08	<48
QC-4	03/21/19	2	1	7.6	45	384	<1.0	9	15	<0.50	13	<1	11.5	-233.08	<48
QC-4	03/28/19	2	2	8.4	45	—	—	—	—	—	—	<1	12.1	-234.08	<48
QC-4	04/25/19	3	1	8.3	50	394	<1.0	9	17	<0.3	26	<1	12	-234.08	<48
QC-4	05/02/19	3	2	8.3	49	—	—	—	—	—	—	3	11.5	-233.08	<48
QC-4	05/09/19	3	3	8.3	51	—	—	—	—	—	—	<1	12.5	-234.08	<48
QC-4	08/01/19	4	1	8.7	63	456	<1.0	8	15	<0.3	10	<1	12.6	-210.08	<48
QC-4	08/07/19	4	2	8.3	47	—	—	—	—	—	—	<1	12.4	-213.08	<48

B-2

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QC-4	10/01/19	5	1	8.5	46	408	1	8	14	0.30	13	<1	13.4	-223.08	<48
QC-4	10/08/19	5	2	8.4	44	—	—	—	—	—	—	<1	12.4	-223.08	<48
QC-17	04/06/17	1	1	8.0	78	438	<1.0	6	180.8	0.17	147	<1	11.7	-187.44	<48
QC-17	04/14/17	1	2	8.1	77	—	—	—	—	—	—	<1	13.1	-225.44	<48
QC-17	05/04/17	2	1	7.9	75	488	<1.0	7	175.04	0.29	150	<1	11.9	-170.44	<48
QC-17	05/11/17	2	2	7.9	74	—	—	—	—	—	—	<1	12.7	-166.44	<48
QC-17	08/03/17	3	1	7.7	79	474	<1.0	6	182.48	0.22	154	<1	13.6	-201.44	<48
QC-17	08/08/17	3	2	7.6	80	—	—	—	—	—	—	<1	12.9	-202.44	<48
QC-17	10/19/17	4	1	8.0	79	492	1.5	6	195.68	0.25	152	2	12.8	-190.44	<48
QC-17	10/26/17	4	2	7.9	78	—	—	—	—	—	—	21	12.7	-196.44	<48
QC-17	11/02/17	4	3	7.0	77	—	—	—	—	—	—	<1	12.5	-217.44	<48
QC-17	02/28/18	1	1	8.1	74	472	2.2	6	176.36	0.25	140	<1	12.4	-214.44	<48
QC-17	03/08/18	1	2	7.2	77	—	—	—	—	—	—	<1	12.3	-215.44	<48
QC-17	04/20/18	2	1	7.8	77	470	<1.0	6	193.88	0.28	152	<1	12.3	-204.44	<48
QC-17	04/27/18	2	2	7.1	58	—	—	—	—	—	—	<1	12.5	-204.44	<48
QC-17	05/24/18	3	2	7.8	60	474	<1.0	6	187.52	0.27	158	<1	13.1	-204.44	<48
QC-17	05/31/18	3	3	7.6	75	—	—	—	—	—	—	<1	13.2	-203.44	<48
QC-17	09/13/18	4	1	7.8	36	482	1	6	154.98	<0.5	150	<1	14.7	-205.44	<48
QC-17	09/20/18	4	2	8.0	65	—	—	—	—	—	—	1	13	-162.44	<48
QC-17	09/27/18	4	3	7.5	48	—	—	—	—	—	—	<1	12.8	-206.44	<48
QC-17	10/11/18	5	1	7.9	78	482	<1.0	5	176.12	<0.5	150	<1	12.5	-206.44	<48
QC-17	10/18/18	5	2	8.0	76	—	—	—	—	—	—	<1	12.8	-203.44	<48
QC-17	02/13/19	1	1	8.4	50	458	<1.0	6	184	<0.5	141	<1	10.8	-201.44	<48
QC-17	02/21/19	1	2	7.6	56	—	—	—	—	—	—	<1	11.8	-201.44	<48
QC-17	03/21/19	2	1	7.1	51	436	<1.0	6	182	<0.5	147	1	11.6	-201.44	<48

B-3

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ²	TDS ²	TOC ²	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC ²	Temp.	GWE ^{2,3}	Recharge	
					mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 mL	°C	ft	Time hr	
QC-17	03/28/19	2	2	7.9	53	—	—	—	—	—	—	<1	12.1	-202.44	<48	
QC-17	04/03/19	2	3	8.0	50	—	—	—	—	—	—	<1	12.1	-201.44	<48	
QC-17	04/25/19	3	1	7.9	58	386	1.1	6	178	<0.3	165	<1	12.3	-201.44	<48	
QC-17	05/02/19	3	2	7.7	57	—	—	—	—	—	—	3	11.6	-190.44	<48	
QC-17	05/09/19	3	3	7.6	64	—	—	—	—	—	—	<1	12.9	-154.44	<48	
QC-17	08/01/19	4	1	7.7	77	524	<1.0	17	183	<0.3	167	<1	12.8	-169.44	<48	
QC-17	08/07/19	4	2	7.6	60	—	—	—	—	—	—	<1	12.8	-173.44	<48	
QC-17	10/01/19	5	1	7.3	65	498	<1.0	14	175	0.30	157	<1	14	-177.44	<48	
QC-17	10/08/19	5	2	7.9	58	—	—	—	—	—	—	<1	12.7	-164.44	<48	
B-4	MW-5	01/20/17	1	1	8.0	72	416	<1.0	64	129.2	<0.1	134	2	12.9	-48.20	<48
	MW-5	01/26/17	1	2	8.2	94	—	—	—	—	—	6	12.4	-55.20	<48	
	MW-5	02/02/17	1	3	8.0	98	—	—	—	—	—	<1	13.2	-53.20	<48	
	MW-5	03/03/17	2	1	7.9	96	620	<1.0	86	222	0.29	212	<1	13.6	-50.20	<48
	MW-5	03/09/17	2	2	7.9	92	—	—	—	—	—	—	<1	13.2	-57.20	<48
	MW-5	04/06/17	3	1	6.5	103	744	<1.0	73	321.92	0.57	344	<1	13.3	-53.20	<48
	MW-5	04/13/17	3	2	7.6	89	—	—	—	—	—	—	4	13.1	-57.20	<48
	MW-5	04/20/17	3	3	7.6	55	—	—	—	—	—	—	<1	13.9	-55.20	<48
	MW-5	05/04/17	4	1	7.7	107	754	<1.0	70	286.65	0.64	322	<1	13.7	-46.20	<48
	MW-5	05/11/17	4	2	7.9	97	—	—	—	—	—	—	<1	13.5	-55.20	<48
	MW-5	07/19/17	5	1	7.9	87	682	<1.0	70	294.54	0.47	316	17	12.9	-55.20	<48
	MW-5	07/26/17	5	2	7.0	70	—	—	—	—	—	—	58	15	-55.20	<48
	MW-5	08/02/17	5	3	7.8	95	—	—	—	—	—	—	4	15	-54.20	<48
	MW-5	10/18/17	6	1	7.3	105	720	1.5	63	302.55	0.67	325	1	14.9	-48.20	<48
	MW-5	10/25/17	6	2	7.9	76	—	—	—	—	—	—	10	14.4	-56.20	<48
MW-5	11/01/17	6	3	7.3	97	—	—	—	—	—	—	4	13.5	-56.20	<48	

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
MW-5	02/23/18	1	1	8.1	105	1,036	<1.0	435	139.55	0.35	157	<1	13.5	-20.20	<48
MW-5	03/02/18	1	2	7.5	100	—	—	—	—	—	—	<1	14.2	34.80	<48
MW-5	04/19/18	2	1	7.0	147	832	<1.0	169	278.85	0.54	309	<1	14.3	-51.20	<48
MW-5	04/25/18	2	2	8.2	137	—	—	—	—	—	—	4	13.2	-51.20	<48
MW-5	05/02/18	2	3	7.9	98	—	—	—	—	—	—	<1	14.8	-56.20	<48
MW-5	05/17/18	3	1	8.0	123	780	<1.0	250	139.5	0.13	146	4	13.9	-52.20	<48
MW-5	05/24/18	3	2	7.8	113	—	—	—	—	—	—	1	14.1	-54.20	<48
MW-5	05/31/18	3	3	7.9	73	—	—	—	—	—	—	<1	15.2	-57.20	<48
MW-5	09/07/18	4	1	8.0	127	658	1.2	120	265.03	<0.5	271	4	14.5	-57.20	<48
MW-5	09/12/18	4	2	8.1	115	—	—	—	—	—	—	15	14	-57.20	<48
MW-5	09/20/18	4	3	7.5	76	—	—	—	—	—	—	47	14.9	-54.20	<48
MW-5	10/11/18	5	1	8.6	128	680	1.2	160	111.45	<0.5	101	<1	13.8	-56.20	<48
MW-5	10/19/18	5	2	7.0	102	—	—	—	—	—	—	<1	14.6	-56.20	<48
MW-5	02/22/19	1	2	7.9	142	1,058	<1.0	359	210	<0.5	202	<1	13.2	-60.20	<48
MW-5	02/27/19	1	3	7.9	129	—	—	—	—	—	—	<1	12.5	-57.20	<48
MW-5	03/21/19	2	1	7.9	106	806	<1.0	181	264	<0.5	217	1	13	-57.20	<48
MW-5	03/28/19	2	2	7.9	97	—	—	—	—	—	—	<1	13	-57.20	<48
MW-5	04/04/19	2	3	7.7	73	—	—	—	—	—	—	<1	12.5	-57.20	<48
MW-5	04/25/19	3	1	7.5	107	792	<1.0	204	230	<0.3	232	<1	13.2	-54.20	<48
MW-5	05/09/19	3	2	7.6	84	—	—	—	—	—	—	58	14.4	-35.20	<48
MW-5	05/15/19	3	3	7.8	84	—	—	—	—	—	—	2	14	-52.20	<48
MW-5	08/02/19	4	1	7.9	84	726	<1.0	116	253	<0.3	207	24	15	-56.20	<48
MW-5	08/08/19	4	2	7.7	80	—	—	—	—	—	—	14	14.5	-56.20	<48
MW-5	08/15/19	4	3	7.5	89	—	—	—	—	—	—	4	15	-56.20	<48
MW-5	10/03/19	5	1	8.4	49	726	1.2	60	224	0.47	138	23	14.3	-52.20	<48

B-5

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ²	TDS ²	TOC ²	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC ²	Temp. °C	GWE ^{2,3}	Recharge
					mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 mL		ft	Time hr
MW-5	10/10/19	5	2	7.9	66	—	—	—	—	—	—	<1	14.5	-57.20	<48
MW-5	10/17/19	5	3	7.9	68	—	—	—	—	—	—	<1	14.8	-57.20	<48
MW-6	01/19/17	1	1	7.7	99	700	1.6	39	328.8	0.59	362	<1	13.3	65.28	<4
MW-6	01/25/17	1	2	7.9	101	—	—	—	—	—	—	<1	13.1	67.28	<4
MW-6	03/02/17	2	1	7.7	106	656	<1.0	34	338.4	0.73	374	<1	13.2	67.28	<4
MW-6	03/08/17	2	2	7.6	105	—	—	—	—	—	—	13	13.4	65.28	<4
MW-6	03/14/17	2	3	7.5	107	—	—	—	—	—	—	<1	12.8	69.28	<4
MW-6	04/06/17	3	1	7.4	105	676	1	37	343.28	0.46	369	<1	12.9	67.28	<4
MW-6	04/13/17	3	2	7.6	107	—	—	—	—	—	—	<1	13	67.28	<4
MW-6	05/04/17	4	1	8.1	107	714	<1.0	37	317.7	0.53	362	1	13.5	66.28	<4
MW-6	05/11/17	4	2	7.8	107	—	—	—	—	—	—	<1	13.9	66.28	<4
MW-6	05/18/17	4	3	7.8	68	—	—	—	—	—	—	<1	13.8	66.28	<4
MW-6	07/21/17	5	1	7.9	78	716	<1.0	35	337.92	0.47	363	25	13.9	67.28	<4
MW-6	07/28/17	5	2	7.6	106	—	—	—	—	—	—	140	14.4	67.28	<4
MW-6	08/04/17	5	3	7.7	108	—	—	—	—	—	—	5	14	65.28	<4
MW-6	10/20/17	6	1	7.0	84	640	1.5	35	344.4	0.49	352	49	14.3	65.28	<4
MW-6	10/27/17	6	2	7.0	82	—	—	—	—	—	—	7	13.1	66.28	<4
MW-6	11/02/17	6	3	7.3	100	—	—	—	—	—	—	6	13.5	67.28	<4
MW-6	02/22/18	1	1	7.5	101	708	<1.0	36	322	0.59	369	NA	13.5	69.28	<4
MW-6	03/02/18	1	2	7.7	106	—	—	—	—	—	—	<1	13	67.28	<4
MW-6	03/09/18	1	3	7.7	98	—	—	—	—	—	—	<1	13.5	67.28	<4
MW-6	04/18/18	2	1	7.4	81	676	1.1	39	481	0.58	365	<1	13.5	67.28	<4
MW-6	04/25/18	2	2	7.4	84	—	—	—	—	—	—	<1	14.1	67.28	<4
MW-6	05/17/18	3	1	7.7	83	752	1.4	33	317.8	0.56	297	96	14.7	68.28	<4
MW-6	05/22/18	3	2	7.9	54	—	—	—	—	—	—	2,700	15.3	65.28	<4

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
MW-6	05/29/18	3	3	7.8	95	—	—	—	—	—	—	200	14	64.28	<4
MW-6	09/05/18	4	1	7.5	100	608	1.4	38	319.79	1.12	311	1	14.3	67.28	<4
MW-6	09/13/18	4	2	7.5	107	—	—	—	—	—	—	1	15.1	63.28	<4
MW-6	09/21/18	4	3	6.8	97	—	—	—	—	—	—	2	14.6	67.28	<4
MW-6	10/12/18	5	1	7.6	96	186	1.4	34	338.2	0.51	341	340	14	67.28	<4
MW-6	10/19/18	5	2	7.1	98	—	—	—	—	—	—	61	13.5	63.28	<4
MW-6	11/02/18	5	3	7.7	100	—	—	—	—	—	—	6	13.9	67.28	<4
MW-6	02/14/19	1	1	7.9	85	636	<1.0	51	334	<0.5	356	<1	13.4	67.28	<4
MW-6	02/20/19	1	2	7.5	80	—	—	—	—	—	—	<1	13.3	67.28	<4
MW-6	03/20/19	2	1	8.1	79	654	1	44	NA ⁴	0.52	357	<1	13.7	68.28	<4
MW-6	03/27/19	2	2	7.7	97	—	—	—	—	—	—	<1	13.4	71.28	<4
MW-6	04/24/19	3	1	7.6	83	710	<1.0	38	343	0.50	343	<1	14.8	71.28	<4
MW-6	05/01/19	3	2	7.5	40	—	—	—	—	—	—	1,100	13.1	69.28	<4
MW-6	05/08/19	3	3	7.6	77	—	—	—	—	—	—	<1	13.9	70.28	<4
MW-6	07/31/19	4	1	7.6	75	724	<1.0	35	319	0.48	330	260	13.8	67.28	<4
MW-6	08/08/19	4	2	7.7	77	—	—	—	—	—	—	2	14.3	66.28	<4
MW-6	08/13/19	4	3	7.1	74	—	—	—	—	—	—	7	14.2	66.28	<4
MW-6	10/03/19	5	1	7.7	54	426	2.2	19	175	0.37	206	9,100	14.7	67.28	<4
MW-6	10/10/19	5	2	7.7	66	—	—	—	—	—	—	200	14.1	67.28	<4
MW-6	10/17/19	5	3	7.8	70	—	—	—	—	—	—	76	13.6	69.28	<4
MW-7	01/19/17	1	1	7.2	113	798	<1.0	36	373	0.62	478	<1	15	19.70	<4
MW-7	01/24/17	1	2	6.4	117	NA ⁴	NA ⁴	NA ⁴	NA ⁴	NA ⁴	NA ⁴	<1	15.1	20.70	<4
MW-7	03/02/17	2	1	7.3	119	646	<1.0	32	339.04	0.55	434	<1	14.5	20.70	<4
MW-7	07/21/17	5	1	7.5	120	924	<1.0	41	389.04	0.44	472	5	16	21.70	<4
MW-7	07/24/17	5	2	7.4	118	—	—	—	—	—	—	<1	16.1	23.70	<4

B-7

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
MW-7	08/02/17	5	3	7.6	118	—	—	—	—	—	—	2	15.8	20.70	<4
MW-7	10/18/17	6	1	7.2	115	828	1.2	36	398.56	0.53	473	5	15.9	21.70	<4
MW-7	10/25/17	6	2	8.6	114	—	—	—	—	—	—	1	15.8	20.70	<4
MW-7	11/01/17	6	3	7.5	117	—	—	—	—	—	—	<1	14.3	17.70	<4
MW-7	02/22/18	1	1	6.3	113	802	<1.0	40	353.2	0.57	471	NA	15	26.70	<4
MW-7	03/02/18	1	2	7.4	73	—	—	—	—	—	—	4	14.1	23.70	<4
MW-7	03/09/18	1	3	7.1	116	—	—	—	—	—	—	4	14.1	16.70	<4
MW-7	04/18/18	2	1	7.2	115	792	1.6	37	395.5	0.63	490	1	14.3	26.70	<4
MW-7	04/26/18	2	2	7.3	94	—	—	—	—	—	—	<1	14.8	21.70	<4
MW-7	05/03/18	2	3	7.1	74	—	—	—	—	—	—	1	15.2	26.70	<4
MW-7	05/18/18	3	1	7.8	113	962	1.6	38	402.8	0.55	484	23	15	18.70	<4
MW-7	05/22/18	3	2	7.3	110	—	—	—	—	—	—	3	15.2	26.70	<4
MW-7	05/29/18	3	3	7.3	108	—	—	—	—	—	—	<1	15.6	18.70	<4
MW-7	09/05/18	4	1	7.1	102	642	1.1	35	354.77	0.51	437	<1	16.6	19.70	<4
MW-7	09/13/18	4	2	6.5	113	—	—	—	—	—	—	<1	16	17.70	<4
MW-7	10/08/18	5	1	7.1	114	836	<1.0	37	402.8	0.56	476	<1	16.6	23.70	<4
MW-7	10/24/18	5	3	6.9	114	—	—	—	—	—	—	<1	15.4	19.70	<4
MW-7	02/15/19	1	1	7.8	92	814	<1.0	39	377	0.57	466	<1	14.8	26.70	<4
MW-7	02/20/19	1	2	7.3	91	—	—	—	—	—	—	<1	14.6	26.70	<4
MW-7	03/20/19	2	1	7.7	94	736	<1.0	43	NA ⁴	0.59	493	<1	15.1	26.70	<4
MW-7	03/27/19	2	2	7.5	92	—	—	—	—	—	—	<1	14.8	26.70	<4
MW-7	04/24/19	3	1	7.4	92	808	<1.0	39	368	0.52	450	<1	14.7	26.70	<4
MW-7	05/01/19	3	2	7.1	69	—	—	—	—	—	—	980	14.8	26.70	<4
MW-7	05/08/19	3	3	7.2	91	—	—	—	—	—	—	74	14.9	26.70	<4
MW-7	07/31/19	4	1	7.4	87	836	<1.0	38	359	0.52	432	<1	14.9	26.70	<4
MW-7	08/08/19	4	2	7.4	88	—	—	—	—	—	—	79	15.3	26.70	<4

B-8

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
MW-7	08/15/19	4	3	7.3	93	—	—	—	—	—	—	<1	15.5	26.70	<4
MW-7	10/03/19	5	1	7.3	78	816	<1.0	38	364	0.59	460	13	15.3	26.70	<4
MW-7	10/10/19	5	2	7.5	88	—	—	—	—	—	—	<1	14.3	26.70	<4
MW-7	10/17/19	5	3	7.6	76	—	—	—	—	—	—	<1	15.2	26.70	<4
MW-8	01/20/17	1	1	7.8	121	806	<1.0	88	321.6	<0.10	398	1	14.4	-28.20	<48
MW-8	01/26/17	1	2	8.0	106	—	—	—	—	—	—	3	13.1	-59.20	<48
MW-8	02/02/17	1	3	8.1	112	—	—	—	—	—	—	<1	13.1	-60.20	<48
MW-8	03/03/17	2	1	8.1	108	694	<1.0	55	318.4	0.11	368	<1	13.9	-60.20	<48
MW-8	03/09/17	2	2	8.0	108	—	—	—	—	—	—	<1	14.2	-59.20	<48
MW-8	04/13/17	3	1	7.9	110	610	1.6	61	272.8	<0.10	333	<1	13.8	-50.20	<48
MW-8	04/20/17	3	2	8.1	113	—	—	—	—	—	—	<1	15.1	-59.20	<48
MW-8	05/04/17	4	1	8.1	107	696	<1.0	58	284	<0.10	369	<1	14.2	-53.20	<48
MW-8	05/11/17	4	2	7.9	110	—	—	—	—	—	—	2	14.5	-59.20	<48
MW-8	05/18/17	4	3	7.9	94	—	—	—	—	—	—	<1	15.3	-61.20	<48
MW-8	07/19/17	5	1	7.9	99	622	<1.0	51	281.6	<0.10	349	100	15.1	-52.20	<48
MW-8	07/26/17	5	2	7.9	202	—	—	—	—	—	—	47	14.8	-47.20	<48
MW-8	08/02/17	5	3	7.9	109	—	—	—	—	—	—	110	15.4	-49.20	<48
MW-8	10/18/17	6	1	7.8	87	596	2.3	43	257.36	<0.10	314	55	15	-56.20	<48
MW-8	10/25/17	6	2	8.0	97	—	—	—	—	—	—	4	14.9	-56.20	<48
MW-8	11/01/17	6	3	7.8	103	—	—	—	—	—	—	3	14.5	-56.20	<48
MW-8	02/23/18	1	1	7.9	105	650	1.2	79	247.8	0.31	346	8,200	14.6	-25.20	<48
MW-8	03/02/18	1	2	7.9	137	—	—	—	—	—	—	91	14	-33.20	<48
MW-8	03/09/18	1	3	7.5	135	—	—	—	—	—	—	17	14.1	-42.20	<48
MW-8	04/19/18	2	1	7.8	112	758	1.1	43	376	0.11	449	2	13.3	-31.20	<48
MW-8	04/25/18	2	2	7.8	112	—	—	—	—	—	—	<1	14.1	-34.20	<48

B-9

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ²	TDS ²	TOC ²	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC ²	Temp.	GWE ^{2,3}	Recharge
					mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 mL	°C	ft	hr
MW-8	05/02/18	2	3	8.2	103	—	—	—	—	—	—	<1	15.5	-28.20	<48
MW-8	05/17/18	3	1	7.7	111	916	1	47	369.1	0.16	434	4	14.6	-7.20	<48
MW-8	05/24/18	3	2	7.6	107	—	—	—	—	—	—	4	14.6	-23.20	<48
MW-8	05/31/18	3	3	7.4	69	—	—	—	—	—	—	3	15.4	-11.20	<48
MW-8	09/07/18	4	1	7.8	100	378	1.7	65	263.63	<0.50	312	14	14.6	-28.20	<48
MW-8	09/12/18	4	2	7.8	106	—	—	—	—	—	—	2	14.7	-42.20	<48
MW-8	09/20/18	4	3	7.6	75	—	—	—	—	—	—	35	14.8	-41.20	<48
MW-8	10/11/18	5	1	8.4	103	744	1.3	42	337.46	<0.50	416	<1	14.4	-39.20	<48
MW-8	10/19/18	5	2	7.8	103	—	—	—	—	—	—	1	14.9	-35.20	<48
MW-8	10/25/18	5	3	7.6	107	—	—	—	—	—	—	<1	14.5	-38.20	<48
MW-8	02/15/19	1	1	8.3	107	772	<1.0	241	184	<0.50	242	<1	14.3	-34.20	<48
MW-8	02/22/19	1	2	7.8	92	—	—	—	—	—	—	<1	14	-33.20	<48
MW-8	03/21/19	2	1	8.1	84	686	<1.0	50	351	<0.50	383	<1	14	-37.20	<48
MW-8	03/28/19	2	2	7.8	86	—	—	—	—	—	—	<1	13.8	-30.20	<48
MW-8	04/25/19	3	1	7.8	89	736	1.2	54	337	<0.3	358	<1	14.8	-36.20	<48
MW-8	05/02/19	3	2	7.6	80	—	—	—	—	—	—	9,600	13.6	-11.20	<48
MW-8	05/09/19	3	3	7.6	82	—	—	—	—	—	—	150	14.7	-44.20	<48
MW-8	08/02/19	4	1	7.8	69	666	<1.0	60	269	<0.3	327	1	14.5	-49.20	<48
MW-8	08/08/19	4	2	7.7	81	—	—	—	—	—	—	2	15	-54.20	<48
MW-8	08/15/19	4	3	7.6	85	—	—	—	—	—	—	1	15.4	-40.20	<48
MW-8	10/03/19	5	1	8.2	27	252	1.2	15	99	<0.3	130	5,000	14.8	5.80	<48
MW-8	10/10/19	5	2	7.9	59	—	—	—	—	—	—	280	14.6	-33.20	<48
MW-8	10/17/19	5	3	8.0	76	—	—	—	—	—	—	29	14.5	-44.20	<48
QD-27	02/02/17	1	3	6.9	235	—	—	—	—	—	—	180	12	-162.37	<48
QD-27	03/03/17	2	1	7.3	250	1,336	9.4	455	41.68	32.13	467	43	12.3	-140.37	<48

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-27	03/08/17	2	2	7.3	254	—	—	—	—	—	—	5	12.4	-182.37	<48
QD-27	03/16/17	2	3	6.8	259	—	—	—	—	—	—	4	12.3	-156.37	<48
QD-27	04/05/17	3	1	6.9	272	1,180	12	383	67.22	28.53	464	650	11.5	-168.37	<48
QD-27	04/12/17	3	2	7.1	252	—	—	—	—	—	—	<1	12.7	-161.37	<48
QD-27	04/19/17	3	3	7.1	241	—	—	—	—	—	—	35	12.7	-182.37	<48
QD-27	05/03/17	4	1	7.2	277	1,316	14	465	49.93	24.40	455	2,400	13.1	-24.37	<48
QD-27	05/10/17	4	2	7.0	237	—	—	—	—	—	—	670	12.5	-166.37	<48
QD-27	05/17/17	4	3	7.4	249	—	—	—	—	—	—	160	13.7	-166.37	<48
QD-27	07/14/17	5	1	7.1	87	1,142	14	342	25.7	28.47	461	15	13.9	-146.37	<48
QD-27	07/20/17	5	2	7.1	279	—	—	—	—	—	—	<1	14.4	-128.37	<48
QD-27	07/27/17	5	3	7.0	263	—	—	—	—	—	—	4,000	13.9	-154.37	<48
QD-27	10/13/17	6	1	7.4	235	1,250	13.1	21	40.35	31.72	480	39	13.4	-155.37	<48
QD-27	10/19/17	6	2	7.2	253	—	—	—	—	—	—	1,300	12.6	-148.37	<48
QD-27	10/26/17	6	3	6.7	256	—	—	—	—	—	—	1,100	12.9	-123.37	<48
QD-27	02/22/18	1	1	7.0	296	1,490	8.7	579	56.55	29.28	487	NA	12.3	-46.37	<48
QD-27	03/01/18	1	2	7.2	227	—	—	—	—	—	—	1,400	12.8	-150.37	<48
QD-27	03/09/18	1	3	7.2	259	—	—	—	—	—	—	29	12.4	-155.37	<48
QD-27	04/19/18	2	1	7.2	250	1,282	17.3	467	40.61	25.03	496	17,000	12.4	-168.37	<48
QD-27	04/25/18	2	2	7.0	259	—	—	—	—	—	—	1,100	12.6	-141.37	<48
QD-27	05/02/18	2	3	7.1	263	—	—	—	—	—	—	57	13.4	-171.37	<48
QD-27	05/17/18	3	1	6.8	276	1,584	9.7	528	64.11	26.84	533	>20,000	13	-86.37	<48
QD-27	05/24/18	3	2	7.2	244	—	—	—	—	—	—	>20,000	13.8	-81.37	<48
QD-27	05/31/18	3	3	6.8	153	—	—	—	—	—	—	1,200	15.3	-162.37	<48
QD-27	09/06/18	4	1	7.2	254	1,116	9.8	449	37.81	26.75	486	>20,000	13	-159.37	<48
QD-27	09/12/18	4	2	7.0	238	—	—	—	—	—	—	2,600	13.7	-172.37	<48
QD-27	09/20/18	4	3	7.2	238	—	—	—	—	—	—	35	13.8	-171.37	<48

B-11

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-27	10/10/18	5	1	7.1	247	1,308	12.1	445	41.76	29.37	514	19	13.8	-169.37	<48
QD-27	10/17/18	5	2	7.2	280	—	—	—	—	—	—	6	12.4	-160.37	<48
QD-27	10/24/18	5	3	7.3	279	—	—	—	—	—	—	10	12.6	-141.37	<48
QD-27	02/13/19	1	1	7.2	217	1,094	10.7	449	48	26.12	513	<1	12.6	-147.37	<48
QD-27	02/21/19	1	2	7.2	189	—	—	—	—	—	—	4	13.3	-152.37	<48
QD-27	02/28/19	1	3	7.1	224	—	—	—	—	—	—	14	11.8	-171.37	<48
QD-27	03/20/19	2	1	7.1	160	1,170	11.1	NA ⁴	83	26.25	528	4	12.5	-172.37	<48
QD-27	03/27/19	2	2	7.1	171	—	—	—	—	—	—	2	12.4	-176.37	<48
QD-27	04/03/19	2	3	7.1	148	—	—	—	—	—	—	1	12.7	-168.37	<48
QD-27	04/24/19	3	1	6.9	200	1,312	8.5	480	52	29.39	532	1	12.6	-158.37	<48
QD-27	05/01/19	3	2	7.3	219	—	—	—	—	—	—	2,700	12.7	-36.37	<48
QD-27	05/08/19	3	3	7.2	189	—	—	—	—	—	—	1,200	12.5	-159.37	<48
QD-27	08/01/19	4	1	7.5	154	1,320	10.3	425	41	27.42	504	<1	14.1	-173.37	<48
QD-27	08/07/19	4	2	7.2	164	—	—	—	—	—	—	<1	13.5	-172.37	<48
QD-27	10/04/19	5	1	7.3	186	1,448	9.5	509	40	26.45	532	17,000	13.3	-47.37	<48
QD-27	10/09/19	5	2	8.2	162	—	—	—	—	—	—	9,700	13.1	-155.37	<48
QD-27	10/16/19	5	3	7.1	154	—	—	—	—	—	—	990	12.6	-173.37	<48
QD-29	01/19/17	1	1	7.1	328	2,290	4.7	166	767	1.04	877	20	12.8	-61.08	<4
QD-29	01/23/17	1	2	6.4	339	—	—	—	—	—	—	5	13	-59.08	<4
QD-29	02/01/17	1	3	7.1	372	—	—	—	—	—	—	1	12.8	-61.08	<4
QD-29	03/02/17	2	1	7.8	380	2,102	3.7	481	45.57	1.23	1,024	<1	12.6	-59.08	<4
QD-29	03/09/17	2	2	7.0	381	—	—	—	—	—	—	1	12.7	-61.08	<4
QD-29	04/05/17	3	1	7.2	374	2,476	5.6	566	928.6	1.24	1,012	<1	12.8	-63.08	<4
QD-29	04/12/17	3	2	7.2	372	—	—	—	—	—	—	250	13.1	-54.08	<4
QD-29	04/19/17	3	3	7.4	327	—	—	—	—	—	—	<1	15.4	-55.08	<4

B-12

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-29	05/03/17	4	1	7.3	384	2,576	4.8	590	846.9	1.13	992	<1	12.9	-43.08	<4
QD-29	05/10/17	4	2	7.2	374	—	—	—	—	—	—	<1	13.1	-50.08	<4
QD-29	07/13/17	5	1	7.1	187	1,198	1.7	176	273.75	0.45	666	4	13.5	-91.08	<4
QD-29	07/19/17	5	2	7.1	177	—	—	—	—	—	—	2	14.5	-103.08	<4
QD-29	07/26/17	5	3	6.8	111	—	—	—	—	—	—	12	13.7	-79.08	<4
QD-29	10/12/17	6	1	7.0	170	922	1.4	169	304.05	0.47	678	25	13.2	-86.08	<4
QD-29	10/18/17	6	2	7.0	182	—	—	—	—	—	—	6	14.7	-67.08	<4
QD-29	10/25/17	6	3	7.4	162	—	—	—	—	—	—	94	13.2	-64.08	<4
QD-29	02/21/18	1	1	6.5	163	1,028	2	161	271.55	0.45	653	<1	12.9	-74.08	<4
QD-29	03/02/18	1	2	6.5	157	—	—	—	—	—	—	<1	13.2	-75.08	<4
QD-29	04/18/18	2	1	6.8	164	1,014	1.7	156	286.45	0.44	721	<1	13.1	-78.08	<4
QD-29	04/26/18	2	2	6.6	126	—	—	—	—	—	—	<1	13.3	-76.08	<4
QD-29	05/16/18	3	1	7.1	89	1,104	1.8	168	NA	0.41	697	<1	14.1	-74.08	<4
QD-29	05/23/18	3	2	6.7	153	—	—	—	—	—	—	100	14.9	-81.08	<4
QD-29	06/01/18	3	3	7.2	103	—	—	—	—	—	—	<1	13.8	-84.08	<4
QD-29	09/06/18	4	1	7.0	155	760	1.7	162	252.53	<0.5	678	4	14.1	-69.08	<4
QD-29	09/13/18	4	2	7.0	154	—	—	—	—	—	—	<1	14.4	-73.08	<4
QD-29	09/19/18	4	3	6.9	154	—	—	—	—	—	—	<1	14.2	-109.08	<4
QD-29	10/10/18	5	1	7.0	207	1,324	2.5	332	292.23	0.51	717	<1	14	-66.08	<4
QD-29	10/25/18	5	3	7.0	248	—	—	—	—	—	—	<1	13.2	-72.08	<4
QD-29	02/13/19	1	1	7.2	121	940	<1.0	158	243	<0.5	628	<1	13.6	-80.08	<4
QD-29	02/21/19	1	2	7.1	118	—	—	—	—	—	—	<1	11.4	-79.08	<4
QD-29	03/19/19	2	1	7.1	118	918	1.3	144	248	<0.5	657	<1	13.4	-85.08	<4
QD-29	03/26/19	2	2	7.4	96	—	—	—	—	—	—	<1	13.4	-87.08	<4
QD-29	04/23/19	3	1	7.1	116	936	<1.0	142	249	0.41	621	<1	13.5	-88.08	<4
QD-29	04/30/19	3	2	7.4	115	—	—	—	—	—	—	12	14.3	-78.08	<4

B-13

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-29	05/07/19	3	3	7.4	119	—	—	—	—	—	—	<1	13.9	-78.08	<4
QD-29	08/01/19	4	1	7.2	104	1,012	1.1	141	223	0.34	596	<1	13.7	-84.08	<4
QD-29	08/08/19	4	2	7.4	112	—	—	—	—	—	—	<1	13.9	-85.08	<4
QD-29	10/04/19	5	1	7.1	98	1,018	1.2	150	244	0.51	665	31	13.5	-66.08	<4
QD-29	10/09/19	5	2	7.0	118	—	—	—	—	—	—	11	13.7	-64.08	<4
QD-29	10/16/19	5	3	7.1	103	—	—	—	—	—	—	3	13.5	-66.08	<4
QD-30	02/02/17	1	3	7.1	136	—	—	—	—	—	—	6	12.1	-96.50	<48
QD-30	03/03/17	2	1	7.5	121	772	<1.0	97	186.99	0.43	465	1	11.9	-92.50	<48
QD-30	03/08/17	2	2	7.2	124	—	—	—	—	—	—	<1	12.3	-106.50	<48
QD-30	04/05/17	3	1	7.1	128	746	<1.0	98	196.88	0.21	475	<1	12.1	-96.50	<48
QD-30	04/12/17	3	2	7.1	128	—	—	—	—	—	—	<1	12.6	-94.50	<48
QD-30	05/03/17	4	1	7.2	120	788	<1.0	101	186.15	0.27	447	6	12.3	-48.50	<48
QD-30	05/10/17	4	2	7.0	126	—	—	—	—	—	—	1	12.7	-93.50	<48
QD-30	05/17/17	4	3	7.2	131	—	—	—	—	—	—	10	13	-94.50	<48
QD-30	07/14/17	5	1	7.3	132	816	<1.0	97	171.2	0.27	475	1	12.7	-98.50	<48
QD-30	07/20/17	5	2	7.3	145	—	—	—	—	—	—	>20,000	12.9	-86.50	<48
QD-30	07/27/17	5	3	7.3	126	—	—	—	—	—	—	900	13.2	-152.50	<48
QD-30	10/13/17	6	1	7.4	142	800	1	112	232.3	0.30	511	2	13.2	-106.50	<48
QD-30	10/19/17	6	2	6.6	134	—	—	—	—	—	—	14	12.5	-97.50	<48
QD-30	10/26/17	6	3	6.5	139	—	—	—	—	—	—	83	12.3	-80.50	<48
QD-30	02/23/18	1	1	6.7	135	926	1	123	244.7	0.33	553	1	12.3	-58.50	<48
QD-30	03/01/18	1	2	7.4	138	—	—	—	—	—	—	3	11.8	-96.50	<48
QD-30	03/09/18	1	3	7.4	137	—	—	—	—	—	—	<1	11.9	-99.50	<48
QD-30	04/19/18	2	1	7.0	148	944	1.5	126	260.4	0.35	620	500	12.3	-121.50	<48
QD-30	04/25/18	2	2	7.0	145	—	—	—	—	—	—	130	12.2	-117.50	<48

B-14

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3}	Recharge
														CCD ft	Time hr
QD-30	05/02/18	2	3	6.4	138	—	—	—	—	—	—	16	12.8	-103.50	<48
QD-30	05/17/18	3	1	7.0	156	1,154	1.2	125	313.9	0.37	650	14	12.6	-77.50	<48
QD-30	05/24/18	3	2	7.4	136	—	—	—	—	—	—	2,900	12.8	-60.50	<48
QD-30	05/31/18	3	3	6.9	92	—	—	—	—	—	—	210	13.3	-93.50	<48
QD-30	09/06/18	4	1	6.9	141	816	1.2	121	NA	<0.5	561	280	12.8	-95.50	<48
QD-30	09/12/18	4	2	7.0	146	—	—	—	—	—	—	12	13	-122.50	<48
QD-30	09/20/18	4	3	7.0	96	—	—	—	—	—	—	4	12.9	-179.50	<48
QD-30	10/10/18	5	1	7.2	138	832	1.1	111	208.99	<0.5	539	<1	13.6	-103.50	<48
QD-30	10/17/18	5	2	7.6	135	—	—	—	—	—	—	<1	12.4	-98.50	<48
QD-30	02/13/19	1	1	7.6	97	776	<1.0	101	196	<0.5	480	<1	14.6	-95.50	<48
QD-30	02/21/19	1	2	7.2	91	—	—	—	—	—	—	<1	11.7	-95.50	<48
QD-30	03/20/19	2	1	7.2	96	872	<1.0	132	273	<0.5	603	2	12.3	-104.50	<48
QD-30	03/27/19	2	2	7.7	92	—	—	—	—	—	—	<1	11.8	-106.50	<48
QD-30	04/03/19	2	3	7.4	95	—	—	—	—	—	—	<1	12.5	-104.50	<48
QD-30	04/24/19	3	1	7.4	114	1,002	1.2	127	289	<0.3	646	<1	12.2	-100.50	<48
QD-30	05/01/19	3	2	7.2	116	—	—	—	—	—	—	15	12.4	-56.50	<48
QD-30	05/08/19	3	3	7.0	115	—	—	—	—	—	—	<1	12.8	-88.50	<48
QD-30	08/01/19	4	1	7.3	103	1,100	<1.0	120	298	<0.3	659	<1	13.5	-99.50	<48
QD-30	08/07/19	4	2	7.8	122	—	—	—	—	—	—	1	12.8	-98.50	<48
QD-30	08/15/19	4	3	7.1	114	—	—	—	—	—	—	<1	12.7	-100.50	<48
QD-30	10/04/19	5	1	7.1	97	1,060	1.2	116	313	0.33	726	210	13	-55.50	<48
QD-30	10/09/19	5	2	7.0	100	—	—	—	—	—	—	13	12.7	-86.50	<48
QD-30	10/16/19	5	3	7.1	91	—	—	—	—	—	—	3	12.6	-89.50	<48
QD-31	02/02/17	1	3	7.2	151	—	—	—	—	—	—	55	11.7	-178.00	<48
QD-31	03/03/17	2	1	7.5	144	716	<1.0	102	131.54	0.72	199	>20,000	11.3	-153.00	<48

B-15

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-31	03/08/17	2	2	7.5	143	—	—	—	—	—	—	98	11.8	-194.00	<48
QD-31	03/16/17	2	3	7.3	153	—	—	—	—	—	—	35	11.2	-183.00	<48
QD-31	04/05/17	3	1	7.4	148	860	<1.0	117	218.8	0.18	273	95	11.6	-192.00	<48
QD-31	04/12/17	3	2	7.4	139	—	—	—	—	—	—	1,200	12.3	-193.00	<48
QD-31	04/19/17	3	3	7.4	144	—	—	—	—	—	—	41	12.4	-195.00	<48
QD-31	05/03/17	4	1	7.5	106	700	14.3	135	73.32	0.17	199	16,000	12.3	13.00	<48
QD-31	05/10/17	4	2	7.3	148	—	—	—	—	—	—	79	12.4	-192.00	<48
QD-31	05/17/17	4	3	7.4	149	—	—	—	—	—	—	960	12.1	-197.00	<48
QD-31	07/14/17	5	1	7.4	139	832	3.1	133	155.7	0.17	265	89,000	12.3	-195.00	<48
QD-31	07/20/17	5	2	7.4	155	—	—	—	—	—	—	>20,000	13.3	-22.00	<48
QD-31	07/27/17	5	3	7.6	105	—	—	—	—	—	—	59,000	13	-190.00	<48
QD-31	10/13/17	6	1	7.6	125	732	1.9	106	229.2	0.14	258	>20,000	12.8	-177.00	<48
QD-31	10/19/17	6	2	7.4	127	—	—	—	—	—	—	>20,000	12.1	-169.00	<48
QD-31	10/26/17	6	3	6.9	110	—	—	—	—	—	—	>20,000	12.1	-135.00	<48
QD-31	02/23/18	1	1	7.4	188	1,074	2	426	70.12	0.32	281	29,000	11.4	15.00	<48
QD-31	03/01/18	1	2	7.4	165	—	—	—	—	—	—	690	11.9	-193.00	<48
QD-31	03/09/18	1	3	7.9	154	—	—	—	—	—	—	22	12.9	-192.00	<48
QD-31	04/19/18	2	1	7.5	118	712	1.8	119	134.6	0.23	213	6,100	11.9	-192.00	<48
QD-31	04/25/18	2	2	7.6	119	—	—	—	—	—	—	9,800	11.5	-190.00	<48
QD-31	05/02/18	2	3	7.1	94	—	—	—	—	—	—	19	13.7	-195.00	<48
QD-31	05/17/18	3	1	7.5	84	534	2.6	84	75.6	0.15	115	>20,000	12.4	-80.00	<48
QD-31	05/24/18	3	2	8.0	76	—	—	—	—	—	—	>20,000	12.4	-61.00	<48
QD-31	05/31/18	3	3	7.3	91	—	—	—	—	—	—	120	12.7	-197.00	<48
QD-31	09/07/18	4	1	7.2	140	738	<1.0	123	173.91	<0.5	277	5,700	13.8	-190.00	<48
QD-31	09/12/18	4	2	7.4	147	—	—	—	—	—	—	100	12.4	-197.00	<48
QD-31	09/20/18	4	3	7.3	97	—	—	—	—	—	—	76	14.3	-229.00	<48

B-16

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-31	10/10/18	5	1	7.3	149	896	<1.0	120	137.1	<0.5	289	22	12.5	-192.00	<48
QD-31	10/17/18	5	2	7.3	151	—	—	—	—	—	—	14	11.9	-196.00	<48
QD-31	10/24/18	5	3	7.2	152	—	—	—	—	—	—	21	12.1	-177.00	<48
QD-31	02/13/19	1	1	7.2	113	882	<1.0	134	200	<0.5	275	42	12.7	-177.00	<48
QD-31	02/21/19	1	2	7.4	101	—	—	—	—	—	—	14	10.5	-184.00	<48
QD-31	02/28/19	1	3	7.4	112	—	—	—	—	—	—	2,200	10.1	-189.00	<48
QD-31	03/20/19	2	1	7.2	97	874	<1.0	132	201	<0.5	293	4	11.7	-187.00	<48
QD-31	03/27/19	2	2	7.9	91	—	—	—	—	—	—	3	10.8	-193.00	<48
QD-31	04/03/19	2	3	7.4	100	—	—	—	—	—	—	1	12.4	-192.00	<48
QD-31	04/24/19	3	1	7.1	116	922	<1.0	132	196	<0.3	270	2	12.5	-183.00	<48
QD-31	05/01/19	3	2	7.7	86	—	—	—	—	—	—	>20,000	12.1	22.00	<48
QD-31	05/08/19	3	3	7.4	101	—	—	—	—	—	—	7,500	12.5	-190.00	<48
QD-31	08/01/19	4	1	7.2	93	946	<1.0	133	198	<0.3	281	1	12.6	-194.00	<48
QD-31	08/07/19	4	2	7.9	111	—	—	—	—	—	—	<1	13.9	-193.00	<48
QD-31	08/15/19	4	3	7.4	95	—	—	—	—	—	—	<1	12.5	-193.00	<48
QD-31	10/04/19	5	1	7.5	87	904	<1.0	123	178	<0.3	309	>20,000	12.4	18.00	<48
QD-31	10/09/19	5	2	7.5	94	—	—	—	—	—	—	330	12.5	-193.00	<48
QD-31	10/16/19	5	3	7.4	87	—	—	—	—	—	—	410	12.1	-218.00	<48
QD-33	02/02/17	1	3	8.0	276	—	—	—	—	—	—	1,000	11.9	-186.00	<48
QD-33	03/03/17	2	1	8.4	253	1,508	<1.0	337	195.46	<0.1	22	2,100	11.5	-170.00	<48
QD-33	03/08/17	2	2	8.2	262	—	—	—	—	—	—	2	12.2	-191.00	<48
QD-33	03/16/17	2	3	8.3	261	—	—	—	—	—	—	7	12.1	-200.00	<48
QD-33	04/05/17	3	1	8.2	269	1,490	<1.0	343	208.4	0.16	26	41	12.1	-188.00	<48
QD-33	04/12/17	3	2	8.2	251	—	—	—	—	—	—	52	12.9	-187.00	<48
QD-33	04/19/17	3	3	8.2	262	—	—	—	—	—	—	3	12.6	-190.00	<48

B-17

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-33	05/04/17	4	1	8.1	220	988	4.7	200	75.24	<0.1	12	2,700	11.8	-68.00	<48
QD-33	05/10/17	4	2	8.0	263	—	—	—	—	—	—	280	12.6	-188.00	<48
QD-33	05/18/17	4	3	7.5	280	—	—	—	—	—	—	29	13.1	-183.00	<48
QD-33	07/14/17	5	1	8.3	207	1,212	4.2	249	119.45	<0.1	18	>200,000	12.8	-191.00	<48
QD-33	07/20/17	5	2	8.1	277	—	—	—	—	—	—	>20,000	13.5	-174.00	<48
QD-33	07/27/17	5	3	8.3	257	—	—	—	—	—	—	53,000	13.4	-171.00	<48
QD-33	10/13/17	6	1	8.4	238	1,300	<1.0	298	325.35	0.10	23	>20,000	13.1	-173.00	<48
QD-33	10/19/17	6	2	8.1	270	—	—	—	—	—	—	>20,000	12.7	-186.00	<48
QD-33	10/26/17	6	3	8.4	138	—	—	—	—	—	—	20,000	12.6	-117.00	<48
QD-33	02/23/18	1	1	8.4	251	1,360	2.1	541	59.28	0.14	23	6,800	11.6	-74.00	<48
QD-33	03/01/18	1	2	7.7	265	—	—	—	—	—	—	20	12.2	-191.00	<48
QD-33	03/09/18	1	3	8.3	270	—	—	—	—	—	—	<1	12.2	-193.00	<48
QD-33	04/19/18	2	1	8.3	245	1,304	1.3	313	152.75	0.21	39	18,000	12.1	-83.00	<48
QD-33	04/25/18	2	2	8.0	246	—	—	—	—	—	—	220	12.6	-78.00	<48
QD-33	05/02/18	2	3	8.1	187	—	—	—	—	—	—	18	13.2	-194.00	<48
QD-33	05/17/18	3	1	8.7	118	788	4.3	128	58.95	0.12	13	>20,000	12.8	-116.00	<48
QD-33	05/24/18	3	2	9.0	121	—	—	—	—	—	—	9,400	12.8	-66.00	<48
QD-33	05/31/18	3	3	8.5	86	—	—	—	—	—	—	210	14	-202.00	<48
QD-33	09/07/18	4	1	8.1	256	1,316	<1.0	359	188.77	<0.5	28	41	12.8	-162.00	<48
QD-33	09/12/18	4	2	8.5	202	—	—	—	—	—	—	520	13.1	-176.00	<48
QD-33	09/20/18	4	3	7.3	90	—	—	—	—	—	—	46	13.9	-198.00	<48
QD-33	10/10/18	5	1	8.1	265	1,574	<1.0	362	182.29	<0.5	43	1	12.9	-208.00	<48
QD-33	10/17/18	5	2	7.8	269	—	—	—	—	—	—	<1	12.2	-198.00	<48
QD-33	10/24/18	5	3	8.1	273	—	—	—	—	—	—	<1	12.6	-182.00	<48
QD-33	02/13/19	1	1	8.0	190	1,436	<1.0	359	212	<0.5	39	150	11.9	-185.00	<48
QD-33	02/21/19	1	2	8.1	193	—	—	—	—	—	—	1	12.3	-190.00	<48

B-18

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3}	Recharge
														CCD ft	Time hr
QD-33	02/28/19	1	3	8.7	169	—	—	—	—	—	—	780	10.2	-191.00	<48
QD-33	03/20/19	2	1	7.7	176	466	<1.0	362	213	<0.5	47	1	12.2	-192.00	<48
QD-33	03/27/19	2	2	8.0	154	—	—	—	—	—	—	1	11.3	-197.00	<48
QD-33	04/03/19	2	3	7.8	170	—	—	—	—	—	—	<1	12.5	-194.00	<48
QD-33	04/24/19	3	1	7.8	202	1,602	<1.0	346	196	<0.3	36	<1	12.3	-185.00	<48
QD-33	05/01/19	3	2	8.8	113	—	—	—	—	—	—	>20,000	12.7	-49.00	<48
QD-33	05/08/19	3	3	8.1	197	—	—	—	—	—	—	7,000	12.5	-175.00	<48
QD-33	08/01/19	4	1	8.1	200	1,510	<1.0	363	210	<0.3	35	1	13.6	-196.00	<48
QD-33	08/07/19	4	2	8.2	186	—	—	—	—	—	—	<1	12.9	-193.00	<48
QD-33	08/15/19	4	3	8.1	182	—	—	—	—	—	—	<1	13	-193.00	<48
QD-33	10/04/19	5	1	8.5	83	990	1.2	131	82	<0.3	11	>20,000	13.2	-88.00	<48
QD-33	10/09/19	5	2	8.1	180	—	—	—	—	—	—	42	13	-206.00	<48
QD-33	10/16/19	5	3	8.0	159	—	—	—	—	—	—	35	12.8	-208.00	<48
QD-34	01/20/17	1	1	6.8	166	864	2.9	186	87.7	2.95	393	>20,000	12.9	-52.00	<4
QD-34	01/25/17	1	2	6.9	157	—	—	—	—	—	—	130	12.8	-62.00	<4
QD-34	02/01/17	1	3	7.0	161	—	—	—	—	—	—	53	12.7	-62.00	<4
QD-34	03/02/17	2	1	8.2	175	1,276	1.1	287	267.12	0.60	654	<1	12.8	-61.00	<4
QD-34	03/09/17	2	2	7.0	200	—	—	—	—	—	—	6	12.6	-65.00	<4
QD-34	03/16/17	2	3	6.8	199	—	—	—	—	—	—	<1	12.2	-63.00	<4
QD-34	04/07/17	3	1	7.1	147	718	4.7	193	64.2	2.13	373	>20,000	12.8	-48.00	<4
QD-34	04/12/17	3	2	7.3	134	—	—	—	—	—	—	500	13	-41.00	<4
QD-34	04/19/17	3	3	7.1	232	—	—	—	—	—	—	94	13.1	-58.00	<4
QD-34	05/03/17	4	1	7.0	239	704	17.2	171	70.53	2.07	370	>20,000	13.2	-42.00	<4
QD-34	05/10/17	4	2	7.3	135	—	—	—	—	—	—	54	14	-53.00	<4
QD-34	05/18/17	4	3	7.1	268	—	—	—	—	—	—	27	13.6	-55.00	<4

B-19

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-34	07/14/17	5	1	6.8	158	862	2.9	142	223.6	2.28	550	51,000	13	-63.00	<4
QD-34	07/20/17	5	2	7.0	141	—	—	—	—	—	—	120	13.3	-68.00	<4
QD-34	07/27/17	5	3	7.1	117	—	—	—	—	—	—	13,000	13.5	-64.00	<4
QD-34	10/12/17	6	1	7.0	159	994	2	152	252.8	0.66	610	>20,000	13	-71.00	<4
QD-34	10/18/17	6	2	7.0	152	—	—	—	—	—	—	9,300	13.5	-62.00	<4
QD-34	10/27/17	6	3	7.1	110	—	—	—	—	—	—	10,000	12.8	-60.00	<4
QD-34	02/23/18	1	1	7.1	196	918	15.8	335	52.95	2.52	378	110,000	12.8	-62.00	<4
QD-34	03/05/18	1	2	6.5	157	—	—	—	—	—	—	150	12.7	-189.00	<4
QD-34	03/13/18	1	3	6.5	159	—	—	—	—	—	—	31	12.8	-65.00	<4
QD-34	04/18/18	2	1	7.2	156	998	1.9	155	258.1	2.08	678	5,900	12.3	-65.00	<4
QD-34	04/25/18	2	2	7.0	158	—	—	—	—	—	—	230	13	-63.00	<4
QD-34	05/02/18	2	3	6.8	151	—	—	—	—	—	—	96	12.9	-66.00	<4
QD-34	05/16/18	3	1	7.2	122	752	7.8	141	NA	1.94	410	>20,000	13.3	-65.00	<4
QD-34	05/25/18	3	2	6.9	133	—	—	—	—	—	—	3,300	14.4	-55.00	<4
QD-34	05/29/18	3	3	7.2	131	—	—	—	—	—	—	390	13.2	-59.00	<4
QD-34	09/06/18	4	1	6.9	114	600	2.4	117	157.02	0.57	418	>20,000	13.5	-64.00	<4
QD-34	09/13/18	4	2	6.9	117	—	—	—	—	—	—	98	14	-60.00	<4
QD-34	09/19/18	4	3	6.7	145	—	—	—	—	—	—	460	14.3	-99.00	<4
QD-34	10/10/18	5	1	6.9	160	1,036	1.9	154	252.75	0.55	713	2	13.2	-64.00	<4
QD-34	10/24/18	5	2	6.7	158	—	—	—	—	—	—	1	13.2	-61.00	<4
QD-34	10/30/18	5	3	6.7	156	—	—	—	—	—	—	<1	13.1	-62.00	<4
QD-34	02/13/19	1	1	7.5	121	966	1.1	149	251	<0.5	625	<1	14.8	-65.00	<4
QD-34	02/19/19	1	2	6.7	117	—	—	—	—	—	—	<1	12.8	-65.00	<4
QD-34	03/21/19	2	1	7.2	97	954	1.6	140	256	0.54	637	2	12.6	-67.00	<4
QD-34	03/28/19	2	2	7.5	96	—	—	—	—	—	—	3	13.1	-68.00	<4
QD-34	04/03/19	2	3	7.1	117	—	—	—	—	—	—	<1	13.3	-70.00	<4

B-20

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-34	04/25/19	3	1	7.2	116	934	1.6	138	252	0.41	685	<1	13.2	-66.00	<4
QD-34	05/03/19	3	2	7.4	84	—	—	—	—	—	—	>20,000	12.9	-59.00	<4
QD-34	05/06/19	3	3	7.0	102	—	—	—	—	—	—	1,200	13.3	-53.00	<4
QD-34	08/01/19	4	1	7.2	109	1,094	1.3	146	253	0.42	656	<1	13.2	-63.00	<4
QD-34	08/09/19	4	2	7.9	115	—	—	—	—	—	—	<1	13.7	-64.00	<4
QD-34	10/02/19	5	1	7.0	90	814	1.7	101	188	1.10	521	4,900	13.7	-60.00	<4
QD-34	10/08/19	5	2	6.7	89	—	—	—	—	—	—	4,000	13.2	-58.00	<4
QD-34	10/15/19	5	3	6.7	86	—	—	—	—	—	—	43	13.1	-56.00	<4
QD-36	01/20/17	1	1	6.8	162	862	1.9	148	185.9	0.38	552	3,300	11.5	-46.00	<4
QD-36	01/25/17	1	2	6.9	162	—	—	—	—	—	—	80	12	-82.00	<4
QD-36	02/01/17	1	3	6.9	160	—	—	—	—	—	—	20	11.7	-80.00	<4
QD-36	03/02/17	2	1	8.3	104	1,130	<1	123	325.16	0.45	660	1	11.2	-74.00	<4
QD-36	03/09/17	2	2	6.8	167	—	—	—	—	—	—	3	11.4	-87.00	<4
QD-36	03/16/17	2	3	6.8	81	—	—	—	—	—	—	<1	11.4	-87.00	<4
QD-36	04/05/17	3	1	7.0	170	1,052	1.8	119	304.3	0.28	687	1	11.7	-81.00	<4
QD-36	04/12/17	3	2	7.0	160	—	—	—	—	—	—	<1	12.8	-77.00	<4
QD-36	04/19/17	3	3	7.0	155	—	—	—	—	—	—	<1	11.6	-82.00	<4
QD-36	05/03/17	4	1	6.9	162	1,060	1.5	116	287.8	0.32	682	20	11.6	-50.00	<4
QD-36	05/10/17	4	2	7.0	160	—	—	—	—	—	—	1	12	-75.00	<4
QD-36	07/13/17	5	1	6.9	161	1,172	1.4	120	345.25	0.29	745	1	12.1	-73.00	<4
QD-36	07/21/17	5	2	6.8	164	—	—	—	—	—	—	100	13	-60.00	<4
QD-36	07/26/17	5	3	6.9	112	—	—	—	—	—	—	11,000	12.2	-72.00	<4
QD-36	10/12/17	6	1	6.9	165	1,036	<1	120	313.6	0.34	668	2,600	11.7	-85.00	<4
QD-36	10/18/17	6	2	7.0	158	—	—	—	—	—	—	56	12.1	-81.00	<4
QD-36	10/27/17	6	3	7.0	161	—	—	—	—	—	—	2,400	11.7	-71.00	<4

B-21

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-36	02/21/18	1	1	6.9	158	1,060	1.9	125	298.7	0.38	689	<1	11.5	-55.00	<4
QD-36	03/02/18	1	2	6.8	156	—	—	—	—	—	—	12	11.8	-77.00	<4
QD-36	03/09/18	1	3	7.0	158	—	—	—	—	—	—	5	11.9	-80.00	<4
QD-36	04/18/18	2	1	7.0	131	1,008	1.6	121	301.1	0.37	735	52	11.8	-76.00	<4
QD-36	04/27/18	2	2	6.8	160	—	—	—	—	—	—	6	12	-82.00	<4
QD-36	05/03/18	2	3	6.6	100	—	—	—	—	—	—	2	12.5	-77.00	<4
QD-36	05/16/18	3	1	6.8	167	1,060	3.6	118	NA	0.42	654	>20,000	12.1	-77.00	<4
QD-36	05/25/18	3	2	7.0	144	—	—	—	—	—	—	86	12.3	-60.00	<4
QD-36	05/29/18	3	3	7.1	151	—	—	—	—	—	—	41	12.5	-71.00	<4
QD-36	09/06/18	4	1	6.9	151	724	5.1	112	184.09	<0.5	557	>2,0000	14.5	-81.00	<4
QD-36	09/13/18	4	2	6.9	118	—	—	—	—	—	—	640	12.8	-78.00	<4
QD-36	09/19/18	4	3	6.8	161	—	—	—	—	—	—	230	12.8	-107.00	<4
QD-36	10/10/18	5	1	6.9	160	1,150	1.8	111	327.22	<0.5	788	5	12.5	-83.00	<4
QD-36	10/24/18	5	2	6.7	160	—	—	—	—	—	—	2	12.2	-78.00	<4
QD-36	10/30/18	5	3	6.7	161	—	—	—	—	—	—	2	12.2	-83.00	<4
QD-36	02/13/19	1	1	7.2	116	968	<1	125	317	<0.5	718	<1	11.5	-80.00	<4
QD-36	02/21/19	1	2	6.9	113	—	—	—	—	—	—	1	11.8	-83.00	<4
QD-36	02/28/19	1	3	7.0	112	—	—	—	—	—	—	50	10.6	-81.00	<4
QD-36	03/21/19	2	1	6.9	102	1,028	1.2	125	317	<0.5	706	5	11.9	-83.00	<4
QD-36	03/28/19	2	2	7.3	95	—	—	—	—	—	—	<1	12.3	-85.00	<4
QD-36	04/03/19	2	3	7.1	119	—	—	—	—	—	—	1	12.3	-86.00	<4
QD-36	04/25/19	3	1	7.1	114	988	1.3	125	303	0.31	733	<1	12.2	-83.00	<4
QD-36	05/02/19	3	2	7.1	88	—	—	—	—	—	—	4,600	12.2	-52.00	<4
QD-36	05/06/19	3	3	6.9	99	—	—	—	—	—	—	78	12.1	-70.00	<4
QD-36	08/01/19	4	1	7.1	107	1,098	1	120	286	0.30	709	<1	12.3	-78.00	<4
QD-36	08/09/19	4	2	7.5	109	—	—	—	—	—	—	<1	12.3	-82.00	<4

B-22

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-36	10/02/19	5	1	7.1	87	814	1.6	89	217	0.31	573	1,300	12.4	-73.00	<4
QD-36	10/08/19	5	2	6.9	89	—	—	—	—	—	—	550	12.6	-69.00	<4
QD-36	10/15/19	5	3	6.6	84	—	—	—	—	—	—	21	12.5	-68.00	<4
QD-46	01/20/17	1	1	7.7	94	542	1.1	50	98.7	0.24	70	4,100	12.3	-116.00	<4
QD-46	01/25/17	1	2	7.8	94	—	—	—	—	—	—	210	11.9	-156.00	<4
QD-46	02/01/17	1	3	7.8	91	—	—	—	—	—	—	78	12	-173.00	<4
QD-46	03/02/17	2	1	8.1	95	534	<1	12	105.75	0.26	64	4	11.8	-169.00	<4
QD-46	03/09/17	2	2	7.9	92	—	—	—	—	—	—	1	11.9	-172.00	<4
QD-46	04/05/17	3	1	7.8	94	528	<1	15	143.8	0.18	81	110	11.8	-157.00	<4
QD-46	04/12/17	3	2	7.6	90	—	—	—	—	—	—	360	12.9	-156.00	<4
QD-46	04/20/17	3	3	8.0	92	—	—	—	—	—	—	95	13.1	-165.00	<4
QD-46	05/04/17	4	1	7.2	84	500	2.1	67	61.95	0.26	92	9,100	12.4	-43.00	<4
QD-46	05/10/17	4	2	7.9	89	—	—	—	—	—	—	110	12.4	-146.00	<4
QD-46	05/16/17	4	3	6.3	95	—	—	—	—	—	—	39	14.4	-144.00	<4
QD-46	07/14/17	5	1	7.8	92	486	1.8	23	111.58	0.19	69	93,000	12.1	-154.00	<4
QD-46	07/18/17	5	2	7.6	90	—	—	—	—	—	—	3,800	13.7	-157.00	<4
QD-46	07/25/17	5	3	7.8	85	—	—	—	—	—	—	72,000	15.8	-40.00	<4
QD-46	10/12/17	6	1	7.9	91	540	<1	11	132.87	0.22	78	5	12.4	-154.00	<4
QD-46	10/18/17	6	2	7.8	84	—	—	—	—	—	—	13,000	13.2	-117.00	<4
QD-46	10/27/17	6	3	7.8	89	—	—	—	—	—	—	590	12.2	-100.00	<4
QD-46	02/23/18	1	1	7.9	121	660	1.3	171	72.96	0.29	109	4,200	12.1	-72.00	<4
QD-46	02/27/18	1	2	7.7	99	—	—	—	—	—	—	98	12.7	-135.00	<4
QD-46	03/09/18	1	3	8.0	104	—	—	—	—	—	—	1	11.9	-158.00	<4
QD-46	04/18/18	2	1	7.6	95	554	1.2	39	120.9	0.25	74	1,200	12.3	-83.00	<4
QD-46	04/27/18	2	2	7.4	95	—	—	—	—	—	—	78	11.5	-147.00	<4

B-23

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-46	05/03/18	2	3	7.7	56	—	—	—	—	—	—	21	13	-159.00	<4
QD-46	05/16/18	3	1	7.7	89	546	1.6	36	NA	0.23	66	7,400	12.5	-120.00	<4
QD-46	05/23/18	3	2	8.1	79	—	—	—	—	—	—	2,400	13	-71.00	<4
QD-46	05/29/18	3	3	7.9	88	—	—	—	—	—	—	110	13.1	-111.00	<4
QD-46	09/06/18	4	1	7.9	85	394	<1	13	136.4	<0.5	70	230	12.6	-137.00	<4
QD-46	09/13/18	4	2	7.7	43	—	—	—	—	—	—	5	13.1	-143.00	<4
QD-46	09/19/18	4	3	8.0	91	—	—	—	—	—	—	2	12.6	-159.00	<4
QD-46	10/10/18	5	1	7.8	87	550	1.1	11	111.23	<0.5	99	<1	12.8	-156.00	<4
QD-46	10/24/18	5	3	7.4	89	—	—	—	—	—	—	<1	12.4	-151.00	<4
QD-46	02/13/19	1	1	8.2	69	538	<1	12	126	<0.5	76	<1	12.6	-165.00	<4
QD-46	02/21/19	1	2	7.9	68	—	—	—	—	—	—	<1	11.9	-164.00	<4
QD-46	03/21/19	2	1	8.0	68	524	<1	12	112	<0.5	65	10	12.4	-164.00	<4
QD-46	03/28/19	2	2	7.8	69	—	—	—	—	—	—	1	12.8	-163.00	<4
QD-46	04/03/19	2	3	7.9	71	—	—	—	—	—	—	2	12.7	-165.00	<4
QD-46	04/25/19	3	1	7.8	70	552	2.1	11	133	<0.3	100	<1	13.2	-160.00	<4
QD-46	05/02/19	3	2	8.9	68	—	—	—	—	—	—	9,400	12.4	-79.00	<4
QD-46	05/09/19	3	3	7.8	68	—	—	—	—	—	—	210	14	-131.00	<4
QD-46	07/31/19	4	1	7.8	65	604	<1	12	128	<0.3	72	<1	12.8	-153.00	<4
QD-46	08/08/19	4	2	7.9	68	—	—	—	—	—	—	<1	13	-153.00	<4
QD-46	10/04/19	5	1	8.0	56	532	<0.3	20	113	0.32	66	2,600	12.5	-89.00	<4
QD-46	10/09/19	5	2	8.0	58	—	—	—	—	—	—	52	12.6	-127.00	<4
QD-46	10/16/19	5	3	8.1	64	—	—	—	—	—	—	14	12.7	-138.00	<4
QD-54	01/20/17	1	1	9.0	70	394	<1	17	136.92	0.17	30	1	12	-35.57	<48
QD-54	01/26/17	1	2	7.7	75	—	—	—	—	—	—	<1	11.9	-47.57	<48
QD-54	03/03/17	2	1	8.8	75	420	<1	17	148.3	0.23	37	<1	11.7	-40.57	<48

B-24

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-54	03/09/17	2	2	8.7	72	—	—	—	—	—	—	<1	12.2	-39.57	<48
QD-54	04/06/17	3	1	8.6	76	430	<1	19	152.35	0.17	39	<1	12.1	-35.57	<48
QD-54	04/13/17	3	2	9.0	73	—	—	—	—	—	—	<1	12.3	-42.57	<48
QD-54	05/04/17	4	1	8.8	79	458	<1	19	154.62	0.27	40	2	12.3	0.43	<48
QD-54	05/11/17	4	2	7.2	77	—	—	—	—	—	—	<1	12.2	-45.57	<48
QD-54	05/18/17	4	3	8.5	78	—	—	—	—	—	—	<1	12.4	-49.57	<48
QD-54	07/19/17	5	1	8.9	77	354	<1	18	144.25	0.21	37	<1	12.7	-45.57	<48
QD-54	07/26/17	5	2	8.8	80	—	—	—	—	—	—	4	12.5	-15.57	<48
QD-54	08/02/17	5	3	8.8	79	—	—	—	—	—	—	<1	13.3	-38.57	<48
QD-54	10/18/17	6	1	8.7	68	392	1.4	17	147.39	0.24	63	5	13.9	-42.57	<48
QD-54	10/25/17	6	2	7.9	76	—	—	—	—	—	—	3	12.7	-8.57	<48
QD-54	11/01/17	6	3	8.9	75	—	—	—	—	—	—	<1	12.5	-24.57	<48
QD-54	02/23/18	1	1	9.3	68	388	<1	18	133.14	0.23	30	<1	12.3	1.43	<48
QD-54	03/02/18	1	2	8.9	76	—	—	—	—	—	—	<1	12	-124.57	<48
QD-54	04/19/18	2	1	8.2	74	402	1	17	153.03	0.19	32	1	12.5	-50.57	<48
QD-54	04/25/18	2	2	8.9	73	—	—	—	—	—	—	<1	12.1	-50.57	<48
QD-54	05/02/18	2	3	8.8	100	—	—	—	—	—	—	<1	13.1	-55.57	<48
QD-54	05/17/18	3	1	9.0	74	482	1	18	164.16	0.17	35	<1	12.4	-22.57	<48
QD-54	05/24/18	3	2	9.5	72	—	—	—	—	—	—	1	13.1	-47.57	<48
QD-54	05/31/18	3	3	8.9	46	—	—	—	—	—	—	<1	13.4	-66.57	<48
QD-54	09/07/18	4	1	8.7	75	1,260	1.2	17	152.25	<0.5	37	<1	12.4	-48.57	<48
QD-54	09/12/18	4	2	8.7	71	—	—	—	—	—	—	<1	12.6	-60.57	<48
QD-54	10/11/18	5	1	8.8	74	438	1	17	154.32	<0.5	35	<1	12.4	-47.57	<48
QD-54	10/19/18	5	2	7.7	71	—	—	—	—	—	—	<1	12.6	-43.57	<48
QD-54	02/15/19	1	1	8.7	54	440	<1	19	149	<0.5	32	<1	9.7	-69.57	<48
QD-54	02/22/19	1	2	8.8	56	—	—	—	—	—	—	<1	11.9	-65.57	<48

B-25

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QD-54	03/21/19	2	1	8.6	59	420	<1	21	166	<0.5	38	<1	12.1	-49.57	<48
QD-54	03/28/19	2	2	9.0	56	—	—	—	—	—	—	<1	13.6	-48.57	<48
QD-54	04/25/19	3	1	8.5	61	394	1.5	21	151	<0.3	31	<1	13.2	-47.57	<48
QD-54	05/02/19	3	2	9.3	55	—	—	—	—	—	—	21	12.3	-0.57	<48
QD-54	05/09/19	3	3	8.5	60	—	—	—	—	—	—	1	12.8	-42.57	<48
QD-54	08/02/19	4	1	8.9	46	458	<1	20	156	0.52	66	<1	13.6	-49.57	<48
QD-54	08/08/19	4	2	8.4	55	—	—	—	—	—	—	<1	12.6	-48.57	<48
QD-54	10/04/19	5	1	8.8	45	468	<1	20	158	<0.3	31	<1	12.4	-20.57	<48
QD-54	10/08/19	5	2	8.7	50	—	—	—	—	—	—	<1	12.7	-59.57	<48
QM-61	01/20/17	1	1	8.8	64	540	2	5	45.38	0.83	162	>20,000	13.5	-116.15	<4
QM-61	01/26/17	1	2	7.4	83	—	—	—	—	—	—	16,000	12.6	-154.15	<4
QM-61	02/01/17	1	3	6.9	79	—	—	—	—	—	—	1,300	13	-159.15	<4
QM-61	03/02/17	2	1	9.6	424	246	<1.0	56	32.62	0.51	117	67,000	13.1	-133.15	<4
QM-61	03/09/17	2	2	7.4	62	—	—	—	—	—	—	860	12.8	-157.15	<4
QM-61	03/14/17	2	3	7.2	62	—	—	—	—	—	—	230	13.2	-159.15	<4
QM-61	04/05/17	3	1	7.5	60	308	1.4	61	33.87	0.28	142	1,500	13.7	-150.15	<4
QM-61	04/12/17	3	2	7.0	60	—	—	—	—	—	—	140	13.5	-140.15	<4
QM-61	04/20/17	3	3	7.6	59	—	—	—	—	—	—	29	13.7	-151.15	<4
QM-61	05/02/17	4	1	7.2	69	360	2.3	90	33.62	4.21	163	100,000	13.7	-114.15	<4
QM-61	05/09/17	4	2	7.3	71	—	—	—	—	—	—	2,200	14.2	-140.15	<4
QM-61	05/16/17	4	3	7.2	57	—	—	—	—	—	—	5,800	14.9	-136.15	<4
QM-61	07/13/17	5	1	7.3	68	296	4.8	61	20.12	1.85	129	>200,000	15.2	-123.15	<4
QM-61	07/20/17	5	2	7.5	55	—	—	—	—	—	—	120,000	13.8	-131.15	<4
QM-61	07/27/17	5	3	7.6	105	—	—	—	—	—	—	20,000	13.8	-126.15	<4
QM-61	10/12/17	6	1	7.4	45	238	1.6	40	28.86	0.42	118	>200,000	14.4	-132.15	<4

B-26

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-61	10/18/17	6	2	7.3	44	—	—	—	—	—	—	34,000	14.1	-127.15	<4
QM-61	10/27/17	6	3	7.3	43	—	—	—	—	—	—	8,300	13.4	-123.15	<4
QM-61	02/21/18	1	1	7.0	107	558	2.6	243	34.42	0.74	186	76,000	13	-128.15	<4
QM-61	02/28/18	1	2	7.2	149	—	—	—	—	—	—	37,000	13.7	-109.15	<4
QM-61	03/07/18	1	3	7.5	154	—	—	—	—	—	—	17,000	13.6	-111.15	<4
QM-61	04/18/18	2	1	7.1	76	400	1.3	95	22.7	0.55	163	1	13.5	-139.15	<4
QM-61	04/25/18	2	2	7.7	73	—	—	—	—	—	—	3	13.4	-126.15	<4
QM-61	05/03/18	2	3	7.3	49	—	—	—	—	—	—	<1	13.8	-130.15	<4
QM-61	05/14/18	3	1	7.7	58	328	1.5	66	NA	0.84	124	31	14.4	-121.15	<4
QM-61	05/25/18	3	2	7.3	41	—	—	—	—	—	—	>20,000	14.5	-107.15	<4
QM-61	05/29/18	3	3	7.5	44	—	—	—	—	—	—	1,100	14.2	-125.15	<4
QM-61	09/06/18	4	1	7.3	58	172	3	58	16.92	0.89	117	>20,000	13.8	-126.15	<4
QM-61	09/11/18	4	2	8.1	34	—	—	—	—	—	—	12,000	14.1	-117.15	<4
QM-61	10/12/18	5	1	7.5	36	660	2.2	37	17.77	0.93	94	15,000	13.5	-107.15	<4
QM-61	10/19/18	5	2	7.8	48	—	—	—	—	—	—	2,600	13.2	-116.15	<4
QM-61	10/25/18	5	3	7.9	50	—	—	—	—	—	—	310	13.7	-123.15	<4
QM-61	02/11/19	1	1	8.2	138	1,030	1	456	63	2.16	259	42,000	13.9	-115.15	<4
QM-61	02/19/19	1	2	7.4	112	—	—	—	—	—	—	350	14.1	-123.15	<4
QM-61	03/01/19	1	3	7.2	109	—	—	—	—	—	—	160,000	13.4	-109.15	<4
QM-61	03/19/19	2	1	7.3	77	528	2.1	223	22	3.07	154	23,000	13.6	-109.15	<4
QM-61	03/26/19	2	2	7.4	62	—	—	—	—	—	—	100	13.1	-109.15	<4
QM-61	04/04/19	2	3	7.6	55	—	—	—	—	—	—	46	13.3	-132.15	<4
QM-61	04/23/19	3	1	7.7	70	370	1.3	101	11	0.72	121	4	12.7	-123.15	<4
QM-61	04/30/19	3	2	7.5	52	—	—	—	—	—	—	110,000	13	-109.15	<4
QM-61	05/06/19	3	3	6.9	71	—	—	—	—	—	—	36,000	13.8	-104.15	<4
QM-61	08/02/19	4	1	7.9	47	348	1	77	2	0.99	107	1	14	-114.15	<4

B-27

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-61	08/09/19	4	2	7.7	49	—	—	—	—	—	—	<1	13.9	-115.15	<4
QM-61	08/14/19	4	3	7.5	49	—	—	—	—	—	—	1	14.1	-129.15	<4
QM-61	10/02/19	5	1	7.9	31	262	1.5	51	15	0.99	94	530	13.8	-107.15	<4
QM-61	10/11/19	5	2	8.2	33	—	—	—	—	—	—	2,900	14	-108.15	<4
QM-61	10/16/19	5	3	8.1	35	—	—	—	—	—	—	390	13.2	-116.15	<4
QM-62	01/20/17	1	1	7.0	87	526	3.5	169	53.05	1.04	178	166,000	13.5	-160.50	<48
QM-62	01/25/17	1	2	6.8	86	—	—	—	—	—	—	5,700	13.8	-165.50	<48
QM-62	02/01/17	1	3	7.3	69	—	—	—	—	—	—	220	14.2	-174.50	<48
QM-62	03/03/17	2	1	7.2	59	372	<1.0	49	82.32	0.44	184	15,000	11.8	-133.50	<48
QM-62	03/08/17	2	2	7.7	88	—	—	—	—	—	—	690	13.7	-170.50	<48
QM-62	03/15/17	2	3	7.2	63	—	—	—	—	—	—	76	13.1	-175.50	<48
QM-62	04/05/17	3	1	6.4	70	356	1.1	51	48.75	0.51	179	1,000	13.6	-161.50	<48
QM-62	04/12/17	3	2	7.4	61	—	—	—	—	—	—	1,100	14.2	-153.50	<48
QM-62	04/19/17	3	3	7.4	65	—	—	—	—	—	—	60	14.4	-165.50	<48
QM-62	05/03/17	4	1	6.8	69	480	2.5	96	57.15	1.79	235	>20,000	14.1	-107.50	<48
QM-62	05/10/17	4	2	7.0	65	—	—	—	—	—	—	4,700	14.2	-158.50	<48
QM-62	05/17/17	4	3	7.3	72	—	—	—	—	—	—	1,100	15.1	-156.50	<48
QM-62	07/14/17	5	1	7.3	58	260	1.4	60	20.48	0.60	156	45,000	15.4	-142.50	<48
QM-62	07/20/17	5	2	6.7	56	—	—	—	—	—	—	29,000	14.3	-152.50	<48
QM-62	07/27/17	5	3	6.5	95	—	—	—	—	—	—	>200,000	16.2	-140.50	<48
QM-62	10/13/17	6	1	6.8	61	366	1	51	72.64	0.31	180	>200,000	13.9	-149.50	<48
QM-62	10/19/17	6	2	6.9	54	—	—	—	—	—	—	37,000	13.7	-142.50	<48
QM-62	10/26/17	6	3	7.1	58	—	—	—	—	—	—	>200,000	13.4	-124.50	<48
QM-62	02/22/18	1	1	7.8	80	660	2.6	272	44.76	1.49	217	83,000	13.4	-112.50	<48
QM-62	03/01/18	1	2	7.3	147	—	—	—	—	—	—	47,000	13.9	-149.50	<48

B-28

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-62	03/08/18	1	3	6.4	118	—	—	—	—	—	—	5,300	13.9	-212.50	<48
QM-62	04/19/18	2	1	7.9	73	374	1.6	106	25.71	0.95	162	18	13.8	-112.50	<48
QM-62	04/26/18	2	2	7.9	66	—	—	—	—	—	—	5	13.7	-137.50	<48
QM-62	05/02/18	2	3	7.8	69	—	—	—	—	—	—	6	14.3	-150.50	<48
QM-62	05/17/18	3	1	7.8	57	332	3.1	89	NA	1.35	140	100,000	14.7	-109.50	<48
QM-62	05/24/18	3	2	7.7	85	—	—	—	—	—	—	>200,000	15.7	-108.50	<48
QM-62	05/31/18	3	3	7.7	58	—	—	—	—	—	—	720	15.6	-139.50	<48
QM-62	09/06/18	4	1	6.9	61	276	2.7	54	27.65	1.08	144	>20,000	14.9	-114.50	<48
QM-62	09/12/18	4	2	7.7	61	—	—	—	—	—	—	6,000	14.3	-129.50	<48
QM-62	09/20/18	4	3	7.1	67	—	—	—	—	—	—	800	15.1	-149.50	<48
QM-62	10/10/18	5	1	7.6	62	288	1.9	44	30.89	0.79	168	23,000	14.7	-115.50	<48
QM-62	10/17/18	5	2	7.9	58	—	—	—	—	—	—	7,900	14.1	-116.50	<48
QM-62	10/24/18	5	3	7.8	65	—	—	—	—	—	—	1,200	13.9	-132.50	<48
QM-62	02/15/19	1	1	7.6	124	688	1.3	253	45	1.27	247	7,600	13.9	-115.50	<48
QM-62	02/21/19	1	2	7.7	60	—	—	—	—	—	—	55	14.1	-129.50	<48
QM-62	02/27/19	1	3	7.4	85	—	—	—	—	—	—	26,000	14	-104.50	<48
QM-62	03/20/19	2	1	7.7	60	430	1.2	95	46	0.72	256	690	13.9	-106.50	<48
QM-62	03/27/19	2	2	7.5	53	—	—	—	—	—	—	48	13.7	-126.50	<48
QM-62	04/03/19	2	3	7.6	49	—	—	—	—	—	—	10	14.2	-130.50	<48
QM-62	04/24/19	3	1	7.6	55	488	1.4	47	48	0.61	866	1	13.9	-131.50	<48
QM-62	05/01/19	3	2	7.7	66	—	—	—	—	—	—	75,000	14.2	-104.50	<48
QM-62	05/08/19	3	3	7.6	73	—	—	—	—	—	—	40,000	14.1	-98.50	<48
QM-62	08/02/19	4	1	8.1	54	418	1	54	40	0.62	173	18	14.3	-117.50	<48
QM-62	08/07/19	4	2	7.5	55	—	—	—	—	—	—	100	14.8	-125.50	<48
QM-62	08/14/19	4	3	7.5	56	—	—	—	—	—	—	16	14.4	-129.50	<48
QM-62	10/01/19	5	1	7.4	47	390	1.5	53	54	0.68	176	3,500	14.3	-110.50	<48

B-29

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3}	Recharge
														CCD ft	Time hr
QM-62	10/09/19	5	2	7.7	44	—	—	—	—	—	—	7,200	13.8	-109.50	<48
QM-62	10/16/19	5	3	7.8	49	—	—	—	—	—	—	220	13.9	-121.50	<48
QM-63	01/20/17	1	1	7.3	171	1,122	2.4	123	517.8	2.00	553	83,000	13.4	-118.90	<48
QM-63	01/25/17	1	2	7.3	194	—	—	—	—	—	—	1,300	12.2	-168.90	<48
QM-63	02/01/17	1	3	7.2	208	—	—	—	—	—	—	43	13.3	-173.90	<48
QM-63	03/03/17	2	1	7.4	184	1,278	1.1	70	688.4	1.84	650	4	12.4	-134.90	<48
QM-63	03/08/17	2	2	7.6	71	—	—	—	—	—	—	68	13.7	-169.90	<48
QM-63	03/15/17	2	3	7.3	183	—	—	—	—	—	—	5	13.2	-172.90	<48
QM-63	04/05/17	3	1	7.2	177	1,538	2.3	50	976.35	2.26	823	1,100	13.2	-157.90	<48
QM-63	04/12/17	3	2	7.1	180	—	—	—	—	—	—	1,200	13.6	-143.90	<48
QM-63	04/19/17	3	3	7.4	206	—	—	—	—	—	—	32	13.9	-157.90	<48
QM-63	05/03/17	4	1	7.3	146	932	2.4	74	399.4	2.18	476	>20,000	13.6	-79.90	<48
QM-63	05/10/17	4	2	7.3	159	—	—	—	—	—	—	1,400	13.8	-150.90	<48
QM-63	05/17/17	4	3	7.4	206	—	—	—	—	—	—	1,200	14.7	-148.90	<48
QM-63	07/14/17	5	1	7.3	181	1,122	2.8	49	684.6	2.17	697	>20,000	14	-134.90	<48
QM-63	07/20/17	5	2	7.2	165	—	—	—	—	—	—	9,500	13.9	-141.90	<48
QM-63	07/27/17	5	3	6.8	105	—	—	—	—	—	—	128,000	15.2	-129.90	<48
QM-63	10/13/17	6	1	7.2	199	1,460	2.3	48	909.4	1.95	717	73,000	13.5	-121.90	<48
QM-63	10/19/17	6	2	7.3	188	—	—	—	—	—	—	34,000	13.6	-133.90	<48
QM-63	10/26/17	6	3	7.1	156	—	—	—	—	—	—	>200,000	13.7	-105.90	<48
QM-63	02/22/18	1	1	7.6	190	1,046	2.8	186	378.8	1.85	497	54,000	13.6	-79.90	<48
QM-63	03/01/18	1	2	7.3	149	—	—	—	—	—	—	14,000	13.4	-114.90	<48
QM-63	03/08/18	1	3	7.1	148	—	—	—	—	—	—	5,600	13.8	-180.90	<48
QM-63	04/19/18	2	1	7.4	199	1,804	3.4	57	1,131.6	2.57	991	4	14.2	-134.90	<48
QM-63	04/26/18	2	2	7.6	205	—	—	—	—	—	—	2	13.9	-128.90	<48

B-30

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-63	05/02/18	2	3	7.6	199	—	—	—	—	—	—	1	14.1	-151.90	<48
QM-63	05/17/18	3	1	7.7	133	1,028	4.3	70	491.2	2.01	515	87,000	14.8	-91.90	<48
QM-63	05/24/18	3	2	7.6	125	—	—	—	—	—	—	71,000	15.7	-87.90	<48
QM-63	05/31/18	3	3	7.5	163	—	—	—	—	—	—	820	14.9	-138.90	<48
QM-63	09/06/18	4	1	7.4	178	1,306	2.9	51	NA	2.39	836	13,000	13.9	-98.90	<48
QM-63	09/12/18	4	2	7.4	201	—	—	—	—	—	—	4,800	14.2	-125.90	<48
QM-63	09/20/18	4	3	7.5	188	—	—	—	—	—	—	57	14.2	-153.90	<48
QM-63	10/10/18	5	1	7.6	204	1,400	2.6	49	837.28	2.22	789	11,000	15.3	-95.90	<48
QM-63	10/17/18	5	2	7.6	146	—	—	—	—	—	—	8,000	14.4	-103.90	<48
QM-63	10/24/18	5	3	7.4	188	—	—	—	—	—	—	690	13.9	-94.90	<48
QM-63	02/15/19	1	1	7.7	143	1,654	1.8	69	929	2.50	858	1,400	13.5	-104.90	<48
QM-63	02/22/19	1	2	7.4	150	—	—	—	—	—	—	29	13.3	-129.90	<48
QM-63	02/27/19	1	3	7.2	148	—	—	—	—	—	—	40,000	13.7	-74.90	<48
QM-63	03/20/19	2	1	7.4	133	1,696	2.3	56	NA ⁴	2.67	985	380	13.7	-97.90	<48
QM-63	03/27/19	2	2	7.4	116	—	—	—	—	—	—	25	13.6	-123.90	<48
QM-63	04/03/19	2	3	7.2	117	—	—	—	—	—	—	4	13.8	-131.90	<48
QM-63	04/24/19	3	1	7.3	158	1,694	2.5	49	997	2.46	864	<1	13.9	-129.90	<48
QM-63	05/01/19	3	2	7.8	131	—	—	—	—	—	—	58,000	13.7	-74.90	<48
QM-63	05/08/19	3	3	7.5	109	—	—	—	—	—	—	24,000	13.9	-71.90	<48
QM-63	08/02/19	4	1	7.7	144	1,830	2	50	1,025	2.48	946	<1	14	-108.90	<48
QM-63	08/07/19	4	2	7.1	150	—	—	—	—	—	—	1	14.4	-125.90	<48
QM-63	08/14/19	4	3	7.4	150	—	—	—	—	—	—	<1	14.6	-127.90	<48
QM-63	10/01/19	5	1	7.4	116	1,606	2.3	48	914	2.31	826	860	14.4	-91.90	<48
QM-63	10/09/19	5	2	7.6	91	—	—	—	—	—	—	36,000	13.9	-94.90	<48
QM-63	10/16/19	5	3	7.8	125	—	—	—	—	—	—	550	13.8	-118.90	<48

B-31

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-64	01/20/17	1	1	7.6	75	418	1.2	58	44.15	1.92	201	910	13.9	-125.60	<4
QM-64	01/25/17	1	2	7.6	78	—	—	—	—	—	—	430	13.7	-158.60	<4
QM-64	02/01/17	1	3	7.5	74	—	—	—	—	—	—	200	13.3	-160.60	<4
QM-64	03/02/17	2	1	8.8	263	334	<1.0	44	46.06	1.98	173	2,400	13.1	-136.60	<4
QM-64	03/09/17	2	2	7.6	76	—	—	—	—	—	—	460	13.5	-164.60	<4
QM-64	03/15/17	2	3	7.5	77	—	—	—	—	—	—	6	10.9	-163.60	<4
QM-64	04/05/17	3	1	7.6	80	386	1.2	53	45.76	1.81	204	320	13.2	-156.60	<4
QM-64	04/12/17	3	2	7.5	75	—	—	—	—	—	—	240	13.8	-147.60	<4
QM-64	04/20/17	3	3	7.6	72	—	—	—	—	—	—	43	14.6	-158.60	<4
QM-64	05/03/17	4	1	7.1	75	388	1.1	44	50.64	1.48	221	1,000	14.1	-112.60	<4
QM-64	05/10/17	4	2	7.5	71	—	—	—	—	—	—	230	15	-151.60	<4
QM-64	05/16/17	4	3	7.5	69	—	—	—	—	—	—	83	17	-140.60	<4
QM-64	07/13/17	5	1	7.6	75	416	1.2	52	42.41	1.70	203	92	15.2	-126.60	<4
QM-64	07/20/17	5	2	7.4	75	—	—	—	—	—	—	86	14.6	-151.60	<4
QM-64	07/27/17	5	3	7.5	75	—	—	—	—	—	—	870	15.6	-183.60	<4
QM-64	10/12/17	6	1	7.6	76	394	1.1	50	41.87	2.16	203	1,300	15.3	-138.60	<4
QM-64	10/18/17	6	2	7.9	72	—	—	—	—	—	—	>20,000	14.4	-136.60	<4
QM-64	10/27/17	6	3	7.7	66	—	—	—	—	—	—	32,000	14.5	-123.60	<4
QM-64	02/21/18	1	1	7.6	72	426	2.5	71	40.97	2.10	196	230	13.9	-124.60	<4
QM-64	02/28/18	1	2	7.9	96	—	—	—	—	—	—	2,200	13.6	-109.60	<4
QM-64	03/07/18	1	3	7.4	96	—	—	—	—	—	—	870	13.8	-105.60	<4
QM-64	04/18/18	2	1	7.6	78	410	1.4	68	43.48	1.72	226	10	13.6	-139.60	<4
QM-64	04/26/18	2	2	7.1	67	—	—	—	—	—	—	<1	14	-140.60	<4
QM-64	05/01/18	2	3	7.3	66	—	—	—	—	—	—	1	14	-146.60	<4
QM-64	05/18/18	3	1	7.5	72	452	2	60	46.63	1.87	208	1,800	14.5	-111.60	<4
QM-64	05/25/18	3	2	7.2	58	—	—	—	—	—	—	660	15.1	-100.60	<4

B-32

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-64	05/29/18	3	3	7.7	70	—	—	—	—	—	—	420	15.7	-119.60	<4
QM-64	09/06/18	4	1	7.5	71	360	1.3	53	38.19	1.58	183	100	15.5	-124.60	<4
QM-64	09/11/18	4	2	7.7	48	—	—	—	—	—	—	4,300	15	-123.60	<4
QM-64	10/08/18	5	1	7.5	71	434	1.4	50	38.58	1.55	206	34	14.6	-118.60	<4
QM-64	10/17/18	5	2	7.6	72	—	—	—	—	—	—	830	14.3	-115.60	<4
QM-64	10/25/18	5	3	7.5	66	—	—	—	—	—	—	140	12.9	-129.60	<4
QM-64	02/11/19	1	1	7.5	56	402	<1.0	54	48	1.83	192	210	13.6	-124.60	<4
QM-64	02/19/19	1	2	7.5	62	—	—	—	—	—	—	97	13.8	-126.60	<4
QM-64	03/01/19	1	3	7.2	60	—	—	—	—	—	—	22	13.6	-108.60	<4
QM-64	03/19/19	2	1	7.5	60	410	1.1	78	34	1.74	210	8	13.8	-106.60	<4
QM-64	03/26/19	2	2	7.6	64	—	—	—	—	—	—	3	13.6	-114.60	<4
QM-64	04/03/19	2	3	8.0	69	—	—	—	—	—	—	3	15.4	-125.60	<4
QM-64	04/23/19	3	1	7.5	58	426	1.1	57	38	1.52	207	1	13.7	-122.60	<4
QM-64	04/30/19	3	2	7.3	58	—	—	—	—	—	—	<1	13.6	-108.60	<4
QM-64	05/06/19	3	3	7.5	59	—	—	—	—	—	—	15	13.9	-98.60	<4
QM-64	08/02/19	4	1	7.7	54	416	<1.0	55	32	1.40	196	2,000	14.2	-115.60	<4
QM-64	08/09/19	4	2	7.6	56	—	—	—	—	—	—	530	14.2	-120.60	<4
QM-64	08/14/19	4	3	7.3	58	—	—	—	—	—	—	110	14.4	-132.60	<4
QM-64	10/02/19	5	1	7.8	47	410	1.1	51	36	1.42	200	4	14.1	-108.60	<4
QM-64	10/11/19	5	2	7.7	47	—	—	—	—	—	—	83	14.1	-105.60	<4
QM-64	10/16/19	5	3	7.8	54	—	—	—	—	—	—	9	13.9	-114.60	<4
QM-65	04/05/17	3	1	7.3	127	708	2.8	108	136.44	5.66	279	1	13.3	-166.40	<48
QM-65	04/12/17	3	2	7.5	127	—	—	—	—	—	—	5	13.8	-156.40	<48
QM-65	04/19/17	3	3	7.7	148	—	—	—	—	—	—	<1	13.7	-170.40	<48
QM-65	05/03/17	4	1	7.2	135	750	2.3	115	131.3	5.68	304	17	13.4	-130.40	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ²	TDS ²	TOC ²	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC ²	Temp.	GWE ^{2,3}	Recharge
					mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 mL	°C	ft	hr
QM-65	05/10/17	4	2	7.0	145	—	—	—	—	—	—	12	13.4	-167.40	<48
QM-65	05/17/17	4	3	7.3	142	—	—	—	—	—	—	12	14.2	-160.40	<48
QM-65	07/14/17	5	1	7.4	135	674	3.1	111	134.42	5.39	312	140	15.2	-159.40	<48
QM-65	07/20/17	5	2	7.1	132	—	—	—	—	—	—	29	13.8	-172.40	<48
QM-65	07/27/17	5	3	7.4	81	—	—	—	—	—	—	170	13.4	-137.40	<48
QM-65	10/13/17	6	1	7.2	149	764	3.1	169	150.48	4.26	351	630	14.4	-150.40	<48
QM-65	10/19/17	6	2	7.3	144	—	—	—	—	—	—	1,300	13.7	-147.40	<48
QM-65	10/26/17	6	3	7.1	143	—	—	—	—	—	—	11,000	14.1	-126.40	<48
QM-65	02/23/18	1	1	7.2	131	696	2.5	100	150.52	5.46	282	33	13.4	-124.40	<48
QM-65	02/28/18	1	2	7.3	139	—	—	—	—	—	—	780	14	-113.40	<48
QM-65	03/09/18	1	3	7.0	150	—	—	—	—	—	—	86	13.2	-120.40	<48
QM-65	04/19/18	2	1	7.0	131	728	3	118	142.05	5.24	321	<1	13.5	-153.40	<48
QM-65	04/26/18	2	2	7.4	137	—	—	—	—	—	—	5	13.3	-156.40	<48
QM-65	05/02/18	2	3	7.3	133	—	—	—	—	—	—	<1	14.2	-162.40	<48
QM-65	05/17/18	3	1	6.9	97	764	2.9	128	152.1	5.75	298	520	13.5	-122.40	<48
QM-65	05/24/18	3	2	7.2	116	—	—	—	—	—	—	2,000	14.1	-110.40	<48
QM-65	05/31/18	3	3	7.6	135	—	—	—	—	—	—	33	14.1	-186.40	<48
QM-65	09/06/18	4	1	7.2	125	722	3	106	142.6	4.87	324	110	14.4	-140.40	<48
QM-65	09/12/18	4	2	7.1	122	—	—	—	—	—	—	99	13.8	-136.40	<48
QM-65	09/20/18	4	3	7.3	143	—	—	—	—	—	—	45	13.8	-172.40	<48
QM-65	10/10/18	5	1	7.5	132	712	2.7	108	81.37	4.73	323	49	15.1	-139.40	<48
QM-65	10/17/18	5	2	7.4	129	—	—	—	—	—	—	440	13.8	-124.40	<48
QM-65	10/24/18	5	3	7.4	132	—	—	—	—	—	—	65	13.4	-144.40	<48
QM-65	02/15/19	1	1	7.7	96	808	1.8	144	175	5.58	359	3	12.6	-130.40	<48
QM-65	02/21/19	1	2	7.4	101	—	—	—	—	—	—	2	13.6	-144.40	<48
QM-65	02/27/19	1	3	7.2	96	—	—	—	—	—	—	14	13.8	-122.40	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ²	TDS ²	TOC ²	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC ²	Temp.	GWE ^{2,3}	Recharge
					mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 mL	°C	ft	hr
QM-65	03/20/19	2	1	7.5	98	594	2.1	114	139	5.01	310	4	13.5	-120.40	<48
QM-65	03/27/19	2	2	7.4	87	—	—	—	—	—	—	2	13.4	-136.40	<48
QM-65	04/04/19	2	3	7.6	85	—	—	—	—	—	—	1	13.6	-150.40	<48
QM-65	04/24/19	3	1	7.6	94	682	1.9	111	130	4.50	288	<1	13.3	-147.40	<48
QM-65	05/01/19	3	2	7.4	94	—	—	—	—	—	—	27	13.5	-120.40	<48
QM-65	05/08/19	3	3	7.3	97	—	—	—	—	—	—	140	13.1	-104.40	<48
QM-65	08/01/19	4	1	7.4	91	746	1.9	120	129	4.36	312	<1	13.9	-135.40	<48
QM-65	08/07/19	4	2	6.9	98	—	—	—	—	—	—	<1	14.5	-142.40	<48
QM-65	10/01/19	5	1	7.2	87	722	2.6	115	129	4.68	329	11	14.2	-137.40	<48
QM-65	10/09/19	5	2	7.4	81	—	—	—	—	—	—	53	13.9	-120.40	<48
QM-65	10/15/19	5	3	7.2	98	—	—	—	—	—	—	6	13.2	-130.40	<48
QM-67	03/03/17	2	1	7.4	137	706	3.9	211	10	12.32	276	4,300	12.9	-159.32	<48
QM-67	03/08/17	2	2	7.4	135	—	—	—	—	—	—	1,700	13.4	-158.32	<48
QM-67	03/15/17	2	3	7.3	137	—	—	—	—	—	—	2,200	12.9	-160.32	<48
QM-67	04/05/17	3	1	7.2	141	678	3.7	199	9.02	12.03	284	2,400	13.1	-157.32	<48
QM-67	04/12/17	3	2	7.2	139	—	—	—	—	—	—	1,100	13.7	-157.32	<48
QM-67	04/19/17	3	3	7.4	142	—	—	—	—	—	—	770	14.5	-158.32	<48
QM-67	05/03/17	4	1	7.5	133	700	3.1	197	5.59	12.12	279	510	13.7	-156.32	<48
QM-67	05/10/17	4	2	7.1	138	—	—	—	—	—	—	910	13.9	-155.32	<48
QM-67	05/17/17	4	3	7.3	141	—	—	—	—	—	—	6,500	14.4	-155.32	<48
QM-67	07/14/17	5	1	7.4	136	554	4	177	8.33	12.36	281	2,600	15	-171.32	<48
QM-67	07/20/17	5	2	7.3	114	—	—	—	—	—	—	6,700	14.1	-157.32	<48
QM-67	07/27/17	5	3	7.3	95	—	—	—	—	—	—	4,400	14.1	-158.32	<48
QM-67	10/13/17	6	1	7.4	126	610	4.2	145	6.29	13.06	291	>20,000	14.9	-160.32	<48
QM-67	10/19/17	6	2	7.1	132	—	—	—	—	—	—	11,000	14.1	-157.32	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-67	10/26/17	6	3	7.0	126	—	—	—	—	—	—	9,000	13.3	-160.32	<48
QM-67	02/22/18	1	1	7.2	77	760	4	211	15.37	14.39	314	NA	14	-159.32	<48
QM-67	03/01/18	1	2	7.2	168	—	—	—	—	—	—	12,000	13.5	-160.32	<48
QM-67	03/08/18	1	3	6.9	168	—	—	—	—	—	—	870	13.3	-165.32	<48
QM-67	04/19/18	2	1	7.2	160	802	3.9	256	12.61	13.97	332	2,000	13	-159.32	<48
QM-67	04/26/18	2	2	7.2	157	—	—	—	—	—	—	1,400	13.6	-159.32	<48
QM-67	05/02/18	2	3	7.3	153	—	—	—	—	—	—	500	14.9	-144.32	<48
QM-67	05/17/18	3	1	7.1	148	778	3.7	241	9.13	13.58	277	1,400	14.4	-167.32	<48
QM-67	05/24/18	3	2	7.2	140	—	—	—	—	—	—	2,300	14.7	-167.32	<48
QM-67	05/31/18	3	3	7.3	137	—	—	—	—	—	—	2,000	14.6	-167.32	<48
QM-67	09/06/18	4	1	7.2	129	668	4.1	166	10.84	13.70	253	7,300	14.1	-156.32	<48
QM-67	09/12/18	4	2	7.2	119	—	—	—	—	—	—	6,600	14.8	-154.32	<48
QM-67	09/20/18	4	3	7.6	116	—	—	—	—	—	—	830	14.6	-128.32	<48
QM-67	10/10/18	5	1	7.5	118	574	4	131	36.39	13.10	242	6,200	14.8	-156.32	<48
QM-67	10/17/18	5	2	7.4	111	—	—	—	—	—	—	4,200	13.5	-154.32	<48
QM-67	10/24/18	5	3	7.4	110	—	—	—	—	—	—	980	13.6	-157.32	<48
QM-67	02/15/19	1	1	7.3	94	722	3	217	24	13.89	271	6,800	12.4	-168.32	<48
QM-67	02/21/19	1	2	7.1	133	—	—	—	—	—	—	2,500	14.3	-154.32	<48
QM-67	02/27/19	1	3	7.3	138	—	—	—	—	—	—	350	12	-154.32	<48
QM-67	03/20/19	2	1	7.3	135	1,054	2.3	417	48	13.95	369	2,700	11.9	-153.32	<48
QM-67	03/27/19	2	2	7.2	138	—	—	—	—	—	—	1,200	13.7	-153.32	<48
QM-67	04/04/19	2	3	7.3	126	—	—	—	—	—	—	590	13.2	-153.32	<48
QM-67	04/24/19	3	1	7.2	153	1,022	2.9	387	54	12.96	331	1,000	13.9	-155.32	<48
QM-67	05/01/19	3	2	7.4	150	—	—	—	—	—	—	2,000	13.5	-154.32	<48
QM-67	05/08/19	3	3	7.3	140	—	—	—	—	—	—	6,400	13.4	-147.32	<48
QM-67	08/01/19	4	1	7.2	101	782	3	226	7	12.16	288	41,000	14.8	-156.32	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-67	08/06/19	4	2	7.1	108	—	—	—	—	—	—	40,000	14.9	-164.32	<48
QM-67	08/14/19	4	3	6.9	103	—	—	—	—	—	—	120,000	14.3	-162.32	<48
QM-67	10/01/19	5	1	7.3	100	732	3.7	180	5	12.99	285	4,400	14.5	-170.32	<48
QM-67	10/09/19	5	2	7.5	83	—	—	—	—	—	—	13,000	14.1	-154.32	<48
QM-67	10/15/19	5	3	7.3	89	—	—	—	—	—	—	9,100	13.7	-169.32	<48
QM-68	01/20/17	1	1	7.5	116	640	1.6	146	43.65	0.89	421	<1	12.8	-107.88	<48
QM-68	01/26/17	1	2	7.1	110	—	—	—	—	—	—	4	13	-108.88	<48
QM-68	02/01/17	1	3	7.3	116	—	—	—	—	—	—	5	13	-113.88	<48
QM-68	03/03/17	2	1	7.3	111	640	<1.0	146	45.08	0.90	412	120	12.5	-115.88	<48
QM-68	03/08/17	2	2	7.3	115	—	—	—	—	—	—	12	13.1	-113.88	<48
QM-68	03/15/17	2	3	7.2	80	—	—	—	—	—	—	1	12.8	-117.88	<48
QM-68	04/05/17	3	1	7.4	117	602	1.7	144	44.03	0.84	413	10	12.7	-110.88	<48
QM-68	04/12/17	3	2	7.2	124	—	—	—	—	—	—	2	13.6	-103.88	<48
QM-68	04/19/17	3	3	7.2	115	—	—	—	—	—	—	1	13.7	-109.88	<48
QM-68	05/03/17	4	1	7.3	111	632	1.5	147	39.23	0.91	405	410	13	-102.88	<48
QM-68	05/10/17	4	2	7.1	113	—	—	—	—	—	—	30	13.6	-113.88	<48
QM-68	05/17/17	4	3	7.4	115	—	—	—	—	—	—	11	14.2	-103.88	<48
QM-68	07/14/17	5	1	7.4	118	630	2	161	43.35	0.82	418	36	13.9	-107.88	<48
QM-68	07/20/17	5	2	7.1	108	—	—	—	—	—	—	3	13.7	-111.88	<48
QM-68	07/27/17	5	3	7.0	87	—	—	—	—	—	—	1	14	-84.88	<48
QM-68	10/13/17	6	1	7.4	118	560	1.6	152	36.06	1.00	415	38	13.4	-141.88	<48
QM-68	10/19/17	6	2	7.2	123	—	—	—	—	—	—	8	13.3	-96.88	<48
QM-68	10/26/17	6	3	7.0	119	—	—	—	—	—	—	2	13.4	-77.88	<48
QM-68	02/22/18	1	1	7.5	65	618	1.8	154	37.98	1.07	413	NA	13.6	-109.88	<48
QM-68	03/01/18	1	2	7.2	117	—	—	—	—	—	—	38	13.1	-139.88	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-68	03/08/18	1	3	6.9	117	—	—	—	—	—	—	170	13	-137.88	<48
QM-68	04/19/18	2	1	7.2	119	646	1.8	152	50.6	0.92	436	<1	13.1	-114.88	<48
QM-68	04/26/18	2	2	7.4	117	—	—	—	—	—	—	<1	13.3	-111.88	<48
QM-68	05/17/18	3	1	7.2	112	702	2.5	146	55.89	0.91	386	2,700	14	-97.88	<48
QM-68	05/24/18	3	2	7.7	106	—	—	—	—	—	—	1,900	14.6	-97.88	<48
QM-68	05/31/18	3	3	7.2	103	—	—	—	—	—	—	60	13.5	-95.88	<48
QM-68	09/06/18	4	1	7.1	114	616	2.1	153	41.72	0.91	409	<1	13.6	-108.88	<48
QM-68	09/12/18	4	2	7.3	114	—	—	—	—	—	—	250	13.7	-100.88	<48
QM-68	10/10/18	5	1	7.4	120	652	2	144	49.55	0.95	405	51	13.4	-105.88	<48
QM-68	10/17/18	5	2	7.3	111	—	—	—	—	—	—	600	13.5	-93.88	<48
QM-68	10/24/18	5	3	7.4	114	—	—	—	—	—	—	15	13.2	-96.88	<48
QM-68	02/15/19	1	1	7.3	90	662	1.3	160	55	0.94	408	<1	12.5	-99.88	<48
QM-68	02/22/19	1	2	7.3	91	—	—	—	—	—	—	<1	13.1	-102.88	<48
QM-68	03/20/19	2	1	7.3	81	584	1.4	155	51	0.98	428	<1	13.3	-94.88	<48
QM-68	03/27/19	2	2	7.4	80	—	—	—	—	—	—	<1	13.4	-101.88	<48
QM-68	04/04/19	2	3	7.3	76	—	—	—	—	—	—	<1	12.9	-104.88	<48
QM-68	04/24/19	3	1	7.3	89	656	1.8	151	50	0.78	379	<1	13.5	-106.88	<48
QM-68	05/01/19	3	2	7.3	88	—	—	—	—	—	—	140	13.2	-101.88	<48
QM-68	05/08/19	3	3	7.4	83	—	—	—	—	—	—	690	13.3	-79.88	<48
QM-68	08/01/19	4	1	7.5	84	712	1.3	150	55	0.83	394	<1	13.8	-102.88	<48
QM-68	08/07/19	4	2	7.3	86	—	—	—	—	—	—	<1	14.5	-102.88	<48
QM-68	10/04/19	5	1	7.3	87	628	1.6	144	52	1.02	429	140	13.1	-98.88	<48
QM-68	10/09/19	5	2	7.3	72	—	—	—	—	—	—	35	13.7	-87.88	<48
QM-68	10/16/19	5	3	7.5	79	—	—	—	—	—	—	1	13.3	-93.88	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

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Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-75	01/20/17	1	1	8.0	37	216	<1.0	13	10.05	0.25	65	<1	11.4	-60.49	<48
QM-75	01/26/17	1	2	8.0	38	—	—	—	—	—	—	11	11	-77.49	<48
QM-75	02/01/17	1	3	7.9	38	—	—	—	—	—	—	<1	11.6	-79.49	<48
QM-75	03/03/17	2	1	7.9	37	208	<1.0	12	< 10	0.29	63	26	11.6	-71.49	<48
QM-75	03/09/17	2	2	7.8	37	—	—	—	—	—	—	3	11.7	-80.49	<48
QM-75	03/15/17	2	3	8.3	275	—	—	—	—	—	—	<1	11.6	-175.49	<48
QM-75	04/06/17	3	1	8.0	37	210	1.1	14	10.67	0.22	61	3	11.5	-62.49	<48
QM-75	04/13/17	3	2	7.7	37	—	—	—	—	—	—	11	11.5	-75.49	<48
QM-75	04/20/17	3	3	7.9	37	—	—	—	—	—	—	20	12.8	-78.49	<48
QM-75	05/04/17	4	1	8.1	35	204	<1.0	13	10.35	0.37	62	290	11.5	-41.49	<48
QM-75	05/11/17	4	2	8.0	38	—	—	—	—	—	—	9	12	-66.49	<48
QM-75	05/18/17	4	3	8.1	38	—	—	—	—	—	—	2	12.8	-76.49	<48
QM-75	07/19/17	5	1	8.2	37	204	<1.0	12	11.17	0.24	63	1	12.1	-78.49	<48
QM-75	07/26/17	5	2	8.1	37	—	—	—	—	—	—	880	12.9	-47.49	<48
QM-75	08/02/17	5	3	8.1	36	—	—	—	—	—	—	60	12.6	-53.49	<48
QM-75	10/19/17	6	1	8.2	36	234	1.2	12	9.71	0.26	66	68	12.7	-134.49	<48
QM-75	10/26/17	6	2	7.8	366	—	—	—	—	—	—	86	12.2	-69.49	<48
QM-75	11/02/17	6	3	7.2	37	—	—	—	—	—	—	8	11.6	-76.49	<48
QM-75	02/22/18	1	1	8.1	38	216	<1.0	14	9.29	0.29	70	NA	11.9	-49.49	<48
QM-75	03/01/18	1	2	7.9	398	—	—	—	—	—	—	240	11.5	-65.49	<48
QM-75	03/08/18	1	3	7.9	379	—	—	—	—	—	—	22	11.7	-97.49	<48
QM-75	04/19/18	2	1	8.0	36	198	1	13	10.99	0.24	60	<1	11.9	-76.49	<48
QM-75	04/26/18	2	2	8.0	38	—	—	—	—	—	—	<1	11.9	-80.49	<48
QM-75	05/17/18	3	1	8.0	37	240	1	14	11.49	0.25	62	370	12.3	-73.49	<48
QM-75	05/24/18	3	2	8.2	35	—	—	—	—	—	—	230	13.3	-51.49	<48
QM-75	05/31/18	3	3	8.1	36	—	—	—	—	—	—	16	12.4	-83.49	<48

TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ²	TDS ²	TOC ²	Cl ⁻	SO ₄ ²⁻	NH ₃ -N	Hardness	FC ²	Temp.	GWE ^{2,3}	Recharge
					mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 mL	°C	ft	hr
QM-75	09/07/18	4	1	8.2	36	216	1	15	< 10	<0.5	60	<1	12.7	-59.49	<48
QM-75	09/12/18	4	2	8.1	36	—	—	—	—	—	—	<1	12.2	-69.49	<48
QM-75	10/11/18	5	1	8.1	34	222	1	12	< 10	<0.5	60	<1	12.1	-53.49	<48
QM-75	10/19/18	5	2	7.9	37	—	—	—	—	—	—	6	11.6	-62.49	<48
QM-75	10/25/18	5	3	7.8	36	—	—	—	—	—	—	1	11.5	-80.49	<48
QM-75	02/15/19	1	1	8.0	25	220	<1.0	15	10	<0.5	63	<1	10.8	-70.49	<48
QM-75	02/22/19	1	2	7.9	28	—	—	—	—	—	—	<1	12.1	-81.49	<48
QM-75	03/21/19	2	1	7.9	27	196	<1.0	15	11	<0.5	58	<1	11.4	-64.49	<48
QM-75	03/28/19	2	2	7.6	28	—	—	—	—	—	—	<1	11.7	-79.49	<48
QM-75	04/04/19	2	3	7.8	24	—	—	—	—	—	—	<1	11.3	-83.49	<48
QM-75	04/25/19	3	1	7.7	28	210	<1.0	14	12	<0.3	61	<1	12.4	-81.49	<48
QM-75	05/02/19	3	2	7.9	26	—	—	—	—	—	—	450	11.4	-44.49	<48
QM-75	05/09/19	3	3	7.7	29	—	—	—	—	—	—	86	12.1	-33.49	<48
QM-75	08/01/19	4	1	7.9	26	240	<1.0	14	13	<0.3	62	1	13.1	-79.49	<48
QM-75	08/07/19	4	2	7.6	28	—	—	—	—	—	—	<1	13.4	-83.49	<48
QM-75	08/14/19	4	3	7.9	27	—	—	—	—	—	—	3	12	-84.49	<48
QM-75	10/04/19	5	1	8.1	24	232	<1.0	13	8	0.33	107	9	12	-43.49	<48
QM-75	10/08/19	5	2	8.1	27	—	—	—	—	—	—	20	12.2	-58.49	<48
QM-75	10/15/19	5	3	8.0	26	—	—	—	—	—	—	1	12	-83.49	<48
QM-77	01/20/17	1	1	8.3	29	158	<1.0	11	<5	<0.1	48	4,000	11.4	-103.84	<48
QM-77	01/26/17	1	2	8.1	27	—	—	—	—	—	—	930	11	-177.84	<48
QM-77	02/01/17	1	3	8.4	27	—	—	—	—	—	—	52	11.7	-181.84	<48
QM-77	03/03/17	2	1	7.8	30	152	<1.0	10	< 10	0.10	47	13,000	12	-142.84	<48
QM-77	03/09/17	2	2	7.4	27	—	—	—	—	—	—	840	11.5	-180.84	<48
QM-77	03/15/17	2	3	7.9	360	—	—	—	—	—	—	95	11.5	-100.84	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-77	04/06/17	3	1	8.2	29	160	<1.0	12	<5	<0.1	47	680	11.5	-123.84	<48
QM-77	04/13/17	3	2	8.2	30	—	—	—	—	—	—	82	11.6	-172.84	<48
QM-77	04/20/17	3	3	7.8	28	—	—	—	—	—	—	2	12.8	-180.84	<48
QM-77	05/04/17	4	1	8.3	30	168	<1.0	11	<5	0.13	44	1,900	11.8	-49.84	<48
QM-77	05/11/17	4	2	8.3	28	—	—	—	—	—	—	1,600	12.3	-133.84	<48
QM-77	05/18/17	4	3	8.3	28	—	—	—	—	—	—	2,300	13.1	-175.84	<48
QM-77	07/14/17	5	1	8.3	28	218	<1.0	10	<5	<0.1	58	>20,000	13.6	-152.84	<48
QM-77	07/19/17	5	2	7.9	26	—	—	—	—	—	—	3,000	13.3	-157.84	<48
QM-77	07/26/17	5	3	8.0	29	—	—	—	—	—	—	5,100	14	-97.84	<48
QM-77	10/19/17	6	1	8.1	27	166	1.1	10	<5	0.11	49	1,000	12.3	-54.84	<48
QM-77	10/26/17	6	2	7.9	268	—	—	—	—	—	—	>20,000	12.1	-153.84	<48
QM-77	11/02/17	6	3	7.5	23	—	—	—	—	—	—	110	11.8	-172.84	<48
QM-77	02/22/18	1	1	8.4	28	162	<1.0	12	<5	0.19	45	2,900	11.9	-77.84	<48
QM-77	03/01/18	1	2	8.1	286	—	—	—	—	—	—	250	12	-148.84	<48
QM-77	03/08/18	1	3	7.7	289	—	—	—	—	—	—	970	11.6	-177.84	<48
QM-77	04/19/18	2	1	8.3	26	134	<1.0	10	<5	0.18	42	10	11.9	-140.84	<48
QM-77	04/26/18	2	2	8.3	279	—	—	—	—	—	—	13	12.1	-151.84	<48
QM-77	05/02/18	2	3	8.2	28	—	—	—	—	—	—	<1	14.6	-177.84	<48
QM-77	05/17/18	3	1	7.8	31	228	2.8	12	<5	0.12	45	6,000	12.1	-78.84	<48
QM-77	05/24/18	3	2	8.4	30	—	—	—	—	—	—	2,500	12.7	-57.84	<48
QM-77	05/31/18	3	3	8.2	28	—	—	—	—	—	—	120	13.1	-161.84	<48
QM-77	09/07/18	4	1	8.3	26	130	<1.0	10	< 10	<0.5	41	3,800	13	-91.84	<48
QM-77	09/12/18	4	2	8.5	27	—	—	—	—	—	—	590	12.5	-136.84	<48
QM-77	09/20/18	4	3	7.2	21	—	—	—	—	—	—	7	13.6	-193.84	<48
QM-77	10/11/18	5	1	8.6	25	138	<1.0	10	< 10	<0.5	42	3,400	12.3	-83.84	<48
QM-77	10/19/18	5	2	8.2	29	—	—	—	—	—	—	330	12	-114.84	<48

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TABLE B-1 (Continued): DATA OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID	Sample Date	Fill Event	Week	pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp. °C	GWE ^{2,3} CCD ft	Recharge Time hr
QM-77	10/25/18	5	3	7.8	26	—	—	—	—	—	—	38	11.7	-161.84	<48
QM-77	02/15/19	1	1	7.9	20	176	<1.0	20	2	<0.5	42	670	11.4	-103.84	<48
QM-77	02/22/19	1	2	8.1	23	—	—	—	—	—	—	73	11.4	-155.84	<48
QM-77	02/27/19	1	3	8.3	25	—	—	—	—	—	—	1,300	11.7	-83.84	<48
QM-77	03/21/19	2	1	8.3	22	106	<1.0	19	2	<0.5	38	810	11.6	-106.84	<48
QM-77	03/28/19	2	2	8.1	26	—	—	—	—	—	—	47	12.3	-156.84	<48
QM-77	04/04/19	2	3	8.1	20	—	—	—	—	—	—	5	11.7	-172.84	<48
QM-77	04/25/19	3	1	8.1	20	150	<1.0	12	2	<0.3	42	<1	13.6	-172.84	<48
QM-77	05/02/19	3	2	8.3	23	—	—	—	—	—	—	4,900	12	-47.84	<48
QM-77	05/09/19	3	3	8.1	23	—	—	—	—	—	—	740	13.8	-59.84	<48
QM-77	08/01/19	4	1	8.0	19	192	<1.0	12	2	<0.3	49	2	13.4	-141.84	<48
QM-77	08/07/19	4	2	7.8	20	—	—	—	—	—	—	1	14	-167.84	<48
QM-77	08/14/19	4	3	8.2	21	—	—	—	—	—	—	17	12.6	-171.84	<48
QM-77	10/04/19	5	1	8.4	20	176	<1.0	13	2	<0.3	63	5,000	12	-54.84	<48
QM-77	10/08/19	5	2	8.3	21	—	—	—	—	—	—	330	12.2	-93.84	<48
QM-77	10/15/19	5	3	8.3	20	—	—	—	—	—	—	17	11.9	-157.84	<48

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¹Groundwater chemistry was analyzed for the first week sample of a fill event except for pH and EC that were measured in the field for all three weeks. For a few dates when the first week sample was not available, chemistry tests were performed using the second or third week sample of a fill event.

²EC = electrical conductivity; TDS = total dissolved solids; TOC = total organic carbon; FC = fecal coliform; GWE = groundwater elevation.

³Relative to Chicago City Datum (579.48 ft above mean sea level).

⁴No reported results due to samples being held beyond the holding time or failing to meet quality assurance.

TABLE B-2: SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
QC-2	Max	8.4	73	394	6.1	52	50	0.50	90	910	16.4	-297
	Min	7.2	39	320	1.1	27	22	0.12	60	1	10.2	-315
	Mean	7.8	49	349	2.0	33	37	0.38	76	104	13.3	-311
	StDev	0.3	10	24	1.5	7	11	0.16	8	257	1.3	5
	CV%	3.7	21	7	73.7	23	29	41.83	11	247	10.0	2
QC-4	Max	8.9	72	456	1.5	10	22	0.50	26	3	14.9	-210
	Min	7.6	44	384	1.0	8	14	0.10	9	1	11.5	-261
	Mean	8.5	60	417	1.0	9	16	0.28	13	1	12.5	-231
	StDev	0.2	10	22	0.1	1	2	0.16	4	0	0.8	9
	CV%	2.9	17	5	12.9	9	13	57.67	35	36	6.3	-4
QC-17	Max	8.4	80	524	2.2	17	196	0.50	167	21	14.7	-154
	Min	7.0	36	386	1.0	5	155	0.17	140	1	10.8	-225
	Mean	7.7	66	470	1.1	7	180	0.33	152	2	12.6	-195
	StDev	0.3	12	33	0.3	4	10	0.12	8	4	0.7	18
	CV%	4.1	18	7	29.8	48	5	35.16	5	206	5.8	9

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TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)	
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL	
B-44	MW-5	Max	8.6	147	1,058	1.5	435	322	0.67	344	58	15.2	35
		Min	6.5	49	416	1.0	60	111	0.10	101	1	12.4	-60
		Mean	7.8	96	752	1.1	155	230	0.43	227	8	13.9	-51
		StDev	0.4	22	150	0.1	112	67	0.17	79	14	0.8	15
		CV%	5.0	23	20	13.1	72	29	39.11	35	187	5.7	29
	MW-6	Max	8.1	108	752	2.2	51	481	1.12	374	9,100	15.3	71
		Min	6.8	40	186	1.0	19	175	0.37	206	1	12.8	63
		Mean	7.6	89	636	1.2	37	331	0.56	341	343	13.8	67
		StDev	0.3	17	141	0.3	6	59	0.17	42	1,454	0.6	2
		CV%	3.7	19	22	27.7	18	18	29.67	12	424	4.4	3
	MW-7	Max	8.6	120	962	1.6	43	403	0.63	493	980	16.6	27
		Min	6.3	69	642	1.0	32	339	0.44	432	1	14.1	17
		Mean	7.3	101	803	1.1	38	375	0.55	465	36	15.2	23
		StDev	0.4	16	87	0.2	3	21	0.05	20	168	0.7	4
		CV%	5.6	16	11	19.6	7	6	8.75	4	470	4.3	15

TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
MW-8	Max	8.4	202	916	2.3	241	376	0.50	449	9,600	15.5	6
	Min	7.4	27	252	1.0	15	99	0.10	130	1	13.1	-61
	Mean	7.9	100	661	1.2	66	286	0.26	346	540	14.5	-40
	StDev	0.2	25	159	0.4	49	71	0.17	77	1,998	0.6	16
	CV%	2.7	25	24	29.4	75	25	65.57	22	370	4.1	39
QD-27	Max	8.2	296	1,584	17.3	579	83	32.13	533	20,000	15.3	-24
	Min	6.7	87	1,094	8.5	21	26	24.40	455	1	11.5	-182
	Mean	7.1	227	1,290	11.3	428	49	27.88	497	2,856	13.0	-146
	StDev	0.2	47	140	2.4	131	14	2.25	28	6,023	0.7	40
	CV%	3.3	21	11	21.4	31	29	8.06	6	211	5.7	27
QD-29	Max	7.8	384	2,576	5.6	590	929	1.24	1,024	250	15.4	-43
	Min	6.4	89	760	1.0	141	46	0.34	596	1	11.4	-109
	Mean	7.1	196	1,351	2.3	241	365	0.63	743	15	13.5	-73
	StDev	0.3	104	622	1.5	159	258	0.32	146	44	0.7	14
	CV%	3.8	53	46	64.9	66	71	50.62	20	290	5.4	19

B-45

TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
QD-30	Max	7.8	156	1,154	1.5	132	314	0.50	726	20,000	14.6	-49
	Min	6.4	91	746	1.0	97	171	0.21	447	1	11.7	-180
	Mean	7.2	123	894	1.1	114	241	0.36	561	604	12.6	-97
	StDev	0.3	19	131	0.1	12	51	0.10	86	3,101	0.6	23
	CV%	4.1	15	15	13.1	11	21	26.89	15	514	4.4	24
QD-31	Max	8.0	188	1,074	14.3	426	229	0.72	309	89,000	14.3	22
	Min	6.9	76	534	1.0	84	70	0.14	115	1	10.1	-229
	Mean	7.4	122	821	2.3	141	158	0.33	253	8,886	12.3	-162
	StDev	0.2	27	132	3.4	80	53	0.17	51	16,797	0.8	67
	CV%	3.0	22	16	146.3	57	34	52.28	20	189	6.6	41
QD-33	Max	9.0	280	1,602	4.7	541	325	0.50	47	200,000	14.0	-49
	Min	7.3	83	466	1.0	128	59	0.10	11	1	10.2	-208
	Mean	8.2	210	1,256	1.8	313	165	0.26	28	9,620	12.6	-168
	StDev	0.3	58	321	1.4	104	74	0.17	12	30,504	0.7	45
	CV%	3.8	28	26	77.6	33	45	63.39	42	317	5.5	27

B-46

TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
QD-34	Max	8.2	268	1,276	17.2	335	267	2.95	713	110,000	14.8	-41
	Min	6.5	84	600	1.1	101	53	0.41	370	1	12.2	-189
	Mean	7.0	143	905	4.2	169	192	1.33	542	7,720	13.2	-64
	StDev	0.3	40	167	5.1	60	83	0.90	130	18,381	0.5	21
	CV%	4.5	28	18	119.6	36	43	67.92	24	238	3.9	32
QD-36	Max	8.3	170	1,172	5.1	148	345	0.50	788	20,000	14.5	-46
	Min	6.6	81	724	1.0	89	184	0.28	552	1	10.6	-107
	Mean	7.0	135	1,013	1.8	120	288	0.38	679	1,463	12.1	-76
	StDev	0.3	30	122	1.1	12	50	0.08	68	4,396	0.6	11
	CV%	3.8	22	12	60.5	10	18	21.65	10	301	4.9	14
QD-46	Max	8.9	121	660	2.1	171	144	0.50	109	93,000	15.8	-40
	Min	6.3	43	394	1.0	11	62	0.18	64	1	11.5	-173
	Mean	7.8	82	537	1.3	32	114	0.31	78	5,106	12.7	-136
	StDev	0.4	15	55	0.4	41	23	0.12	14	17,484	0.8	35
	CV%	4.5	19	10	31.6	126	20	37.10	18	342	6.0	26

B-47

TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
QD-54	Max	9.5	100	1,260	1.5	21	166	0.52	66	21	13.9	1
	Min	7.2	45	354	1.0	17	133	0.17	30	1	9.7	-125
	Mean	8.7	68	475	1.1	18	151	0.31	38	2	12.5	-43
	StDev	0.5	12	212	0.2	1	9	0.14	11	3	0.7	22
	CV%	5.3	17	45	14.8	8	6	44.50	28	185	5.6	52
QM-61	Max	9.6	424	1,030	4.8	456	63	4.21	259	200,000	15.2	-104
	Min	6.9	31	172	1.0	5	2	0.28	94	1	12.6	-159
	Mean	7.5	74	415	1.9	108	27	1.25	141	29,228	13.7	-125
	StDev	0.5	60	212	1.0	112	15	1.07	41	51,282	0.5	15
	CV%	6.3	81	51	50.9	104	56	85.71	29	175	3.9	12
QM-62	Max	8.1	147	688	3.5	272	82	1.79	866	200,000	16.2	-99
	Min	6.4	44	260	1.0	44	20	0.31	140	1	11.8	-213
	Mean	7.4	69	419	1.8	96	46	0.89	229	32,959	14.2	-135
	StDev	0.4	20	125	0.8	73	17	0.42	173	59,878	0.7	24
	CV%	5.8	29	30	45.4	75	36	46.67	76	182	5.1	18

TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
QM-63	Max	7.8	208	1,830	4.3	186	1,132	2.67	991	200,000	15.7	-72
	Min	6.8	71	932	1.1	48	379	1.84	476	1	12.2	-181
	Mean	7.4	160	1,407	2.5	69	777	2.24	751	20,939	13.9	-124
	StDev	0.2	34	296	0.7	37	249	0.26	172	39,297	0.6	29
	CV%	2.8	21	21	27.7	53	32	11.55	23	188	4.6	23
QM-64	Max	8.8	263	452	2.5	78	51	2.16	226	32,000	17.0	-99
	Min	7.1	47	334	1.0	44	32	1.40	173	1	10.9	-184
	Mean	7.6	72	405	1.3	56	42	1.74	202	1,603	14.2	-129
	StDev	0.3	30	29	0.4	9	5	0.23	13	5,411	0.9	20
	CV%	3.4	42	7	31.2	17	13	13.52	6	337	6.6	15
QM-65	Max	7.7	150	808	3.1	169	175	5.75	359	11,000	15.2	-104
	Min	6.9	81	594	1.8	100	81	4.26	279	1	12.6	-186
	Mean	7.3	119	719	2.6	119	137	5.08	314	435	13.8	-141
	StDev	0.2	23	51	0.5	18	20	0.52	23	1,736	0.5	19
	CV%	2.7	19	7	18.5	15	15	10.24	7	399	3.7	14

TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
QM-67	Max	7.6	168	1,054	4.2	417	54	14.39	369	120,000	15.0	-128
	Min	6.9	77	554	2.3	131	5	12.03	242	350	11.9	-171
	Mean	7.3	128	743	3.6	224	17	13.10	292	8,493	13.9	-158
	StDev	0.1	22	141	0.6	80	16	0.78	33	19,261	0.8	7
	CV%	2.0	17	19	15.8	36	91	5.96	11	227	5.5	5
QM-68	Max ²	7.7	124	712	2.5	161	56	1.07	436	2,700	14.6	-78
	Min	6.9	65	560	1.0	144	36	0.78	379	1	12.5	-142
	Mean	7.3	103	636	1.7	150	47	0.92	411	174	13.4	-105
	StDev	0.1	17	38	0.4	5	6	0.08	15	506	0.5	13
	CV%	2.0	16	6	21.5	4	14	8.36	4	290	3.5	12
QM-75	Max	8.3	398	240	1.2	15	13	0.50	107	880	13.4	-33
	Min	7.2	24	196	1.0	12	8	0.22	58	1	10.8	-175
	Mean	7.9	62	217	1.0	13	10	0.33	65	67	12.0	-73
	StDev	0.2	94	14	0.1	1	1	0.11	12	163	0.6	23
	CV%	2.5	152	6	5.3	8	11	31.90	18	243	4.9	32

TABLE B-2 (Continued): SUMMARY STATISTICS OF GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF THE TUNNEL AND RESERVOIR PLAN¹

Well ID		pH	EC ² mS/m	TDS ² mg/L	TOC ² mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ² CFU/100 mL	Temp °C	GW Elevation ² CCD ³ (ft)
IAC ² Part 620 Groundwater Standard		6.5–9	NL ⁴	1,200	NL	200	400	NL	NL	NL	NL	NL
QM-77	Max	8.6	360	228	2.8	20	10	0.50	63	20,000	14.6	-48
	Min	7.2	19	106	1.0	10	2	0.10	38	1	11.0	-194
	Mean	8.1	54	163	1.1	12	5	0.25	46	2,282	12.3	-132
	StDev	0.3	84	31	0.4	3	3	0.16	6	4,413	0.8	44
	CV%	3.5	157	19	40.1	25	57	65.27	14	193	6.8	33

¹For values less than minimum and greater than maximum laboratory reporting limits, the laboratory minimum and maximum reporting limits were used in calculation of descriptive statistics. Geometric mean was used for fecal coliform.

²EC = electrical conductivity; TDS = total dissolved solids; TOC = total organic carbon; GW Elevation = groundwater elevation; IAC = Illinois Administrative Code.

³Relative to Chicago City Datum (579.48 ft above sea level).

⁴No standard limit was established in relevant IAC regulations.

TABLE B-3: DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
01/01/17	-229.1	-272.1	-296.0	-72.0
01/02/17	-224.1	-272.1	-297.0	-71.7
01/03/17	-104.9	-262.4	-292.0	-71.5
01/04/17	-82.6	-253.8	-296.0	-71.5
01/05/17	-205.8	-253.8	-298.0	-71.5
01/06/17	-197.4	-263.4	-300.0	-71.7
01/07/17	-192.5	-272.1	-302.0	-71.6
01/08/17	-186.1	-272.3	-304.0	-71.7
01/09/17	-179.3	-272.3	-302.0	-71.7
01/10/17	-171.0	-259.8	-300.0	-71.5
01/11/17	-169.5	-246.9	-299.0	-71.4
01/12/17	-151.2	-226.5	-287.0	-70.3
01/13/17	-199.6	-225.6	-279.0	-71.7
01/14/17	-233.6	-233.4	-290.0	-71.6
01/15/17	-248.7	-247.0	-300.0	-72.2
01/16/17	-234.6	-242.0	-304.0	-66.6
01/17/17	-54.2	-34.2	-289.0	-50.7
01/18/17	-49.5	-126.2	-264.0	-66.8
01/19/17	-148.7	-152.2	-274.0	-72.5
01/20/17	-43.7	-16.6	-276.0	-65.4
01/21/17	-132.4	-131.8	-275.0	-68.6
01/22/17	-166.7	-165.6	-273.0	-68.2
01/23/17	-207.3	-206.6	-275.0	-70.9
01/24/17	-231.0	-230.5	-281.0	-71.3
01/25/17	-243.7	-253.3	-286.0	-71.5
01/26/17	-234.0	-269.3	-289.0	-71.3
01/27/17	-226.3	-271.8	-293.0	-71.1
01/28/17	-219.4	-271.9	-294.0	-70.5
01/29/17	-212.4	-272.0	-302.0	-71.2
01/30/17	-205.0	-272.0	-306.0	-71.3
01/31/17	-196.6	-272.1	-311.0	-71.8
02/01/17	-186.9	-272.1	-306.0	-71.5
02/02/17	-177.6	-267.3	-304.0	-71.5
02/03/17	-211.1	-252.6	-301.0	-69.4
02/04/17	-227.9	-271.8	-299.0	-71.8
02/05/17	-221.9	-272.3	-296.0	-71.8
02/06/17	-216.3	-272.4	-298.0	-72.2
02/07/17	-185.6	-236.6	-293.0	-71.5
02/08/17	-161.8	-219.2	-291.0	-71.6

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
02/09/17	-185.3	-216.9	-291.0	-69.9
02/10/17	-225.2	-224.8	-267.0	-71.8
02/11/17	-236.9	-236.6	-267.0	-71.8
02/12/17	-246.3	-255.4	-276.0	-72.0
02/13/17	-237.7	-272.5	-290.0	-72.1
02/14/17	-231.4	-272.5	-298.0	-72.0
02/15/17	-225.7	-272.6	-300.0	-70.6
02/16/17	-220.4	-272.6	-298.0	-68.8
02/17/17	-214.9	-272.6	-298.0	-68.8
02/18/17	-209.2	-256.5	-299.0	-72.1
02/19/17	-203.4	-252.5	-301.0	-71.9
02/20/17	-197.9	-250.9	-303.0	-72.0
02/21/17	-190.6	-249.2	-306.0	-71.8
02/22/17	-200.7	-247.5	-309.0	-70.2
02/23/17	-216.1	-246.2	-307.0	-70.2
02/24/17	-207.0	-238.9	-303.0	-70.2
02/25/17	-236.8	-239.2	-301.0	-71.6
02/26/17	-247.4	-248.9	-299.0	-71.5
02/27/17	-239.7	-253.7	-296.0	-72.0
02/28/17	-231.1	-248.8	-272.0	-70.3
03/01/17	-161.3	-36.7	-248.0	-65.6
03/02/17	-142.2	-140.5	-247.0	-69.6
03/03/17	-165.0	-164.1	-250.0	-70.9
03/04/17	-198.3	-197.6	-253.0	-70.9
03/05/17	-223.8	-223.2	-256.0	-71.5
03/06/17	-239.3	-239.4	-259.0	-70.6
03/07/17	-244.4	-244.7	-259.0	-67.7
03/08/17	-246.7	-252.5	-263.0	-70.5
03/09/17	-234.1	-248.7	-266.0	-70.9
03/10/17	-227.6	-246.5	-270.0	-71.4
03/11/17	-221.6	-244.9	-275.0	-71.2
03/12/17	-215.4	-243.6	-278.0	-71.8
03/13/17	-208.1	-242.3	-282.0	-71.7
03/14/17	-199.6	-240.9	-286.0	-71.7
03/15/17	-190.9	-239.6	-231.0	-71.7
03/16/17	-182.9	-238.4	-243.0	-71.2
03/17/17	-174.4	-237.3	-273.0	-71.1
03/18/17	-172.5	-236.2	-277.0	-71.0
03/19/17	-221.6	-235.0	-281.0	-71.1

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
03/20/17	-232.6	-234.5	-227.0	-71.6
03/21/17	-238.6	-238.4	-254.0	-71.7
03/22/17	-247.0	-254.2	-271.0	-71.6
03/23/17	-235.8	-250.4	-285.0	-71.1
03/24/17	-229.8	-247.7	-286.0	-71.1
03/25/17	-216.8	-240.1	-285.0	-71.1
03/26/17	-188.1	-227.5	-281.0	-67.1
03/27/17	-165.1	-221.5	-284.0	-69.0
03/28/17	-189.3	-219.2	-284.0	-70.7
03/29/17	-229.1	-228.8	-288.0	-71.3
03/30/17	-95.6	-48.4	-237.0	-51.3
03/31/17	1.5	-17.9	-228.0	-36.0
04/01/17	-149.2	-148.2	-228.0	-36.0
04/02/17	-186.0	-185.1	-229.0	-44.0
04/03/17	-205.0	-205.3	-228.0	-59.5
04/04/17	-204.7	-205.8	-233.0	-64.6
04/05/17	-192.7	-151.7	-218.0	-62.6
04/06/17	23.9	-3.6	-188.0	-37.4
04/07/17	-28.1	-39.5	-186.0	-45.2
04/08/17	-139.3	-138.7	-187.0	-59.4
04/09/17	-166.0	-165.0	-190.0	-62.1
04/10/17	-187.3	-186.4	-193.0	-65.7
04/11/17	-187.0	-186.1	-195.0	-55.0
04/12/17	-205.6	-204.8	-198.0	-57.2
04/13/17	-199.7	-198.5	-202.0	-66.3
04/14/17	-201.0	-200.3	-204.0	-63.4
04/15/17	-207.3	-206.9	-210.0	-69.7
04/16/17	-195.9	-193.4	-214.0	-63.9
04/17/17	-210.6	-210.0	-218.0	-68.1
04/18/17	-227.6	-227.3	-223.0	-69.8
04/19/17	-238.7	-238.4	-227.0	-71.7
04/20/17	-247.0	-251.1	-232.0	-70.3
04/21/17	-235.3	-250.8	-237.0	-71.9
04/22/17	-228.6	-248.8	-242.0	-71.4
04/23/17	-222.5	-247.4	-247.0	-71.4
04/24/17	-216.1	-246.2	-252.0	-71.7
04/25/17	-209.2	-245.3	-256.0	-72.0
04/26/17	-201.9	-244.2	-260.0	-72.5
04/27/17	-189.5	-241.7	-264.0	-71.3

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
04/28/17	-180.8	-240.5	-268.0	-72.0
04/29/17	-134.6	-201.1	-252.0	-69.8
04/30/17	30.9	-4.0	-233.0	-40.4
05/01/17	29.8	-7.0	-203.0	-36.0
05/02/17	25.9	-14.7	-200.0	-36.0
05/03/17	20.9	-15.5	-202.0	-36.0
05/04/17	-69.1	-77.7	-203.0	-36.4
05/05/17	-147.8	-147.0	-209.0	-52.8
05/06/17	-185.6	-184.6	-214.0	-62.6
05/07/17	-217.3	-216.8	-213.0	-69.6
05/08/17	-235.3	-235.0	-221.0	-71.5
05/09/17	-249.0	-250.0	-213.0	-70.2
05/10/17	-225.6	-230.9	-193.0	-69.3
05/11/17	-58.3	-14.9	-189.0	-52.5
05/12/17	-105.1	-104.6	-190.0	-62.4
05/13/17	-151.8	-151.1	-194.0	-70.5
05/14/17	-178.7	-177.8	-198.0	-69.9
05/15/17	-197.1	-196.5	-204.0	-69.6
05/16/17	-214.7	-214.2	-209.0	-71.6
05/17/17	-233.9	-233.7	-211.0	-71.9
05/18/17	-238.0	-237.5	-216.0	-64.8
05/19/17	-239.4	-241.9	-221.0	-70.8
05/20/17	-224.1	-237.8	-224.0	-70.7
05/21/17	-209.1	-231.3	-228.0	-71.7
05/22/17	-197.9	-229.3	-233.0	-71.8
05/23/17	-186.2	-227.5	-238.0	-71.8
05/24/17	-158.5	-208.0	-240.0	-67.3
05/25/17	-189.0	-203.9	-244.0	-72.0
05/26/17	-220.2	-219.6	-248.0	-70.7
05/27/17	-208.3	-207.3	-252.0	-66.5
05/28/17	-228.5	-227.9	-256.0	-71.6
05/29/17	-241.0	-241.4	-253.0	-69.9
05/30/17	-237.0	-244.6	-247.0	-71.8
05/31/17	-229.9	-243.8	-248.0	-71.8
06/01/17	-221.7	-242.9	-252.0	-72.1
06/02/17	-213.4	-242.2	-257.0	-72.0
06/03/17	-206.0	-241.7	-262.0	-71.7
06/04/17	-198.8	-241.1	-266.0	-71.7
06/05/17	-190.4	-240.5	-271.0	-71.8

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
06/06/17	-182.6	-240.0	-275.0	-71.6
06/07/17	-173.1	-239.5	-279.0	-71.4
06/08/17	-164.5	-239.0	-282.0	-72.1
06/09/17	-189.3	-238.3	-287.0	-71.8
06/10/17	-236.5	-239.4	-290.0	-71.6
06/11/17	-245.4	-248.0	-294.0	-72.0
06/12/17	-237.5	-248.3	-293.0	-71.5
06/13/17	-232.2	-247.3	-294.0	-72.2
06/14/17	-217.4	-237.5	-289.0	-70.4
06/15/17	-165.0	-198.9	-280.0	-69.9
06/16/17	-177.7	-196.5	-278.0	-71.6
06/17/17	-210.2	-209.7	-282.0	-71.4
06/18/17	-222.0	-221.4	-286.0	-71.5
06/19/17	-239.8	-239.4	-289.0	-71.6
06/20/17	-241.6	-249.8	-280.0	-71.9
06/21/17	-234.6	-247.9	-287.0	-71.9
06/22/17	-229.3	-246.6	-298.0	-71.3
06/23/17	-214.0	-221.2	-283.0	-59.0
06/24/17	-195.2	-208.5	-297.0	-64.2
06/25/17	-186.5	-207.1	-301.0	-71.6
06/26/17	-179.3	-205.8	-304.0	-71.7
06/27/17	-174.0	-204.8	-303.0	-71.9
06/28/17	-199.9	-206.0	-291.0	-71.9
06/29/17	-201.9	-200.2	-290.0	-52.8
06/30/17	-221.2	-221.0	-287.0	-67.2
07/01/17	-238.7	-239.1	-287.0	-70.3
07/02/17	-242.4	-247.1	-286.0	-71.4
07/03/17	-235.3	-246.0	-294.0	-70.9
07/04/17	-231.3	-244.8	-300.0	-70.9
07/05/17	-227.0	-244.0	-304.0	-71.4
07/06/17	-223.2	-243.3	-308.0	-71.2
07/07/17	-219.0	-242.4	-296.0	-66.7
07/08/17	-214.3	-241.5	-295.0	-68.0
07/09/17	-209.9	-241.0	-293.0	-72.3
07/10/17	-191.2	-229.8	-286.0	-69.1
07/11/17	-175.5	-222.3	-285.0	-72.5
07/12/17	-45.6	-98.4	-283.0	-45.0
07/13/17	-98.8	-101.5	-282.0	-36.0
07/14/17	-181.1	-179.6	-282.0	-36.0

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
07/15/17	-201.6	-200.4	-281.0	-36.0
07/16/17	-220.8	-220.0	-281.0	-40.0
07/17/17	-235.6	-235.0	-282.0	-59.8
07/18/17	-241.0	-246.7	-284.0	-70.3
07/19/17	-223.6	-246.3	-285.0	-72.0
07/20/17	-49.6	-79.9	-283.0	-46.9
07/21/17	17.6	-9.3	-287.0	-38.6
07/22/17	26.8	-5.4	-275.0	-36.0
07/23/17	16.5	-13.6	-277.0	-36.0
07/24/17	7.0	-12.6	-281.0	-36.0
07/25/17	-49.9	-53.2	-286.0	-50.1
07/26/17	-171.6	-170.3	-285.0	-68.9
07/27/17	-180.7	-205.4	-285.0	-71.7
07/28/17	-229.8	-229.4	-284.0	-71.3
07/29/17	-245.9	-246.7	-283.0	-71.3
07/30/17	-241.7	-250.3	-286.0	-72.1
07/31/17	-234.5	-248.2	-288.0	-71.4
08/01/17	-228.1	-245.1	-289.0	-71.2
08/02/17	-219.9	-240.6	-289.0	-71.6
08/03/17	-225.0	-233.8	-287.0	-70.6
08/04/17	-222.1	-221.2	-288.0	-69.8
08/05/17	-238.3	-238.0	-288.0	-71.1
08/06/17	-243.1	-247.1	-288.0	-72.1
08/07/17	-235.2	-245.6	-289.0	-71.9
08/08/17	-230.2	-238.1	-290.0	-71.8
08/09/17	-225.2	-226.1	-290.0	-72.0
08/10/17	-218.3	-225.1	-289.0	-71.8
08/11/17	-225.8	-229.0	-289.0	-70.9
08/12/17	-220.1	-239.5	-289.0	-71.8
08/13/17	-245.4	-247.7	-289.0	-71.5
08/14/17	-237.9	-247.2	-288.0	-72.1
08/15/17	-232.6	-245.1	-287.0	-72.0
08/16/17	-228.2	-243.9	-287.0	-72.2
08/17/17	-223.0	-242.7	-287.0	-70.0
08/18/17	-218.4	-241.7	-288.0	-71.6
08/19/17	-213.8	-240.9	-289.0	-71.7
08/20/17	-209.4	-240.2	-290.0	-72.5
08/21/17	-209.2	-239.2	-288.0	-72.7
08/22/17	-226.8	-233.7	-287.0	-71.9

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
08/23/17	-243.3	-242.9	-287.0	-72.2
08/24/17	-246.9	-247.2	-287.0	-72.1
08/25/17	-239.2	-235.8	-287.0	-72.2
08/26/17	-235.4	-234.2	-288.0	-72.4
08/27/17	-234.2	-234.3	-289.0	-72.7
08/28/17	-230.6	-233.5	-290.0	-71.5
08/29/17	-230.0	-231.5	-290.0	-70.3
08/30/17	-237.1	-236.3	-289.0	-71.3
08/31/17	-246.2	-245.5	-289.0	-72.1
09/01/17	-245.1	-252.6	-289.0	-72.7
09/02/17	-237.4	-250.1	-289.0	-71.9
09/03/17	-230.9	-247.6	-288.0	-71.6
09/04/17	-227.0	-246.3	-287.0	-71.3
09/05/17	-223.1	-245.4	-287.0	-71.9
09/06/17	-219.7	-244.5	-287.0	-72.0
09/07/17	-216.7	-243.7	-287.0	-72.4
09/08/17	-210.6	-242.8	-285.0	-71.8
09/09/17	-209.1	-242.1	-284.0	-71.2
09/10/17	-239.9	-243.1	-283.0	-71.3
09/11/17	-251.8	-252.6	-281.0	-71.4
09/12/17	-242.0	-252.5	-280.0	-70.4
09/13/17	-236.3	-250.2	-283.0	-71.5
09/14/17	-232.4	-246.0	-287.0	-71.2
09/15/17	-228.6	-237.0	-288.0	-70.2
09/16/17	-226.0	-236.0	-291.0	-72.0
09/17/17	-240.0	-239.1	-294.0	-71.8
09/18/17	-250.4	-250.5	-295.0	-71.5
09/19/17	-239.6	-248.6	-292.0	-70.2
09/20/17	-233.9	-242.0	-290.0	-71.6
09/21/17	-230.1	-235.2	-289.0	-72.0
09/22/17	-226.3	-233.9	-287.0	-71.9
09/23/17	-222.7	-232.7	-286.0	-71.4
09/24/17	-219.3	-232.1	-286.0	-71.4
09/25/17	-215.6	-231.5	-285.0	-72.5
09/26/17	-211.6	-231.1	-284.0	-71.6
09/27/17	-207.5	-230.6	-285.0	-72.3
09/28/17	-203.4	-230.2	-290.0	-71.0
09/29/17	-198.8	-229.8	-297.0	-71.1
09/30/17	-194.1	-229.3	-299.0	-71.4

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
10/01/17	-189.8	-228.8	-297.0	-71.4
10/02/17	-185.4	-228.3	-295.0	-71.3
10/03/17	-180.7	-227.6	-336.0	-71.2
10/04/17	-209.2	-227.2	-288.0	-71.3
10/05/17	-232.5	-231.1	-287.0	-71.5
10/06/17	-231.5	-230.6	-287.0	-70.6
10/07/17	-230.4	-228.9	-287.0	-69.8
10/08/17	-222.7	-221.1	-287.0	-68.2
10/09/17	-228.8	-227.4	-288.0	-71.5
10/10/17	-232.8	-231.6	-287.0	-71.0
10/11/17	-121.3	-82.8	-287.0	-61.4
10/12/17	-150.1	-148.7	-283.0	-69.6
10/13/17	-184.0	-182.8	-286.0	-70.5
10/14/17	-46.5	-37.8	-228.0	-53.1
10/15/17	30.7	0.4	-224.0	-36.0
10/16/17	-4.4	-26.2	-224.0	-36.0
10/17/17	-155.9	-154.2	-225.0	-36.0
10/18/17	-175.5	-176.1	-229.0	-44.9
10/19/17	-184.6	-183.2	-234.0	-66.1
10/20/17	-186.4	-185.0	-239.0	-70.4
10/21/17	-176.3	-177.1	-244.0	-70.6
10/22/17	-167.1	-167.9	-248.0	-70.2
10/23/17	-27.0	-8.6	-252.0	-67.6
10/24/17	23.9	-5.3	-228.0	-63.2
10/25/17	-31.3	-44.6	-220.0	-66.5
10/26/17	-141.3	-140.1	-220.0	-68.4
10/27/17	-168.2	-166.9	-223.0	-70.7
10/28/17	-205.2	-204.6	-228.0	-71.2
10/29/17	-229.2	-229.2	-233.0	-71.4
10/30/17	-245.5	-248.9	-238.0	-71.1
10/31/17	-239.6	-290.0	-244.0	-71.2
11/01/17	-231.0	-286.3	-252.0	-68.7
11/02/17	-219.4	-261.9	-257.0	-70.3
11/03/17	-212.0	-290.0	-262.0	-72.0
11/04/17	-192.5	-246.6	-265.0	-68.7
11/05/17	-220.6	-231.9	-269.0	-69.4
11/06/17	-246.2	-247.5	-269.0	-71.0
11/07/17	-240.2	-285.7	-269.0	-71.6
11/08/17	-231.9	-290.0	-262.0	-72.0

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
11/09/17	-225.4	-290.0	-266.0	-71.9
11/10/17	-219.3	-290.5	-270.0	-71.6
11/11/17	-213.2	-290.6	-275.0	-71.3
11/12/17	-206.1	-290.3	-277.0	-72.1
11/13/17	-196.7	-283.1	-284.0	-71.6
11/14/17	-189.3	-290.3	-286.0	-71.5
11/15/17	-181.1	-263.8	-287.0	-71.8
11/16/17	-221.0	-246.0	-285.0	-71.7
11/17/17	-242.5	-278.1	-286.0	-72.0
11/18/17	-231.3	-237.3	-284.0	-66.6
11/19/17	-230.2	-228.7	-270.0	-68.3
11/20/17	-244.3	-245.7	-275.0	-71.3
11/21/17	-237.2	-277.0	-278.0	-71.8
11/22/17	-228.8	-289.6	-281.0	-71.7
11/23/17	-221.8	-290.3	-282.0	-71.4
11/24/17	-215.2	-290.3	-283.0	-71.5
11/25/17	-208.4	-290.5	-284.0	-71.5
11/26/17	-201.4	-290.6	-287.0	-71.8
11/27/17	-193.8	-290.2	-287.0	-71.8
11/28/17	-185.4	-290.0	-288.0	-71.7
11/29/17	-177.1	-290.4	-288.0	-71.6
11/30/17	-169.2	-290.0	-289.0	-71.8
12/01/17	-161.9	-290.2	-289.0	-71.9
12/02/17	-154.7	-286.6	-289.0	-71.7
12/03/17	-183.5	-254.2	-288.0	-72.0
12/04/17	-243.6	-250.4	-287.0	-71.8
12/05/17	-249.9	-276.2	-287.0	-71.0
12/06/17	-238.5	-290.3	-286.0	-71.3
12/07/17	-233.4	-290.5	-286.0	-71.8
12/08/17	-228.2	-290.5	-286.0	-71.7
12/09/17	-223.7	-290.3	-285.0	-71.3
12/10/17	-219.3	-290.5	-285.0	-71.5
12/11/17	-214.7	-290.4	-285.0	-71.7
12/12/17	-209.7	-290.7	-286.0	-72.0
12/13/17	-204.5	-290.6	-286.0	-71.9
12/14/17	-198.8	-290.9	-286.0	-72.1
12/15/17	-193.0	-290.9	-285.0	-72.0
12/16/17	-187.7	-290.8	-284.0	-72.0
12/17/17	-182.4	-290.8	-283.0	-72.4

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
12/18/17	-176.6	-290.5	-283.0	-72.0
12/19/17	-170.9	-290.3	-284.0	-72.1
12/20/17	-165.7	-290.4	-285.0	-72.2
12/21/17	-160.4	-290.5	-285.0	-72.2
12/22/17	-161.7	-263.1	-286.0	-72.2
12/23/17	-166.5	-255.1	-287.0	-71.9
12/24/17	-166.5	-255.1	-289.0	-71.8
12/25/17	-166.5	-255.1	-289.0	-72.7
12/26/17	-166.5	-255.1	-290.0	-71.8
12/27/17	-166.5	-255.1	-290.0	-72.1
12/28/17	-204.2	-274.2	-290.0	-72.5
12/29/17	-234.6	-290.3	-289.0	-72.3
12/30/17	-232.7	-289.3	-289.0	-72.2
12/31/17	-250.9	-261.3	-289.0	-72.1
01/01/18	-246.4	-258.3	-289.0	-71.8
01/02/18	-241.6	-258.1	-288.0	-72.3
01/03/18	-238.4	-253.7	-287.0	-71.9
01/04/18	-236.0	-250.0	-287.0	-72.4
01/05/18	-234.0	-247.9	-287.0	-72.2
01/06/18	-232.1	-246.2	-286.0	-72.2
01/07/18	-230.2	-245.2	-285.0	-72.4
01/08/18	-228.2	-244.2	-283.0	-72.3
01/09/18	-225.9	-243.2	-283.0	-72.1
01/10/18	-222.3	-242.3	-282.0	-72.0
01/11/18	-215.3	-249.5	-281.0	-71.7
01/12/18	-203.5	-256.9	-282.0	-72.1
01/13/18	-197.7	-256.4	-283.0	-71.7
01/14/18	-196.7	-255.0	-284.0	-72.1
01/15/18	-245.5	-256.7	-284.0	-72.3
01/16/18	-273.3	-271.8	-285.0	-72.4
01/17/18	-266.6	-270.9	-289.0	-72.5
01/18/18	-240.6	-258.3	-292.0	-72.2
01/19/18	-235.6	-258.3	-292.0	-72.4
01/20/18	-231.9	-258.3	-291.0	-71.7
01/21/18	-228.3	-258.3	-292.0	-71.5
01/22/18	-208.2	-245.1	-284.0	-64.6
01/23/18	-185.4	-235.8	-284.0	-69.3
01/24/18	-198.0	-235.0	-287.0	-71.2
01/25/18	-240.8	-239.2	-296.0	-70.9

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
01/26/18	-253.0	-251.5	-295.0	-71.9
01/27/18	-272.7	-263.4	-299.0	-71.3
01/28/18	-259.6	-264.1	-304.0	-71.5
01/29/18	-239.9	-258.3	-304.0	-71.6
01/30/18	-234.2	-258.3	-303.0	-71.6
01/31/18	-228.9	-258.3	-305.0	-71.7
02/01/18	-225.1	-258.3	-304.0	-71.8
02/02/18	-221.2	-258.3	-304.0	-71.8
02/03/18	-217.1	-258.3	-302.0	-71.2
02/04/18	-213.4	-258.3	-301.0	-71.8
02/05/18	-209.3	-258.3	-303.0	-71.9
02/06/18	-204.9	-258.3	-306.0	-72.1
02/07/18	-199.9	-258.3	-305.0	-71.5
02/08/18	-194.5	-257.3	-306.0	-72.2
02/09/18	-189.8	-256.1	-306.0	-72.2
02/10/18	-192.4	-255.0	-307.0	-71.7
02/11/18	-246.0	-254.1	-304.0	-72.1
02/12/18	-261.7	-259.4	-304.0	-71.9
02/13/18	-269.6	-267.5	-301.0	-72.0
02/14/18	-257.4	-263.9	-300.0	-72.0
02/15/18	-230.9	-256.6	-292.0	-67.4
02/16/18	-217.5	-257.1	-294.0	-67.6
02/17/18	-209.1	-256.1	-301.0	-66.9
02/18/18	-201.3	-254.1	-307.0	-68.1
02/19/18	-189.7	-250.0	-286.0	-70.1
02/20/18	9.6	-84.6	-214.0	-44.0
02/21/18	29.8	-0.1	-181.0	-45.4
02/22/18	27.5	-8.1	-176.0	-36.0
02/23/18	16.8	-8.5	-166.0	-36.0
02/24/18	-129.3	-11.4	-176.0	-36.0
02/25/18	-155.7	-11.2	-176.0	-47.5
02/26/18	-224.2	-14.3	-177.0	-63.8
02/27/18	-236.8	-45.0	-234.0	-69.7
02/28/18	-227.6	-60.9	-267.0	-71.1
03/01/18	-203.5	-38.7	-282.0	-63.1
03/02/18	-180.7	-11.6	-269.0	-61.8
03/03/18	-235.1	-20.3	-281.0	-67.3
03/04/18	-234.5	-50.0	-285.0	-71.1
03/05/18	-227.5	-66.5	-292.0	-72.4

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
03/06/18	-220.0	-82.2	-269.0	-71.7
03/07/18	-211.5	-98.8	-249.0	-66.4
03/08/18	-204.5	-124.4	-271.0	-66.7
03/09/18	-199.0	-149.3	-286.0	-72.1
03/10/18	-193.5	-170.9	-269.0	-71.2
03/11/18	-190.6	-186.5	-260.0	-71.8
03/12/18	-202.9	-201.7	-255.0	-71.6
03/13/18	-215.3	-213.7	-271.0	-71.7
03/14/18	-226.8	-225.5	-290.0	-71.6
03/15/18	-236.5	-235.2	-292.0	-71.8
03/16/18	-246.4	-245.1	-292.0	-71.8
03/17/18	-263.4	-261.8	-279.0	-71.3
03/18/18	-260.6	-267.4	-269.0	-71.8
03/19/18	-242.4	-258.5	-271.0	-72.0
03/20/18	-238.0	-256.8	-284.0	-72.0
03/21/18	-234.9	-251.6	-292.0	-72.2
03/22/18	-232.4	-247.5	-287.0	-67.8
03/23/18	-229.9	-246.8	-287.0	-68.1
03/24/18	-244.3	-247.9	-263.0	-69.2
03/25/18	-253.4	-257.8	-267.0	-70.3
03/26/18	-259.6	-268.6	-272.0	-71.6
03/27/18	-268.6	-266.8	-276.0	-68.3
03/28/18	-271.5	-269.6	-249.0	-70.2
03/29/18	-264.7	-267.7	-281.0	-72.0
03/30/18	-241.7	-258.3	-281.0	-71.5
03/31/18	-237.3	-258.3	-293.0	-71.4
04/01/18	-233.6	-258.3	-305.0	-71.6
04/02/18	-246.4	-260.8	-302.0	-70.8
04/03/18	-244.3	-258.4	-302.0	-72.0
04/04/18	-236.8	-257.7	-301.0	-71.3
04/05/18	-233.0	-255.7	-303.0	-71.8
04/06/18	-228.2	-248.2	-306.0	-69.9
04/07/18	-249.3	-250.2	-305.0	-71.4
04/08/18	-255.5	-257.2	-303.0	-71.7
04/09/18	-242.3	-255.8	-299.0	-70.6
04/10/18	-237.3	-254.0	-299.0	-67.4
04/11/18	-234.2	-252.9	-302.0	-70.0
04/12/18	-236.1	-247.8	-304.0	-71.8
04/13/18	-241.8	-240.2	-306.0	-72.1

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
04/14/18	-225.8	-232.3	-306.0	-68.5
04/15/18	-172.3	-189.0	-287.0	-51.6
04/16/18	7.6	-152.0	-290.0	-53.0
04/17/18	-69.2	-142.1	-291.0	-66.1
04/18/18	-186.7	-131.7	-296.0	-69.4
04/19/18	-177.4	-122.3	-295.0	-70.2
04/20/18	-165.0	-119.2	-295.0	-68.5
04/21/18	-157.1	-131.0	-296.0	-71.5
04/22/18	-149.2	-137.5	-297.0	-71.4
04/23/18	-147.5	-146.2	-296.0	-71.8
04/24/18	-157.7	-156.5	-297.0	-71.4
04/25/18	-164.5	-163.4	-306.0	-71.8
04/26/18	-179.1	-170.1	-306.0	-71.5
04/27/18	-227.5	-170.3	-302.0	-71.9
04/28/18	-231.8	-177.2	-301.0	-71.4
04/29/18	-228.9	-186.2	-299.0	-71.8
04/30/18	-225.7	-192.1	-303.0	-71.6
05/01/18	-222.6	-201.4	-307.0	-71.4
05/02/18	-225.0	-203.2	-307.0	-69.6
05/03/18	-123.5	-120.8	-305.0	-36.3
05/04/18	-107.7	-104.9	-307.0	-36.0
05/05/18	-228.0	-108.0	-308.0	-36.0
05/06/18	-227.3	-131.2	-307.0	-54.4
05/07/18	-222.9	-146.7	-304.0	-68.3
05/08/18	-230.4	-160.9	-302.0	-68.6
05/09/18	-241.1	-161.7	-302.0	-69.1
05/10/18	-234.6	-161.2	-305.0	-71.3
05/11/18	-245.9	-170.0	-306.0	-71.8
05/12/18	-236.5	-185.0	-304.0	-72.5
05/13/18	-211.9	-151.6	-292.0	-64.3
05/14/18	-157.7	-110.5	-283.0	-62.5
05/15/18	28.1	-4.7	-273.0	-36.3
05/16/18	-30.0	-33.8	-288.0	-51.2
05/17/18	-72.1	-72.7	-303.0	-68.1
05/18/18	-99.2	-99.8	-301.0	-71.6
05/19/18	-135.8	-114.5	-295.0	-71.4
05/20/18	-229.5	-112.3	-294.0	-69.7
05/21/18	-123.4	-56.7	-282.0	-51.9
05/22/18	27.4	-13.8	-294.0	-36.0

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
05/23/18	-7.3	-26.8	-290.0	-38.2
05/24/18	-60.9	-61.5	-293.0	-60.8
05/25/18	-89.0	-89.5	-306.0	-69.7
05/26/18	-115.5	-115.5	-309.0	-69.8
05/27/18	-137.3	-136.9	-302.0	-72.0
05/28/18	-160.3	-161.1	-307.0	-71.7
05/29/18	-207.7	-183.3	-307.0	-71.3
05/30/18	-245.4	-197.2	-306.0	-69.6
05/31/18	-226.3	-218.4	-302.0	-66.2
06/01/18	-233.4	-232.4	-297.0	-71.3
06/02/18	-247.6	-246.4	-300.0	-71.1
06/03/18	-245.2	-245.3	-299.0	-71.8
06/04/18	-267.8	-266.6	-299.0	-70.5
06/05/18	-242.0	-259.6	-301.0	-72.0
06/06/18	-233.9	-258.8	-303.0	-71.9
06/07/18	-228.3	-258.1	-305.0	-71.6
06/08/18	-247.6	-256.8	-297.0	-71.7
06/09/18	-232.3	-248.0	-297.0	-43.6
06/10/18	-208.6	-212.4	-292.0	-36.0
06/11/18	-201.4	-199.3	-297.0	-37.8
06/12/18	-209.7	-208.0	-304.0	-58.0
06/13/18	-186.0	-185.1	-306.0	-69.6
06/14/18	-123.5	-123.4	-296.0	-71.4
06/15/18	-258.9	-257.7	-296.0	-71.6
06/16/18	-221.4	-237.1	-291.0	-62.1
06/17/18	-236.9	-236.1	-295.0	-71.0
06/18/18	-229.2	-229.6	-295.0	-71.9
06/19/18	-245.8	-254.0	-295.0	-70.4
06/20/18	-264.7	-262.9	-293.0	-71.5
06/21/18	-199.0	-180.9	-251.0	-56.1
06/22/18	12.1	-25.2	-226.0	-36.0
06/23/18	27.4	-8.8	-223.0	-36.0
06/24/18	-110.7	-11.0	-227.0	-36.0
06/25/18	-209.2	-12.1	-234.0	-36.0
06/26/18	-237.9	-9.6	-236.0	-50.8
06/27/18	-212.3	-27.6	-239.0	-52.7
06/28/18	-186.4	-65.8	-247.0	-63.9
06/29/18	-162.2	-92.9	-253.0	-69.7
06/30/18	-137.2	-119.3	-259.0	-70.7

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
07/01/18	-140.0	-138.2	-261.0	-71.9
07/02/18	-157.0	-155.2	-266.0	-71.5
07/03/18	-181.3	-179.9	-284.0	-71.7
07/04/18	-203.1	-201.5	-298.0	-71.4
07/05/18	-213.6	-204.3	-286.0	-72.4
07/06/18	-210.0	-201.3	-260.0	-71.4
07/07/18	-222.2	-220.7	-262.0	-71.9
07/08/18	-235.7	-234.8	-272.0	-71.6
07/09/18	-244.9	-243.2	-272.0	-71.9
07/10/18	-248.7	-246.9	-262.0	-71.5
07/11/18	-254.1	-252.3	-273.0	-72.1
07/12/18	-260.8	-258.9	-275.0	-72.3
07/13/18	-268.5	-266.7	-280.0	-72.1
07/14/18	-274.8	-272.9	-287.0	-71.6
07/15/18	-261.3	-266.0	-298.0	-71.9
07/16/18	-237.0	-254.0	-306.0	-72.1
07/17/18	-229.8	-255.8	-298.0	-72.2
07/18/18	-225.2	-257.5	-298.0	-72.4
07/19/18	-220.6	-257.5	-298.0	-72.8
07/20/18	-230.7	-255.9	-298.0	-72.7
07/21/18	-232.0	-251.9	-292.0	-72.1
07/22/18	-229.1	-248.6	-296.0	-71.5
07/23/18	-252.4	-250.1	-296.0	-71.8
07/24/18	-266.1	-263.6	-300.0	-72.3
07/25/18	-259.6	-264.4	-305.0	-72.0
07/26/18	-239.0	-257.7	-305.0	-71.4
07/27/18	-234.0	-258.0	-305.0	-72.3
07/28/18	-229.9	-258.3	-302.0	-71.6
07/29/18	-226.0	-258.3	-302.0	-71.8
07/30/18	-223.6	-258.2	-303.0	-71.8
07/31/18	-258.8	-265.4	-304.0	-72.0
08/01/18	-264.5	-267.2	-304.0	-72.1
08/02/18	-240.5	-257.9	-305.0	-71.5
08/03/18	-235.2	-258.2	-302.0	-72.3
08/04/18	-231.2	-258.3	-302.0	-72.6
08/05/18	-227.5	-258.3	-304.0	-72.9
08/06/18	-222.2	-257.6	-305.0	-71.2
08/07/18	-223.5	-250.1	-305.0	-68.8
08/08/18	-207.7	-225.4	-304.0	-65.1

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
08/09/18	-231.3	-229.4	-302.0	-71.6
08/10/18	-238.7	-237.0	-302.0	-68.6
08/11/18	-248.8	-247.2	-303.0	-71.8
08/12/18	-268.6	-266.7	-304.0	-70.9
08/13/18	-256.0	-262.8	-308.0	-71.7
08/14/18	-238.3	-258.4	-306.0	-71.4
08/15/18	-232.8	-258.1	-302.0	-69.1
08/16/18	-225.7	-256.9	-302.0	-58.9
08/17/18	-208.3	-251.1	-303.0	-70.6
08/18/18	-237.0	-239.7	-297.0	-72.0
08/19/18	-257.3	-255.2	-293.0	-71.9
08/20/18	-256.8	-264.7	-289.0	-70.9
08/21/18	-226.7	-243.8	-252.0	-68.8
08/22/18	-253.1	-251.1	-255.0	-71.7
08/23/18	-264.8	-263.0	-288.0	-72.0
08/24/18	-242.7	-256.7	-292.0	-72.6
08/25/18	-246.9	-260.4	-292.0	-65.5
08/26/18	-260.8	-264.8	-303.0	-72.1
08/27/18	-238.9	-258.3	-302.0	-71.3
08/28/18	-231.0	-256.7	-300.0	-62.7
08/29/18	-171.3	-206.4	-300.0	-37.4
08/30/18	-227.5	-198.9	-291.0	-42.7
08/31/18	-236.6	-211.5	-298.0	-65.8
09/01/18	-200.5	-185.0	-299.0	-70.9
09/02/18	-234.5	-171.6	-292.0	-63.7
09/03/18	-156.3	-160.9	-290.0	-47.8
09/04/18	-0.5	-99.1	-275.0	-39.3
09/05/18	-187.8	-92.5	-274.0	-59.5
09/06/18	-200.4	-67.6	-278.0	-69.8
09/07/18	-235.1	-52.1	-282.0	-67.7
09/08/18	-226.2	-65.6	-282.0	-69.3
09/09/18	-220.1	-96.8	-286.0	-70.9
09/10/18	-214.7	-122.9	-288.0	-71.2
09/11/18	-207.4	-145.7	-295.0	-68.4
09/12/18	-200.0	-176.5	-298.0	-71.3
09/13/18	-199.1	-197.2	-300.0	-69.4
09/14/18	-216.7	-215.3	-302.0	-69.2
09/15/18	-234.1	-233.2	-302.0	-71.9
09/16/18	-251.4	-250.1	-302.0	-71.8

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
09/17/18	-261.9	-265.1	-307.0	-71.8
09/18/18	-239.6	-258.6	-306.0	-71.6
09/19/18	-233.9	-258.1	-303.0	-71.6
09/20/18	-227.4	-256.9	-300.0	-72.1
09/21/18	-222.7	-258.4	-300.0	-72.1
09/22/18	-218.1	-258.6	-299.0	-72.5
09/23/18	-213.6	-258.5	-300.0	-72.0
09/24/18	-218.5	-258.6	-302.0	-72.3
09/25/18	-244.3	-255.4	-304.0	-69.8
09/26/18	-234.3	-252.1	-301.0	-71.6
09/27/18	-229.8	-248.5	-302.0	-72.6
09/28/18	-225.6	-244.5	-302.0	-72.3
09/29/18	-231.1	-244.1	-304.0	-72.0
09/30/18	-251.9	-249.9	-301.0	-72.0
10/01/18	-267.7	-266.0	-301.0	-71.6
10/02/18	-184.0	-198.7	-295.0	-55.7
10/03/18	-214.3	-199.2	-302.0	-69.9
10/04/18	-242.6	-205.0	-304.0	-67.6
10/05/18	-228.4	-212.7	-301.0	-70.4
10/06/18	-178.5	-166.3	-294.0	-65.1
10/07/18	-206.0	-153.8	-293.0	-70.8
10/08/18	-205.5	-87.9	-283.0	-64.2
10/09/18	-232.3	-82.9	-285.0	-69.5
10/10/18	-218.1	-59.1	-293.0	-69.2
10/11/18	-194.5	-15.5	-297.0	-65.1
10/12/18	-225.9	-15.9	-290.0	-70.8
10/13/18	-239.6	-47.4	-298.0	-71.4
10/14/18	-231.0	-77.7	-306.0	-71.6
10/15/18	-223.1	-98.9	-304.0	-71.8
10/16/18	-215.9	-108.0	-304.0	-71.5
10/17/18	-209.2	-119.3	-305.0	-71.6
10/18/18	-202.5	-116.2	-306.0	-71.8
10/19/18	-195.4	-131.6	-309.0	-72.0
10/20/18	-188.5	-140.2	-302.0	-71.8
10/21/18	-182.2	-166.0	-296.0	-72.1
10/22/18	-184.4	-182.7	-299.0	-72.5
10/23/18	-183.4	-181.7	-298.0	-72.2
10/24/18	-186.9	-185.2	-295.0	-72.1
10/25/18	-192.4	-190.7	-293.0	-72.3

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
10/26/18	-199.5	-197.8	-291.0	-71.9
10/27/18	-217.9	-216.6	-289.0	-71.9
10/28/18	-234.0	-232.6	-292.0	-72.0
10/29/18	-249.0	-247.6	-294.0	-72.5
10/30/18	-269.2	-267.2	-299.0	-72.6
10/31/18	-229.0	-245.3	-302.0	-70.8
11/01/18	-241.9	-243.3	-296.0	-71.5
11/02/18	-255.1	-253.2	-305.0	-71.8
11/03/18	-259.4	-271.5	-305.0	-72.3
11/04/18	-236.2	-258.0	-304.0	-71.3
11/05/18	-217.8	-256.9	-298.0	-70.5
11/06/18	-193.6	-248.3	-301.0	-68.9
11/07/18	-234.5	-246.0	-302.0	-71.6
11/08/18	-255.6	-253.7	-304.0	-71.7
11/09/18	-265.7	-263.7	-306.0	-71.2
11/10/18	-262.3	-265.6	-305.0	-71.6
11/11/18	-237.7	-254.7	-303.0	-71.7
11/12/18	-233.3	-258.4	-300.0	-71.8
11/13/18	-261.5	-265.6	-297.0	-71.7
11/14/18	-240.0	-258.7	-297.0	-68.6
11/15/18	-233.6	-258.7	-301.0	-70.8
11/16/18	-228.4	-258.5	-301.0	-71.5
11/17/18	-249.0	-261.6	-301.0	-71.4
11/18/18	-272.9	-271.0	-296.0	-71.9
11/19/18	-257.7	-264.4	-296.0	-71.7
11/20/18	-237.8	-258.7	-297.0	-71.9
11/21/18	-232.5	-258.5	-306.0	-70.1
11/22/18	-227.9	-258.4	-306.0	-70.5
11/23/18	-250.3	-263.5	-302.0	-71.7
11/24/18	-273.0	-272.0	-301.0	-71.5
11/25/18	-239.8	-257.4	-302.0	-69.6
11/26/18	-207.5	-232.2	-280.0	-67.5
11/27/18	-176.9	-222.3	-282.0	-66.8
11/28/18	-163.4	-220.7	-284.0	-70.5
11/29/18	-206.2	-219.8	-289.0	-70.6
11/30/18	-228.1	-226.4	-293.0	-71.6
12/01/18	-188.4	-211.4	-308.0	-59.8
12/02/18	27.5	-152.4	-288.0	-36.0
12/03/18	-128.3	-140.9	-286.0	-36.0

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
12/04/18	-151.1	-149.1	-288.0	-36.0
12/05/18	-161.0	-159.4	-305.0	-41.2
12/06/18	-174.0	-172.4	-308.0	-65.1
12/07/18	-188.5	-187.0	-308.0	-71.7
12/08/18	-202.3	-200.8	-307.0	-71.7
12/09/18	-215.3	-213.7	-303.0	-71.5
12/10/18	-226.8	-225.4	-299.0	-71.7
12/11/18	-238.2	-236.8	-298.0	-71.9
12/12/18	-251.9	-250.4	-294.0	-71.8
12/13/18	-261.8	-264.3	-302.0	-72.4
12/14/18	-231.9	-257.3	-310.0	-72.1
12/15/18	-244.0	-259.4	-306.0	-71.9
12/16/18	-235.3	-258.9	-307.0	-71.4
12/17/18	-228.3	-259.0	-308.0	-71.7
12/18/18	-239.4	-259.5	-309.0	-72.0
12/19/18	-272.9	-270.8	-309.0	-71.6
12/20/18	-244.6	-259.3	-309.0	-71.9
12/21/18	-234.0	-259.0	-305.0	-71.1
12/22/18	-227.9	-259.1	-301.0	-71.5
12/23/18	-222.3	-259.2	-298.0	-71.8
12/24/18	-220.8	-259.2	-296.0	-71.7
12/25/18	-266.3	-269.0	-297.0	-71.6
12/26/18	-242.0	-259.2	-300.0	-72.0
12/27/18	-226.2	-256.0	-304.0	-68.7
12/28/18	-199.8	-256.1	-296.0	-70.3
12/29/18	-227.5	-261.0	-297.0	-71.7
12/30/18	-269.3	-266.9	-297.0	-71.6
12/31/18	-244.3	-258.1	-297.0	-67.0
01/01/19	-188.5	-233.4	-284.0	-63.0
01/02/19	-222.1	-231.9	-285.0	-69.6
01/03/19	-237.2	-235.4	-296.0	-71.4
01/04/19	-242.3	-240.5	-303.0	-72.1
01/05/19	-248.1	-246.4	-308.0	-71.3
01/06/19	-257.3	-255.5	-309.0	-71.6
01/07/19	-249.3	-260.6	-307.0	-69.5
01/08/19	-235.5	-255.2	-300.0	-69.2
01/09/19	-265.3	-263.5	-298.0	-71.2
01/10/19	-255.0	-263.6	-303.0	-71.8
01/11/19	-235.5	-259.1	-307.0	-71.6

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
01/12/19	-229.0	-259.1	-308.0	-71.5
01/13/19	-221.1	-259.0	-309.0	-71.3
01/14/19	-223.1	-258.9	-307.0	-71.9
01/15/19	-270.9	-269.8	-302.0	-71.8
01/16/19	-251.3	-259.1	-302.0	-71.8
01/17/19	-254.7	-258.9	-304.0	-71.6
01/18/19	-270.9	-259.2	-299.0	-71.1
01/19/19	-292.8	-259.3	-299.0	-71.5
01/20/19	-292.9	-259.2	-302.0	-71.7
01/21/19	-292.8	-259.2	-305.0	-71.7
01/22/19	-292.8	-259.1	-306.0	-72.6
01/23/19	-279.2	-258.6	-304.0	-72.7
01/24/19	-292.8	-258.7	-299.0	-72.1
01/25/19	-292.8	-257.6	-294.0	-72.0
01/26/19	-292.8	-256.4	-294.0	-71.6
01/27/19	-292.8	-255.3	-297.0	-71.7
01/28/19	-292.8	-254.2	-301.0	-72.2
01/29/19	-292.8	-253.1	-307.0	-71.8
01/30/19	-292.8	-252.2	-309.0	-71.9
01/31/19	-292.8	-251.1	-310.0	-72.0
02/01/19	-292.8	-250.1	-307.0	-72.2
02/02/19	-288.2	-249.1	-305.0	-72.3
02/03/19	-242.5	-239.8	-307.0	-67.8
02/04/19	-190.3	-216.7	-294.0	-52.9
02/05/19	-145.1	-199.4	-278.0	-52.8
02/06/19	-185.5	-167.5	-277.0	-56.1
02/07/19	-200.3	-113.5	-282.0	-57.3
02/08/19	-167.5	-77.9	-278.0	-60.4
02/09/19	-226.3	-76.8	-280.0	-67.2
02/10/19	-224.2	-92.9	-283.0	-66.7
02/11/19	-216.8	-105.1	-285.0	-70.2
02/12/19	-195.3	-95.5	-285.0	-68.9
02/13/19	-197.6	-88.6	-280.0	-69.4
02/14/19	-241.1	-92.5	-281.0	-68.6
02/15/19	-224.0	-106.9	-281.0	-59.3
02/16/19	-216.8	-129.8	-284.0	-70.6
02/17/19	-211.1	-143.3	-288.0	-71.0
02/18/19	-205.7	-153.5	-291.0	-71.8
02/19/19	-199.8	-161.3	-295.0	-72.1

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
02/20/19	-193.8	-169.2	-285.0	-72.0
02/21/19	-185.7	-169.6	-291.0	-71.5
02/22/19	-179.7	-172.0	-283.0	-71.1
02/23/19	-168.7	-164.4	-295.0	-67.3
02/24/19	3.6	-95.0	-295.0	-51.4
02/25/19	-75.6	-77.7	-289.0	-66.3
02/26/19	-177.7	-69.9	-292.0	-71.1
02/27/19	-219.8	-63.2	-294.0	-71.5
02/28/19	-237.6	-76.6	-290.0	-69.9
03/01/19	-231.5	-95.0	-297.0	-66.9
03/02/19	-227.4	-112.5	-295.0	-62.9
03/03/19	-223.7	-120.1	-296.0	-70.4
03/04/19	-220.2	-128.6	-299.0	-72.0
03/05/19	-216.6	-142.2	-306.0	-71.7
03/06/19	-213.0	-158.5	-302.0	-71.2
03/07/19	-210.8	-173.6	-299.0	-71.7
03/08/19	-242.0	-179.0	-301.0	-72.0
03/09/19	-238.1	-182.4	-299.0	-69.1
03/10/19	-233.9	-158.3	-296.0	-62.7
03/11/19	-239.9	-163.5	-299.0	-70.4
03/12/19	-233.2	-174.9	-302.0	-68.8
03/13/19	-196.2	-182.1	-300.0	-66.3
03/14/19	-200.5	-141.6	-294.0	-63.8
03/15/19	-157.0	-94.1	-287.0	-69.6
03/16/19	-158.3	-88.5	-287.0	-71.0
03/17/19	-210.6	-86.5	-288.0	-69.8
03/18/19	-243.3	-87.6	-291.0	-71.3
03/19/19	-234.3	-97.7	-300.0	-71.4
03/20/19	-229.3	-104.7	-300.0	-70.4
03/21/19	-224.1	-110.5	-298.0	-70.9
03/22/19	-219.6	-120.8	-296.0	-71.5
03/23/19	-221.6	-132.5	-289.0	-71.6
03/24/19	-245.6	-137.4	-289.0	-71.5
03/25/19	-237.6	-150.0	-294.0	-71.6
03/26/19	-233.7	-163.0	-298.0	-71.5
03/27/19	-228.1	-174.5	-300.0	-71.3
03/28/19	-227.6	-188.2	-300.0	-71.6
03/29/19	-237.1	-197.1	-300.0	-72.0
03/30/19	-234.4	-179.2	-298.0	-71.8

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
03/31/19	-226.8	-178.5	-285.0	-71.6
04/01/19	-222.8	-182.5	-287.0	-71.7
04/02/19	-209.7	-182.0	-291.0	-72.0
04/03/19	-221.6	-196.1	-291.0	-71.9
04/04/19	-244.9	-196.6	-298.0	-72.7
04/05/19	-236.9	-201.8	-303.0	-71.9
04/06/19	-232.7	-209.0	-295.0	-71.3
04/07/19	-227.9	-214.1	-294.0	-71.2
04/08/19	-219.8	-205.2	-301.0	-71.6
04/09/19	-237.9	-204.7	-307.0	-71.7
04/10/19	-234.3	-211.8	-298.0	-71.6
04/11/19	-230.1	-219.2	-297.0	-70.8
04/12/19	-205.8	-203.8	-305.0	-71.8
04/13/19	-216.0	-204.1	-308.0	-71.3
04/14/19	-244.2	-201.2	-309.0	-71.1
04/15/19	-218.3	-171.4	-297.0	-69.5
04/16/19	-224.1	-148.7	-293.0	-67.7
04/17/19	-239.0	-148.9	-292.0	-69.5
04/18/19	-226.1	-145.3	-293.0	-69.1
04/19/19	-209.9	-126.6	-289.0	-70.6
04/20/19	-201.0	-140.9	-290.0	-71.4
04/21/19	-193.2	-157.6	-292.0	-71.6
04/22/19	-185.0	-174.2	-294.0	-71.9
04/23/19	-185.2	-183.7	-298.0	-71.8
04/24/19	-196.5	-194.9	-305.0	-71.7
04/25/19	-205.1	-203.4	-307.0	-71.7
04/26/19	-216.1	-207.9	-306.0	-71.1
04/27/19	-245.1	-207.3	-306.0	-70.7
04/28/19	-217.0	-176.4	-295.0	-67.6
04/29/19	-86.4	-90.7	-266.0	-47.9
04/30/19	29.5	-7.1	-245.0	-36.0
05/01/19	34.0	1.2	-245.0	-36.0
05/02/19	30.2	-4.3	-194.0	-36.0
05/03/19	28.0	-7.9	-176.0	-36.0
05/04/19	-28.0	-9.9	-169.0	-36.0
05/05/19	-194.0	-11.6	-168.0	-36.0
05/06/19	-240.1	-39.0	-169.0	-36.0
05/07/19	-218.2	-21.5	-171.0	-36.0
05/08/19	-239.4	-50.7	-172.0	-36.0

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
05/09/19	-178.3	-13.6	-173.0	-36.0
05/10/19	-126.2	-10.1	-158.0	-36.0
05/11/19	-199.9	-11.1	-159.0	-36.5
05/12/19	-239.8	-42.0	-163.0	-50.0
05/13/19	-227.9	-67.3	-167.0	-59.4
05/14/19	-219.7	-66.0	-172.0	-68.4
05/15/19	-241.0	-63.7	-178.0	-69.7
05/16/19	-236.9	-72.1	-184.0	-69.1
05/17/19	-222.6	-72.2	-189.0	-71.2
05/18/19	-210.0	-72.2	-189.0	-70.3
05/19/19	-198.9	-46.8	-188.0	-68.7
05/20/19	-236.2	-40.6	-190.0	-71.8
05/21/19	-237.5	-49.6	-196.0	-72.5
05/22/19	-213.1	-14.3	-202.0	-69.5
05/23/19	-218.6	-11.5	-192.0	-68.2
05/24/19	-240.3	-11.4	-183.0	-69.4
05/25/19	-227.9	-36.8	-186.0	-70.1
05/26/19	-222.0	-64.8	-193.0	-70.9
05/27/19	-178.8	-56.9	-199.0	-71.6
05/28/19	25.5	-11.0	-179.0	-70.8
05/29/19	27.8	-4.9	-166.0	-62.9
05/30/19	-1.4	-8.4	-142.0	-67.1
05/31/19	-144.1	-11.1	-133.0	-66.9
06/01/19	-234.8	-11.1	-130.0	-68.3
06/02/19	-233.6	-44.2	-132.0	-67.3
06/03/19	-227.3	-70.9	-133.0	-69.8
06/04/19	-222.0	-79.0	-137.0	-69.6
06/05/19	-214.6	-23.0	-143.0	-59.9
06/06/19	-224.2	-12.5	-146.0	-67.2
06/07/19	-244.6	-25.6	-152.0	-68.9
06/08/19	-235.3	-68.0	-149.0	-71.6
06/09/19	-231.3	-95.8	-153.0	-71.5
06/10/19	-227.7	-122.8	-160.0	-72.1
06/11/19	-224.3	-142.0	-167.0	-71.8
06/12/19	-219.6	-159.9	-180.0	-71.2
06/13/19	-195.9	-158.6	-186.0	-69.1
06/14/19	-204.5	-177.4	-183.0	-72.1
06/15/19	-245.1	-188.5	-183.0	-72.3
06/16/19	-233.4	-200.4	-187.0	-72.0

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
06/17/19	-230.0	-220.3	-188.0	-71.9
06/18/19	-235.2	-231.7	-195.0	-71.8
06/19/19	-241.4	-237.7	-198.0	-72.4
06/20/19	-239.3	-239.6	-203.0	-71.4
06/21/19	-251.3	-251.0	-196.0	-71.6
06/22/19	-272.8	-269.1	-203.0	-71.6
06/23/19	-244.4	-257.9	-210.0	-69.6
06/24/19	-243.2	-249.7	-212.0	-65.7
06/25/19	-249.6	-247.9	-215.0	-70.1
06/26/19	-248.3	-246.8	-219.0	-71.8
06/27/19	-245.0	-242.7	-224.0	-71.9
06/28/19	-241.7	-239.1	-219.0	-71.7
06/29/19	-247.7	-244.0	-208.0	-71.6
06/30/19	-254.8	-255.9	-196.0	-71.8
07/01/19	-250.5	-261.8	-188.0	-72.2
07/02/19	-272.7	-261.9	-191.0	-72.5
07/03/19	-208.6	-221.3	-195.0	-70.1
07/04/19	-236.6	-215.7	-191.0	-72.0
07/05/19	-238.3	-220.2	-195.0	-72.0
07/06/19	-235.1	-228.3	-201.0	-71.9
07/07/19	-248.8	-239.2	-209.0	-72.6
07/08/19	-291.8	-243.1	-219.0	-72.4
07/09/19	-292.3	-242.4	-227.0	-72.4
07/10/19	-292.3	-241.6	-236.0	-70.3
07/11/19	-290.4	-240.9	-244.0	-72.1
07/12/19	-287.8	-240.3	-253.0	-72.3
07/13/19	-249.8	-246.0	-257.0	-72.3
07/14/19	-270.7	-265.2	-259.0	-72.0
07/15/19	-292.3	-258.6	-264.0	-71.8
07/16/19	-292.3	-258.1	-265.0	-72.1
07/17/19	-289.4	-258.1	-262.0	-68.6
07/18/19	-224.0	-218.8	-261.0	-46.8
07/19/19	-191.2	-170.7	-253.0	-42.8
07/20/19	-246.0	-170.8	-249.0	-66.5
07/21/19	-229.9	-169.4	-252.0	-54.7
07/22/19	-241.4	-160.7	-249.0	-57.0
07/23/19	-255.8	-169.4	-255.0	-68.7
07/24/19	-292.1	-169.1	-260.0	-72.0
07/25/19	-292.2	-167.8	-263.0	-72.5

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
07/26/19	-292.0	-166.6	-262.0	-66.9
07/27/19	-292.3	-165.4	-260.0	-69.3
07/28/19	-290.0	-164.1	-261.0	-72.0
07/29/19	-276.3	-159.0	-263.0	-71.8
07/30/19	-256.2	-149.2	-263.0	-72.2
07/31/19	-292.0	-147.9	-268.0	-72.3
08/01/19	-292.3	-146.7	-273.0	-72.1
08/02/19	-291.8	-145.6	-270.0	-72.0
08/03/19	-287.2	-144.6	-273.0	-71.9
08/04/19	-246.8	-155.3	-276.0	-72.0
08/05/19	-240.7	-186.2	-277.0	-72.0
08/06/19	-237.3	-199.2	-280.0	-72.0
08/07/19	-277.6	-209.9	-280.0	-71.8
08/08/19	-291.9	-206.9	-283.0	-71.7
08/09/19	-292.3	-205.7	-287.0	-72.4
08/10/19	-292.3	-204.9	-277.0	-72.6
08/11/19	-292.3	-204.1	-283.0	-72.4
08/12/19	-279.5	-202.9	-299.0	-72.7
08/13/19	-234.9	-196.1	-291.0	-72.4
08/14/19	-288.3	-194.3	-282.0	-72.5
08/15/19	-292.2	-193.1	-288.0	-72.8
08/16/19	-292.3	-192.1	-288.0	-72.1
08/17/19	-274.7	-188.9	-280.0	-71.9
08/18/19	-226.3	-143.0	-264.0	-71.5
08/19/19	-202.5	-107.4	-276.0	-72.6
08/20/19	-195.7	-101.1	-283.0	-71.2
08/21/19	-201.9	-104.3	-285.0	-72.0
08/22/19	-247.8	-113.9	-292.0	-72.5
08/23/19	-240.2	-138.0	-303.0	-72.0
08/24/19	-236.6	-162.5	-298.0	-72.7
08/25/19	-234.1	-196.5	-295.0	-71.9
08/26/19	-205.0	-199.4	-294.0	-68.3
08/27/19	-184.4	-181.5	-301.0	-70.4
08/28/19	-212.9	-180.1	-297.0	-71.8
08/29/19	-236.9	-179.4	-299.0	-71.9
08/30/19	-234.9	-184.4	-301.0	-71.7
08/31/19	-231.5	-184.6	-302.0	-71.6
09/01/19	-224.0	-180.5	-289.0	-71.1
09/02/19	-214.0	-182.0	-289.0	-70.0

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
09/03/19	-209.0	-192.0	-288.0	-67.6
09/04/19	-220.0	-216.0	-287.0	-71.9
09/05/19	-230.0	-229.0	-287.0	-71.7
09/06/19	-245.0	-244.0	-287.0	-70.8
09/07/19	-266.0	-264.5	-287.0	-71.6
09/08/19	-284.0	-266.0	-285.0	-71.7
09/09/19	-292.0	-258.0	-284.0	-72.3
09/10/19	-292.0	-259.0	-283.0	-71.4
09/11/19	-292.0	-258.0	-281.0	-70.6
09/12/19	-264.0	-256.0	-280.0	-67.5
09/13/19	-201.0	-233.0	-283.0	-43.7
09/14/19	-212.0	-219.0	-287.0	-46.5
09/15/19	-204.0	-211.0	-288.0	-67.8
09/16/19	-226.0	-218.0	-291.0	-71.6
09/17/19	-246.0	-217.0	-294.0	-71.7
09/18/19	-231.0	-231.0	-295.0	-72.1
09/19/19	-238.0	-237.0	-292.0	-72.0
09/20/19	-246.0	-245.0	-290.0	-72.0
09/21/19	-265.0	-263.0	-289.0	-72.5
09/22/19	-237.0	-254.0	-287.0	-69.6
09/23/19	-200.0	-235.0	-286.0	-61.3
09/24/19	-250.0	-234.0	-286.0	-70.6
09/25/19	-248.0	-247.5	-285.0	-68.2
09/26/19	-254.0	-253.0	-284.0	-71.4
09/27/19	-240.0	-250.0	-285.0	-69.0
09/28/19	-51.0	-170.0	-290.0	-55.8
09/29/19	0.0	-120.0	-297.0	-56.6
09/30/19	-153.0	-81.0	-299.0	-62.2
10/01/19	-201.0	-79.3	-297.0	-70.3
10/02/19	-240.3	-81.7	-295.0	-68.6
10/03/19	0.0	-7.0	-336.0	-37.5
10/04/19	-6.3	-10.0	-288.0	-36.0
10/05/19	-212.0	-12.0	-287.0	-45.1
10/06/19	-250.0	-12.0	-287.0	-65.6
10/07/19	-230.0	-86.0	-287.0	-71.0
10/08/19	-222.0	-111.0	-287.0	-71.8
10/09/19	-223.0	-134.0	-288.0	-71.8
10/10/19	-293.0	-132.0	-287.0	-72.1
10/11/19	-231.5	-128.0	-287.0	-60.5

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
10/12/19	-214.5	-126.0	-283.0	-65.5
10/13/19	-207.5	-137.5	-286.0	-71.9
10/14/19	-188.0	-181.5	-228.0	-71.9
10/15/19	-204.5	-197.0	-224.0	-72.2
10/16/19	-293.0	-197.5	-224.0	-71.4
10/17/19	-293.0	-196.0	-225.0	-72.1
10/18/19	-292.0	-194.0	-229.0	-72.5
10/19/19	-292.0	-194.0	-234.0	-72.5
10/20/19	-238.0	-204.0	-239.0	-72.5
10/21/19	-232.0	-218.0	-244.0	-72.5
10/22/19	-230.0	-228.0	-248.0	-72.5
10/23/19	-292.0	-228.0	-252.0	-72.5
10/24/19	-292.0	-227.0	-228.0	-72.5
10/25/19	-292.0	-227.0	-220.0	-72.5
10/26/19	-246.0	-226.0	-220.0	-72.5
10/27/19	28.0	-8.0	-223.0	-72.5
10/28/19	-142.0	-15.0	-228.0	-50.5
10/29/19	-224.0	-15.0	-233.0	-46.6
10/30/19	-238.0	-7.0	-238.0	-61.9
10/31/19	-189.0	-7.0	-244.0	-62.5
11/01/19	-148.0	-15.0	-230.0	-67.3
11/02/19	-62.0	-61.0	-231.0	-67.4
11/03/19	-87.0	-87.0	-230.0	-70.0
11/04/19	-116.0	-116.0	-231.0	-70.3
11/05/19	-137.0	-136.0	-231.0	-72.2
11/06/19	-194.0	-148.0	-231.0	-70.9
11/07/19	-149.0	-151.0	-236.0	-72.1
11/08/19	-232.0	-175.0	-238.9	-71.7
11/09/19	-226.0	-195.0	-244.6	-70.6
11/10/19	-220.0	-217.0	-252.9	-71.7
11/11/19	-223.0	-224.0	-257.9	-71.6
11/12/19	-234.0	-233.0	-261.5	-72.1
11/13/19	-243.0	-241.0	-265.9	-72.1
11/14/19	-256.0	-255.0	-270.2	-72.3
11/15/19	-244.0	-259.0	-274.6	-71.4
11/16/19	-235.0	-259.0	-277.9	-72.2
11/17/19	-232.0	-259.0	-284.2	-71.9
11/18/19	-227.0	-258.0	-285.5	-71.8
11/19/19	-273.0	-258.0	-285.2	-71.9

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
11/20/19	-266.0	-258.0	-285.1	-72.4
11/21/19	-272.0	-270.0	-282.0	-69.1
11/22/19	-239.0	-242.0	-285.5	-69.0
11/23/19	-252.0	-251.0	-294.0	-68.0
11/24/19	-271.5	-269.5	-294.0	-69.3
11/25/19	-277.0	-275.0	-295.0	-71.7
11/26/19	-275.0	-273.0	-295.2	-71.4
11/27/19	-218.0	-253.0	-297.3	-67.5
11/28/19	-243.0	-245.0	-298.0	-71.1
11/29/19	-258.0	-257.0	-301.0	-72.2
11/30/19	-261.5	-267.0	-302.3	-72.5
12/01/19	-228.0	-255.0	-300.1	-68.2
12/02/19	-268.0	-266.0	-303.7	-70.2
12/03/19	-260.0	-258.0	-304.7	-70.0
12/04/19	-259.0	-258.0	-301.5	-71.0
12/05/19	-266.0	-264.0	-293.3	-71.6
12/06/19	-265.0	-264.0	-291.0	-71.6
12/07/19	-272.0	-270.0	-295.5	-71.7
12/08/19	-275.0	-273.0	-298.7	-71.9
12/09/19	-261.5	-266.0	-299.4	-72.3
12/10/19	-239.0	-259.0	-302.4	-72.2
12/11/19	-267.0	-265.0	-290.6	-71.4
12/12/19	-264.0	-262.0	-298.0	-72.1
12/13/19	-264.0	-262.0	-286.4	-72.1
12/14/19	-273.5	-271.5	-294.8	-71.7
12/15/19	-274.0	-272.3	-279.9	-71.9
12/16/19	-272.0	-270.0	-290.5	-72.3
12/17/19	-268.0	-266.0	-293.0	-72.2
12/18/19	-265.0	-263.0	-293.0	-71.7
12/19/19	-270.0	-268.0	-289.7	-72.6
12/20/19	-268.5	-266.5	-295.5	-72.4
12/21/19	-267.0	-265.5	-292.3	-71.8
12/22/19	-275.0	-273.0	-296.0	-71.7
12/23/19	-277.0	-275.0	-292.0	-72.4
12/24/19	-241.5	-259.0	-287.0	-72.0
12/25/19	-249.0	-259.3	-289.5	-71.8
12/26/19	-248.3	-259.3	-285.2	-72.1
12/27/19	-231.3	-258.3	-285.8	-72.1
12/28/19	-271.0	-269.0	-293.2	-71.8

TABLE B-3 (Continued): DAILY AVERAGE OF WATER ELEVATION RELATIVE TO CHICAGO CITY DATUM AT UPPER DES PLAINES, DES PLAINES, MAINSTREAM, AND CALUMET TUNNELS OF THE TUNNEL AND RESERVOIR PLAN

Date	Des Plaines	Mainstream	Calumet	Upper Des Plaines
12/29/19	-218.0	-239.0	-293.1	-67.1
12/30/19	-195.5	-225.0	-291.3	-66.0
12/31/19	-228.5	-227.0	-293.2	-71.0

TABLE B-4: DATA OF DAILY PRECIPITATION AT MIDWAY AIRPORT WEATHER STATION

Day	Precipitation (inches)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017												
1	0	0	0.07	0	0.33	0	0	0	0	0	0.33	0
2	0.09	0	0	0	0.1	0	0	0	0.26	0	0.08	0
3	0.01	0	0	0.24	0	0	0.01	0.66	0	0.12	0	0
4	0	0	0	0	0	0	0	0.01	0	0.06	0.44	0.01
5	0	0	0	1.11	0	0	0	0	0	0.01	0.01	0
6	0	0	0	0.36	0.07	0	0	0	0	0.29	0	0
7	0	0.55	0.31	0	0	0	0	0	0	0.46	0	0
8	0	0	0	0	0.01	0.05	0	0	0	0	0	0
9	0	0	0	0	0.32	0.02	0	0	0	0	0	0.01
10	0.24	0	0	0.52	0.82	0	0.39	0	0	0.99	0	0
11	0.4	0	0	0	0	0	0.02	0	0	0.76	0	0.03
12	0.08	0	0	0	0	0	0.73	0	0	0	0.1	0
13	0	0	0.45	0.19	0	0.05	0	0	0.07	0	0	0
14	0	0	0.04	0.15	0	1.05	0	0	0	5.2	0	0
15	0	0	0	0	0	0	0	0	0	0.31	0.23	0
16	0.53	0	0	0.34	0	0.08	0	0	0	0	0	0
17	0.43	0	0.03	0	0.47	0.03	0	0.17	0	0	0.52	0
18	0	0	0	0	0.01	0	0	0	0	0	0.58	0.02
19	0.69	0	0	0.06	0.25	0.23	0.2	0	0.23	0	0	0
20	0.18	0	0.43	0	0.33	0.01	1.09	0.06	0	0	0	0
21	0	0.13	0	0	0.07	0	1.21	0.69	0	0	0.04	0
22	0	0	0	0	0.01	0.02	0.48	0.05	0	0.57	0	0
23	0	0.16	0	0	0.36	0.6	0.03	0	0	1.01	0	0
24	0	0.07	0.48	0	0.35	0	0	0	0	0.55	0	0.08
25	0.05	0	0.45	0	0	0	0	0	0	0	0	0
26	0	0	0.15	0.26	0.26	0	0.07	0	0	0	0	0
27	0	0	0	0.11	0	0	0	0.12	0	0	0	0
28	0	1.49	0	0	0.01	0.24	0	0.04	0	0.01	0	0
29	0		0.21	1.83	0	0.21	0	0	0	0	0	0.02
30	0		2	1.1	0	0.01	0	0	0	0	0	0
31	0.01		0		0		0	0		0		0
Monthly Total	2.71	2.4	4.62	6.27	3.77	2.6	4.23	1.8	0.56	10.34	2.33	0.17
Annual Total	41.80											

TABLE B-4 (Continued): DATA OF DAILY PRECIPITATION AT MIDWAY AIRPORT
WEATHER STATION

Day	Precipitation (inches)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018												
1	0	0	0.53	0	0	0	0.01	0.04	0.04	1.21	0	0.81
2	0	0	0	0	0.26	0.54	0	0	0	0.18	0	0.08
3	0	0.01	0	0.07	0.19	0	0	0	0.45	0	0.05	0
4	0	0.01	0	0	0	0	0.15	0	0	0.06	0.41	0
5	0	0.15	0.08	0.09	0	0.01	0.52	0.07	0.39	1.26	0.29	0
6	0	0.01	0.03	0	0	0.04	0	0.06	0.4	0.18	0.05	0
7	0.03	0.04	0.01	0	0	0	0	0.62	0.2	0.86	0	0
8	0	0.09	0	0	0	0.23	0	0.01	0	0.12	0	0
9	0	0.39	0	0.03	0.21	0.28	0	0.07	0	0.09	0.06	0
10	0.01	0.04	0	0	0	1.27	0	0	0	1.11	0	0
11	0.14	0.15	0	0	0.06	0.09	0	0	0	0	0	0
12	0	0	0	0.02	0.43	0	0	0	0	0	0	0
13	0	0	0	0.06	0.01	0	0	0	0	0	0	0.22
14	0.01	0	0	0.43	1.29	0	0.23	0	0	0.09	0	0.14
15	0.02	0	0	0.6	0	0	0	0.13	0	0.08	0.08	0
16	0	0	0	0	0	0.63	0.17	0.07	0	0	0	0
17	0	0.09	0.14	0	0	0	0	0.17	0	0	0.12	0
18	0	0	0	0.07	0.03	0.01	0	0	0	0	0.03	0
19	0	0.74	0	0.03	0.2	0.1	0.01	0	0	0.06	0	0
20	0	2.31	0	0	0.08	0	0.51	0.29	0	0	0	0.02
21	0.01	0.11	0	0	1.23	2.37	0.05	0.03	0	0	0	0.04
22	0.63	0	0	0	0.05	1.03	0.28	0	0	0	0	0
23	0.06	0.14	0	0	0	0	0	0	0	0	0.04	0
24	0	0.08	0	0	0	0	0	0.05	0.05	0	0.13	0
25	0	0.03	0	0	0.13	0	0	0.06	0.71	0	0.77	0.01
26	0	0	0.19	0	0	0.96	0	0	0	0	0.12	0
27	0	0	0.24	0.03	0	0.04	0	0	0	0.03	0	0.52
28	0	0	0	0	0	0	0	0.84	0.05	0.12	0	0
29	0		0.08	0	0	0	0	0.42	0.02	0	0	0.01
30	0		0	0	0.22	0	0	0	0.01	0.55	0	0
31	0		0.05		0		0.01	1.07		0.26		0.66
Monthly Total	0.91	4.39	1.35	1.43	4.39	7.6	1.94	4	2.32	6.26	2.15	2.51
Annual Total	39.25											

TABLE B-4 (Continued): DATA OF DAILY PRECIPITATION AT MIDWAY AIRPORT
WEATHER STATION

Day	Precipitation (inches)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019												
1	0	0	0	0	0.61	0.03	0	0	0.67	0	0	0.07
2	0	0	0	0	0.32	0	1.26	0	0	0.41	0	0
3	0	0	0	0.02	0.02	0	0.09	0	0.17	0.18	0	0
4	0	0.02	0	0.3	0	0.16	0	0	0	0	0	0
5	0	0.26	0	0	0	0.38	0	0	0	0.28	0	0
6	0	0.04	0	0	0.04	0	0	0.27	0	0	0	0
7	0.38	0.42	0	0.08	0.45	0	0	0	0	0	0	0
8	0	0	0	0	0.38	0	0	0	0.04	0	0	0
9	0	0	0.37	0	0	0.03	0	0	0.01	0	0	0.02
10	0	0.04	0	0.06	0	0	0	0	0	0.1	0.01	0
11	0	0.19	0	0.34	0.07	0	0	0	0.13	0.46	0.14	0
12	0.07	0.26	0	0.13	0.08	0.7	0	0.49	0.24	0	0	0
13	0	0	0.47	0	0	0.02	0.14	0.28	0.64	0	0	0
14	0	0	0.32	0.45	0	0.04	0	0.45	0	0	0	0
15	0	0	0	0	0	0.2	0	0	0.61	0.01	0	0
16	0	0	0	0	0.14	0.09	0.15	0	0	0	0	0
17	0	0.09	0	0	0.27	0	0.28	0.05	0	0	0	0
18	0	0.02	0	0.52	0.42	0	1.43	1.39	0	0	0	0
19	0.04	0	0	0	0.34	0.3	0	0	0	0	0.03	0
20	0	0.04	0.08	0	0	0.21	0.01	0.17	0.01	0	0	0
21	0	0	0	0	0.19	0	0.32	0	0.45	0.08	0.49	0
22	0.11	0	0	0.19	0.02	0	0	0	0.6	0.05	0	0
23	0.19	0.42	0	0	0.02	0.25	0	0	0	0.01	0	0
24	0	0.01	0.11	0	0.11	0.05	0	0	0	0	0	0
25	0	0	0	0.03	0	0	0	0	0	0	0	0
26	0.03	0	0	0.03	0.01	0.16	0	0.58	0	2.26	0.35	0
27	0	0	0.08	0.85	1.28	0	0	0	1.54	0.03	0.14	0
28	0.25	0	0.01	0	0.74	0.45	0	0	0.25	0	0	0.15
29	0		0.39	1.14	0.08	0	0.68	0	0.8	0.11	0.01	0.85
30	0		0.22	1.29	0.13	0.26	0	0	0	0.89	0.17	0.07
31	0.03		0		0		0	0.11		0.13		0
Monthly Total	1.1	1.81	2.05	5.43	5.72	3.33	4.36	3.79	6.16	5	1.34	1.16
Annual Total	41.25											

TABLE B-5: HISTORIC MEAN VALUES OF THE GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF TUNNEL AND RESERVOIR PLAN DURING THE PERIOD FROM 1995–2013

Well ID	pH	EC ¹ mS/m	TDS ¹ mg/L	TOC ¹ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ¹ CFU/100 mL	Temp. °C	GWE ^{1,2} CCD (ft)
MW-5	7.8	104.6	917	2.1	140	303	0.01	340	1	14.3	-49
MW-6	7.7	81.2	782	2.2	38	328	0.48	394	1	13.4	55
MW-7	7.5	85.5	932	1.5	36	402	0.5	528	1.3	14.8	16
MW-8	8	80.2	770	1.9	58	307	0.074	359	1.4	14	-40
QC-2	7.8	55.1	415	3.8	2	31	0.67	112	19	13.1	-262
QC-4	8.1	53.4	442	2.8	12	19	0.16	11	1.3	12.3	-235
QC-17	7.8	59.4	542	1.7	8.4	186	0.26	166	1	12.6	-170
QD-27	7.4	161.6	1,240	24	316	61	24	511	1	12.2	-194
QD-29	7.3	115.4	1,153	3.6	120	290	0.36	717	24	12.7	-185
QD-30	7.3	124.9	1,270	3.6	134	365	0.37	774	1	11.8	-134
QD-31	7.6	121.9	967	2.9	123	213	0.24	328	1.5	11.6	-183
QD-33	8.1	188.1	1,694	2.8	363	200	0.3	28	1	12.2	-157
QD-34	7.3	114.6	1,276	2.7	116	357	0.34	784	1	12.4	-110
QD-36	7.2	129.9	1,401	3.3	129	398	0.27	861	1.1	11.8	-118
QD-46	7.9	82.4	656	2.5	19	144	0.23	107	1	12.2	-175
QD-54	8.3	61.3	461	1.8	19	145	0.21	40	1	12.2	-21
QM-61	7.8	63	402	2.6	75	27	0.37	150	4.9	13.4	-169
QM-62	7.8	56.6	418	3.2	54	46	0.6	183	15	13.8	-188
QM-63	7.5	132.7	1,524	3.2	51	822	1.8	787	3.8	13.5	-181
QM-64	7.6	63.5	493	2.9	58	56	2	236	3.3	13.7	-165
QM-65	7.3	176.9	1,411	11	392	197	8.7	580	1.3	12.9	-192
QM-67	7.4	117.2	942	5.6	187	101	5.3	464	49	13.6	-161
QM-68	7.8	34.4	280	1.7	29	41	0.65	175	1.9	13	-132

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TABLE B-5 (Continued): HISTORIC MEAN VALUES OF THE GROUNDWATER QUALITY PARAMETERS FOR PRIORITY WELLS OF TUNNEL AND RESERVOIR PLAN DURING THE PERIOD FROM 1995–2013

Well ID	pH	EC ¹ mS/m	TDS ¹ mg/L	TOC ¹ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L	NH ₃ -N mg/L	Hardness mg/L	FC ¹ CFU/100 mL	Temp. °C	GWE ^{1,2} CCD (ft)
QM-75	7.9	30.1	239	1.4	14	12	0.26	70	1.3	11.8	-62
QM-77	8	23.9	193	2	11	6.2	0.13	43	2	11.8	-164

¹EC = electrical conductivity; TDS = total dissolved solids; TOC = total organic carbon; FC = fecal coliform; GWE = groundwater elevation.

²Relative to Chicago City Datum (579.48 ft above sea level).