State of Illinois
Illinois Emergency Management Agency

2017 Radiological Environmental Monitoring Report for Palos Forest Preserve

IEMA

(This Page Intentionally Left Blank)

Table of Contents

Introduction

The Illinois Emergency Management Agency (IEMA) is charged with protecting the citizens of Illinois from the potentially harmful effects of radioactive materials. To that end, the IEMA's Division of Nuclear Safety monitors the environment in Illinois for the presence of radionuclides. One of the locations monitored by IEMA is the area around the Site A/Plot M Disposal Sites within Red Gate Woods. Red Gate Woods is a part of the Palos Forest Preserve and is near the village of Palos Park. Appendix A includes maps of the area around the Palos Forest Preserve indicating the locations of IEMA and Argonne National Laboratory sampling points.

History of the Site

In the early 1940s, Enrico Fermi and a team of scientists assembled the world's first atomic "pile" (nuclear reactor), named "CP-1" for "Chicago Pile 1" under an abandoned squash court beneath the Stagg Field football stadium at the University of Chicago, resulting in the first self-sustaining nuclear chain reaction on December 2, 1942. Recognizing the potential radiation exposure to the population of the city of Chicago, the reactor was transferred to Red Gate Woods in 1943, which is part of Palos Forest Preserve, a wooded site located 20 miles southwest of downtown Chicago. There, the reactor was rebuilt, and renamed CP-2.

In 1944, CP-3, the first heavy-water cooled and moderated reactor started operation at the Palos Forest Preserve site. By the mid-1950s, all research programs had been transferred to the current site of Argonne National Laboratory, so CP-2 and CP-3 reactors were decommissioned, surveyed, decontaminated, demolished, and components buried at "Site A" in Red Gate Woods. The U.S. Department of Energy performed a limited remediation for Site A in 1996-1997 after high levels of radioactive material (specifically tritium) were found in surface water that drain from the site. In addition to the 19-acre Site A, radioactive material from nuclear research conducted from 1944-1949 is buried in a 150-foot by 140-foot area called "Plot M," also in Red Gate Woods. The material in Plot M is entombed under a 1-foot thick concrete barrier, with side walls extending down 8 feet into the ground, and covered with 2.5 feet of dirt on top.

IEMA Radiological Environmental Monitoring Program

IEMA's radiological environmental monitoring program at Palos Forest Preserve is performed in cooperation with Argonne National Laboratory. Argonne staff collects water samples from six locations within Red Gate Woods (Red Gate Woods Well #5160, Red Gate Wells #11 and #12, Plot M Boreholes #4 and #10, and Site A Borehole #56) during the second quarter of the year, and supplies IEMA with splits of these samples. IEMA collects an additional 14 samples. The IEMA samples are scheduled to be collected quarterly, but are not always obtainable or accessible due to weather condition, and/or facility closures.

All samples collected are analyzed for man-made and naturally occurring radionuclides. Sample results are then compared to applicable drinking water and groundwater standards. Water Standards are regulated by the USEPA and IEPA, IEMA's purpose for sampling private wells and public water supplies is solely to screen for the presence of radionuclides in drinking water.

In 2017, only sample results from water collected at Plot M Borehole #4 exceeded USEPA and IEPA Drinking Water Standards, sample results from all other locations fell below federal and state safety guidelines.

Laboratory Analysis

This report contains tables of data showing analysis results of samples taken by both Argonne and IEMA staff. Analysis was performed by the IEMA Radiochemistry Laboratory in Springfield.

All analytical methods have limitations: amounts that are too small to be detected. The Minimum Detectable Concentration (MDC) is an "a priori" measure of that limitation – an estimate of the lower limit of detection. It is defined as the smallest quantity that an analytical method has 95% likelihood of detecting. For example, the MDC for IEMA's method for tritium in water is 200 picocuries per liter (pCi/L). Given a sample with a tritium concentration of 200 pCi/L, our laboratory would detect that tritium approximately 95 times out of 100. Samples with concentrations less than 200 pCi/L could be detected, but with less certainty. Conversely, samples with concentrations higher than 200 pCi/L would be more likely to be detected, approaching 100% as concentrations increase.

Analytical methods are chosen, in part, on their MDC. As a general rule, methods are chosen such that their MDC is less than 10% of any applicable regulatory limit.

Tritium Results

Tritium (H-3) was measured in water samples using EPA Method 906.0, "Tritium in Drinking Water." Sample analysis was performed using a liquid scintillation analyzer, calibrated for tritium analysis. To provide additional perspective on tritium concentrations at various locations, **Appendix B** depicts historical tritium results at sampling locations.

The U.S. Environmental Protection Agency's (US EPA) drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000) and the Illinois Environmental Protection Agency's (IEPA) groundwater standard (Groundwater Quality Standards for Class I: Potable Resource Groundwater, 2013) both set the limit for tritium in groundwater at 20,000 pCi/L.

The highest levels of tritium were found in the boreholes at Plot M. Test results from Plot M Borehole #4 exceeded the US EPA and IEPA standards referenced above, but is used for testing purposes only and is capped and kept locked to ensure that the public does not have access to water from the well. Results from several other sampling locations were above the MDC set for tritium, but did not ecxceed the USEPA and IEPA standards. While not all wells are capped and locked like the Plot M boreholes, all wells do require the use of a pump handle assembly to retrieve water. The pump handle assemblies are only attached when sampling is being conducted, and immediately removed once complete.

Strontium Results

Radiostrontium was measured in water using EPA 402-R-10-001d, "Rapid Radiochemical Method for Total Radiostrontium (Sr-90) in Water for Environmental Restoration Following Homeland Security Events." Gas proportional counting was performed on a low-background gas proportional counter. Strontium results can be found in **Table C.3** of **Appendix C**.

The established MDC for Total Strontium was met at the Bullfrog Lake Well #5031 during the March 22, 2017 sampling. An issue with the hand pump on Well #5031 was discovered during the subsequent sampling attempt, and follow up samples have not been able to be collected. Argonne and the Park Preserve were notified of the needed repair, but the pump remained unusable for the remainder of 2017. Although the MDC was met, the sample result for Total Strontium was still below the U.S. Environmental Protection Agency's (US EPA) drinking water standard (National Primary Drinking

Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000), as well as the Illinois Environmental Protection Agency's (IEPA) groundwater standard (Groundwater Quality Standards for Class I: Potable Resource Groundwater, 2013) of 8 pCi/L for Strotium-90. When operational, well #5031 is used for testing purposes only and requires the use of a pump handle assembly to retrieve water. The pump handle assemblies are only attached when sampling is being conducted, and immediately removed once sampling is complete.

Gamma Spectroscopy Results

The gamma spectroscopy analyses in water samples were processed using the IEMA Method BES-SRC-PLS-115; "Gamma Spectroscopy of Samples." One-liter aliquots of unfiltered waters were transferred to 1-L Marinelli beakers and counted for 15 hours. The data was collected with high purity germanium detectors and analyzed with Canberra APEX Lab Productivity Suite/Genie 2000 software. **Table C.3**. of **Appendix C** contains gamma spectroscopy results.

All gamma spectroscopy results were below established MDCs.

Background Sampling Location

IEMA has established the environs of Sangchris Lake State Park, a cooling lake for a coal-fired power station near Kincaid, IL, as the Background Sampling Location. To establish "background" radiation levels, water samples are collected and analyzed utilizing the same procedures and methodologies used for the Palos Forest Preserve samples.

Results for background samples can be found in Appendix D.

Summary

In 2017, all test results for samples collected as part of IEMA's radiological environmental monitoring program of groundwater within and around the Palos Forest Preserve that are obtainable by the general public, indicate that the level of groundwater contamination is below the limits set by the U.S. Environmental Protection Agency's (US EPA) drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000) and the Illinois Environmental Protection Agency's (IEPA) groundwater standard (Groundwater Quality Standards for Class I: Potable Resource Groundwater, 2013). With the exception of samples collected from Plot M Borehole #4, results from all samples collected in 2017 were below the national and state standards referenced above. Plot M borehole #4, contained tritium in excess of the state and national standards. These results are expected, as samples collected from this location have historically produced results in excess of the 20,000 pCi/L standard for tritium. The water sampled from this location is not used for public drinking water, and the boreholes are capped and kept locked when not being tested.

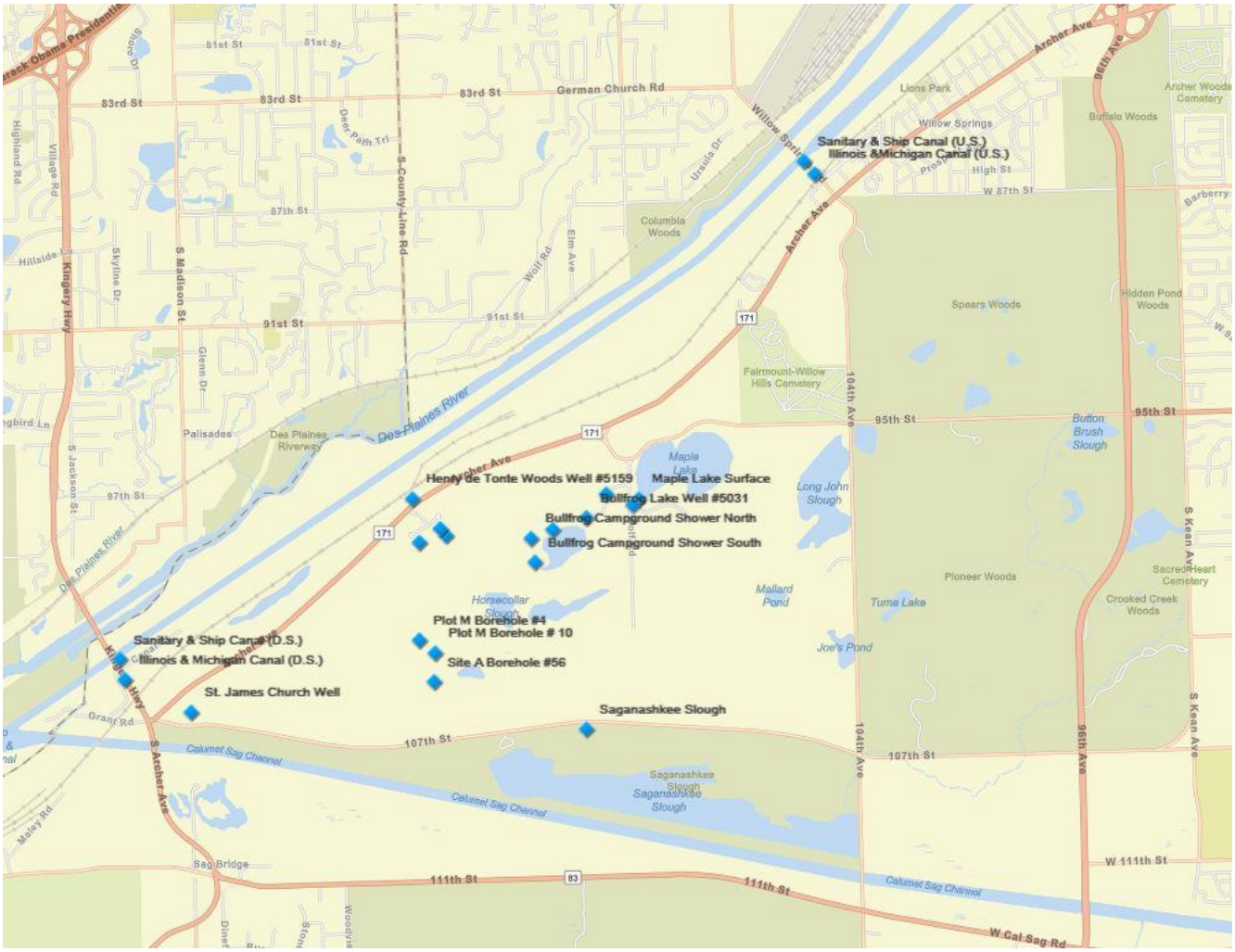
APPENDIX A
Sampling Locations

Map A.1. Palos Park Forest Preserve Sampling Locations

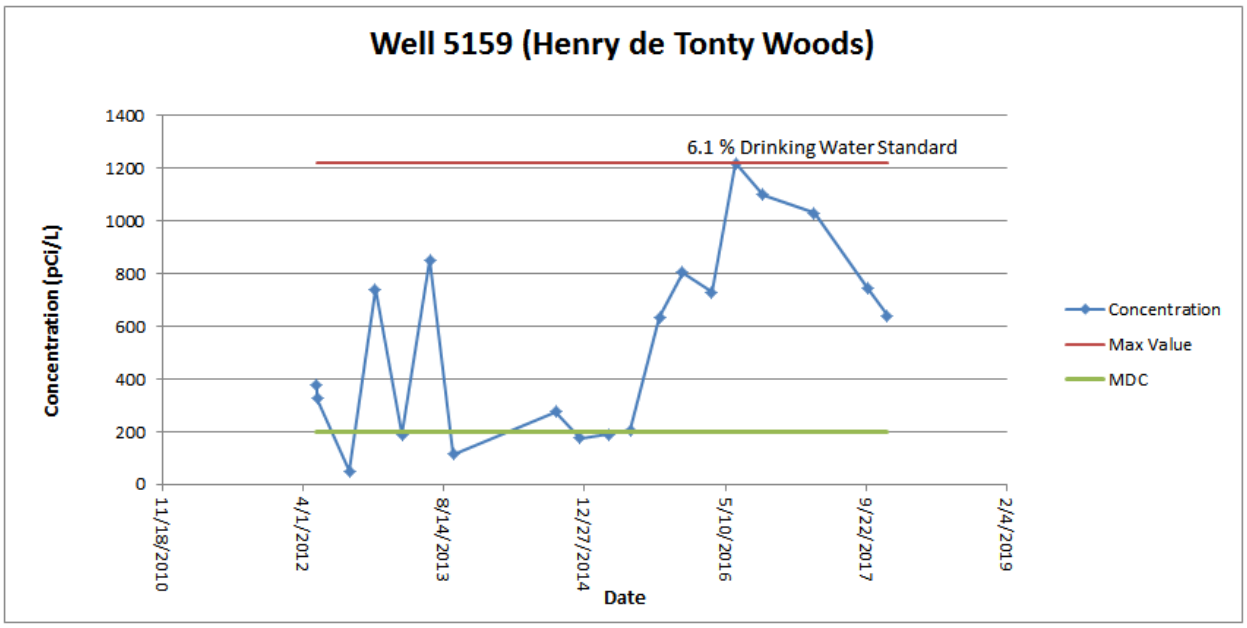
Map Key:

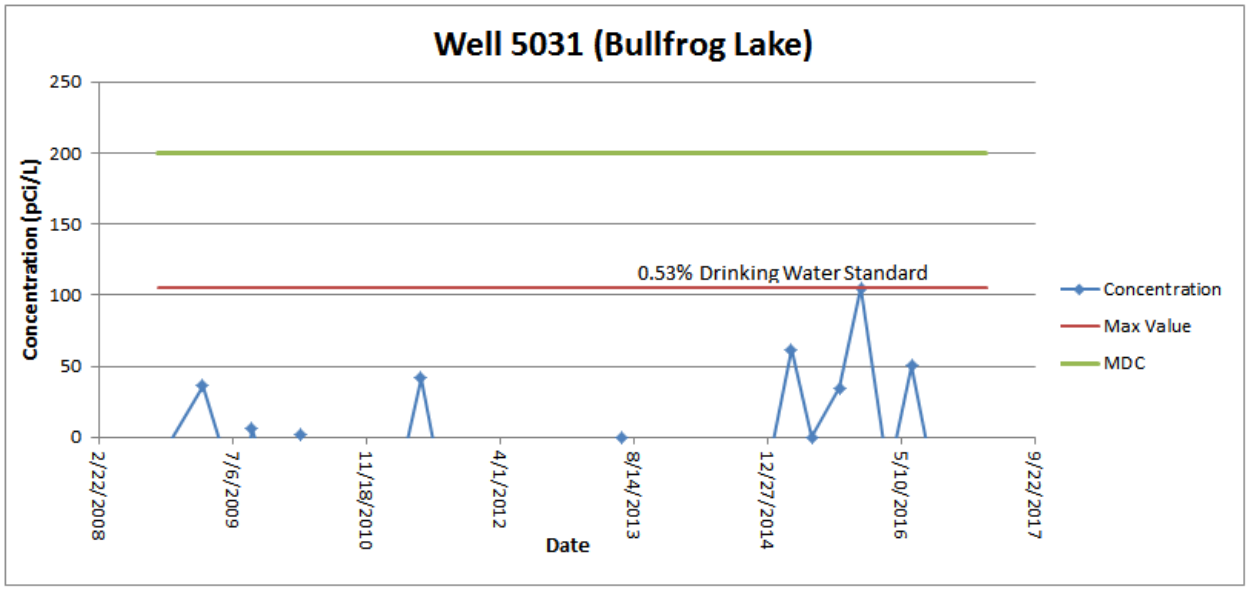
◆ **Water Sampling Location**

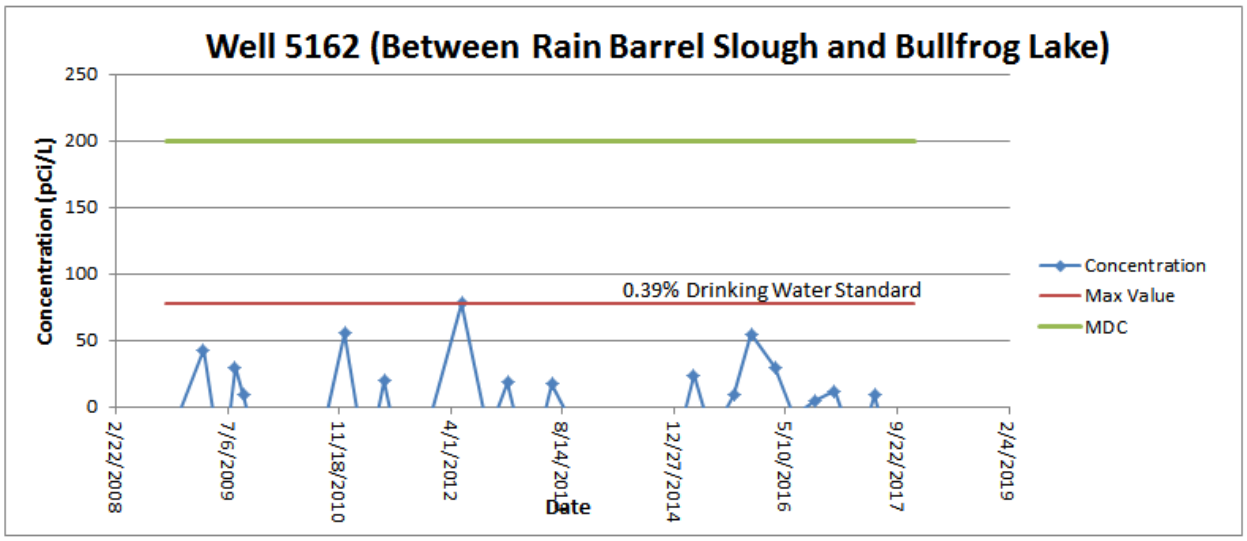
Map A.2. Palos Park Forest Preserve and Peripheral Sampling Locations

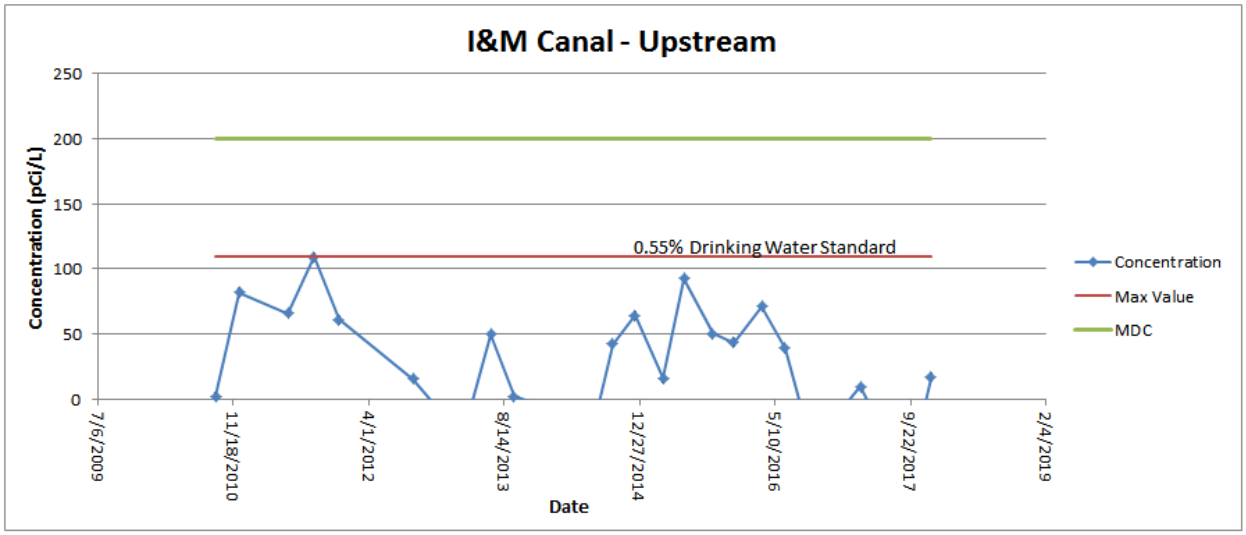


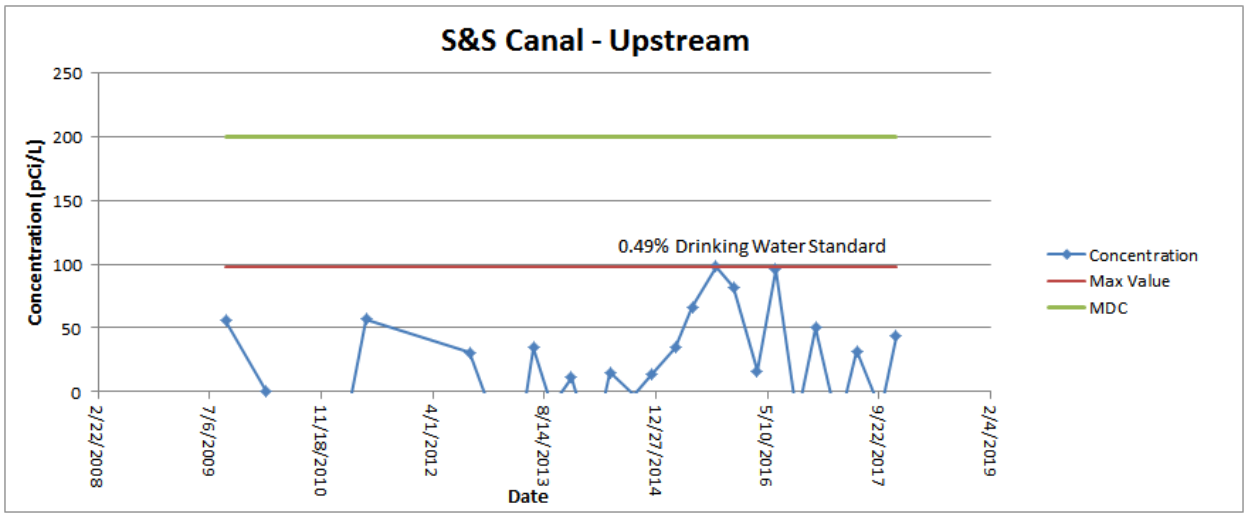
APPENDIX B
Graphical Representations of Tritium Water Sample Results through 2017

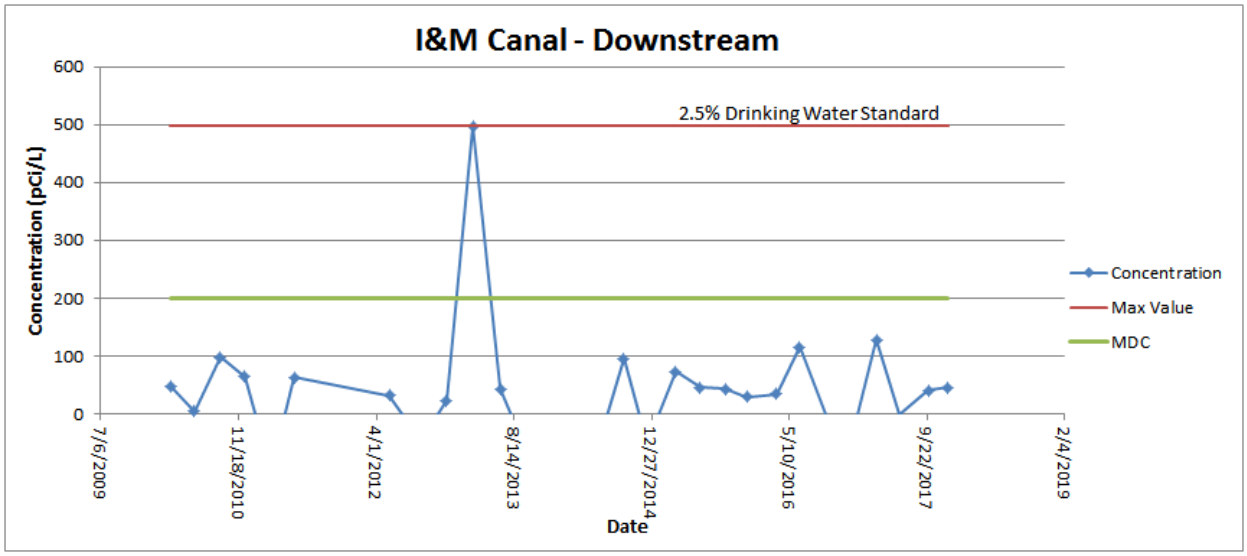


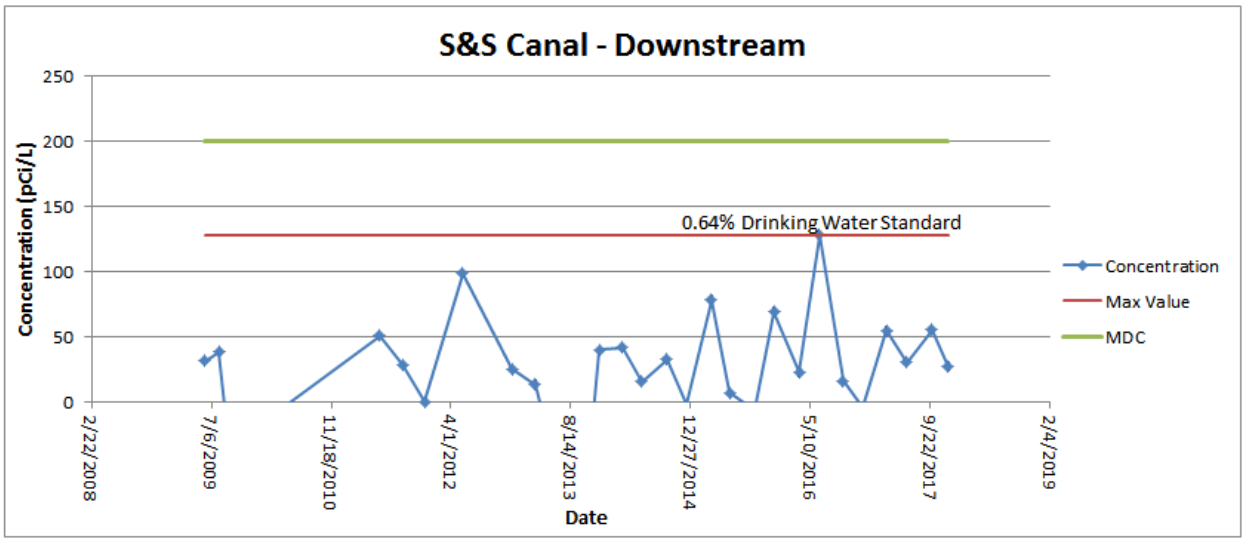


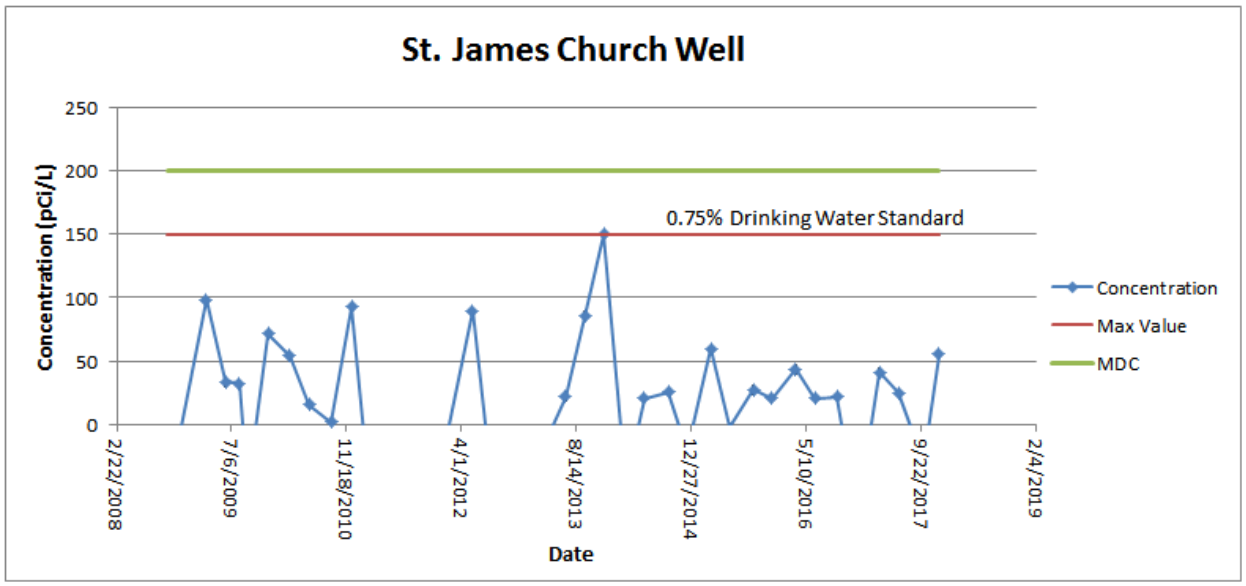

Well 5162 (Between Rain Barrel Slough and Bullfrog Lake)
Concentration (pCi/L)
250
200
150
100
50
0
0.39% Drinking Water Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
Date
Concentration
Max Value
MDC

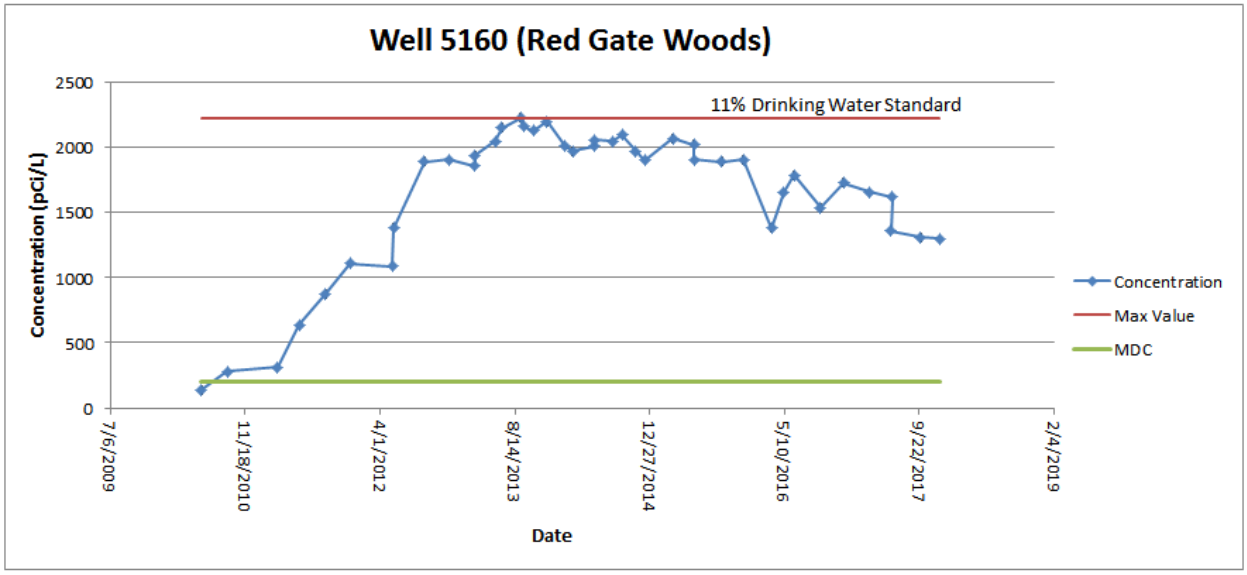

I&M Canal - Upstream
Concentration (pCi/L)
250
200
150
100
50
0
0.55% Drinking Water Standard
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
Date
Concentration
Max Value
MDC

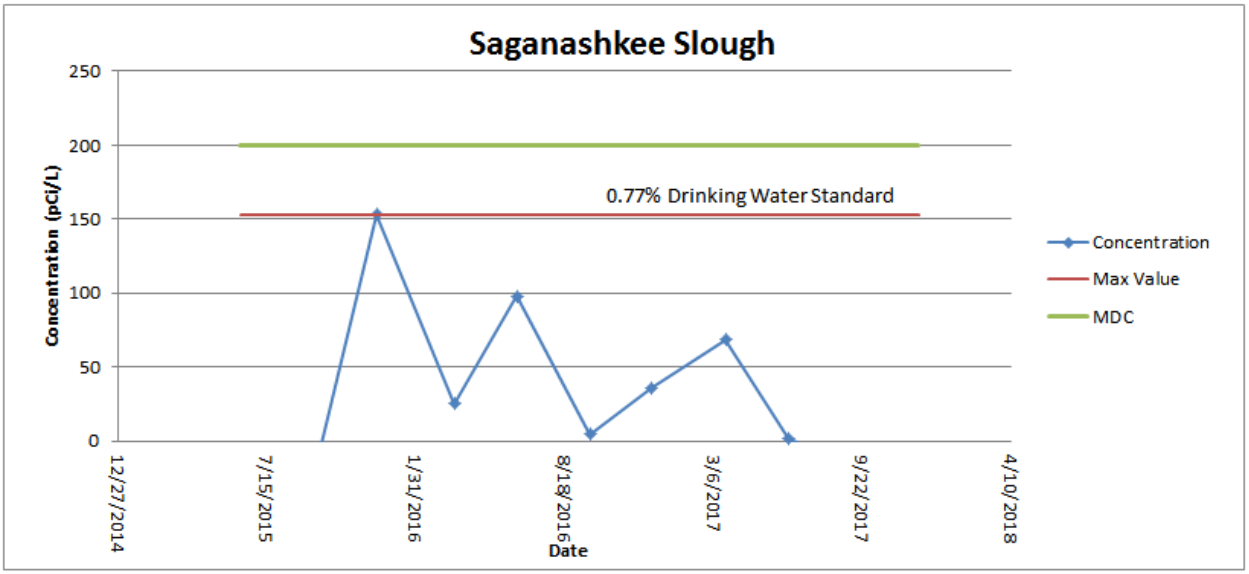

S&S Canal - Upstream
250
200
150
100
50
0
Concentration (pCi/L)
0.49% Drinking Water Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
Date
Concentration
Max Value
MDC

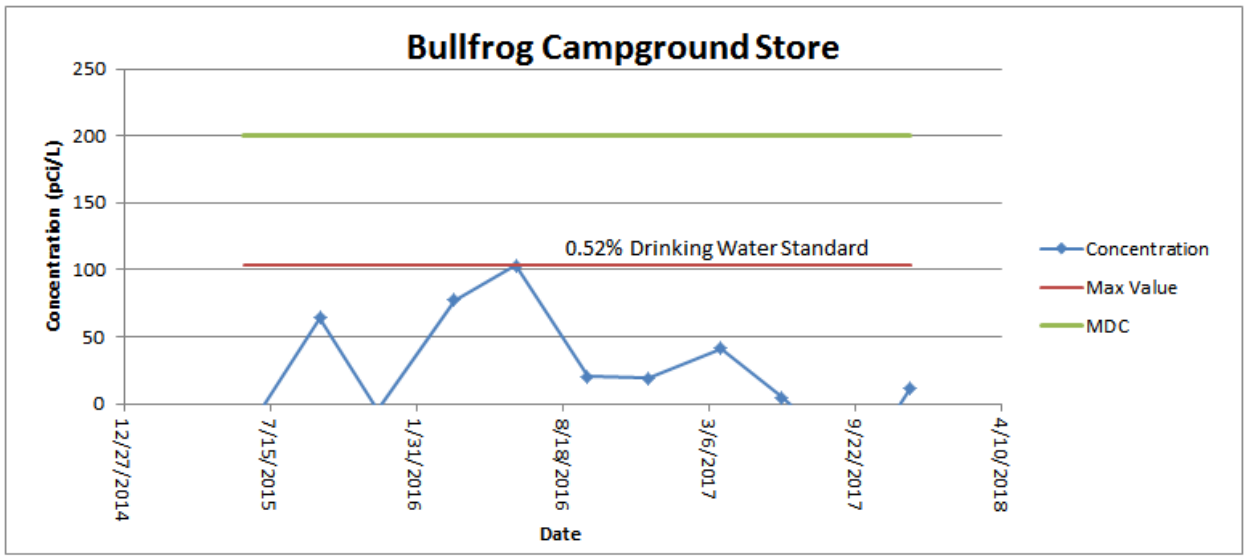

I&M Canal - Downstream
600
500
400
300
200
100
0
Concentration (pCi/L)
2.5% Drinking Water Standard
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
Date
Concentration
Max Value
MDC

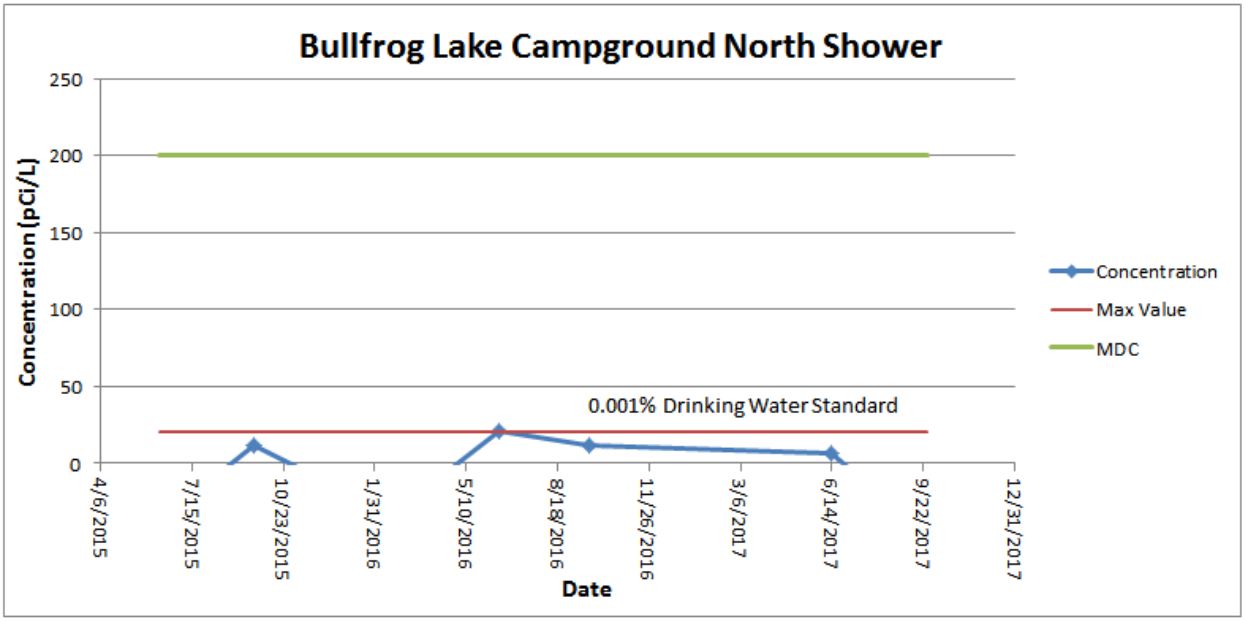

S&S Canal - Downstream
250
200
150
100
50
0
Concentration (pCi/L)
0.64% Drinking Water Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
Date
Concentration
Max Value
MDC

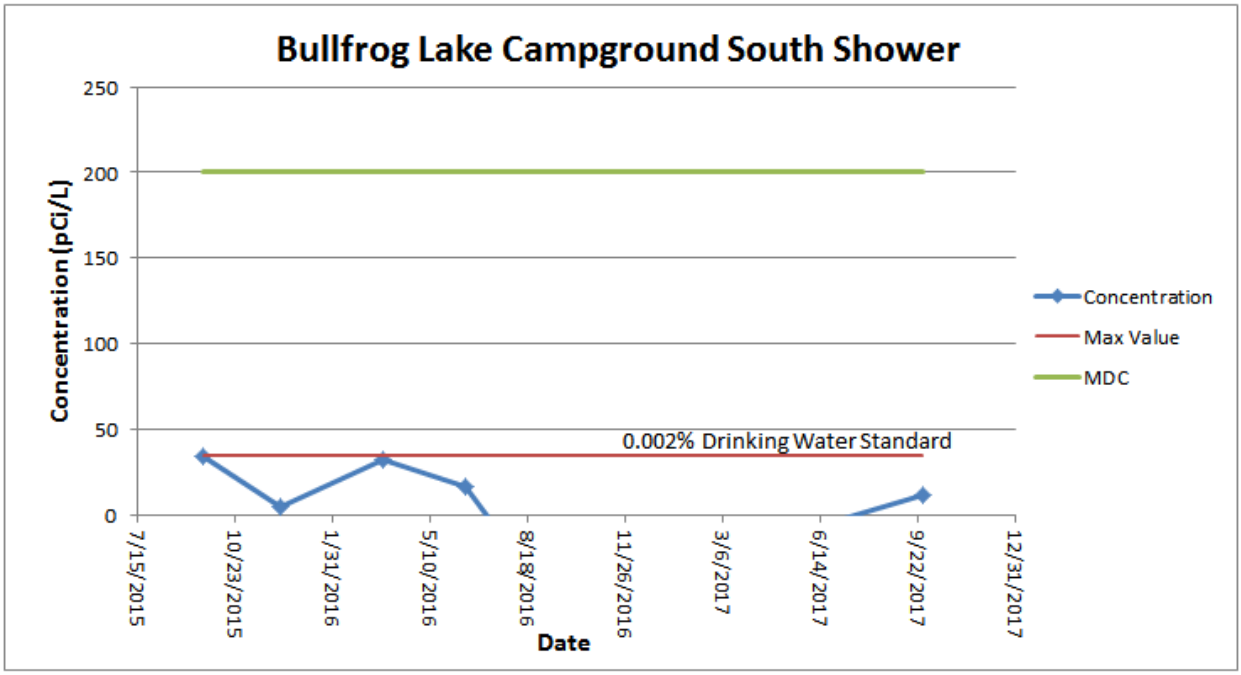

St. James Church Well
250
200
150
100
50
0
Concentration (pCi/L)
0.75% Drinking Water Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
Date
Concentration
Max Value
MDC

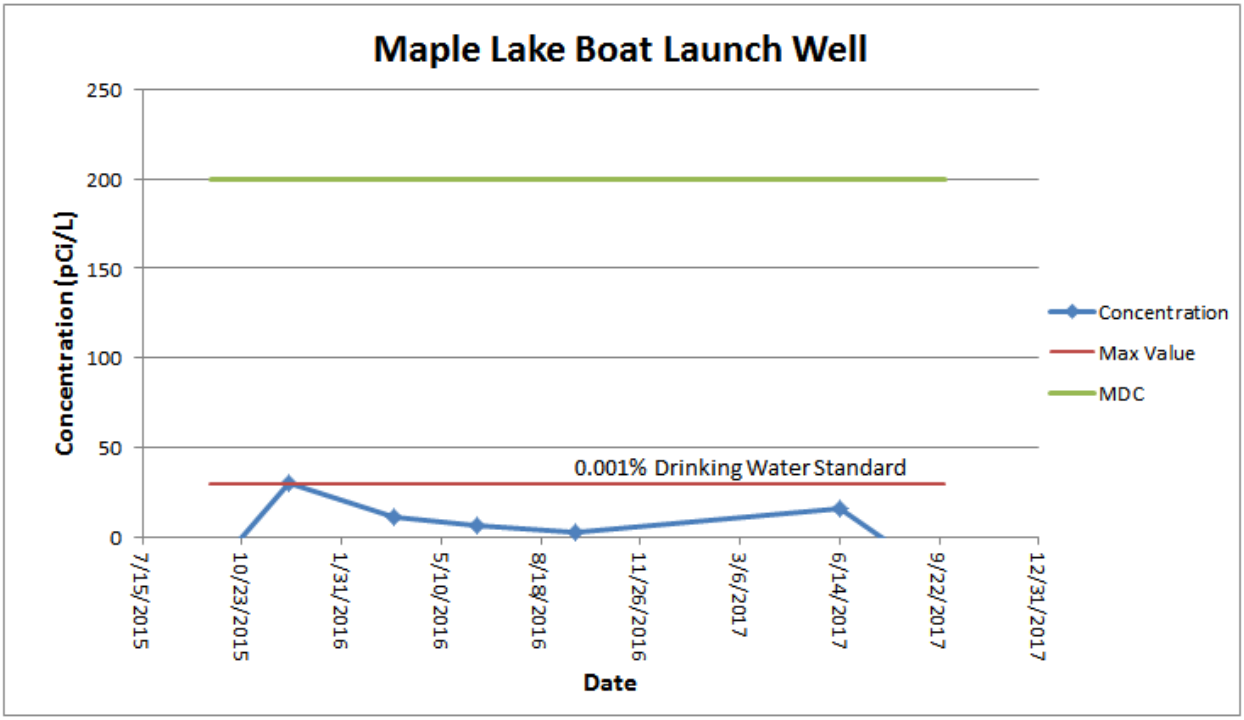

Well 5160 (Red Gate Woods)
11% Drinking Water Standard
Concentration (pCi/L)
2500
2000
1500
1000
500
0
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
Date
Concentration
Max Value
MDC

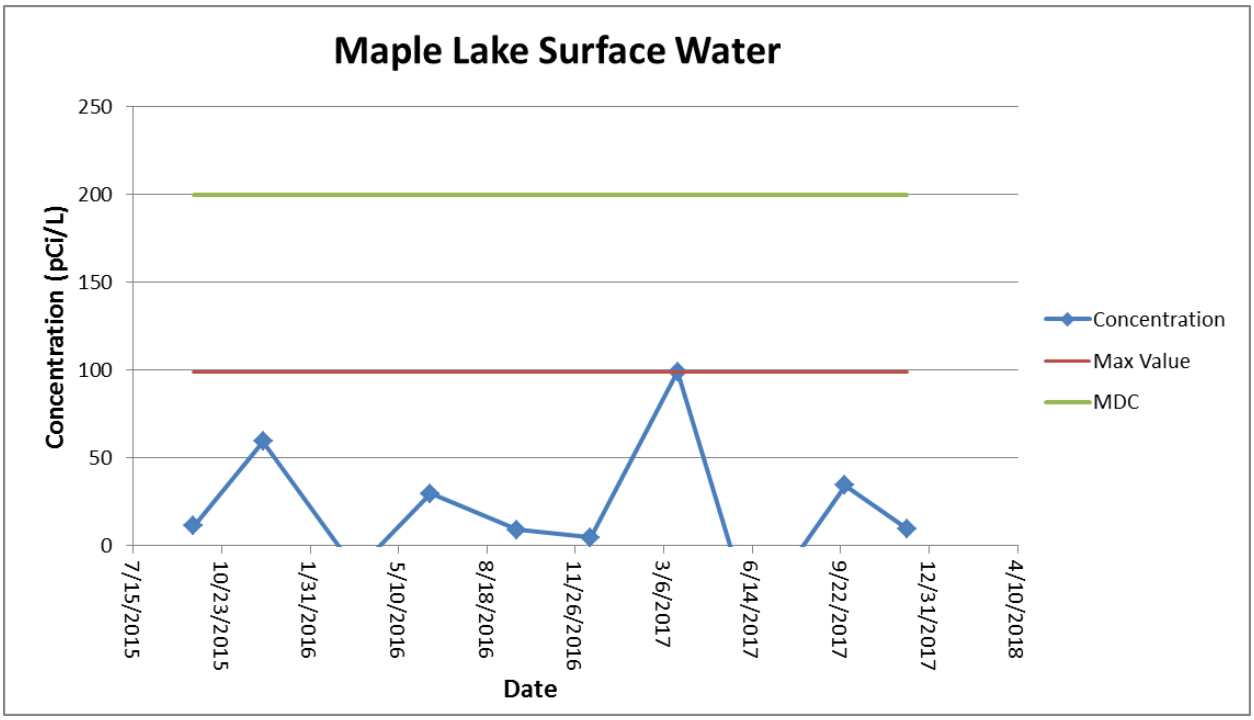

Saganashkee Slough
0.77% Drinking Water Standard
Concentration (pCi/L)
250
200
150
100
50
0
12/27/2014
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
Date
Concentration
Max Value
MDC

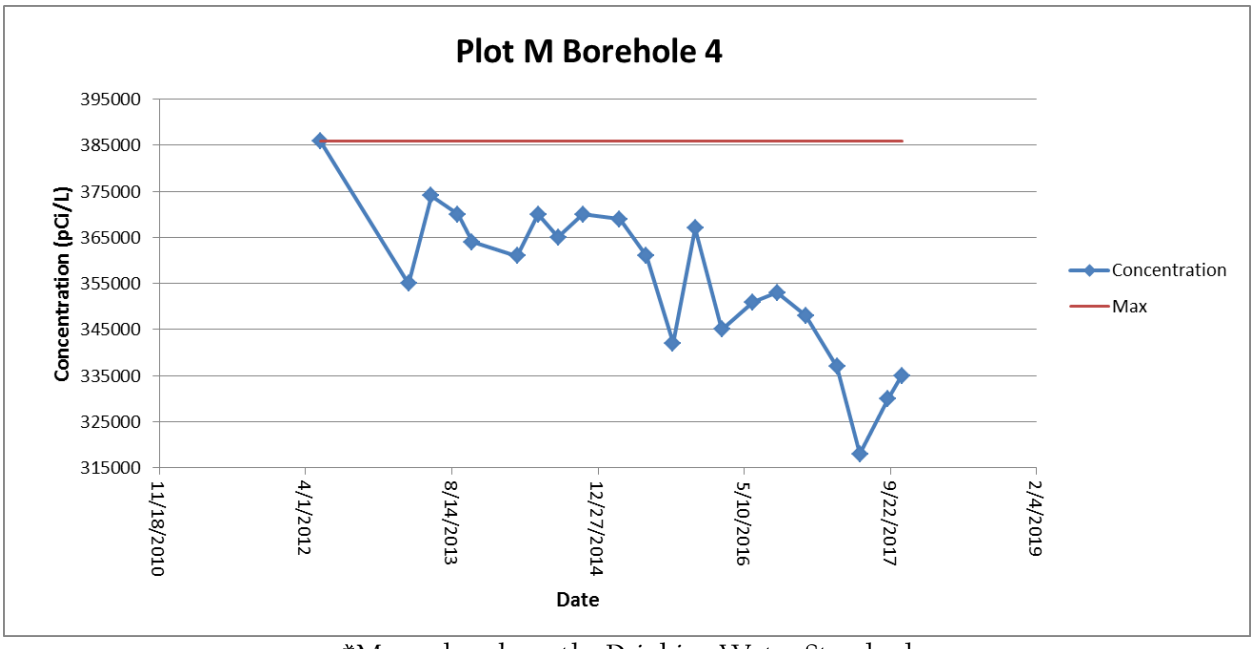

Bullfrog Campground Store
250
200
150
100
50
0
Concentration (pCi/L)
0.52% Drinking Water Standard
12/27/2014
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
Date
Concentration
Max Value
MDC


Bullfrog Lake Campground North Shower
250
200
150
100
50
0
Concentration (pCi/L)
0.001% Drinking Water Standard
4/6/2015
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
3/6/2017
6/14/2017
9/22/2017
12/31/2017
Date
Concentration
Max Value
MDC

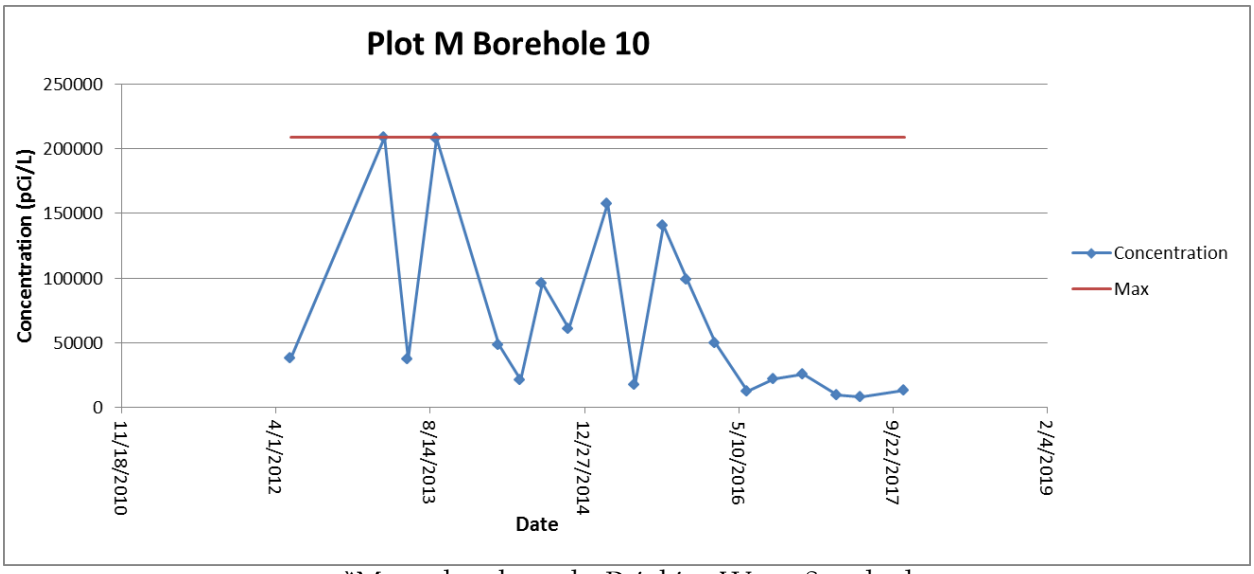

Bullfrog Lake Campground South Shower
Concentration (pCi/L)
250
200
150
100
50
0
0.002% Drinking Water Standard
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
3/6/2017
6/14/2017
9/22/2017
12/31/2017
Date
Concentration
Max Value
MDC


Maple Lake Boat Launch Well
Concentration (pCi/L)
250
200
150
100
50
0
0.001% Drinking Water Standard
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
3/6/2017
6/14/2017
9/22/2017
12/31/2017
Date
Concentration
Max Value
MDC

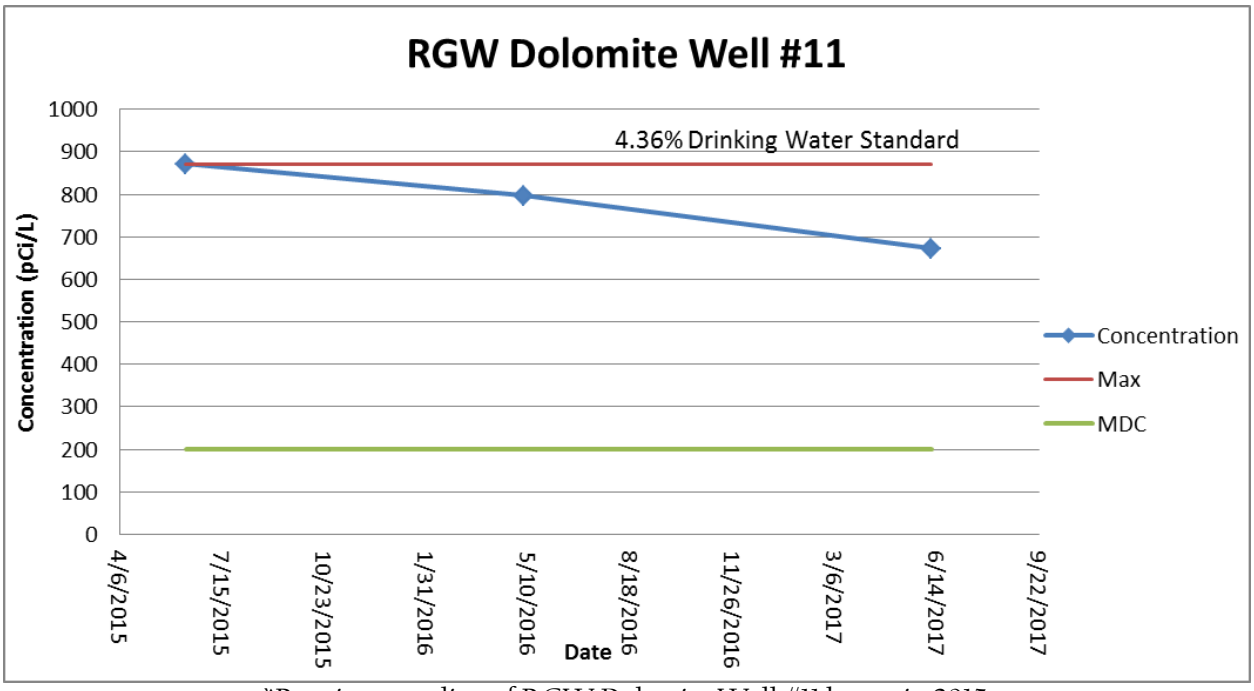




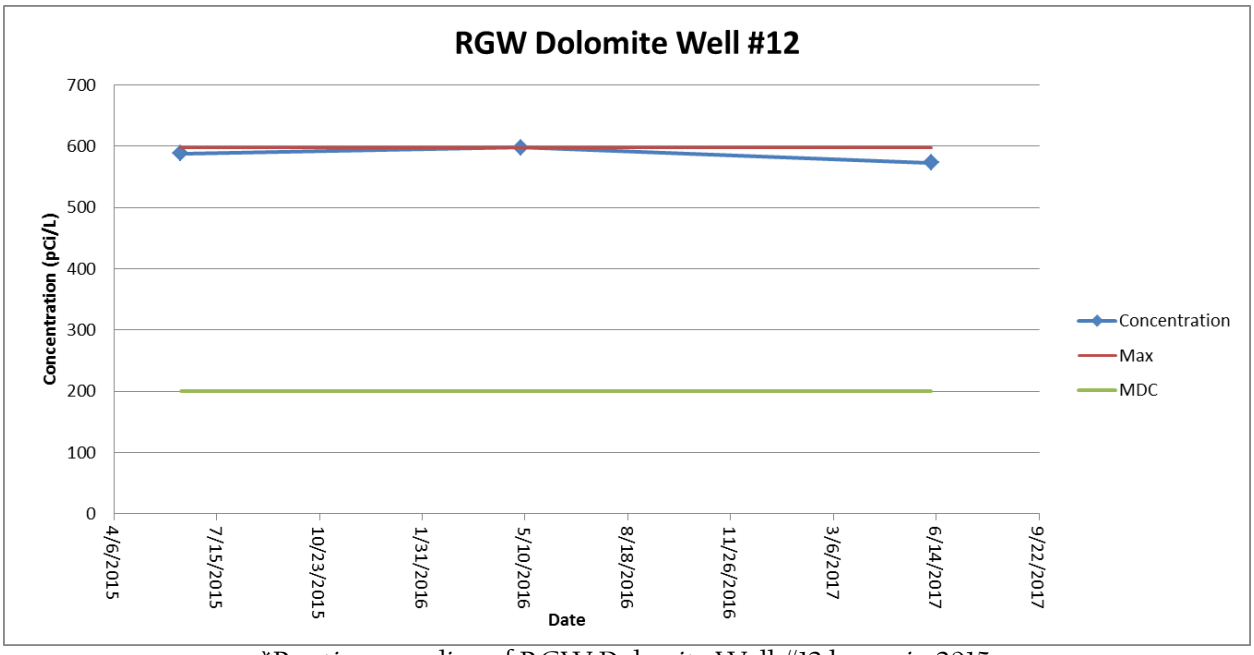
*Max value above the Drinking Water Standard



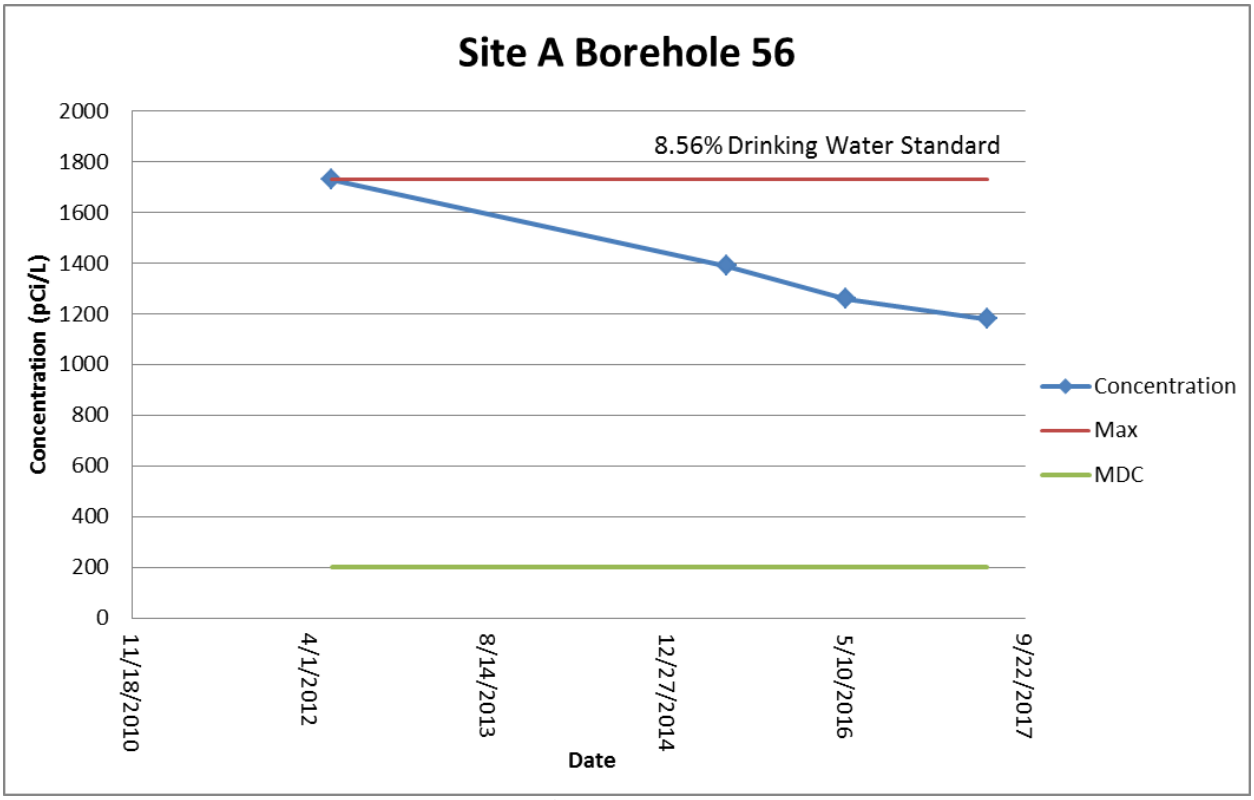
*Max value above the Drinking Water Standard



*Routine sampling of RGW Dolomite Well #11 began in 2015.



*Routine sampling of RGW Dolomite Well #12 began in 2015.



*Routine sampling of Site A Borehole 56 began in 2015.

APPENDIX C
Site A / Plot M and Palos Park Sample Results

Table C.1 Tritium (H-3) Results for Water Samples
Results are in picocuries per liter (pCi/L)

Location	H-3	
Date	Result	MDC
Rain Barrel Slough Well #5162		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200
Bullfrog Campground Shower North		
6/14/2017	<MDC	200
9/27/2017	<MDC	200
Bullfrog Campground Shower South		
6/14/2017	<MDC	200
9/27/2017	<MDC	200
Bullfrog Campground Store		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200
Bullfrog Lake Well #5031		
3/22/2017	<MDC	200
Henry de Tonty Woods Well #5159		
3/22/2017	1030	200
9/27/2017	748	200
12/6/2017	642	200
Illinois & Michigan Canal (DnS)		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200

Location	H-3	
Date	Result	MDC
Illinois & Michigan Canal (UpS)		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200
Maple Lake Boat Launch Well		
6/14/2017	<MDC	200
9/27/2017	<MDC	200
Maple Lake Surface		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200
Plot M Borehole #10		
3/24/2017	9770	200
6/9/2017	7890	200
10/30/2017	13400	200
Plot M Borehole #4		
3/24/2017	337000	200
6/9/2017	318000	200
9/14/2017	330000	200
10/30/2017	335000	200
Red Gate Woods Well #5160		
3/22/2017	1660	200
6/9/2017	1360	200
6/14/2017	1620	200
9/27/2017	1310	200
12/6/2017	1300	200

Location	H-3	
Date	Result	MDC
RGW Dolomite Well #11		
6/9/2017	672	200
RGW Dolomite Well #12		
6/9/2017	573	200
Saganashkee Slough		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200
Sanitary & Ship Canal (DnS)		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200
Sanitary & Ship Canal (UpS)		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200
Site A Borehole #56		
6/9/2017	1180	200
St. James Church Well		
3/22/2017	<MDC	200
6/14/2017	<MDC	200
9/27/2017	<MDC	200
12/6/2017	<MDC	200

Table C.2 Gamma Results for Water Samples
Results are in picocuries per liter (pCi/L)

Location	Cs-137	
Date	Result	MDC
Rain Barrel Slough Well #5162		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Bullfrog Campground Shower North		
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
Bullfrog Campground Shower South		
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
Bullfrog Campground Store		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Bullfrog Lake Well #5031		
3/22/2017	<MDC	4.0
Henry de Tonty Woods Well #5159		
3/22/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Illinois & Michigan Canal (DnS)		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0

Location	Cs-137	
Date	Result	MDC
Illinois & Michigan Canal (UpS)		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Maple Lake Boat Launch Well		
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
Maple Lake Surface		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Plot M Borehole #10		
3/24/2017	<MDC	4.0
6/9/2017	<MDC	4.0
10/30/2017	<MDC	4.0
Plot M Borehole #4		
3/24/2017	<MDC	4.0
6/9/2017	<MDC	4.0
9/14/2017	<MDC	4.0
10/30/2017	<MDC	4.0
Red Gate Woods Well #5160		
3/22/2017	<MDC	4.0
6/9/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0

Location	Cs-137	
Date	Result	MDC
RGW Dolomite Well #11		
6/9/2017	<MDC	4.0
RGW Dolomite Well #12		
6/9/2017	<MDC	4.0
Saganashkee Slough		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Sanitary & Ship Canal (DnS)		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Sanitary & Ship Canal (UpS)		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0
Site A Borehole #56		
6/9/2017	<MDC	4.0
St. James Church Well		
3/22/2017	<MDC	4.0
6/14/2017	<MDC	4.0
9/27/2017	<MDC	4.0
12/6/2017	<MDC	4.0

Table C.3 Total Strontium Results for Water Samples
Results are in picocuries per liter (pCi/L)

Location	Strontium	
Date	Result	MDC
Bullfrog Campground Shower North		
9/27/2017	<MDC	1.8
Bullfrog Campground Store		
9/27/2017	<MDC	1.8
12/6/2017	<MDC	1.8
Bullfrog Lake Well #5031		
3/22/2017	1.8	1.8
Plot M Borehole #10		
3/24/2017	<MDC	1.8
6/9/2017	<MDC	1.8
10/30/2017	<MDC	1.8
Plot M Borehole #4		
3/24/2017	<MDC	1.8
6/9/2017	<MDC	1.8
9/14/2017	<MDC	1.8
10/30/2017	<MDC	1.8
Red Gate Woods Well #5160		
6/9/2017	<MDC	1.8
6/14/2017	<MDC	1.8
RGW Dolomite Well #11		
6/9/2017	<MDC	1.8
RGW Dolomite Well #12		
6/9/2017	<MDC	1.8
Saganashkee Slough		
12/6/2017	<MDC	1.8
Site A Borehole #56		
6/9/2017	<MDC	1.8
St. James Church Well		
3/22/2017	<MDC	1.8
12/6/2017	<MDC	1.8

APPENDIX D
Background Location Sample Results

Table D.1 Tritium (H-3) Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location	H-3	
Date	Result	MDC
East Boat Ramp		
1/11/2017	<MDC	200
4/19/2017	<MDC	200
7/18/2017	<MDC	200
10/18/2017	<MDC	200
Strawkaws Boat Ramp		
1/11/2017	<MDC	200
4/19/2017	<MDC	200
7/18/2017	<MDC	200
10/18/2017	<MDC	200
West Boat Ramp		
1/11/2017	<MDC	200
4/19/2017	<MDC	200
7/18/2017	<MDC	200
10/18/2017	<MDC	200

Table D.2 Gamma Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location	Cs-137	
Date	Result	MDC
East Boat Ramp		
1/11/2017	<MDC	3.8
4/19/2017	<MDC	3.8
7/18/2017	<MDC	3.8
10/18/2017	<MDC	3.8
Strawkaws Boat Ramp		
1/11/2017	<MDC	3.8
4/19/2017	<MDC	3.8
7/18/2017	<MDC	3.8
10/18/2017	<MDC	3.8
West Boat Ramp		
1/11/2017	<MDC	3.8
4/19/2017	<MDC	3.8
7/18/2017	<MDC	3.8
10/18/2017	<MDC	3.8

Illinois Emergency Management Agency
1035 Outer Park Drive
Springfield, IL 62704

www.iema.illinois.gov

Printed by the Authority of the State of Illinois 12-17 Web IOCI 18-0323