State of Illinois
Illinois Emergency Management Agency

2018 Radiological Environmental Monitoring Report for Palos Forest Preserve

IEMA

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Introduction

The Illinois Emergency Management Agency (IEMA) is charged with protecting the citizens of Illinois from the potentially harmful effects of radioactive materials. In support of that mission, IEMA's Division of Nuclear Safety monitors the environment in Illinois for the presence of radionuclides through its radiological environmental monitoring program. This program has three primary functions: 1) collection of diverse samples from carefully chosen locations on a routine basis; 2) analyzing samples for radionuclides; and 3) evaluation of test results on both an annual and historical basis.

One of the locations monitored as part of IEMA's radiological environmental monitoring program is the environs of the Site A/Plot M Disposal Sites within Red Gate Woods. Site A/Plot M Disposal Sites and Red Gate Woods are a part of the Palos Forest Preserve which is located near the village of Palos Park, IL.The purpose of this report is to provide updated results of monitoring activities conducted during calendar year 2018.

Site Description

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, and then demolished and 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.

Red Gate Woods and the waste burial areas at Site A and Plot M have been incorporated into the area's forest preserve system. The Palos Forest Preserve is open to the public for educational and recreational use. Recreational activities include fishing, boating, camping, biking, and hiking. To ensure that water from impacted ground water wells is not accessible to the general public, wells located within Red Gate Woods and near Site A or Plot M are either capped and locked, or require the use of a pump handle assembly to retrieve water. Pump handle assemblies are only attached when sampling is being conducted, and immediately removed once complete.

IEMA Radiological Environmental Monitoring Program

IEMA's radiological environmental monitoring program at Palos Forest Preserve is performed in cooperation with Argonne National Laboratory (ANL). Argonne staff collects water samples from six locations within Red Gate Woods and supplies IEMA with splits of these samples. IEMA collects 14 samples on a quarterly basis. Appendix A contains maps of the area around the Palos Forest Preserve indicating the locations of IEMA and ANL sampling points.

All samples collected are analyzed for man-made radionuclides. Sample results are then compared to applicable drinking water and groundwater standards, as well as to historical data collected from the site. Drinking and groundwater standards are regulated by the US EPA 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. A summary of the sample collection, analysis, and results follows. Sample result tables are located in Appendix B and C.

In 2018, only sample results from water collected at Plot M Boreholes #4 and #10 exceeded national and state water standards, sample results from all other locations fell below federal and state guidelines. Plot M Boreholes #4 and #10 are capped, locked, and only accessed during sampling activities.

Sampling Activities

IEMA Water Sampling

As part of its environmental monitoring program at the Palos Forest Preserve, IEMA collects and analyzes water samples quarterly from the following locations:

Surface Water

Illinois & Michigan Canal- Downstream of the site.
Illinois & Michigan Canal- Upstream of the site.
Chicago Sanitary & Ship Canal- Downstream of the site.
Chicago Sanitary & Ship Canal- Upstream of the site.
Sanganashkee Slough
Maple Lake

Ground Water Accessible to the Public

Bullfrog Campground shower- North
Bullfrog Campground shower- South
Bullfrog Campground store
Maple Lake boat launch well
St. James Church well

Ground Water Inaccessible to the Public

Rain Barrel Slough Well #5162
Henry de Tonty Woods Well #5159
Red Gate Woods Well #5160

ANL Water Sampling

Argonne National Laboratory collects water samples from the following locations, and provides IEMA with split samples for analysis:

Ground Water Inaccessible to the Public

Plot M Borehole #4- Collected quarterly.
Plot M Borehole #10- Collected quarterly.
Site A Borehole #56- Collected annually (Second quarter).
Red Gate Woods Well #5160- Collected annually (Second quarter).
Red Gate Woods Dolomite Well #11- Collected annually (Second quarter).
Red Gate Woods Dolomite Well #12- Collected annually (Second quarter).

Background Reference 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 reference 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 reference samples can be found in Appendix D.

General Sampling Information

Every effort is made to collect all scheduled environmental samples; however, occasionally samples are unobtainable due to weather conditions, water levels, or obstructed access.

Laboratory Analysis

This report contains tables of data showing analysis results of samples taken by both Argonne and IEMA staff. Samples were analyzed to determine the concentration of tritium, total strontium, and of certain gamma emitting radionuclides. All samples were analyzed by the IEMA Radiochemistry Laboratory located in Springfield, IL. The laboratory participates in semi-annual proficiency testing programs through Environmental Resource Associates, an accredited proficiency testing provider, and the Department of Energy (DOE) Radiological and Environmental Science Laboratory's Mixed Analyte Performance Evaluation Program (MAPEP).

Tritium Analysis

Tritium emits a low energy beta particle. This beta energy is too low to be detected by ordinary analytical methodologies for evaluating gross beta activity. Therefore, to measure the concentration of tritium, water samples are analyzed using liquid scintillation counting; a technique that is capable of measuring radioactive emissions at very low energies and very low concentrations.

Gamma Analysis

Gamma emitting radionuclides are analyzed using a high-purity germanium detector in a process called gamma spectroscopy, which allows the identification of individual radionuclides.

Total Strontium Anaysis

Strontium is easily masked by other radionuclides, including those which are naturally occurring. Therefore, samples being analyzed for total strontium undergo preliminary chemical separation so that the strontium may

be isolated for analysis. Samples analysis for total strontium is performed using a low-background gas proportional counter.

Minimum Detectable Concentration (MDC)

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 less than 200 pCi/L could be detected, but with less certainty. Conversely, samples with more 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.

Sampling Results

Tritium Results

Tritium results are compared to historical data, data collected from the background reference location, and to 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) which both set a limit for tritium 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 exceed the USEPA and IEPA standards.

To provide additional perspective on tritium concentrations, Appendix B depicts historical tritium results at each sampling location.

Total Strontium Results

Strontium results are compared to historical data, data collected from the background reference location, and to 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) which both set a limit for strontium-90 at 8 pCi/L.

Results from total strontium analysis indicated that the established MDC was met in some samples collected from Site A and Plot M. Although occasionally above the established MDC, all sample results for total strontium remained below the US EPA and IEPA standards referenced above.

Gamma Spectroscopy Results

The gamma spectroscopy results are compared to historical data and to data collected from the background reference location.

Gamma spectroscopy results were below established MDCs.

Summary

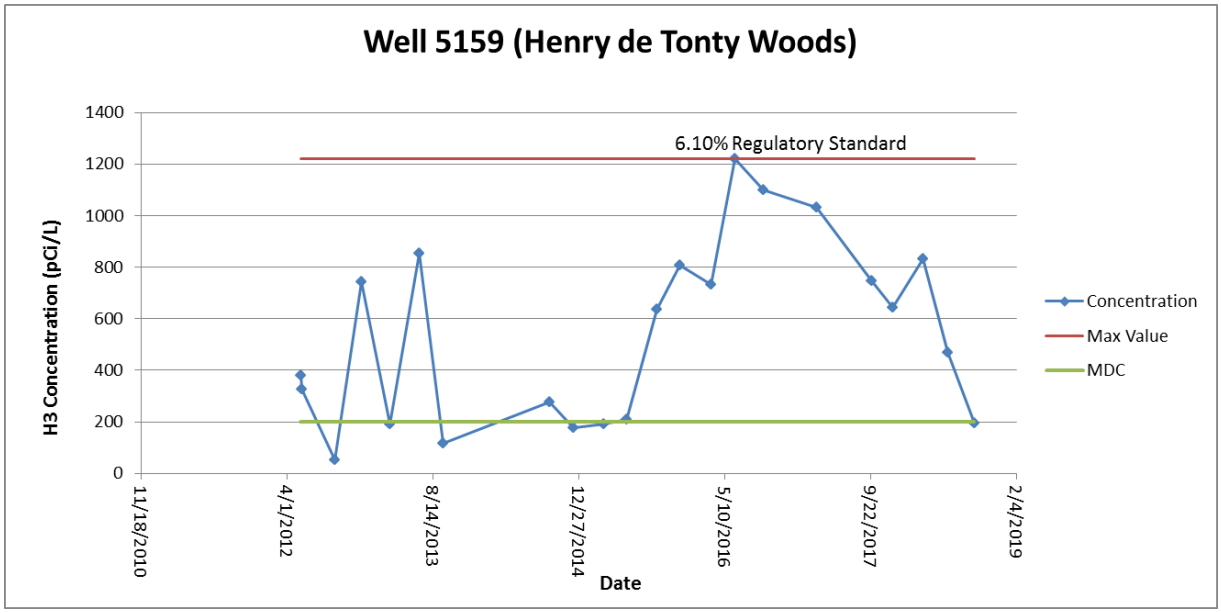
In 2018, analytical results for all publically accessible water sources, analyzed as part of IEMA's monitoring program at the Palos Forest Preserve, were below the national and state standards for all radionuclides and were consistent with historical data. Analytical results for samples collected from Plot M Borehole #4 and Borehole #10 indicated tritium concentrations in excess of the US EPA and IEPA standards. Plot M Boreholes #4 and #10 are used for testing purposes only and are capped and kept locked to ensure that the public does not have access to water from the well. Results in excess of these standards are routinely seen from Borehole #4, and occassionaly seen from Borehole #10. Despite the occasional spike in tritium concentrations seen at some locations, all boreholes and wells with tritium in excess of the established MDC continue to show a gradual decline in tritium concentrations.

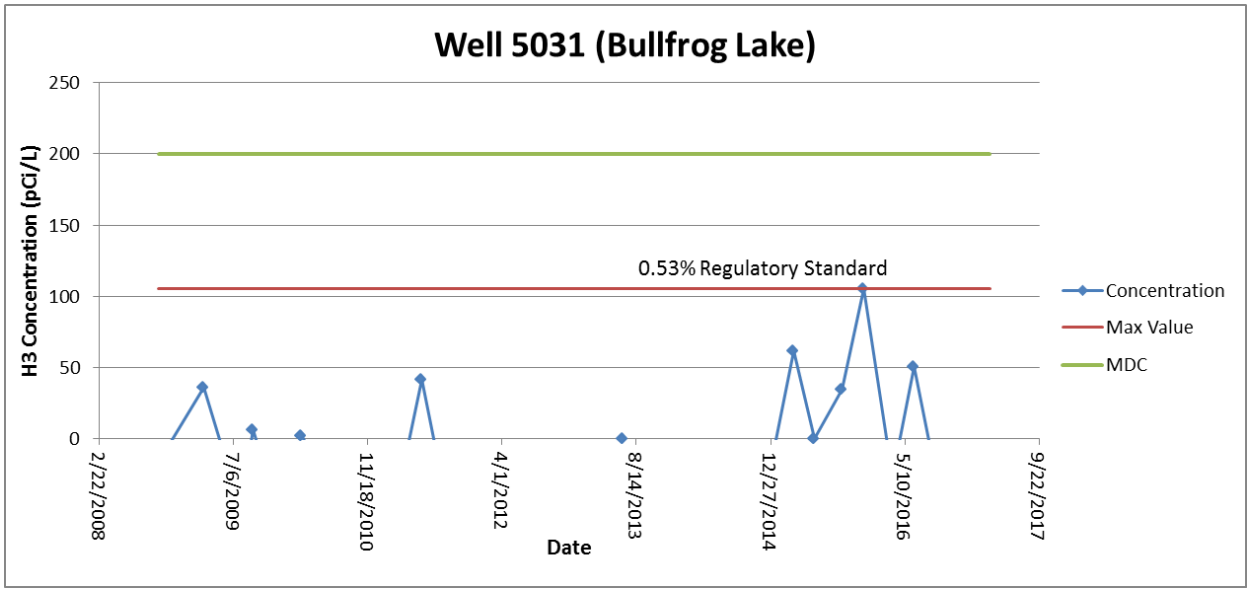
APPENDIX A
Sampling Locations

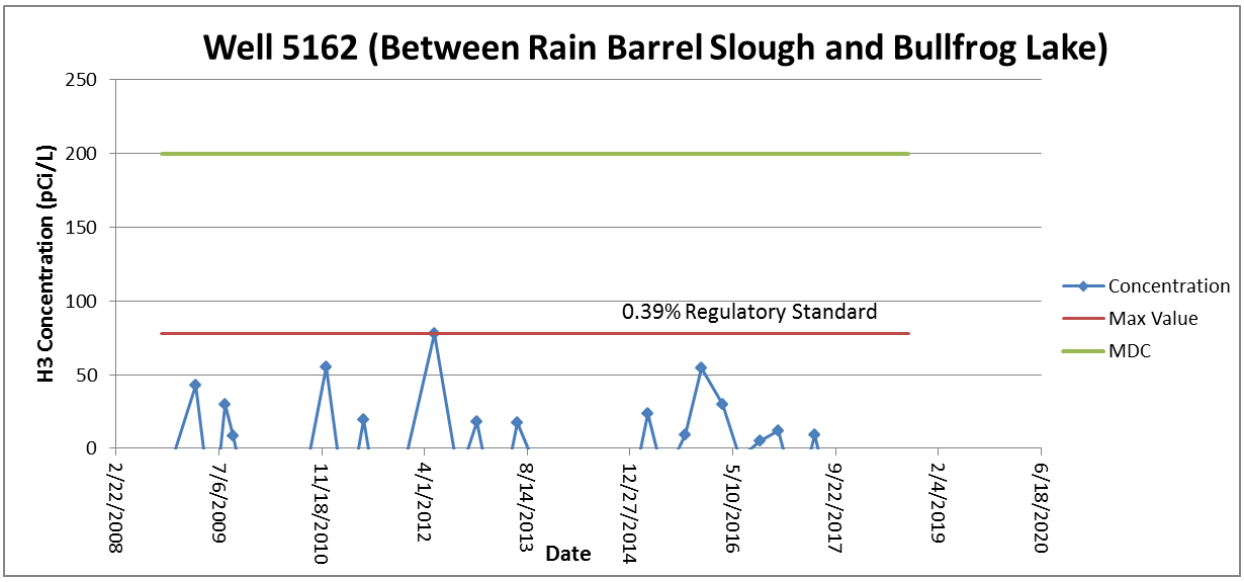
Map A.1. Palos Park Forest Preserve Sampling Locations

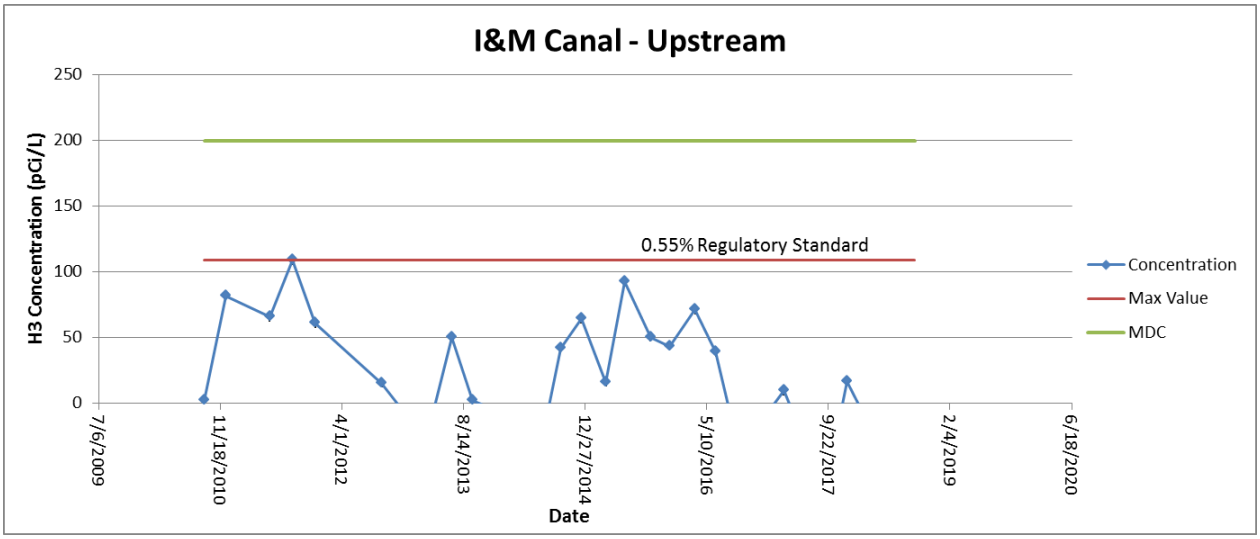
Map A.2. Palos Park Forest Preserve and Peripheral Sampling Locations

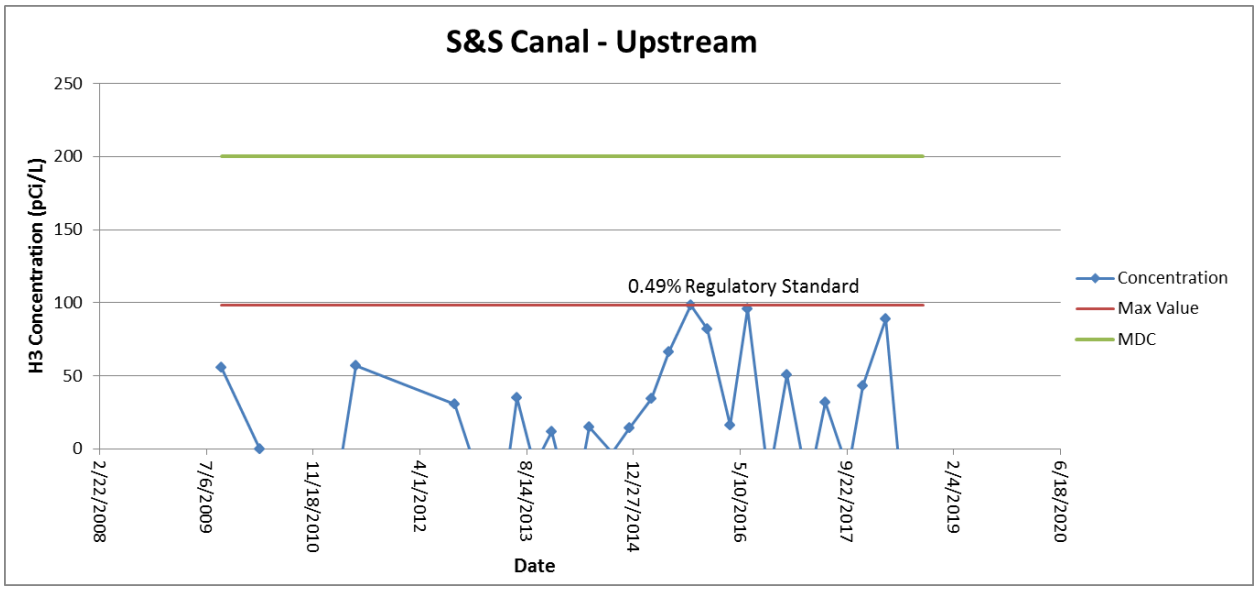
APPENDIX B
Graphical Representations of Tritium Water Sample Results through 2018

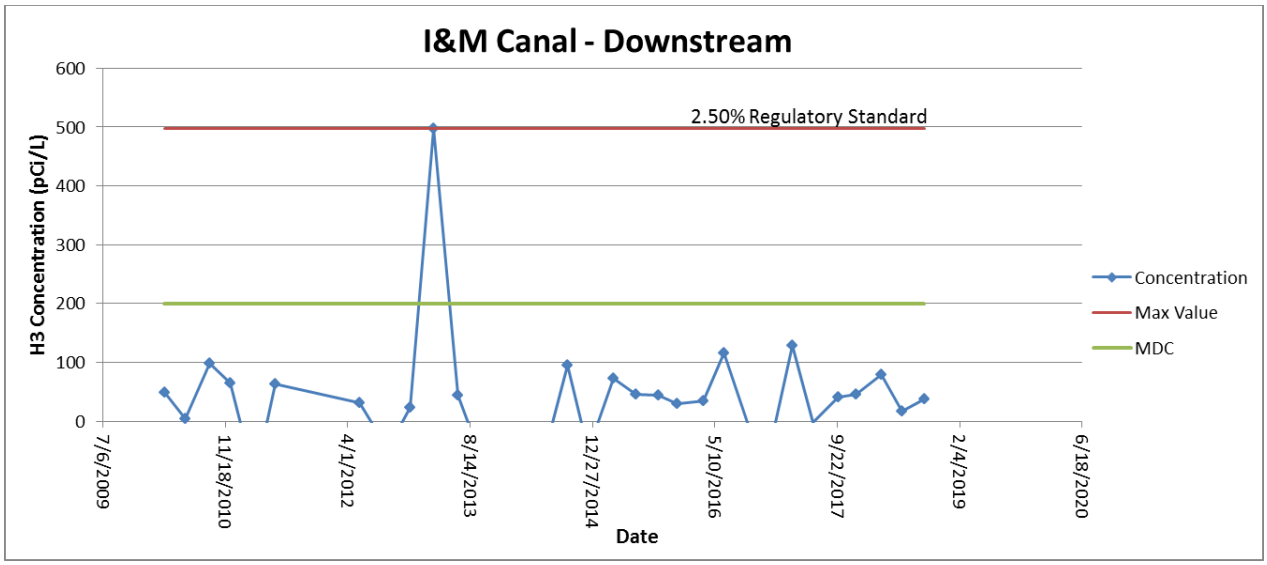


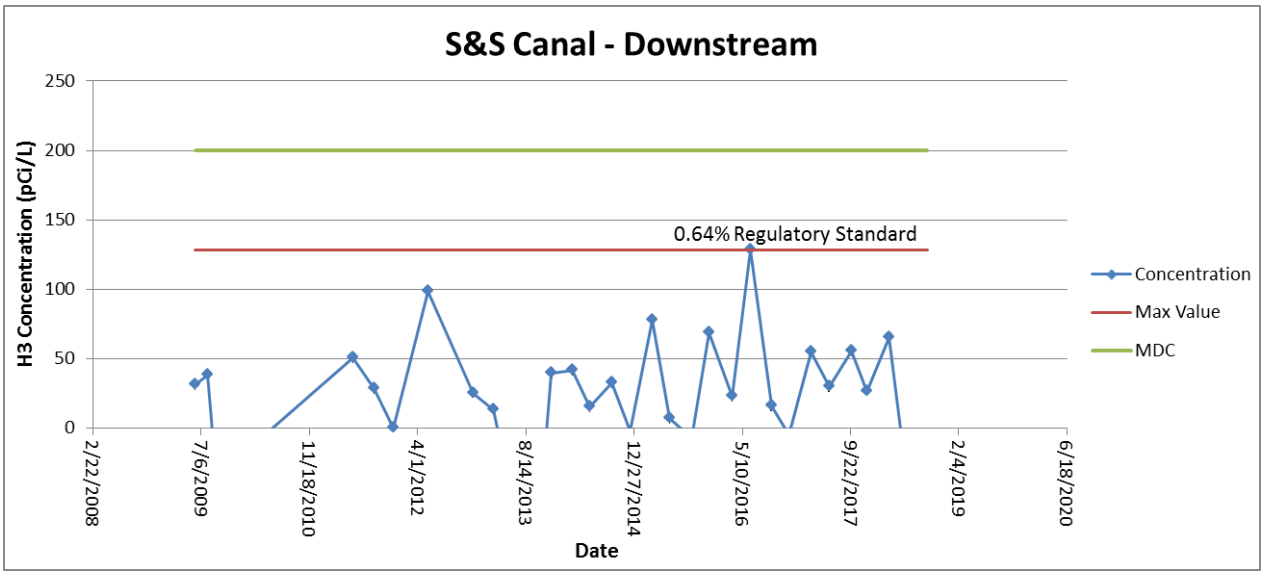


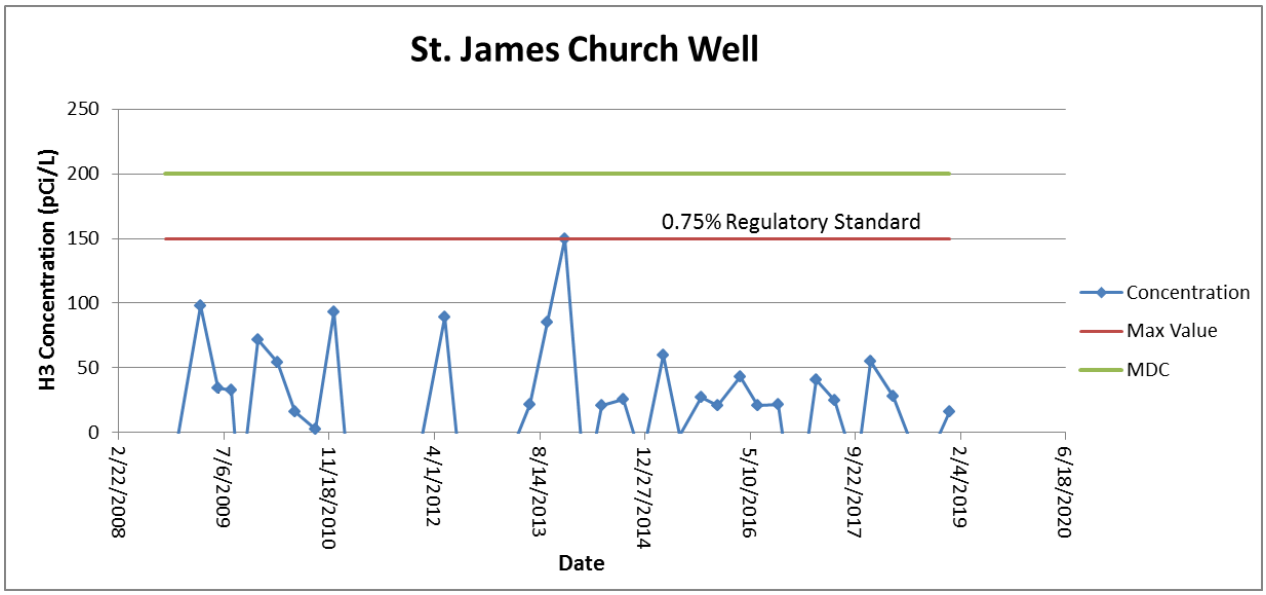

Well 5162 (Between Rain Barrel Slough and Bullfrog Lake)
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.39% Regulatory Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date
Concentration
Max Value
MDC

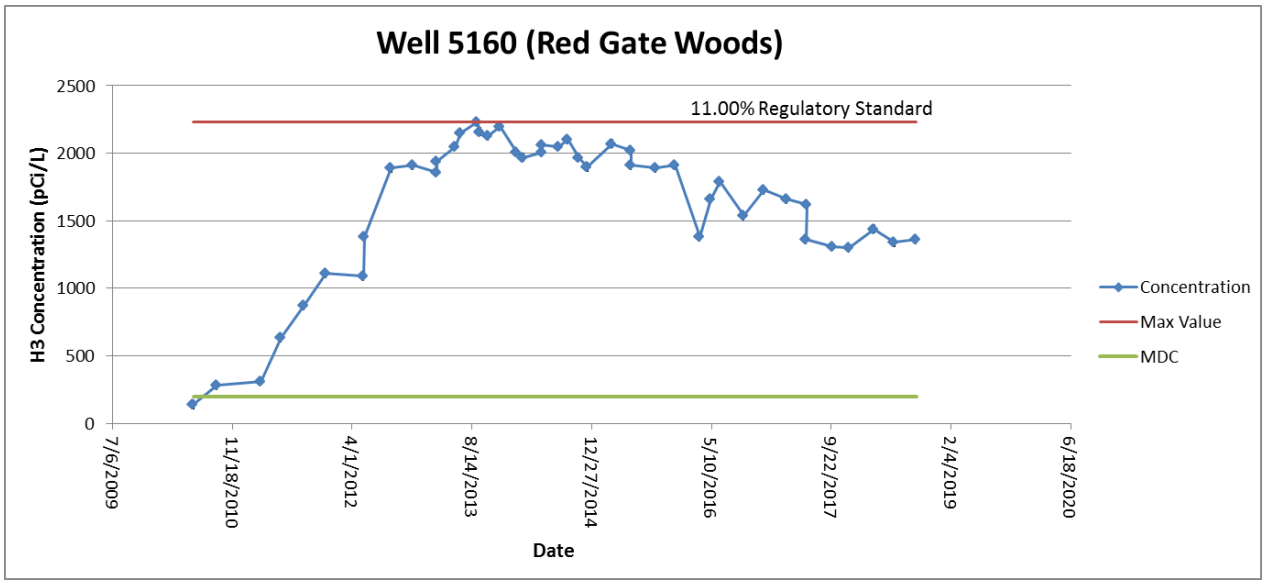

I&M Canal - Upstream
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.55% Regulatory Standard
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date
Concentration
Max Value
MDC

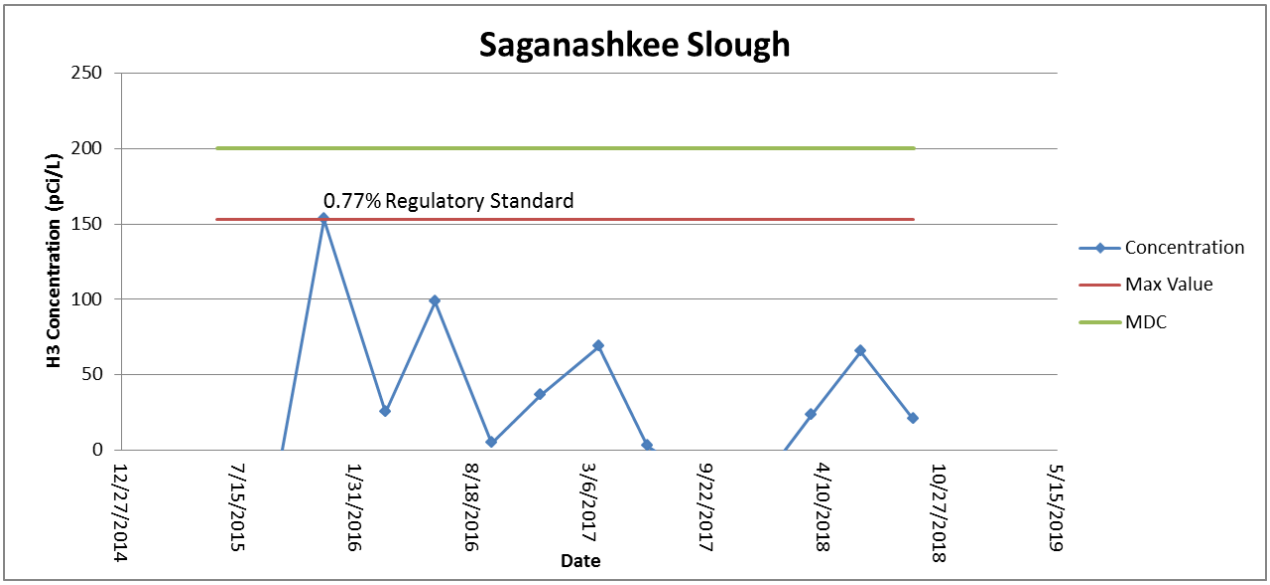

S&S Canal - Upstream
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.49% Regulatory Standard
Concentration
Max Value
MDC
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date

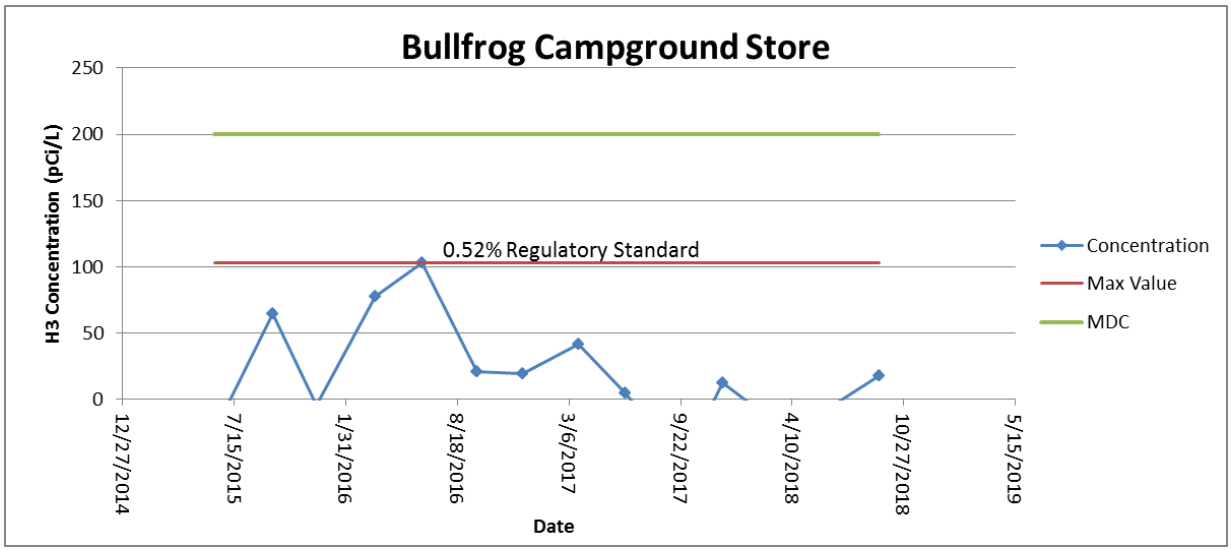

I&M Canal - Downstream
H3 Concentration (pCi/L)
600
500
400
300
200
100
0
2.50% Regulatory Standard
Concentration
Max Value
MDC
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date

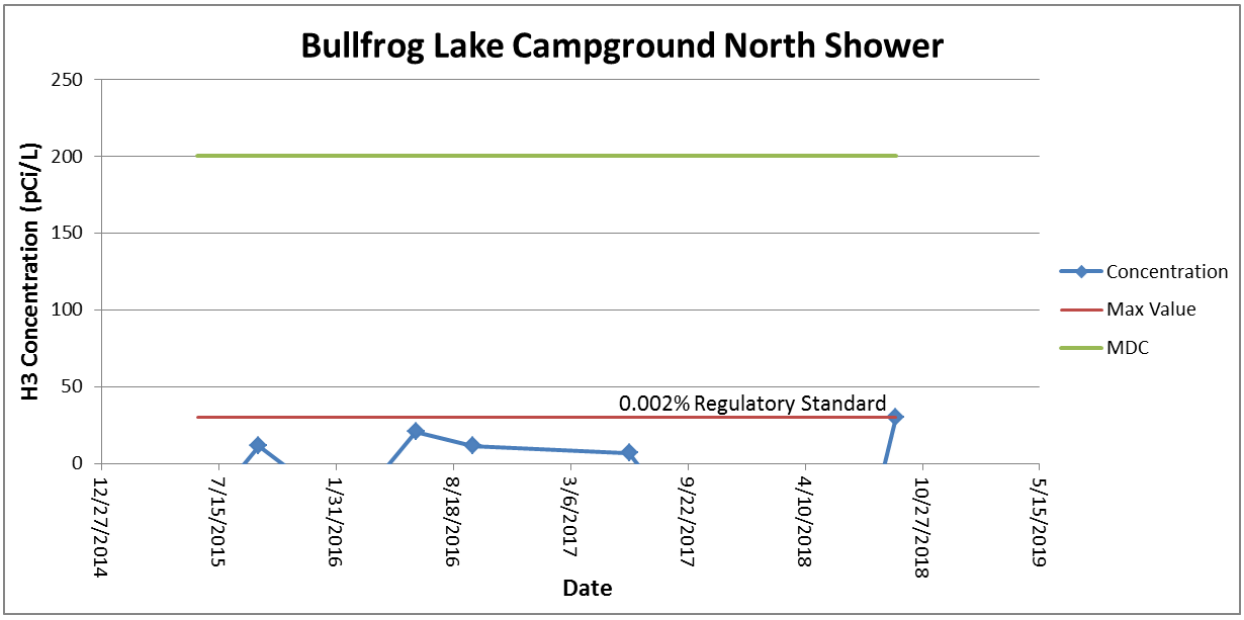

S&S Canal - Downstream
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.64% Regulatory Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date
Concentration
Max Value
MDC

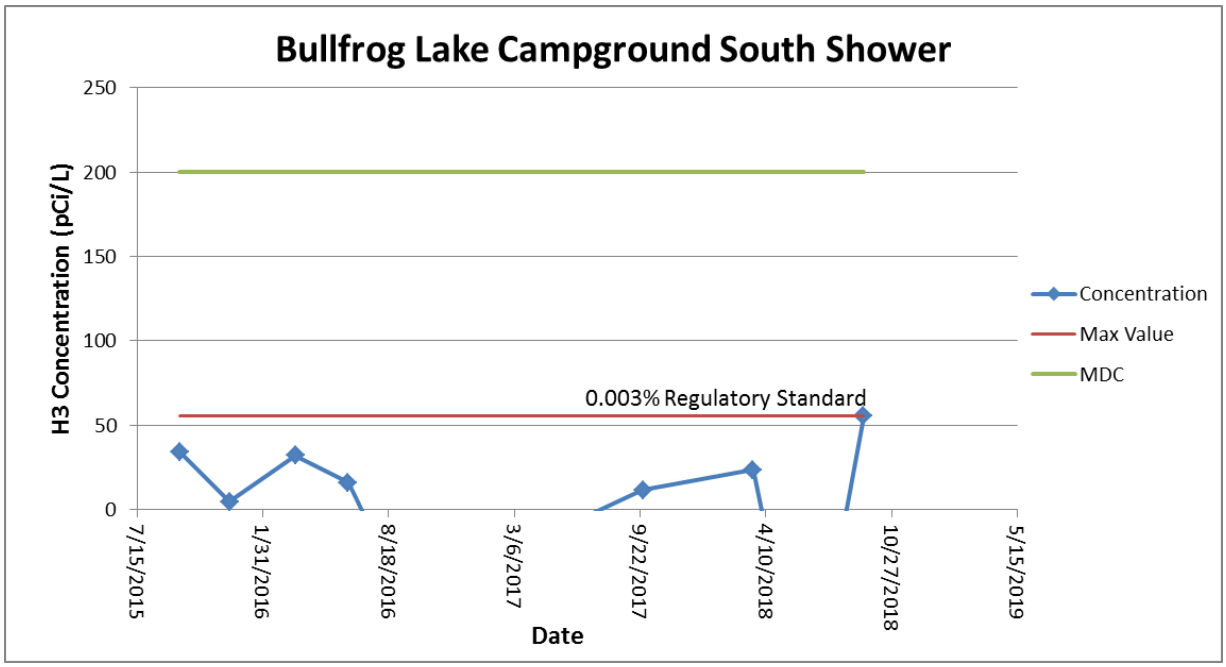

St. James Church Well
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.75% Regulatory Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date
Concentration
Max Value
MDC

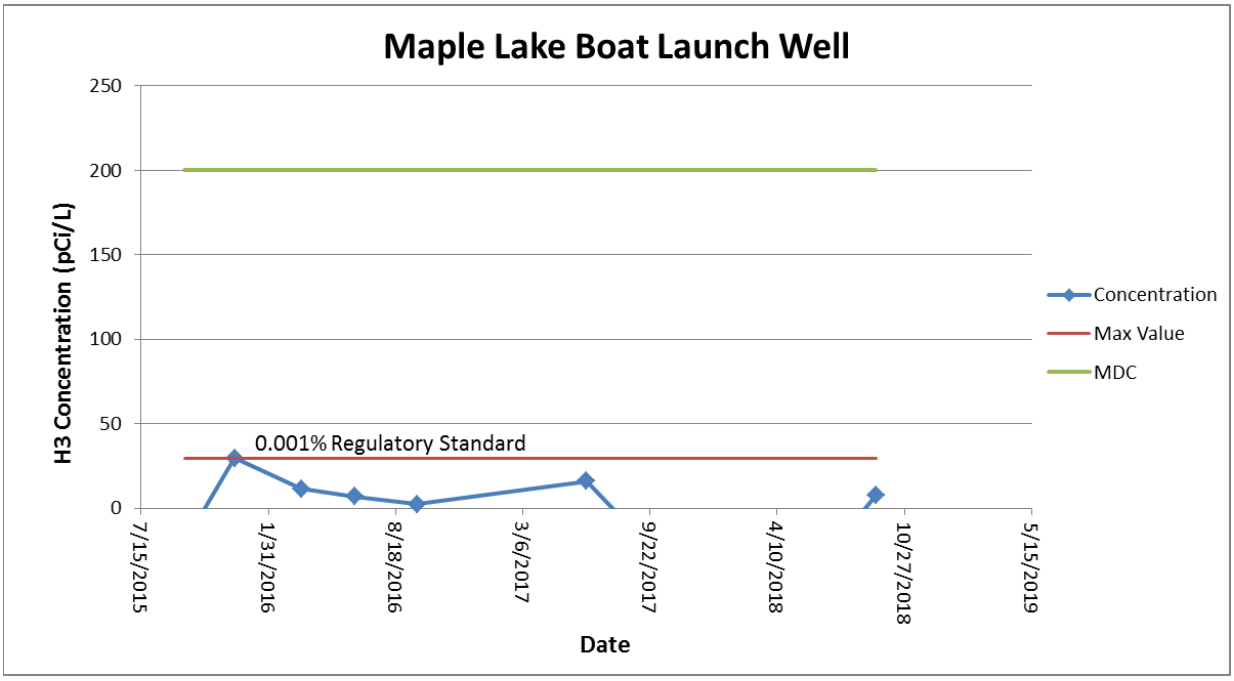

Well 5160 (Red Gate Woods)
11.00% Regulatory Standard
H3 Concentration (pCi/L)
2500
2000
1500
1000
500
0
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date
Concentration
Max Value
MDC

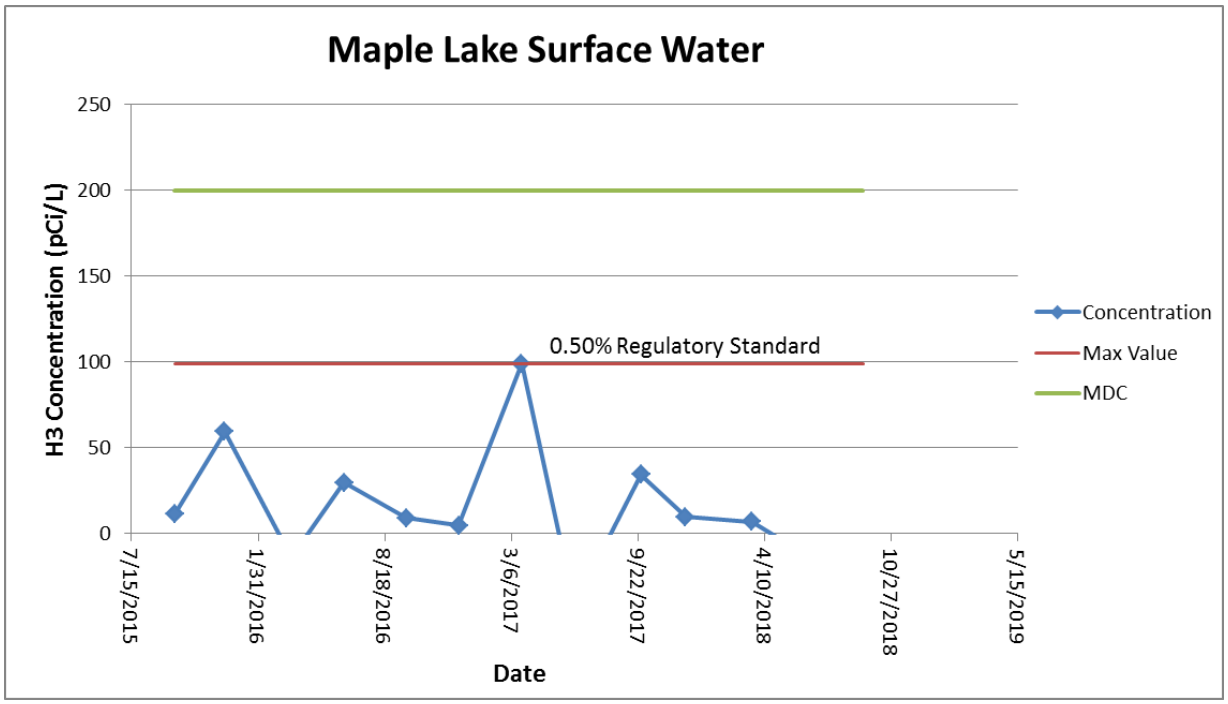

Saganashkee Slough
0.77% Regulatory Standard
H3 Concentration (pCi/L)
250
200
150
100
50
0
12/27/2014
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
10/27/2018
5/15/2019
Date
Concentration
Max Value
MDC

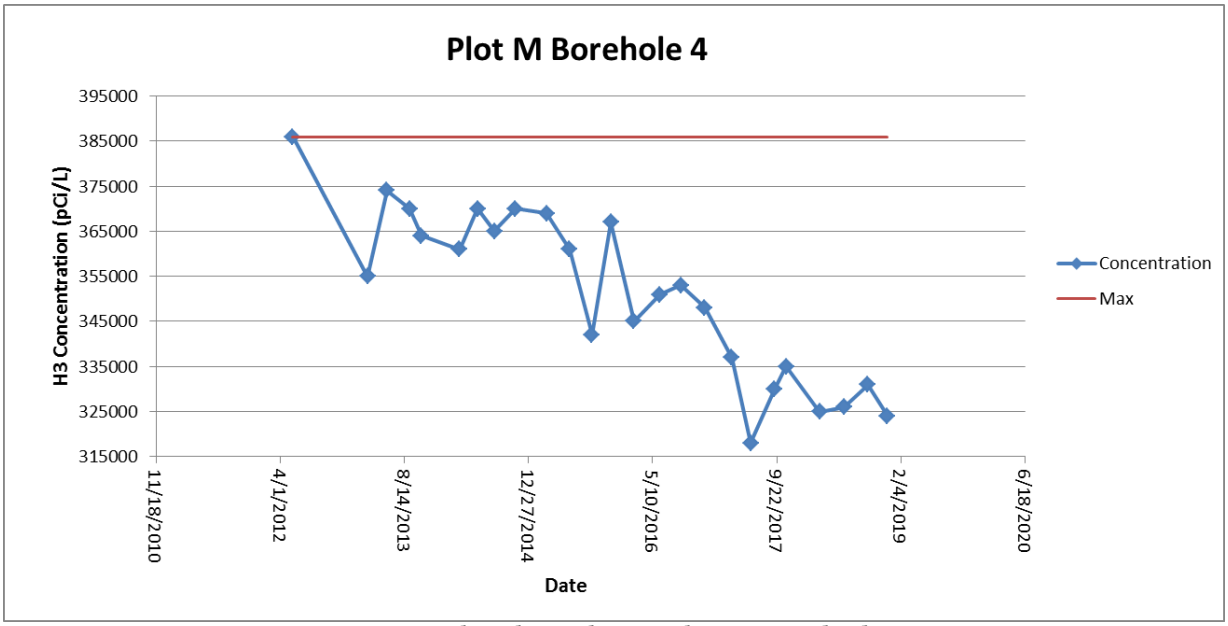

Bullfrog Campground Store
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.52% Regulatory Standard
12/27/2014
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
10/27/2018
5/15/2019
Date
Concentration
Max Value
MDC


Bullfrog Lake Campground North Shower
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.002% Regulatory Standard
12/27/2014
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
10/27/2018
5/15/2019
Date
Concentration
Max Value
MDC

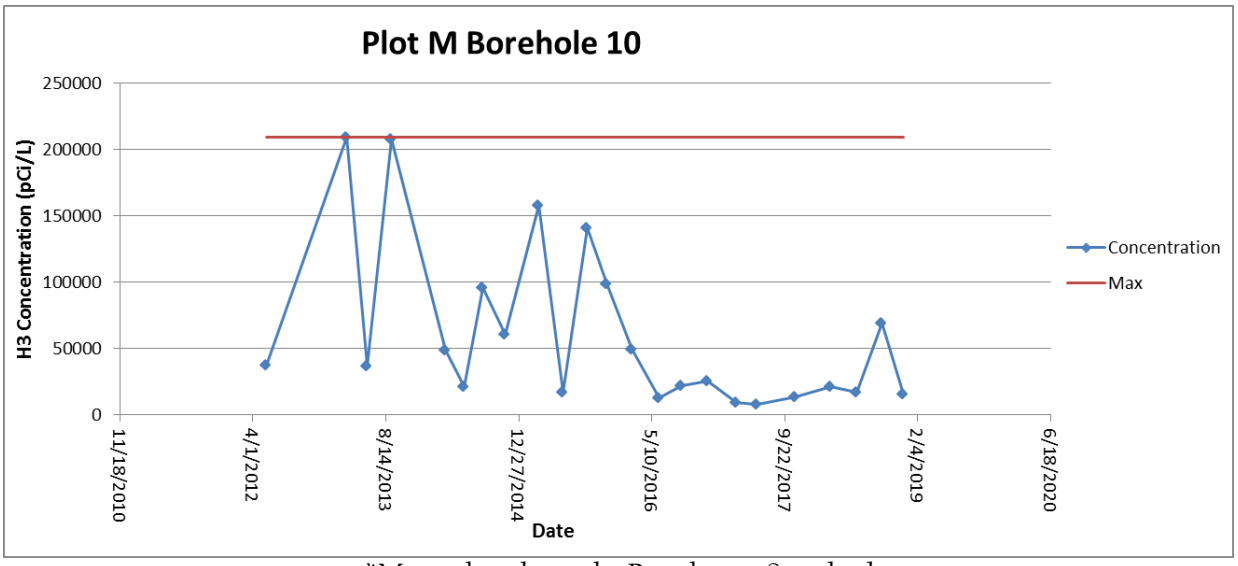

Bullfrog Lake Campground South Shower
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.003% Regulatory Standard
Concentration
Max Value
MDC
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
10/27/2018
5/15/2019
Date


Maple Lake Boat Launch Well
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.001% Regulatory Standard
Concentration
Max Value
MDC
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
10/27/2018
5/15/2019
Date

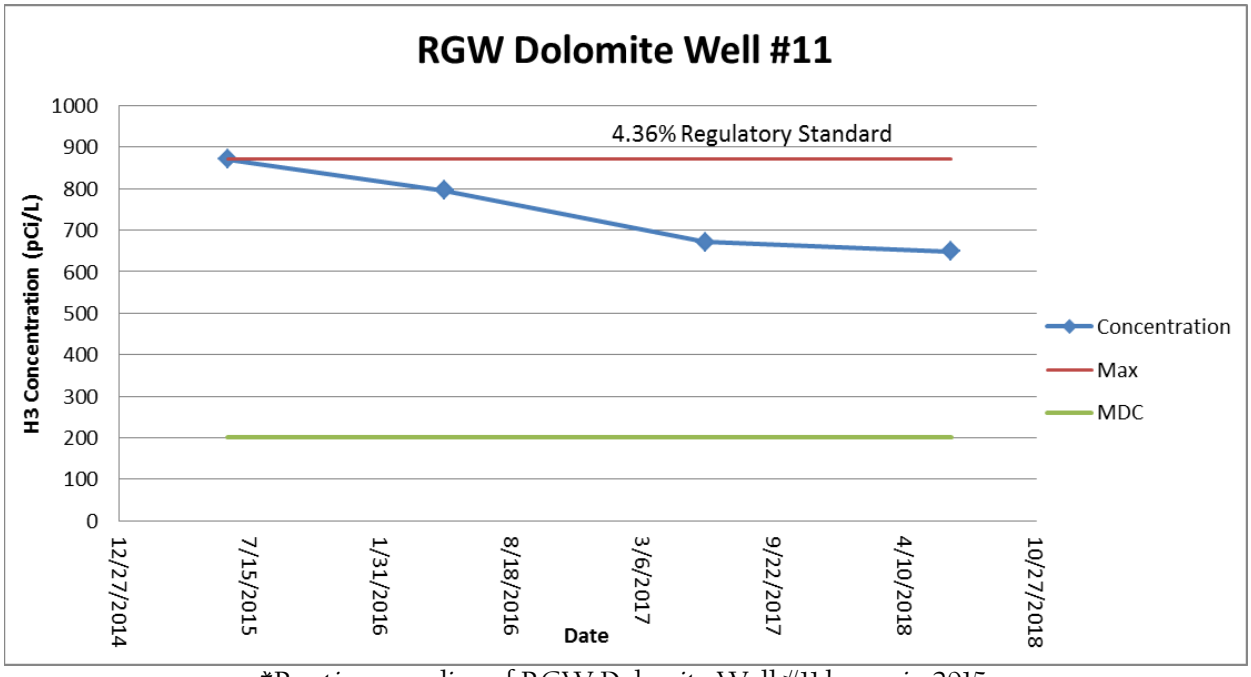




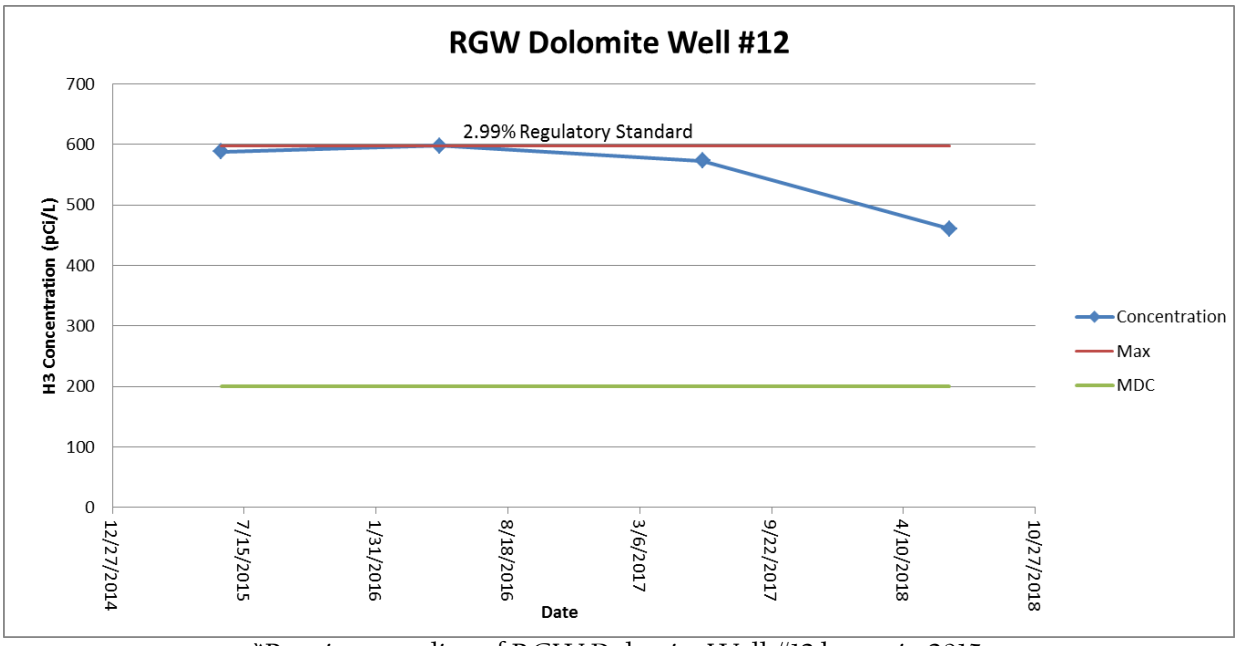
*Max value above the Regulatory Standard



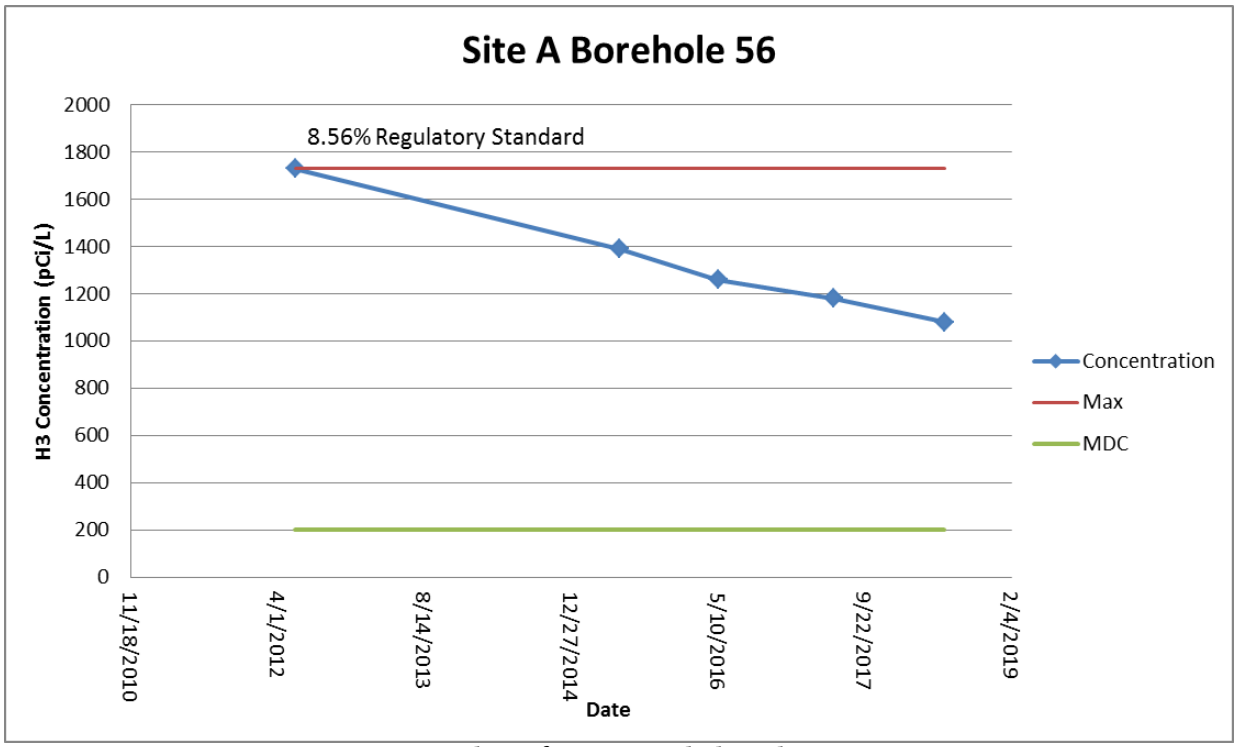
*Max value above the Regulatory Standard



*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 Collected by IEMA
Results are in picocuries per liter (pCi/L)

Location	H-3	
Date	Result	MDC
Rain Barrel Slough Well #5162		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
12/12/2018	<MDC	182
Bullfrog Campground Shower North		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
Bullfrog Campground Shower South		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
Bullfrog Campground Store		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
Henry de Tonty Woods Well #5159		
3/21/2018	833	182
6/13/2018	471	182
9/12/2018	196	182
12/12/2018	<MDC	182
Illinois & Michigan Canal (DnS)		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
Illinois & Michigan Canal (UpS)		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182

Location	H-3	
Date	Result	MDC
Maple Lake Boat Launch Well		
6/13/2018	<MDC	182
9/12/2018	<MDC	182
Maple Lake Surface		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
Red Gate Woods Well #5160		
3/21/2018	1440	182
6/13/2018	1340	182
9/12/2018	1360	182
12/12/2018	1250	182
Saganashkee Slough		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
Sanitary & Ship Canal (DnS)		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
12/12/2018	<MDC	182
Sanitary & Ship Canal (UpS)		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
12/12/2018	<MDC	182
St. James Church Well		
3/21/2018	<MDC	182
6/13/2018	<MDC	182
9/12/2018	<MDC	182
12/12/2018	<MDC	182

Table C.2 Tritium (H-3) Results for Water Samples Collected by Argonne
Results are in picocuries per liter (pCi/L)

Location	H-3	
Date	Result	MDC
Plot M Borehole #10		
3/15/2018	21100	181
6/20/2018	17300	181
9/24/2018	69200	181
12/11/2018	15600	181
Plot M Borehole #4		
3/15/2018	325000	181
6/20/2018	326000	181
9/24/2018	331000	181
12/11/2018	324000	181
Red Gate Woods Well #5160		
6/19/2018	1410	181
Red Gate Woods Dolomite Well #11		
6/19/2018	649	181
Red Gate Woods Dolomite Well #12		
6/19/2018	461	181
Site A Borehole #56		
6/20/2018	1080	181

Table C.3 Gamma Results for Water Samples Collected by IEMA
Results are in picocuries per liter (pCi/L)

Location	Cs-137	
Date	Result	MDC
Bullfrog Campground Shower North		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
Bullfrog Campground Shower South		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
Bullfrog Campground Store		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
Henry de Tonty Woods Well #5159		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
12/12/2018	<MDC	3.8
Illinois & Michigan Canal (D.S.)		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
Illinois & Michigan Canal (UpS)		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
Maple Lake Boat Launch Well		
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8

Location	Cs-137	
Date	Result	MDC
Maple Lake Surface		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
Rain Barrel Slough Well #5162		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
12/12/2018	<MDC	3.8
Red Gate Woods Well 5160		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
12/12/2018	<MDC	3.8
Saganashkee Slough		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
Sanitary & Ship Canal (DnS)		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
12/12/2018	<MDC	3.8
Sanitary & Ship Canal (UpS)		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
12/12/2018	<MDC	3.8
St. James Church Well		
3/21/2018	<MDC	3.8
6/13/2018	<MDC	3.8
9/12/2018	<MDC	3.8
12/12/2018	<MDC	3.8

Table C.4 Gamma Results for Water Samples Collected by Argonne
Results are in picocuries per liter (pCi/L)

Location	Cs-137	
Date	Result	MDC
Plot M Borehole #10		
3/15/2018	<MDC	4
6/20/2018	<MDC	4
9/24/2018	<MDC	4
12/11/2018	<MDC	4
Plot M Borehole #4		
3/15/2018	<MDC	4
6/20/2018	<MDC	4
9/24/2018	<MDC	4
12/11/2018	<MDC	4
Red Gate Woods Dolomite Well #11		
6/19/2018	<MDC	4
Red Gate Woods Dolomite Well #12		
6/19/2018	<MDC	4
Red Gate Woods Well #5160		
6/19/2018	<MDC	4
PA-Site A Borehole #56		
6/20/2018	<MDC	4

Table C.5 Total Strontium Results for Water Samples Collected by IEMA
Results are in picocuries per liter (pCi/L)

Location	Strontium	
Date	Result	MDC
Rain Barrel Slough Well #5162		
12/12/2018	<MDC	1.0
Bullfrog Campground Shower North		
9/12/2018	<MDC	1.0
Bullfrog Campground Store		
9/12/2018	<MDC	1.0
Henry de Tonty Woods Well #5159		
9/12/2018	<MDC	1.0
12/12/2018	<MDC	1.0
Red Gate Woods Well #5160		
3/21/2018	<MDC	1.0
12/12/2018	<MDC	1.0
St. James Church Well		
3/21/2018	<MDC	1.0

Table C.6 Total Strontium Results for Water Samples Collected by Argonne
Results are in picocuries per liter (pCi/L)

Location	Strontium	
Date	Result	MDC
Plot M Borehole #10		
3/15/2018	1.2	0.9
6/20/2018	<MDC	0.9
9/24/2018	<MDC	0.9
12/11/2018	<MDC	0.9
Plot M Borehole #4		
3/15/2018	<MDC	0.9
6/20/2018	<MDC	0.9
9/24/2018	1.6	0.9
12/11/2018	<MDC	0.9
Red Gate Woods Well #5160		
6/19/2018	<MDC	0.9
Red Gate Woods Dolomite Well #11		
6/19/2018	<MDC	0.9
Red Gate Woods Dolomite Well #12		
6/19/2018	<MDC	0.9
Site A Borehole #56		
6/20/2018	0.9	0.9

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

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