State of Illinois
Illinois Emergency Management Agency

2020 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, Illinois. The purpose of this report is to provide updated results of monitoring activities conducted during calendar year 2020.

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 drains 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). ANL 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 U.S. Environmental Protection Agency (US EPA) and Illinois Environmental Protection Agency (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 2020, sample results from water collected at Plot M Borehole #4 exceeded the national drinking water and state groundwater standards for tritium concentrations. Plot M Borehole #4 is capped, locked, and only accessed during sampling activities. Sample results for all other radionuclides and locations were below established federal and state standards.

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

ANL 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)

General Sampling Information

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

Sampling and Monitoring Adjustments

The pump mechanism for Red Gate Woods Well #5160 was found to be non-functional in the third quarter of 2019. Therefore, samples were not collected in this location in 2020. Until the pump is able to be repaired, sampling of water from Red Gate Woods Well #5160 will not be possible.

The pump mechanism for Well #5162 was tagged out of service during first quarter of 2020 and remained out of service fror the remainder of 2020 for treatment. Until well #5162 is returned to service by the Forest Preserve District of Cook County (FPDCC), sampling will not be possible.

The Bullfrog Campground South was closed all of 2020 due to Covid-19 restrictions. Therefore, samples were not collected in this location in 2020. Until the Covid-19 restrictions are lifted, sampling of water from Campground Shower South will not resume.

ANL staff reported that Plot M Borehole #10 well was dry after first quarter 2020. Therefore samples from this borehole were unavailable for the remainder of the year. Until Plot M Borehole #10 is replenished, sampling will not be possible.

Laboratory Analysis

This report contains tables of data showing analysis results of samples taken by both ANL 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, Illinois. 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 for the identification of individual radionuclides.

Total Strontium Analysis

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 are analyzed for total strontium using a low-background gas proportional counter.

Analysis Adjustments

No adjustments were made to the analysis of samples in 2020.

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 US EPA drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000) and the 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 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 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 US EPA drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000), as well as the 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 one sample collected from the Red Gate Woods (RGW) Dolomite Well #12. 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.

Result Interpretation or Limit Adjustments

No adjustments were made to how results are interpreted or to the limits applied for 2020.

Background Reference Location

IEMA has established the environs of Sangchris Lake State Park, a cooling lake for a coal-fired power station near Kincaid, Illinois, 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.

Summary

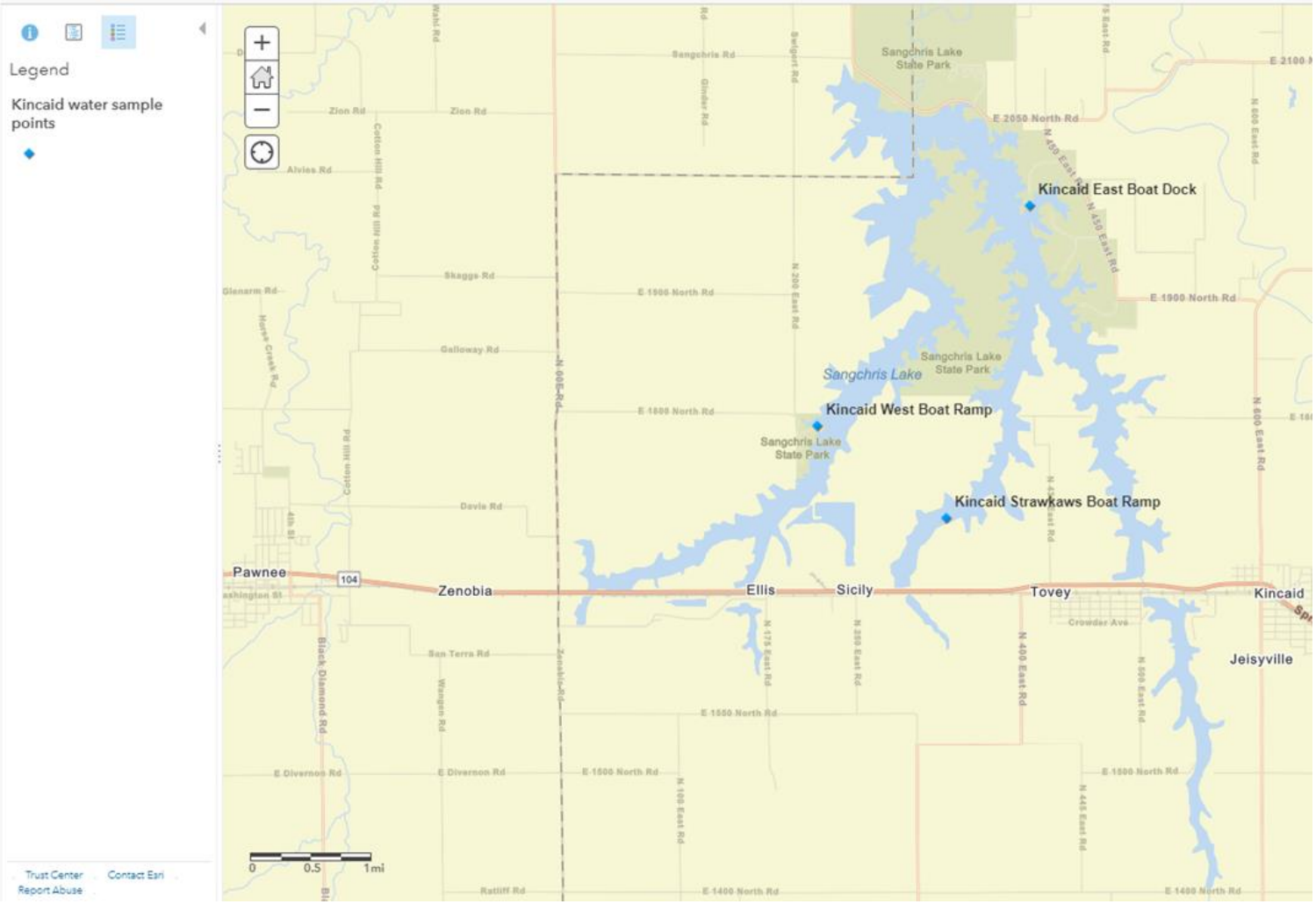
In 2020, analytical results for all publicly accessible water sources, analyzed as part of IEMA's monitoring program at the Palos Forest Preserve, were below the national and state standards for all radionuclides and were consistent with historical data. Analytical results for samples collected from Plot M Borehole #4 indicated tritium concentrations in excess of the US EPA and IEPA standards. Plot M Boreholes #4 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 in excess of regulatory standards are routinely seen from Borehole #4, and occassionally seen from Borehole #10. Despite the occasional spike in tritium concentrations seen at some locations, most boreholes and wells with tritium in excess of the established MDC continue to show a gradual decline in tritium concentrations. The one exception was Plot M Borehole #4, which showed a increase in tritium concentration in 2020.

APPENDIX A
Sampling Locations

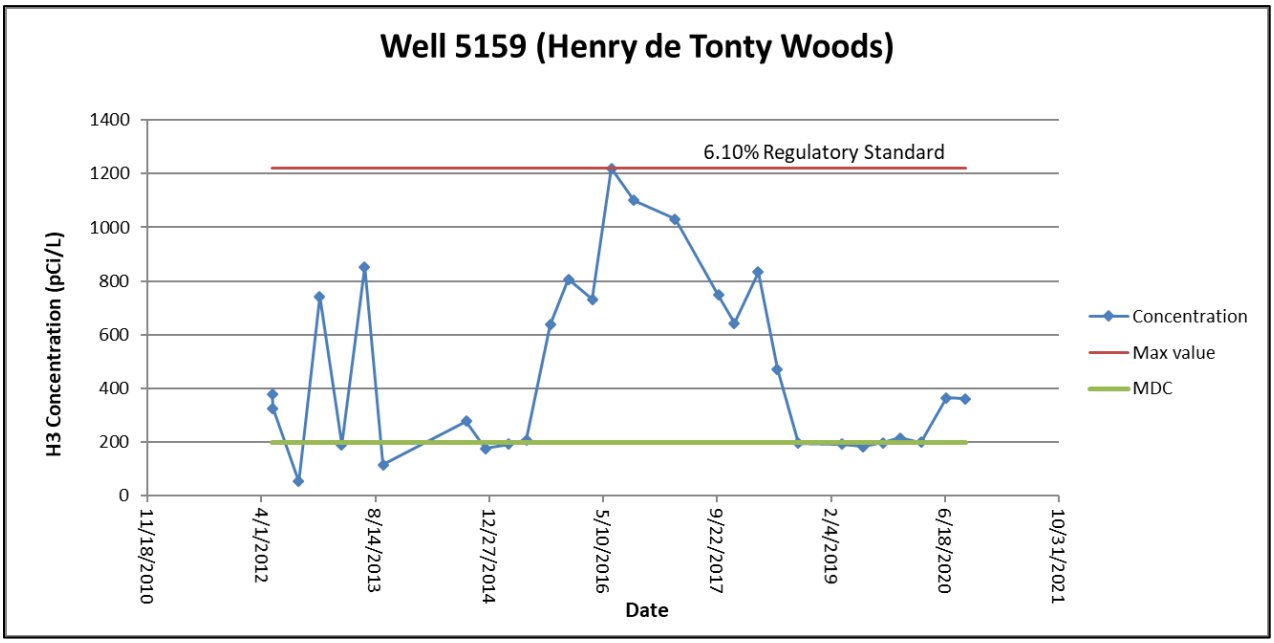
Map A.1. Palos Park Forest Preserve Sampling Locations

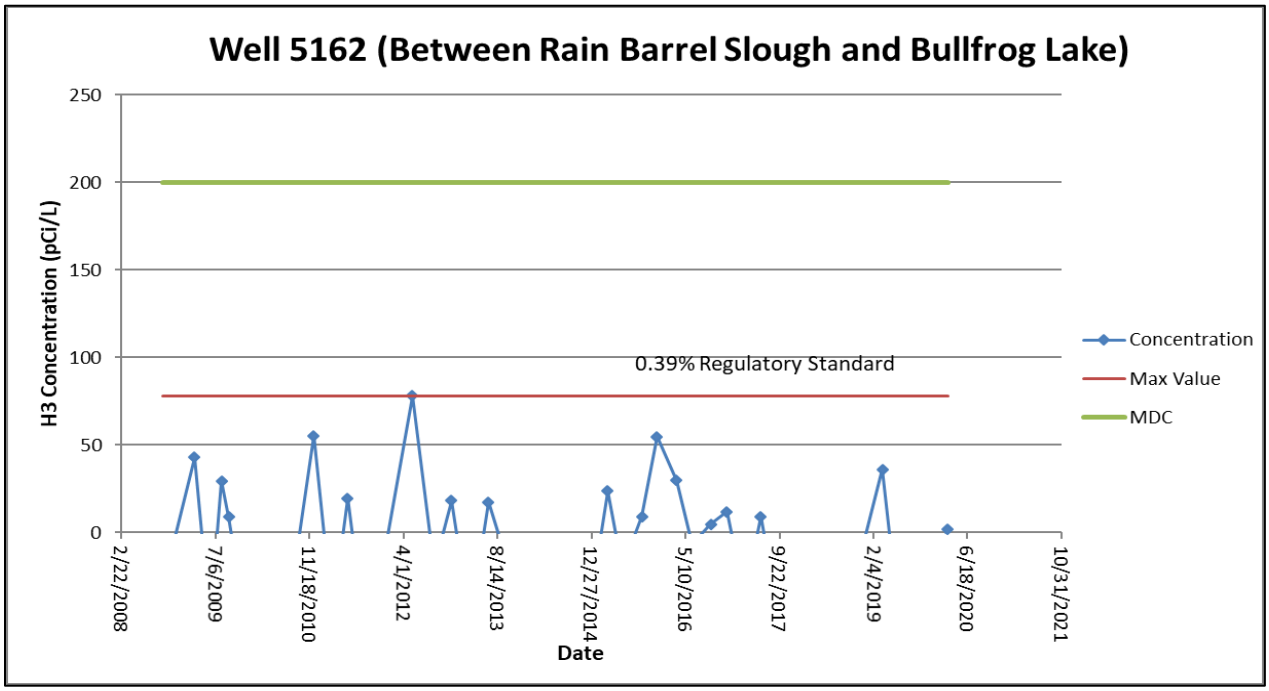
Map A.2. Palos Park Forest Preserve and Peripheral Sampling Locations

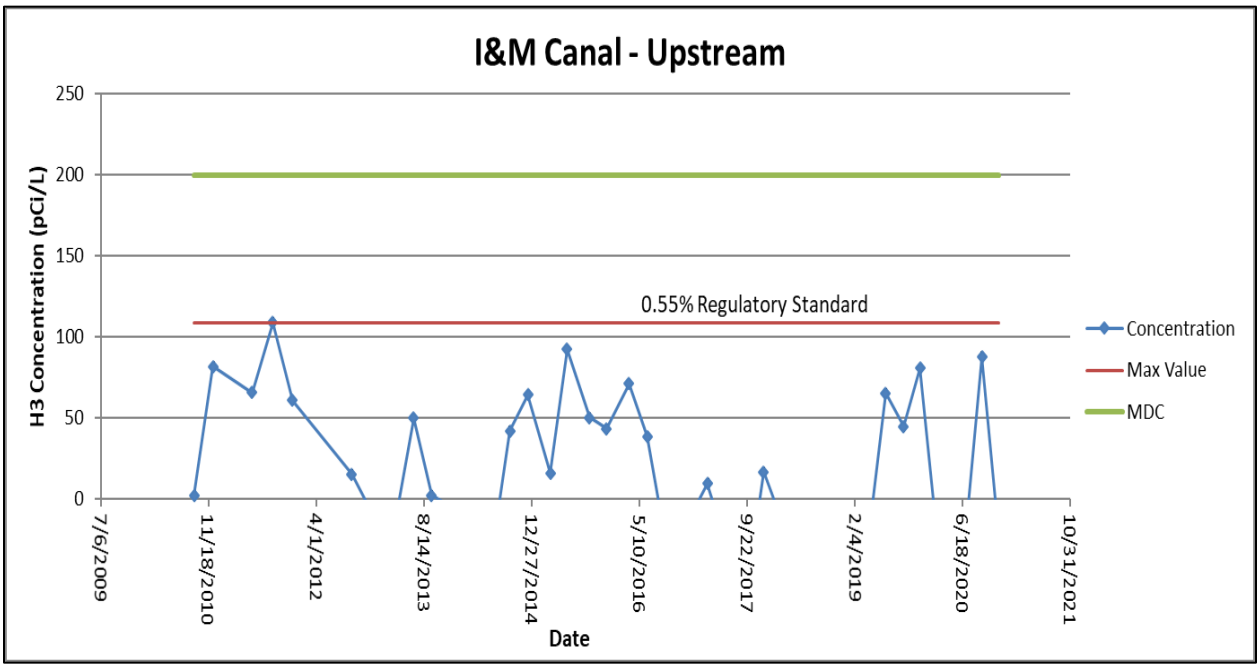
Map A.3. Background Sampling Locations:
Sangchris Lake State Park near Kincaid, Illinois

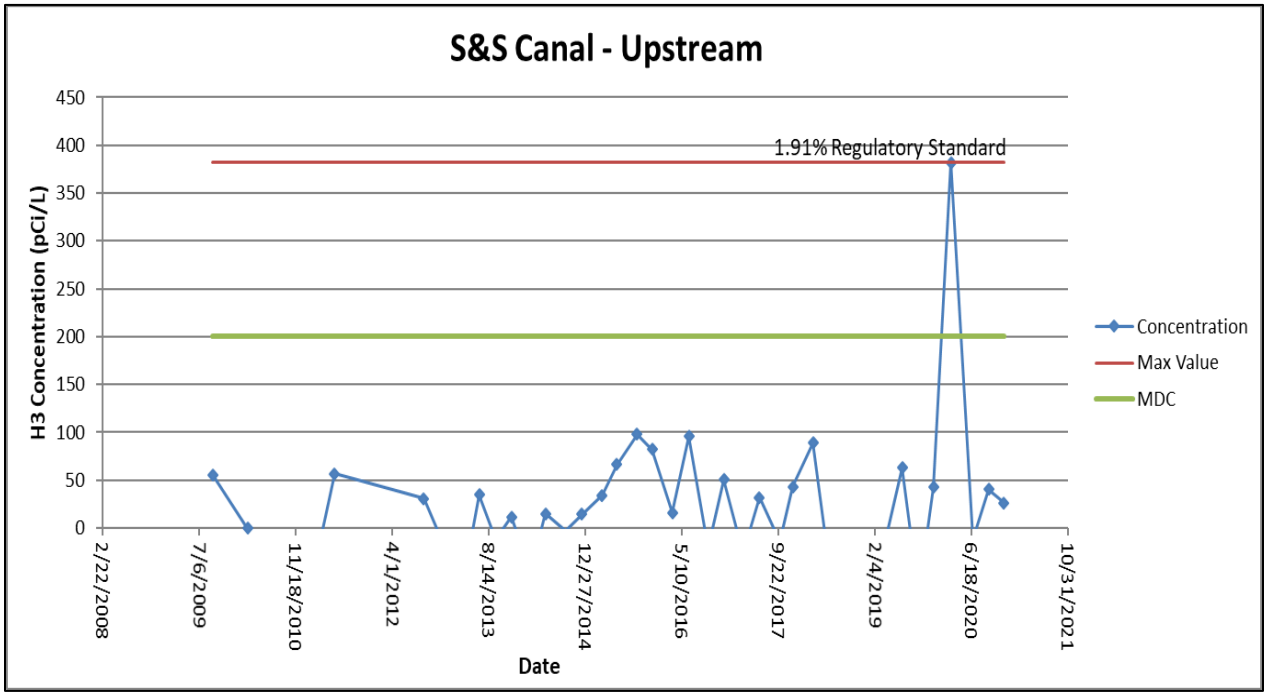


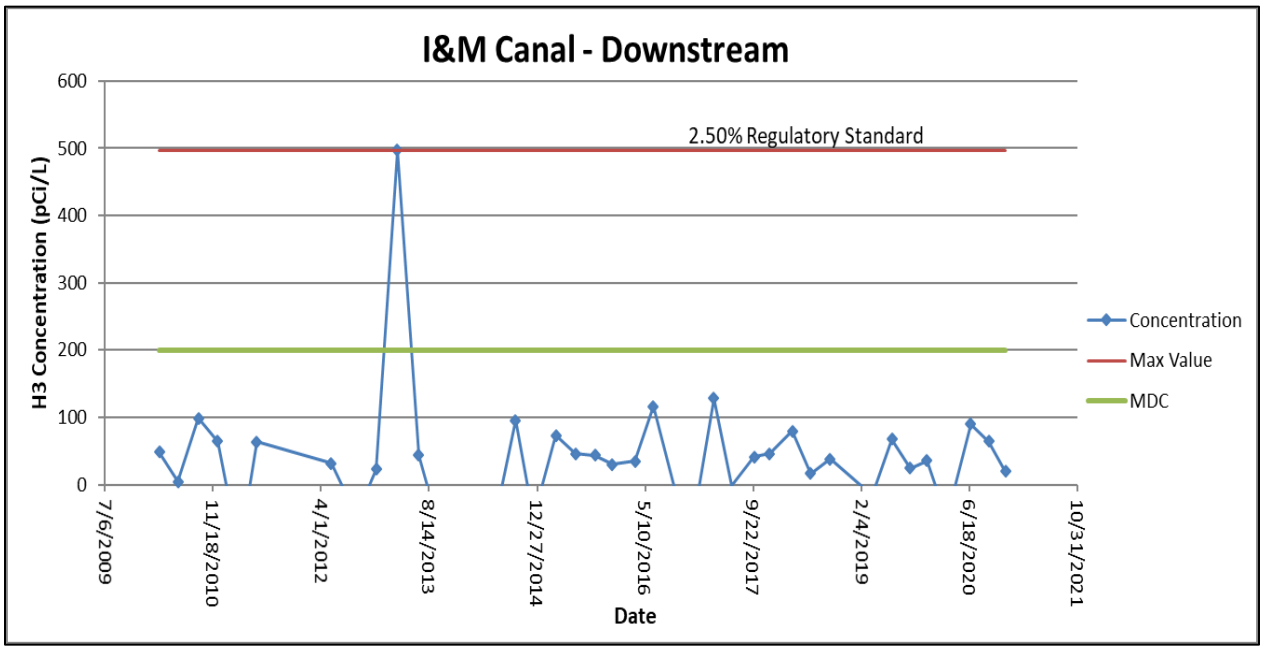
APPENDIX B
Graphical Representations of Tritium Water Sample Results through 2020

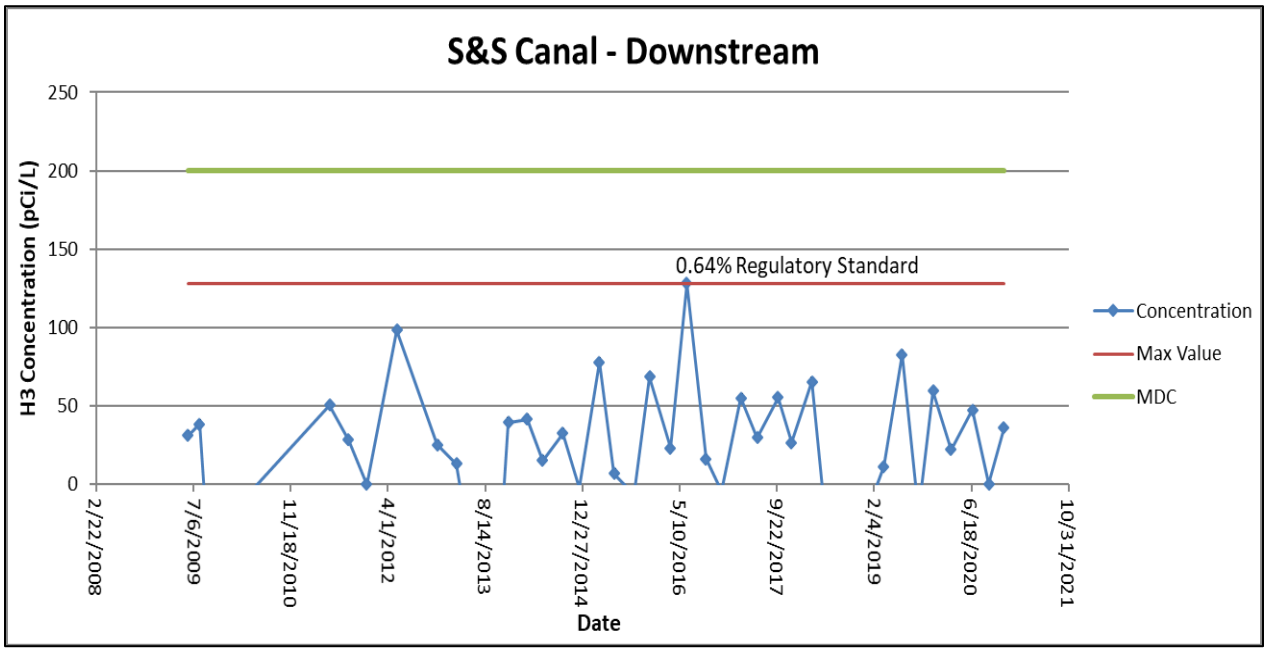


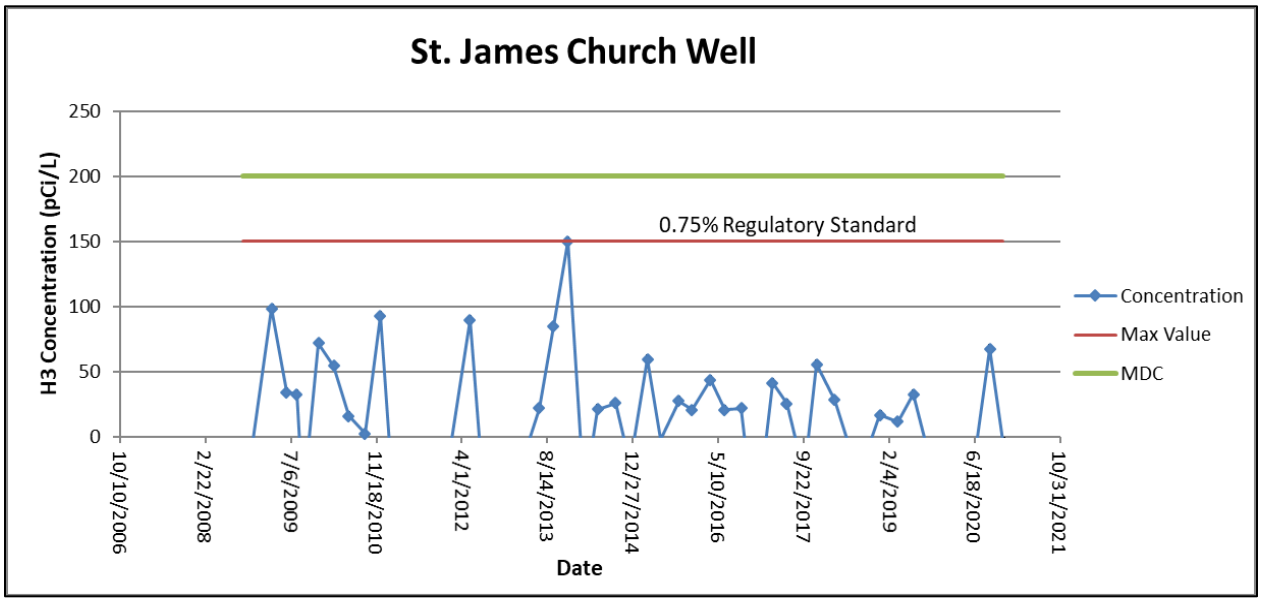


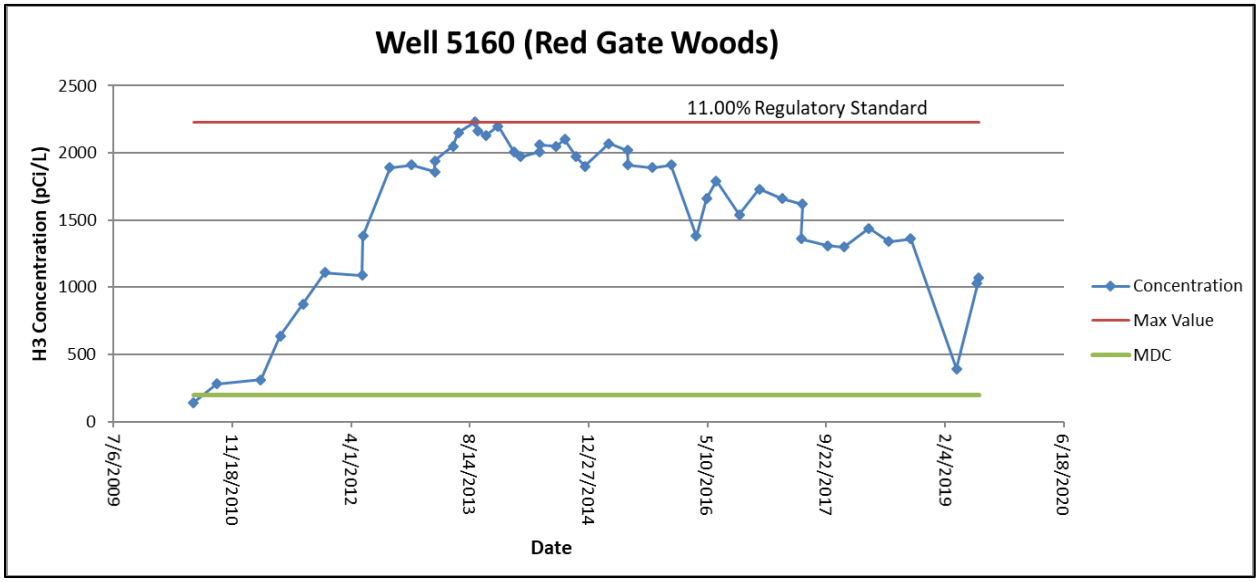

I&M Canal - Upstream
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.55% Regulatory Standard
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC

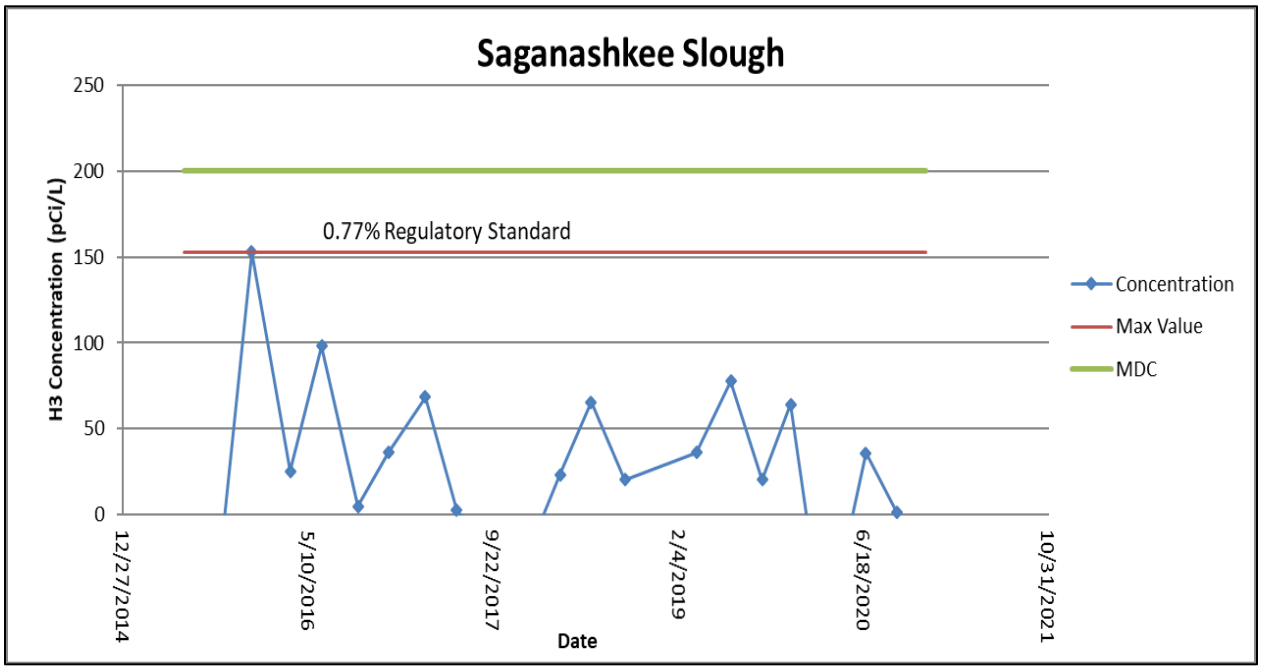

S&S Canal - Upstream
H3 Concentration (pCi/L)
450
400
350
300
250
200
150
100
50
0
1.91% Regulatory Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC

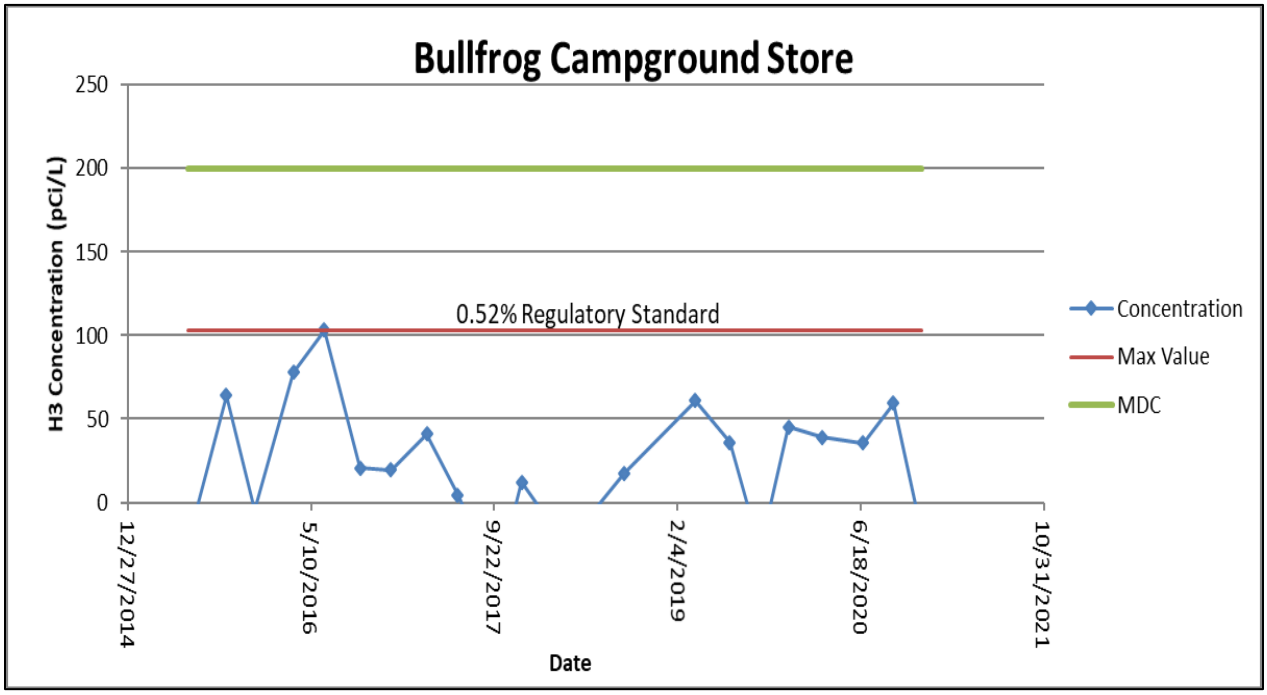

I&M Canal - Downstream
H3 Concentration (pCi/L)
600
500
400
300
200
100
0
2.50% Regulatory Standard
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC

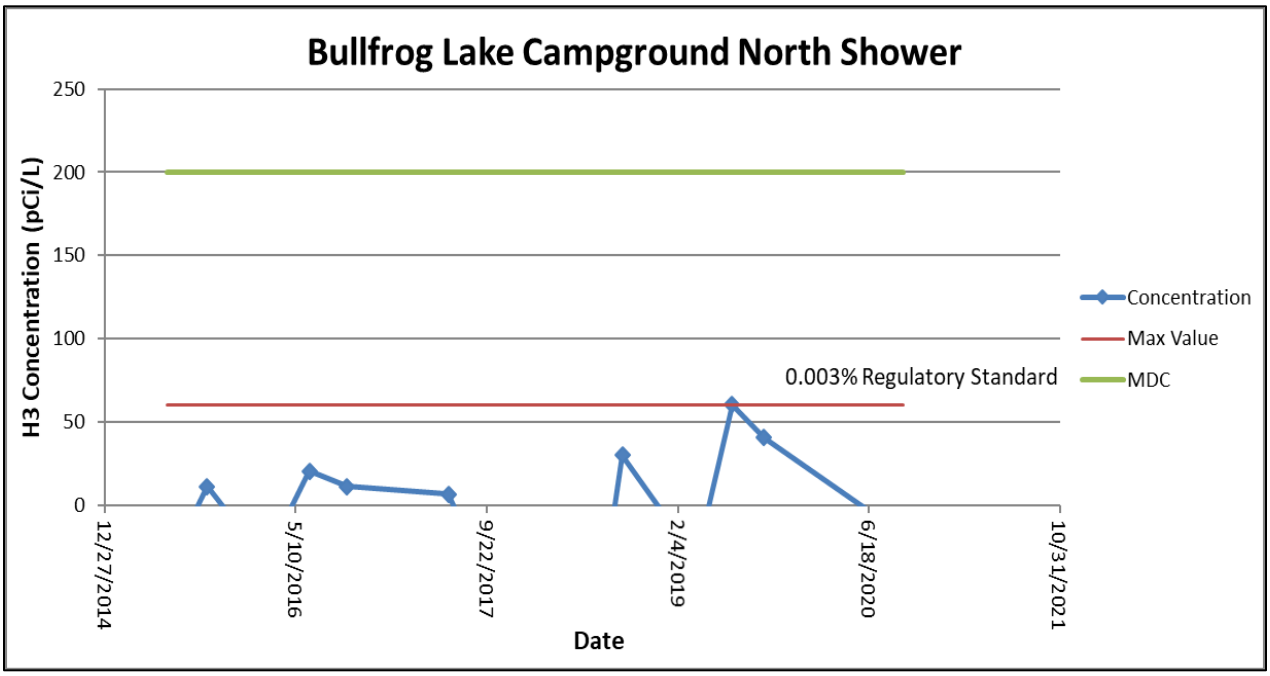

S&S Canal - Downstream
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.64% Regulatory Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC

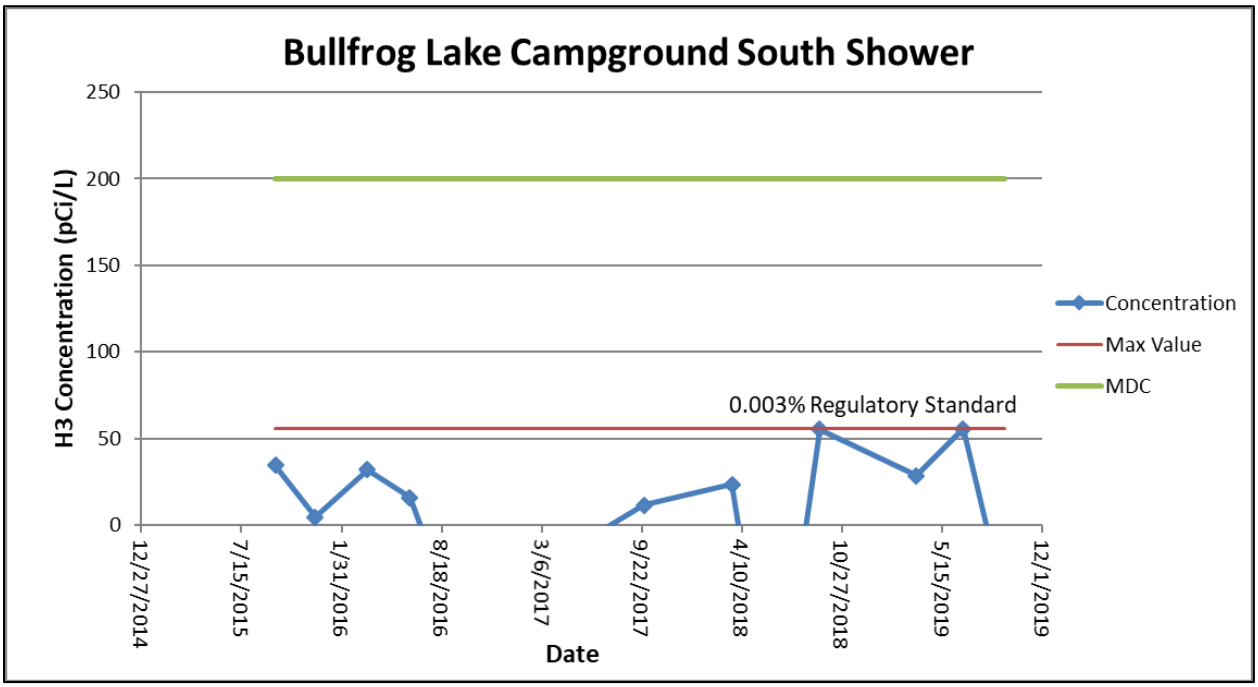

St. James Church Well
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.75% Regulatory Standard
10/10/2006
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC

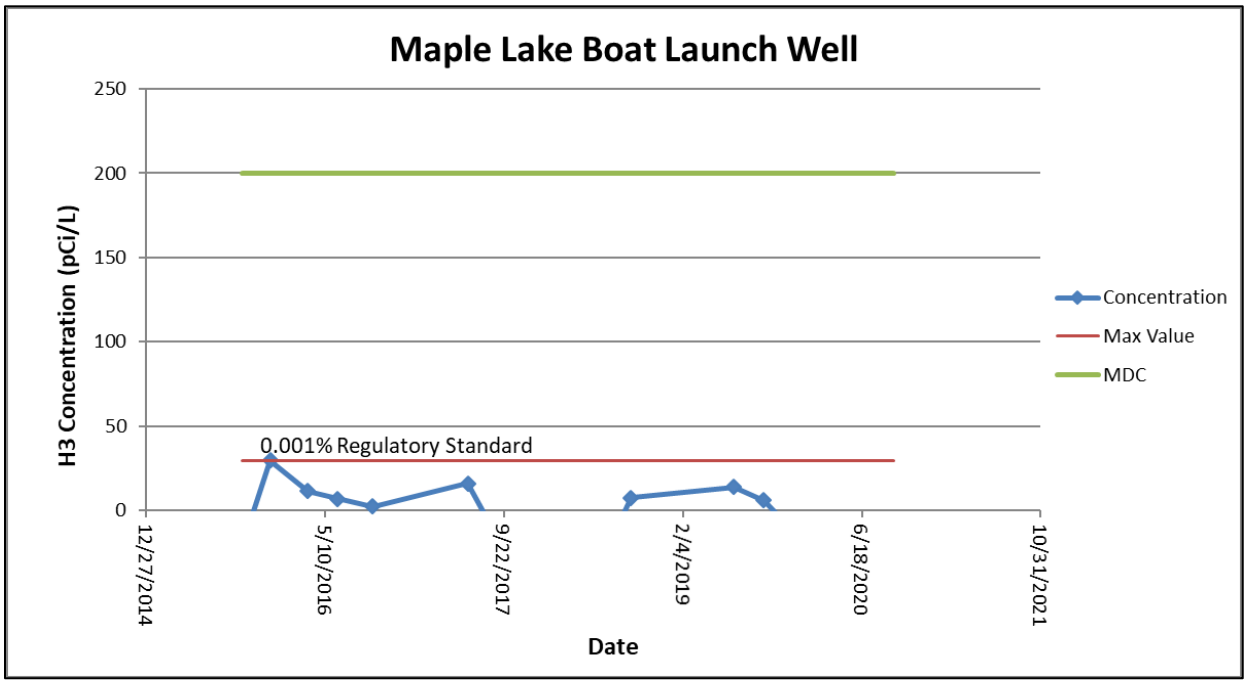

Well 5160 (Red Gate Woods)
H3 Concentration (pCi/L)
2500
2000
1500
1000
500
0
11.00% Regulatory Standard
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
Date
Concentration
Max Value
MDC

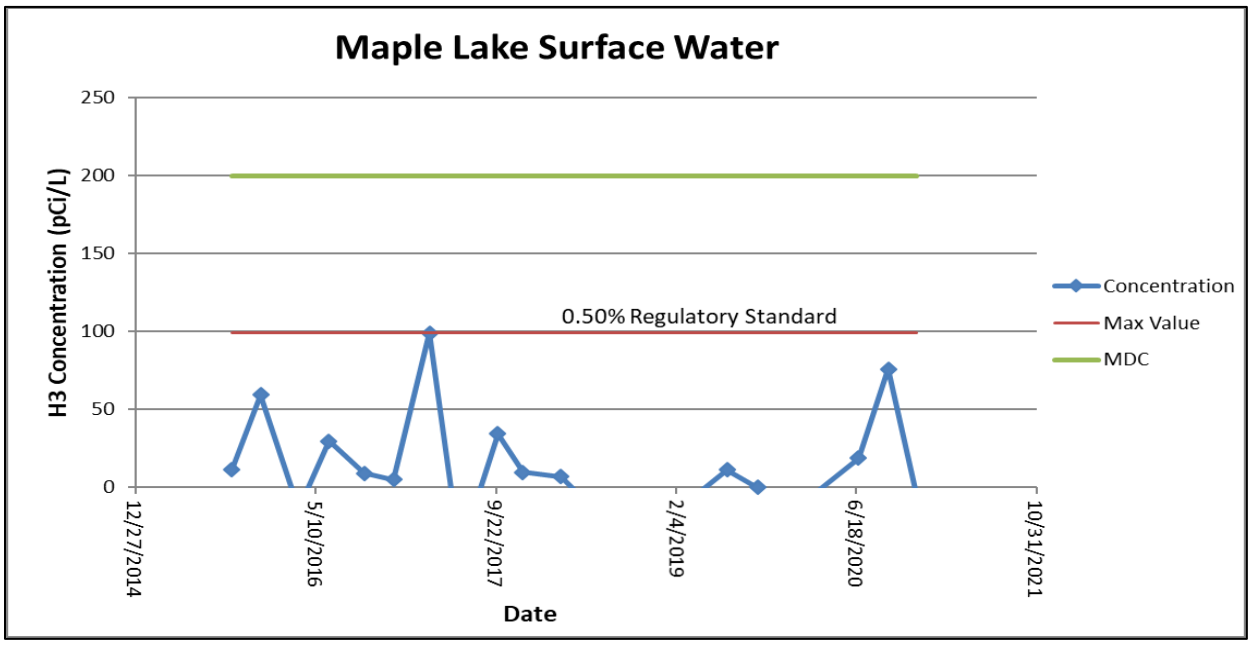

Saganashkee Slough
250
200
150
100
50
0
H3 Concentration (pCi/L)
0.77% Regulatory Standard
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC

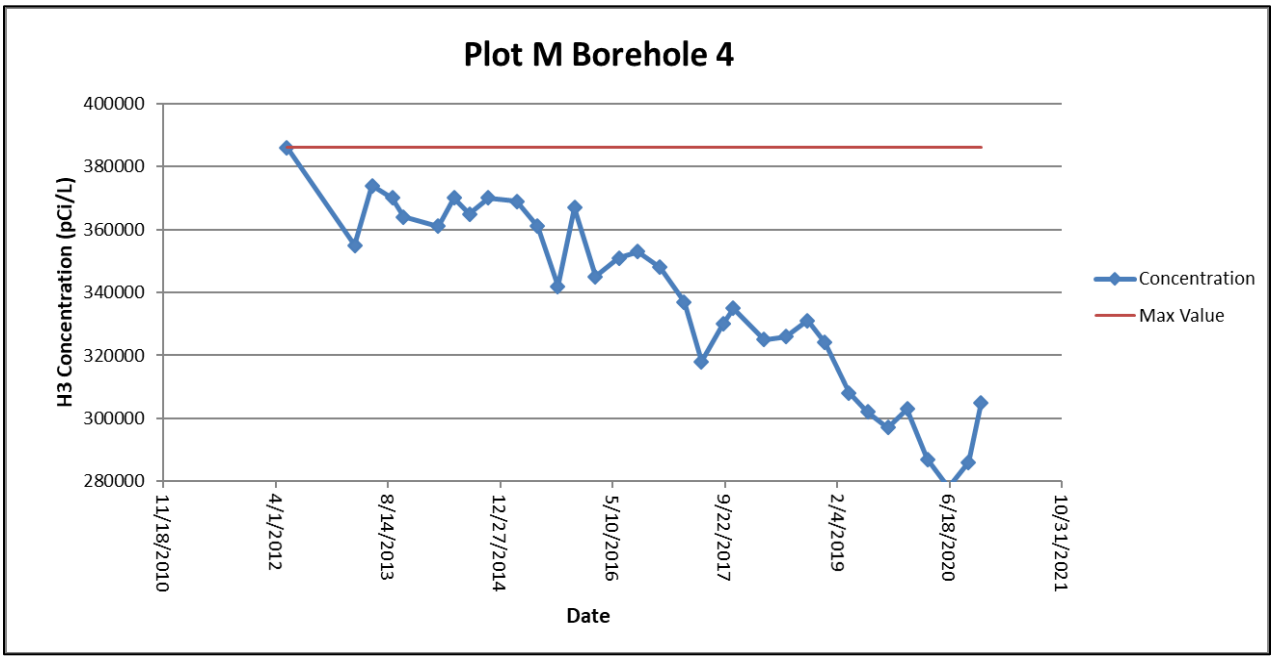

Bullfrog Campground Store
250
200
150
100
50
0
H3 Concentration (pCi/L)
0.52% Regulatory Standard
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC


Bullfrog Lake Campground North Shower
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.003% Regulatory Standard
Concentration
Max Value
MDC
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date

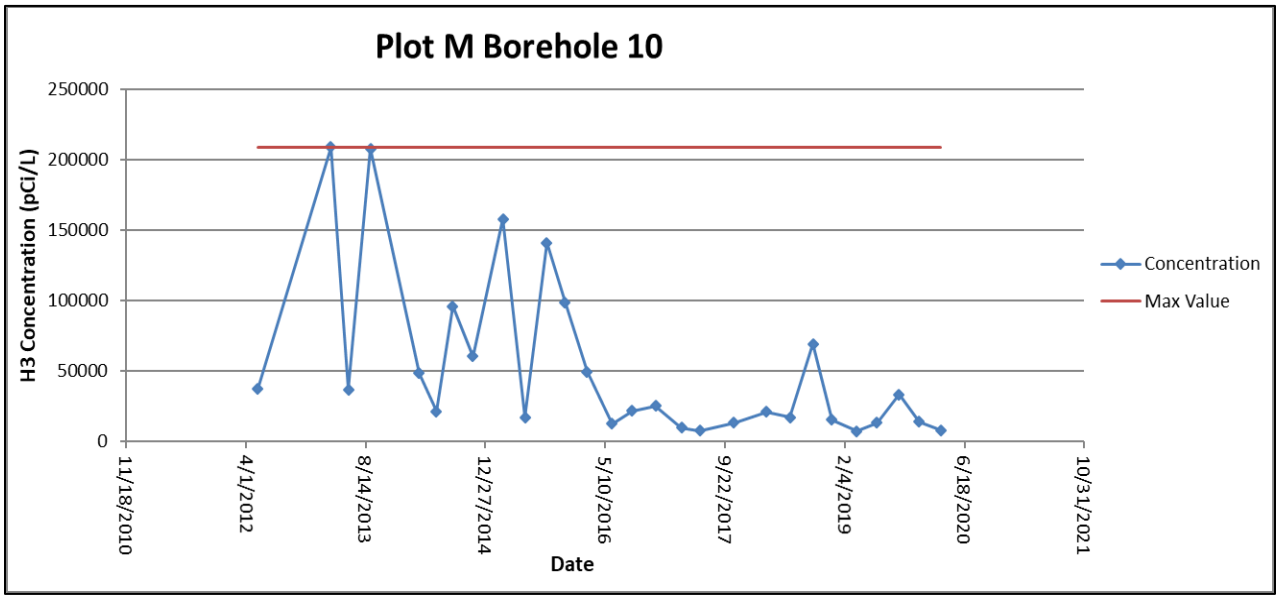

Bullfrog Lake Campground South Shower
H3 Concentration (pCi/L)
250
200
150
100
50
0
0.003% Regulatory Standard
Concentration
Max Value
MDC
12/27/2014
7/15/2015
1/31/2016
8/18/2016
3/6/2017
9/22/2017
4/10/2018
10/27/2018
5/15/2019
12/1/2019
Date


Maple Lake Boat Launch Well
250
200
150
100
50
0
H3 Concentration (pCi/L)
0.001% Regulatory Standard
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC

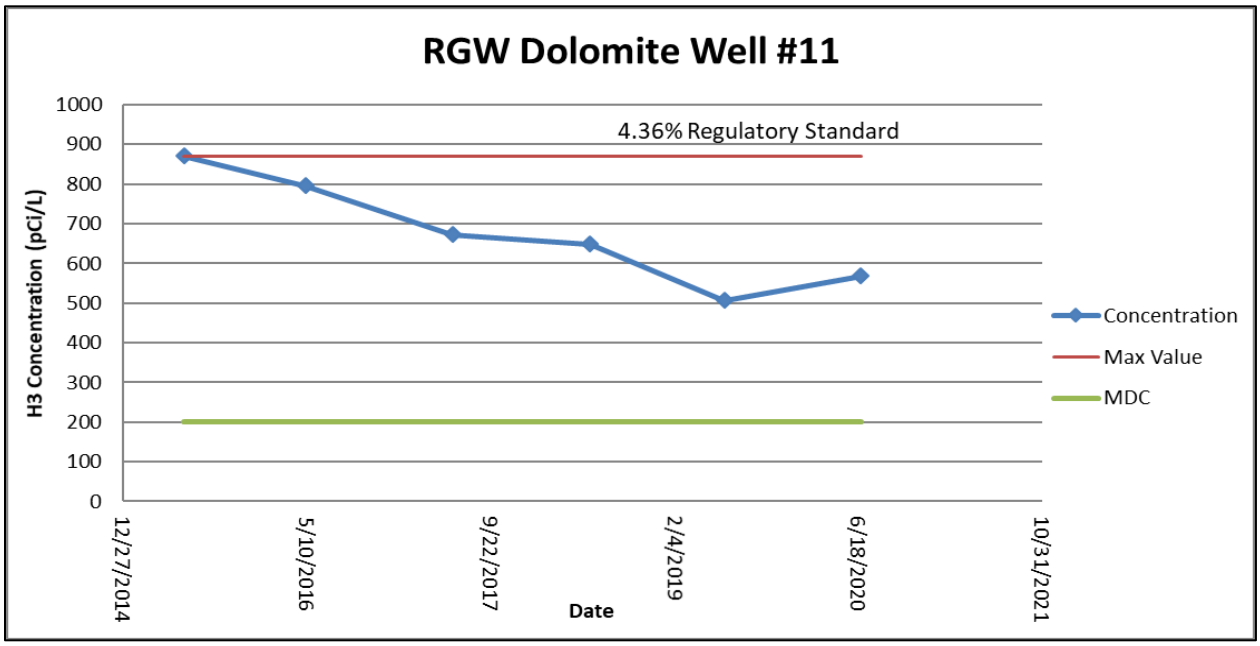

Maple Lake Surface Water
250
200
150
100
50
0
H3 Concentration (pCi/L)
0.50% Regulatory Standard
12/27/2014
5/10/2016
9/22/2017
2/4/2019
6/18/2020
10/31/2021
Date
Concentration
Max Value
MDC



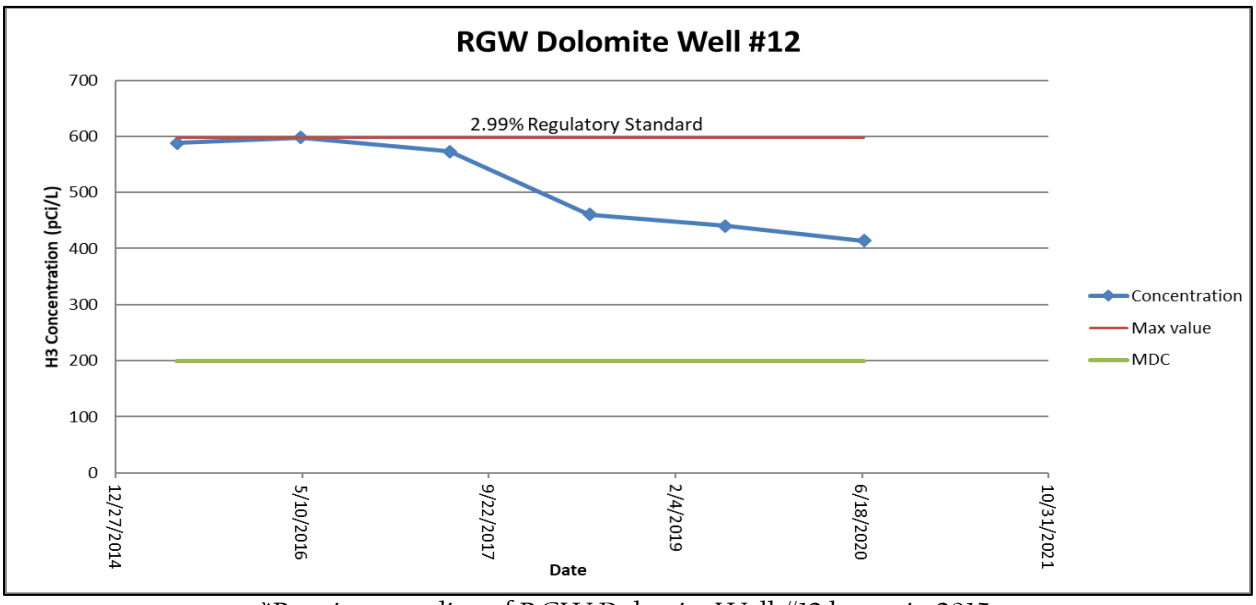
*Max value above the Regulatory Standard



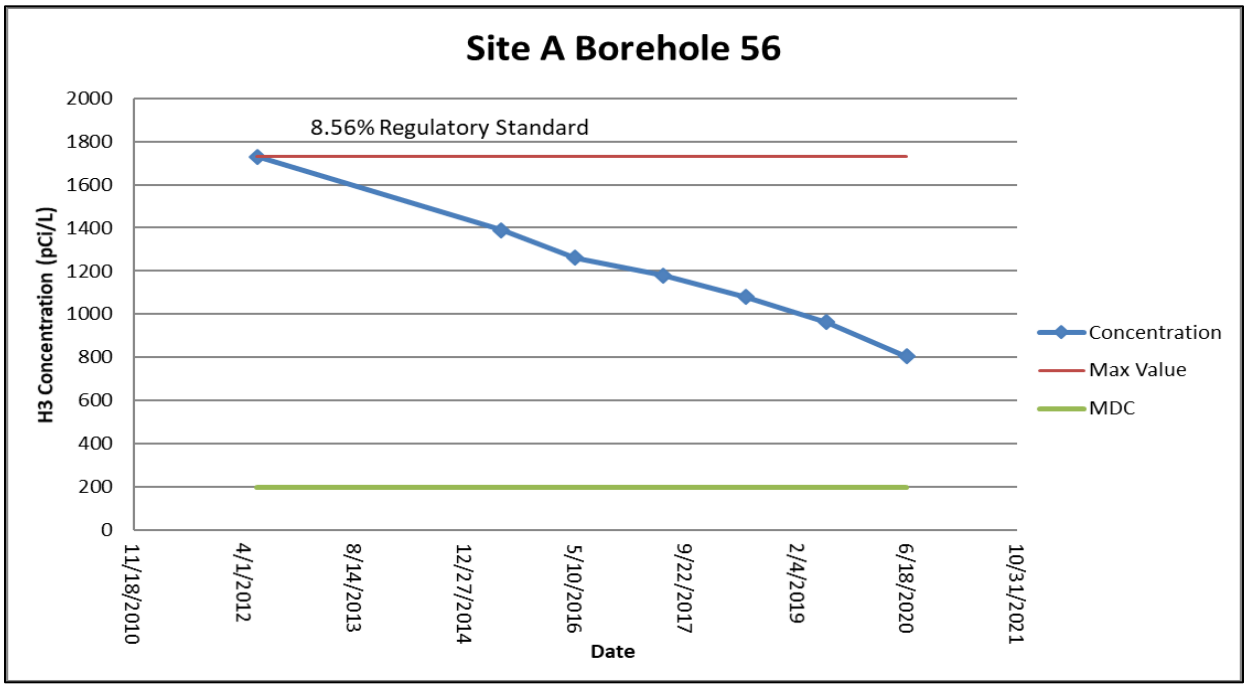
*Max value above the Regulatory Standard



*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 Forest Preserve 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
Maple Lake Boat Launch Well		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
Maple Lake Surface		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200
Saganashkee Slough		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200
Sanitary & Ship Canal (DnS)		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200
Sanitary & Ship Canal (UpS)		
3/4/2020	382	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200
St. James Church Well		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200

Location	H-3	
Date	Result	MDC
Rain Barrel Slough Well #5162		
3/4/2020	<MDC	200
Bullfrog Campground Shower North		
6/24/2020	<MDC	200
9/15/2020	<MDC	200
Bullfrog Campground Shower South		
Closed due to Covid-19		
Bullfrog Campground Store		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200
Henry de Tonty Woods Well #5159		
3/4/2020	200	200
6/24/2020	365	200
9/15/2020	361	200
Illinois & Michigan Canal (DnS)		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200
Illinois & Michigan Canal (UpS)		
3/4/2020	<MDC	200
6/24/2020	<MDC	200
9/15/2020	<MDC	200
12/2/2020	<MDC	200
Red Gate Woods Well #5160		
No Samples Available		

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

Location	H-3	
Date	Result	MDC
Plot M Borehole # 10		
3/11/2020	8020	200
Plot M Borehole #4		
3/11/2020	287000	200
6/15/2020	278000	200
9/10/2020	286000	200
11/4/2020	305000	200
RGW Dolomite Well #11		
6/23/2020	568	200
RGW Dolomite Well #12		
6/23/2020	414	200
Site A Borehole #56		
6/16/2020	805	200
Red Gate Woods Well #5160		
No Samples available		

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
Rain Barrel Slough Well #5162		
3/4/2020	<MDC	3.8
Bullfrog Campground Shower North		
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
Bullfrog Campground Store		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
Henry de Tonty Woods Well #5159		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
Illinois & Michigan Canal (DnS)		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
Illinois & Michigan Canal (UpS)		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
Maple Lake Boat Launch Well		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8

Location	Cs-137	
Date	Result	MDC
Maple Lake Surface		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
Saganashkee Slough		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
Sanitary & Ship Canal (DnS)		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
Sanitary & Ship Canal (UpS)		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
St. James Church Well		
3/4/2020	<MDC	3.8
6/24/2020	<MDC	3.8
9/15/2020	<MDC	3.8
12/2/2020	<MDC	3.8
Red Gate Woods Well #5160		
No Samples Available		
Bullfrog Shower South		
Closed Due to Covid-19		

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

Location	Cs-137	
Date	Result	MDC
Plot M Borehole # 10		
3/11/2020	<MDC	3.8
Plot M Borehole #4		
3/11/2020	<MDC	3.8
6/15/2020	<MDC	3.8
9/10/2020	<MDC	3.8
11/4/2020	<MDC	3.8
RGW Dolomite Well #11		
6/23/2020	<MDC	3.8
RGW Dolomite Well #12		
6/23/2020	<MDC	3.8
Site A Borehole #56		
6/16/2020	<MDC	3.8
Red Gate Woods Well #5160		
No Samples Available		

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
Bullfrog Campground Shower North		
9/15/2020	<MDC	1.1
Bullfrog Campground Store		
6/24/2020	<MDC	1.1
9/15/2020	<MDC	1.1
Henry de Tonty Woods Well #5159		
9/15/2020	<MDC	1.1
Maple Lake Boat Launch Well		
9/15/2020	<MDC	1.1
St. James Church Well		
3/4/2020	<MDC	1.1

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

Location	Strontium	
Date	Result	MDC
Plot M Borehole # 10		
3/11/2020	<MDC	1.1
Plot M Borehole #4		
3/11/2020	<MDC	1.1
6/15/2020	<MDC	1.1
9/10/2020	<MDC	1.1
11/4/2020	<MDC	1.1
RGW Dolomite Well #11		
6/23/2020	<MDC	1.1
RGW Dolomite Well #12		
6/23/2020	2.6	1.1
Site A Borehole #56		
6/16/2020	<MDC	1.1
Red Gate Woods Well #5160		
No Samples Available		

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
Kincaid E Boat Dock		
3/9/2020	<MDC	200
6/16/2020	<MDC	200
9/29/2020	<MDC	200
11/16/2020	<MDC	200
Strawkaws Boat Ramp		
3/9/2020	<MDC	200
6/16/2020	<MDC	200
9/29/2020	<MDC	200
11/16/2020	<MDC	200
Kincaid W Boat Ramp		
3/9/2020	<MDC	200
6/16/2020	<MDC	200
9/29/2020	<MDC	200
11/16/2020	<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
Kincaid E Boat Dock		
3/9/2020	<MDC	3.8
6/16/2020	<MDC	3.8
9/29/2020	<MDC	3.8
11/16/2020	<MDC	3.8
Strawkaws Boat Ramp		
3/9/2020	<MDC	3.8
6/16/2020	<MDC	3.8
9/29/2020	<MDC	3.8
11/16/2020	<MDC	3.8
Kincaid W Boat Ramp		
3/9/2020	<MDC	3.8
6/16/2020	<MDC	3.8
9/29/2020	<MDC	3.8
11/16/2020	<MDC	3.8

Table D.3 Total Strontium Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location	Strontium	
Date	Result	MDC
E Boat Ramp		
6/16/2020	<MDC	0.6
Strawkaws Boat Ramp		
3/9/2020	<MDC	0.6
11/16/2020	<MDC	0.6
W Boat Ramp		
9/29/2020	<MDC	0.6

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