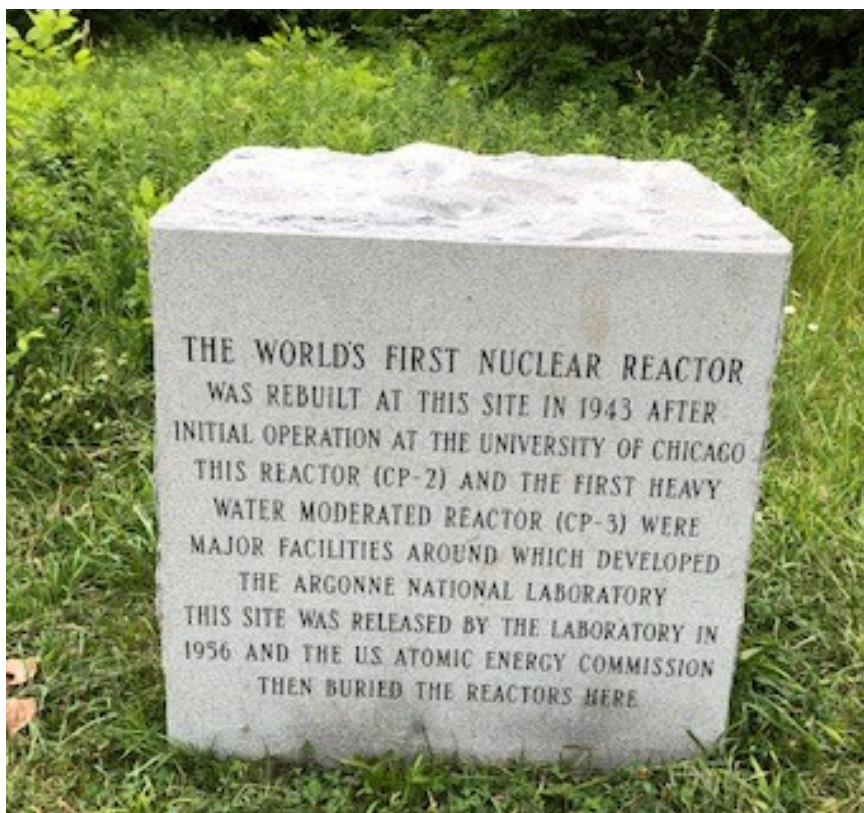


Site A and Plot M 2023 Surveillance Report and 2024 Inspection Report

Environment, Safety, and Health Directorate



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Site A and Plot M 2023 Surveillance Report and 2024 Inspection Report

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August 2024

PREFACE

This report is prepared for the U. S. Department of Energy (DOE) Office of Legacy Management (DOE-LM) by the Worker Safety & Environment (WSE) Division at Argonne National Laboratory (Argonne). Beginning in 2024, Argonne drafted a combined report containing the annual inspection results for the current year and the annual surveillance data/discussion from the previous year. The annual inspection results will be contained within an appendix at the end of the surveillance report. The results of the environmental monitoring program at Site A and Plot M and an assessment of the impact of the site on the environment and the public are presented in this publication as well as findings and assigned corrective actions as a result of the Site A/Plot M annual inspection. Funding to support this program was provided by DOE-LM.

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SURVEILLANCE OF SITE A AND PLOT M

ANNUAL REPORT FOR 2023

1.0 SUMMARY

The results of the environmental surveillance program conducted at Site A/Plot M for calendar year (CY) 2023 are presented within this document. Site A/Plot M is in the Palos Area Preserves managed by the Forest Preserve District of Cook County. The surveillance program consists of the collection and analysis of surface and groundwater samples to determine the amount of hydrogen-3 and strontium-90 present in the environment within and surrounding the site of the former research facility (Site A) and waste burial site (Plot M).

The surveillance program was modified in 2015 by the removal of eight groundwater monitoring wells at Site A and Red Gate Woods, and the reduction in the sampling frequency, for all but the Plot M wells, from quarterly to annual. The changes were based on a review of monitoring results compiled over many years. These results indicated that the concentrations of hydrogen-3 and strontium-90 in the wells that were closed were low and consistently trending downward, and further monitoring of these wells was not required.

The CY2023 results indicate that, with few exceptions, the amounts of hydrogen-3 and strontium-90 are slowly decreasing as a result of decay and dilution. The maximum potential radiation dose to a hypothetical resident near Plot M resulting from residual radioactivity in this area was estimated to be 0.399 mrem/y, based upon very conservative assumptions. A more realistic estimate of potential dose is 0.00055 mrem per visit for an occasional park visitor. The maximum potential dose is far below the DOE's allowable dose to the public of 100 mrem/y.

Hydrogen-3 concentrations in surface water in two small intermittent streams that pass by Plot M were below the detection limit of 0.1 nCi/L upstream of Plot M, and appeared at a maximum of 7.6 nCi/L downstream of Plot M, a value below the IL EPA Class I groundwater quality standard of 20 nCi/L. Five samples of surface water were collected from ponds in the vicinity of Site A. None of these ponds contained hydrogen-3 above the detection limit of 0.1 nCi/L.

Hydrogen-3 continued to be detected during CY2023 in nine wells surrounding Plot M. The results were found to be slowly decreasing and consistent with previous results in seven of the

nine monitoring wells. Monitoring wells BH06 and BH35 had the highest concentrations of hydrogen-3. In recent years, the hydrogen-3 concentration in BH06 has increased compared to concentrations found prior to 2009 as seen in Figure 4-6. As seen in Figure 4-7, hydrogen-3 concentration in BH35 slightly increased in CY2023 compared to previous years. Low levels of strontium-90 were found in groundwater from four of the eight Plot M wells sampled. Well BH09 was dry during this sampling effort. Since 2010, the strontium-90 results in well BH06 appear to be slightly increasing, but a decrease in concentration was seen in CY2023. The other strontium-90 results are consistent with those measured in the past. All concentrations were below the State of Illinois' Class I Groundwater Quality Standard of 8 pCi/L for strontium-90.

The two wells in the vicinity of Site A were found to contain much lower amounts of hydrogen-3 than the Plot M wells. The amounts present were found to be slowly decreasing and were consistent with past observations. Low levels of strontium-90 were also found in the two Site A wells. All results were below groundwater quality standards. The six deep wells at Red Gate Woods that were constructed in the dolomite bedrock downgradient of Plot M were found to contain low levels of hydrogen-3, all below the State of Illinois' Class I Groundwater Quality Standard of 20 nCi/L. The CY2023 results were consistent with past findings and demonstrate that hydrogen-3 concentrations in these wells are slowly decreasing.

Two unused former picnic wells were also sampled at Red Gate Woods. Both wells had low levels of hydrogen-3, similar to last year's results. The hydrogen-3 levels in the former picnic well at Red Gate Woods North increased from 2010 to 2014, followed by a downward trend from 2014 to the CY2023 sampling event. All results were below the State of Illinois' Class I Groundwater Quality Standard of 20 nCi/L for hydrogen-3.

The results of the surveillance program indicate that the radioactivity remaining at Site A/Plot M does not endanger the health or safety of the public visiting the site, using the picnic areas, or living in the vicinity.

2.0 INTRODUCTION

2.1 Site History

The environmental surveillance program discussed in this report is an ongoing activity that resulted from the 1976-1978 radiological characterization of the former site of Argonne National Laboratory and its predecessor, the University of Chicago's Metallurgical Laboratory. This site was part of the World War II Manhattan Engineer District Project and was located in a forested area southwest of Chicago, IL, owned by the Forest Preserve District of Cook County, now known as the Palos Area Preserves. Research was conducted at two locations in the Palos Area Preserves: Site A, a 19-acre parcel that contained experimental laboratories and nuclear reactor facilities; and Plot M, a 150 ft x 140 ft area used for the burial of radioactive waste. The location of the Palos Area Preserves is shown in Figure 2.1. The locations of Site A and Plot M are shown in Figure 2.2 along with the Site A surface water sample locations and Red Gate Woods picnic well locations. Previous comprehensive reports on this subject^{1,2} provide additional detail and illustrations on sampling locations and provide descriptive material along with the results through 1981. Annual surveillance reports are available for 1982 through 2022.^{3-36,50-56} While earlier data will not be repeated in this report, reference is made to some of the results.

Operations at Site A began in 1943 and ceased in 1954. Among the research programs carried out at Site A were reactor physics studies, fission product separations, hydrogen-3 recovery from irradiated lithium, and work related to the metabolism of radionuclides in laboratory animals. Radioactive waste and radioactively contaminated laboratory articles from these studies were buried at Plot M. At the termination of the programs, the reactor fuel and heavy water, used for neutron moderation and reactor cooling, were removed, and shipped to Oak Ridge National Laboratory. The biological shield for the CP-3 reactor located at Site A, together with various pipes, valves, and building debris, was buried in place in 1956.

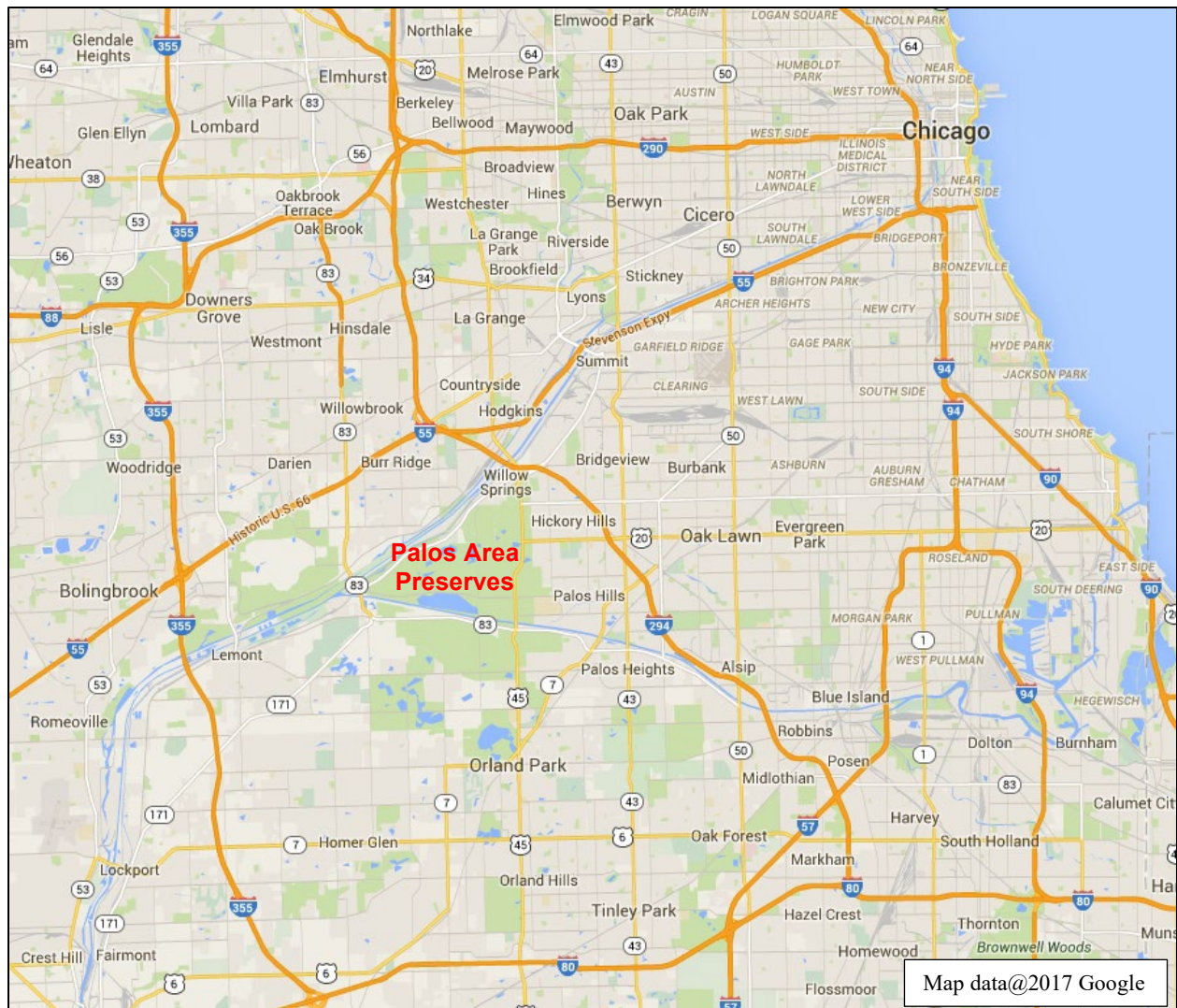


Figure 2-1 Location of Palos Area Preserves

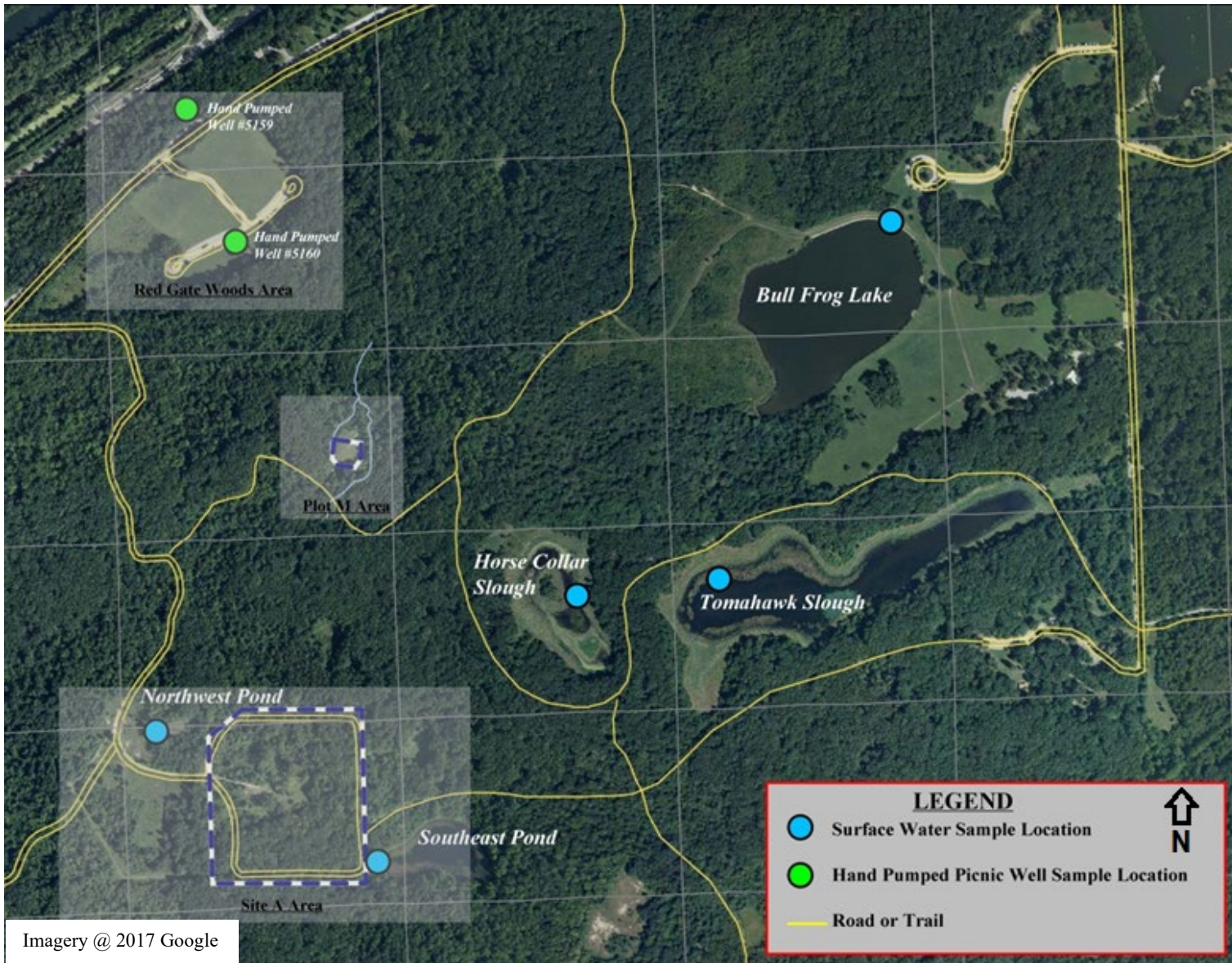


Figure 2-2 Site A/Plot M Area Map

Burial of radioactive waste at Plot M began in 1944 and was discontinued in 1949. Waste was buried in six-foot deep trenches and covered with soil until 1948, after which burial took place in steel bins. The steel bins were removed in 1949 and sent to Oak Ridge National Laboratory for disposal; however, the waste buried in trenches was allowed to remain in place. Concrete sidewalls, eight feet deep, were poured around the perimeter of the burial area and a one-foot-thick reinforced concrete slab was poured over the top. The concrete slab was covered with soil and seeded with grass. Both the Site A and Plot M areas were decommissioned in 1956.

In 1973, elevated levels of hydrogen-3 (as tritiated water) were detected by Argonne in two nearby hand-pumped picnic wells (#5160 and #5159). Later investigations found the hydrogen-3 to be migrating from the Plot M burial plot into the surrounding soil and aquifers. As a result, a radiological survey of the area surrounding the site was conducted by Argonne in 1976 with special emphasis on the Site A and Plot M areas.¹

In 1990, elevated levels of radioactivity were discovered outside the original developed area. By 1997, additional characterization and remediation had been completed by DOE to remove residual radioactivity and document the remediation of the area.

The terminology used in previous reports is continued in this report. A hole drilled and well installed into the glacial drift is called a borehole (BH). Water from such wells is called groundwater. Monitoring wells drilled into the dolomite bedrock are called deep holes (DH). The former hand-pumped drinking water wells, which are completed into or close to the dolomite bedrock, are called picnic wells. They are identified by a location name and well number.

The results of radioactivity measurements are expressed in this report in terms of picocuries per liter (pCi/L) for strontium-90 and nanocuries per liter (nCi/L) for hydrogen-3 in water samples. The use of the term dose throughout this report refers to effective dose equivalent. Radiation effective dose equivalent calculations are reported in units of millirem (mrem) or millirem per year (mrem/y). Other abbreviations of units are defined within the text of this report.

2.2 Site Characteristics

Geologically, Plot M is constructed on a moraine upland which is dissected by two valleys, the Des Plaines River valley to the north and the Calumet Sag valley to the south. The upland is characterized by rolling terrain with poorly developed drainage. Streams are intermittent and either drain internally or flow to one of the valleys. The area is underlain by glacial drift, dolomite, and other sedimentary rocks. The uppermost bedrock is Silurian dolomite, into which both the picnic wells and some of the monitoring wells are placed. The dolomite bedrock is about 200 feet thick. The overlying glacial drift has a thickness that ranges from 165 feet at Site A to zero at the Des Plaines River and Calumet Sag Canal. The boreholes terminate in this layer of overlying glacial drift. The depth to bedrock at Plot M is about 130 feet.

Hydrologically, the surface water consists of ponds and intermittent streams. When there is enough precipitation, an intermittent stream flows past Plot M, continues near the Red Gate Woods picnic well (#5160 in Figure 2.2), and discharges into the Illinois and Michigan (I&M) Canal. The groundwater in the glacial drift and dolomite bedrock forms two distinct flow systems. The flow of groundwater in the drift is controlled principally by topography. The groundwater in the dolomite, which is recharged by groundwater migrating downward through the glacial drift, flows toward two discharge areas, the Des Plaines River to the north and the Calumet Sag Canal to the south. There is no groundwater usage downgradient of Site A/Plot M. The former hand-pumped picnic wells have been disabled by removing the handles. These wells are currently used only for groundwater monitoring.

The climate is that of the upper Mississippi valley, as moderated by Lake Michigan, and is characterized by cold winters and hot summers. Precipitation averages about 37 inches annually. The largest rainfalls occur between April and September. The average monthly temperature ranges from 21°F in January to 73°F in July. Approximately 8.9 million people reside within 50 miles of the site; the population within a five-mile radius is about 150,000. The only portion of the Palos Area Preserves in the immediate area of Plot M and Site A that is developed for public use is the Red Gate Woods picnic area (Figure 2.2), although small numbers of individuals use the hiking and biking trails that pass through more remote areas of the Preserve.

3.0 MONITORING PROGRAM

3.1 Purpose of the Monitoring Program

The monitoring program at Site A/Plot M was conducted in accordance with the “Long-Term Surveillance and Maintenance Plan for Site A and Plot M, Palos Forest Preserve, Cook County, Illinois”, issued in January 2015³⁷. DOE-LM conducts stewardship activities at Site A and Plot M to protect human health and the environment, facilitate stakeholder involvement, and to comply with applicable regulations. DOE-LM carries out its stewardship responsibilities through a combination of government ownership of the encapsulated waste material, groundwater monitoring wells, Site A and Plot M monuments, and Plot M corner markers, conducting regular inspections, maintaining institutional controls, facilitating public awareness, and monitoring environmental media.

The monitoring program is assessed by DOE-LM periodically to determine if the goals are being met. At each review, changes to the monitoring program may be recommended. The current monitoring program was put in place by DOE-LM in 2015 following reviews conducted in 2011 (DOE 2011)³⁸ and 2014 (DOE 2014)³⁹. These reviews found that, except for hydrogen-3 at Plot M, past monitoring results indicated that concentrations of radionuclides were low, and trends were decreasing and consistent. The low concentrations, coupled with the consistent trends, indicated that, with the exception of sampling for hydrogen-3 at Plot M, the major monitoring objectives could be met through annual rather than quarterly sampling. It was found that eight groundwater monitoring wells could be plugged and abandoned without jeopardizing monitoring objectives. These wells were sealed and abandoned, in accordance with Illinois Environmental Protection Agency requirements, in 2015. Four wells were closed at Site A (BH41, BH51, BH52 and BH54). Four deep dolomite wells at Red Gate Woods were also closed (DH09, DH10, DH13, and DH17). The sampling frequency for the remaining wells at Site A and Red Gate Woods and including the two picnic wells and five ponds near Site A and Plot M, were reduced from quarterly to annual in 2015. The sampling program for Plot M was not changed in 2015 and remains on a quarterly schedule. The constituents of concern in groundwater and surface water continued to be limited to hydrogen-3 and strontium-90.

3.2 Structure of the Monitoring Program

The Site A/Plot M monitoring program follows the guidance for monitoring at DOE facilities.⁴⁰ Although Site A/Plot M is not an active DOE facility, the same monitoring principles

are applicable. The monitoring program is designed to assess the concentration of hydrogen-3 and strontium-90 in groundwater near these sites, and to monitor hydrogen-3 in two of the former picnic wells in Red Gate Woods and several surface waters in the vicinity. This is accomplished by analyzing water samples collected from groundwater wells and surface water. Sampling locations are described in the following sections of this report. Samples collected, analyses performed, and the sampling frequency are shown in Table 3-1.

The samples were analyzed by the Argonne Radiological Protection Division Analytical Services Radiochemistry laboratories using DOE-approved methods. The detection limit for hydrogen-3 in water is 0.1 nCi/L. The detection limit for strontium-90 is 0.25 pCi/L in water. The uncertainties associated with individual concentrations for strontium-90 shown in the tables are the statistical counting errors at the 95% confidence level. Because of the amount of hydrogen-3 data presented in many of the tables, the uncertainty values are not included. In such cases, the following typical uncertainties apply:

<u>Hydrogen-3 Concentration (nCi/L)</u>	<u>Uncertainty (% of Conc.)</u>
0.1-1.0	40-5%
1-10	5-1%
> 10	1%

Table 3-1 Environmental Monitoring Program for Site A and Plot M

Location name	Frequency – Hydrogen-3	Frequency – Strontium-90
Site A – Groundwater from monitoring wells in glacial drift		
BH55	Annual	Annual
BH56	Annual	Annual
Site A region – surface water ponds		
Northwest Pond	Annual	NSR
Southeast Pond	Annual	NSR
Bull Frog Lake	Annual	NSR
Horse Collar Slough	Annual	NSR
Tomahawk Slough	Annual	NSR
Plot M - Groundwater from monitoring wells in glacial drift		
BH02	Quarterly	Annual
BH03	Quarterly	Annual
BH04	Quarterly	Annual
BH06	Quarterly	Annual
BH09	Quarterly	Annual
BH10	Quarterly	Annual
BH11	Quarterly	Annual
BH26	Quarterly	Annual
BH35	Quarterly	Annual
Red Gate Woods – Groundwater from monitoring wells in dolomite		
DH03	Annual	NSR
DH04	Annual	NSR
DH11	Annual	NSR
DH12	Annual	NSR
DH14	Annual	NSR
DH15	Annual	NSR
Red Gate Woods - Groundwater from former picnic wells in dolomite		
5159	Annual	NSR
5160	Annual	NSR
Plot M - Surface Water		
Location 1	Quarterly	NSR
Location 6	Quarterly	NSR
Location 7	Quarterly	NSR
Location 8	Quarterly	NSR

NSR = No Sample Required

4.0 RESULTS OF THE MONITORING PROGRAM

Unless otherwise noted in the appropriate table, during CY2023, all planned samples were collected. Results of the environmental surveillance program conducted during CY2023 are presented in the following sections of this report.

4.1 Plot M Surface Water and Forest Preserve Ponds

Surface water samples were collected quarterly from four sampling locations along the two streams that flow around Plot M, shown in Figure 4.1, when sufficient flow was present. Location 1 is upstream of the Plot M area. Location 6 is immediately north and downstream of Plot M, with Locations 7 and 8 slightly further north. During the four quarters of CY2023, attempts were made to collect stream samples from Plot M after significant precipitation events. No water was present in the stream beds during the second and fourth quarters of CY2023, thus no surface water samples were collected from these locations. During the 2017 DOE-LM site visit, it was decided that because the stream flow is intermittent, the Location 6 sample would only be collected when flowing water is present.

The stream samples were analyzed for hydrogen-3 and the results are shown in Table 4.1. The same concentration pattern in the water flowing around Plot M was observed this year as in the past. Concentrations were below the detection limit upstream of Plot M (Location 1); hydrogen-3 was the highest at Location 6 during the third quarter. The amount of hydrogen-3 at Location 6 in the July of CY2023 sample was 7.6 nCi/L.

Historically, Surface Water Location #6 was identified as a seep. Over time, erosion patterns in the shallow streambed near Location #6 created low spots for water to remain in-between precipitation events. Quarterly samples were then subsequently collected from these low spots. It was determined that the integrity of the seep be distinguished as flowing or non-flowing. In January 2017, a site visit to Plot M was performed after several days of below freezing conditions to verify flow at Surface Water Location #6 (seep #6). No ice/water mounding was observed along the slope wall in the vicinity of Location #6 (seep #6). Due to the lack of flow in the vicinity of the seep, it was determined to reclassify the location as Surface Water Location #6 and remove the seep designation.

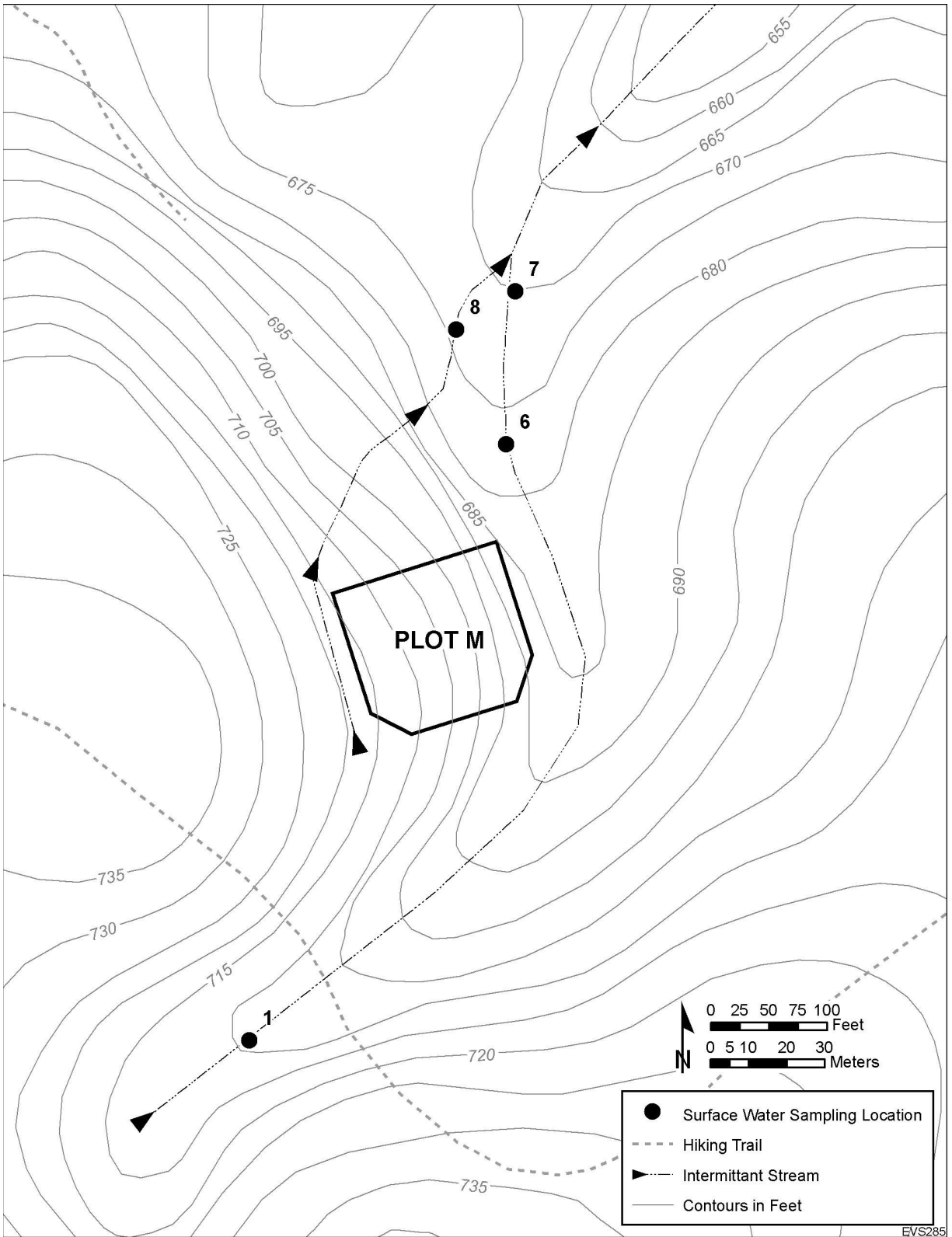


Figure 4-1 Stream Sampling Locations near Plot M

Table 4-1 Hydrogen-3 Content of Streams Next to Plot M, 2023

Location Number ¹	Date Collected (Concentrations in nCi/L)			
	February 9	May 3	July 12	November 2
1	< 0.1	DRY	< 0.1	DRY
6	1.0	DRY	7.6	DRY
7	1.0	DRY	0.7	DRY
8	0.2	DRY	< 0.1	DRY

¹ See Figure 4.1

Hydrogen-3 concentrations in the streams vary greatly, depending in part on the amount of precipitation prior to sample collection. Figure 4.2 illustrates how some of the previous years' samples from Locations 7 and 8 had higher than normal hydrogen-3 concentrations. In previous years, samples were collected during times of very low flow in the streams due to dry weather prior to the sampling event. The low flow conditions could have resulted in surface water with higher contribution of groundwater emanating from the Plot M area, resulting in higher-than-normal hydrogen-3 concentrations. This also allows for a more conservative risk assessment of human health and the environment.

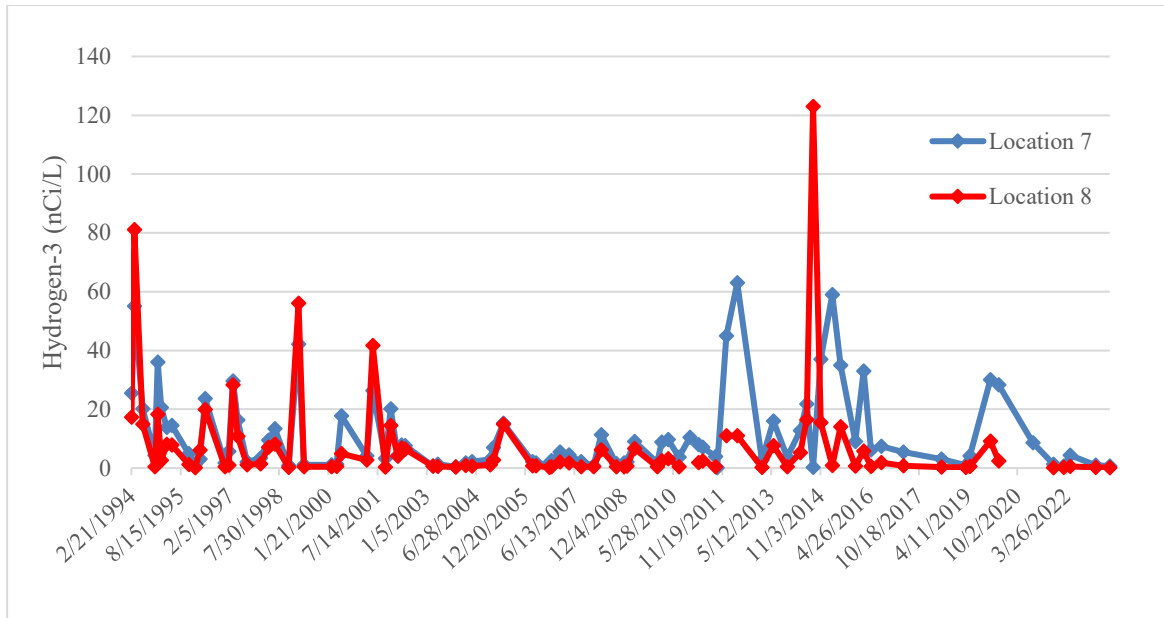


Figure 4-2 Hydrogen-3 in Plot M Streams Locations 7 and 8

One set of samples from five surface water bodies in the vicinity of Site A was collected in June of CY2023. These surface water bodies are the pond northwest of Site A, the pond southeast of Site A, Horse Collar Slough, Tomahawk Slough, and Bull Frog Lake. These locations are identified in Figure 2.2. The samples were analyzed for hydrogen-3 and the results are presented in Table 4.2. All the hydrogen-3 results were below the detection limit of 0.1 nCi/L.

Table 4-2 Hydrogen 3 Content of Site A Area Ponds, 2023

Location	June 1 (Concentrations in nCi/L)
NW Site A	< 0.1 (< 0.1) ¹
SE Site A	< 0.1
Bull Frog Lake	< 0.1
Horse Collar Slough	< 0.1
Tomahawk Slough	< 0.1 (< 0.1) ¹

¹ Duplicate QC sample results are denoted in parentheses.

4.2 Plot M Groundwater

Nine boreholes screened within the glacial drift are present in and around Plot M (Figure 4.3). Two of these wells (BH09 and BH10) were drilled at a 45° angle to intercept groundwater under the waste. Water samples were collected in all nine wells and water level measurements were recorded quarterly in seven wells. The water levels for the angle wells were not measured. During the second, third, and fourth quarters of CY2023, BH09 was dry.

All the water samples were analyzed for hydrogen-3; the results are shown in Table 4.3. Duplicate quality control sample results are shown in parentheses. The hydrogen-3 concentrations varied widely from well to well and, in some cases, from quarter to quarter. The hydrogen-3 concentrations follow similar trends over the past several years. Most of the results indicate that hydrogen-3 concentrations are slowly decreasing in these wells.

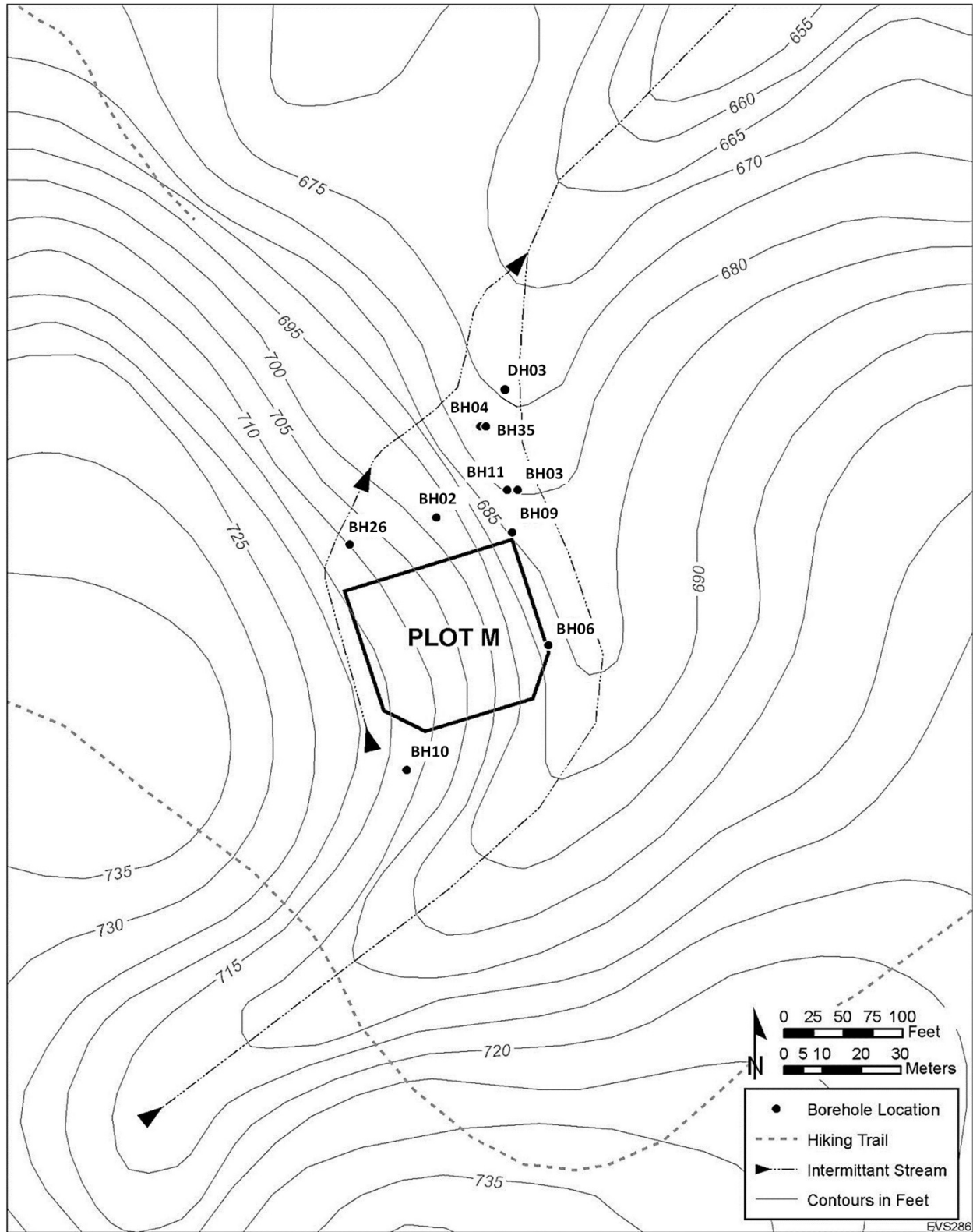


Figure 4-3 Map of Plot M Site

Table 4-3 Hydrogen-3 Content of Plot M Monitoring Well Water, 2023

Borehole Number	Well Depth (ft)	Date Collected (Concentrations in nCi/L)			
		March 21	May 25	September 20	November 16
BH02	39.41	1.4	4.5	3.0 (3.1) ¹	3.5
BH03	40.00	74 (73) ¹	75	4.5	11
BH04	36.05	263	249	268	252 (263) ¹
BH06	40.30	282	428	1,231	906
BH09 ²	40.00	288	DRY	DRY	DRY
BH10 ²	40.00	5.8	25.4	7.6	10.8
BH11	39.30	49	43	50	53
BH26	60.65	0.8	44	0.6	1.3
BH35	105.50	631	815	845	914

¹ Duplicate QC sample results are denoted in parentheses.

² Slant well drilled at 45° to a depth of 40 ft. below the surface.

The highest hydrogen-3 concentrations near Plot M during CY2023 were found in BH04, BH06, BH35, and the angle well BH09. Figure 4.4 shows the trend in hydrogen-3 concentrations in BH03 and BH04. Since 1989, there has been a steady decrease in hydrogen-3 concentration in these wells. Figure 4.5 shows the trend of hydrogen-3 concentrations in BH09. This well had very high levels of hydrogen-3 during the 1990s but concentrations have significantly decreased since 1999.

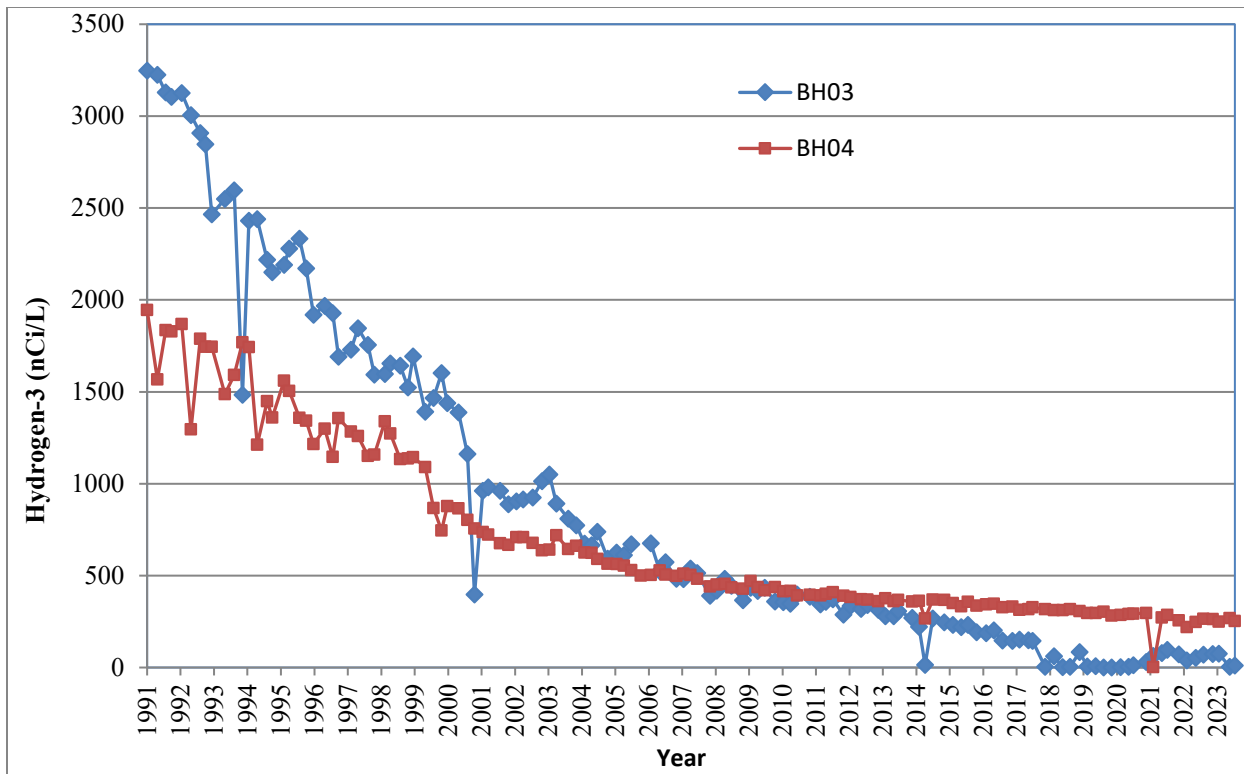


Figure 4-4 Hydrogen-3 in Plot M Wells BH03 and BH04

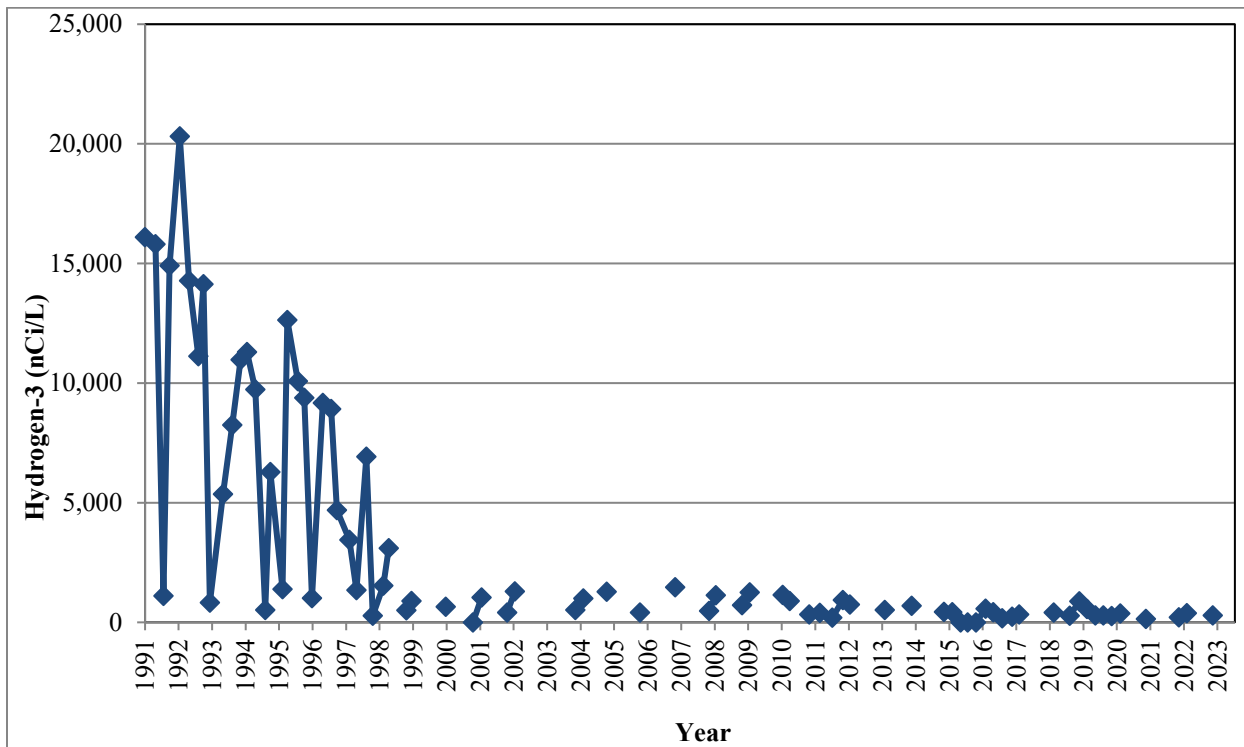


Figure 4-5 Hydrogen-3 in Plot M Well BH09

As shown in Table 4.3, Well BH06 contained relatively high hydrogen-3 concentrations during all four quarters of CY2023, with the third quarter of CY2023 being the highest. The trend in hydrogen-3 concentrations in BH06 since CY1991 is shown in Figure 4.6, which also depicts groundwater elevations in this well. From CY1994 through the first half of CY2009, the hydrogen-3 concentrations ranged from 50 to 150 nCi/L. Since CY2009, the highest concentration of hydrogen-3 was seen in CY2019 at 5,693 nCi/L and the lowest in CY2014 at 46 nCi/L. In CY2023, the highest concentration was 1,231 nCi/L (September 2023). During this time period, groundwater elevations were found to have fluctuated more than during the period between 1994 and 2009. The changing groundwater elevations could be responsible for the recent increase in hydrogen-3 concentrations and the wide variability between sample results.

The hydrogen-3 concentrations in Well BH35, shown in Figure 4.7, have been steadily increasing since 2003. The cause of the increase is related to downward movement of the hydrogen-3 plume beneath Plot M to the northeast towards the Des Plaines River. Well BH35 is the deepest at 105 feet and is located downgradient of Plot M.

Figure 4.8 shows hydrogen-3 concentrations in Well BH02 since 1991. The hydrogen-3 concentrations in this well remained at low levels during CY2023, as compared to 2012 and 2013, which had samples with relatively high levels of hydrogen-3. This figure also shows the groundwater elevation in the well. Figure 4.8 indicates that the spikes in hydrogen-3 concentration that occurred in previous years happened during periods when the groundwater elevation was lower than normal. Lower groundwater elevations could change the way groundwater moves and interacts with contaminated soil under Plot M, causing the hydrogen-3 concentrations to vary widely.

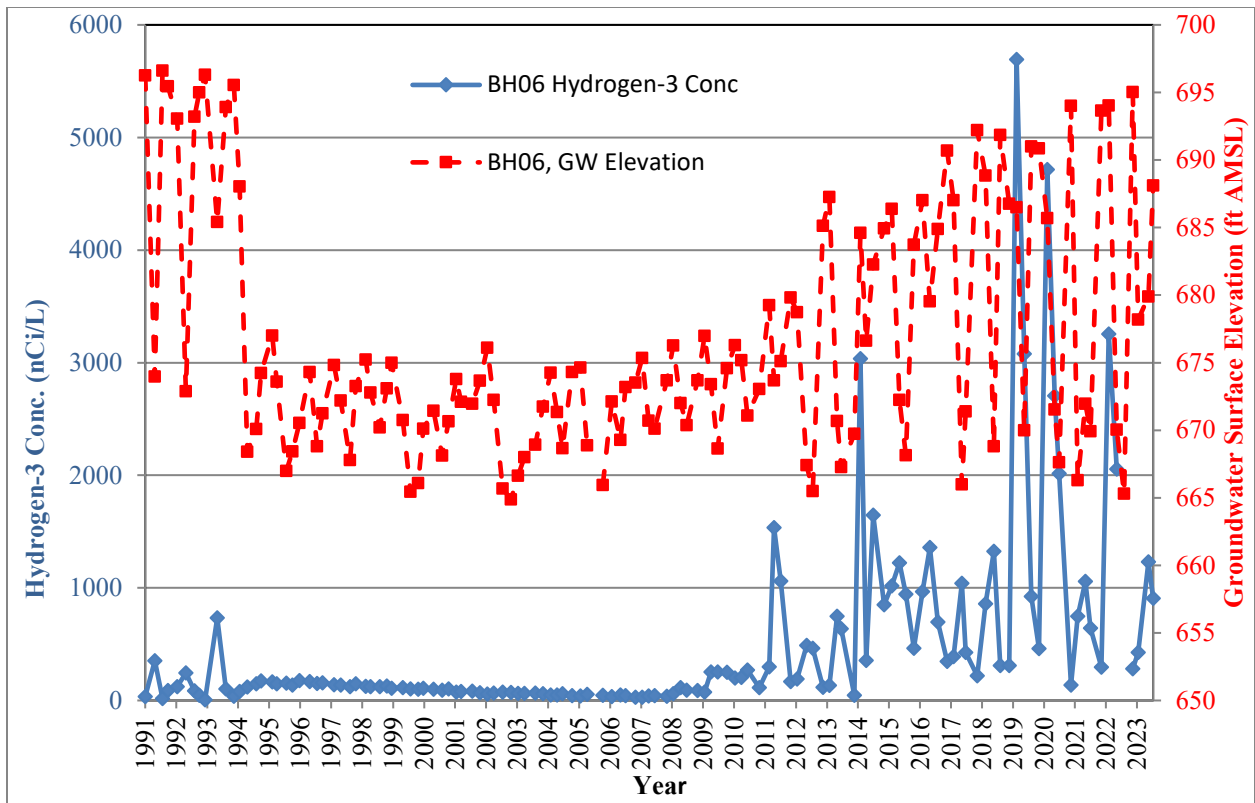


Figure 4-6 Hydrogen-3 and Groundwater Elevation in Well BH06

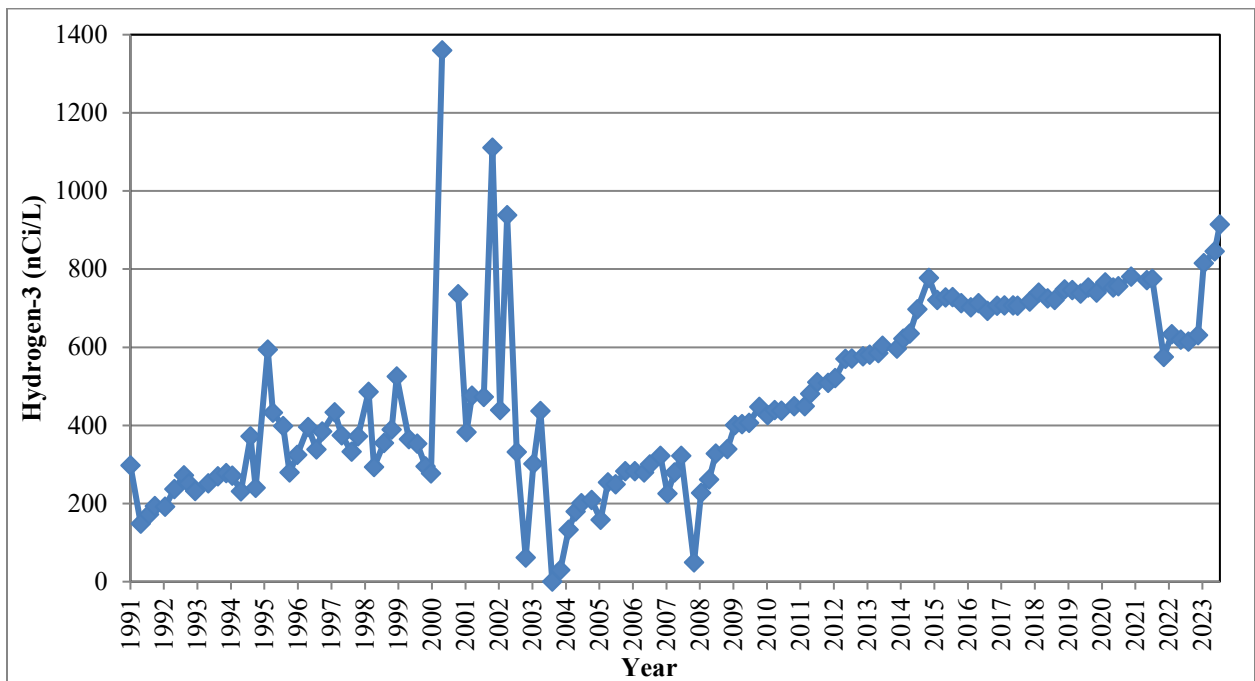


Figure 4-7 Hydrogen-3 in Well BH35

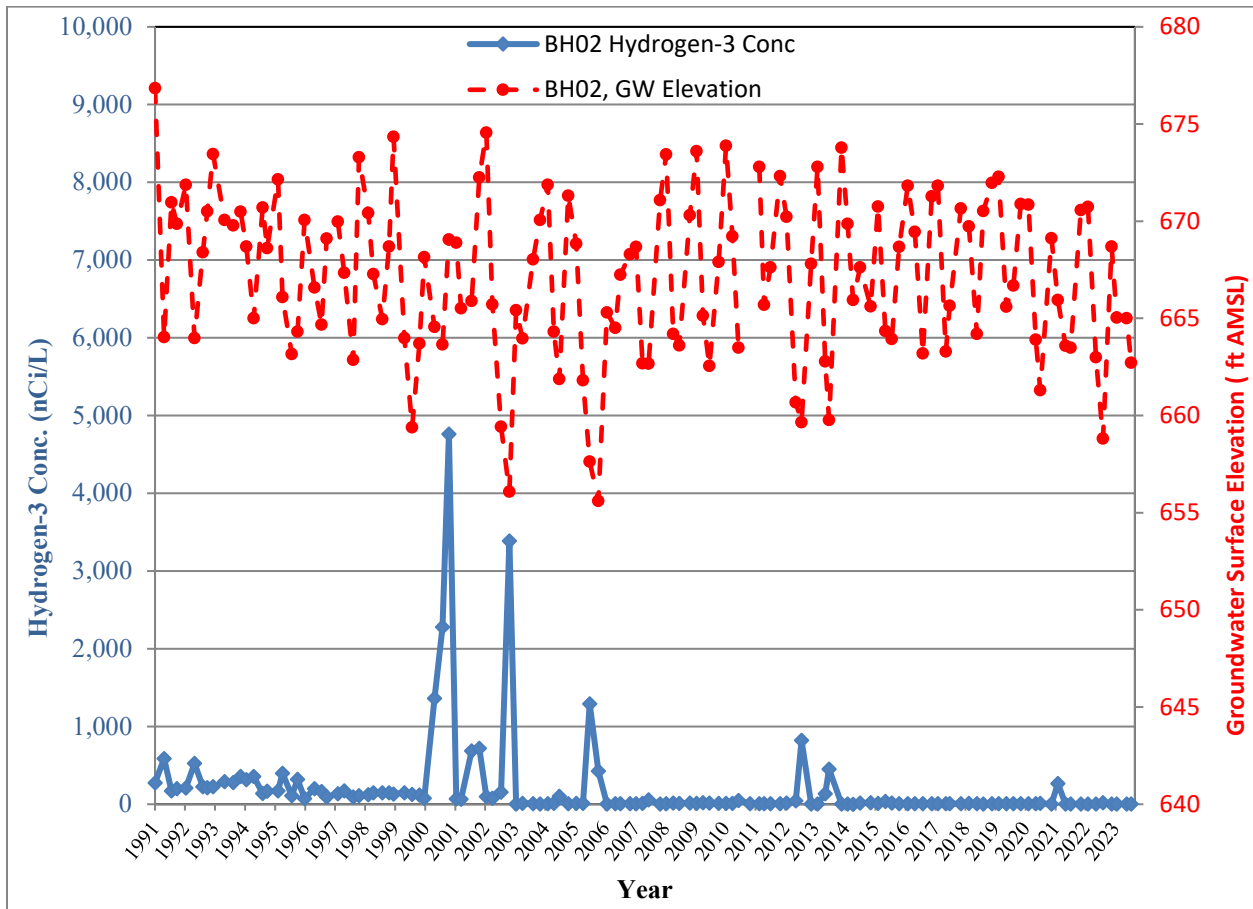


Figure 4-8 Hydrogen-3 and Groundwater Elevation in Well BH02

Groundwater samples from the Plot M monitoring wells were analyzed once for strontium-90 during CY2023. The results are shown in Table 4.4. Strontium-90 concentrations greater than the detection limit of 0.25 pCi/L were found in four (BH02, BH06, BH11, and BH26) of the nine wells sampled. Well BH09 was dry during the May sampling event. The highest strontium-90 concentration in CY2023 was 1.39 pCi/L in water collected from BH11. Strontium-90 concentrations were detected in BH02 at 0.42 pCi/L, in BH06 at 1.11 pCi/L, and BH26, at 0.28 pCi/L. Figure 4.9 illustrates the historical trend of strontium-90 results in BH06 and 11. BH02 and BH09 strontium results cannot be illustrated due to the wells frequently being dry. With a few exceptions, the amount of strontium-90 in BH11 is decreasing over time. Strontium-90 concentrations in BH06, which had been relatively consistent since 2010, have since been exhibiting an unpredictable behavior to date. All results were less than the State of Illinois Class 1 Ground Water Quality Standard of 8 pCi/L for strontium-90.

Table 4-4 Strontium-90 Content of Monitoring Well Water Samples Near Plot M, 2023

Well Number ¹	Well Depth (ft.)	May 25 (Concentrations in pCi/L)
BH02	39.41	0.42 ± 0.091
BH03	40.00	<0.25
BH04	36.05	<0.25 ³
BH06	40.30	1.11 ± 0.114
BH09 ²	40.00	DRY
BH10 ²	40.00	<0.25
BH11	39.30	1.39 ± 0.135
BH26	60.65	0.28 ± 0.075
BH35	105.50	<0.25

¹ See Figure 4.2 for map of Plot M site

² BH09 and BH10 are slant wells drilled at 45° to a depth of 40 ft. below the surface.

³ BH04 was analyzed each quarter for Sr-90 and Cs-137 as part of the intercomparison program with the IEMA laboratory. All samples collected during 2023 were <0.25 pCi/L.

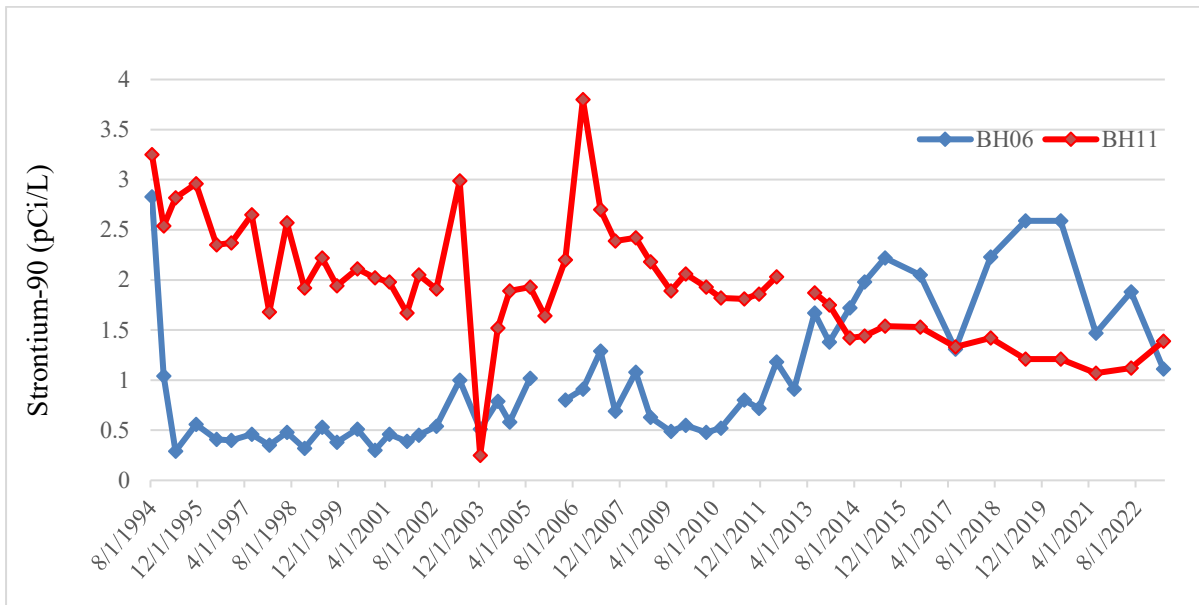


Figure 4-9 Strontium-90 in Plot M Wells BH06 and BH11

The depth-to-groundwater and groundwater elevations in the vertical wells at Plot M are shown in Table 4.5. Groundwater elevations measured during CY2023 in most of the shallow wells were consistent with typical groundwater elevations in these wells. Groundwater elevations for the two slant wells are not included in this table. Due to the difference in the screen depth of these wells, data cannot be used to develop potentiometric surface maps of the Plot M area. The differing well depths, in addition to the groundwater elevation differences between nearby wells, indicate that a hydraulic connection between the wells cannot be assumed. In general, Plot M groundwater flows downward and downgradient to the northeast, toward the Des Plaines River.

Table 4-5 Water Level Measurements in Monitoring Wells Near Plot M, 2023

Well Number ¹	Depth (ft.)	Top of Casing Elevation (ft AMSL) ²	Date Measured							
			March 21		May 25		September 20		November 16	
			Depth to water (ft.)	Water Surface Elevation (ft AMSL)	Depth to water (ft.)	Water Surface Elevation (ft AMSL)	Depth to water (ft.)	Water Surface Elevation (ft AMSL)	Depth to water (ft.)	Water Surface Elevation (ft AMSL)
BH2	39.41	692.70	24.01	668.69	27.66	665.04	27.7	665	29.98	662.72
BH3	40.00	693.30	34.46	658.84	33.29	660.01	33.24	660.06	33.45	659.85
BH4	36.05	682.20	18.61	663.59	19.1	663.1	20.98	661.22	19.7	662.5
BH6	40.30	704.90	9.87	695.03	26.72	678.18	25.02	679.88	16.8	688.1
BH11	39.30	693.00	19.91	673.09	25.61	667.39	26.33	666.67	25.27	667.73
BH26	60.65	692.30	50.68	641.62	49.08	643.22	50.48	641.82	50.32	641.98
BH35	105.5	682.40	93.55	588.85	93.77	588.63	93.56	588.84	93.59	588.81

¹ Water depth for wells 09 and 10 are not shown since these are slant wells.

² From 1994 IT Study report. AMSL = Above Mean Sea Level.

4.3 Site A Groundwater

The locations of the two Site A monitoring wells are shown in Figure 4.10. Hydrogen-3 monitoring results are shown in Table 4.6. Strontium-90 monitoring results are shown in Table 4.7. The results found in water from wells BH55 and BH56 are most likely originating from the buried CP-3 biological shield. The hydrogen-3 concentrations at Site A are several orders of magnitude lower than those found at Plot M and are trending downward. Figure 4.11 shows the decreasing hydrogen-3 concentrations in these two wells. Figure 4.12 shows the decreasing strontium-90 concentrations in these two wells. Groundwater levels were measured in these monitoring wells, and the values appear in Table 4.8.

Table 4-6 Hydrogen-3 Content of Monitoring Well Water Samples Near Site A, 2023

Well Number	Depth (ft.)	May 25 (Concentrations in nCi/L)
BH55	87.20	0.82
BH56	102.40	0.76

Table 4-7 Strontium-90 Content of Monitoring Well Water Samples Near Site A, 2023

Borehole Number	Depth (ft.)	June 10 (Concentrations in pCi/L)
BH55	87.20	1.49 ± 0.180
BH56	102.40	0.96 ± 0.225

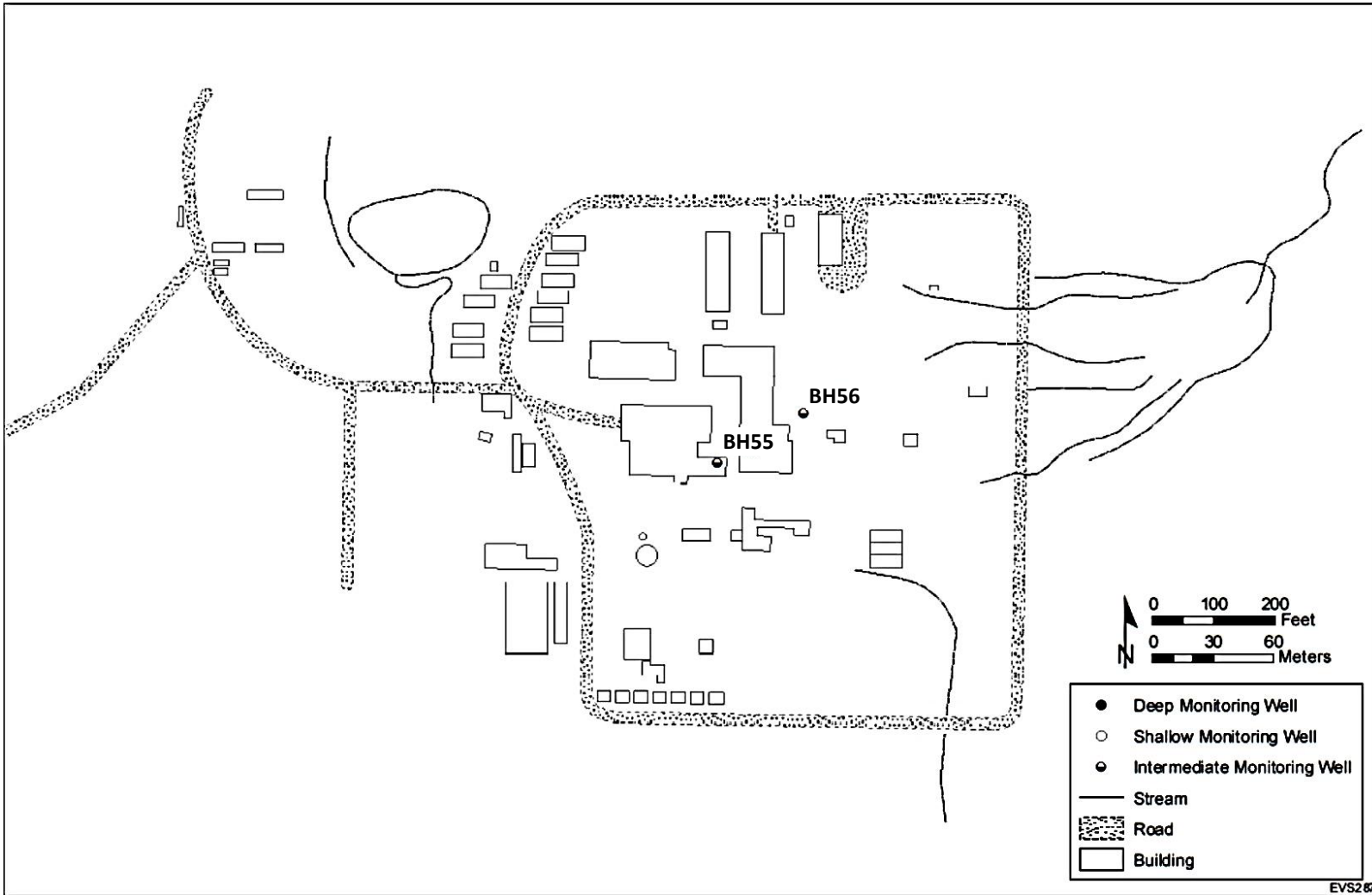


Figure 4-10 Monitoring Wells at Site A

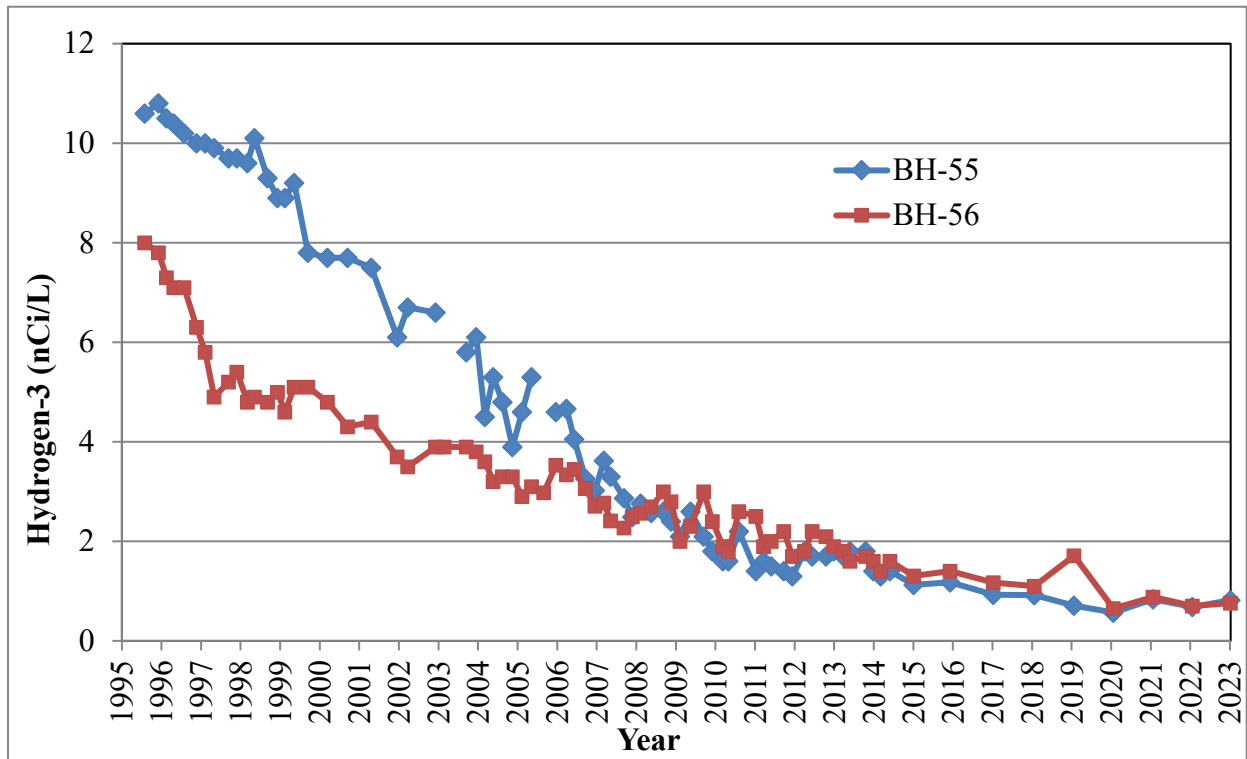


Figure 4-11 Hydrogen-3 in Site A Wells BH55 and BH56

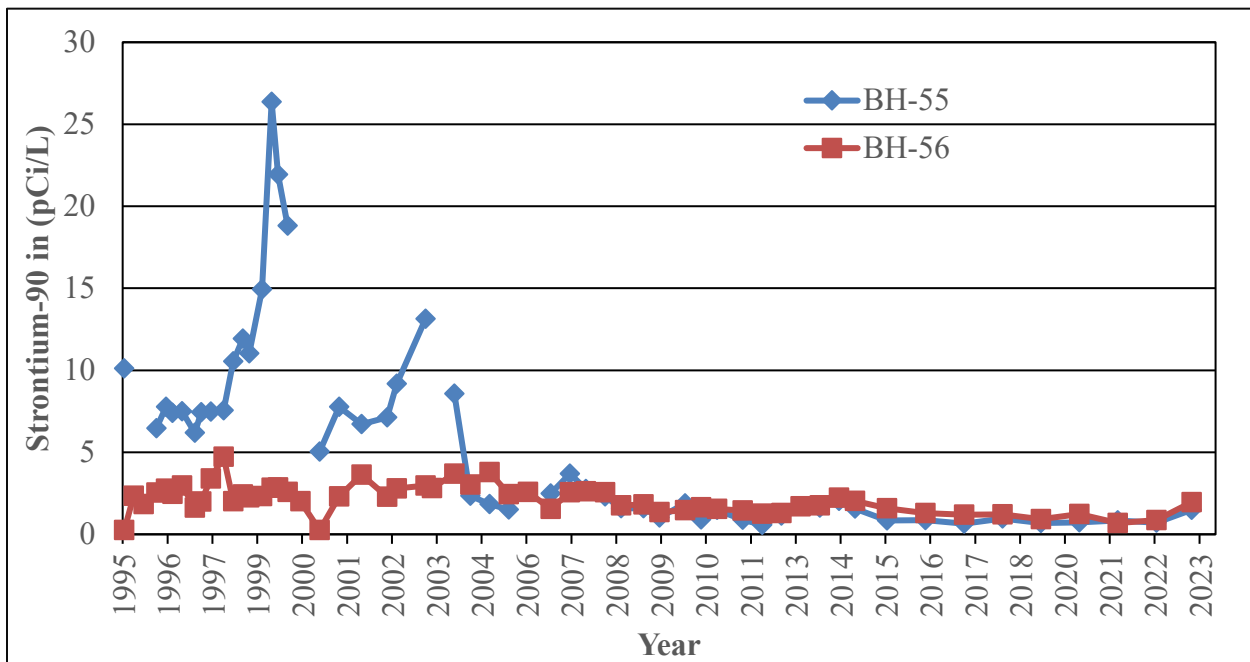


Figure 4-12 Strontium-90 in Site A Wells BH55 and BH56

Table 4-8 Water Level Measurements in Monitoring Wells Near Site A, 2023

Well Number	Depth to Bottom (ft.)	Top of Casing Elevation (ft AMSL) ¹	May 25	
			Depth to water (ft.)	Water Surface Elevation (ft AMSL) ¹
BH55	87.2	743.78	84.03	659.75
BH56	102.4	742.23	89.06	653.17

¹ From 1996 Advanced Surveying and Mapping topo map.
AMSL = Above Mean Sea Level.

4.4 Red Gate Woods

Six wells cased into the dolomite bedrock were sampled once in CY2023 to monitor the movement of hydrogen-3 within this aquifer located downgradient of Plot M. One of the dolomite wells (DH03) is located just north of Plot M. Five dolomite wells that are located north of Plot M in the Red Gate Woods area are shown in Figure 4.13. All samples were analyzed for hydrogen-3. The results are shown in Table 4.9. All the dolomite wells exhibited low but measurable hydrogen-3 concentrations, and all the results are consistent with concentrations measured in the past. The well with the consistently highest hydrogen-3 results is DH15. Figure 4.14 shows the hydrogen-3 concentrations in DH15 since 1990. The hydrogen-3 results were stable over the period from 1998 through 2017, after which a steady decline has been observed. All the dolomite well samples were below the State of Illinois Class 1 Groundwater Quality Standard of 20 nCi/L. The presence of hydrogen-3 in these wells is explained by the 1988 USGS investigation⁴¹, which indicated a hydrogen-3 plume underlies the stream which flows from Plot M and passes to the northeast of these wells. The plume has spread downward and downgradient, resulting in small amounts of hydrogen-3 in the dolomite aquifer in this area.

Two dolomite wells, DH03 and DH04, are located close to and downgradient of Plot M. The CY2023 hydrogen-3 result for DH03 was 0.63 nCi/L, and 0.75 nCi/L for DH04 which are slightly lower than previous samples. The hydrogen-3 concentrations in all dolomite wells were below 20 nCi/L. Previous analyses of soil core samples⁴² indicated the presence of hydrogen-3 as deep as the drift-dolomite interface in the vicinity of these wells.

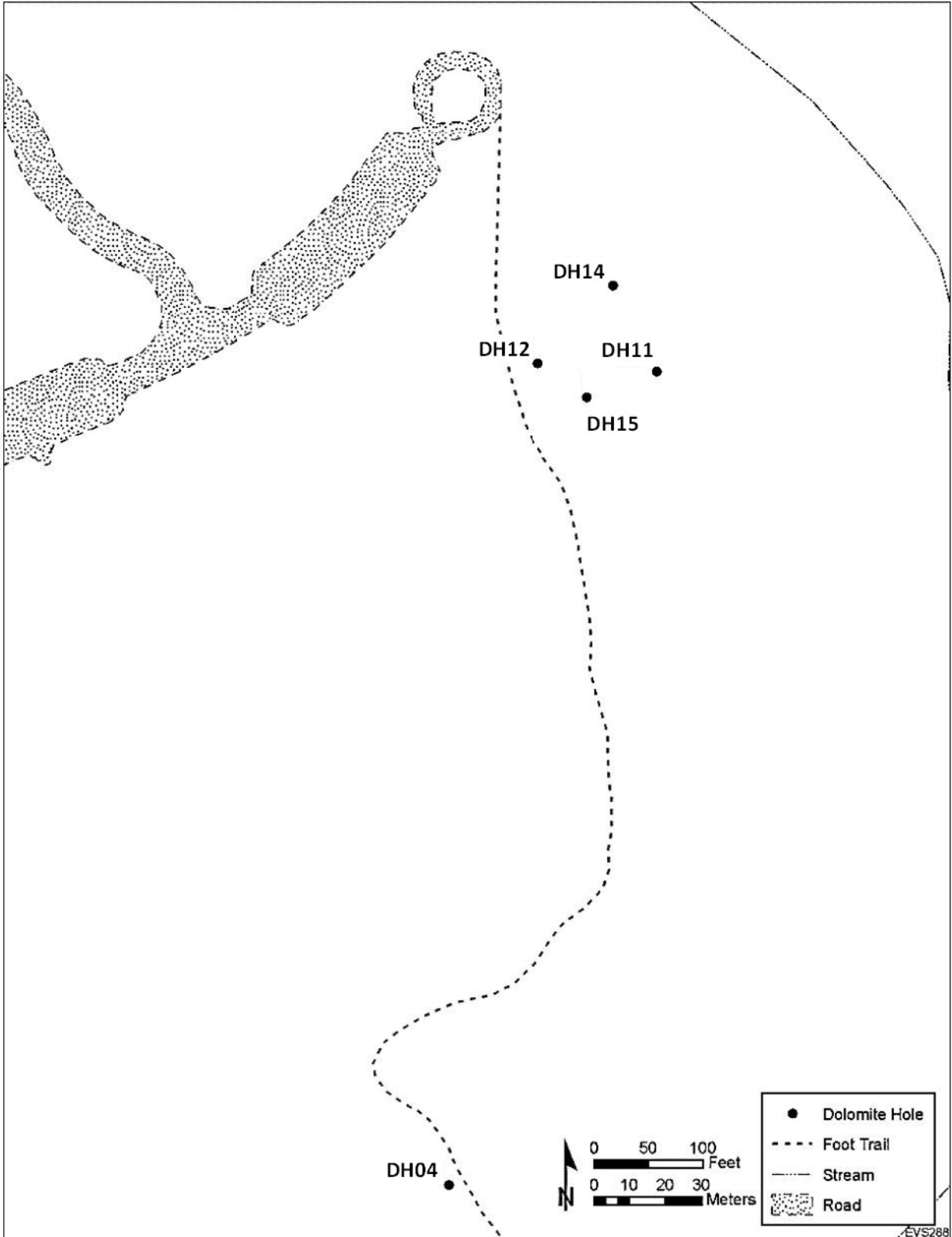


Figure 4-13 Locations of Dolomite Wells North of Plot M

Table 4-9 Hydrogen-3 Content of Dolomite Well Water, 2023

Dolomite Well Number	May 18 (Concentrations in nCi/L)
DH03	0.63 (0.63) ¹
DH04	0.75
DH11	0.43
DH12	0.36
DH14	0.40
DH15	1.86

¹ Duplicate QC sample results are denoted in parentheses.

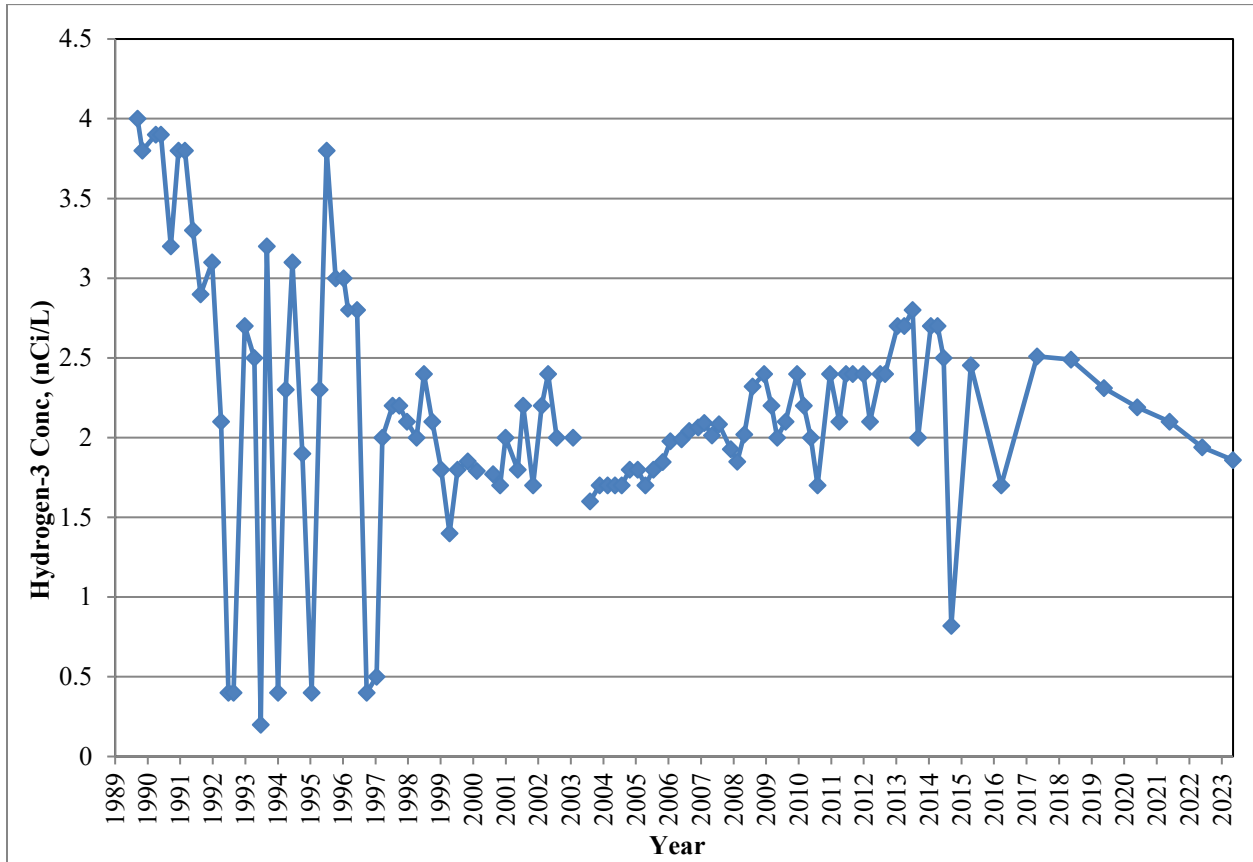


Figure 4-14 Hydrogen-3 Concentrations in Dolomite Well DH15

Water levels were measured in the dolomite wells, as shown in Table 4.10. Since these wells are installed in the dolomite aquifer, which is much deeper than the glacial till and not affected as much by recent weather, the groundwater elevations showed less seasonal variation than what was observed in the shallow glacial till wells. The groundwater elevations were consistent with historical measurements in these wells.

Since four dolomite wells (DH11, DH12, DH14, and DH15) in this area are located very close to one another, it is not possible to use groundwater elevation information to develop groundwater elevation contour maps. However, the relative elevation of the groundwater surface in the wells indicates that the groundwater is moving towards the nearby canal/river system, as described in the 1994 IT report⁴², which concluded that groundwater in this area is moving towards the Des Plaines River Valley.

4.5 Red Gate Woods Former Picnic Wells

Sampling was conducted once during CY2023 at two former forest preserve picnic wells (#5160 and #5159) located north of Plot M, as shown in Figure 2.2. The Red Gate Woods North Well (#5160) was disabled in 1999 by removing the pump handle, due to high fecal coliform bacteria levels. The well opposite Red Gate Woods (#5159) is located within an undeveloped area of the forest preserve, south of Red Gate Woods parking area and north of Archer Avenue and is unusable as a water source since the pump handle has also been removed. Samples were collected in the second quarter of CY2023 from Picnic wells #5160 and #5159 and were analyzed for hydrogen-3, with the results listed in Table 4.11. The maximum and average hydrogen-3 concentrations since 1996 for wells #5160 and #5159 are presented in Table 4.12. The change in hydrogen-3 concentrations in these wells since 1992 is shown in Figure 4.15.

In previous sampling events, the hydrogen-3 concentration in well #5160 was similar to the concentrations observed since 2008. For unknown reasons, the hydrogen-3 levels in this well increased between 2010 and 2013, after experiencing a significant decrease in 2009. The CY2022 sample collected from well #5159 contained a concentration of hydrogen-3 similar to the previous three years. The concentrations of hydrogen-3 in these picnic wells are below the State of Illinois Groundwater Quality Standard of 20 nCi/L.

Table 4-10 Water Level Measurements in Dolomite Wells, 2023

Well Number	Ground Surface Elevation (ft. AMSL)	Top of Casing Elevation (ft. AMSL) ¹	May 18	
			Depth to water (ft.)	Water Surface Elevation (ft. AMSL)
DH03	678.10	679.50	98.44	581.06
DH04	673.80	674.60	92.81	581.79
DH11	655.36	656.90	76.10	580.80
DH12	650.34	651.60	77.18	574.42
DH14	651.43	653.20	72.19	581.01
DH15	659.14	660.80	79.81	580.99

¹ From 1994 IT Study report. AMSL = Above Mean Sea Level.

Table 4-11 Hydrogen-3 Content of Former Picnic Wells Near Site A/Plot M, 2023

Date Collected	May 18 (Concentrations in nCi/L)
Opposite Red Gate #5159	0.37
Red Gate North #5160	0.73

Table 4-12 Hydrogen-3 Concentrations in the Red Gate Woods Wells

Year	Red Gate Woods North (#5160)		Opposite Red Gate Woods (#5159)	
	Maximum (nCi/L)	Annual Average (nCi/L)	Maximum (nCi/L)	Annual Average (nCi/L)
1996	2.19	1.56	0.55	0.33
1997	1.26	1.00	1.13	0.35
1998	1.23	1.03	0.72	0.47
1999	1.22	1.07	2.14	0.45
2000	1.54	1.33	2.20	0.70
2001	1.59	1.49	0.27	0.16
2002	1.47	1.04	3.17	0.45
2003	1.78	1.06	1.49	0.43
2004	1.08	1.00	0.34	0.17
2005	1.01	0.95	0.34	0.19
2006	1.14	1.06	2.63	1.11
2007	1.45	1.28	0.66	0.33
2008	1.24	0.33	0.32	0.26
2009	0.13	0.10	0.50	0.33
2010	0.28	0.19	0.51	0.34
2011	0.91	0.67	3.60	1.10
2012	2.10	1.60	0.74	0.34
2013	2.24	2.14	0.75	0.35
2014	2.02	1.96	0.55	0.37
2015	1.92	- ^a	0.51	-
2016	1.71	-	1.16	-
2017	1.28	-	0.70	-
2018	1.33	-	0.48	-
2019	0.80	-	0.20	-
2020	NS ^b	-	0.31	-
2021	0.80	-	0.20	-
2022	0.78	-	0.28	-
2023	0.73	-	0.37	-

^a Annual sampling frequency started in 2015.

^b NS-No sample; well not operational.

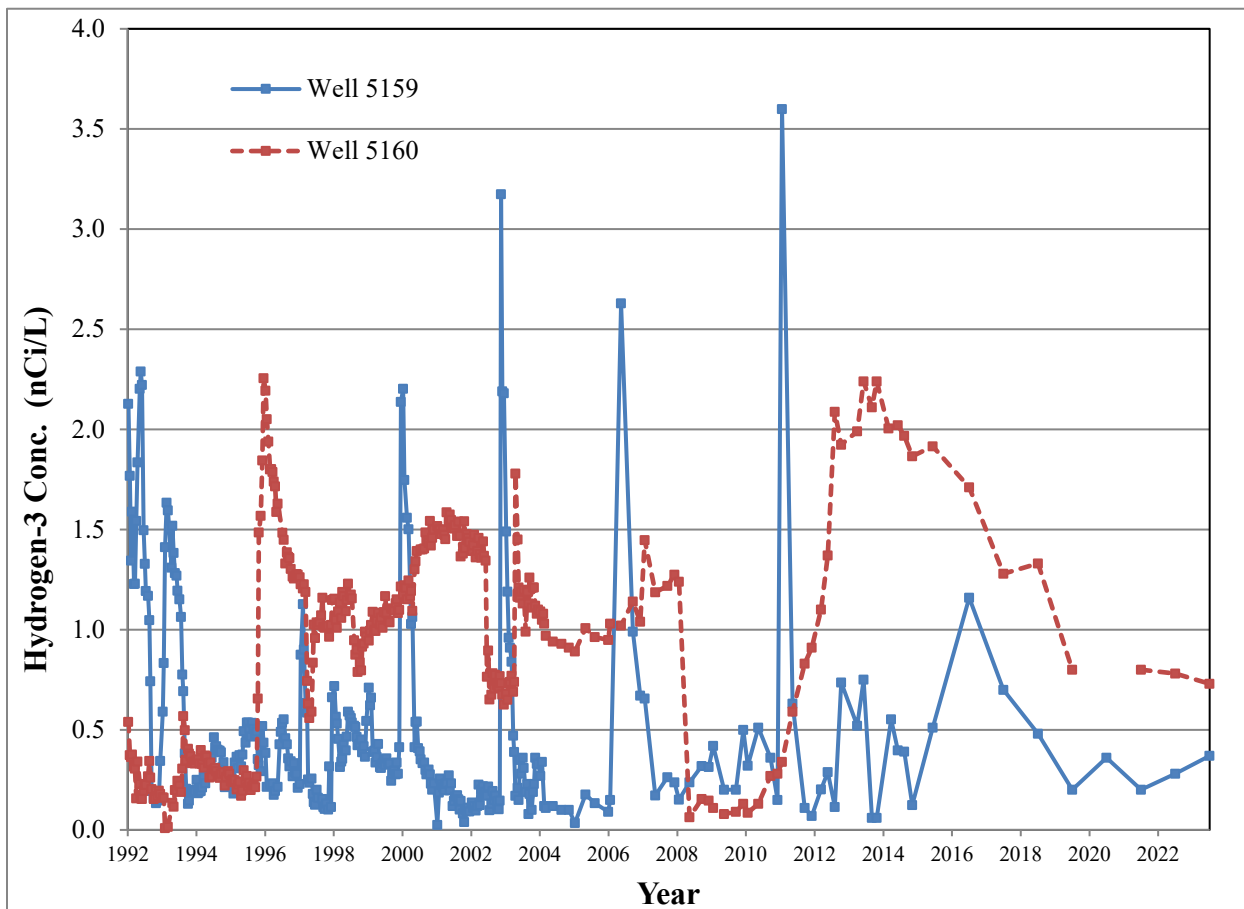


Figure 4-15 Hydrogen-3 in Former Picnic Wells from 1992 through 2023

5.0 SUMMARY OF POTENTIAL RADIATION DOSE AND RISK ESTIMATES

5.1 Dose Estimates

Since there is no human consumption of water from surface water or wells, the radioactive material present in this area does not represent a health risk to the public. However, to evaluate the theoretical risk to health from residual contamination if this water were to be consumed by an individual, the potential radiation dose to a hypothetical individual was estimated using methodology prescribed in DOE Order O 458.1.⁴³ The committed effective dose equivalent from consumption of water was estimated by calculating the total quantity of hydrogen-3 potentially ingested. Taking a very conservative approach, it was assumed the hypothetical individual drank only surface water containing hydrogen-3 at the maximum levels found at Plot M (Stream Location 6) during CY2023. The concentration of hydrogen-3 was multiplied by the general public water ingestion rate of 730 L/y.⁴⁴ This annual intake was then multiplied by the 50-year Committed Effective Dose Equivalent (CEDE) factor.⁴⁵ The CEDE for hydrogen-3 in water is 7.2×10^{-5} rem/ μ Ci (based on the derived concentration standard of 1.9×10^{-3} μ Ci/mL). The worst-case annual dose based on the CY2023 maximum concentration of 7.6 nCi/L was determined to be 0.399 mrem/y. A similar dose calculation was made for the former Red Gate Woods North picnic well (#5160), assuming this was the sole source of water consumed. For this well, based on the CY2023 maximum concentration of 0.73 nCi/L, the estimated dose was 0.038 mrem/y. These estimated doses are shown in Table 5.1. The DOE dose limit for the public is 100 mrem/y, so even under a highly conservative and unlikely scenario, the potential dose is far below DOE limits.

A more realistic estimation was made based upon the scenario of an occasional visitor to the Plot M area. The doses from this potential exposure were estimated by assuming a visitor drinks one liter of water from Stream Location 6 and one liter of water from the Red Gate Woods North (#5160) picnic well, combining the two doses. The results are shown in Table 5.2. The total maximum estimated dose was 0.00055 mrem per visit. To put the doses into perspective with other types of radiation exposure, comparisons can be made to annual average doses received by the public from natural or other generally accepted sources of radiation.⁴⁶ These are listed in Table 5.3. It is obvious that the magnitude of the doses potentially received near Plot M from radioactive substances are insignificant compared to other common sources.

5.2 Risk Estimates

The potential for possible negative health effects from radiation doses received from Plot M were estimated, to gain another perspective on interpreting the effects of radiation. Estimates for carcinogenic risk, the risk of contracting cancer from these exposures, are included in Table 5.1 and Table 5.2. Based on the BIER V report,⁴⁷ a dose of one mrem/y equates to an increased cancer risk of 7×10^{-7} . This conversion ratio is used to estimate incremental risk of contracting cancer from radiation exposure. For example, a carcinogenic risk of 10^{-7} would mean, on average, one additional person out of 10,000,000 contracts cancer assuming all individuals are under the assumed exposure conditions. The EPA environmental protection standards are based upon an acceptable risk between 10^{-4} and 10^{-6} . Table 5.1 indicates that under a very conservative assumption of ingestion of only Plot M surface water containing hydrogen-3 at the maximum concentration of 7.6 nCi/L, the estimated maximum carcinogenic risk is 2.80×10^{-7} , which is consistent with EPA standards. Table 5.2 shows that the hypothetical total maximum dose of 0.00055 mrem/visit to an occasional visitor would result in an increased maximum carcinogenic risk of about 4.20×10^{-10} . The incremental risk from exposure to radionuclides at Plot M can be compared to the risk associated with various life events. Examples are shown in Table 5.4. The risk from naturally occurring sources of radioactivity listed in Table 5.3 is estimated to bring about one additional individual that contracts cancer in a population of 4,600. The incremental risk from residual contamination at Site A/Plot M, under even the most conservative assumptions, is low. The monitoring program results have demonstrated that the impact of radioactivity at Site A/Plot M is very low and does not endanger the health of those living in the area or visiting the site.

Table 5-1 Hypothetical Dose from Exposure to Hydrogen-3, 2023

Assumed Source	Maximum		Maximum Carcinogenic Risk
	Conc. (nCi/L)	Dose ¹ (mrem/y)	
<u>Surface Water</u>			
Plot M Location 6	7.6	0.399	2.80 x 10 ⁻⁷
<u>Well Water</u>			
Red Gate Woods North (#5160)	0.73	0.038	2.69 x 10 ⁻⁸

¹ DOE Dose limit is 100 mrem/year

Table 5-2 Hypothetical Dose Hydrogen-3 Exposures to a Casual Visitor, 2023

Pathway	Maximum Dose ¹ (mrem/visit)	Maximum Carcinogenic Risk
<u>Surface Water</u>		
Plot M Location 6	0.0005	3.83 x 10 ⁻¹⁰
<u>Well Water</u>		
Red Gate Woods North (#5160)	0.00005	3.68 x 10 ⁻¹¹
Total	0.00055	4.20 x 10 ⁻¹⁰

¹ DOE Dose limit is 100 mrem/year

Table 5-3 Annual Average Dose Equivalent in the U. S. Population

Sources ¹	Dose (mrem)
Natural Sources	
Radon	228
Internal (⁴⁰ K and ²²⁶ Ra)	29
Cosmic	33
Terrestrial	21
Medical	
Computed Tomography	147
Nuclear Medicine	77
Interventional Fluoroscopy	43
Conventional Radiography & Fluoroscopy	33
Consumer (All Sources)	
Building Materials	13
Commercial Air Travel	
Cigarette Smoking	
Mining and Agricultural	
Combustion of Fossil Fuels	
Highway and Road Construction Materials	
Glass and Ceramics	
Industrial (All Sources)	
Nuclear-power Generation	0.3
DOE Installations	
Decommissioning and Radioactive Waste	
Industrial, Medical, Educational, and Research Activities	
Contact with Nuclear-medicine Patients	
Security Inspection Systems	
Occupational (All Sources)	
Medical	0.5
Aviation	
Commercial Nuclear Power	
Industrial and Commercial	
Education and Research	
Government, DOE, and Military	
Total	624

¹NCRP report No. 160.⁴⁸

Table 5-4 Annual Risk of Death from Various Events

Cause	Risk
Earthquake	1.03×10^{-7}
Flood	1.12×10^{-7}
Storm	3.70×10^{-7}
Firearms	1.2×10^{-6}
Motorcycle	1.6×10^{-5}
Walking	2.4×10^{-5}
Driving	2.07×10^{-5}
Drug Poisoning	2.5×10^{-4}

Source: Insurance Information Institute, CDC, 2020

6.0 QUALITY ASSURANCE PROGRAM

The radiological instrumentation used in this program is calibrated with standardized sources obtained from or traceable to the U. S. National Institute of Standards and Technology (NIST). Calibration of the instrumentation is verified by using secondary counting standards prior to the analysis of the samples. Approximately 10% of the samples are analyzed in duplicate or with the addition of known amounts of a radionuclide to check precision and accuracy.

Argonne participates in the DOE Mixed-Analyte Performance Evaluation Program (MAPEP). The MAPEP is administered by the DOE Radiological and Environmental Sciences Laboratory (RESL), located in Idaho Falls, Idaho. RESL provides an unbiased technical component to DOE oversight of contractor operations at DOE facilities and sites. RESL conducts cost-effective measurement quality assurance programs that help assure that key DOE missions are completed in a safe and environmentally responsible manner. By assuring the quality and stability of key laboratory measurement systems throughout DOE, and by providing expert technical assistance to improve those systems and programs, it assures the reliability of data on which decisions are based. The primary objective of this performance evaluation program is to foster reliability and credibility for the analytical results used in the decision-making process, particularly as it relates to the environment and public health and safety. MAPEP checks for specific analytical proficiencies in radiological, stable inorganic, or organic analyses. The MAPEP study addresses data quality requirements in DOE Order O 458.1, "Radiation Protection of the Public and the Environment."

MAPEP studies are conducted each February and August. MAPEP samples include water, soil, and air filter matrices that are spiked with environmentally important stable inorganic, organic, and radioactive constituents that are traceable to the National Institute of Standards and Technology. RESL performs sample preparation, distribution, data evaluation, and reporting. The 2023 Argonne MAPEP study resulted in H-3 and Sr-90 analyses being within the MAPEP acceptable range.

Many factors enter into an overall quality assurance program other than the analytical laboratory quality control process discussed above. Representative sampling is of prime importance. Appropriate sampling protocols are followed for each type of sample being collected. Water samples are pre-treated in a manner designed to maintain the integrity of the constituent

of interest. For example, samples collected for strontium-90 analysis are filtered and acidified immediately after collection to prevent hydrolytic loss of metal ions and reduce leaching from suspended solids. Samples collected for hydrogen-3 analysis do not require filtration or acidification.

To ensure groundwater samples are representative of the in-place groundwater, stagnant water in the well is removed prior to sampling in accordance with USEPA guidance.⁵⁰ The volume of stagnant water in the casing is determined by measuring the water depth from the surface. From one to three times the well volume is removed. After the well refills with groundwater, it is sampled by bailing with a Teflon bailer or dedicated pump. Wells that do not recharge quickly are pumped nearly dry and allowed to refill before samples are collected. The Red Gate Woods dolomite wells are not purged since they are open boreholes drilled into the bedrock where stagnant water does not accumulate. All samples are placed in pre-cleaned bottles, labeled, filtered, and preserved (strontium-90 samples only). All sampling equipment is cleaned by field rinsing with Type II deionized water. New equipment is used whenever possible to prevent cross-contamination. The samples are transferred to the analytical laboratory, accompanied by a chain-of-custody transfer document.

6.1 Applicable Standards

The standard relevant to this study is the DOE Order O 458.1, "Radiation Protection of the Public and the Environment," which established a total effective dose limit of 100 mrem/y.⁴³ The dose limit and dose calculation methodology are applicable to all media: surface water, deep holes, boreholes, and picnic well water. The EPA drinking water standard⁴⁴ is not applicable to the picnic wells since they do not meet the definition of a public water system; however, the IEPA standard of 20 nCi/L for hydrogen-3 and the IEPA Class I groundwater standard of 8 pCi/L for strontium-90 are used in this report for comparison purposes.

6.2 Analytical Methods

The analytical methods used to obtain the data in this report are identical to those used to generate the results presented in ANL-23/01.⁵⁶

6.3 Intercomparison Program

Commencing in 2012, Argonne has participated in a program of dividing a subset of the Site A/Plot M water samples collected and submitting one half of each sample to the Illinois Emergency Management Agency (IEMA) for analysis. The IEMA operates a laboratory which conducts radiological analyses using methods similar to Argonne. A duplicate set of two samples during the first, third and fourth quarter, and six samples during the second quarter, is analyzed by both Argonne and the IEMA for hydrogen-3, strontium-90, and cesium-137. The results are compared to identify any discrepancies that may be occurring within the processes being conducted by the two analytical laboratories that would affect the results. The results from the CY2023 split samples are shown in Tables 6.1 through 6.3. The relative percent difference (RPD) for hydrogen-3 results from pairs of samples exhibiting results greater than three times the minimum detectable activity (MDA) is shown in Table 6.1.

Table 6-1 Intercomparison Sample Hydrogen-3 Results for 2023

Sampling Location	Argonne H-3 Results (nCi/L)	Argonne Uncertainty	Argonne MDA	IEMA H-3 Results (nCi/L)	IEMA Uncertainty	IEMA MDA	RPD ^a
First Quarter							
Plot M Borehole BH04	263^b	0.658	0.1	255	NA ^c	0.122	3.0%
Plot M Borehole BH10	5.81	0.105	0.1	5.74	NA	0.122	1.2%
Second Quarter							
Plot M Borehole BH04	249	0.643	0.1	248	NA	0.125	0.4%
Plot M Borehole BH10	25.5	0.206	0.1	NA	NA	0.135	-
Site A Borehole BH56	0.76	0.053	0.1	0.74	NA	0.125	2.6%
Picnic Well 5160	0.73	0.053	0.1	0.70	NA	0.125	4.1%
RGW Dolomite Well DH11	0.43	0.048	0.1	0.40	NA	0.125	7.0%
RGW Dolomite Well DH12	0.36	0.047	0.1	0.35	NA	0.125	2.8%
Third Quarter							
Plot M Borehole BH04	268	0.657	0.1	263	NA	0.124	1.9%
Plot M Borehole BH10	7.6	0.116	0.1	7.4	NA	0.124	2.6%
Fourth Quarter							
Plot M Borehole BH04	252	0.638	0.1	244	NA	0.124	3.2%
Plot M Borehole BH10	10.8	0.138	0.1	11.9	NA	0.124	9.2%

a Relative Percent Difference (RPD) was calculated only for those results where both Argonne and IEMA results were greater than three times the MDA

b Bold font indicates the result is greater than three times the MDA

c IEMA uncertainty was not available for all Hydrogen-3 results

Table 6-2 Intercomparison Sample Strontium-90 Results for 2023

Sampling Location	Argonne Sr-90 Results (pCi/L)	Argonne Uncertainty	Argonne MDA	IEMA Sr-90 Results (pCi/L)	IEMA Uncertainty	IEMA MDA
First Quarter						
Plot M Borehole #4	-0.006	0.0557	0.25	0.79	NA ^a	1.24
Plot M Borehole #10	0.201	0.0637	0.25	0.95	NA	1.36
Second Quarter						
Plot M Borehole #4	0.129	0.0547	0.25	0.17	NA	1.85
Plot M Borehole #10	0.014	0.2276	0.25	NA	NA	-
Site A Borehole #56	1.958	0.2249	0.25	1.09	NA	1.36
Picnic Well 5160	0.068	0.0576	0.25	-0.26	NA	2.06
RGW Dolomite Well #11	0.068	0.0533	0.25	-0.15	NA	1.68
RGW Dolomite Well #12	0.091	0.0552	0.25	0.71	NA	1.66
Third Quarter						
Plot M Borehole #4	0.009	0.0202	0.25	1.13	NA	1.52
Plot M Borehole #10	0.146	0.0239	0.25	0.39	NA	1.60
Fourth Quarter						
Plot M Borehole #4	0.007	0.0438	0.25	1.53	NA	1.61
Plot M Borehole #10	0.253	0.0572	0.25	2.87	NA	2.03

^a IEMA uncertainty was not available for all Strontium-90 results

Table 6-3 Intercomparison Sample Cesium-137 Results for 2023

Sampling Location	Argonne Cs-137 Results (pCi/L)	Argonne Uncertainty	Argonne MDA	IEMA Cs-137 Results (pCi/L)	IEMA Uncertainty	IEMA MDA
First Quarter						
Plot M Borehole #4	0.676	1.565	2	-1.5	NA ^a	1.9
Plot M Borehole #10	1.152	1.280	2	-0.5	NA	1.8
Second Quarter						
Plot M Borehole #4	0.320	1.062	2	-1.0	NA	2.1
Plot M Borehole #10	0.000	2.356	2	NA	NA	NA
Site A Borehole #56	1.046	1.238	2	-1.3	NA	1.8
Picnic Well 5160	-0.062	0.696	2	0.1	NA	2.3
RGW Dolomite Well #11	0.370	1.252	2	0.9	NA	2.5
RGW Dolomite Well #12	-0.068	0.429	2	-1.0	NA	2.3
Third Quarter						
Plot M Borehole #4	1.499	2.286	2	-1.5	NA	3.1
Plot M Borehole #10	0.423	1.103	2	0.2	NA	2.1
Fourth Quarter						
Plot M Borehole #4	2.601	2.193	2	1.7	NA	3.3
Plot M Borehole #10	2.443	2.894	2	-1.9	NA	2.3

^a IEMA uncertainty was not available for all Cesium-137 results

7.0 2024 ANNUAL INSPECTION REPORT FOR SITE A AND PLOT M

7.1 EXECUTIVE SUMMARY

The Site A/Plot M Decommissioned Reactor Site was inspected on April 30, 2024. Site A/Plot M is in the Palos Area Preserves, operated by the Forest Preserve District of Cook County. The site was found to be in good condition with negligible erosional concerns across the grass covered mound at Plot M. Landscaping timbers installed along the footpath of Plot M have been effective in reducing erosion down the eastern slope, thus, no additional timber steps are needed at this time. The bike trail, installed by Cook County Forest Preserve, located to the south and east of Plot M has helped to significantly reduce traffic at the site. The Site A and Plot M monuments were both replaced on May 1, 2021, and remain in good condition. Thirteen of the seventeen groundwater monitoring wells at Site A/Plot M were found to be secure and in good condition. Dolomite well DH11, located north of Plot M, had its well cap tagged with graffiti, in addition to a small amount of rust observed on the outer casing. Two weeks prior to the on-site inspection, the well caps of Plot M wells BH04 and BH35 were found to be missing as a result of heavy equipment being utilized recently by the Forest Preserves of Cook County to mitigate invasive species of plants. At this time, temporary protective caps were installed, and the wells were secured. These temporary protective caps are shown in Photograph P08. BH56 appeared to have the beginnings of an ant infestation when the well cap was opened.

7.2 Annual Inspection Background

This report presents the findings of the 2024 annual inspection of the Site A/Plot M, Illinois, Decommissioned Reactor Site at the Palos Forest Preserve in Cook County, Illinois. Features and photographed locations discussed in this report are shown in Sections 4.0 and 6.0.

Argonne conducted the site inspection on April 30, 2024. The DOE-LM contracts directly with Argonne for all environmental sampling, analysis, and reporting. This DOE-LM site located in a Cook County Forest Preserve is open to the public and was found to be in good condition as documented in this inspection report.

The inspection was conducted in accordance with the Long-Term Surveillance and Maintenance Plan, Site A and Plot M, Palos Forest Preserve, Cook County, Illinois

(LMS/SAM/S01063, January 2015). The purposes of the inspection were to look for evidence that the integrity of the disposal site is not threatened, evaluate the condition of the monuments, locate and assess the condition of the Plot M corner markers, determine whether maintenance is needed, and examine the condition of the DOE-LM monitoring wells.

8.0 INSPECTION RESULTS

Two employees from Argonne conducted the annual site inspection of Site A and Plot M, with two additional Argonne employees in attendance as observers. Additionally, three representatives from the IEMA, three representatives from the Forest Preserves of Cook County, and one representative from DOE-LM, were in attendance.

The inspectors from Argonne and the attendees convened at the Red Gate Woods parking area at 0900 hours on April 30, 2024, and reviewed the Plan of the Day and Job Safety Analysis. Figures 4-1 and 4-2 show the Site A/Plot M 2024 Annual Field Attendance Sheet. Maps containing the locations of the inspection areas, as shown in the CY2023 Surveillance portion of this report, were distributed to the attendees. Conditions were sunny and dry with temperatures in the mid to upper 60s degrees Fahrenheit at the time of the inspection, and due to overgrowth, trip hazards and uneven ground conditions were discussed prior to advancing towards the monitoring wells. During the inspection, photographs were taken by the Argonne inspection team of the various monitoring wells, and the monuments at Site A and Plot M.

8.1 Red Gate Woods

Six dolomite wells, shown in Photographs P11-P16, were all locked and intact and in good condition with all well numbers on the outer casing. One of these wells is located near Plot M, and the remaining five are located north of Plot M in the Red Gate Woods area as shown in Figures 4.3 and 4.12 of the CY23 Annual Surveillance Report. The well cap of DH11 had been tagged with graffiti, in addition to a small amount of rust observed on the outer casing. Cited as an improvement opportunity (further discussed in Section 4.0 of this report), Argonne personnel will remove the graffiti from the well cap to DH11, in addition to removing the rust from the outer casing.

8.2 Plot M

All but two groundwater wells at Plot M were locked and intact and found to be in good condition. The well caps to both groundwater monitoring wells BH04 and BH35 were missing, having been sheared off by heavy equipment utilized by the Forest Preserves of Cook County to mitigate invasive plants. This was cited as two separate issues, and further discussed in Section 4.0 of this report. Prior to the time of the inspection, Argonne personnel were able to place

temporary protective covers onto wells BH04 and BH35. Photographs P01 through P08 show the various monitoring wells at Plot M.

During the time of the inspection, Plot M surface water flow was nonexistent from the four sampling locations along the two stream beds that flow around Plot M, shown in Figure 4.1 of the CY2023 Surveillance report. Location 1 is upstream of the Plot M area. Locations 6, 7, and 8 are immediately north and downstream of Plot M.

The Plot M monument was replaced in May 2021. Several letters had been chiseled off the old, pre-2021 replacement monument by vandals as reported several years ago. Photographs P19 and P20 show the new monument at Plot M; it remains in good condition. All six corner markers of Plot M were located during the inspection and found to be in good condition. Erosion controls have been reasonably effective with the addition of four additional landscape timbers installed in 2020 along the north trail. Argonne conducts quarterly maintenance reviews of the cap and north trail. Photograph P19 shows one of the Plot M corner markers in the foreground, with the terraced steps along the eastern slope of Plot M in the background.

8.3 Site A

The locations of the two groundwater wells at Site A are shown in Figure 4.10 of the CY23 Annual Surveillance Report. Both wells, BH55 and BH56, were found to be locked and intact and in good condition, with the well numbers visible on the outer casing. Upon removal of the well cap to BH56, what appeared to be the early stages of an ant infestation was observed within this well. Noted as an improvement opportunity, and further discussed in Section 4.0 of this report, Argonne personnel will return to apply an ant bait trap to well BH56. Photographs P09 and P10 show the two monitoring wells, BH55 and BH56, respectively, at Site A.

The Site A monument was replaced in May 2021. Photographs P21 and P22 show the new monument at Site A; it remains in good condition.

Site A/Plot M 2024 Annual Inspection

Tuesday, April 30, 2024. Commence at 0900 hours at Red Gate Woods Parking Lot.



Figure 8-1 Site A/Plot M 2024 Annual Field Attendance Sheet, Page 1

Sign-In Sheet

Name	Organization
GERALD BAUDIN ^D	Argonne
STEPHEN PITTON	DOE-LM
KEVIN NEARY	EPRI
John Pellegrino	FPOL
Sam Pirmaselli	FPCC
Cheryl Head	ICMA-OHS
Heath Green	ICMA-OHS
Kelly Grogan	ICMA-OHS
Steven Miller	Argonne
Collin Klimet	Argonne
Dee VaneK	Argonne

Figure 8-2 Site A Plot M 2024 Annual Field Attendance Sheet, Page 2

9.0 INSPECTION ISSUES, IMPROVEMENT OPPORTUNITIES, AND CORRECTIVE ACTIONS

1. **Issue #1:** The well cap to groundwater monitoring well BH04 was missing, having been sheared off by heavy equipment utilized by the Forest Preserves of Cook County to mitigate invasive plants.

Corrective Action: Argonne personnel procured the materials necessary to repair the well cap to BH04 and permanent repairs were performed on May 15, 2024.

2. **Issue #2:** The well cap to groundwater monitoring well BH35 was missing, having been sheared off by heavy equipment utilized by the Forest Preserves of Cook County to mitigate invasive plants.

Corrective Action: At the time of the inspection, Argonne personnel were able to place a temporary protective cover onto well BH35. Argonne personnel procured the materials necessary to repair the well cap to BH35 and permanent repairs were performed on May 15, 2024.

3. **Improvement Opportunity #1:** The well cap of DH11 had been tagged with graffiti, in addition to a small amount of rust observed on the outer casing.

Corrective Action: Argonne personnel will remove the graffiti from the well cap to DH11, in addition to removing the rust from the outer casing.

4. **Improvement Opportunity #2:** Upon removal of the well cap to BH56, what appeared to be the early stages of an ant infestation was observed within this well.

Corrective Action: Argonne personnel will apply an ant bait trap to well BH56.

The results of the CY2024 annual inspection cited two issues and two improvement opportunities, as noted above. The inspection results will be entered into the PRISM database, Argonne's online management tool for tracking and trending issues, opportunities for improvement, assessments, inspections, and tracked to completion.

10.0 INSPECTION PHOTOGRAPHS

Photograph Number	Photograph Location and Description. <i>Photos were taken at the time of the inspection.</i>
P01	Monitoring Well BH02 at Plot M
P02	Monitoring Well BH03 at Plot M
P03	Monitoring Well BH06 at Plot M
P04	Monitoring Well BH09 at Plot M
P05	Monitoring Well BH10 at Plot M
P06	Monitoring Well BH11 at Plot M
P07	Monitoring Well BH26 at Plot M
P08	Monitoring Wells BH04 and BH35 with Temporary Well Caps at Plot M
P09	Monitoring Well BH55 at Site A
P10	Monitoring Well BH56 at Site A
P11	Monitoring Well DH03 at Red Gate Woods
P12	Monitoring Well DH04 at Red Gate Woods
P13	Monitoring Well DH11 at Red Gate Woods, Displaying Graffiti on Well Cap
P14	Monitoring Well DH12 at Red Gate Woods
P15	Monitoring Well DH14 at Red Gate Woods
P16	Monitoring Well DH15 at Red Gate Woods
P17	Picnic Well 5160 at Red Gate Woods
P18	Plot M Corner Marker in Foreground, Eastern Slope Terraced Steps in Background
P19	Plot M Monument, Rear View
P20	Plot M Monument, Front View
P21	Site A Monument, Rear View
P22	Site A Monument, Front View



P01 - Monitoring Well BH02 at Plot M



P02 – Monitoring Well BH03 at Plot M



P03 – Monitoring Well BH06 at Plot M



P04 - Monitoring Well BH09 at Plot M



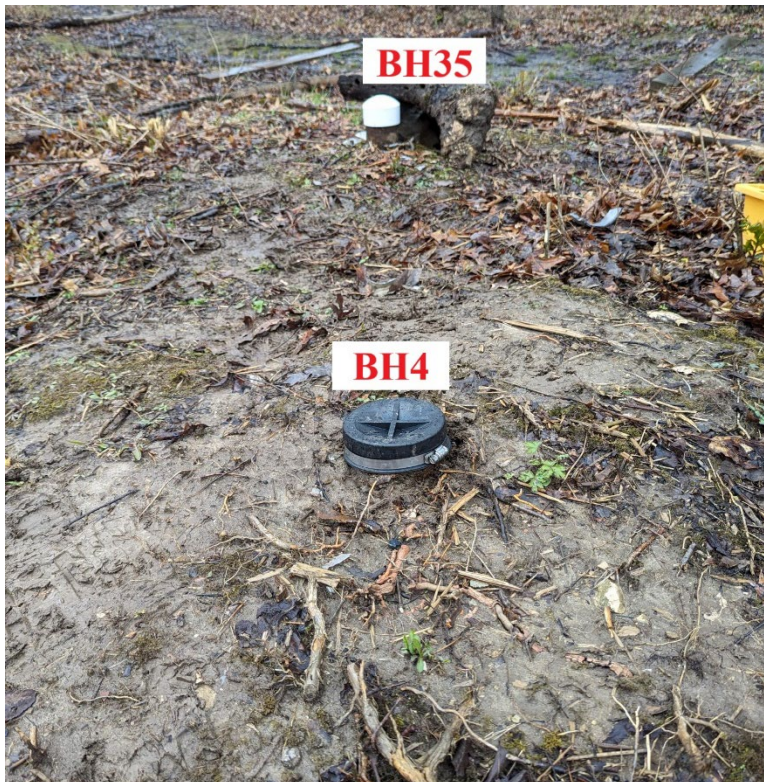
P05 – Monitoring Well BH10 at Plot M



P06- Monitoring Well BH11A at Plot M



P07 - Monitoring Well BH26 at Plot M



P08 – Monitoring Wells BH04 and BH35 with Temporary Well Caps at Plot M



P9 – Monitoring Well BH55 at Site A



P10 – Monitoring Well BH56 at Site A



P11 - Monitoring Well DH03 at Red Gate Woods



P12 - Monitoring Well DH04 at Red Gate Woods



P13 – Monitoring Well DH11 at Red Gate Woods, Displaying Graffiti on Well Cap



P14 – Monitoring Well DH12 at Red Gate Woods



P15 – Monitoring Well DH14 at Red Gate Woods



P16 – Monitoring Well DH15 at Red Gate Woods



P17 – Picnic Well 5160 at Red Gate Woods



P18 – Plot M Corner Marker in Foreground, Eastern Slope Terraced Steps in Background



P19 – Plot M Monument, Rear View



P20 – Plot M Monument, Front View



P21 – Site A Monument, Rear View



P22 – Site A Monument, Front View

11.0 REFERENCES

1. Golchert, N. W. and Sedlet, J., Formerly Utilized MED/AEC Sites Remedial Action Program - Radiological Survey of Site A, Palos Park Forest Preserve, Chicago, Illinois, U. S. Department of Energy Report DOE/EV-0005/7 (April 1978).
2. Golchert, N. W., Sedlet, J., and Hayes, K. A., Environmental Surveillance of the Palos Park Forest Preserve, Argonne National Laboratory Report ANL-83-6 (January 1983).
3. Golchert, N. W. and Sedlet, J., Site Surveillance and Maintenance Program for Palos Park - Report for 1982, Argonne National Laboratory (available from the authors) (April 1984).
4. Golchert, N. W. and Sedlet, J., Site Surveillance and Maintenance Program for Palos Park - Report for 1983, Argonne National Laboratory (available from the authors) (June 1984).
5. Golchert, N. W. and Sedlet, J., Site Surveillance and Maintenance Program for Palos Park - Report for 1984, Argonne National Laboratory (available from the authors) (April 1985).
6. Golchert, N. W. and Sedlet, J., Site Surveillance and Maintenance Program for Palos Park - Report for 1985, Argonne National Laboratory Report ANL-86-25 (April 1986).
7. Golchert, N. W., Site Surveillance and Maintenance Program for Palos Park - Report for 1986, Argonne National Laboratory Report ANL-87-8 (April 1987).
8. Golchert, N. W., Site Surveillance and Maintenance Program for Palos Park - Report for 1987, Argonne National Laboratory Report ANL-88-12 (April 1988).
9. Golchert, N. W., Site Surveillance and Maintenance Program for Palos Park - Report for 1988, Argonne National Laboratory Report ANL-89/7 (April 1989).
10. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1989, Argonne National Laboratory Report ANL-90/7 (April 1990).
11. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1990, Argonne National Laboratory Report ANL-91/2 (May 1991).
12. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1991, Argonne National Laboratory Report ANL-92/13 (May 1992).
13. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1992, Argonne National Laboratory Report ANL-93/4 (May 1993).
14. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1993, Argonne National Laboratory Report ANL-94/9 (May 1994).
15. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1994, Argonne National Laboratory Report ANL-95/7 (May 1995).

16. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1995, Argonne National Laboratory Report ANL-96/2 (June 1996).
17. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1996, Argonne National Laboratory Report ANL-97/5 (May 1997).
18. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1997, Argonne National Laboratory Report ANL-98/1 (May 1998).
19. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1998, Argonne National Laboratory Report ANL-99/2 (May 1999).
20. Golchert, N. W., Surveillance of Site A and Plot M - Report for 1999, Argonne National Laboratory Report ANL-00/3 (May 2000).
21. Golchert, N. W., Surveillance of Site A and Plot M - Report for 2000, Argonne National Laboratory Report ANL-01/1 (May 2001).
22. Golchert, N. W., Surveillance of Site A and Plot M - Report for 2001, Argonne National Laboratory Report ANL-02/1 (May 2002).
23. Golchert, N. W., Surveillance of Site A and Plot M - Report for 2002, Argonne National Laboratory Report ANL-03/1 (May 2003).
24. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2003, Argonne National Laboratory Report ANL-04/1 (May 2004).
25. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2004, Argonne National Laboratory Report ANL-05/01 (April 2005).
26. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2005, Argonne National Laboratory Report ANL-06/01 (April 2006).
27. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2006, Argonne National Laboratory Report ANL-07/01 (April 2007).
28. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2007, Argonne National Laboratory Report ANL-08/04 (March 2008).
29. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2008, Argonne National Laboratory Report ANL-09/01 (April 2009).
30. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2009, Argonne National Laboratory Report ANL-10/01 (April 2010).
31. Golchert, N. W., Surveillance of Site A and Plot M – Report for 2010, Argonne National Laboratory Report ANL-11/01 (May 2011).

32. Golchert, N. W. and Moos, L.P., Surveillance of Site A and Plot M – Report for 2011, Argonne National Laboratory Report ANL-12/01 (June 2012).
33. Moos, L.P., Surveillance of Site A and Plot M – Report for 2012, Argonne National Laboratory Report ANL-13/01 (June 2013).
34. Moos, L.P., Surveillance of Site A and Plot M – Report for 2013, Argonne National Laboratory Report ANL-14/01 (June 2014).
35. Moos, L.P., Surveillance of Site A and Plot M – Report for 2014, Argonne National Laboratory Report ANL-15/01 (June 2015).
36. Moos, L.P., Surveillance of Site A and Plot M – Report for 2015, Argonne National Laboratory Report ANL-16/01 (June 2016).
37. U. S. Department of Energy Office of Legacy Management, “Long-Term Surveillance and Maintenance Plan for Site A and Plot M, Palos Forest Preserve, Cook County, Illinois”, LMS/SAM/S01063-1.0, January 2015
38. U. S. Department of Energy Office of Legacy Management, “Groundwater and Surface Water Monitoring Activities at Site A and Plot M”, LMS/SAM/S07581, March 2011.
39. U. S. Department of Energy Office of Legacy Management, “Supplemental Assessment: Groundwater and Surface Water Monitoring Activities at Site A and Plot M”, 2014.
40. U. S. Department of Energy, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," DOE/EH-0173T, January 1991.
41. Nicholas, J. R. and Healy, R. W., "Hydrogen-3 Migration from a Low-Level Radioactive-Waste Disposal Site Near Chicago, Illinois," U. S. Geological Survey Water-Supply Paper 2333, 1988.
42. International Technology Corporation, “Tritium Migration and Hydrogeological Studies in the Vicinity of Plot M Palos Forest Preserve”, August 1994.
43. U. S. Department of Energy, "Radiation Protection of the Public and the Environment," DOE O 458.1, Change 2, June 6, 2011.
44. U. S. Environmental Protection Agency, "National Primary Drinking Water Regulations," 40 CFR Part 141.
45. U. S. Department of Energy, "Derived Concentration Technical Standard," DOE-STD-1196-2011, April 2011.
46. International Commission on Radiological Protection, "Reference Man: Anatomical, Physiological, and Metabolic Characteristics," ICRP Publication 23, Pergamon Press, New York, NY (1975).

47. Committee on Biological Effects of Ionizing Radiation, Health Effects on Populations of Exposure to Low Levels of Ionizing Radiation - BEIR V Report, National Academy Press, Washington, 1990.
48. National Council on Radiation Protection and Measurements, Ionizing Radiation Exposure of the Population of the United States, NCRP Report No. 160, August 20, 2009.
49. U. S. Environmental Protection Agency, 1986, RCRA Ground Water Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, Office of Solid Waste and Emergency Response, Washington, DC.
50. Piorkowski, R.E., Surveillance of Site A and Plot M – Report for 2016, Argonne National Laboratory Report ANL-17/01 (August 2017).
51. Piorkowski, R.E., Surveillance of Site A and Plot M – Report for 2017, Argonne National Laboratory Report ANL-18/01 (June 2018).
52. Piorkowski, R.E., Surveillance of Site A and Plot M – Report for 2018, Argonne National Laboratory Report ANL-19/01 (August 2019).
53. Piorkowski, R.E., Surveillance of Site A and Plot M – Report for 2019, Argonne National Laboratory Report ANL-20/02 (August 2020).
54. Piorkowski, R.E., Surveillance of Site A and Plot M – Report for 2020, Argonne National Laboratory Report ANL-21/01 (September 2021).
55. Baudino, G., Surveillance of Site A and Plot M – Report for 2021, Argonne National Laboratory Report ANL-22/01 (September 2022).
56. Klimek, C., Surveillance of Site A and Plot M – Report for 2022, Argonne National Laboratory Report ANL-23/01 (September 2023)

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