LMS/HAL/44877

2023 Annual Inspection and Status Report for the Hallam, Nebraska, Decommissioned Reactor Site

July 2023

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
IHX	intermediate heat exchanger
LM	Office of Legacy Management
LMS	Legacy Management Support
NHHS	Nebraska Health and Human Services
NPPD	Nebraska Public Power District
pCi/L	picocuries per liter

Executive Summary

The former Hallam Nuclear Power Facility (now the Hallam, Nebraska, Decommissioned Reactor Site) was inspected on April 11, 2023. No changes were observed on the Intermediate Heat Exchanger Building atop the entombment or the grass-covered decommissioned reactor infrastructure. The groundwater monitoring wells remain secured and uncompromised. No cause for a follow-up inspection was identified.

The U.S. Department of Energy Office of Legacy Management (LM) monitors groundwater as a best management practice in response to a request from Nebraska Health and Human Services. The 2021 sampling results continue to trend within the historical range for the site. A new high gross beta radiation activity was measured for the shallow series wells, but it is within the historical range for the site when deeper wells are considered. Results are posted on the site-specific LM webpage (https://www.energy.gov/lm/hallam-nebraska-decommissioned-reactor-site). Sampling events occur every 5 years (next samplings are in 2026 and 2031), after which they will occur three more times at 10-year intervals (2041, 2051, and 2061). If the data continue to trend within the site's historical range, groundwater monitoring will end in fiscal year 2062 with a Final Program Closeout Report.

1.0 Introduction

This report presents the findings of the annual U.S. Department of Energy (DOE) Office of Legacy Management (LM) inspection of the Hallam, Nebraska, Decommissioned Reactor Site, which was conducted on April 11, 2023. Features discussed in this report are shown in Appendix A. Photographs to support specific observations are identified in the text and on the site drawing (Appendix A) by photograph location numbers.

The Legacy Management Support (LMS) contractor, RSI EnTech, LLC, conducted the inspection, which was led by M. Miller, LMS site lead. The LM site manager, A. Keim, accompanied the LMS contractor on the inspection. Representatives from Nebraska Health and Human Services (NHHS) declined the invitation to join the 2023 annual inspection. A representative of the Nebraska Public Power District (NPPD) escorted the inspection team.

The inspection was conducted in accordance with the *Long-Term Surveillance Plan for the Hallam, Nebraska, Decommissioned Reactor Site* (LMS/HAL/S03478) and LMS procedures for site inspections. The inspection was conducted to (1) confirm the integrity of the Intermediate Heat Exchanger (IHX) Building, (2) assess the condition of the grass cover on the decommissioned reactor structure, and (3) examine the condition of LM-owned monitoring wells and sprinkler system. Also during the inspection, discussions were held with a Sheldon Station representative about any changed conditions at the plant. The Sheldon Station is an active, coal-fired power plant owned and operated by NPPD.

2.0 Inspection Results

The Hallam site has the following features:

- IHX cells entombed in a waterproofed, above-grade, concrete building (the IHX Building).
- A massive below-grade, reinforced concrete structure that was the foundation of the former reactor. The cover of this structure—a waterproof membrane, soil, and grass—is called "the grass-covered mound." Fixed radioactive materials remain at three principal locations inside this structure.
- Nineteen groundwater monitoring wells (OBS-1A, OBS-1B, OBS-2A, OBS-2B, OBS-2B2, OBS-2C2, OBS-3A, OBS-3B, OBS-4A, OBS-4B, OBS-4C, OBS-5A, OBS-5B, OBS-6A, OBS-6B, OBS-7B, OBS-7C, OBS-8B, and OBS-8C).

The IHX Building, the below-grade concrete structure, and the groundwater monitoring wells are at Sheldon Station.

2.1 IHX Building

The IHX Building is a massive 40 × 80-foot concrete sarcophagus at the north end of the former Hallam Nuclear Power Facility. The south side of the building is two stories tall (about 25–30 feet high) with a slightly crowned roof, and the north side of the building is one story with a roof that is sloped to drain. Inspectors viewed the roof of the IHX Building from the roof of Sheldon Station to the north.

The roof of the IHX Building was replaced in 2007. The entire roof is capped with a layer of rock material that protects the underlying roofing fabric. Inspectors noted in 2008 that roof rock was missing in the northwest and southwest corners of the crowned roof, exposing the underlying fabric. Strong winds are believed to be the cause of the missing stones. Paver stones were placed in all corners of the roof in 2009 to correct the problem. No changes were observed on the roof of the IHX Building during the 2023 inspection. No bare spots were observed (Photo 1).

Photo 1. Roof of IHX Building

In 2009, soil and gravel were placed in a shallow, narrow depression in the ground around the base of the IHX Building that trapped water against the base. With the depression filled, water now drains away from the building base. The perimeter slope around the IHX Building was in good condition during the inspection. In addition, the site marker attached to the IHX Building continues to be in excellent condition (Photo 2).

Photo 2. Site Inspectors Aside Site Marker Located on Side of IHX Building

During the 2023 inspection, several existing surface cracks continued to be observed on the walls of the IHX Building. The cracks do not appear to compromise the structure. No corrective action is recommended at this time to address the cracks. They will be inspected each year to visually assess whether they are adversely affecting the protectiveness of the building.

2.2 Buried Concrete Structure (Former Reactor Foundation)

The old reactor foundation is buried beneath the 1.4-acre flat-topped grass-covered mound immediately south of the IHX Building. Inspectors verified that erosion is not developing on the mound. Mound grass was well-established and in good condition with the exception of several brown areas given the inspection was conducted early in the season (Photo 3).

Photo 3. Condition of the Mound Grass

Prior to the 2023 inspection, Sheldon Station staff replaced sprinkler heads on the DOE-owned sprinkler system. LM conveyed to the Sheldon Station supervisor that it plans to obtain a local subcontractor to conduct preventive maintenance on the sprinkler system to alleviate the maintenance burden on Sheldon Station staff and so that the system is fully operational for the 2024 growing season.

2.3 Groundwater Monitoring Wells

During the inspection, all 19 onsite monitoring wells were inspected and found to be properly secured. The successful conversion to flush-mount monitoring wells was well received by Sheldon Station staff as a proactive improvement by DOE to lessen the traffic pattern burdens (Photo 4 and Photo 5, respectively).

Photo 4. Flush-Mount Monitoring Wells OBS-2A, OBS-2B, OBS-2B2, and OBS-2C2

Photo 5. Flush-Mount Monitoring Wells OBS-7B and OBS-7C

Similar to what was discovered during the 2022 inspection, the outer casing of the monitoring wells needs to be repainted because of weathering and rusting. This will be addressed during the 2026 sampling event (Photo 6).

Photo 6. Example of Monitoring Wells' Outer Casing Requiring Repainting

2.4 Groundwater Monitoring Program

A surveillance and monitoring program was initiated in 1970 by NHHS and funded by the U.S. Atomic Energy Commission, the predecessor to DOE. It included the analysis of samples from deep production wells at Sheldon Station (groundwater from the regional aquifer at depths greater than 180 feet). In 1990, NHHS was concerned about the possibility of shallow groundwater contacting the buried radiological materials along the underground reactor walls. Subsequently, DOE and NHHS agreed to further characterize hydrologic conditions and establish a monitoring program in the shallow, perched groundwater zones. LM therefore monitors shallow, perched groundwater as a best management practice in response to a request from NHHS.

In 2006, LM issued a groundwater monitoring assessment that recommended discontinuing groundwater monitoring because analytical results since 1970 demonstrated no impact to shallow, perched groundwater and no current or anticipated unacceptable risk to human health and the environment. The State of Nebraska did not concur with the recommendation to stop monitoring but did agree to reduce sampling and analysis from once a year to once every 2 years. That schedule began in 2008.

In 2016, LM issued a second groundwater monitoring assessment. It reported that the entire dataset of water quality continued to demonstrate no negative impacts to the shallow, perched groundwater from radioactive materials entombed at the site since 1969 (DOE 2016). Specifically, the assessment showed that:

- Gross alpha and beta radiation activities were the only parameters detected at statistically significant concentrations.
- Gross alpha radiation activities between 2007 and 2016 were consistent with previously reported values and were attributed to naturally occurring radionuclides (e.g., uranium and uranium decay chain products) in groundwater.
- All nickel-63 and tritium radiation results between 2007 and 2016 qualified as nondetects.
- Water quality data between 2007 and 2016 demonstrated no negative impacts on the perched groundwater from the radioactive materials entombed at the site.
- There were no negative impacts on the perched groundwater during periods of relative drought and when the annual average precipitation was above normal.

Based on the 2016 assessment, LM changed the sampling frequency. The new schedule took effect in 2018, requiring sampling once every 5 years from 2021 to 2041 and once every 10 years from 2041 to 2061. The next groundwater sampling event is scheduled to occur in fiscal year 2026.

Groundwater samples were last collected in June 2021 in accordance with the *Long-Term Surveillance Plan for the Hallam, Nebraska, Decommissioned Reactor Site*. Water levels were measured in 16 of 19 monitoring wells, and those wells were sampled for gross alpha and gross beta radiation, tritium radiation, gamma spectrometry, nickel-63 radiation, and uranium radiation. Monitoring wells 6A and 6B were not sampled in 2021 due to slow recovery rates. Monitoring well 7B was not sampled in 2021 because its lock could not be removed. The 2021 sampling results continue to trend within the historical range for the site and are posted on the site-specific LM webpage (https://www.energy.gov/lm/hallam-nebraska-decommissioned-reactor-site). A brief summary is provided below.

2.4.1 Gross Alpha Radiation

Gross alpha radiation activity measurements for 2021 are consistent with measurements reported previously and are attributed to naturally occurring radionuclides, such as uranium and its decay chain products in the groundwater. Table 1 provides a summary of gross alpha radiation activity from testing performed from 2007 to 2016, supplemented with 2021 activities. The first seven of eight columns in Table 1 come directly from Table 2 of the 2016 assessment (DOE 2016). The far-right column shows results from 2021. As shown in column 5, the maximum measured gross alpha radiation activity in samples tested between 2007 and 2016 was 22.1 picocuries per liter (pCi/L) in monitoring well 2B. The maximum measured gross alpha radiation activity from 2021 was 22.2 pCi/L in monitoring well 2B.

Table 1. Summary of Results for Gross Alpha Radiation Activity from 2007–2016 and the 2021 Sampling Results

Well ID	No. of Samples	No. of Nondetects	Percentage of Nondetects	Maximum Detected Value (pCi/L)	2-Sigma Uncertainty (pCi/L)	Year of Maximum Detected Value	2021 Result (pCi/L)
1A	9	4	44	3.70	1.3	2012	**4.04**
1B	6	1	17	11.6	2.26	2007	**4.59**
2A	6	1	17	12.7	2.55	2007	**8.55**
2B	6	1	17	**22.1**	4.3	2010	**22.2**[a]
2B2	6	1	17	10.7	2.38	2007	**2.4**
2C2	6	1	17	5.92	1.6	2016	**3.64**
3A	6	1	17	17.5	10.1	2016	**14.3**
3B	7	2	29	12.8	2.85	2007	**5.45**
4A	6	1	17	6.95	2.2	2012	**4.29**
4B	6	1	17	16.9	3.2	2007	**11.6**
4C	6	1	17	20.3	4.0	2010	**17.0**
5A	6	1	17	7.44	1.59	2007	**5.1**
5B	6	0	0	19.8	3.4	2010	**12.1**
7B	6	1	17	7.2	1.59	2007	**ns**
7C	6	1	17	8.34	1.8	2010	**4.96**
8B	6	1	17	9.23	2.1	2014	**6.44**
8C	6	1	17	7.85	1.78	2007	**10.3**

Note:
[a] The 2021 result was above the high of 22.1 pCi/L (in bold font as the Maximum Detected Value) measured from testing performed from 2007 through 2016.

Abbreviation:
ns = not significant

Figure 1 is a graph of gross alpha radiation activities (from 1998 to 2021) for the shallowest wells (A-series wells). It illustrates that gross alpha radiation activities measured in 2021 are consistent with previous activities, and all gross alpha radiation activities measured in 2021 were below the U.S. Environmental Protection Agency (EPA) standard for gross alpha-particle radiation activity (excluding radon and uranium) of 15 pCi/L. The maximum gross alpha radiation activity recorded for 2021 in the shallow series wells was 14.3 pCi/L in monitoring well 3A.

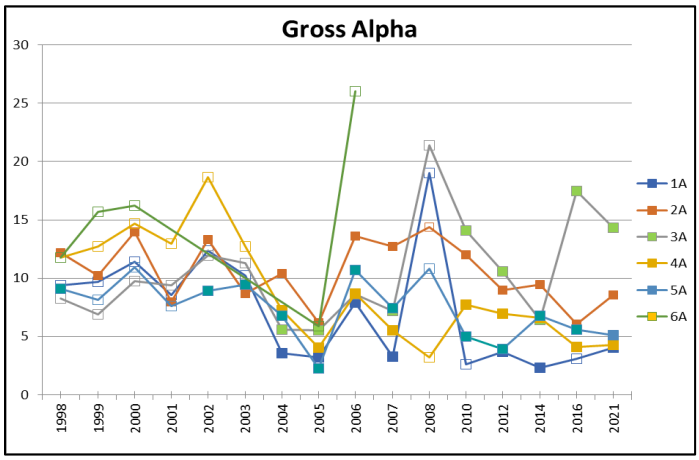


Figure 1. Hallam Site Gross Alpha Radiation Activities (1998–2021)

2.4.2 Uranium Radiation

In 2006, LM demonstrated that the gross alpha radiation exceedances of the EPA standard of 15 pCi/L could be attributed to naturally occurring radionuclides (e.g., uranium and uranium decay chain products) in the groundwater (DOE 2006). LM added the analysis of total uranium (beginning in 2021) to provide data for site background levels should exceedances occur again. Because there were no gross alpha radiation exceedances in 2021, there is no need to demonstrate that naturally occurring radionuclides (e.g., uranium, uranium decay chain products) were contributors to the 2021 gross alpha radiation results. The 2021 results for uranium appear in Table 2.

Table 2. Uranium Radiation Results from 2021

Monitoring Wells	Results (mg/L)
1A	0.0048
1B	0.014
2A	0.0048
2A (duplicate)	0.017
2B	0.04
2B2	0.019
2C2	0.0038
3A	0.023
3B	0.011
4A	0.012
4B	0.027
4C	0.034
5A	0.011
5B	0.036
6A	Not sampled
6B	Not sampled
7B	Not sampled
7C	0.016
8B	0.015
8C	0.017

Abbreviation:
mg/L = milligrams per liter

2.4.3 Gross Beta Radiation

Expanding on the 2016 assessment, Table 3 provides a summary of gross beta radiation activities from 2007 through 2016 and also 2021 activities (DOE 2016). The first seven of eight columns in Table 3 are directly from Table 3 of the 2016 assessment. The far right column shows results from 2021. As shown in column 5, the maximum high for 2007 through 2016 was 17.1 pCi/L in monitoring well 4C. The following two measurements from 2021 are above 17.1 pCi/L:

- Monitoring well 2B: 19.2 pCi/L
- Monitoring well 3A: 25 pCi/L

Table 3. Summary of Results for Gross Beta Radiation Activity from 2007–2016 and the 2021 Sampling Results

Well ID	No. of Samples	No. of Nondetects	Percentage of Nondetects	Maximum Detected Value (pCi/L)	2-Sigma Uncertainty (pCi/L)	Year of Maximum Detected Value	2021 Result (pCi/L)
1A	11	2	18	5.24	2.4	2016	**12.9**
1B	6	1	17	10.1	2.21	2007	**7.35**
2A	6	1	17	8.31	2.19	2007	**6.56**
2B	6	0	0	15.9	3.0	2014	**19.2**[a]
2B2	6	0	0	12.3	3.2	2007	**4**
2C2	6	0	0	7.39	2.1	2012	**4.68**
3A	6	2	33	15.4	4.3	2012	**25**[a]
3B	7	2	29	13.0	3.64	2007	**7.4**
4A	6	1	17	14.5	3.1	2016	**7.26**
4B	6	1	17	11.9	2.7	2014	**9.17**
4C	6	1	17	**17.1**	3.4	2012	**14.5**
5A	6	0	0	6.79	1.8	2010	**5.84**
5B	6	0	0	11.9	2.23	2007	**11**
7B	6	0	0	9.61	1.9	2014	**ns**
7C	6	1	17	7.44	1.53	2007	**5.14**
8B	6	1	17	8.65	1.7	2016	**7.73**
8C	6	0	0	8.50	2.2	2014	**12.0**

Note:
[a] The 2021 result was above the high of 17.1 pCi/L (in bold font as the Maximum Detected Value) measured from 2007 through 2016.

Abbreviation:
ns = not sampled

Figure 2 is a graph of gross beta radiation activities for the shallowest wells (A-series wells). It illustrates that gross beta radiation activities in 2021 are consistent with previous activities with the exception of monitoring well 3A.

Monitoring well 3A had a gross beta radiation activity of 25 pCi/L in 2021. The previous maximum for monitoring well 3A (15.4 pCi/L) was measured in 2012. The 2021 activity of 25 pCi/L is a new maximum gross beta radiation activity for the shallow, A-series wells but not for the deeper, B-series wells. In 2006, monitoring well 7B had a measured gross beta radiation activity of 26 pCi/L. Between 2007 and 2021, the gross beta radiation activity at monitoring well 7B decreased and remained at or below 9.61 pCi/L.

Because the gross beta radiation activity is not a new high for the site, and based on the variation in gross beta radiation activity measured in monitoring well 7B, continued monitoring of monitoring well 3A is recommended. If the gross beta radiation activity does not decrease and continues to increase to a new site maximum, LM will take additional appropriate steps to determine a cause.

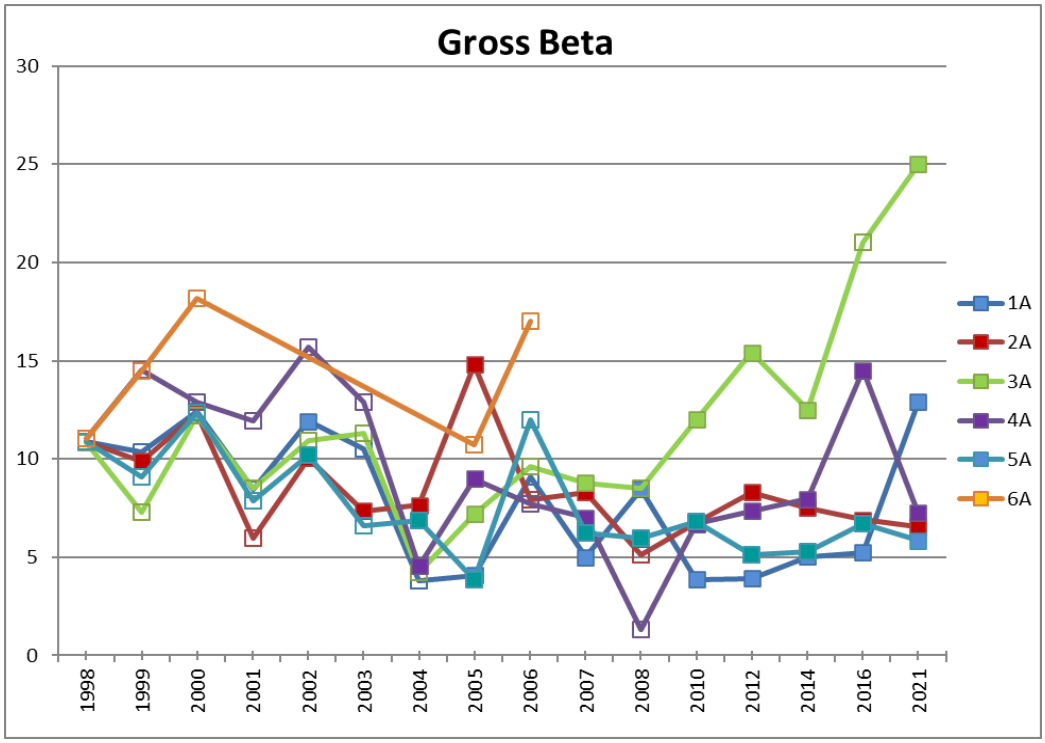


Figure 2. Hallam Site Gross Beta Radiation Activities (1998–2021)

2.4.4 Tritium Radiation

The following three detections for tritium radiation were reported in 2021:

- Monitoring well 4A, 141 pCi/L (method detection limit of 98 pCi/L)
- Monitoring well 4B, 118 pCi/L (method detection limit of 75 pCi/L)
- Monitoring well 2C2, 176 pCi/L (method detection limit of 97 pCi/L)

All three detections for tritium radiation are within the historical range (240–320 pCi/L) previously reported in Table 2 of the 2006 assessment (DOE 2006).

2.4.5 Water Elevations

Water levels were measured in 2021 and the results are provided in Figure 3. As shown in Figure 3, water levels were fairly steady from 1998 to 2008. Between 2008 and 2016, the elevations fluctuated. Water levels measured in 2021 indicate a return to the trend recorded before 2008. As reported in the 2016 assessment (DOE 2016), water elevation fluctuations between 2008 and 2015 are attributed to a large variation in precipitation during this period.

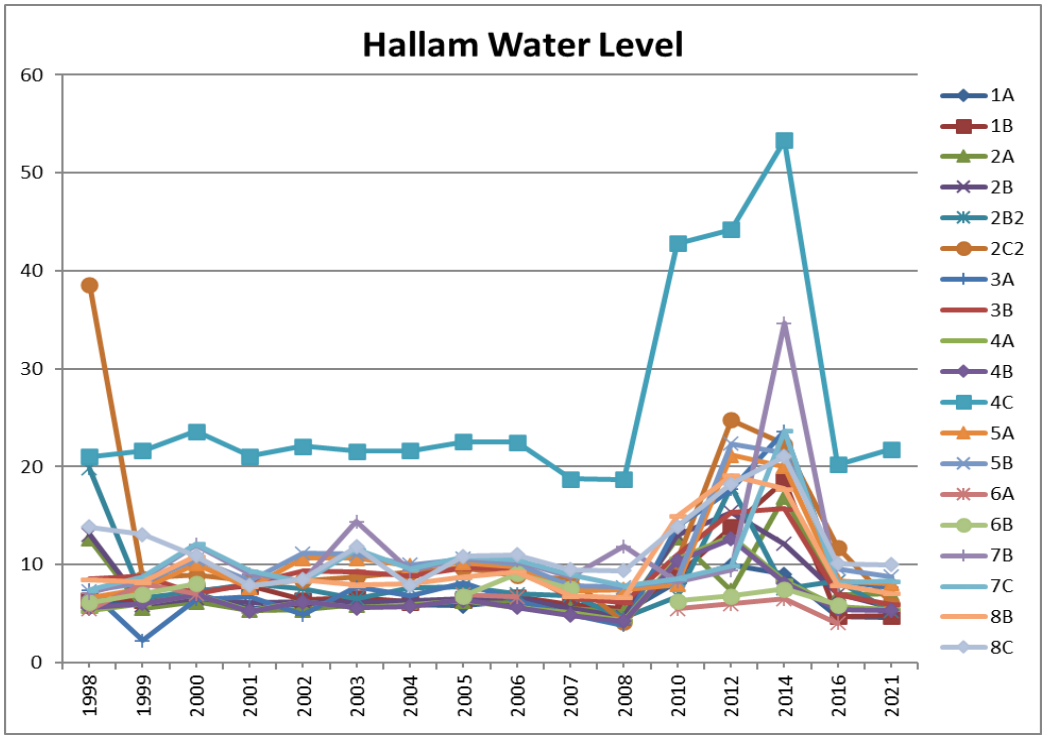


Figure 3. Hallam Site Water Levels 1998–2021

3.0 Minor Maintenance Actions

Sheldon Station personnel replaced malfunctioning sprinkler heads to make the system fully operational for the rest of 2023. LM conveyed to the Sheldon Station supervisor that a preventive maintenance subcontract would be put in place for the sprinkler system so that it remains operational for future seasons.

4.0 References

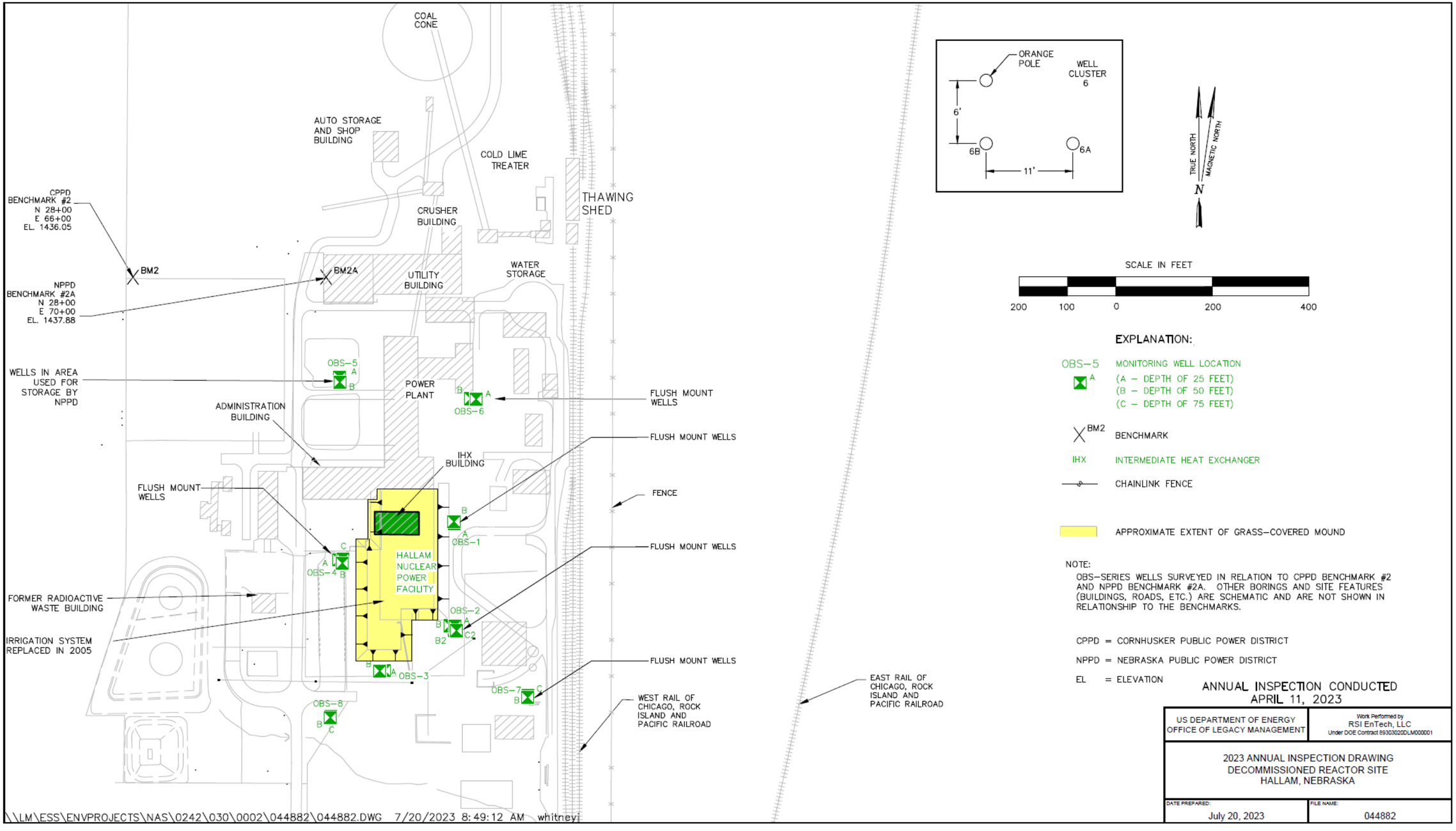
DOE (U.S. Department of Energy), 2006. *Summary of Ground Water Monitoring Results and Recommendation to Discontinue Monitoring at the Decommissioned Hallam Nuclear Power Facility, Hallam Nebraska*, DOE-LM/1319-2006, Office of Legacy Management, September.

DOE (U.S. Department of Energy), 2016. *Monitoring Assessment Report for the Decommissioned Hallam Nuclear Power Facility*, LMS/HAL/S14752, Office of Legacy Management, December.

Long-Term Surveillance Plan for the Hallam, Nebraska, Decommissioned Reactor Site, LMS/HAL/S03478, continually updated, prepared by the LMS contractor for the U.S. Department of Energy Office of Legacy Management.

Appendix A

Site Drawing



Site Drawing of Hallam, Nebraska, Decommissioned Reactor Site