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Environmental Programs Group

Environmental Monitoring Summary
Entombed Hallam Nuclear Power Facility

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James D. Paulson
Project Manager
(630) 252-2770

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Environmental Monitoring Summary
Hallam Nuclear Power Facility

1) Introduction

In response to a meeting between the DOE Chicago and the DOE Grand Junction Office (GPO) in January, 1998, it was agreed that a summary of the environmental monitoring program for the Hallam Nuclear Power Facility (HNPF) be prepared. The summary would provide a brief synopsis of the program, to date, and assist in the transition of the project to the GPO. It was also decided that CH should complete the entry of key documents into the records management system, and that it would be beneficial in future discussions.

1.1) Location

The HNPF is located in Lancaster County in southeastern Nebraska. It is approximately 20 miles (32 kilometers) south of Lincoln, near the town of Hallam, which is about 1.5 miles to the south of the site. The reactor is entombed and immediately adjacent to the operating Sheldon Power Station, a coal fired plant, which is located on 640 acre site.

1.2) History of the Demonstration Reactor

The history of this reactor project has been described by Smith(1967) and ORISE (1994a, 1994b) and is provided here as background information. The HNPF was sodium cooled, graphite moderated reactor. Testing o n the reactor began in August 1961, however, the reactor began to experience failure of its moderator elements in February, 1964. By September, 1964, the reactor had to be shutdown. In August, 1965, the Atomic Energy Commission (AEC) announced that the AEC-Consumer Public Power District (CPPD) contract would be terminated due to technical problems associated with the reactor core. In June of 1966,the AEC announced that HNPF would be decommissioned as a result of moderator can failures inside the reactor facility (Smith, 1967).

Subsequently, the facility was dismantled and decontaminated, with the exception of three storage areas which contain radioactive components used during the plants' reactor former operation. These storage areas are located near the center of the reactor entombment. The first area includes the reactor vessel and internals, reactor outer vessel, cavity liner, loading face shield, and biological shielding, the second area consists of 85 thimbles (high level radioactivity), and the third area consists of 12 moderator storage cells (ORISE, 1994a and 1994b).

The balance of the isolation structure consists of storage pits, vaults, pipeways, and the maintenance cell. Although these areas were not used for the storage of high level radioactive or contaminated components, some items of low-level radioactivity were included in the items placed for storage or left in place in these areas prior to the sealing of the isolation structure. All nuclear fuel was removed from the site and all of the residual sodium remaining in the secondary sodium system was reacted in the HNPF steam cleaning facility. The isolation structure was then sealed by placing suitable closures in all penetrations and the radiation and radioactive contamination levels at all accessible portions of the plants were measured and determined to be within the limits set forth in 10 CFR 20 for unrestricted areas. No radiation levels, radioactive materilas, or radioactive contamination in excess of these limits remained outside the isolation structure (Heine, 1969).

2) **Early Environmental Monitoring Program**

The HNPF, an entombed research reactor located in Hallam, Nebraska, has been monitored by the U.S. Department of Energy's Chicago Operations Office for several years. After the reactor was entombed, the DOE and its predecessor organizations, conducted environmental surveillance and sampling activites by contracting with the Nebraska Department of Health (NDH), Radiological Health Division. Those activities consisted of collecting grab water samples from several deep water supply wells that were owned by the Nebraska Public Power District (NPPD), and performing a radiological survey over the buried structure. The NPPD owns and operates the Sheldon Power

Station which is immediately adjacent to the entombed nuclear reactor. NPPD, therefore owns the property that includes the HNPF. The same monitoring approach was followed year after year until September of 1991, when it was agreed to transition the monitoring program to address NDH concerns over potential impacts to shallow groundwater. Their concerns reflected the possibility that groundwater surrounding the entombed reactor might leach some radiological contaminants from the buried structure, which might be detectable through the sampling of the deep groundwater.

3) **Concerns About Shallow Groundwater**

The NDH began having concerns about shallow groundwater with respect the HNPF around the 1990 timeframe. Because, they felt that there was a possibility of groundwater coming in contact with some radiological materials along the buried walls of the reactor. Part of the reason they had concerns is that a 1963 study by the U.S. Geological Survey (Keech) indicated that there was a near surface loess (silty soil) layer that was shown to extend in the area of the Sheldon Power Station and HNPF. It was NDH's desire that the DOE investigate the glacial deposits surrounding buried reactor so that soils could be collected and tested. At first there were there urgings by the NDH that DOE perform many soil borings in a series of concentric circles around the entombed reactor. This eventually led to a compromise in the Fall of 1991 with NDH, where DOE in response proposed installation of multiple wells to investigate shallow groundwater.

4) **Initial Soil Study by Oak Ridge Associated University**

After some negotiations, DOE agreed to perform a limited soil investigation in the Summer of 1990, and soils were collected and tested from borings. That investigation was conducted by Oak Ridge Associated Universities and was focused on recovery of soils for laboratory analysis. The radiological testing did not indicate the presence of contaminants in soil. A report detailing these findings was submitted to DOE in 1991.

5) **License Agreement with NPPD**

In April of 1993, the DOE CH office reached agreement with the Nebraska Public Power District to establish a license for DOE to access the HNPF for site characterization work. Previously, DOE's environmental monitoring was non-intrusive in nature as it was limited to collecting grab water samples and performing a walk-over radiological survey. This document was obtained to authorize DOE to conduct a field investigation with drilling and sampling of soil and groundwater, handling of drilling spoils and providing safety personnel on the NPPD property. The inital agreement was limited to field work specified in a DOE work plan dated March 26, 1993. Later DOE modified the agreement to allow another investigation in 1995 and for annual monitoring work through 2000.

6) **Groundwater Investigations**

After further discussions with NDH, the DOE began in 1992 to search and review all available site characteristization records for the Sheldon Power Station and the HNPF. Through the help of the NPPD, the DOE was able to retrieve: 1) geotechnical reports for various plant improvement projects, 2) various drawings related to the Sheldon Power Station, and 3) other reports pertaining to the site. All of that historical information was then utilized to plan a field investigation. The pre-existing geotechnical data that was reviewed showed that the original surface soils at the site had been modified, and that an old ridge top was essentially flattened due to extensive construction activites associated with the Sheldon Power Station. and demonstration nuclear reactor.

6.1) **Phase 1 Field Investigation**

By the summer of 1993, a field investigation was successfully completed that consisted of installing thirteen sampling points (piezometers) that were targeted for different depths and placed at six different locations. Piezometers are simply monitoring points whereby a section of casing with a short section of screen at the bottom is appropriately placed into geologic materials to measure hydrologic conditions. Through the cooperation of the NPPD, DOE was permitted to install piezometer pairs at two

locations that were directly adjacent to the Sheldon Power Station. They permitted this so that DOE could better understand the groundwater flow conditions, because it was suspected that it might be otherwise difficult to ascertain flow direction in the glacial till with less control. The piezometers were targeted to depths of approximately 25, 50 feet, and one to 75 feet. . (Note that for ease of discussion purposes when the monitoring points are discussed they will be all referred to as piezometers). The naming convention for the 25, 50, and 75 foot piezometers were named OBS#A, OBS#B, and OBS#C, respectively. The investigation depths were based on the probability that the near surface glacial materials were more likely the host of the perched groundwater and it was understood that the loess was very likely removed. The one deep piezometer was installed at the request of the NDH to ensure that we monitored the deeper groundwater for at least at one point

The DOE approach was that the investigation would involve of two phases of investigation to ascertain whether sufficient groundwater was present to surround the reactor. The DOE installed piezometers constituted the Phase I study. The experience of installing the 25 and 50 foot wells was that with the exception of the first location, they did observe water in the boreholes about 12 hours after drilling. The deep well (75 foot deep) didn't yield water until about a month after it was installed. All the wells were purged and developed to the extent possible. Limited sampling was performed on some of the wells. All the wells were constructed with 1.25 inch casings, except for the 75 foot well and one location (OBS1A & 1B) where 2 inch diameter wells were installed.

6.2 **Groundwater Screening in 1993**

NDH collected a composite waste water sample and obtained groundwater samples at piezometers (OBS2,OBS5B,OBS6, and OBS4C). NDH also collected composite waste soil and soil samples from the drilling of OBS4C. The hydropunch method was used to collect the groundwater sample at OBS6B. The NDH laboratory tested the water samples for radionuclides (gross alpha, gross beta, tritium, gamma

spectrometry, and nickel-63), volatile organic compounds, and TOX, and the waste water was also tested for RCRA metals.

6.3) Investigation Derived Waste in 1993

After the soil samples were tested by NDH, associated with the 1993 Field Investigation, and the results reported to DOE-CH. The NDH results were inconclusive for the nickel-63 test data. This then led the DOE CH to obtain another set of soil samples and to have those tested by NDH and another laboratory. The split samples were collected by IT Corporation on March 30-31, 1994,. and their results confirmed that there was no nickel- 63 contamination. NDH results also showed the same thing.

6.4) Groundwater Monitoring

Once the wells were installed, the DOE contracted the U.S.G.S.'s Lincoln, Nebraska office to conduct groundwater level monitoring in the piezometers from September 1993 through February 1994. This was done, to ensure that we understood the ability of the piezometers to yield samples and secondly, to get high quality groundwater level data that nearly reflected equilibrium flow conditions. The U.S.G.S. was funded through an Interagency Agreement. Also, during the period of July 1994 to October 1994, groundwater samples were collected by the U.S.G.S. from piezometers OBS1B through 6, and from OBS4C. Those samples were tested for radiological constituents by the NDH. The NDH also performed a radiological survey of the entombed reactor. The NDH provided a report to DOE CH on January 26, 1995.

6.5) Aquifer Testing Work

It was realized that more representative measurements for hydraulic conductivity were needed on the glacial till and that geophysical logging would help to understand the site characteristics. This work was done by the U.S.G.S. under an interagency agreement. The slug tests were long term ones (months) on the 2-inch diameter wells at the Hallam

site. The results showed extremely low hydraulic conductivities for the till, and a report was submitted to the DOE CH office on December 20, 1994.

6.6) **Piezometer Installation Project**

In the summer of 1995, Argonne National Laboratory (ANL) was funded by the DOE to install 6 piezometers at three locations. This project was an opportunity to test the innovative "mini-piezometer" concept and to enhance our understanding of the groundwater flow system in the till. These piezometers are small diameter ones (0.75 inch casings). ANL used a cone penetrometer truck to install mini piezometers at those locations. They had done similar characterization work in Nebraska for the Department of Agriculture, and agreed to collaborate on the project. It provided the following: 1) an additional two piezometers at two new stations that were completed at the 50 foot depths (OBS7B and OBS8B), 2) one 50-foot twin piezometer (OBS2B2), and 3) three piezometers were completed at 75 foot depths (OBS2C, OBS7C, and OBS8C. A comparison of monitoring data between OBS2B, which was conventionally constructed with hollow stem augers, and OBS2B2, installed with the cone penetrometer, has yet to be documented

7.0) **Surveillance and Maintenance**

7.1) **FY1996 Monitoring**

The U.S.G.S.'s Lincoln, Nebraska office was contracted to obtain groundwater level monitoring data from all the piezometers, and to collect water samples from seventeen of the piezometers. The U.S.G.S. was funded through an Interagency Agreement. The Battelle Memorial Laboratory was utilized to conduct the radiological testing on those water samples, however, their were problems with testing and the data are considered unreliable.

7.2) **FY1997 Monitoring**

The U.S. Geological Survey's Lincoln, Nebraska office was contracted to obtain groundwater level monitoring data from all the piezometers, and to collect water samples from seventeen of the piezometers. The Grand Junction Office Analytical Laboratory was utilized to analyze the water samples. The U.S.G.S. report was completed on November 14, 1997. The GrandJunction Analytical Laboratory submitted their report to DOE on November 4, 1997.

The installation details for all the piezometers is provided on Table 1. Monthly groundwater data that was collected by the U.S.G.S. is shown on Table 2. Potentiometric surfaces approximated for the "A" level and "B" level piezometers are plotted on Figures 2 and 3, respectively. Figure 4 provides a posting of groundwater data for the "C" level. Figures 2, 3, and 4 are constructed with data collected on September 11, 1997. Figure 5 illustrates the variation of groundwater levels over the period of the five measurements made by the U.S.G.S. Figures 2 and 3 indicate that groundwater flow in the till is generally in northwest to southwest direction in the immediate vicinity of the entombed reactor. At the "C" level in the till, the approximate groundwater flow is toward the northwest direction.

8.0) **Recommendations and Conclusions**

This is the first year that we have successfully sampled the entire set of piezometers (19 sample collection points) surrounding the entombed reactor, and tested the groundwater for radionuclides. The project over the years has embodied good coordination between the NPPD, NDH, and the DOE-CH. The interactions have been personal and informal over the years with NPPD and NDH. There was no contamination found in the 1997 environmental sampling program. All of the monitoring stations involve piezometers (except OBS4C which is a monitoring well). The piezometers are installed in low hydraulic conductivity glacial till. At OBS1A, this piezometer was completed in a sand lens. CPT data for OBS8C also suggests that it is completed in a local sand lens.

This program reflects DOE's staged approach to investigating the feasibility and practicality of sampling groundwater in glacial till at Hallam.

It is recommended that the Lincoln office of the U.S.G.S.be utilized to sample groundwater annually to confirm for one or more years that the reactor was safely entombed. Key aspects for discussion:

1)How long should DOE sample groundwater in the till?;

2)How does the NPPD feel about the existence of the piezometers? (I would expect that they would like them removed and the ground restored in the foreseeable future;

3)A closure plan is needed and it should include all the available information as basis for closure (it may make sense to close the piezometers in more than one phase, but there is added cost due to mobilization);

4) Its time to re-visit the monitoring approach with the State;

5) A radiological survey of the entombment should be done in conjunction with the next sampling and monitoring event;

6) The recent analytical results provide an opportunity to propose that the purge water from any upcoming sampling events no longer needs to be containerized in drums (as IDW pending receipt of test results);

7) The performance of the "mini-piezometers" should be documented and it is an opportunity to illustrate a comparison between conventially drilled and CPT installed piezometers. Perhaps a paper could be written.

Attachments

1). DOE License Agreement Modification, with cover letter from NPPD, dated October 31, 1995

2). DOE License Agreemetn Modification, with cover letter to NPPD, dated April 28, 1995

3.) DOE License Agreement, dated May 5, 1993

4.) DOE License Agreement with cover letter to NPPD, dated April 30, 1993

5.) AEC Order Terminating Operating Authorization, dated July 20, 1971

6.) Lease of Land between Consumers Public Power and the AEC,dated July 24, 1959

7.) DOE National Environmental Policy Act, Categorical Exclusion Documentation, dated October 13, 1992,

8.) U.S.G.S., Report on Groundwater Monitoring Activities at Hallam Nuclear Powere Facility, Hallam, Nebraska, Data collection from August 1997 to September 26, 1997.

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TABLE 1
PIEZOMETER INSTALLATION SUMMARY
FOR THE
HALLAM NUCLEAR POWER FACILITY
HALLAM, NEBRASKA

Piezometer	Depth (Feet)	Casing Diameter (Inches)	Top Screen Depth (Feet)	Ground Surface Elevation (Feet)	Top Riser Pipe Elevation (Feet)	Grid Coordinates	
						North	East
OBS1A	25	2.0	16	1438.61	1440.35	2289.02	7265.33
OBS1B	50	2.0	39	1438.58	1440.50	2293.61	7264.78
OBS2A	26	1.25	20	1439.45	1441.02	2077.44	7266.65
OBS2B	54	1.25	43	1439.60	1441.29	2078.14	7256.67
OBS2B2	53	1.0	43	1439.61	1442.62	2067.96	7266.10
OBS2C	76	1.0	71	1439.53	1442.61	2067.83	7270.01
OBS3A	25	1.25	19	1438.14	1439.03	1985.10	7121.37
OBS3B	54	1.25	43	1437.99	1439.39	1984.19	7111.19
OBS4A	25	1.25	19	1437.81	1438.50	2214.40	7026.71
OBS4B	55	1.25	44	1437.66	1438.61	2207.57	7033.68
OBS4C	75	1.0	64	1437.80	1439.77	2215.99	7034.63
OBS5A	25	1.25	19	1436.57	1437.63	2592.63	7028.24
OBS5B	50	1.25	39	1436.87	1437.95	2582.30	7028.28
OBS6A	18.5	1.25	11	1438.13	1437.57	2547.25	7310.61
OBS6B	52	1.25	41	1438.15	1437.55	2548.24	7299.85
OBS7B	45	1.0	40	1439.96	1443.11	1929.43	7417.53
OBS7C	75	1.0	70	1440.03	1443.23	1933.46	7417.94
OBS8B	45	1.0	40	1437.77	1440.97	1889.75	7009.78
OBS8C	68	1.0	63	1437.70	1441.03	1887.52	7008.74

Table 2. Water-level data for U.S. Department of Energy observation wells, Hallam Nuclear Facility, Hallam, Nebraska, 1997
[---, no measurement or no data]

Name	Local	Date	Water level	Date	Water level	Date	Water level	Date	Water level	Date	Water level
OBS1A	7N 6E19DABB1	8-28-97	4.03	9-04-97	4.46	9-11-97	4.46	9-17-97	4.75	9-26-97	6.45
OBS1B	7N 6E19DABB2	8-28-97	4.26	9-04-97	4.53	9-11-97	4.67	9-17-97	4.69	9-26-97	4.48
OBS2A	7N 6E19DABC1	8-28-97	5.22	9-04-97	5.17	9-11-97	5.74	9-17-97	4.80	9-26-97	4.95
OBS2B	7N 6E19DABC2	8-28-97	4.99	9-04-97	4.96	9-11-97	4.67	9-17-97	5.21	9-26-97	4.79
OBS2B2	7N 6E19DABC5	8-28-97	4.20	9-04-97	3.81	9-11-97	4.22	9-17-97	4.30	9-26-97	0.79
OBS2C2	7N 6E19DABC6	8-28-97	5.55	9-04-97	5.56	9-11-97	5.53	9-17-97	5.57	9-26-97	6.74
OBS3A	7N 6E19DABC3	8-28-97	7.37	9-04-97	7.54	9-11-97	6.40	9-17-97	7.99	9-26-97	8.05
OBS3B	7N 6E19DABC4	8-28-97	6.59	9-04-97	6.83	9-11-97	8.20	9-17-97	6.39	9-26-97	12.40
OBS4A	7N 6E19DBAD1	8-28-97	---	9-04-97	5.36	9-11-97	5.40	9-17-97	5.71	9-26-97	4.93
OBS4B	7N 6E19DBAD2	8-28-97	---	9-04-97	6.20	9-11-97	7.28	9-17-97	7.51	9-26-97	5.13
OBS4C	7N 6E19DBAD3	8-28-97	---	9-04-97	20.31	9-11-97	19.13	9-17-97	18.99	9-26-97	63.28
OBS5A	7N 6E19ACDD1	8-28-97	7.28	9-04-97	8.78	9-11-97	8.07	9-17-97	8.39	9-26-97	7.48
OBS5B	7N 6E19ACDD2	8-28-97	7.66	9-04-97	8.21	9-11-97	8.45	9-17-97	8.77	9-26-97	8.00
OBS6A	7N 6E19DABB3	8-28-97	7.23	9-04-97	6.13	9-11-97	6.47	9-19-97	6.07	9-26-97	5.35
OBS6B	7N 6E19DABB4	8-28-97	6.08	9-04-97	6.65	9-11-97	6.86	9-19-97	6.35	9-26-97	7.01
OBS7B	7N 6E19DACB1	8-28-97	4.75	9-04-97	4.93	9-11-97	5.03	9-17-97	4.83	9-26-97	16.65
OBS7C	7N 6E19DACB2	8-28-97	4.97	9-04-97	5.23	9-11-97	5.33	9-17-97	5.33	9-26-97	4.68
OBS8B	7N 6E19DBDA1	8-28-97	5.25	9-04-97	6.12	9-11-97	6.64	9-17-97	6.58	9-26-97	7.10
OBS8C	7N 6E19DBDA2	8-28-97	5.73	9-04-97	6.24	9-11-97	6.47	9-17-97	6.56	9-26-97	6.66

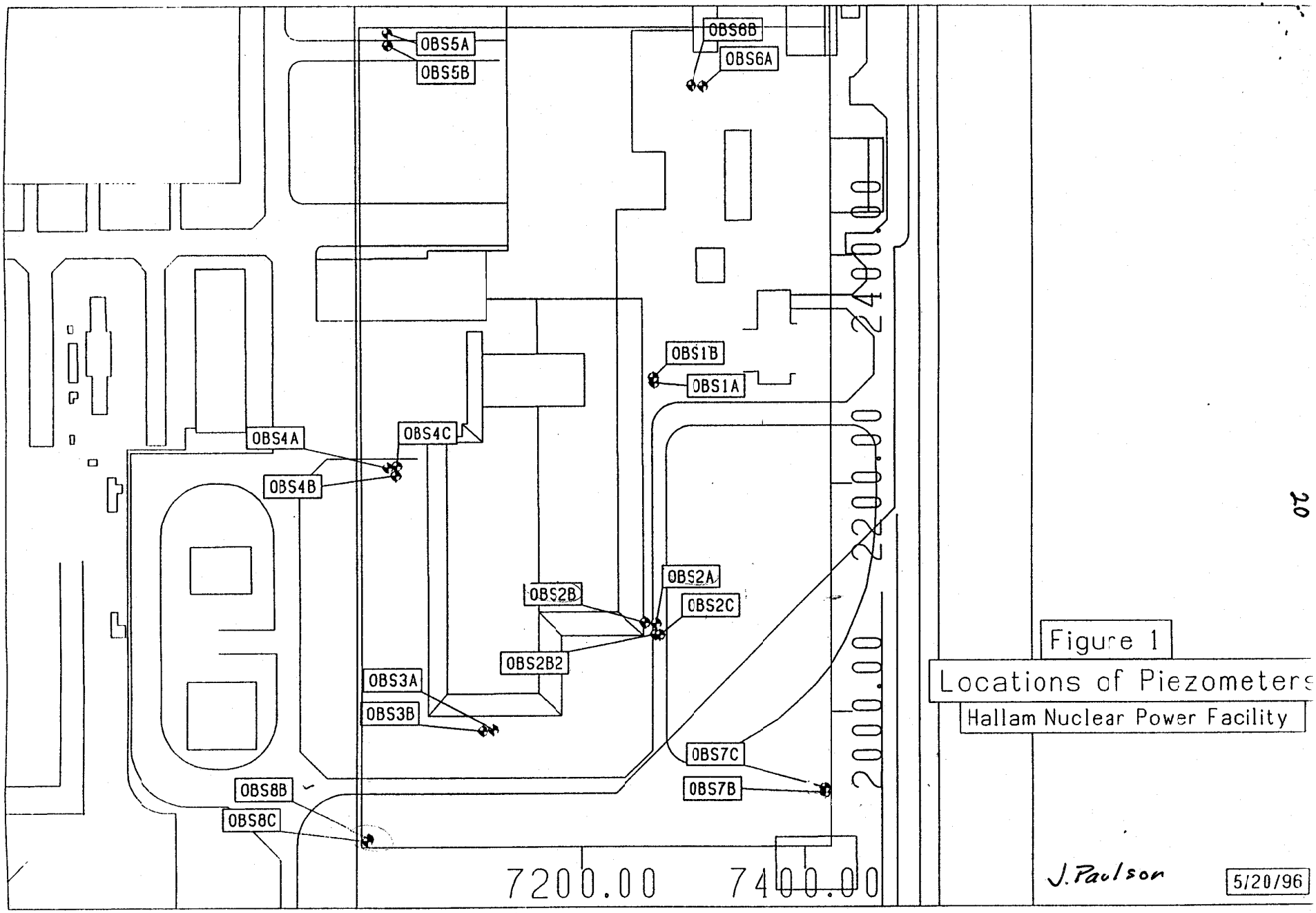


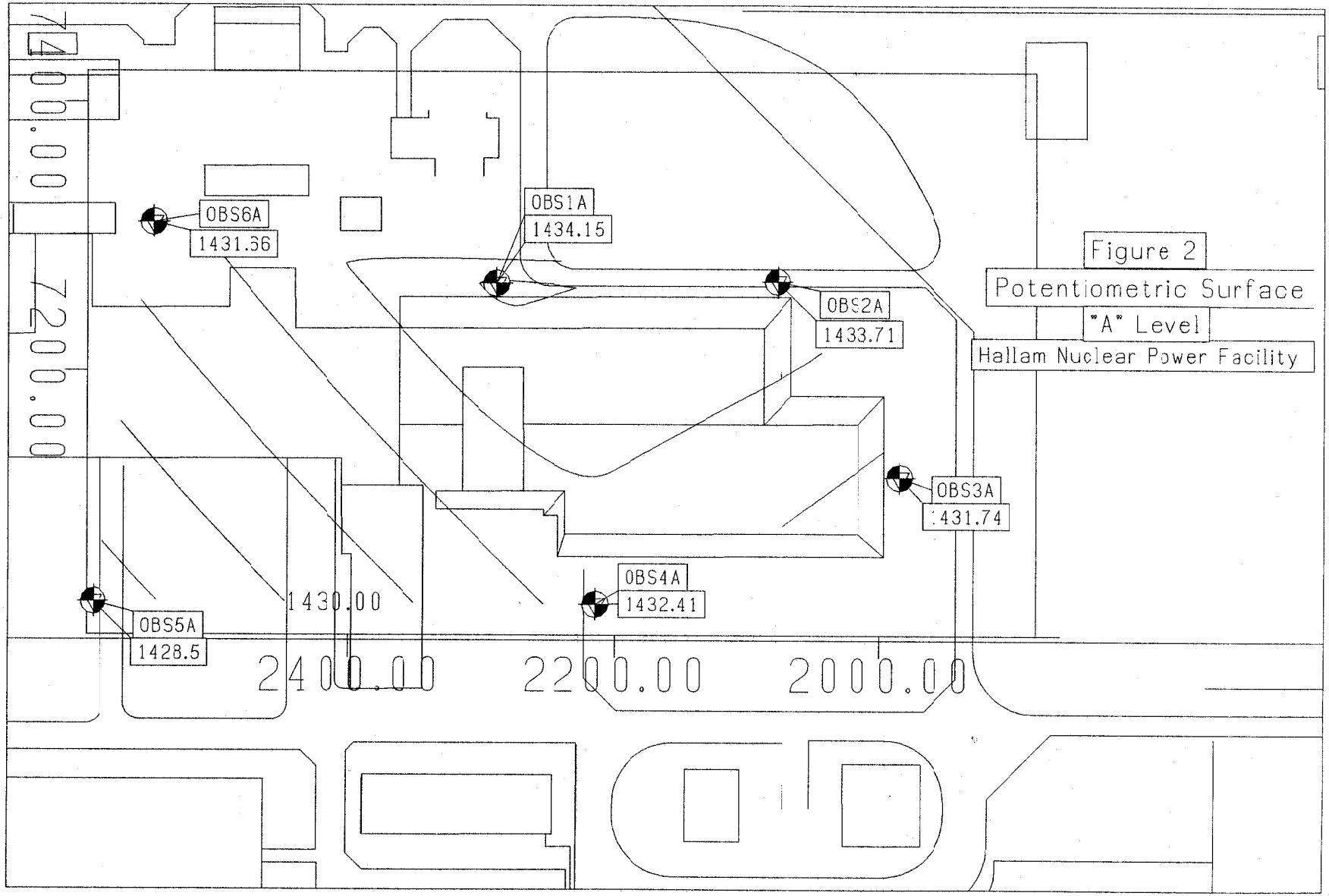
Figure 1

Locations of Piezometers

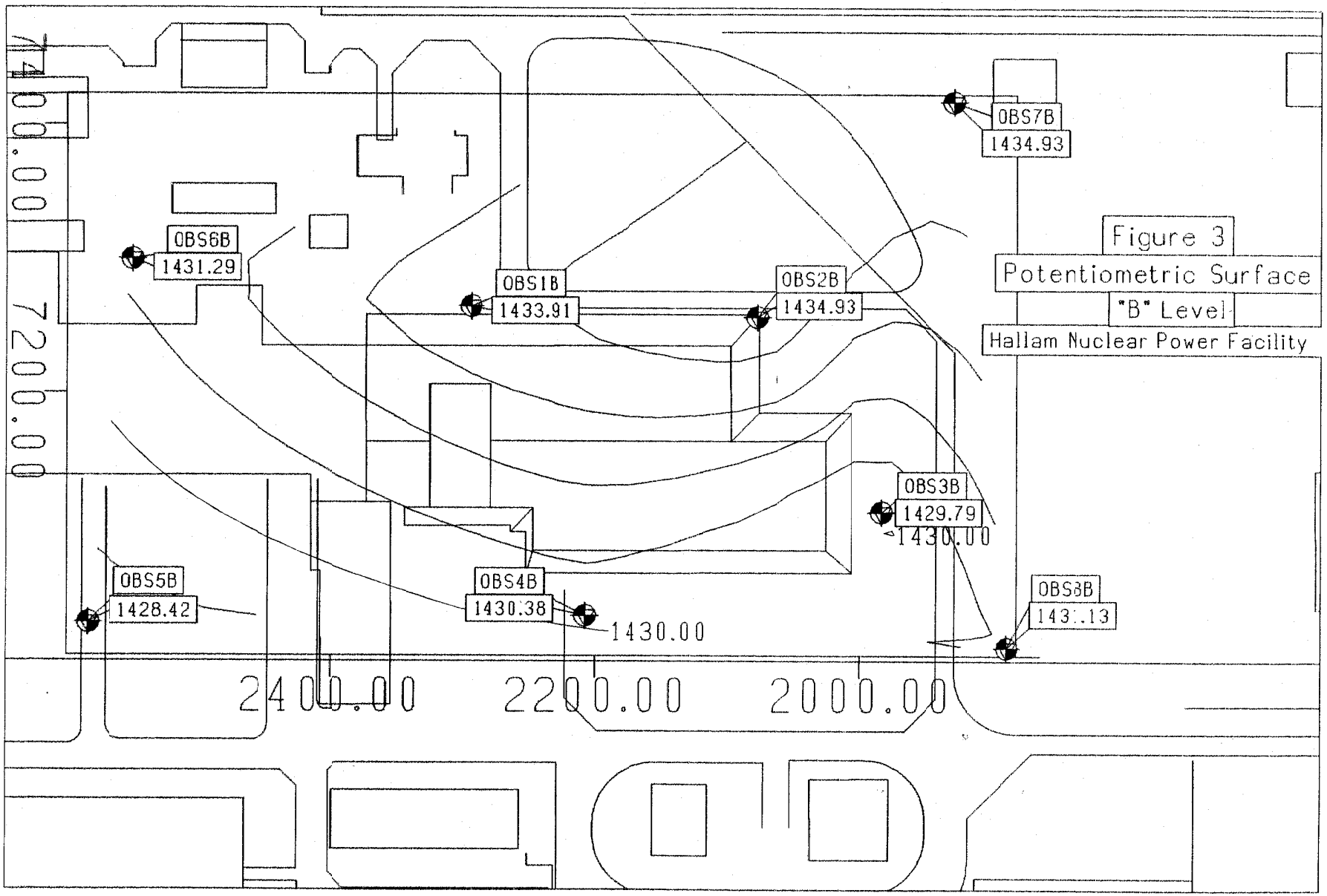
Hallam Nuclear Power Facility

J. Paulson

5/20/96



Note: groundwater measurements were made on 9/11/97. J. Paulson



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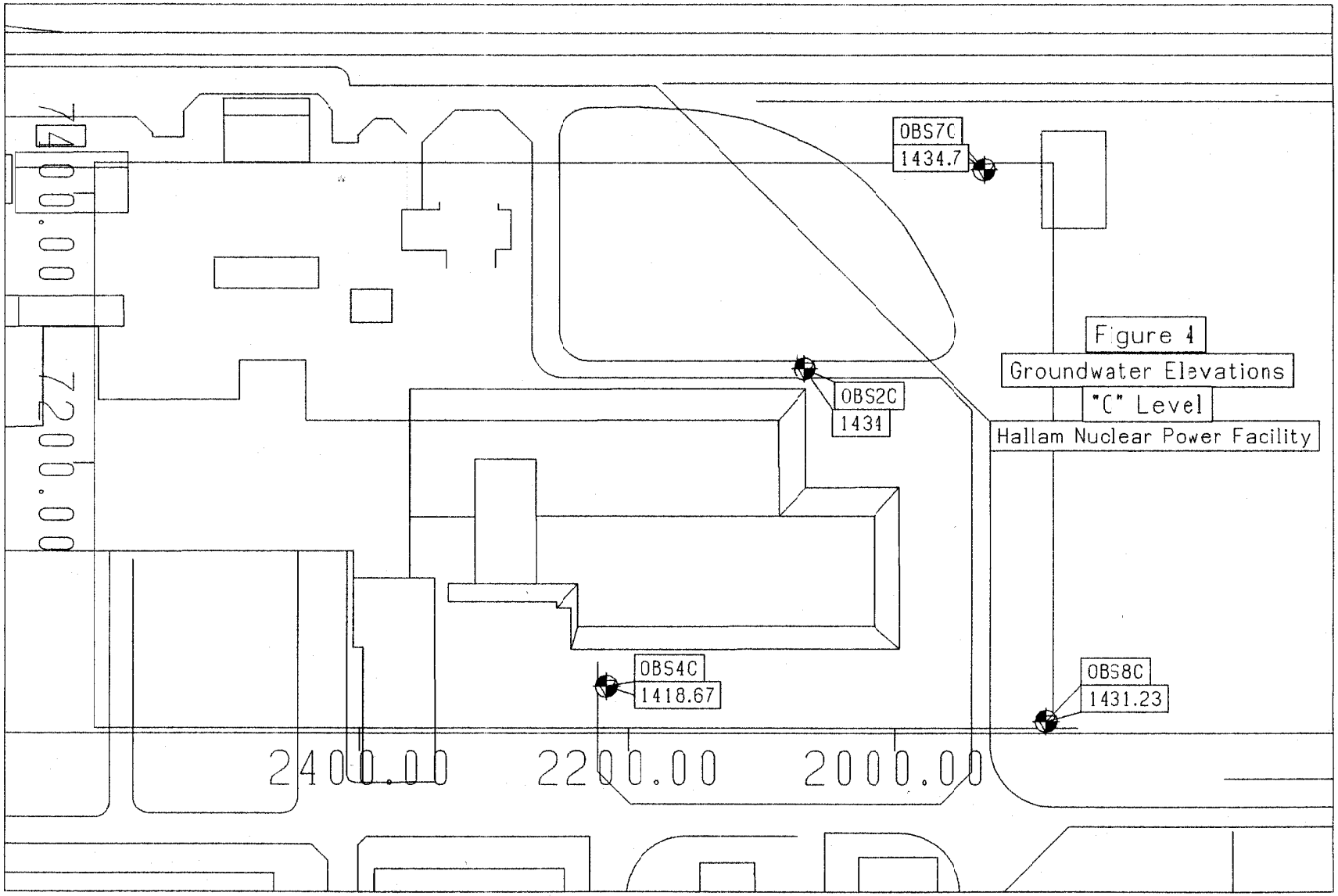
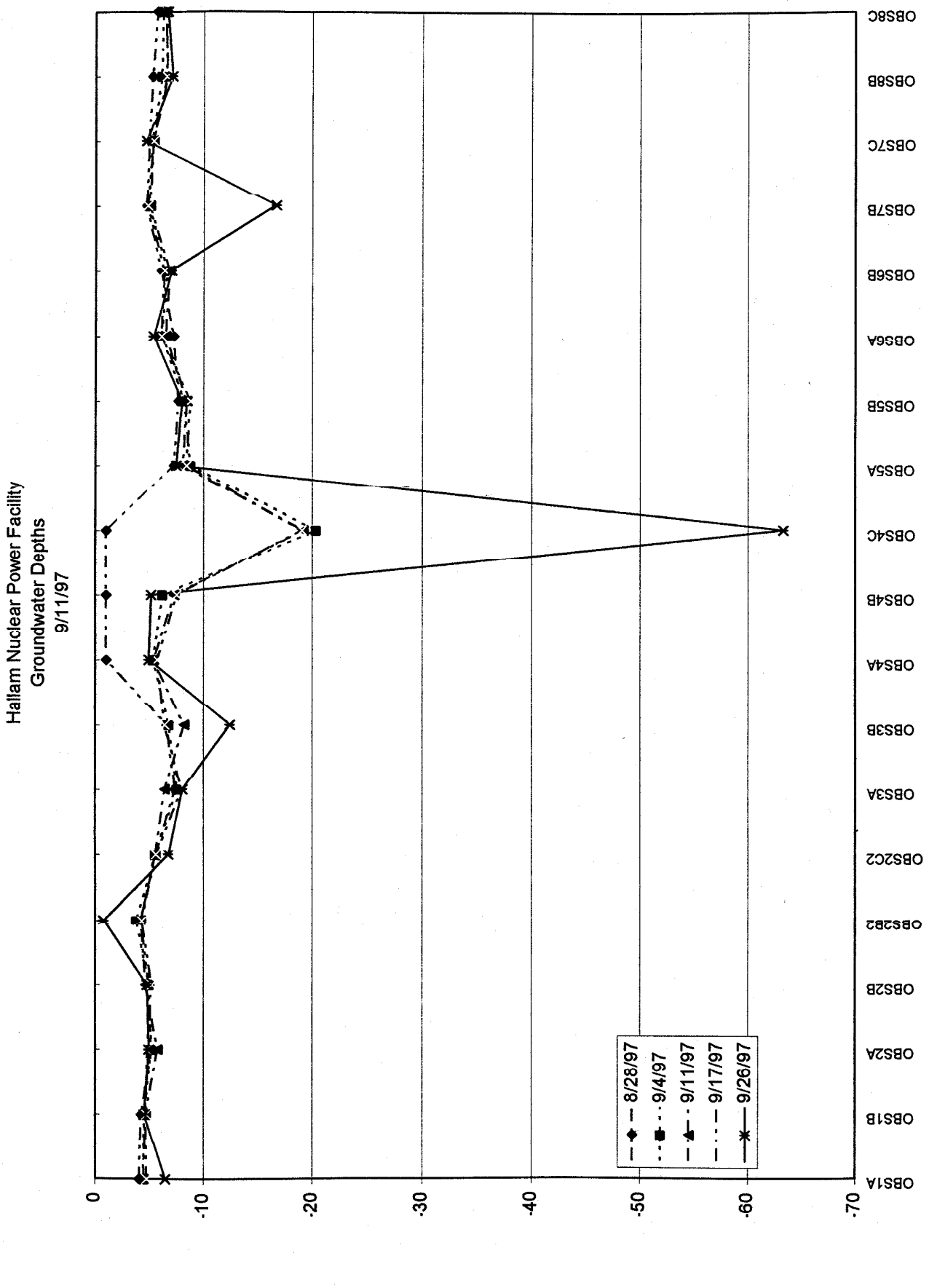


Note: groundwater measurements were made on 9/11/97. J. Paulson


Hallam Nuclear Power Facility
Groundwater Depths
9/11/97
0
-10
-20
-30
-40
-50
-60
-70
OBS1A
OBS1B
OBS2A
OBS2B
OBS2B2
OBS2C2
OBS3A
OBS3B
OBS4A
OBS4B
OBS4C
OBS5A
OBS5B
OBS6A
OBS6B
OBS7B
OBS7C
OBS8B
OBS8C
8/28/97
9/4/97
9/11/97
9/17/97
9/26/97
C:\msoffice\excel\halgraph
3/11/98 10:23 AM
J. Paulson