WCH-488
Rev. 0

River Corridor
Closure Contract

618-11 Burial Ground Caissons Investigation

September 2011

For Public Release

Washington Closure Hanford

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Assistant Manager for River Corridor

DOCUMENT CONTROL 09/01/11 DR

WCH-488
Rev. 0

STANDARD APPROVAL PAGE

Title: 618-11 Burial Ground Caissons Investigation

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1.0 PURPOSE

Previous historical documents including monthly reports, as-built drawings, radiation survey records, etc., and reconnaissance geophysical surveys and 618-11 Burial Ground nonintrusive characterization geophysics attempts failed to identify the probable number of caissons. This document represents the conglomeration of three decades of documents and the recent geophysical investigation summary to identify the number of caissons at 618-11 Burial Ground. Additionally, this document should be used in place of previous historical documents that identified the number of caissons at the 618-11 Burial Ground. The purpose of this report is to investigate the caisson's design and number of caissons (Dry Waste Disposal Tanks) used at the 618-11 Burial Ground (also known as the 300-Wye Burial Ground) by:

- Review of the historical documents including monthly reports, as-built drawings, radiation survey records, published waste disposal records, and previous geophysics investigation reports and provide any additional data that can be used for better characterizing the caissons' inventory.

- Addressing discrepancies in the historical documents that may need correction prior to 618-11 Burial Ground caissons remediation activities.

- Reporting the results of a detailed geophysical survey over the caisson area using both a 270 MHz and bi-static 100 MHz antenna to further characterize the caisson area.

2.0 BACKGROUND

The 618-11 Burial Ground was active from 1962 to 1970 according to WHC-MR-0400, *Engineering Assessment of Low-Level Liquid Waste Disposal Caisson Locations at the 618-11 Burial Ground*. In 1970, all of the principle operating contractors of the Hanford Site joined together to conduct a study of solid waste disposal practices. They recommended segregation and labeling of several waste types, including transuranic, asbestos wastes, polychlorinated biphenyls (PCBs), radioactive animal carcasses, and many other categories. They also recommended that all future burials take place in the 200 Areas. The implementation of the last recommendation resulted in the final closure of the 618-11 Burial Ground in 1970 and ended solid waste burials in the 300 Area according to WHC-MR-0400. However, BHI-00012, *300-FF-2 Operable Unit Technical Baseline Report,* states that 618-11 Burial Ground was operational from March 1962 to December 1967 (DOE-RL 1993b).

The site is located approximately 100 m (328 ft) due west of Energy Northwest's Columbia Generating Station – No. 2 (9.7 km [6 mi] north of the 300 Area). The burial ground consists of three trenches approximately 274 m (900 ft) long, 7.6 m (25 ft) deep, and 15.3 m (50 ft) wide, running east-west. The trenches constitute 75% of the site area. Construction of the first 40 drum storage units were completed in September 1963. Trench #1 was in operation from March 1962 to October 3, 1962.

The construction of an additional 10 drum storage units and two Disposal Tanks (caissons) was completed prior to August 1964. In 1965 Trench #3 and the final two Disposal Tanks (D&E Tanks, caissons) were added. There are 50 drum storage units (five 209–L (55-gal) steel drums welded together) buried in three rows in the northeast corner. In addition, previous records to date indicated that three to five caissons were believed to be located at the west end of the center row of the drum storage units.

Based on historical documents and the most current geophysical investigation, Figure 4 is developed from an aerial photo taken in 1964. The photo documents the construction of the trench #2 and three rows of vertical pipe units (VPUs) and location of the first two caisson chutes. Based on the recent non-intrusive characterization geophysical surveys and measurements, location of the first trench, third trench, disturbed areas, and last two western caissons have been identified and superimposed on the photo. The geophysical survey conducted in 1995 does not support the trench overlay. The interpreted geophysical data indicates three relatively uniform east-west trenches. The centerlines of the northern, middle, and southern trenches are about 50, 150, and 250 feet, respectively, south of the southern row of VPUs, and the disturbed areas are likely only a surface feature.

2.1 DESCRIPTION OF CAISSONS

Dry waste disposal tanks at the 618-11 Burial Ground were in use beginning in September 1964 (WHC-MR-0440). The caisson area is located just west of the center row of the drum storage units along N12,428.24. The design selected for at least three caissons has dimensions of 2.4 m (8-ft) in diameter by 3 m (10 ft) high, and shows the caissons to be an 8-gauge corrugated culvert-style metal pipe (Figures 1 and 2). The caissons are buried 4.6 m (15 ft) below grade and are connected to the surface through an offset pipe (Figure 1). The 2.4-m (8-ft) diameter caissons were spaced between 4.6 and 5 m (15 and 16.5 ft) apart (Figure 3). The centerline of the off-set drop pipe was spaced 11.5 ft from the center of the caisson. Typically, a concrete slab was placed atop the caisson during construction to provide additional shielding. After the placement of the concrete shield and earth backfilling to the top of the caisson, the offset drop pipe was installed. The final 4.6 m (15 ft) of earth fill was placed over the caisson to meet ground level. No bottom (except dirt) existed in the caisson units (PNL-2557 and Appendix B).

The first and second generation caissons were installed at the burial ground, from June 1964 to August 1964 and had 61 and 91.4 cm (24 and 36 in) drop pipes (Figures 1 and 5). The second generation of the caissons, double-chute, has been identified in the GE 1962-1964 report that suggests that one 2.4-m (8-ft) diameter caisson and one double-chute 3.7-m (12-ft) caisson designs were being considered (Appendix B). This is supported by: (1) HW-84291, *Waste Disposal and Decontamination Monthly Report, September 1964,* which states that they have had no problem in getting the waste boxes to travel to the bottom of the tanks; (2) Figure 3 shows two 61 cm (24 in.) outside-diameter caisson pipe openings at W2,939.17 and W2,922.67, next to the 0.9-m (3-ft) diameter caisson pipe opening at W2,906.67; (3) Figure 4, 1964 photo, clearly shows the two most westerly caisson waste pipe openings at a substantially smaller diameter than the adjacent 0.9-m (3-ft) caisson opening; and (4) the electromagnetic induction (EMI) done (WHC-MR-0400, BHI-00291) clearly shows three anomalies to the west of the VPUs at W2,906.67 to W2,939.17 (Figure 3).

DOE/RL-93-49 indicates the existence of two 61-cm (24-in.) diameter offset chutes feeding a single caisson as indicated in Figure 5. This caisson is a 243.8-cm (96-in.) diameter corrugated metal pipe, 6.4 m (12 ft) long, and lies horizontally with timbers blocking the open ends. The document suggests that the two evenly-spaced chutes were installed to ensure efficient filling. This design also offers an explanation consistent with the two 61-cm (24-in.) openings shown in the aerial photographs, and an indication from geophysics investigation of smaller opening resolutions when compared to 91.4 cm (36 in.), and why the geophysics investigation data resolution does not show a flat horizon depicting the top of the caisson because it is deeper than other caissons and does not have a flat reflective top surface.

Figure 1. The 618-11 Burial Ground First Generation Caissons Design (DOE/RL-99-53/WHC-MR-0388).

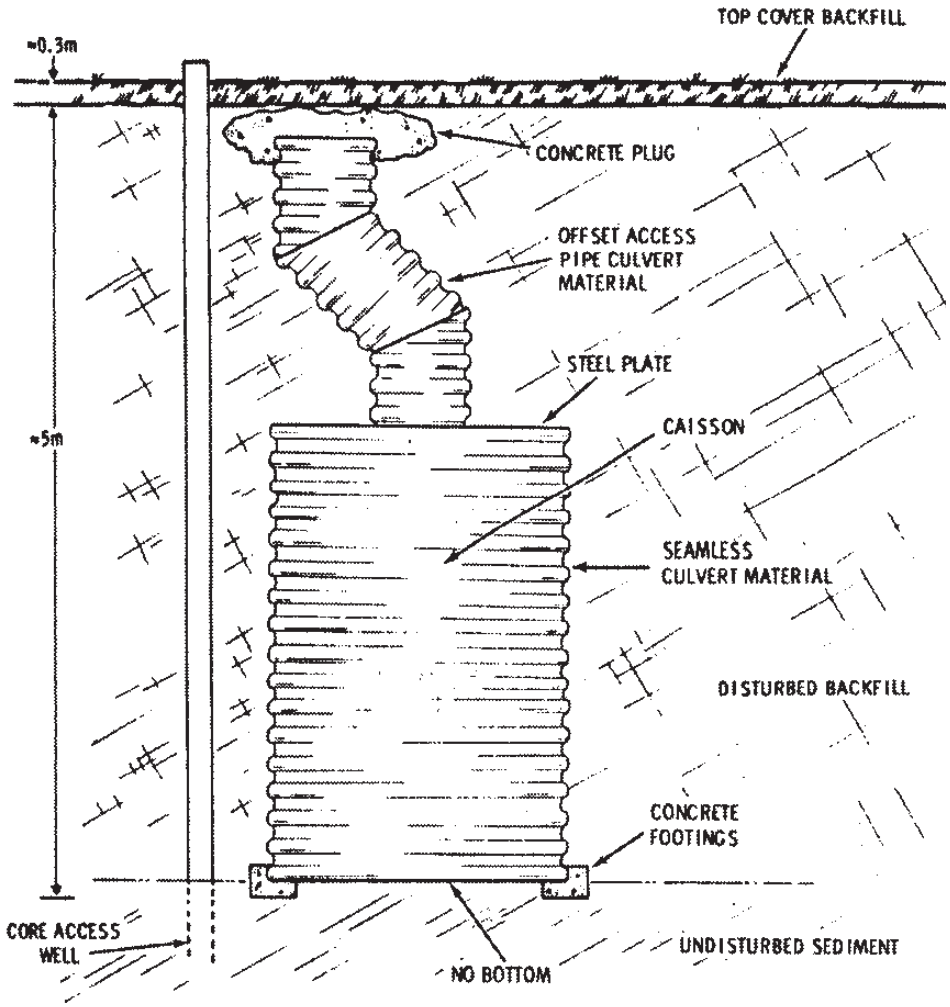


Figure 2. Latest Caissons Design (BHI-00012).

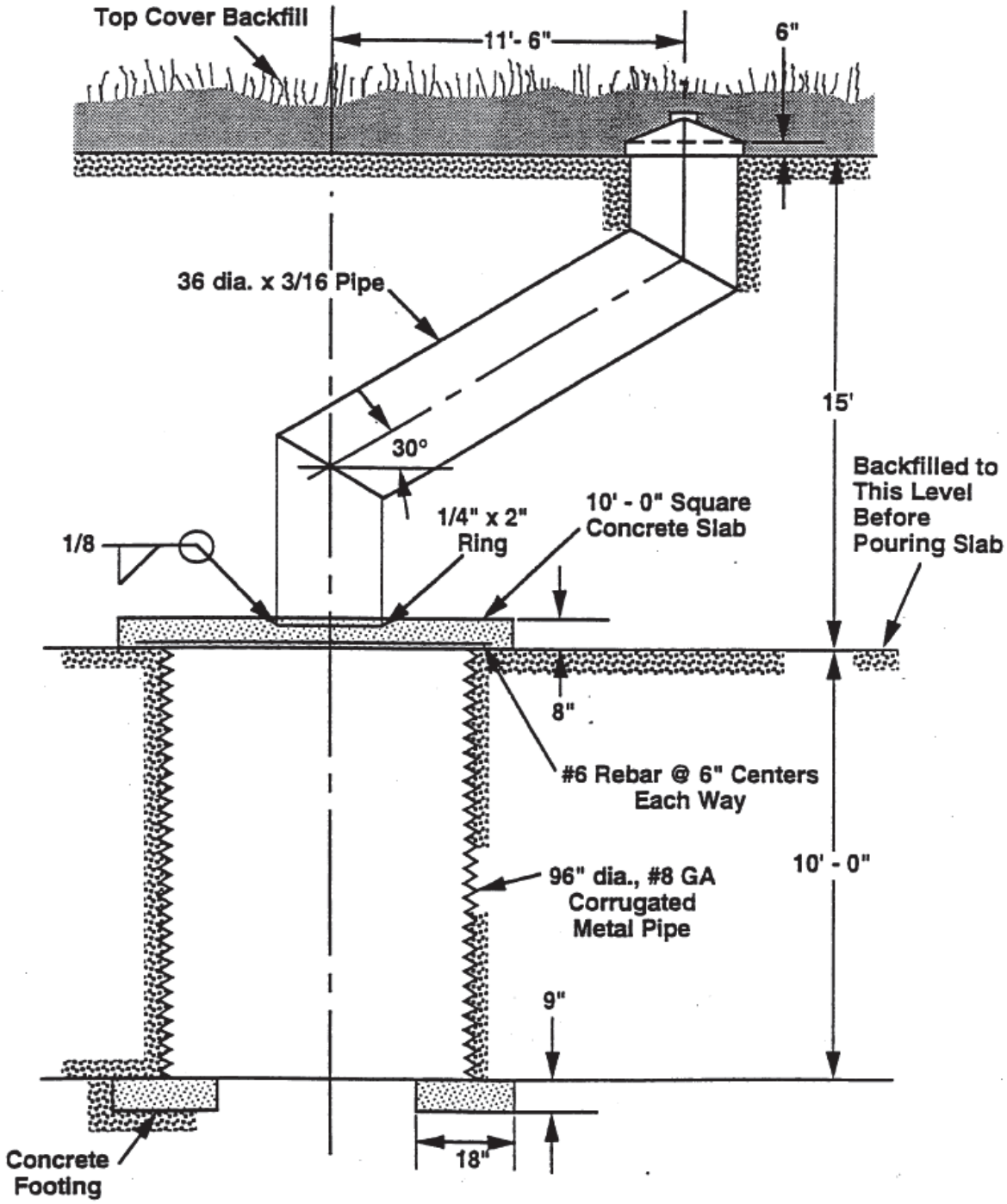


Figure 3. Plot Plan -- 618-11 Wye Burial Ground.

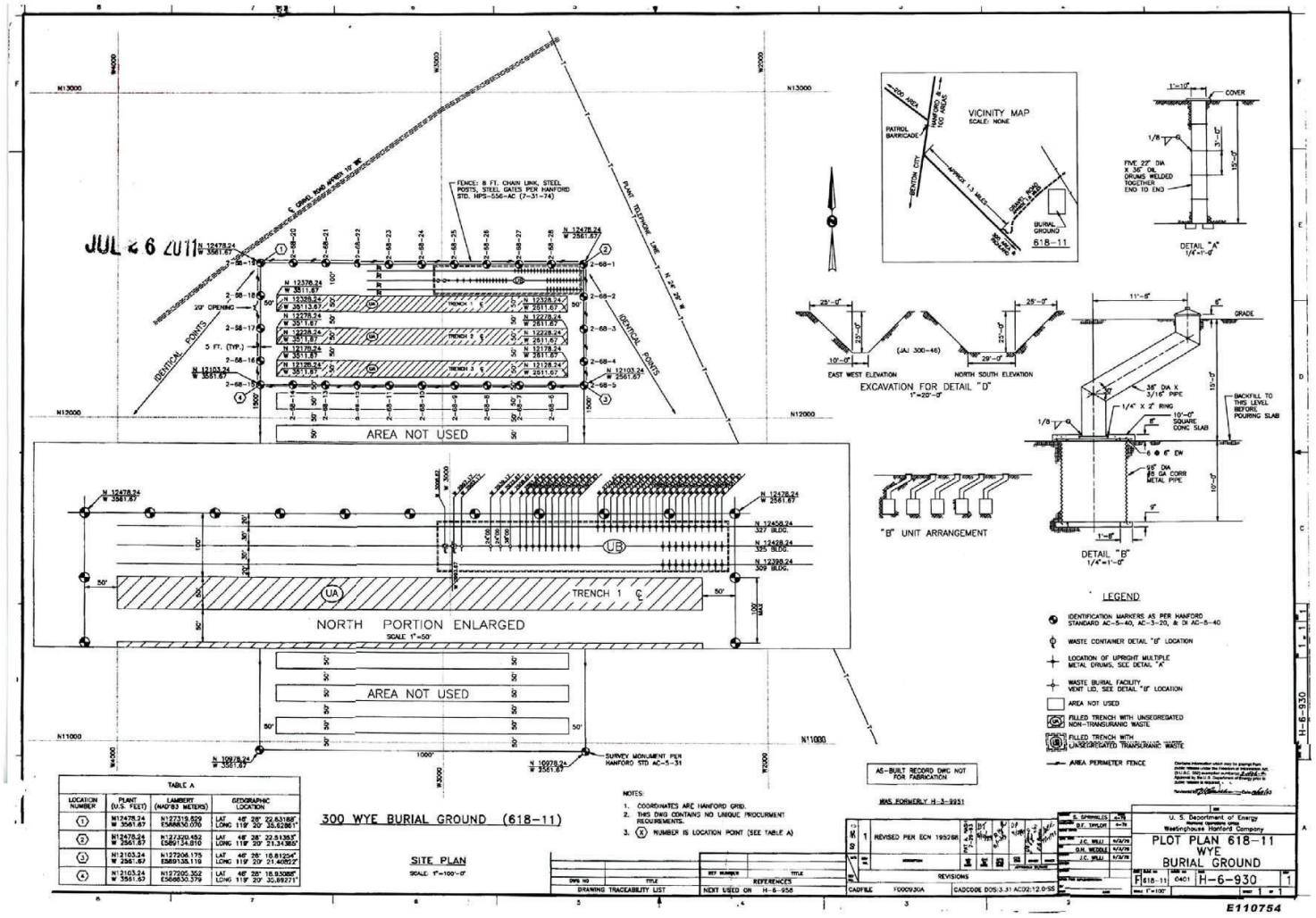


Figure 4. 618-11 Wye Burial Ground.

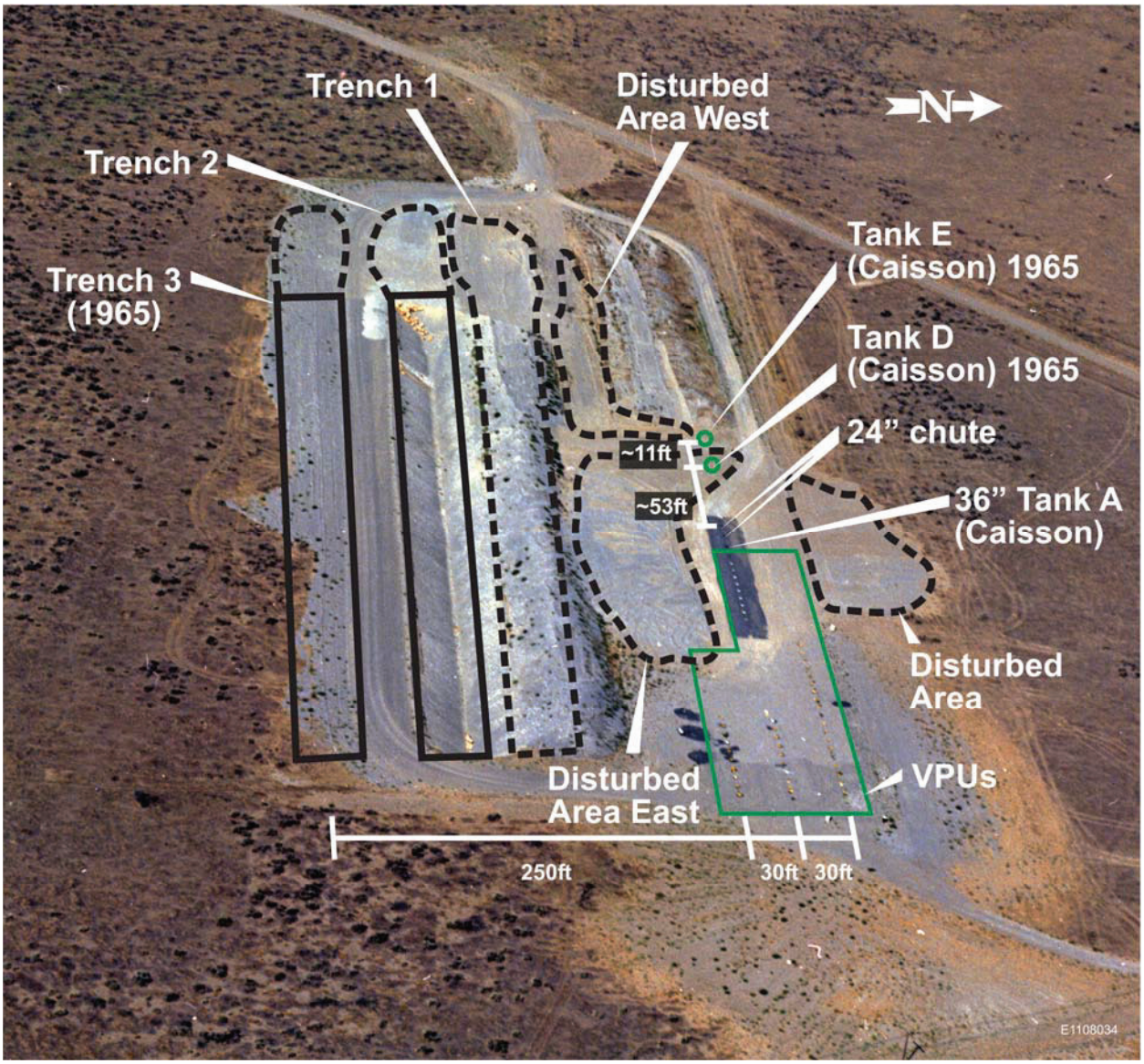
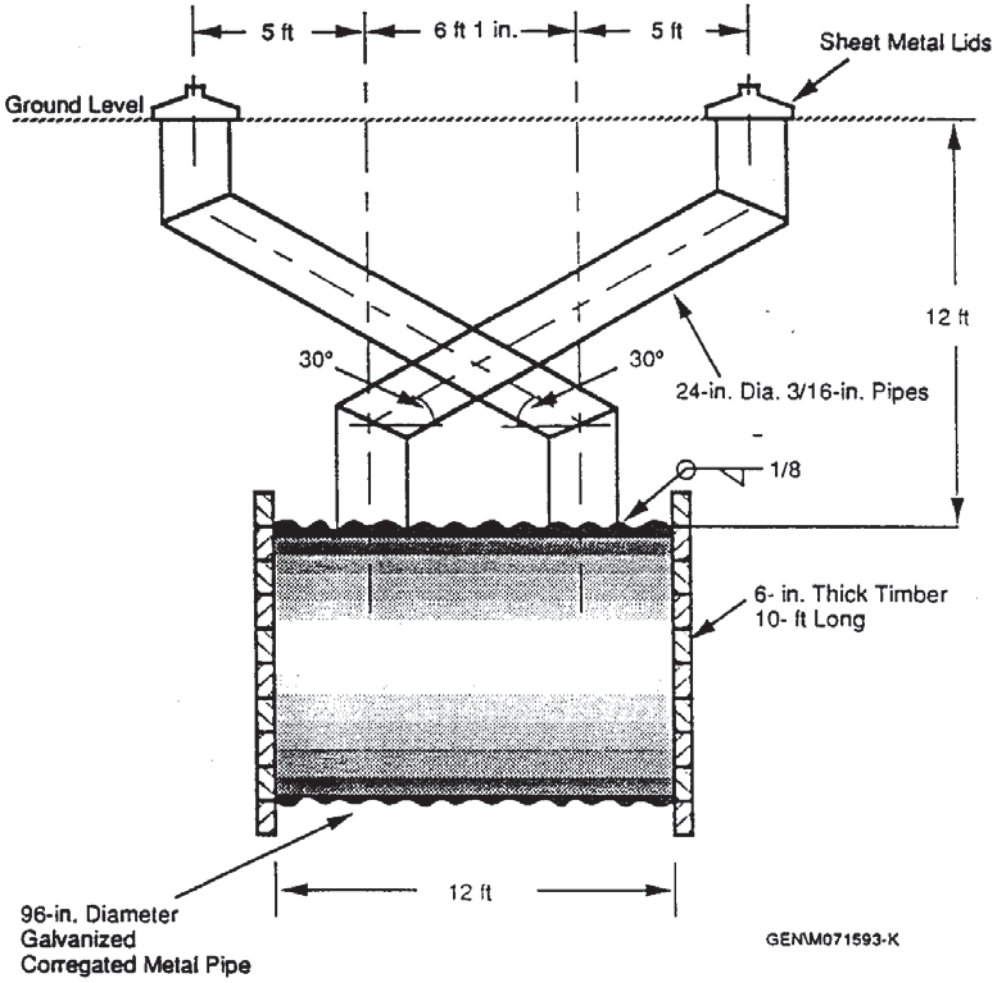


Figure 5. Alternate (Second Generation) Caissons Design (BHI-00012).



2.2 SITE DISCREPANCIES

As stated in HNF-EP-0649, *Characterization of the 618-11 Solid Waste Burial Ground, Disposed Waste, and Description of the Waste-Generating Facilities*, several discrepancies exist in the data of the 618-11 Burial Ground. These discrepancies show up in the documentation written during the past three decades to describe and characterize the site. Documents differ on the total number of drum storage units and caissons. The range varies from 12 trenches and 54 VPUs (Pauly 1990) to three trenches, one large buried culvert, and three large underground tanks (BNWL-2184). However, historical documents and reports typically identify the presence of three trenches, 50 drum storage units, and up to five 2.4-m (8-ft) diameter caissons.

Cadwell (1971) indicates 50 drum storage units, one 0.9-m (3-ft) diameter culvert and three 2.4-m (8-ft) diameter underground tanks (caissons) for dry storage.

The EMI completed in 1995, and the August 1964 aerial photograph of the site, refute the number of caissons. It is clear there are 50 drum storage units (VPUs). The caisson count is either five 2.4-m (8-ft) diameter caissons or three 2.4-m (8-ft) diameter caissons and one 12-ft long by 8-ft diameter double-chute caisson (Figure 2). To have installed a 0.9-m (3-ft) diameter culvert during June to August 1964 is inconceivable after so many contamination spread problems with drum storage units, contamination concerns by the AEC (HW-77274), and new caisson designs being evaluated (Appendix B) (GE 1962-1964).

The EMI of the site done in 1982 depicts three scattered drum storage unit images in the north row, one missing drum storage unit in the center row, and denotes another caisson at the western end of the center row (WHC-MR-0400). These discrepancies can be voided by enlargements of site photographs (Figure 4) and the EMI/ground penetrating radar (GPR) done in 1994 (BHI-00291). The photographic enlargements clearly show three rows of drum storage units. The northern-most row shows 20 drum storage units and the southern-most row shows 10 drum storage units. The middle row is split into two segments, with an easterly segment of 10 drum storage units and a westerly segment of 10 drum storage units. All drum storage units are evenly spaced so as to match the Hanford drawing H-6-930. Three additional units at W 2,939.17 to W 2,906.67 appear as the "vent lid" waste burial facility storage units depicted in Detail "B" of drawing H-3-930. Figure 3 shows the larger-diameter unit, shown as 91.4 cm (36 in.) outside diameter at W 2,906.67 on H-6-930. These photos, however, do not show the other caissons located between W 3,009.67 and W 2,982.17. The EMI done in 1995 clearly shows that only two caissons exist at the west, along NT 12,428.24 (Figure 3).

Other discrepancies associated with the trench layouts exist in the site engineering drawing. The first burial ground layouts shown in H-3-9951 were done for 14 trenches, running east/west, to be contained in a plot 305 m (1,000 ft) east/west by 457.5 m (1,500 ft) north/south. That plot layout was never changed and is still shown incorrectly on the current H-6-930 drawing issued April 3, 1979.

The drawing also shows a scale of 2.5 cm (1 in.) = 30.5 m (100 ft) in the sign-off block, but labels the base plot layout at 0.3 m (1 ft) = 254 cm (100 in.) and the "north portion enlarged" as 0.3 m (1 ft) = 127 cm (50 in.) The north portion enlarged area shows 20 drum storage units in the northern row (N 12,458.24) while the base scale view shows 21 units. The count of caissons and drum storage units in the other two rows is identical. Westerly grid coordinates are incorrect for the caisson and vent lid, located between W 3,009.67 and W 2,993.67.

Further review of the 1964 photo (Figure 4) revealed that the first trench and disturbed areas layouts may not have been within the same dimensions as the Trench # 2. It appears that one small disturbed area exists on the north extending beyond the site boundary.

3.0 SOLIDS WASTE DISPOSAL HISTORY

The 618-11 Burial Ground is an inactive, solid radioactive waste burial ground and it is also known as the Y Burial Ground, 318-11, and the 300 Wye Burial Ground. ARH-183, *Specification and Standards for the Disposal of Battle Northwest Solid Wastes,* provides specifications and standards that assured all BNW generated solid wastes were packaged and disposed in accordance with Atlantic Richfield Hanford Company (ARHCO) waste management program and radiation protection standards (ARH-220). The specification for Tank Disposal (Caisson) specifies the following:

- Criticality Prevention

  a) Fissile material wastes for disposal shall be packaged in metal containers.
  b) The quantity of fissile material per container shall not exceed the following:

Minimum Can Volume	Maximum Quantity Per Can			
	Depleted and Natural U	Enriched U up to 0.95 Wt.% U-235, pounds	Enriched U 0.95 to 2.5 Wt.% U-235, pounds	Enriched U >2.5 Wt.% U-235 and Pu in any form, grams
Up to 300 mL	No limit	0.7	0.3	2
300 to 600 mL	No limit	1.3	0.7	4
600 mL to 1 qt	No limit	2.0	1.0	6
1 qt to 6 qt	No limit	8.0	4.0	12
6 qt to 15 gal	No limit	8.0	4.0	12
15 gal to 55 gal	No limit	8.0	4.0	12

- Site Termination

  a) When the capacity of a tank waste disposal facility is exhausted or it is removed from service, the following terminal conditions shall be achieved:

  b) The surface radiation levels shall be reduced to less than 1 MRAD/hour by backfill or permanent shielding

  c) The site shall be inspected periodically (minimum of once/month the first year, quarterly thereafter) to assure that condition in a) above, are maintained.

  d) Locations of terminated solid waste disposal site shall be accurately and permanently marked according to Hanford Standard AC-5-40.

- Standards for Tank Disposal (Caisson)

  - Fissionable end small-structural material wastes for burial shall be packaged in types of containers presently used, which will contain the contamination and withstand normal transfer and handling without rupture. Maximum size of containers presently used are as follows:

    - 33 cm (13 in.) O.D. by 91 cm (36 in.) long (325 Bldg.)
    - 23 cm (9 in.) O.D. by 56 cm (22 in.) long (327 Bldg.)
    - 10 cm (4 in.) O.D. by 91 cm (36 in.) long (324 Bldg.)

- Solid waste should be essentially dry. Damp wastes should be packaged in an inner plastic container such that the integrity of the outer container is not jeopardized prior to burial. Liquid wastes for disposal by burial should be packaged with sufficient absorbing media (e.g., vermiculite) so that no liquid escapes, should the liquid container be broke in transit.

3.1 MILK PAILS, GRAPE JUICE CANS, AND GATLING GUNS

Beginning about 1960, after waste had become hotter in the 325 and 327 Buildings, cardboard waste containers and gunk catchers were replaced by the milk pail disposal system. Radioactive wastes were collected in the operations buildings in 19- to 22.8-L (5- to 6-gal) aluminum milk pails. A commercial gelatin was poured in to seal the top, and each milk pail then was placed in an individual cask containing lead shielding surrounded by an aluminum shell. These casks were transported to the 618-10 Burial Ground and, beginning in September 1963, to the 618-11 Burial Ground where the milk pails (not the casks) were disposed of in the buried caissons and covered with sand or concrete. The 618-10 and 618-11 Burial Grounds also received 0.95-L (1-qt) "grape juice cans" that held used, highly-radioactive charcoal filters from the operations buildings. Grape juice cans were transported in cylindrical, shielded cask known as "Gatling Gun Cask."

3.2 PAINT CANS AND LARD CANS

Solid waste disposal caissons and containers used for 300 Area disposals changed in two ways. A new type of caisson (sometimes called a "silo") with its top opening angled at 45 degrees to give better radiation shielding to disposal workers was designed and fabricated at Hanford. At the same time, the milk pail system was replaced by the paint can system. Radioactive wastes from operations buildings were collected in 3.8-L (1-gal) paint cans with metal lids fastened on by two sets of clips. Eight paint cans together fit into a new cylindrical cask with lead shielding surrounded by a stainless steel shell. Thus, more securely sealed and heavily shielded solid wastes traveled to the Wye burial grounds and, after 1970, to burial grounds in the 200 Areas. The casks themselves were not disposed of but were reused many times.

4.0 GEOPHYSICS

4.1 GENERAL SYNOPSIS OF GEOPHYSICAL SURVEYS TO DATE

Several geophysical data acquisition campaigns have been conducted at the 618-11 Burial Ground. Each event had different goals and focus areas. Pacific Northwest Laboratory conducted some of the first, wide-reconnaissance, geophysical surveys in 1979 and 1980 (PNL-2557). In 1995, Bechtel Hanford, Inc., conducted a more detailed, but still reconnaissance level investigation (BHI-00291). Survey objectives were more reconnaissance in nature included identifying the general configuration of the burial ground, delineating individual trench boundaries, locating the highest concentrations of debris, determining the thickness of the overburden, and confirming the general location of the VPUs and caissons. A 300 MHz GPR antenna was used in the 1995 investigation.

In 2004, a detailed surface geophysical investigation was conducted by Fluor Hanford focusing primarily on the VPU/caisson portion of the burial ground (WMP-21465). A 200 MHz GPR antenna was utilized for this investigation. The primary objective of this survey was to provide more detail on the number, location, depth, and character of the VPUs. This report suggested the likelihood of 50 VPUs and five anomalies interpreted to be associated with the caissons/caisson's chutes. The character of these five anomalies is different from that of the interpreted VPUs. Three of the five anomalies associated with the caisson/chutes area were reported to have a GPR character that might be expected from an angled pipe-chute as shown in Figures 1 and 2. The other two anomalies in the interpreted caisson area do not appear to be associated with an angled chute. The GPR data did not provide any definitive information from depths expected for the top of the caissons.

In February 2011, WCH conducted a small test GPR survey over the caisson area using both a 270 MHz and 100 MHz antenna to determine potential applicability of these antennas for further characterization of the caisson area as part of the 618-11 Burial Ground pre non-intrusive characterization activities. At that time, the ground surface included bunch grass and small undulations in topography. The condition of the ground surface did not warrant further high resolution/3-D surveys, but the data were encouraging for deeper characterization given a better surface to work from.

In July 2011, North Wind conducted a high-resolution full GPR survey over the VPUs and caissons for the nonintrusive characterization activities. A high-resolution geophysical investigation of the 618-11 Burial Ground VPUs and caissons (North Wind, 2011, *High Resolution Geophysical Investigation, 618-11 Burial Ground Vertical Pipe Units & Caissons*) report indicated three caisson chutes and two units with weakly expressed resolutions. The confidence of the position and depth of the caisson units at depth was very low because of limited GPR signal penetration.

In August 2011, WCH conducted a detailed GPR survey over the caisson area using a 270 MHz and bi-static 100 MHz antenna for characterization to the top of the caissons ~6.1 m (20 ft) (Appendix A). The collected data combined with the historical data has been depicted on a 3-D caisson orientation and configuration sketch for future planning and remediation purposes (Figure 6).

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The conclusion presented in this document is based on the use of a bi-static 100 MHz antenna that yields information down to the top of the caissons no deeper than about 6.1 m (20 ft). A 3D survey configuration (Figure 6), using both a 270 MHz and 100 MHz antenna provides a clearer understanding of the caisson configuration and number of caissons. This required collecting radar profiles spaced about 0.5 to 1 m (1.6 to 3.3 ft) apart, in two directions, over the caisson area. The 270 MHz antenna provided higher resolution in the upper 3 to 3.6 m (10 to 12 ft). The 100 MHz antenna has the power and frequency to get information from depths up to 6.1 m (~20 ft).

A review of the geophysical survey in August 2011 along with the review of the historical documents including monthly reports, as-built drawings, radiation survey records, published waste disposal records, and geophysics investigation reports concluded that there are four caissons with variable configurations at 618-11 Burial Ground (Figure 9).

The geophysical investigation summary report (Appendix A) identifies Ports 3 and 4 (Figure 6) do not display a reflector at a depth of 5 m (16.4 ft) consistent with the caissons associated with Ports 1, 2, and 5. Figure 2 displays an interpreted chute sloping downward to the west from Port 4, to a depth greater than the chute extending from Port 5.

The fourth interpreted caisson does not have a character typical of the other three caissons (Figure 4). There is no flat character in the radar reflections and it is at a depth of approximately 6 m (19.6 ft). Diffractions from the caisson directly to the east and the sloping chute above partly mask the target and it is not imaged as clearly as the other three interpreted caissons.

The reflections at 6 m (19.6 ft), while not as clear, are consistent over a series of three West to East profiles. Parabolic reflections (pipe like anomalies) are present north of Ports 3 and 4. These features appear to be isolated targets and not clearly associated with the caissons or chutes. These anomalies are shown in magenta in Figure 6.

Strong caisson chute geophysical resolution (Port 3 and 4) at 1.83 to 3 m (6 to 10 ft) below grade-level suggest that different caisson configurations exist (60.9 and 105.8 cm [24 and 36 in.] waste drop chutes) at W2,906.67 , W2,939.17 , W 3008.67 (91.4 cm [36 in.]) when compared to W2,939.17 and W2,922.67 (possibly 61 cm [24 in.]). Based on the GI# 0621203, caissons at W 3008.67 (W 2993.67) and W 2997.17 (W 2982.17) configurations match up with

latest caissons design as shown in Figure 2. Caisson at W 2906.67 configuration based on the radar reflection data obtained matches with the first generation caisson design with the offset access pipe culvert material as shown in Figure 1 (PNL-2557). Similarly, the caisson at W 2939.19 and W 2922.67 has a configuration that may be completely different than second generation design shown in Figure 5. A sketch of double chute caisson has been created based on the geophysical investigation report and is depicted in Figure 10.

5.2 RECOMMENDATIONS

A review of the geophysical investigation and historical documents concluded that several areas of concern exist in regards to the path forward with the 618-11 Burial Ground remediation scope. These concerns and associated recommendations are:

1. Irregular site disturbances exist that should be further investigated as shown in Figure 4. These irregular site disturbances have been gathered by enlarging the 618-11 Burial Ground 1964 aerial photo.

2. Parabolic reflections, pipe like anomalies, are present north of Ports 3 and 4. These features are close to the caisson. These features appear to be isolated targets and not clearly associated with the caissons or chutes. These anomalies are shown in Figure 7 of the GI-0621203.

3. Drawing H-6-930, Rev 1, Plot Plan 618-11 WYE Burial Ground, identifies typical caissons detail design but it does not address the other designs as stated in this report. This drawing should be revised to show the latest geophysical data per GI-0621203.

4. Drawing H-6-930, Rev 1, Plot Plan 618-11 WYE Burial Ground, identifies multiple trenches not in use. WHC-MR-0400 and BHI-00291 identify the existence of three filled trenches with unsegregated non-transuranic waste. This drawing should be revised to show the correct number of trenches for the purpose of remediation design scope and activities.

5. Geophysical data over the trenches initially indicated little to no solid waste in the southern trench. With the success of the imaging to depths on the order of 20 feet with the bi-static 100 MHz GPR antenna, consideration should be given to revisiting some of the trench surveys.

Figure 6. 2011 Geophysical Investigation (Appendix A).

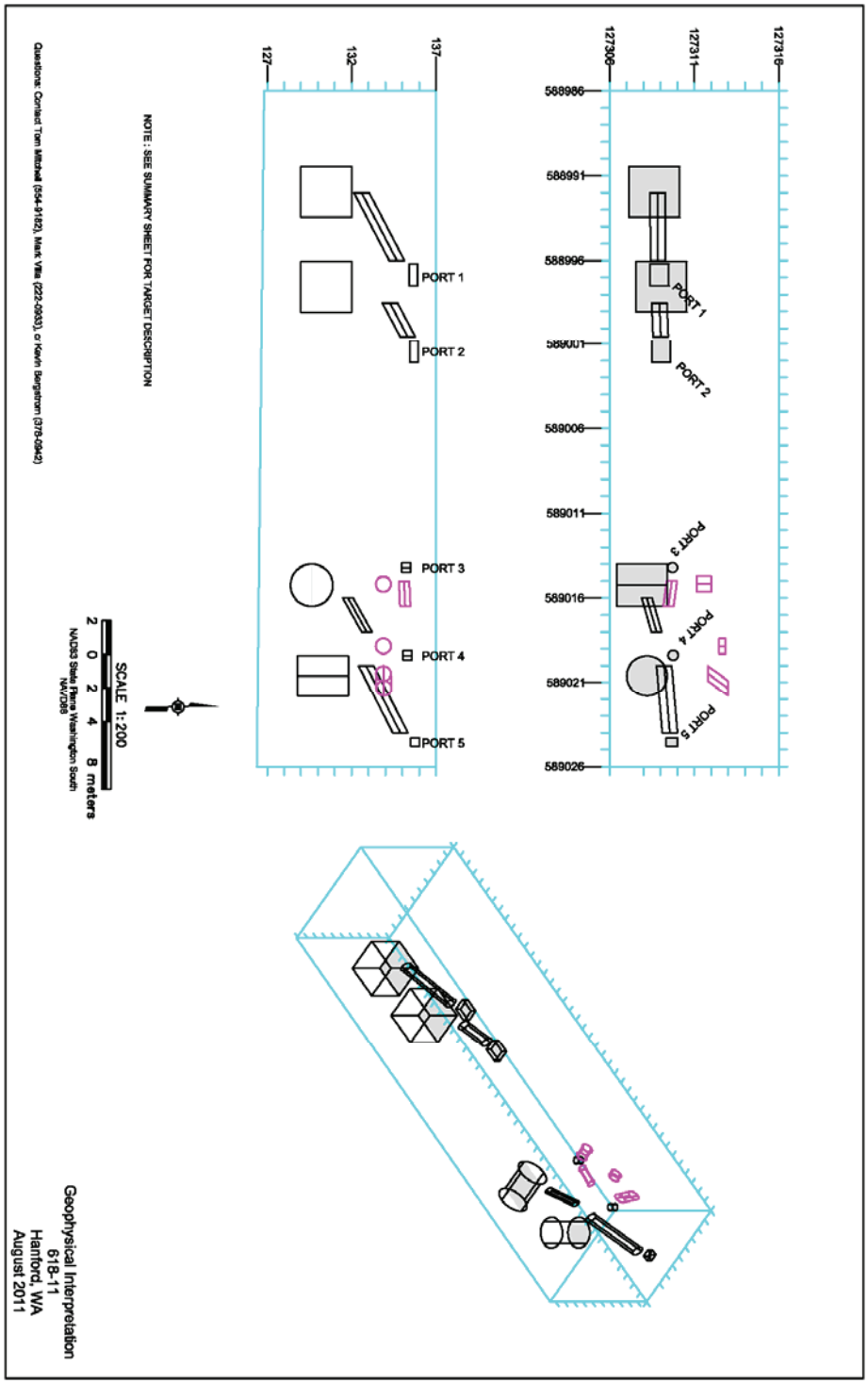


Figure 7. North Wind - Data Reports - High Resolution Geophysical Investigation, 618-11 Burial Ground Caissons.

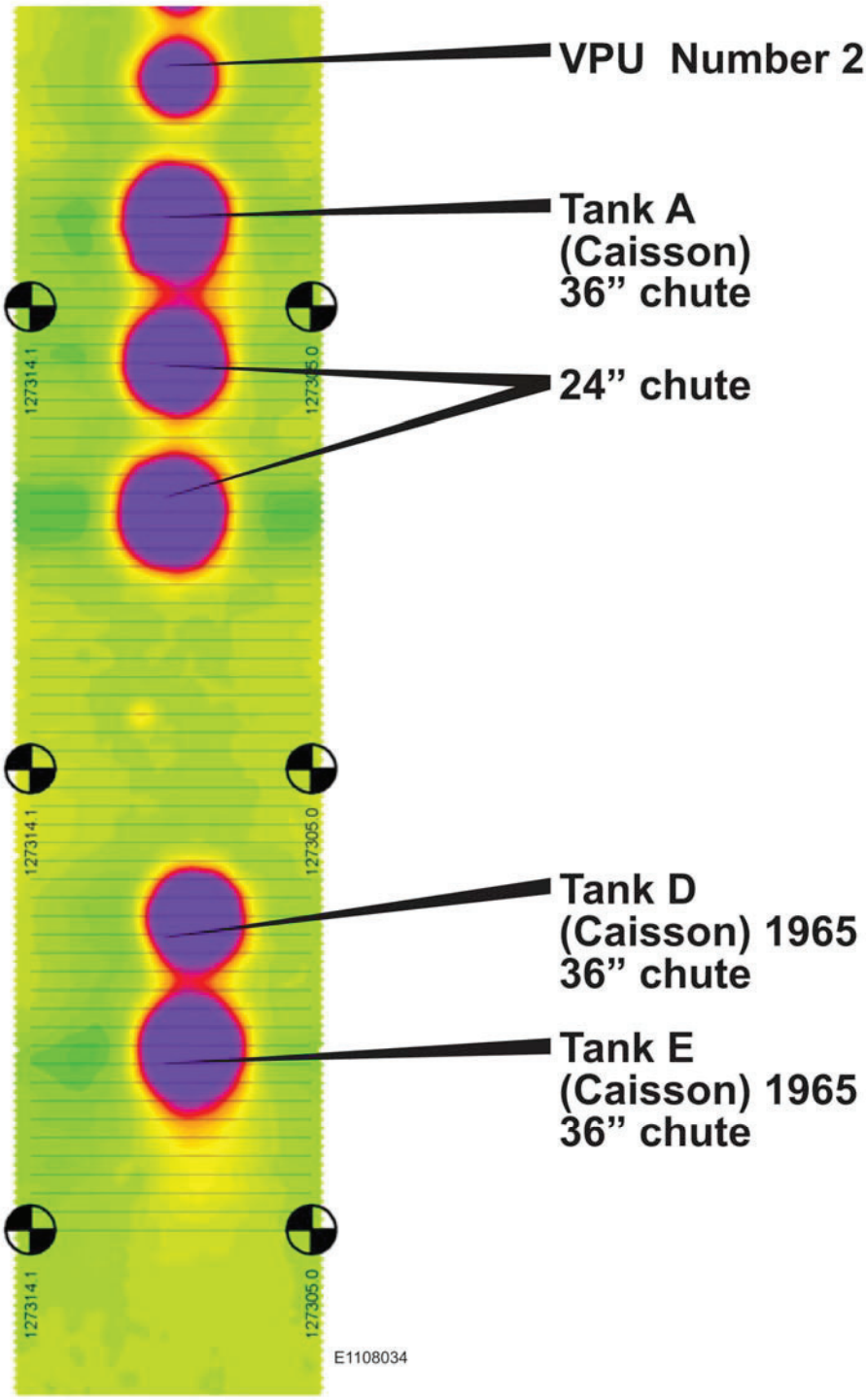


Figure 8. North Wind - Data Reports - High Resolution Geophysical Investigation, 618-11 Burial Ground Caissons.

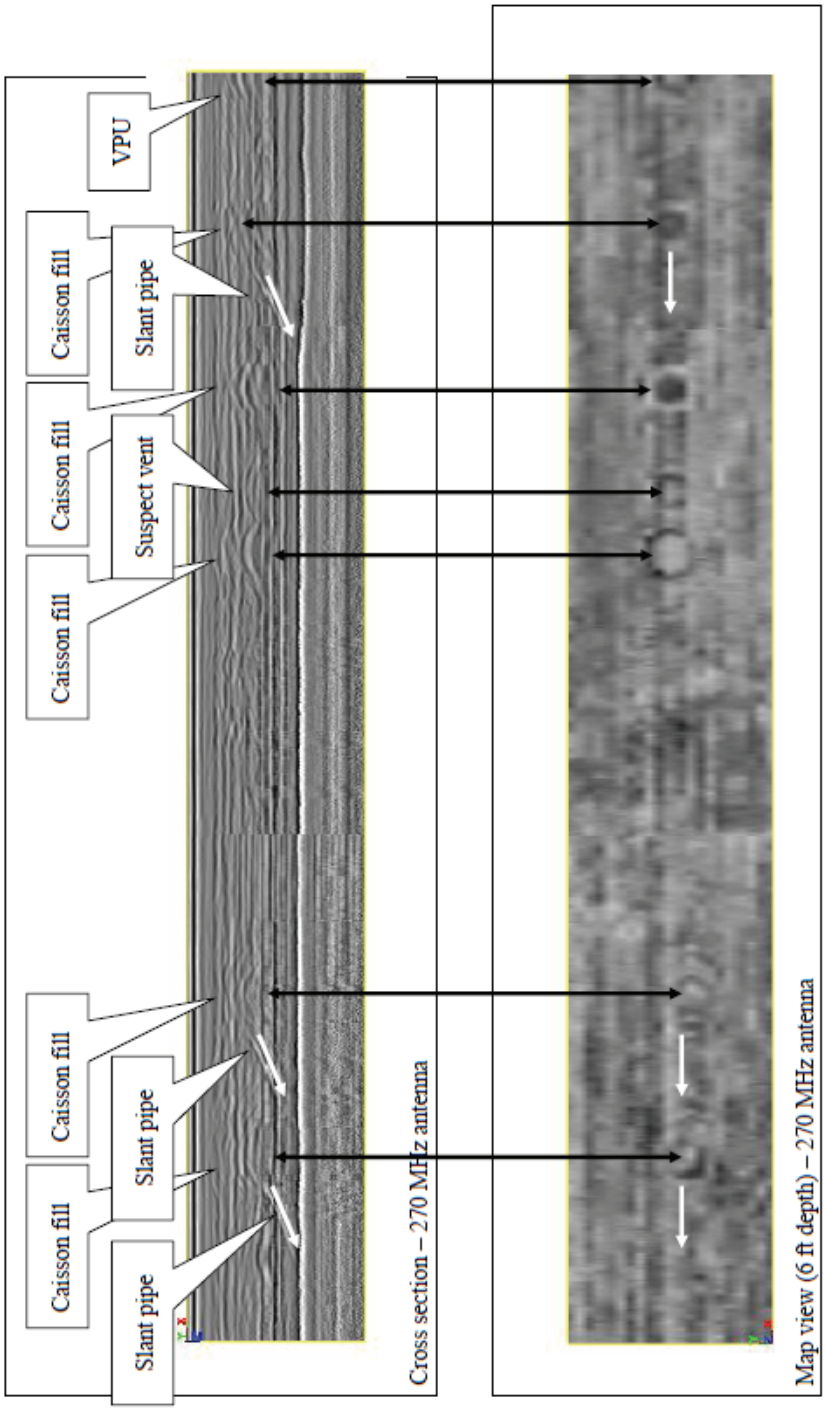


Figure #9 Representative GPR map figures– 270 MHz antenna, caissons (upper) cross section (lower) map view at 6 foot depth including chute orientation

Figure 9. 618-11 Burial Ground Caissons Layout and Configuration Based on Interpretation of Ground Penetrating Radar Data with Historical Records.

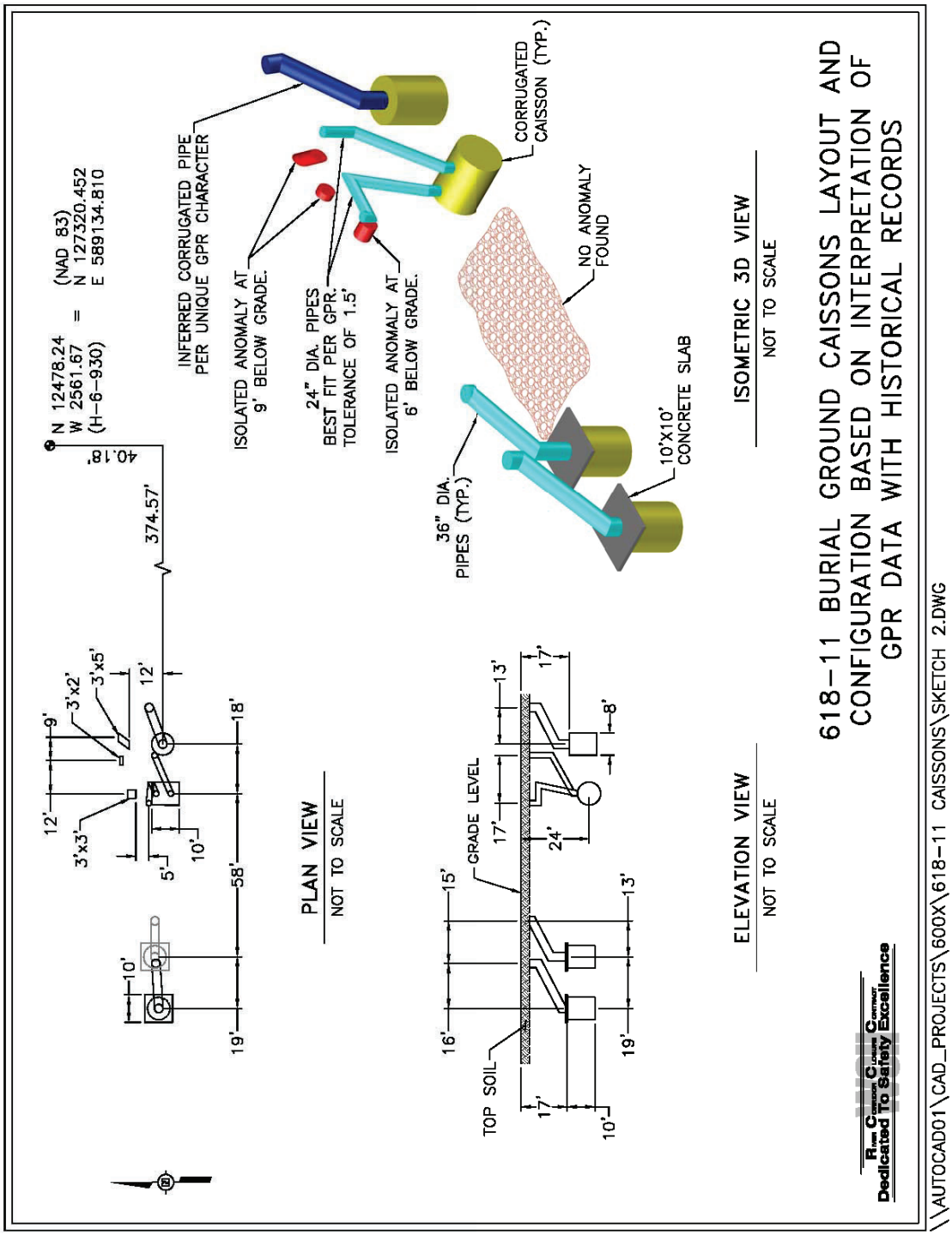
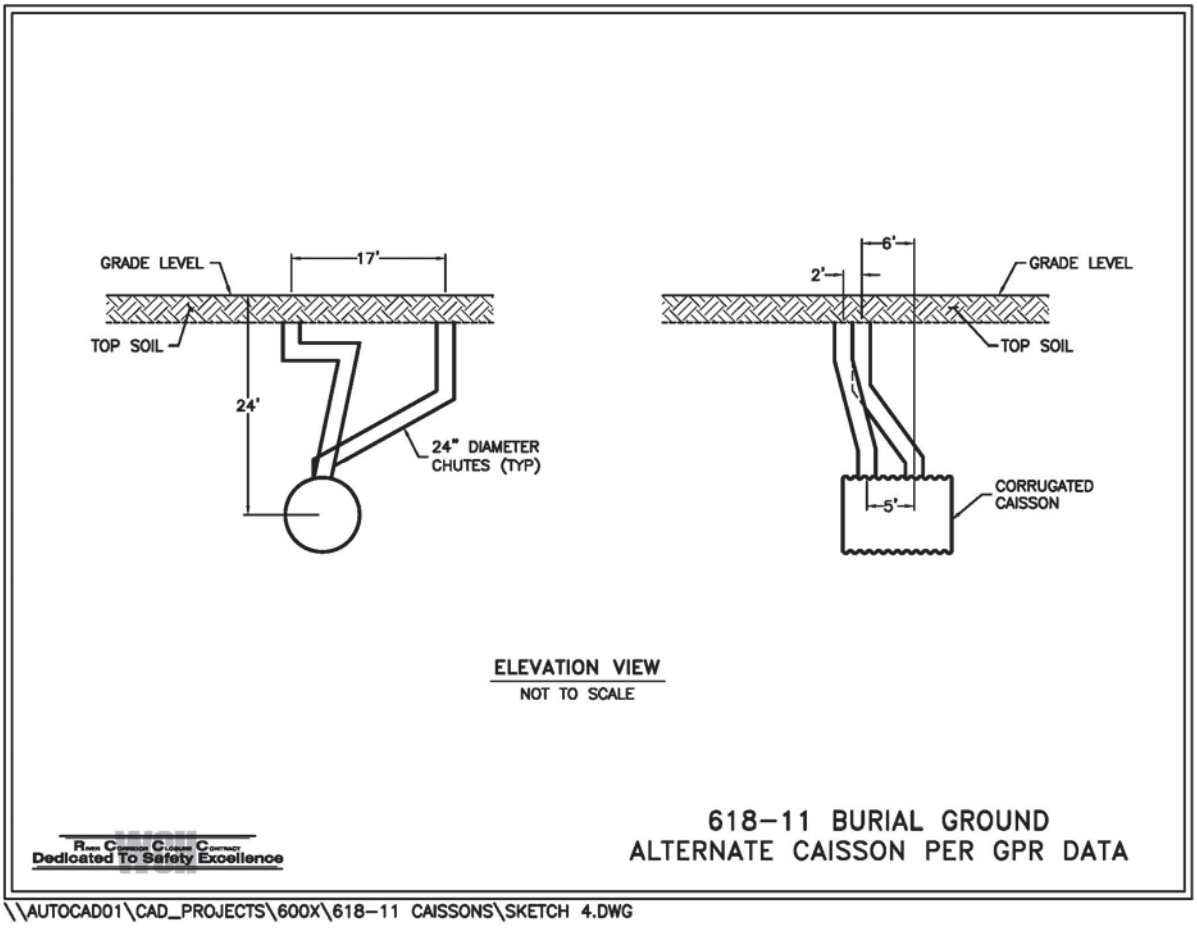


Figure 10. 618-11 Burial Ground Caisson with Double Offset Drop Pipe Configuration Based on Interpretation of Ground Penetrating Radar Data with Historical Records.



6.0 OTHER HISTORICAL REFERENCES

The following historical references are provided to complete this report. These references provided additional information that is important to make this investigation report complete.

605536, 1965, “300 Wye Burial Ground, January 14, 1965,” *Radiation Survey Report*, Battelle Memorial Institute, Richland, Washington.

HW-81019, 1964, *Hanford Laboratories Monthly Activities Report, February 1964,* Hanford Atomic Products Operation, General Electric, Richland, Washington.

HW-72103, 1962, “Radioactive Waste Handling at the Hanford Laboratory Radio-metallurgy Facility,” General Electric Company, Richland, Washington.

HW-79046, 1963, *Hanford Laboratories Monthly Activities Report, September 1963*, Hanford Atomic Products Operation, General Electric, Richland, Washington.

HW-83000, 1964, *Hanford Laboratories Monthly Activities Report, June 1964*, Hanford Atomic Products Operation, General Electric, Richland, Washington.

HW-83445, 1964, *Hanford Laboratories Monthly Activities Report, July 1964*, Hanford Atomic Products Operation, General Electric, Richland, Washington.

WHC-MR-0416, 1993, *Miscellaneous Information Regarding Operation and Inventory of 618-11 Burial Ground*, Westinghouse Hanford Company, Richland, Washington.

7.0 REFERENCES

00013, 1965, “327 Building Wye Burial Ground, March 1, 1965,” *Radiation Survey Report*, Battelle Northwest Laboratory, Richland, Washington.

00041, 1965, “300 Wye Burial Ground, March 10, 1965,” *Radiation Survey Report*, Battelle Northwest Laboratory, Richland, Washington.

00623, 1965, “300 Wye Burial Ground, October 21, 1965,” *Radiation Survey Report*, Battelle Northwest Laboratory, Richland, Washington.

01070, 1966, “300 Wye Burial Ground, May 11, 1966,” *Radiation Survey Report*, Battelle Memorial Institute, Richland, Washington.

01082, 1966, “300 Wye Burial Ground, May 19, 1966,” *Radiation Survey Report*, Battelle Memorial Institute, Richland, Washington.

01275, 1966, “Wye Burial Ground, November 4, 1966,” *Radiation Survey Report*, Battelle Memorial Institute, Richland, Washington.

605525, 1965, “300 Wye Burial Ground, January 12, 1965,” *Radiation Survey Report*, Battelle Memorial Institute, Richland, Washington.

ARH-183, 1967, *Specifications and Standards for the Disposal of Battelle Northwest Solid Wastes*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-220, *Radiation Protection Standards,* Atlantic Richfield Hanford Company, Richland, Washington.

BHI-00012, 1994, *300-FF-2 Operable Unit Technical Baseline Report*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-00291, 1997, *Geophysical Investigations of the 618-10 and 618-11 Burial Grounds, 300-FF-2 Operable Unit,* Rev. 1, Bechtel Hanford Inc., Richland, Washington.

BNWL-2184, 1977, *Initial Site Characterization and Evaluation of Radionuclide Contaminated Solid Waste Burial Grounds*,” Pacific Northwest Laboratories, Richland, Washington.

Cadwell, J. J., 1971, “Waste Management Records on In-Soil Stored Radioactivity,” external letter to T. A. Nemzek, U.S. Atomic Energy Commission, from J. J. Cadwell, Battelle Northwest, Richland, Washington, July 21.

DOE/RL-99-53, 2000, *Proposed Plan for the 300-FF-2 Operable Unit,* Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-93-49, 1993, *618-11 Burial Ground Expedited Response Action Proposal*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-40, 2000, *Focused Feasibility Study for the 300-FF-2 Operable Unit,* Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

GE, 1962-1964, *Hanford Laboratories Operation Monthly Activities Reports,* Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

HNF-EP-0649, 1997, *Characterization of the 618-11 Solid Waste Burial Ground, Disposed Waste, and Description of the Waste-Generating Facilities*, Rev. 0, Lockheed Martin Services, Richland, Washington.

HW-77274, 1963, *Burial of Hanford Radioactive Wastes*, Radiation Protection Operation, Hanford Laboratories, General Electric Company, Richland, Washington.

HW-84291, 1964, *Waste Disposal and Decontamination Monthly Report, September 1964*, General Electric Company, Richland, Washington.

North Wind, 2011, *High Resolution Geophysical Investigation, 618-11 Burial Ground Vertical Pipe Units & Caissons*, C019338A01-09-003-001A, North Wind Incorporated, Richland, Washington.

Pauly, T. R., 1990, *Engineering Study for Waste Receiving and Processing (WRAP) Facility Module 2*, WHC-SD-W100-ES-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

PNL-2557, 1980, *Characterization of the Hanford 300 Area Burial Grounds, Final Report Decontamination and Decommissioning*, Pacific Northwest Laboratory, Richland, Washington.

WHC-MR-0388, 1992, *Past Practices Technical Characterization Study – 300 Area – Hanford Site*, Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0400, 1982, *Engineering Assessment of Low-Level Liquid Waste Disposal Caisson Locations at the 618-11 Burial Ground,"* Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0440, 1993, *Multiple Missions: The 300 Area in Hanford Site History*, Westinghouse Hanford Company, Richland, Washington.

WMP-21465, 2004, *Update to Geophysical Investigations of the 618-10 and 618-11 Burial Grounds, 300-FF-2 Operable Unit,* Rev. 0, Fluor Hanford, Inc., Richland, Washington.

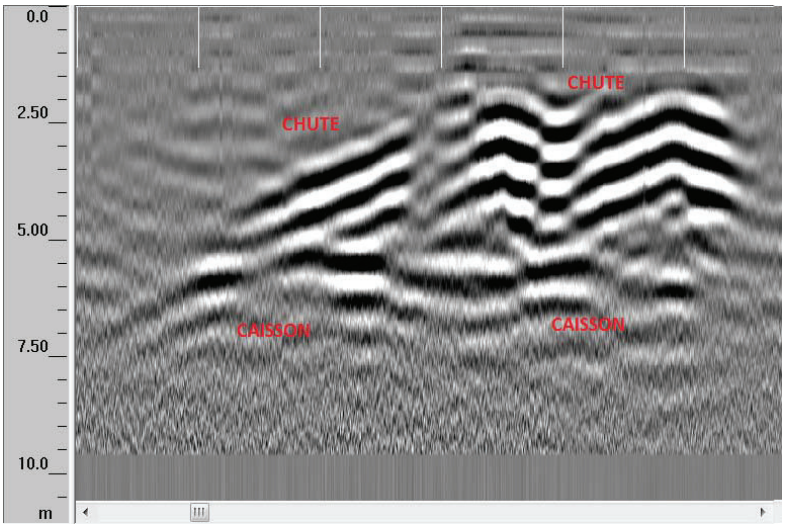
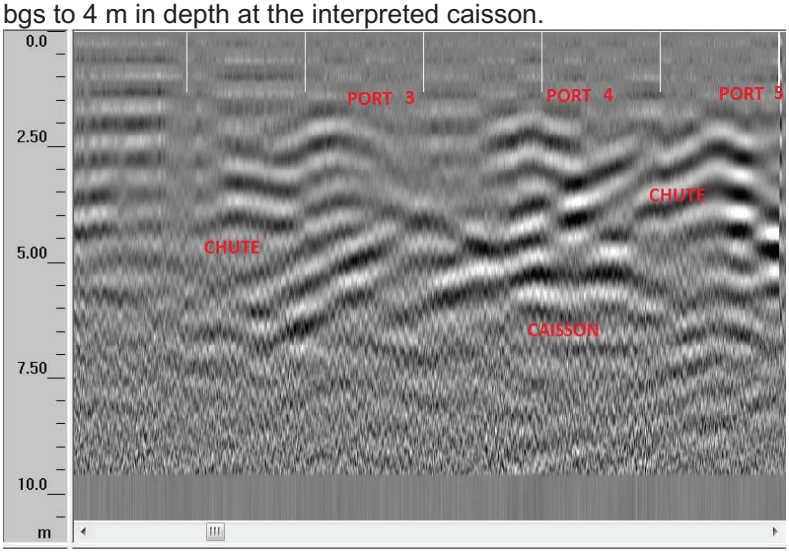
APPENDIX A

618-11 BURIAL GROUND PENETRATING RADAR DATA AND SKETCHES

APPENDIX A

618-11 BURIAL GROUND GROUND PENETRATING RADAR DATA AND SKETCHES

Geophysical Investigation Summary Sheet (GI# 0621203)	
Site	618-11 Caisson Area
Date	08/3/11 & 08/04/11
Approximate size	40 x 10 m
Terrain	Flat, clean gravel/sand
Vegetation/ground cover	none
Weather	Dry
Limitations/obstacles	N/A
Equipment	
Ground Penetrating Radar (GPR)	Geophysical Survey Systems, Inc., SIR3000 control unit with Model 5104 (270MHz) & 3207AP and 3207F (100MHz with high power transmitter and fiber optic link) antennas
Time Domain Electromagnetic Induction (EM61)	Geonics EM61-MK2 , HH (Hand-held) and 0.5 x 1.0 m coil configuration in wheel mode
Investigators	
Kevin Bergstrom	Washington Closure Hanford 509.378-0942
Tom Mitchell	Washington Closure Hanford 509.5549182
Mark Villa	Geophysical Survey LLC 509.222-0933
Data Collection and Processing Parameters	
Grid location control and data collection lines	A Trimble [1] ProXRT Differential Global Positioning System (VRS mode) was used to establish a control grid. A surveyors tape was used to mark grid points between control points on 1 m spacing. [1] Trimble is a trademark of Trimble Navigation Limited, Sunnyvale, California
SIR3000	GPR data was collected on 0.5 m spacing in both N-S and E-W directions with the 270 MHz antenna. Location control was established using a survey wheel and marked grid. Data were collected at 50 scans per meter with a 75 ns window, gains and filters set in field to match soil conditions. Data was processed using Radan V6.6 I3Dsoftware. GPR data were collected on 1.0 m spacing in both N-S and E-W directions with the 100 MHz antenna. Location control was established using a survey wheel and marked grid. Data were collected at 40 scans per meter with a 200 ns window, gains and filters set in field to match soil conditions. Data was processed using Radan V6.6 I3Dsoftware.
EM61-MK2	The EM61-MK2 (0.5 x 1.0 m coils) data were collected along N-S profiles spaced 1-m apart with data readings along each profile spaced ~0.2-m apart. Data were processed and contoured with Surfer V 8.08 software.
EM61-HH-MK2 option	The EM61HH data were collected along N-S profiles spaced 1-m apart with data readings along each profile spaced ~0.2-m apart. Data were processed and contoured with Surfer V 8.08 software.
Results	
Data Discussion/	Refer to 618-11 Caisson Interpretation (Figure 7) for discussion of anomalies.

Geophysical Investigation Summary Sheet (GI# 0621203)	
Interpretation	Near surface features Port 1 & 2 (see Figure 7) each have an associated high amplitude flat reflector present at a depth of 5 m. These flat reflectors are interpreted as caissons. Each port has a parabolic reflector sloping from a depth of approximately 2 m to a depth of 4 m. These reflections are consistent with the chute/caisson design shown in Figure 2 included in report BHI-00012, Rev 0, 300-FF-2 Operable Unit Technical Baseline Report, D. H. Deford, R. W. Carpenter, M. W. Einan, August 1994. Figure 1 below is a 1-D west to east GPR profile showing the features discussed above.  **Figure 11** Port 5 (see figure 7) has an associated high amplitude flat reflector at a depth of ~5 m which is similar to the two interpreted caissons at the west end of the survey area. The interpreted caisson associated with Port 5 is shown in Figure 2. A parabolic reflector slopes down to the west from Port 5, starting at ~2 m bgs to 4 m in depth at the interpreted caisson.  **Figure 12**

Geophysical Investigation Summary Sheet (GI# 0621203)	
	The parabolic reflector associated with the chute from Port 5, interpreted from N-S GPR profiles, is a sloping chute similar to the interpreted chutes at Ports 1 & 2, but with a lower amplitude character (see Figure 3). It is possible this is due to a different chute configuration or pipe culvert material, as possibly suggested in DOE/RL-99-53, Rev 0, 300-FF-2 operable Unit Transuranic-Contaminated Burial Grounds.

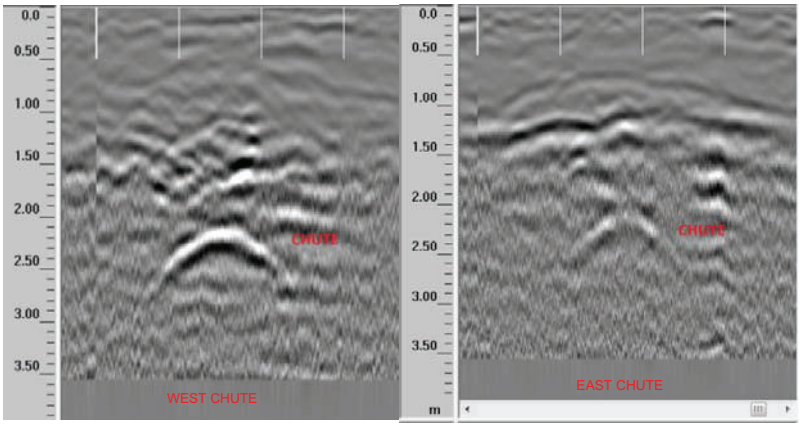


Figure 13

Ports 3 & 4 (see Figure 7) do not display a reflector at a depth of 5 m consistent with the caissons associated with Ports 1, 2 & 5. Figure 2 displays an interpreted chute sloping downward to the west from Port 4, to a depth greater than the chute extending from Port 5.

The fourth interpreted caisson does not have a character typical of the other three caissons (Figure 4). There is no flat character in the radar reflections and it is at a depth of approximately 6 m. Diffractions from the caisson directly to the east and the sloping chute above partly mask the target and it is not imaged as clearly as the other three interpreted caissons.

Geophysical Investigation Summary Sheet (GI# 0621203)

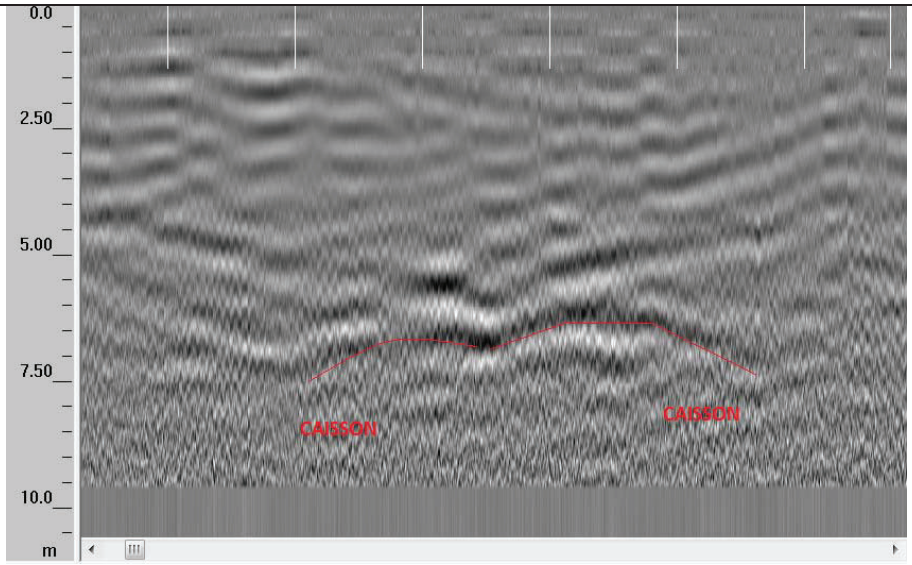


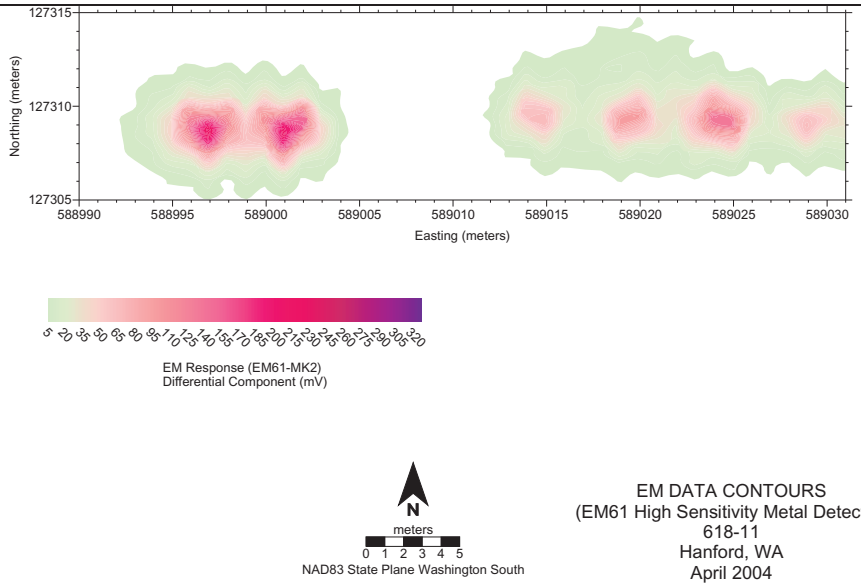
Figure 14

The reflections at 6 m, while not as clear, are consistent over a series of three west to east profiles.

Parabolic reflections (pipe like anomalies) are present north of Ports 3 & 4. These features appear to be isolated targets and not clearly associated with the caissons or chutes. These anomalies are shown in magenta in Figure 7.

Figure 5 is the contoured data from the high sensitivity metal detector (EM61) configured to respond to features up to 3 to 4 m deep. Note the subtle response to metal to the north of interpreted Ports 3, 4, and 5. This is likely from the isolated targets shown in Figure 7 and detected with GPR. The most eastern anomaly in this figure, at about E589029, is an interpreted VPU. Also note the highest and similar amplitudes of the anomalies associated with Ports 1 and 2 suggesting similar designs, but different from Ports 3, 4, and 5. Ports 3 and 4 have the lowest amplitudes of the five Ports, suggesting less metal, smaller diameters, and/or thinner wall thickness.

Geophysical Investigation Summary Sheet (GI# 0621203)



Note: Geonics EM61 0.5 x 1.0 m coil

Figure 5.

Figure 6 is the contoured data from the high sensitivity metal detector (EM61HH) configured to respond to features up to about 1 to 2 m deep. Note that the features north of Ports 3, 4, and 5 are not detected in this data. This is likely from the isolated targets shown in Figure 7 and detected with GPR. Once again, the most eastern anomaly in this figure, at about E589029, is an interpreted VPU. The relative amplitudes of the anomalies are similar to that discussed above for Figure 5. The deeper metal that might be associated with a caisson would not be detected in this data set.

Geophysical Investigation Summary Sheet (GI# 0621203)

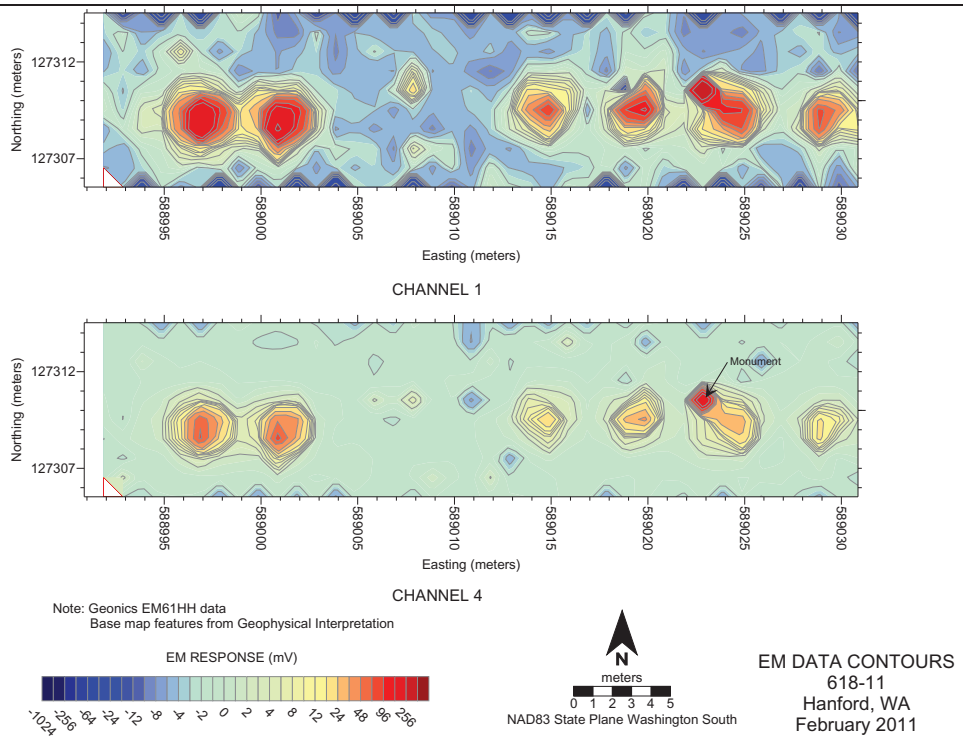


Figure 6

Geophysical Investigation Summary Sheet (GI# 0621203)

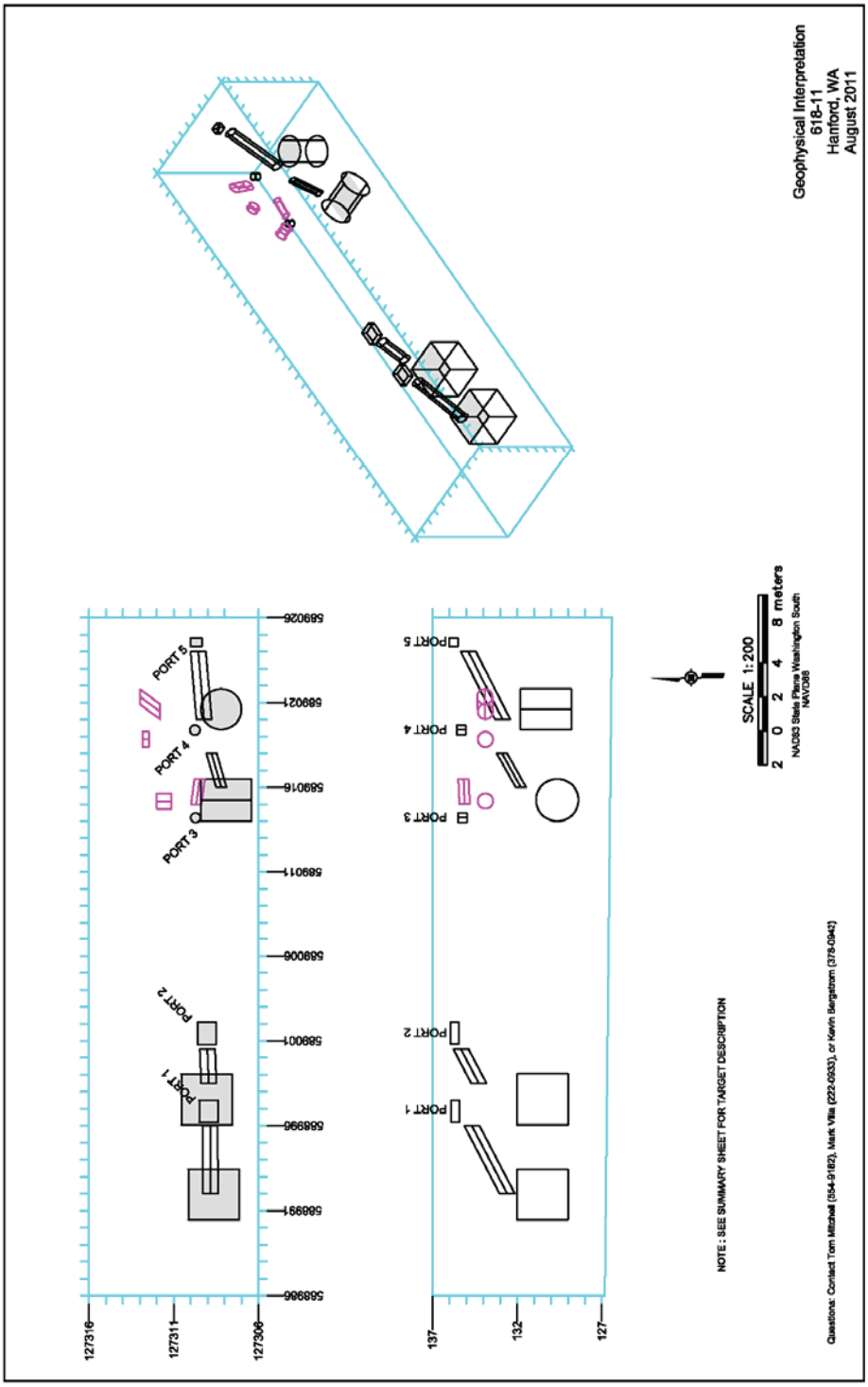


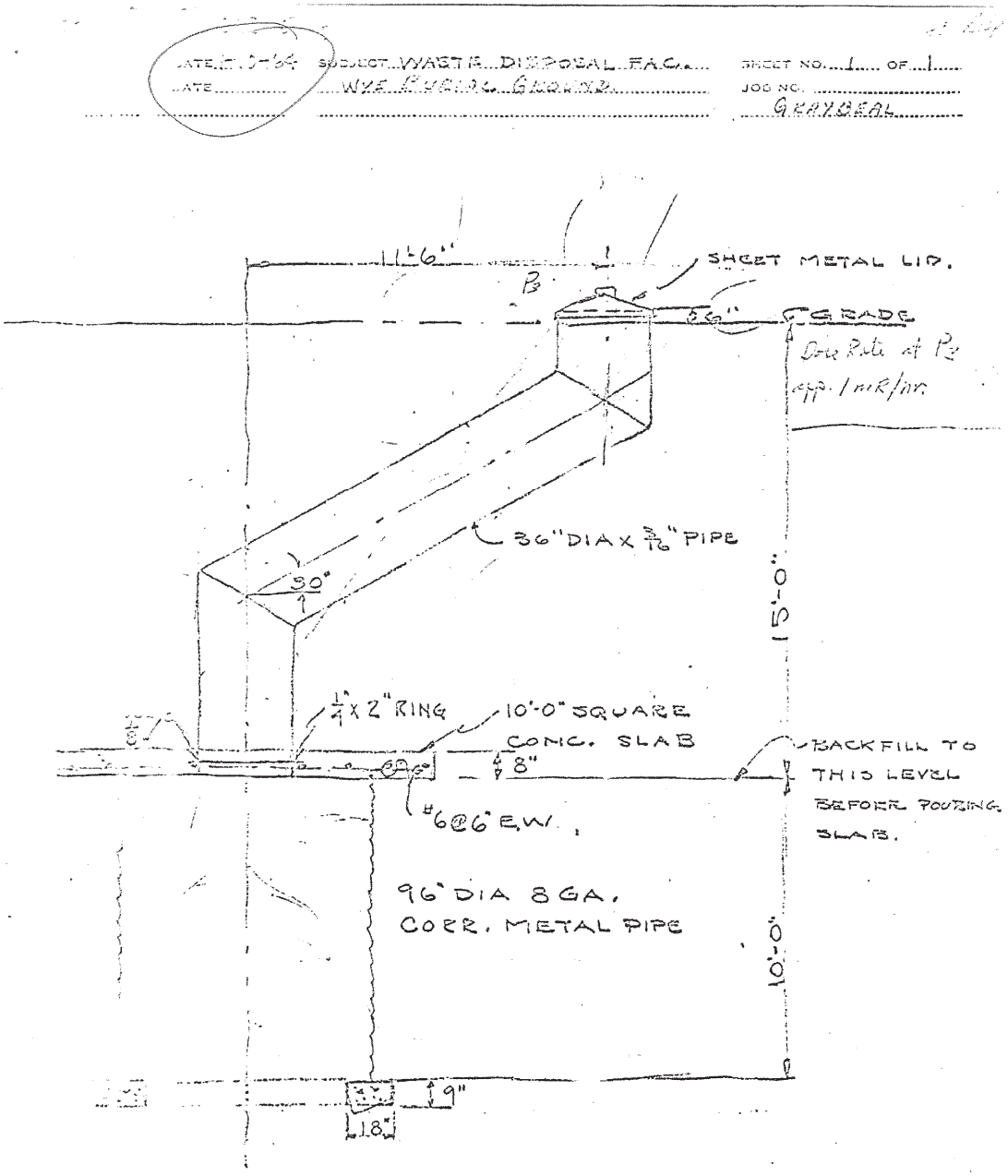
Figure 7

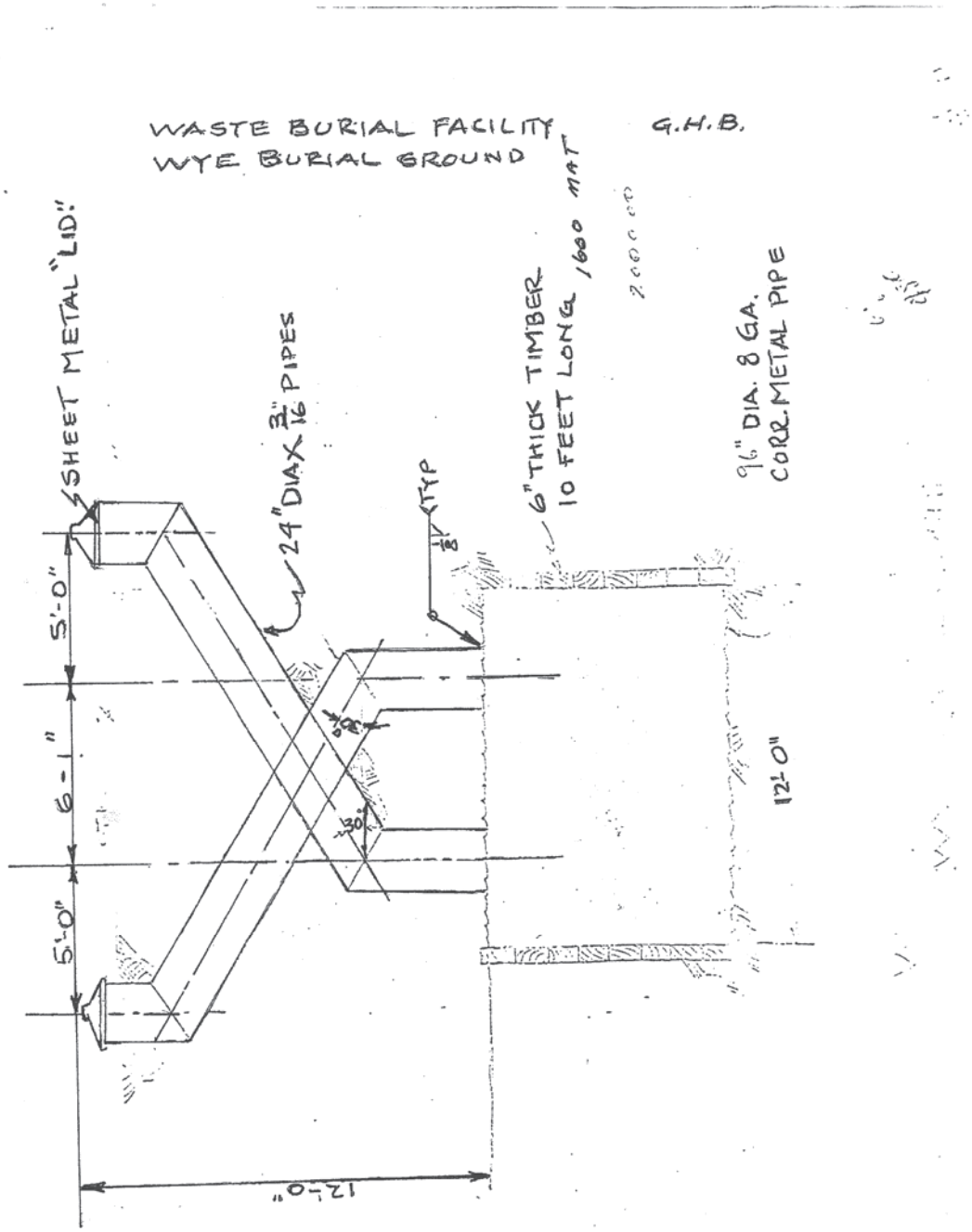
APPENDIX B

WYE BURIAL GROUND WASTE DISPOSAL FACILITY

APPENDIX B

WYE BURIAL GROUND WASTE DISPOSAL FACILITY




WASTE BURIAL FACILITY
WYE BURIAL GROUND
G.H.B.
SHEET METAL "LID"
24" DIA X 3/16" PIPES
TYP
6" THICK TIMBER
10 FEET LONG
1600 MAT
96" DIA. 8 GA.
CORR. METAL PIPE
5'-0"
6'-1"
5'-0"
12'-0"
12'-0"
45°
30°

WASTE BURIAL FACILITY 4-4-72
WYE BURIAL GROUND

72" Ø GA PIPE (ARMCO'S RECOMM

CALCULATE LOADS TIMBER END STAKE

CONSIDER CONCENTRATED LOAD ON SURF
OF 16000# (WHEEL LOAD FOR H-20 LO
CREATES LATERAL PRESSURE 16'-0" UN
GROUND OF:

USE FORMULA P. 342 "SPANGLER"

$$p_h = P\frac{X^2 z}{R^5}$$

LOCATE POSITION TO PRODUCE
MAX HORIZONTAL UNIT PRESSURE

	X^2	z	R	X^2z	$\frac{X^2z}{R^5}$
5	25	16	16.77	400	.0000301
10	100		18.85	1600	.000671
15	225		21.15	3600	.000671
20	400		25.20	6400	.000585
25	625		29.65	10000	.000434

MAX PRESSURE OCCURS WHEN X = 15

$$p_h = (16000)(.000671)$$
$$p_h = 11.36\ ^{\#}/\square'$$

DOUBLE p_h FOR TWO WHEEL LOADS
TOTAL PRESSURE

$$p = (2.0)(16) + (2)(11.36) = 54.72\ ^{\#}/\square'$$

FROM "WOOD STRUCTURAL DESIGN DATA"
6" THICK TIMBER IS WILL CARRY LOAD

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