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M. B. Walter
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November 1984

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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A FIELD LYSIMETER FACILITY FOR EVALUATING THE PERFORMANCE OF COMMERCIAL SOLIDIFIED LOW-LEVEL WASTE

M. B. Walter
M. J. Graham
G. W. Gee

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Pacific Northwest Laboratory
Richland, Washington 99352

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SUMMARY

Shallow land burial is being used as a disposal method for commercial low-level wastes at waste disposal sites in Beatty, Nevada, the Hanford site near Richland, Washington, and Barnwell, South Carolina. The current trend in low-level waste management is to solidify liquid wastes from commercial power reactors with a solidifying agent (e.g., cement) and then ship the wastes to one of these waste disposal sites. This trend is encouraged by transportation regulations as well as the waste stabilization requirements contained in 10 CFR-Part 61 (NRC 1982).

Analyzing the potential migration of radionuclides from sites containing these wastes requires knowledge of contaminant concentrations in the soil solution surrounding the waste. This soil solution concentration is generally referred to as the source term and is determined by such factors as the concentration of radionuclides in the solid waste, the rate of leachate formation, the concentration of dissolved species in the leachate, any solubility reactions occurring when the leachate contacts the soil, and the rate of water flow in the soil surrounding the waste.

A field lysimeter facility established at the Hanford site is being used to determine typical source terms in arid climates for commercial low-level wastes solidified with cement, Dow polymer[a] (vinyl ester-styrene), and bitumen. The field lysimeter facility consists of 10, 3-m-deep by 1.8-m-dia closed-bottom lysimeters situated around a 4-m-deep by 4-m-dia central instrument caisson. Commercial cement and Dow polymer[a] waste samples were removed from 210-L drums and placed in 8 of the lysimeters. Two bitumen samples are planned to be emplaced in the facility's remaining 2 lysimeters during 1984. The central caisson provides access to the instrumentation in the individual lysimeters and allows selective sampling of the soil and waste. Suction candles (ceramic cups) placed around the waste forms will be used to periodically

(a) Product of the Dow Chemical Co., Midland, MI 48640.

collect soil-water samples for chemical analysis. Meteorological data, soil moisture content, and soil temperature are automatically monitored at the facility.

Characterization of the soils and waste forms have been partially completed. These data consist of moisture release characteristics, particle-size distribution, and distributions and concentrations of radionuclides in the waste forms.

CONTENTS

FIGURES

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INTRODUCTION

Low-level radioactive wastes generated by commercial nuclear power reactors have been disposed of in licensed shallow land burial (SLB) sites since 1962 (O'Connell and Holcomb 1974). Three active low-level waste disposal sites currently exist (Holcomb 1980). Two sites are in the arid West (Hanford site near Richland, Washington; and Beatty, Nevada), and one site is in the humid Southeast (Barnwell, South Carolina). The current trend in low-level waste management is to solidify liquid wastes from commercial power reactors with a solidifying agent and then ship the wastes to one of these waste disposal sites. The solidifying agents in use or being evaluated for use are cement, bitumen, and Dow polymer[a] (vinyl ester-styrene). This trend is encouraged by transportation regulations as well as the waste stabilization requirements contained in 10 CFR-Part 61 (NRC 1982). To predict the performance of solidified commercial wastes in SLB sites, information is required on the contaminant concentrations in the soil solution surrounding the waste. This soil solution concentration is generally referred to as the source term and is determined by the concentration of radionuclides in the solid waste, the rate of leachate formation, the concentration of dissolved chemical species in the leachate, solubility reactions occurring when the leachate contacts the soil, and the rate of water flow in the the soil surrounding the waste.

The Department of Energy (DOE) has initiated research programs to quantify the performance of solidified commercial low-level wastes for humid SLB sites (Special Waste Form Lysimeters-Humid Program at the Savannah River site near Aiken, South Carolina) and for arid SLB sites (Special Waste Form Lysimeters-Arid Program at the Hanford site). The cornerstone of these research programs is the construction of lysimeter facilities, which are being used to conduct field-scale waste-form leaching tests. The use of lysimeters permits direct measurements of the migration of radioactivity from these waste forms. Measurement of the factors affecting this migration is also possible. These data will provide a technical basis for predicting how these waste forms will perform in actual SLB sites. The purpose of this document is to describe the

(a) Product of the Dow Chemical Co., Midland, MI 48640.

field lysimeter facility constructed at the Hanford site by Pacific Northwest Laboratory (PNL) as part of DOE's low-level waste management research efforts. In addition to the field monitoring, which is the central purpose of the program, a series of laboratory testing and geochemical modeling exercises is being conducted. The goals of the laboratory and modeling work are to identify which mechanisms are controlling the release of radioactivity from the waste forms.

SITE SELECTION AND DESCRIPTION

Selection of a site for the field lysimeter facility was based on several criteria: 1) a controlled government reservation where radionuclides could be used in situ within the facility; 2) a controlled area with limited public access; 3) a site where geologic media was uncontaminated (i.e., at or below background radiation levels with respect to isotopes used); 4) a nominally flat topography such that boundary effects would be minimized; 5) a site where the water table was at a sufficient depth to allow the facility to remain under partially saturated conditions at all times; 6) a site where the geologic media was analogous to that media actually used for SLB of radioactive materials and could be made isotropic and homogeneous; and 7) a site where a well was available.

The site selected in accordance with the above criteria is located adjacent to an existing buried waste test facility site in southeastern Washington State (Figure 1), and to lysimeters used in another low-level waste research program (Phillips et al. 1979). The location of this facility is also ~30 km from the commercial low-level waste burial site, operated by U.S. Ecology Company, on the DOE Hanford site (see Figure 1). Classified as a shrub-steppe grassland (Daubenmire 1970), the field lysimeter site is located on a river terrace plain within the Hanford site, ~3.5 km from the Columbia River. Figure 2 shows the general topography of the area.

The geologic material consists of glaciofluvial sediments deposited during the Pleistocene Epoch. Eolian sands mantle the ground surface at the site. The undisturbed sediments consist predominately of horizontally deposited units of coarse to medium sands with lenses of sands containing gravels and cobbles.

The water table at the test facility occurs at an approximate depth of 13 m. Several saturated zone monitoring wells are located within 100 m of the site. Two of these wells have permanently installed submersible pumps, thereby providing a permanent, accessible water supply. Having water available is important if a decision is made to irrigate selected lysimeters.

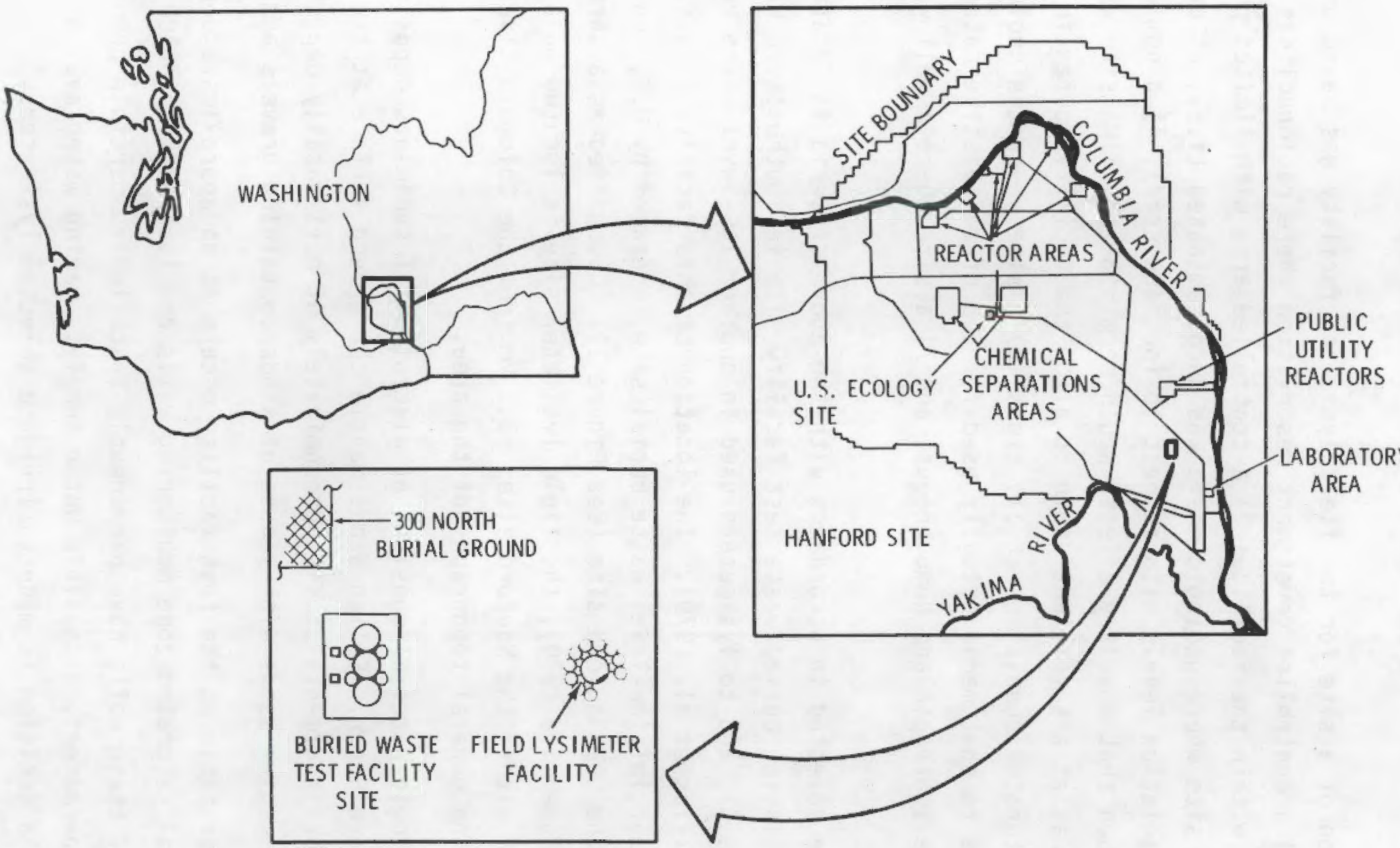

FIGURE 1. Location of Field Lysimeter Facility Within the Hanford Site

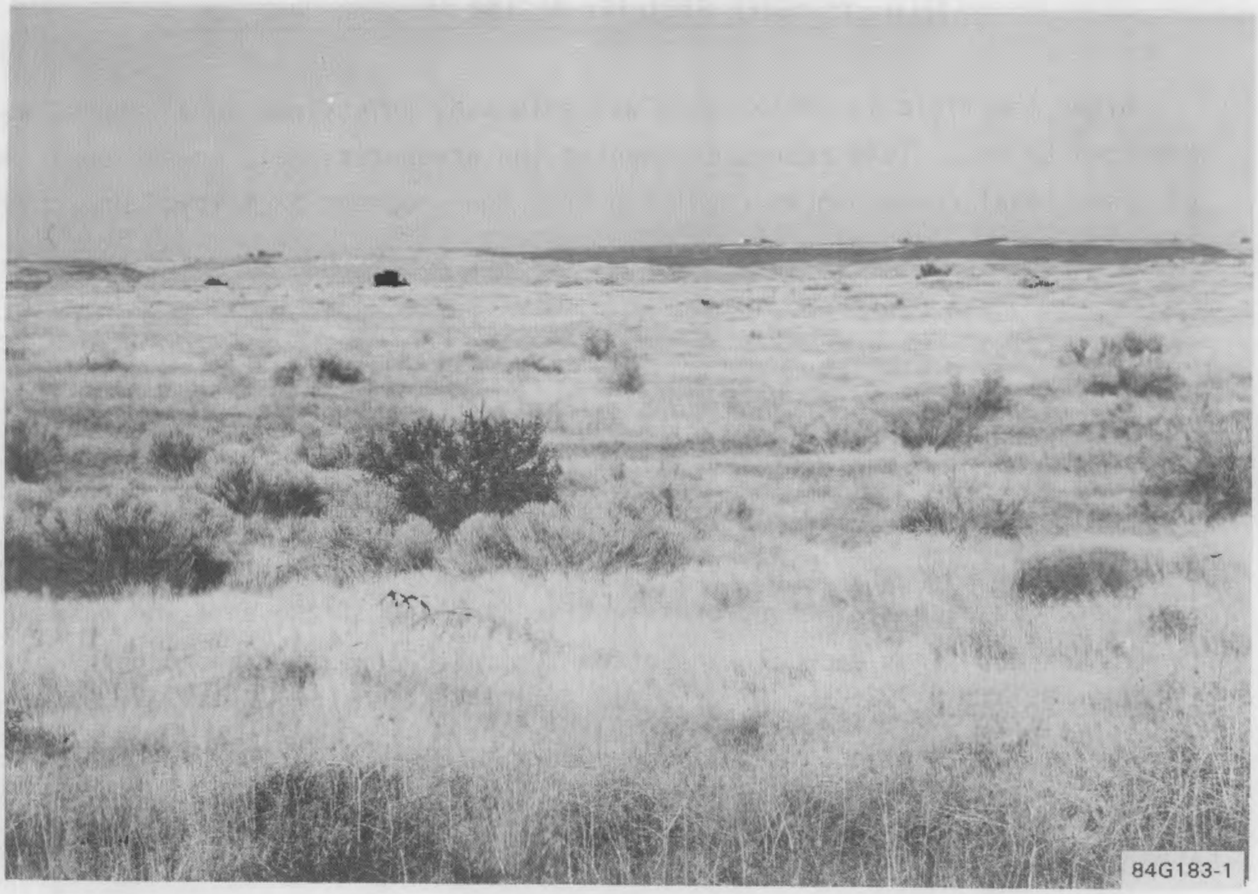

FIGURE 2. General Topography of the Area Surrounding the Field Lysimeter Facility

FIELD LYSIMETER FACILITY DESIGN AND CONSTRUCTION

After the field lysimeter site was selected, an environmental report was submitted to DOE. This report documented the preoperational, operational, and postoperational consequences resulting from the proposed facility. On approval of the report, facility design and construction proceeded.

FACILITY DESIGN

The field lysimeter facility is designed to accommodate 10 waste forms. Ten 3-m-deep by 1.8-m-dia closed-bottom lysimeters are arranged around a 4-m-deep by 4-m-dia central instrument caisson (Figure 3). The central caisson houses all data and sample collection equipment while providing access to sampling ports in each lysimeter for selective sampling of the soil and waste forms. Leachate from each closed-bottom lysimeter drains to the central caisson where it can be collected, measured, and sampled. Engineering drawings of the facility are included in the Appendix.

EXCAVATION

Two excavations were performed to prepare the field lysimeter site for installation of 1 instrument caisson and 10 lysimeter caissons. One dig removed ~585 m^3 of soil and rock forming a hole ~3.5 m deep, 20 m in diameter at the soil surface, and 10 m in diameter at the bottom. A second dig removed an additional 21 m^3 of material for placement of the instrument caisson in the center of the lysimeter cluster. This second hole brought the depth at the center to ~4 m with a bottom hole diameter of ~6 m.

The soil material removed from the excavation was stockpiled adjacent to the construction site and used as backfill in and around the caissons.

CONSTRUCTION

Construction of the facility proceeded in the following steps: 1) pouring the concrete structural pads, 2) emplacing the caissons, 3) connecting the

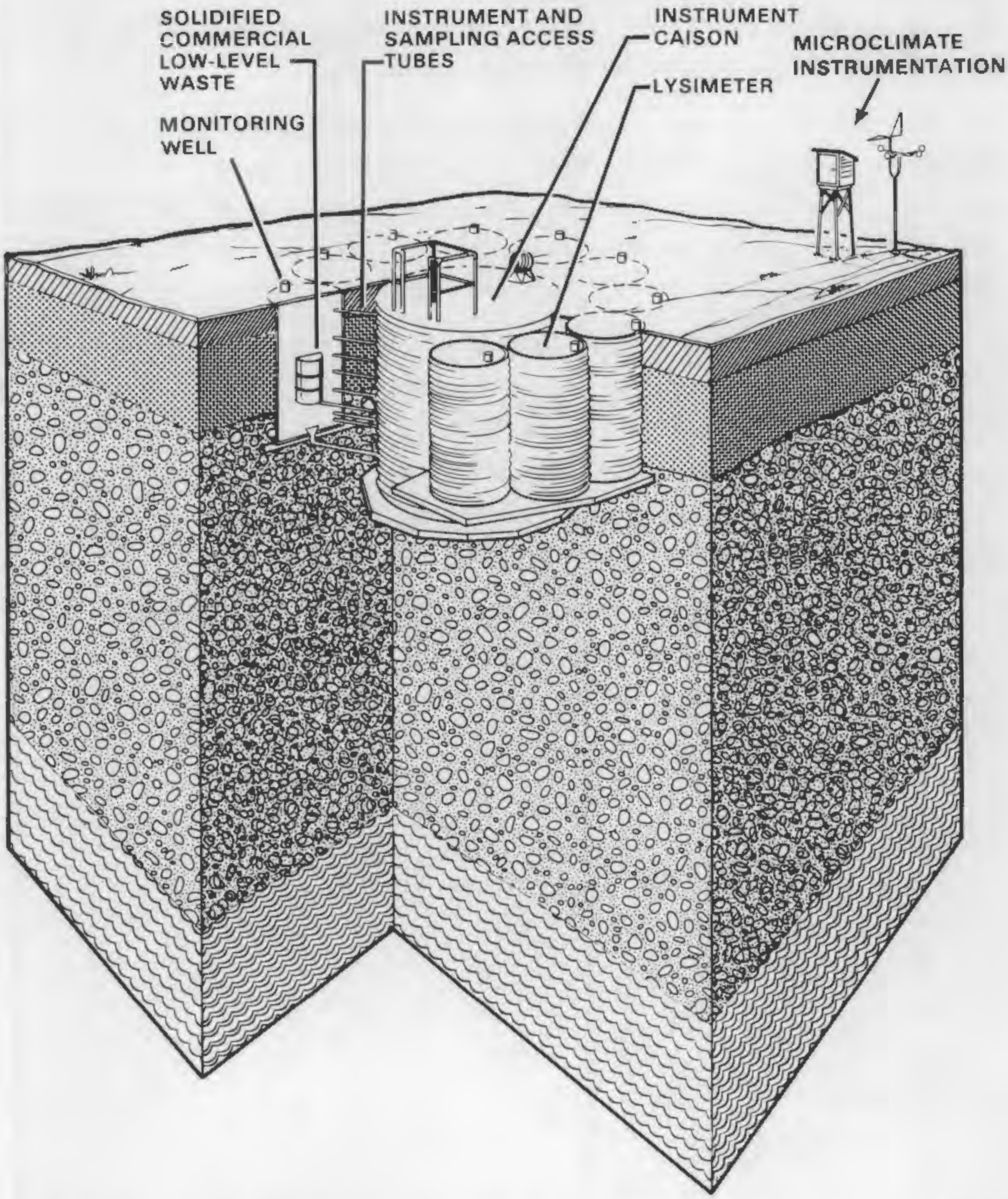

FIGURE 3. Conceptual Drawing of the Field Lysimeter Facility for the Special Waste Form Lysimeters-Arid Program

sampling ports between the instrument caisson and lysimeter caissons, 4) backfilling around the caissons, 5) sealing the inside surface of the lysimeters, and 6) backfilling inside the lysimeter caissons.

The 4-m-dia caisson in the center of the cluster was placed on a concrete pad at ~4 m below the soil surface in the center of the excavation (Figure 4). Drainlines were run under the steel reinforcement for the lysimeter pad (Figure 5), which was then poured at ~3.2 m below ground level, and the individual lysimeters were set into the concrete (Figure 6 and Appendix A.2).

The caissons for the lysimeters were formed from galvanized, corrugated steel. Seven 5-cm-dia sampling ports connect each lysimeter to the instrument caisson. Six of these ports extend 15 cm to the lysimeter caisson and one extends 91 cm to the middle of the caisson to facilitate near-source-term destructive sampling (Appendix A.5). Epoxy paint was applied to all inside surfaces of the caissons to further seal the lysimeters.

Soil from the excavation was used to backfill around the outside of the facility. At the end of 1983, the lysimeters had been covered as a safety precaution and to prevent intruding rainfall, and were ready to receive waste (Figure 7).

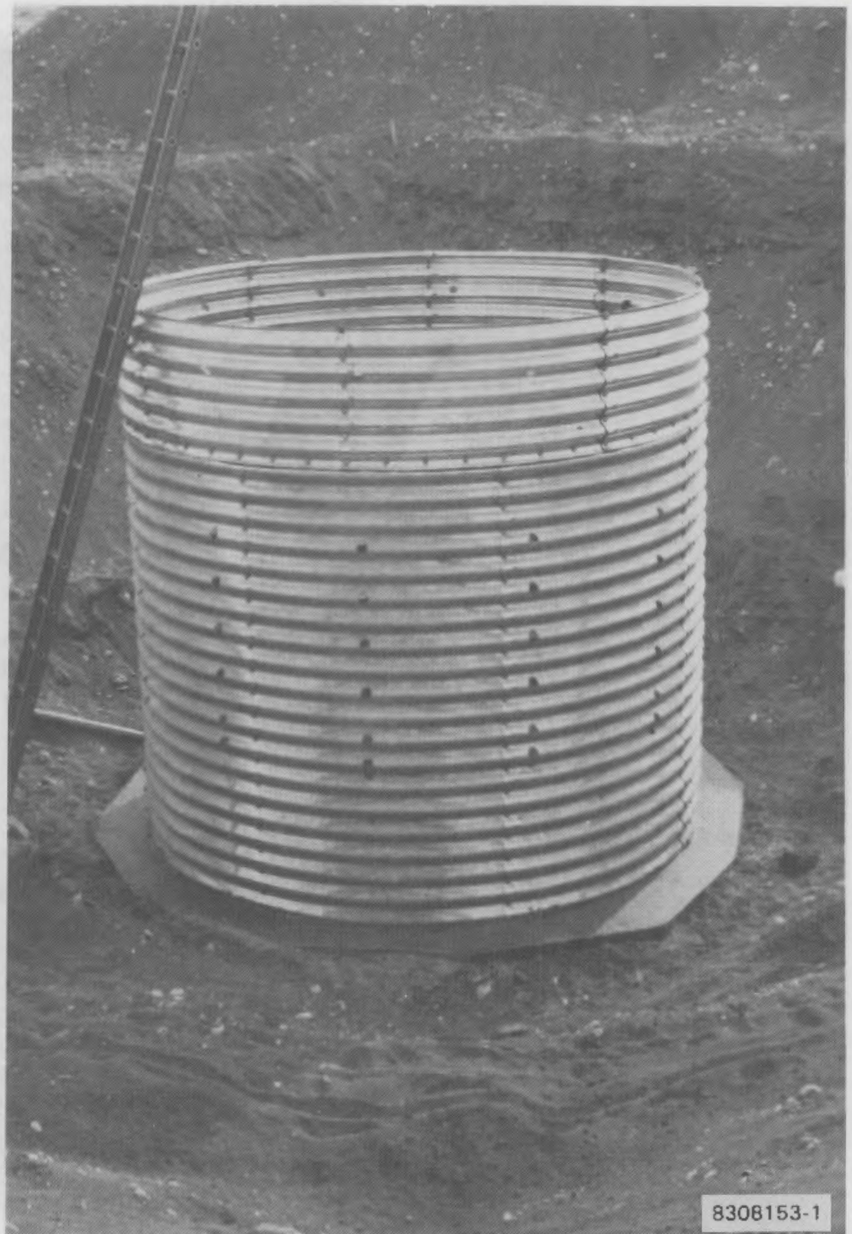

FIGURE 4. Central Instrument Caisson on Concrete Pad in Center of Excavation

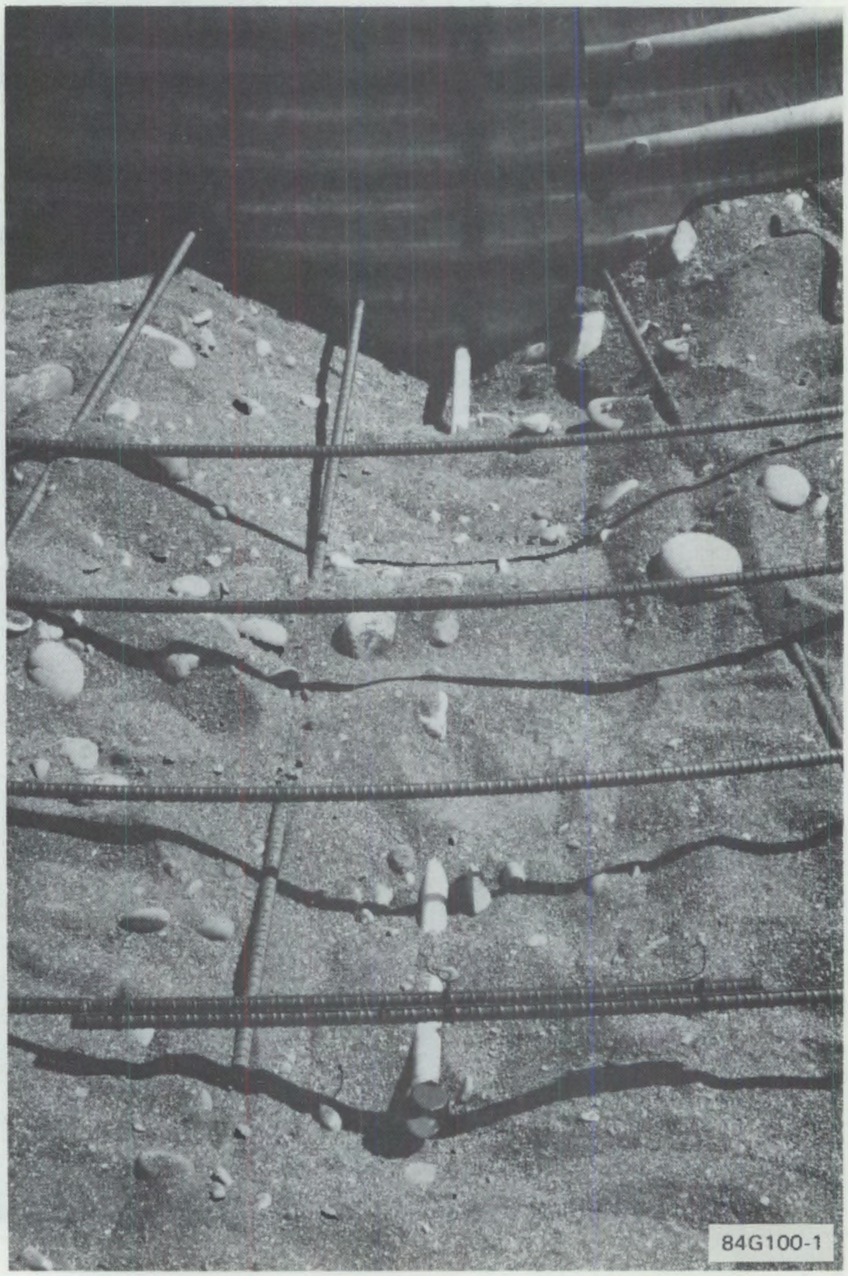

FIGURE 5. Drainline from a Lysimeter to the Instrument Caisson

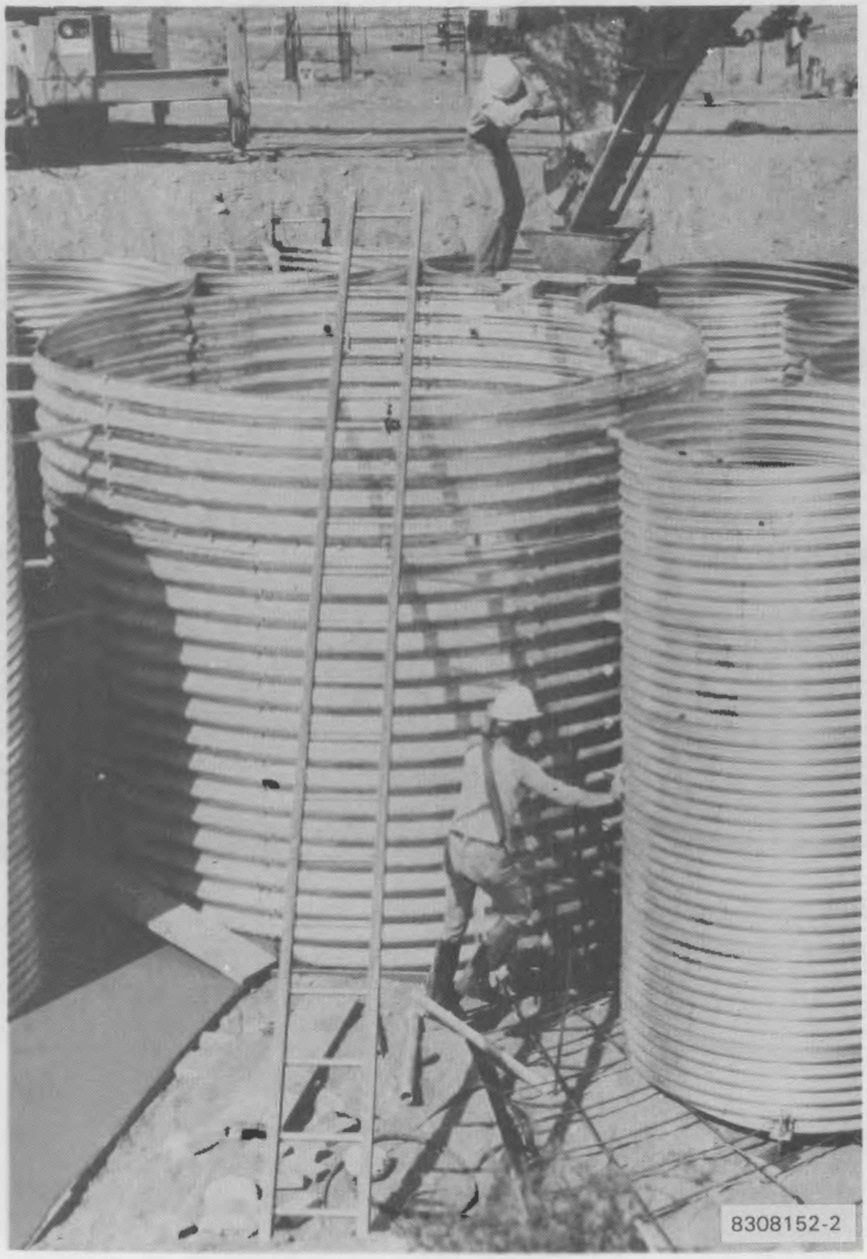

FIGURE 6. Lysimeters Embedded in Cement Pad

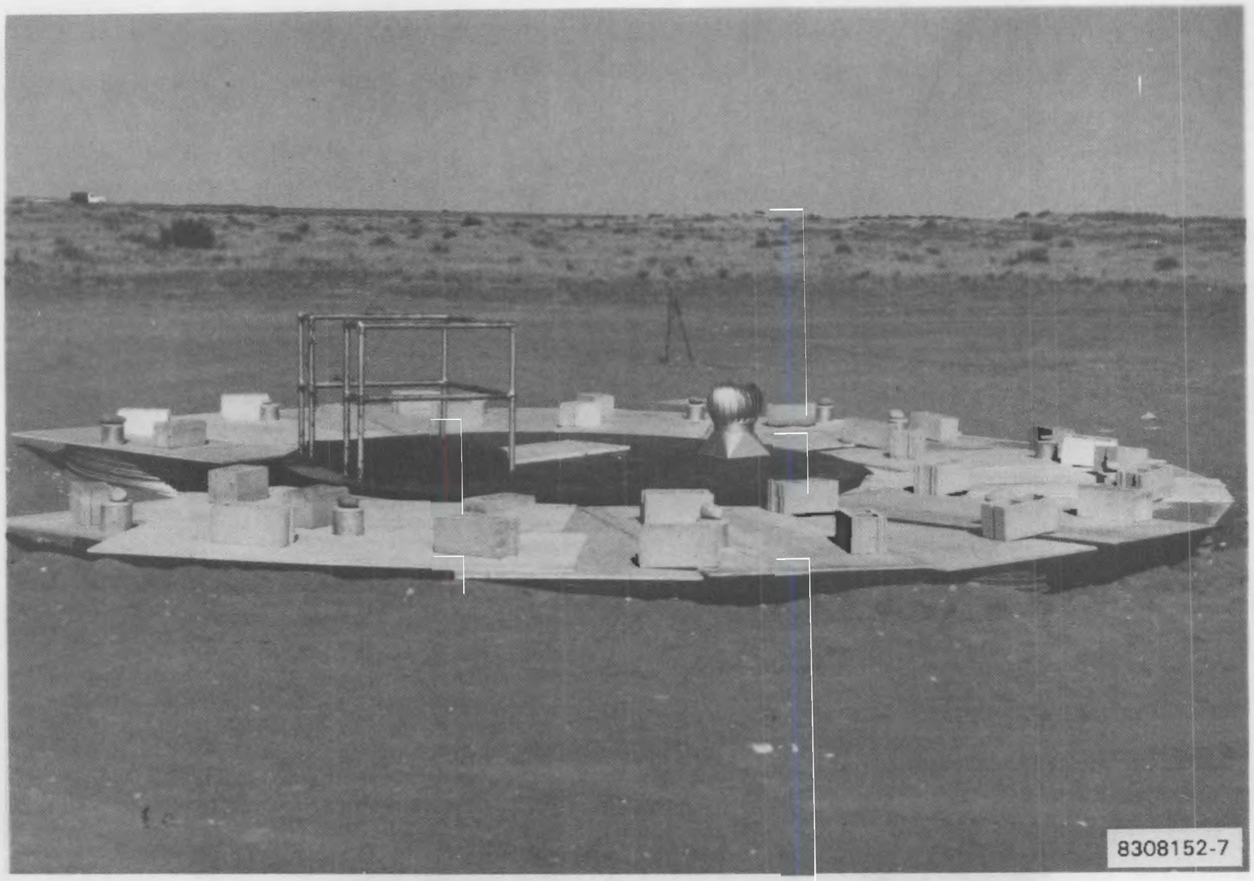

FIGURE 7. Covered Field Lysimeter Facility Awaiting Waste Installation

INSTRUMENTATION AND WASTE EMPLACEMENT

Facility construction was completed at the end of 1983. Waste emplacement and instrumentation activities were initiated in early 1984.

MICROMETEOROLOGICAL INSTRUMENTATION

Micrometeorological instruments were installed at the field lysimeter site to collect information used in the assessment of mass transport and energy balance within the lysimeters. Short-wave solar radiation at the site is measured with a pyranometer that, when installed vertically upward, monitors total incoming radiation between wavelengths of 0.2 to 4.5 μm. Heat transfer above the ground surface is measured continuously using thermistors and thermocouples to a height of 2 m. Wind velocity and direction are measured with a cup anemometer and wind vane placed near the lysimeter site. Relative humidity data are collected from two separate humidity sensors. One is a capacitive sensor that functions independently of temperature; the other is a combined relative humidity and temperature probe that compensates for temperature before providing the output. In addition, weekly wet and dry bulb temperatures are measured manually at the site using a standard Assmann psychrometer. These psychrometer readings are used to check the calibration of the two continuously recording humidity sensors. Ambient precipitation on the site, the largest factor in mass transfer of water through the lysimeter, is measured with a tipping bucket rain gauge. The gauge is propane heated for snow collection and has a resolution of 0.025 cm of rainfall.

SOIL PHYSICS INSTRUMENTATION

Thermocouples and moisture blocks were placed in the lysimeters and used to monitor thermal and moisture gradients, respectively. Thermocouples transmit temperature from locations inside the caissons, providing both vertical and horizontal gradients. Several thermocouples were strategically placed near the waste forms to monitor the temperature effects produced by radioactive samples buried in the lysimeters. Fiberglass moisture blocks were installed near the waste forms and at levels of interest in the caissons. When moisture levels rise adjacent to a fiberglass block, more moisture is absorbed by the block, causing an increase in the electrical conductivity between two electrodes. The electrical conductivity in mmhos is recorded by the CR5 data logger.[a] The correlation between this conductivity and actual moisture conditions was determined in the lab prior to installation of the blocks. Each block was evaluated in standard laboratory tests, and a calibration curve was produced. Computer programs were generated for converting the block readings directly into moisture content, which can be displayed graphically.

In addition to thermocouples and moisture blocks, suction candles[b] were installed during the backfilling operation (Figure 8). The suction candles used were 30-cm-long porous, ceramic tubes placed near the waste form to facilitate sampling of the leachate. Two polyethylene tubes were attached to one end of each closed candle, and the loose ends were directed through a sampling port into the instrument caisson. The samples may then be analyzed as representative leachate at various locations near the waste form.

The backfilling operation and instrument installation were conducted in concert. Sorted gravel (0.6 cm to 5 cm) was placed at the bottom of each lysimeter to a depth of 15 cm. Sifted sand was poured into each caisson to the level of an instrument placement or 30 cm, whichever was less, and the soils tamped to a bulk density of ~1.6 g/cm^3. Instrument locations were measured to the surface and the height adjusted to correspond with the design specifications. This process was repeated until the level that corresponded with the bottom of the waste form was reached. At this point an ~27-m-long by ~0.6-m-dia steel sleeve was suspended in the center of the caisson. The last suction candles were angled under the bottom of the sleeve, and sand and more instruments were placed outside the sleeve to a level just above the estimated height of the waste form.

(a) CR5 data logger is a product of Campbell Science, Logan, UT 84321.
(b) Suction candles are a product of Soil Moisture Equipment Company, Santa Barbara, CA 93117.

FIGURE 8. Installation of Suction Candles

WASTE ACQUISITION AND EMPLACEMENT

Brookhaven National Laboratory acquired actual commercial solidified low-level waste samples (forms) for this program. The waste forms consisted of boric acid waste from a pressurized water reactor and evaporator-concentrate and ion-exchange-resin wastes from a boiling water reactor (Table 1). Duplicates of each waste form were received. The samples were shipped in 210-L steel barrels from the utilities and off-loaded and stored near the field lysimeter facility.

A protective building was placed over a lysimeter opening (Figure 9). Then a barrel was lowered by crane into the building where the top of the barrel was opened with a cutting torch or unbolted, exposing a hook embedded in the waste form (Figure 10). While suspended from this hook, the barrel was cut away. In the case of the Dow polymer and masonry cement waste forms, the use

TABLE 1. Waste Forms Obtained for the Special Waste Form Lysimeters-Arid Program

Waste Stream	Reactor	Solidifying Agent
Boric acid concentrate waste	PWR	Masonry cement
Evaporator-concentrate (regenerative) waste	BWR	Portland Type III cement
Evaporator-concentrate (regenerative) waste and ion-exchange-resin waste	BWR	Portland Type III cement
Evaporator-concentrate (regenerative) waste and ion-exchange-resin waste	BWR	Dow polymer (Vinyl ester-styrene)

Note: PWR = pressurized water reactor.
BWR = boiling water reactor.

of a liner made it possible to slip off the barrel without cutting it (Figure 11). Samples were taken of the loose material on top of the form (when present). The waste form was lowered through the sleeve and uncoupled. Total depth to the waste form was measured, and the sleeve was pulled up through the roof. The exposed waste form was covered with sand, and the building was hoisted to the next installation site. Several more instruments were installed above the waste, and backfilling continued until the backfill was flush with the top of the caisson.

FIGURE 9. Construction Site Showing Sleeves in Empty Lysimeters

FIGURE 10. Cutting Barrel in Protective Building

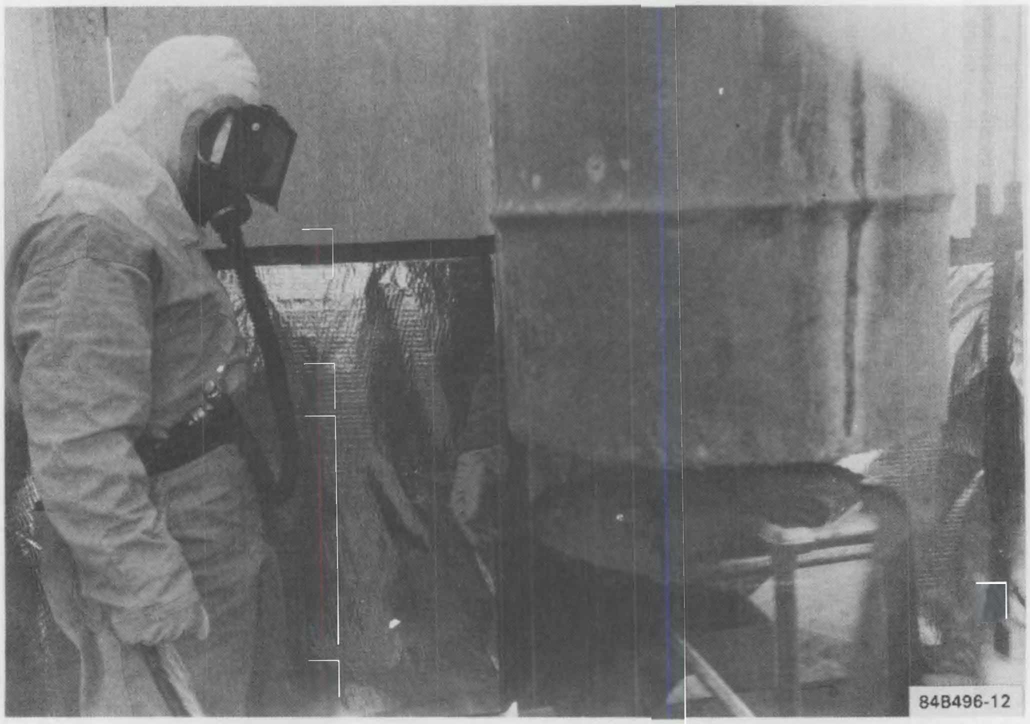

FIGURE 11. Waste Form Removed from Barrel

DATA COLLECTION AND REDUCTION

Monitoring will be done in two ways: continuous remote data collecting and data collecting by a field technician during onsite visits. Two data loggers operating on preset cycles record information provided by micro-meteorological and soil physics instruments. These data are stored on magnetic tape and in data logger memory for access by telephone link. Offsite automated computer equipment contacts the data logger on assigned intervals to collect recent data and insert it into permanent storage.

Moisture profile data for each lysimeter are collected by a field technician at regular intervals using a downwell neutron probe. A neutron probe is lowered into monitoring wells connected to the caisson walls, and neutron return counts are recorded for various depths. Neutrons have approximately the same mass as hydrogen; therefore they will be slowed by collisions with hydrogens in the soils water molecules. The neutron probe is commonly used to monitor soil moisture (Gardner 1965). In our particular application, the downwell access tube is much larger (15.2 cm) than the instrument probe (4.7 cm), and the hole is positioned next to the edge of the lysimeter. Special saturation procedures are needed to properly adjust the geometry and account for absolute water content changes. Relative moisture content changes can be accounted for by the changes in the count using techniques described by Gardner (1965) and Greacen (1981). We are currently working on special calibration procedures that will allow construction of moisture profiles to represent the level and distribution of moisture in each lysimeter.

BASELINE DATA

Baseline data collected on the field lysimeter facility include characterization of the soils in the lysimeters and the waste forms. The soils data include water-retention characteristics, hydraulic conductivities, and particle-size distributions for samples collected from each of the lysimeters (Tables 2, 3, and 4). Samples L1 through L10 represent composite samples taken from each of the 10 lysimeters. (See Figure 12 for the lysimeter numbering scheme.) Standard laboratory procedures were used in the analyses of the soils (Klute 1965; Richards 1965; ASTM 1972).

The waste forms were characterized with waste package assay instrumentation before the steel drums were removed. The instrumentation consists of a high resolution germanium diode gamma-ray spectrometer incorporated in a segmented gamma scanner and a passive neutron interrogation system (Brodzinski 1983). This instrumentation is designed to measure the neutrons emitted spontaneously from a waste package. By measuring the neutrons emitted from calibration standards made with matrix materials similar to the waste forms, the concentrations of radionuclides in the waste forms were calculated (Table 5). These radionuclides were found to be uniformly distributed in the waste forms.

TABLE 2. Water Retention Characteristics of the Field Lysimeter Facility Soils (All samples packed to 1.6 g/m^3 density; water content, cm^3/cm^3)

Sample	Hanging Water Column						Pressure Plate		
	Saturation	5 cm	10 cm	20 cm	50 cm	100 cm	100 cm	1020 cm	1530 cm
L1	0.465	0.463	0.457	0.249	0.073	0.071	0.10	0.048	0.043
L2	0.462	0.461	0.435	0.197	0.083	0.069	0.11	0.048	0.044
L3	0.389	0.386	0.368	0.144	0.088	0.072	0.09	0.049	0.045
L4	0.395	0.394	0.375	0.158	0.086	0.071	0.10	0.050	0.046
L5	0.389	0.374	0.363	0.153	0.082	0.069	0.11	0.050	0.046
L6	0.347	0.347	0.335	0.119	0.075	0.071	0.12	0.055	0.047
L7	0.397	0.389	0.382	0.145	0.089	0.077	0.08	0.045	0.044
L8	0.400	0.392	0.388	0.144	0.080	0.076	0.09	0.050	0.046
L9	0.409	0.405	0.397	0.209	0.097	0.081	0.09	0.051	0.049
L10	0.382	0.380	0.370	0.162	0.094	0.082	0.09	0.049	0.049

TABLE 3. Hydraulic Conductivities of the Field Lysimeter Facility Soils

Sample	Hydraulic Conductivity (cm/s)
L1	2.19E-03
L2	2.80E-03
L3	2.50E-03
L4	2.02E-03
L5	2.22E-03
L6	2.66E-03
L7	2.92E-03
L8	2.15E-03
L9	2.35E-03
L10	2.43E-03

TABLE 4. Particle-Size Analysis of the Field Lysimeter Facility Soils

Sample	Soil Type (%)		
	Sand	Silt	Clay
L1	90	9	1
L2	91	7	2
L3	91	7	2
L4	92	6	2
L5	93	5	2
L6	92	6	2
L7	93	5	2
L8	93	5	2
L9	95	3	2
L10	96	3	1

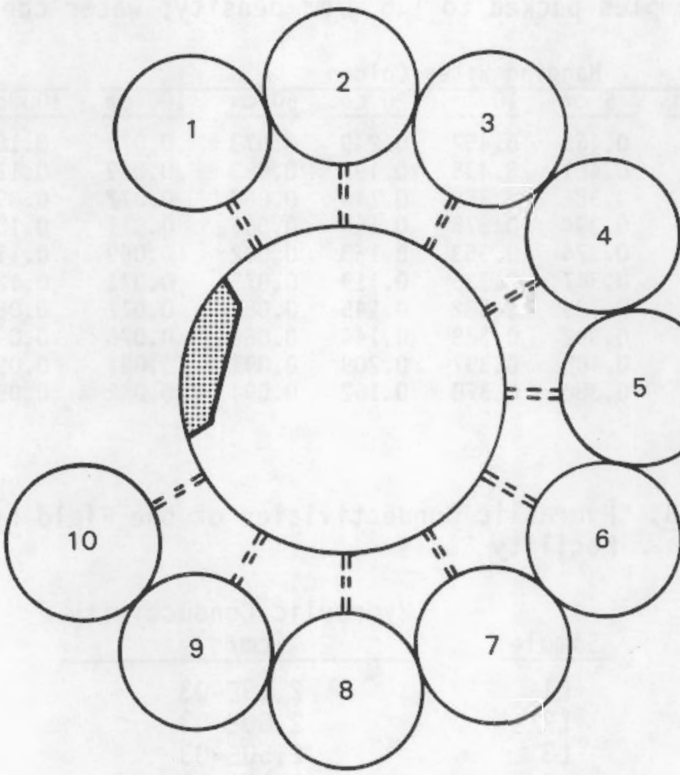

FIGURE 12. Numbering Scheme for Field Lysimeters

TABLE 5. Radionuclide Concentrations in the Waste Forms (mCi)

Lysimeter Number	Waste Type	Solidification Agent	^{54}Mn	^{60}Co	^{134}Cs	^{137}Cs
1	Boric acid concentrate	Masonry cement	0.0920	0.491 ± 0.055	6.0 ± 1.5	11.3
2	Evaporator concentrate	Portland Type III cement	4.2 ± 1.3	89.0	<10.0	14.6 ± 5.4
3	Evaporator concentrate and ion exchange resin	Portland Type III cement	7.0 ± 1.6	134.0	<7.4	37.8 ± 6.7
4	Evaporator concentrate and ion exchange resin	Vinyl ester-styrene	3.15 ± 0.95	111.3 ± 0.6	<12.0	<11.0
7	Boric acid concentrate	Masonry cement	0.100	0.545 ± 0.075	7.1 ± 1.8	13.2
8	Evaporator concentrate	Portland Type III cement	5.3 ± 1.3	90.4	1.53 ± 0.74	16.5 ± 5.4
9	Evaporator concentrate and ion exchange resin	Portland Type III cement	7.00 ± 0.63	154.0 ± 12.0	2.34 ± 0.27	19.4 ± 1.7
10	Evaporator concentrate and ion exchange resin	Vinyl ester-styrene	4.4 ± 1.0	131.2 ± 0.5	<6.3	<20.0

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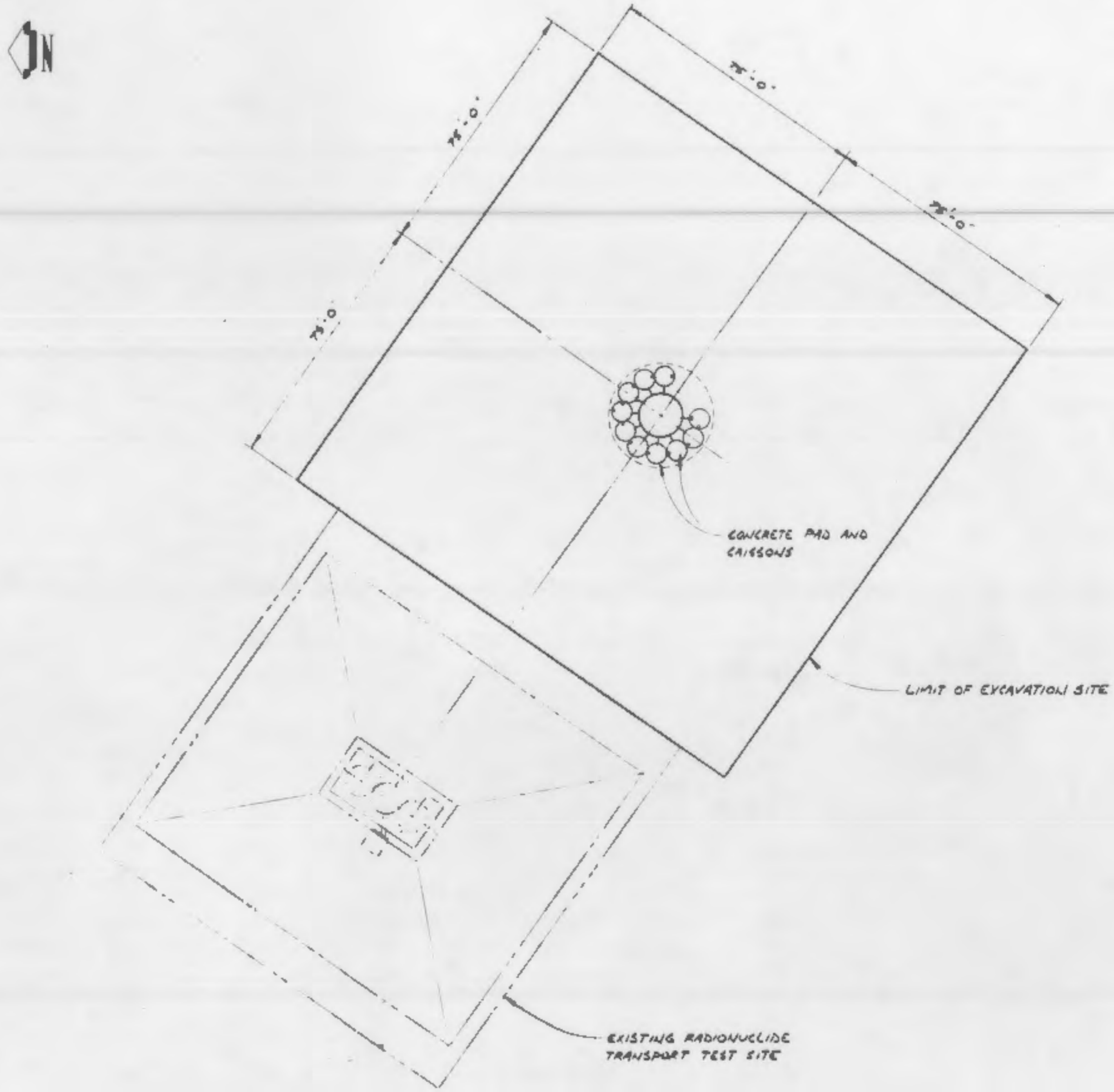
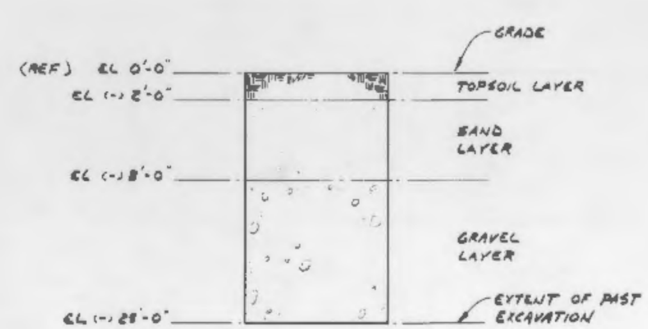
APPENDIX

ENGINEERING DRAWINGS FOR FIELD LYSIMETER FACILITY



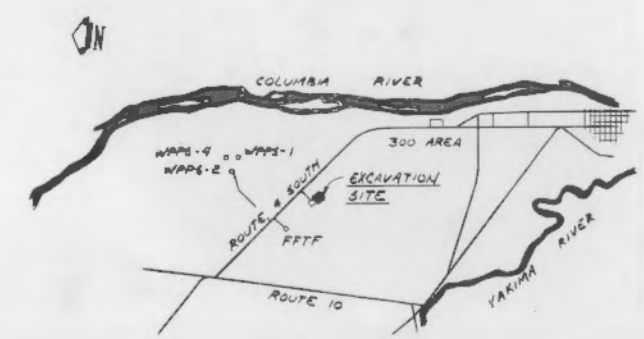
EXCAVATION PLAN

1"=20' 20 0 20 40 scale feet



SOIL PROFILE

NO SCALE
(REFERENCE FROM EXCAVATIONS AT EXISTING TEST SITE, ACTUAL PROFILE MAY VARY FOR NEW SITE)



AREA MAP

NO SCALE

GENERAL NOTES

(UNLESS OTHERWISE SPECIFIED)

A. SCOPE

WORK IS TO PROVIDE ALL NECESSARY LABOR, MATERIALS AND TOOLS TO CONSTRUCT THE LYSIMETER. WORK SHALL INCLUDE BUT NOT BE LIMITED TO EXCAVATION, CONCRETE WORK, INSTALLATION AND JOINING CAISSONS STRUCTURE AND BACKFILL.

B. MATERIALS

1. CONCRETE: 28 DAY COMPRESSIVE STRENGTH - 3000 PSI
   AGGREGATE - 1 1/2-INCH MAXIMUM
   SLUMP - 4-INCH MAXIMUM
   MIXTURE PREPARATIONS - ASTM C94, SECT. 5.3, SET 2
   REINFORCING - ASTM A615 GRADE 40 DEFORMED BARS MIN.
   ASTM A185 WELDED WIRE FABRIC
   FINISH - FREE OF ANY HONEYCOMB POCKETS OR VOIDS
   13-FOOT CAISSON FINISHED FLOOR - LIGHT BROOM TEXTURE
   6-FOOT CAISSON SHAPED FLOOR - SMOOTH STEEL TROWELED
2. METAL: STRUCTURAL STEEL SHAPES - ASTM A36
   GALVANIZED PIPE - ASTM A53
   GALVANIZED SHEET STEEL - ASTM A446
3. CAISSONS: (SUPPLIED BY OWNER)
   a. SIZE 6-FOOT INSIDE DIAMETER; SHOP ASSEMBLED WITH WATER TIGHT LOCK SEAMS; 3-INCH X 1-INCH CORRUGATIONS; 16- GAGE; GALVANIZED.
   b. SIZE 13-FOOT INSIDE DIAMETER; FIELD ASSEMBLED WITH BOLTED CONNECTIONS; 6-INCH X 2-INCH CORRUGATIONS; 12-GAGE, GALVANIZED. SECTIONS TO BE FASTENED WITH DOUBLE ROW OF ASTM A325 BOLTS AND NUTS, 3/4 INCH DIA., GALVANIZED. FASTENERS BY MANUFACTURER DESIGNED FOR LEAK TIGHT CONNECTION.
4. INSULATION: EXPANDED POLYSTYRENE BOARD, 1" THICK WITH FLAME SPREAD RATING LESS THAN 25. ADHESIVE AS RECOMMENDED BY MANUFACTURER.
5. SEALANT: SINGLE COMPONENT POLYURETHANE BASED, COMPLYING WITH FS TT-S-230, CLASS A TYPE II (NON-SAG), COLOR GRAY.
6. PAINT: PRODUCTS BY PITTSBURG PAINTS OR EQUAL.
   a. SEMI-GLOSS ENAMEL, ALKED-OIL BASED, COLOR - LIGHT GRAY.
   b. PRIMER: ZINC CHROMATE PRIMER, TINTED GREEN.
   c. ZINC RICH PAINT: ZINC DUST-ZINC CHROMATE BASE, COLOR GRAY, SELF PRIMING.
   d. EPOXY ENAMEL: TOP COAT PITTSBURG PITTSGLAZE, PRIMER AS REQUIRED BY MANUFACTURER.
7. DRAIN: STANDARD INDUSTRIAL QUALITY PROPROPOLYENE GRATING COVER. 4" OPENING. PLASTIC PIPING SYSTEMS OR EQUAL.
8. VENTILATION: STANDARD INDUSTRIAL QUALITY TURBINE VENTILATOR, ALL PARTS GALVANIZED; 12-INCH THROAT OPENING; WITH FACTORY BASE FOR FLAT METAL ROOF, LOMANEO OR EQUAL.

C. INSTALLATION

1. EXCAVATION:
   a. PERFORM NO EXCAVATION OUTSIDE OF LIMITS SHOWN BY EXCAVATION PLAN.
   b. SIDES OF EXCAVATION AND ANY ADJACENT EARTH STOCKPILES SHALL NOT EXCEED A SLOP OF 1 1/2 TO 1.
   c. GRUB AREA TO BE EXCAVATED FREE OF DEBRIS. EXCAVATE 2' LEVEL OF TOP SOIL AND STOCKPILE FOR BACKFILL.
   d. SELECT FROM EXCAVATION 175 CU YDS OF SAND AND SOIL FREE OF ANY DEBRIS OR GRAVEL LARGER THAN 1/4". THOROUGHLY MIX AND STOCKPILE ON SITE FOR BACKFILL OF CAISSONS BY OTHERS.
   e. EXCAVATE TO A FLAT NATURAL BOTTOM AT (-)10'-6". STOCK-PILE MATERIALS AS NEEDED FOR BACKFILL.
2. BACKFILL: (OUTSIDE CAISSONS)
   a. BACKFILL USING STORED MATERIAL PLACED IN ABOUT 12" EVEN LIFTS. PLACE MATERIAL IN REVERSE ORDER OF EXCAVATION IN LAYERS TO APPROXIMATE GRAVEL, SAND, TOPSOIL LAYER.
   b. COMPACT BACKFILL WITHIN 4 FT OF CAISSONS TO FIRM AND UNIFORM DENSITY.
3. SEALANT:
   a. APPLY CONTINUOUS BEAD OF SEALANT AROUND EXTERIOR BASE OF EACH CAISSON AND AT INTERIOR FALSE FLOOR OF EACH 6'-DIA. CAISSON.
   b. APPLY CONTINUOUS BEAD OF SEALANT TO EXTERIOR JOINTS OF 13'-DIA. CAISSON.
   c. SEAL ALL PENETRATIONS OF DRAIN CONNECTIONS BETWEEN CAISSONS.
      1) APPLY CONTINUOUS BEAD OF SEALANT TO EXTERIOR JOINTS OF 13'-DIA. CAISSON.
      2) SEAL ALL PENETRATIONS OF DRAIN CONNECTIONS BETWEEN CAISSONS.
4. PAINTING:
   a. PREPARE ALL SURFACES AND APPLY COATINGS AS RECOMMENDED BY MANUFACTURER.
   b. PAINT INSIDE OF 6' DIAMETER CAISSONS AND 6" SCHEDULE 10 PIPE WITH EPOXY ENAMEL.
   c. PAINT ALL UNFINISHED FERROUS METALS WITH ZINC CHROMATE PRIMER AND 1-COAT ENAMEL.
   d. PAINT ALL WELDS ON GALVANIZED SURFACES AND TOUCH UP ALL DAMAGED GALVANIZED SURFACES WITH ZINC RICH PAINT.
5. PLACE GRAVEL INSIDE CAISSONS IN EVEN UNIFORM LIFT. CAREFULLY PLACE 3" GRAVEL OVER. TAKE PRECAUTIONS NECESSARY TO PREVENT BREAKING DRAIN DURING BACKFILL.

D. INSPECTIONS HOLD POINTS

CONSTRUCTION SHALL NOT COVER UP THE ITEMS LISTED WITHOUT INSPECTION AND PRIOR APPROVAL FROM OWNER.

1. EXCAVATION AND VERIFICATION OF DEPTH.
2. PLACEMENT OF REINFORCING STEEL AND POSITION OF CAISSONS PRIOR TO PLACING CONCRETE.
3. COMPLETION OF FOUNDATION.
4. INSPECTION OF DRAIN OPERATION AND FLOOR COATING.
5. INSTALLATION OF ANY PIPES OR CONDUITS.
6. INSTALLATION OF ROOF STRUCTURE.
7. VERIFICATION OF THE FOLLOWING DIMENSIONS.
   a. DEPTH OF EXCAVATION
   b. DEPTH TO TOP OF DRAIN IN 6' CAISSONS
   c. DEPTH TO TOP OF GRAVEL IN 6' CAISSONS

REFERENCE DRAWINGS

DWG NO	REV NO	DRAWING TITLE OR INDEX NO
H-3-54280	0	LYSIMETER BACKFILL & INSTM
H-3-54279	0	LYSIMETER INSTL ENCLOSURE

REVISIONS

BY-DATE	FOR	REV BY DATE	DESCRIPTION		REV NO
[illegible]	PNL	[illegible]	AS-BUILT	[signature]	1

5TH ISSUE 6-28-83 JQP# 1135

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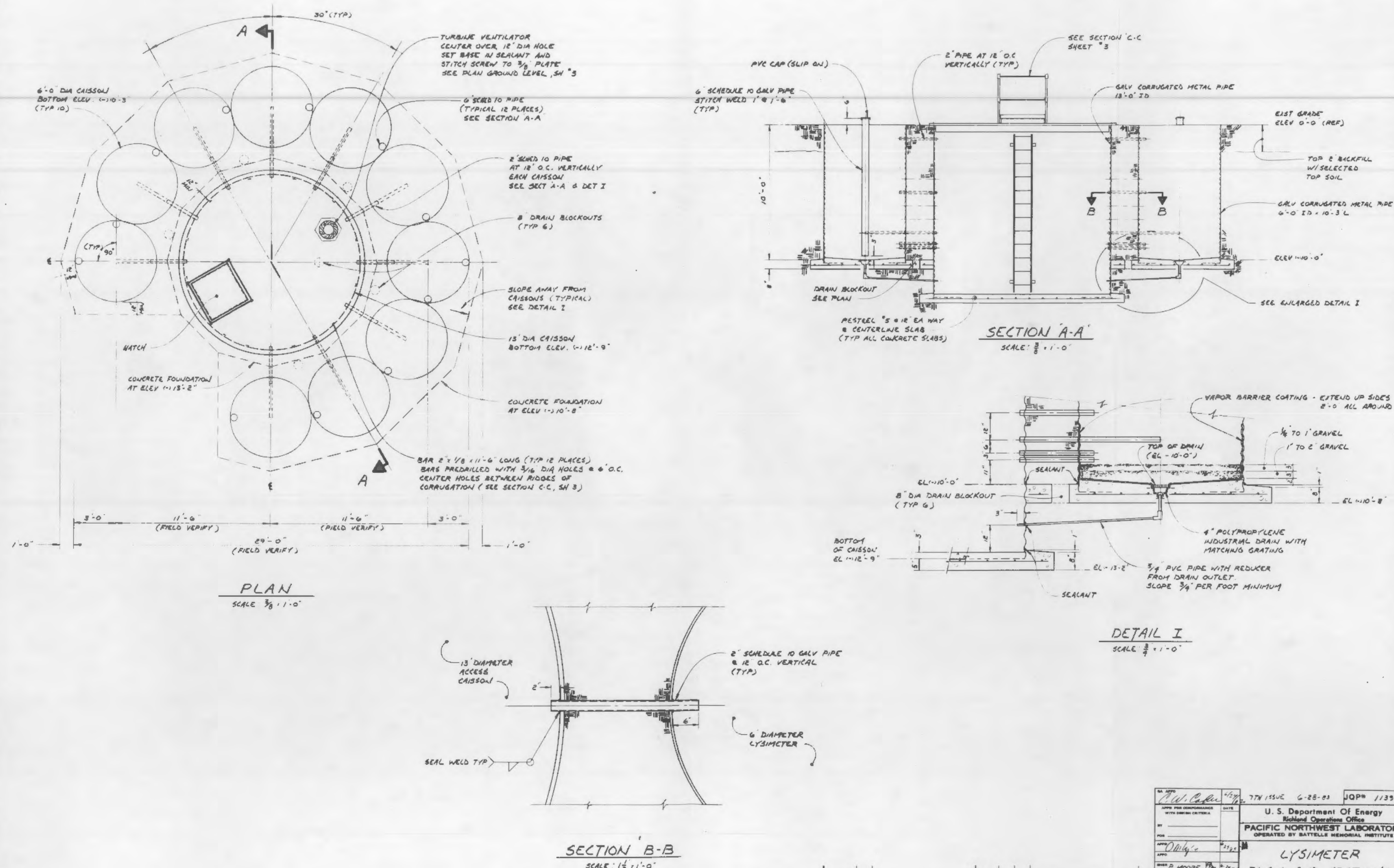
CHECKED Hutchins
DRAWN D.S. BOYLE
SCALE SHOWN

M LYSIMETER EXCAVATION PLAN

300 GENERAL | 0110, 0800

DWG NO H-3-54278 | SHEET NO 1 | SHEETS 3 | REV 1



DWG NO	REV NO	DRAWING TITLE OR INDEX NO
4-3-54278	0	LYSIMETER EXCAVATION PLAN

REFERENCE DRAWINGS

REV NO	DESCRIPTION	BY DATE	APPD
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REVISIONS

7TH ISSUE 6-28-83 JOP# 1139

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LYSIMETER
PLAN AND SECTIONS

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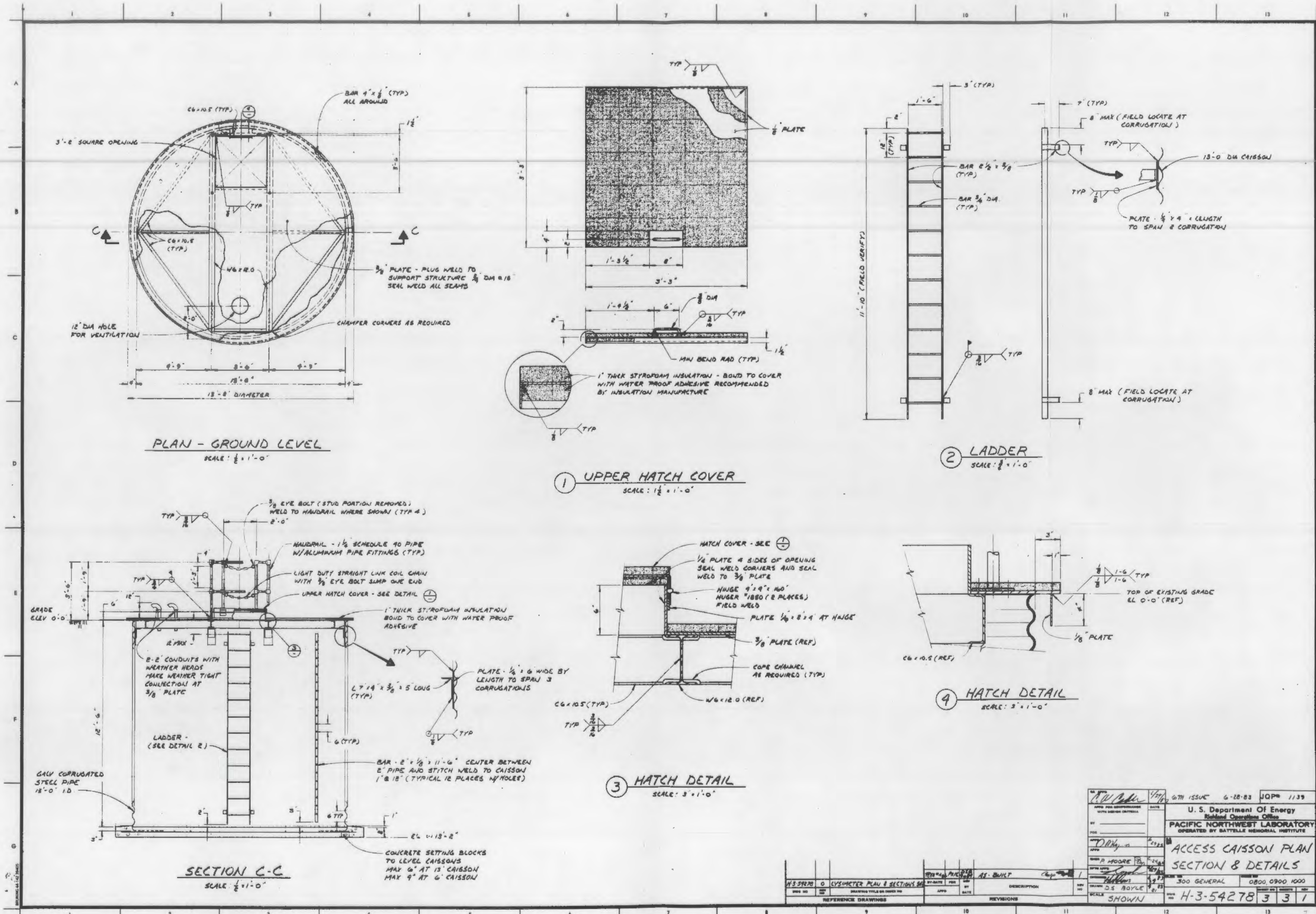
DRAWN D.S. BOYLE
SCALE SHOWN
BLDG 300 GENERAL
0800, 0900, 1000
DWG NO 4-3-54278
SHEET NO 2 | SHEETS 3 | REV 1


PLAN - GROUND LEVEL
SCALE: 1/2" = 1'-0"
3'-2" SQUARE OPENING
C6x10.5 (TYP)
BAR 4" x 1/2" (TYP) ALL AROUND
W6x12.0
3/8" PLATE - PLUG WELD TO SUPPORT STRUCTURE 1/2" DIA @ 18" SEAL WELD ALL SEAMS
12" DIA HOLE FOR VENTILATION
CHAMFER CORNERS AS REQUIRED
13'-8" DIAMETER
1 UPPER HATCH COVER
SCALE: 1 1/2" = 1'-0"
1/8" PLATE
1" THICK STYROFOAM INSULATION - BOND TO COVER WITH WATER PROOF ADHESIVE RECOMMENDED BY INSULATION MANUFACTURE
MIN BEND RAD (TYP)
2 LADDER
SCALE: 3/8" = 1'-0"
BAR 2 1/2" x 3/8" (TYP)
BAR 3/4" DIA. (TYP)
11'-10" (FIELD VERIFY)
8" MAX (FIELD LOCATE AT CORRUGATION)
13'-0" DIA CAISSON
PLATE - 1/4" x 4" x LENGTH TO SPAN 2 CORRUGATION
SECTION C-C
SCALE: 1/2" = 1'-0"
3/8" EYE BOLT (STUD PORTION REMOVED) WELD TO HANDRAIL WHERE SHOWN (TYP 4)
HANDRAIL - 1 1/2" SCHEDULE 40 PIPE W/ALUMINUM PIPE FITTINGS (TYP)
LIGHT DUTY STRAIGHT LINK COIL CHAIN WITH 3/8" EYE BOLT SNAP ONE END
UPPER HATCH COVER - SEE DETAIL 1
1" THICK STYROFOAM INSULATION BOND TO COVER WITH WATER PROOF ADHESIVE
GRADE ELEV 0'-0"
2-2" CONDUITS WITH WEATHER HEADS MAKE WEATHER TIGHT CONNECTION AT 3/8" PLATE
PLATE - 1/2" x 6" WIDE BY LENGTH TO SPAN 3 CORRUGATIONS
L 7" x 4" x 3/8" x 5" LONG (TYP)
LADDER - (SEE DETAIL 2)
BAR - 2" x 1/2" x 11'-6" CENTER BETWEEN 2" PIPE AND STITCH WELD TO CAISSON 1" @ 18" (TYPICAL 12 PLACES W/HOLES)
GALV CORRUGATED STEEL PIPE 13'-0" ID
EL -13'-2"
CONCRETE SETTING BLOCKS TO LEVEL CAISSONS MAX 6" AT 13' CAISSON MAX 4" AT 6' CAISSON
3 HATCH DETAIL
SCALE: 3" = 1'-0"
HATCH COVER - SEE 1
1/4" PLATE 4 SIDES OF OPENING SEAL WELD CORNERS AND SEAL WELD TO 3/8" PLATE
HINGE 4" x 4" x 1/60" HAGER #1860 (2 PLACES) FIELD WELD
PLATE 1/8" x 2" x 4" AT HINGE
3/8" PLATE (REF)
COPE CHANNEL AS REQUIRED (TYP)
W6x12.0 (REF)
C6x10.5 (TYP)
4 HATCH DETAIL
SCALE: 3" = 1'-0"
TOP OF EXISTING GRADE EL 0-0" (REF)
1/8" PLATE
C6x10.5 (REF)
H-3-54270 LYSIMETER PLAN & SECTIONS
REFERENCE DRAWINGS
AS-BUILT
REVISIONS
6TH ISSUE 6-28-83 JOP 1139
U. S. Department Of Energy
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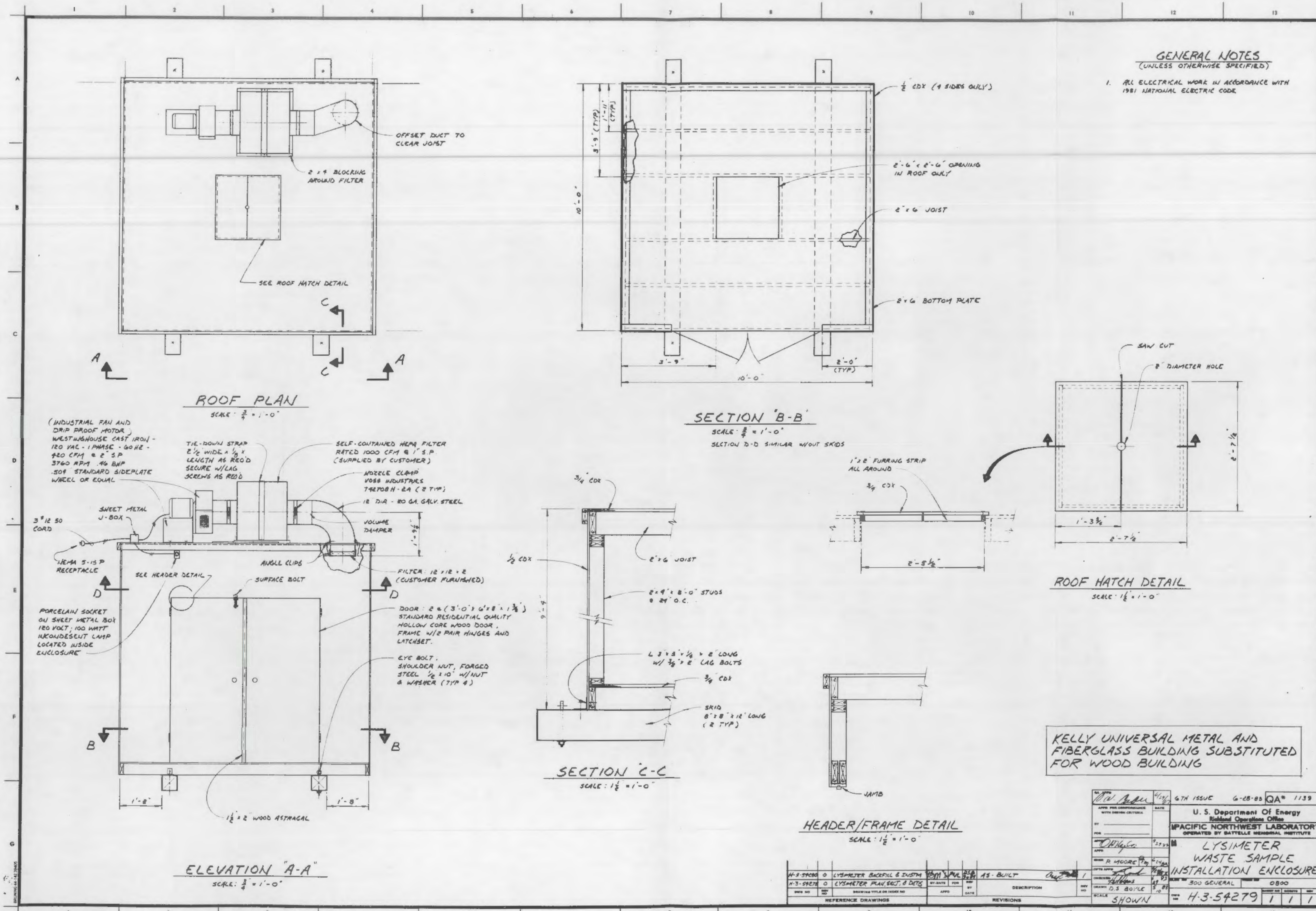
ACCESS CAISSON PLAN SECTION & DETAILS
P. MOORE
D.S. BOYLE
300 GENERAL
0800, 0900, 1000
SCALE SHOWN
H-3-54278 3 3 1


GENERAL NOTES
(UNLESS OTHERWISE SPECIFIED)
1. ALL ELECTRICAL WORK IN ACCORDANCE WITH 1981 NATIONAL ELECTRIC CODE
OFFSET DUCT TO CLEAR JOIST
2 x 4 BLOCKING AROUND FILTER
SEE ROOF HATCH DETAIL
ROOF PLAN
SCALE: 3/4 = 1'-0"
1/2 CDX (4 SIDES ONLY)
2'-6" x 2'-6" OPENING IN ROOF ONLY
2" x 6" JOIST
2 x 6 BOTTOM PLATE
SECTION 'B-B'
SCALE: 3/4 = 1'-0"
SECTION D-D SIMILAR W/OUT SKIDS
SAW CUT
8" DIAMETER HOLE
ROOF HATCH DETAIL
SCALE: 1 1/2 = 1'-0"
1" x 2" FURRING STRIP ALL AROUND
(INDUSTRIAL FAN AND DRIP PROOF MOTOR WESTINGHOUSE CAST IRON - 120 VAC - 1 PHASE - 60 HZ - 420 CFM @ 2" SP 3760 RPM .46 BHP .50# STANDARD SIDEPLATE WHEEL OR EQUAL
TIE-DOWN STRAP 2 1/2 WIDE x 1/8 x LENGTH AS REQ'D SECURE W/LAG SCREWS AS REQ'D
SELF-CONTAINED HEPA FILTER RATED 1000 CFM @ 1" S.P. (SUPPLIED BY CUSTOMER)
NOZZLE CLAMP VOSS INDUSTRIES T46708 H-2A (2 TYP)
12 DIA - 20 GA. GALV. STEEL
VOLUME DAMPER
SHEET METAL J-BOX
3#12 SO CORD
NEMA 5-15P RECEPTACLE
SEE HEADER DETAIL
SURFACE BOLT
ANGLE CLIPS
FILTER: 12 x 12 x 2 (CUSTOMER FURNISHED)
DOOR: 2 @ (3'-0" x 6'x 8" x 1 3/8") STANDARD RESIDENTIAL QUALITY HOLLOW CORE WOOD DOOR, FRAME W/2 PAIR HINGES AND LATCHSET.
PORCELAIN SOCKET ON SHEET METAL BOX 120 VOLT; 100 WATT INCONDESCENT LAMP LOCATED INSIDE ENCLOSURE
EYE BOLT, SHOULDER NUT, FORGED STEEL 1/2 x 10" W/NUT & WASHER (TYP 4)
1 1/2 x 2 WOOD ASTRAGAL
ELEVATION "A-A"
SCALE: 3/4 = 1'-0"
3/4 CDX
2" x 6 JOIST
1/2 CDX
2 x 4" x 8'-0" STUDS @ 24" O.C.
L 3 x 3 x 1/4 x 2" LONG W/ 3/8 x 2 LAG BOLTS
SKID 8" x 8" x 12' LONG (2 TYP)
SECTION "C-C"
SCALE: 1 1/2 = 1'-0"
JAMB
HEADER/FRAME DETAIL
SCALE: 1 1/2 = 1'-0"
KELLY UNIVERSAL METAL AND FIBERGLASS BUILDING SUBSTITUTED FOR WOOD BUILDING
6TH ISSUE 6-28-83 QA# 1139
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LYSIMETER WASTE SAMPLE INSTALLATION ENCLOSURE
300 GENERAL
0800
SHOWN
H-3-54279
H-3-54280 LYSIMETER BACKFILL & INSTM
H-3-54278 LYSIMETER PLAN, SECT. & DETS
AS-BUILT
REFERENCE DRAWINGS
REVISIONS
D.S. BOYLE
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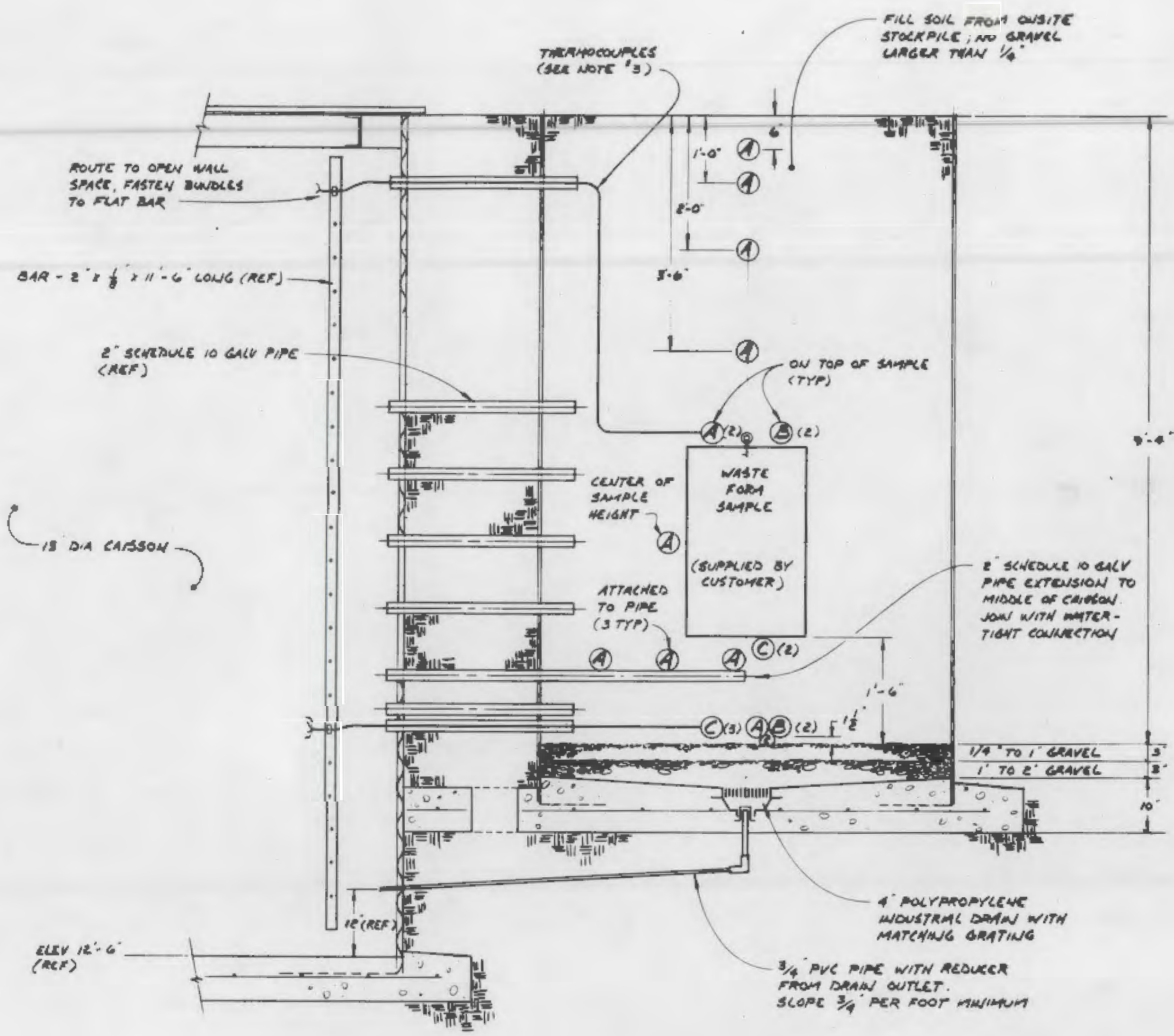

ELEVATION (SECTION)

SCALE: 1" = 1'-0"

NOTE:
1. INSTRUMENT WITH NUMERICAL QUANTITY EXAMPLE (A)(2) = 2 THERMOCOUPLES
2. ROUTE LEADS FROM (A) & (B) THROUGH 2" PIPE @ ELEV (-)12" ROUTE TUBE FROM (C) THROUGH 2" PIPE @ ELEV (-) 9'-1"
3. THERMOCOUPLES ABOVE THE 59" LEVEL IN 2 CAISSONS ONLY
4. INSTRUMENTATION - FURNISHED BY BNW
5. ALL EXTERIOR BACKFILL BY FIXED PRICE CONTRACTOR

KEY

(A) THERMOCOUPLE

(B) MOISTURE POTENTIAL SAMPLER

(C) SUCTION CANDLE (WITH PLASTIC TUBES)

GENERAL NOTES
(UNLESS OTHERWISE SPECIFIED)

1. SCOPE

WORK IS TO PROVIDE ALL NECESSARY LABOR, TOOLS AND MATERIALS TO FILL 6-FT CAISSONS FROM TOP OF GRAVEL (EL -8'-4") TO FINISHED GRADE (EL 00). WORK SHALL INCLUDE: BACKFILL WITH SOIL; INSTALLATION OF INSTRUMENTATIONS AND INSTALLATION OF WASTE FORM SAMPLE.

2. SOIL FILL

MATERIAL TO BE SELECTED FROM STOCKPILE ON SITE. MIXTURE TO BE SANDY LOAM WITH NO GRAVEL LARGER THAN 1/4-INCH NO DEBRIS LARGER THAN 1-INCH. PLACE SOIL FILL IN MAXIMUM 12-INCH LIFTS AND HAND TRAMP TO UNIFORM DENSITY. CARE SHALL BE TAKEN NOT TO DAMAGE OR DISLODGE BURIED INSTRUMENTATION OR SAMPLES DURING FILL.

3. INSTRUMENTATION

THERMOCOUPLES MOISTURE POTENTIAL SAMPLERS AND SUCTION CANDLES WILL BE PROVIDED BY PNL AND INSTALLED BY CPAF CONTRACTOR. INSTALL AT DEPTHS SHOWN WITH TOLERANCE (±) 1/2 INCH. LOCATE INSTRUMENTATION AS DIRECTED IN FIELD BY PNL. DEPTHS TO BE VERIFIED BY PNL. LEADS FROM INSTRUMENTATION SHALL BE ROUTED AROUND INSIDE OF 13-FT CAISSON AND FASTENED TO WALL AS DIRECTED BY PNL.

4. WASTE FORM SAMPLES

WASTE FORMS SHALL BE SUPPLIED BY PNL TO SITE IN 55 GAL STEEL DRUMS. CPAF CONTRACTOR SHALL REMOVE WASTE SAMPLES FROM DRUMS AND INSTALL AT DEPTH SHOWN WITH TOLERANCE (±) 1-INCH. DEPTH TO BE VERIFIED BY PNL.

5. REMOVAL OF WASTE

WASTE FORM SAMPLES SHALL BE REMOVED FROM DRUMS IN ENCLOSURE STRUCTURE PROVIDED (REF. H-3-54280) IN THE FOLLOWING PROCEDURE.

A. CONNECT AND VERIFY OPERATION OF LIGHTS AND EXHAUST.
B. PLACE WASTE FORM DRUM ON PALLET INSIDE ENCLOSURE.
C. CLOSE DOOR AND HATCH.
D. REMOVE METAL DRUM WITH CUTTING TORCH. LIMIT CUT DEPTH TO THICKNESS OF DRUM.
E. REMOVE WASTE FORM AND PLACE IN CONTAINER PROVIDED BY PNL.
F. VACUUM AND BAG DEBRIS AND DRUM PARTS AS REQUIRED BY RWP.
G. REPEAT PROCEDURE FOR EACH WASTE FORM SAMPLE DRUM.

6. INSPECTION HOLD POINTS (INSPECTION BY PNL)

A. FIELD VERIFY DRAIN OPERATION PRIOR TO STANDARD FILL.
B. INSTALLATION OF EACH SUCTION CANDLE.
C. INSTALLATION OF EACH THERMOCOUPLE.
D. INSTALLATION OF MOISTURE POTENTIAL SAMPLER.
E. INSTALLATION OF WASTE FORM SAMPLE.
F. MEASURE DISTANCE FROM 6" MONITOR WELLS TO WASTE FORM SAMPLE.

7. RADIATION WORK PROCEDURE

A RADIATION WORK PROCEDURE (RWP) WILL BE REQUIRED FOR ALL WORK HANDLING WASTE FORM SAMPLES.

REFERENCE DRAWINGS		
H-3-54278	0	LYSIMETER PLAN, SECT, & DETS

REVISIONS: 1 — AS-BUILT

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LYSIMETER BACKFILL AND INSTRUMENTATION

DRAWN	D.S. BOYLE
	R.E. MOORE
SCALE	SHOWN
CLASSIFIED BY	NOT REQD
CLASSIFICATION	NONE
BLDG NO	300 GENERAL
	59-23
DWG NO	H-3-54280
SHEET	1 of 1

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