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ENVIRONMENTAL RESTORATION PROGRAM

Site Characterization Report for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee

ENERGY SYSTEMS ER

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DEPARTMENT OF ENERGY
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contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program

Site Characterization Report for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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ACRONYMS

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ASL	analytical subcontract laboratory
BNAE	base/neutral/acid-extractable
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH	contact-handled
CLP	Contract Laboratory Program
CSL	Close Support Laboratory
D&D	decontamination and decommissioning
DOE	Department of Energy
ES&H	environmental, safety, and health
EPA	Environmental Protection Agency
FFA	federal facility agreement
FWG	field work guide
GC-MS	gas chromatography-mass spectroscopy
G-M	Geiger-Mueller
HEPA	high-efficiency particulate air
HPGe	high-purity germanium
LDR	land disposal restriction
LLLW	liquid low-level waste
LSA	low specific activity
MCL	maximum contaminant level
MDL	minimum detection limit
NHF	New Hydrofracture Facility
OHF	Old Hydrofracture Facility
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
P&A	plugging and abandonment
PCB	polychlorinated biphenyl
QC	quality control
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RH	remote-handled
RI/FS	remedial investigation/feasibility study
ROI	region of interest
RPD	relative percent difference
S&M	surveillance and maintenance
SDWA	Safe Drinking Water Act
SLLW	solid low-level waste
SVOC	semivolatile organic compound
SWSA	solid waste storage area
TAL	Target Analyte List
TBP	tributyl phosphate
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure

ACRONYMS (continued)

TIC	tentatively identified compound
TRU	transuranic
TSCA	Toxic Substances Control Act
VLA	very low activity
VOC	volatile organic compound
WAG	waste area grouping
WM	waste management
WMRAD	Waste Management and Remedial Action Division

EXECUTIVE SUMMARY

BACKGROUND

Several Old Hydrofracture Facility (OHF) structures (i.e., Building 7852, the bulk storage bins, the pump house, water tank T-5, and pump P-3) are surplus facilities at Oak Ridge National Laboratory (ORNL) slated for decontamination and decommissioning (D&D). OHF, also known as HF-3, is approximately 1 mile southwest of the main ORNL complex in Melton Valley, near the intersection of OHF/WAG 5 Road and Intermediate Pond Access. OHF was one of four sites in Melton Valley used in the development and full-scale application of hydrofracture operations. The facility covers approximately an acre; its boundaries coincide approximately with ORNL grid coordinates N17100, E28500 and N17,300, E28700. Building 7852 includes a control room, an engine pad, and three cells (mixing, pump, and wellhead cells). The one-room pump house contains two pumps.

OHF was constructed in 1963 to allow experimentation and operations with an integrated solids storage, handling, mixing, and grout injection facility. It was shut down in 1980 and transferred to ORNL's Surveillance and Maintenance Program.

The hydrofracture process was a unique disposal method that involved injecting waste materials mixed with grout and additives under pumping pressures of 2000 psi or greater into a deep, low-permeability shale formation. The injected slurry spread along fractures and bedding planes for hundreds of feet from the injection points, forming thin grout sheets (often less than 1/8 in. thick). The grout ostensibly immobilized and solidified the liquid wastes.

Site characterization activities were conducted in the winter and spring of 1994 to collect information necessary to plan the D&D of OHF structures. The characterization followed the *Site Characterization Plan for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee*. This site characterization report documents the results of the investigation of OHF D&D structures, presenting data from the field investigation and laboratory analyses in the form of a site description, as-built drawings, summary tables of radiological and chemical contaminant concentrations, and a waste volume estimate.

SUMMARY OF FINDINGS

The facility did not appear to have been decontaminated before it was abandoned; most of the equipment and piping used in the cells and control room are still present. Exceptions are the high-pressure pump and diesel engine used for grout injection, which have been removed from the pump cell and engine pad, respectively. The cells contain other items such as ladders, drums, cleaning equipment, ropes and cable, pins, and bolts. The integrity of the OHF structures is adequate (i.e., the structures will remain structurally intact) for safe decontamination or demolition. All rooms and cells are contaminated with hotspots. The pump house, control room, and cell areas are all contaminated, with most of the contamination fixed to the surface of the room/cell walls and floors. Exceptions are the loose grout on the floor of the mixing cell and grout in piping. The exteriors of water tank T-5, pump P-3, and the four bulk storage bins were surveyed and found to be free of loose surface (smearable) contamination.

The concrete foundation slab of the room/cells ranged from 4 to 9 in. thick. The floor slabs in the mixing and pump cells consist of two distinct layers: a top layer (approximately 3 in. and 1 in. thick, respectively) and a bottom layer (approximately 6 and 7 in. thick, respectively). Slit scanning of the concrete cores indicates that most of the measured gamma activity is within the first few inches of the surface. The activity along the length of the core is nonuniform; the activity is generally high at surfaces, decreases to near background level, and increases slightly again near the bottom where the core contacts underlying soil. The two-piece core from the mixing cell behaves differently than the others; the top portion has high activity at the surface, decreases to near background level, and increases at the interface by a factor of 20. The bottom section behaves the same as the other cores.

General area measurements and concrete and soil sample gamma spectroscopy results indicate that the primary gamma emitting isotope present is cesium-137/barium-137m. Other radiological contaminants include strontium-90/yttrium-90, cobalt-60, uranium, thorium, and plutonium, although in very small amounts. Comparison of direct measurement and smear results indicates that most of the contamination is fixed on surfaces.

The general area average exposure rates (closed window) in these areas range from 3 to 60 mR/h. Alpha activity is generally higher in the cells than in the control room, engine pad, and pump house. The average alpha activity ranges from approximately 59 to 4500 dpm/100 cm^2; smear results range from approximately1 to 800 dpm/100 cm^2. In addition, there are several hot spots in the mixing and pump cells and the pump house. The elevated exposure rates in the mixing cell are on the bottom of the mixing tank and the suction lines used for transporting grout to the pump cell (120–160 mR/h and 270–400 mrad/h) and in the floor drain (300 mrad/h and 150 mR/h). The elevated contact exposure rates were on the two grout suction lines from the mixing cell (800 mrad/h and 120 mR/h, and 3000 mrad/h and 300 mR/h) and the pipe suspended (hanging vertically) from the ceiling (1000 mrad/h and 800 mR/h; these exposure rates were measured before the pipe was shielded with lead blanket and lead sheet). A few areas on the pump house concrete pad under the lead shielding exhibit high exposure rates (maximum 2500 mrad/h and 1000 mR/h) approximately 6 in. from the floor.

Location-specific direct beta/gamma average readings about 10 cm from the surface ranged from approximately 5 to 200 mR/h (closed window) and 6 to 300 mrad/h (open window). The open window measurements were approximately 10 to 30% higher than the closed window measurements because of the beta field.

Concrete rubble is estimated to contribute approximately 1/4 of the volume of waste generated during OHF D&D. The bulk storage bins, tank T-5, and other scrap metal contribute most of the remaining fraction of disposal volume; however, the metal contribution is based on the assumption that the bins and tank are unsectioned or uncut. The waste volume from tank T-5 and the bins can be reduced by orders of magnitude if cut into smaller pieces.

None of the concrete cores or soil samples contain base/neutral/acid-extractables, pesticides, or inorganics that exceed the Resource Conservation and Recovery Act (RCRA) toxicity characteristic equivalent limits for solids, nor do any contain polychlorinated biphenyls that exceed the limit imposed by the Toxic Substances Control Act. Two potential RCRA constituent metals (chromium and lead) were identified in the paint chip samples. A toxicity characteristic leaching procedure (TCLP) test should be performed on the rubblized waste before disposal to determine whether the chromium and lead are RCRA constituents; however, the paint is not expected to fail the TCLP test because of its relatively low leachability. Two samples were collected from the bins for asbestos analysis; test results were negative. Energy Systems plans a complete asbestos survey at a later date. The lead (shielding) plates in the room/cells are considered low-level radioactive mixed waste.

1. INTRODUCTION

Portions of the Old Hydrofracture Facility (OHF) at Oak Ridge National Laboratory (ORNL) were characterized in 1994. Characterization activities centered on various aboveground structures at OHF, equipment outside and inside those structures, and the soils immediately surrounding some of those structures.

The site characterization was performed under the ORNL Remedial Investigation/Feasibility Study (RI/FS) Project and made extensive use of the existing programmatic infrastructure. Permanent records of the investigation (including logbooks, photographs, laboratory analytical results, and engineering calculations) are maintained as RI/FS Project records.

Site characterization activities followed the *Site Characterization Plan for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (Bechtel 1994a). The plan presents a detailed discussion of the data needs, data uses, and collection methods; that information is not repeated in this report, which documents the results of the investigation.

1.1 LOCATION

OHF, also known as HF-3, is approximately 1 mile southwest of the main ORNL complex in Melton Valley, near the intersection of OHF/WAG 5 Road and Intermediate Pond Access (Fig. 1.1). OHF was one of four sites in Melton Valley used in the development and full-scale application of hydrofracture operations. OHF covers approximately an acre; its boundaries coincide approximately with ORNL grid coordinates N17100, E28500 and N17,300, E28700.

1.2 HISTORICAL MISSION

OHF was constructed in 1963 to allow experimentation and operations with an integrated solids storage, handling, mixing, and grout injection facility. The facility was shut down in 1980 and transferred to ORNL's Surveillance and Maintenance (S&M) Program.

The hydrofracture process was a unique disposal method that involved injecting waste materials mixed with grout and additives under pumping pressures of 2000 psi or greater into a deep, low-permeability shale formation (Fig. 1.2). The injected slurry spread along fractures and bedding planes for hundreds of feet from the injection points, forming thin grout sheets (often less than 1/8 in. thick). The grout ostensibly immobilized and solidified the liquid wastes.

The facility was used for 7 experimental injection campaigns in 1964 and 1965 and 18 operational campaigns from 1966 to 1979. The experimental campaigns injected grout plus radioactive tracers; the operational campaigns injected grout plus approximately 969,000 gal of liquid low-level waste (LLLW). The experimental injections were at an average depth of 945 ft; operational injections were at an average depth of 792 ft (Haase and Stow 1988).

1.3 OBJECTIVES AND SCOPE

The objective of the field investigation was to provide information necessary for

- engineering evaluation and planning of decontamination and decommissioning (D&D) approaches,
- planning for protection of D&D workers, and
- estimating waste volumes from D&D activities.

The site characterization focused principally on OHF components for which the ORNL D&D Program is responsible: Building 7852, the four bulk solids bins, water tank T-5, pump P-3, and the pump house (excluding the valve pit, which is under control of ORNL Waste Operations). For the purposes of characterization only, this report also addresses two items assigned to the ORNL Remedial Action (RA) Program:

- the injection wellhead in Building 7852, and
- the soil underneath and surrounding the D&D structures (e.g., Building 7852 and the pump house) to a distance of 5 ft from the structures.

The site characterization plan also listed the dual-compartment valve pit as requiring characterization, but ORNL later removed it from the scope of work. Section 2 describes these OHF components and the programs to which they are assigned.

Characterization consisted primarily of inspections, radiological measurements, and radiological and chemical sampling and analysis. Inspections determine general facility conditions, as-built information, and specialized information (such as structural evaluations). Radiological sampling and measurements define the quantity and distribution of radioactive contaminants; this information is used to calibrate a dose model of the facility and estimate the total activity, in curies, of each major radioactive isotope. The radiological information from sample analyses is used to refine the radiological model of the facility, and the radionuclide and hazardous chemical analyses are used for waste management planning. This report presents data from the field investigation and laboratory analyses in the form of a site description, as-built drawings, summary tables of radiological and chemical contaminant concentrations, and a waste volume estimate.

Field investigation of ancillary aboveground external piping within 5 ft of the D&D structures was limited to visual identification and cross-referencing to existing drawings; no excavation was performed to locate or characterize underground piping or drains outside of the scope of this investigation. In addition, investigations of all underground tanks and piping at OHF were outside of the scope of this characterization campaign.

It was beyond the scope of this work to sample the contents or characterize the interior of any equipment (e.g., containers or piping) whose only access was via destructive entry (e.g., cutting) or disassembly. No isolated containers or inoperable valves were forced open, and no waste samples were collected from inside sealed equipment. Although sealed equipment was not opened, the equipment was characterized via external, direct radiological measurements and their evaluation.

It was also beyond the scope of work to characterize the site with regard to asbestos. The Energy Systems Industrial Hygiene group conducted a separate asbestos investigation for the bin removal project, and the results of that investigation are included in this report. Energy Systems is planning a full asbestos investigation for the other OHF components.

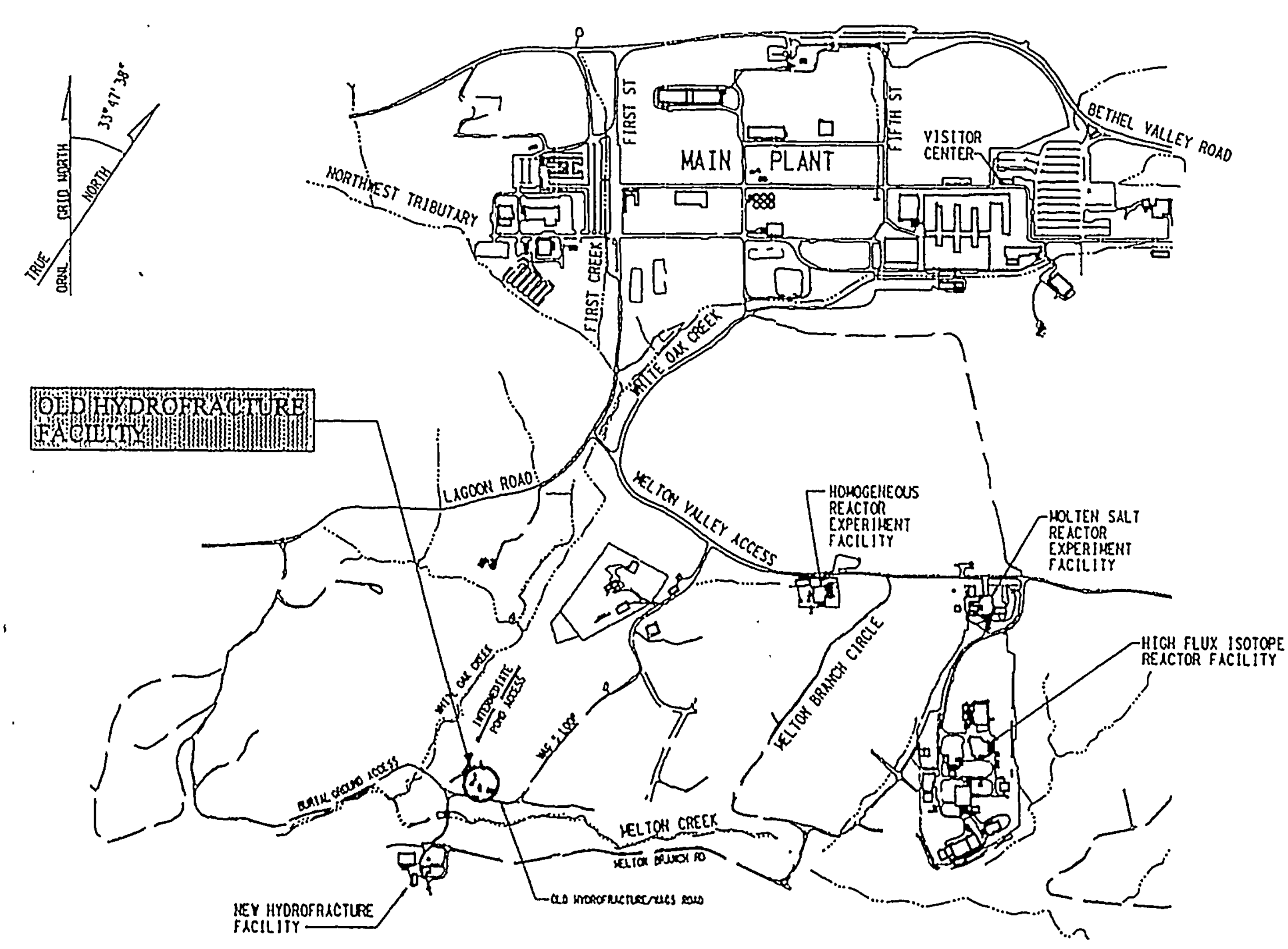

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Fig. 1.1. Map showing OHF relative to main plant.

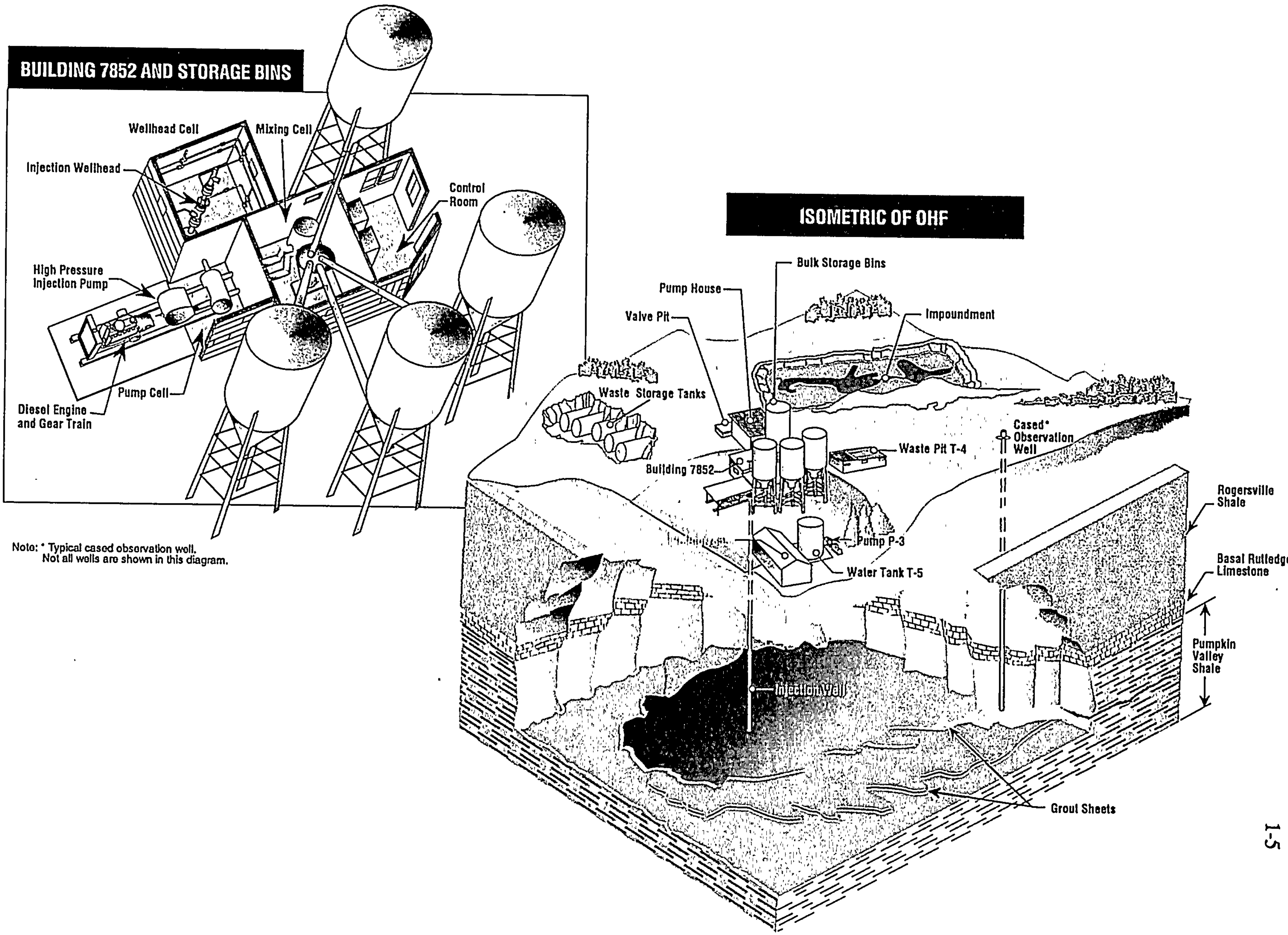

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Fig. 1.2. Artist's rendering of OHF.

2. SITE DESCRIPTION

This section first describes in general terms the major components of OHF (Sects. 2.1 through 2.4), and then describes in detail those components investigated during the characterization (Sects. 2.5 through 2.14). Section 2.15 describes ongoing operational and maintenance activities.

2.1 OHF STRUCTURES AND PIPING

Figure 2.1 is a 1989 aerial photograph of OHF (looking south), and Fig. 2.2 is a site map with principal components labeled. Table 2.1 lists the buildings and other principal structures shown in Fig. 2.2 and briefly discusses each. (Note: the last column in the table, which identifies the program responsible for final remediation of a particular component, is discussed in Sect. 2.4).

The piping includes waste feed, recirculation, drain, and water lines. Figure 2.3 is an area piping general plan redrawn from historical schematics (e.g., ORNL Drawings P-10002-EE-012-D and C-10002-EA-005-D); it does not show compressed air, gas, and electrical lines.

Although the facility first became operational in 1963 for testing and the first injection was made in 1964, various improvements and upgrades were made circa 1966, 1968, 1973, and 1974 based on historical drawings stamped "approved for construction." Appendix A lists those drawings (as well as various historical photographs) obtained from ORNL. The 1966 improvements included installing buried waste storage tanks T-3 and T-4 next to tanks T-1, T-2, and T-9; installing a weigh tank and scales near the two blending tanks; and constructing two additional waste cells next to the original cell of waste pit T-4. Improvements circa 1968 included constructing the control room on the north side of Building 7852 to replace the original operator's platform and shed. Improvements circa 1973 consisted of upgrading the electrical system in the control room and mixing cell; and installing a tank and pump house ventilation system, a new mixing tank and associated piping in the mixing cell, shielding and a hoist on the mixing cell roof, and a pump head trolley hoist in the pump cell. In 1974, air pads and associated air piping/tubing were attached to the bulk storage bins to facilitate solids flow.

2.2 OHF PROCESS

Figure 2.4 illustrates the "batch" process flow for OHF. The grout consisted of a mixture of portland cement (typically 2 lb/gal waste), fly ash (2 lb/gal waste), clays (e.g., attapulgite, grundite, and illite; 1.5 lb/gal waste), and set-retarding material (glucono delta lactone; 0.003 lb/gal waste) (de Laguna et al. 1971).

Preparation for an injection generally required several days to one week (de Laguna et al. 1971).

- Liquid waste was pumped to OHF through a waste transport line and stored in the five buried waste tanks. Either before or after the waste was transferred, a sample was analyzed. If this analysis indicated that components were within concentration boundaries prescribed by treatability studies, then the standard solids mix was selected for the injection.

- The waste tanks were agitated by means of air spargers. The air stream from each tank passed through a common manifold to a high-efficiency filter system (south of the pump house) and then was discharged to the atmosphere.

- The clays and set-retarding material or other additives were procured and moved to OHF, and arrangements were made for cement and fly ash to be delivered in pneumatic transporter trucks. Cement and fly ash were discharged from the transporter trucks to the 820-ft^3 weigh tank until a predetermined weight was reached. The clays and retarder were then added in the desired proportion by means of a small screw conveyor. The solids in the weigh tank were then air-blown to one of the two 800-ft^3 blending tanks, and the solids were thoroughly mixed by blowing them back and forth between the blending tanks. They were then blown to one of the bulk storage bins, and other batches were mixed until all the dry solids required for the injection had been stored in the bins.

- Typically, four injections were made into a single slot in the injection well. Before the next injection, the old slot in the well casing was plugged with cement, and fresh cuts were made in the casing about 10 ft above the old set using the "hydrojet" technique. After the slotting was completed, the wellhead assembly was rigged for injection and water was pumped into the well under pressure until the formation began fracturing.

The injection itself typically required 4 to 12 h to complete. At the start of the injection, the off-gas blowers (not shown in Fig. 2.4) for Building 7852 were turned on. The waste pumps in the pump house transferred the liquid waste in the storage tanks through a flow metering station to the jet mixer at the bottom of the hopper in the mixing cell. On the inlet side of the waste pump, a small amount of tributyl phosphate (TBP) was added to the waste solution by means of a Milton Roy pump (not shown in Fig. 2.4) attached to portable drums. The TBP was added at a rate of about 190 mL/min at full injection rate to help decrease the amount of air entrained in the grout; entrained air made the solids/waste proportioning difficult to control and the operation of the injection pump ragged (de Laguna et al. 1971).

When the waste solution flow reached the mixer (under a pressure of 100 psi), the flow of mixed solids from one of the bulk storage tanks was started using aeration. The solids flowed out of the bin, through an air slide (an enclosed chute continuously aerated from below), and into the metering hopper. As the solids moved to the bottom of the hopper, they were picked up by the jet stream and mixed with the waste. The resulting grout was dumped into the mixing (surge) tank and mixed with an agitator. Control of the solids-to-waste proportion was critical to obtaining a grout that was easy to pump, that would retain the liquid (no phase separation), and that would not be subject to premature setting. With the proper level of grout in the mixing tank, the injection pump in the pump cell began to transfer the grout through the high-pressure wellhead manifold in the wellhead cell, down the injection well, and out into the fracture at the bottom of the tubing string.

A standby pump, similar to the main injection pump, was rented for each waste injection. It was a standard truck-mounted unit that could, if needed, pump water from tank T-5, through the wellhead manifold, and to the injection well to provide a means for flushing the injection well free of grout if the main injection pump failed.

When the desired quantity of waste had been injected, the contaminated grout was followed by clean grout and then washup water, which served to materially decontaminate the equipment and piping. Washup water and water used in slotting operations drained to waste pit T-4 and pumped out of the pit by the waste pumps in the pump house for reuse. Drains in the "hot cells" also led to the waste pit. (For the purposes of this report, the term "hot cells" refers to the radiologically contaminated mixing cell, pump cell, and wellhead cell, and should not be confused with the heavily shielded caves equipped with remote manipulators that are also often called hot cells.)

The impoundment or emergency waste basin was installed as a safety measure against the possibility that the wellhead might rupture, allowing the injection grout to flow back up the well with no way to stop the flow. Should such an event occur, the grout would flow from the wellhead cell through an 18-in. line to the impoundment, where it would set and be covered with earth fill (de Laguna et al. 1971). When OHF was in service, several minor spills were discharged to the impoundment. For example, during an experimental injection in May 1965, a leak occurred in the high-pressure piping, and about 200 gal of waste grout containing an estimated 2 Ci flowed from the wellhead cell to the impoundment before the leak was detected and the injection halted. The standby pump was used to pump the injection well free of grout. The wellhead cell (including the ceiling) was decontaminated, and the leaking fitting was replaced. All the cell interiors were repainted.

2.3 POTENTIAL CONTAMINANTS IN INJECTED WASTE

Huang et al. (1984) estimated that the average concentration of radionuclides in the grout mixture prior to injection was approximately 0.26 mCi/mL or less for beta/gamma emitting radionuclides and 10 nCi/g or less for transuranic (TRU) alpha emitting radionuclides.

The radioactive tracers injected with the grout during the experimental campaigns were gold-198 (30 Ci), cerium-144 (4100 Ci), cesium-137 (5200 Ci), ruthenium-106 (40 Ci), strontium-90 (1400 Ci), and cobalt-60 (20 Ci) (de Laguna et al. 1968). The LLLW injected during the operational period contained approximately 604,000 Ci of cesium-137, 38,600 Ci of strontium-90, 233 Ci of curium-244, and 5.8 Ci of TRU other than curium (Myrick and Stow 1987). Thus, the two principal contaminants of concern are cesium-137 and strontium-90.

Additional information on potential contaminants can be obtained by referring to analytical results of the contents of waste tanks T-1, T-2, T-3, T-4, and T-9, which were sampled during 1988 (Autrey et al. 1990; ORNL 1993). The tanks were used to store LLLW until it was ready to be blended with grout, and they still contain significant quantities of liquid and sludge waste. In addition to cesium-137 and strontium-90, other beta/gamma emitters found in the tank contents were cobalt-60, europium-152/154/155, carbon-14, and tritium. Alpha emitters included uranium-233, plutonium-238/239, curium-244, americium-241, thorium-232/238, and californium-252.

Based on analysis of the water and sediment in the OHF impoundment and waste pit T-4 as reported by Huang et al. (1984), beta/gamma emitters included cesium-137, strontium-90, cobalt-60, europium-154, and cesium-134; alpha emitters included curium-244, plutonium-238/239, americium-241, and uranium-235/238.

An overview of the potential Resource Conservation and Recovery Act (RCRA) status of the OHF tank contents is provided by Autrey et al. (1990). None of the waste tanks contained a RCRA ignitable waste or were classified as RCRA corrosive. The pH of the tank liquids was basic (pH of 8.8 and higher). Toxicity characteristic leaching procedure (TCLP) tests were not performed, but Autrey et al. indicate that potential inorganics of concern include chromium, lead, and mercury based on elevated total concentrations, particularly in the sludges. In general, the tank contents contained little organic matter. However, volatile organic compounds (VOCs) of concern (TCLP constituents detected in tank samples) consisted primarily of solvents; RCRA-listed semivolatile organic constituents (SVOCs) consisted primarily of various phthalates and polynuclear aromatic hydrocarbons.

De Laguna et al. (1971) indicate that the approximate chemical content of the waste solution (prior to mixing with solids) included NaOH [0.05 molar solution (*M*)], $NaNO_3$ (0.8 *M*), $(NH_4)_2SO_4$ (0.15 *M*), $Al_2(SO_4)_3$ (0.05 *M*), NaCl (0.05 *M*), and $NaCO_3$ (0.05 *M*).

2.4 PROGRAMMATIC SETTING

Responsibility for OHF and its immediate environs is currently shared by three ORNL programs: D&D, Waste Management (WM), and RA (Bechtel 1992). Interface among the programs is required for proper coordination and scheduling of field actions. Each program oversees specific activities (e.g., maintenance, characterization, remediation) for selected OHF structures as well as for portions of the environmental media (e.g., soils, surface water) in the vicinity.

The ORNL D&D Program is responsible for Building 7852, the four bulk solids bins, water tank T-5, pump P-3, and the pump house. As noted in Sect. 1, the valve pit is not part of this characterization campaign. This responsibility includes the entire structure, plus the foundation and equipment and materials within the structure.

The ORNL WM Program is responsible for Building 7853, a former change room currently used as a storage facility (Huang et al. 1984). This building has been identified as "surplus" by the ORNL WM Program and will probably be transferred to the Transition Program before transfer to the D&D Program.

The ORNL RA Program is responsible for remediation of OHF areas not currently under the auspices of either D&D or WM; this includes both surface and subsurface facilities and media. The ORNL RA Program is currently conducting an RI/FS that includes investigation and assessment of environmental releases and selection of corrective measures. Guidance for the RA Program activities is in accordance with the Federal Facility Agreement (FFA) for the Oak Ridge Reservation (ORR) (December 1991). The principal regulatory driver under the FFA is the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended. RCRA requirements (such as cleanup standards) have become applicable or relevant and appropriate requirements under CERCLA.

To facilitate the RI/FS, the ORNL site has been divided into waste area groupings (WAGs), each of which is the subject of separate planning and implementation. OHF is directly associated with WAG 5 (ORNL 1988; 1992a) and WAG 10 (ORNL 1992b).

- WAG 5—OHF is in the southwest corner of WAG 5 [approximately 90% of WAG 5 is solid waste storage areas (SWSAs) used for shallow land burial]. Within the OHF boundary, the ORNL RA Program (WAG 5) is principally responsible for the valve pit in the pump house, the impoundment, waste pit T-4, the five underground waste storage tanks, and various shallow monitoring wells. The ORNL RA Program (WAG 5) is also responsible for contaminated environmental media on the surface and the shallow subsurface, for all piping external to the D&D structures, and for associated spill sites.

- WAG 10—This WAG is defined as the deep underground component of the four hydrofracture sites (i.e., wells, injected grout sheets, and contaminated media). Within OHF, the ORNL RA Program (WAG 10) is responsible for the injection well, including the wellhead in the wellhead cell of Building 7852, and a group of other deep observation and monitoring wells used in the hydrofracture process. The planned remedial response for the WAG 10 wells is plugging and abandonment (P&A), which could occur either before or after the wellhead cell structure is fully or partially dismantled. Integration of the D&D/P&A methodology will depend on the degree of access needed to the wellhead, exposure potential, and whether the contamination is isolated at the wellhead or has spread to other areas (e.g., walls or floors) of the wellhead cell.

The OHF D&D structures are within or adjoin the administrative boundaries of RA's WAG 5 and WAG 10. Because of this proximity, WAG remediation, which is subject to CERCLA regulations, is integrated with OHF D&D. The OHF D&D structures will be characterized to support D&D planning and design (see Sect. 1.3); however, the characterization data will also be reviewed and assimilated by WAGs 5 and 10 as needed.

In 1984, an ORNL ad hoc committee performed a decommissioning alternatives assessment for OHF (Reed 1984); specific options were reviewed for the aboveground structures, the buried waste tanks, the waste pits, the impoundment, the underground piping, and the wells. In 1984, all of OHF was under one ORNL program for final decommissioning. For those structures currently assigned to the ORNL D&D Program, the 1984 ad hoc committee recommended dismantlement and disposal as the preferred alternative. For those components currently assigned to ORNL programs other than D&D, the committee recommended either continued S&M, reconditioning and reuse, entombment, or other limited remedial action, depending on the characteristics of the component and the potential remedial responses available.

The current strategy remains that of dismantlement and disposal for structures assigned to the D&D Program. The Department of Energy (DOE) plans to reevaluate the current strategy of dismantlement by performing a second alternatives assessment for the OHF D&D structures that will be based on information available at that time.

ORNL D&D plans an early action for OHF (removal of the bulk solids bins and water tank T-5) as a routine maintenance action.

2.5 BUILDING 7852

This section addresses the general layout and exterior of Building 7852; Sects. 2.6 through 2.10 describe each room or area in greater detail.

2.5.1 General Layout

Building 7852 comprises five areas: control room, mixing cell, pump cell, wellhead cell, and engine pad. Figure 2.5a shows the Building 7852 floor plan, Figure 2.5b shows the exterior elevation, and Table 2.2 lists some of the dimensions.

The three hot cells (mixing cell, pump cell, and wellhead cell) were used in mixing, pumping, and injecting the grout mixture into the subsurface formations. The purpose of the cells was to reduce the radiation exposure of the operators and limit the area that would become contaminated in the event of a leak in the equipment or piping. All necessary control operations were carried on from outside these cells during an injection.

Each cell has 12-in.-thick concrete walls whose inside surfaces are not lined but are painted. Each cell also has small windows to the outside. Because the process piping in the pump cell and the wellhead cell were under considerable pressure, the windows were made of bulletproof glass. Table 2.3 lists the seven windows installed in the hot cells. The control room also has seven windows to the outside.

Figure 2.6 shows exterior views of Building 7852. The building construction is concrete block on a concrete slab foundation measuring 6 to 9 in. in depth (based on the lengths of concrete cores drilled in the slab; see Table 3.1). A gravel fill/sub-base exists under the floors of the hot cells. The four bulk solids bins are arrayed in a semicircle around the mixing cell; the steel stanchions and concrete pier supports come as close as 3 ft to the sides of the building. The area around the building is gravel-covered and flat. Sticking out of the ground near the southwest corner are the tops of two vertical buried pipes in which well tools were stored (Figs. 2.6f and 2.7a). The pipe depths were not indicated in ORNL drawings obtained by the Bechtel Team; however, the caption for ORNL Photograph 3323-72 indicates that a slotting swivel drive was stored in a 30-ft storage tube below ground in the area of the buried pipes.

Negative air pressure is maintained in the hot cells by an existing operational ventilation system located under bin 3. ORNL drawings show that the ventilation system connects to each cell with 4-, 6-, or 8-in. ducts and exhausts through both prefilters and HEPA filters. The ducts penetrate the mixing and pump cells through the roof and the wellhead cell through the cell's south wall. Flow rates for exiting air range from 500 to 1400 cfm. The control room is also under negative pressure and is serviced by the ventilation system—a datum that is not shown in available ORNL drawings.

2.5.2 Building 7852 Roof and Equipment on Roof

Figure 2.7a shows most of the roof of Building 7852 as seen from the top of bin 4. The roof of the control room is metal decking; that of the engine pad is corrugated sheet metal. The mixing cell roof is fixed in place, but those of the pump and wellhead cells are removable. The mixing cell was roofed originally with 3/4-in. grating covered with sheet metal; facility alterations circa 1973 added 1/2-in.-thick lead and steel sheets for shielding purposes (see ORNL Drawing S-20974-EB-005-D). Because the process piping in the pump cell and the wellhead cell was under considerable pressure, the roof grating for those cells was covered with 1/4-in. steel plate on both sides. The roofs of the mixing cell and the pump cell each have one access hatch; the wellhead cell has two.

Protective handrails currently exist around the edge of the hot cells' roof, which can be reached via a vertical steel rung ladder attached to the wellhead cell's west wall (near the southwest corner; see Fig. 2.6f) and a slanted steel step ladder attached to the pump cell's east wall (see Figs. 2.6d and 2.6e). Energy Systems reports that the east wall ladder has been inspected and approved as safe for use.

The tops of the enclosed mixing tank and mixing hopper (see Sect. 2.7) protrude above the roof of the mixing cell (Fig. 2.7b). Connecting the top of the mixing hopper and the top of bin 4 is a 4-in.-diameter steel vent pipe. One of the improvements made to OHF circa 1973 was the installation of a 1-ton-capacity hoist and steel hoist frame above the mixing tank and hopper (see Fig. 2.7c and ORNL Drawing S-20974-EB-006-D). The frame measures roughly 9 ft by 5 ft by 9 ft high. There are three disconnected air slides (solids conveyors) that run from the solids bins to the top of the mixing hopper (Figs. 2.7b and 2.7c). The air slide from bin 1 is not present.

In the background of Fig. 2.7c, resting on the metal deck roof of the control room, is a piece of equipment identified by Reed (1984) as an air filter and blower. During site characterization, the filter/blower was found to be disconnected from the ventilation piping that fed it. As discussed in Sect. 6, material that looked like radioactively contaminated grout was found at the entrance to the ventilation equipment where the feed piping was disconnected, and some areas of the equipment have high radiological survey readings (see Fig. 2.7d and Appendix B). Before leaving the site, the field team reattached the piping to the ventilation equipment to prevent the spread of any contamination that might migrate from the area. Based on photographs taken during characterization, the feed piping, some of which is plastic, appears to ventilate two pieces of equipment in the mixing cell (see Sect. 2.7): the hopper and the mixing tank. One set of 4-in. ventilation piping exits the mixing cell through its east wall near the roof, and then runs to the ventilation equipment; another set of piping exits the west side of the mixing tank, runs along the interior west wall of the mixing cell near the ceiling, traverses the roof in the southwest corner of the mixing cell, and then doubles back to the ventilation equipment over the control room.

2.6 CONTROL ROOM

When first constructed in 1963, the north exterior face of the mixing cell was attached to a shed and an operators' platform (ORNL Drawing S-10002-EE-039-D). The elevated platform allowed the operators to view mixing operations through windows in the intervening wall and to access an instrument panel attached to the wall. The shed was apparently replaced by construction (circa 1968) of a new control room or operators' area enclosure (ORNL Drawing A-10002-EB-011-D). The platform was also replaced. The roof is metal decking and the floor slab, according to the concrete core sample (04450), is 7 in. thick. The added walls are made from 8-in. hollow concrete block, and both the exterior and interior surfaces are painted. The control room is accessed through a 3-ft-wide, key-locked door on the north side. Keys to Building 7852 are held by the OHF Facility Manager.

Figure 2.8 shows the control room interior. The split-level platform (Fig. 2.8d) along the south wall is accessed by a 3-step stair-ladder (Fig. 2.8b). Above the platform on the south wall are one shielded window looking into the mixing cell and two windows looking onto the roof of the mixing cell. The air slides can be seen through the eastern window and the mixing tank interior, reflected in a mirror, can be seen through the western window. The control room contains primarily instrumentation, control panels, and electrical boxes, with associated wiring and conduit/piping. Appendix A lists the principal ORNL drawings available that describe electrical systems, instrumentation, or instrument panel controls (e.g., I-10002-EE-034-D and I-20974-QE-001-D).

Miscellaneous stored items include piping, an empty 55-gal container that, according to its label, contained glucono delta lactone (GDL) in the form of a coarse powder; a heavy 55-gal steel drum (unopened) that, according to its label, contains lead bricks; furniture (e.g., chair and equipment stool); a wooden platform; a wall clock; and a portable heater on a steel table.

2.7 MIXING CELL

The mixing cell (see Fig. 2.9) contains an accumulating or mixing hopper, a mixing tank, ancillary valves and piping, and equipment support legs. The 4-in. LLLW feed line enters the mixing cell through the floor slab in the northwest corner of the room behind the mixing tank and runs along the north wall before passing under the mixing hopper. Valve extension handles from the feed line penetrate the north wall into the control room. (The path of the grout line from the pump house to the mixing cell is shown in ORNL Drawing C-20974-EA-001-D.) As measured by the concrete core sample (04550), the floor slab is approximately 9 in. thick, and it appears to be composed of a top pour measuring 2.5 in. and a bottom pour measuring 6.5 in. A 4-in.-diameter floor drain is in the southwest corner of the cell.

The vertical, conical-shaped hopper received bulk solids for grout formulation from the storage bins surrounding Building 7852. The hopper diameter is approximately 5 ft at its top and 7 in. at its bottom; the height is approximately 5.5 ft. The five vertical structural supports are made of 2-in. schedule 40 pipe. A transparent Plexiglas™ window in the hopper allowed a view from the control room window of dry solids falling through the mass flow meter. Attached to the hopper bottom is a jet mixer assembly that combined the solids exiting the hopper with LLLW arriving from the pump house, and then fed the resulting slurry to a mixing tank. The overflow nozzle (west side of hopper) is plugged (unattached to other piping), and the off-gas nozzle (east side) is connected to the air filter blower on the control room roof. The top of the hopper projects above the mixing cell roof and is enclosed with a metal shield to confine the solids and any liquid flow that might splash or scatter if the jet mixer became plugged.

The original mixing tank, or "tub," installed in 1963, was rectangular in shape (ORNL Drawing M-10002-EE-009-D-2). Inside the tub was a densimeter pump that circulated grout to two densimeters located elsewhere in the mixing cell. A hydraulic oil pump outside the mixing cell's east wall circulated oil to the densimeter pump in the tub; the oil pump was situated on a pump pad measuring approximately 4 ft by 2 ft by 6 in. The tub (with attached piping and pumps) was replaced circa 1973 by a vertical, cylindrical mixing tank with an agitator (see ORNL Drawings P-20974-EE-001-D through -003-D). The mixing tank is almost 6.5 ft in height and 3 ft in diameter. The tops of the enclosed mixing tank and the agitator motor extend through the mixing cell roof and are therefore exposed to the environment. Two 5-in. grout feed lines run from the bottom of the mixing tank into the adjoining pump cell, penetrating the intervening wall about 17 in. off the floor. Two ventilation nozzles are positioned on the side of the tank, about 4 ft 9 in. from the tank bottom. The nozzle on the east side is plugged; the nozzle on the west side is attached to the air filter/blower on the control room roof.

Figure 2.10 shows the mixing cell interior near the deteriorating ceiling, and Fig. 2.11 shows the interior near the floor. As shown in Fig. 2.10d, access to the mixing cell was via a 2-ft by 2.5-ft hatch near the southeast corner of the nonremovable roof. A metal rung-and-rail ladder, constructed from 3/4- and 1-1/4-in.-diameter schedule 40 pipe, is attached to the south wall of the mixing cell and extends from the floor to the hatch. The overhead spray system piping (see Figs. 2.10b, c, and d) runs parallel to the north, east, and south walls of the cell. With sprinkler heads attached to the underside of the pipes, the spray system facilitated decontamination or cleanup efforts. Stored items in the cell include miscellaneous tools (see Figs. 2.10d and 2.11c and d) and cleaning equipment (see Fig. 2.10c).

2.8 PUMP CELL

Figure 2.12 shows the interior walls of the pump cell, and Fig. 2.13 shows views of the grout suction lines, ceiling, and floor. The pump cell contains only minor stored items (see Figs. 2.12a, b, and c) such as hoses, rope, chain, a ladder, a vise, a barrel, cans, tools, and equipment parts. A rack on the north and east walls holds most of the equipment parts. The high-pressure grout injection pump (a Halliburton HT-400 triplex positive displacement pump) and driver were moved from the pump cell to the New Hydrofracture Facility (NHF), south of OHF (see Fig. 1.1). The pump head was isolated within the cell and separated from the rest of the pump on the engine pad by a steel splash plate that was fitted around the head of the injection pump and extended to the walls, floor, and roof of the cell. ORNL Drawing S-20974-EB-007-D indicates that a 1/2-ton-capacity trolley hoist and 10-ft-long support beam were installed in the pump cell circa 1973 to facilitate maintenance on the pump head (see Figs. 2.12a and d); the support beam is still present. A metal plate approximately 3 ft high by 3 ft wide curves up from the floor (not shown in Fig. 2.12 or 2.13).

Grout feed for the injection pump came through two 5-in. lines traversing the north wall near the floor (see Fig. 2.13a); these lines are disconnected in the pump cell, and grout deposited in the suction lines was sampled and analyzed during the characterization effort (see Sect. 5.3.4 for a discussion of radiological results). Discharge for the injection pump was through a 2 3/8-in. diameter pipe that passed through a 4-in.-diameter hole in the west wall, 8 in. above the floor.

Access to the pump cell is through the roof or the south wall. As shown in Fig 2.13b, a 2-ft by 2.5-ft hatch exists near the northwest corner of the removable roof. A metal rung-and-rail ladder attached to the north wall extends from the floor to the hatch. The south wall of the pump cell is sheet metal covering a steel brace framework. Access is available through a door in that wall (see Fig. 2.12d); the OHF Facility Manager has the key.

Immediately in front of the door (approximately 4 ft) in Fig. 2.12d is a vertical pipe that was found during an initial site survey to have elevated readings. The pipe was wrapped with lead blankets (in plastic covers) and thin lead sheets (already present in the cell). Figure 2.13b shows piping running across the ceiling in an east-west direction; one is covered with insulation, and the other has sprinkler heads and was probably used for cell decontamination. Figure 2.13c also shows piping traversing the floor of the cell in an east-west direction. Based on the length of the concrete core sample (04553), the floor is approximately 8 in. thick and is apparently composed of a top pour measuring 1 in. and a bottom pour measuring 7 in. A 4-in.-diameter drain to waste pit T-4 is in the northwest corner of the pump cell; another approximate 4-in.-diameter hole in the floor is in the northeast corner near the east wall, stuffed with rags.

2.9 WELLHEAD CELL

The wellhead cell contains a piping manifold, valves, piping support, tank T-8, and the top of the injection well. These items are diagrammed in Fig. 2.14 and can be seen in Fig. 2.15, which gives interior views of the wellhead cell walls. The source drawings for Fig. 2.14 are dated 1963; other drawings of the piping manifold and support (such as P-20974-EE-006-D and -005-D, both dated 1973) do not match the photographs and are therefore assumed never to have been used for construction, although they were stamped "approved for construction."

Most of the piping and valves are along the north and west walls. According to the high-pressure piping specification in ORNL Drawing P-10002-EE-032-D, most of the manifold valves are shutoff (gate) valves; the exceptions are two check valves (V-11 and V-13) and one relief valve (V-12). The valve handles protruding from the exterior wall of the wellhead cell (see Fig. 2.6e) are part of the high-pressure valve rack. The wellhead is in the southeast quadrant of the cell, centered approximately 3 ft from the south and east walls. The piping manifold connected the injection pump, the injection well, the standby injection pump, and the waste pit. The connection from the manifold to the waste pit is a 3-in.-diameter pipe that penetrates the floor slab near the interior north wall. The piping support consists of 2-in. by 2-in. by 1/4-in. angles welded into a continuous rack and anchored to the walls and floor.

The grout line enters the cell through a 4-in.-diameter hole toward the base of the east wall near the wellhead (see Fig. 2.15d). The grout flow then follows a tortuous path to the top of the wellhead by first entering the piping manifold near the upper center of the cell's north wall and exiting the manifold near the center of the northwest corner (between valves 4 and 5).

ORNL personnel indicate that no sampling ports exist in the piping. A sampling port had reportedly been installed on the wellhead but was eventually removed. Stored items in the wellhead cell include unconnected piping, a heater, miscellaneous tools and spare parts (primarily on an east wall rack), rope and chain, and an unidentified piece of equipment wrapped in plastic (in the southeast corner of the cell by the wellhead; see Fig. 2.15d).

As shown in Fig. 2.16a, access to the wellhead cell is via a 2-ft by 2.5-ft hatch near the southwest corner of the removable roof. A metal rung-and-rail ladder attached to the south wall extends from the floor to the hatch, and there is a second hatch directly over the injection wellhead in the southeast quadrant. At the bottom of the access ladder is an 18-in.-diameter drain (see Fig. 2.16b) that leads to the impoundment. Two pipes feed the drain: a water pipe from tank T-5 and the 3-in.-diameter discharge/overflow line from tank T-8 (see Fig. 2.15a), located in the opposite corner of the wellhead cell. Tank T-8, which measures approximately 3 ft tall and 18 in. in diameter, provides surge capacity for material sent to the impoundment. The tank is supported on 1-ft legs and has a drain valve near the bottom.

Although not visible in the photographs, ORNL Drawing P-10002-EE-015-D indicates a 4-in.-diameter (to the waste pit) in the northeast corner of the cell, behind tank T-8. This line joins with other 4-in.-diameter drain lines from the southwest corner of the mixing cell and the northwest corner of the pump cell. The floor slab is approximately 7.5 in. thick based on the length of the concrete core sample (04552).

2.10 ENGINE PAD

The engine pad, a concrete slab measuring approximately 10 ft by 22.5 ft, extends southward from the pump cell (see Fig. 2.6f). The pad is approximately 6 in. thick, based on the concrete core sample (04471) length. The pad, covered by a corrugated metal roof at a height of 9 to 10 ft above the ground, was built to accommodate a skid holding the injection pump, a ten-speed transmission, and a VT-12 Cummins diesel engine. According to ORNL drawings, the engine pad was adjoined on the east side by a smaller (4 ft by 7 ft) concrete pad that supported a 275-gal-capacity diesel fuel tank; however, neither the tank nor the pad was found during the site walkover. Absorbent materials, intended to prevent rainwater from entering the pump cell, currently lie on the pad near the pump cell.

2.11 BULK SOLIDS BINS

The four mild steel bulk solids storage bins to the northwest and east of Building 7852 are shown in Fig. 2.17 (foundation and elevation), Fig. 2.18 (views of the top), and Fig. 2.19 (views of the bottom). The bulk solids bins were used to store cement, fly ash, clay, and other solids prior to their mixing with waste to form the pumpable grout. Based on their process history, the bins are considered to be relatively uncontaminated and are expected to represent no serious radiological impacts (see Sect. 6.3.4 for results of radiological surveys). However, the bins are exposed to the elements, are deteriorating, and may cause safety hazards; they are coated with lead-based paint that is peeling badly, and the metal exhibits extensive corrosion.

Visual surveys indicate that the bins are empty but a thin powder residual coats the interior surfaces (see Fig. 2.19e). Each vertical cylindrical bin has a conical bottom, measures 12 ft in diameter and 20 ft in height, and has a capacity of 2780 ft^3. The bottoms of the tanks are approximately 6 ft above the top of the mixing cell, and the center of each is on a radius of 21 ft 6 in. from the center of the mixing hopper. Each bin, supported more than 22 ft above the ground by four steel stanchions on concrete piers, permits gravity flow through air slides to the mixing hopper in Building 7852. Some of the stanchions are bolted directly to the concrete piers; others are pinned to a metal hinge bolted to the pier. The footings for each concrete pier measure 6 ft by 6 ft by 20 in. thick. The steel stanchions serve also as convenient supports for electrical conduit, pneumatic tubing, and miscellaneous piping.

At higher elevations, the bins are encircled by railings and interconnected by a catwalk. A ladder (with a safety cage) on the west side of bin 2 reaches up to the catwalk from ground level (see Fig. 2.18b). An Energy Systems inspection of the ladder and catwalk determined that they are severely corroded and cannot be certified safe for use. Instead, an electrician's boom truck and operator were provided by Energy Systems for characterization at higher elevations. To investigate the interior of each bin, a member of the field team was lifted to the top of the bin adjacent to the manway hatch. A hatch at the top of the bins is large enough to permit manned entry and ladders do exist inside the bins; however, manned entry was not permitted during site characterization.

Appurtenances to the bins include

- a bag house (dust collector) on top of bin 2 (see Fig. 2.18b),
- an operating air compressor underneath bin 1 (see Fig. 2.19a),
- a blower by bin 2 (see Fig. 2.19b),
- operating ventilation equipment underneath bin 3 (see Fig. 2.19c),
- concrete pads for the weigh tank and 2 solids-blend tanks (see Figs. 2.1 and 2.2), and
- compressed air lines, vent lines, and air slides.

According to ORNL personnel, the air compressor is relatively new and is used to operate level equipment and pressurize the buried waste storage tanks. The compressor's concrete support pad measures approximately 4 ft by 3 ft by 8 in. thick. The ventilating equipment underneath bin 3 is part of the exhaust and filter system that connects to each cell in Building 7852. The equipment sits on a pad measuring approximately 9 ft by 8.5 ft by 7 in. thick. No attempt was made to access, via disassembly, the inside of the exhaust system (filter and fan underneath bin 3) or other appurtenances (characterization of "sealed" appurtances will be by external surveys and smears). The weigh tank and two 820-ft^3 solids-blend tanks, previously situated just north of bins 1 and 2, were removed to NHF; however, the concrete support pads still exist. According to ORNL Drawing S-10002-EB-010-D, the weigh tank pad measured approximately 12 ft by 11 ft by 16 in. thick. Reed (1984) reported that a small vessel once used to contain a very-short-lived radioactive tracer fluid was located under bin 4, surrounded by concrete shielding blocks; this tracer tank was not present during the recent site walkover. These appurtenances are considered to be the responsibility of D&D rather than RA, but any action regarding them will be coordinated with RA. With the possible exception of the ends of the air slides near the mixing hopper, the appurtances are believed to be uncontaminated.

2.12 PUMP HOUSE AND VALVE PIT

Figure 2.20 shows a plan view of the pump house and valve pit, including principal piping, based on ORNL Drawings P-10002-EA-004-D, -EE-001-D, and -EE-008-D. Also included in Fig. 2.20 are building sections and exterior elevations.

The 225-ft^2 concrete block pump house, northwest of Building 7852, is partially underground and is covered by a corrugated steel sheet roof (see Fig. 2.21a). The floor pad is approximately 5 in. thick, based on the concrete core sample (04551) length, and rests on a gravel fill/sub-base. Access is through a padlocked, 7-ft by 3-ft steel door at the northeast corner of the building; keys are held by the OHF Facility Manager. Electrical junction boxes are mounted on the exterior south and north walls of the pump house (see ORNL Drawing E-10002-ED-003-D).

Immediately south of the pump house are a fan and filter system used to exhaust the waste storage tanks and the pump house (see Fig. 2.21b; see also ORNL Drawings H-20974-EG-001-D and -003-D). Negative air pressure was provided during entry by this existing ventilation system, which has a design rating of 320 to 400 cfm and exhausts through both a prefilter and HEPA filter.

Approximately 3 ft from the southeast corner of the pump house is a concrete box, called a waste flow metering pit, which is almost all below grade and is covered with steel bar grating and an aluminum sheet. Traversing the length of the box is a 4-in.-diameter waste transfer line from the nearby valve pit. The exhaust system and the metering pit were not included in the characterization; they are under ORNL RA's jurisdiction.

On the west end of the pump house is a 5 ft 4-in.-deep dual compartment valve pit that contains most of the valves in the waste handling system (see Fig. 2.21c). Reed (1984) describes the valve pit as follows:

> The west end of the pump house has its floor at the same elevation as the rest of the building, but it has four short walls (no door) that barely extend out of the ground. This end of the building is called a valve pit and it has been extended to the south. The entire valve pit is 6 ft 4 in. by 21 ft in plan area, and it is covered with metal plates through which valve handles extend upwards to the outdoors.

The valve pit has approximately 11 pipe penetrations on its west side and 7 on its east side. Access is through the cover plates over the pit, although access was not attempted during characterization. According to ORNL drawings, the original cover consisted of 16-gage sheet metal tack-welded to a 3/4-in. removable steel grating; lead plates now lie on top of the metal grating. Some long-handled tools for the valve pit are mounted on the exterior west wall of the pump house.

Figures 2.22 and 2.23 show interior views of the pump house from photographs. The pump house contains two pumps and their drivers on L-shaped concrete pads, suction and discharge piping connecting the pumps with other piping in the valve pit, lead shielding covering portions of the pump/piping system, rubber drain hoses connecting the pumps to the floor drain, electrical controls and junction boxes on the interior east wall (see ORNL Drawing E-10002-ED-003-D), conduit and other small-diameter piping, miscellaneous tools and supplies for pump maintenance, a three-door equipment locker, and a sump pump. The drains from the pump house and valve pit join the 18-in.-diameter line running from the wellhead cell to the impoundment.

Both pumps, which are 25- to 30-hp progressive-cavity-type (Moyno, type 2L14H) pumps, were capable of pumping approximately 180 gpm at 120 psi and could be run simultaneously if needed. A screen (removable strainer) is provided on the pump suction line, and a 250-psi pressure relief valve is installed on the discharge line. These pumps were used to draw radioactive waste from the storage tanks and feed it to the mixing assembly in Building 7852 through 4-in.-diameter underground piping. According to Energy Systems personnel, the pumps were last operated more than two years ago to pump wastewater from the waste pit to the LLLW system. It is expected that they could still be operated with minor preparation.

According to ORNL drawings, one improvement made circa 1973 was the installation of lead sheets around the pump heads and piping to provide radiation shielding. Lead sheet (1/2 in. thick) was hung on both sides of the pump head from an overhead support. Lead shielding (1 in. thick) was also attached to a unistrut framework set in place over the suction piping. Although lead shielding is present in the pump house, the site walkover showed that the shielding design approved in the drawings does not now exist. The current shielding is in the form of lead plates under the pump and discharge line and covering the pump pedestals, and lead sheet wrapped around or laid on top of the pump and discharge line.

2.13 WATER TANK T-5

The 25,000-gal cylindrical water tank T-5 (see Fig. 2.24) sits on an aboveground concrete pad approximately 15 to 20 ft north of Building 7853. The painted mild steel tank measures approximately 21 ft in height by 14 ft 4 in. in diameter; the pad is 16 ft 6 in. on each side and is approximately 1 ft thick. A fire extinguisher and housing are located on the west side of the pad, next to the tank. The tank supplied water to Building 7853, to the injection and pump house pumps for priming, to drains for flushing, and to other parts of the grout injection system as process makeup water. The tank supplied water via gravity feed or pump P-3. Reed (1984) reported that uncontaminated water was stored in the tank for possible use in fire protection.

The approximate depth of water in the tank is 18 ft. Although there is a small valve on the north side of the tank, sampling was through a lid on the top. The lid is not fully mated with its flange, which allows some rainwater to enter the tank.

2.14 PUMP P-3

Pump P-3, just north of Building 7853, supplied water to and discharged water from tank T-5. As shown in Fig. 2.25 (and ORNL Drawing P-10002-EE-014-D), the piping and associated valves connecting the Moyno pump and tank are above ground. The pump exterior is considered to be relatively free of loose surface (smearable) contamination, and no serious radiological impacts are expected. The L-shaped pump foundation is a poured concrete slab measuring approximately 10 ft long by 3.5 ft wide (maximum) by 1.5 ft high. The pump is reportedly not operable (Reed 1984).

2.15 ONGOING OPERATIONAL AND MAINTENANCE ACTIVITIES

Energy Systems (Tank Operations) records on a check sheet the waste levels in the buried tanks and performs a check on the cathodic protection system installed to protect piping between the tanks and the valve pit. The instrumentation for the waste levels was originally in a panel mounted on the west wall of the control room. However, it was difficult for the operators to read the gages clearly through the window from the outside (operators do not enter the control room), so gages were also installed in a cabinet next to the tanks. The air compressor under bin 1 supplies the instrument air.

Energy Systems S&M follows a weekly check list: access controls, chains, and placarding; vegetation control; condition of the access roads; pond level; off-gas system for the hot cells (under bin 3); off-gas system for the tanks (south wall of the pump house); and general appearance and "housekeeping." The off-gas systems, which have power on-off switches next to them, operate continuously.

The Radiation Protection Division at ORNL performs radiation surveys at OHF semiannually to update their exposure maps.

The Office of Quality Programs and Inspections at ORNL performs (1) an annual check of the exhaust filter system for the pump house and Building 7852 including HEPA efficiency tests; (2) an annual inspection of the air receiver (tank under bin 1), including a test of the pressure relief valve; and (3) an inspection every five years of the "fixed" ladders at the site.

Table 2.1. OHF areas of concern

Area	Description	Oversight Program
Building 7852	This building has a control room, engine pad, and 3 shielded cells housing the injection wellhead (RA, WAG 10), grout mixer, piping, and other equipment.	D&D (OHF)
Bulk solids bins and appurtenances	The four bins (raised hoppers) surrounding Building 7852 were used to store blended solids prior to mixing with waste. Appurtenances include a weigh tank and two blending tanks (only the foundations/pads currently remain) and other equipment located near, or attached to, the bins.	D&D (OHF)
Pump house	This one-room structure (adjacent to the valve pit) contains two large pumps that were used to draw radiological waste from the OHF waste storage tanks, through the waste flow pit, to Building 7852.	D&D (OHF)
Water tank T-5	The water tank ensured adequate water supply to pumps for priming and to pipes for flushing or process makeup.	D&D (OHF)
Pump P-3	Pump P-3 pumped water to and from water tank T-5.	D&D (OHF)
Building 7853	Building 7853 is a "Butler" or portable-type building that was used primarily by OHF workers as a change room; it is used currently for furniture and spare parts storage.	WM
Septic tank	The inactive septic tank is a 750-gal-capacity concrete structure used to collect raw domestic sewage from Building 7853; the sewage was periodically pumped into a tanker truck for disposal. The tank is not listed in the FFA.	RA (WAG 5)
Impoundment	This 100,000-gal-capacity impoundment (or retention pond) was used as an emergency storage basin for grout during hydrofracture. The sides are lined with riprap. Inflow was at the south end via an 18-in. line from the injection wellhead cell.	RA (WAG 5)
Waste pit T-4	The pit is comprised of three separate concrete-walled cells, each measuring 12 ft by 12 ft by 9 ft. The cells allowed recycling of contaminated water during slotting and washup. The southernmost cell is filled with radioactive grout from an experimental injection; the others contain water-covered sludge.	RA (WAG 5)
Waste flow pit	This concrete box measures 8.5 ft by 3 ft by 5 ft deep. Piping traversing the pit includes a turbine flow meter and gate valve.	RA (WAG 5)
Waste storage tanks	The inactive carbon steel tanks consist of tanks T-1, T-2, T-3, T-4, and T-9. Tank capacities range from 13,000 to 25,000 gal; residual volumes range from 1800 to 10,000 gal (ORNL 1988). The buried tanks were used during OHF operations to store LLLW until it was ready to be blended with grout.	RA (WAG 5)
Valve pit	This dual-compartment pit (adjacent to the pump house) contains valves and piping as part of the waste storage tank system.	RA (WAG 5)
Underground pipelines and conduits[a]	Many underground pipelines and conduits connect the buildings, tanks, bins, and pits throughout the OHF site. A flow-measuring station is buried in a 5-ft-deep pit at the southeast corner of the pump house.	RA (WAG 5)
Wells[a]	Monitoring and observation wells were installed to ascertain nature and extent of contaminant migration.	RA (WAGs 5 and 10)
Injection wellhead[a]	The top of the injection well is in the wellhead cell of Building 7852.	RA (WAG 10)

[a]Not shown in Fig. 2.2.

Table 2.2. Dimensions of Building 7852 rooms

Room	Length	Width	Height	Wall thickness
Mixing cell (interior)	12 ft 6 in.	11 ft 6 in.	7 ft 10 in.	12 in.
Pump cell (interior)	10 ft	7 ft 6 in.	7 ft 10 in.	12 in.
Wellhead cell (interior)	11 ft	11 ft	9 ft 10 in.	12 in.
Control room (interior)	13 ft 2 in.	10 ft	10 ft 8 in.	8 in.
Engine pad	22 ft 6 in.	9 ft 10 in.	6 in.	NA

Source: ORNL Drawings A-10002-EB-011-D, S-10002-B-003-D, and S-10002-B-004-D.

Table 2.3. Hot cell windows

Cell	Location	Material	Approximate dimensions (in.)	Comments
Mixing cell	North wall[a]	Plexiglas™	20 × 18 × 3/8	
	West wall	Plexiglas™	26 × 18 × 3/8	Covered with metal hatch
	East wall	Plexiglas™	26 × 18 × 3/8	Covered with metal hatch
Pump cell	Two windows on east wall	Bullet-resistant plate glass	23 × 15 × 1 17 × 15 × 1	
Wellhead cell	North wall	Bullet-resistant plate glass	23 × 15 × 1	Covered with metal hatch
	South wall	Bullet-resistant plate glass	23 × 15 × 1	

Source: ORNL Drawings S-10002-B-006-D, -007-D, and -008-D.

[a]This window is situated between the control room and the mixing cell.

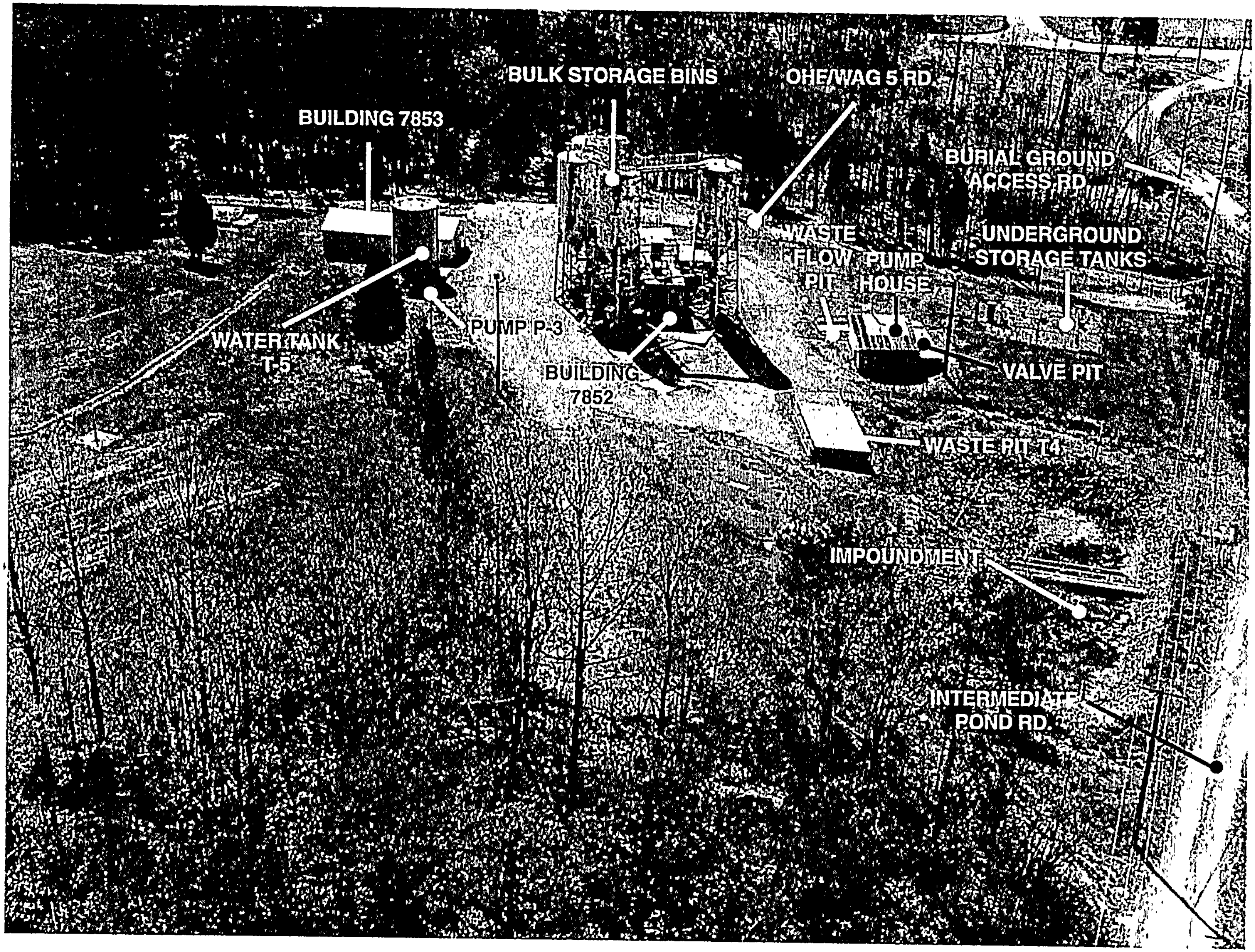


Fig. 2.1. Aerial photograph of OHF (view to the south). *Source: ORNL Photo 2525-89.*

SYQ 5.1 2279.1

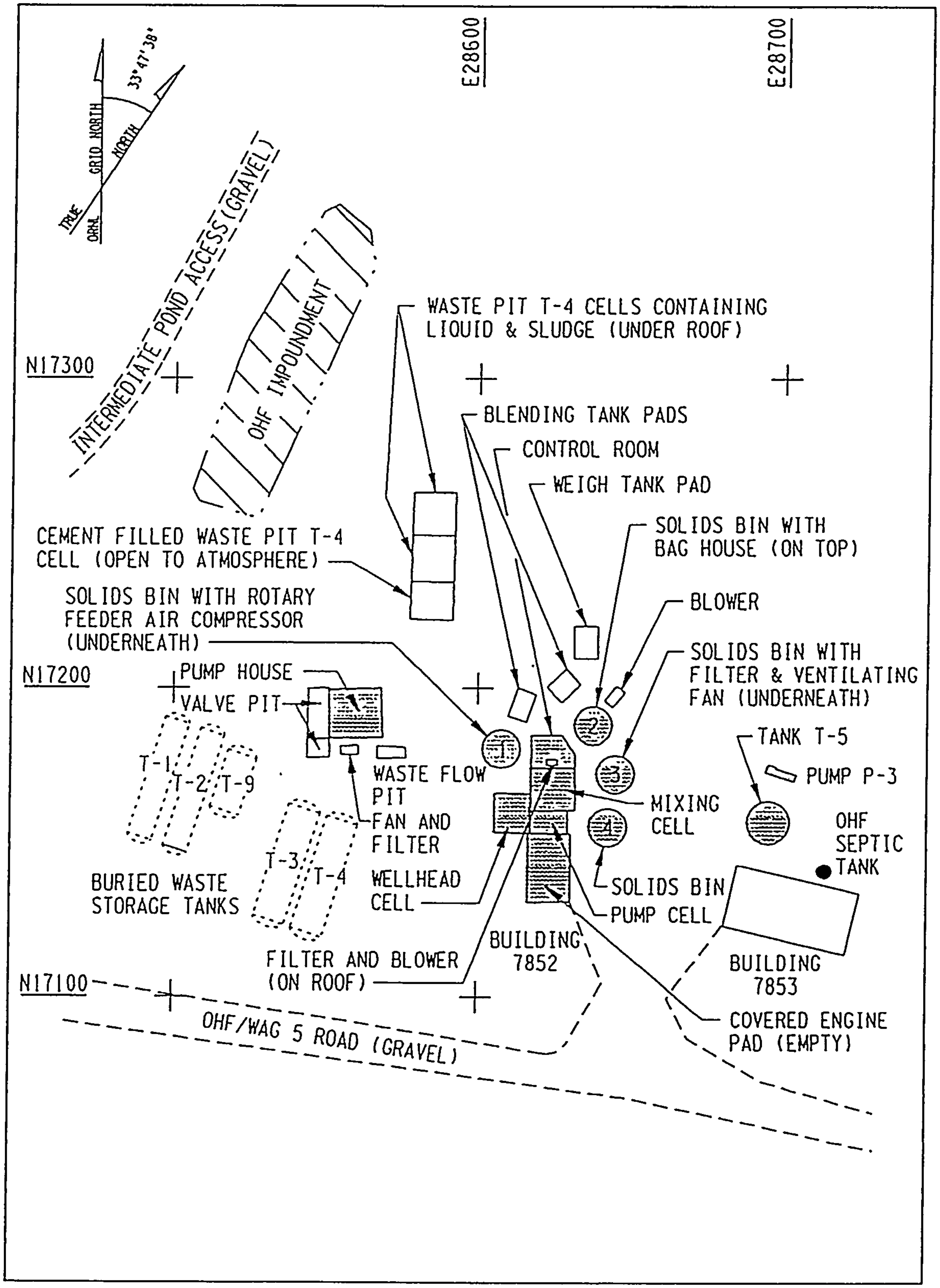


Fig. 2.2. OHF site plan.

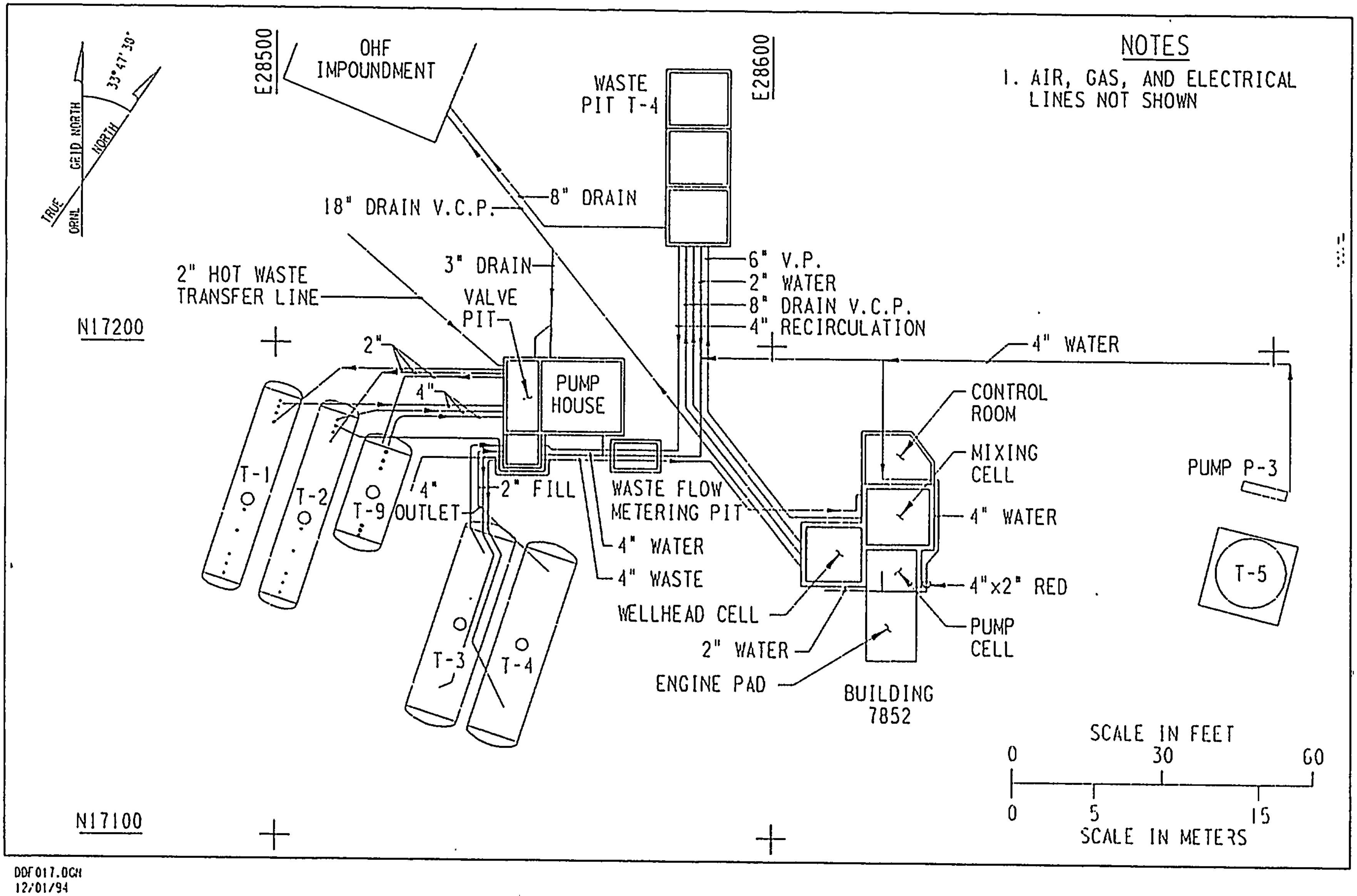


Fig. 2.3. Area piping near OHF D&D structures.

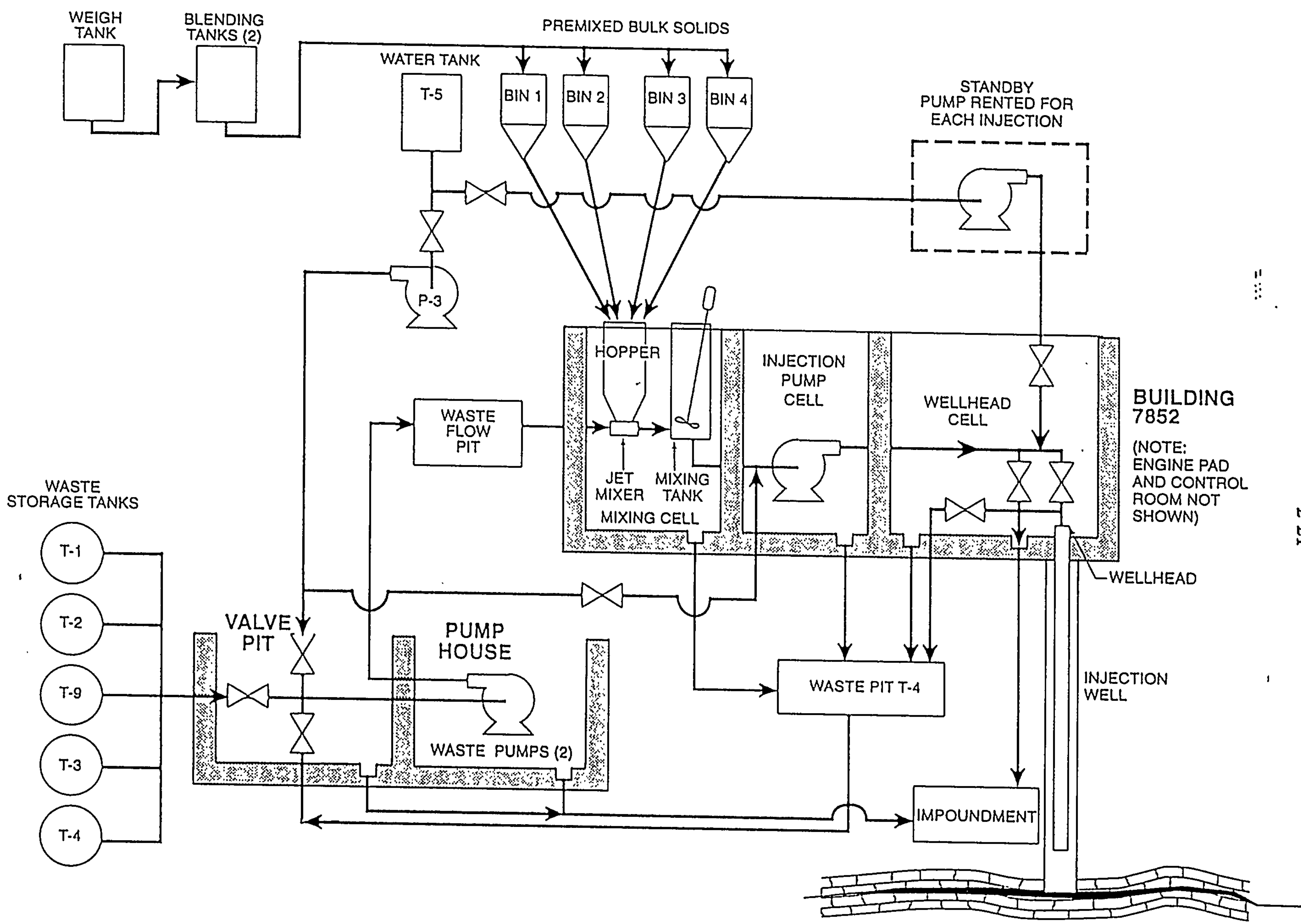
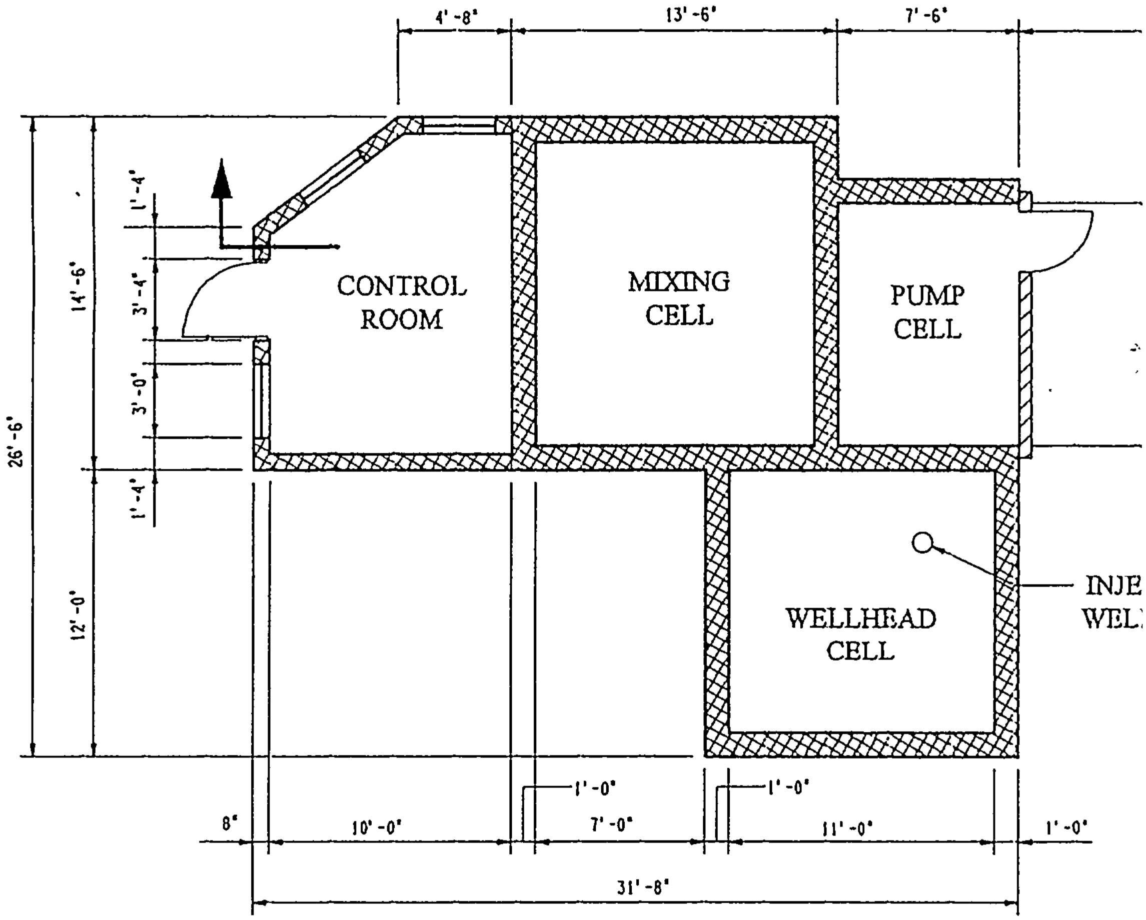


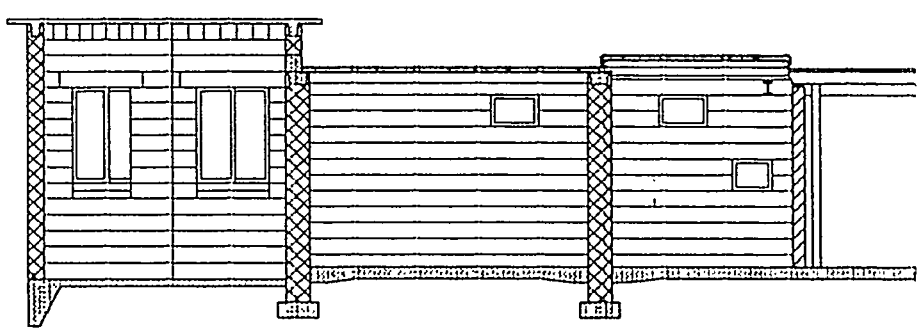
Fig. 2.4. OHF batch process flow diagram.

SYO 5.1 2279.3



BUILDING 7852 - PLAN

SCALE: 1/8" = 1'-0"



BUILDING SECTION A

SCALE: 1/8" = 1'-0"

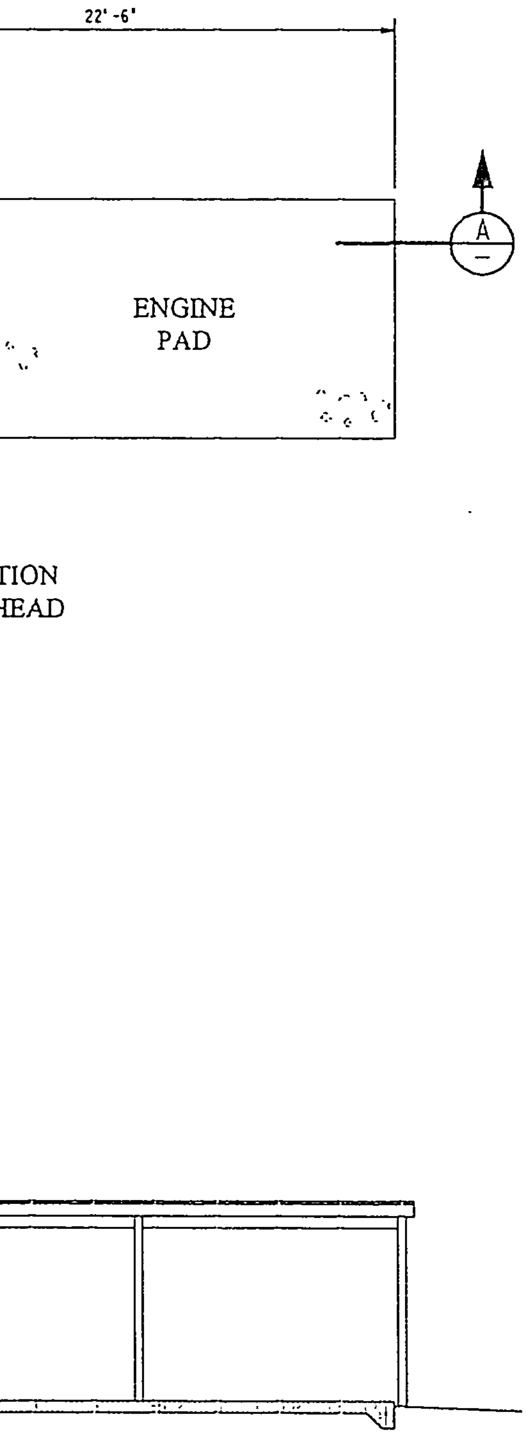
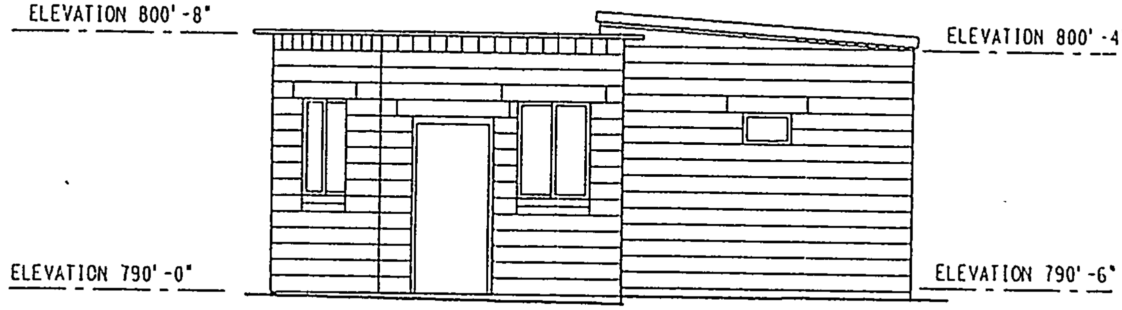
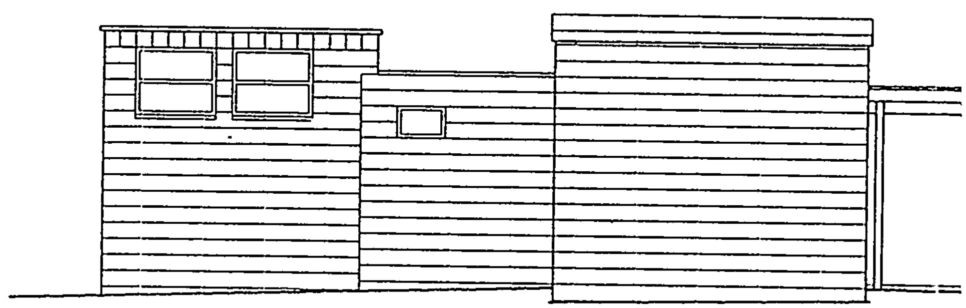


Fig. 2.5a. Building 7852, plan and section.



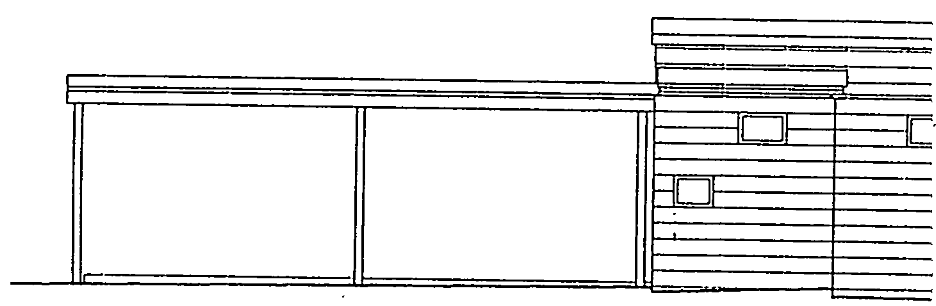
NORTH ELEVATION

SCALE: 1/8" = 1'-0"



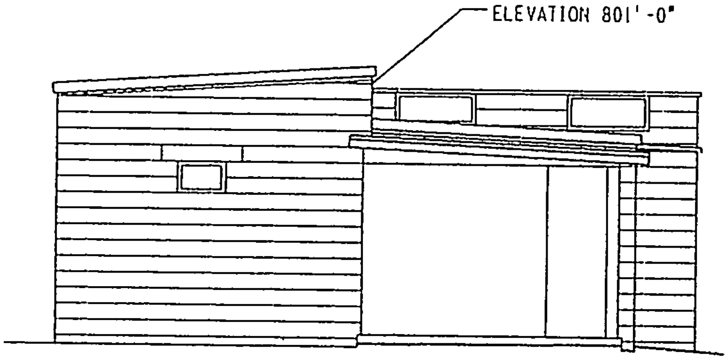
WEST ELEVATION

SCALE: 1/8" = 1'-0"

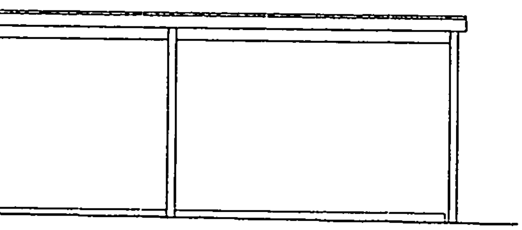


EAST ELEVATION

SCALE: 1/8" = 1'-0"



SOUTH ELEVATION
SCALE: 1/8" = 1'-0"



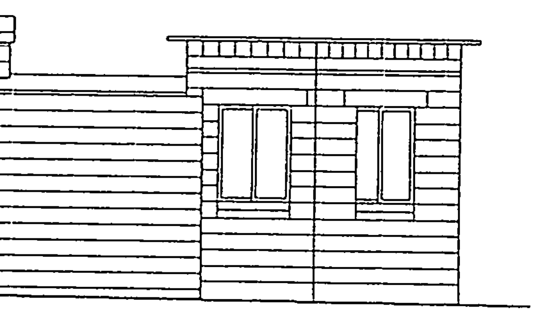


Fig. 2.5b. Building 7852, exterior elevations.

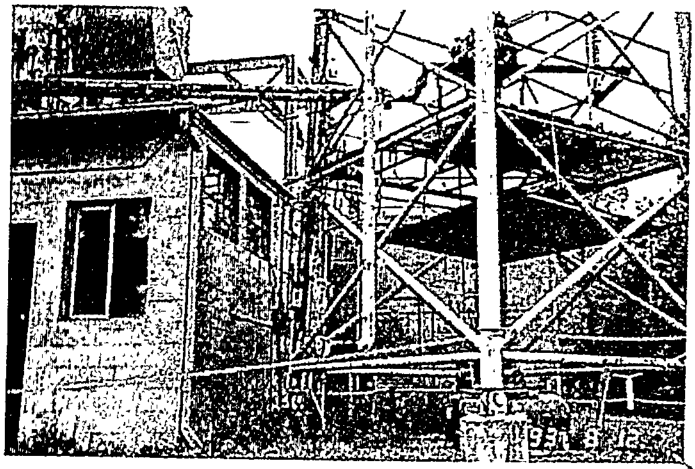


Fig 2.6a.

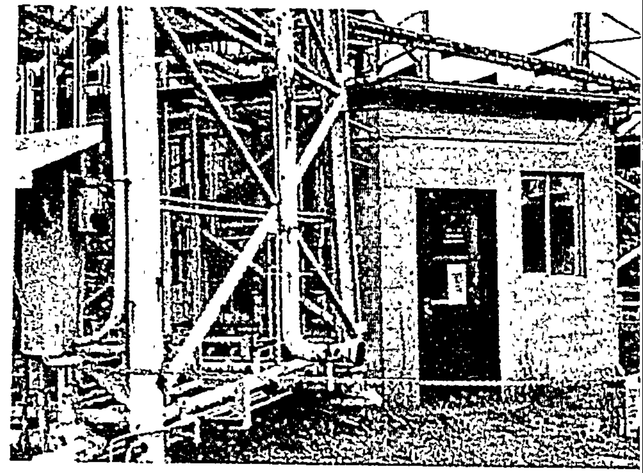
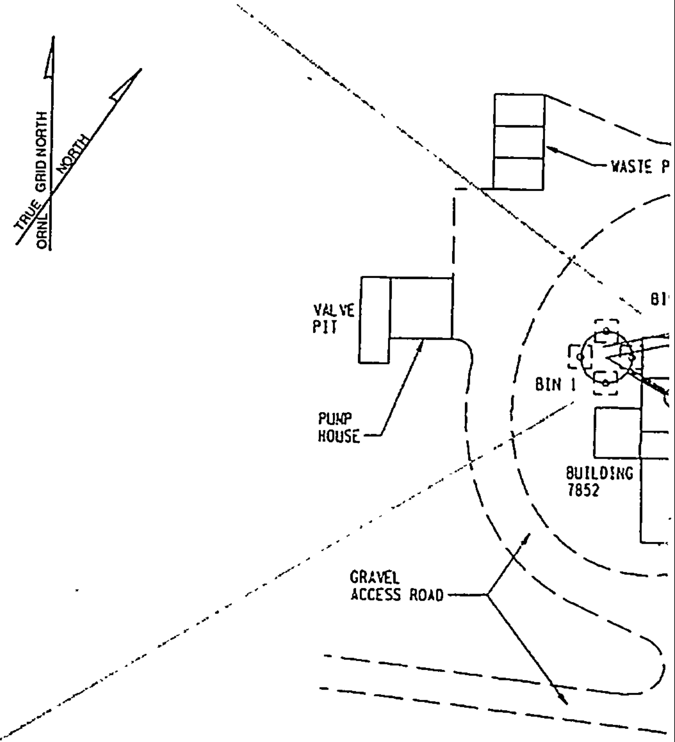


Fig 2.6b.



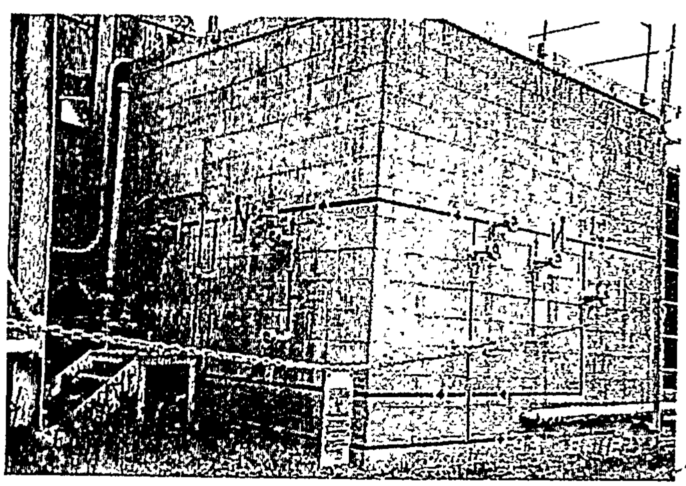


Fig 2.6e.

Old Hydrofracture

Fig 2.6c.

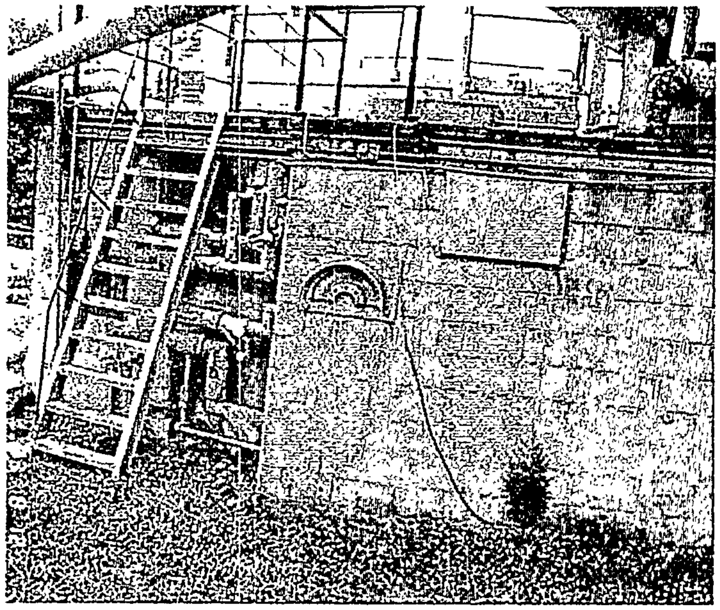
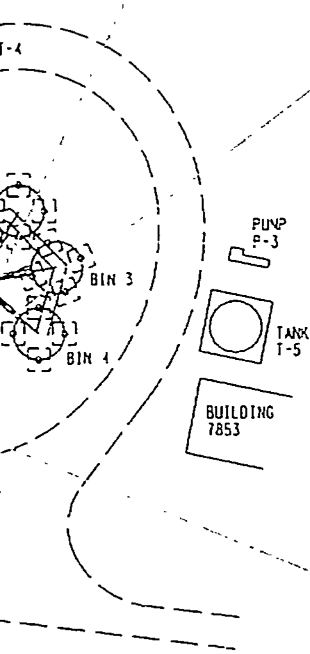


Fig 2.6d.



ea (not to scale)

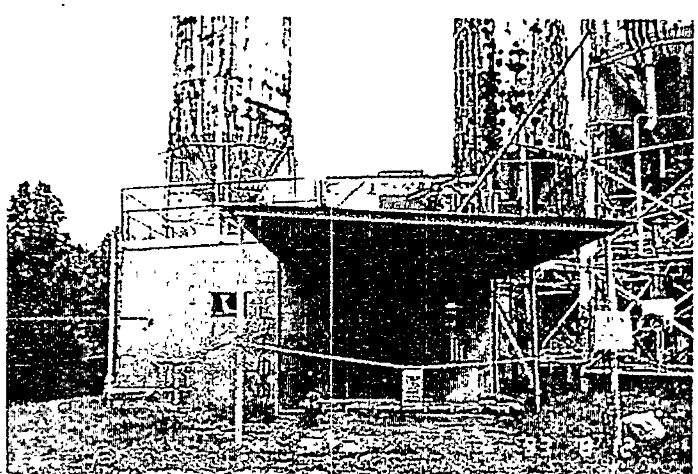


Fig 2.6f.

Fig. 2.6. Building 7852, exterior walls.

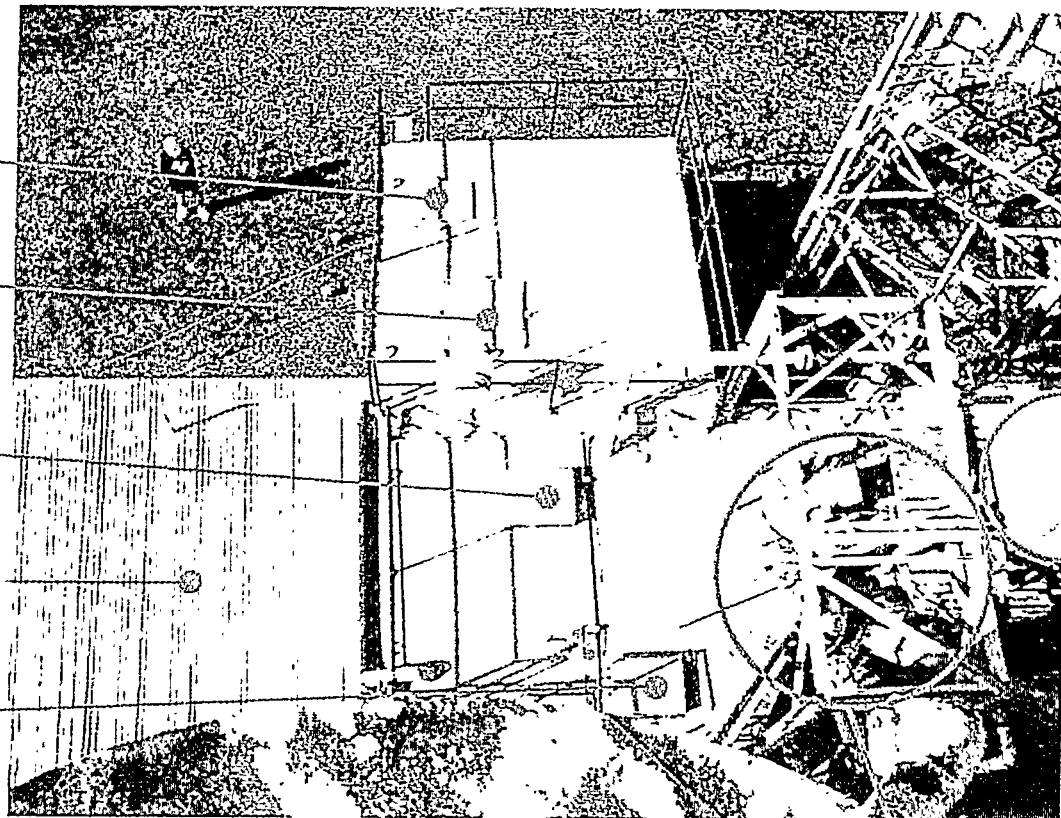


Fig. 2.7a. Roof of Building 7852 as seen from top of Bin 4.

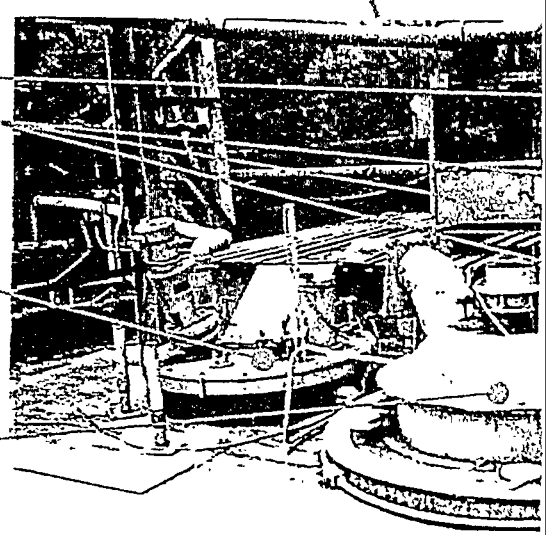


Fig. 2.7b. Mixing cell roof (foreground) an
(background).

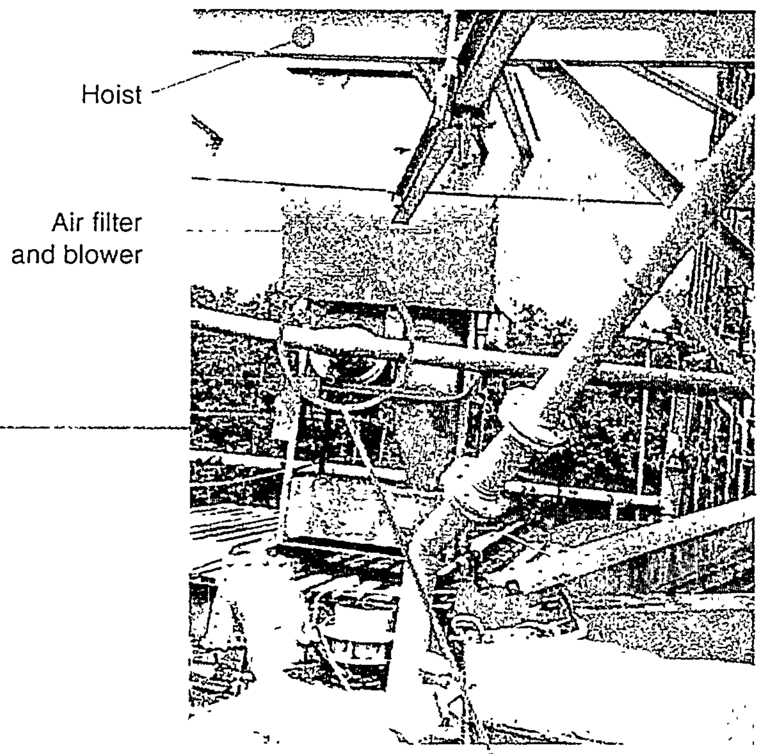
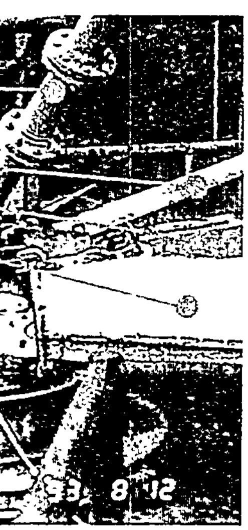


Fig. 2.7c. Ventilation equipment on control room roof.



:ontrol room roof

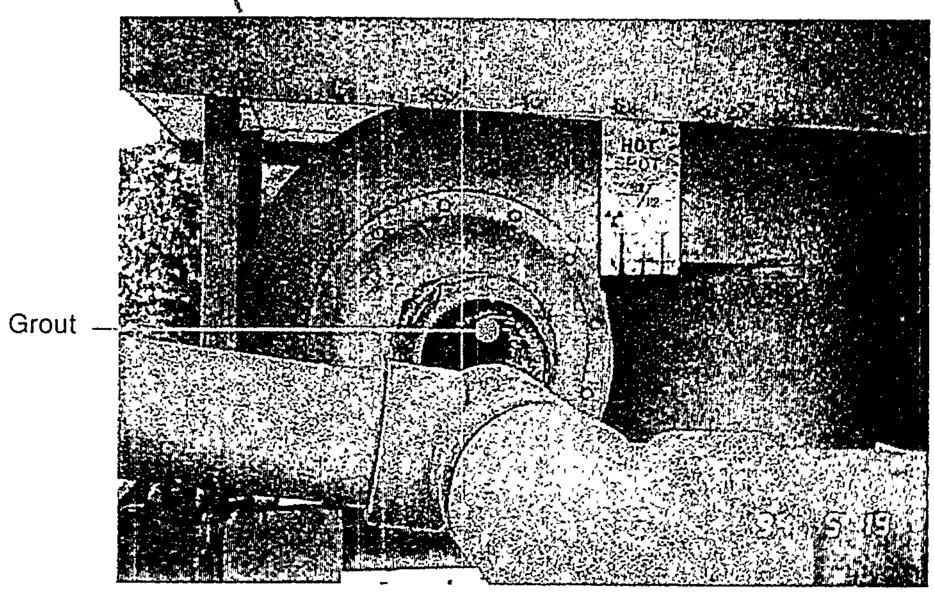


Fig 2.7d. Inlet to ventilation equipment (feed piping disconnected).

Fig. 2.7. Building 7852, roof and equipment on roof.

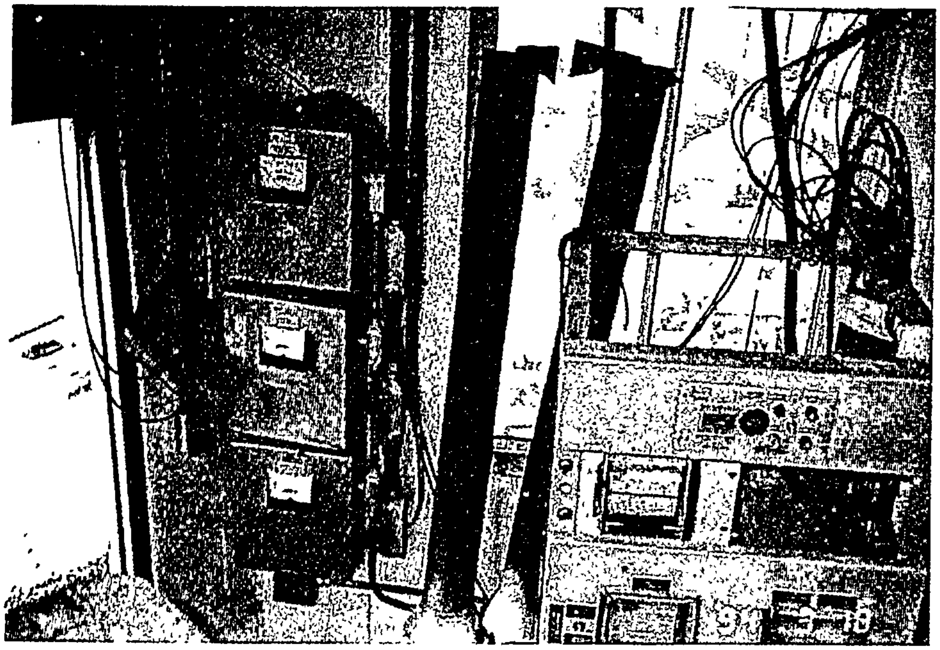
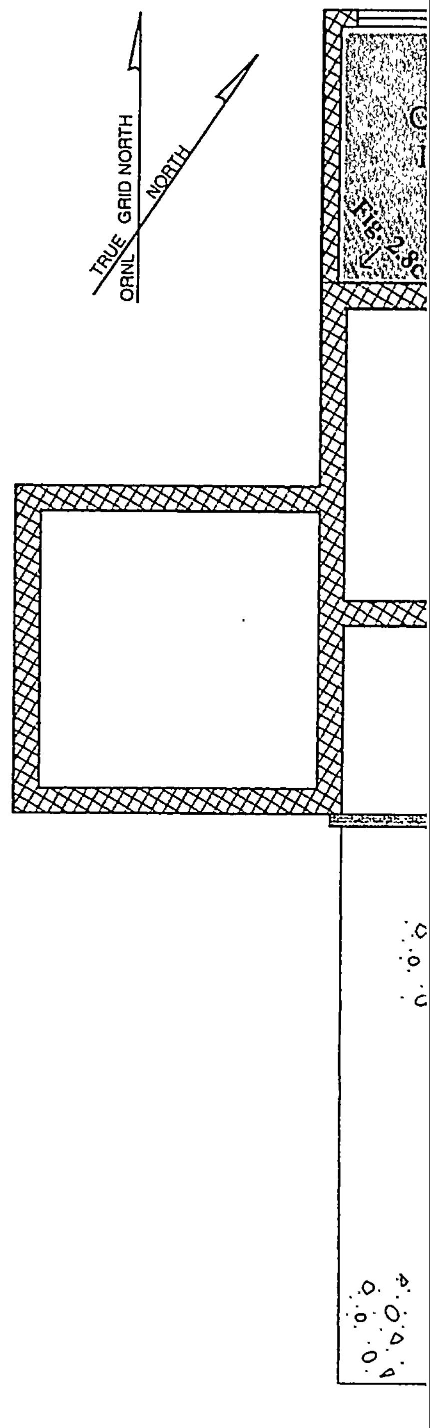
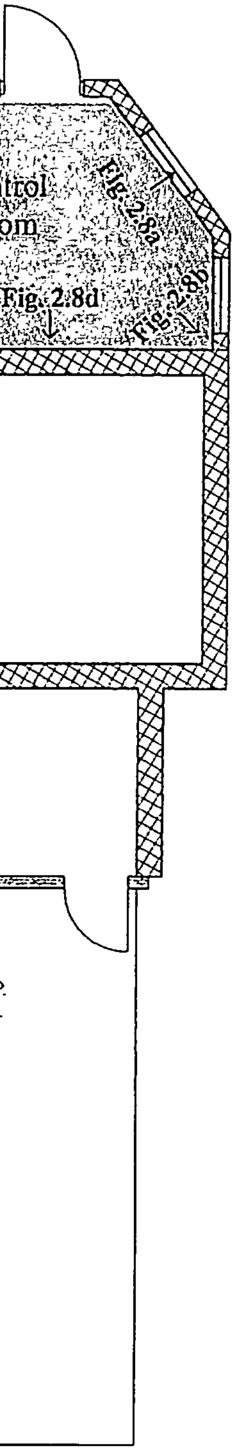


Fig. 2.8a.

Fig. 2.8c.



Building 7



2 Plan

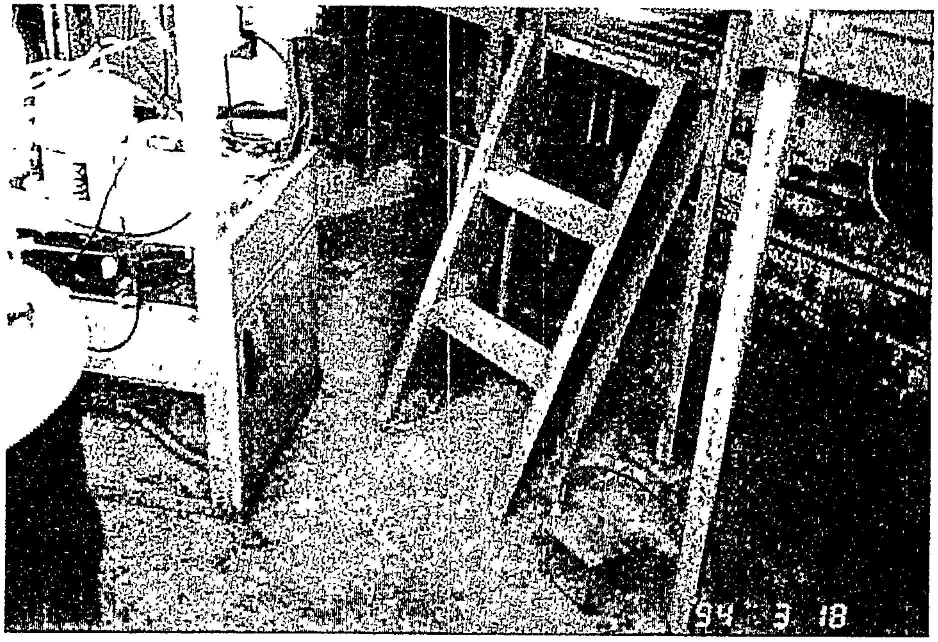


Fig. 2.8b.

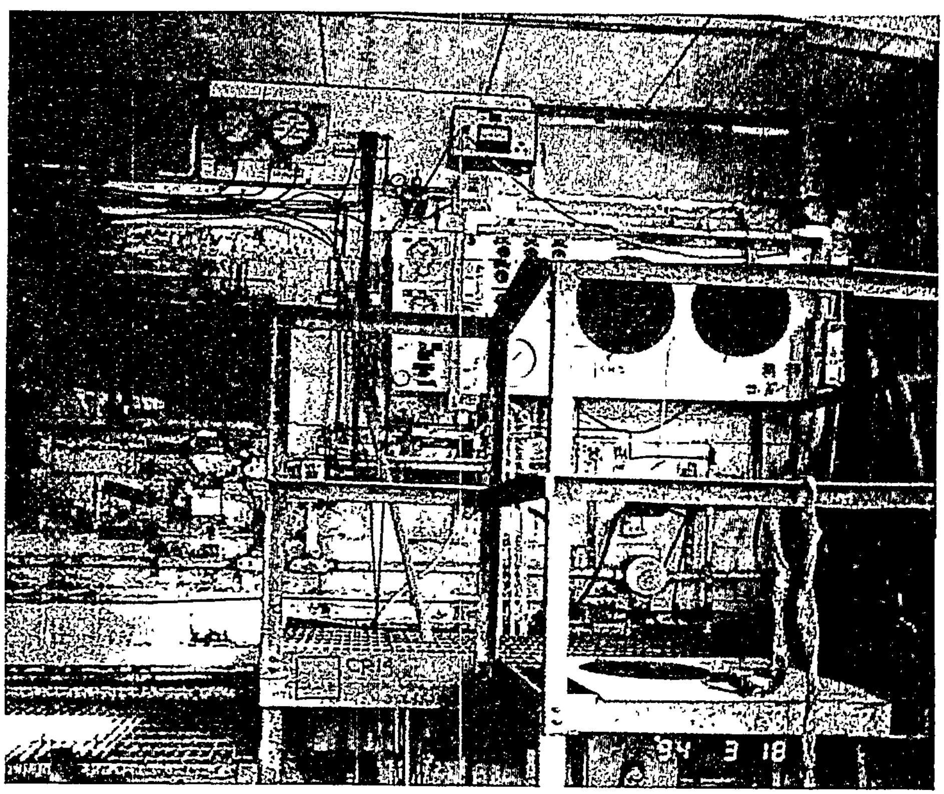
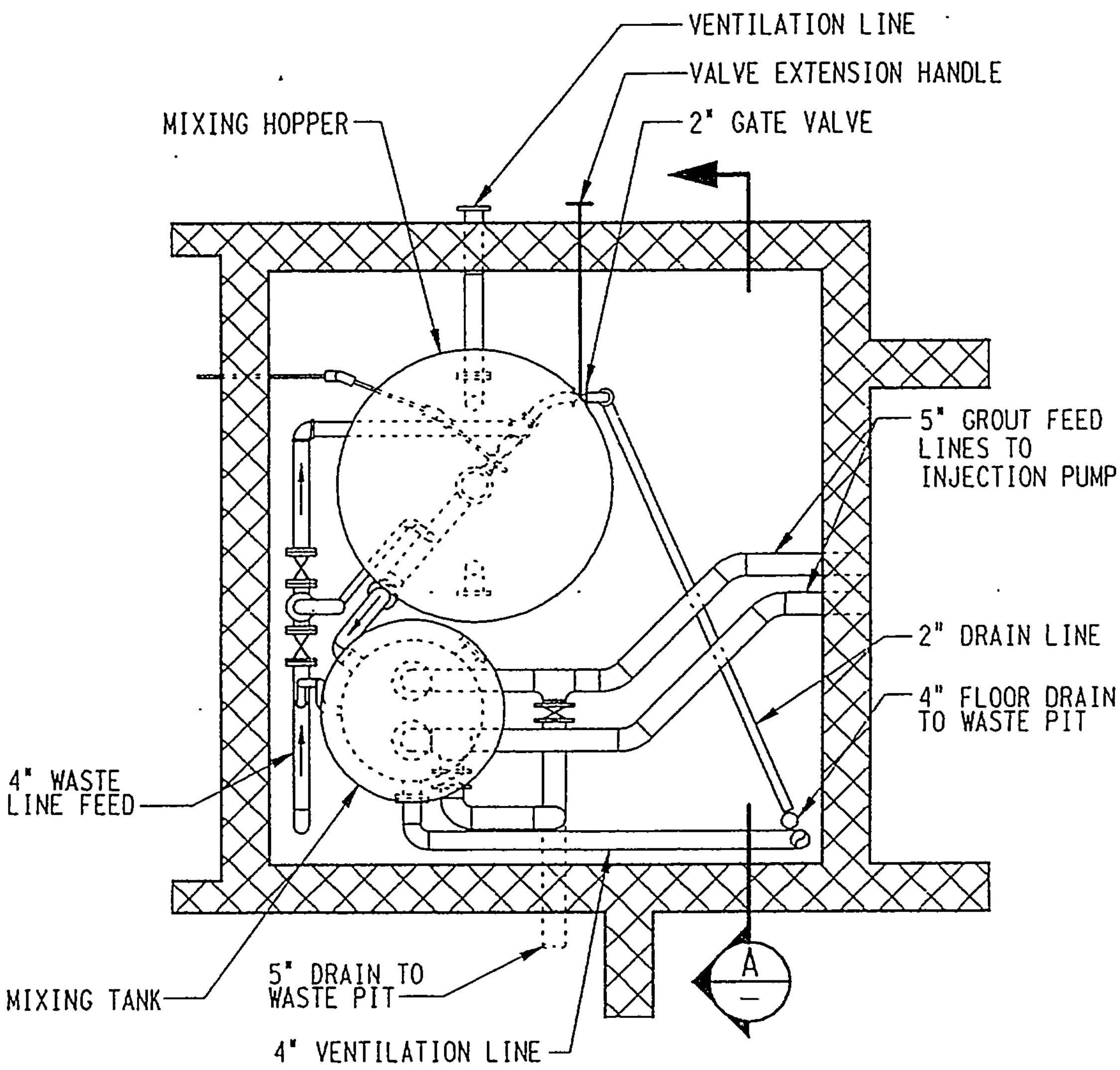


Fig. 2.8d.

Fig. 2.8. Control room interior.



EQUIPMENT PLAN AT MIXING CELL

SCALE: 1/4" = 1'-0"

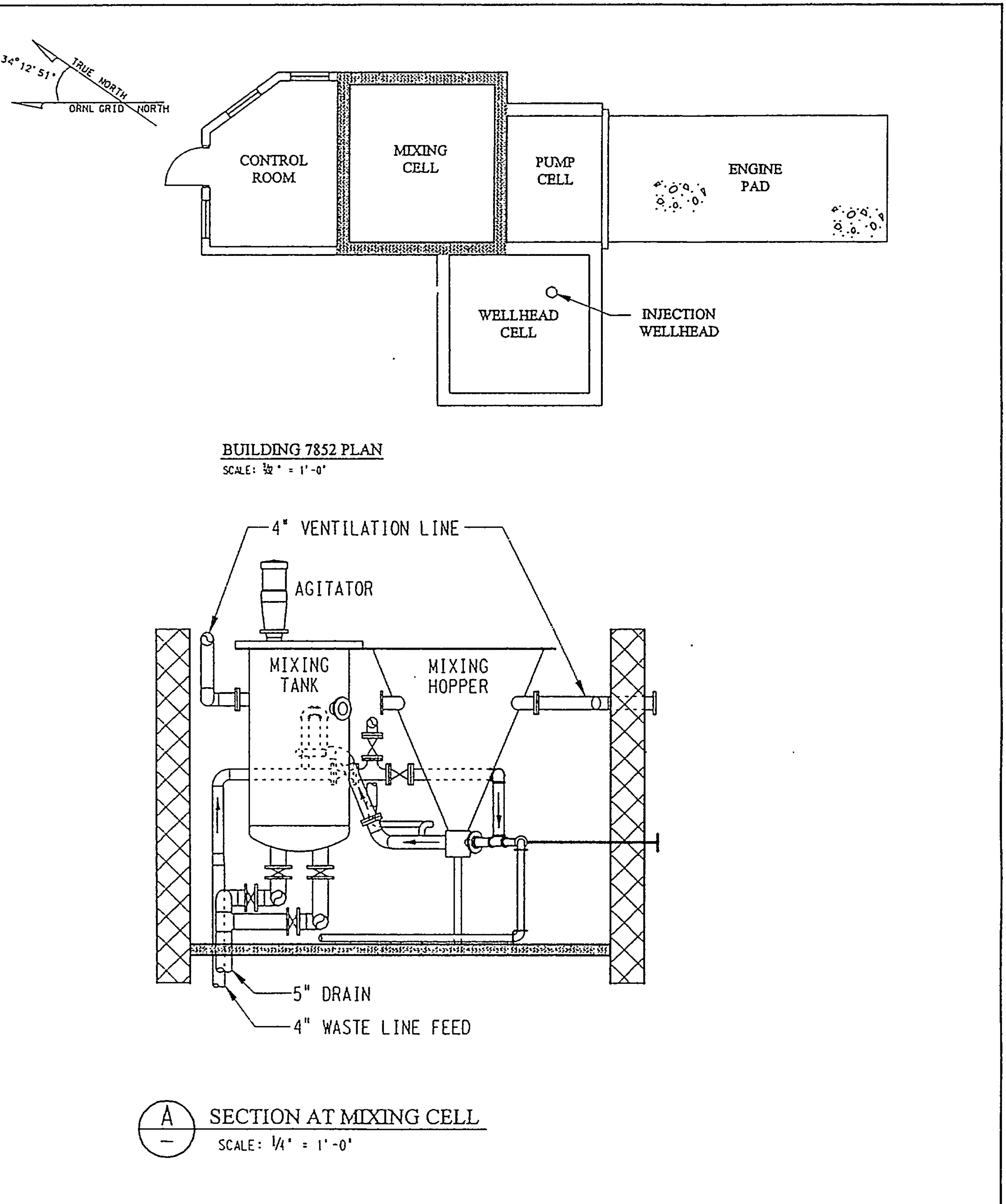
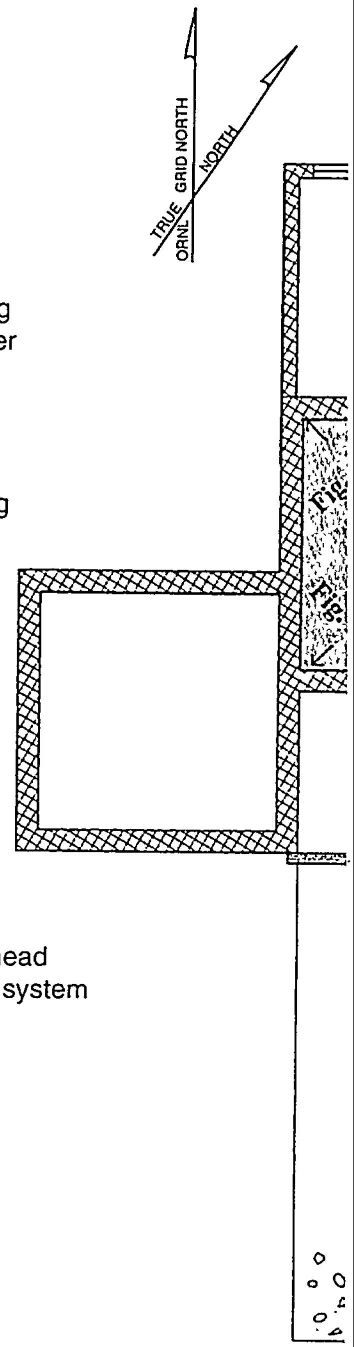


Fig. 2.9. Mixing cell, plan and section. Source: P-20974-EE-004-D.

Fig. 2.10a. Northwest interior corner of mixing cell near ceiling.



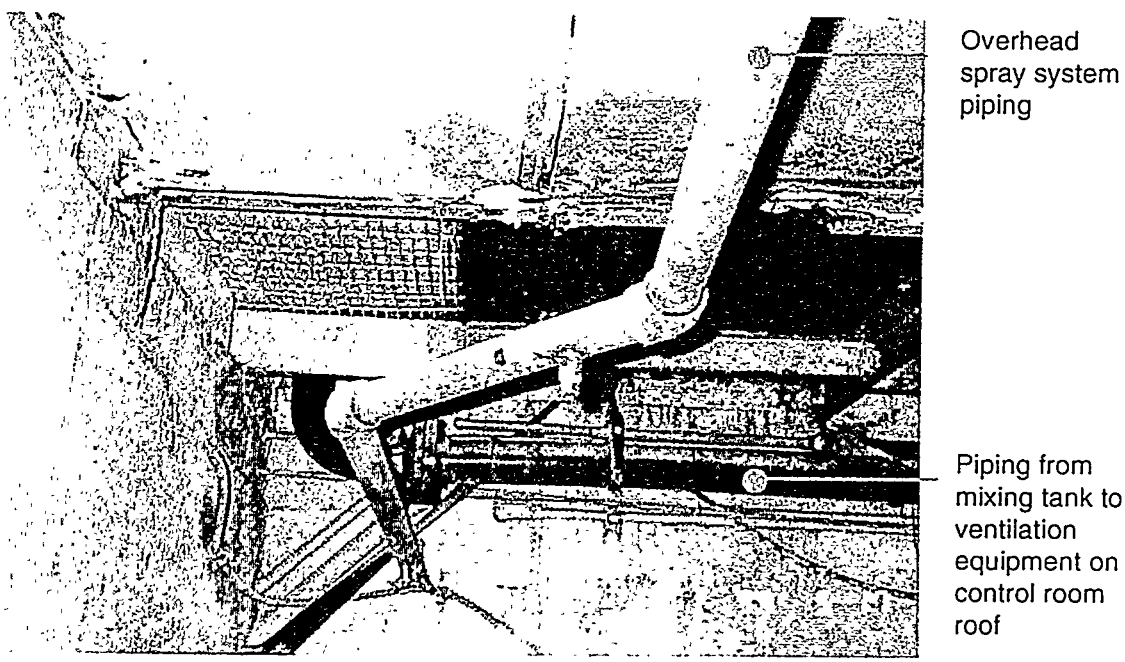
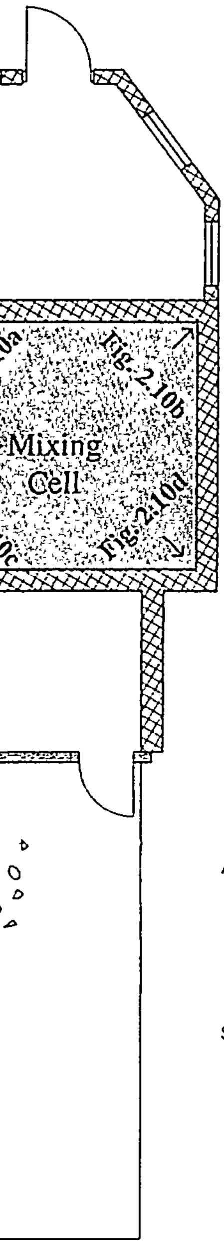


Fig. 2.10c. Southwest interior corner of mixing cell near ceiling.



g 7852 Plan

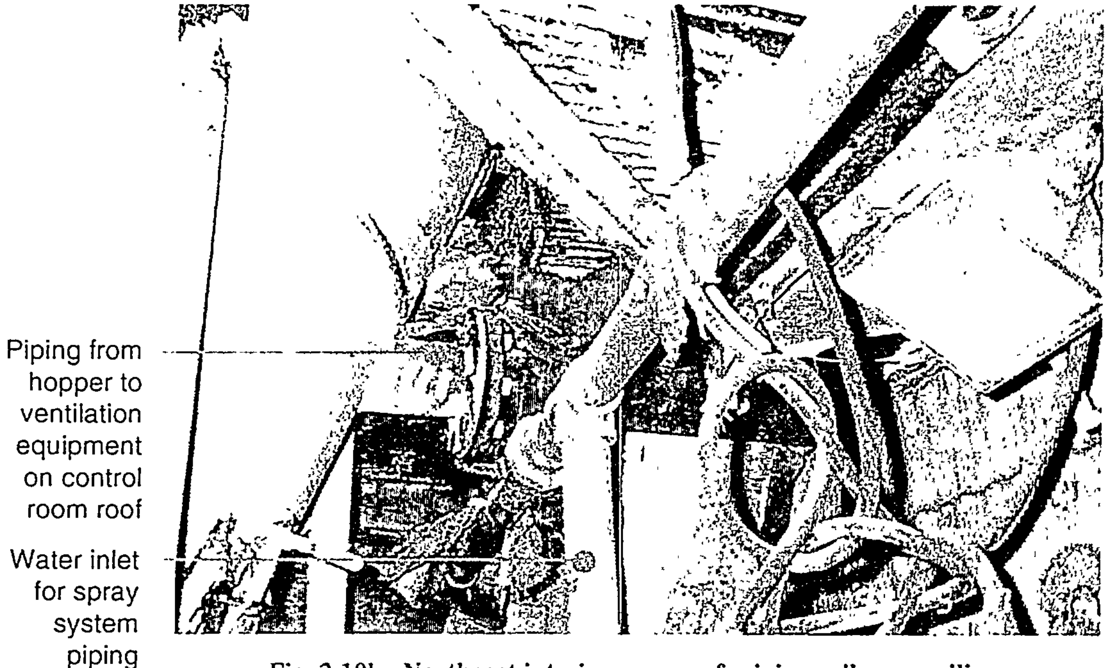


Fig. 2.10b. Northeast interior corner of mixing cell near ceiling.

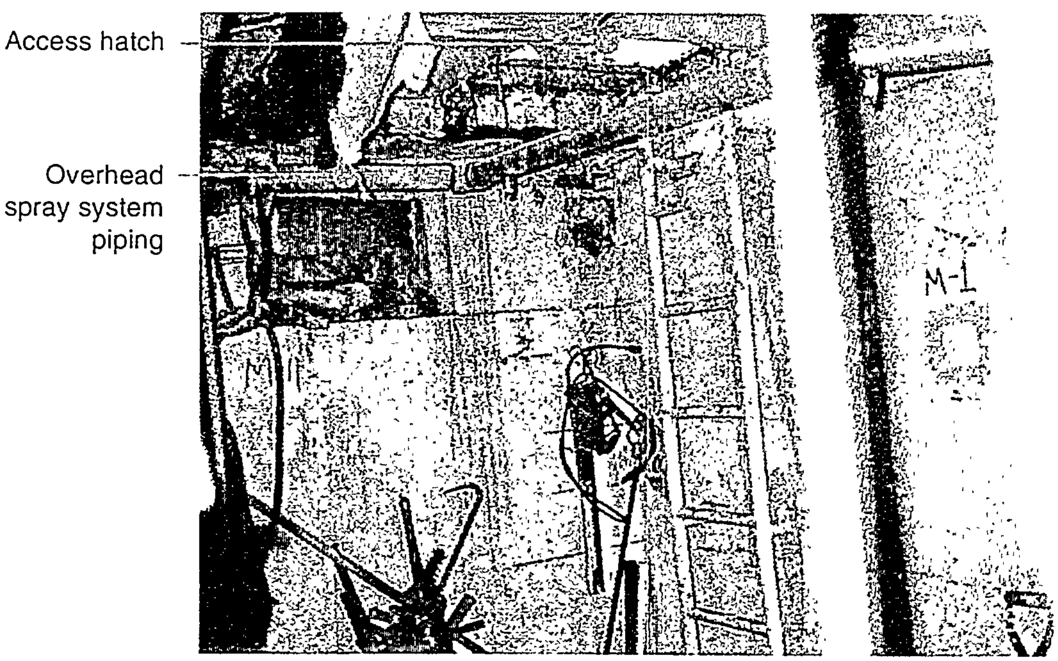


Fig. 2.10d. Southeast interior corner of mixing cell near ceiling.

Fig. 2.10. Mixing cell, interior views near ceiling.

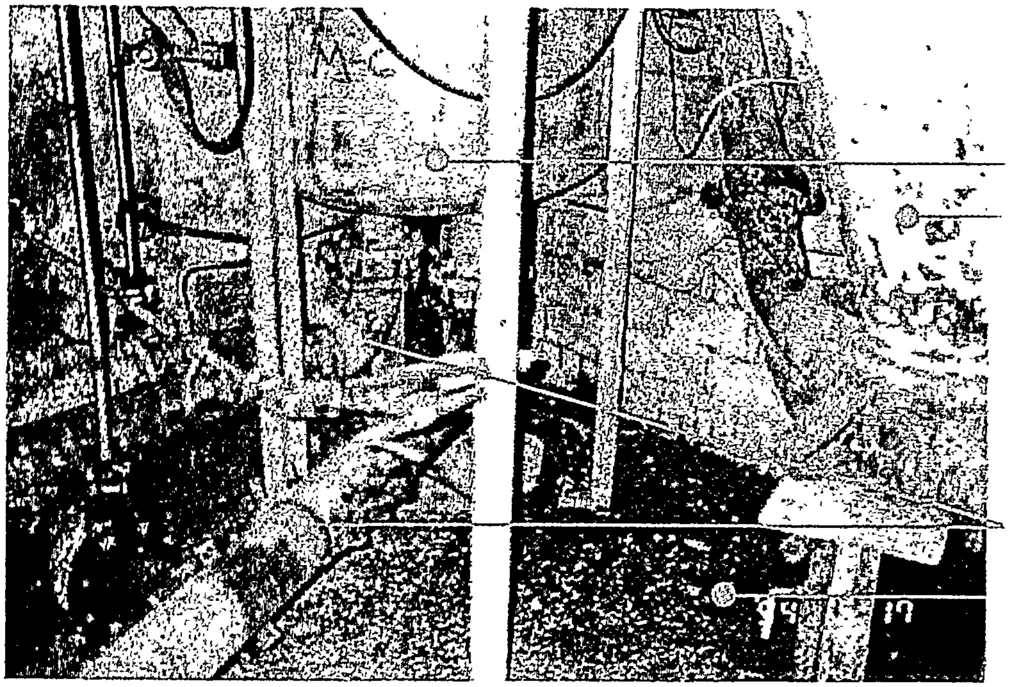


Fig. 2.11a. Northwest interior corner of mixing cell, near floor.

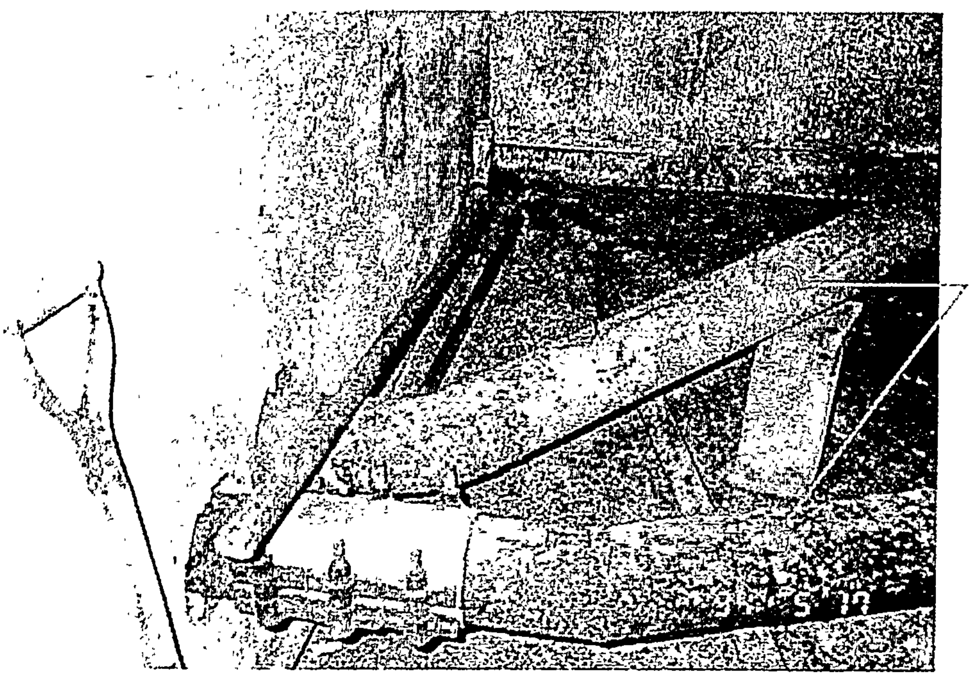
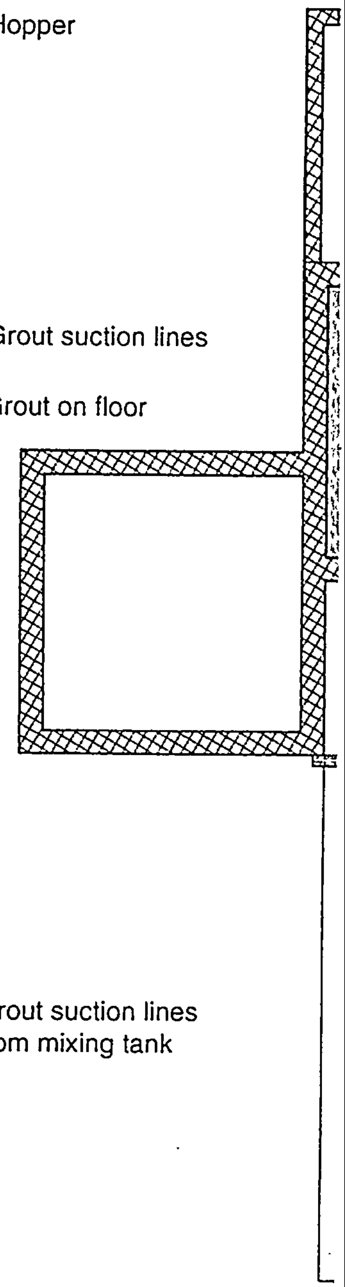


Fig. 2.11c. Southwest corner of mixing cell near floor.



Building 7

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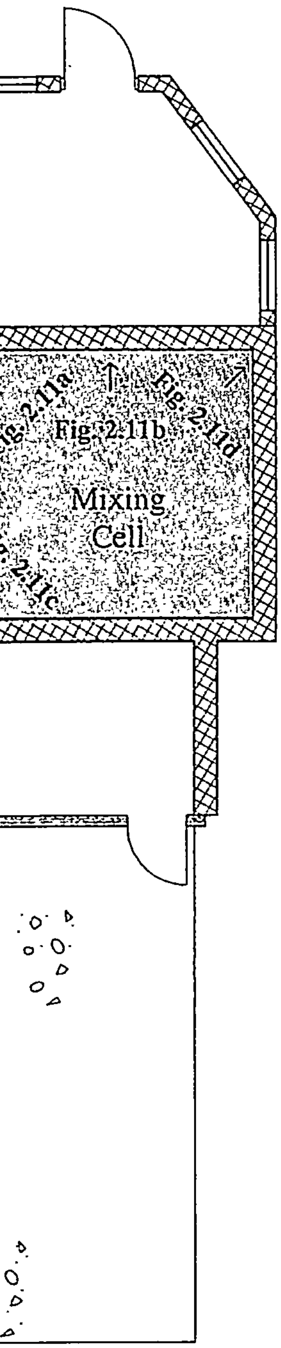


...52 Plan

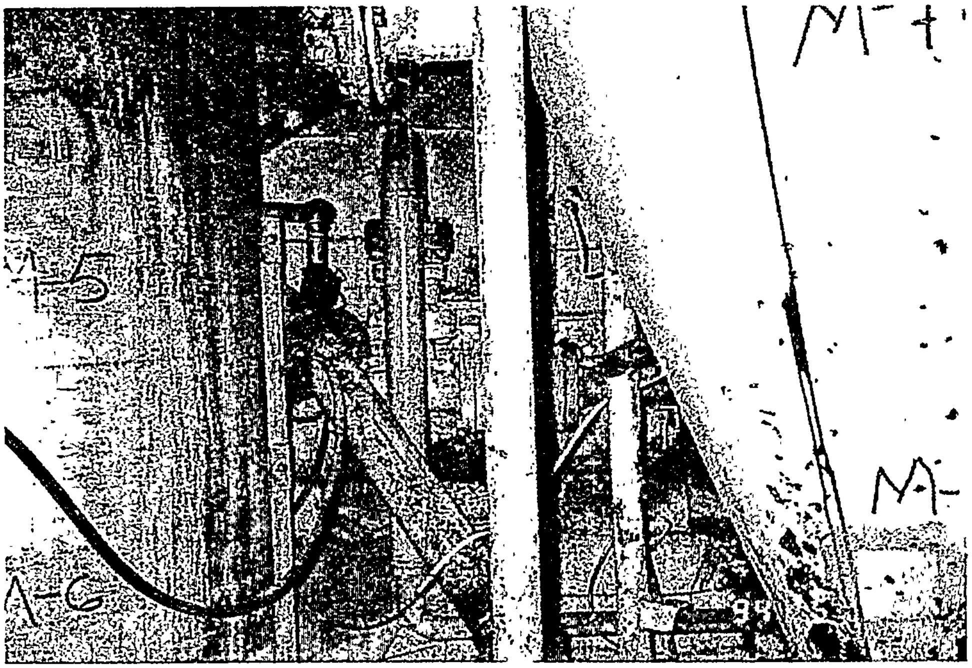


Fig. 2.11b North wall of mixing cell between the mixing tank (left) and the hopper (right).

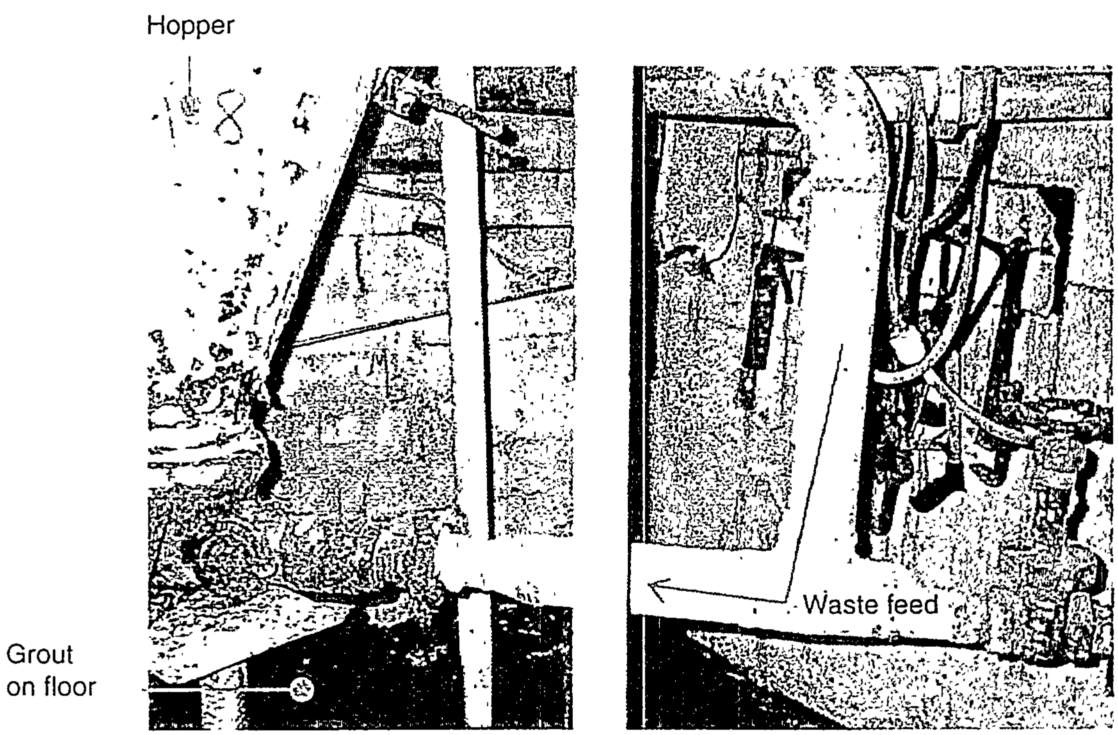


Fig. 2.11d. Composite of northeast interior corner of mixing cell; note grout deposited on floor.

Fig. 2.11. Mixing cell, interior views near floor.

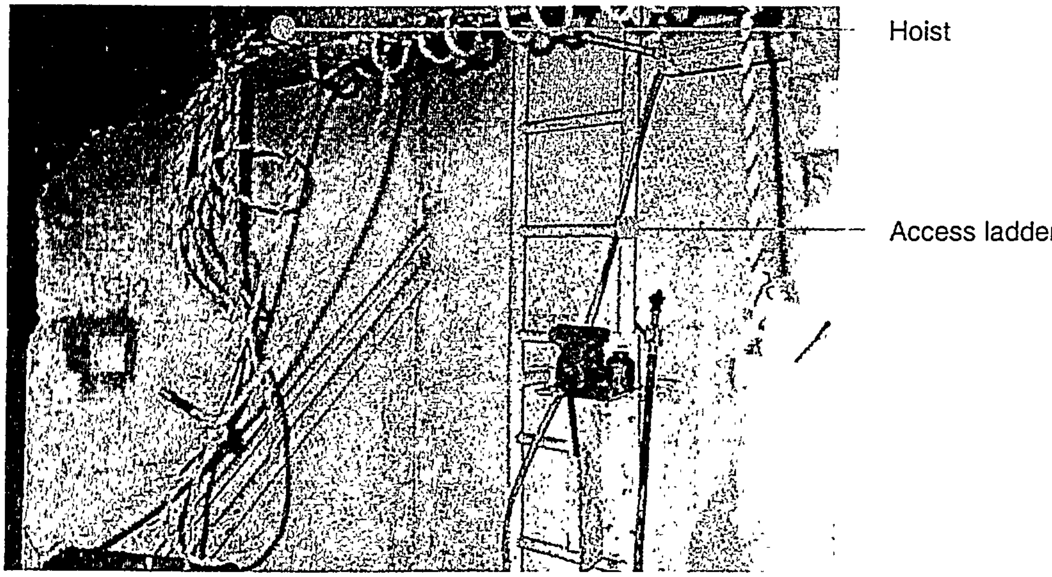


Fig. 2.12a. Northwest interior corner of pump cell.

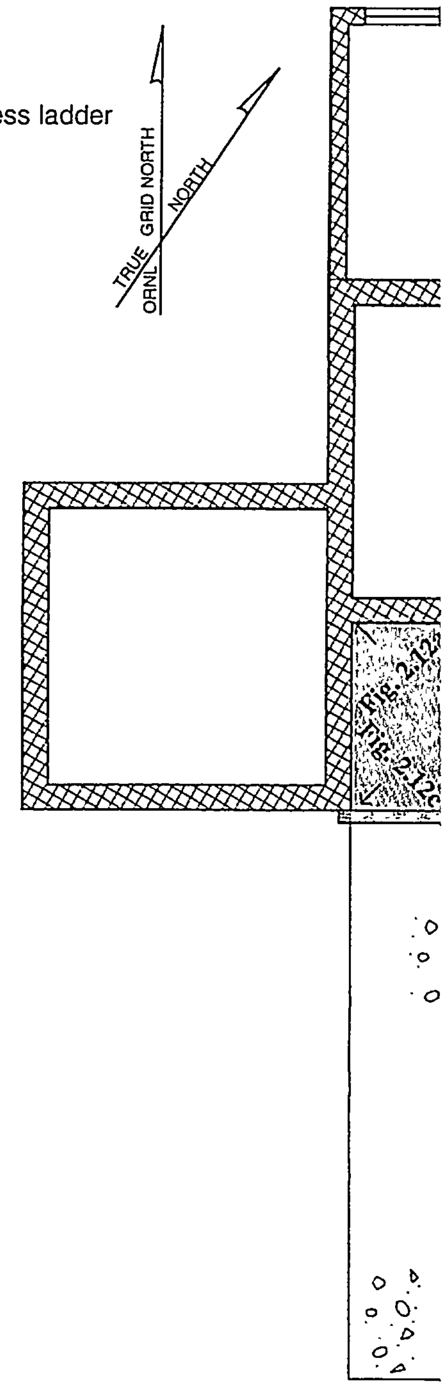
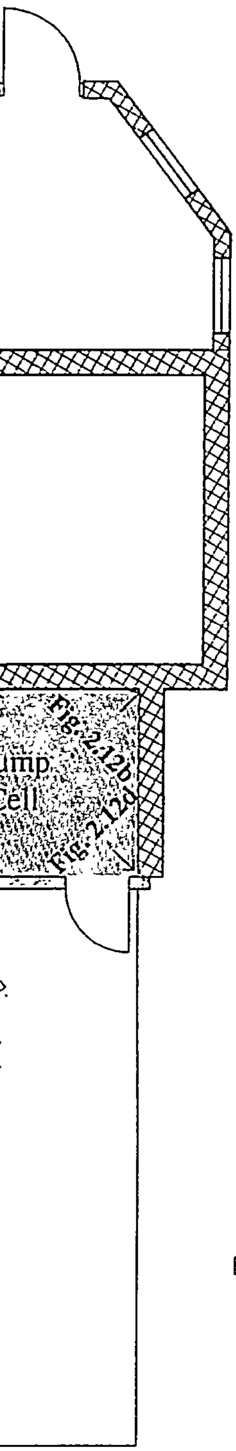


Fig. 2.12c. Southwest interior corner of pump cell.

Building 7



2 Plan

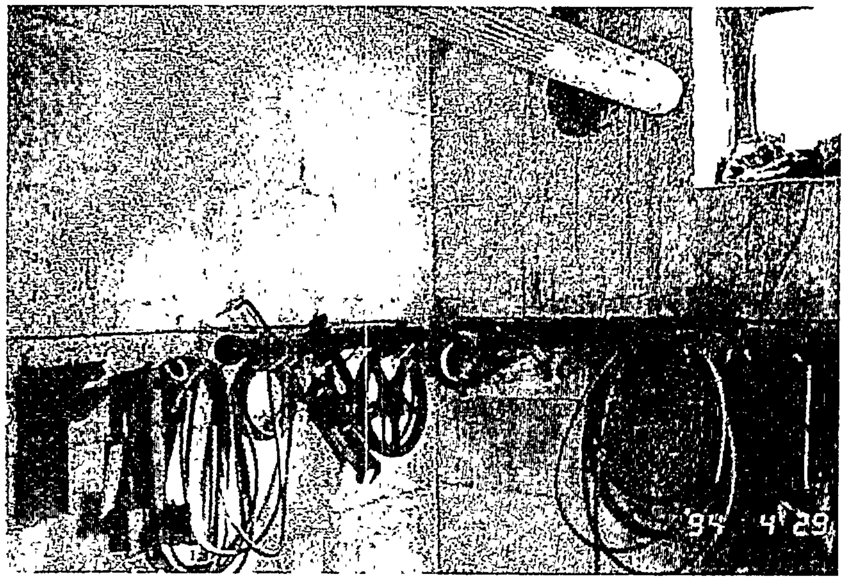


Fig. 2.12b. Northeast corner of pump cell.

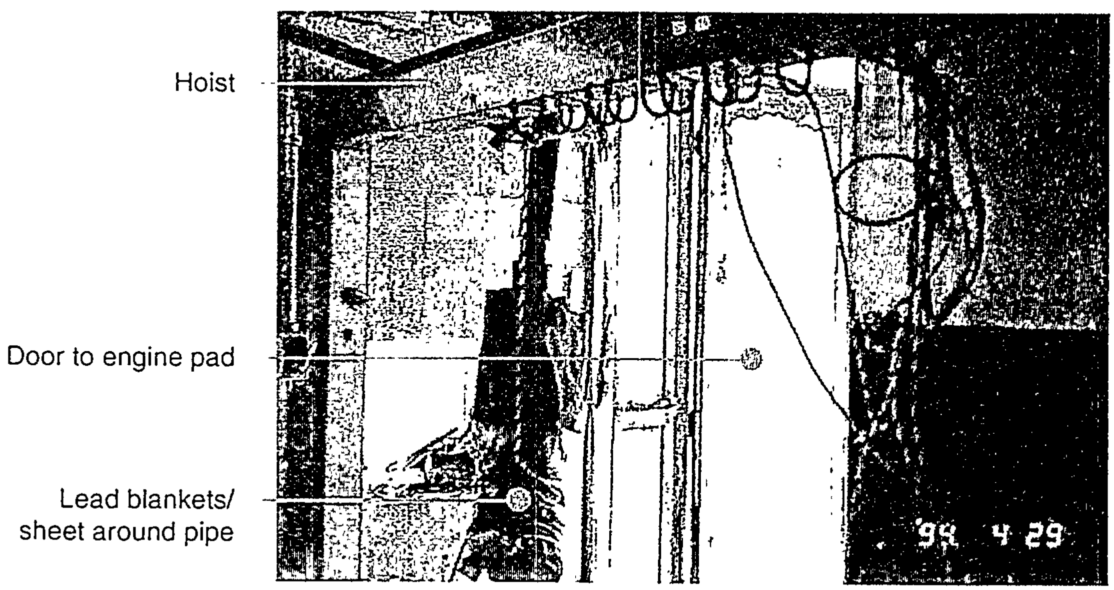


Fig. 2.12d. Southeast corner of pump cell.

Fig. 2.12. Pump cell, interior walls.

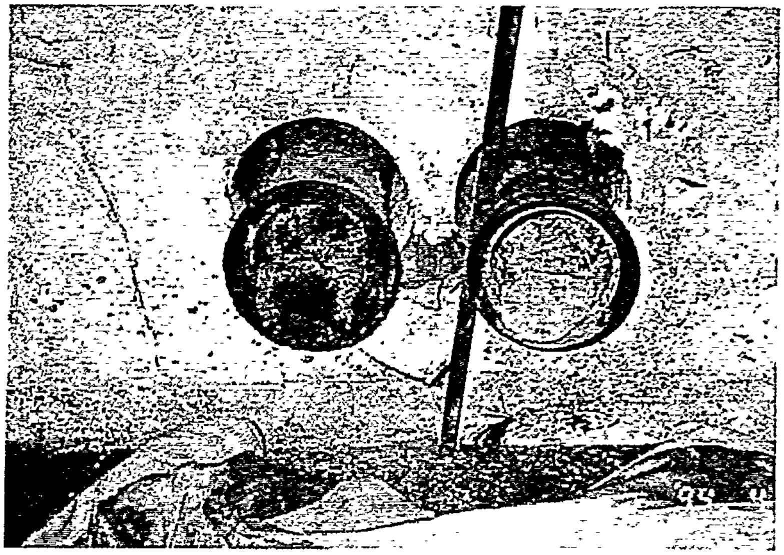


Fig 2.13a. Open ends of grout suction lines entering the pump cell from the mixing cell.

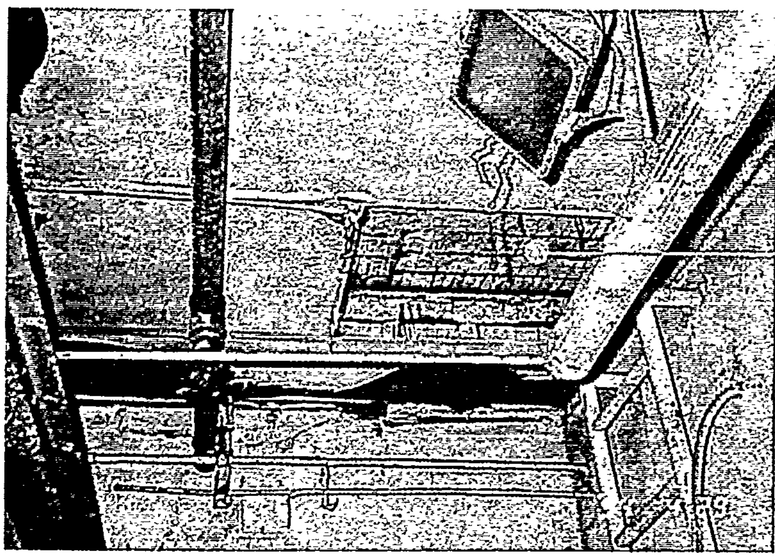


Fig. 2.13b. North-west quadrant of pump cell ceiling.

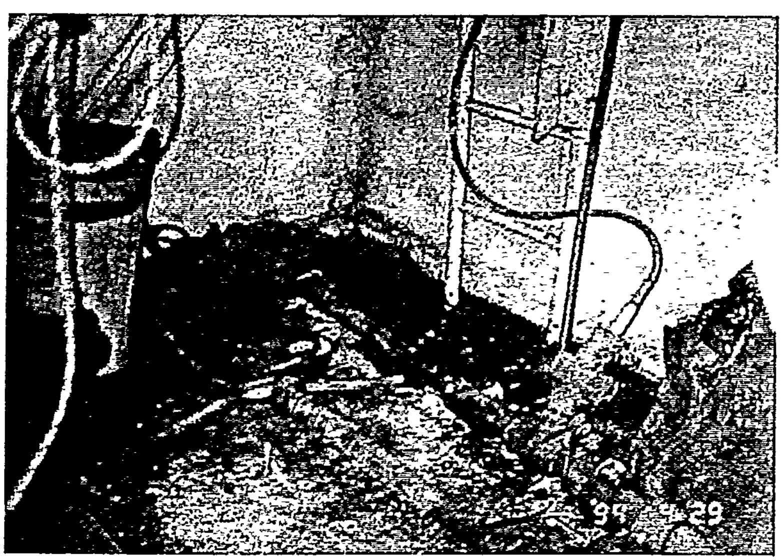


Fig 2.13c. North-west quadrant of pump cell floor.

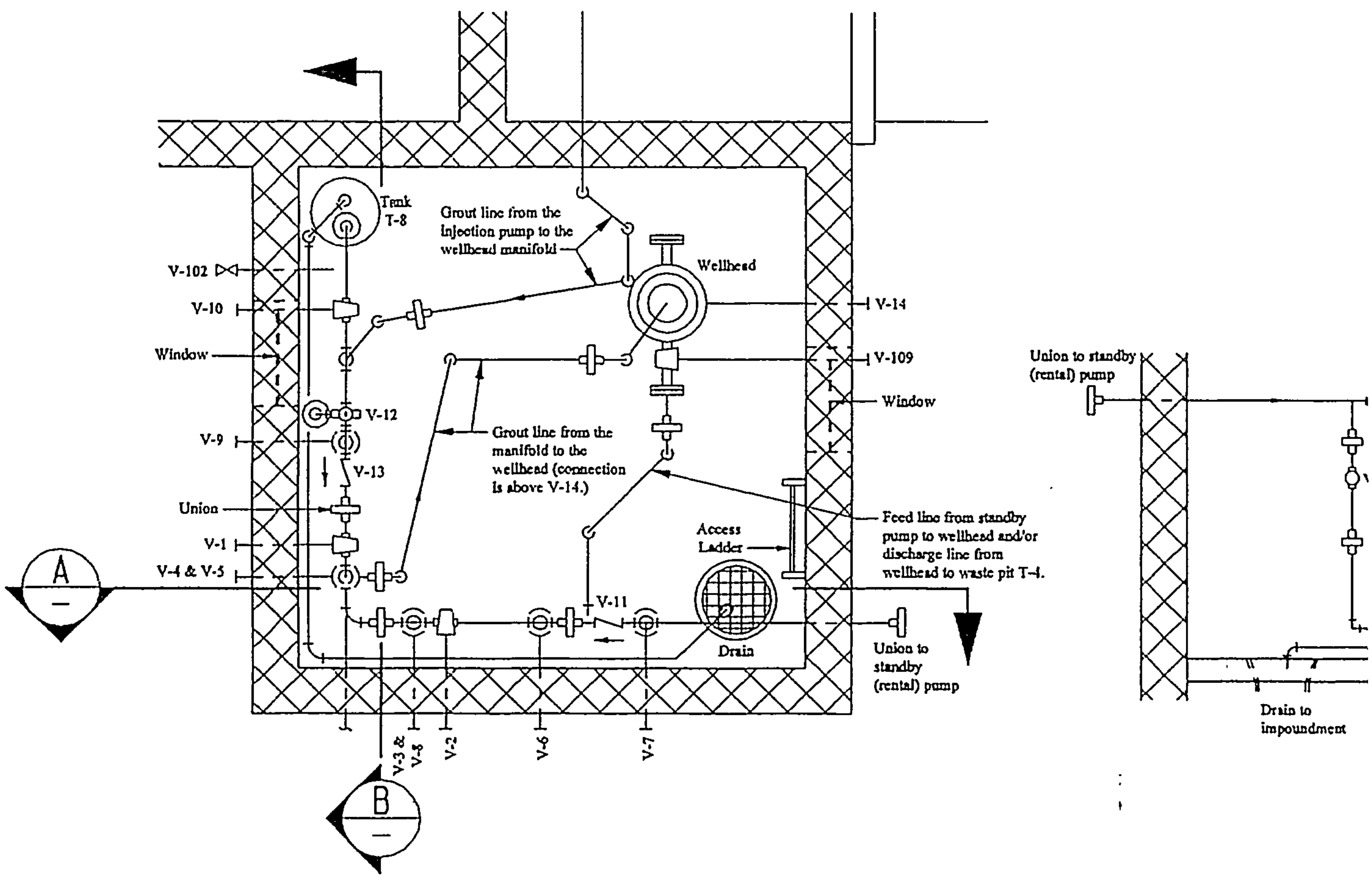
Fig. 2.13. Pump cell, ceiling and floor.

Notes:

1. Piping support and disconnected piping not shown. Additional details for wellhead cell may be found in ORNL Drawings P-10002-EE-013-D-1, -017-D-0, and 044-D.

2. The overhead spray system has been dismantled and is not shown in this drawing; however, disconnected piping for the spray system is still present in the wellhead cell.

3. Placement of valves and piping is not to scale. Piping, valves, and unions are approximately 2" in size.



EQUIPMENT PLAN AT WELLHEAD CELL

A SECTION

dnd wellhead.dgn
12/23/94

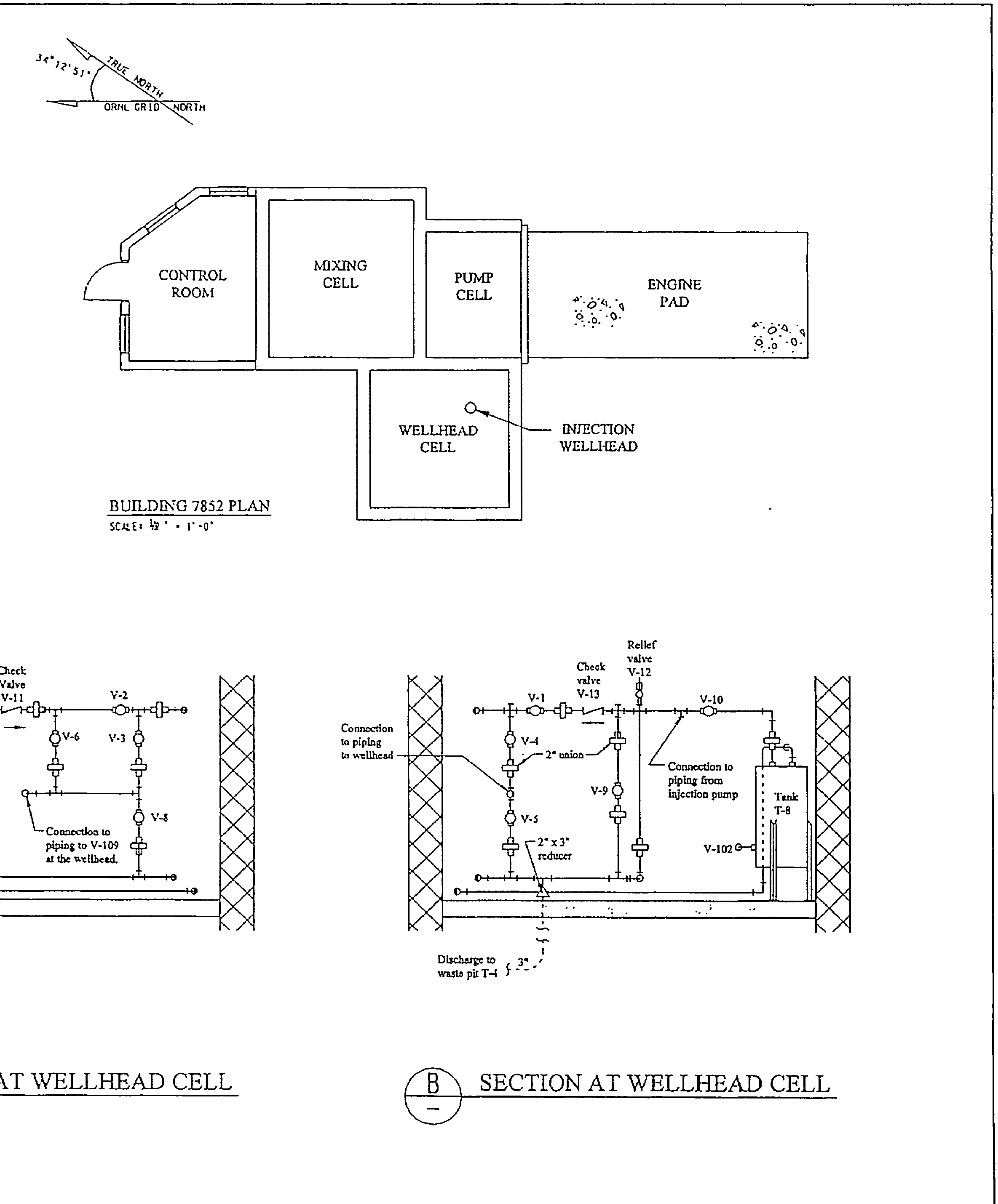


Fig. 2.14. Wellhead cell, plan and sections.
Source: ORNL Drawing P-10002-EE-013-D-1.

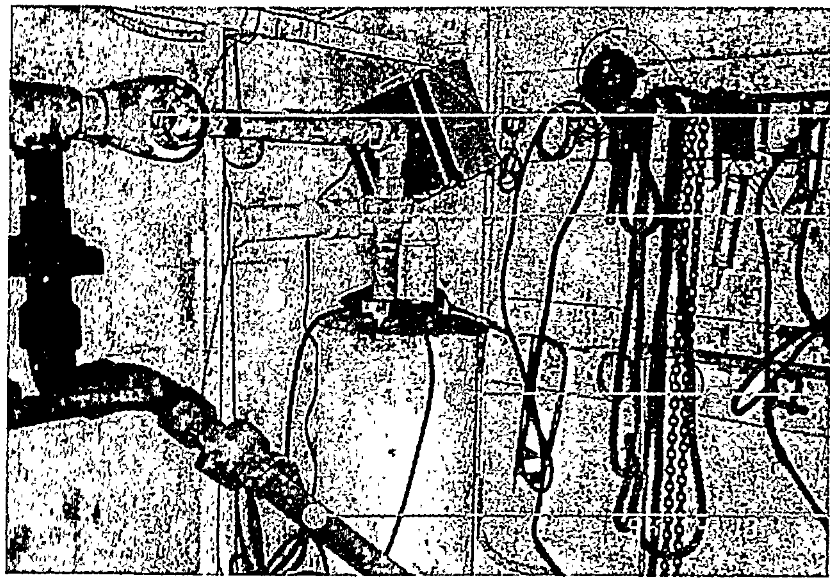


Fig. 2.15a. Northeast interior corner of wellhead cell.

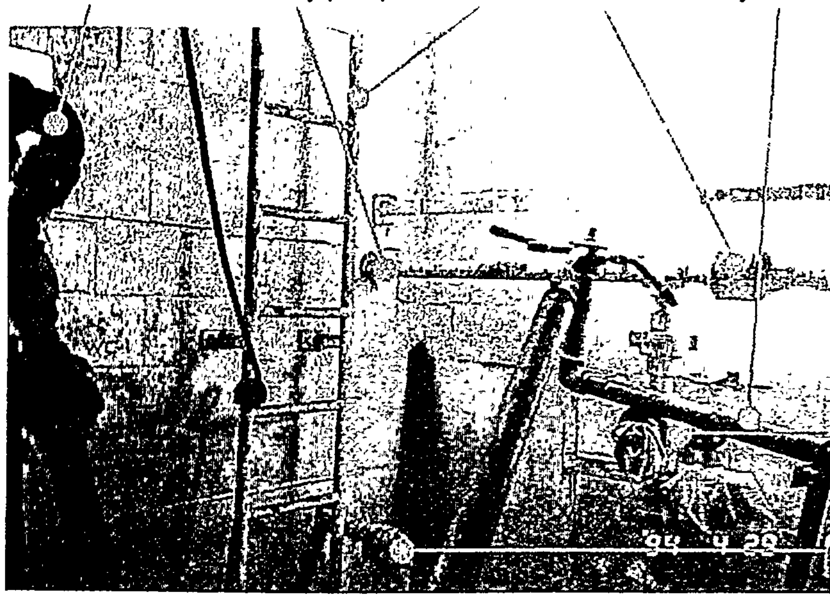
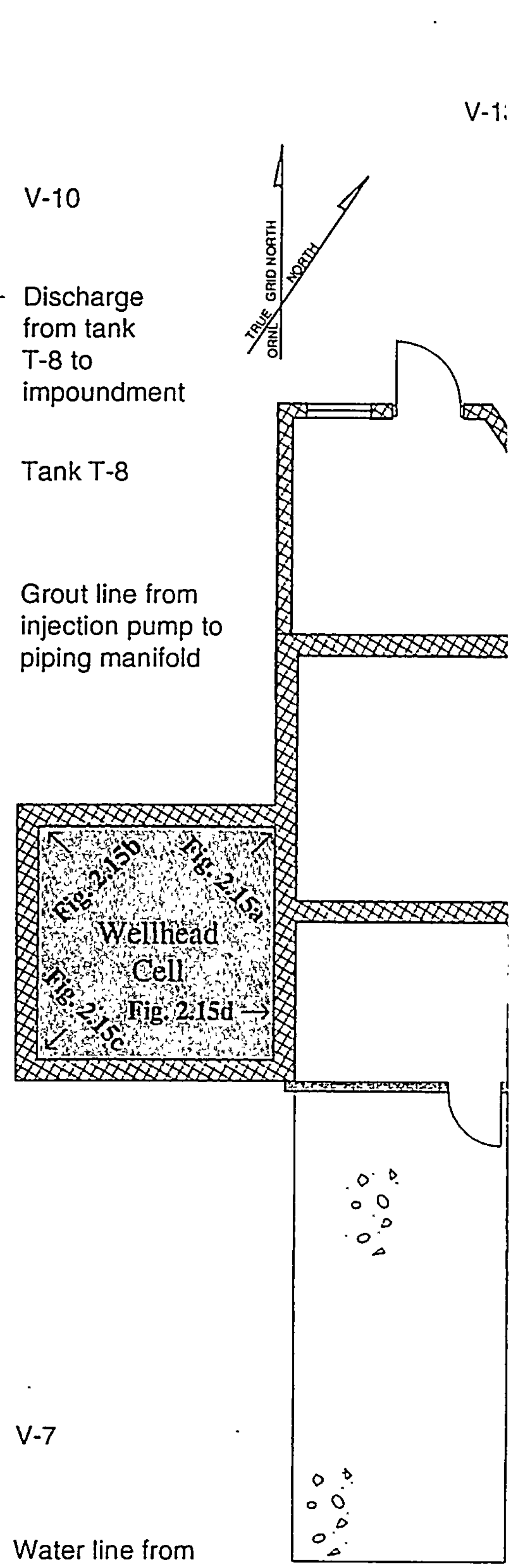


Fig. 2.15c. Southwest interior corner of wellhead cell.



Building 7852 Pla

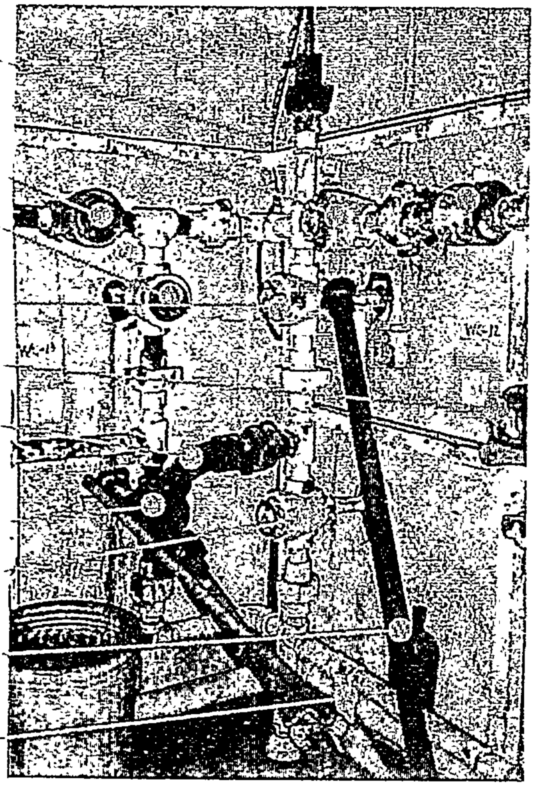


Fig. 2.15b. Northwest interior corner of wellhead cell.

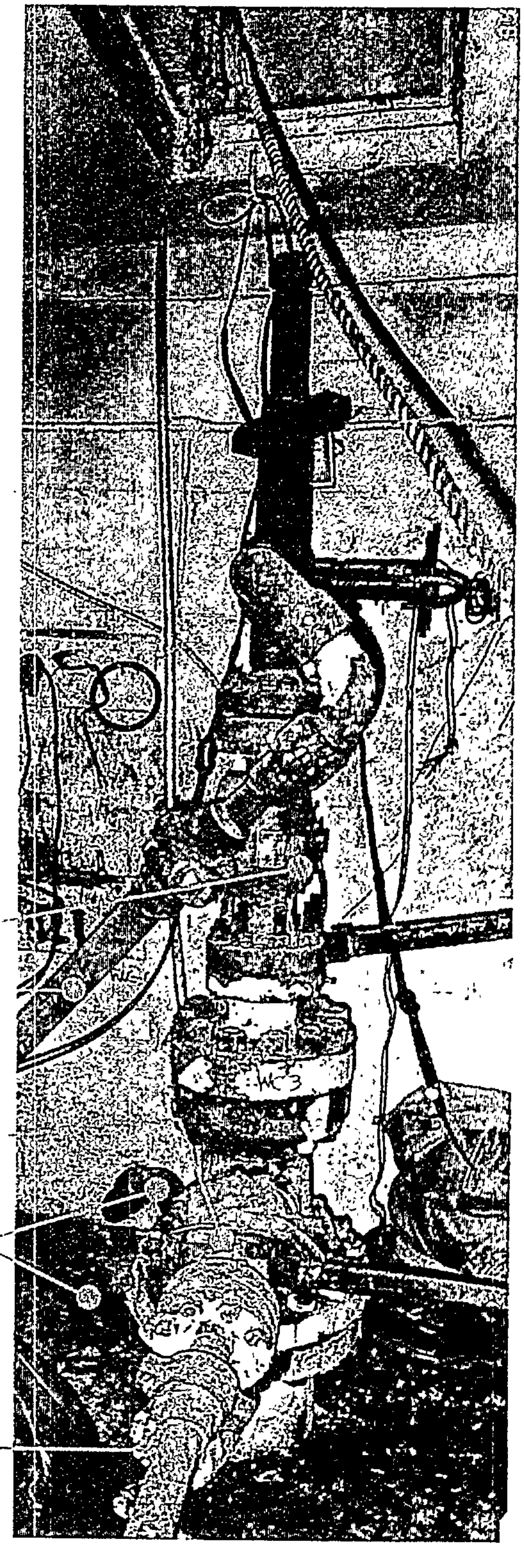


Fig. 2.15d. Composite photo of injection wellhead in southeast cell quadrant (view to the east).

Fig. 2.15. Wellhead cell, interior walls and injection wellhead.

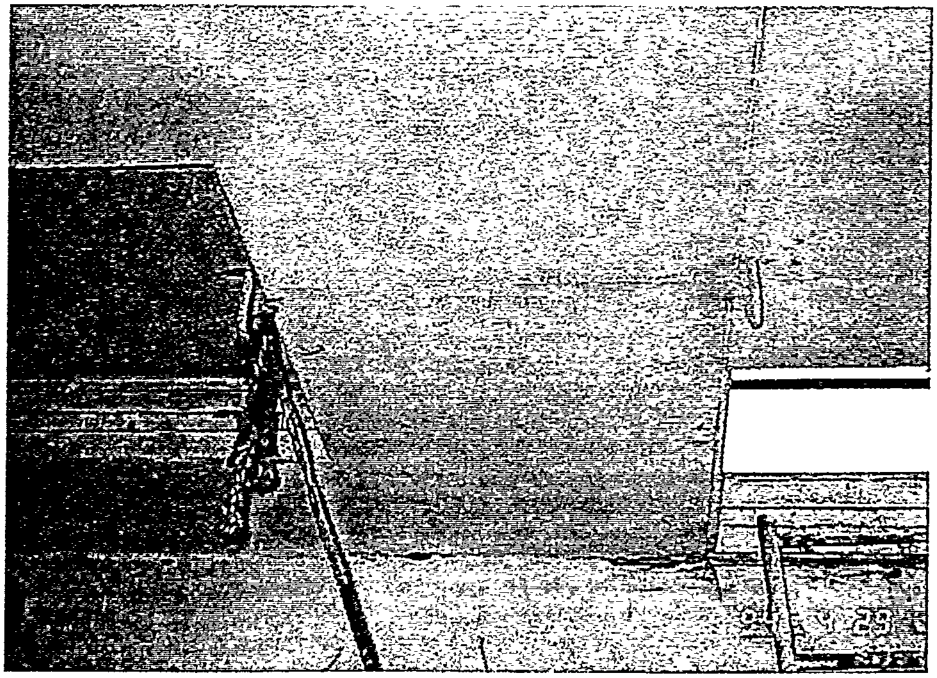


Fig 2.16a. Access hatches in ceiling of wellhead cell (view toward south).

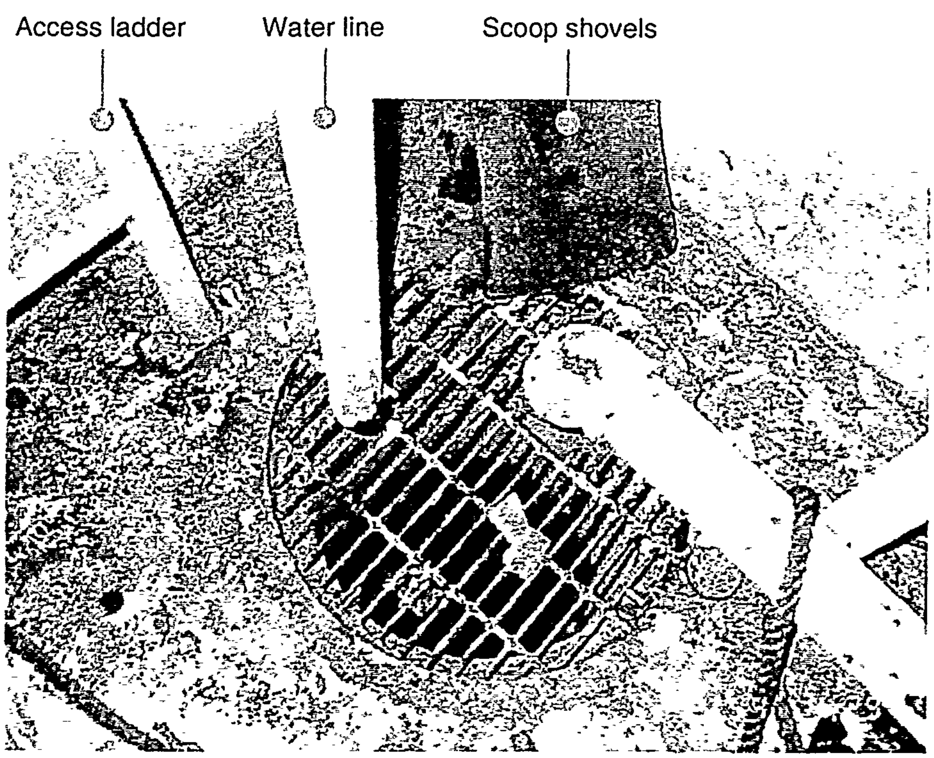
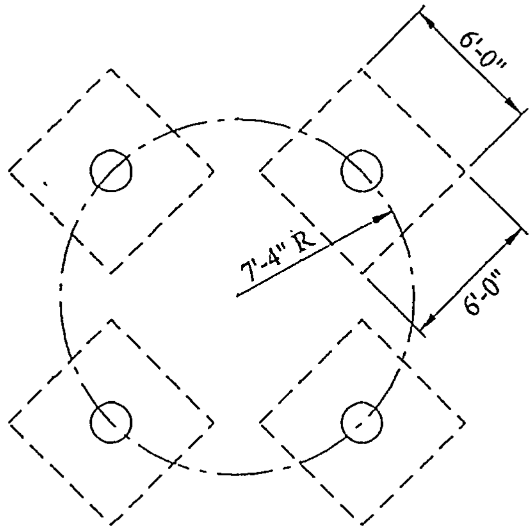


Fig 2.16b. Drain to impoundment in southwest corner of wellhead cell floor.

Fig. 2.16. Wellhead cell, ceiling and floor.



OHF STORAGE BIN PLAN

SCALE: 1/8" = 1'-0"

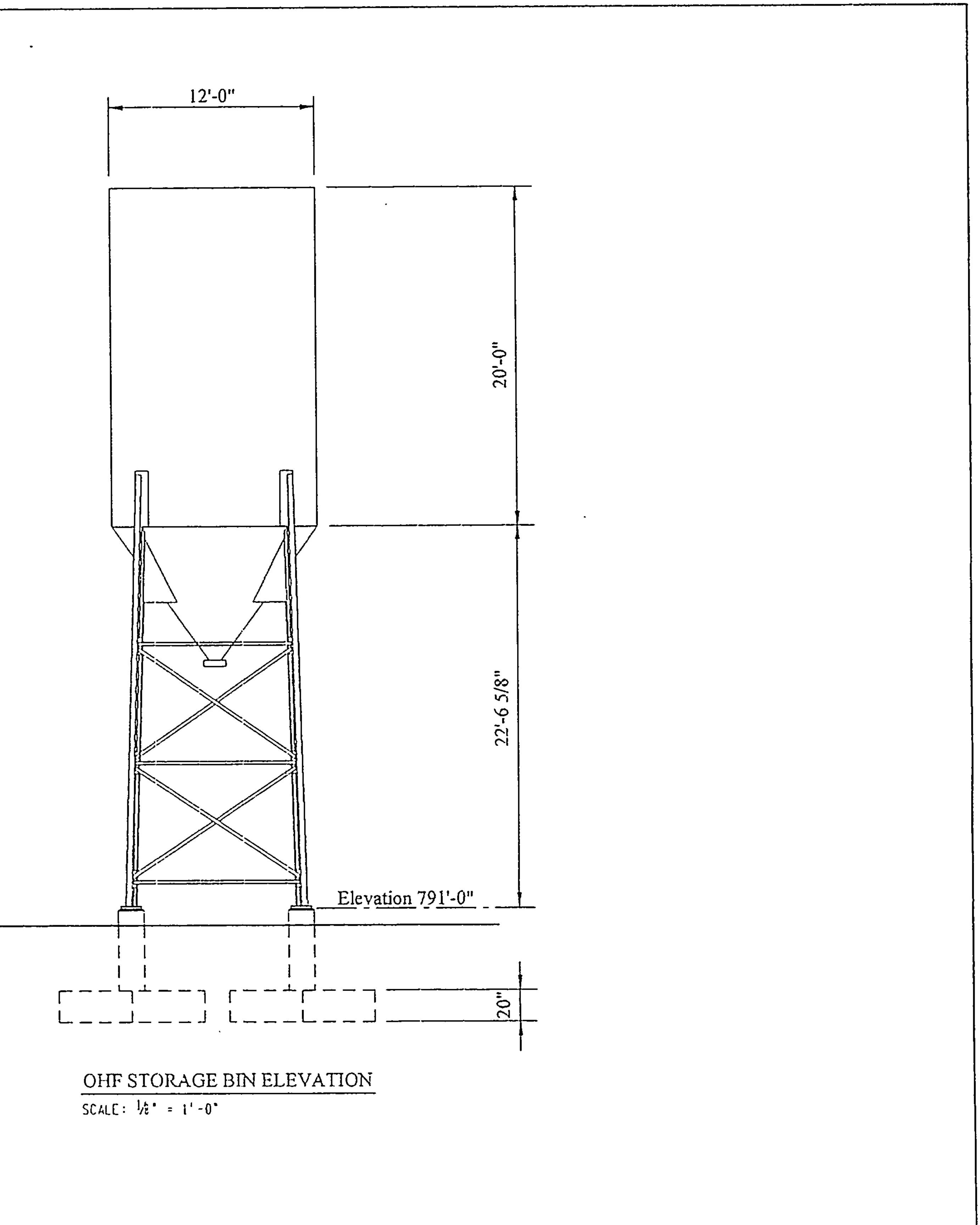


Fig. 2.17. Bulk storage bins, foundation and elevation.

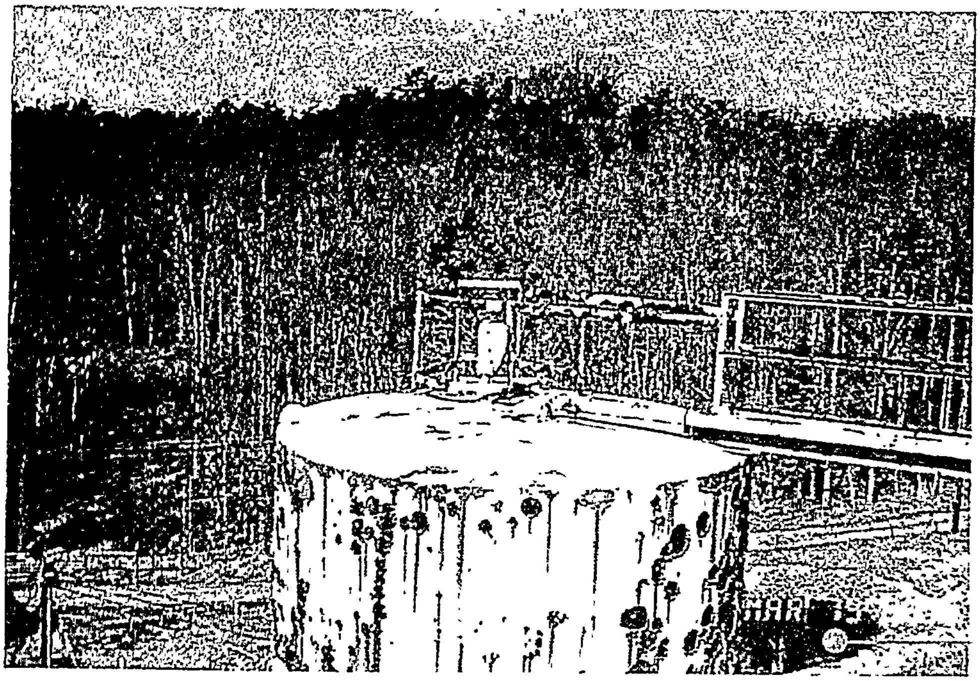


Fig. 2.18a. Bin 1 (view toward northwest).

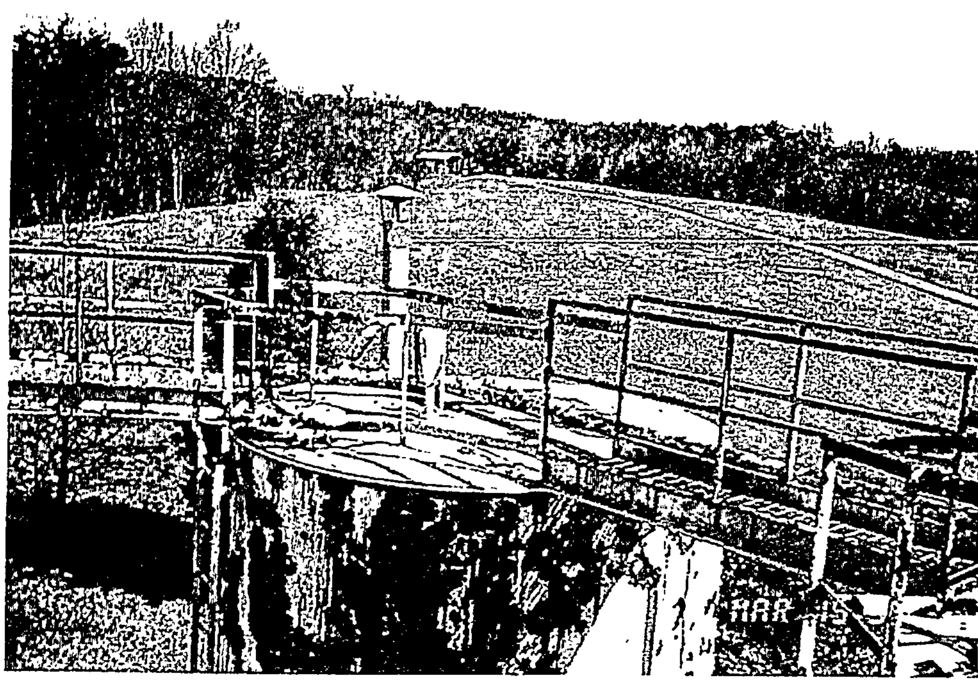
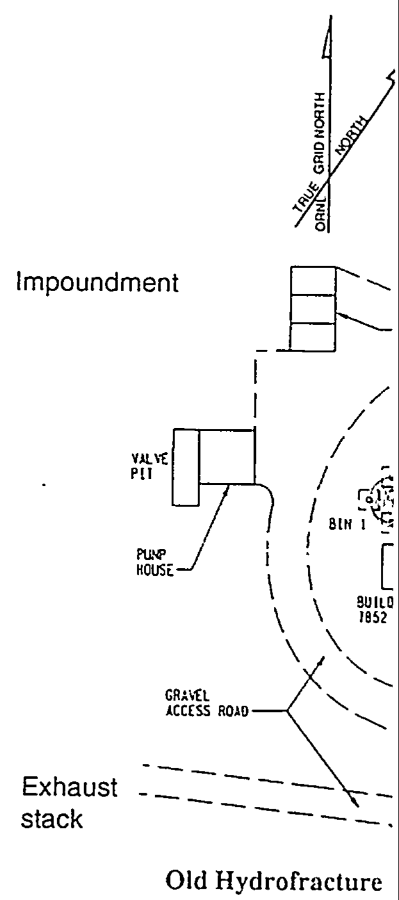


Fig. 2.18c. Bin 3 (view toward northeast).



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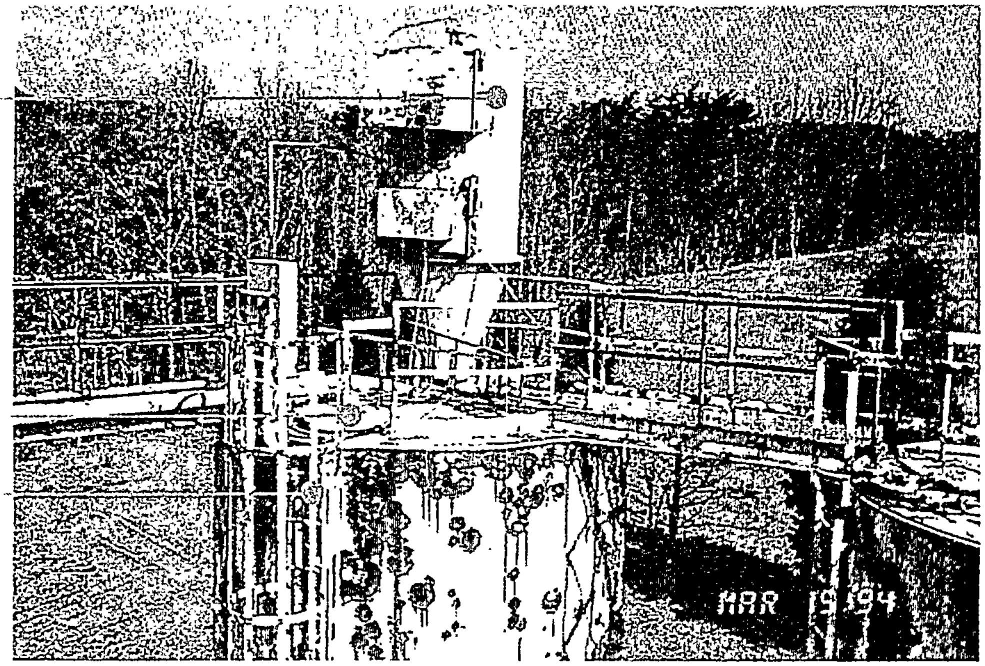
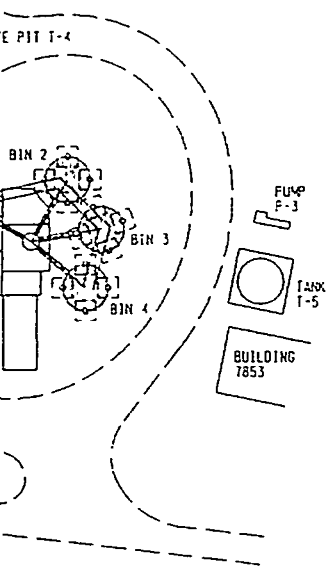


Fig. 2.18b. Bin 2 (view toward northeast).



ea (not to scale)

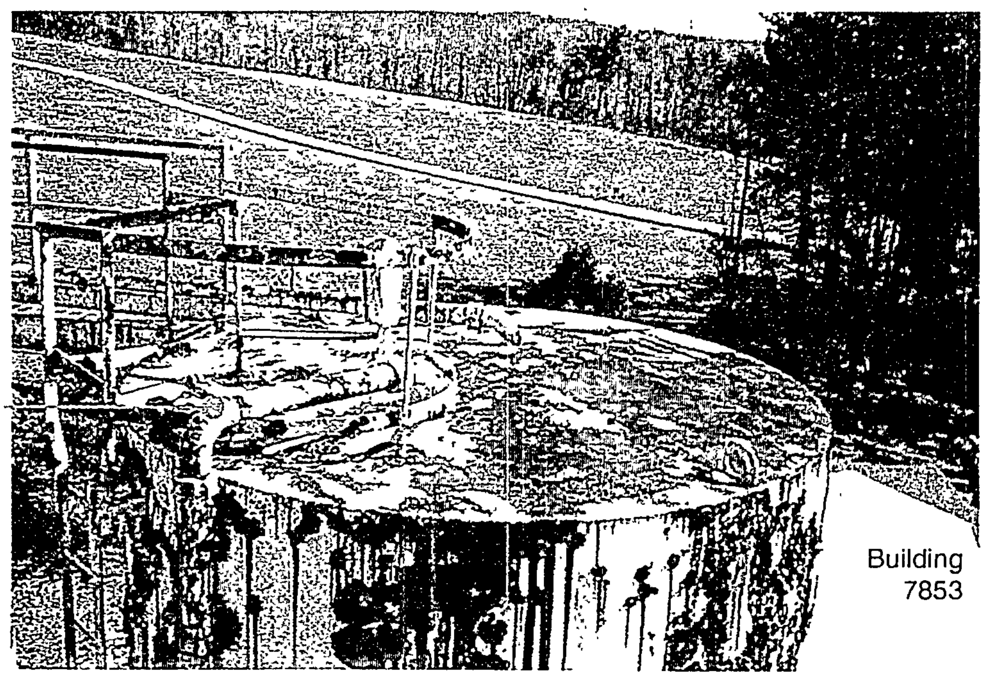


Fig. 2.18d. Bin 4 (view toward east).

Fig. 2.18. Bulk storage bins, exterior views near top.

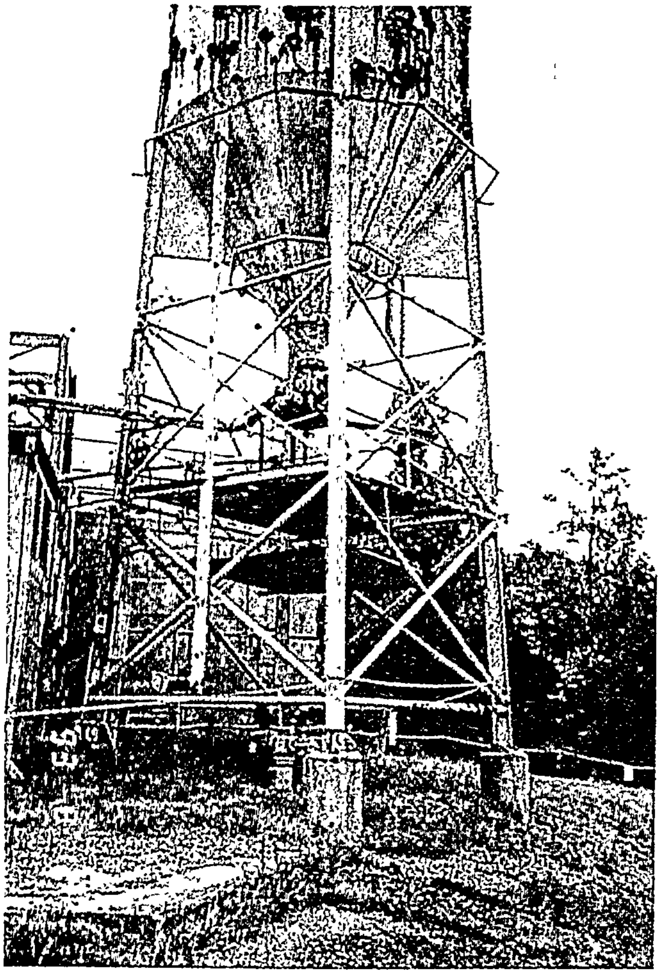


Fig. 2.19a. Bin 1.

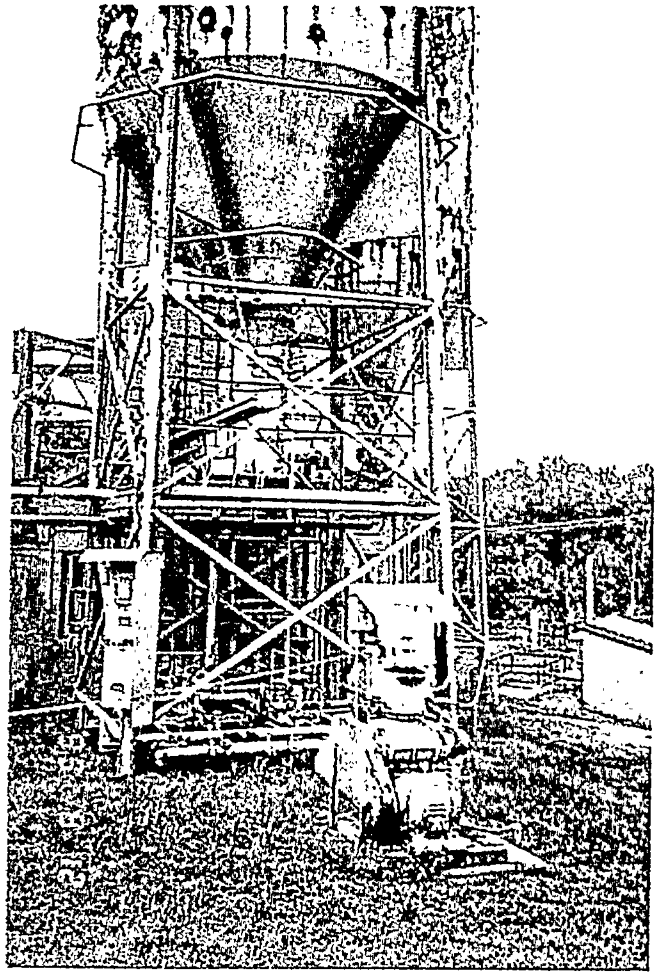


Fig. 2.19b. Bin 2.

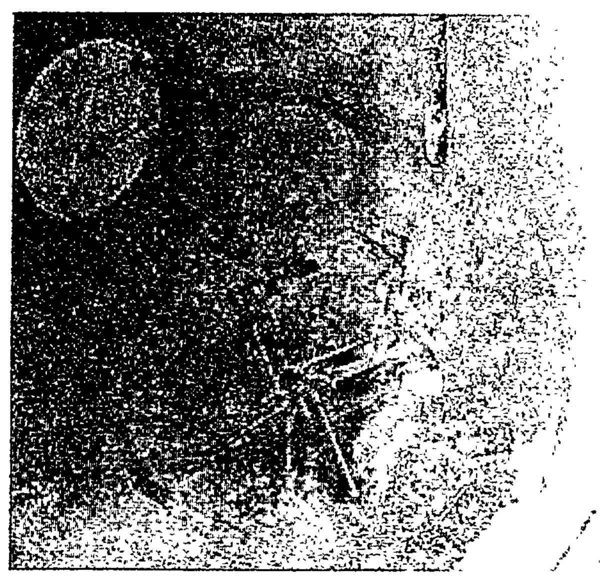


Fig. 2.19e. Bin interior.

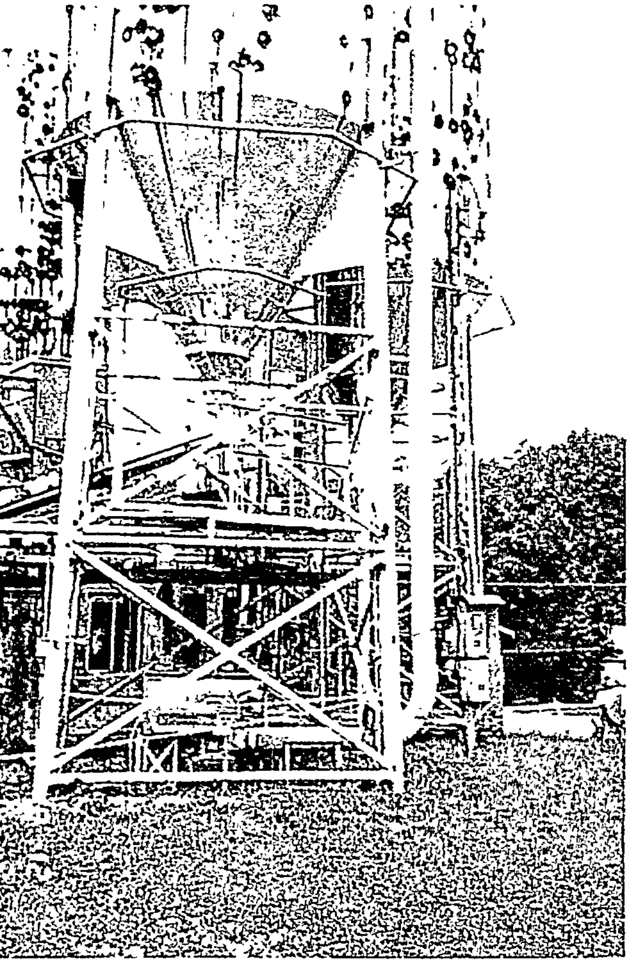


Fig. 2.19c. Bin 3.

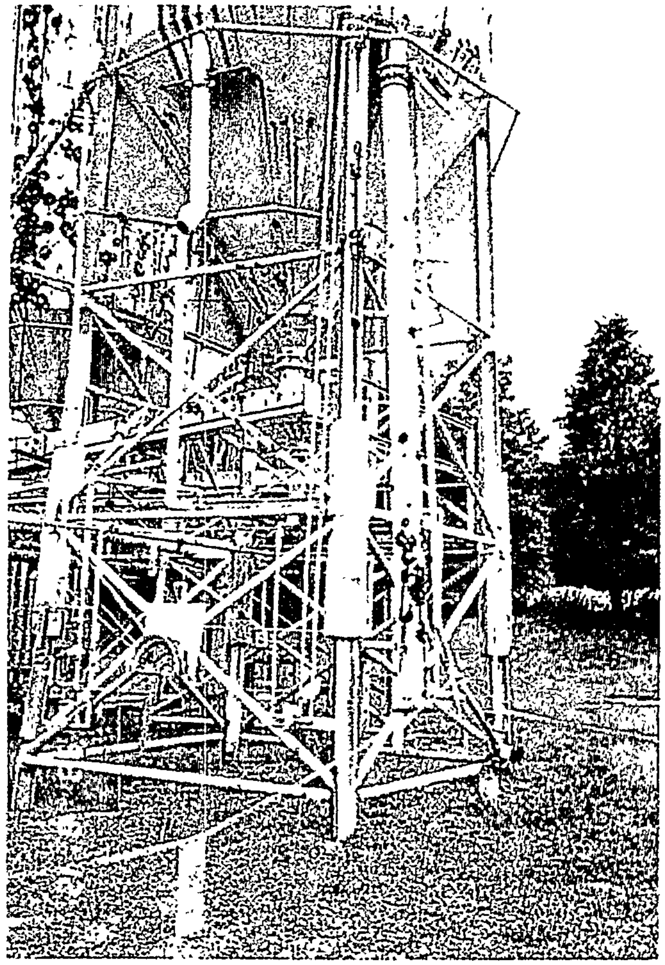
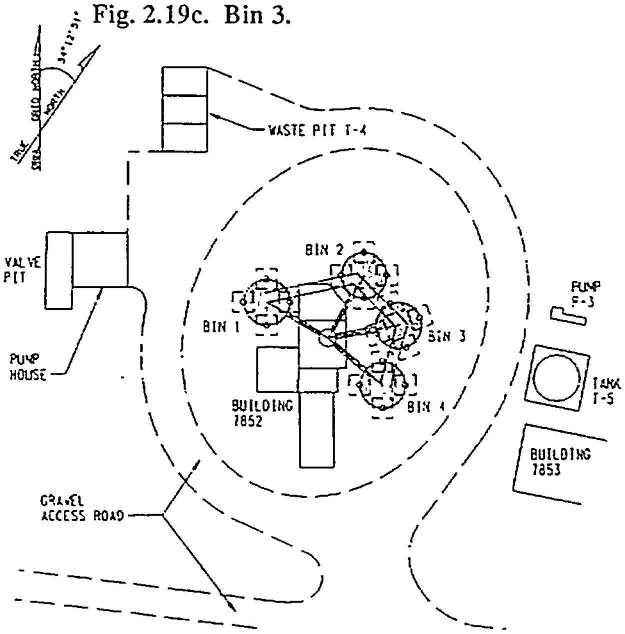
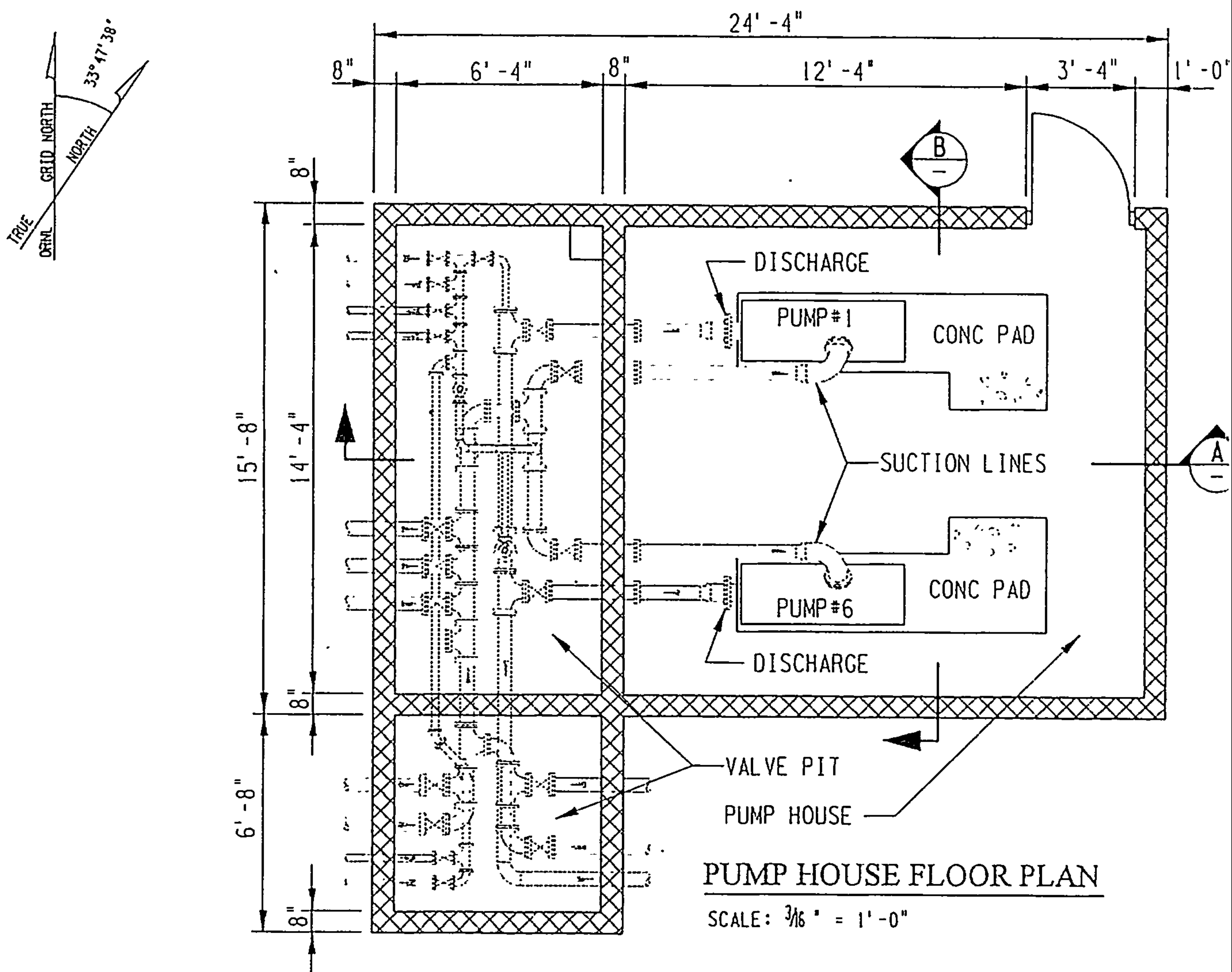


Fig. 2.19d. Bin 4.



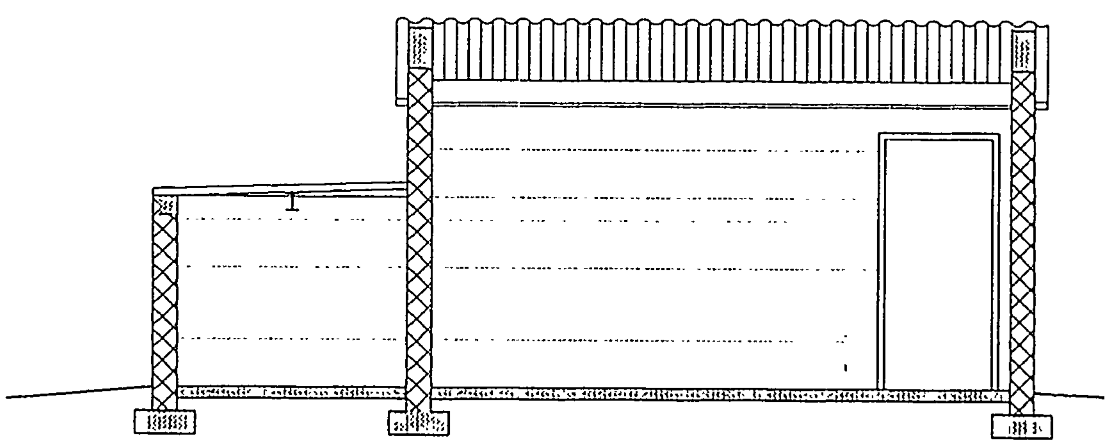
Old Hydrofracture Area (not to scale)

Fig. 2.19. Bulk storage bins, exterior views near bottom and interior view.



PUMP HOUSE FLOOR PLAN

SCALE: 3/16" = 1'-0"



A BUILDING SECTION

SCALE: 3/16" = 1'-0"

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12/23/94

NOTES:

1. LEAD SHIELDING AROUND PUMP HEAD AND PIPING IS NOT SHOWN.
2. PUMP DRIVERS ON CONCRETE PADS ARE NOT SHOWN.

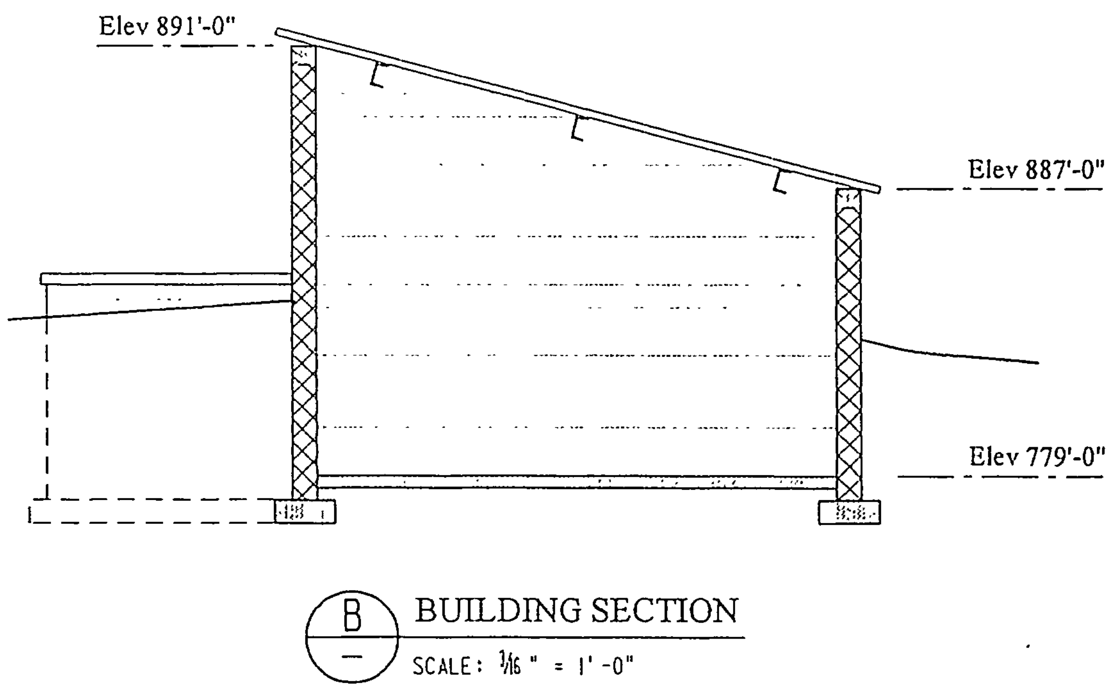
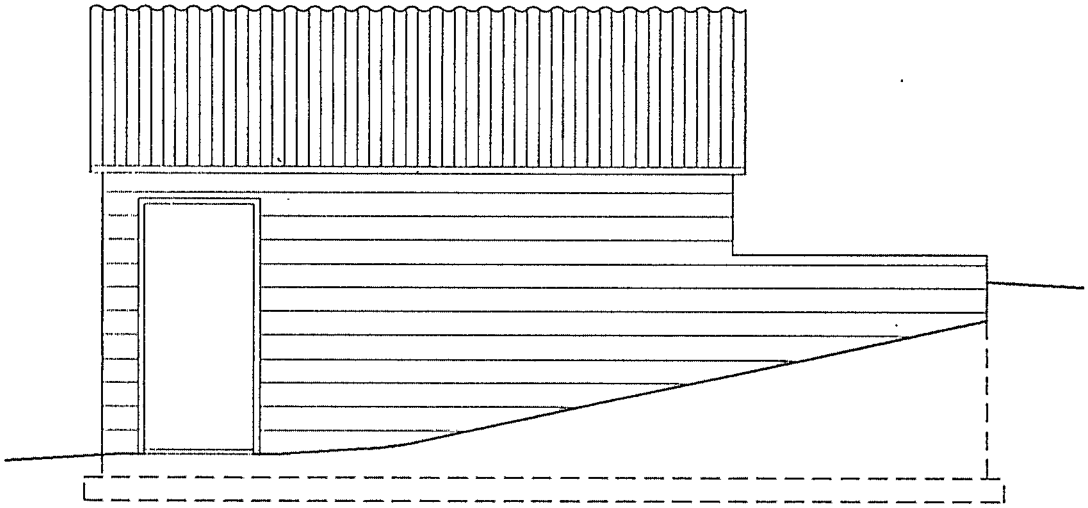
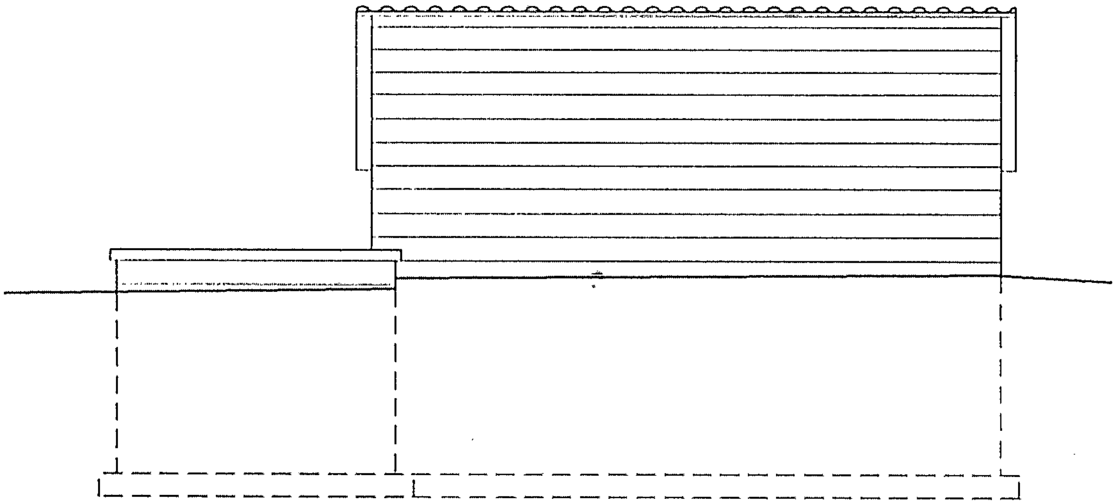


Fig. 2.20a. Pump house and valve pit, plan and section.



NORTH ELEVATION

SCALE: 3/16" = 1'-0"



SOUTH ELEVATION

SCALE: 3/16" = 1'-0"

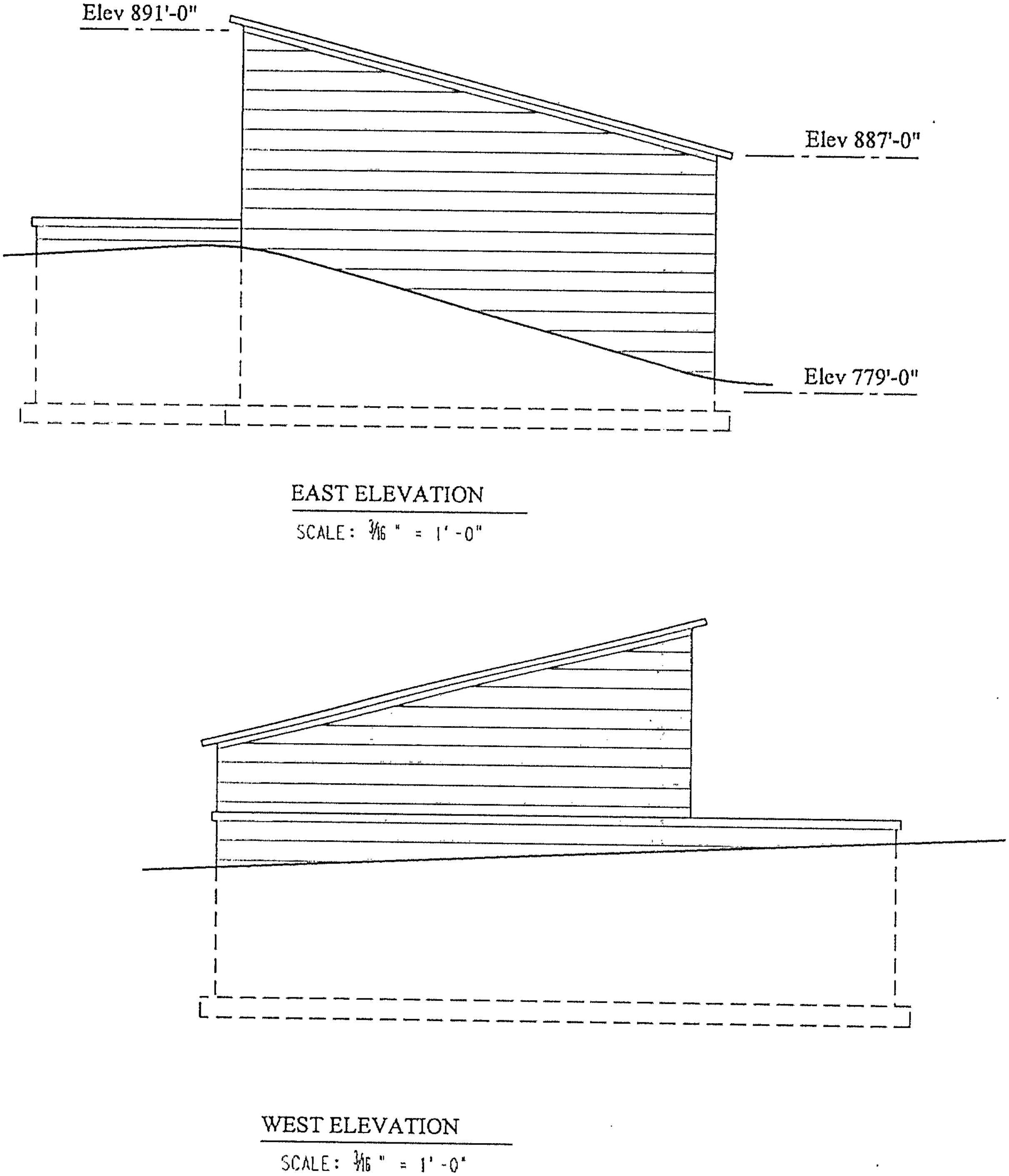


Fig. 2.20b. Pump house and valve pit, exterior elevations.

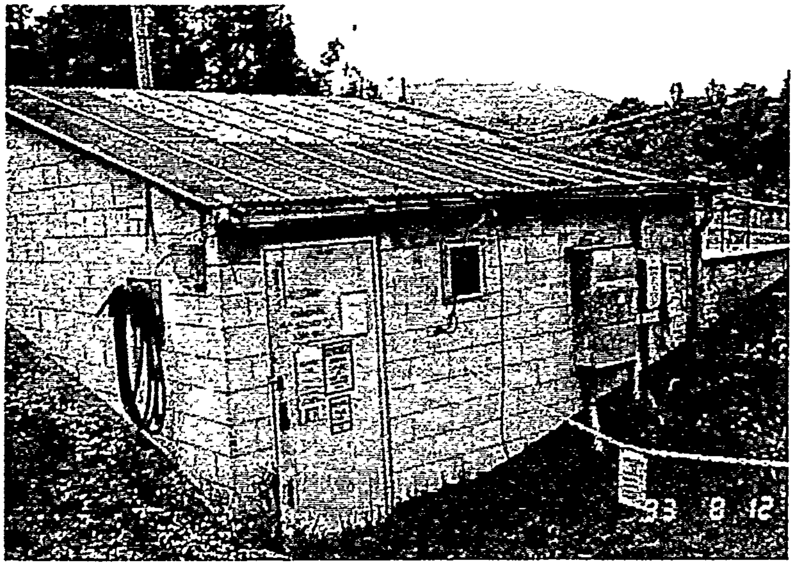


Fig. 2.21a. Northeast corner of pump house.

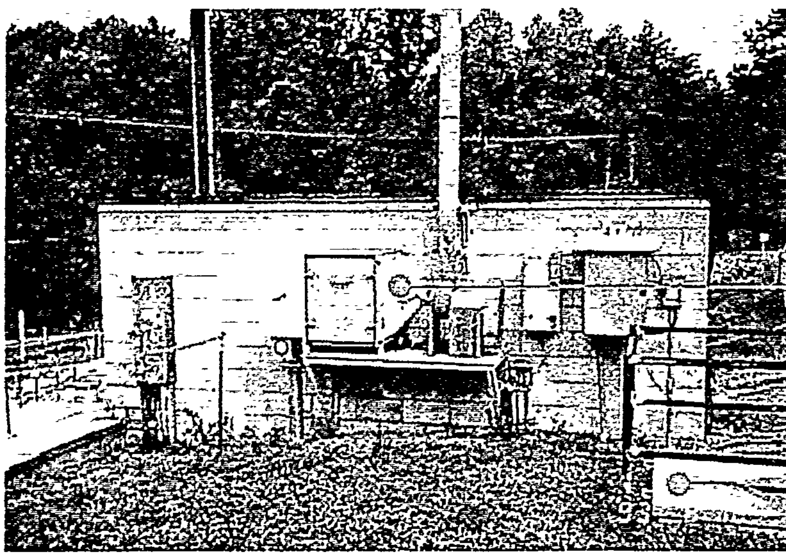


Fig. 2.21b. South side of pump house.

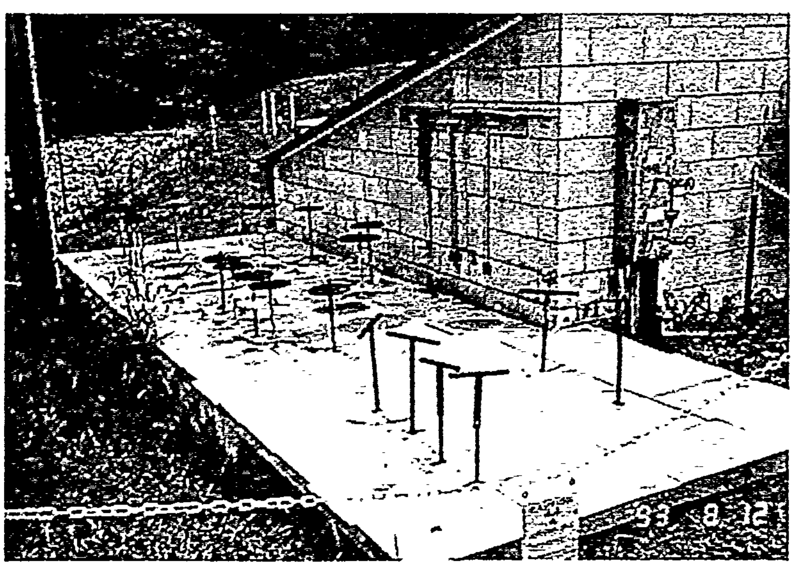


Fig. 2.21.c. Southwest corner of pump house, overlooking the covered (shielded) valve pit.

Fig. 2.21. Pump house and valve pit, exterior views.

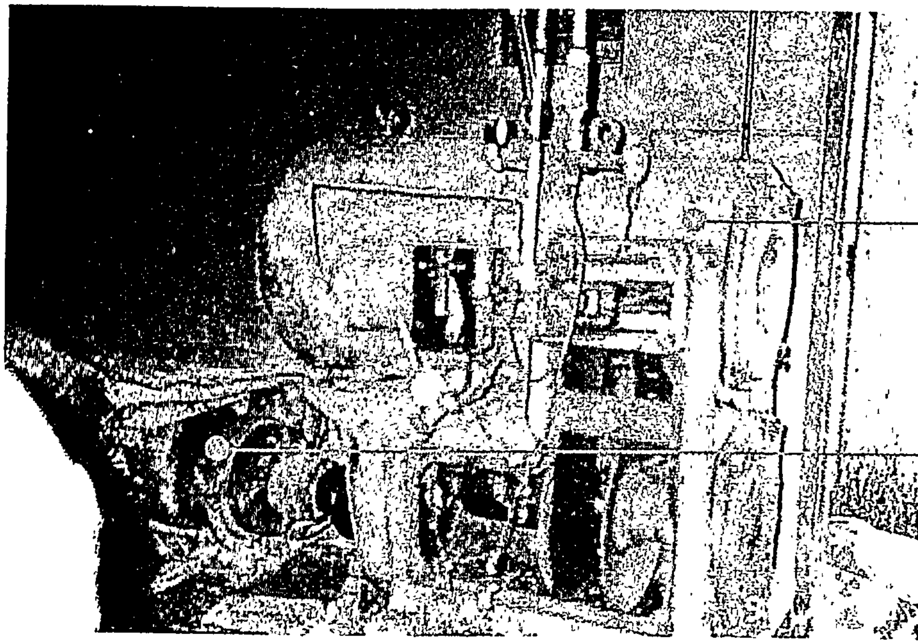
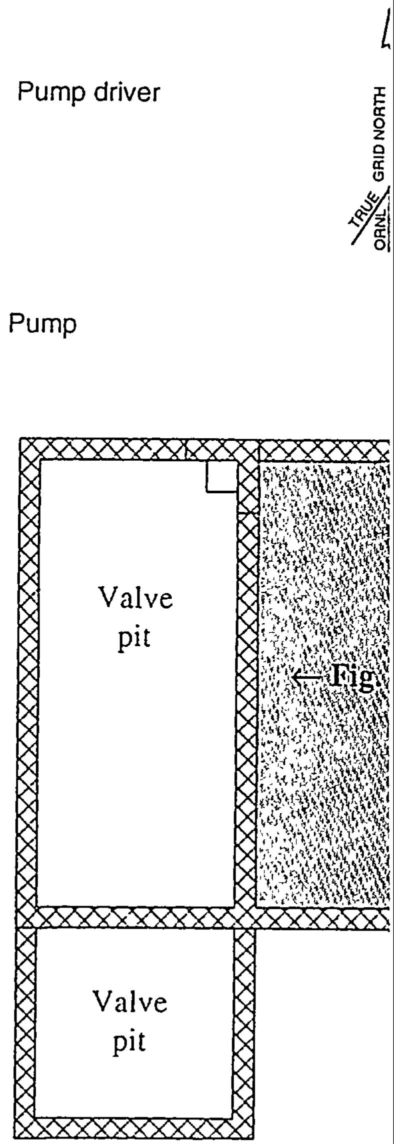


Fig. 2.22a. North interior wall of pump house.



Pump house an

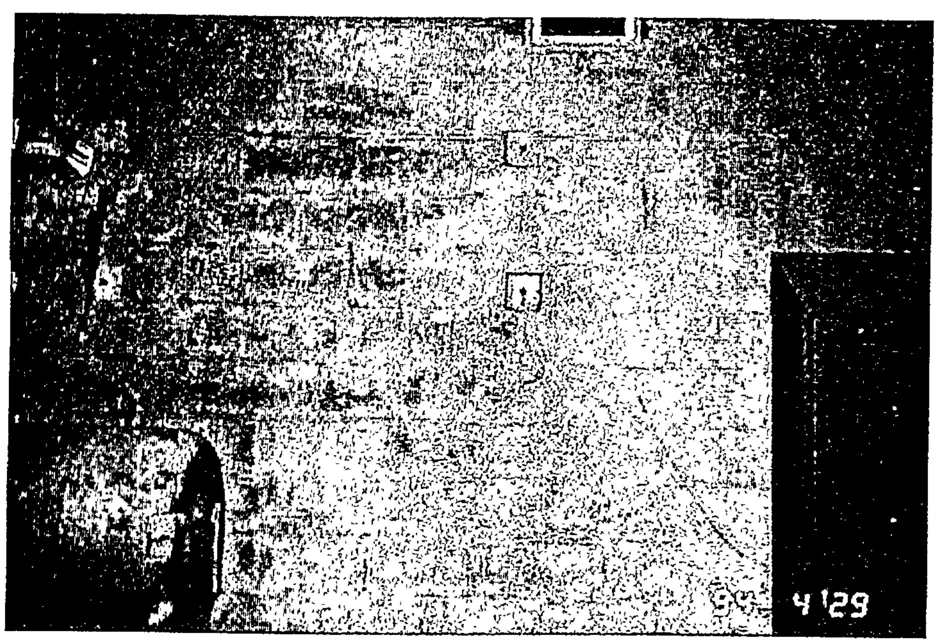
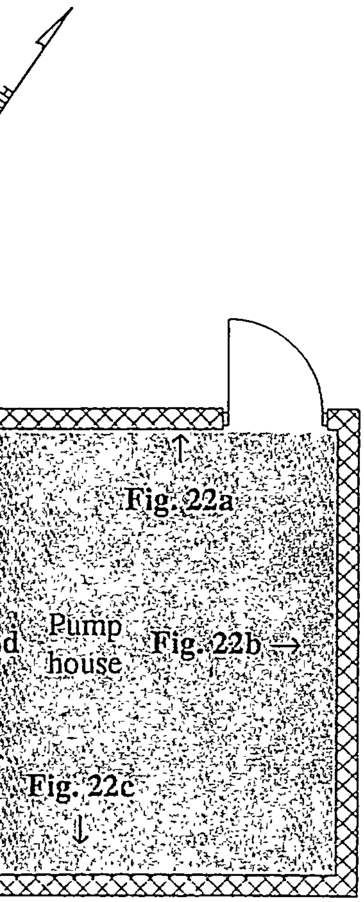


Fig. 2.22c. South interior wall of pump house.



alve pit plan.

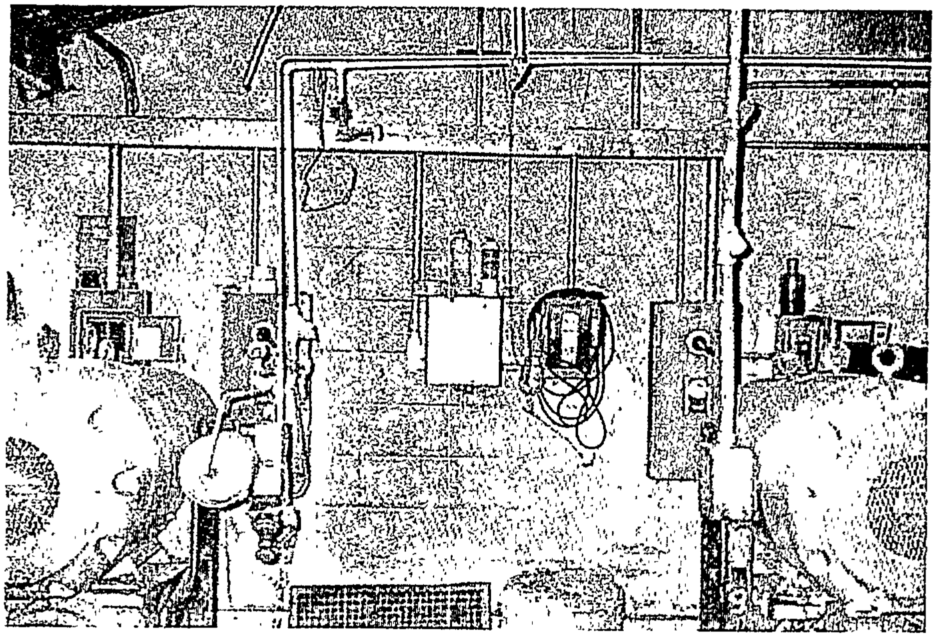


Fig. 2.22b. East interior wall of pump house between pump drivers.

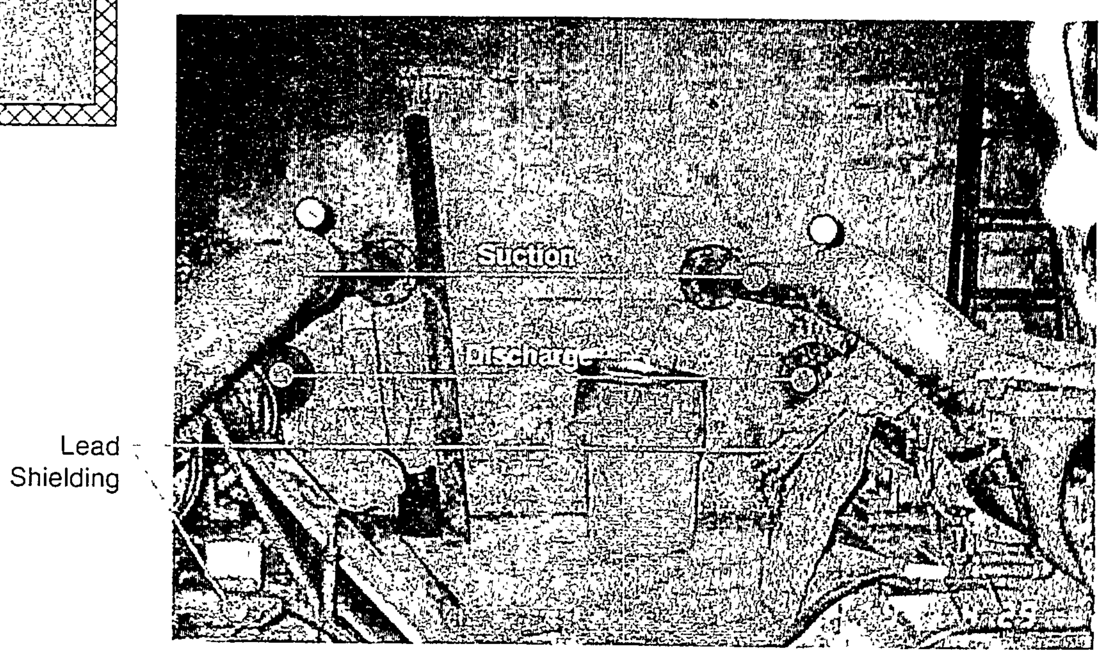


Fig. 2.22d. West interior wall of pump house between pump suction lines.

Fig. 2.22. Pump house, interior walls.

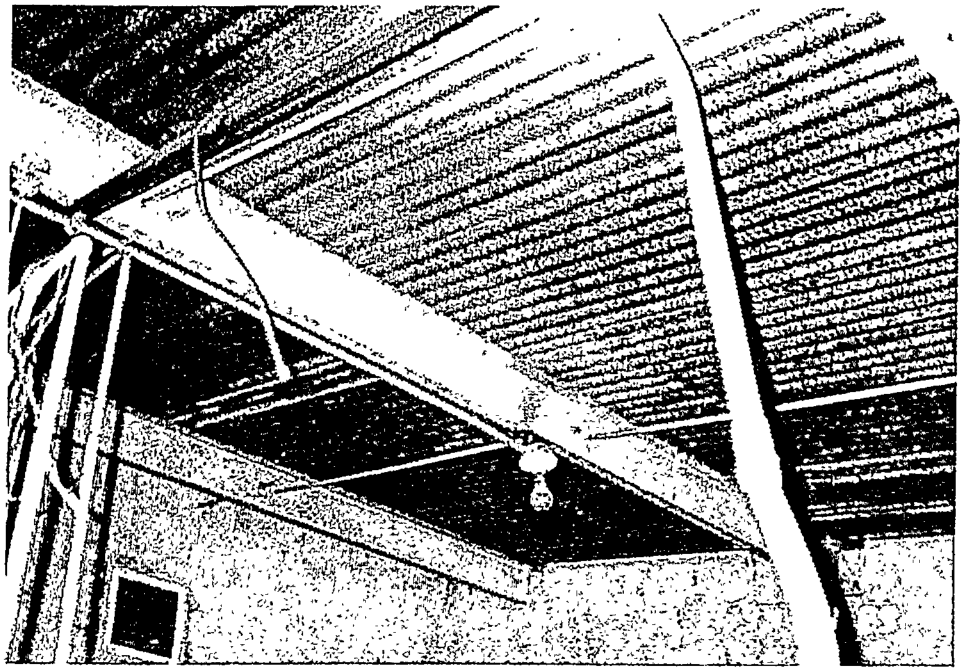


Fig 2.23a. Pump house ceiling (view toward southwest corner).

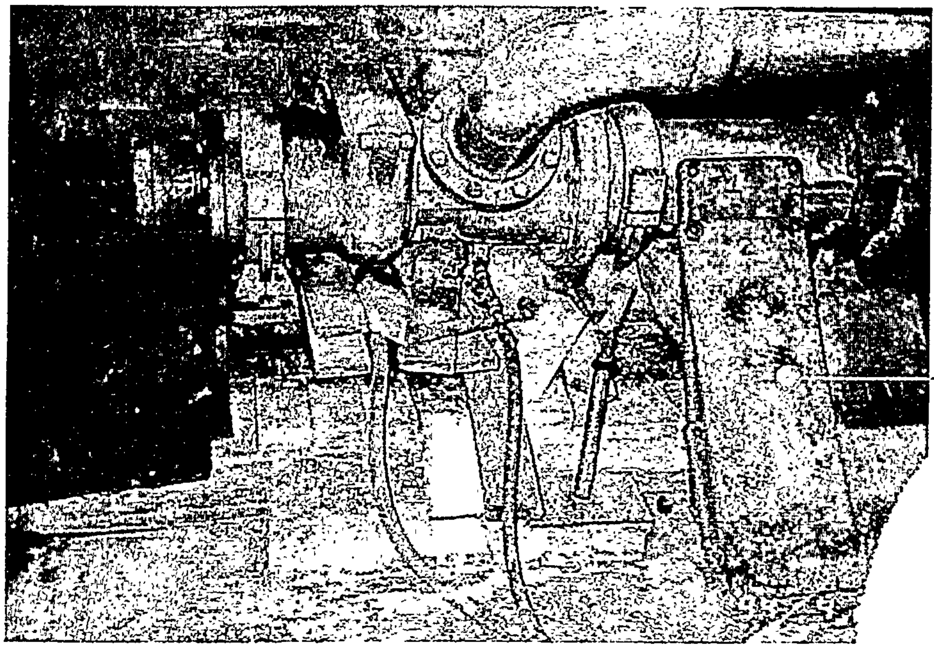


Fig 2.23c. Lead shielding under the discharge line of the south pump
(view toward south).

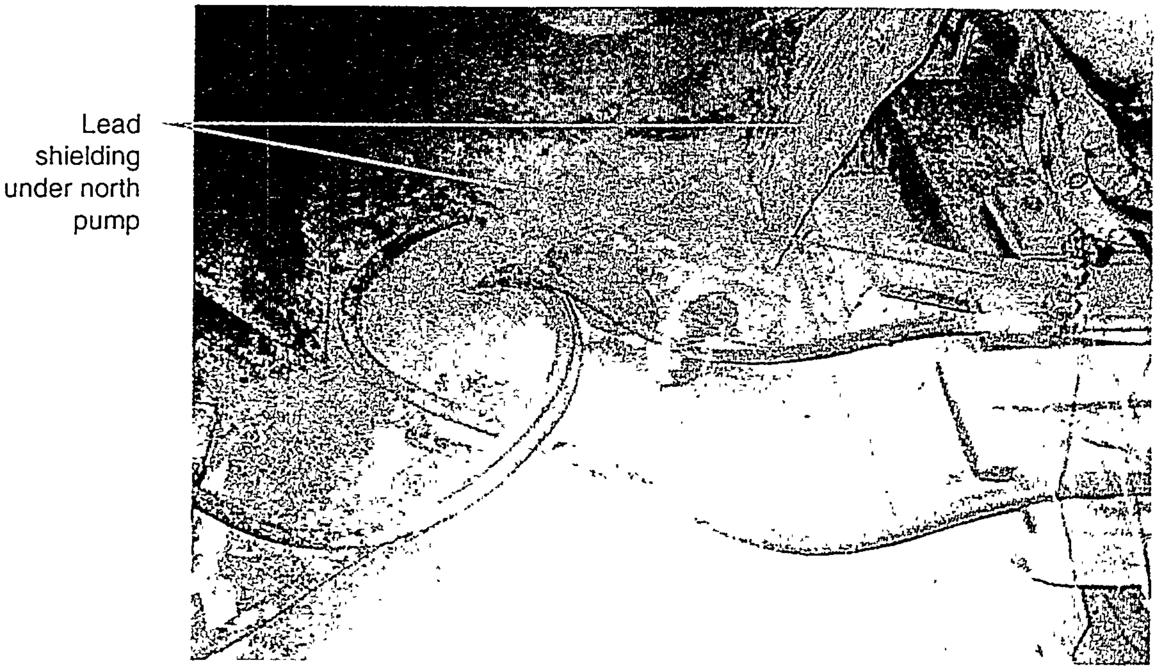


Fig 2.23b. Drain in center of pump house floor, between the pumps (view toward west).

Fig 2.23d. Sump pump wrapped in plastic in southwest corner of pump house.

Fig. 2.23. Pump house ceiling, floor, and equipment.

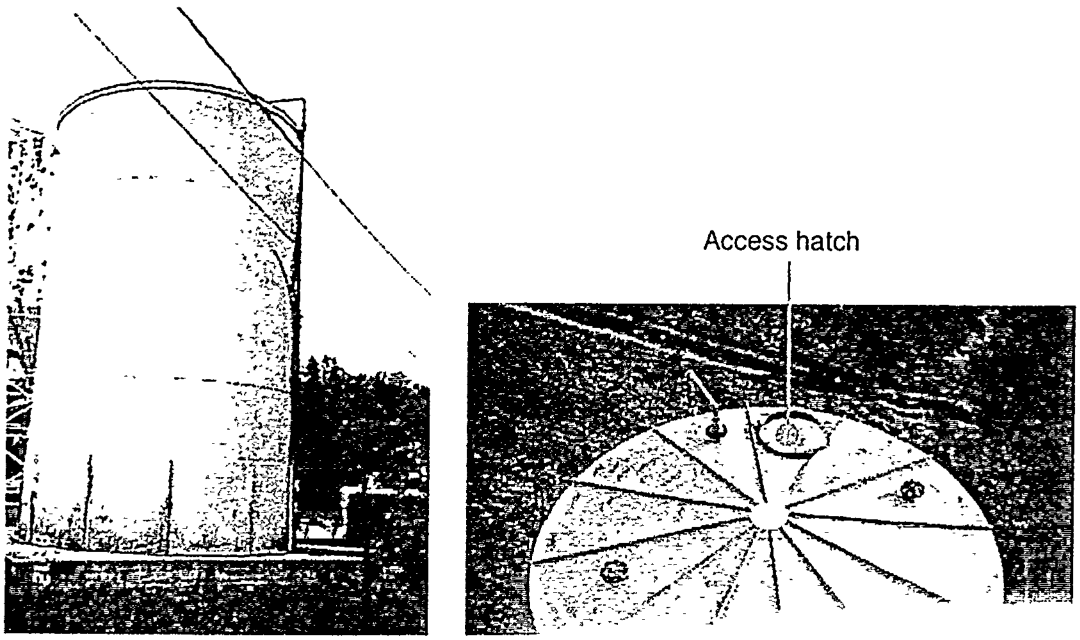


Fig. 2.24. Water tank T-5 (left, east side of tank; right, top of tank).

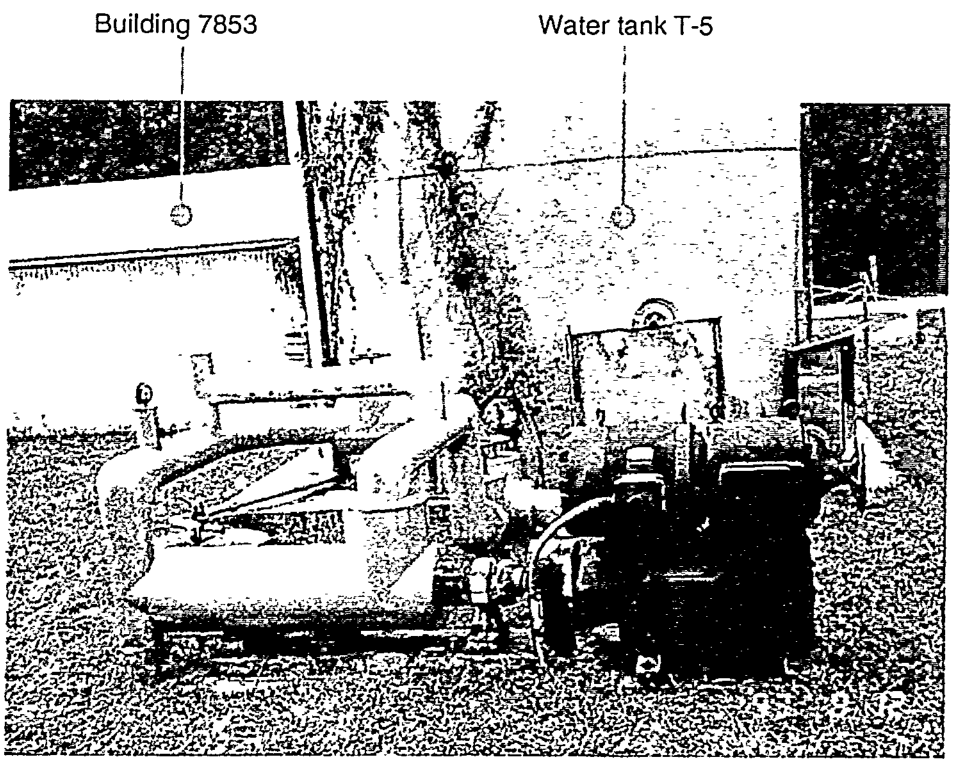


Fig. 2.25. Pump P-3.

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3. CHARACTERIZATION METHODS

Characterization of OHF involved three techniques—inspections, sampling and analysis, and field radiological measurements.

3.1 INSPECTIONS

No as-built information on OHF structures (after the 1973 modifications) was found when drawings and literature were searched. Inspections were done by field team members to reconcile as-built dimensions against building design drawings and to provide records for future D&D planning.

Photography and inspection were the primary methods of documenting conditions in and around the facility. Photographs provide a permanent record of conditions on the date of the inspection, and comparison of photographs with available drawings verifies as-built information and documents previous decommissioning activities. All photographs were recorded in a logbook, with time, date, photographer, and subject as minimum recorded information. A fully automatic 35mm camera was used so that the best possible images would be obtained regardless of the skill of the photographer. Complete albums of the photographs, along with negatives, are maintained as permanent ORNL RI/FS Project records.

As-built dimensions measured in the field with a steel tape to verify design drawings were recorded in field logbooks. Concrete core samples taken from floors provided as-built thicknesses of the poured concrete. Because of safety concerns regarding wiring, piping, and other possible obstructions, no cores were taken from the walls, and wall thicknesses were determined using existing ORNL design drawings.

A structural engineer inspected OHF structures; the evaluation of the structure with respect to potential decommissioning is presented in Appendix C. The paint used on the interior and the exterior of OHF structures was qualitatively examined for lead, and one paint sample from the storage bins was sent to an off-site analytical subcontract laboratory (ASL) for chemical analyses. Findings of field lead paint screening and lab results are included in Sect. 4.

3.2 SAMPLING AND ANALYSIS

The objectives of sampling were to identify radioisotopes present, including certain TRU isotopes; determine depth of radionuclide penetration into concrete surfaces; and screen for the presence of hazardous chemicals. Samples consisted of concrete cores, subfoundation soil, outside soil, water, and grout from the cell area. Because of the small size of the OHF structures and the high cost of laboratory analyses, sampling activities were limited to just a few in each room or cell. Figures 3.1 and 3.2 show internal and external sampling locations, and Table 3.1 summarizes the samples collected and analyses performed. Laboratory analyses included a full suite of hazardous chemicals and radionuclides; results are presented in Sects. 4 and 5.

radionuclide penetration. Slit-scanning involves shielding the detector so that only a 1/4-in. slice of the core is measured at any one time; each 1/4-in. increment is measured to develop a contamination profile.

Soil samples were collected from under the room and cell floor slabs (through core holes) and outside of OHF structures using a hand auger.

In addition, miscellaneous grab/composite samples were collected from water in tank T-5, from grout on the floor of the mixing cell, and from the suction lines in the pump cell.

3.3 RADIOLOGICAL MEASUREMENTS

Field measurements of the radiological conditions, which are of primary importance, can be divided into "general area" [or environmental, safety, and health (ES&H)] and "location-specific." General area measurements included exposure rate surveys, directional gamma measurements, and smears. Exposure rate surveys provide the general area exposure rates needed for ALARA (as low as reasonably achievable) planning and D&D task sequencing; directional gamma measurements provide radiation profiles for modeling radiological sources; and smears provide indication of loose surface contamination.

Location-specific measurements (field counts and smears to quantify loose contamination) were done on potentially contaminated structural surfaces within the cells and rooms. A protocol was developed to help ensure quantitative results under field conditions. First, calibrated field instruments were source- and background-checked before each day's use. Second, measurements at each selected location were as follows.

- Using a 10-cm × 10-cm square template, the location was outlined and numbered.
- Using a 0.68-cm standoff spacer, an alpha measurement consisting of three integrated counts was conducted.
- Using a 10-cm standoff spacer, a beta/gamma (open window) measurement consisting of three integrated counts was conducted.
- Using a 10-cm standoff spacer, a gamma (closed window) measurement consisting of three integrated counts was conducted.
- A smear sample was collected inside the 10-cm × 10-cm outline.
- The location was photographed.

Third, the field instruments were source- and background-checked at the end of each day's use. Primary instruments were the Eberline HP-270 beta/gamma Geiger-Mueller detector and the Eberline AC-3 alpha scintillation detector, both with the Eberline ESP-2 counter/ratemeter.

The smear samples were analyzed for gross beta/gamma, gross alpha, and gamma emitters (spectroscopy for smears exceeding 500 cpm gross beta/gamma activity); strontium-90 analysis was conducted if gross beta levels exceeded 500 cpm and could not be accounted for by gamma spectroscopy results.

The OHF site characterization plan (Bechtel 1994a) includes detailed descriptions of the instruments and methods used for radiological measurements. Appendix D lists the instruments used in this investigation. Results of field radiological measurements are presented in Sect. 6.

3.4 FIELD QUALITY CONTROL

Field quality control (QC) was ensured by adherence to approved plans, procedures, and field work guides (FWGs). These documents include requirements for training, record keeping, field QC checks, and personnel responsibilities. The FWGs detail proper measurement and sampling sequences.

Several QC oversight surveillances were conducted with checklists developed from approved ORNL RI/FS Project FWGs and other applicable procedures to ensure that activities were performed in accordance with appropriate requirements. These QC surveillances covered activities such as

- availability of work-controlling documents (project procedures and FWGs) for the work team at the site;
- deployment of required equipment and supplies;
- review of training records;
- initial entry for health and safety monitoring activities;
- use of appropriate personal protective equipment;
- access to the facility in prescribed sequence based on results of the initial health and safety monitoring;
- systematic survey of the areas;
- selecting and marking of the measurement locations;
- methods of obtaining samples;
- radiological measurements;
- entry of measurement results and other information into field logbooks;
- photography of the building, remaining equipment, access points, and selected sample locations; and

- taking, marking, and handling of the concrete core and soil samples.

These surveillances resulted in no adverse findings or corrective action requests.

Table 3.1. Sampling summary

Location No.[a]	Sample No.	Sample Type	Sample Description	Chemical Analyses[b] TCL VOCs	TCL BNAEs	TCL Pest./PCBs	TAL Metals	TAL Cyanide	Radiological Analyses
74.SB001	04453	Soil (outside)	Hand-augered composite soil sample taken between water tank T-5 and pump P-3. VOC samples were collected from the 1.5- to 2-ft depth interval; other samples were composited over the 2- to 5-ft interval. Refusal was not reached.	X	X	X	X	X	X
	04466	Trip blank/ water	Submitted with sample 04453.	X					
74.SB002	04556	Soil (outside Building 7852)	Hand-augered composite soil sample taken near the southeast corner of the mixing cell. The sample was composited over the 1- to 5-ft depth interval; an exception was the VOC sample that was collected from the 1.8- to 2.2-ft interval. Refusal was not reached.	X	X	X	X	X	X
	04468	Trip blank/ water	Submitted with sample 04556 (also submitted with sample 04555, location 74.SB004).	X					
74.SB003	04557	Soil (outside Building 7852)	Hand-augered composite soil sample taken on the west side of the wellhead cell. The sample was composited over the 2- to 5-ft depth interval; an exception was the VOC sample that was collected from the 1.5- to 2-ft interval. Refusal was not reached.	X	X	X	X	X	X
	04467	Trip blank/ water	Submitted with sample 04557.	X					

Table 3.1 (continued)

Location No.[a]	Sample No.	Sample Type	Sample Description	Chemical Analyses[b]					Radiological Analyses
				TCL VOCs	TCL BNAEs	TCL Pest./PCBs	TAL Metals	TAL Cyanide	
74.SB004	04555	Soil (outside Building 7852)	Hand-augered composite soil sample taken on the south side of the wellhead cell. The sample was composited over the 0- to 3.8-ft depth interval; an exception was the VOC sample that was collected from the 2-ft depth. Auger refusal was at 3.8 ft. Radiation readings ranged from 45,000 cpm to 11,000 cpm, decreasing with depth.	X	X	X	X	X	X
	04468	Trip blank/ water	Submitted with sample 04555 (also submitted with sample 04556, location 74.SB002).	X					
74.SB005	04558	Soil (outside Building 7852)	Hand-augered composite soil sample taken under an asphalt layer on the east side of the pump house. The sample volume was insufficient to fill all containers. The sample was composited over the 0.8- to 3-ft depth interval; an exception was the VOC sample that was collected from the 0.8- to 2-ft interval. Auger refusal was at 3 ft; limestone gravel was in the bottom of the hole.	X	X	X	X	X	X
	04470	Trip blank/ water	Submitted with sample 04558.	X					
74.SB006	04450	Concrete core	Core taken from the approximate center of the control room floor. The core length is approximately 7 in.		X	X	X	X	X

Table 3.1 (continued)

Location No.[a]	Sample No.	Sample Type	Sample Description	Chemical Analyses[b]					Radiological Analyses
				TCL VOCs	TCL BNAEs	TCL Pest./PCBs	TAL Metals	TAL Cyanide	
74.SB006 (cont.)	04452	Soil (subfloor)	Hand-augered composite soil sample taken below the control room slab. The sample was composited over the 0.6- to 5-ft depth interval; an exception was the VOC sample that was collected from the 3- to 3.6-ft interval. Refusal was not reached. Fill dirt was encountered from 0.6 to 2 ft, gravel from 2 to 2.2 ft, and native soil from 2.2 to 5 ft. Soil moisture increased with depth.	X	X	X	X	X	X
	04321	Trip blank/ water	Submitted with samples 04450 and 04452.	X					
74.SB007	04550	Concrete core	Core containing 1/4-in. rebar was taken from the southeast corner of the mixing cell floor. The core is approximately 9 in. long, and is composed of a top pour measuring 2.5 in. and a bottom pour measuring 6.5 in. Gravel was at the bottom of the core hole.		X	X	X	X	X
74.SB008	04553	Concrete core	Core taken from the northwest corner of the pump cell floor. The core length is approximately 8 in. and is composed of a top pour measuring 1 in. and a bottom pour measuring 7 in. The radiation levels at the interface were 26 mR/h closed window and 400 mrad/h open window.		X	X	X	X	X

Table 3.1 (continued)

Location No.[a]	Sample No.	Sample Type	Sample Description	Chemical Analyses[b]					Radiological Analyses
				TCL VOCs	TCL BNAEs	TCL Pest./ PCBs	TAL Metals	TAL Cyanide	
74.SB008 (cont.)	04559	Soil (subfloor)	Hand-augered composite soil sample taken underneath the pump cell and underneath a gravel layer (0.75 to 1.7 ft). The sample was composited over the 1.7- to 4-ft depth interval; an exception was the VOC sample that was collected at the 1.7- to 2-ft interval. Refusal was not reached, but augering was stopped at 4 ft due to the hole caving in.	X	X	X	X	X	X
	04569	Trip blank/ water	Submitted with samples 04553 and 04559.	X					
74.SB009	04552	Concrete core	Core taken from the southwest corner of the wellhead cell floor. The core length is approximately 7.5 in. Hand augering into underlying gravel fill/sub-base produced no sample. Refusal occurred at a depth of 1.33 ft when concrete rubble was encountered.		X	X	X	X	X
74.SB010	04451	Equipment rinsate (unfiltered)	Prior to taking the concrete core and soil samples at location 74.SB010, deionized water was circulated through the core drilling equipment to obtain an equipment rinsate sample.		X	X	X	X	X
	04471	Concrete core	Core taken from the engine pad. The core length is approximately 6 in.		X	X	X	X	X

Table 3.1 (continued)

Location No.[a]	Sample No.	Sample Type	Sample Description	Chemical Analyses[b]					Radiological Analyses
				TCL VOCs	TCL BNAEs	TCL Pest./PCBs	TAL Metals	TAL Cyanide	
74.SB010 (cont.)	04554	Soil (subfloor)	Hand-augered composite soil sample taken underneath the engine pad. The sample was composited over the 2- to 5-ft depth interval; an exception was the VOC sample that was collected over the 1.5- to 2-ft interval. Refusal was not reached.	X	X	X	X	X	X
	04469	Trip blank/ water	Submitted with samples 04471 and 04554.	X					
74.SB011	04551	Concrete core	Core taken from the pump house floor. The core length is approximately 5 in. Hand augering into underlying gravel fill produced no sample. Refusal occurred at a depth of 0.9 ft due to caving gravel.		X	X	X	X	X
74.7852PC	04582	Concrete (grab)	Using a hammer and chisel, grout and sand material was taken from pipes located in the Building 7852 pump cell.						X
74.7852MC	04583	Concrete (grab)	Using a stainless steel spatula, grout material was taken from piles on the floor of the mixing cell at Building 7852, under the hopper and the mixing tanks.						X
74.BINSPC	04597	Paint chips (composite)	Paint chip samples (along with flaking rust) were collected from the legs and struts of the bulk storage bins using a plastic scraper, and then composited. Qualitative lead indicator tests were also conducted on the samples.				X		

Table 3.1 (continued)

Location No.[a]	Sample No.	Sample Type	Sample Description	Chemical Analyses[b]					Radiological Analyses
				TCL VOCs	TCL BNAEs	TCL Pest./PCBs	TAL Metals	TAL Cyanide	
74.SW001G	03937	Water	Water sample was collected from water tank T-5 by inserting a bailer through a hatch at the top of the tank. Field measurements indicated a pH reading of 8.21, an Eh reading of 185.9, a temperature of 27.7°C, and a conductivity of 0.179 μmho.	X	X	X	X	X	X

[a] Locations 74.SB006 through 74.SB011 are shown in Fig. 3.1. Locations 74.SB001 through 74.SB005 are shown in Fig. 3.2.
[b] TCL - Target Compound List; TAL - Target Analyte List; BNAE - base/neutral/acid-extractble; Pest. - pesticides; VOC - volatile organic compound.

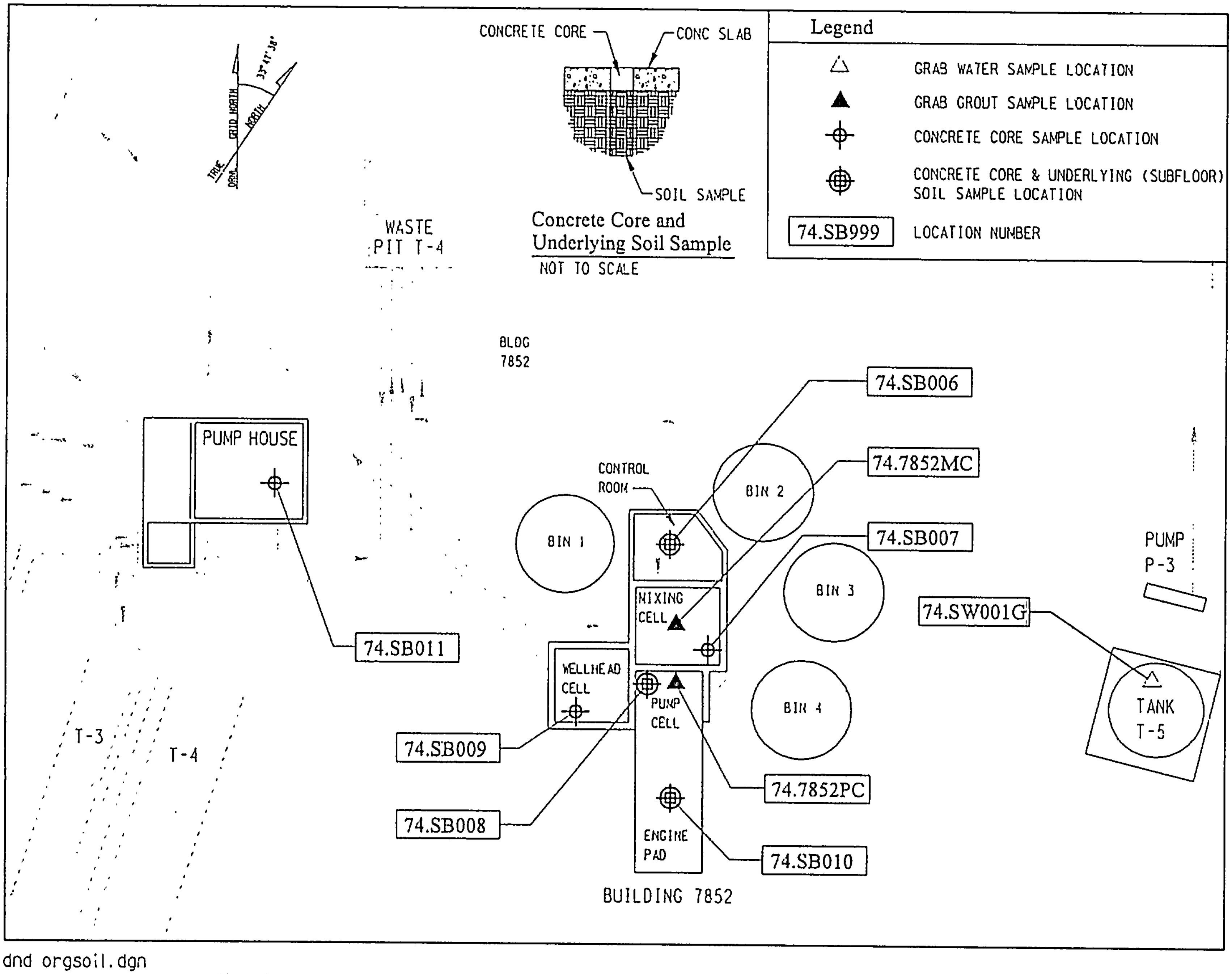
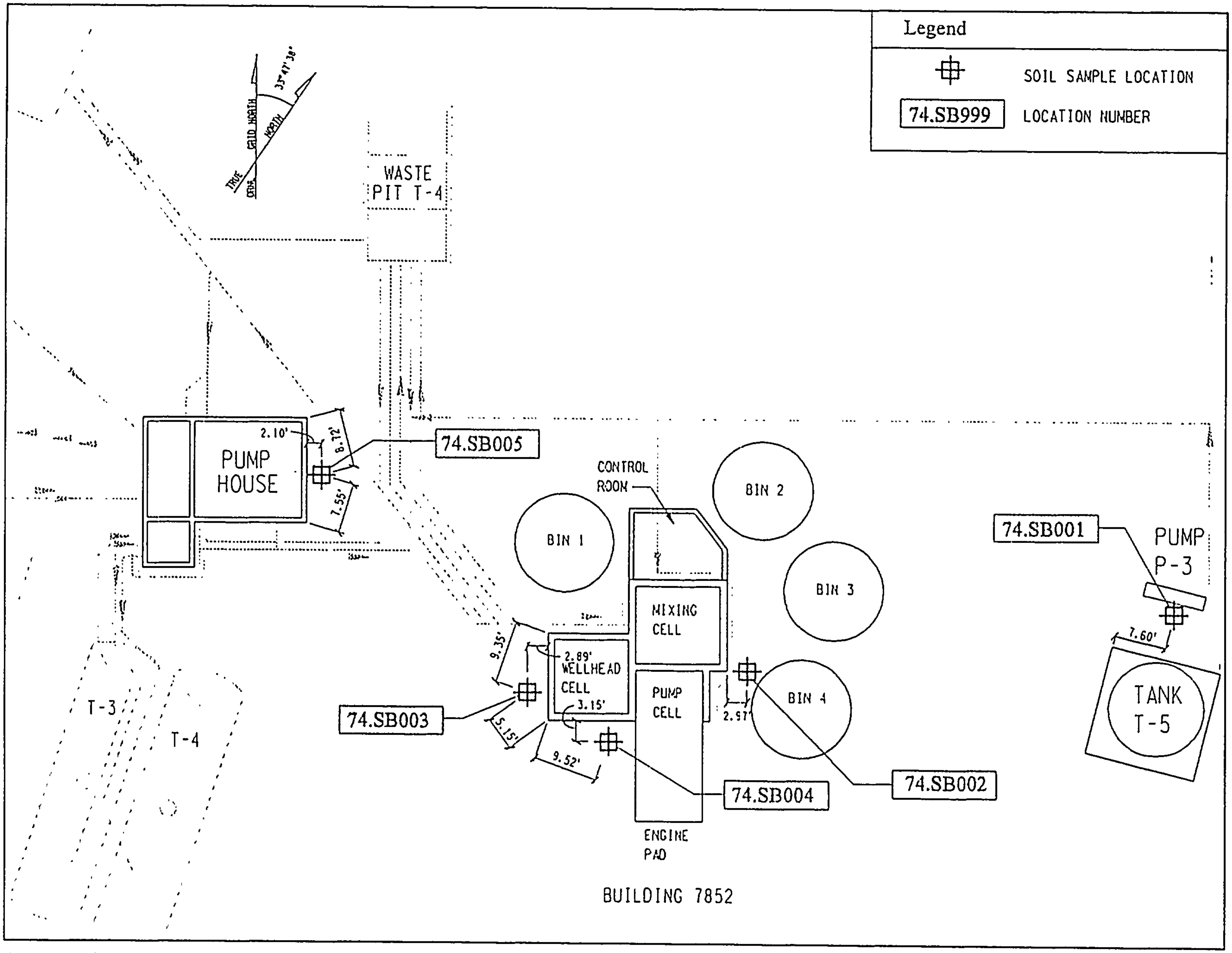


Fig.3.1. Concrete core, soil, and grab sampling locations inside OHF structures.



dnd orgsoil.dgn

Fig. 3.2. Soil sampling locations outside OHF structures.

4. CHEMICAL SAMPLING AND ANALYSIS

This section discusses the chemical results from sample analysis; Sect. 5 discusses the radiological results. During the period April through June 1994, one equipment (core drill) rinsate sample, six concrete core samples, three subfloor soil samples, five outdoor soil samples, one tank water sample, and a paint chip sample were collected and submitted to the ASL for chemical analyses. Appropriate QC samples were also collected and analyzed. No chemical characterization studies of the OHF D&D structures and the immediately surrounding soil are known to have been performed before the 1994 field effort.

4.1 DATA PRESENTATION

Chemical data for liquid samples (e.g., rinsate or water) are presented in units of micrograms of analyte per liter of liquid ($\mu g/L$); one microgram per liter is approximately equivalent to one part per billion (ppb). Chemical data for solid samples (e.g., soil, concrete, or paint chip) are presented in units of milligrams of analyte per kilogram of solid (mg/kg) on a dry weight basis; one milligram per kilogram is equivalent to one part per million (ppm).

For organic analytes, only those analytes detected (i.e., "hits") are reported in this section. For inorganic analytes (i.e., metals and cyanide), all data are reported. When an inorganic analyte concentration is reported as a "less than" value (e.g., <20 mg/kg), this indicates that it was not detected at or above its detection limit (in this case, 20 mg/kg).

The analytical data presented here for the regular samples have been qualified by the project as part of the validation process. The qualifiers applicable to this report are defined as follows.

J: The associated numerical value is an estimated quantity. For organic compounds, the qualifier also means the compound was detected at a value less than the quantitation limit.

NJ: Presumptive evidence for the analyte exists (tentative identification) at an estimated quantity.

R: Values are unusable (i.e., compound may or may not be present). Resampling and/or reanalysis is necessary for verification.

In the discussion that follows for the organic compounds, the notation "TIC" (tentatively identified compound) means that the compound has been identified solely by its mass spectrum in a machine search of spectra contained in a computer's library. The quantitation is based on the response factor of the nearest internal standard present in the chromatogram. Because of the nature of the quantitation procedure, all nonrejected values reported are, by definition, approximate concentrations and bear the NJ qualifier. Parentheses in the organic analytical data tables indicate the number of TICs.

Chemical analyses [Environmental Protection Agency (EPA) analytical support level IV] include both Target Compound List (TCL) and Target Analyte List (TAL) analyses. Appendix E lists the individual TCL organic and TAL inorganic analytes, as well as their respective contract-required detection/quantitation limits as referenced in EPA's Statements of Work (EPA 1991a,b). Organic TICs are not specifically on the TCL but were reported by the laboratory if detected.

The concrete cores were slit-scanned soon after they were collected. After slit-scanning, each core was broken up into <2-in. fragments, placed in a capped stainless steel tube, and sent to an off-site ASL, where the concrete was crushed and homogenized and then distributed among containers for designated analyses.

In addition to the samples collected by the Bechtel team, Energy Systems Industrial Hygiene personnel collected and analyzed one sample of building material for asbestos content (see Sect. 4.10).

4.2 DATA USABILITY ASSESSMENT

Documentation provided by the laboratories for the chemical analyses met RI/FS Project QC level III requirements, as stated in the Technical Specification for Analytical Services (Bechtel 1993). (Note: this QC level refers to reporting requirements for analytical laboratory services and is not to be confused with EPA analytical support levels.) QC level III mandates that QC data, including raw data (e.g., calibration and control data), be reported in a Contract Laboratory Program (CLP), or "CLP-like," data package.

Although the data packages from the laboratories met QC level III documentation requirements, validation of the packages met RI/FS Project QC level II requirements. Level II data validation means that the chemical data were reviewed in accordance with EPA CLP data validation procedures for organic data (EPA 1990) and inorganic data (EPA 1988), but the raw data were not checked by the validator to the same degree that they would have been checked in a QC level III protocol. QC level II validation was judged sufficient for this investigation.

The preparation and quantitative measurements of samples for organic compounds followed CLP methodology (EPA 1991a). VOCs were determined using the CLP method for volatiles in water and solids by purge-and-trap gas chromatography-mass spectrometry (GC-MS). Base/neutral/acid-extractable constituent (BNAE) analysis involved extraction using methylene chloride, followed by GC-MS. Pesticide/polychlorinated biphenyl (PCB) samples were prepared using sonification extraction and then measured using a capillary column GC method with an electron capture detector.

The analytical method for inorganics requested by the Bechtel Team and employed by the laboratories followed the CLP Statement of Work (EPA 1991b). In accordance with CLP protocol, arsenic, lead, selenium, and thallium were analyzed using atomic absorption (furnace technique); mercury was analyzed using the cold vapor technique (a flameless atomic absorption procedure); cyanide was analyzed using a semiautomated spectrophotometric technique; and the remaining metals were analyzed by inductively coupled plasma atomic emission spectroscopy.

Difficulties arose with the TCL organics analyses because of severe matrix effects, particularly with the concrete core samples. Although the overall quality of the TCL organics data was acceptable, some of the BNAE and PCB analyses were qualified as estimated (J) or rejected (R) because the concrete matrix negatively affected surrogate and matrix spike recoveries. For most of the concrete samples, poor BNAE recoveries occurred only for the acid fraction (i.e., phenolic compounds); for concrete core sample 04450, recoveries were low for both the acid and base/neutral fractions. The validator's response to the poor recoveries was to qualify the appropriate detected BNAEs as estimated (J) and the nondetected BNAEs as rejected (R).

With regard to TAL inorganic analytical results, poor matrix spike recoveries necessitated some data qualification. The matrix spike sample analysis provides information about the effect of each sample matrix on the digestion and measurement methodology. Analytes most often found with percent recoveries less than the acceptable limits (of 80 to 120%) included antimony, arsenic, and selenium; lead and manganese also occasionally had low recoveries. These spike recoveries indicate a negative bias, and associated sample results were qualified [as estimated (J) or rejected (R)] as appropriate. A positive bias was found in isolated cases for barium, cadmium, cobalt, copper, lead, and manganese because these metals were found (though infrequently) with a percent recovery greater than the acceptable limit. Validation of the duplicate samples indicated poor precision in specific samples for calcium, copper, lead, magnesium, and mercury; the appropriate data were flagged as estimated (J).

All paint chip sample (04597) and tank water sample (03937) analyses were performed at the IT laboratory in St. Louis, Missouri. For the other samples, TCL organics analyses were performed at the TMA laboratory in Monravia, California, and TAL inorganics analyses were performed at the TMA/Skinner and Sherman laboratory in Waltham, Massachusetts.

The following subsections discuss the nonradiological chemicals detected, organized by contaminant groupings: VOCs, BNAEs, pesticides/PCBs, metals and cyanide, lead shielding, and asbestos. Although the main text of this section discusses results by contaminant grouping, the summary at the end of this section gives results by medium (e.g., soil, concrete, water). Summaries of chemical findings by location are presented in Appendix F; complete analytical data packages are available as part of the ORNL RI/FS Project permanent records.

4.3 REGULATIONS AND STANDARDS USED FOR DATA COMPARISON

Various regulations and other standards and references that are used in this section for comparisons with data from "solid" samples (e.g., soil, concrete, paint chips) include RCRA (Sect. 4.3.1), the Toxic Substances Control Act (TSCA) (Sect. 4.3.2), and WAG 5 reference values for soil (Sect. 4.3.3). Regulations used for comparison with the water sample data include RCRA and the Safe Drinking Water Act (SDWA) (Sect. 4.3.4). Use of these regulations or standards for comparison purposes does not necessarily imply that they are considered legal and enforceable OHF requirements.

4.3.1 RCRA Toxicity Characteristic

Under RCRA, solid waste is classified as hazardous if it exhibits any of the following characteristics: (1) ignitability, (2) reactivity, (3) corrosivity, or (4) toxicity. As described in 40 CFR 261.24, toxicity is generally determined by using an extraction procedure (i.e., TCLP) with a 4.8–5.2 pH acetic acid solution to mimic sanitary landfill conditions. If the sample extract from the TCLP test contains toxic contaminants at concentrations greater than EPA's specified maxima for those contaminants, then the waste is considered hazardous. (If the waste is a liquid, the waste is considered to be the extract for the TCLP determination.) Appendix G tabulates the contaminants evaluated by EPA in the TCLP test and the regulatory level or concentration (in mg/L) of those contaminants above which the solid waste exhibits the characteristic of toxicity. The TCLP list contains 10 VOCs, 14 BNAEs, 8 pesticides, and 8 metals; all but 5 of the TCLP analytes are included as TCL/TAL parameters.

For the OHF characterization, TCL organic and TAL inorganic analyses (which give "total" analyte concentrations in the sample) were performed rather than TCLP tests (which give "leached" analyte concentrations). The "leached" quantities are typically some fraction of the "total" quantity present in a sample. It was acknowledged during initial planning that the TCLP test might not be required for a particular analyte if it could be demonstrated that the total concentration of the analyte in the sample, assuming it was *all* leached out by the TCLP acetic acid solution, would not cause the TCLP maximum concentration for that analyte to be exceeded. A direct comparison between TAL/TCL results and TCLP maxima is not possible for solid samples because the TAL/TCL results are in mg/kg of sample and the TCLP maxima are in units of mg/L of extract.

To facilitate the comparison between the total analyte concentrations determined in the TAL/TCL analyses with the TCLP maxima, a TCLP equivalent limit for solids can be derived; these equivalent limits are shown in Appendix G. The TCLP equivalent limits for solids (in mg/kg) are defined as 20 times the EPA regulatory limits for the extract (in mg/L) because of a 20-fold dilution during the extraction procedure for solids. The equivalent limits are approximate, however, since the sample's moisture content is not taken into account. Therefore, if the total concentration of a particular analyte in a solid sample is greater than the TCLP equivalent limit in Appendix G, that analyte becomes suspect as a RCRA constituent exhibiting the toxicity characteristic and a TCLP test must be performed.

4.3.2 TSCA PCB Limits

The TSCA regulations in 40 CFR 700 contain storage, disposal, and cleanup requirements for materials contaminated with PCBs (Etnier et al. 1993). These regulations require that debris with PCB concentrations greater than 50 ppm (40 CFR 761.60) be incinerated (40 CFR 761.70) or stored in a chemical waste landfill (40 CFR 761.75). Energy Systems policy (ESS-EP-125, Rev. 1) states that waste soil, concrete, and other debris contaminated with PCBs to levels under 50 ppm should be disposed of by incineration or burial in a chemical waste landfill, or through an approved alternative method. With appropriate approvals, on-site burial is allowed for debris, soil, or concrete with an average PCB concentration of less than 25 ppm.

4.3.3 Reference Soil Values

Reference values are included in the soil data comparison primarily for the purposes of WAG 5 remediation, which is integrated with OHF D&D (see Sect. 2.4). "Reference values" represent concentrations of chemicals (or radionuclides) that are present on the ORR but are uninfluenced by site waste management practices. (The traditional "background values" refer to concentrations of chemicals or radionuclides that are naturally occurring and uninfluenced by human activities.) Reference soil samples were not collected during the D&D site characterization or during the WAG 5 RI. The approach of the WAG 5 reference program was to use results of previous efforts to determine ambient concentrations of potential constituents of concern. Soil reference data presented in this section were obtained from Bechtel (1994b).

4.3.4 Chemical-Specific Limits for Water

Analytical results for the tank T-5 water sample will be compared against chemical-specific limits for water.

- Subtitle C of RCRA lists maximum concentration levels for 14 chemicals in groundwater at the plant boundary of a RCRA-permitted facility (40 CFR 264.94).

- EPA has promulgated primary and secondary drinking water regulations in the SDWA (40 CFR 141) that are applicable to certain public water systems. The primary drinking water regulations include maximum contaminant levels (MCLs), which are standards that take into consideration human health effects, available treatment technologies, and costs of treatment. The secondary regulations regulate those contaminants that affect the aesthetic qualities related to public acceptance of drinking water.

Etnier et al. (1993) describe these regulations, their chemical-specific limits, and the conditions under which the regulations are applicable.

4.4 VOC CONTAMINATION

TCL VOC analyses were performed for the five outdoor soil samples, the three subfloor soil samples, and the water sample from tank T-5. These analyses were not performed on the concrete samples because of (1) the implausibility of significant quantities of VOCs remaining in concrete over years of non-use of the facility, or (2) the possibility of prematurely liberating the VOCs during drilling and core fragmentation (prior to shipment).

4.4.1 VOCs in Soil Samples

Figure 4.1 shows the VOCs and VOC TICs detected in the outdoor and subfloor soil samples. VOCs were detected in minor amounts in six of the eight soil samples; VOC TICs in three. No VOCs were detected in the samples from borings east and west of Building 7852 (locations 74.SB002 and 74.SB003, respectively).

The contaminant found with the highest concentration was acetone; it was detected underneath the control room (74.SB006) at a concentration of 0.19 mg/kg, and under the pump cell (74.SB008) at 0.16 mg/kg. Toluene was detected most frequently (i.e., at all six detect locations), but at minor concentrations ranging from 0.001 to 0.011 mg/kg. The other VOCs—which included bromomethane, 2-butanone (also called methyl ethyl ketone), chloroform, chloromethane, and 4-methyl-2-pentanone—were detected at concentrations ranging from 0.001 to 0.04 mg/kg.

Of these VOCs, only 2-butanone (0.04 mg/kg) and chloroform (0.002 mg/kg) are on EPA's TCLP list. The RCRA equivalent limits for soils are 4000 and 120 mg/kg for 2-butanone and chloroform, respectively; because these equivalent limits exceed the actual concentrations detected by at least four orders of magnitude, 2-butanone and chloroform are not potential RCRA constituents. In addition, these same two VOCs were the only ones found at concentrations less than their soil reference values (see Table 4.1).

VOC TICs were detected under the control room (74.SB006), under the pump cell (74.SB008), and under the engine pad (74.SB010). The number of TICs ranged from one to four at each location; the total (summed) concentration ranged from 0.033 under the engine pad to 0.079 mg/kg under the control room.

4.4.2 VOCs in the Water Sample

No VOCs exceeding the detection limit of 10 μg/L were detected in the water sample (03937) from tank T-5.

4.5 BNAE CONTAMINATION

TCL BNAE analyses were performed for the five outdoor soil samples, the three subfloor soil samples, the six concrete core samples, the water sample from tank T-5, and the equipment rinsate sample.

4.5.1 BNAEs in Soil Samples

As shown in Fig. 4.1, BNAEs were detected in seven of the eight soil locations; BNAE TICs were detected in all eight. The soil samples are hand-augered composites.

The BNAE detected most frequently (at seven locations) was bis(2-ethylhexyl)phthalate, a common plasticizer; concentrations ranged from 0.058 to 0.077 mg/kg. The plasticizer, which is not listed as a RCRA toxicity characteristic contaminant, may have originated as a laboratory contaminant. Besides the plasticizer, the only other BNAEs detected were 4-nitrophenol and pentachlorophenol, with concentrations ranging from 0.047 to 0.093 mg/kg. Pentachlorophenol is on EPA's TCLP list, but the RCRA equivalent limit for soils of 2000 mg/kg exceeds the actual concentrations by four orders of magnitude. The phenolic compounds were detected under the pump cell (74.SB008) and under the engine pad (74.SB010).

None of the BNAEs detected were found in the reference soil sampling program.

Four to 18 TICs were found at each soil boring location; total (summed) concentrations ranged from 0.842 in the soil sample from under the engine pad to 21.07 mg/kg under the control room.

4.5.2 BNAEs in Concrete Cores

Figure 4.2 shows the BNAEs and BNAE TICs detected in the six concrete cores extracted from the floors of Building 7852 and the pump house. BNAEs were detected in two of the six locations; BNAE TICs in five. No BNAEs or BNAE TICs were detected in the floor core from the control room (74.SB006).

The two locations with detected BNAEs were the well cell and the pump house. The floor core from the well cell (74.SB009) contained bis(2-ethylhexyl)phthalate at 1.9 mg/kg and isophorone at 0.96 mg/kg. The floor core from the pump house (74.SB011) contained isophorone at 0.52 mg/kg and 4-nitrophenol at 0.25 mg/kg. EPA does not include these BNAEs on the TCLP list as RCRA hazardous constituents.

Moderate quantities of TICs, consisting primarily of unknown hydrocarbons, were found in the concrete cores. The number of TICs for each core ranged from 10 to 20, and the total (summed) concentration of TICs ranged from approximately 97 mg/kg in the pump house core to 3425 mg/kg in the engine pad core. The smallest number and lowest total concentration of detected TICs were in the pump house core; the largest number and highest total concentration was from the engine pad core. In general, the concentrations of TICs in the concrete cores were one to three orders of magnitude larger than those in soil. Although their origin is unknown, it may be hypothesized that some of the TICs in the concrete cores originated from core drill grease or lubricants liberated and transported during wet drilling operations.

4.5.3 BNAEs in the Water Sample

No BNAEs were detected in water sample 03937 from tank T-5. Twelve TICs (labeled as unknown compounds) were detected at a total (summed) concentration of 83 μg/L.

4.5.4 BNAEs in the Equipment Rinsate

Before drilling began at location 74.SB010, deionized water was circulated through the core drilling machine to provide an equipment rinsate sample (04451). The BNAEs detected included 4-nitrophenol (1 μg/L) and the common plasticizer di-n-butylphthalate (2 μg/L). Five BNAE TICs were also detected at a summed concentration of 103 μg/L. This indicates that even though the core drill was not operating when the rinsate was collected, some BNAES were still present. Higher levels of BNAEs might have been found if the core drill had been operating.

4.6 PESTICIDE/PCB CONTAMINATION

TCL pesticide/PCB analyses were performed for the five outdoor soil samples, the three subfloor soil samples, the six concrete core samples, the water sample from tank T-5, and the equipment rinsate sample.

4.6.1 Pesticides/PCBs in Soil Samples

As shown in Fig. 4.1, pesticides/PCBs were detected in only two of the eight soil sampling locations:

- Outdoor sample 04453, taken from 74.SB001 near pump P-3 and tank T-5, was found to contain dieldrin at 0.0041 mg/kg. This compound was not detected in the reference soils program, and EPA has not included the compound in its TCLP list as a potential RCRA constituent. Dieldrin was formerly used as an insecticide, the manufacture and use of which has been discontinued in the U.S.

- Subfloor sample 04559, taken from 74.SB008 in the pump cell, was found to contain aroclor-1254 at 0.29 mg/kg (ppm) and aroclor-1260 at 0.063 mg/kg (ppm). These PCBs were not detected in the reference soils program. However, since the PCB concentrations are less than 50 ppm, the soil should not be considered a TSCA waste (or a mixed waste if also radioactively contaminated).

4.6.2 Pesticides/PCBs in Concrete Cores

As shown in Fig. 4.2, PCBs were detected in all six concrete cores, but pesticides in only one.

PCBs, consisting of aroclors-1254 and -1260, were detected in individual concentrations ranging from 0.0048 to 19 mg/kg (ppm). If the aroclor concentrations are summed at each location, the lowest total PCB concentration was in the control room core (0.0055 mg/kg or ppm), and the highest was in the pump cell core (25.3 mg/kg or ppm). All the PCB concentrations were less than the TSCA limit of 50 ppm.

Aldrin was detected in the engine pad core (74.SB010) at a concentration of 0.031 mg/kg. Aldrin was formerly used as an insecticide, the manufacture and use of which has been discontinued in the U.S.; it is not included in the TCLP list.

4.6.3 Pesticides/PCBs in the Water Sample

Two insecticides were detected in water sample 03937 from tank T-5: aldrin at 0.071 μg/L and heptachlor epoxide at 0.07 μg/L. Aldrin is not included under RCRA or EPA's SDWA, but heptachlor epoxide is included under the SDWA. The regulatory limit for heptachlor epoxide is 0.2 μg/L, which exceeds the concentration found in the water sample by a factor of three.

4.6.4 Pesticides/PCBs in the Equipment Rinsate

No pesticides/PCBs were detected in the equipment rinsate sample (04451).

4.7 METALS AND CYANIDE CONTAMINATION

Metals occur naturally in soil and are therefore an integral component of structural materials (such as concrete) that are comprised of soil-related minerals. TAL inorganic (i.e., metals and cyanide) analyses were performed for the five outdoor soil samples, the three subfloor soil samples, the six concrete core samples, the paint chip sample, the water sample from tank T-5, and the equipment rinsate sample. Cyanide, selenium, and thallium were not detected in any sample; antimony was detected in only one.

EPA includes eight metals in its TCLP list for potential RCRA constituents; Table 4.2 shows the concentrations of these metals in the outdoor soil, subfloor soil, concrete core, and paint chip samples. For purposes of comparison, the table also includes the RCRA toxicity characteristic equivalent limits for solids.

4.7.1 Metals in Soil Samples

As shown in Table 4.2, none of the eight metals is present at sufficiently elevated levels to exceed the toxicity characteristic equivalent limit for solids; based on these data, the soils do not contain RCRA metals.

Table 4.3 compares the inorganic results for soils with reference values. Of the 24 TAL analytes listed, only cadmium, calcium, copper, magnesium, and silver were at concentrations greater than the maximum reference concentration. Most of the other metals have maximum concentrations within a factor of two to five of the reference maximum. The calcium maximum (326,000 mg/kg in subfloor soil sample 04452)—a factor of 15 higher than the next highest calcium result—is roughly equal to the typical calcium concentration of ordinary concrete.

4.7.2 Metals in Concrete Cores

As shown in Table 4.2, none of the RCRA metals is present in the concrete cores at sufficiently elevated levels to exceed the toxicity characteristic equivalent limit for solids.

No reference values exist for concrete samples. However, for comparison and because soil components are an integral part of concrete, it is instructive to compare the inorganic results for concrete with the reference soil values. Only 4 of the 24 TAL analytes exceed reference soil values: barium (264 versus 212 mg/kg), calcium (328,000 versus 2110 mg/kg), magnesium (20,000 versus 7430 mg/kg), and mercury (0.58 versus 0.34 mg/kg).

4.7.3 Metals in the Paint Chip Sample

The paint chips were scraped from the legs and struts of the bulk storage bins, along with flaking rust, and then mixed together. Table 4.2 indicates that chromium (1240 mg/kg) and lead (1270 mg/kg) were detected at levels that exceed the toxicity characteristic equivalents. The concentrations of chromium and lead are a factor of approximately 12 greater than the RCRA equivalent limits of 100 mg/kg.

The Bechtel Team also performed qualitative analyses for lead-based paint in the field using Lead Check Swabs™ (logbook 70-DD-002; June 23, 1994). The analyses were performed on the top coat of paint covering the surface of an area; no attempt was made to access underlying layers. Areas tested were the Building 7852 exterior, the control room interior, the pump cell interior, the wellhead cell interior, the pump house exterior, and the pump house interior. Generally, all four sides of a room/building were tested, with as many as three locations per room wall or side of a building. Of these multiple tests, only four locations tested positive: the exterior east wall of Building 7852, the interior side of the control room door, the interior north wall of the pump cell, and the interior south wall of the wellhead cell. However, the negative results for the other locations may be inconclusive given the relatively high frequency of false negatives with this technique (i.e., negative results should not necessarily be interpreted as an indication of the absence of lead).

A characterization of the paint removed during D&D will be necessary to determine whether any chromium or lead residuals may be classified as RCRA characteristic waste. If any fail the TCLP, the RCRA land disposal restrictions (LDRs) of 40 CFR 268 may be triggered [40 CFR 262.11;

TDEC 1200-1-11-.03(e)]. However, it is expected that the paint will be sufficiently immune to leaching that the extracted chromium and lead concentrations will be below their RCRA limits.

Removal of any lead-based paint must comply with the Occupational Safety and Health Administration final rule on lead abatement or exposure (29 CFR 1926.62, issued May 1993). This rule sets a permissible exposure limit at 50 $\mu g/m^3$ of air computed as an 8-h time-weighted average. The rule requires that in any construction work (which includes demolition or salvage of structures) where there is any occupational exposure to lead, an exposure assessment must be conducted to determine whether exposure exceeds the action level of 30 $\mu g/m^3$ computed as an 8-h time-weighted average. In addition to the exposure assessment, interim protection must be provided for certain listed activities while the assessment is being conducted.

4.7.4 Metals in the Water Sample

Nine metals were detected in the water sample (03937) from tank T-5; of these, calcium, magnesium, sodium, and vanadium are not listed under either RCRA or SDWA.

- Barium was detected at 32.2 μg/L (a factor of 30 less than the RCRA limit of 1000 μg/L, and a factor of 60 less than the SDWA MCL of 2000 μg/L).

- The chromium concentration was 46.2 μg/L (slightly under the RCRA limit of 50 μg/L, and a factor of 2 less than the SDWA MCL of 100 μg/L).

- Lead is not a RCRA concern because its concentration of 3.9 μg/L does not exceed the limit of 50 μg/L. No MCL exists for lead; however, EPA has established an "action level" of 15 μg/L which, if exceeded, invokes a treatment technology requirement. This action level is a factor of four above the lead concentration.

- Manganese was detected at 3.5 μg/L, a factor of approximately 14 less than the secondary MCL of 50 μg/L (no RCRA limit exists).

- The zinc concentration detected was 138 μg/L, which is significantly less than EPA's secondary standard for zinc of 5000 μg/L (no RCRA limit exists).

4.7.5 Metals in the Equipment Rinsate

Only three metals were detected in the equipment rinsate sample (04451): barium (3.4 μg/L), lead (2.1 μg/L), and zinc (35.4 μg/L). The presence of metals in the rinsate is minor compared to that of the sample from tank T-5.

4.8 LEAD SHIELDING

Photographs show lead shielding in the pump house around the pump heads and piping and on top of the pump foundation (see Figs. 2.22b and 2.22c). Lead blankets and sheets have also been wrapped around a vertical pipe in the pump cell. Some 1/2-in.-thick lead sheets were installed on the mixing cell roof circa 1973, and there are lead plates on top of the metal grating overlying the valve pit. A 55-gal drum in the control room may contain lead bricks based on the drum label; this was not visually verified.

The lead inside the pump house and pump cell would probably be considered mixed low-level radioactive waste, and decontamination activities would be governed by the exposure limits of DOE Orders 5400.5 and 5820.2A as well as the RCRA LDRs. The lead shielding on top of the mixing cell and valve pit is exposed to the elements, and it is not known if it is radioactively contaminated; this shielding may eventually need to be radiologically surveyed in a low-background area. Likewise, it is unknown if the suspected lead brick in the 55-gal drum is contaminated. Lead shielding is classified in the LDRs under waste code D008, which includes radioactive lead solids (40 CFR 268.42, Table 3). The LDR for D008 is a technology-based standard: macroencapsulation with surface coating materials such as polymeric organics (e.g., resins and plastics) or with a jacket of inert organic materials to substantially reduce surface exposure to potential leaching media.

4.9 ASBESTOS

On September 30, 1994, as part of the bins removal project (see Sect. 2.4), ORNL personnel collected two samples of bulk insulation padding material and submitted it to the Industrial Hygiene analytical laboratory for bulk asbestos analysis (ORNL Method SOP-IH-26.1; laboratory sample Nos. 94-0698-01 and 02). The insulation/padding was wrapped around the legs of bin 4, approximately 5 to 7 ft off the ground. The asbestos content results were negative for the samples. ORNL plans to perform a comprehensive asbestos survey of the OHF structures; results will be appended to this site characterization report when they become available.

EPA has listed asbestos as a hazardous substance under CERCLA (40 CFR 302.4) and regulates asbestos emissions during building demolition via specific work practices under the Clean Air Act. Nevertheless, if any detected asbestos material is classified during D&D as radioactively contaminated, it may be disposed of at SWSA 6 in accordance with SWSA 6 waste acceptance criteria (Energy Systems 1993a).

4.10 SUMMARY

4.10.1 Soil Results

Five outdoor and three subfloor soils samples were analyzed for TCL organics (VOCs, BNAEs, and pesticides/PCBs) and TAL inorganics (metals and cyanide). No significant differences between the outdoor and subfloor soil results were found. None of the soil samples contained VOCs, BNAEs, pesticides, or inorganics that exceed the RCRA toxicity characteristic equivalent limits for solids, nor did any of the soil samples contain PCBs that exceed the TSCA limit.

VOCs. Seven VOCs were detected in minor amounts in six of the eight samples, with total VOC concentrations in a sample ranging from 0.001 mg/kg (one VOC detected) to 0.217 mg/kg (five VOCs detected). VOC TICs were detected in three samples; the number of TICs ranged from one to four at each location, and the total (summed) concentration ranged from 0.033 to 0.079 mg/kg.

BNAEs. Three BNAEs were detected in minor amounts in seven samples, with total concentrations in a sample ranging from 0.058 mg/kg (one BNAE detected) to 0.222 mg/kg (three BNAEs detected). Four to 18 BNAE TICs were found at each soil boring location; total (summed) concentrations ranged from 0.842 to 21.07 mg/kg.

Pesticides/PCBs. The outdoor sample taken between pump P-3 and tank T-5 contained dieldrin at 0.004 mg/kg. The pump cell subfloor sample contained total PCBs at 0.353 mg/kg (ppm).

Inorganics. Only five of the metals exceeded reference values.

4.10.2 Concrete Core Results

One concrete core was drilled in the floor slab of each of the five rooms/areas of Building 7852, and one core was drilled in the pump house floor. The cores were analyzed for TCL BNAEs, TCL pesticides/PCBs, and TAL inorganics. None of the cores contained BNAEs, pesticides, or inorganics that exceeded the RCRA toxicity characteristic equivalent limits for solids, nor did any contain PCBs that exceeded the TSCA limit. Concrete core results are summarized as follows.

BNAEs. Three BNAEs were detected in minor amounts in two of the six samples, with total concentrations in a sample ranging from 0.77 mg/kg (two BNAEs detected) to 2.86 mg/kg (two BNAEs detected). Ten to 20 BNAE TICs were found at five of the six locations; total (summed) concentrations ranged from 97 to 3425 mg/kg.

Pesticides/PCBs. The engine pad core contained aldrin at 0.031 mg/kg. Up to two aroclors were detected at each location; total PCB concentrations ranged from 0.0055 to 25.3 mg/kg (ppm).

Inorganics. Most of the TAL metals were detected, but at nominal concentrations.

4.10.3 Paint Chip Sample Results

One paint chip composite taken from the solids storage bins was submitted for TAL metals analyses, and two potential RCRA constituents (chromium and lead) were identified. Although the paint is not expected to fail the TCLP test because of its relatively low leachability, the test should be performed on the rubble before disposal.

4.10.4 Water Sample Results

Water sample 03937 from tank T-5 was submitted for full TCL/TAL analyses. No VOCs or PCBs were detected, and none of the detected analytes exceeded RCRA or SDWA criteria.

BNAEs. Twelve BNAE TICs were detected at a total concentration of 83 μg/L.

Pesticides. The two insecticides detected were aldrin at 0.071 μg/L and heptachlor epoxide at 0.07 μg/L.

Inorganics. Nine metals were detected at nominal concentrations.

4.10.5 Lead Shielding

ORNL drawings and the field investigation indicated the presence of lead shielding, a potential mixed low-level radioactive waste, at various OHF locations.

4.10.6 Asbestos

Asbestos samples were taken from insulation padding wrapped around the legs of bin 4. However, the results were negative. ORNL plans to perform a complete asbestos survey of OHF at a later date.

Table 4.1. Comparison of VOC results for soils with reference values

VOCs	OHF Soil Samples			Reference Soil Samples[a]	
	Fraction of locations with detects	Maximum concentration (mg/kg)	Location of maximum detected concentration	Fraction of locations with detects	Maximum concentration (mg/kg)
Acetone	2/8	0.19	74.SB006	28/36	0.064
Bromomethane	2/8	0.002J	74.SB010	0/36	0.010[b]
2-Butanone	1/8	0.04	74.SB008	6/36	0.079J
Chloroform	1/8	0.002J	74.SB008	1/36	0.008
Chloromethane	1/8	0.002J	74.SB001	0/36	0.010[b]
4-Methyl-2-pentanone	1/8	0.004J	74.SB008	0/36	0.049[b]
Toluene	6/8	0.011J	74.SB008	0/36	0.005[b]

Note: Shaded values indicate that the maximum OHF soil sample concentration is greater than the maximum reference soil sample concentration, or that a chemical detected at the OHF was not detected in the reference program.

[a] Reference values obtained from Bechtel (1994b).

[b] For those chemicals shown that were not detected in the reference program, the maximum concentrations listed are actually the detection limits reported for those chemicals.

Table 4.2. Analytical results (in mg/kg) for RCRA metals in OHF soil, concrete, and paint chip samples

Sample Type	Outdoor Soil Samples					Subfloor Soil Samples			RCRA toxicity characteristic equivalent limit for solids[a]
Location ID	74.SB001	74.SB002	74.SB003	74.SB004	74.SB005	74.SB006	74.SB008	74.SB010	
Sample ID	04453	04556	04557	04555	04558	04452	04559	04554	
Arsenic	3.8	<3.9	4.2J	3J	<5.7	3J	2.7J	1.7	100
Barium	84.4	69.1	88.3	88.4	129	36.7	86.2	66.3	2,000
Cadmium	<0.4	0.45	0.54	0.77	0.38	<0.22	<0.4	<0.24	20
Chromium	24.6	31.3	41.2	35.4	34.1	<5.6	37.9	28.9	100
Lead	14.8J	17.2	27.7	17.3	16.1	6.3J	32.5	9.4J	100
Mercury	<0.06	<0.06	0.10	0.11	0.08	<0.05	0.09	<0.06	4
Selenium	<0.36	<0.37R	<0.37R	<0.34R	<0.33R	<0.29R	<0.37R	<0.051	20
Silver	2.6	3.3	3.2	2.8	3.0	<0.71	3.9	2.2	100

Sample Type	Concrete Core Samples from Floor Slabs						Paint Chips	RCRA toxicity characteristic equivalent limit for solids[a]
Location ID	74.SB006	74.SB007	74.SB008	74.SB009	74.SB010	74.SB011	74.BINSPC	
Sample ID	04450	04550	04553	04552	04471	04551	04597	
Arsenic	2.8J	<1.9	1.3J	1.3	<3.3	3.4	2.2J	100
Barium	70.6	105J	57.3	66.1	74.1	264	39.4J	2000
Cadmium	<0.22	<0.21	<0.29	<0.21	<0.22	<0.2	2.8J	20
Chromium	<5.6	<10.6	7.9	8.0	<8.2	6.7	1,240J	100
Lead	5.4J	<5	5	5.0	28.2	6.9	1,270	100
Mercury	<0.05	<0.05	0.08	<0.05	0.09	0.58J	0.09	4
Selenium	<0.28R	<0.44	<0.42	<0.44	<0.29R	<0.42	<0.36	20
Silver	<0.73	<0.63	<0.71	<0.63	<0.73	<0.6	<0.68	100

[a] The RCRA-equivalent limits are derived from values in 40 CFR 261.24; the maximum concentration of contaminants for the toxicity characteristic, listed by EPA in 40 CFR 261.24 in units of mg/L, was multiplied by a factor of 20 to obtain equivalent limits for solids in units of mg/kg.
Note: Shaded values indicate that the total metal content is greater than RCRA toxicity characteristic equivalent limits.

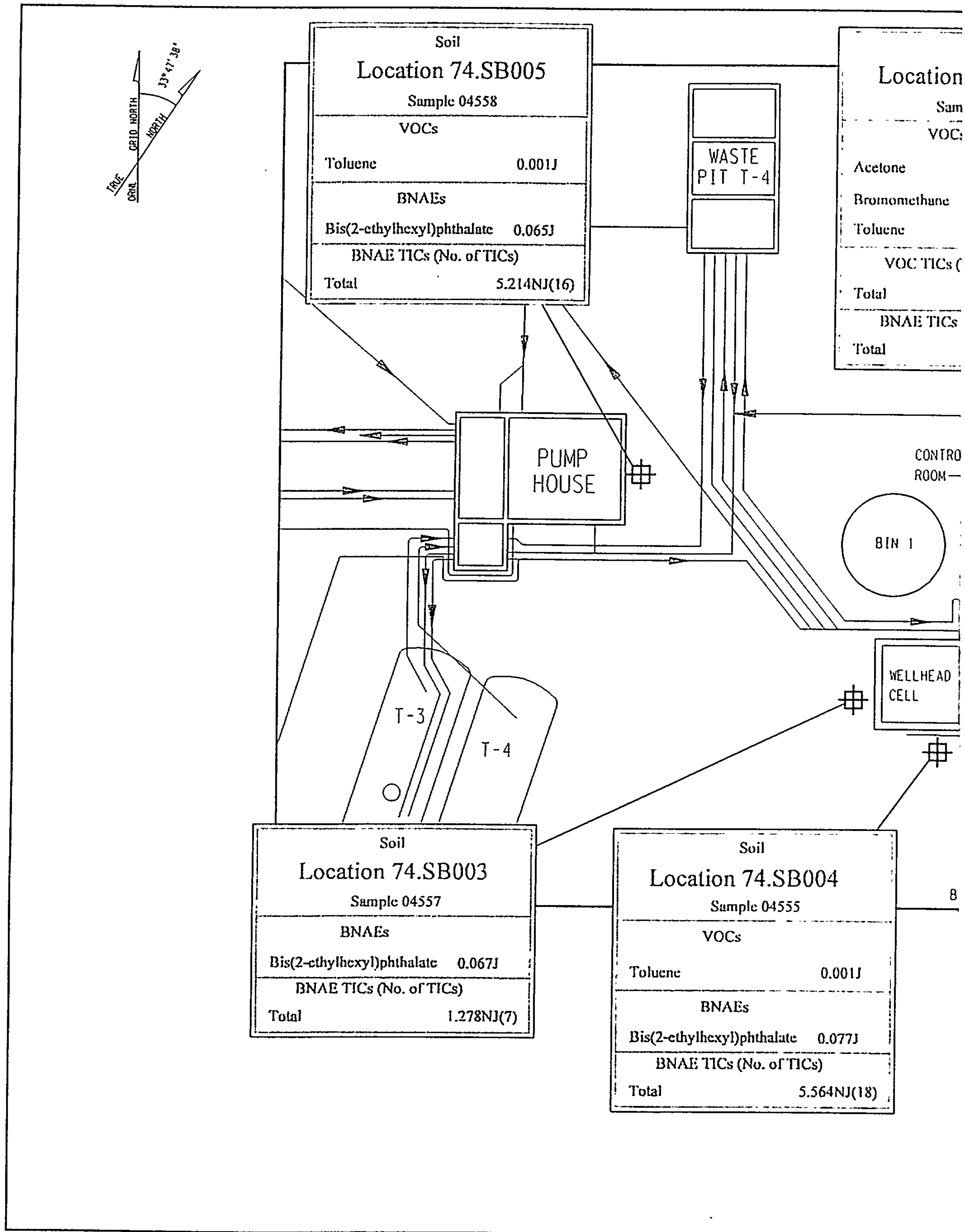
Table 4.3. Comparison of inorganic results for soils with reference values

Inorganics	OHF Soil Samples			Reference Soil Samples[a]	
	Fraction of locations with detects	Maximum concentration (mg/kg)	Location of maximum detected concentration	Fraction of locations with detects	Maximum concentration (mg/kg)
Aluminum	8/8	37,500	74.SB004	36/36	44,300
Antimony	0/1	<2.9	ND	3/36	1.4J
Arsenic	6/8	4.2J	74.SB003	34/36	20.2
Barium	8/8	129	74.SB005	36/36	212
Beryllium	7/8	1.5	74.SB005	36/36	2.2
Cadmium	4/8	0.77	74.SB004	0/36	<0.19
Calcium	7/8	326,000	74.SB006	24/36	2,110
Chromium	7/8	41.2	74.SB003	36/36	57.3
Cobalt	7/8	21.1	74.SB005	36/36	37
Copper	2/8	73.6	74.SB001	36/36	38.9J
Cyanide	0/8	<0.65	ND	10/35	0.63J
Iron	8/8	41,800	74.SB003	36/36	52,000J
Lead	8/8	32.5	74.SB008	35/35	48.2
Magnesium	8/8	16,100	74.SB006	36/36	7,430
Manganese	8/8	1,050	74.SB005	36/36	2,420
Mercury	4/8	0.11	74.SB004	12/36	0.34
Nickel	8/8	34	74.SB005	36/36	56.7
Potassium	8/8	3,990	74.SB004	36/36	5,890
Selenium	0/2	<0.51	74.SB010	14/36	1.2
Silver	7/8	3.9	74.SB008	0/36	<2.8
Sodium	5/8	120	74.SB008	0/3	<301
Thallium	0/8	<0.54	ND	8/36	0.79
Vanadium	7/8	44.2	74.SB003	36/36	60.1
Zinc	2/8	62.1	74.SB001	36/36	108

ND indicates not detected; a location is not indicated because the inorganic analyte was not detected.

Note: Shaded values indicate that the maximum OHF soil sample concentration is greater than the maximum reference concentration.

[a]Reference values obtained from Bechtel (1994b).



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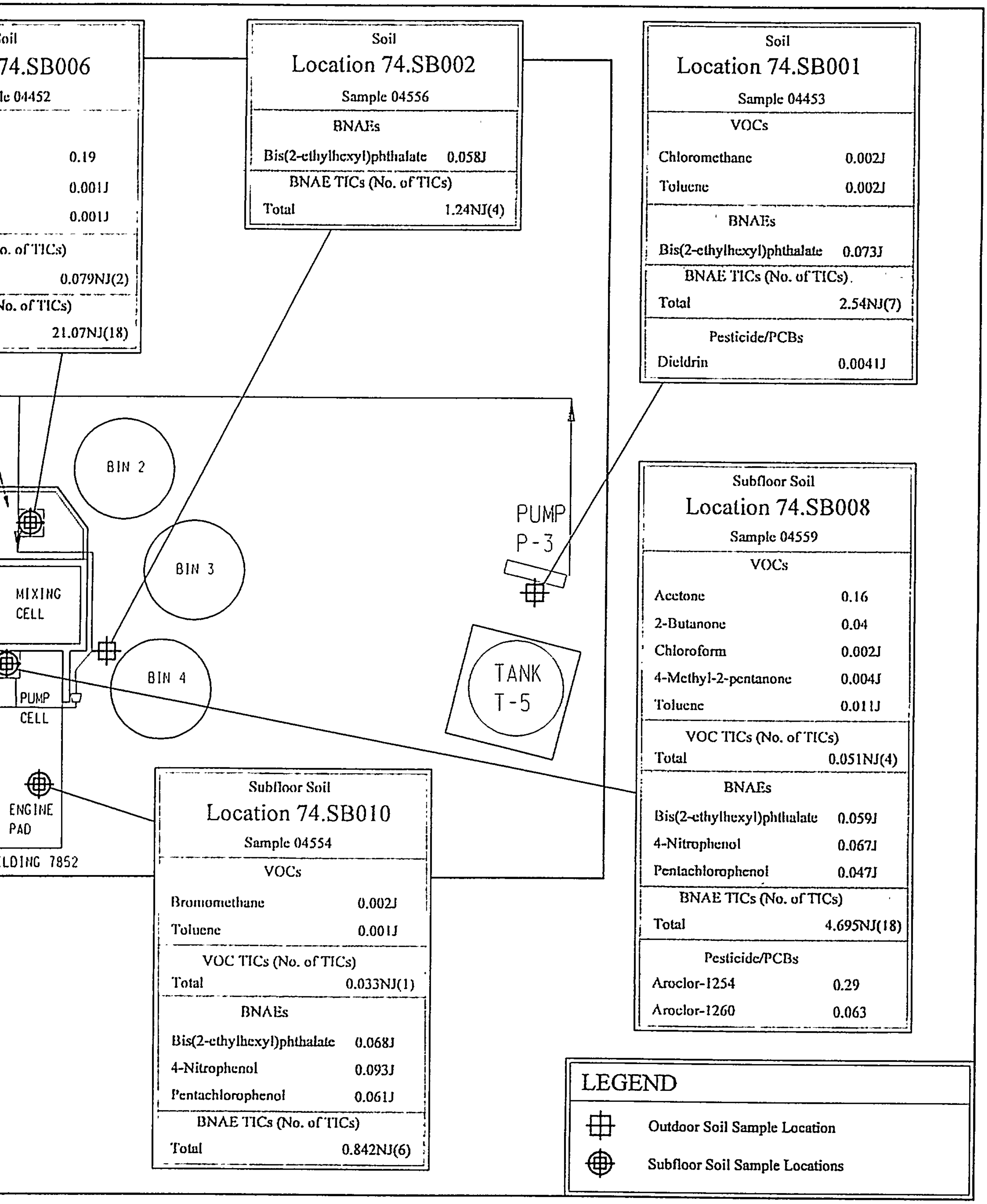
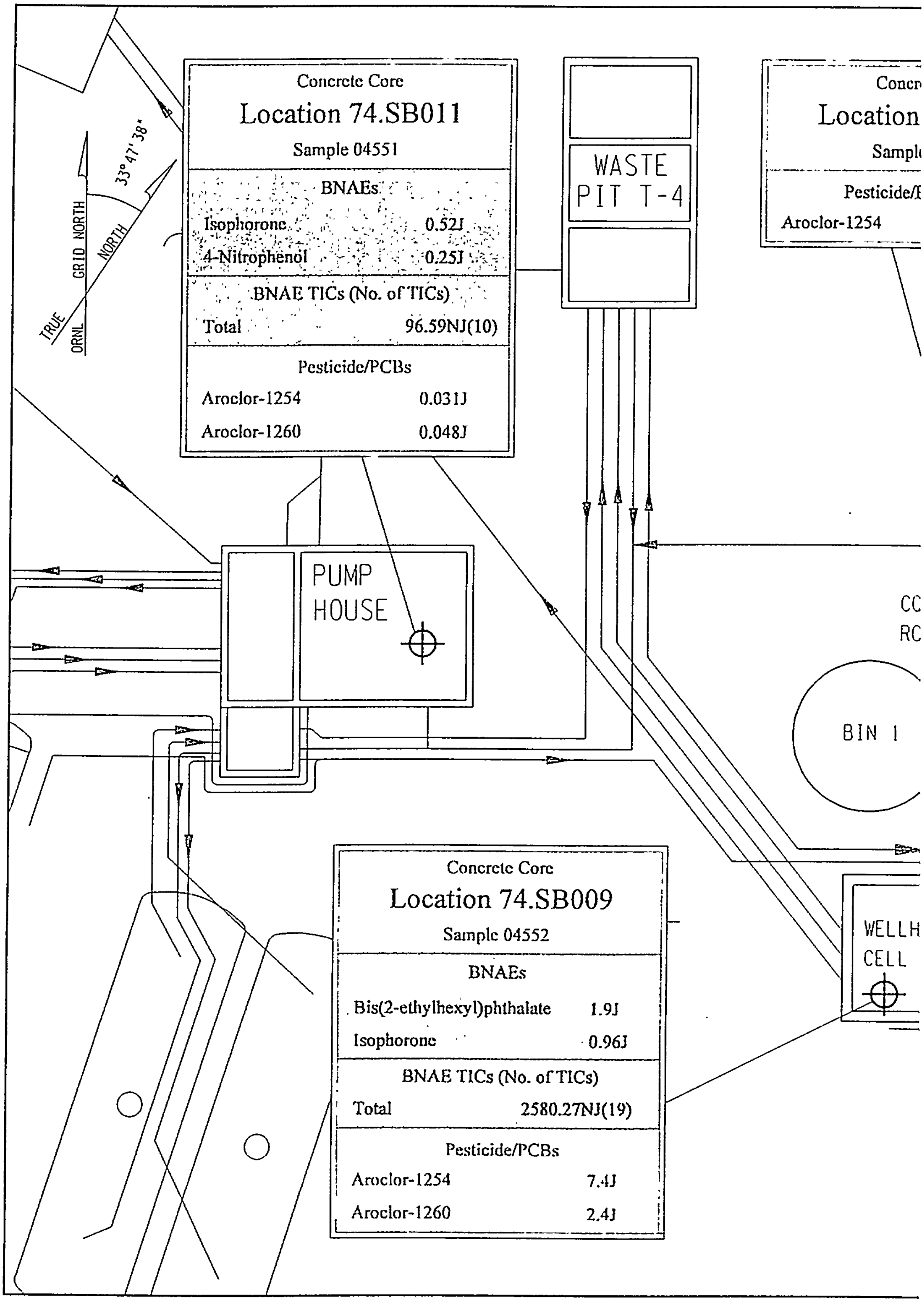


Fig. 4.1. Organic compounds detected in outdoor and subfloor soil sampling locations at OHF.



Concrete Core
Location 74.SB011
Sample 04551
BNAEs
Isophorone 0.52J
4-Nitrophenol 0.25J
BNAE TICs (No. of TICs)
Total 96.59NJ(10)
Pesticide/PCBs
Aroclor-1254 0.031J
Aroclor-1260 0.048J
WASTE PIT T-4
Concr
Location
Sampl
Pesticide/I
Aroclor-1254
33°47'38"
GRID NORTH
TRUE NORTH
ORNL
PUMP HOUSE
CC
RC
BIN 1
WELLH
CELL
Concrete Core
Location 74.SB009
Sample 04552
BNAEs
Bis(2-ethylhexyl)phthalate 1.9J
Isophorone 0.96J
BNAE TICs (No. of TICs)
Total 2580.27NJ(19)
Pesticide/PCBs
Aroclor-1254 7.4J
Aroclor-1260 2.4J

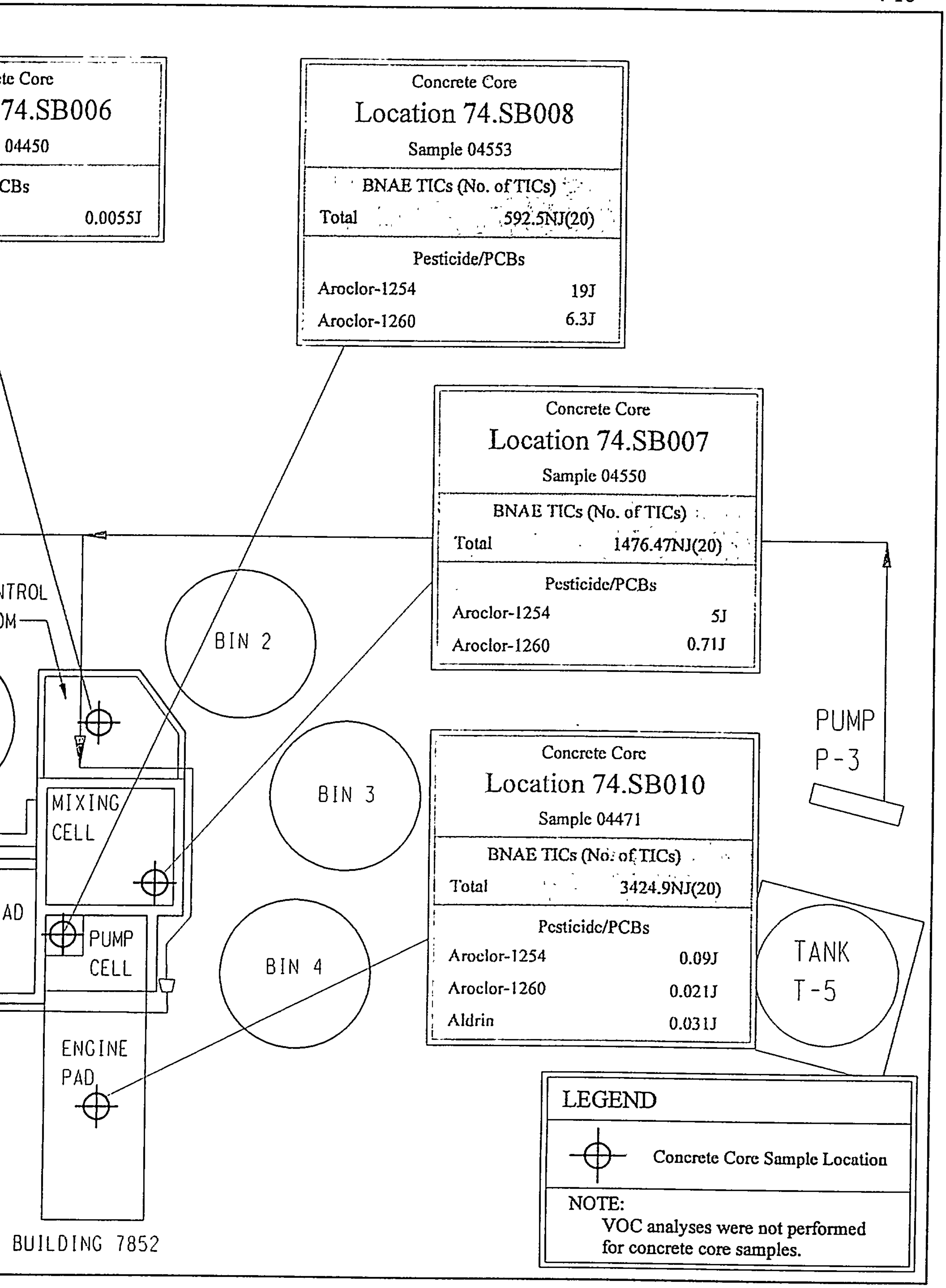


Fig. 4.2. Organic compounds detected in concrete cores taken from floors of Building 7852 and the pump house.

5. RADIOLOGICAL SAMPLING AND ANALYSIS

5.1 DATA PRESENTATION

Radiological data for liquid samples (e.g., rinsate or water blanks) are presented in units of picocurie activity of a radioisotope per liter of liquid (pCi/L). Data for solid samples (e.g., soil, concrete, or sediment) are presented in units of picocurie activity of a radioisotope per gram of solids (pCi/g) on a dry weight basis.

On occasion, the concentration of a radionuclide is reported as a "less than" value (e.g., <2 pCi/g). This indicates that the radionuclide was not detected at or above its measurement method detection limit, referred to as minimum detection limit (MDL) (in this case, 2 pCi/g).

The radiological results presented for the regular samples were qualified by the ASL and the project as part of the validation process. The ASL prepared the blanks, spikes, and duplicates and qualified the blanks. The qualifiers (flags) for the regular samples were applied by RI/FS Project validators according to project procedures, taking the results of regular samples, blanks, spikes, and duplicates into consideration. The qualifiers present the following information.

J: The detected numerical value is an estimated quantity.

U: The radionuclide was not detected; the MDL value is reported.

UJ: The MDL numerical value is an estimated quantity.

R: Indicates that the data are unusable (e.g., calibration data are wrong or resampling and/or reanalysis is necessary for verification; the MDL is reported.)

- (or blank): No problems requiring the qualification of results.

ASL analyses included gross alpha; gross beta; gamma spectroscopy; total radioactive strontium; and plutonium, thorium, and uranium isotopics. Table 5.1 presents analytical methods, and Table 3.1 provides location number, sample number, sample type and description, and types of analyses performed for each sample collected by the Bechtel Team. Tables 5.2, 5.3, and 5.4 provide results of the radiological analyses for concrete core, soil, and miscellaneous samples, respectively. Median radionuclide concentrations from WAG 5 reference soil sample results (Bechtel 1994b) are listed in Table 5.3 for comparison of current study soil and reference soil sampling radionuclide concentrations. Appendix F presents detailed results of radiological analyses.

5.2 DATA USABILITY ASSESSMENT

Radiological analyses were performed at the IT and TMA laboratories in Oak Ridge, Tennessee, and the IT laboratory in Richland, Washington. The preparation and quantitative measurements of samples for radionuclide analysis followed the ASL's standard operating procedures, which are equivalent to the methods stipulated in Table 5.1. Documentation provided by the laboratories met RI/FS Project QC level III requirements, as described in Sect. 4. Validation of the data packages met RI/FS Project QC level II requirements; analytical results were reviewed in accordance with RI/FS validation procedures for radiological data (Project Procedure 1503.2), but the raw data were not checked by the validator to the same degree that they would have been checked in a QC level III validation protocol. Deficiencies and uncertainties observed in the results follow.

- All of the thorium isotopic results for the concrete core from the engine pad (location 74.SB010, sample 04471) were flagged R because tracer recovery was low (<20%).

5.3 ANALYTICAL RESULTS

One QC equipment rinsate, one tank water (grabbed from tank T-5), two grout (grabbed from the mixing cell and pump cell), six concrete core, and eight soil samples were sent off site for radiological analysis. The concrete cores were crushed before they were shipped to the ASL, where they were ground to a homogenized powder and analyzed to determine radionuclide concentrations. Soil samples were also composited and mixed before radiological analysis. In addition, one composite paint chip sample collected from exterior surfaces of the storage bins was analyzed at the CSL.

5.3.1 Concrete Cores (Interior)

Six concrete cores were collected from the floor slabs in the control room, pump cell, mixing cell, wellhead cell, engine pad, and pump house.

All concrete cores indicated low levels (<6 pCi/g) of alpha emitting isotopes except cores obtained at locations 74.SB008 and 74.SB009 (25 to 87 pCi/g) (see Fig. 3.1 and Table 5.2). The major gamma emitting isotope is cesium-137, at concentrations of approximately 1000 to 9400 pCi/g in all but the control room core (74.SB006), which was much lower (2.38 pCi/g). Strontium-90 was detected in all areas except the control room; the highest concentration was in the pump cell (1440 pCi/g).

5.3.2 Soil Samples (Interior and Exterior)

Eight soil samples were collected during the characterization—five from outside (see Fig. 3.2) within 5 ft of the structures, and three from under the concrete floor slabs (control room, pump cell, and engine pad) (see Fig. 3.1). No soil samples were collected from the mixing cell, wellhead cell, or pump house because of difficulties encountered during hand augering (see Table 3.1).

All soil sample results indicated low levels (<2 pCi/g) of alpha emitters (see Table 5.3). Samples collected from 74.SB002, 74.SB004, and 74.SB008 (see Figs. 3.1 and 3.2) had cesium-137 concentrations of approximately 73, 6440, and 335 pCi/g, respectively. Most samples exhibited low concentrations of strontium-90 (<8 pCi/g); concentrations in samples from 74.SB004, 74.SB005, and 74.SB008 were higher (two of these locations are the same as those exhibiting higher cesium-137 concentrations). All soil sample results indicate that the primary gamma emitter in soil is cesium-137/barium-137m.

5.3.3 QC Equipment Rinsate (Sample 04451)

An equipment rinsate sample from the core drill equipment was treated in the same way as a regular sample and analyzed for the parameters listed in Table 5.1. Except for thorium-230, which was detected in very small quantities (approximately 0.25 pCi/L) (see Table 5.4), concentrations of all the radionuclides analyzed for were less than or equal to their MDLs.

5.3.4 Miscellaneous Grab/Composite Samples

Four miscellaneous samples were collected during site characterization—two grab grout samples from the mixing and pump cells, one grab water sample from tank T-5, and one composite paint chip sample from the storage bins. Table 5.4 lists the results for these samples.

Grab samples of grout were collected from the mixing cell floor (74.7852MC, sample 04583; see Figs. 2.11a and 2.11d) and the pump cell pipe (74.7852PC, sample 04582; see Fig. 2.13a). The activity levels of these samples were high, and very small aliquots were used for the analyses; therefore, most results are flagged as J (estimated values). Some of the high activity levels reported could be due to the high dilution factor used.

Gross alpha and beta activities in pump cell grout were 5740 and 2.70E+6 pCi/g. Plutonium isotopes ranged from 124 to 236 pCi/g. The thorium-228, -230, and -232 results were approximately 13.8, 3.8, and 3.13 pCi/g. The uranium-234, -235, and -238 results were 805 pCi/g, MDL (see Table 5.4), and 4.12 pCi/g. The cesium-137 and strontium-90 concentrations were approximately 1.70E+6 and 1.21E+6 pCi/g, and cobalt-60 was detected at approximately 3.11E+3 pCi/g.

Gross alpha and beta activities in mixing cell grout were 1140 and 1.18E+6 pCi/g. Most uranium results were less than or equal to their MDLs (see Table 5.4); an exception was uranium-234, detected at 88.5 pCi/g. All thorium isotopes were <3.7 pCi/g, and plutonium isotopes ranged from 14 to 35 pCi/g. Cesium-137 and strontium-90 concentrations were approximately 1.13E+6 and 7.4E+4 pCi/g, and cobalt-60 was detected at approximately 5.16E+2 pCi/g.

The water sample from tank T-5 contained some uranium isotopics (36 pCi/g total) and tritium (15,000 pCi/L). ORNL ARARs (applicable or relevant and appropriate requirements) include no specific limits for uranium in water samples, but there is a limit of 20,000 pCi/L for tritium (see Appendix H).

A composite sample of paint chips from the storage bins (74.BINSPC, sample 04597) was screened at the Close Support Laboratory (CSL) for gross alpha and beta/gamma, tritium, and carbon-14; no ASL radiological analyses were performed. Gross alpha and beta activities were 1.2E-5 and 3.0E-4 μCi/g, and carbon-14 and tritium results were 3.1E-6 and 6.2E-6 μCi/g.

5.4 SUMMARY

By far the highest radiological contaminant concentrations were found in grout samples. Concentrations of alpha emitters analyzed for ranged from 1.2 pCi/g to hundreds of picocuries per gram. Very high levels of cesium-137, strontium-90, and cobalt-60 were also detected in these samples (on the order of 1.0E+8, 1.0E+5, and 1.0E+3 pCi/g, respectively).

Contaminant concentrations in concrete cores were generally higher than those in soil samples, except for the exterior soil sample from south of the wellhead cell.

Concrete cores from the control room, mixing cell, and engine pad exhibited similar low levels of alpha activity (all the alpha emitters analyzed for were at concentrations <2 pCi/g), but alpha activity was higher in the pump and wellhead cells. Except for uranium isotopes (higher by approximately a factor of three), results for the pump house alpha emitters were similar to those of the control room. The control room core cesium-137 concentration was low (approximately 2.4 pCi/g); cesium-137 was approximately three to four orders of magnitude higher in the cores from the mixing cell (927 pCi/g), pump cell (3793 pCi/g), wellhead cell (9390 pCi/g), engine pad (1116 pCi/g), and pump house (6366 pCi/g). Strontium-90 concentrations in the cores follow a trend similar to that of cesium-137, except that strontium-90 was higher in the pump cell (1440 pCi/g) than in the wellhead cell (1240 pCi/g). Strontium-90 concentrations in cores from the control room, mixing cell, engine pad, and pump house were 0.24, 58.6, 2.3, and 617.0 pCi/g, respectively.

Soil samples exhibited very low concentrations of alpha emitting radionuclides (all <2 pCi/g); there was no significant difference between interior and exterior sample results. Cesium-137 concentrations ranged from approximately 2 to 6440 pCi/g; the highest was in the exterior sample from south of the wellhead cell (location 74.SB004, sample 04555), followed by 335 pCi/g in the interior sample from the pump cell (location 74.SB008, sample 04559). Strontium-90 concentrations in soil follow the same trend as cesium-137; the highest (467 pCi/g) was in the exterior sample from south of the wellhead cell, followed by 248 pCi/g in the interior sample from the pump cell.

Water in tank T-5 is fairly clean; except for tritium at 15,000 pCi/L, which is below ORNL ARAR and SDWA limits, no significant levels of radionuclides were detected.

Curium was not detected in any sample, and americium-241 was detected only in pump cell core sample 04553 at a concentration of 2.71 pCi/g. Cobalt-60 was detected in concrete cores from the mixing cell (04550), pump cell (04553), and pump house (04551); the pump cell interior soil sample (04559); and grout samples from the mixing cell (04583) and pump cell (04582). The maximum concentration detected was 33.27 pCi/g.

Figures 5.1 and 5.2 show the sample locations and present tables indicating total alpha isotopics and cesium-137/barium 137m and strontium-90/yttrium-90 concentrations.

The concentrations of alpha emitting radionuclides in soil samples from OHF D&D areas are generally similar to those in WAG 5 reference soil samples. Exceptions are cesium-137 and strontium-90, with concentrations that are consistently higher than reference samples.

Table 5.1. Analytical methods

Parameter	Analytical Technique	Method Number[a]	Detection Limit[b] (solids, liquids)
Gross alpha	Gas flow proportional counting	USEPA 900.0	1 pCi/g, 1 pCi/L
Gross beta	Gas flow proportional counting	USEPA 900.0	2 pCi/g, 4 pCi/L
Gamma spectroscopy	Gamma spectroscopy	USEPA 600/901.1	0.2 pCi/g Cs-137, 20 pCi/L Cs-137
Total radioactive strontium	Radiochemical separation followed by gas flow proportional counting	USEPA 600/905	0.5 pCi/g, 5 pCi/L
Plutonium isotopics (^{238}Pu, $^{239/240}$Pu)	Radiochemical separation followed by alpha spectroscopy	EML Pu-02	0.6 pCi/g, 1 pCi/L
Thorium isotopics (^{228}Th, ^{230}Th, ^{232}Th)	Radiochemical separation followed by alpha spectroscopy	LANL ER200	0.6 pCi/g, 1 pCi/L
Uranium isotopics (^{232}U, $^{233/234}$U, ^{235}U, ^{238}U)	Radiochemical separation followed by alpha spectroscopy	EML U-02	0.6 pCi/g, 1 pCi/L

Sources: Bechtel National, "Technical Specification for Analytical Laboratory Services," Specification 19118-99-SP-03, Rev. 4, 1993; EPA, *Index to EPA Test Methods*, EPA 901/3-88-001; EPA, *Contract Laboratory Program Statements of Work for Organics and Inorganics Analysis*, Documents OLM01.8 and ILM02.1, 1991; DOE, *EML Procedures Manual*, HASL-300, 1992; and LANL, *Health and Environmental Chemistry: Analytical Techniques, Data Management, and Quality Assurance Manual*, LA-10300M/UC907, 1986.

[a] Abbreviations are: EML—Environmental Measurements Laboratory; LANL—Los Alamos National Laboratory; CLP—Contract Laboratory Program; and SOW—Statement of Work.

[b] Detection limits for radiological parameters are expressed as "detection limit goals."

Table 5.2. Radiological analysis results for concrete cores

Sample ID / Location ID	04450 Concrete 74.SB006 Control room			04550 Concrete 74.SB007 Mixing cell			04553 Concrete 74.SB008 Pump cell			04552 Concrete 74.SB009 Wellhead cell			04471 Concrete 74.SB010 Engine pad			04551 Concrete 74.SB011 Pump house		
	Concentration (pCi/g)	Uncertainty (±)	Review qualifier /MDL	Concentration (pCi/g)	Uncertainty (±)	Review qualifier /MDL	Concentration (pCi/g)	Uncertainty (±)	Review qualifier /MDL	Concentration (pCi/g)	Uncertainty (±)	Review qualifier /MDL	Concentration (pCi/g)	Uncertainty (±)	Review qualifier /MDL	Concentration (pCi/g)	Uncertainty (±)	Review qualifier /MDL
Gross Alpha	0.46	7.20	U/3.50	20.80	7.30	-	194.30	5.40	-	77	19	-	-15.80	6.00	U/3.50	9.70	4.50	-
^{241}Am							2.71	1.57	-									
$^{239/240}$Pu	0.00	0.00	UJ/0.19	0.22	0.22	U/0.26	3.05	1.03	-	0.141	0.063	-	0.00	0.00	U/0.12	-0.01	0.02	U/0.23
^{238}Pu	0.84	0.51	J	0.47	0.31	-	5.78	1.69	-	0.332	0.109	-	0.08	0.12	U/0.20	0.09	0.15	U/0.23
^{228}Th	0.17	0.16	-	0.28	0.20	J	1.20	0.42	-	0.320	0.113	-	0.00	0.00	R/0.41	0.38	0.27	-
^{230}Th	1.12	0.50	-	1.15	0.44	-	1.10	0.51	-	0.557	0.164	-	0.43	0.58	R/0.71	1.20	0.52	J
^{232}Th	0.20	0.17	-	0.53	0.28	-	0.46	0.23	-	0.255	0.095	J	0.00	0.00	R/0.41	0.47	0.29	-
$^{233/234}$U	0.92	0.36	-	1.56	0.63	-	26.13	5.81	-	12.0	2.6	-	0.67	0.28	-	2.20	0.89	-
^{235}U	0.08	0.08	UJ/0.05	-0.01	0.01	U/0.16	0.06	0.06	U/0.07	1.29	0.35	-	0.00	0.00	U/0.05	0.10	0.12	UJ/0.09
^{238}U	1.25	0.44	J	1.88	0.72	-	0.70	0.25	-	86.4	18.5	-	1.88	0.58	-	5.20	1.90	J
Gross Beta	11.00	5.20	-	1150.40	29.60	-	10720.30	91.40	-	7680	1540	-	568.90	21.60	-	6670.20	67.80	-
^{137}Cs	2.38	0.10	-	927.80	3.50	-	3793.00	5.00	-	9390	1040	J	1116	2.00	-	6366.00	5.30	-
^{40}K	3.20	0.54	-				10.24	2.34	-				11.80	1.00	-			
^{152}Eu							23.70	1.81	-									
^{154}Eu							15.72	2.06	-									
^{90}Sr	0.24	0.85	U/0.55	58.60	2.33	-	1440.00	14.40	J	1240	127	-	2.31	1.20	J	617.00	10.20	-
^{60}Co				1.36	0.13	-	33.27	0.50	-							3.60	0.18	-
^{3}H	1.49	0.92	-	0.42	1.39	U/0.67	0.40	0.85	U/0.45	0.917	0.098	-	0.18	0.76	U/0.39	1.11	0.70	-

Notes: (1) Blank spaces indicate that no detects were reported by the ASL.

(2) Most of the concrete aggregate is composed of sandstone with the following natural background concentrations*:
radium-226, 0.71 pCi/g;
uranium-228, 0.4 pCi/g;
thorium-232, 0.65 pCi/g; and
potassium-40, 8.8 pCi/g.

**Source*: Eisenbud, M. 1987. *Environmental Radioactivity from Natural, Industrial, and Military Sources*, Academic Press, Inc., 3rd edition.

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Table 5.3. Radiological analysis results for soil samples

Sample ID Location ID	WAG 5 Reference	04453 Exterior Soil 74.SB001			04556 Exterior Soil 74.SB002			04557 Exterior Soil 74.SB003			04555 Exterior Soil 74.SB004		
	Soil sample median[a] (pCi/g)	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL
Gross Alpha		14.1	5.8	-	10.5	5.3	-	9.60	5.05	-	28.9	9.3	-
$^{239/240}Pu$	.023	0.0155	0.0221	U/0.021	0.0279	0.0434	U/0.078	0.0214	0.0330	U/0.056	0.0826	0.0537	-
^{238}Pu	0.46	0.0774	0.0515	-	0.0296	0.0369	U/.055	0.0659	0.0533	-	0.139	0.074	-
^{228}Th	1.05	1.73	0.5	-	1.92	0.55	-	1.81	0.56	-	1.94	0.50	-
^{230}Th	0.801	1.34	0.41	-	1.19	0.38	-	1.13	0.40	-	0.978	0.290	-
^{232}Th	1.10	1.35	0.41	-	1.65	0.49	J	1.44	0.48	-	1.57	0.42	-
$^{233/234}U$	0.865	0.872	0.225	-	0.819	0.221	-	1.15	0.29	-	1.33	0.32	-
^{235}U	0.042	0.0292	0.0321	U/0.047	0.0476	0.0374	-	0.0677	0.0461	-	0.0368	0.0321	-
^{238}U	0.89	0.990	0.25	-	1.03	0.27	-	1.04	0.26	-	0.829	0.213	-
Gross Beta		30.7	7.8	-	88.6	18.8	-	37.7	9.1	-	7730	1550	-
^{137}Cs	0.027	1.83	0.27	J	72.6	10.3	J	7.80	1.12	J	6440	910	J
^{40}K	21	21.9	3.2	J	22.6	3.3	J	20.5	3.0	J	22.6	3.3	J
^{226}Ra	0.84	0.648	0.062	J	0.61	0.09	J	0.683	0.07	J	0.606	0.088	J
^{228}Ra		1.14	0.13	J	1.38	0.18	J	1.35	0.15	J	1.38	0.18	J
^{152}Eu								0.213	0.120	UJ/0.33			
^{154}Eu													
^{90}Sr	0.75	0.794	0.273	-	6.32	0.74	-	7.38	0.84	-	467	51	-
^{60}Co					0.06	0.03	UJ/.06				0.056	0.029	UJ/0.057
^{3}H		0.611	0.078	-	0.466	0.067	-	0.151	0.047	-	0.206	0.039	-

Table 5.3 (continued)

Sample ID	WAG 5 Reference	04558 Exterior Soil			04452 Subfloor Soil (Control room)			04559 Subfloor Soil (Pump cell)			04554 Subfloor Soil (Engine pad)		
Location ID		74.SB005			74.SB006			74.SB008			74.SB010		
	Soil sample median[a] (pCi/g)	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL
Gross Alpha		11.3	5.5	-	5.50	8.57	UJ/3.90	15.8	6.2	-	9.20	4.61	-
$^{239/240}Pu$	.023	0.0522	0.0457	-	0.14	0.22	UJ/0.35	0.0979	0.0625	-	0.0161	0.0230	U/0.022
^{238}Pu	.046	0.0898	0.0575	-	1.50	0.74	J	0.320	0.126	-	0.0161	0.0230	U/0.022
^{228}Th	1.05	1.53	0.44	-	1.22	0.46	-	1.45	0.40	-	1.46	0.42	-
^{230}Th	0.801	1.39	0.41	-	1.08	0.41	-	1.18	0.33	-	1.56	0.44	-
^{232}Th	1.10	1.60	0.46	-	0.91	0.37	-	1.68	0.45	-	1.80	0.49	-
$^{233/234}U$	0.865	0.924	0.239	-	1.17	0.42	-	1.85	0.44	-	0.792	0.210	-
^{235}U	0.042	0.0472	0.0349	-	0.11	0.11	U/0.12	0.0621	0.0434	-	0.0122	0.0174	U/0.017
^{238}U	0.89	0.964	0.248	-	1.44	0.48	-	0.924	0.242	-	0.815	0.214	-
Gross Beta		175	36	-	51.90	8.70	-	696	140	-	31.7	7.7	-
^{137}Cs	0.027	32.3	4.6	J	22.50	0.34	-	335	38	J	2.35	0.35	J
^{40}K	21	21.0	3.0	J	22.7	1.32	-	20.4	2.6	J	24.1	3.5	J
^{226}Ra	0.84	0.671	0.078	J				0.604	0.132	J	0.628	0.063	J
^{228}Ra		1.16	0.15	J	1.50	0.22	-	1.36	0.23	J	1.33	0.14	J
^{152}Eu								1.10	0.23	J			
^{154}Eu								0.557	0.159	J			
^{90}Sr	0.75	65.7	6.6	-	5.07	1.32	J	248	25	-	0.539	0.255	0.39
^{60}Co		0.034	0.029	UJ/0.04				2.23	0.20	J			
^{3}H		0.150	0.035	-	-0.28	0.83	U/0.45	1.06	0.13	-	0.547	0.072	0.060

[a] All radionuclide median concentrations of reference samples are based on the hit (detected) results.

Note: Blank spaces indicate that no detects were reported by the ASL.

Source: Bechtel 1994b. "Reference Sampling for the Remedial Investigation of WAG 5," 05-TB-034.

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Table 5.4. Radiological analysis results for QC and miscellaneous samples

Sample ID Location ID	04451 QC Rinsate 74.SB010			04582 Grout (Pump cell) 74.7852PC			04583 Grout (Mixing cell) 74.7852MC			03739 Tank T-5 (Liquid) 74.SW001G		
	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL	Concen-tration (pCi/g)	Uncer-tainty (±)	Review qualifier /MDL
Gross Alpha	0.711	0.538	U/3.50	5740	808	J	1140	374	J	25.7	6.13	-
$^{239/240}Pu$	0.0040	0.0231		124	18.4	J	14.1	11.3	J	0	0.0277	U/0.025
^{238}Pu	0.0198	0.0284		236	29.2	J	35	17.4	J	0	0.0277	U/0.025
^{228}Th	0.0115	0.0573		13.8	5.63	-	1.17	4.21	-	0.00247	0.0284	U/0.0849
^{230}Th	0.238	0.111J		3.80	2.71	-	1.81	3.62	-	0	0.035	U/0.035
^{232}Th	0.0173	0.3272		3.13	2.56	-	3.62	5.12	-	0	0.035	U/0.035
$^{233/234}U$	0.0548	0.0705		805	82.4	J	88.5	31.9	J	33.4	3.81	-
^{235}U	0.0323	0.0462		2.34	2.60	UJ/3.24	-31.7	7.32	UJ/13.6	0.654	0.237	-
^{238}U	-0.0026	0.0343		4.12	4.00	J	-17.5	10.0	UJ/20.1	2.5	0.513	-
Gross Beta	1.56	0.71	-	2.70E+06	2.04E+05	J	1.18E+06	7.92E+04	J	6.91	2.21	-
^{137}Cs	<13		U/13	1.7E+06	1.7E+05	J	1.13E+06	1.13E+05	J	1.99	8.95	U/17.9
^{40}K				4.66E+02	4.8E+02	UJ/9.34E+02	5.7E+03	2.07E+03	J	173	129	U/313
^{90}Sr	0.663	0.415		1.21E+06	4.13E+05	J	7.38E+04	2.48E+04	J	0.43	0.377	UJ/0.923
^{60}Co				3.11E+03	3.7E+02	J	5.16E+02	2.17E+02	J	-1.57	9.39	U/18.8
^{3}H	-391	127UJ/								15800	1390	J

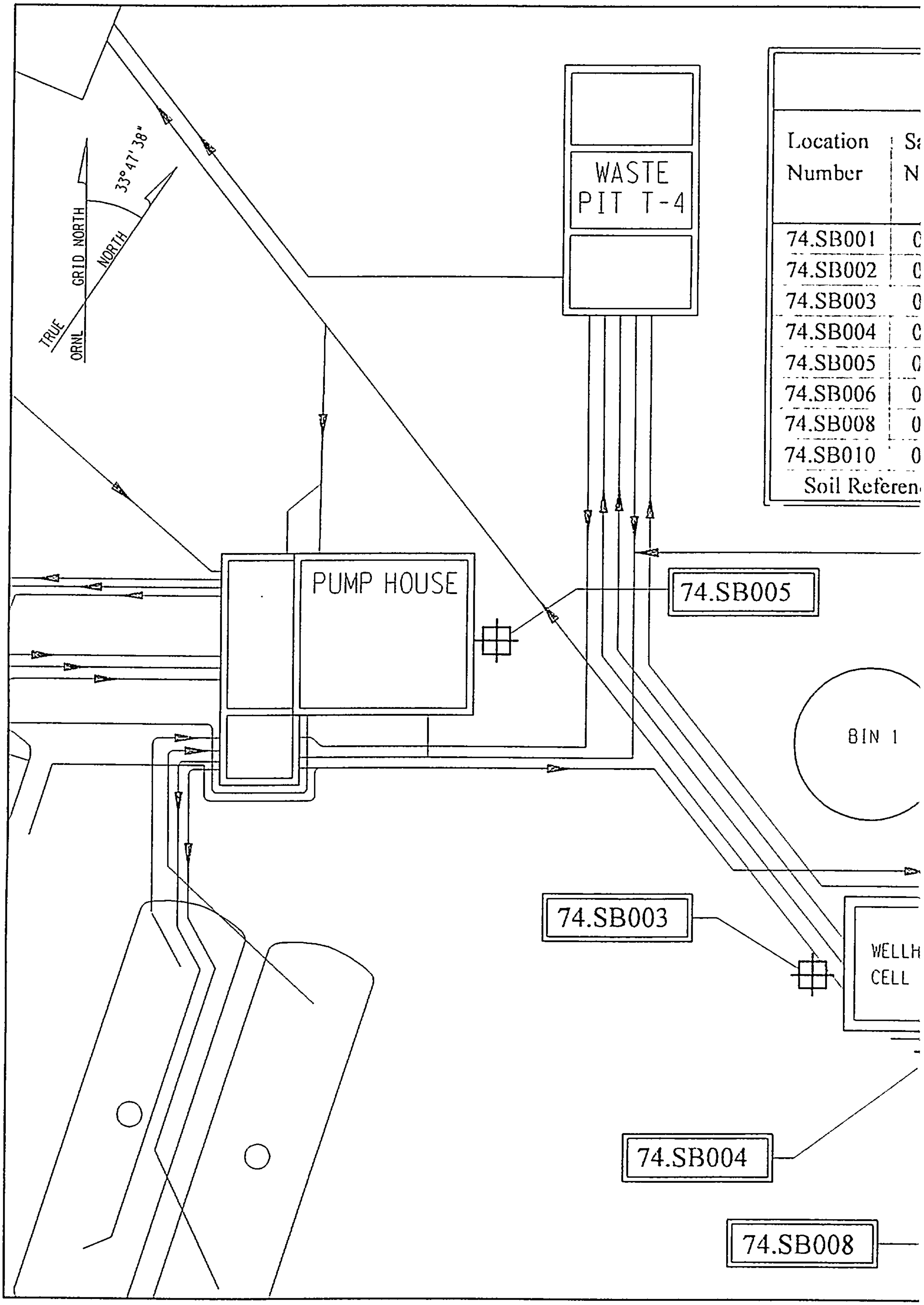
Notes:

(1) Most of the concrete aggregate is composed of sandstone with the following natural background concentrations*:
radium-226, 0.71 pCi/g;
uranium-228, 0.4 pCi/g;
thorium-232, 0.65 pCi/g; and
potassium-40, 8.8 pCi/g.

**Source*: Eisenbud, M. 1987. *Environmental Radioactivity from Natural, Industrial, and Military Sources*, Academic Press, Inc., 3rd edition.

(2) See Appendix G for ORNL ARARs for groundwater and surface water contamination.

(3) Blank spaces indicate that no detects were reported by the ASL.



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Results of Radiological Analyses for Soil Samples (pCi/g)

mple mber	Alpha Emitters				Beta Emitters			
	Ra (total)	Pu (total)	Th (total)	U (total)	Sr-90	Cs-137	Co-60	Eu (total)
4453	1.78	0.09	4.42	1.89	0.79	1.83	ND	ND
4456	1.99	< 0.13	4.76	1.90	6.32	72.6	ND	ND
4457	2.30	0.12	4.38	2.26	7.38	7.8	ND	ND
4555	1.99	0.22	4.49	2.20	467	6440	ND	ND
4558	1.83	0.14	4.52	1.90	65.7	32.3	ND	ND
4452	1.5	1.64	3.21	2.72	5.07	22.5	ND	ND
4559	1.96	0.42	4.31	2.84	248	335	2.23	1.66
4471	1.95	< 0.04	4.82	1.62	0.539	2.35	ND	ND
e	0.84	0.07	2.95	1.80	0.75	0.027	ND	ND

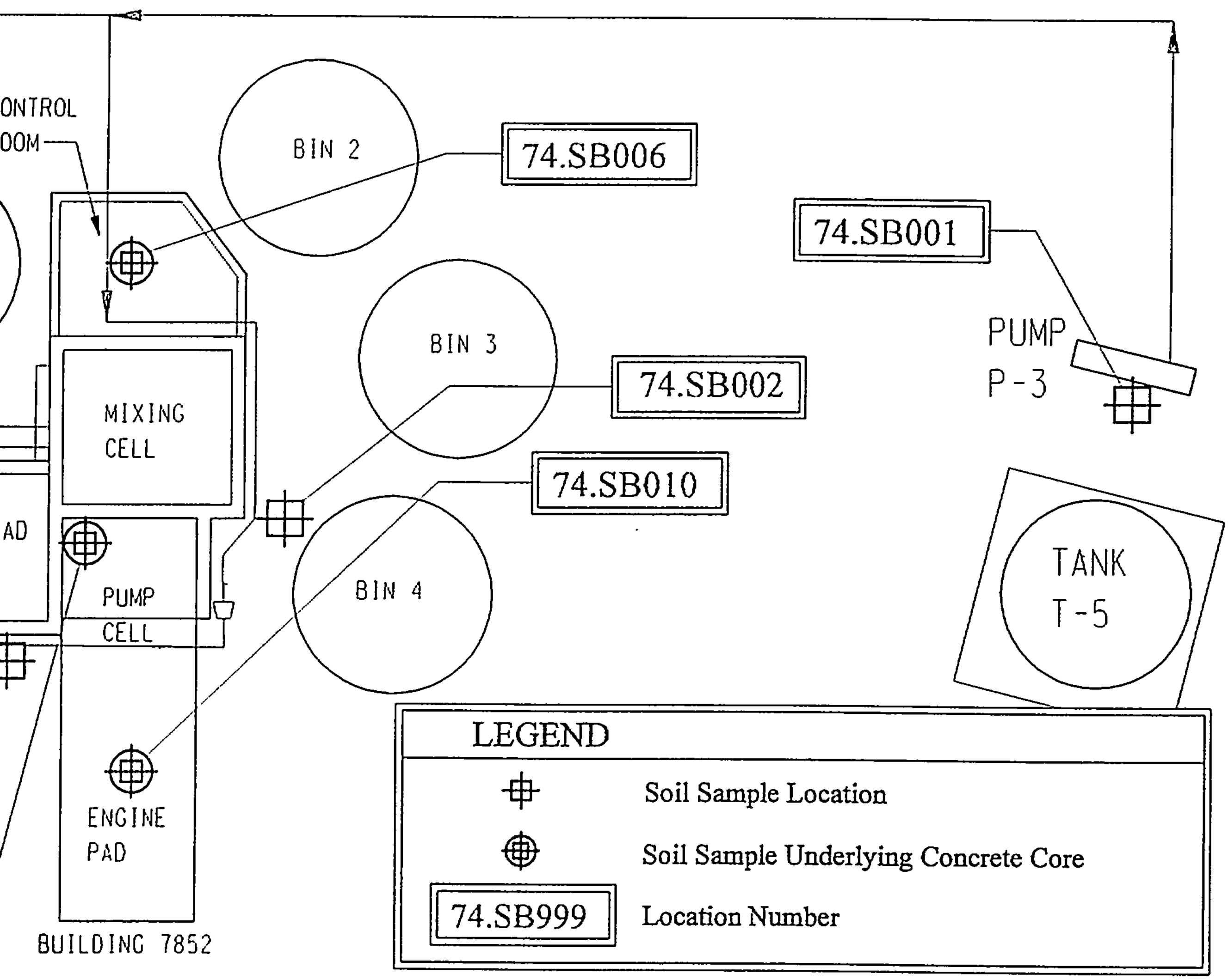
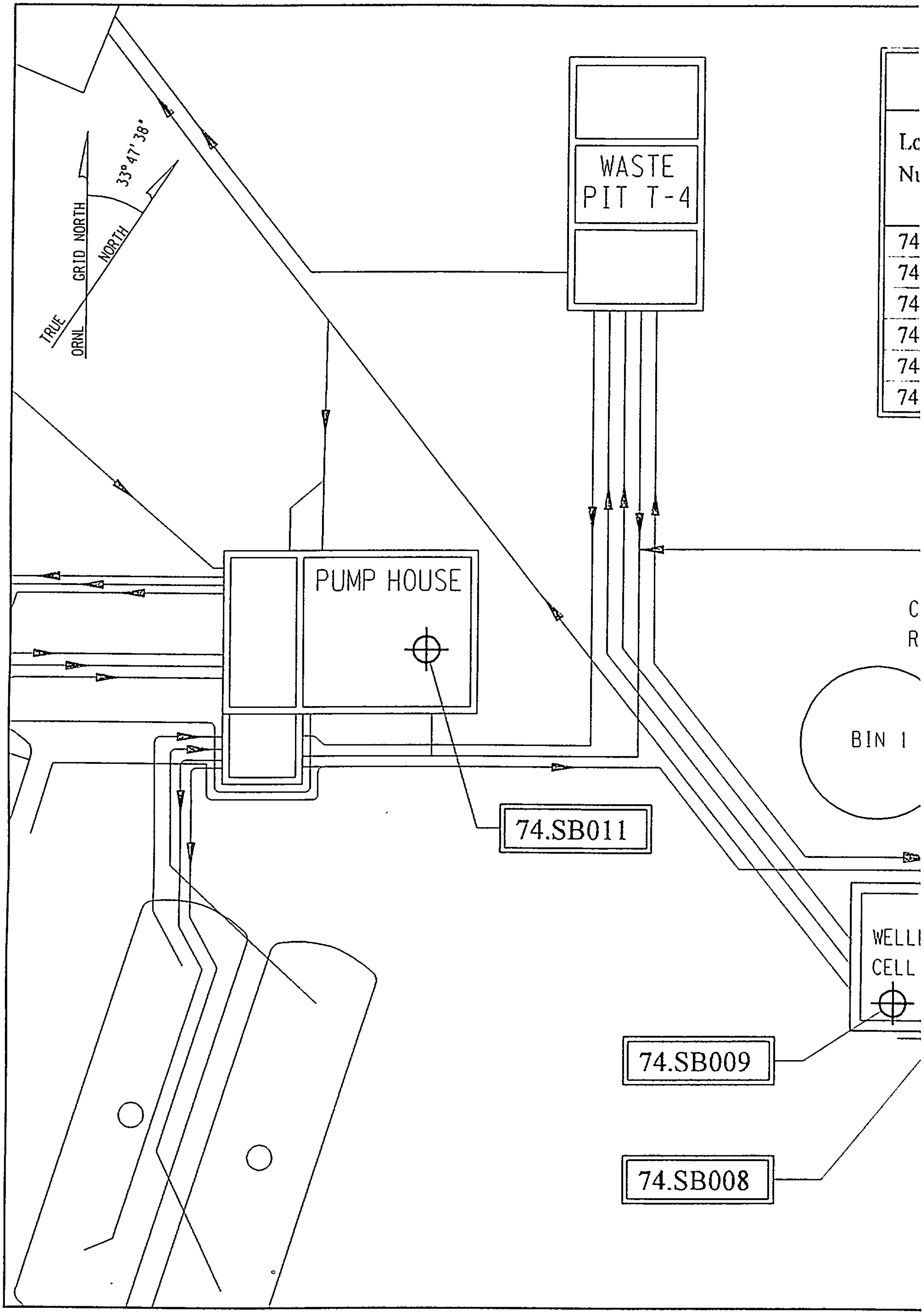


Fig. 5.1. Radionuclide concentrations found in and subfloor soil sampling locations at OHF.



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Results of Radiological Analyses for Concrete Core Samples (pCi/g)

ation mber	Sample Number	Alpha Emitters				Beta Emitters			
		Am-241	Pu (total)	Th (total)	U (total)	Sr-90	Cs-137	Co-60	Eu (total)
SB006	04450	ND	0.84	1.49	2.2	< 0.55	2.38	ND	ND
SB007	04450	ND	0.73	1.96	3.6	58.6	927.8	1.36	ND
SB008	04453	2.71	8.83	2.76	26.9	1440	3793	33.27	39.42
SB009	04552	ND	0.473	1.61	99.69	1240	9390	ND	ND
SB010	04471	ND	< 0.32	< 1.53	2.6	2.31	1116	ND	ND
SB011	04551	ND	< 0.46	2.05	7.5	617	6366	3.6	ND

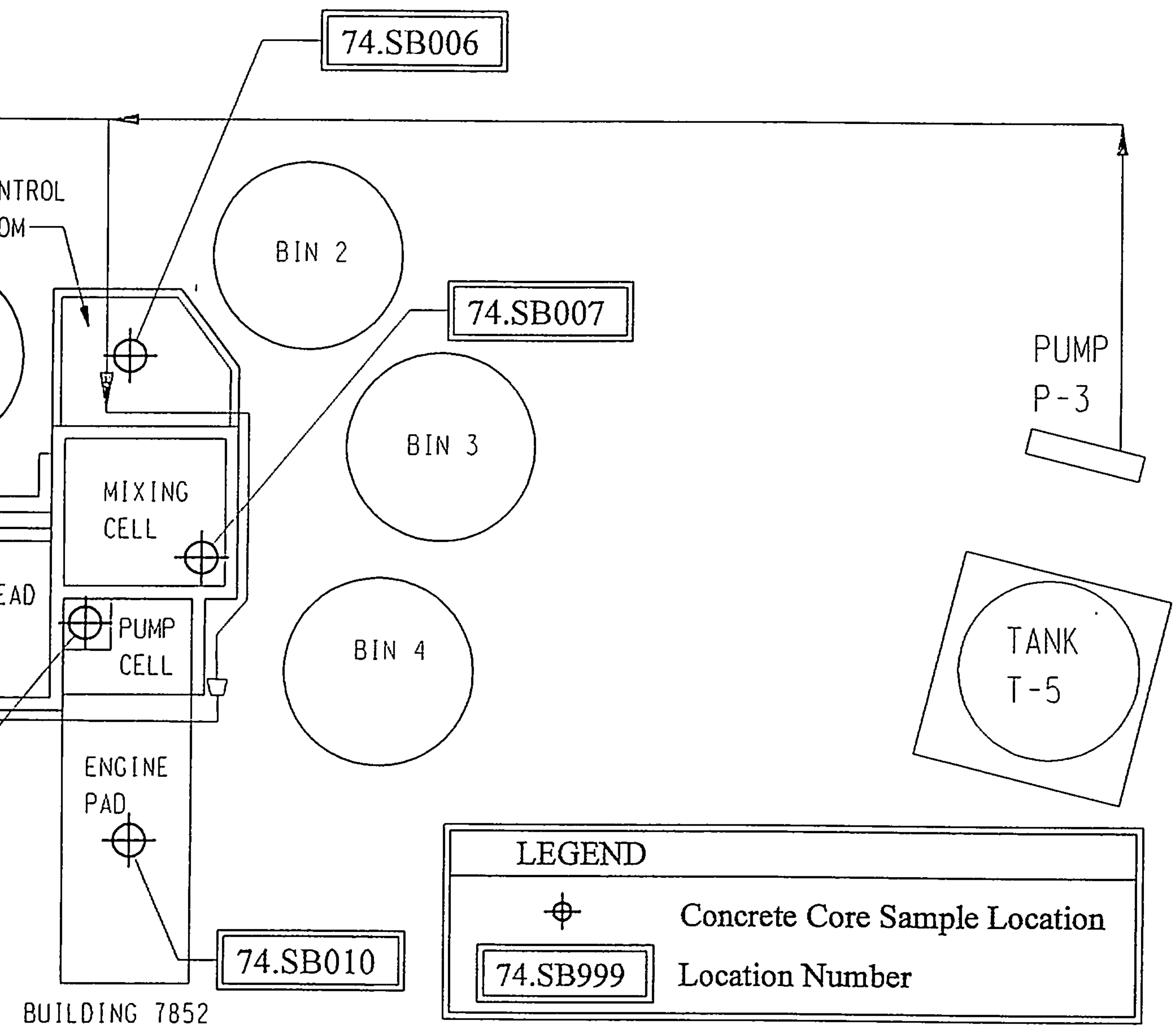

Fig. 5.2. Radionuclide concentrations found in concrete core sampling locations at OHF.

6. RADIOLOGICAL FIELD MEASUREMENTS

6.1 DATA PRESENTATION

As appropriate and depending on the instrument used, radiological data collected during field measurements are presented in counts per minute (cpm), disintegrations per minute (dpm), milliroentgen per hour (mR/h), or milliradiation absorbed dose per hour (mrad/h). Smear sample results are reported in microcuries per one hundred square centimeters (μCi/100 cm^2) or disintegrations per minute per one hundred square centimeters (dpm/100 cm^2). Modeling results are reported in nanocuries per cubic centimeter (nCi/cm^3), microcuries (μCi), or millicuries (mCi) as appropriate.

6.2 DATA USABILITY ASSESSMENT

The measuring scheme for the OHF D&D structures was "biased" (nonrandom) rather than "unbiased" (random or gridded). Biased measurements generally represent higher contamination than might exist overall at the site. Unbiased measurement is sometimes used to predict overall site characteristics or to provide representative estimates. However, a biased scheme was used for this site characterization to increase the chance of obtaining measurements and samples from the most heavily contaminated areas. In most cases, direct-reading instruments surveyed and identified "hotspots" that were used as measurement locations for the characterization. In addition, within the cells, locations were selected by observing anomalies such as stains, detritus, and traps. Biased measurements generally represent higher contamination than might exist overall at the site.

To ensure that the data collected are of known and acceptable quality, the survey instruments were calibrated at ORNL calibration facilities and were source-checked at the beginning and end of each day of use. The proper daily source checks and survey technique were accomplished by adhering to FWGs and procedures and by documenting this adherence in field logbooks, ES&H notebooks, and sample results. The daily source checks for an instrument were all performed in the same fixed geometry. These operational checks were an ongoing effort during the course of the characterization.

To ensure known and acceptable quality, the data were evaluated for precision, accuracy, representativeness, completeness, and comparability. The validation was an ongoing effort during the course of the characterization.

6.2.1 Precision

Precision is a measure of the mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is evaluated through the use of duplicate or replicate measures and is determined using the concept of "relative percent difference" (RPD).

During the characterization, each location was measured three times, results were recorded and documented on field measurement data sheets, and the RPD was determined randomly on approximately 10% of the locations. If the RPD were to fall outside a control limit of two times the standard deviation of measurements, the instrument would be removed from service and all data collected since the last acceptable RPD would be reviewed. No such situation was encountered during the D&D field activities. Precision analysis was not performed for smears because they were collected from each location only once.

6.2.2 Accuracy

Accuracy is the degree of agreement between the observed (measured) value and the true value. Each instrument was calibrated at the ORNL calibration facility in accordance with ORNL procedures, and changes in accuracy were monitored daily via source checks for an instrument in a fixed geometry. RI/FS Project procedures and appropriate field documents were followed to provide quality data for radiological analyses and counting at the CSL. During the D&D characterization survey, the field survey instruments were source-checked at the beginning and end of each day, when in use. Daily source checks were monitored ensure that the source checks fell within the 2σ value limit. The source checks were recorded and documented on field measurement data sheets. If the source check were to fall outside the 2σ limit, the instrument would be rechecked; if it were still outside the limit, the instrument would be removed from service and the data collected since the last acceptable source check would be reviewed. No such situation was encountered during the D&D field activities.

6.2.3 Representativeness

Representativeness expresses the degree to which the data represent the contaminants present in the area of interest. Therefore, representativeness is dependent on appropriate measurement and sampling techniques for the matrix and contaminants under study and on measurement and sampling locations that are typical of the area being surveyed.

Measurement and sampling techniques and the strategy for selecting locations are described in Sects. 4 through 6 of the site characterization plan (Bechtel 1994a). This investigation was conducted using biased sampling so that assumptions for D&D planning will be conservative. All sampling and measurements were performed in accordance with the site characterization plan (Bechtel 1994a) and FWGs. During the field investigation, QC checks were conducted by RI/FS Project QC personnel to ensure adherence to measurement techniques and documentation requirements. No deviations were reported.

6.2.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount specified by the characterization plan (Bechtel 1994a). For each data type, the data set was considered complete even if the actual number of field measurements was less than the planned number due to difficult access through the roof of the cells, ALARA considerations, or administrative dose limitations for field team members. The maximum number of planned location-specific measurements was 110; the number of locations actually selected was 87.

6.2.5 Comparability

Comparability expresses the confidence with which one data set may be compared to another. This includes two elements of the survey process: the measurement instruments and the techniques by which measurements and samples were obtained.

Comparability of data collected with different measurement instruments was ensured through the achievement of precision and accuracy. Comparability of survey techniques was accomplished by adhering to FWGs and procedures and by documenting this adherence in field logbooks, ES&H notebooks, and sample results.

Field measurements were performed in accordance with appropriate RI/FS Project procedures and FWGs to ensure the quality and consistency of the data collected. RI/FS QC personnel conducted QC checks to ensure adherence to procedures and documentation requirements. No deviations were reported. In addition, field measurements were taken three times at each location to ensure representative and reliable results, and field and laboratory results were compared when data were available. The average results of core scanning in the field were compared with lab results; field values were higher (they were all within one order of magnitude of the lab results), concentrations, which would be expected because of unfavorable geometry, higher background levels, and count time in the field.

6.3 FIELD MEASUREMENTS

The OHF D&D structures were divided into three main areas: Building 7852, the pump house, and tank T-5 and pump P-3; Building 7852 was further subdivided into six areas for this series of measurements (control room, mixing cell, pump cell, wellhead cell, engine pad, and bulk storage bins). Measurements in the rooms and cells and the pump house included gross alpha, gross beta/gamma, smears, directional gross gamma, and concrete core slit scanning with an HPGe gamma spectroscopy system. Sixty-seven 10-cm × 10-cm locations on the Building 7852 walls and floors and 22 on the pump house floor and walls were selected for measurements. Three gross beta/gamma and three gross alpha measurements were made and a smear was collected at each location; gross beta/gamma and gross alpha results were averaged and used as accepted values for this location. The smears were analyzed at the CSL for gross alpha, gross beta/gamma, and gamma spectroscopy (if gross beta/gamma >500 cpm); if gamma spectroscopy results did not account for the beta activity, some of the smears were also screened for strontium-90/yttrium-90.

6.3.1 Location-Specific Measurements

Building 7852 was divided into five areas for location-specific measurements (the storage bins were excluded). Table 6.1 presents summary results for the location-specific measurements. As expected, floors generally exhibited higher activities than walls. Alpha activities were higher in the mixing and pump cells than in the wellhead cell, and beta/gamma activities were higher in the mixing cell than those in the pump and wellhead cells. The control room and engine pad have similar alpha and beta/gamma activities (the engine pad is slightly higher). Alpha activities ranged widely (approximately 5.9E+1 to 3.0E+4 dpm/100 cm^2 for walls and 1.8E+2 to 4.2E+4 dpm/100 cm^2 for floors) and varied by orders of magnitude from one area to another. Beta/gamma field measurements behave similarly: measurements for walls and floors averaged approximately 9 to 45 mR/h and 5 to 197 mR/h. Detailed results (location by location) are tabulated in Appendix I; measurement locations are shown in Figs. 6.1 through 6.6.

The average background value measured for the field alpha counting system (an Eberline AC-3 probe) was approximately 13.9 dpm/100 cm^2. The average background values measured for the field beta/gamma counting system (an Eberline HP-270 probe) were approximately 9.5E-4 mrad/h and 9.3E-4 mR/h for open and closed window mode, respectively. Background measurements were performed at the instrument trailer at the RI/FS Field Operations Facility. (Note: background has *not* been subtracted from field measurement results presented in this section, but it has been subtracted from the CSL results for smears.)

The beta field contribution to the total radiation exposure field can be estimated by comparing closed and open window HP-270 results. When the window is closed, most beta particles are prevented from penetrating the active volume of the detector and subsequently being registered. Therefore, in the closed window mode, the detector is most sensitive to penetrating ionizing radiation such as gamma or X-rays. In the open window mode, the detector is sensitive to gamma rays, X-rays, and beta rays; thus the difference between the two modes can provide an indication of the relative strength of the beta and gamma fields. The HP-270 is an energy compensated Geiger-Mueller (G-M) tube with a 30 mg/cm^2 thick stainless steel wall, housed inside 1/16 in. ABS plastic. The plastic housing and stainless steel wall together are thick enough to prevent most of the strontium-90/yttrium-90 betas from entering the active area of the G-M tube. Open window readings were generally higher (10 to 30%) than closed window readings in these areas, indicating a slight elevation in the exposure fields due to beta activities.

In addition to HP-270 measurements, directional gross gamma measurements were conducted at some locations; results of location-specific directional measurements are presented in Appendix J. These measurements were made with a modified Eberline HP-220A [see Bechtel (1994a)] probe encased in approximately 1/4 in. of Plexiglas™. This probe is very insensitive to low exposure rates (fields <10 mR/h) and is not designed for low exposure field measurements. This probe has a 90° conical solid angle with a front-to-back ratio of 20 : 1 for the cesium-137/barium-137m gamma line (662 keV). These measurements at each location can be used in conjunction with HP-270 closed window (omnidirectional measurements) results to estimate the direction of the radiation fields generated at each location.

Loose contamination was compared with fixed surface contamination using the results of the location-specific measurements. Smear results represent loose surface contamination; fixed contamination is determined by subtracting the loose contamination values from the total surface contamination represented by the average direct (alpha or beta/gamma) readings.

A comparison of average direct alpha readings and alpha smear counting results, both of which are shown in units of dpm/100 cm^2 in Table 6.1, indicates that the alpha contamination is mostly fixed. Comparison of average direct beta/gamma readings and beta/gamma smear results is less straightforward using Table 6.1 because the units for the direct readings (mR/h for closed window) and the units for the smear results (μCi/100 cm^2) are different. The following steps were taken to convert the units for the smear results to mR/h.

(1) The principal contributor was assumed to be cesium-137/barium-137m (see Table 5.2).
(2) The cesium-137/barium-137m smear results for each wall and the floor were averaged (average values shown in Table 6.1).
(3) The Microshield gamma shielding code (Version 4, Grove Engineering 1992) was used to estimate exposure rates at 10 cm from surfaces (infinite plane model) based on the average cesium-137/barium-137m smear results.

Table 6.2 shows the Microshield results; comparison of these model results and the direct beta/gamma counting results (closed window at 10 cm) indicates that most of the surface contamination (i.e., cesium-137/barium-173m) is fixed.

The equipment (hopper and mixing tank) inside the mixing cell exhibited higher exposure rates and alpha activity. The mixing tank exposure rates on the average were 3.23E+2 mrad/h and 2.93E+2 mR/h; alpha activity was higher at the bottom than at the top and ranged from 3.51E+3 to 9.69E+3 dpm/100 cm^2. The hopper behaved similarly; exposure rates on the average were 1.75E+2 mrad/h and 1.62 mR/h, and alpha activity ranged from 5.75E+2 to 8.25E+2 dpm/100^2. The high exposure rate readings on the hopper could be caused by the closeness of the hopper to the mixing tank.

Measurements on the purge tank in the northeast corner of the wellhead cell and the pipe going to the tank also indicated higher exposure rates. Exposure rates at the middle of the tank were 1.19E+2 mrad/h and 9.52E+1 mR/h with alpha activity of 2.49E+4 dpm/100 cm^2. The pipe on top of the tank exhibited exposure rates of 1.94E+2 mrad/h and 1.72E+2 mR/h with an alpha activity of 5.75E+3 dpm/100 cm^2.

6.3.2 Smear Gamma Spectroscopy

CSL gamma spectroscopy analyses were performed on all smears with gross beta/gamma counts of >500 cpm (summarized in Table 6.1). Cesium-137 activity per smear for walls and floors averaged approximately 1.34E-4 to 1.03E-2 μCi/100 cm^2 and 8.05E-4 to 3.33E-2 μCi/100 cm^2. A few smears had very small amounts of cobalt-60 (approximately two to three orders of magnitude less than cesium-137/barium-137m). In addition, any smear with total beta activity that could not be accounted for by gamma spectroscopy was screened for strontium-90/yttrium-90; Table 6.3 presents the results.

6.3.3 Concrete Core Slit Scanning

Six concrete cores were obtained from floor pads (sample locations are shown in Fig. 3.1).

- One from the control room (location 74.SB006), approximately 8 in. long (see Fig. 6.7).

- One from the mixing cell (location 74.SB007; see Fig. 6.8). This core was retrieved in two sections, which indicates that the floor was made of two separate pours, as required by contamination control practices in use at the time. The top section was approximately 3 in. long and the bottom was approximately 6 in. Each piece was slit scanned separately. The top concrete layer covered the highly contaminated cell floor, stabilized the contamination, and provided shielding for gamma emitters.

- One from the pump cell (location 74.SB008), approximately 8 in. long (see Fig. 6.9). This core was also apparently two separate pours (a 1-in. top and 7-in. bottom). These two pieces were wrapped in aluminum foil and slit scanned as one whole piece.

- One from the wellhead cell (location 74.SB009), approximately 7.5 in. long (see Fig. 6.10).

- One from the engine pad (location 74.SB010), approximately 7 in. long (see Fig. 6.11).

- One from the pump house (location 74.SB011), approximately 4 in. long (see Fig 6.12).

A field HPGe gamma spectroscopy system set up in a tent at the RI/FS Project decontamination facility was used to slit scan (see Fig. 6.13) the entire length of each core before it was broken up and shipped to the ASL. The width of the slit was approximately 0.25 in. The distance between the control room and engine pad cores and the surface of the detector was approximately 4 in.; for the rest of the cores the distance was 8 in. (see Fig. 6.14, typical). The detector was shielded with lead and steel blocks on all sides to minimize the effects of local area background. Each 0.25-in. section was scanned for 4 min, and the core was rotated in place by 1/4 turn every minute to allow all quadrants to be exposed to the slit for an equal time and make the measurement results more uniform. Results indicate that the primary isotope present is cesium-137/barium-137m.

Each 0.25-in. section of core was modeled in a cylindrical geometry to estimate contaminant concentrations. The model cesium-137 concentration was assumed to be 1 $\mu Ci/cm^3$ and uniform within the field of view of the slit, and the core density was assumed to be 2.35 g/cm^3 (average concrete density). The cesium-137/barium-137m activity for each section was estimated by ratioing the field gamma spectroscopy measurement results to the model results, taking into account the detector's intrinsic efficiency (approximately 14% for a 662-keV gamma line of cesium-137/barium-137m) and the model curie loading of cesium-137. Background measurements performed at the decontamination facility showed a small amount of cesium in the counting area [approximately 4.5 counts in 4 min above the continuum in the region of interest (ROI)]. The slit scanning results provided relative information about contaminant penetration into the concrete.

Readings from all but one core indicated higher contamination levels near the floor surface (generally within 1 to 2 in.), then a rapid decrease to counting area background level, and a slight increase again near the bottom where the core contacts underlying soil. The increase in activity at the bottom of the cores is thought to be caused by contaminants present in underlying soil, either due to fallout or site contaminant migration. The exception is the top portion of the mixing cell core, which starts high, decreases to near background level, and then increases again by a factor of approximately 20 at the interface. The bottom portion of this core at the interface has an activity 20 times lower than the top portion. Slit scanning results are tabulated location by location in Appendix J and plotted in Figs. 6.15 through 6.20.

6.3.4 Bulk Storage Bins Measurements

ES&H survey measurements were performed on the outside surfaces of the storage bins, the supporting columns, and the inside lip of the manway on top of the bins to determine levels of radiological contaminants (including gross alpha, gross beta/gamma, exposure rates, and loose contamination). The results for all 172 smears were less than site release limits of 20 and 200 dpm/100 cm^2 for smearable alpha and beta/gamma contamination; and 300 and 1000 dpm/100 cm^2 for total (smearable and fixed) alpha and beta/gamma contamination. The results of these radiological ES&H surveys are presented in Appendix B.

6.3.5 Water Tank T-5 and Pump P-3 Measurements

Similar ES&H measurements were performed on the exterior surfaces of tank T-5 and pump P-3. The 31 tank T-5 smears indicated that no radiological contaminants exceeded the site release criteria, as did the 15 smears from exterior surfaces of pump P-3 except at 4 direct measurement locations with fixed contamination on the heavily oxidized surfaces. Beta/gamma contamination ranged from 3000 to 30,000 dpm/100 cm^2 (mean of 10,500). One location on the pump had alpha contamination at 200 dpm/100 cm^2. The contamination observed on the pump shaft, however, indicates that the pump might be internally contaminated; the pump should be monitored for contamination during D&D. ES&H survey results are presented in Appendix B.

6.3.6 Other Observations/Exposure Rate Model

The injection wellhead was modeled using Microshield Version 4.0 to predict exposure rates as a function of distance around the wellhead (assuming the injection wellhead is the only source of exposure in the cell after decontamination) based on field measurements (approximately 25 and 6.5 mR/h on the side of the wellhead for omnidirectional and directional measurements). Exposure rates from model and field measurements were matched at the measurement location for both exposure rates, and the model was used to predict exposure rates at various distances around the injection wellhead. The following approach was used to estimate exposure rates as a function of distance from the injection wellhead (using maximum gross gamma directional measurements with the modified HP-220A probe of 6.5 mR/h at 10 cm from the surface.

- Created a modeled source and geometry to represent that portion of the contaminated injection wellhead in the directional detector (HP-220A) field of view (approximately 20 in. long).

- Used Microshield Version 4.0 gamma shielding code to predict the exposure rate due to the modeled source at a distance of 10 in. where WHC-3 and WHC-4 were measured.

- Normalized the source strength of the modeled source to produce the same exposure rate as measured at WHC-3 and WHC-4. This was achieved by multiplying the source strength of the modeled source by the ratio of the measured-to-estimated exposure rates.

- Created a second modeled source to represent all of the injection wellhead (approximately 4 ft long).

- Then, estimated the exposure rates as a function of distance using this model and Microshield Version 4.0.

The following approach was used to estimate exposure rates as a function of distance from the injection wellhead (using the maximum gross gamma (closed window) omnidirectional measurements (HP-270) of 25.2 mR/h at 10 cm from the wellhead surface.

- Created a model source and geometry to represent the contaminated wellhead (approximately 4 ft long).

- Used Microshield Version 4.0 to predict the exposure rate due to the modeled source at a distance of 10 in. where WHC-3 and WHC-4 were measured.

- Normalized the source strength of the modeled source to produce the same exposure rates as measured at WHC-3 and WHC-4.

- Calculated the exposure rate as a function of distance from the injection wellhead by multiplying all the Microshield exposure rates by the ratio of the omnidirectional (WHC-4) exposure rate to the calculated exposure rate at 10 in. Results are tabulated in Table 6.4 and plotted in Fig. 6.21.

The exposure rate drops fairly quickly as distance from the injection wellhead increases and falls below 1 mR/h at approximately 4 ft and 7 ft (directional and omnidirectional model, respectively). In addition, ES&H personnel conducted a series of general area and initial site surveys, summarized in Sect. 6.3.7.

6.3.7 ES&H Survey Results (General Area)

- The general area exposure rate in the control room varies between 6 and 10 mrad/h close to the floor and 10 and 40 mrad/h at greater height, especially around the windows (see Appendix B). The increase at higher elevations near the glass windows between the control room and mixing cell (south wall) is possibly caused by the shine from the mixing cell.

- In the mixing cell, general area exposure rates range approximately from 35 to 100 mR/h and 45 to 100 mrad/h. Exposure rates are higher on the bottom of the mixing tank and the pipes used for transporting grout to the pump cell (120–160 mR/h and 270–400 mrad/h) and in the floor drain (150 mR/h and 300 mrad/h) (see Appendix B).

- The general area exposure rates in the pump cell range approximately from 20 to 50 mrad/h and 20 to 40 mR/h. However, contact exposure rates are high on the two grout pipes from the mixing cell (1000 mrad/h and 800 mR/h and 3000 mrad/h and 300 mR/h) and the pipe suspended from the ceiling (800 mrad/h and 120 mR/h) (see Appendix B).

- The wellhead cell general exposure rates range approximately from 13 to 120 mrad/h and 10 to 75 mR/h. Contact measurements at various locations on the injection wellhead range from 36 to 65 mrad/h and 16 to 24 mR/h. The highest contact exposure rate measured is on the pipe entering the tank in the northeast corner of the cell: 340 mrad/h and 300 mR/h (see Appendix B).

- General area exposure rates on the engine pad are lower than others, ranging from approximately 1.3 to 12 mR/h; no differences were observed between closed and open window measurements (see Appendix B). Some of the higher exposure rates measured on the engine pad near the pump cell may be caused by "shine" from the pump cell.

- General area exposure rates on the roof of Building 7852 range approximately from 1.8 to 19.0 mR/h in most locations. Near the blower on the roof of the control room, however, the general area exposure rate increases to 140 mR/h, and the contact exposure rate measurement is as high as 1200 mR/h at the inlet pipe on the south side of the blower (see Appendix B).

- The pump house general area exposure rates range from 3 to 50 mrad/h and 2 to 40 mR/h. A few areas on the pump pad under the lead shielding exhibit high exposure rates (maximum 2500 mrad/h and 1000 mR/h) approximately 6 in. from the floor (see Appendix B).

6.4 SUMMARY

The control room and engine pad exhibit low levels of contamination except for a few isolated locations; the cells and pump house have higher levels. The exteriors of the bulk storage bins, tank T-5, and pump P-3 seem to be clean except for a few locations on pump P-3. Open window readings were higher than closed window readings, indicating surface beta contamination. Most of the contamination in the OHF D&D areas surveyed was observed to be fixed on the surface. Concrete cores are contaminated, and the activity patterns look similar among the cores as a function of distance from the surface; most of the contamination was detected in the first 1 to 2 in.

In general, the OHF D&D areas are contaminated with cesium-137/barium-137m (major contaminant), strontium-90/yttrium-90, and some alpha emitters.

Table 6.1. Summary results of location-specific measurements at OHF D&D structures

	Control Room		Mixing Cell		Pump Cell		Wellhead Cell		Engine Pad	Pump House	
	Wall	Floor	Wall	Floor	Wall	Floor	Wall	Floor	Floor	Wall	Floor
Direct alpha counting[a] (dpm/100 cm²)											
Range	3.43E+1 - 9.54E+1	7.13E+1 - 5.00E+2	3.14E+2 - 2.43E+3	7.14E+2 - 8.9E+4	5.69E+2 - 5.22E+4	5.02E+3 - 7.74E+4	3.33E+2 - 2.89E+4	6.41E+3 - 2.01E+4	4.71E+1 - 5.53E+2	0.0E+0 - 1.47E+2	4.72E+1 - 4.17E+2
Average	5.87E+1	2.00E+2	1.25E+3	4.48E+4	2.96E+4	4.19E+4	5.90E+3	1.38E+4	1.85E+2	3.54E+1	2.08E+2
Direct beta/ gamma counting at 10 cm											
Open window (mrad/h)											
Range	1.47E+0 - 3.18E+1	4.41E+0 - 9.36E+0	6.86E+1 - 4.51E+2	2.88E+2 - 3.14E+2	1.51E+1 - 3.20E+1	5.03E+1 - 4.31E+2	1.56E+1 - 1.43+2	6.91E+1 - 2.73E+2	2.27E+0 - 1.51E+1	2.39E+0 - 2.25E+1	1.37E+0 - 4.36E+1
Average	9.46E+0	6.47E+0	1.94E+2	3.01E+2	2.06E+1	1.74E+2	5.62E+1	1.43E+2	9.1E+0	8.32E+0	1.74E+1
Closed window (mR/h)											
Range	1.11E+0 - 3.12E+0	3.82E+0 - 5.70E+0	6.07E+1 - 4.13E+2	1.89E+2 - 2.04E+2	1.09E+1 - 2.33E+1	1.48E+1 - 6.00E+1	1.25E+1 - 1.17E+2	4.66E+1 - 2.34E+2	1.63E+0 - 1.31E+1	1.96E+0 - 1.96E+1	1.07E+0 - 3.33E+1
Average	9.02E+0	4.94E+0	1.73E+2	1.97E+2	1.50E+1	2.98E+1	4.49E+1	1.10E+2	7.48E+0	7.19E+0	1.36E+1

Table 6.1 (continued)

	Control Room		Mixing Cell		Pump Cell		Wellhead Cell		Engine Pad	Pump House	
	Wall	Floor	Wall	Floor	Wall	Floor	Wall	Floor	Floor	Wall	Floor
Smear counting[b]											
Alpha (dpm/100 cm^2)											
Range	0.0E+0 - 2.54E+0	3.95E+0 - 4.76E+1	3.82E+0 - 4.84E+1	2.97E+2 - 1.4E+3	8.13E+0 - 1.12E+2	2.46E+1 - 3.17E+2	3.66E+0 - 3.42E+2	6.06E+1 - 1.31E+2	0.0E+0 - 6.97E+1	0.0E+0 - 1.52E+1	3.95E+0 - 2.16E+1
Average	8.86E-1	1.66E+1	2.15E+1	8.47E+2	4.86E+1	1.26E+2	5.64E+1	9.75E+1	1.65E+1	2.29E+0	9.47E+0
Beta/gamma (dpm/100 cm^2)											
Range	1.30E+1 - 1.61E+3	1.48E+3 - 4.25E+4	4.48E+2 - 2.38E+5	1.19E+5 - 2.26E+5	1.34E+3 - 2.42E+4	6.37E+3 - 5.73E+4	9.50E+2 - 8.33E+4	1.77E+4 - 3.66E+4	4.16E+2 - 7.92E+4	5.34E+1 - 1.39E+3	5.34E+3 - 7.24E+4
Average	4.09E+2	1.31E+4	5.24E+4	1.73E+5	1.01E+4	2.40E+4	1.50E+4	2.66E+4	1.95E+4	4.49E+2	1.93E+4
CSL cesium-137 smears[b] (μCi/100 cm^2)											
Range	6.51E-4 - 6.65E-4	3.07E-4 - 1.42E-3	1.39E-4 - 4.15E-2	4.75E-3 - 5.69E-2	5.47E-4 - 6.87E-3	2.29E-3 - 1.28E-2	2.9E-4 - 7.19E-3	4.74E-3 - 1.03E-2	2.93E-3 - 5.66E-2	1.05E-4 - 1.92E-4	1.79E-3 - 1.49E-2
Average	6.58E-4	8.05E-4	1.03E-2	3.33E-2	3.69E-3	5.86E-3	2.33E-3	7.43E-3	1.64E-2	1.34E-4	5.45E-3

[a]Background has not been subtracted from these measurements.
[b]All smears were counted at the CSL, and background has been subtracted.

Table 6.1 (continued)

Note: Detailed results are given in Appendix I.
Radiological contamination control levels of surfaces as recommended by U.S. DOE "Radiological Control Manual," June 1992, are:

	Category	Removable	Total (fixed plus removable)
I	^{nat}U, ^{235}U, ^{238}U, and associated decay products	1,000 dpm α/100 cm^2	5,000 dpm α/100 cm^2
II	Transuranics	20 dpm α/100 cm^2	500 dpm α/100 cm^2
III	^{nat}Th, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, ^{133}I	200 dpm α/100 cm^2	1,000 dpm α/100 cm^2
IV	Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and other noted above	1,000 dpm β-γ/100 cm^2	5,000 dpm β-γ/100 cm^2
V	Tritium organic compounds	1,000 dpm β-γ/100 cm^2	10,000 dpm β-γ/100 cm^2

Table 6.2. Model prediction and direct measurement average exposure rates at OHF D&D structures

Area	Smear Cesium-137 (μCi/100 cm^2)		Smear Exposure Rates (mR/h)		Direct (HP-270 Closed) Exposure Rates (mR/h)	
	Average Wall	Average Floor	Average Wall	Average Floor	Average Wall	Average Floor
Control Room	6.58E-4	8.05E-4	1.11E-3	1.43E-3	9.02E+0	4.94E+0
Mixing Cell	1.03E-2	3.33E-2	1.74E-2	5.63E-2	1.73E+2	1.97E+2
Pump Cell					1.50E+1	2.98E+1
Wellhead Cell	2.23E-3	7.43E-3	3.77E-3	1.25E-2	4.49E+1	1.10E+2
Engine Pad		1.64E-2		2.78E-2		7.48E+0
Pump House	1.34E-4	5.45E-3	2.26E-4	9.19E-3	7.19E+0	1.36E+1

Table 6.3. Strontium-90 analysis results for OHF D&D structures

Area	Location	^{90}Sr Activity ($\mu Ci/100\ cm^2$)
Mixing cell	OHF-MC-02	3.90E-04
West wall	OHF-MC-03	1.80E-04
	OHF-MC-04	8.40E-04
	OHF-MC-12	2.60E-04
North wall	OHF-MC-13	2.00E-04
	OHF-MC-14	3.40E-03
Floor	OHF-MC-09	2.10E-02
Upper tank	OHF-MC-05	3.20E-03
Lower tank	OHF-MC-06	7.30E-03
Upper hopper	OHF-MC-07	2.80E-04
Lower hopper	OHF-MC-08	3.40E-04
Pump cell		
East wall	OHF-PC-03	1.40E-03
	OHF-PC-04	
North wall	OHF-PC-06	2.50E-04
	OHF-PC-07	2.80E-04
	OHF-PC-08	5.10E-05
West wall	OHF-PC-09	2.10E-05
	OHF-PC-10	1.20E-03
Floor	OHF-PC-01	1.30E-04
	OHF-PC-02	2.60E-04
	OHF-PC-05	1.10E-04
	OHF-PC-11	4.30E-03
Wellhead cell		
South wall	OHF-WHC-01	2.50E-04
	OHF-WHC-02	8.90E-04
East wall	OHF-WHC-05	9.80E-05
	OHF-WHC-06	3.40E-04
	OHF-WHC-07	1.90E-04

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Table 6.3 (continued)

Area	Location	^{90}Sr Activity (μCi/100 cm^2)
Wellhead cell (continued)		
North wall	OHF-WHC-10	4.70E-03
	OHF-WHC-11	7.90E-04
	OHF-WHC-12	5.80E-04
West wall	OHF-WHC-13	2.50E-03
	OHF-WHC-14	8.90E-05
Floor	OHF-WHC-15	2.00E-03
	OHF-WHC-16	1.40E-03
	OHF-WHC-17	2.10E-04
Injection wellhead, south face	OHF-WHC-03	1.50E-04
Injection wellhead, north face	OHF-WHC-04	4.10E-05
Tank mid-south face	OHF-WHC-08	4.90E-04
Pump house		
West wall	OHF-PH-01	6.90E-06
East wall	OHF-PH-10	1.60E-04
West wall	OHF-PH-22	8.30E-06
Floor	OHF-PH-18	1.10E-04
Floor	OHF-PH-08	1.60E-05
Floor	OHF-PH-03	2.80E-04
Floor	OHF-PH-11	3.10E-05
Floor	OHF-PH-13	2.20E-06

Table 6.4. Model exposure rate prediction around the injection wellhead as a function of distance

	Exposure Rate (mR/h)	
Distance (ft)	Directional	Omnidirectional
0.3	7.70	25.20
1	3.99	13.05
2	1.95	6.39
3	1.12	3.68
4	0.72	2.36
5	0.50	1.63
6	0.36	1.19
7	0.28	0.90
8	0.22	0.71
9	0.17	0.57
10	0.14	0.47

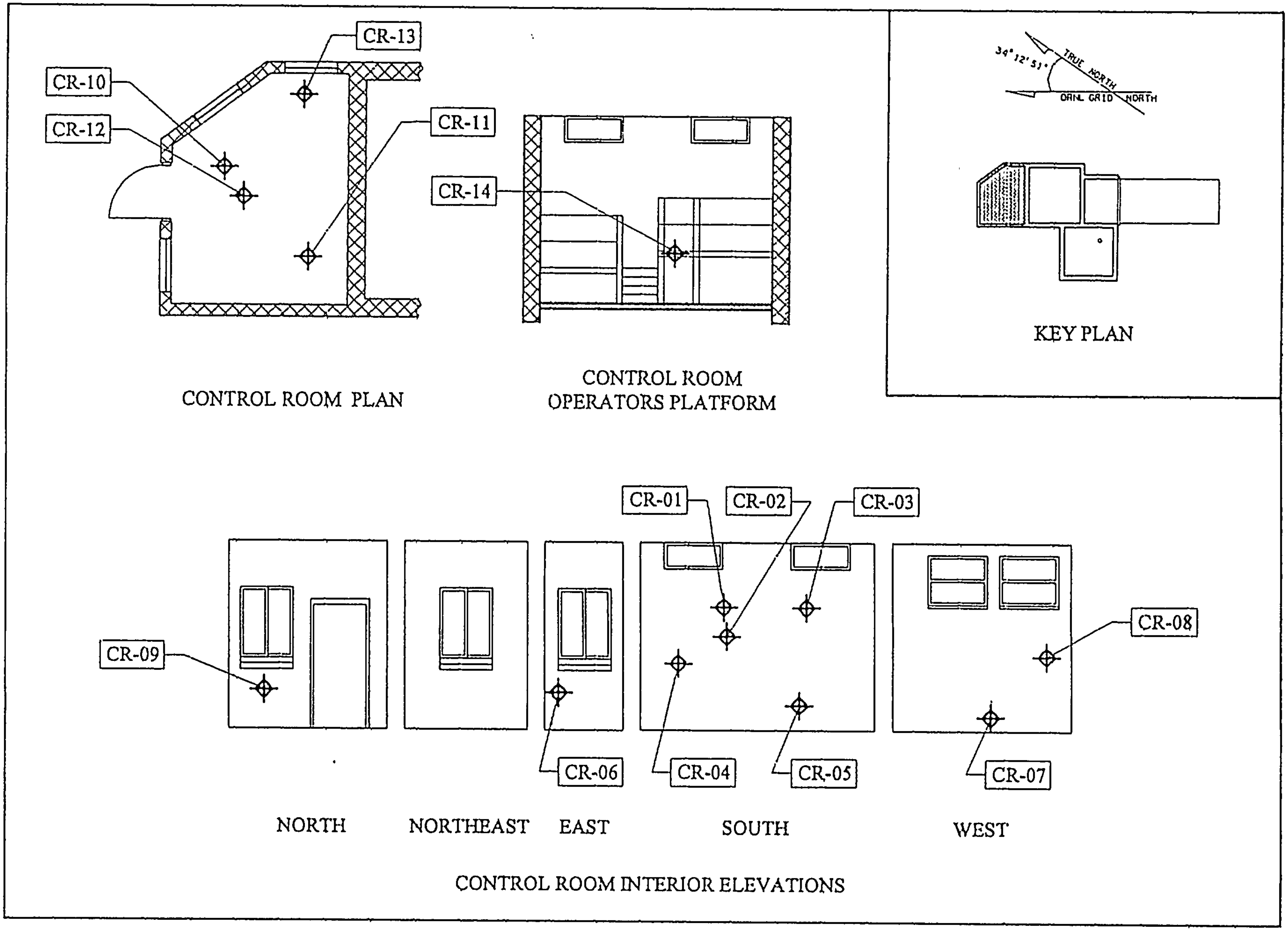

Fig. 6.1. Control room field measurement locations.

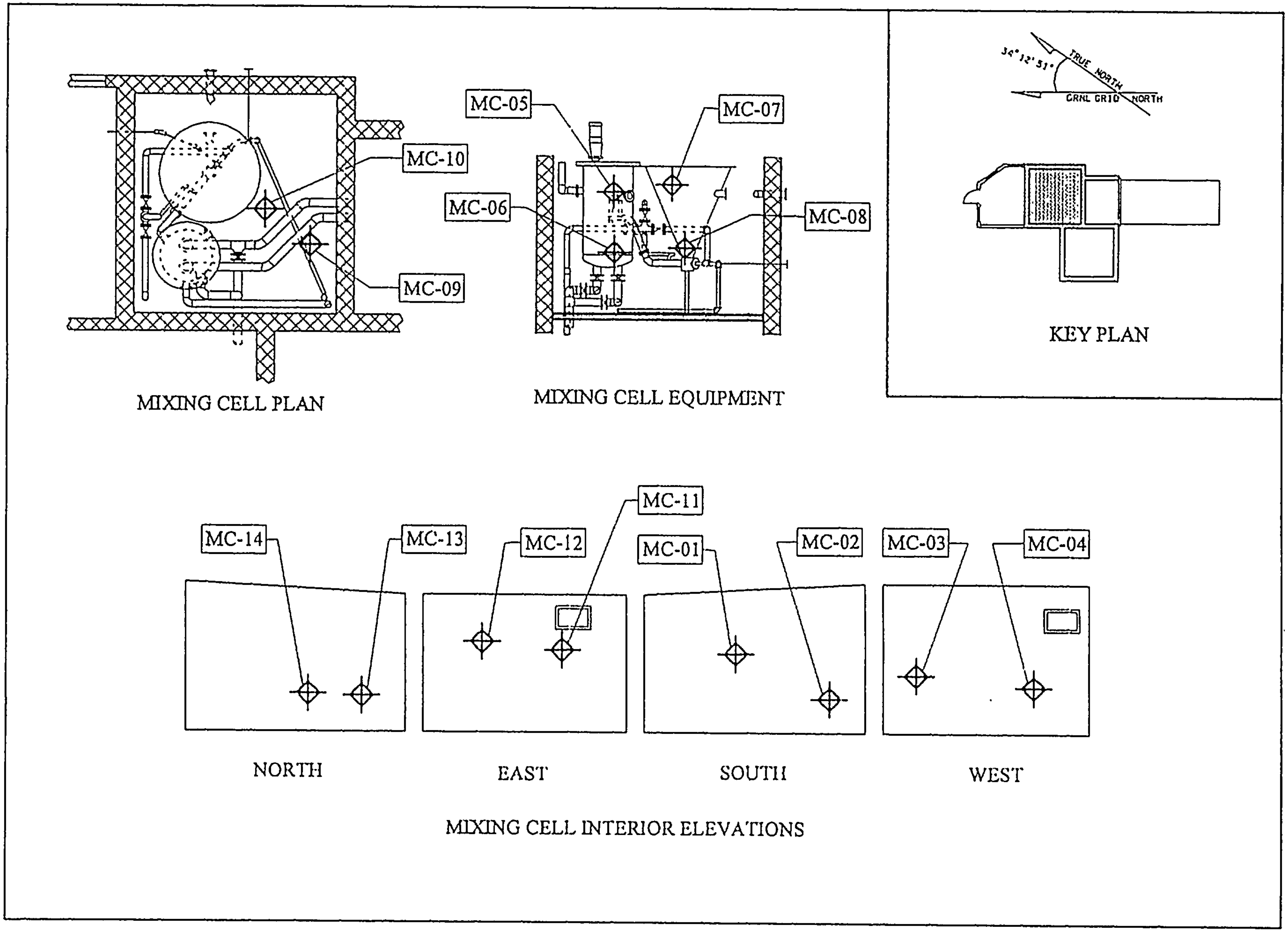

Fig. 6.2. Mixing cell field measurement locations.

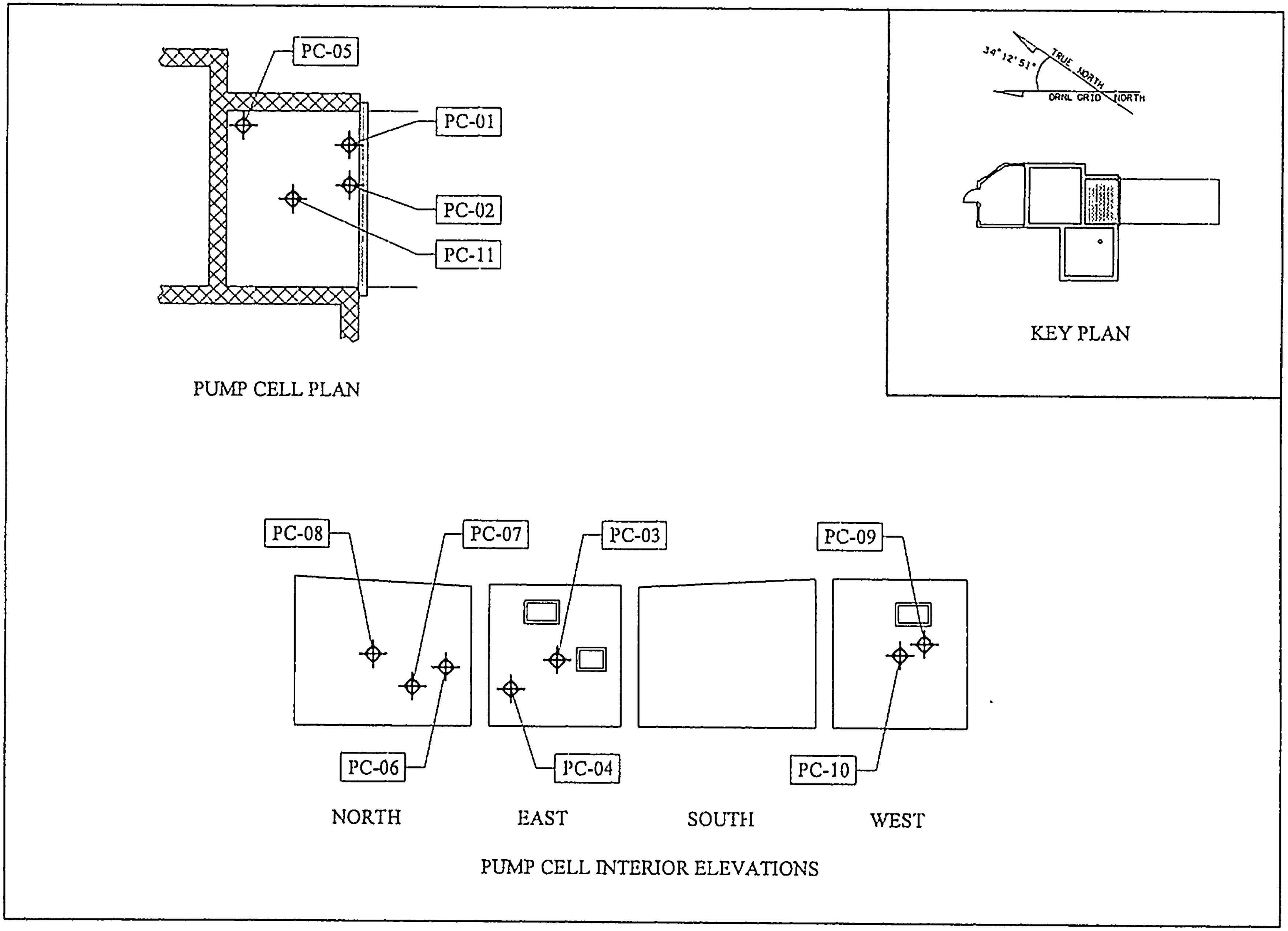

Fig. 6.3. Pump cell field measurement locations.

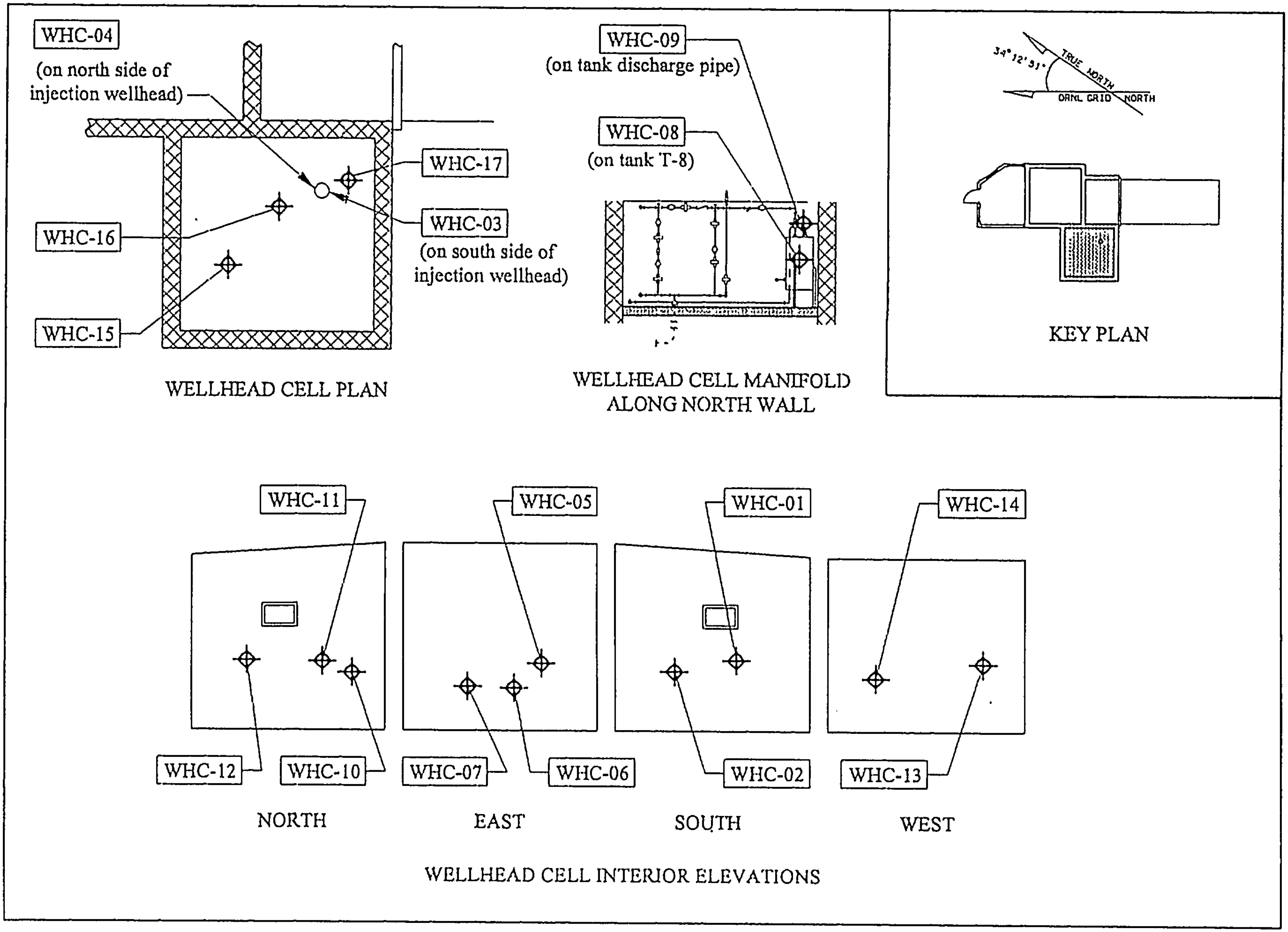

Fig. 6.4. Wellhead cell field measurement locations.

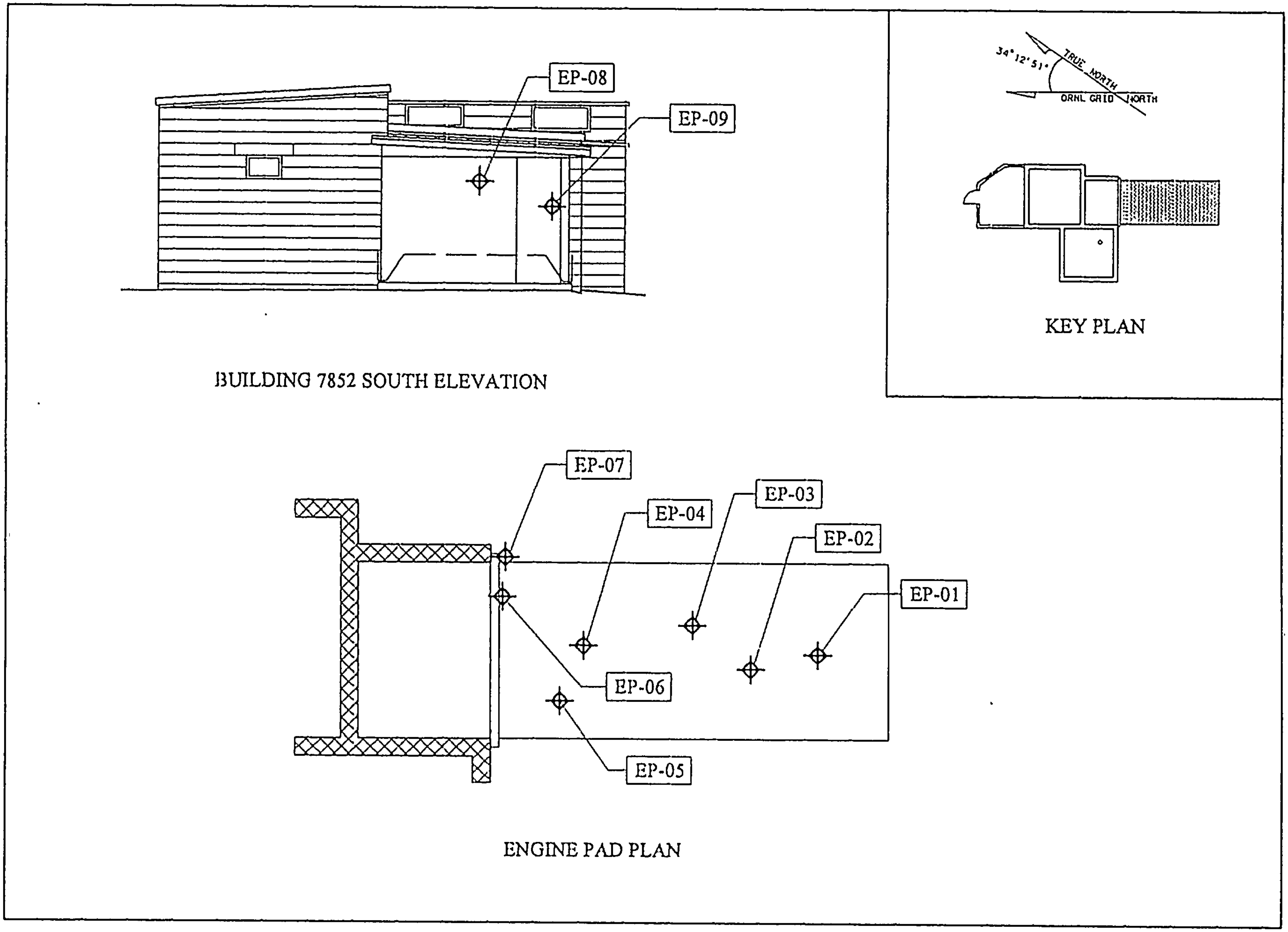

Fig. 6.5 Engine pad field measurement locations.

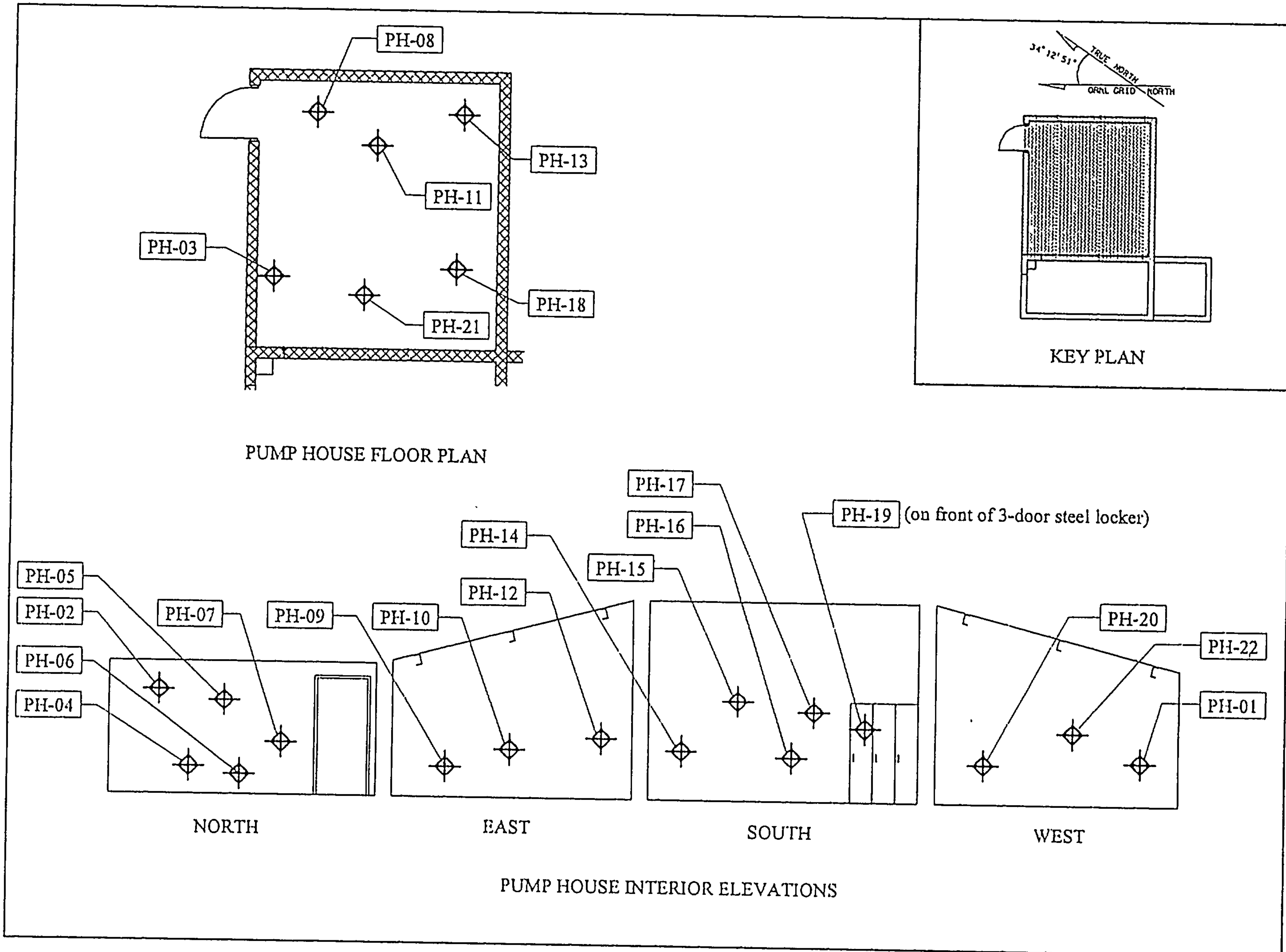

Fig. 6.6. Pump house field measurement locations.

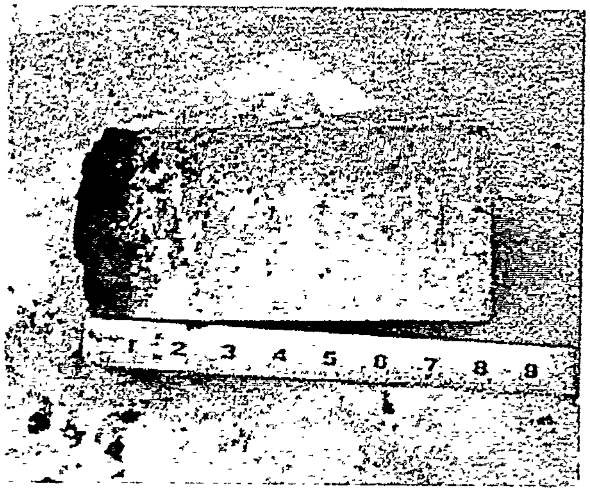

Fig. 6.7. Concrete core from control room floor (location 74.SB006).

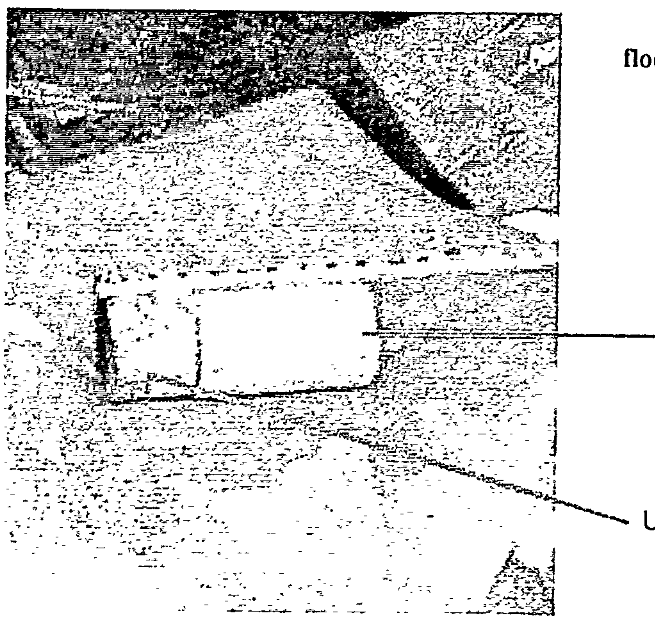

Fig. 6.8. Concrete core from mixing cell floor (location 74.SB007).

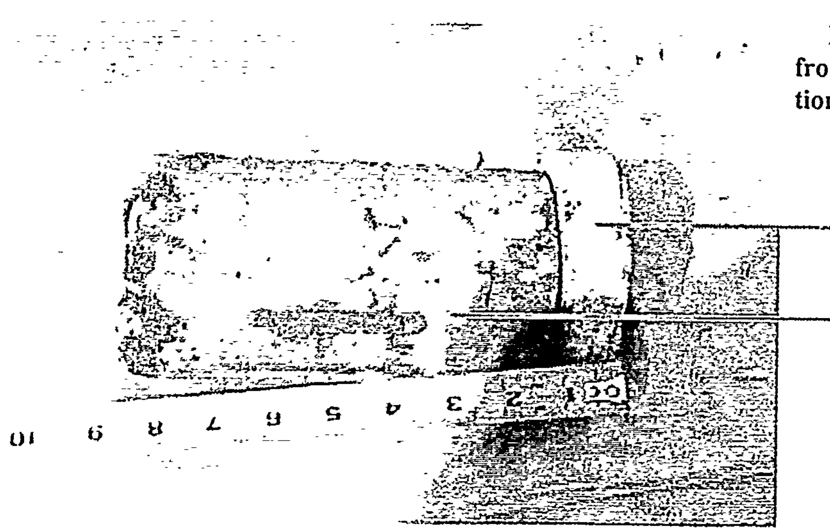

Fig. 6.9. Concrete core from pump cell floor (location 74.SB008).

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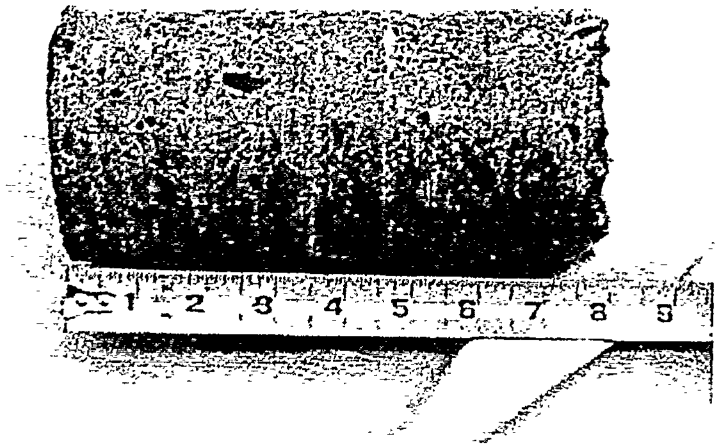

Fig. 6.10. Concrete core from wellhead cell floor (location 74.SB009).

Fig. 6.11. Concrete core from engine pad (location 74.SB010).

Fig. 6.12. Concrete core from pump house floor (location 74.SB011).

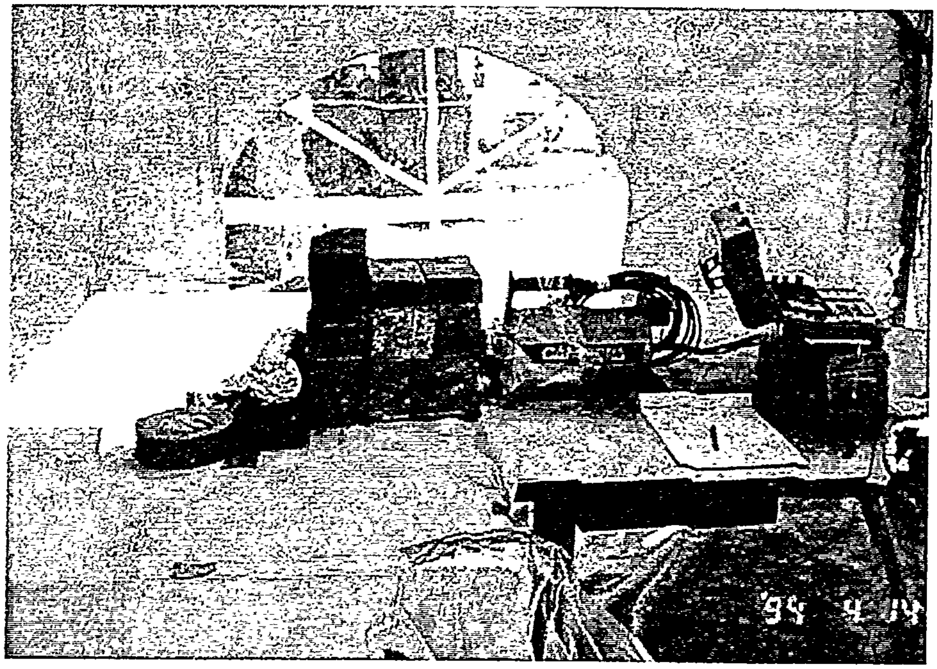

Fig. 6.13. Gamma spectroscopy (HPGe) slit-scanning geometry/configuration.

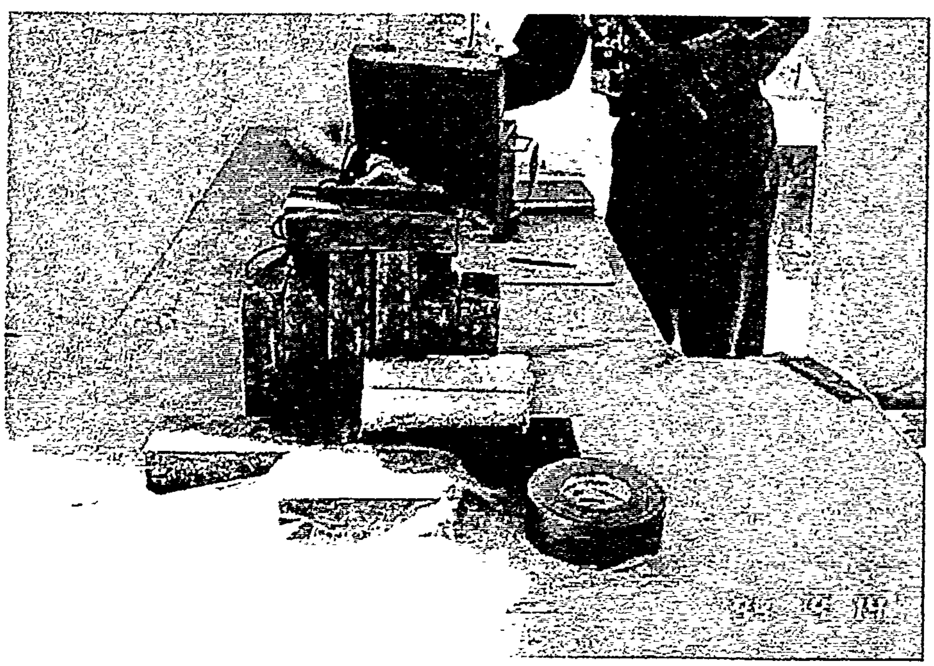

Fig. 6.14. Slit-scanning slot size and core-counting geometry.

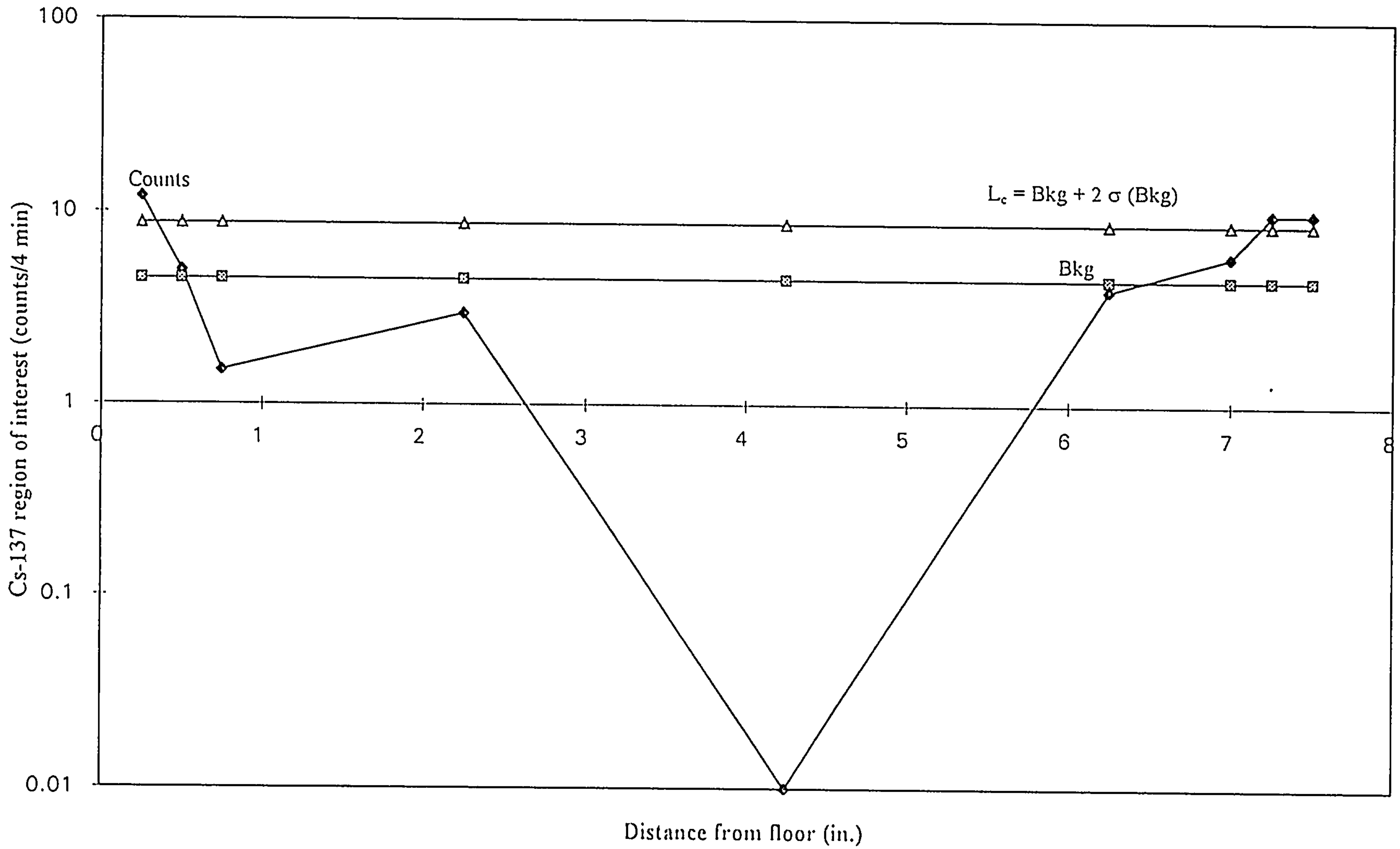

Fig. 6.15. Slit scanning results for concrete core 74.SB006.

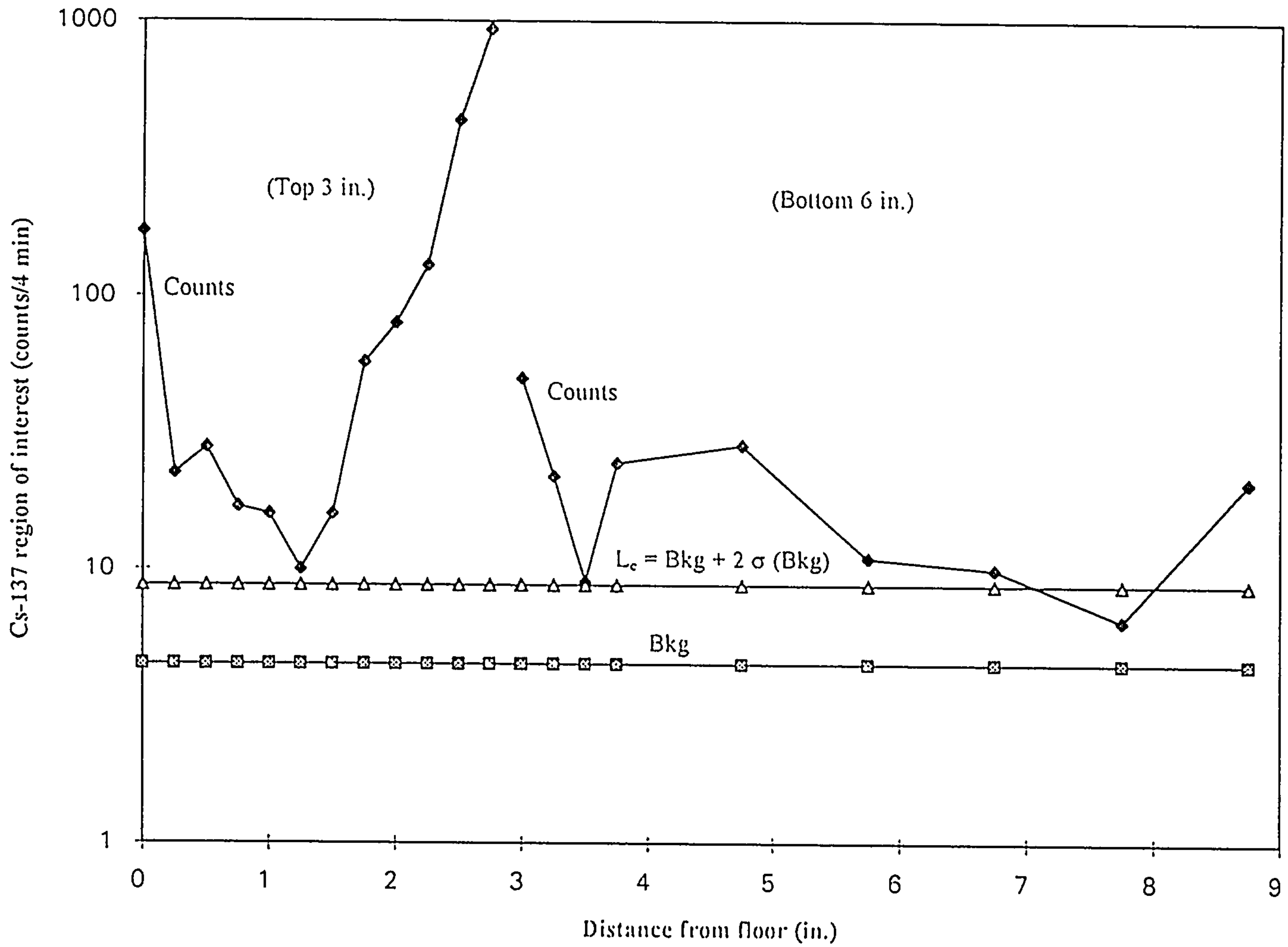

Fig. 6.16. Slit scanning results for concrete core 74.SB007 (top and bottom pieces).

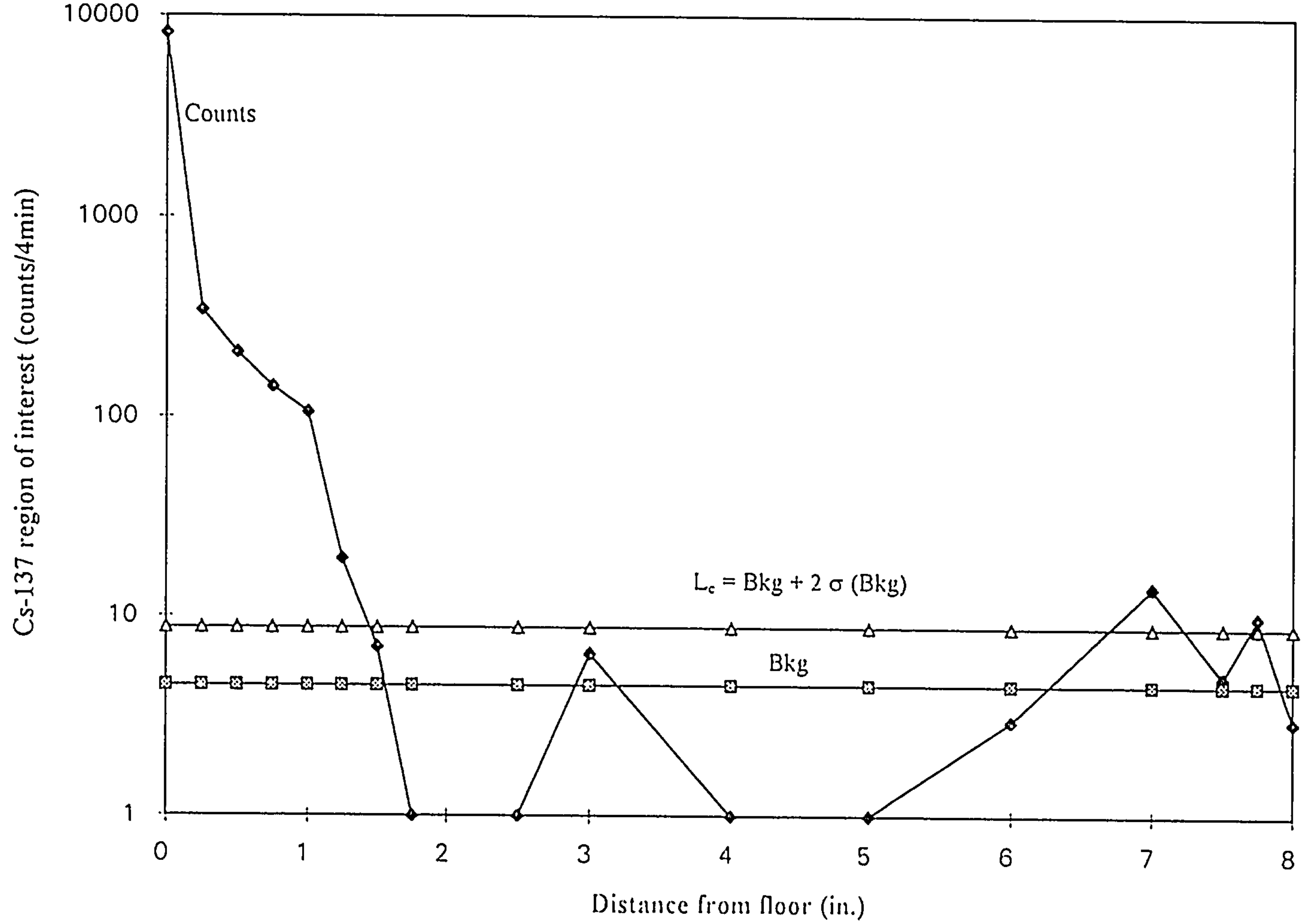

Fig. 6.17. Slit scanning results for concrete core 74.SB008.

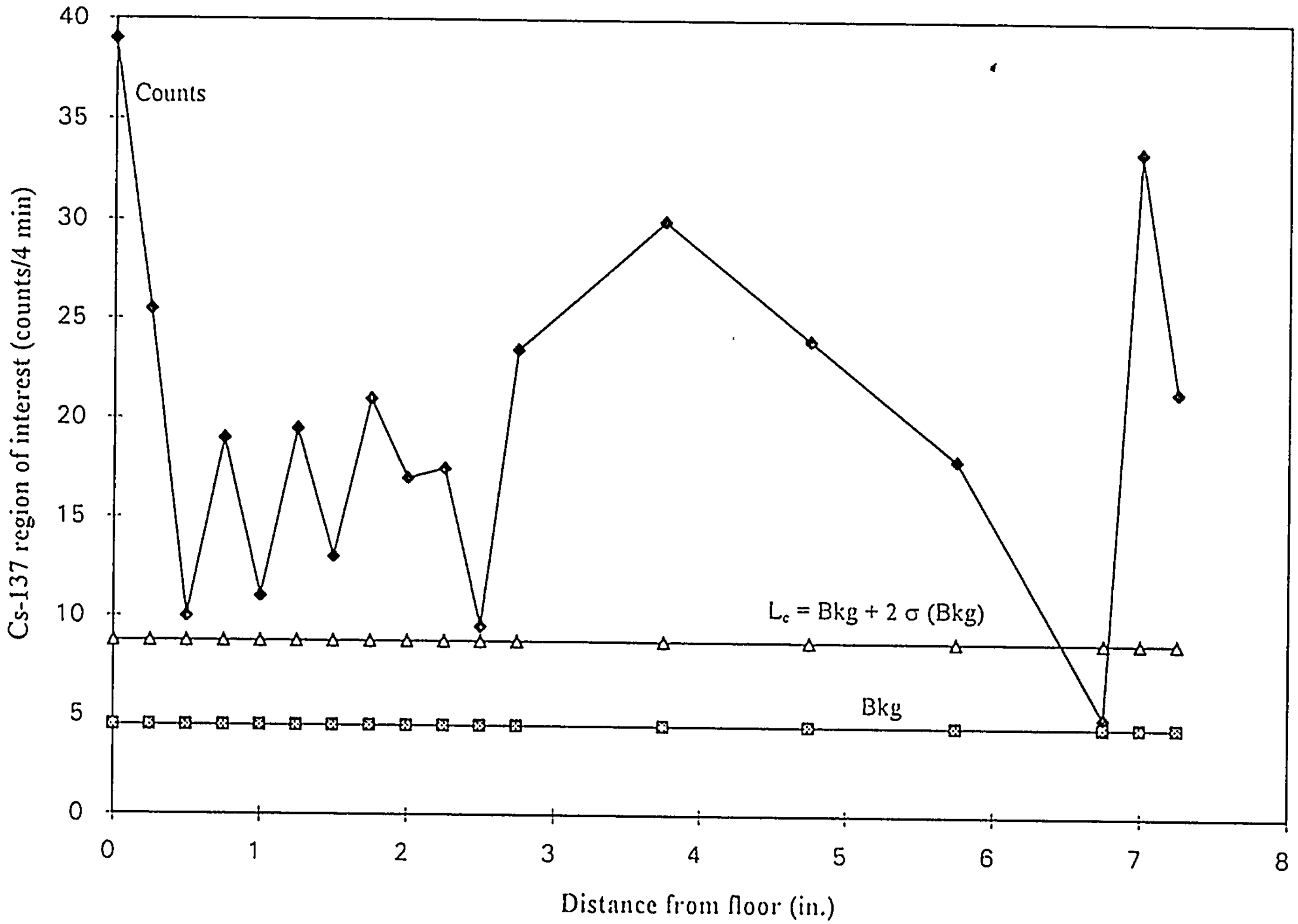

Fig 6.18. Slit scanning results for concrete core 74.SB009.

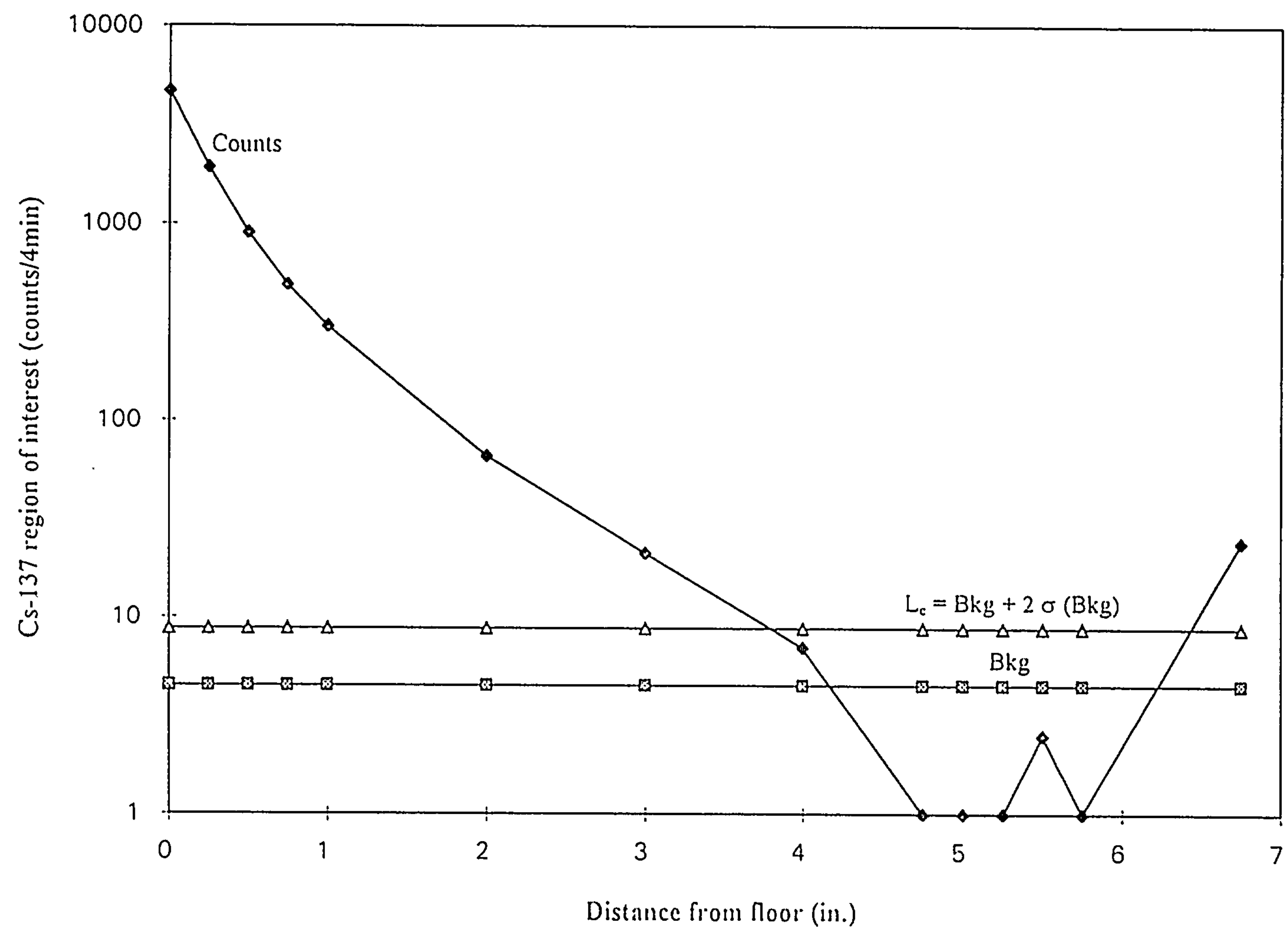

Fig. 6.19. Slit scanning results for concrete core 74.SB010.

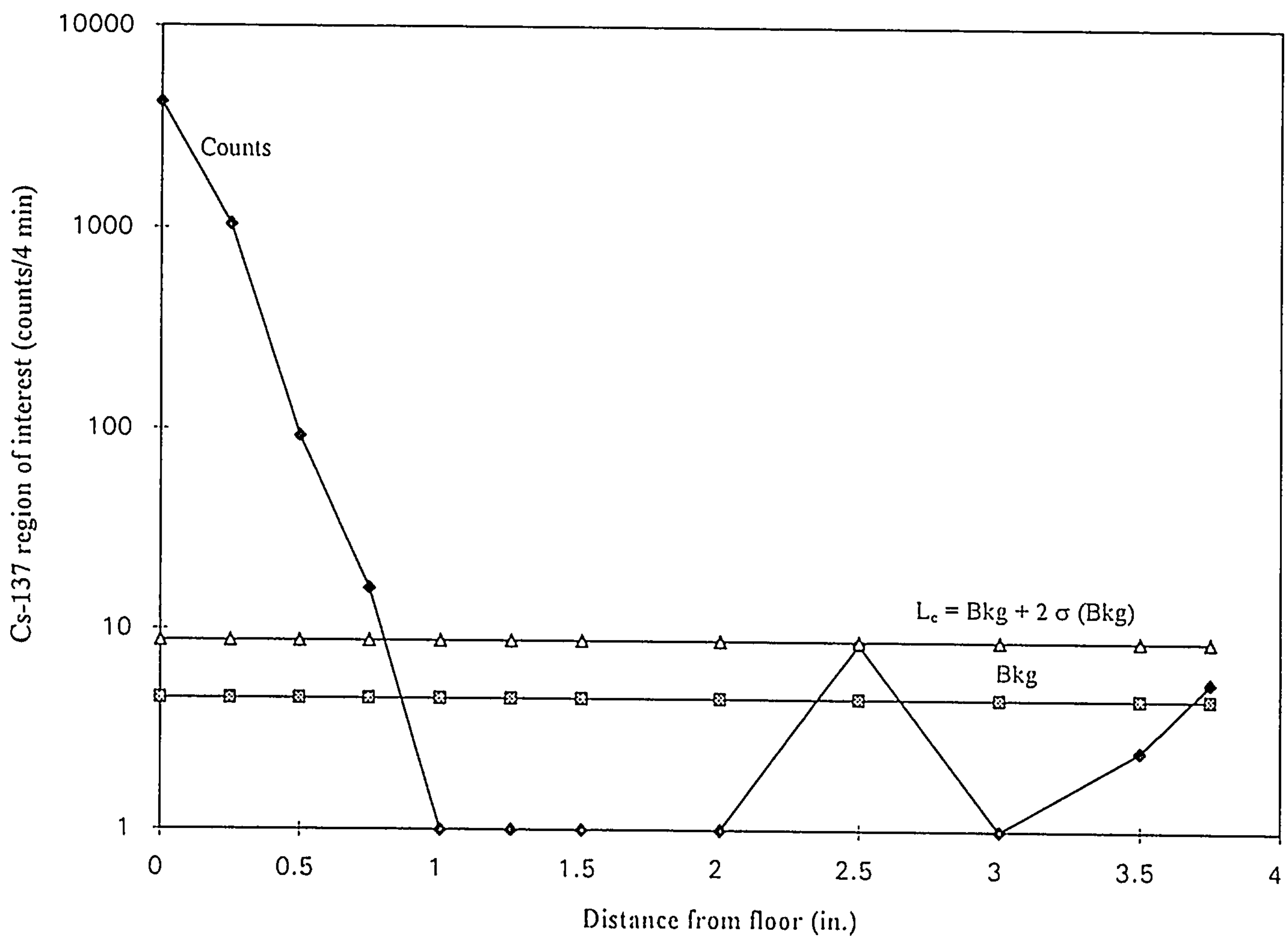

Fig. 6.20. Slit scanning results for concrete core 74.SB011.

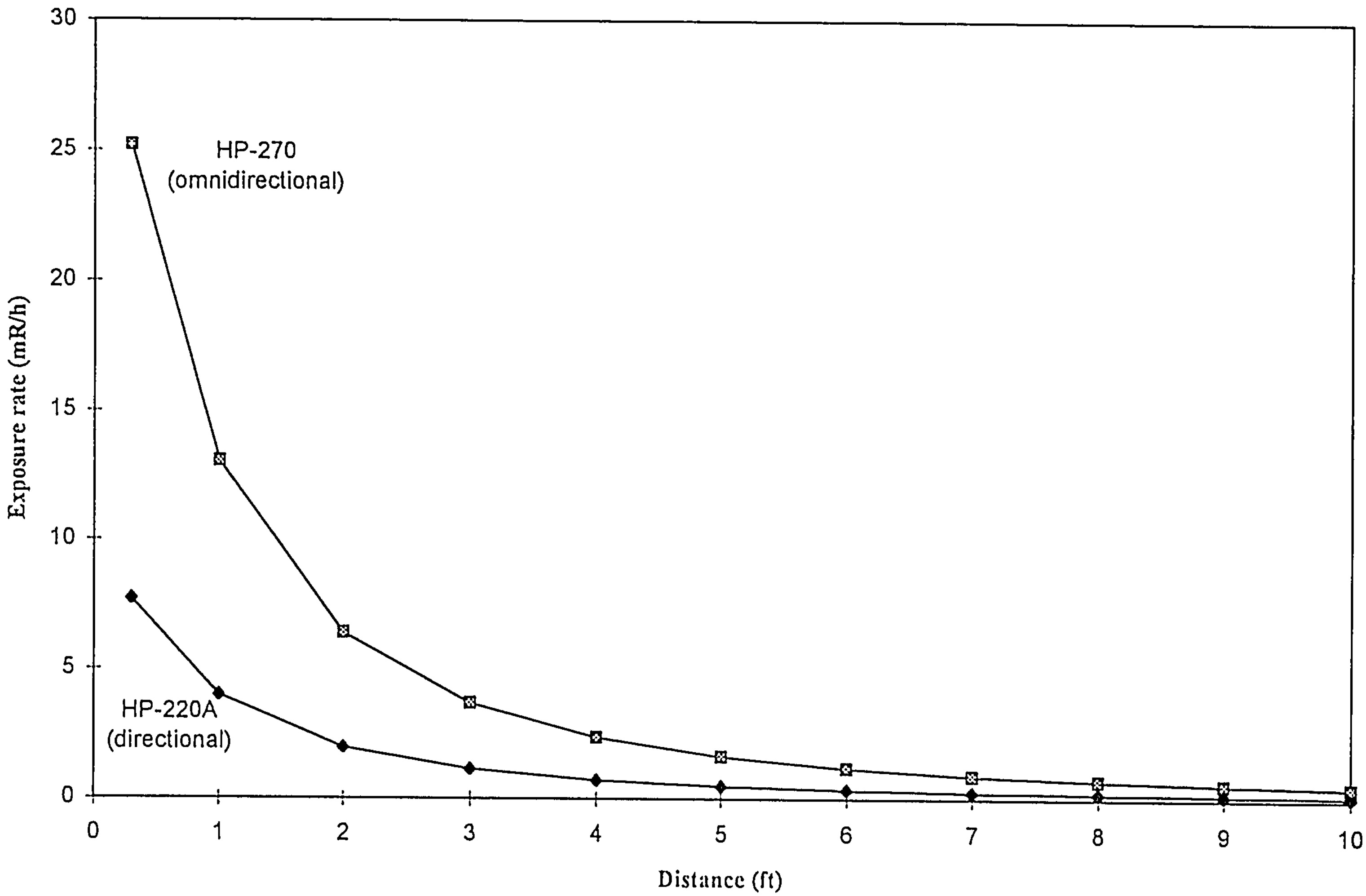

Fig. 6.21. HP-270 vs HP-220A model exposure rate prediction around the injection wellhead.

7. WASTE TYPES AND VOLUME ESTIMATES

7.1 WASTE DISPOSAL TYPES

Solid and liquid wastes at ORNL are divided into four general categories: radioactive, hazardous, mixed, and sanitary. The waste categories can be further broken down into subcategories that have been defined in waste management plans and for which some protocols and waste acceptance criteria are available (Energy Systems 1993a,b; Gilpin 1992). If a final waste form resulting from D&D of OHF matches the definition and waste acceptance criteria of an ORNL waste subcategory, then disposal or storage of the waste can proceed according to the waste management protocols.

7.1.1 Radioactive

The principal wastes expected to be generated during D&D are radioactive—specifically, solid low-level waste (SLLW) and perhaps liquid low-level waste remaining in piping, tanks, and equipment, if any. SLLW is defined as waste that (1) contains beta/gamma activity and/or alpha activity and is not classified as high-level waste, TRU waste, or spent fuel, and (2) is certified as containing no RCRA-regulated hazardous wastes. The SLLW category is divided into various subcategories; those with potential application to OHF D&D are defined below (Energy Systems 1993a).

- Very-Low-Activity (VLA) Waste—Waste that contains no measurable contamination by radiation survey but, because of past history and inaccessibility, is judged by ORNL Radiation Protection to be possibly contaminated in excess of defined free release limits. Candidates for VLA waste include the bulk storage bins and ancillary equipment, pump P-3, and water tank T-5.

- Contact-Handled (CH) SLLW—Packaged waste with an unshielded container surface radiation dose equivalent rate of ≤2 mSv/h (200 mrem/h). CH SLLW is divided into two groups: compactible (e.g., plastic bags and sheets, paper, cardboard, cloth, rubber gloves and shoe coverings, plastic bottles) and noncompactible (e.g., wood, scrap metal, glass bottles, metal tools, equipment). Major portions of Building 7852 and the pump house, as well as the surrounding soil, are expected to be CH SLLW. This conclusion is based on a Microshield calculation of the exposure rates on the surface of a 55-gal drum or low-specific-activity (LSA) box filled with concrete rubble or soil. The calculated exposure rates were more than a factor of 50 less than the CH SLLW maximum dose equivalent rate of 2 mSv/h (200 mrem/h).

- Remote-Handled (RH) SLLW—Packaged waste with an unshielded container surface radiation dose equivalent rate of >2 mSv/h (200 mrem/h). RH SLLW is divided into two groups: (1) 2 mSv/h (200 mrem/h) to 10 mSv/h (1 rem/h) and (2) >10 mSv/h (1 rem/h). RH SLLW >10 mSv/h (1 rem/h) will be placed in retrievable storage. The grout (detritus and dust) on the mixing cell floor and the grout deposited in the process piping are candidates for RH SLLW. This conclusion is based on Microshield-predicted exposure rates two to three times higher than the dose equivalent rate of 2 mSv/h (200 mrem/h) on the surface of a grout-filled 55-gal drum or LSA box.

VLA and CH SLLW, assuming that all the waste acceptance criteria are satisfied, are currently disposed of at ORNL's Interim Waste Management Facility at SWSA 6. Small quantities of RH SLLW are retrievably stored in wells at SWSA 6; large, bulky quantities are generally placed in 4 ft × 4 ft × 6 ft boxes, overpacked in concrete, and then temporarily stored in a Class III–IV above-ground storage facility at SWSA 6.

Those subcategories of radioactive waste that were reviewed and, based on available information, do *not* apply to OHF D&D are discussed below (Energy Systems 1993a).

- TRU Waste—Waste contaminated with alpha emitting transuranic radionuclides (atomic number >92) with half-lives >20 years and specific activities >100 nCi/g at the time of assay. Californium-252, curium-244, and uranium-233 are also managed as TRU waste at ORNL. Most of the existing solid TRU waste storage facilities at ORNL are in the north area of SWSA 5; the wastes are stored there pending development of an approved strategy for permanent disposal. A review of OHF sample results indicates that the specific activities of alpha emitting radionuclides are at least four orders of magnitude less than the 100 nCi/g limit for a TRU waste.

- Fissile Waste Material—Solid waste that contains the isotopes uranium-233, uranium-235, plutonium-238, plutonium-239, plutonium-241, and/or the elements neptunium, americium, curium, berkelium, and californium. If the concentration of fissile isotopes is greater than 1 g/ft^3 uranium-235 equivalent (or if the amount of fissile isotopes placed in a small package exceeds 1 g of uranium-235 equivalent), then it will be handled as fissile waste and stored retrievably. A review of sample data indicates that to be classified as a fissile waste, OHF material would need quantities of the target isotopes one to two orders of magnitude greater than thus far discovered.

7.1.2 Hazardous

The primary regulatory driver for ORNL hazardous waste management operations is RCRA; the secondary driver is TSCA. "Hazardous" compounds/substances are those that are listed in Subpart D of 40 CFR 261, and/or exhibit any of the characteristics of a hazardous waste as defined in Subpart C of 40 CFR 261 and 40 CFR 268, or fail the TCLP. If a waste is determined to be a hazardous waste, it must be handled in strict accordance with RCRA. The State of Tennessee, under the auspices of EPA, has implemented hazardous waste laws essentially equivalent to those of RCRA (Gilpin 1992). TSCA waste includes those compounds and substances contaminated with PCBs, as described in 40 CFR 761; nonradioactive asbestos is also regulated under TSCA. Several ORNL facilities are used for short-term storage of hazardous waste. Although it is possible that small amounts of hazardous materials may be generated from OHF D&D, it is considerably more probable that any chemical contamination is mixed with radiological contamination.

7.1.3 Mixed

Mixed waste is hazardous waste found to contain radioactive contamination. Examples include cleaning fluids or oils found in a radioactive environment and surface-contaminated lead (e.g., the lead shielding in the pump house would be considered mixed waste). No on-site treatment for solid mixed wastes is currently available, and storage capacity at the ORR is limited.

7.1.4 Sanitary

If some of the construction debris (including concrete, asphalt, and asbestos) resulting from D&D of OHF is nonradioactive and nonhazardous, it may be disposed of at the Sanitary Landfill II at the

Y-12 Plant, or at an equivalent facility available at the time D&D is performed. Given the nature and extent of radiological contamination, however, it is expected that most construction debris will be considered radioactive waste and not eligible for release as sanitary waste.

The water in tank T-5 does not qualify as a drinking water source and therefore is not subject to specific legal requirements (e.g., ARARs); disposition of the water will depend on DOE orders and ORNL environmental compliance procedures. Nevertheless, for the purpose of comparison only, radiological analyses of the water sample from tank T-5 did not identify any analyte concentrations that exceeded radionuclide-specific ARARs (Etnier et al. 1993) for groundwater and surface water at the ORR. In addition, no radionuclide concentrations exceeded the "Derived Concentration Guide" values established in DOE Order 5400.5, Chapter III. According to Energy Systems personnel, the water could probably be sent to the nonradioactive wastewater treatment plant.

7.1.5 Summary and Uncertainties

In summary, the waste categories most relevant and applicable to OHF D&D include VLA waste, RH and CH SLLW, mixed waste and, possibly, sanitary waste. Uncertainties or issues with regard to waste categorization include the following.

- The nature and extent of contamination of some individual equipment items and piping, and the level of contamination of the foundation/footings, have not been determined. In addition, comprehensive radiological surveys to assess free release of materials have not been performed. Given the characterization information available, it is not currently possible to assign portions of the equipment to specific SLLW categories (e.g., RH, CH, or VLA) or to the sanitary waste category.

- Potential RCRA constituent metals were identified in the paint chip sample. TCLP analysis may be needed to determine RCRA applicability for the paint, although it is not expected to fail the TCLP test given its relatively low leachability.

- Two samples were collected for asbestos analysis; test results were negative. ORNL plans a complete asbestos survey of OHF at a later date.

7.2 WASTE DISPOSAL VOLUMES

The waste disposal volume estimates include Building 7852, the pump house, the bulk storage bins and associated equipment, tank T-5, and pump P-3, plus the foundations of those structures and the equipment or materials within Building 7852 and the pump house. They do not include the soils underneath and surrounding the structures or the ancillary external piping or drains leading to or from the structures. Remediation of the valve pit, the injection wellhead, the soils, and ancillary external piping has been assigned to ORNL RA and is not currently considered a part of D&D implementation. Miscellaneous items such as furniture, tools, spare parts, electrical conduit, minor piping, unattached piping, trash, and investigation-derived waste (e.g., protective clothing and equipment used during D&D implementation) are not included in the volume estimate. The disposal volume was estimated on the basis of as-built conditions determined through field investigation and Energy Systems design drawings.

Volume estimates were performed for concrete, steel, and lead materials. The concrete volume estimates for the structures include the walls, floor slabs, and foundations/footings. The steel volume estimates include the building roofs, the bulk storage bins and associated equipment, pumps, vessels/tanks, platforms and supports, ducting, and major piping inside the structures. The lead volume estimate includes lead shielding in the pump house, lead plates on the mixing cell roof, and (assumed) lead bricks in a 55-gal drum in the control room. The building material volumes were multiplied by the following swell factors to establish a disposal volume: concrete 1.25, steel 1.35, and lead 1.35.

One set of waste volume estimates was prepared assuming complete dismantlement of the D&D structures and demolition and removal of all the above- and below-ground materials. No partial dismantlement options were considered. Table 7.1 shows disposal volume estimates as a function of waste category, D&D structure, and construction material. A significant fraction of the disposal volume is due to the four bins and tank T-5; the table uses the bin and tank volumes prior to any sectioning or cutting up of the bins or tank.

7.3 TOTAL ACTIVITY ESTIMATES FOR BUILDING 7852 AND THE PUMP HOUSE

The total activity (i.e., curie content) of the radionuclides in the structural concrete and grout deposits was calculated using the concrete and grout volume estimates, the location-specific measurement readings, and the radionuclide concentrations reported by the ASL for the concrete cores and grout samples. The calculations assumed a density of approximately 2.35 g/cm^3 for both the concrete and grout.

Concentrations of radionuclides in the floor slabs and grout deposits were assumed to be equal to the concentrations discovered in the concrete floor core and the grout samples, respectively. No samples were taken from the concrete block walls, and the radionuclide concentrations in the walls were inferred from results of location-specific radiological surveys rather than direct laboratory analysis. To be specific, the radionuclide concentrations in the walls were assumed to be represented by the floor core concentrations multiplied by the ratio of the average of the location-specific radiological survey readings on the walls to the average readings on the floor. The alpha survey results were used to obtain the wall-to-floor ratio for the alpha emitters, and the beta/gamma surveys (closed window) were used to obtain the ratio for the beta/gamma emitters.

As shown in Table 7.2. the total activity for various radionuclides was calculated separately for the floors, walls, and grout deposits, and then summed to obtain a total curie estimate. For most of the radionuclides, the total activity in the grout deposits is significantly greater than that in the floors or walls.

Table 7.1. Disposal volume estimates (ft^3)

Facility	Material	Solid Waste Categories: RH SLLW	CH SLLW	VLA or Sanitary	Mixed or Hazardous	Total
Building 7852	Concrete rubble[a]		2,991			2,991
	Steel[b]		155	36		191
	Lead shielding[c]				18	18
	Grout in piping[d]	19				19
	Grout on mixing cell floor[e]	9				9
Pump house (excludes the valve pit)	Concrete rubble[f]		938			938
	Steel (plus equipment)		78	11		89
	Lead shielding				29	29
Bulk storage bins (and ancillary equipment)	Concrete rubble[g]			1,435		1,435
	Steel[h]			14,715		14,715
Tank T-5 and pump P-3	Concrete rubble			403		403
	Steel[i]			4,650		4,650
Total		28	4,162	21,250	47	25,487

Note: no contingency has been added to the estimates. Disposal volume includes a fluff factor of 35% for steel and metal structures and a fluff factor of 25% for concrete and equipment.

[a] The volumes of the floor slab and foundation of Building 7852 are approximately 457 and 176 ft^3, respectively. The bending and weigh tanks pad volume is approximately 380 ft^3.
[b] It is assumed that the steel inside Building 7852 is contaminated and that exposed to the elements is not.
[c] The lead shielding includes only the lead plate on the mixing cell roof; it does not include the 55-gal drum that supposedly contains lead brick, nor does it include lead blankets that were put around piping during the field investigation.
[d] Piping in the mixing cell and well cell that was used for grout injection was conservatively assumed to be completely full of grout.
[e] Grout on the mixing cell floor was assumed to cover 20% of the floor area at an average depth of 3 in.
[f] The volumes of the pump house footing, floor slab, and pump pads are approximately 74, 95, and 83 ft^3, respectively.
[g] Estimate does not include volume of pads for two blending tanks and the weigh tank.
[h] The steel volume includes the total volume of each bin uncollapsed and uncut. Estimate does not include HVAC unit under bin 3, blower by bin 2, or air compressor under bin 1.
[i] The steel volume includes the total volume of tank T-5 uncollapsed and uncut.

Table 7.2. Total activity estimate (μCi) for concrete in Building 7852 and the pump house

Radionuclide	Floors[a]	Walls[b]	Grout Deposits[c]	Sum
^{241}Am	8.95	23.18	0.00	32.14
$^{239/240}$Pu	17.55	30.76	130.44	178.89
^{238}Pu	33.35	61.15	252.16	346.80
^{228}Th	16.90	18.11	14.33	49.57
^{230}Th	41.74	32.00	4.66	79.17
^{232}Th	17.15	11.77	4.85	34.07
$^{233/234}$U	195.82	407.12	845.34	1,449.67
^{235}U	9.73	19.18	9.74	38.71
^{238}U	540.28	1,225.63	13.73	1,782.96
^{137}Cs	152,832.93	278,531.43	2,236,422.72	2,671,845.40
^{40}K	162.66	193.52	3,658.88	4,015.06
^{152}Eu	78.30	144.48	0.00	222.78
^{154}Eu	51.94	95.83	0.00	147.77
^{90}Sr	18,807.20	37,135.03	1,242,295.86	1,298,631.43
^{60}Co	162.36	297.00	3,349.14	3,810.78
^{3}H	35.91	110.52	0.00	147.13

[a] The radionuclide concentrations in the floor cores are assumed to represent of the average concentrations in the entire floor slab. For the purpose of the activity estimates, the concrete foundations/footings of Building 7852 and the pump house were assumed to be relatively uncontaminated and were therefore not included with the floor slabs.

[b] It is assumed that the ratio of the average concentrations of the radionuclides in the walls to the average concentrations in the floors is proportional to the ratio of the average of the location-specific survey readings on the walls to the average readings on the floors.

[c] The radionuclide concentrations found in the grout samples are assumed to represent the average concentrations in the deposits. The volume of the grout deposited in the piping was calculated by assuming that the entire pipe cross section (of selected process piping in the mixing cell and well cell) was filled with grout. The volume of the grout on the floor of the mixing cell was calculated by assuming that 20% of the floor area was covered by grout to an average depth of 3 in.

8. SUMMARY AND CONCLUSIONS

OHF site characterization consisted of three primary activities: inspections, radiological measurements, and radiological and chemical sampling and analyses for Building 7852 (including the injection wellhead in the wellhead cell), the four bulk solids storage bins and equipment surrounding the building, the pump house, water tank T-5, pump P-3, and adjacent soils. Other components (e.g., the impoundment, waste pit, buried tanks, valve pit, and underground piping) are assigned to the ORNL RA Program for characterization; an exception is Building 7853, which is assigned to the ORNL WM Program (see Sect. 2).

This section summarizes key planning information gathered during site characterization that may assist in the engineering of D&D approaches, the protection of D&D workers, and the management of D&D-generated wastes. The summaries presented here are organized by the data needs identified in the site characterization plan. The organization is somewhat arbitrary, as much of the data collected can and will be used for engineering, personnel protection, and waste management.

8.1 ENGINEERING PLANNING

- No decontamination was performed on OHF after it was shut down in 1980, and the building interior, including the process piping and equipment, remains essentially unchanged. Ongoing maintenance activities include daily checks on the liquid levels in the tanks and weekly checks on the continuously operating off-gas systems and radiation protection measures. The off-gas systems ventilate and filter the air in the buried tanks, Building 7852, and pump house. The air compressor, which supplies instrument air, also operates continuously.

- An exterior survey shows that the structural integrity of the facilities is adequate (i.e., they will remain structurally intact) for safe decontamination or demolition (see Appendix C). However, the bins exhibit extensive corrosion, are deteriorating, and present some safety hazards (e.g., Energy Systems has not approved the use of the ladder with the safety cage). Access to the interior of the mixing cell, the wellhead cell, the bins, and tank T-5 is through hatches on the roof or top of the structures; doors allow access to the other enclosed areas (see Sect. 2).

- During coring of the floor pads, it was discovered that a gravel layer acts as a sub-base for most of Building 7852 and the pump house and that the concrete floors range from 6 to 9 in. in depth. The mixing cell and pump cell floor cores were each composed of two discrete pours, possibly indicating that a concrete layer was added to the original floors to contain and/or shield contamination (see Sect. 3.11).

- Loose grout was found on the floor of the mixing cell; grout was also found inside the open ends of the grout suction lines entering the pump cell. In addition, material that looked like grout was found in the ventilation piping on the roof of the Building 7852 control room. The extent of grout deposited throughout the process piping is unknown (investigation of pipe interiors was outside the scope of this task) (see Sect. 2 and Table 3.1).

- Slit scanning performed on the concrete cores indicates that most of the measured gamma activity is within the first few inches of the surface. The activity along the length of the core is nonuniform; activity is generally high at surfaces, decreases to near background level, and increases slightly again near the bottom where the core contacts underlying soil. The two-piece core from the mixing cell behaves differently than other cores. The top portion has high activity at the surface, decreases to near background level, and increases at the interface by a factor of 20. The bottom portion behaves the same as the other cores (see Sect. 6).

- Comparison of location-specific direct measurements and smears collected within the same locations indicates that most of the contamination is fixed or inside the piping and equipment (see Sect. 6). However, grout on the mixing cell floor is loose and highly radioactive. The grout in the suction pipes in the pump cell is also highly radioactive.

- Per Energy Systems' direction, the valve pit west of the pump house was not investigated. On the basis of historical information, however, this area should be considered a contamination and radiation area and should be characterized before final D&D activities begin.

- Contamination of piping and equipment interiors, concrete-embedded piping, and underground piping also was not investigated.

- ASL sample results, CSL smear results, and concrete core slit scanning indicate that the primary gamma emitting isotope is cesium-137/barium-137m.

8.2 PERSONNEL PROTECTION PLANNING

- The general area exposure rate (approximately 1 m above floor level in air) in the OHF structures varies from area to area.

  - The general area exposure rate in the control room varies between 6 and 10 mrad/h near the floor and between 10 and 40 mrad/h at greater height, especially around the glass windows on the south wall. The increase in the fields with distance from the floor on the south wall is possibly due to the "shine" from the mixing cell (see Sect. 6).

  - In the mixing cell, general area exposure rates range from 45 to 100 mrad/h and 35 to 100 mR/h. Exposure rates are higher on the bottom of the mixing tank and the pipes used for transporting grout to the pump cell (120–160 mR/h and 270–400 mrad/h) and in the floor drain (300 mrad/h and 150 mR/h).

  - The general area exposure rates in the pump cell range approximately from 20 to 50 mrad/h and 20 to 40 mR/h. However, contact exposure rates are high on the two grout pipes from the mixing cell (800 mrad/h and 120 mR/h, and 3000 mrad/h and 300 mR/h) and the pipe suspended (hanging vertically) from the ceiling (1000 mrad/h and 800 mR/h) before it was shielded with lead blanket and lead sheet.

  - The exposure readings after shielding was added to the pipe were 250 mrad/h and 200 mR/h in contact with the shield.

- The wellhead cell general area exposure rates range approximately from 13 to 120 mrad/h and 10 to 75 mR/h. Contact measurements at various locations on the injection wellhead range from 36 to 65 mrad/h and 16 to 24 mR/h. The highest contact exposure rate measured is on the pipe entering the tank in the northeast corner of the cell: 340 mrad/h and 300 mR/h.

- General area exposure rates on the engine pad are lower than others, ranging from approximately 1.3 to 12 mR/h; no differences were observed between closed and open window measurements. Some of the high exposure rates observed on the engine pad near the pump cell could be caused by the "shine" from the pump cell.

- General area exposure rates on the roof of Building 7852 range approximately from 1.8 to 19.0 mR/h in most locations. Near the blower on the roof of the control room, however, the general area exposure rate increases to 140 mR/h, and the contact exposure rate measurement is as high as 1200 mR/h at the inlet pipe on the south side of the blower.

- The pump house general area exposure rates range from 3 to 50 mrad/h and 2 to 40 mR/h. A few areas on the concrete pump pad under the lead shielding exhibit high exposure rates (maximum 2500 mrad/h and 1000 mR/h) approximately 6 in. from the floor.

• Alpha activities in OHF structures range widely (approximately 59 to 3000 dpm/100 cm^2 for walls and 180 to 42,000 dpm/100 cm^2 for floors) and vary by orders of magnitude from one area to another. The floors generally have higher alpha activity than the walls. A comparison between smear results and direct field measurements indicates that most alpha activity in these areas is fixed. The high alpha activity is expected, given the known process history (see Sect. 6).

• Beta/gamma field measurements behave in the same fashion as alpha measurements. Beta/gamma measurements (closed window) for walls and floors average approximately 9 to 45 mrad/h and 5 to 197 mrad/h. Open window measurements ranged approximately 10 to 30% higher than closed window, probably because of the beta field (see Sect. 6).

8.3 WASTE MANAGEMENT PLANNING

• Five outdoor and three subfloor soil samples were analyzed for radionuclides, TCL organics (VOCs, BNAEs, and pesticides/PCBs), and TAL inorganics (metals and cyanide).

  - No alpha emitting isotopes analyzed for exceed the WAG 5 reference soil sampling results. Cesium-137/barium-137m and strontium-90/yttrium-90 concentrations exceed reference results in all soil samples; one exterior sample (location 74.SB004) exhibits very high levels of cesium-137/barium-137m and strontium-90/yttrium-90 (7730 and 467 pCi/g, respectively) (see Sect. 5).

  - No significant differences were found between the outdoor and subfloor soil results. None of the soil samples contain VOCs, BNAEs, pesticides, or inorganics that exceed the RCRA toxicity characteristic equivalent limits for solids, nor do any contain PCBs that exceed the TSCA limit (see Sect. 4).

- One concrete core was drilled in the floor slab of each of the five rooms/areas of Building 7852, and one core was drilled in the pump house floor. The cores were analyzed for TCL BNAEs, TCL pesticides/PCBs, and TAL inorganics.

  - Most of the alpha emitters analyzed for were detected at low concentrations; the exceptions are higher levels of uranium-233/234 and uranium-238 in two cores (approximately 26 and 86 pCi/g). Small concentrations (<6 pCi/g) of plutonium isotopes were detected in four of the cores. Americium-241 was detected on only one core (74.SB008) at a low concentration (2.71 pCi/g). Except for the control room core, all cores show high levels of cesium-137/barium-137m and strontium-90/yttrium-90 (approximately 1000 to 10,000 pCi/g). Strontium-90/yttrium-90 concentrations on the engine pad are low (~2 pCi/g) (see Sect. 5).

  - None of the concrete cores contain BNAEs, pesticides, or inorganics that exceeded the RCRA toxicity characteristic equivalent limits for solids, nor do any contain PCBs that exceed the TSCA limit (see Sect. 4).

- One paint chip composite taken from the solids storage bins was submitted to the CSL for radiological screening and to the ASL for TAL metals analyses.

  - The CSL results indicate that this sample has very low levels of alpha and beta activities (12 and 660 dpm/100 cm^2). These are below DOE release criteria. Before the final disposition of the bins, they should be reanalyzed in a very low background area to confirm these findings.

  - Two potential RCRA constituent metals (chromium and lead) were identified. A TCLP test should be performed before waste disposal to determine whether they are RCRA constituents; however, the paint is not expected to fail the TCLP test because of its relatively low leachability (see Sect. 4).

- Two samples were collected from the bins for asbestos analysis; test results were negative. Energy Systems plans a complete asbestos survey at a later date (see Sect. 4).

- Concrete rubble is estimated to contribute approximately 1/4 of the volume of waste generated during OHF D&D. The bulk storage bins, tank T-5, and other scrap metal contribute most of the remaining fraction of disposal volume. However, the metal contribution is based on the assumption that the bins and tank are unsectioned or uncut, and the volume can be reduced by orders of magnitude if they are cut into smaller pieces (see Sect. 7).

- Solid wastes generated from D&D are expected to primarily include (1) VLA or sanitary waste, (2) CH SLLW, (3) RH SLLW, and (4) mixed or hazardous waste (see Sect. 7).

  (1) VLA or sanitary waste: Candidates for this category include the bulk storage bins and ancillary equipment, pump P-3, water tank T-5, various concrete pads for (outside) tanks, and perhaps (portions of) the roofs of Building 7852 and the pump house. This waste category should have the largest volume because of the large quantities of scrap metal involved.

  (2) CH SLLW: Major portions of Building 7852 and the pump house are expected to be CH SLLW; this expectation is based on a calculation of exposure rates on the outside of a 55-gal

drum or LSA box filled with concrete waste having the maximum radioisotope concentration found in the concrete samples. Although the soil around the D&D structures is not within the D&D scope, a calculation predicted that the soil, if excavated, would also be CH SLLW.

(3) RH SLLW: The loose grout lying on the mixing cell floor and the grout deposited in the process piping are candidates for RH SLLW. Two samples of the grout were analyzed during the characterization effort; based on the concentrations found, a conservative calculation indicated that the exposure rate on the surface of an unshielded package would be greater than the minimum allowed for RH SLLW.

(4) Mixed or hazardous waste: Lead shielding, which may be surface-contaminated, exists in the pump house around the pumps and piping and on top of the pump foundation. Lead blankets or sheets are also wrapped around some piping in Building 7852. Some 1/2-in.-thick lead sheets, which may not be surface-contaminated, are installed on the mixing cell roof. A 55-gal drum in the control room contains lead bricks based on drum's label; however, this was not visually verified.

- Based on the maximum contaminant concentration results, solid wastes generated from D&D of OHF would not be considered fissile or TRU waste (see Sect. 7).

- The total curie content of concrete material in Building 7852 and the pump house was estimated for the following major isotopes (see Sect. 7).

Isotope	Activity (Ci)
Cesium-137	2.67
Strontium-90	1.30
Cobalt-60	3.81E-3
Uranium (total)	3.27E-3
Plutonium (total)	5.26E-4
Thorium (total)	1.63E-4

- Only minor contamination was found in the tank T-5 water sample; the water could probably be disposed of at the nonradioactive wastewater treatment plant (Sects. 4, 5, and 7).

8.4 CONCLUSIONS

- The control room and engine pad have relatively low levels of contamination, and the mixing cell, pump cell, wellhead cell, and pump house have higher levels. Most of the contamination is fixed, except for some loose grout in a small pile under the hopper and mixing tank in the mixing cell.

- Most of the radiation fields in these areas are generated by gamma emitters.

- The major gamma emitter is cesium-137/barium-137m. A small amount of cobalt-60 was also detected in some areas.

- There are a few hotspots with high contact exposure levels (300 to 1200 mR/h) in the mixing cell, pump cell, and pump house. However, most of the general area surveys are under 50 mR/h.

- It is recommended that D&D activities be performed in steps. Isolate, decontaminate, and remove the major source term contributors, then perform a quick characterization survey, and repeat the steps until D&D objectives are attained.

- Standard health physics and safety practices (e.g., air monitoring, protective clothing, respirators, contamination control, equipment grounding) will be sufficient for protection of D&D workers. Remote decontamination and demolition methods will probably not be necessary.

- It will be time- and cost-effective for the OHF D&D activities to be coordinated with RA activities for WAG 5, WAG 10, and other programs that might be affected by these activities.

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Appendix A:
List of Historical Drawings and Photographs of OHF

Historical ORNL drawings of OHF

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
A-10002-EB-011-D	0	03/19/68	Shale Fracture Operation OPERATORS AREA ENCLOSURE: FLOOR PLAN, ELEVATIONS & SECTIONS	Approved for construction
A-10002-EB-012-D	0	03/19/68	Shale Fracture Operation OPERATORS AREA ENCLOSURE: DOOR, WINDOW & ROOF DETAILS	Approved for construction
C-10002-EA-002-D		05/06/63	Shale Fracturing Experiment GRADING PLAN	Approved for construction
C-10002-EA-005-D		01/08/68	Hydrofracturing Facility PARTIAL PLOT PLAN: "AS BUILT"	Approved
C-10002-EE-018-D	0	09/13/63	Shale Fracturing Experiment LINES "A", "B", "F", "G", "H", & "S"; OFF GAS AND DRAIN LINES: PROFILES & DETAILS	Approved for construction
C-10002-EE-019-D	0	09/13/63	Shale Fracturing Experiment LINES "C", "D", "N", "P", "R", & "T"; WATER, DRAIN, AND OFF GAS: PROFILES AND DETAILS	Approved for construction
C-10002-EE-020-D	0	09/13/63	Shale Fracturing Experiment LINES E, J, K, L & M: WATER LINE PROFILES	Approved for construction
C-20974-EA-001-D		03/07/73	Improvements to Hydrofracturing WASTE FLOW METERING PIT PLANS & DETAILS	Approved for construction
E-10002-ED-001-D		03/13/63	Shale Fracturing Experiment 2400 V POWER SUPPLY--PLOT PLAN	Approved for construction
E-10002-ED-002-D		03/13/63	Shale Fracturing Experiment POLE DETAILS & EQUIPMENT LIST	Approved
E-10002-ED-003-D	2	09/13/63	Shale Fracturing Experiment ELECTRICAL PLOT PLAN & SECTIONS, & ELECTRICAL PLAN 7 SECT. FOR PUMP HOUSE	Approved for construction
E-10002-ED-004-D	2	09/13/63	Shale Fracturing Experiment ELECTRICAL SECTIONS & DETAILS	Approved for construction

Historical ORNL drawings of OHF (continued)

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
E-10002-ED-005-D	1	09/13/63	Shale Fracturing Experiment ELECTRICAL SCHEMATIC & WIRING DIAGRAM	Approved for construction
E-10002-ED-006-D	4 & 5	09/15/66	Upgrade Exist. Electrical Power LINE PLOT PLAN AND SUBSTATION DETAILS	Approved for construction
E-20974-ED-001-D		05/19/73	Improvements to Hydrofracture ELECTRICAL PLAN: ELEVATIONS & DETAILS	Approved for construction
H-10002-EE-040-D		09/11/63	Shale Fracturing Experiment DETAIL OF OFF-GAS FILTER	Approved for construction
H-10002-EE-043-D		11/10/66	Hydrofracturing Waste Disposal Facility OFF-GAS EXHAUST FILTER ASSEMBLY, SECTIONS AND DETAILS	Approved for construction
H-10002-EF-002-D		05/15/64	Shale Fracturing Experiment BUILDING EXHAUST SYSTEM AND FILTERS	Sketch
H-20974-EG-001-D		02/05/73	Improvements to Hydrofracture TANK AND PUMP HOUSE VENTILATION: PLAN AND NOTES	Approved for construction
H-20974-EG-002-D		03/07/73	Improvements to Hydrofracture TANK AND PUMP HOUSE VENTILATION SECTION	Approved for construction
H-20974-EG-003-D		03/07/73	Improvements to Hydrofracture TANK AND PUMP HOUSE VENTILATION: FAN AND FILTER INSTALLATION	Approved for construction
H-20974-EG-004-D		05/18/73	Improvements to Hydrofracture BUILDING AND MIXING TANK EXHAUST SYSTEM: PLAN AND ELEVATION	Approved for construction
H-20974-EG-005-D		03/07/73	Improvements to Hydrofracture BUILDING AND MIXING TANK EXHAUST FILTERS DETAILS	Approved for construction
I-10002-EE-034-D	0	09/10/63	Shale Fracturing Experiment INSTRUMENT PANEL DETAILS	Approved for construction
I-20974-QE-001-D	0	05/10/73	Improvements to Hydrofracture INSTRUMENT PANEL & VALVE CABINET	Approved

Historical ORNL drawings of OHF (continued)

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
I-20974-QE-003-D	0	05/10/73	Improvements to Hydrofracture VALVE PANEL TUBING	Approved
M-10002-E-025-D		07/02/63	Shale Fracturing Experiment DUST COLLECTOR PLATFORM: PLAN, SECTIONS & DETAILS	Preliminary; not for construction
M-10002-E-026-D		07/02/63	Shale Fracturing Experiment DUST COLLECTOR DETAILS	Preliminary; not for construction
M-10002-E-027-D		07/02/63	Shale Fracturing Experiment OFF-GAS PIPING: PLAN, ELEVATIONS, SECTIONS & DETAILS	Preliminary; not for construction
M-10002-E-028-D		07/02/63	Shale Fracturing Experiment DAMPER DETAILS	Preliminary; not for construction
M-10002-E-029-D		07/02/63	Shale Fracturing Experiment OFF-GAS FILTERS, FAN AND STACK: PLAN AND ELEVATIONS	Preliminary; not for construction
M-10002-E-030-D		07/02/63	Shale Fracturing Experiment OFF-GAS STACK AND PAD DETAILS	Preliminary; not for construction
M-10002-E-031-D	0	07/02/63	Shale Fracturing Experiment OFF-GAS FILTER HOUSING DETAILS	Preliminary; not for construction
M-10002-EE-004-D		03/05/63	Shale Fracturing Experiment MODIFICATIONS TO TANKS T-1 AND T-2	Approved for construction
M-10002-EE-005-D		03/05/63	Shale Fracturing Experiment MODIFICATIONS TO TANK T-9	Approved for construction
M-10002-EE-006-D		03/05/63	Shale Fracturing Experiment FLOAT INDICATOR DETAILS FOR TANKS T-1, T-2, & T-9	Approved for construction
M-10002-EE-009-D	2	09/13/63	Shale Fracturing Experiment TUB ASSEMBLY	Approved for construction
M-10002-EE-010-D	2	09/13/63	Shale Fracturing Experiment ARRANGEMENT OF BULK STORAGE TANKS, MIXER AND RELATED EQUIPMENT	Approved for construction

Historical ORNL drawings of OHF (continued)

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
M-10002-EE-011-D		09/13/63	Shale Fracturing Experiment HOPPER & MIXER ASSEMBLY	Approved for construction
M-10002-EE-021-D	0	09/13/63	Shale Fracturing Experiment HOPPER & MIXER DETAILS: SHEET NO. 1	Approved for construction
M-10002-EE-022-D	0	09/13/63	Shale Fracturing Experiment HOPPER & MIXER DETAILS: SHEET NO. 2	Approved for construction
M-10002-EE-023-D	1	09/13/63	Shale Fracturing Experiment TUB DETAILS: SHEET NO. 1	Approved for construction
M-10002-EE-024-D	1	09/13/63	Shale Fracturing Experiment TUB DETAILS: SHEET NO. 2	Approved for construction
M-10002-EE-042-D	1	09/16/66	Hydrofracturing Waste Tanks WASTE STORAGE TANKS NO. 3 & NO. 4	Approved for construction
M-20974-EE-001-D	1	03/07/73	Improvements to Hydrofracture MIXING TANK ASSEMBLY & DETAILS, SHEET NO. 1	Approved for construction
M-20974-EE-002-D		03/07/73	Improvements to Hydrofracture MIXING TANK DETAILS, SHEET NO. 2	Approved for construction
M-20974-EE-003-D	1	03/07/73	Improvements to Hydrofracture MIXING TANK DETAILS, SHEET NO. 3	Approved for construction
P-10002-EA-004-D	1	10/24/66	Hydrofracturing Waste Tanks PIPING PLAN -- SECTIONS & DETAILS	Approved for construction
P-10002-EC-001-D		03/27/63	Shale Fracturing Experiment HOT WASTE TRANSFER LINE	Approved
P-10002-EC-002-D		03/27/63	Shale Fracturing Experiment DETAILS & GENERAL NOTES: HOT WASTE TRANSFER LINE	Approved
P-10002-EE-001-D		03/05/63	Shale Fracturing Experiment STORAGE TANK PIPING PLAN	Approved for construction

Historical ORNL drawings of OHF (continued)

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
P-10002-EE-002-D		03/05/63	Shale Fracturing Experiment STORAGE TANK PIPING ELEVATIONS	Approved for construction
P-10002-EE-008-D	2	03/05/63	Shale Fracturing Experiment PUMP HOUSE: PIPING AND DETAIL	Approved for construction
P-10002-EE-012-D	3	09/13/63	Shale Fracturing Experiment AREA PIPING GENERAL PLAN	Approved for construction
P-10002-EE-013-D	1	09/13/63	Shale Fracturing Experiment PIPING IN WELLHEAD CELL	Approved for construction
P-10002-EE-014-D		09/13/63	Shale Fracturing Experiment PLAN AND SECTION OF WATER PUMP PIPING	Approved for construction
P-10002-EE-015-D	2	09/13/63	Shale Fracturing Experiment PLAN OF PIPING AT MIXING CELL	Approved for construction
P-10002-EE-016-D	2	09/13/63	Shale Fracturing Experiment PIPING SECTIONS AT MIXING CELL	Approved for construction
P-10002-EE-017-D	0	09/13/63	Shale Fracturing Experiment DETAILS FOR WELLHEAD & MIXING CELL	Approved for construction
P-10002-EE-032-D	0	09/13/63	Shale Fracturing Experiment HIGH PRESSURE PIPING DETAILS AT WELLHEAD CELL	Approved for construction
P-10002-EE-033-D	0	09/13/63	Shale Fracturing Experiment INSTRUMENT PANEL PIPING	Approved for construction
P-10002-EE-035-D		09/13/63	Shale Fracturing Experiment COMPRESSED AIR PIPING PLAN	Approved for construction
P-10002-EE-036-D	0	09/13/63	Shale Fracturing Experiment COMPRESSED AIR PIPING DETAIL SHEET 1	Approved for construction
P-10002-EE-037-D	0	09/13/63	Shale Fracturing Experiment COMPRESSED AIR PIPING DETAIL SHEET 2	Approved for construction

Historical ORNL drawings of OHF (continued)

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
P-10002-EE-041-D	1	10/28/66	Shale Fracturing Experiment WASTE STORAGE TANKS FLOW SHEET	Approved for construction
P-10002-EE-044-D		08/31/72	Hydrofracture PROCESS FLOW DIAGRAM	As built
P-10002-EE-045-D		08/31/72	Hydrofracture COMPRESSED AIR FLOW DIAGRAM	As built
P-11197-EA-001-D		08/04/66	Replacement of Plastic ILW Transfer Line PLAN AND PROFILE	Approved for construction
P-20974-EE-004-D		03/07/73	Improvements to Hydrofracture MIXING CELL: PIPING PLAN AND SECTION	Approved for construction
P-20974-EE-005-D		03/07/73	Improvements to Hydrofracture WELLHEAD CELL: PIPING PLAN & SUPPORT DET.	Approved for construction
P-20974-EE-006-D		03/07/73	Improvements to Hydrofracture WELLHEAD CELL: PIPING--SECTIONS	Approved for construction
P-20974-EE-007-D		03/07/73	Improvements to Hydrofracture PUMP HOUSE: SHIELDING DETAILS	Approved for construction
P-20974-EE-008-D		03/09/73	Improvements to Hydrofracture VALVE OPERATOR AIR PIPING AND TUBING INSTALLATION	Approved for construction
P-20974-EE-009-D		02/25/74	Improvements to Hydrofracture AIR PAD PIPING INSTALLATION AND FLEX. PIPE CONN. TIE DOWN	Approved for construction
P-20974-EE-010-D		02/25/74	Improvements to Hydrofracture AIR PAD PIPING INSTALLATION	Approved for construction
S-10002-EA-003-D	2	10/16/66	Hydrofracturing Waste Tanks WASTE TANKS T-3 & T-4: GRADING PLAN-INSTALLATION PLAN, SECTIONS & DETAILS	Approved for construction

Historical ORNL drawings of OHF (continued)

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
S-10002-EB-001-D	0	03/19/63	Shale Fracturing Experiment PUMP HOUSE: FOUNDATION PLAN & DETAILS	Approved for construction
S-10002-EB-002-D		03/19/63	Shale Fracturing Experiment PUMP HOUSE: PLAN & SECTIONS	Approved for construction
S-10002-EB-003-D	1	08/13/63	Shale Fracturing Experiment MIXING, PUMP & WELL HOUSE STRUCTURAL FOUNDATIONS: PLANS & DETAILS	Approved for construction
S-10002-EB-004-D	1	08/13/63	Shale Fracturing Experiment MIXING, PUMP & WELL HOUSE WALLS & ROOF: PLAN & SECTIONS SHEET NO. 1	Approved for construction
S-10002-EB-005-D		08/13/63	Shale Fracturing Experiment MIXING, PUMP & WELL HOUSE WALLS & ROOF: PLAN & SECTIONS SHEET NO. 2	Approved for construction
S-10002-EB-006-D		08/13/63	Shale Fracturing Experiment MIXING, PUMP & WELL HOUSE WALLS & ROOF: PLAN & SECTIONS SHEET NO. 3	Approved for construction
S-10002-EB-007-D		08/13/63	Shale Fracturing Experiment MIXING, PUMP & WELL HOUSE: ELEVATION Y-Y & WINDOW DETAILS (WINDOWS A, B, D & F)	Approved for construction
S-10002-EB-008-D		08/13/63	Shale Fracturing Experiment MIXING HOUSE WINDOW DETAILS: WINDOWS C, E & G	Approved for construction
S-10002-EB-009-D	1	09/13/63	Shale Fracturing Experiment T-4 WASTE PIT & P-3 PUMP FOUNDATION: PLAN, SECTIONS & DETAILS	Approved for construction
S-10002-EB-010-D	1	09/22/66	Hydrofracturing Blending Weigh Tank TANK SCALES FOUNDATION: PLAN & SECTION, GRADING PLAN	Approved for construction
S-10002-EE-003-D		03/05/63	Shale Fracturing Experiment STORAGE TANK INSTALLATION DETAILS	Approved for construction
S-10002-EE-039-D	0	09/12/63	Shale Fracturing Experiment PLATFORM & SHED AT NORTH SIDE OF MIXING CELL	Approved for construction

Historical ORNL drawings of OHF (continued)

Number[a]	Rev.[b]	Date[c]	Drawing Title	Status
S-20974-EB-005-D		03/07/73	Improvements to Hydrofracture MIXING CELL ROOF SHIELDING: PLANS, DETAILS & SECTIONS	Approved for construction
S-20974-EB-006-D		03/07/73	Improvements to Hydrofracture MIXING HOPPER HOIST: FRAMING PLAN, SECTION & DETAILS	Approved for construction
S-20974-EB-007-D		03/27/73	Improvements to Hydrofracture PUMP HEAD TROLLEY HOIST: PLAN, SECTIONS & DETAILS	Approved for construction

[a] For drawings, the first letter of the number indicates the general subject of the drawing:

A = architectural
C = civil
E = electrical
H = heating, ventilation, air conditioning
I = instrumentation
M = mechanical
P = piping
S = structural

[b] The revision space was left blank if no revision was indicated on the drawing.

[c] The date is the latest date that is readable on the ORNL drawing copy obtained by BNI.

Historical ORNL photographs of OHF-

Number[a]	Photograph Description
2133-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2134-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2135-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2177-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2178-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2179-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2180-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2181-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2182-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
2183-71	OHF construction: T-4 waste pit and pipe trench from Bldg 7852
3066-72	Moyno pump barrels. Rebuilt at Y-12 for use at ORNL. Spares for ILW transfer pumps. Rotor visible at near end (discharge flange). Note packing gland beyond suction flange. Packing is difficult to change.
3067-72	Covering stored clay with 4-mil plastic and canvas tarpaulins.
3068-72	Close up view of 6" rock bit after removal from hole. Bit showed no wear for four days drilling in shale.
3069-72	Contamination run down pit. Submersible air driven water removal pump in operation discharging into tank truck.
3070-72	Equipment on location. Drill rod on rack at the left. Casing on the ground at the right.
3072-72	Setting first casing section. Note centralizer which is used on every other length of casing. Casing shoe has been attached at bottom end. Shoe will catch the cementing ball pumped down to wipe casing clean of cement when annulus is full of cement.
3074-72	View showing top of chip catcher. Top piece is specially machined 4" pipe cap.
3075-72	Casing joint lowered. Vise grips casing below coupling to retain for disconnect of sub. Next casing length will screw into coupling. 800' of casing was set in hold.
3076-72	Connecting sub to casing coupling.
3077-72	Installing sub on swivel for setting casing.
3079-72	Drill assembly and drill rod stored on rack at drilling site. Bit is 6" tricone. Drill rod is 2 3/8". Four-inch chip catcher was necessary component, since 6" bit was oversize for combination of available drill rod and water pump capacity.
3080-72	Collection pit for runoff from contaminated drilling operation. Hoses at left convey compressed air to submerged pump and liquids to trailer. Hose at right background is used to pump out when water is not contaminated. Hose at right foreground is for wash water from well.
3081-72	Walking pallet of solids from delivery trailer to storage location.
3082-72	Bagged solids crew placing pallets for temporary storage at the Shale Fracture Plant.

Historical ORNL photographs of OHF (continued)

Number[a]	Photograph Description
3083-72	ORNL drilling crew at new well No. 200-S. Checking out bottom assembly before going down hole. From bottom up: 6" rock bit, connecting adaptor, coupling, 4" chip catcher.
3084-72	ORNL drilling rig at right is core drilling in one hole while contractor's cable tool rig is "churn drilling" at adjacent location. ORNL water supply tank and portable drilling pump is in the background. Well No. 300-E.
3086-72	Forklift with load from the truck.
3085-72	Forklift traveling to storage site. Help is needed to keep from dropping bags.
3087-72	Choker passed around pallets at the front of the truck.
3088-72	Forklift at the rear of the truck.
3089-72	Bagged clay delivery. Pallets have been pulled to the rear of the trailer for access by the forklift truck.
3090-72	Lower end of 6" rock bit tool setup has been withdrawn from well, 840' depth, and is hoisted upside down to remove chips from chip catcher. The man at the right is hammering catcher to dislodge chips.
3091-72	ORNL drilling operation. Drilling rig in the background. Tank truck is being filled with contaminated washings from drilling water pit. Casing is at the right on the ground.
3174-72	Truck loads of fly ash and cement spotted for unloading into weigh tank. Plant water supply tank, 25,000 gallons, is at the right.
3175-72	Spare Moyno pumps for the ILW pumping units at the pump house.
3176-72	Components for the dry solids mix are weighed into the weigh tank. One batch consists of 15,000 pounds of cement, 15,000 pounds of fly ash, and 3,000 pounds each of the two clays—grundite and attapulgite.
3177-72	Screw conveyor in operation. Bags are cut just prior to loading into conveyor hopper. Conveyor transports solids to top inlet nozzle of weigh tank.
3178-72	Bringing up another load for the screw conveyor.
3182-72	Bench mark No. 6-B showing stainless steel ball.
3182-72	Screw conveyor, the "bazooka," in operation by ORNL personnel.
3183-72	One of 60 ORNL hydrofracture bench marks. Note stainless steel ball imbedded in concrete at the bottom of excavated hole. Marker is aluminum angle.
3184-72	Survey rod. Calibrated by the Bureau of Standards. Numbers are reversed to accommodate telescope optics. Rod man must be able to hold rod perfectly steady.
3186-72	Surveying through the woods, accuracy to 0.1 mm at a distance of 30 meters.
3187-72	Level survey rod. Rod has level bubble, thermometer, and bracing rods.
3188-72	USGS survey party assisted by ORNL personnel. Umbrella shaded level at all times. Rods are positioned over bench marks.
3189-72	Dry solids open storage. Pallets are stacked two-high, covered first with polyethylene film, then with canvas tarpaulin.

Historical ORNL photographs of OHF (continued)

Number[a]	Photograph Description
3190-72	Halliburton engineer holding denosmeter, a device for continuously measuring density of grout mix.
3191-72	View showing screw conveyor and dry clay bags stored in the background. Fifteen truck loads of clay (600,000 pounds) were stored in the area for use in four injections, fall of 1972.
3192-72	Fly ash truck spotted for unloading into weigh tank. Truck capacity is 45,000 pounds. Compressed air control manifold can be seen beneath hopper at the right center.
3291-72	Screw conveyor in position for loading pulverized clays into weigh tank. Capacity of weigh tank is 50,000 pounds.
3292-72	View showing the four hoppers. Capacity 125,000 pounds of dry solids each.
3293-72	Hoppers are connected at the top with catwalks. Dust collector on the top of hopper No. 2 is partially visible. Blend tanks at lower level.
3294-72	View of 125,000-gallon-capacity emergency pond for Shale Fracture.
3295-72	Well No. 200-S cementing complete. Loading leftover bags for haul to next well.
3296-72	View from the south side of the plant. Fire hose at the right is run through culverts where necessary and for 300' on the surface to supply water to the cementing truck at the well.
3297-72	Cementing operation. Cutting bags and introducing additives.
3298-72	Radiator of ORNL HT-400 pumper at the right. Well cell in the background.
3299-72	Left side view of control room. Shielded window midway up the wall allows the view of dry solids falling through mass flow meter. Air slides from hoppers can be seen through upper windows.
3300-72	Standby pumper connected. Air slides under hoppers can be seen, leading to top of mixing cell.
3301-72	Cementing finished.
3302-72	Cementing well. Air compressor at the left for pumping run down pit water into tanker at the left rear. Halliburton service vehicle in center and pumper at right. Cement bags on ground in background.
3303-72	Interior view of beta-gamma logging trailer.
3304-72	North side of well cell. Shows initial path of ILW in well cell.
3305-72	Connecting slotting tool. Hydraulic power hoses from drive engine can be seen at the left.
3306-72	Raising tubing string to shorten and get ready for slotting.
3307-72	Control room, right side. Ten-speed remote shift control on quadro pod at the right. Operator can see mixing tube through window, reflected in mirror, not shown.
3308-72	West wall of mixing cell. Extensions protruding for mixing tub valves.
3309-72	Beta-gamma logging trailer in position for well survey.
3310-72	Grappling vise for slotting tool.

Historical ORNL photographs of OHF (continued)

Number[a]	Photograph Description
3311-72	ORNL mobile crane spotted in position for slotting. Slotting tool in center covered in fiber glass boot.
3312-72	Mixing cone and water jet connections shown in foreground. Halliburton and ORNL personnel.
3313-72	Cementing operation about to commence. Additives in the foreground. Mixing and suction tank at the left on the ground.
3314-72	Halliburton and ORNL personnel cutting cement bags.
3315-72	View of Shale Fracture Plant from the west side. Rock cover well in foreground. Beyond in sequence are: emergency pond, temporarily stored bagged clays, walls of operating pits, screw conveyor, blending tanks, and hoppers. Dust collector can be seen on top of hopper to the left.
3316-72	Monitor well with probe ready for lowering - Well No. 200-S.
3317-72	From left to right: standby pumper, ORNL injection pump, pump cell, mixing cell, and control room. Three hoppers visible.
3318-72	Shale Fracture tank farm collection sumps to contain leaks, if any.
3319-72	South wall of well cell. Standby pump connected. ORNL injection pump at the right.
3320-72	Slotting tools in position, supported by a 35-ton crane.
3321-72	Beta-gamma logging probe ready for lowering in to Well No. 200-S.
3322-72	Slotting swivel with jet catcher at top. Southwest corner of well cell.
3323-72	West wall of well cell. Control room to the left. Slotting swivel drive stored at the right in 30' storage tube below ground.
3324-72	Placing pallet of sand in preparation for slotting operation.
3325-72	ILW lead-shielded valve and manifold pit adjacent to ILW pump house. Drums of TBP in foreground for antifoaming use. Emergency pond in background.
3327-72	Man-handling cement bags for cementing operation at well No. 200-S.
3328-72	View of Shale Fracture from north side. Bagged solids in view. Injection proceeding.
3329-72	Cementing Well No. 200-S. Tanker ready to receive contaminated water from pit.
3330-72	Seismograph Company setup to cover injection shocks, if any.
3331-72	Halliburton Company standby pumper. Fresh water suction and swivel joint discharge lines connected. Injection position.
3333-72	North face of Shale Fracture well cell.
3334-72	Purging well before cementing using containment pit. Note color caused by cuttings.
3335-72	Hold-up pit for contamination drilling effluent circulation water.
3337-72	Halliburton Company cementing well No. 300-E.
3376-72	Receiving cement and flu ash prior to injection. Solids mixing proceeding.

Historical ORNL photographs of OHF (continued)

Number[a]	Photograph Description
8053-84	OHF aerial view (looking toward the southeast)
7445-88	View from ground of Building 7852 and the storage bins (looking toward the northeast)
2525-89	OHF aerial view (looking toward the south)

[a]Last two digits of identification number may give the year the photograph was taken.

Appendix B:
ES&H Surveys of OHF D&D Facilities

ORNL RI/FS Project
Job 19118

ES&H Survey Form

ocation: OHF-Bldg. 7852	HWP number: 05 0031	Survey number: 05 000 SR 169	Date: 3-9-94
escription: control room survey	Surveyor(s): Weatherford	Badge number(s): 688005	Time: 15:00

urvey type: ☒ Dose rate O Liquid ☒ Smear ☒ Direct frisk O Other

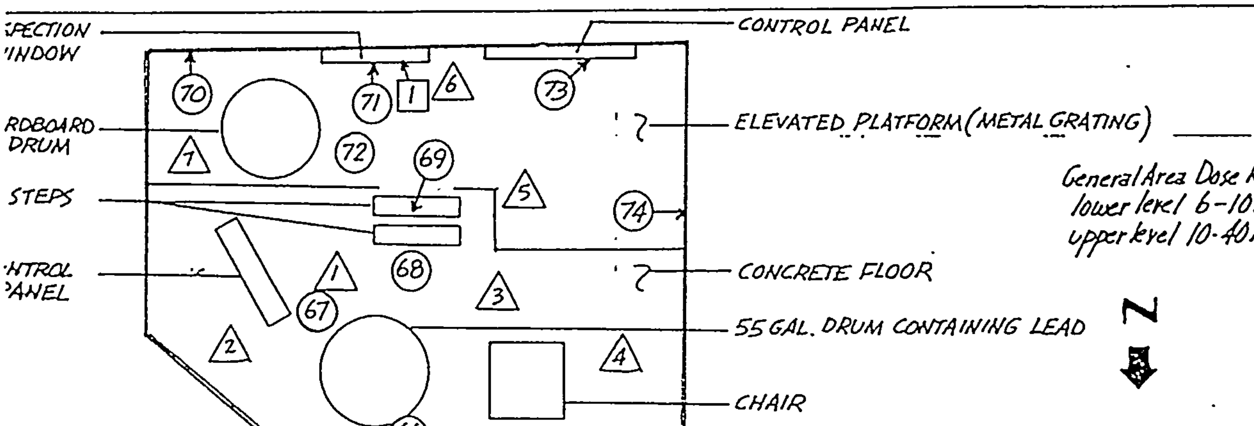
Radiation type: ☒ Alpha ☒ Beta ☒ Gamma O Neutron O Other

Smear results			Smear results			Direct frisk results			Dose rate results		
o	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
5)	<20	<200				1	~1000	N/A	1	40	40
7)	<20	2703				2	<300	↓			
3)	<20	451				3	↓	↓			
)	<20	935				4	↓	↓			
)	<20	<200				5	↓	↓			
)	<20	216				6	↓	↓			
2)	<20	227				7	↓	↓			
3)	<20	<200						↓			
2)	<20	2000						↓			

enotations:
- ○ - Smear
- △ - Direct frisk
- □ - Dose rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
RO-2	4042	N/A	N/A	<.2 mR/hr	response ck	B contact 3.8	3-26-94
ASP-1	4578	AC3-7	4047	<1 α	17.0	9.1	3-13-94
LB 5100	68828	—	—	DAILY	37.0	2.7/2.6 B/α	N/A

Comments: SMEAR LOCATIONS (66) on concrete floor, just inside doorway, (67) on concrete floor SE of 55 gal. drum, (68) on concrete floor, base of steps, (69) top step, (70) SE wall ~5½' up, (71) on inspection window, (72) on metal grating, (73) on control panel, (74) on W wall ~6' up



General Area Dose Rates:
lower level 6-10 mRad/hr
upper level 10-40 mRad/hr

NOT DRAWN TO SCALE

Health and Safety Technician (signature)

Field Health and Safety Supervisor (signature: Ed Kelley)

BECHTEL

ORNL RI/FS Project
Job 19118

ES&H Survey Form

Page 1 of ____

Location:	HWP number:	Survey number:	Date:
Old Hydrofracture Facility - Mixing Cell	05-0031	05.000 DA.409	4/15/94
Description:	**Surveyor(s):**	**Badge number(s):**	**Time:**
Initial Site Survey	P. Weatherford	688005	0926

Survey Type: ☒ Smear ☐ Direct Frisk ☒ Dose Rate ☐ Other

Radiation Type: ☒ Alpha ☒ Beta ☒ Gamma ☐ Neutron ☐ Other

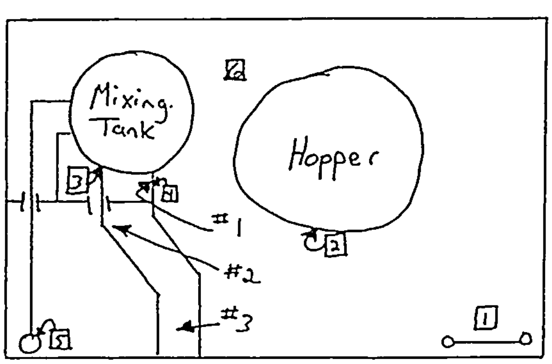
Smear			Smear			Direct Frisk			Dose Rate		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
1			12			#1	22,000	—	1	45	35
2			13			#2	57,200	—	2	100	80
3			14			#3	176,000	—	3	270	120
4			~~15~~ KNF					-	4	400	160
5			~~16~~ KNF						5	300	150
6			~~17~~ KNF						6	100	100
7											
8											
9											
10											
11											

Denotations:
- ✓ - Smear
- # - Direct Frisk
- ☐✓ - Dose Rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
Ludlum 2000	NA	43-10	NA	NA	NA	NA	NA
Ludlum 2000	NA	44-40	NA	NA	NA	NA	NA
RO-2	4043	—	—	∠.2 mr/hr	—	—	7-31-94
ASP-1	4578	AC-3-7	20T	∠1	11.4%	8.8	9-30-94
ASP-2	4034	HP210T	4977	35	10.%	64.5	9-22-94

Comments: Loose grout (≃1 to 2 inches deep) is present under the Hopper. Smaller amount located under Tank. Drawing below does not indicate the total number of pipe lines existing in the cell. Only access around Hopper is to the East. A horizontal pipe at 3' height and several vertical pipes inhibit access.

Smears
1. South Wall
2. South Wall
3. West Wall
4. West Wall
5. Top of Mixing Tank
6. Bottom of Mixing Tank
7. Top of Hopper
8. Bottom of Hopper
9. Floor, South West
10. Floor, Central Area
11. East Wall
12. East Wall
13. North Wall
14. North Wall



N ↑

Dose Rate
1. Bottom of ladder ~1m from floor
2. Hopper
3. Bottom of Mixing Tank
4. Pipe from Mixing Tank
5. Drain in floor
6. 1 meter From North Wall ~1 meter from floor

Ed Kelley for Paul Weatherford
Health and Safety Technician

Ed Kelley
Field Health and Safety Supervisor

ORNL RI/FS Project
Job 19118

ES&H Survey Form

Location: OHF-BLDG. 7852-PUMPCELL	HWP number: 05 0031	Survey number: 05 000DR.408	Date: 3-30-94
Description: INITIAL SURVEY.	Surveyor(s): WEATHERFORD	Badge number(s): 688005	Time: 10:00

Survey type: X Dose rate O Liquid X Smear O Direct frisk O Other

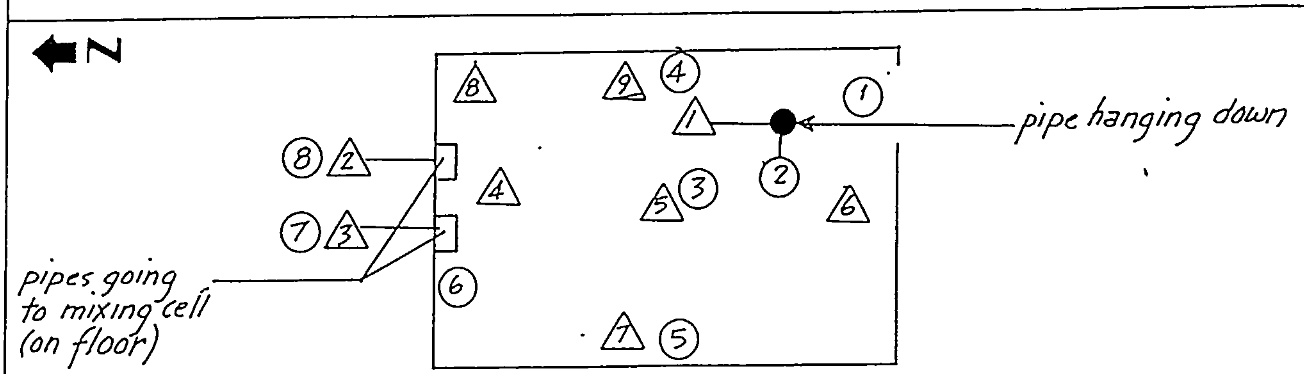
Radiation type: (EPK) X Alpha X Beta X Gamma O Neutron O Other

Smear results No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	Dose rate results No	Open mrad/hr	Closed mrad/hr
(1)	~100	45,000	△1	1000	800
(2)	~400	1,000,000	△2	3000	300
(3)	~400	250,000	△3	800	120
(4)	~100	10,000	△4	30	20
(5)	~100	8,500	△5	50	40
(6)	~100	20,000	△6	25	25
(7)	~14,000	1,000,000	△7	20	20
(8)	~100	4,000,000	△8	20	20
			△9	30	30

Denotations:
○ - Smear
- Direct frisk
△ - Dose rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
RO-2	4041	N/A	N/A	<.2mR/hr	response ck.	β contact 3.8	7-25-94
ASP-1	4044	HP210T	4276	25	10.0	64.5	9-23-94

Comments: DOSE RATES △1 △2 △3 ARE CONTACT READINGS - THE OTHERS WERE TAKEN APPROXIMATELY 1 METER ABOVE THE CONCRETE FLOOR - SMEARS (4) (5) (6) WERE TAKEN ON THE WALLS



Health and Safety Technician

Field Health and Safety Supervisor

ORNL RI/FS Project
Job 19118

ES&H Survey Form

Page 1 of ____

Location:	HWP number:	Survey number:	Date:
Old Hydrofracture Facility - Injection Well Cell	05-0031	05.000.0r. 410	4/13/94
Description:	**Surveyor(s):**	**Badge number(s):**	**Time:**
Initial Site Survey	P. Weatherford	688005	0815

Survey Type: ☒ Smear ☐ Direct Frisk ☒ Dose Rate ☐ Other

Radiation Type: ☒ Alpha ☒ Beta ☒ Gamma ☐ Neutron ☐ Other

Smear			Smear			Direct Frisk			Dose Rate		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
						#1	19,360		1	13	10
						#2	2,640		2	40	25
									3	80	28
									4	36	16
									5	46	24
									6	65	24
									7	150	46
									8	120	55
									9	340	300
									10	120	75
									11	100	75

Denotations	Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
o - Smear	Ludlum 2000	NA	43-10	NA	NA	NA	NA	NA
# - Direct Frisk	Ludlum 2000	NA	44-40	NA	NA	NA	NA	NA
☐ - Dose Rate	ASP-1	4578	AC3-7	207	<1	11.4%	8.8	9-30-94
	RO2	4034	—	—	<2 mR/hr	—	—	7-31-94
		4041						

Comments:

See attached drawing.

Ed Kelley for Paul Weatherford
Health and Safety Technician

Ed Kelley
Field Health and Safety Supervisor

ORNL RI/FS Project
Job 19118

ES&H Survey Form

Page 2 of ____

Location: OHF InJection Well Cell	HWP number: OS 0031	Survey number: 05.000.0r.410	Date: 4/13/94
Description: Initial Site Survey	Surveyor(s): Paul Weatherford	Badge number(s): 688005	Time: 0815

Survey Type: ☐ Smear ☐ Direct Frisk ☒ Dose Rate ☐ Other

Radiation Type: ☐ Alpha ☒ Beta ☒ Gamma ☐ Neutron ☐ Other

Smear			Smear			Direct Frisk			Dose Rate		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
									12	30	25
									13	17	14

Denotations	Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
o - Smear	Ludlum 2000		43-10					
# - Direct Frisk	Ludlum 2000		44-40					
☐ - Dose Rate								

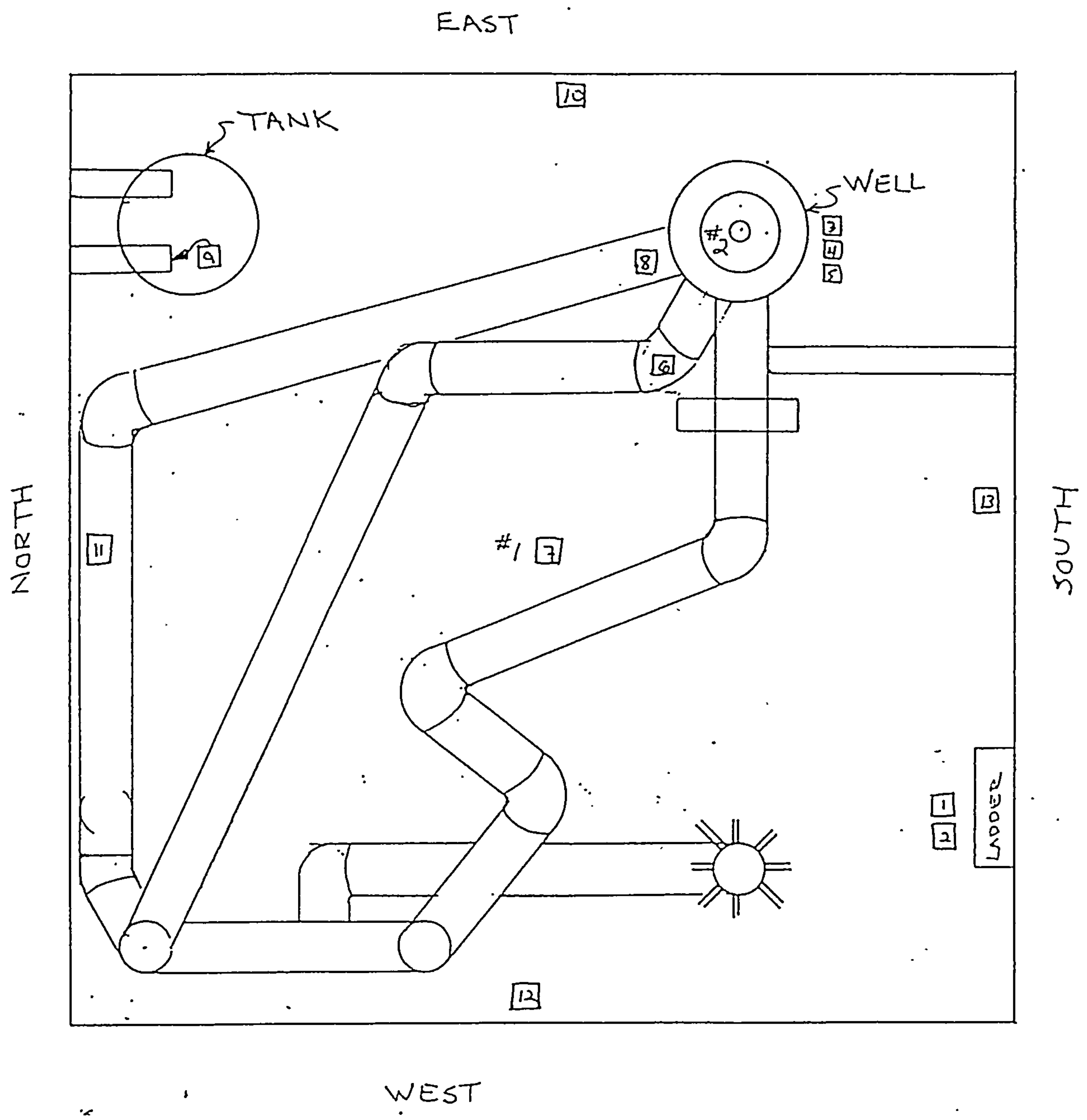
Comments:

Health and Safety Technician

Field Health and Safety Supervisor

Calculation Sheet

Originator ______ Date ______ Calc. No. ______ Rev. No. ______
Project ______ Job No. ______ Checked ______ Date ______
Subject ______ Sheet No. ______



OHF WELL CELL

ORNL RI/FS Project
Job 19118

ES&H Survey Form

ocation: *OHF - Bldg. 7852*	HWP number: *05 0031*	Survey number: *05 000 SR 168*	Date: *3-9-94*
escription: *concrete engine pad survey*	Surveyor(s): *WEATHERFORD*	Badge number(s): *688005*	Time: *10:30*

urvey type: (Dose rate O Liquid ☒ Smear ☒ Direct frisk O Other

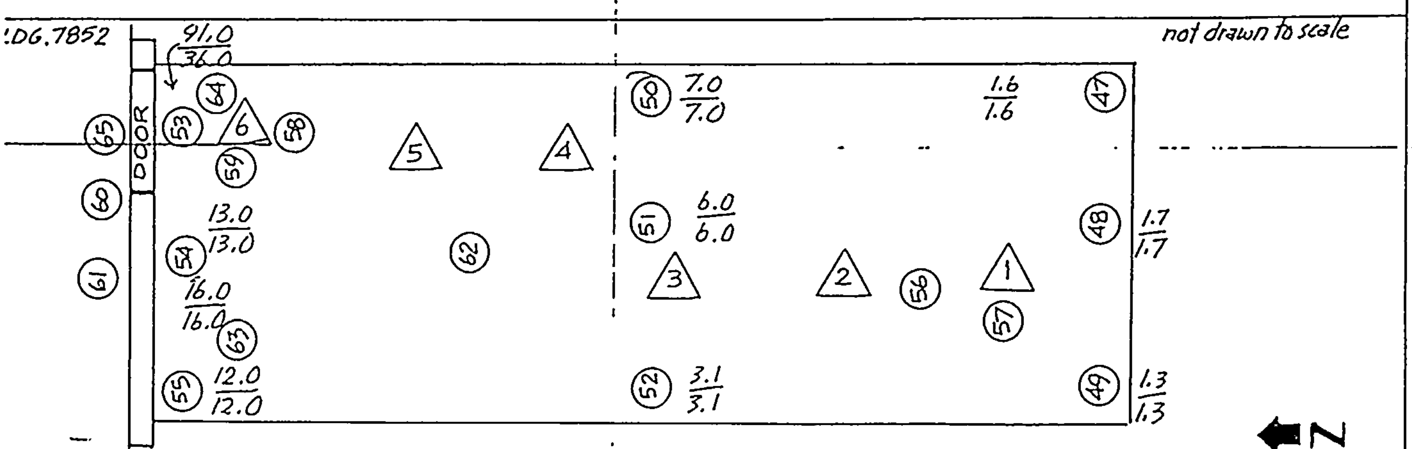
Radiation type: ☒ Alpha ☒ Beta ☒ Gamma O Neutron O Other

Smear results			Smear results			Direct frisk results			Dose rate results		
o	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
7)	<20	713	(58)	<20	18395	/1\	450	N/A		see diagram	
8)	<20	457	(59)	<20	4859	/2\	700	↓			
9)	<20	<200	(60)	<20	431	/3\	200	↓			
0)	<20	3239	(61)	<20	<200	/4\	300	↓			
1)	<20	5035	(62)	<20	3027	/5\	700	↓			
2)	<20	349	(63)	<20	6899	/6\	450	↓			
3)	<20	13932	(64)	<20	<200						
4)	<20	3027	(65)	<20	2073						
5)	<20	3147									
6)	<20	2462									
7)	<20	.3343									

enotations:
○ - Smear
△ - Direct frisk
#/# - Dose rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
RO-2	4042	—	—	<.2 mR/hr	response ck.	β contact 3.8	3-26-94
ASP-1	4578	AC-3-7	4047	<1 α	17.0	9.1	3-13-94
LB 5100	68828	—	—	DAILY CK.	37.0	2.7β / 2.6α	N/A

Comments:



D. Weatherford
Health and Safety Technician

Earl Kelley
Field Health and Safety Supervisor

ORNL RI/FS Project
Job 19118

ES&H Survey Form

Location: OHF
HWP number: 05 0031
Survey number: 05 000 SR 183
Date: 3-29-94

Description: Radiological Survey of Bin #-1, 2, 3, 4
Surveyor(s): Weatherford
Badge number(s): 688005
Time: 16:00

Survey Type: ■ Smear ■ Direct Frisk □ Dose Rate □ Other

Radiation Type: ■ Alpha ■ Beta ■ Gamma □ Neutron □ Other

Smear			Smear			Direct Frisk			Dose Rate		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
	< 20	< 200		< 20	< 200	* SEE COMMENTS					

Denotations

- o - Smear
- # - Direct Frisk
- □ - Dose Rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
Ludlum 2000	4440	43-10	4132	<1 α	40.1	2.494	7-94
Ludlum 2000	4446	44-40	6173	33 βγ	7.2	13.889	7-94
ASP-1	4046	AC3-7	4799	<1 α	17.0	9.3	5-30-94
ASP-1	4044	HP-210T	4276	30 βγ	10.0	64.5	9-23-94

* Comments: NOT ALL SURFACE AREA WAS ACCESSIBLE DUE TO SIZE, LOCATION IN CONJUNCTION WITH BLDG. 7852, AND GENERAL AREA BKG. LEVELS FOR BETA/GAMMA RADIATION - THE AREAS THAT WERE DIRECTLY FRISKED INDICATED LEVELS ≤ BACKGROUND READINGS FOR ALPHA, BETA/GAMMA RADIATION

[signature]
Health and Safety Technician

[signature]
Field Health and Safety Supervisor

ORNL RI/FS Project
Job 19118

ES&H Survey Form

Location: O.H.F.	HWP number: 05 0031	Survey number: 05 000SR 167	Date: 3-8-94
Description: PUMP SURVEY	Surveyor(s): WEATHERFORD	Badge number(s): 688005	Time: 1400

Survey type: O Dose rate O Liquid X Smear X Direct frisk O Other

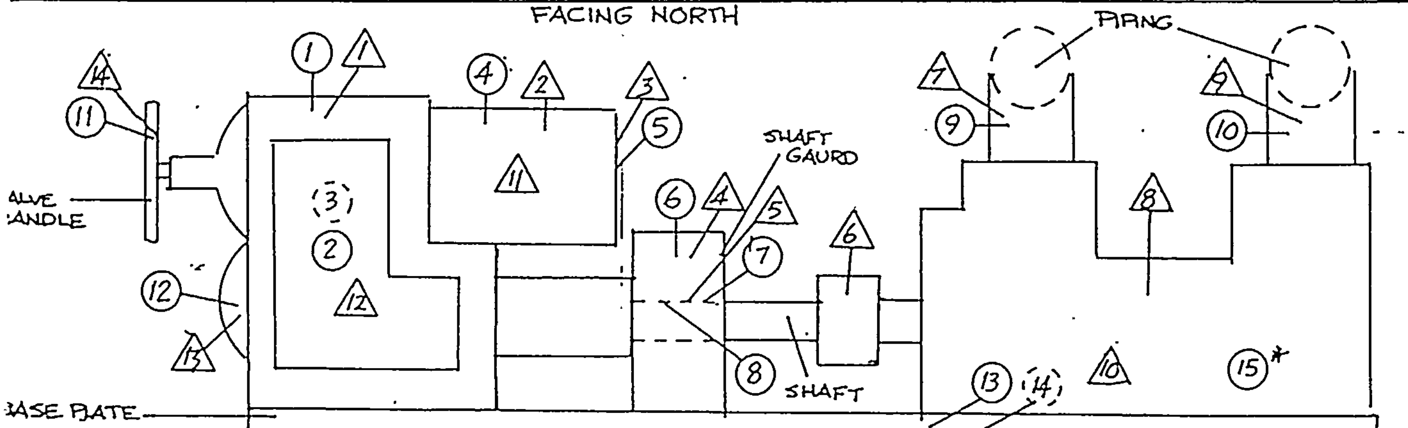
Radiation type: X Alpha X Beta X Gamma O Neutron O Other

Smear results			Smear results			Direct frisk results			Dose rate results		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
1	<20	<200	12	<20	<200	1	200	4000		N/A	
2	↓	↓	13	↓	↓	5	<200	30000			
3			14			7	<200	3000			
4			15			9	<200	5000			
5											
6											
7											
8											
9											
10											
11											

Denotations:
○ - Smear
△ - Direct frisk
- Dose rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
ASP-1	4578	AC3-7	4047	<1 α	17.0	9.1:	3-13-94
ESP	4058	HP210T	4061	40 βγ	10.0	64.5	3-22-94
LB 5100	68828	—	—	DAILY	37.0	2.7/2.6	N/A

Comments: NOT DRAWN TO SCALE - ONLY DIRECT FRISK RESULTS RECORDED ARE THOSE WHICK EXCEEDED BACKGROUND READINGS - *SMEAR (15) TAKEN ON VALVES BESIDE WATER TANK - SMEARS (3), (14) TAKEN ON NORTH SIDE OF PUMP



D. Weatherford
Health and Safety Technician

Ed Kelley
Field Health and Safety Supervisor

page 1 of 2

ORNL RI/FS Project
Job 19118

ES&H Survey Form

Location: O.H.F.	HWP number: 05 0031	Survey number: 06 000 SR 166	Date: 3-8-94
Description: WATER TANK SURVEY	Surveyor(s): WEATHERFORD	Badge number(s): 688005	Time: 1500

Survey type: O Dose rate O Liquid ☒ Smear ☒ Direct frisk O Other

Radiation type: ☒ Alpha ☒ Beta ☒ Gamma O Neutron O Other

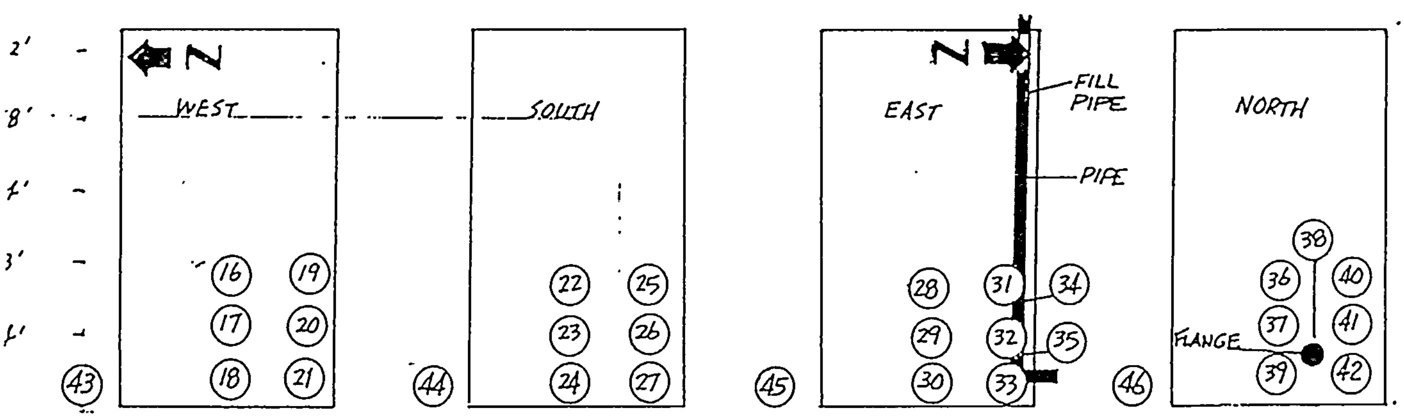
Smear results			Smear results			Direct frisk results			Dose rate results		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
16	< 20	< 200	27	< 20	< 200		< 300	< 1000		N/A	N/A
17	↓	↓	28	↓	↓		↓	↓		↓	↓
18			29								
19			30								
20			31								
21			32								
22			33								
23			34								
24			35								
25			36								
26	↓	↓	37	↓	↓		↓	↓		↓	↓

Denotations:

- Smear
- Direct frisk
- Dose rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	Eff. (%)	Cal. Factor	Calibration Due date
ESP 2	4058	HP210T	4061	40 6γ	10.0	64.5	3-22-94
LB5100	68828	—	—	CK. DAILY	37.0	2.7 β / 2.6 α	N/A

Comments: SMEAR (43) CONCRETE PAD NW CORNER NOT DRAWN TO SCALE
(44) SW CORNER
(45) SE CORNER
(46) NE CORNER



Health and Safety Technician

Field Health and Safety Supervisor

ORNL RI/FS Project
Job 19118

ES&H Survey Form
Smear/Direct Frisk Continuation Sheet

Location: O.H.F.	HWP number: 05 0031	Survey number: 70 000 SR 166	Date: 3-8-94

Smear Results				Direct Frisk Results			
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	Comments	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	Comments
38	<20	<200			<300	<1000	
39							
40							
41							
42							
43							
44							
45							
46							

Comments:

ORNL RI/FS Project_ ...
Job 19118

ES&H Survey Form

Location:	HWP number:	Survey number:	Date:
OHF (pump house)	05 0031	05 000 DR 159	3-22-94
Description:	**Surveyor(s):**	**Badge number(s):**	**Time:**
Initial ES&H Survey	WEATHERFORD	688005	1430

Survey type: ✓ Dose rate O Liquid ✓ Smear O Direct frisk O Other

Radiation type: ✓ Alpha ✓ Beta ✓ Gamma O Neutron O Other

Smear results			Smear results			Direct frisk results			Dose rate results		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
(1)	<20	6.5 K	(12)	<20	8 mRad						
(2)	↓	14 K									
(3)	↓	6.5 K									
(4)	↓	52 K									
(5)	↓	180 K									
(6)	↓	10 K									
(7)	↓	25 K									
(8)	↓	600 K									
(9)	↓	660 K									
(10)	↓	110 K									
(11)	↓	6 mRad									

Denotations:
- ◯ - Smear
- · Direct frisk
- ☐ - Dose rate

Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
RO-2	4041	N/A	N/A	<2mR/hr	response ck.	@ contact 3.8	7-25-94
JOHNSON EXTENDER	6283	N/A	N/A	<25 uR/hr	response ck.	@ contact 1.0	6-4-94
ASP-1	4058	HP260	4060	40 cpm βγ	10%	64.5	7-16-94
ASP-1	4046	AC3-7	4799	<1 cpm α	17%	9.3	5-30-94

Comments: see attached sheet for dose rates and smear location information

[signature: Weatherford]
Health and Safety Technician

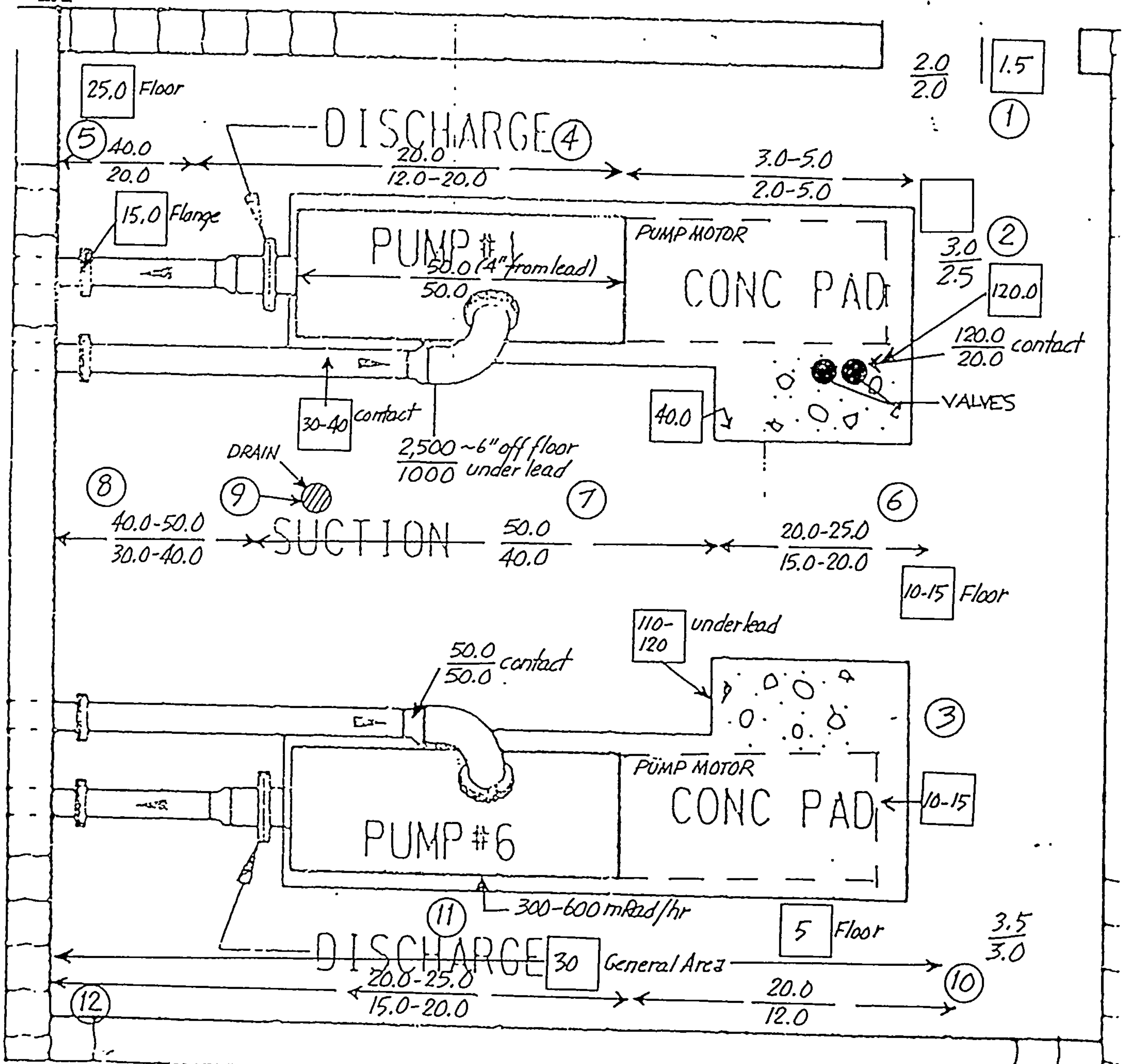
[signature: Ed Kelley]
Field Health and Safety Supervisor

...2 readings

all dose rates @ 1 m unless otherwise noted
top reading = open window (mRad/hr), bottom reading = closed window (mR/hr)

☐ EXTENDER readings (open window only - mRad/hr)

◯ Approximate smear locations (results are on page 1)



ORNL RI/FS Project
Job 19118

ES&H Survey Form

Location: OHF - Bldg. 7852	HWP number: 05 0031	Survey number: 05 000 SR 170	Date: 3-10-94
Description: Initial Roof Survey	Surveyor(s): WEATHERFORD	Badge number(s): 688005	Time: 10:00

Survey type: ☒ Dose rate O Liquid ☒ Smear O Direct frisk O Other

Radiation type: ☒ Alpha ☒ Beta ☒ Gamma O Neutron O Other

Smear results			Smear results			Direct frisk results			Dose rate results		
No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Alpha dpm/100cm²	Beta/Gamma dpm/100cm²	No	Open mrad/hr	Closed mrad/hr
(75)	<20	<200	(86)	<20	<200						
(76)	<20	<200	(87)	<20	<200						
(77)	<20	<200	(88)	<20	<200						
(78)	<20	<200	(89)	<20	<200						
(79)	<20	300	(90)	<20	<200						
(80)	<20	<200									
(81)	<20	<200									
(82)	<20	<200									
(83)	<20	<200									
(84)	<20	<200									
(85)	<20	<200									

Denotations:

O - Smear
- Direct frisk
#/# - Dose rate

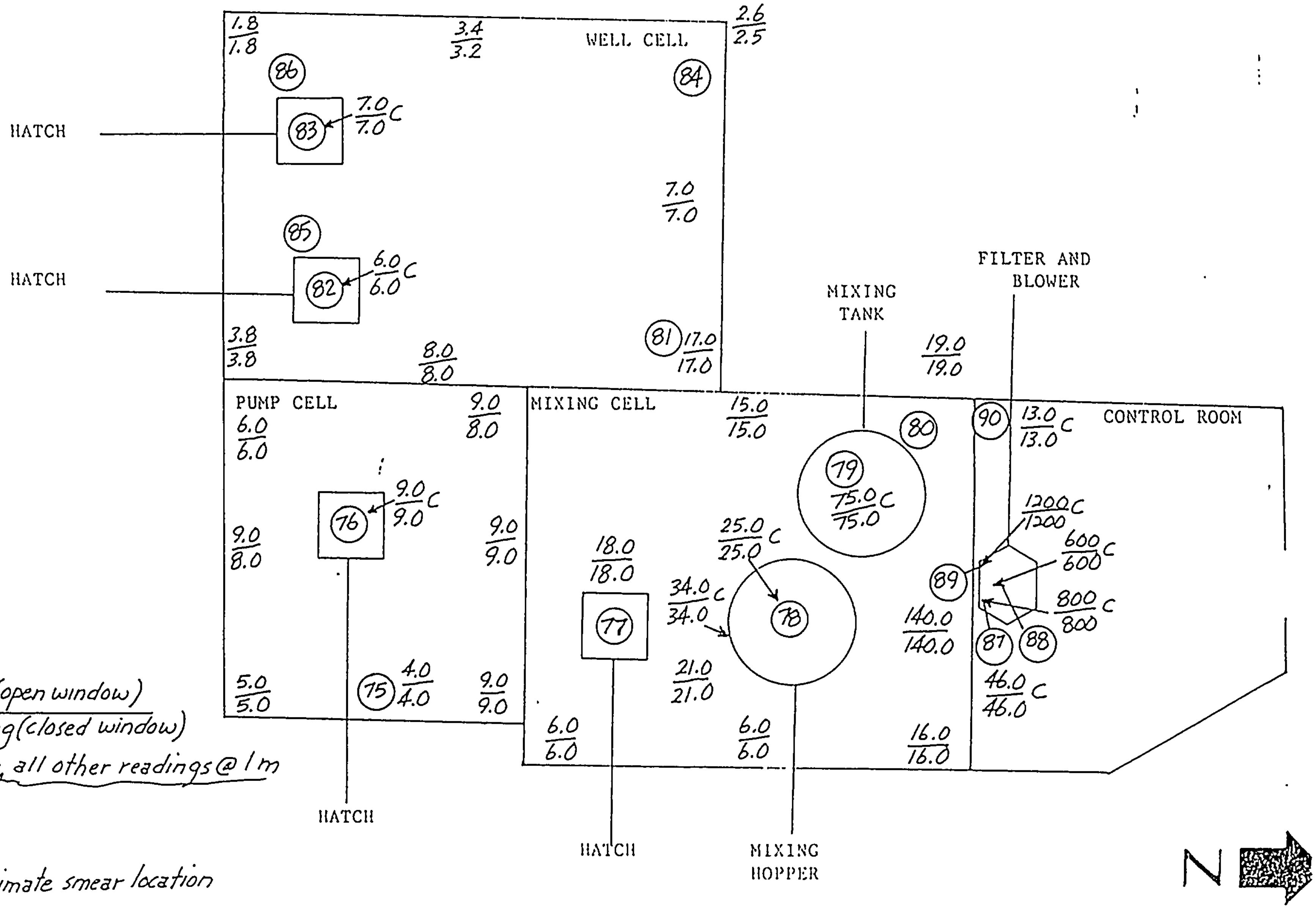
Instrument	Serial Number	Probe	Serial Number	BKG (cpm)	EFF. (%)	Cal. Factor	Calibration Due date
RO-2	4042	—	—	<.2mR/hr	response ck.	B- contact	3-26-94
LB5100	68828	—	—	DAILY	37.0	2.7 β / 2.6 α	N/A

Comments: SEE ATTACHED DIAGRAM FOR DOSE RATES AND SMEAR LOCATIONS

[signature]
Health and Safety Technician

[signature: Earl Kelley]
Field Health and Safety Supervisor

ROOF AREA DIAGRAM
(not drawn to scale)



top reading (open window)
bottom reading (closed window)

C = contact, all other readings @ 1m

1 mRad/hr
1 mRem/hr

(#) = approximate smear location

Appendix C:
Structural Evaluation of OHF

WAG 74
STRUCTURAL INTEGRITY EVALUATION FOR DECONTAMINATION AND DECOMMISSIONING OF THE OLD HYDROFRACTURE FACILITY PUMP HOUSE AT OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENNESSEE

1.0 PURPOSE

The pump house at the Old Hydrofracture Facility (OHF) is being decommissioned. This structural evaluation provides information to be used in developing a detailed approach for dismantling and disposing of the structures. This inspection is being performed in accordance with the *Site Characterization Plan for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (Bechtel, January 1994), Section 5.3.

Because conditions were restrictive, the inspection was performed by video from a distance of approximately 20 ft; access to the interior of the pump house was not available, and the evaluation is limited.

2.0 PUMP HOUSE

2.1 Location and Usage

OHF, also known as HF-3, is approximately 1 mile southwest of the main Oak Ridge National Laboratory (ORNL) complex. Approximate ORNL site coordinates for the pump house are N17192, E28561. Approximate construction date is 1963-1964. The pump house contains a dual-compartment valve pit and room with two large pumps that were used to draw radiological waste from the OHF underground waste storage tanks to Building 7852.

2.2 Construction and Description

The pump house is a building of concrete masonry unit (CMU) construction measuring approximately 24 ft 4 in. in length (east-west) and 15 ft 8 in. in width (north-south). CMUs are nominally 8 in. thick. Based on the building use and shielding requirements, it may be assumed that all cells of the CMU are grouted and vertical reinforcement is 1-#5 bar at a spacing of 16 in. Waterproofing compound has been applied to those portions of the wall below grade, as evidenced by exposed compound.

The north side of the building is 10 blocks high with an additional 8-in. lintel; the south side is approximately 18 blocks high. Three large electrical conduits with electrical panels are mounted on the exterior face of the north wall. These conduits go below grade at a distance of 1 ft from the face of the wall.

Interior equipment and facilities were not inspected due to entrance restrictions.

Readily apparent appurtenances to the pump house bins include a blower and 4-in.-diameter pipe valve and piping mounted on the south wall.

Additional information is provided in (Bechtel, January 1994).

2.2.1 Pump Room

The roof is corrugated sheet metal, possibly 22 gage. Subroofing may include plywood and 1/4-in.-thick sheet steel. The roof is monoslope, downward from the south side toward the north side. A gutter extends the full length of the north edge of the roof and slopes toward one downspout at the northwest corner of the building. A stainless steel or aluminum plate surrounds the perimeter of the building, closing off any space between the roof and the top of the masonry construction. Due to entrance restrictions, ceiling materials, if any, could not be viewed.

2.2.2 Valve Pit

The valve pit is totally below grade with the exception of the roof and the uppermost 8 in. of the walls. The roof of the valve pit consists of a 1/4-in.-thick steel sheet on top of which are 64 lead plates that are nominally 18 in. by 18 in. and 1/2 in. thick. Some of the lead plates are furnished with handles for lifting, although most are severely corroded and their ability to lift the lead plates is questionable. Due to entrance restrictions, ceiling materials, if any, could not be viewed.

3.0 INSPECTION FINDINGS

The CMU walls are in good condition. No significant leaching, spalling, rust stain, or other defects were observed. The corrugated sheet metal roof has rust over its entire top surface, but deterioration of the corrugated metal was not observed. Subroofing appears in good condition.

The 1/4-in.-thick steel sheet roof of the valve pit is covered with rust over the total exposed surface, and the lead sheets are warped and handles severely corroded.

4.0 STRUCTURAL EVALUATION

The pump house walls are in good structural condition, but roof support structures cannot be evaluated.

5.0 SUMMARY

This building is considered to be structurally able to withstand preplanned demolition activities without collapse, although personnel should be prohibited from working on the roofs unless further inspection or analysis is performed to ensure worker safety.

6.0 REFERENCES

1. ACI 201.1R-68 Guide for making a Condition Survey of Concrete in Service.

2. ANSI/ASCE 11-90 Guidelines for Structural Condition Assessment of Existing Buildings.

3. ORNL/ER/Sub/87-99053/70, *Site Characterization Plan for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (Bechtel National, Inc., January 1994).

STRUCTURAL INTEGRITY EVALUATION FOR DECONTAMINATION AND DECOMMISSIONING OF OHF BULK SOLIDS BINS 1, 2, 3, and 4

1.0 PURPOSE

The bulk solids bins at the Old Hydrofracture Facility (OHF) are being decommissioned. The structural inspection and this evaluation provide information to be used in planning to develop a detailed approach for dismantling and disposing of the structures. This inspection is being performed in accordance with the *Site Characterization Plan for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (Bechtel, January 1994), Section 5.3.

Because inspection conditions were restrictive, the inspection was performed from grade using video. Access was not available to view the bin roofs and other elements, thus limiting the effectiveness of this evaluation. An additional video of the roof structures was reviewed, and applicable observations are included in this document.

2.0 BULK SOLIDS BINS

2.1 Location and Usage

OHF, also known as HF-3, is approximately 1 mile southwest of the main Oak Ridge National Laboratory (ORNL) complex. Approximate ORNL site coordinates are (1) Bin 1, N17180, E28608; (2) Bin 2, N17188, E28638; (3) Bin 3, N17172, E28645; (4) Bin 4, N17155, E28643. Approximate construction date is 1963-1964. The bulk storage bins stored cement, fly ash, and other solids prior to mixing with waste to form the pumpable grout.

2.2 Construction, Description, and Condition

The bulk storage bins are 20-ft-high, 12-ft-diameter plate steel bins, supported on wide flange structural steel members and braced with structural tubing members. The bins are covered with flat steel plate. Penetrations for equipment, access, and piping exist in the roofs. These vertical, cylindrical bins have conical bottoms that stop at approximately 25 ft above grade. The wide flange columns are anchored to concrete piered foundations with four anchor bolts at each column.

Appurtenances to the bins include a blower by Bin 2, a bag house on top of Bin 2, ventilating equipment under Bin 3, an air compressor under Bin 1, catwalks, screw conveyors, and access ladders. No equipment exists below Bin 4 and there are numerous pipes beneath Bin 2.

Additional information is provided in Bechtel (1994).

3.0 INSPECTION FINDINGS

3.1 General

The findings in this section are applicable to all bins unless specifically excluded.

The surfaces of the steel bin walls and roofs, structural columns, and bracing members show extensive surface corrosion (in excess of 50%). Existing conditions include large amounts of peeled paint and rust stains. Corrosion on the walls is primarily due to manual hammering on the outside walls performed to loosen the solids within the bins.

At the lower levels of the support frame, flanges show considerable corrosion. Flange corrosion is frequently completely through the thickness of the flange and sufficient to reduce the width of the flange from one-quarter to one-half of the full width of the flange. This condition is generally found at the connections of bracing to the columns.

Connections of bracing members to the plates attached to columns also are severely corroded. This corrosion has resulted in delamination of the steel plates through the entire thickness of the plates. Corrosion at the welds connecting braces to steel plates has resulted in severance of at least one bracing member.

Severe corrosion is apparent at the column-to-baseplate connections. Column-to-baseplate welds could not be inspected, but the severe corrosion at these locations makes their integrity highly questionable.

Catwalks between bins are corroded with accompanying loss of structural capacity. Bin lifting lugs are also structurally inadequate due to loss of sound steel material.

3.2 Bin 1

Columns are wide flange sections supported on pinned supports that in turn are supported on 24-in.-diameter concrete piers. The grout beneath the baseplate and the top of the pier is approximately 3 to 4 in. thick, shows significant cracking, and is rust stained. Grout cracking may be due to rust formation, expansion forces, and/or excessive compression forces. Anchor bolts are corroded, and some anchor bolts show inadequate projection above the face of the nut. Adequate projection is required to develop the tensile strength of the anchor bolt material.

Pinned connections at the piers show corrosion, especially at the weld connecting the structural column to the baseplate. Column flanges show heavy corrosion, reducing flange effective widths by 50%. The concrete piers are in good condition.

Only one lifting lug could be viewed and it appears to be undamaged. However, at the weld connecting the lug to the roof, there is a dark line that may either be corrosion or a crack in the weld or base material. Handrails on Bin 1 have no toeplates.

3.3 Bin 2

Structural connections and column flanges are severely corroded. Bin 2 has a caged access ladder that begins at approximately 15 ft above grade. The ladder and cage display extensive surface corrosion. Ladder connections to the supporting members and ladder rung connections could not be inspected directly but are probably of the same or greater level of corrosion as other connections on the structure. On the roof, the handrail has a screened toeplate. Lifting lugs are severely corroded.

3.4 Bin 3

In addition to the general findings, one bracing connection showed complete separation of the brace from the connection plate due to the combined effects of corrosion and overloading as the capacity of the brace was reduced. This brace is no longer structurally functional.

The connections of the catwalk beams from Bin 4 to Bin 3 are corroded and deteriorated; approximately 1 in. of bearing length remains to support the weight of the catwalk and any personnel loads that may be placed thereon. Lifting lugs are severely corroded. Handrails on Bin 3 have no toeplates.

3.5 Bin 4

In addition to the general findings, one baseplate was fabricated with notches of approximate dimensions 2 in. by 2½ in. Handrails on Bin 4 have no toeplates.

4.0 STRUCTURAL EVALUATION

It cannot be determined that the bulk solids bins are structurally impaired due to excessive corrosion. The bins themselves do not appear to have experienced serious structural damage. The support structures and bracing systems are inadequate to safely withstand personnel usage in combination with loads generated by winds. Failure of the support structure can be expected upon excessive wind loads or other impact to the structure including earthquake activity. Personnel should be kept at a distance sufficient to prevent harm in the event of a collapse.

A structural disposition on the bin roofs, catwalks, and access ladder cannot be made. Usage of the roofs should remain limited, although the possibility of a roof collapse could not be evaluated based on the limited inspection. A closer inspection of the roofs and the handrails on the roofs should be performed to evaluate worker use and safety. Until that has been performed, no concentrated loads in excess of 100 lb should be allowed on the roofs. Personnel and other loads should be distributed to apply no more than 5 lb/ft^2 of roof surface. The ladder and catwalks should not be used unless prior testing or inspections are performed to assess the remaining structural capacity.

5.0 SUMMARY

The bin cylinders are considered to be structurally able to withstand preplanned demolition activities without collapse. The bin support structures are not structurally able to safely withstand demolition activities, using personnel in combination with loads due to winds. During demolition, inspection, or other activities, personnel should be prohibited from working on the bins or using the catwalks, ladders, or the support structures unless further inspection or analysis is performed to ensure worker safety. During high winds (greater than 30 mph), personnel and equipment should be cleared from the area.

6.0 REFERENCES

1. ANSI/ASCE 11-90, "Guidelines for Structural Condition Assessment of Existing Buildings."
2. ORNL/ER/Sub/87-09053/70, *Site Characterization Plan for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Bechtel National, Inc., January 1994.

WAG - 74
STRUCTURAL CONDITION ASSESSMENT FOR DECONTAMINATION AND DECOMMISSIONING OF THE OLD HYDROFRACTURE FACILITY - BUILDING 7852 AT THE OAK RIDGE NATIONAL LABORATORY OAK RIDGE, TENNESSEE

1.0 PURPOSE

The purpose of this structural condition assessment is to document the existing condition of Building 7852 so that the worker safety concerns may be appropriately considered and addressed during the dismantlement process, and to facilitate the planning of dismantlement activities.

This assessment is being performed at the direction of the *Site Characterization Plan for the Old Hydrofracture Facility* Section 5.3, (Reference 4).

2.0 BUILDING 7852

2.1 Location and Usage

The Old Hydrofracture Facility (OHF), also known as HF-3, is located approximately 1 mile southwest of the main Oak Ridge National Laboratory (ORNL) complex. Approximate ORNL site coordinates of Building 7852 are N17,150, E28,620. The facility consists of five areas: the control room, mixing cell, pump cell, wellhead cell and engine pad.

2.2 Construction and Description

Building 7852 was built approximately during 1963-1964. Building 7852 is a concrete masonry unit (CMU) building of shear and load bearing wall construction. Wall thicknesses are estimated to be 12 inches as evidenced by the double wythe construction of 6 in. thick CMU at the top of the wall. Overall building and room dimensions are provided in Figure 2.2 and Table 2.1 of the Site Characterization Plan (Ref.4).

One modification to the 1963-1964 structure was the installation of a structural steel frame for a hoist on the roof of the mixing cell. Another modification was the addition of ½ in. thick lead and steel sheets on the roof of the mixing cell for shielding purposes (Ref. 4, Section 2.1.1).

3.0 EXAMINATION RESULTS

3.1 Methodology

Due to administrative controls, access to the inside of the building was not permitted at the time of the examination. The interior of the building was not examined. Later video and photographs of the building were taken and have been used in developing this assessment. For the purposes of this assessment, east is taken as the side of Building 7852 facing bulk solid Bin 3.

3.2 Walls

3.2.1 General

The exterior walls of building 7852 are constructed of a double-wythe of 6-in.-thick concrete masonry units (CMU) built to an approximate height of 12 ft. 4 in. at the peak of the roof. Construction is rough and grooves are unfinished. Masonry is of undeterminable strength. Mortar joints appear sound. All exterior walls are painted. The interior faces of the wall display staining, leaching and peeled paint.

Window and doors have 8 in. deep lintels above the door or window which extend 6 to 8 in. on either side of the door or window. The windows also have a 3 in. deep lintel at the base of the window. No structural cracking or problems unless specified below.

Major structural concerns include efflorescence (leaching of material) and rusting of reinforcement both of which are evident on the surface of the walls. Additional detail on architectural features is given in the Site Characterization Plan (Ref. 3).

3.2.2 East Wall

There are pipe and other penetrations in this wall. Miscellaneous metal appurtenances (e.g. hose reel) exist on the wall. Several conduits are mounted on the east wall particularly near the roof.

3.2.3 North Wall

A personnel door is located on the north west wall.

3.2.4 West Wall

The west wall has minor vertical cracks (less than 1 mm) and is painted. The paint is flaking and peeling over the entire painted area. The west and south walls of the wellhead cell display what appears to be a significant structural crack ((70-PL-001-032-11).

Conduit and electrical panels or window closures are located on the west wall. A 4 inch diameter pipe or conduit exists the facility through the west wall at 15 inches above grade and goes below grade within 2 feet of the wall. Four valve handles extend from within the mixing cell through the west wall. An additional 5 valve handles extend through the north wall of the wellhead cell with some interconnection piping.

3.2.5 South Wall

The surfaces of the walls show no cracking, leaching, or presence of voids. However, there is some peeling of paint, minor popouts, discoloration, or other indications of poor construction or of concrete surface deterioration. The south wall has one window.

A personnel door is located on the south wall.

3.3 Roofs and Ceilings

3.3.1 Engine Pad

The roof is corrugated sheet metal and has no ceiling. The roof is monoslope, from the west side downward to the east side. The roof metal is supported on light gage steel channel and angle purlins, 2 to 4 inches deep, which in turn are supported by four 3-in. diameter steel pipe sections.

The corrugated sheet metal roof has rust over its entire top surface. The lower surface of the roof appears clean with minor rusting at connections to the supporting purlins. The corrugated sheet metal roof is supported by light gage steel purlins in both horizontal directions.

The purlins are connected to the structural steel 3-inch diameter columns. The steel purlins exhibit light rusting.

3.3.2 Mixing Cell

The roof consists of sheets of the steel and/or lead which are visible at the edges of the roof (70-PL-002-034-025). The roof appears to be in good condition. The ceiling consists of light metal gage paneling attached at the level of the bottom of the steel purlins. Paint on the ceiling panels is peeling and flaking with corrosion of the ceiling (70-PI-002-022, 70-PI-002-034-007, and 70-PI-002-034-009). The mixing cell has a hatch for entry.

3.3.3 Control Room

The roof construction of the control room is unknown but appears to be the same as the roof of the mixing cell. The roof appears to be in good condition. The ceiling consists of light metal gage paneling attached at the level of the bottom of the steel purlins (70-PL-027-20A and 21A).

3.3.4 Pump Cell

The roof construction of pump cell is unknown but also appears to be the same as the roof of the mixing cell. The roof appears to be in good condition. The ceiling consists of light metal gage paneling attached at the level of the bottom of the steel purlins (PL-001-032-03 and 04). It is reported that the pump cell has a hatch in the roof.

3.3.5 Wellhead cell

The roof consists of sheets of the steel and/or lead which are visible at the edges of the roof. The roof appears to be in good condition. The roof of the wellhead cell also is covered with metal plates nominally 6 inches wide by ½ inch thick (70-PL-001-028-017). The ceiling consists of light metal gage paneling attached at the level of the bottom of the steel purlins. The wellhead cell has two hatches for entry (Ref. 6, PL-001-032-15). The roof slopes from the east downward to the west.

3.4 Floor

The floors of all rooms are concrete and are covered with waste of different types (70-PL-001-032-01, 70-PL-001-027-22A). Overall, the floor is in good condition and shows some minor random cracking. The wellhead cell has a sump, of unknown size, covered with grating (PL-001-032-019). The mixing cell has a floor drain in the south west corner.

3.5 Stairs

Building 7852 has two stairs. A main stair from grade to the roof of the building on the east side of the pump cell and a 3-step stair built in one unit is located on the north face of the wellhead cell to access five valves.

The main stair is steep relative to current OSHA guidelines. The stair is heavily coated with paint prohibiting the close inspection of joints and connections. Connections of treads to structural members show significant corrosion accompanied by flaking of paint and the steel. The connections of the stairs to the roof of the facility appear in good condition.

The 3-step stair leads to a 2 ft x 3 ft platform 30 inches above grade. There are no handrails. The structural steel stair located on the outside face of the north wall of the wellhead cell, has moderate corrosion at the tread support connections, and at all welded connections. The 3-step stair is severely rusted with peeled and flaking paint.

3.6 Ladders

The only ladder on the exterior the facility is located on the west wall of the wellhead cell. The ladder extends from grade to the roof. The ladder does not extend above the roof. There is some corrosion at the base of the ladder, and corrosion at the connections of rungs to rails varies from light to very heavy. Connections of the ladder to the masonry wall do not show corrosion or damage or surrounding masonry. All hatches in the roof lead to ladders which extend from the roof to the floor of the respective cell. These ladders terminate below the hatch and are not constructed to protrude through the roof when opened.

3.7 Handrails

No deterioration was observed on the stair handrails or at the connections of those handrails to the stair structural members. Significant corrosion of the connections attaching the handrails to the roof was observed, primarily those located on the north and west walls of the wellhead cell. The plate material used in these connections showed considerable loss in the thickness and of the nominal plate area with resulting loss of structural capacity. There are no toeplates on the roof handrails.

3.8 Foundations

The foundations are all below grade and were not examined.

3.9 Engine Pad

The engine pad is a concrete slab, approximately 10 ft. by 22 ft. 6 in. in dimension. Conduit, 1½in. and 2 in. in diameter project through the slab carrying cables from the remainder of the building.

3.10 Appurtenances

Three electrical conduits with electrical panels are mounted on the exterior face of the west wall. The conduits are buried upon leaving the facility. The hoist support frame on the roof of the mixing cell shows extensive corrosion. Additional details on the hoist structure are given in Section 2.1.1 of the Site Characterization Plan (Ref. 3). The control room has a ventilation unit mounted on its roof (70-PL-002-034-024).

As noted in the Structural Condition Assessment for the Bins (Ref 5), Bins 3 and 4 each have a conveyor that conveys from the bin to the roof of Building 7852. Additional information is provided in the Section 2 of the Site Characterization Plan (Ref. 4).

A review of photographs in reference 6 show that the building is complete with all equipment, mezzanines, miscellaneous structural columns and beams, conduit, lighting fixtures, etc. that were used during facility operation.

4.0 STRUCTURAL ASSESSMENT

4.1 Assessment Basis

The following assessment is based on the examination, photographs and the approximate date of construction. Calculations and material testing were not performed to support this assessment.

Due to restrictive inspection conditions, the examination was performed from grade. Access was not available within the building, thus limiting the examination.

4.2 Walls

Based on operational and shielding requirements, the cells of the CMU could be grouted and vertical reinforcement may exist. Horizontal reinforcement is not expected. The crack in the west and south walls of the wellhead cell do not appear at this time to significantly impair the structural integrity of the building as it stands or during dismantlement/demolition. Verification of grout in the CMU and the need for bracing of the walls upon removal of the roof should be addressed prior to dismantlement/demolition.

For a structure of this size and layout, planned and engineered work directives are sufficient to ascertain a hazard-free condition. Based on a review of existing information, this building is considered to be structurally able to withstand preplanned demolition activities without collapse.

4.3 Roof and Ceilings

It can be assumed that the roof construction is the same over the entire building with the exception of the engine pad. The entire roof structure appears sound.

Personnel loads should be minimized on the roof of the engine pad, and no equipment or storage loads should be placed on this roof. Equipment loads should not permitted on the roof of the building.

Personnel and other loads should not be applied to the ceiling due to its light construction, connection deterioration, and unknown method of connection.

4.4 Floor

The floors of the building and the engine pad appear sound. Utilities and drains, piping and sewers below the floors should be identified in the event collapse of these could precipitate damage to machinery or equipment performing demolition and dismantlement.

4.5 Stairs

The connections of both stair treads to the stair structure are acceptable for light personnel duty. Inspections and load verification of these connections should be performed if the stairs should be used for heavier loadings.

4.6 Ladders

The connections of the ladder to the structure appear structurally adequate for personnel use, however deterioration of the masonry could change this assessment. During demolition, inspection, or other activities personnel should be prohibited from using the ladder unless further inspection or analysis is performed to ensure worker safety. The ladder does not meet OSHA requirements for extending 30 inches above the platform (roof). Additionally, the CMU construction should be checked for grout in the CMU cells at the points of anchorage of the ladder to the wall.

4.7 Handrails

The connections of the handrails to the building are deemed structurally inadequate. During demolition, inspection, or other activities personnel should be prohibited from using the handrails unless further inspection or analysis is performed to ensure worker safety. Toe plates should be provided at all handrails if the areas bounded are to be used.

4.8 Foundations

Based on construction above grade, the foundation is assessed to be in relatively good condition and are considered to be structurally able to withstand preplanned demolition activities without failure.

4.9 Engine Pad

The steel purlins and columns of the engine pad appear to be in good condition however loads on the corrugated roof should be limited until further load capacity is performed.

4.10 Appurtenances

Based on the severe corrosion of the structural members of the hoist support, this feature should not be used for loads without further load evaluation and /or verification. External equipment and mounting features including connections of the appurtenances to the building not be used to support equipment, construction or personnel loads without additional load verification/evaluation or testing.

4.11 Materials

The following building characteristics were not examined or verified, however based on building utility and age, the following rough estimates are attempted; these are provided for guidance and estimating but should not be used for design or analysis without verification.

(a) floor thickness: 8 inches

(b) floor slab reinforcement: of one mat of #4 reinforcing bars (½ in. diameter) spaced at 12 inches (center to center) in both horizontal directions

(c) floor slab concrete strength, f'_c: 3,000 psi

(d) strength of reinforcement in the walls and in the floor, f_y: 60,000 psi.

(e) CMU masonry strength with grout, f'_m: 1,000 psi

(f) CMU reinforcement: 1-#4 reinforcing bar (½ in. diameter) spaced horizontally at 24 inches (center to center)

(g) CMU cell grout strength, f'_m: 1,500 psi

(h) purlin steel strength, f_y: 24,000 psi

(i) Foundation footers: 2 ft. 6 in. wide by 1 ft. 6 in. deep, continuous beneath all walls and doors.

(j) Top of foundation at 1 ft. below lowest grade adjacent to building

(k) Column and hoist structure steel, ASTM A7 (possibly ASTM A36)

(l) Bolt steel, ASTM A325 or ASTM A307

5.0 REFERENCES

1. AC 201.R, Guide for Making a Condition Survey of Concrete in Service.

2. ANSI/ASCE 11-90, Guidelines for Structural Condition Assessment of Existing Buildings.

3. X-O-231, Preliminary Decommissioning Study Report. Volume 14: Waste Evaporator Facility (3506) and Fission Product Pilot Plant (3515), September 1984, J. R. Harden.

4. ORNL/E/Sub/87-99053/70 Site Characterization Plan for the Old Hydrofracture Facility at Oak Ridge National Laboratory, Oak Ridge, Tennessee, Bechtel, January, 1994.

5. Structural Condition Assessment of the Old Hydrofracture Facility - Bulk Solids Bins 1, 2, 3, & 4, A. A. Herget, December 1, 1994, CCN 028197.

6. Bechtel, RI/FS Photograph Logbooks, 70-PL-001-024 through 70-PL-001-034 and 70-PL-002-035.

Appendix D:
Field Investigation Measurement Equipment

Instrument	Manufacturer	Model
Alpha probe	Eberline	AC-3
Beta/gamma probe	Eberline	HP-270
Gamma probe	Eberline	HP-290
Directional gamma probe	Eberline	Modified HP-220A
Portable readout ratemeter/scaler	Eberline	ESP-2
Portable readout ratemeter/scaler	Eberline	SRM-100
Beta/gamma survey meter	Eberline	RO-2 or RO-2A
Portable gamma spectroscopy detector	EG&G ORTEC	2-in. NaI(Tl)
Portable gamma spectroscopy detector	CANBERRA	Coaxial HPGe with beryllium window
Portable multichannel analyzer	EG&G ORTEC	7500 and 7500B
Soil sample collection tool		2- and 3-in. hand augers
Concrete core drill	Diamond Tool and Fastener; Black & Decker	4-in. diamond bit drill

Appendix E:
Contract-Required Detection Limits
for TAL Inorganics
and
Contract-Required Quantitation Limits
for TCL VOCs, SVOCs, and Pesticides/PCBs

Contract Required Detection Limits (CRDLs) for TAL Inorganics

Metals	CRDLs[a] for Liquids (μg/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Cyanide	10
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20

[a]The CRDLs for solids will be higher than those for liquids and will be a function of the percent moisture present in the sample.

TARGET COMPOUND LIST (TCL) AND CONTRACT-REQUIRED QUANTITATION LIMITS (CRQL)

	Analyte	CAS Number	Quantitation Limits[a] Water (µg/L)	Low Soil (µg/kg)	Med. Soil (µg/kg)	On Column (ng)
	VOLATILES					
1.	Chloromethane	74-87-3	10	10	1200	(50)
2.	Bromomethane	74-83-9	10	10	1200	(50)
3.	Vinyl Chloride	75-01-4	10	10	1200	(50)
4.	Chloroethane	75-00-3	10	10	1200	(50)
5.	Methylene Chloride	75-09-2	10	10	1200	(50)
6.	Acetone	67-64-1	10	10	1200	(50)
7.	Carbon Disulfide	75-15-0	10	10	1200	(50)
8.	1,1-Dichloroethene	75-35-4	10	10	1200	(50)
9.	1,1-Dichloroethane	75-34-3	10	10	1200	(50)
10.	1,2-Dichloroethene (total)	540-59-0	10	10	1200	(50)
11.	Chloroform	67-66-3	10	10	1200	(50)
12.	1,2-Dichloroethane	107-06-2	10	10	1200	(50)
13.	2-Butanone	78-93-3	10	10	1200	(50)
14.	1,1,1-Trichloroethane	71-55-6	10	10	1200	(50)
15.	Carbon Tetrachloride	56-23-5	10	10	1200	(50)
16.	Bromodichloromethane	75-27-4	10	10	1200	(50)
17.	1,2-Dichloropropane	78-87-5	10	10	1200	(50)
18.	cis-1,3-Dichloropropene	10061-01-5	10	10	1200	(50)
19.	Trichloroethene	79-01-6	10	10	1200	(50)
20.	Dibromochloromethane	124-48-1	10	10	1200	(50)
21.	1,1,2-Trichloroethane	79-00-5	10	10	1200	(50)
22.	Benzene	71-43-2	10	10	1200	(50)
23.	trans-1,3-Dichloropropene	10061-02-6	10	10	1200	(50)
24.	Bromoform	75-25-2	10	10	1200	(50)
25.	4-Methyl-2-pentanone	108-10-1	10	10	1200	(50)
26.	2-Hexanone	591-78-6	10	10	1200	(50)
27.	Tetrachloroethene	127-18-4	10	10	1200	(50)
28.	Toluene	108-88-3	10	10	1200	(50)
29.	1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	(50)
30.	Chlorobenzene	108-90-7	10	10	1200	(50)
31.	Ethyl Benzene	100-41-4	10	10	1200	(50)
32.	Styrene	100-42-5	10	10	1200	(50)

Analyte	CAS Number	Quantitation Limits[a] Water (μg/L)	Low Soil (μg/kg)	Med. Soil (μg/kg)	On Column (ng)
33. Xylenes (Total)	1330-20-7	10	10	1200	(50)
SEMIVOLATILES					
34. Phenol	108-95-2	10	330	10000	(20)
35. bis(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
36. 2-Chlorophenol	95-57-8	10	330	10000	(20)
37. 1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
38. 1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
39. 1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
40. 2-Methylphenol	95-48-7	10	330	10000	(20)
41. 2,2'-oxybis (1-Chloropropane)[b]	108-60-1	10	330	10000	(20)
42. 4-Methylphenol	106-44-5	10	330	10000	(20)
43. N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	(20)
44. Hexachloroethane	67-72-1	10	330	10000	(20)
45. Nitrobenzene	98-95-3	10	330	10000	(20)
46. Isophorone	78-59-1	10	330	10000	(20)
47. 2-Nitrophenol	88-75-5	10	330	10000	(20)
48. 2,4-Dimethylphenol	105-67-9	10	330	10000	(20)
49. bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
50. 2,4-Dichlorophenol	120-83-1	10	330	10000	(20)
51. 1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
52. Naphthalene	91-20-3	10	330	10000	(20)
53. 4-Chloroaniline	106-47-8	10	330	10000	(20)
54. Hexachlorobutadiene	87-68-3	10	330	10000	(20)
55. 4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
56. 2-Methylnaphthalene	91-57-6	10	330	10000	(20)
57. Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
58. 2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
59. 2,4,5-Trichlorophenol	95-95-4	25	800	25000	(50)
60. 2-Chloronaphthalene	91-58-7	10	330	10000	(20)
61. 2-Nitroaniline	88-74-4	25	800	25000	(50)
62. Dimethylphthalate	131-11-3	10	330	10000	(20)
63. Acenaphthylene	208-96-8	10	330	10000	(20)

Analyte	CAS Number	Quantitation Limits[a] Water (µg/L)	Low Soil (µg/kg)	Med. Soil (µg/kg)	On Column (ng)
64. 2,6-Dinitrotoluene	606-20-2	10	330	10000	(20)
65. 3-Nitroaniline	99-09-2	25	800	25000	(50)
66. Acenaphthene	83-32-9	10	330	10000	(20)
67. 2,4-Dinitrophenol	51-28-5	25	800	25000	(50)
68. 4-Nitrophenol	100-02-7	25	800	25000	(50)
69. Dibenzofuran	132-64-9	10	330	10000	(20)
70. 2,4-Dinitrotoluene	121-14-2	10	330	10000	(20)
71. Diethylphthalate	84-66-2	10	330	10000	(20)
72. 4-Chlorophenyl-phenyl ether	7005-72-3	10	330	10000	(20)
73. Fluorene	86-73-7	10	330	10000	(20)
74. 4-Nitroaniline	100-01-6	25	800	25000	(50)
75. 4,6-Dinitro-2-methylphenol	534-52-1	25	800	25000	(50)
76. N-nitrosodiphenylamine	86-30-6	10	330	10000	(20)
77. 4-Bromophenyl-phenylether	101-55-3	10	330	10000	(20)
78. Hexachlorobenzene	118-74-1	10	330	10000	(20)
79. Pentachlorophenol	87-86-5	25	800	25000	(50)
80. Phenanthrene	85-01-8	10	330	10000	(20)
81. Anthracene	120-12-7	10	330	10000	(20)
82. Carbazole	86-74-8	10	330	10000	(20)
83. Di-n-butylphthalate	84-74-2	10	330	10000	(20)
84. Fluoranthene	206-44-0	10	330	10000	(20)
85. Pyrene	129-00-0	10	330	10000	(20)
86. Butylbenzylphthalate	85-68-7	10	330	10000	(20)
87. 3,3'-Dichlorobenzidine	91-94-1	10	330	10000	(20)
88. Benzo(a)anthracene	56-55-3	10	330	10000	(20)
89. Chrysene	218-01-9	10	330	10000	(20)
90. bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	(20)
91. Di-n-octylphthalate	117-84-0	10	330	10000	(20)
92. Benzo(b)fluoranthene	205-99-2	10	330	10000	(20)
93. Benzo(k)fluoranthene	207-08-9	10	330	10000	(20)
94. Benzo(a)pyrene	50-32-8	10	330	10000	(20)
95. Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	(20)
96. Dibenz(a,h)anthracene	53-70-3	10	330	10000	(50)
97. Benzo(g,h,i)perylene	191-24-2	10	330	10000	(50)

	Analyte	CAS Number	Quantitation Limits[a] Water (μg/L)	Low Soil (μg/kg)	On Column (ng)
	PESTICIDES/AROCLORS				
98.	alpha-BHC	319-84-6	0.05	1.7	5
99.	beta-BHC	319-85-7	0.05	1.7	5
100.	delta-BHC	319-86-8	0.05	1.7	5
101.	gamma-BHC (Lindane)	58-89-9	0.05	1.7	5
102.	Heptachlor	76-44-8	0.05	1.7	5
103.	Aldrin	309-00-2	0.05	1.7	5
104.	Heptachlor epoxide	1024-57-3	0.05	1.7	5
105.	Endosulfan I	959-98-8	0.05	1.7	5
106.	Dieldrin	60-57-1	0.10	3.3	10
107.	4,4'-DDE	72-55-9	0.10	3.3	10
108.	Endrin	72-20-8	0.10	3.3	10
109.	Endosulfan II	33213-65-9	0.10	3.3	10
110.	4,4'-DDD	72-54-8	0.10	3.3	10
111.	Endosulfan sulfate	1031-07-8	0.10	3.3	10
112.	4,4'-DDT	50-29-3	0.10	3.3	10
113.	Methoxychlor	72-43-5	0.50	17.0	50
114.	Endrin ketone	53494-70-5	0.10	3.3	10
115.	Endrin aldehyde	7421-36-3	0.10	3.3	10
116.	alpha-Chlordane	5103-71-9	0.05	1.7	5
117.	gamma-Chlordane	5103-74-2	0.05	1.7	5
118.	Toxaphene	8001-35-2	5.0	170.0	500
119.	Aroclor-1016	12674-11-2	1.0	33.0	100
120.	Aroclor-1221	11104-28-2	2.0	67.0	200
121.	Aroclor-1232	11141-16-5	1.0	33.0	100
122.	Aroclor-1242	53469-21-9	1.0	33.0	100
123.	Aroclor-1248	12672-29-6	1.0	33.0	100
124.	Aroclor-1254	11097-69-1	1.0	33.0	100
125.	Aroclor-1260	11096-82-5	1.0	33.0	100

[a]Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher. There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of pesticides/aroclors.

[b]Previously know by the name bis(2-Chloroisopropyl)ether.

Appendix F:
Radiological and Chemical Analytical Findings

Sample ID	04450 Concrete		
Location ID	74.SB006		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	0.46	7.20	U/3.50
Am241			
Pu239/240	0.00	0.00	UJ/0.19
Pu238	0.84	0.51	J
Th228	0.17	0.16	–
Th230	1.12	0.50	–
Th232	0.20	0.17	–
U233/234	0.92	0.36	–
U235	0.08	0.08	UJ/0.05
U238	1.25	0.44	J
Gross Beta	11.00	5.20	–
Cs137	2.38	0.10	–
K40	3.20	0.54	–
Eu152			
Eu154			
Sr90	0.24	0.85	U/0.55
Co60			
H3	1.49	0.92	–

Sample ID	04550 Concrete		
Location ID	74.SB007		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	20.80	7.30	–
Am241			
Pu239/240	0.22	0.22	U/0.26
Pu238	0.47	0.31	–
Th228	0.28	0.20	J
Th230	1.15	0.44	–
Th232	0.53	0.28	–
U233/234	1.56	0.63	–
U235	–0.01	0.01	U/0.16
U238	1.88	0.72	–
Gross Beta	1150.40	29.60	–
Cs137	927.80	3.50	–
K40			
Eu152			
Eu154			
Sr90	58.60	2.33	–
Co60	1.36	0.13	–
H3	0.42	1.39	U/0.67

Sample ID	04452 Soil		
Location ID	74.SB006		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	5.50	8.57	UJ/3.90
Pu239/240	0.14	0.22	UJ/0.35
Pu238	1.50	0.74	J
Th228	1.22	0.46	–
Th230	1.08	0.41	–
Th232	0.91	0.37	–
U233/234	1.17	0.42	–
U235	0.11	0.11	U/0.12
U238	1.44	0.48	–
Gross Beta	51.90	8.70	–
Cs137	22.50	0.34	–
K40	22.7	1.32	–

Sample ID	04583 Concrete Grout MC		
Location ID	74.7852MC		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	1140	374	J
Pu239/240	14.1	11.3	J
Pu238	35	17.4	J
Th228	1.17	4.21	–
Th230	1.81	3.62	–
Th232	3.62	5.12	–
U233/234	88.5	31.9	J
U235	–31.7	7.32	UJ/13.6
U238	–17.5	10.0	UJ/20.1
Gross Beta	1180000	79200	J
Cs137	1130000	113000	J
K40	5700	2070	J

Sample ID	04452 Soil		
Location ID	74.SB006		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Ra226			
Ra228	1.50	0.22	–
Eu152			
Eu154			
Eu155			
Sr90	5.07	1.32	J
H3	–0.28	0.83	U/0.45

Sample ID	04583 Concrete Grout MC		
Location ID	74.7852MC		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Sr90	73800	24800	J
Co60	512	217	J
H3			

Location ID	74.SB006	
Sample ID	04450	04452
Sample Type	Concrete	Soil
Units	mg/kg	mg/kg
RCRA Metals		
Arsenic	2.8J	3J
Barium	70.6	36.7
Cadmium	<0.22	<0.22
Chromium	<5.6	<5.6
Lead	5.4J	6.3J
Mercury	<0.05	<0.05
Selenium	0.28R	0.29R
Silver	<0.73	<0.71
Other TAL Metals		
Aluminum	3,490	3,600
Antimony	<3.9	<2.9
Beryllium	0.17	0.19
Calcium	317,000	326,000
Cobalt	<2.2	<2
Copper	<11	<10.5
Iron	4,630	4,540
Magnesium	15,400	16,100
Manganese	193	199
Nickel	3.8	4
Potassium	573	662
Sodium	<230	<266
Thallium	<0.18	<0.19
Vanadium	<7.6	<7.8
Zinc	<20.8	<20.4
TAL Cyanide		
Cyanide	<0.49	<0.53

Location ID	74.SB007
Sample ID	04550
Sample Type	Concrete
Units	mg/kg
RCRA Metals	
Arsenic	<1.9
Barium	105J
Cadmium	<0.21
Chromium	<10.6
Lead	<5
Mercury	<0.05
Selenium	<0.44
Silver	<0.63
Other TAL Metals	
Aluminum	4,870J
Antimony	<2.3
Beryllium	0.37
Calcium	258,000
Cobalt	2.9
Copper	<6.2
Iron	5,750
Magnesium	18,400
Manganese	191
Nickel	4.8
Potassium	861
Sodium	<165
Thallium	<0.46
Vanadium	7.5
Zinc	<25.6
TAL Cyanide	
Cyanide	<0.53

F-4

Location ID	74.SB006	
Sample ID	4450	4452
Sample Type	Concrete	Soil·
Units	mg/kg	mg/kg
VOCs		
Bromomethane	NA	0.001J
Chloromethane	NA	
Chloroform	NA	
Acetone	NA	0.19
2-Butanone	NA	
4-Methyl-2-l	NA	
Toluene	NA	0.001J
VOC TICs (No. of TICs)a		
Unknown alkan	NA	
Unknown hydrc	NA	0.079NJ(2)
Unknown keton	NA	
BNAEs		
4-Nitrophenol		
Pentachloro-phenol		
Isophorone		
Di-n-butylphthalate		
Bis(2-ethylhexyl)phthalate		
BNAE TICs (No. of TICs)a		
Hexanedioic acid ester isomer		
Unknown alkene		
Unknown PCBs		
Unknown sulfur compound		1.2NJ(1)
Unknown aromatic		3.8NJ(2)
Unknown acid		
Unknown alcohol		2.5NJ(1)
Unknown carboxylic acid ester		
Unknown ketone		
Unknown alkane		0.44NJ(1)
Unknown hydrocarbon		12.41NJ(11)
Unknown compound		
Unknown polynuclear aromatic		0.36NJ(1)
Substituted phenol		
Substituted acetate		
Substituted naphthalene		0.36NJ(1)
Phosphoric acid ester isomer		
Trimethylbenzene isomer		
4-Hydroxy-4-methyl-2-pentanone		
Prometon		
Pesticides/PCBs		
Aroclor-1254		
Aroclor-1260		
Aldrin		
Dieldrin	0.0041J	
Heptachlor epoxide		

Location ID	74.SB007
Sample ID	4550
Sample Type	Concrete
Units	mg/kg
VOCs	
Bromomethane	NA
Chloromethane	NA
Chloroform	NA
Acetone	NA
2-Butanone	NA
4-Methyl-2-l	NA
Toluene	NA
VOC TICs (No. of TICs)a	
Unknown alkan	NA
Unknown hydrc	NA
Unknown keton	NA
BNAEs	
4-Nitrophenol	
Pentachloro-phenol	
Isophorone	
Di-n-butylphthalate	
Bis(2-ethylhexyl)phthalate	
BNAE TICs (No. of TICs)a	
Hexanedioic acid ester isomer	
Unknown alkene	
Unknown PCBs	10.27NJ(7)
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	
Unknown alcohol	
Unknown carboxylic acid ester	
Unknown ketone	
Unknown alkane	
Unknown hydrc	62.7NJ(11)
Unknown compound	
Unknown polynuclear aromatic	
Substituted phe	3.5NJ(1)
Substituted acetate	
Substituted naphthalene	
Phosphoric acid ester isomer	
Trimethylbenzene isomer	
4-Hydroxy-4-	1,400NJ(1)
Prometon	
Pesticides/PCBs	
Aroclor-1254	
Aroclor-1260	
Aldrin	
Dieldrin	
Heptachlor epoxide	

Sample ID	04553 Concrete		
Location ID	74.SB008		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	194.30	5.40	–
Am241	2.71	1.57	–
Pu239/240	3.05	1.03	–
Pu238	5.78	1.69	–
Th228	1.20	0.42	–
Th230	1.10	0.51	–
Th232	0.46	0.23	–
U233/234	26.13	5.81	–
U235	0.06	0.06	U/0.07
U238	0.70	0.25	–
Gross Beta	10720.30	91.40	–
Cs137	3793.00	5.00	–
K40	10.24	2.34	–
Eu152	23.70	1.81	–
Eu154	15.72	2.06	–
Sr90	1440.00	14.40	J
Co60	33.27	0.50	–
H3	0.40	0.85	U/0.45

Sample ID	04552 Concrete		
Location ID	74.SB009		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	77	19	–
Am241			
Pu239/240	0.141	0.063	–
Pu238	0.332	0.109	–
Th228	0.320	0.113	–
Th230	0.557	0.164	–
Th232	0.255	0.095	J
U233/234	12.0	2.6	–
U235	1.29	0.35	–
U238	86.4	18.5	–
Gross Beta	7680	1540	–
Cs137	9390	1040	J
K40			
Eu152			
Eu154			
Sr90	1240	127	–
Co60			
H3	0.917	0.098	–

Sample ID	04559 Soil		
Location ID	74.SB008		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	15.8	6.2	–
Pu239/240	0.0979	0.0625	–
Pu238	0.320	0.126	–
Th228	1.45	0.40	–
Th230	1.18	0.33	–
Th232	1.68	0.45	–
U233/234	1.85	0.44	–
U235	0.0621	0.0434	–
U238	0.924	0.242	–
Gross Beta	696	140	–
Cs137	335	38	J
K40	20.4	2.6	J

Sample ID	04559 Soil		
Location ID	74.SB008		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Ra226	0.604	0.132	J
Ra228	1.36	0.23	J
Eu152	1.10	0.23	J
Eu154	0.557	0.159	J
Eu155			
Sr90	248	25	–
H3	1.06	0.13	–

Sample ID	04582 Concrete Grout PC		
Location ID	74.7852PC		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	5740	8.08	J
Pu239/240	124	18.4	J
Pu238	236	29.2	J
Th228	13.8	5.63	–
Th230	3.80	2.71	–
Th232	3.13	2.56	–
U233/234	805	82.4	J
U235	2.34	2.60	UJ/3.24
U238	4.12	4.00	J
Gross Beta	2700000	204000	J
Cs137	1700000	170000	J
K40	466	480	U/934
Sr90	1210000	413000	J
Co60	3110	370	J
H3			

Location ID	74.SB008	
Sample ID	04553	04559
Sample Type	Concrete	Soil
Units	mg/kg	mg/kg
RCRA Metals		
Arsenic	1.3J	2.7J
Barium	57.3	86.2
Cadmium	<0.29	<0.4
Chromium	7.9	37.9
Lead	5	32.5
Mercury	0.08	0.09
Selenium	<0.42	0.37R
Silver	<0.71	3.9
Other TAL Metals		
Aluminum	4,110	34,600
Antimony	<2.9	3.9R
Beryllium	<0.32	1.3
Calcium	328,000	5,860J
Cobalt	<3	17.1
Copper	5.2	46.4
Iron	5,670	38,600
Magnesium	20,000	4360J
Manganese	211J	467
Nickel	4.2	29.5
Potassium	1,040	2,730
Sodium	<330	120
Thallium	<0.44	<0.4
Vanadium	5.8	38.9
Zinc	<16.8	<55
TAL Cyanide		
Cyanide	<0.52	<0.65

Location ID	74.SB009
Sample ID	04552
Sample Type	Concrete
Units	mg/kg
RCRA Metals	
Arsenic	1.3
Barium	66.1
Cadmium	<0.21
Chromium	8
Lead	5
Mercury	<0.05
Selenium	<0.44
Silver	<0.63
Other TAL Metals	
Aluminum	4,120
Antimony	<2.3
Beryllium	<0.17
Calcium	267,000
Cobalt	<2.9
Copper	10.9J
Iron	5,210
Magnesium	17,900
Manganese	203
Nickel	4
Potassium	1,120
Sodium	<217
Thallium	<0.46
Vanadium	6.4
Zinc	13.3J
TAL Cyanide	
Cyanide	<0.53

Location ID	74.SB008	
Sample ID	4553	4559
Sample Type	Concrete	Soil
Units	mg/kg	mg/kg
VOCs		
Bromomethane	NA	
Chloromethane	NA	
Chloroform	NA	0.002J
Acetone	NA	0.16
2-Butanone	NA	0.04
4-Methyl-2-(	NA	0.004J
Toluene	NA	0.011J
VOC TICs (No. of TICs)a		
Unknown alkan	NA	
Unknown hydrc	NA	0.043NJ(3)
Unknown keton	NA	0.008NJ(1)
BNAEs		

Location ID	74.SB009
Sample ID	4552
Sample Type	Concrete
Units	mg/kg
VOCs	
Bromomethane	NA
Chloromethane	NA
Chloroform	NA
Acetone	NA
2-Butanone	NA
4-Methyl-2-(	NA
Toluene	NA
VOC TICs (No. of TICs)a	
Unknown alkan	NA
Unknown hydrc	NA
Unknown keton	NA
BNAEs	

Location ID	74.SB008	
Sample ID	4553	4559
Sample Type	Concrete	Soil
Units	mg/kg	mg/kg
4-Nitrophenol		0.067J
Pentachloro-phenol		0.047J
Isophorone		
Di-n-butylphthalate		
Bis(2-ethylhexyl)phthalate		0.059J
BNAE TICs (No. of TICs)a		
Hexanedioic acid ester isomer		
Unknown alkene		
Unknown PCBs	7.5NJ(5)	
Unknown sulfur compound		
Unknown arom.	7.9NJ(1)	0.96NJ(1)
Unknown acid		0.091NJ(1)
Unknown alcohol		
Unknown carbo	1.7NJ(1)	
Unknown ketone		
Unknown alkane		
Unknown hydrc	573.3NJ(12)	3.644NJ(16)
Unknown compound		
Unknown polynuclear aromatic		
Substituted phenol		
Substituted acetate		
Substituted naphthalene		
Phosphoric acid	2.1NJ(1)	
Trimethylbenzene isomer		
4-Hydroxy-4-methyl-2-pentanone		
Prometon	0.38NJ(1)	
Pesticides/PCBs		
Aroclor-1254		
Aroclor-1260		
Aldrin		
Dieldrin		
Heptachlor epoxide		

Location ID	74.SB009
Sample ID	4552
Sample Type	Concrete
Units	mg/kg
4-Nitrophenol	
Pentachloro-phenol	
Isophorone	0.96J
Di-n-butylphthalate	
Bis(2-ethylhex	1.9J
BNAE TICs (No. of TICs)a	
Hexanedioic acid ester isomer	
Unknown alken	68NJ(1)
Unknown PCBs	10.08NJ(8)
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	
Unknown alcohol	
Unknown carboxylic acid ester	
Unknown ketone	
Unknown alkane	
Unknown hydrc	2478.89NJ(8)
Unknown compound	
Unknown polynuclear aromatic	
Substituted phenol	
Substituted acetate	
Substituted naphthalene	
Phosphoric acid	23.3NJ(2)
Trimethylbenzene isomer	
4-Hydroxy-4-methyl-2-pentanone	
Prometon	
Pesticides/PCBs	
Aroclor-1254	0.0055J
Aroclor-1260	
Aldrin	
Dieldrin	
Heptachlor epoxide	

Sample ID	04471 Concrete		
Location ID	74.SB010		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	−15.80	6.00	U/3.50
Am241			
Pu239/240	0.00	0.00	U/0.12
Pu238	0.08	0.12	U/0.20
Th228	0.00	0.00	R/0.41
Th230	0.43	0.58	R/0.71
Th232	0.00	0.00	R/0.41
U233/234	0.67	0.28	–
U235	0.00	0.00	U/0.05
U238	1.88	0.58	–
Gross Beta	568.90	21.60	–
Cs137	1116	2.00	–
K40	11.80	1.00	–
Eu152			
Eu154			
Sr90	2.31	1.20	J
Co60			
H3	0.18	0.76	U/0.39

Sample ID	04551 Concrete		
Location ID	74.SB011		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	9.70	4.50	–
Am241			
Pu239/240	−0.01	0.02	U/0.23
Pu238	0.09	0.15	U/0.23
Th228	0.38	0.27	–
Th230	1.20	0.52	J
Th232	0.47	0.29	–
U233/234	2.20	0.89	–
U235	0.10	0.12	UJ/0.09
U238	5.20	1.90	J
Gross Beta	6670.20	67.80	–
Cs137	6366.00	5.30	–
K40			
Eu152			
Eu154			
Sr90	617.00	10.20	–
Co60	3.60	0.18	–
H3	1.11	0.70	–

Sample ID	04554 Soil		
Location ID	74.SB010		
	Concen–tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	9.20	4.61	–
Pu239/240	0.0161	0.0230	U/0.022
Pu238	0.0161	0.0230	U/0.022
Th228	1.46	0.42	–
Th230	1.56	0.44	–
Th232	1.80	0.49	–
U233/234	0.792	0.210	–
U235	0.0122	0.0174	U/0.017
U238	0.815	0.214	–
Gross Beta	31.7	7.7	–
Cs137	2.35	0.35	J
K40	24.1	3.5	J

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Sample ID	04554 Soil		
Location ID	74.SB010		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Ra226	0.628	0.063	J
Ra228	1.33	0.14	J
Eu152			
Eu154			
Eu155	0.092	0.071	UJ/0.11
Sr90	0.539	0.255	0.39
H3	0.547	0.072	0.060

Location ID	74.SB010		
Sample ID	04451	04471	04554
Sample Type	Rinsate	Concrete	Soil
Units	ug/L	mg/kg	mg/kg
RCRA Metals			
Arsenic	<1.5	<3.3	1.7
Barium	3.4	74.1	66.3
Cadmium	<1	<0.22	<0.24
Chromium	<4.4	<8.2	28.9
Lead	2.1J	28.2	9.4J
Mercury	<0.2	0.09	<0.06
Selenium	<2.1	0.29R	<0.51
Silver	<3	<0.73	2.2
Other TAL Metals			
Aluminum	<41.1	4,590	36,100
Antimony	10.8R	3R	2.6R
Beryllium	<0.8	0.31	0.97
Calcium	<205	299,000J	<197
Cobalt	<2.3	2.6	16.6
Copper	<5.6	<8	<15.9
Iron	<108	6,760	40,600
Magnesium	<76.7	19,000J	4,070
Manganese	<1.9	224	574
Nickel	<4.5	5.2	25.5
Potassium	<135	1,060	2,890
Sodium	<113	170	<62.9
Thallium	<2.2	<0.31	<0.54
Vanadium	<2.6	6.5	38.7
Zinc	35.4	29.3	57.2
TAL Cyanide			
Cyanide	<10.0	<0.53	<0.65

Location ID	74.SB011
Sample ID	04551
Sample Type	Concrete
Units	mg/kg
RCRA Metals	
Arsenic	3.4
Barium	264
Cadmium	<0.2
Chromium	6.7
Lead	6.9
Mercury	0.58J
Selenium	<0.42
Silver	<0.6
Other TAL Metals	
Aluminum	4,650
Antimony	<2.2
Beryllium	<0.16
Calcium	293,000
Cobalt	2.3
Copper	15.3
Iron	5,130
Magnesium	18,600
Manganese	228
Nickel	5.2
Potassium	867
Sodium	<214
Thallium	<0.44
Vanadium	7
Zinc	31J
TAL Cyanide	
Cyanide	<0.52

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Location ID	74SB.010		
Sample ID	4451	4471	
Sample Type	Rinsate	Concrete	
Units	mg/kg	mg/kg	
VOCs			
Bromomethane	NA	NA	
Chloromethane	NA	NA	
Chloroform	NA	NA	
Acetone	NA	NA	
2-Butanone	NA	NA	
4-Methyl-2-|	NA	NA	
Toluene	NA	NA	
VOC TICs (No. of TICs)a			
Unknown alkan	NA	NA	0.033NJ(1)
Unknown hydrc	NA	NA	
Unknown keton	NA	NA	
BNAEs			
4-Nitrophenol	1J		0.093J
Pentachloro-phenol			0.061J
Isophorone			
Di-n-butylpht	2J		
Bis(2-ethylhexyl)phthalate			0.068J
BNAE TICs (No. of TICs)a			
Hexanedioic acid ester isomer			
Unknown alken	4NJ(1)		
Unknown PCBs			
Unknown sulfur compound			
Unknown aromatic			
Unknown acid			
Unknown alcohol			
Unknown carboxylic acid ester			
Unknown keton	2NJ(1)	2,900NJ(1)	0.084NJ(1)
Unknown alkane		249.1NJ(12)	0.674NJ(4)
Unknown hydrc	97NJ(3)	275.8NJ(7)	0.084NJ(1)
Unknown compound			
Unknown polynuclear aromatic			
Substituted phenol			
Substituted acetate			
Substituted naphthalene			
Phosphoric acid ester isomer			
Trimethylbenzene isomer			
4-Hydroxy-4-methyl-2-pentanone			
Prometon			
Pesticides/PCBs			
Aroclor-1254		5J	19J
Aroclor-1260		0.71J	6.3J
Aldrin			
Dieldrin			
Heptachlor epoxide			

Location ID	74.SB011
Sample ID	4551
Sample Type	Concrete
Units	mg/kg
VOCs	
Bromomethane	NA
Chloromethane	NA
Chloroform	NA
Acetone	NA
2-Butanone	NA
4-Methyl-2-|	NA
Toluene	NA
VOC TICs (No. of TICs)a	
Unknown alkan	NA
Unknown hydrc	NA
Unknown keton	NA
BNAEs	
4-Nitrophenol	0.25J
Pentachloro-phenol	
Isophorone	0.52J
Di-n-butylphthalate	
Bis(2-ethylhexyl)phthalate	
BNAE TICs (No. of TICs)a	
Hexanedioic acid ester isomer	
Unknown alkene	
Unknown PCBs	
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	
Unknown alcohol	
Unknown carboxylic acid ester	
Unknown keton	0.68NJ(1)
Unknown alkane	
Unknown hydrc	95.06NJ(8)
Unknown compound	
Unknown polynuclear aromatic	
Substituted phenol	
Substituted acetate	
Substituted naphthalene	
Phosphoric acid ester isomer	
Trimethylbenze	0.85NJ(1)
4-Hydroxy-4-methyl-2-pentanone	
Prometon	
Pesticides/PCBs	
Aroclor-1254	0.29
Aroclor-1260	0.063
Aldrin	
Dieldrin	
Heptachlor epoxide	

Sample ID	04453 Soil		
Location ID	74.SB001		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	14.1	5.8	–
Pu239/240	0.0155	0.0221	U/0.021
Pu238	0.0774	0.0515	–
Th228	1.73	0.5	–
Th230	1.34	0.41	–
Th232	1.35	0.41	–
U233/234	0.872	0.225	–
U235	0.0292	0.0321	U/0.047
U238	0.990	0.25	–
Gross Beta	30.7	7.8	–
Cs137	1.83	0.27	J
K40	21.9	3.2	J
Ra226	0.648	0.062	J
Ra228	1.14	0.13	J
Eu152			
Eu154			
Eu155			
Sr90	0.794	0.273	–
H3	0.611	0.078	–

Sample ID	04556 Soil		
Location ID	74.SB002		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	10.5	5.3	–
Pu239/240	0.0279	0.0434	U/0.078
Pu238	0.0296	0.0369	U/.055
Th228	1.92	0.55	–
Th230	1.19	0.38	–
Th232	1.65	0.49	J
U233/234	0.819	0.221	–
U235	0.0476	0.0374	–
U238	1.03	0.27	–
Gross Beta	88.6	18.8	–
Cs137	72.6	10.3	J
K40	22.6	3.3	J
Ra226	0.61	0.09	J
Ra228	1.38	0.18	J
Eu152			
Eu154			
Eu155			
Sr90	6.32	0.74	–
H3	0.466	0.067	–

Location ID	74.SB001
Sample ID	04453
Sample Type	Soil
Units	mg/kg
RCRA Metals	
Arsenic	3.8
Barium	84.4
Cadmium	<0.4
Chromium	24.6
Lead	14.8J
Mercury	<0.06
Selenium	<0.36
Silver	2.6
Other TAL Metals	
Aluminum	27,600
Antimony	3.7R
Beryllium	<1.4
Calcium	623
Cobalt	20.3
Copper	73.6
Iron	35,100
Magnesium	4,250

Location ID	74.SB002
Sample ID	04556
Sample Type	Soil
Units	mg/kg
RCRA Metals	
Arsenic	<3.9
Barium	69.1
Cadmium	0.45
Chromium	31.3
Lead	17.2
Mercury	<0.06
Selenium	0.37R
Silver	3.3
Other TAL Metals	
Aluminum	34,700
Antimony	3.5R
Beryllium	1.3
Calcium	6,400J
Cobalt	13.8
Copper	<24.2
Iron	40,000
Magnesium	5,060J

Location ID	74.SB001
Sample ID	04453
Sample Type	Soil
Units	mg/kg
Manganese	845
Nickel	33.1
Potassium	1,960
Sodium	<71.6
Thallium	<0.23
Vanadium	30.1
Zinc	62.1
TAL Cyanide	
Cyanide	<0.65

Location ID	74.SB002
Sample ID	04556
Sample Type	Soil
Units	mg/kg
Manganese	449
Nickel	29.5
Potassium	2,960
Sodium	49.2
Thallium	<0.39
Vanadium	36.4
Zinc	<68
TAL Cyanide	
Cyanide	<0.65

Location ID	74.SB001
Sample ID	4453
Sample Type	Soil
Units	mg/kg
VOCs	
Bromomethane	
Chloromethane	0.002J
Chloroform	
Acetone	
2-Butanone	
4-Methyl-2-pentanone	
Toluene	0.002J
VOC TICs (No. of TICs)a	
Unknown alkane	
Unknown hydrocarbon	
Unknown ketone	
BNAEs	
4-Nitrophenol	
Pentachloro-phenol	
Isophorone	
Di-n-butylphthalate	
Bis(2-ethylhex	0.073J
BNAE TICs (No. of TICs)a	
Hexanedioic acid ester isomer	
Unknown alkene	
Unknown PCBs	
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	
Unknown alcohol	
Unknown carboxylic acid ester	
Unknown ketone	
Unknown alkane	
Unknown hydrc	2.54NJ(7)
Unknown compound	
Unknown polynuclear aromatic	

Location ID	74.SB002
Sample ID	4556
Sample Type	Soil
Units	mg/kg
VOCs	
Bromomethane	
Chloromethane	
Chloroform	
Acetone	
2-Butanone	
4-Methyl-2-pentanone	
Toluene	
VOC TICs (No. of TICs)a	
Unknown alkane	
Unknown hydrocarbon	
Unknown ketone	
BNAEs	
4-Nitrophenol	
Pentachloro-phenol	
Isophorone	
Di-n-butylphthalate	
Bis(2-ethylhex	0.058J
BNAE TICs (No. of TICs)a	
Hexanedioic aci	0.3NJ(1)
Unknown alkene	
Unknown PCBs	
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	
Unknown alcohol	
Unknown carboxylic acid ester	
Unknown ketone	
Unknown alkane	
Unknown hydrc	0.94NJ(3)
Unknown compound	
Unknown polynuclear aromatic	

Location ID	74.SB001
Sample ID	4453
Sample Type	Soil
Units	mg/kg
Substituted phenol	
Substituted acetate	
Substituted naphthalene	
Phosphoric acid ester isomer	
Trimethylbenzene isomer	
4-Hydroxy-4-methyl-2-pentanone	
Prometon	
Pesticides/PCBs	
Aroclor-1254	
Aroclor-1260	
Aldrin	
Dieldrin	0.0041J
Heptachlor epoxide	

Location ID	74.SB002
Sample ID	4556
Sample Type	Soil
Units	mg/kg
Substituted phenol	
Substituted acetate	
Substituted naphthalene	
Phosphoric acid ester isomer	
Trimethylbenzene isomer	
4-Hydroxy-4-methyl-2-pentanone	
Prometon	
Pesticides/PCBs	
Aroclor-1254	
Aroclor-1260	
Aldrin	
Dieldrin	
Heptachlor epoxide	

Sample ID	04557 Soil		
Location ID	74.SB003		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	9.60	5.05	–
Pu239/240	0.0214	0.0330	U/0.056
Pu238	0.0659	0.0533	–
Th228	1.81	0.56	–
Th230	1.13	0.40	–
Th232	1.44	0.48	–
U233/234	1.15	0.29	–
U235	0.0677	0.0461	–
U238	1.04	0.26	–
Gross Beta	37.7	9.1	–
Cs137	7.80	1.12	J
K40	20.5	3.0	J
Ra226	0.683	0.07	J
Ra228	1.35	0.15	J
Eu152	0.213	0.120	UJ/0.33
Eu154			
Eu155			
Sr90	7.38	0.84	–
H3	0.151	0.047	–

Sample ID	04555 Soil		
Location ID	74.SB004		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	28.9	9.3	–
Pu239/240	0.0826	0.0537	–
Pu238	0.139	0.074	–
Th228	1.94	0.50	–
Th230	0.978	0.290	–
Th232	1.57	0.42	–
U233/234	1.33	0.32	–
U235	0.0368	0.0321	–
U238	0.829	0.213	–
Gross Beta	7730	1550	–
Cs137	6440	910	J
K40	22.6	3.3	J
Ra226	0.606	0.088	J
Ra228	1.38	0.18	J
Eu152			
Eu154			
Eu155			
Sr90	467	51	–
H3	0.206	0.039	–

Location ID	74.SB003
Sample ID	04557
Sample Type	Soil
Units	mg/kg
RCRA Metals	
Arsenic	4.2J
Barium	88.3
Cadmium	0.54
Chromium	41.2
Lead	27.7
Mercury	0.10
Selenium	0.37R
Silver	3.2
Other TAL Metals	
Aluminum	36,100
Antimony	3.9R
Beryllium	1.3
Calcium	8,590J
Cobalt	17.3
Copper	<31.5
Iron	41,800
Magnesium	4,770J

Location ID	74.SB004
Sample ID	04555
Sample Type	Soil
Units	mg/kg
RCRA Metals	
Arsenic	3J
Barium	88.4
Cadmium	0.77
Chromium	35.4
Lead	17.3
Mercury	0.11
Selenium	0.34R
Silver	2.8
Other TAL Metals	
Aluminum	37,500
Antimony	3.6R
Beryllium	1.2
Calcium	22,000J
Cobalt	10.5
Copper	<20.2
Iron	38,300
Magnesium	10,900J

Location ID	74.SB003
Sample ID	04557
Sample Type	Soil
Units	mg/kg
Manganese	601
Nickel	28.1
Potassium	3,190
Sodium	59.2
Thallium	<0.4
Vanadium	44.2
Zinc	<62.1
TAL Cyanide	
Cyanide	<0.63

Location ID	74.SB004
Sample ID	04555
Sample Type	Soil
Units	mg/kg
Manganese	186
Nickel	25.9
Potassium	3,990
Sodium	94.7
Thallium	<0.36
Vanadium	36
Zinc	<59
TAL Cyanide	
Cyanide	<0.64

Location ID	74.SB003
Sample ID	4557
Sample Type	Soil
Units	mg/kg
VOCs	
Bromomethane	
Chloromethane	
Chloroform	
Acetone	
2-Butanone	
4-Methyl-2-pentanone	
Toluene	
VOC TICs (No. of TICs)a	
Unknown alkane	
Unknown hydrocarbon	
Unknown ketone	
BNAEs	
4-Nitrophenol	
Pentachloro-phenol	
Isophorone	
Di-n-butylphthalate	
Bis(2-ethylhex	0.067J
BNAE TICs (No. of TICs)a	
Hexanedioic aci	0.16NJ(1)
Unknown alkene	
Unknown PCBs	
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	
Unknown alcohol	
Unknown carbo	0.66NJ(3)
Unknown ketone	
Unknown alkane	
Unknown hydrc	0.458NJ(3)
Unknown compound	
Unknown polynuclear aromatic	

Location ID	74.SB004
Sample ID	4555
Sample Type	Soil
Units	mg/kg
VOCs	
Bromomethane	
Chloromethane	
Chloroform	
Acetone	
2-Butanone	
4-Methyl-2-pentanone	
Toluene	0.001J
VOC TICs (No. of TICs)a	
Unknown alkane	
Unknown hydrocarbon	
Unknown ketone	
BNAEs	
4-Nitrophenol	
Pentachloro-phenol	
Isophorone	
Di-n-butylphthalate	
Bis(2-ethylhex	0.077J
BNAE TICs (No. of TICs)a	
Hexanedioic acid ester isomer	
Unknown alkene	
Unknown PCBs	
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	
Unknown alcohol	
Unknown carbo	0.38NJ(1)
Unknown ketone	
Unknown alkan	1.1NJ(5)
Unknown hydrc	3.034NJ(10)
Unknown compound	
Unknown polyn	0.67NJ(1)

Location ID	74.SB003
Sample ID	4557
Sample Type	Soil
Units	mg/kg
Substituted phenol	
Substituted acetate	
Substituted naphthalene	
Phosphoric acid ester isomer	
Trimethylbenzene isomer	
4-Hydroxy-4-methyl-2-pentanone	
Prometon	
Pesticides/PCBs	
Aroclor-1254	
Aroclor-1260	
Aldrin	
Dieldrin	
Heptachlor epoxide	

Location ID	74.SB004
Sample ID	4555
Sample Type	Soil
Units	mg/kg
Substituted phenol	
Substituted acetate	
Substituted naphthalene	
Phosphoric acid ester isomer	
Trimethylbenzene isomer	
4-Hydroxy-4-methyl-2-pentanone	
Prometon	0.38NJ(1)
Pesticides/PCBs	
Aroclor-1254	
Aroclor-1260	
Aldrin	
Dieldrin	
Heptachlor epoxide	

Sample ID	04558 Soil		
Location ID	74.SB005		
	Concen-tration (pCi/g)	Uncertainty	Review qualifier /MDL
Gross Alpha	11.3	5.5	–
Pu239/240	0.0522	0.0457	–
Pu238	0.0898	0.0575	–
Th228	1.53	0.44	–
Th230	1.39	0.41	–
Th232	1.60	0.46	–
U233/234	0.924	0.239	–
U235	0.0472	0.0349	–
U238	0.964	0.248	–
Gross Beta	175	36	–
Cs137	32.3	4.6	J
K40	21.0	3.0	J
Ra226	0.671	0.078	J
Ra228	1.16	0.15	J
Eu152			
Eu154			
Eu155			
Sr90	65.7	6.6	–
H3	0.150	0.035	–

Location ID	74.SB005
Sample ID	04558
Sample Type	Soil
Units	mg/kg
RCRA Metals	
Arsenic	<5.7
Barium	129
Cadmium	0.38
Chromium	34.1
Lead	16.1
Mercury	0.08
Selenium	0.33R
Silver	3
Other TAL Metals	
Aluminum	30,600
Antimony	3.7R
Beryllium	1.5
Calcium	10,800J
Cobalt	21.1
Copper	<23.7
Iron	34,700
Magnesium	6,700J

Location ID	74.SB005
Sample ID	04558
Sample Type	Soil
Units	mg/kg
Manganese	1,050
Nickel	34.0
Potassium	2,810
Sodium	61.5
Thallium	<0.36
Vanadium	33.6
Zinc	<72.8
TAL Cyanide	
Cyanide	<0.59

Location ID	74.SB005
Sample ID	4558
Sample Type	Soil
Units	mg/kg
VOCs	
Bromomethane	
Chloromethane	
Chloroform	
Acetone	
2-Butanone	
4-Methyl-2-pentanone	
Toluene	0.001J
VOC TICs (No. of TICs):a	
Unknown alkane	
Unknown hydrocarbon	
Unknown ketone	
BNAEs	
4-Nitrophenol	
Pentachloro-phenol	
Isophorone	
Di-n-butylphthalate	
Bis(2-ethylhex	0.065J
BNAE TICs (No. of TICs):a	
Hexanedioic aci	0.17NJ(1)
Unknown alkene	
Unknown PCBs	
Unknown sulfur compound	
Unknown aromatic	
Unknown acid	0.13NJ(1)
Unknown alcoh	0.084NJ(1)
Unknown carbo	3.27NJ(7)
Unknown ketone	
Unknown alkane	
Unknown hydrc	1.3NJ(4)
Unknown comp	0.13NJ(1)
Unknown polynuclear aromatic	

Location ID	74.SB005
Sample ID	4558
Sample Type	Soil
Units	mg/kg
Substituted phenol	
Substituted acet	0.13NJ(1)
Substituted naphthalene	
Phosphoric acid ester isomer	
Trimethylbenzene isomer	
4-Hydroxy-4-methyl-2-pentanone	
Prometon	
Pesticides/PCBs	
Aroclor-1254	
Aroclor-1260	
Aldrin	
Dieldrin	
Heptachlor epoxide	

Appendix G:
Maximum Concentration of Contaminants for the Toxicity Characteristic

Maximum concentration of contaminants for the toxicity characteristic

EPA HW No.[a]	TCLP Contaminant	CAS No.[b]	Regulatory Level (mg/L)	Equivalent Limits for Solids[c] (mg/kg)	TCL VOC	TCL BNAE	TCL Pest	TAL Metal
D004	Arsenic	7440-38-2	5.0	100				X
D005	Barium	7440-39-3	100.0	2000				X
D018	Benzene	71-43-2	0.5	10	X			
D006	Cadmium	7440-43-9	1.0	20				X
D019	Carbon tetrachloride	56-23-5	0.5	10	X			
D020	Chlordane	57-74-9	0.03	0.6			X	
D021	Chlorobenzene	108-90-7	100.0	2000	X			
D022	Chloroform	67-66-3	6.0	120	X			
D007	Chromium	7440-47-3	5.0	100				X
D023	o-Cresol	95-48-7	200.0[d]	4000		X		
D024	m-Cresol	108-39-4	200.0[d]	4000				
D025	p-Cresol	106-44-5	200.0[d]	4000		X		
D026	Cresol		200.0[d]	4000				
D016	2,4-D	94-75-7	10.0	200		X		
D027	1,4-Dichlorobenzene	106-46-7	7.5	150		X		
D028	1,2-Dichloroethane	107-06-2	0.5	10	X			
D029	1,1-Dichloroethylene	75-35-4	0.7	14	X			
D030	2,4-Dinitrotoluene	121-14-2	0.13[e]	2.6		X		
D012	Endrin	72-20-8	0.02	0.4			X	
D031	Heptachlor (and its epoxide)	76-44-8	0.008	0.16			X	
D032	Hexachlorobenzene	118-74-1	0.13[e]	2.6		X		
D033	Hexachlorobutadiene	87-68-3	0.5	10		X		
D034	Hexachloroethane	67-72-1	3.0	60		X		
D008	Lead	7439-92-1	5.0	100				X
D013	Lindane	58-89-9	0.4	8			X	
D009	Mercury	7439-97-6	0.2	4				X
D014	Methoxychlor	72-43-5	10.0	200			X	
D035	Methyl ethyl ketone	78-93-3	200.0	4000	X			

EPA HW No.[a]	TCLP Contaminant	CAS No.[b]	Regulatory Level (mg/L)	Equivalent Limits for Solids[c] (mg/kg)	TCL VOC	TCL BNAE	TCL Pest	TAL Metal
D036	Nitrobenzene	98-95-3	2.0	40		X		
D037	Pentachlorophenol	87-86-5	100.0	2000		X		
D038	Pyridine	110-86-1	5.0[e]	100				
D010	Selenium	7782-49-2	1.0	20				X
D011	Silver	7440-22-4	5.0	100				X
D039	Tetrachloroethylene	127-18-4	0.7	14	X			
D015	Toxaphene	8001-35-2	0.5	10			X	
D040	Trichloroethylene	79-01-6	0.5	10	X			
D041	2,4,5	95-95-4	400.0	8000			X	
D042	2,4,6	88-06-2	2.0	40			X	
D017	2,4,5-TP (Silvex)	93-72-1	1.0	20				
D043	Vinyl chloride	75-01-4	0.2	4	X			

[a] Hazardous waste number.
[b] Chemical abstracts service number.
[c] The RCRA equivalent limits for solids are derived from the regulatory levels listed in the fourth column. The maximum concentration of contaminants for the toxicity characteristic, listed by EPA in 40 CFR 261.24 in units of mg/L and repeated in the fourth column of this table, was multiplied by a factor of 20 to obtain equivalent limits for solids in units of mg/kg.
[d] If o-, m-, and p-cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/L.
[e] Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.

Source: modified from Table 1 of 40 CFR 261.24.

Note: M-cresol (D024), cresol (D026), pyridine (D038), and 2,4,5-TP (D017) are not TCL/TAL constituents.

Appendix H:
Radionuclide-specific ARARs
for Groundwater and Surface Water at the ORR

Radionuclide-specific ARARs for groundwater and surface water contamination at the ORR

Radionuclide	Current SDWA MCLs[a]	Proposed SDWA MCLs[b]
Radium[c]	5 pCi/L	20 pCi/L
Radon-222	300 pCi/L	300 pCi/L
Gross alpha[d]	15 pCi/L	15 pCi/L
Gross beta	4 mrem/year	4 mrem/year
Strontium-90[e]	8 pCi/L	42 pCi/L
Tritium[e]	20,000 pCi/L	60,900 pCi/L
Natural uranium		20 μg/L[f]
All other manmade radionuclides	4 mrem/year[g]	4 mrem/year[g]

Source: E.L. Etnier, E. P. McDonald, and L. M. Houlberg 1993. *Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Action at the Oak Ridge Reservation: A Compendium of Environmental Laws*, ES/ER/TM-1/R2.

[a]SDWA MCL = Safe Drinking Water Act maximum contaminant level.
[b]Proposed rule, July 18, 1991 (56 *FR* 33050); final rule expected December 1993.
[c]The present MCL applies to combined ^{226}Ra and ^{228}Ra; the proposed MCL applies to each separately.
[d]The present MCL excludes radon and uranium but includes ^{226}Ra and ^{228}Ra; the proposed MCL excludes all three radionuclides.
[e]These values are not MCLs; rather they are concentrations that result in the effective dose equivalent of 4 mrem/year, the MCL for gross beta emissions.
[f]Approximately equal to 30 pCi/L.
[g]If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem/year.

Appendix I:
Detailed Location-Specific Measurement Results

OHF Control Room, Location Specific Measurement Results

	Location	Instrument Measurements Performed At Each Location (above water level)				Smear Screening (CSL) Results For Each Location			
		AC-3	HP-270, Open	HP-270, Closed	HP-220A, Mod				
		Alpha	Beta/Gamma	Beta/Gamma	Gamma, Dirct.	Gross Alpha	Gross Beta/Gamma	Cesium-137	Strontium-90
		(dpm/100 cm^2)	(mrad/h)	(mR/h)	(mR/h)	(dpm/100 cm^2)	(dpm/100 cm^2)	(µCi/100 cm^2)	(µCi/100 cm^2)
Control Room									
South Wall	OHF-CR-01	6.20E+01	3.18E+01	3.12E+01	1.14E+01	0.00E+00	9.85E+01		
	OHF-CR-02	7.41E+01	1.78E+01	1.75E+01	6.78E+00	1.14E+00	1.61E+03	6.65E-04	
Cntrl Panl	OHF-CR-03	4.91E+01	1.84E+01	1.77E+01	5.74E+00	3.95E+00	4.43E+02		
	OHF-CR-04	9.54E+01	9.54E+00	8.88E+00	5.87E+00	2.54E+00	1.40E+03	6.51E-04	
	OHF-CR-05	6.20E+01	5.44E+00	4.97E+00	5.90E+00	1.14E+00	3.80E+01		
East Wall	OHF-CR-06	4.63E+01	1.47E+00	1.11E+00	5.51E+00	0.00E+00	2.61E+01		
West Wall	OHF-CR-07	5.83E+01	3.32E+00	2.95E+00	6.18E-01	1.14E+00	6.41E+01		
	OHF-CR-08	3.70E+01	4.25E+00	3.74E+00	5.45E+00	1.14E+00	2.73E+01		
North Wall	OHF-CR-09	3.43E+01	2.10E+00	1.76E+00	5.21E+00	0.00E+00	1.30E+01		
Floor	OHF-CR-10	5.00E+02	9.36E+00	4.97E+00	4.54E+00	4.76E+01	4.25E+04	1.42E-03	
	OHF-CR-11	7.13E+01	5.89E+00	5.29E+00	3.55E+00	5.36E+00	1.48E+03	3.70E-04	
	OHF-CR-12	1.14E+02	6.24E+00	5.70E+00	5.65E+00	9.58E+00	6.22E+03	9.33E-04	
	OHF-CR-13	1.14E+02	4.41E+00	3.82E+00	6.42E+00	3.95E+00	2.31E+03	6.77E-04	
Side of Stl Deck	OHF-CR-14	4.91E+01	1.09E+01	1.00E+01	7.92E+00	2.54E+00	1.09E+02		

OHF Mixing Cell, Location Spec .easurement Results

	Location	AC-3 Alpha (dpm/100 cm^2)	HP-270, Open Beta/Gamma (mrad/h)	HP-270, Closed Beta/Gamma (mR/h)	HP-220A, Mod Gamma, Dirct. (mR/h)	Gross Alpha (dpm/100 cm^2)	Gross Beta/Gamma (dpm/100 cm^2)	Cesium-137 (µCi/100 cm^2)	Strontium-90 (µCi/100 cm^2)
		Instrument Measurements Performed At Each Location (above water level)				Smear Screening (CSL) Results For Each Location			
Mixing Cell									
South Wall	OHF-MC-01	4.64E+02	7.97E+01	6.96E+01	5.64E+00	3.82E+00	4.48E+02	1.39E-04	
	OHF-MC-02	1.11E+03	1.46E+02	1.20E+02	1.07E+01	2.49E+01	8.59E+04	1.80E-02	3.90E-04
West Wall	OHF-MC-03	8.89E+02	1.54E+02	1.36E+02	1.80E+01	8.88E+00	3.49E+03	9.38E-04	1.80E-04
	OHF-MC-04	2.89E+03	2.50E+02	2.28E+02	1.41E+01	4.84E+01	5.86E+04	1.07E-02	8.40E-04
Up Tank	OHF-MC-05	3.51E+03	2.98E+02	2.71E+02	4.01E+01	4.75E+02	1.98E+04	5.40E-03	3.20E-03
Low Tank	OHF-MC-06	9.69E+03	3.48E+02	3.14E+02	7.87E+01	9.46E+02	5.68E+04	2.07E-02	7.30E-03
Up Hopper	OHF-MC-07	5.75E+02	1.67E+02	1.55E+02	2.25E+02	2.86E+01	3.86E+03	7.65E-04	2.80E-04
Low Hopper	OHF-MC-08	8.25E+02	1.82E+02	1.69E+02	2.66E+01	4.44E+01	1.74E+04	2.93E-03	3.40E-04
Floor	OHF-MC-09	8.90E+04	2.88E+02	1.89E+02	1.68E+01	1.40E+03	2.26E+05	9.75E-03	2.10E-02
	OHF-MC-10	7.14E+02	3.14E+02	2.04E+02	1.98E+01	2.97E+02	1.19E+05	5.69E-02	
East Wall	OHF-MC-11	3.14E+02	6.86E+01	6.07E+01	5.83E+00	1.21E+01	1.98E+03	1.06E-03	
	OHF-MC-12	1.04E+03	1.19E+02	1.06E+02	8.59E+00	2.60E+01	1.61E+04	4.71E-03	2.60E-04
North Wall	OHF-MC-13	8.97E+02	2.83E+02	2.52E+02	2.35E+02	9.17E+00	1.48E+04	5.31E-03	2.00E-04
	OHF-MC-14	2.43E+03	4.51E+02	4.13E+02	5.42E+01	3.84E+01	2.38E+05	4.15E-02	3.40E-03

OHF Pump Cell, Location Specific Measurement Results

	Location	AC-3 Alpha (dpm/100 cm^2)	HP-270, Open Beta/Gamma (mrad/h)	HP-270, Closed Beta/Gamma (mR/h)	HP-220A, Mod Gamma, Dirct. (mR/h)	Gross Alpha (dpm/100 cm^2)	Gross Beta/Gamma (dpm/100 cm^2)	Cesium-137 (µCi/100 cm^2)	Strontium-90 (µCi/100 cm^2)
		Instrument Measurements Performed At Each Location (above water level)				Smear Screening (CSL) Results For Each Location			
Pump Cell									
Floor	OHF-PC-01	7.74E+04	1.03E+02	2.41E+01	7.58E+00	2.46E+01	6.37E+03	2.29E-03	1.30E-04
	OHF-PC-02	2.98E+04	1.14E+02	2.02E+01	7.09E+00	1.21E+02	2.31E+04	5.25E-03	2.60E-04
East Wall	OHF-PC-03	2.70E+04	2.51E+01	2.23E+01	4.46E+00	1.12E+02	2.42E+04	6.87E-03	1.40E-03
	OHF-PC-04	5.07E+04	1.60E+01	1.10E+01	6.32E+00	3.95E+01	1.05E+04	4.74E-03	
Floor	OHF-PC-05	5.02E+03	5.03E+01	1.48E+01	6.82E+00	4.24E+01	9.08E+03	3.12E-03	1.10E-04
North Wall	OHF-PC-06	5.22E+04	1.57E+01	1.09E+01	6.68E+00	5.33E+01	7.53E+03	2.54E-03	2.50E-04
	OHF-PC-07	1.31E+03	3.20E+01	1.90E+01	7.30E+00	5.02E+01	1.80E+04	5.02E-03	2.80E-04
	OHF-PC-08	4.54E+04	2.15E+01	1.50E+01	5.96E+00	4.57E+01	5.24E+03	1.90E-03	5.10E-05
West Wall	OHF-PC-09	3.02E+04	1.51E+01	1.22E+01	5.42E+00	8.13E+00	1.34E+03	5.47E-04	2.10E-05
	OHF-PC-10	5.69E+02	1.88E+01	1.46E+01	6.12E+00	3.13E+01	3.60E+03	1.21E-03	1.20E-03
Floor	OHF-PC-11	5.54E+04	4.31E+02	6.00E+01	2.28E+01	3.17E+02	5.73E+04	1.28E-02	4.30E-03

OHF Wellhead Cell, Location Specific Measurement Results

	Location	Instrument Measurements Performed At Each Location (above water level)				Smear Screening (CSL) Results For Each Location			
		AC-3 Alpha (dpm/100 cm^2)	HP-270, Open Beta/Gamma (mrad/h)	HP-270, Closed Beta/Gamma (mR/h)	HP-220A, Mod Gamma, Dirct. (mR/h)	Gross Alpha (dpm/100 cm^2)	Gross Beta/Gamma (dpm/100 cm^2)	Cesium-137 (µCi/100 cm^2)	Strontium-90 (µCi/100 cm^2)
Wellhead Cell									
South Wall	OHF-WHC-01	3.33E+02	2.07E+01	1.68E+01	2.09E+01	1.01E+01	3.69E+03	9.59E-04	2.50E-04
	OHF-WHC-02	3.89E+02	1.56E+01	1.25E+01	4.50E+00	1.23E+01	1.22E+04	4.13E-03	8.90E-04
On Inj. WH South	OHF-WHC-03	2.37E+03	2.29E+01	1.38E+01	5.17E+00	2.80E+01	2.71E+04	4.17E-03	1.50E-04
On Inj. WH North	OHF-WHC-04	1.24E+03	3.42E+01	2.52E+01	6.50E+00	5.08E+00	2.44E+03	6.62E-04	4.10E-05
East Wall	OHF-WHC-05	6.94E+02	3.91E+01	3.29E+01	5.42E+00	3.66E+00	9.50E+02	2.90E-04	9.80E-05
	OHF-WHC-06	8.25E+02	6.71E+01	5.71E+01	7.31E+00	5.51E+00	2.58E+03	8.36E-04	3.40E-04
	OHF-WHC-07	7.12E+03	1.43E+02	1.17E+02	1.21E+01	2.10E+01	2.93E+04	5.91E-03	1.90E-04
Tank Mid South	OHF-WHC-08	2.49E+04	1.19E+02	9.52E+01	2.48E+01	7.24E+01	8.64E+03	3.68E-03	4.90E-04
Pipe Top of Tank	OHF-WHC-09	5.75E+03	1.94E+02	1.72E+02	6.46E+01	7.35E+01	1.24E+04	5.89E-03	
North Wall	OHF-WHC-10	2.89E+04	1.08E+02	8.60E+01	1.07E+01	3.42E+02	8.33E+04	7.19E-03	4.70E-03
	OHF-WHC-11	8.81E+03	6.84E+01	5.47E+01	8.64E+00	8.90E+01	7.50E+03	1.05E-03	7.90E-04
	OHF-WHC-12	7.20E+03	4.86E+01	3.69E+01	6.26E+00	5.42E+01	5.57E+03	9.50E-04	5.80E-04
West Wall	OHF-WHC-13	4.00E+03	3.17E+01	1.76E+01	5.96E+00	1.87E+01	3.11E+03	6.67E-04	2.50E-03
	OHF-WHC-14	6.94E+02	2.07E+01	1.76E+01	4.63E+00	7.75E+00	1.39E+03	3.51E-04	8.90E-05
Floor	OHF-WHC-15	6.41E+03	6.91E+01	5.08E+01	8.95E+00	1.01E+02	1.77E+04	7.24E-03	2.00E-03
	OHF-WHC-16	1.48E+04	7.63E+01	4.66E+01	7.36E+00	6.06E+01	3.66E+04	4.74E-03	1.40E-03
	OHF-WHC-17	2.01E+04	2.83E+02	2.34E+02	3.40E+00	1.31E+02	2.53E+04	1.03E-02	2.10E-04

OHF Engine Pad, Location Spe   ıeasurement Results

	Instrument Measurements Performed At Each Location (above water level)					Smear Screening (CSL) Results For Each Location			
	Location	AC-3	HP-270, Open	HP-270, Closed	HP-220A, Mod				
		Alpha	Beta/Gamma	Beta/Gamma	Gamma, Dirct.	Gross Alpha	Gross Beta/Gamma	Cesium-137	Strontium-90
		(dpm/100 cm^2)	(mrad/h)	(mR/h)	(mR/h)	(dpm/100 cm^2)	(dpm/100 cm^2)	(µCi/100 cm^2)	(µCi/100 cm^2)
Engine Pad									
	OHF-EP-01	2.22E+02	2.57E+00	1.80E+00	3.63E+00	6.76E+00	8.49E+03	3.32E-03	
	OHF-EP-02	3.06E+02	2.27E+00	1.63E+00	4.42E+00	6.97E+01	2.43E+04	1.31E-02	
	OHF-EP-03	8.98E+01	5.04E+00	3.73E+00	4.96E+00	1.15E+01	3.22E+04	2.25E-02	
	OHF-EP-04	5.53E+02	1.10E+01	6.00E+00	5.41E+00	4.64E+01	7.92E+04	5.66E-02	
	OHF-EP-05	1.23E+02	5.99E+00	5.06E+00	5.00E+00	2.54E+00	7.50E+03	2.93E-03	
	OHF-EP-06	1.18E+02	1.51E+01	1.31E+01	6.18E+00	2.79E+00	1.04E+04	7.58E-03	
	OHF-EP-07	1.45E+02	1.49E+01	1.26E+01	8.46E+00	8.60E+00	1.28E+04	9.09E-03	
	OHF-EP-08	4.71E+01	1.22E+01	1.15E+01	1.06E+01	0.00E+00	5.72E+02		
	OHF-EP-09	5.83E+01	1.28E+01	1.19E+01	1.12E+01	0.00E+00	4.16E+02		

OHF Pump House, Location Spe .leasurement Results

	Location	AC-3 Alpha (dpm/100 cm^2)	HP-270, Open Beta/Gamma (mrad/h)	HP-270, Closed Beta/Gamma (mR/h)	HP-220A, Mod Gamma, Dirct. (mR/h)	Gross Alpha (dpm/100 cm^2)	Gross Beta/Gamma (dpm/100 cm^2)	Cesium-137 (µCi/100 cm^2)	Strontium-90 (µCi/100 cm^2)
		Instrument Measurements Performed At Each Location (above water level)				Smear Screening (CSL) Results For Each Location			
Pump House									
West Wall	OHF-PH-01	1.47E+02	2.25E+01	1.96E+01	3.29E+00	1.10E+01	1.39E+03	1.92E-04	6.90E-06
North Wall	OHF-PH-02	4.72E+01	6.79E+00	5.69E+00	2.41E-01	0.00E+00	6.65E+01		
Floor	OHF-PH-03	1.67E+02	8.23E+00	6.30E+00	5.47E+00	3.95E+00	1.01E+04	3.10E-03	2.80E-04
North Wall	OHF-PH-04	4.72E+01	8.60E+00	7.70E+00	1.82E-01	1.14E+00	5.36E+02		
	OHF-PH-05	1.94E+01	6.17E+00	5.53E+00	3.65E-01	0.00E+00	5.34E+01		
	OHF-PH-06	2.78E+01	7.13E+00	6.23E+00	7.90E-01	0.00E+00	9.67E+02		
	OHF-PH-07	1.94E+01	3.31E+00	2.77E+00	1.82E-01	2.54E+00	1.27E+02		
Floor	OHF-PH-08	4.72E+01	1.37E+00	1.07E+00	2.43E-01	3.95E+00	5.34E+03	1.79E-03	1.60E-05
East Wall	OHF-PH-09	9.17E+00	2.65E+00	1.96E+00	2.74E-01	0.00E+00	3.06E+02		
	OHF-PH-10	6.39E+01	6.62E+00	4.36E+00	2.43E-01	1.52E+01	1.19E+03	1.05E-04	1.60E-04
Floor	OHF-PH-11	7.50E+01	1.60E+01	1.43E+01	1.03E+00	6.76E+00	7.83E+03	2.49E-03	3.10E-05
East Wall	OHF-PH-12	0.00E+00	2.39E+00	2.09E+00	3.65E-01	1.14E+00	1.51E+02		
Floor	OHF-PH-13	2.03E+02	2.59E+00	1.38E+00	3.04E-01	5.36E+00	5.48E+03	1.87E-03	2.20E-06
South Wall	OHF-PH-14	3.61E+01	2.92E+00	2.39E+00	3.64E-01	1.14E+00	2.86E+02		
	OHF-PH-15	1.94E+01	4.72E+00	4.21E+00	4.57E-01	1.14E+00	1.07E+02		
	OHF-PH-16	1.94E+01	1.16E+01	9.99E+00	6.37E-01	0.00E+00	2.90E+02		
	OHF-PH-17	1.94E+01	8.77E+00	7.58E+00	5.47E-01	0.00E+00	2.67E+02		
Floor	OHF-PH-18	3.42E+02	4.36E+01	3.33E+01	2.21E+00	1.52E+01	7.24E+04	1.49E-02	1.10E-04
Locker S. Wall	OHF-PH-19	2.78E+01	1.10E+01	9.67E+00	7.90E-01	1.14E+00	4.52E+02		
West Wall	OHF-PH-20	2.78E+01	1.52E+01	1.35E+01	2.38E+00	0.00E+00	7.13E+02		
Floor	OHF-PH-21	4.17E+02	3.28E+01	2.52E+01	1.21E+00	2.16E+01	1.44E+04	8.52E-03	
West Wall	OHF-PH-22	2.78E+01	1.56E+01	1.42E+01	2.00E+00	1.14E+00	2.85E+02	1.05E-04	8.30E-06

Appendix J:
Concrete Core Slit Scanning Results

Results of control room concrete core scanning

CORE POSITION (IN)	ROI AREA (CTS)	AREA-BKG (CTS)	bkg	Lc	Activity nCi/cc	Activity nCi/cc Meas.VS.BKG
0.25	12	7.5	4.5	8.742640687	0.252528909	0.252528909
0.5	5	0.5	4.5	8.742640687	0.016835261	BKG LEVEL
0.75	1.5	-3	4.5	8.742640687	-0.101011563	BKG LEVEL
2.25	3	-1.5	4.5	8.742640687	-0.050505782	BKG LEVEL
4.25	0	-4.5	4.5	8.742640687	-0.151517345	BKG LEVEL
6.25	4	-0.5	4.5	8.742640687	-0.016835261	BKG LEVEL
7	6	1.5	4.5	8.742640687	0.050505782	BKG LEVEL
7.25	10	5.5	4.5	8.742640687	0.185187866	0.185187866
7.5	10	5.5	4.5	8.742640687	0.185187866	0.185187866

Results of mixing cell concrete core

CORE POSITION (IN)	ROI AREA (CTS)	AREA-BKG (CTS)	bkg	Lc	Activity nCi/cc	Activity nCi/cc Meas.VS.BKG
0	172	167.5	4.5	8.742640687	16.48735641	16.48735641
0.25	22.5	18	4.5	8.742640687	1.771775614	1.771775614
0.5	28	23.5	4.5	8.742640687	2.313151497	2.313151497
0.75	17	12.5	4.5	8.742640687	1.230399732	1.230399732
1	16	11.5	4.5	8.742640687	1.131967754	1.131967754
1.25	10	5.5	4.5	8.742640687	0.541375882	0.541375882
1.5	16	11.5	4.5	8.742640687	1.131967754	1.131967754
1.75	57.5	53	4.5	8.742640687	5.216894865	5.216894865
2	79.5	75	4.5	8.742640687	7.382398394	7.382398394
2.25	130	125.5	4.5	8.742640687	12.35321331	12.35321331
2.5	435	430.5	4.5	8.742640687	42.37496678	42.37496678
2.75	936	931.5	4.5	8.742640687	91.68938805	91.68938805
0	50	45.5	4.5	8.742640687	4.478655025	4.478655025
0.25	22	17.5	4.5	8.742640687	1.722559625	1.722559625
0.5	9	4.5	4.5	8.742640687	0.442943904	0.442943904
0.75	24.5	20	4.5	8.742640687	1.968639572	1.968639572
1.75	28.5	24	4.5	8.742640687	2.362367486	2.362367486
2.75	11	6.5	4.5	8.742640687	0.639807861	0.639807861
3.75	10	5.5	4.5	8.742640687	0.541375882	0.541375882
4.75	6.5	2	4.5	8.742640687	0.196863957	BKG LEVEL
5.75	21	16.5	4.5	8.742640687	1.624127647	1.624127647

Results of pump cell concrete core scanning

CORE POSITION (IN)	ROI AREA (CTS)	AREA-BKG (CTS)	bkg	Lc	Activity nCi/cc	Activity nCi/cc Meas.VS.BKG
0	8251.5	8247	4.5	8.742640687	811.7685274	811.7685274
0.25	341	336.5	4.5	8.742640687	33.12236079	33.12236079
0.5	209.5	205	4.5	8.742640687	20.17855561	20.17855561
0.75	141	136.5	4.5	8.742640687	13.43596508	13.43596508
1	106	101.5	4.5	8.742640687	9.990845826	9.990845826
1.25	19.5	15	4.5	8.742640687	1.476479679	1.476479679
1.5	7	2.5	4.5	8.742640687	0.246079946	BKG LEVEL
1.75	0	-4.5	4.5	8.742640687	-0.442943904	BKG LEVEL
2.5	0	-4.5	4.5	8.742640687	-0.442943904	BKG LEVEL
3	6.5	2	4.5	8.742640687	0.196863957	BKG LEVEL
4	0	-4.5	4.5	8.742640687	-0.442943904	BKG LEVEL
5	1	-3.5	4.5	8.742640687	-0.344511925	BKG LEVEL
6	3	-1.5	4.5	8.742640687	-0.147647968	BKG LEVEL
7	14	9.5	4.5	8.742640687	0.935103797	0.935103797
7.5	5	0.5	4.5	8.742640687	0.049215989	BKG LEVEL
7.75	10	5.5	4.5	8.742640687	0.541375882	0.541375882
8	3	-1.5	4.5	8.742640687	-0.147647968	BKG LEVEL

Results of wellhead cell concrete core scanning

CORE POSITION (IN)	ROI AREA (CTS)	AREA-BKG (CTS)	bkg	Lc	Activity nCi/cc	Activity nCi/cc Meas.VS.BKG
0	39	34.5	4.5	8.742640687	3.395903261	3.395903261
0.25	25.5	21	4.5	8.742640687	2.06707155	2.06707155
0.5	10	5.5	4.5	8.742640687	0.541375882	0.541375882
0.75	19	14.5	4.5	8.742640687	1.427263689	1.427263689
1	11	6.5	4.5	8.742640687	0.639807861	0.639807861
1.25	19.5	15	4.5	8.742640687	1.476479679	1.476479679
1.5	13	8.5	4.5	8.742640687	0.836671818	0.836671818
1.75	21	16.5	4.5	8.742640687	1.624127647	1.624127647
2	17	12.5	4.5	8.742640687	1.230399732	1.230399732
2.25	17.5	13	4.5	8.742640687	1.279615722	1.279615722
2.5	9.5	5	4.5	8.742640687	0.492159893	0.492159893
2.75	23.5	19	4.5	8.742640687	1.870207593	1.870207593
3.75	30	25.5	4.5	8.742640687	2.510015454	2.510015454
4.75	24	19.5	4.5	8.742640687	1.919423582	1.919423582
5.75	18	13.5	4.5	8.742640687	1.328831711	1.328831711
6.75	5	0.5	4.5	8.742640687	0.049215989	0.049215989
7	33.5	29	4.5	8.742640687	2.854527379	2.854527379
7.25	21.5	17	4.5	8.742640687	1.673343636	1.673343636

Results of engine pad concrete core scanning

CORE POSITION (IN)	ROI AREA (CTS)	AREA-BKG (CTS)	bkg	Lc	Activity nCi/cc	Activity nCi/cc Meas.VS.BKG
0	4658	4653.5	4.5	8.742640687	156.6857702	156.6857702
0.25	1908	1903.5	4.5	8.742640687	64.09183702	64.09183702
0.5	899	894.5	4.5	8.742640687	30.11828117	30.11828117
0.75	487	482.5	4.5	8.742640687	16.24602646	16.24602646
1	301	296.5	4.5	8.742640687	9.983309523	9.983309523
2	66	61.5	4.5	8.742640687	2.070737051	2.070737051
3	21	16.5	4.5	8.742640687	0.555563599	0.555563599
4	7	2.5	4.5	8.742640687	0.084176303	BKG LEVEL
4.75	0	-4.5	4.5	8.742640687	-0.151517345	BKG LEVEL
5	1	-3.5	4.5	8.742640687	-0.117846824	BKG LEVEL
5.25	0	-4.5	4.5	8.742640687	-0.151517345	BKG LEVEL
5.5	2.5	-2	4.5	8.742640687	-0.067341042	BKG LEVEL
5.75	0	-4.5	4.5	8.742640687	-0.151517345	BKG LEVEL
6.75	24	19.5	4.5	8.742640687	0.656575163	0.656575163

Results of pump house concrete core scanning

CORE POSITION (IN)	ROI AREA (CTS)	AREA-BKG (CTS)	bkg	Lc	Activity nCi/cc	Activity nCi/cc Meas.VS.BKG
0	4198	4193.5	4.5	8.742640687	412.7745022	412.7745022
0.25	1045	1040.5	4.5	8.742640687	102.4184737	102.4184737
0.5	92.5	88	4.5	8.742640687	8.662014115	8.662014115
0.75	16	11.5	4.5	8.742640687	1.131967754	1.131967754
1	0	-4.5	4.5	8.742640687	-0.442943904	BKG LEVEL
1.25	0	-4.5	4.5	8.742640687	-0.442943904	BKG LEVEL
1.5	0	-4.5	4.5	8.742640687	-0.442943904	BKG LEVEL
2	0	-4.5	4.5	8.742640687	-0.442943904	BKG LEVEL
2.5	8.5	4	4.5	8.742640687	0.393727914	BKG LEVEL
3	1	-3.5	4.5	8.742640687	-0.344511925	BKG LEVEL
3.5	2.5	-2	4.5	8.742640687	-0.196863957	BKG LEVEL
3.75	5.5	1	4.5	8.742640687	0.098431979	BKG LEVEL

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