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# Environmental Data Package for ORNL Waste Area Grouping-Five (WAG-5), Solid Waste Storage Area-Five (SWSA-5)

R. R. Shoun

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ORNL/RAP-19

# ENVIRONMENTAL DATA PACKAGE FOR ORNL WASTE AREA GROUPING-FIVE (WAG-5), SOLID WASTE STORAGE AREA-FIVE (SWSA-5)

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CHEMICAL TECHNOLOGY DIVISION

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ABSTRACT

The ORNL Waste Area Grouping-Five (WAG-5) consists of ten subgroupings which include not only the Solid Waste Storage Area-Five (SWSA-5) itself, but nearby low level waste (LLW) line leak sites, the Old Hydrofracture Facility (OHF) surface facilities, tanks, sludge basins, and the New Hydrofracture Site surface facilities. This report describes the site locations, the site history, known waste inventory and release, the hydrology, geology, and ecology, and remedial actions taken in the past. Supporting bibliography, drawings, and pictures are included as considered appropriate.

This document is not intended to be an exhaustive compilation of data, but to be a starting point for the assimilation of information necessary for the decision-making processes mandated by the Resource Conservation and Recovery Act (RCRA).

# 1. INTRODUCTION

As a Waste Area Grouping (WAG) known to contribute radioactivity to the environment, WAG-5 must be addressed under Section 3004u of the 1984 Resource Conservation and Recovery Act (RCRA) reauthorization. The Remedial Action/Feasibility Study (RI/FS) determines the extent of the problem and provides an assessment of available alternatives for remedial action and recommendations for implementation. This report provides a review and presentation of much of the available information related to WAG-5 with extensive bibliography that should be useful to those responsible for subsequent stages in the RI/FS process.

# 2. GENERAL SITE DESCRIPTION OF WAG-5

## 2.1 HISTORY, PURPOSE, AND GEOGRAPHIC LOCATION OF SWSA-5

Since the early operation of the Clinton Laboratories in 1943, solid, low-level radioactive wastes at ORNL have been disposed of by shallow-land burial in six solid waste storage areas (SWSAs). As each of the first four successively larger SWSAs were filled, another was opened to accept waste. SWSA-5 was commissioned in 1959 and the land set aside for this unit was more than double that of the preceding four SWSAs combined (32.3 ha vs 14.1 ha) or 80 acres vs 35 acres. The selection of the site for SWSA-5 was based on experience gained as a result of previous burial operations, as well as studies which addressed radionuclide transport in soil. Criteria that were established for the selection of the SWSA-5 site included depth to groundwater, ease of operation, flood potential, soil erosion by surface runoff, easy excavation, short handling distance, restricted access roads, and underlying geology (Bates, 1983; Grizzard, 1986). However, because of topographic and hydrologic unsuitability of some parts of the SWSA-5 area, only about 20.2 ha (50 acres) has actually been used for trench disposal (Evaluation Research Corporation, 1982).

During the period 1955 to 1963, Oak Ridge was designated by the Atomic Energy Commission as the Southern Regional Burial Ground; both SWSA-4 and SWSA-5 received an estimated $2.83 \times 10^4$ $m^3$ of poorly characterized wastes from approximately 50 agencies (Lomenick and Cowser, 1961; Davis and Shoun, 1986; Evaluation Research Corporation 1982; Myrick et al., 1984). SWSA-5 was closed to routine trench burial of waste in 1973.

A section of SWSA-5 (north) was set aside for the retrievable storage of transuranium (TRU) wastes in 1970. Prior to that time, TRU wastes were historically segregated from other radioactive wastes prior to burial in drums, in some concrete capped holes, and in some concrete or asphalt capped trenches. In 1974 the Atomic Energy Commission (AEC) proposed a ban on soil burial of wastes containing more than 10 nCi/g of TRU and required AEC-approved storage for retrievability for 20 years (Evaluation Research Corporation, 1982).

SWSA-5 is located on a hillside east of White Oak Creek, between SWSA-4 and Melton Branch and is south-southwest of the main ORNL complex lying in Melton Valley, which is bounded on the northwest by Haw Ridge and on the southeast by Copper Ridge. Coordinates are: latitude 35.91401, longitude 84.31295. Figure 1 shows SWSA-5 in relation to the ORNL complex and other SWSAs. SWSA-5 actually consists of two distinct geographical areas — the larger southern section on the moderately sloping hillside, and the smaller northern section on a reasonably flat ridge top. The southern section contains most of the buried waste, while the northern section is used for the retrievable storage of TRU waste. A photograph of SWSA-5 (Fig. 2) shows the southern section of SWSA-5 in the foreground, with the northern section near the top center portion of the picture. An aerial view of the TRU waste storage area is shown in Fig. 3 (Oakes and Shank, 1979; Evaluation Research Corporation, 1982; National Research Council, 1985).

## 2.2 GEOLOGY

The Oak Ridge Reservation lies in the Valley and Ridge portion of the Appalachian Highland Physiographic Province, which extends from Alabama to Virginia. The northeast-southwest trending ridges, in general, are underlain by sandstones, and the more siliceous limestones are dolomites that are relatively resistant to erosion; the valleys are underlain by more easily erodable shales and more soluble carbonate rocks. Principal formations are identified in Fig. 4.

These geologic formations have been subjected to a series of great overthrusts. Fault blocks have resulted, and each of these blocks, or

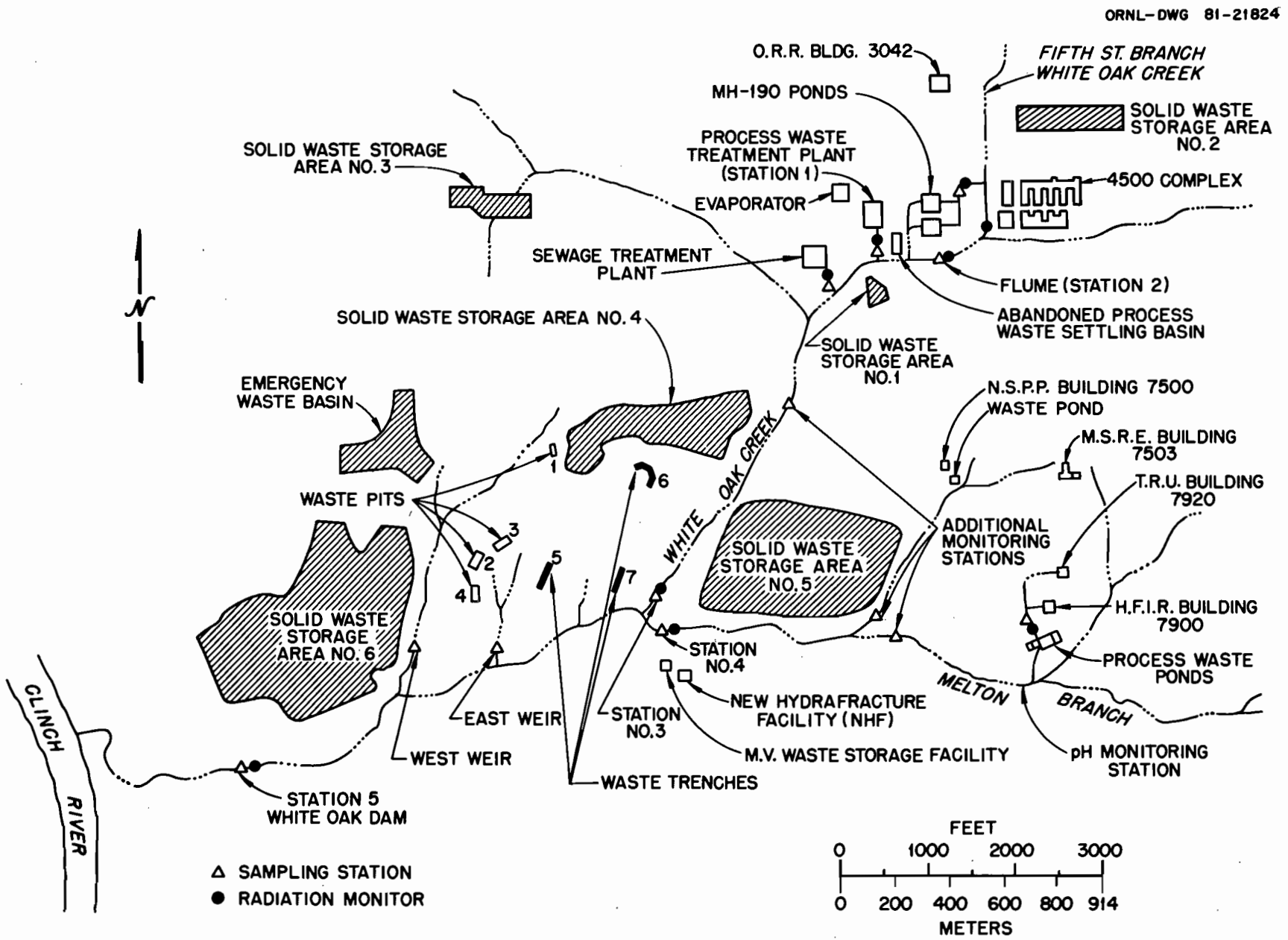


Fig. 1. Bethel and Melton Valley watershed.

ORNL-PHOTO 79-822

Fig. 2. Photograph of SWSA-5.

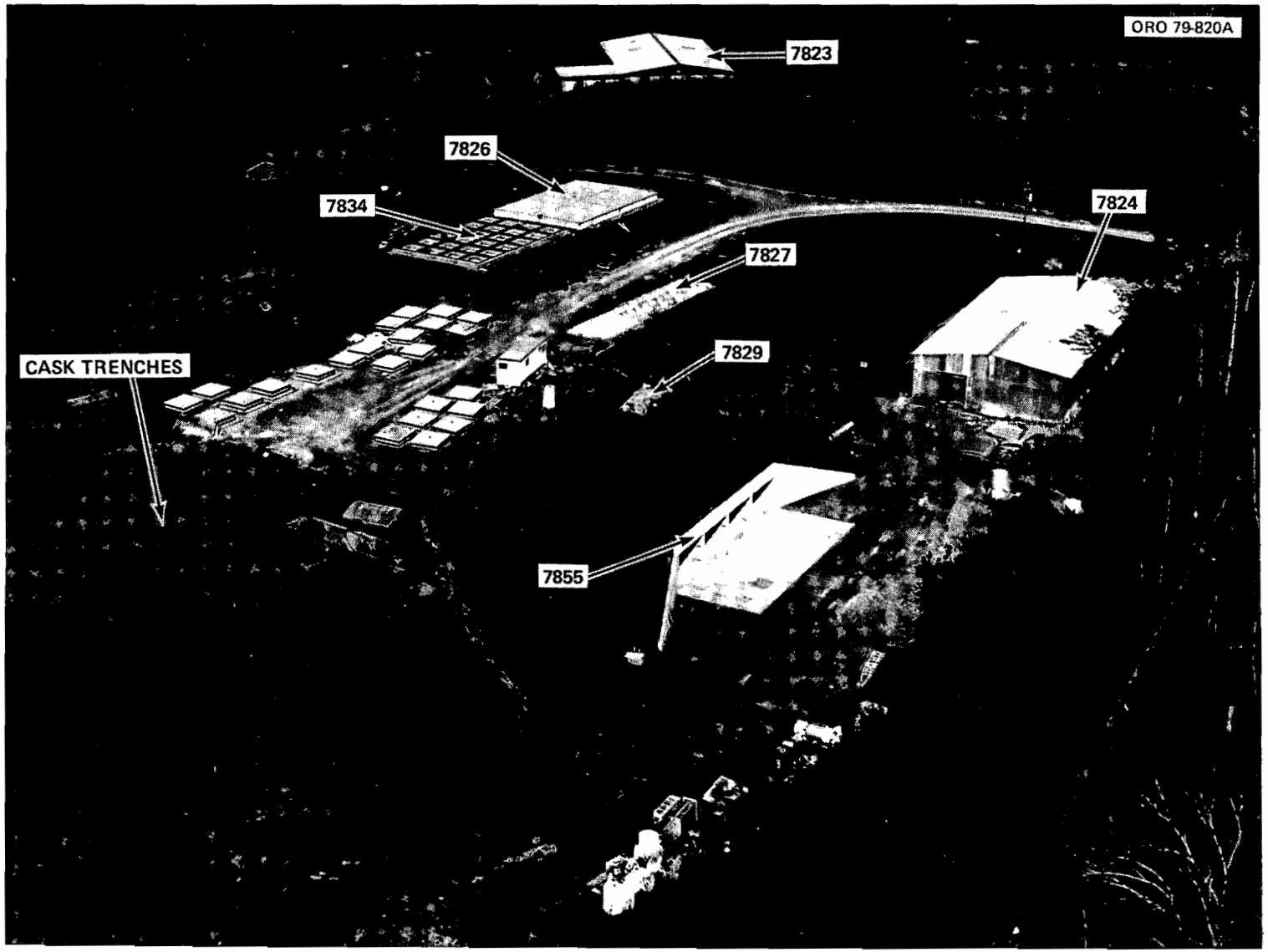


Fig. 3. Retrievable waste facilities in SWSA-5 north.

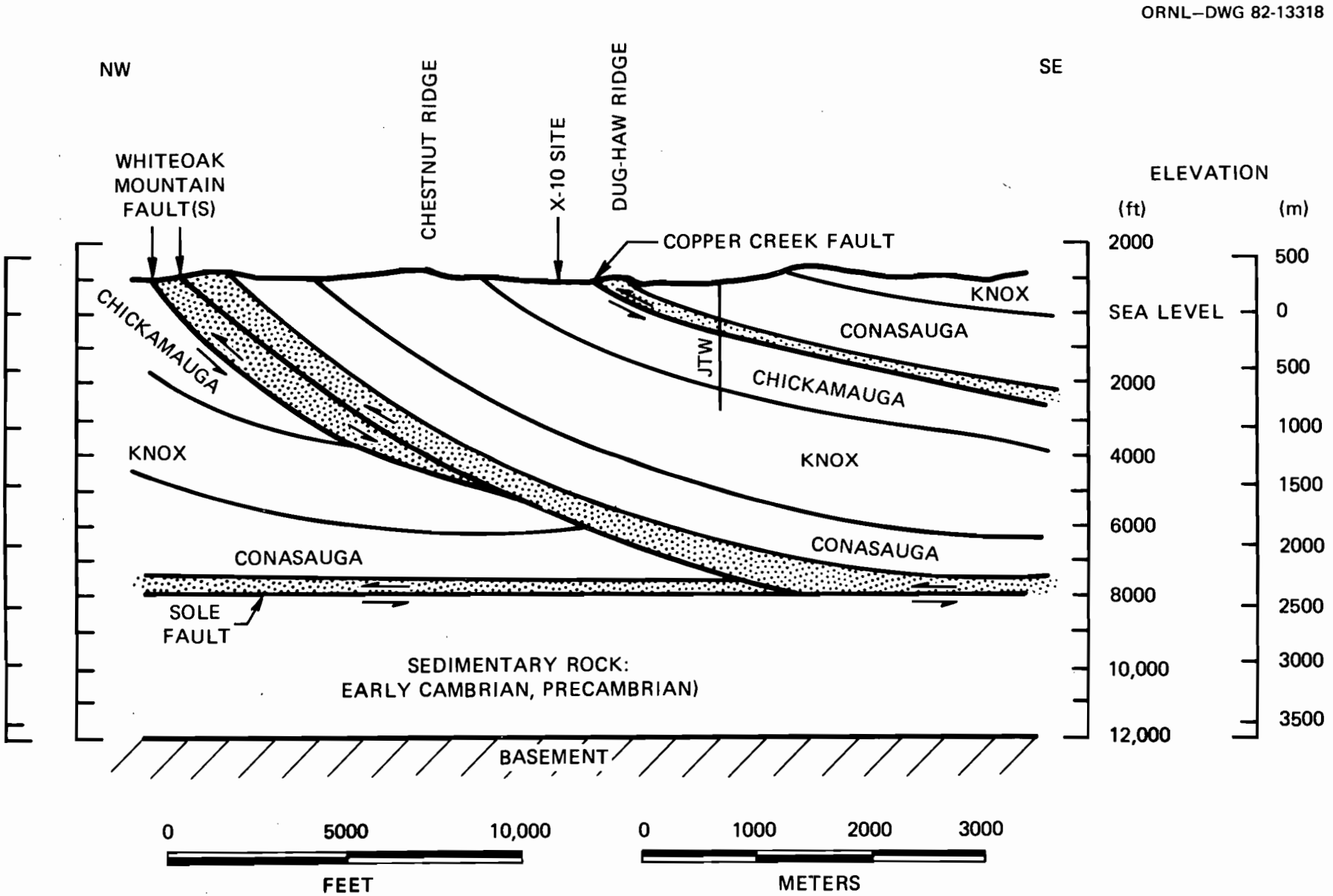


Fig. 4. Basic geological formations in the ORNL vicinity.

layers of rocks roughly 3 km (10,000 ft) thick, have been moved to their present position as much as several tens of miles to the northwest. These blocks have overridden similar layers of rock and, in turn, have been overridden by other layers. Formations on the reservation dip gently to the southeast and become more deeply buried southeastward. As a result of the overthrust faulting, the geology of the area is very complex, and the sequence of formations at Oak Ridge, as shown in Fig. 4, is not always a normal stratigraphic sequence (youngest to oldest).

Four groups of formations are of immediate interest at Oak Ridge. The oldest is the Rome formation, of Lower Cambrian age. The upper part of this formation is composed largely of beds of hard brittle quartzite 2 to 30 cm (1 to 11 in.) thick. The Rome is normally overlain by rocks of the Conasauga group. The Conasauga group of formations and smaller units include, from top to bottom, the Maynardsville limestone, the Nolichucky shale, the Maryville limestone, the Rogersville shale, the Rutledge limestone, and the Pumpkin Valley shale. In aggregate, the Conasauga group is about 600 m (2000 ft) thick. The bottom 100 m (325 ft) of the Conasauga — the Pumpkin Valley member — is a dense argillaceous shale that is thinly bedded and dominantly red. This is the unit into which radioactive waste was injected by hydrofracture. Shales and subordinate interbedded limestones of the Conasauga group underlie the solid waste burial grounds (SWSA 5 is underlain by limestone); the upturned tiled edges of these rocks are commonly concealed and mantled by soil and soft weathered rock to depths ranging from 1 to 12 m (3 to 4 ft). In areas underlain by rocks of the Conasauga group, the depth of weathering ranges with topography, being thicker beneath ridges and thinner in low-lying areas. The thickness of the soil and soft weathered rock varies greatly in low-lying areas.

Dolomites of the Knox group normally overlie the rocks of the Conasauga. The Knox is characterized by broad ridges and incised drainage bordered by steep slopes. In this area there is a deeply weathered blanket of cherty, and somewhat clayey, silt soil; a deep water table; and some karst features (sinkholes, swallow holes) that indicate solutional enlargement of rock fractures.

The Chickamauga group consists of several hundred feet of shales and limestones. These rocks commonly occupy valley bottoms, such as Bethel Valley. The Chickamauga lies in an area of gentle topography whose soils are variable in thickness but, overall, relatively thin — commonly less than 3 m (10 ft).

The coarsely crystalline limestone grades upward into the Reedsville shale, a calcareous, tan to orange-brown, fissile, thin-bedded, fossiliferous shale, which is the uppermost unit of the Chickamauga limestone. This unit is 60 to 75 m (200 to 250 ft) thick.

In Bethel Valley, lithologic differences within the formation are more distinct, and the stratigraphic sequence is more easily defined than in other parts of the area The residual mantle is generally thinner, and outcrops of the beds are more common. Also, the beds are persistent in character along strike, and each unit has more distinguishing features. The Chickamauga in Bethel Valley can be divided into at least eight units. Three of these units consist of redbeds: one about 35 m (120 ft) above the base, another near the middle of the formation, and another at or near the top.

A cross-sectional diagram of the subsurface geology is given in Fig. 4. A test well has been drilled to a depth of 995 m (3263 ft) on a site near Melton Creek on the cross section. The depth of the various geologic formations in this area were determined from the cores of this well.

Most of the soils are silt, with considerable amounts of clay — the weathered residual products of the underlying rocks. They are highly leached, low in organic matter, and acidic; the pH ranges from 4.5 to 5.7 (Cowser et al., 1961).

The weathering characteristics of these rocks are important because they relate to the sorptive qualities of the residual materials. Kaolinite is the principal clay mineral in the soils of the Knox, and both kaolinite and illite are common in the Chickamauga. The chief minerals in the weathered rocks of the Conasauga group are illite, smectite, and vermiculite. The sorptive properties of the clay minerals range considerably (Means et al., 1978); smectite and vermiculite generally have the greatest sorbent capacity (National Research Council, 1985).

The soil produced by weathering of the Chickamauga typically consists of yellow, light reddish orange, or red clay containing variable amounts of chert. Chert is abundant enough in the lower layers to cause development of a line of low hills on the northwestern sides of the valleys. This is more pronounced in Bethel Valley, where the basal material is composed of alternating siltstone beds and beds of block chert.

The surfaces of the valleys underlain by the formation are irregular; the more silty and cherty layers underlie low ridges and hills. Sinkholes are present, but these are not as numerous or as large as those in the Knox group.

Fossils, including brachiopods, bryozoans, gastropods, cephalopods, crinoid stems, corals, and trilobites, are common throughout the formation.

The age of the Chickamauga limestone is Middle and Upper Ordovician. The boundary between Middle and Upper Ordovician rocks in this area is drawn at the base of the Reedsville shale. The thickness of the Chickamauga in Bethel Valley is about 530 m (1750 ft) (Boyle et al, 1982).

## 2.3 HYDROLOGY

### 2.3.1 Surface Water

An early study of hydrologic features of the ORNL site was made by DeBuchananne (Stockdale, 1951). He states that the section of Bethel Valley in which the main part of ORNL is located, is drained by White Oak Creek and its tributaries. White Oak Creek flows out of Bethel Valley through Haw Gap at an elevation of 235 m (770 ft). After passing through the gap, it is joined by Melton Branch and then flows south-southwest into the Clinch River, approximately 3.3 km (2.0 miles) away. Flow to the Clinch River is controlled by White Oak Dam, located approximately 1.0 km (0.6 mile) from the mouth of the creek, which forms White Oak Lake.

A later study of the hydrology of the Oak Ridge area provides data on runoff in area streams. The seasonal variation in runoff, averaged for the water years 1961-64 and adjusted to the 1936-60 water years, is as follows in terms of percentage of annual runoff: October-December, 17%; January-March, 49%; April-June, 23%; July-September, 11%. McMaster (1967) states that a large part of the runoff is derived from discharge of stored groundwater. The periods of maximum and minimum runoff correspond to the variations in rainfall. These data represent averages for the Oak Ridge area, but they presumably apply to the burial ground sites (Evaluation Research Corporation, 1982). White Oak Creek is the natural drainage and, as such, is an integral part of the Laboratory's water system, conveying effluents from various parts of the ORNL complex to points beyond the reservation (Webster, 1976). The natural flow of water into the White Oak Creek is augmented by water piped into ORNL from outside the drainage basin and subsequently discharged to White Oak Creek. During prolonged periods of dry weather, the discharge from these sources often makes up a major fraction of the creek flow (Boyle, et al., National Research Council, 1985).

### 2.3.2 Groundwater

The geology and climate at Oak Ridge significantly affect the groundwater conditions; the distinctive groundwater conditions, in turn, significantly affect waste management practices. Emphasis is placed upon groundwater because it is a carrier of contamination, not because of its potential use a drinking water — there are no water wells subject to contamination by groundwater at ORNL.

The sedimentary rocks in the areas used for waste management, chiefly shale and subordinate amounts of limestone, have a low permeability. The flow that does occur is mainly through fractures rather than through the rock matrix — the greatest porosity is in the upper weathered zone. As a result, these beds of the Conasauga group

yield very small quantities of of groundwater to the test wells (less than 38 L/m, or 10 gal/min, average). There are no productive water wells near the waste storage areas. The residual material over the Conasauga is less compact, and the water-bearing openings are larger than in unweathered bedrock. The porosity of the residual material acts as a reservoir feeding water to the fracture system. The rock fractures tend to decrease in size with depth; consequently, the residuum bears most of the groundwater in the Conasauga group outcrop belt, and because the thickness of the residuum in these belts is less than 10 m (30 ft) in most places, the volume of groundwater storage is small and is nearly depleted by September or October (McMaster, 1967).

The Chickamauga group is a poor aquifer because it contains so much shale and siltstone. This formation is practically devoid of any large solution cavities, and the only water derived from it probably permeates along the bedding planes and joint partings. Although numerous small openings may occur within, but rarely beyond, 30 m (100 ft) of the surface, rates and quantity of water transport are small. Recharge is further restricted by the high clay content of the overburden. The residual material is typically less than 3 m (10 ft) thick; therefore, most water input is diverted to surface runoff.

In Bethel Valley, depth to the water table ranges from 0.3 to 11 m (1 to 35 ft), whereas in Melton Valley the range is from 0.3 to 20 m (1 to 67 ft). Seasonal fluctuations tend to be greatest beneath hillsides and near groundwater divides. As much as 4.5-m (15-ft) seasonal variation was reported for Melton Valley.

Water table contour maps are useful, in a general way, for estimating the direction of groundwater movement, especially in the weathered residual soil or unconsolidated materials overlying bedrock. However, direction of movement in the underlying bedrock is influenced more strongly by directional variations in permeability. Groundwater flow in the residual soil is generally toward the individual streams of the surface-drainage network. In Bethel Valley, groundwater in the Chickamauga limestone moves through small solution channels. Although the rate of groundwater flow in the area is not known, the direction and pattern of this flow on the Bethel Valley site is essentially a subdued replica of the topography. Thus, water flows from areas of

high elevation to those of low elevation, and the principal movement is in directions normal to the contour lines. The lay of the land is such that drainage at and below the surface of the Bethel Valley site apparently converges to feed WOC and White Oak Lake. An exception to this situation occurs in the western end of the Bethel Valley site where the groundwater west of a groundwater divide flows west into the Racoon Creek drainage basin rather than into WOC (Boyle et al., 1982).

The distinctive, hilly ridge-and-valley topography with closely spaced streams results in a relatively short flow path of the groundwater from recharge to storage to discharge. The water table is a subdued replica of land surface topography; therefore, it is easy to approximate water table contours and to determine the general direction of groundwater flow from ridge tops to the nearest creek. The groundwater flow paths tend to range from as little as 6 m (20 ft) to as much as 300 m (1000 ft), but most range from 60 to 210 m (200 to 700 ft). Some groundwater is not discharged into the nearest creek because it is shunted out to the land surface after periods of heavy precipitation as seeps on lowland slopes. Groundwater travel time may vary from a few months to many hundreds of years.

The groundwater in the drainage basin is neutral to slightly alkaline (pH 7 to 8.5) and is of the calcium bicarbonate type (high contents of calcium, magnesium and bicarbonate), reflecting the influence of the limestone and dolomite through which the water moves. The limestone constituents are only slightly more dilute in local surface streams. The calcium and magnesium in the ground waters and surface waters interfere with sorption of $^{90}Sr$ on soils and sediments, thereby increasing the mobility and aggravating the management of this important radioactive waste constituent in the ORNL environment (Webster, 1976; Spalding and Cerling, 1979; Boyle et al., 1982; National Research Council, 1985).

The relationship between climate, surface water, groundwater flow, and shallow-land burial of radioactive materials was summarized by Richardson (1963):

> The relatively large amount of rainfall at Oak Ridge has several effects. It causes the water table to occur at shallow depths and is responsible for seasonably large stream flow; it contributes to the development of a high drainage density, thereby reducing the distance between points of ground-water recharge and discharge and the length of time of ground water residence; it lowers soil pH and influences the development of clay minerals that can control or modify the migration of radioactive ions...

Upward movement of contaminated groundwater can occur. Where the water table is shallow, evaporation of water into the atmosphere can be expected; however, as Webster points out, the only radionuclide expected to migrate to any extent by this process is tritium. Studies near the waste pits (Auerbach et al., 1958) showed that $^{106}Ru$ had been accumulated from ground water by trees and deposited on the ground in fallen leaf litter. Other studies at ORNL (Struxness, 1962) showed that $^{60}Co$, $^{137}Cs$, and $^{90}Sr$ can be translocated from ground water by this mechanism.

## 2.4 ECOLOGY

### 2.4.1 Flora

The primary vegetation surrounding the SWSA-5 site is the oak-hickory association, which is typified by extensive stands of mixed yellow pine and hardwoods, as well as oak and hickory. Since waste disposal sites were first constructed at ORNL in the 1940s, the existing forest has been cleared, the trenches have been excavated and filled with waste, and the approximate 1 m (3 ft) of soil cover has been seeded to grass to prevent soil erosion. A grass cover has been maintained at SWSA-5, which requires both periodic mowing during the summer and yearly applications of nitrogen-containing fertilizer.

A comprehensive listing of plant species that potentially occur on the Oak Ridge Reservation has been compiled (Mann and Nelson, 1976). There have been no studies on invading species specific to the burial grounds; however, the general pattern of succession of abandoned land is one in which the earliest phase is dominated by annual plants and grasses such as ragweed and crabgrass. The next phase is dominated by biennial

and perennial plants such as horseweed, primrose, many species of aster, and other composite. Fescue is dominant at this stage in areas such as power line corridors where it has been planted for erosion control. Areas that are periodically mowed (e.g., SWSA-5), are generally dominated by fescue and other grasses, rapidly growing weedy annuals, and low growing perennials. The grass phase is generally followed by a shrub phase; the grassland is invaded by rapidly growing shrubs, woody vines, and tree seedlings such as sassafras, red cedar, pines, and various hardwoods.

### 2.4.2 Fauna

The animal population captured or observed on the Oak Ridge Reservation (and likely to inhabit portions of SWSA-5) consists of small mammals (mice, chipmunks, land shrews), and larger mammals (squirrels, opossum, rats, groundhogs, muskrats, foxes, weasels, bobcats, and deer). Groundhogs, in particular, have found old waste trenches to make ideal dens. Wooded and open areas, as well as edge communities, create favorable habitats for a wide variety of bird species.

Mammallian species inhabiting old field or disturbed areas are quite similar, whether the vegetative cover is grass, tree seedlings, or shrubs. In a 1-ha (2.5 acre) study area indicative of these habitats, the dominant vegetation was tall fescue and *sericia lespedeza*. Small mammals trapped were cotton rats, white-footed mice, a golden mouse, a rice rat, short-tail shrews, and western harvest mice (Kitchings and Mann, 1976; Jacobs et al., 1980; Davis and Shoun, 1986).

## 2.5 LAND USE

### 2.5.1 Trench Burial

SWSA-5 (including the northern and southern portions) is a fenced area of approximately 32.3 ha (80 acres), of which only approximately 20.2 ha (50 acres) have actually been used for waste disposal (Myrick et al., 1984). The majority of this area is contained in the southern part, known as SWSA-5 (south). SWSA-5 (south) is a moderately sloping hillside with a grass cover (Fig. 5). The area is fenced and contains several unpaved access roads. As was mentioned previously, portions of the area are topographically or hydrologically unsuitable for trench disposal and thus have not been used for burial of waste. The

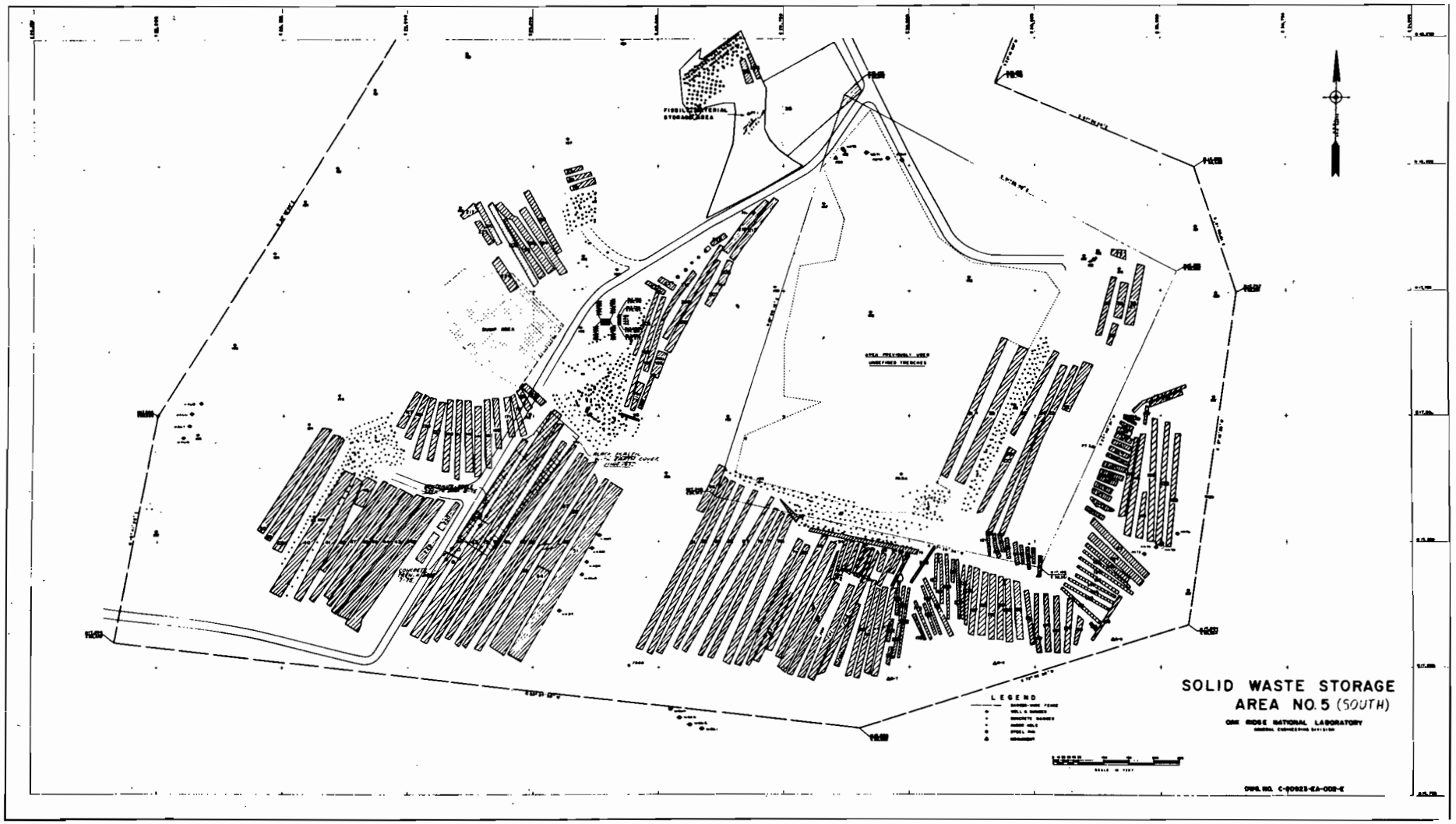


Fig. 5. SWSA-5 (south).

ORNL Old Hydrofracture Facility, utilized for many years for permanent disposal of ORNL generated liquid waste, but now deactivated, is located just inside the southwestern corner of SWSA-5 (south) near coordinates N17,200 and E28,600.

Waste disposal in SWSA-5 (south) was accomplished in a manner similar to that used for SWSA-4 (Davis and Shoun, 1986). Beta-gamma contaminated waste was disposed of by normal trench burial, that is, excavation by backhoe and covered with weathered shale (Bates, 1983). Trenches in the area vary considerably in size from approximately 12 to 150 m (40 to 500 ft) in length, and they are approximately 4.4 m (15 ft) deep and 3.5 (12 ft) wide. The trenches were located at right angles to the strike of the shale to minimize collapse of the trench walls; thus, most trenches are located parallel to the slope. The "undefined area" shown was used primarily for disposal of segregated alpha-contaminated waste which was trench buried and occasionally covered with a slab of concrete. The records for the "undefined area" are missing as are many that were burned in the Building 7803 fire. Auger holes were utilized for disposal of higher-activity and fissile wastes in the areas designated on Fig. 5.

### 2.5.2 Retrievable Storage

SWSA-5 (north) has been used almost exclusively for the retrievable storage of transuranic (TRU) wastes (Webster, 1976; Myrick et al., 1984; Bates, 1983) (Fig. 6). Since the segregation of TRU waste began in 1970 at ORNL, in response to a DOE order for retrievability, three retrievable storage methods have been used: stored drums, stainless steel-lined wells, and concrete casks. Figure 7 shows the TRU waste storage area and the facilities involved.

Solid TRU wastes with low external gamma exposure rates (<200 mR/hr) were first stored in 114-L or 220-L (30- or 55-gal) stainless steel drums in Building 7823, as shown in Fig. 8. The drums are sealed with a neoprene gasket and a closure ring (Gilbert/Commonwealth, 1981). Building 7823 (now used as a temporary holding area) is 15 m (48 ft) wide, 24 m (78 ft) long, and two-thirds below grade; it has a crushed rock floor, metal roof and walls, and ceiling of chain-link fence fabric. Once a sufficient number of drums have accumulated, a cell of the Retrievable Waste Storage Facility,

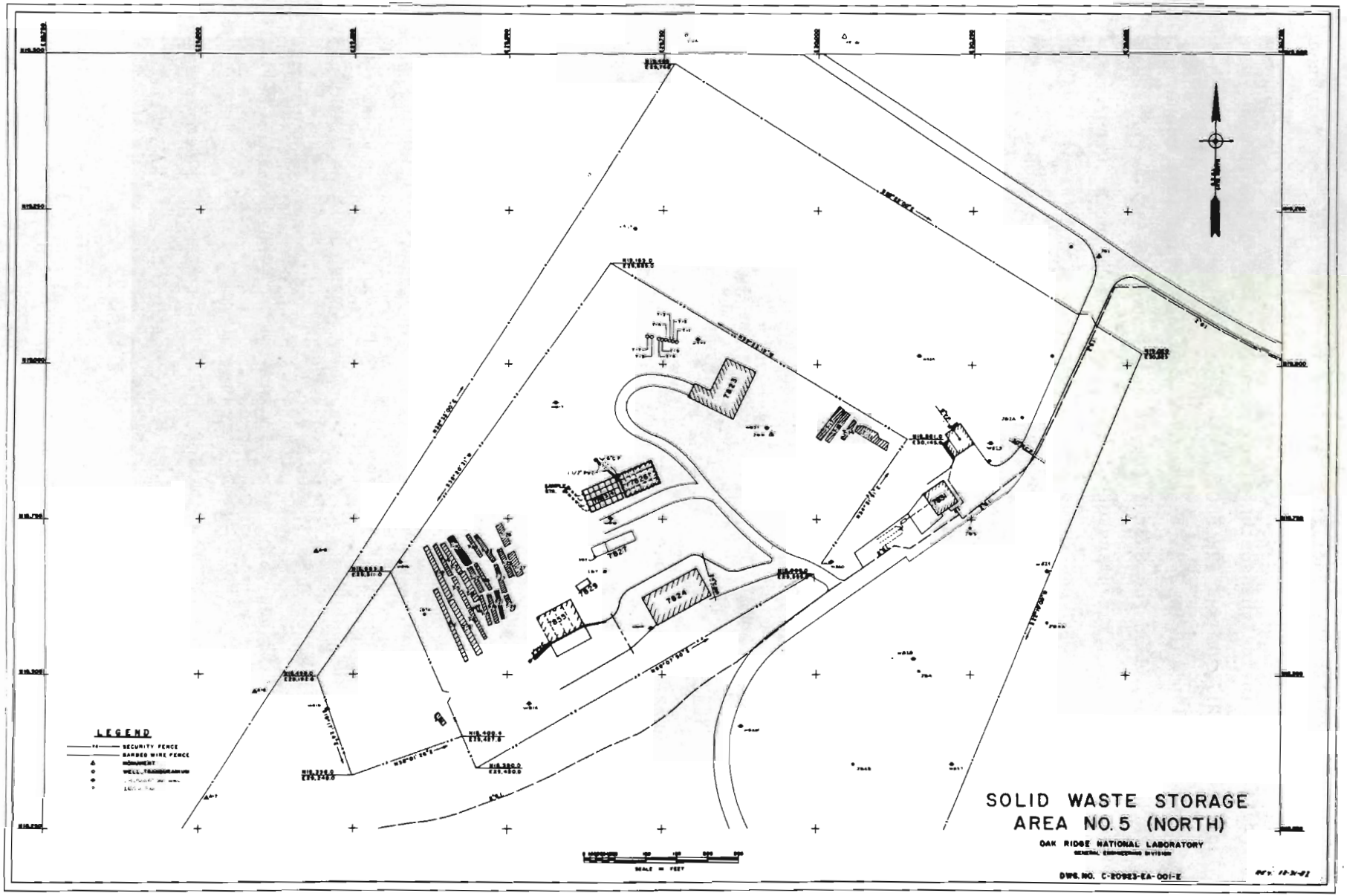


Fig. 6. SWSA-5 (north).

ORNL-PHOTO 8039-81

Fig. 7. Aerial view of TRU waste storage area.

ORNL-PHOTO 2806-73

Fig. 8. Inside of TRU drum holding area (Building 7823).

Building 7826, is opened and the waste drums emplaced for storage. Building 7826, which was constructed in 1976, is a one-story reinforced-concrete-and-concrete-block structure measuring 12 m (39 ft) by 17 m (55 ft) and 4 m (13 ft) in height with 85% of the structure below grade. There are 24 cells which hold 220-L drums, with 64 drums/cell, 16 drums/layer, and 4 layers/cell. Figure 9 is a photograph of Building 7826 with the cover removed and drums being loaded into a cell. A second storage facility (Building 7834) with a larger holding capacity was completed in 1980. It has removable concrete plugs rather than metal roofing and has space for an additional layer of drums in each cell (Gilbert/Commonwealth, 1981). About 85% of the structure is below grade.

Prior to completion of Building 7826, the TRU wastes were stored in mild steel boxes, black iron drums, or stainless steel drums in Building 7823 (National Academy of Science, 1976). Use of the black iron drums was discontinued because they were subject to deterioration. The drums are periodically inspected for leakage and are routinely maintained (Gilbert Commonwealth, 1981). Criticality control is maintained by limiting the quantity of fissionable material to 20 g in each 114-L (30-gal) drum. The quantity of fissionable material allowed in each 220-L (55-gal) drum is 36 g (1979 ORNL Radioactive Solid Waste Operations Manual).

The total storage capacity of Buildings 7826 and 7834 is 3456 drums. At the end of 1979, approximately 1600 drums were in storage, 1300 of the stainless steel type and 300 of the black iron type (Gilbert/Commonwealth, 1981).

TRU waste with high external gamma exposure rates (>200 mR/h) or having high neutron emission levels are sealed in reinforced concrete casks at the point of origin. The majority of the waste placed into concrete casks has been generated in Building 7920 (Gilbert/Commonwealth, 1981). Currently, concrete casks with three different wall thicknesses (thin, intermediate, and thick) are available for waste burial. The internal diameters range from 65 to 100 cm (27 to 42 in.), and the lengths range from 150 to 190 cm (58 to 73 in.) (ORNL Radioactive Solid Waste Operations Manual, 1979). The wall

ORNL-PHOTO 5206-76

Fig. 9. Inside of the TRU waste storage facility (Building 7826).

thicknesses of available casks range from 11 to 30 cm (5 to 12 in.), depending on the shielding requirements, and the casks are 2.5 m (8 ft) in height (Gilbert/ Commonwealth, 1981). Once the casks are filled and sealed, they are transported by tractor-trailer units and unloaded by mobile crane into a 3-m (10-ft)-deep trench, as shown in Fig. 10. The trench is backfilled with soil when loaded to capacity (National Academy of Sciences, 1976). Use of the 11-cm (4.3 in.) casks was discontinued in the late 1970s (Gilbert/ Commonwealth, 1981). Criticality control is maintained by limiting the fissionable material to 200 g per cask (Procedures and Practices for Radiation Protection, Health Physics Manual, Oak Ridge National Laboratory, 1980).

The practice of burial in trenches in the northern section of SWSA-5 (TRU area) was discontinued in 1979, and storage was initiated in a cave-like facility (Building 7855) in the side of a knoll (Fig. 11) (Gilbert/Commonwealth, 1981). Building 7855 is a one-story, four bay concrete block structure with a reinforced-concrete slab base and roof. The casks are loaded into the cave using a forklift. At the end of 1979, 190 casks had been buried in trenches; cave storage began in 1980 (Gilbert/Commonwealth, 1981).

Small TRU-contaminated waste packages with high external gamma exposure rates have been placed in stainless steel (or in some cases, brass) capsules and sealed with a metal-gasket-and-bolt closure assembly for storage. The first capsules were stored in individual auger holes, each lined with stainless steel and closed with a stepped concrete plug (Fig. 12). The auger holes are 2.75 m (9 ft) deep and have a 24-cm (9-in.) outer layer of concrete placed around the stainless steel liner to prevent flotation. The auger hole itself has an internal diameter of 20 to 75 cm (8 to 30 in.), and the concrete plugs are 46 cm (18 in.) thick. One meter spacing was maintained between the eight auger holes.

Buildings 7827 and 7829, built after the first eight auger holes, are an improved extension of ORNL facilities for storing TRU wastes with high external gamma exposure rates. Currently, Building 7827 has 30 wells; 15 of them are 4.6 m (15 ft) deep, and the remaining 15 are 3.1 m (10 ft) deep. Each group is comprised of an equal number of 20-cm

ORNL-PHOTO 1641-71

Fig. 10. Concrete casks used for TRU wastes with high external gamma exposure rates.

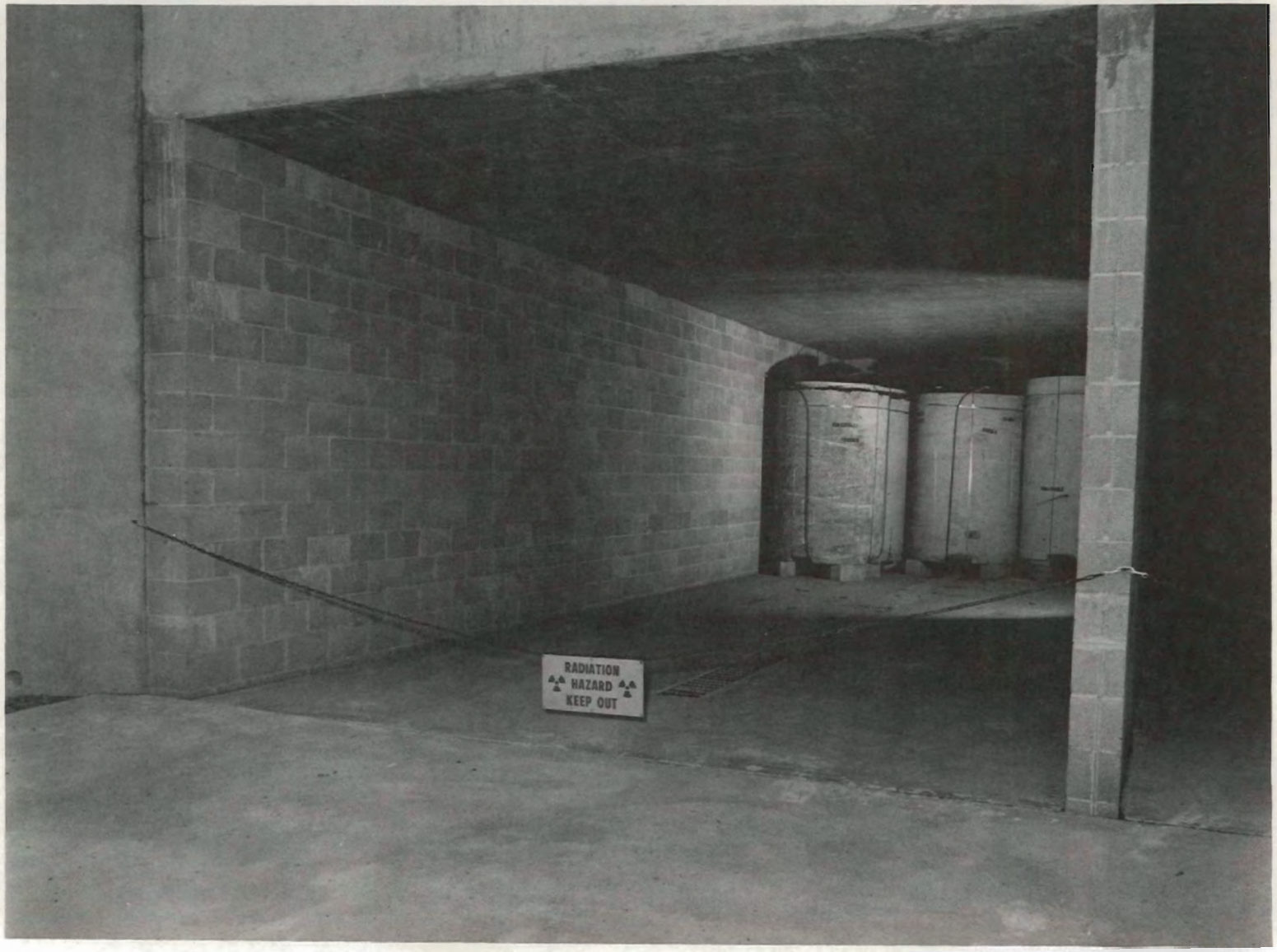


Fig. 11. Cave-like facility for storing TRU waste with high external gamma exposure rates or having high neutron emission levels.

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Fig. 12. The above-ground portion of a stainless steel-lined auger hole.

(8-in.), 40-cm (16-in.), and 76-cm (30-in.) diam holes lined with stainless steel and capped with steeped concrete plugs. Building 7829 contains ten wells 30 cm (12 in.) in diameter by 4.6 m (15 ft) deep. The waste containers are held by a cable and lowered into the wells from a shielded carrier (Gilbert Commonwealth, 1981). Spacing between wells is maintained in such a manner that noncriticality is ensured (1979 ORNL Radioactive Solid Waste Operations Manual).

The volumes and quantities of solid radioactive waste retrievably stored at DOE sites are shown in Table 1. ORNL has a relatively small volume of TRU wastes stored in retrievable form in comparison to other DOE sites. The quantity of plutonium stored at ORNL is significantly less than that stored at other DOE sites; yet the quantities of other TRU nuclides stored at ORNL are surpassed only by those at the Idaho National Engineering Laboratory (Evaluation Research Corporation, 1982).

## 2.6 EXPERIMENTAL PROJECTS AND REMEDIAL ACTIONS

Over a period of time as problems were recognized, a number of remedial actions were undertaken in order to reduce radionuclide release. A discussion of some of these corrective actions and experimental projects follows.

Normal problems caused by infiltration of precipitation were aggravated in SWSA-5 because of poor trench orientation (Webster, 1976; Evaluation Research Corporation, 1982). Trenches in this burial ground were excavated with their long axes in an upslope-downslope direction, paralleling the hydraulic gradient of the water table. The extent of water seepage might have been less if the long axis of the trenches paralleled the hillslope contours and crossed the hydraulic gradient; however, the trenches may have experienced considerably more sidewall collapse (Fig. 13). Some of these trenches filled with water, which seeped out the lower ends of the trenches, a phenomenon known as "bathtubbing."

### 2.6.1 Trench Cover and Dam

In 1975, corrective actions were taken to reduce the seepage in the southeast corner of SWSA-5 found to have relatively high amounts of $^{90}Sr$ and measurable mounts of $^{244}Cm$ and $^{238}Pu$ (Evaluation Research

Table 1. Solid radioactive wastes buried at DOE sites as of October 1, 1976[a]

| Site | Volume ($m^3$) | Activitity at burial (kCi) | Uranium (kg) | TRU (kg) |
|---|---|---|---|---|
| Oak Ridge National Laboratory | 180,000 | 100 | 100 | 13 |
| Hanford | 170,000 | 2,000 | 600,000 | 370 |
| Savannah River Plant | 260,000 | 8,200 | 84,000 | 7 |
| Idaho National Engineering Laboratory | 150,000 | 6,100 | 310,000 | 360 |
| Los Alamos Scientific Laboratory | 240,000 | 300 | 200,000 | 13 |

[a]From Dieckhoner, 1977.

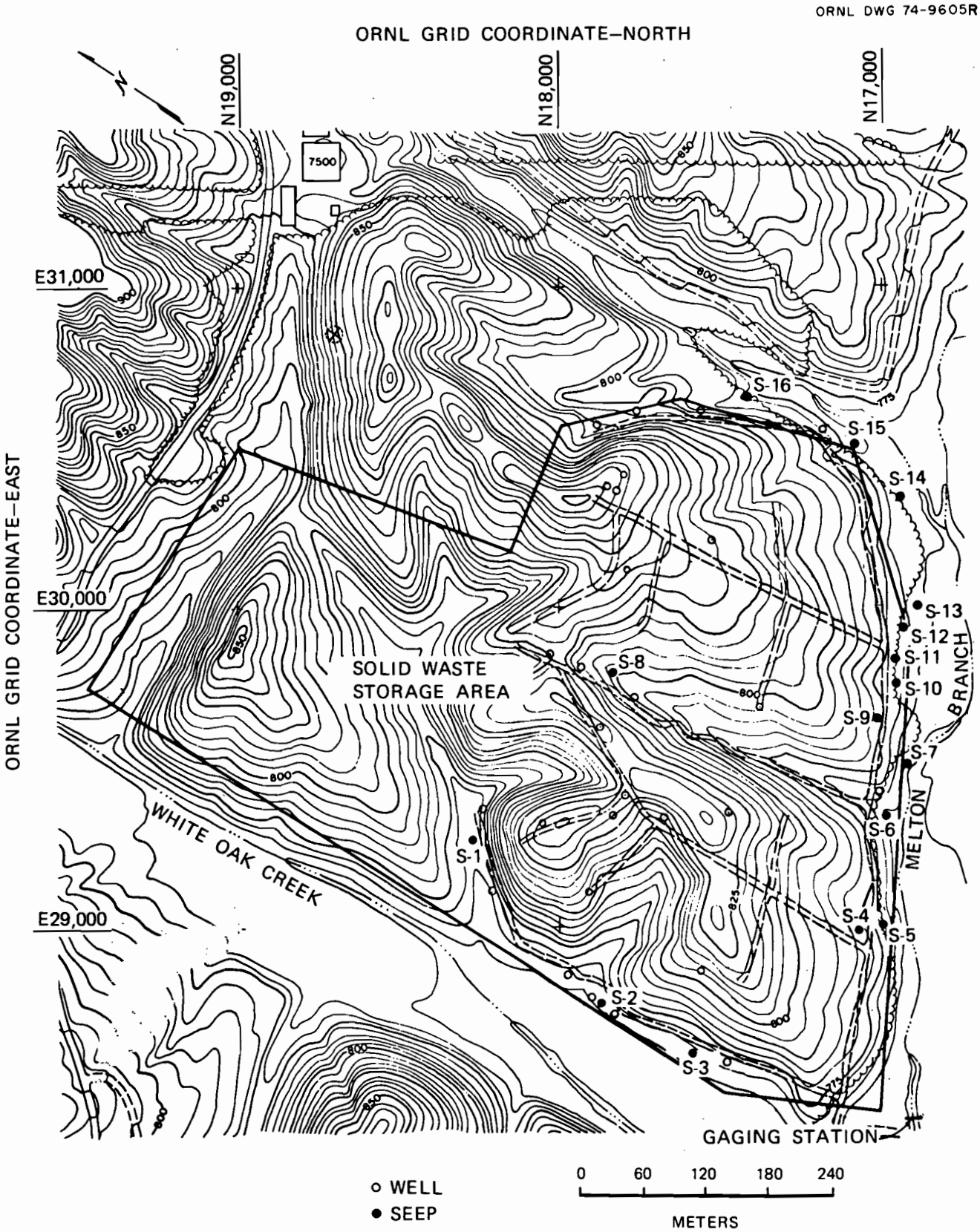


Fig. 13. Location of groundwater seeps on the perimeter of SWSA-5 as identified by Duguid (1975).

Corporation, 1982). Initially, about 0.6 m (2 ft) of overburden was removed from the area overlying four of the burial trenches: 105, 83, 72, and 69. Two underground dams, one of concrete, placed approximately 55 m from the southwestern end of trenches 105 and 83, and one of bentonite-shale, placed approximately 82.5 m (270 ft) from the southwestern end of the same trenches (Figs. 14 and 15) were installed. The stripped area, including the dammed trenches and two parallel trenches (72 and 69) on the southeast, were then covered with 0.254-mm-thick (0.01 in.) PVC membrane with an estimated life of 25 years (Duguid, 1976). The approximately 0.6 m (2 ft) of stripped overburden was replaced, and the area was seeded with grass to prevent erosion.

Duguid (1975a) identified 16 groundwater seeps around SWSA-5 (Fig. 13). The concentration of $^{90}Sr$ in these seeps, as reported by Duguid, is seen in Table 2. The highest concentration of $^{90}Sr$ (517.0 kBq/L) found at seep 4 by Duguid in 1974 was not apparent in the study of Spalding and Munro (1984b) since the seep was dry, thus indicating the success of the corrective actions of damming and PVC-covering of the group of trenches in this area as discussed above. The $^{90}Sr$ concentrations for seep 5 just south of seep 4 are very similar for samples taken in 1974 by Duguid and in 1980 by Spalding and Munro.

While these actions decreased the amount of $^{3}H$ and $^{90}Sr$ migrating from SWSA-5 (Tamura et al., 1980) for a time, the annual migration of these radionuclides has apparently recovered to earlier rates. There is a wide fluctuation of these releases; however, apparently the $^{90}Sr$ release rate was at its lowest level in 1981 (National Research Council, 1985).

### 2.6.2 Surface Seal

In SWSA-5 (north) a near-surface seal of 14 trenches in the TRU waste area (Fig. 16) was attempted in 1977. The area, consisting of 1765 $m^2$(0.4 acre) just west of E 29,500 and lying between N 18,500 and N 18,750, was covered with a bentonite shale mixture at the rate of 0.04 $kg/m^2$ (0.008 $lb/ft^2$) of bentonite in an attempt to reduce excessive infiltration of precipitation. Results similar to the above actions may be attributed to this remediation project.

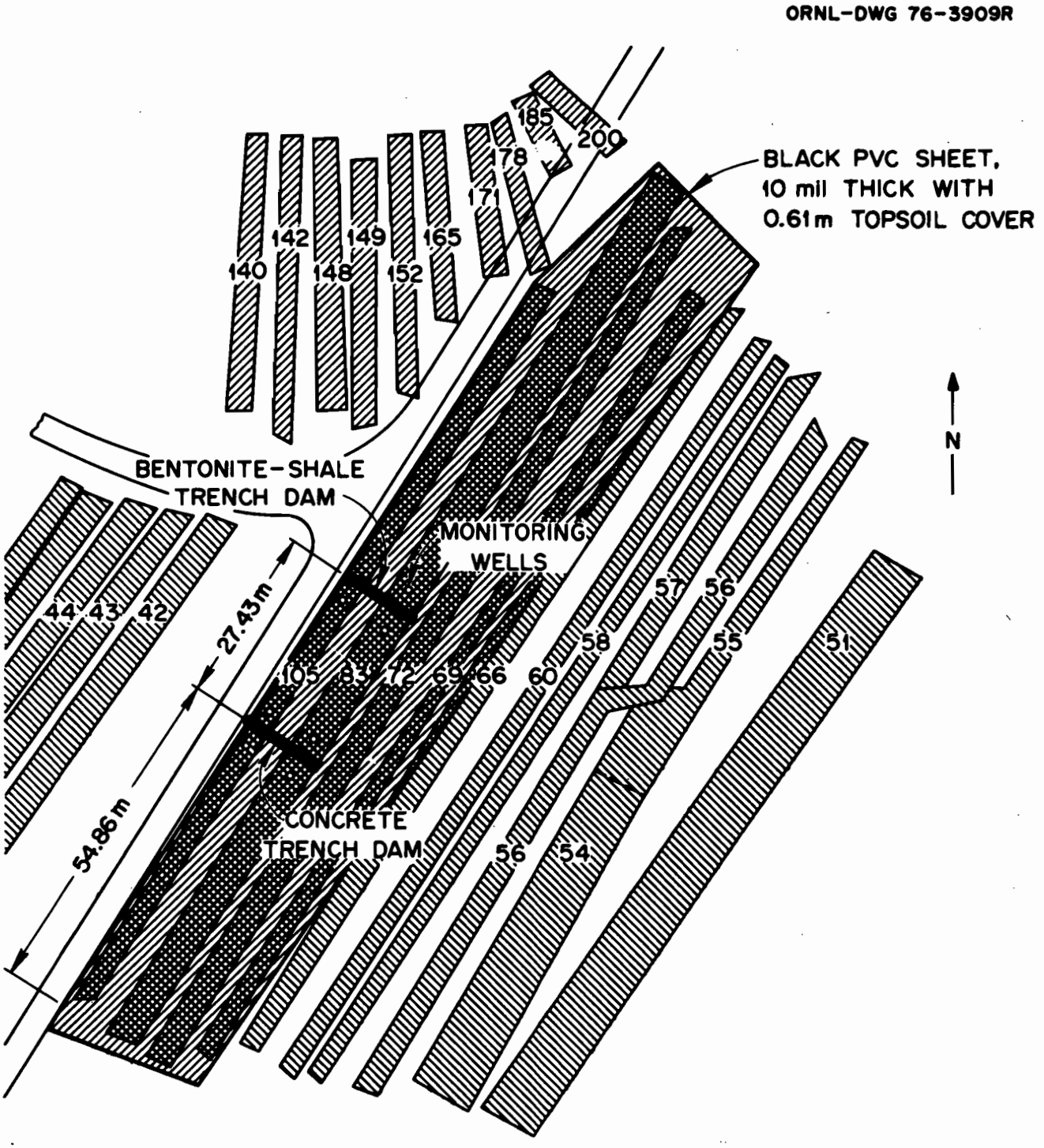


Fig. 14. Near-surface sealing of trenches in SWSA-5.

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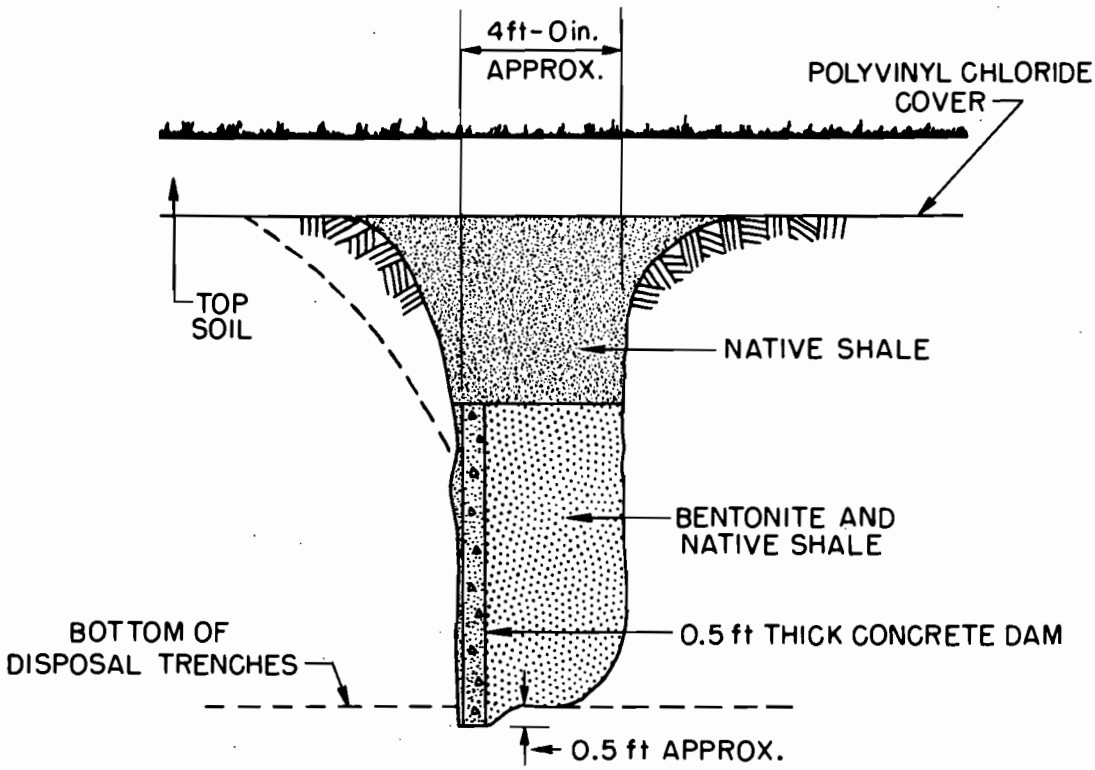
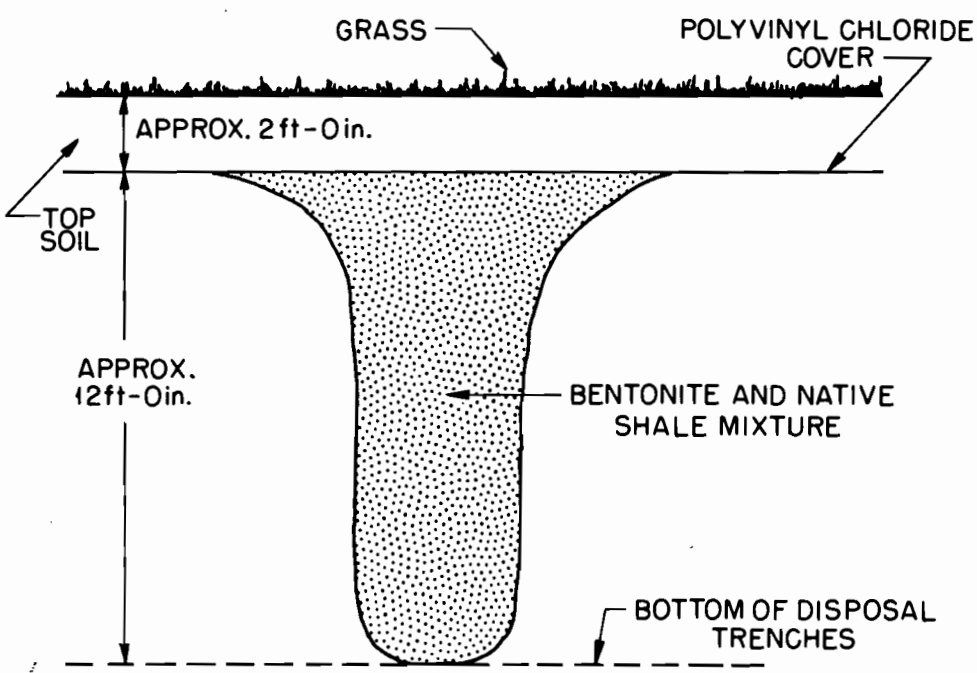



CONCRETE TRENCH DAM VIEW LOOKING WEST




BENTONITE-SHALE TRENCH DAM VIEW LOOKING WEST

Fig. 15. Cross sections of the concrete and bentonite-shale dams across trenches 105 and 83.

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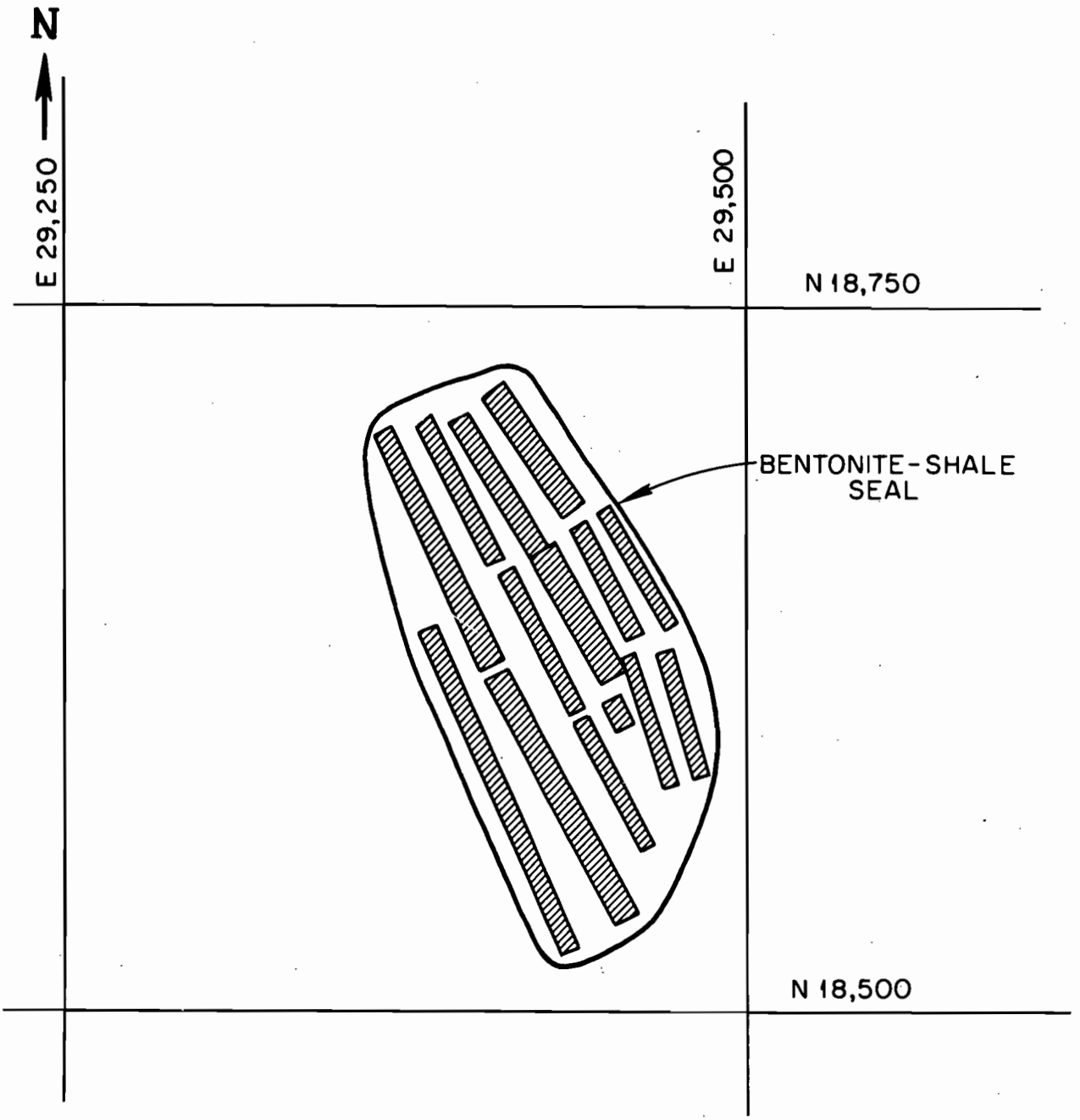


Fig. 16. Bentonite-shale surface seal in SWSA-5.

Table 2. Concentrations of $^{90}Sr$ in groundwater seep samples on the perimeter of SWSA-5 reported by Duguid (1975)[a]

| Seep No.[b] | Date sampled | $^{90}Sr$ (kBq/L) |
|---|---|---|
| S1 | Nov. 13, 1973 | <0.001 |
| S2 | Nov. 13, 1973 | <0.001 |
| S3 | Nov. 13, 1973 | <0.001 |
| S4 | Mar. 11, 1974 | 517.0 |
| S5 | Mar. 11, 1974 | 5.8 |
| S6 | Mar. 11, 1974 | 0.13 |
| S7 | Mar. 11, 1974 | 0.088 |
| S8 | Mar. 11, 1974 | <0.001 |
| S9 | Mar. 11, 1974 | 2.27 |
| S10 | Mar. 11, 1974 | 0.60 |
| S11 | Mar. 11, 1974 | 0.39 |
| S12 | Mar. 11, 1974 | 0.022 |
| S13 | Mar. 11, 1974 | 0.46 |
| S14 | Mar. 11, 1974 | 0.003 |
| S15 | Mar. 11, 1974 | 0.15 |
| S16 | Mar. 11, 1974 | 0.005 |

[a]From Spalding (1984a).
[b]See Fig. 13.

### 2.6.3 Miscellaneous Actions and Analyses

Additional corrective measures taken during the same time frame include filling in of collapsed trenches, surface contouring for improved drainage, and installation of concrete-lined drainage ditches (Tamura et al., 1980; Duguid, 1976; Evaluation Research Corp., 1982, Grizzard, 1986; National Research Council, 1985).

Both groundwater and surface water drainage in SWSA-5 are predominantly southeast toward Melton Branch and southwest toward White Oak Creek. The water-table contour map shows that the steepest gradient is in the direction of Melton Branch, which implies that the prevailing movement is to the southeast. Therefore, most of the potential radionuclide transport by surface water is monitored at Station 4 (Fig. 1) on Melton Branch (Myrick, 1984).

In 1964, radiochemical analyses were made on water samples collected from several wells and from the drainage that divides the site into two sections (5 south area and 5 north area). The principal contaminants found were $^{90}Sr$, $^{106}Ru$, $^{3}H$, and trivalent rare earths. Only minor movement of $^{106}Ru$, $^{137}Cs$, and $^{60}Co$ from trenches was observed from analyzed core samples of new wells (Webster, 1976; Oakes and Shank, 1979).

Water samples collected from seeps from SWSA-5 in 1974 indicated that $^{90}Sr$ and $^{3}H$ were principal contaminants. The average concentration of $^{3}H$ in the samples was $3.9 \times 10^{5}$ dpm/ml, or 0.2 mCi/ml. Water samples collected at a sampling station about 1.6 km (1 mile) downstream from the confluence of Melton Branch with White Oak Creek have indicated that several thousand curies of $^{3}H$ had passed that point annually since the mid-1960s. Most of the $^{3}H$ found at the station is believed to have been discharged to Melton Branch in groundwater from SWSA-5 (Webster, 1976).

Spalding and Munro (1983b) found increased concentrations of $^{90}Sr$ in groundwater in two major areas along the perimeter of SWSA-5. One area was south of the Old Hydrofracture Facility (OHF) (Building 7860) just outside of and west of the SWSA-5 perimeter fence. Due to the directional flow path of the water in the area, it is assumed that the elevated $^{90}Sr$ concentrations were related to operations of the OHF. The second area of elevated $^{90}Sr$ concentrations is in a region

downslope from specific trenches in the eastern portion of SWSA-5 that are known to contain high inventories of $^{90}Sr$.

2.6.4 Caustic Soda—Soda Ash Experiments

The more recent work of Spalding and Munro (1984b) investigated the $^{90}Sr$ concentrations found in grab samples from the main drainage tributary and the small tributary in SWSA-5 and in boreholes placed at 3-m (10 ft) intervals along the perimeter of SWSA-5. Additional water quality parameters from these perimeter boreholes were documented, including hardness, electrical conductivity, and pH.

The applicability of a short-term corrective action for $^{90}Sr$ release from SWSA-5 was studied by Spalding and Munro (1983). In this experiment, fourteen 22.5-kg bags of anhydrous light soda ash (>98% $Na_2CO_3$) were buried two bags to a 50-60 cm deep hole in the groundwater flow path leading to the seep. In addition, 45 kg of soda ash was placed on the surface. This treatment was found to effectively reduce the $^{90}Sr$ concentration from 7000 Bq/L to 900 Bq/L for 90 days after burial followed by a gradual rise to pretreatment levels over the next 100 d as the soda ash was consumed in the precipitation of Ca, Mg, and Sr from the groundwater.

In a similar experiment, Spalding (1984a) injected trench 117 in SWSA-5 (Fig. 17) with caustic soda, soda ash, caustic soda, and lime/soda ash, respectively, over a 1-year period. Much of the $^{90}Sr$ was found to be coprecipitated with calcium carbonate, and the $^{90}Sr$ concentration of one well at the foot of the trench decreased from over 100 kBq/L to less than 10 kBq/L. As in the earlier experiment, several additional water quality parameters were correlated, soil analyses were made, and a generic assessment is presented.

## 3. ADDITIONAL WAG COMPONENTS

### 3.1 OHF FACILITIES

3.1.1 Process Waste Sludge Basin (Bldg. 7835)

The process waste sludge basin is an approximately 24 x 24 x 2.4 m (78 x 78 x 8 ft) deep pond designed for storage of sludge generated by the Process Waste Treatment Plant. The pond has a compacted clay bottom and is lined with PVC. It is located in SWSA-5 (north), on a bluff southeast of the TRU Waste Storage area approximately 90 m (300

Fig. 17. Groundwater sampling perimeter line on the southern and eastern sides of SWSA-5. Cumulative distance along this perimeter is indicated in meters with every tenth sample identification number indicated. From Spalding and Mauro (1984).

ft) from Bldg. 7824 (see Fig. 6 for reference). Prior to use of this facility being discontinued in 1981, sludge was pumped from the treatment plant to this basin, the sludge was allowed to settle, and the supernate was pumped back to the Equalization Basin. There is an approximately 1.2 m (4-ft) layer of sediment in the open pond consisting of ferrous sulfate, ferric hydroxide, and an estimated 1857 Bq (50 Ci) of mixed fission products (Myrick, et al., 1984).

### 3.1.2 OHF Impoundment (Area 7852A)

The OHF impoundment is located in Melton Valley, slightly more than 1 mile south of the main ORNL complex (Fig. 18). The facility is situated on the west edge of SWSA-5 at ORNL grid coordinates N17,400, E 28,500. The impoundment is situated at the base of a north-trending valley wall at an elevation below the OHF main plant facilities (see Figs. 17, 18, and 19). White Oak Creek flows southward through Melton Valley, approximately 120 m (400 ft) west of the impoundment, and westward-flowing Melton Branch lies approximately the same distance to the south. Three partially buried concrete waste vaults lie less than 15 m (50 ft) to the east of the south end of the impoundment at a slightly higher elevation. In addition, five steel tanks are buried approximately 20 m (70 ft) south of the impoundment. The vaults and tanks contain radioactive wastes from the hydrofracture operation.

The impoundment was constructed as part of the hydrofracture operation in 1963, essentially by excavating a rectangular basin in the base of the valley wall. Construction dimensions of the bottom of the basin are 6 m (20 ft) in width by 30 m (100 ft) in length, with sides sloping at 1 vertical on 1.5 horizontal pitch. The depth of the pond is slightly greater than 1.5 m (5 ft) at the low (west) side. The sides are lined with limestone riprap. Design capacity was 379,000 L (100,000 gal). Inflow was to the south end of the impoundment via a buried 46-cm (18-in.) line from the injection well cell. A 20.3-cm (8-in.) line from a waste pit, which was part of the injection operation, is also shown on drawings as entering the impoundment at the same location. Construction drawings specified that the pond bottom be sprayed with liquid asphalt to control erosion, and a plastic liner was placed in the pond prior to experimental injections. However, no evidence of either of these treatments was observed while

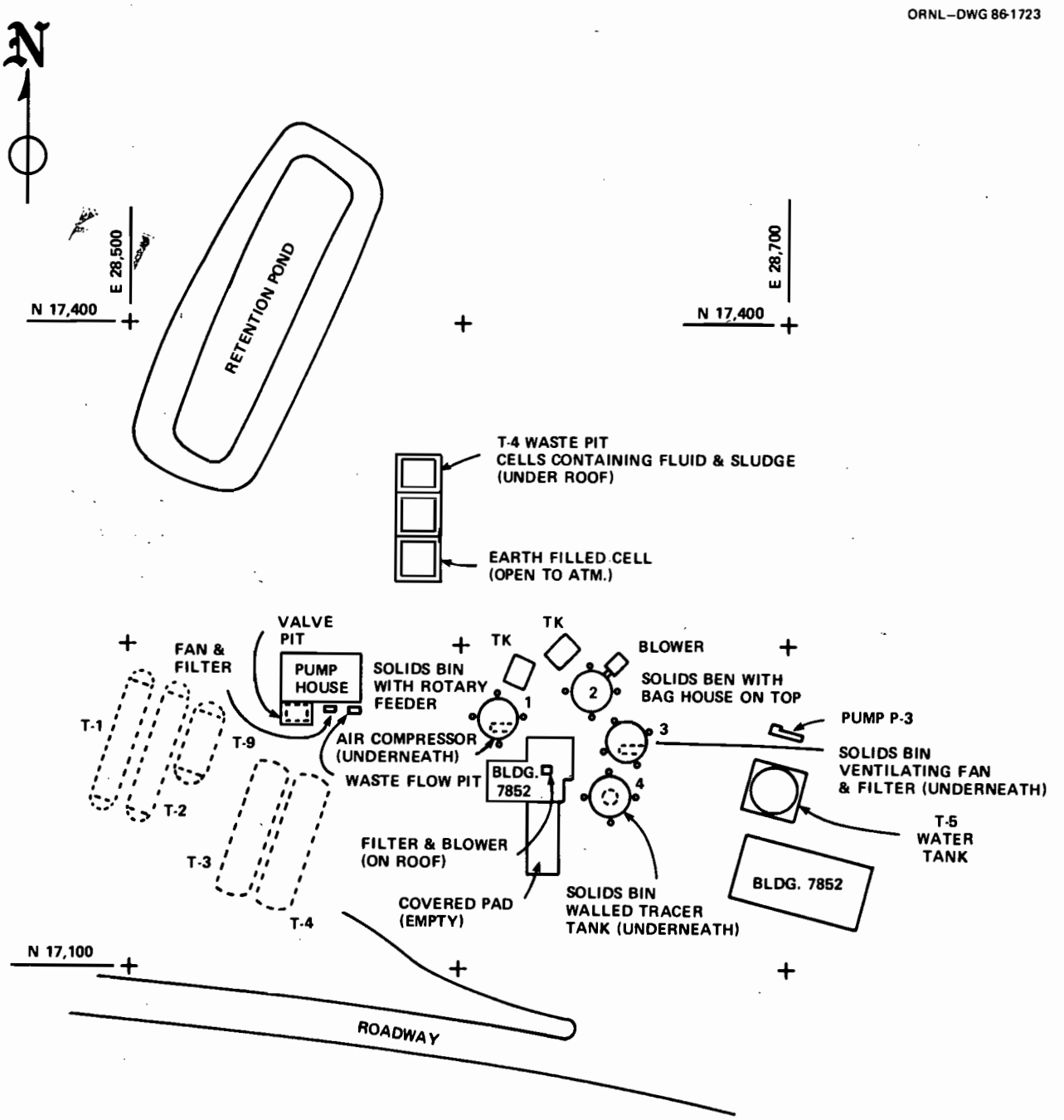


Fig. 18. Site plan of the Old Hydrofracture Facility.

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Fig. 19. Aerial photograph of the Old Hydrofracture Facility with the impoundment visible at lower right.

sampling the sediment for this study (Stansfield and Francis, 1986). A concrete standpipe, 1.5 m (5 ft) high, was provided as an emergency outflow at the north end of the impoundment. ORNL Drawing S-10916 EA 001D shows this vertical standpipe connected to 20-cm (8-in.) vitrified clay pipeline. The drawing shows this line extending to the west approximately 15 m (50 ft), where it empties into a shallow natural swale at approximate elevation 233 m (763 ft). Probings made during a recent study indicate that the bottom of the impoundment is at an approximate elevation of 233.1 m (764.6 ft). A geologic section is seen in Fig. 20, and a water table map of the impoundment is seen in Fig. 21.

The impoundment was constructed to serve as an emergency containment basin in the event of a spill from the radioactive grout injections, for example, caused by the backflow of grout. Due to malfunction of pumping equipment or piping, the impoundment did receive radioactive grout from injections made in 1965 (deLaguna et al., 1971) and 1977. Prior to a grout injection at the facility, the water level in the pond was required to be low enough that there would be sufficient freeboard capacity in the impoundment to hold the radioactive grout should an emergency arise that required such action during the operation. Prior to some injections, depending on the water level, this necessitated decanting the water from the pond. Before contamination of the impoundment by radioactive waste, the pond water was siphoned to the White Oak Creek flood plain. Subsequent to contamination of the impoundment, the water was pumped to the low-level waste system for processing.

Operation of the OHF ceased by 1980 (Myrick, 1984). In the winter of 1984-85, the pond received drilling fluid and drill cuttings from an exploratory core boring (5.7-cm core diam and 8.6-cm hole diam) through the radioactive grout sheets underlying the OHF site.

Probings made during a recent study indicate that the thickness of the sediment in the impoundment averages 27 cm (0.9 ft). This amounts to approximately 55,000 L (14,500 gal) of sediment. From the size and length (165 m or 542 ft) of the exploratory core, approximately 900 L (230 gal), or less than 2% of the total sediment volume, is sediment from the 1985 core-drilling operation (Stansfield and Francis, 1986).

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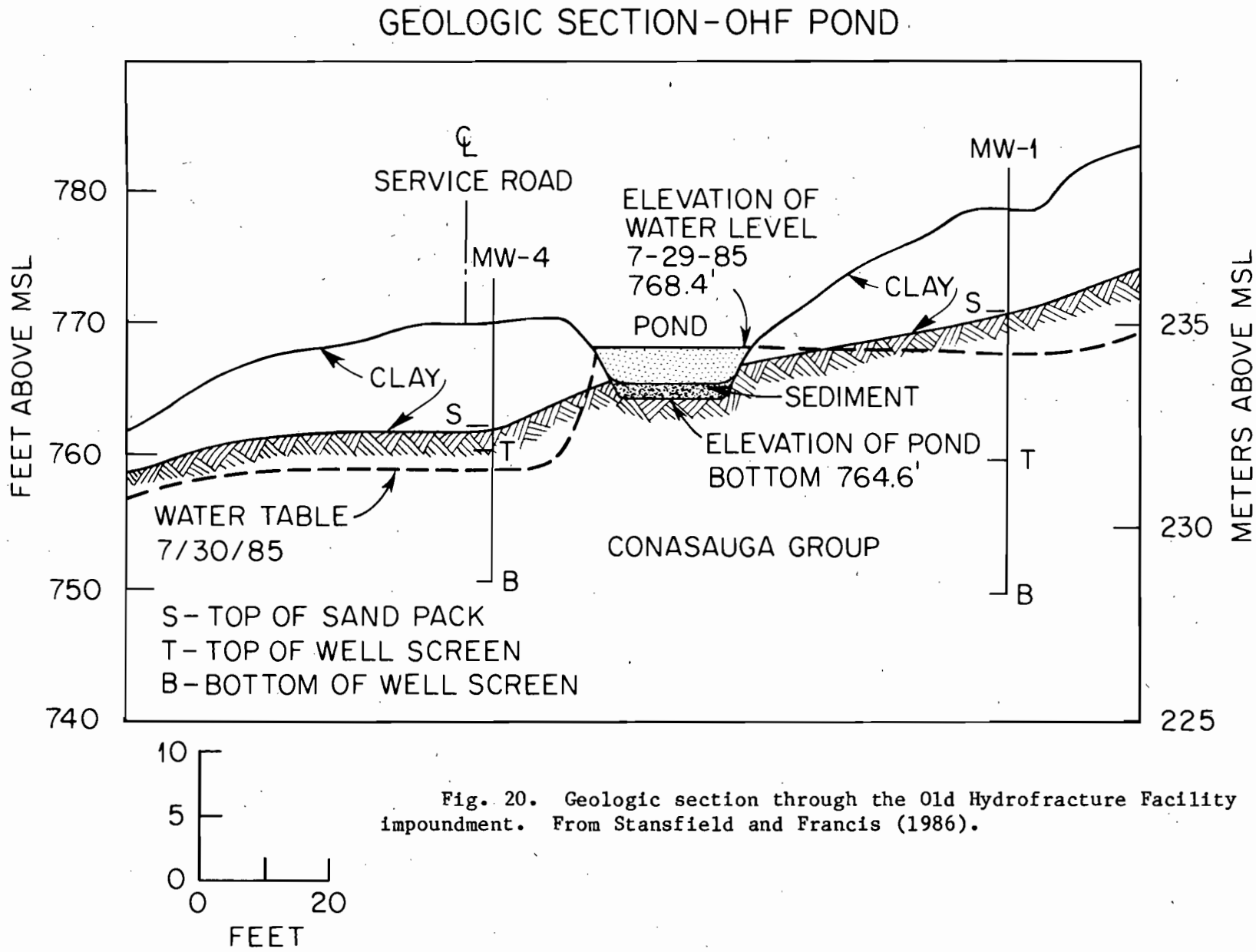


Fig. 20. Geologic section through the Old Hydrofracture Facility impoundment. From Stansfield and Francis (1986).

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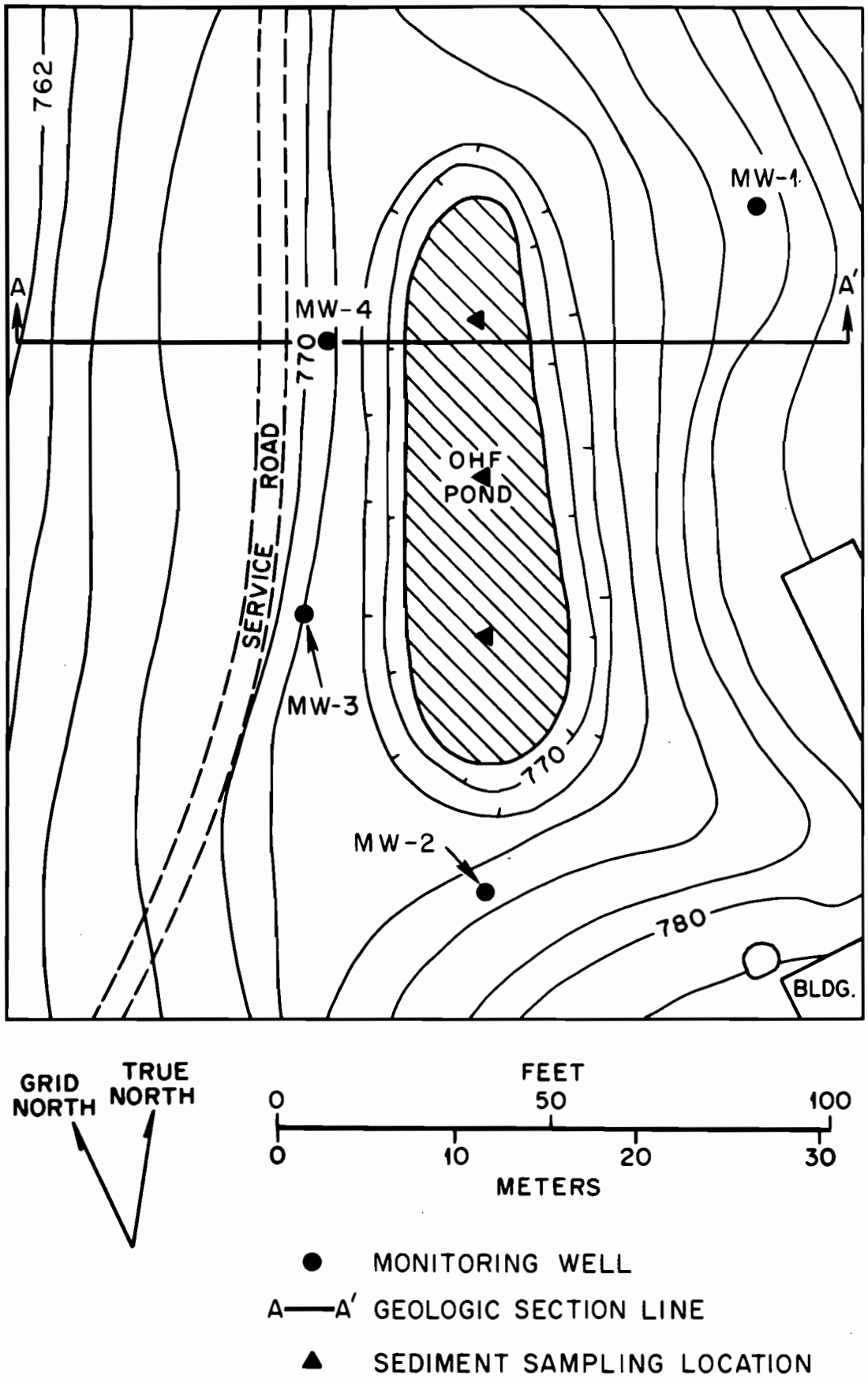


Fig. 21. Water-table map of the Old Hydrofracture Facility impoundment. From Stansfield and Francis (1986).

To determine the constituents of the waste sediment, samples were taken from the north, center, and south sections of the impoundment. Two sets of samples were obtained: the first in November 1984 and the second in February 1985.

The purpose of sampling was to determine whether the sediment in the bottom of the OHF pond would be classified as a hazardous waste under CERCLA or RCRA regulations; EP toxicity is of primary concern.

The major contaminants in groundwater at the OHF impoundment appear to be radionuclides; gross alpha and gross beta concentrations exceed NIPDWS concentrations in upgradient and downgradient wells. With the exception of one possibly contaminated sample, concentrations of metals, herbicides, and pesticides were below NIPDWS maximum limits. The main contaminants include $^{137}Cs$, $^{90}Sr$, and $^{60}Co$. The maximum dose rates are 100 and 300 mrad/h at a height of 10 cm (4 in.) above the pond water. The total estimated activities of the water, sediment, and clay are 71,404, and 12 Ci, respectively. Extensive survey information has been presented by Stansfield and Francis (1986) and Francis and Stansfield (1986b).

Four monitoring wells were installed in March 1985 around the perimeter of the OHF impoundment (see Fig. 21). Monitoring well 1 was located to sample groundwater upgradient from the impoundment. This well is located at the northeast corner of the impoundment ~15 m from the edge of the standing water contained in the impoundment. However, it is located ~30 m downgradient from a disposal trench in a low-level solid waste storage area (SWSA-5), which is a potential source of contamination. Monitoring wells 2, 3, and 4 were located to collect groundwater downgradient from the impoundment.

The depth from ground surface of monitoring well 1 is ~10 m as compared with ~7 m for monitoring wells 2, 3, and 4. The grid coordinates and elevations to specific parts of each of the monitoring wells are presented in Table 3. A geologic cross section of the impoundment, illustrating the relative position of the water table and the monitoring wells, is presented in Fig. 20.

Recent groundwater measurements (Francis and Stansfield, 1986b) indicate that except for radioactivity and coliform bacteria, NIPDWS contaminants were below RCRA maximum limits. The major contaminants in

Table 3. Grid coordinates and elevations for Old Hydrofracture Facility monitoring wells

| | Monitoring well | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| ORNL grid coordinates, m | | | | |
| North | 280.7 | 875.6 | 5272.7 | 5285.0 |
| East | 8717.4 | 8688.3 | 8685.8 | 8692.6 |
| Elevations, m | | | | |
| Top of well casing | 238.4 | 236.8 | 235.8 | 235.8 |
| Ground surface | 237.5 | 236.0 | 234.9 | 234.9 |
| Top of well screen | 231.7 | 232.0 | 231.8 | 231.8 |
| Bottom of well screen | 228.6 | 229.2 | 228.7 | 228.8 |
| Top of sand pack | 234.6 | 234.1 | 233.1 | 232.4 |
| Bottom of well hole | 226.9 | 228.7 | 227.6 | 227.6 |

downgradient wells appear to be $^{90}Sr$ and tritium (mean concentrations of 460 and 80,000 Bq/L, respectively, over four quarters of sampling). The tritium concentrations appear to be derived from a source other than the impoundment, as the mean concentration of tritium in the upgradient wells over the same four quarters of sampling was slightly higher (91,000 Bq/L) than the mean for the downgradient wells. The most likely source of tritium in these groundwater samples is the low-level radiological waste disposed of in the burial ground (SWSA-5) northeast of the OHF. Tritium has been observed in groundwater sampled immediately below this waste burial ground. For example, in 1974 water samples from seeps at the bottom of the hill on the south side of the burial grounds contained $10^9$ Bq/L of tritium (Duguid, 1976).

Other than the radiological measurements and coliform counts, there were instances where the concentrations of barium, chromium, and lead in the downgradient wells exceeded the RCRA maximum limits (see Appendix D). The degree to which these concentrations exceeded the

limit was generally very small: for example, the concentration of barium was 1.09 mg/L and the limit was 1; the concentration of chromium was 0.08 mg/L (limit, 0.05); and the concentration of lead was 0.09 mg/L (limit, 0.05). Lead concentrations in monitoring well 3 were 0.08, 0.08, and 0.09 mg/L, respectively, in the last three quarters sampled.

### 3.1.3 Old Hydrofracture Site Surface Facilities

#### 3.1.3.1 Description of the Facility

The OHF was used for the permanent disposal of liquid radioactive waste in impermeable shale formations at depths ranging from approximately 229 to 300 m (750 to 1000 ft) from 1964 to 1979 (Weeren, 1976 and 1980). The liquid waste was formed into a pumpable grout by blending with cement and special clays used to immobilize radionuclides against groundwater transport. The grout was injected through a slotted well casing into the shale where it solidified into nearly horizontally thin sheets, depending on the orientation of the shale formation, around the injection well in a generally elliptical pattern. The average concentrations of radionuclides in the grout mixture prior to injection were approximately 10 MBq/mL (2.6 Ci/L) or less for beta-gamma-emitting radionuclides and 370 Bq/g (10 nCi/g) or less for transuranic alpha-emitting radionuclides. As much as 7.6 x $10^6$ L (2 x $10^6$ gal) of waste grout containing as much as 2.2 x $10^4$ GBq (6.0 x $10^5$ Ci) was disposed of in a single injection.

The OHF is lcoated approximately 2 m (1.1 miles) southwest of the main complex of the Oak Ridge National Laboratory at the confluence of Melton Branch and White Oak Creeks (see Fig. 22). Immediately to the east of the OHF is the western fenced boundary of SWSA-5, where low-level radioactive solid wastes were buried between 1958 and 1973. The facility is approximately 120 m (400 ft) east of White Oak Creek and approximately the same distance north of the Melton Branch. White Oak Creek flows into White Oak Lake and hence into the Clinch River.

The OHF site consists of three buildings (Buildings 7852, 7853, and a pump house) and some waste-related containment facilities (waste

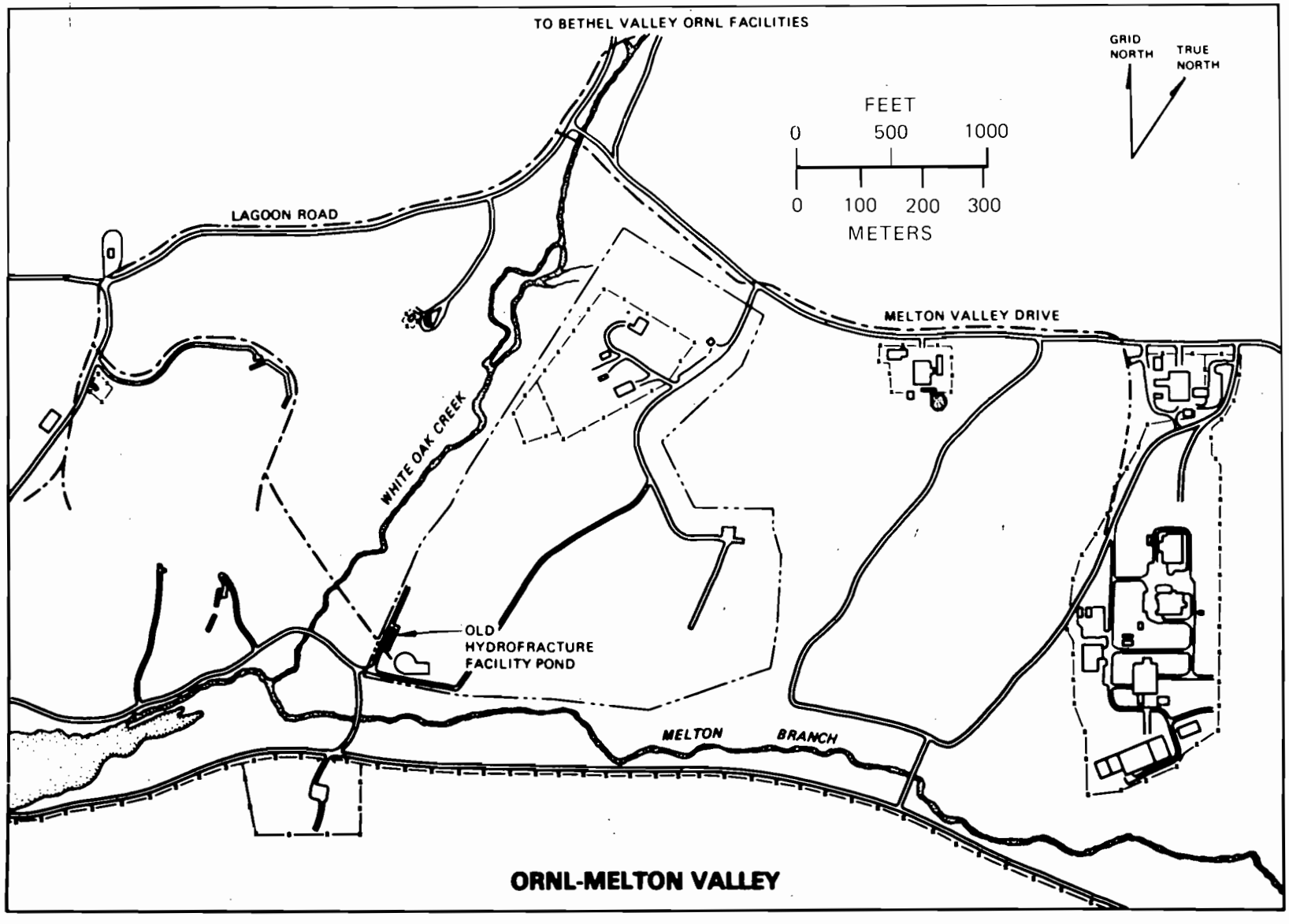


Fig. 22. Location of the Old Hydrofracture Facility at the Oak Ridge National Laboratory.

pits, tanks, and an impoundment discussed previously that was constructed to serve as an emergency containment basin in the event of a spill from the radioactive grout injections. The site plan and a photograph of the OHF are presented in Figs. 23 and 24, respectively.

3.1.3.2 Buildings

3.1.3.2.1 Building 7852

Building 7852 contains a mixing cell, a pump cell for the head end of the injection pump, a well cell, a transit-roof-covered engine pad (at the south end), and a control room (at the north end). The three cells, which were used for the mixing, pumping, and injection of the grout, have 30-cm (12-in.)-thick concrete walls and are covered with a metal roof [triple-layered steel, two 0.63-m (1/4-in.) plates on either side of a steel grating]. The walls, however, are only painted and are not lined with metal as is the ceiling. The hot cells have windows constructed of bulletproof glass. The roof of the mixing cell is fixed in place, but the roofs of the pump cell and the well cell can be removed. The control-room roof is metal decking. On the roof of Building 7852 are a hoist, an air filter and blower, and three disconnected solids conveyers used to transport solids from the adjacent bulk storage bins. Table 4 lists the dimensions for rooms in Building 7852.

Within the mixing cell are located a mixer assembly and a grout mix "tub." The mixer assembly is approximately 2.7 m (8 ft) high and has the shape of a cone that is 1.5 m (5 ft) in diameter at the top. The grout tub is approximately 1 m (3 ft) in diameter and 2 m (6.5 ft) high. The tops of both of these vessels and the motor for the agitation of the grout mix extend through the roof of the mixing cell. The cell also contains valves and piping.

The well cell contains a small drum-sized tank, piping, valves, and the top of the injection well. The pump cell also contains some equipment, namely, hoses, piping, and valves.

Around Building 7852 are located four cylindrical bulk storage bins, with conical bottoms (see Fig. 23), which are elevated to permit

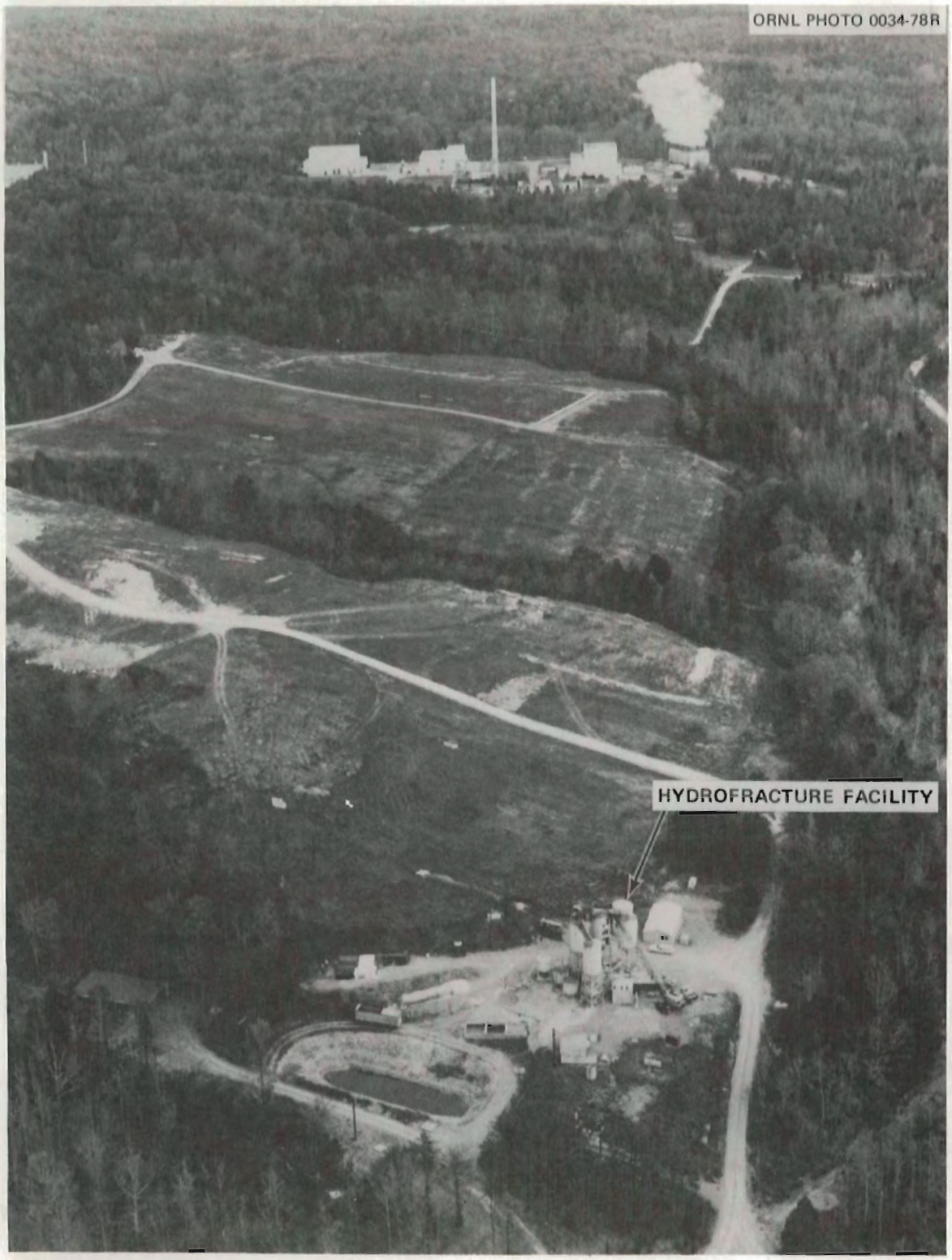


Fig. 23. Aerial photograph of the Old Hydrofracture Facility, SWSA-5, HFIR, TRU, and TURF facilities.

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Fig. 24. Photograph of the Old Hydrofracture Facility.

Table 4. Dimensions for rooms in Building 7852[a]

| Room | Length (m) | Width (m) | Height (m) |
|---|---|---|---|
| Mixing cell | 3.8 | 3.5 | 2.4 |
| Pump cell | 3.0 | 2.3 | 2.4 |
| Well cell | 3.3 | 3.4 | 3.0 |
| Control room | 4.4 | 3.3 | 3.1 |
| Engine pad | 9.1 | 3.0 | 2.7-3.0 |

[a]From Francis and Stansfield (1986a).

gravity flow of the solids (cement, fly ash, clay, and other additives used during the process) through air slides to Building 7852. Each of the bins is now connected to the mix hopper in Building 7852; all of them are interconnected by piping and by a catwalk. Under bin 4 is a small vessel once used to contain a short-lived radioactive tracer fluid; concrete shielding blocks surround this vessel. Directly to the east of Building 7852 is a 97,000-L (25,000-gal) water tank and pump for delivering water to the facility during mixing and injection.

3.1.3.2.2 Building 7853

This building was used as a change room for operators of the OHF during grout injections. At present, it is used for storage.

3.1.3.2.3 Pump House

The pump house, located to the northwest of Building 7852, contains two 30-hp progressive-cavity-type pumps that were used to feed waste from the nearby buried storage tanks, via underground piping, to Building 7852. This 33-$m^2$ (360-$ft^2$) concrete block house was built in an excavation with only the roof and southeast corner (at the door) being fully exposed. A valve pit [6 ft 4 in. by 21 ft (1.9 by 6.4 m)] is located at the southwest corner of the pump house. This pit is covered with metal plates through which valve handles extend for opening and closing valves.

3.1.4 Waste Pits

The waste pits, which are composed of three separate concrete-walled cells [12 x 12 ft wide and approximately 9 ft deep (3.7 x 3.7 x 2.7 m)], are located approximately 6.2 m (20 ft) to the northeast of the pump house. These pits were used to allow maximum recycle of contaminated water during slotting and washup, minimizing the need to inject waste water. The original pit, the southern cell, was filled with grout during an experimental injection, and two additional cells were built to the north. These two pits now contain water-covered sludge. The two northern cells are covered with a corrugated plastic roof, while the south cell remains uncovered.

### 3.1.5 Waste Tanks

Five buried carbon-steel tanks, placed horizontally, were used for storing liquid radioactive waste prior to injection by the OHF. These tanks, which are located about 18 m (60 ft) directly west of Building 7852, are still connected to the Intermediate-Level Waste (ILW) transfer line; thus, they can serve as a possible emergency storage site. There remains in each of the tanks approximately 1 ft (30 cm) of residual ILW, amounting to less than 10% of the total volume. The tanks were installed on concrete pads in open pits that were equipped with concrete dividing walls to serve as a means of separation and allow for monitoring of possible leakage. They are covered with approximately 1.2 m (4 ft) of soil, are under cathodic protection, and are vented through a HEPA filter to the atmosphere. The voltage/amperage applied to the cathodic protection system and the general radiation background of the storage tank dry well systems (monitoring wells located within the concrete enclosure built to contain each of the tanks) are monitored daily. The ventilation system is also checked daily, and any accumulated liquids in the storage tank dry well systems are sampled and analyzed for radioactivity (Francis and Stansfield, 1986).

### 3.1.6 OHF Status

A preliminary radiological survey was completed on the buildings by S. F. Huang (EOSD, personal communication, September 1984) in Francis and Stansfield, 1986a). Standard ORNL radiation survey instruments were used for all surveys. Beta-gamma readings were made with a GM meter, a Victoreen 440 (a low-range air ionization chamber), or a Cutie Pie (Gupton, 1961). Smear samples were taken over areas of approximately 100 $cm^2$ (15.5 $in.^2$) and surveyed in alpha and beta-gamma sample counters or with a portable survey instrument when high levels of contamination were present.

#### 3.1.6.1 Building 7852

Radiation and contamination levels in the interiors of the control room, mixing cell, pump cell, well cell, and pump room

were measured. To determine the high levels of transferable contamination on the rough surfaces of the interior walls, wet paper towel smears were used. These smears were surveyed with a portable instrument, rather than with smear counters, to prevent contamination of the smear counters.

In the control room, the absorbed dose rates ranged from 0.75 to 6 mGy/h (75 to 600 mrad/h). Smearable activity per 100 $cm^2$ varied from 330 to 820 Bq (8.9 to 22.3 nCi) of beta-gamma and from 0.3 to 0.7 Bq (8 to 22 pCi) of alpha. High levels of direct beta-gamma readings ranging from 1.5 to 40 mGy/h (150 to 4000 mrad/h) were observed in the mixing, pump, and well cells. Removable beta-gamma activity measured from 0.05 to 0.35 mGy (5 to 35 mrad). For the most part, removable alpha activity was less than 1.7 Bq/100 $cm^2$ (<50 pCi/100 $cm^2$) in these rooms. At 10 cm above the engine pad, the dose rates ranged from 0.2 to 3 mGy/h (20 to 300 mrad/h). Removable beta-gamma activity on the engine pad, using the wet towel smear technique previously described, varied from 5 to 10 μGy/h (0.5 to 1 mrad/h) per 100 $cm^2$ (15.5 $in.^2$). Alpha activity, using the same smear technique, was usually less than 0.5 Bq (14 pCi) per 100 $cm^2$ (15.5 $in.^2$).

3.1.6.2 Building 7853

This building, which was used as a change room during OHF operations, was also "considered to be relatively uncontaminated, with no serious radiological impacts expected."

3.1.6.3 Pump House

The interior surfaces of the pump house were contaminated with fixed and removable activity from 0.2 to 80 mGy/h (20 to 8000 mrad/h) and 5 to 150 μGy/h (0.5 to 15 mrad/h), respectively. A radiation reading of 50 μGy/h (5 mrad/h) was measured directly above the sheet metal covering the concrete blocks of the valve pit. The interior of the pit was considered likely to be contaminated with fixed and removable activity.

3.1.6.4 Soils

S. F. Huang made direct beta-gamma readings on 6-by 6-m (20-by 20-m) grids covering a 96-by 60-m (345-by 197-ft) area that encompassed the OHF. Also illustrated in Fig. 25 are the locations

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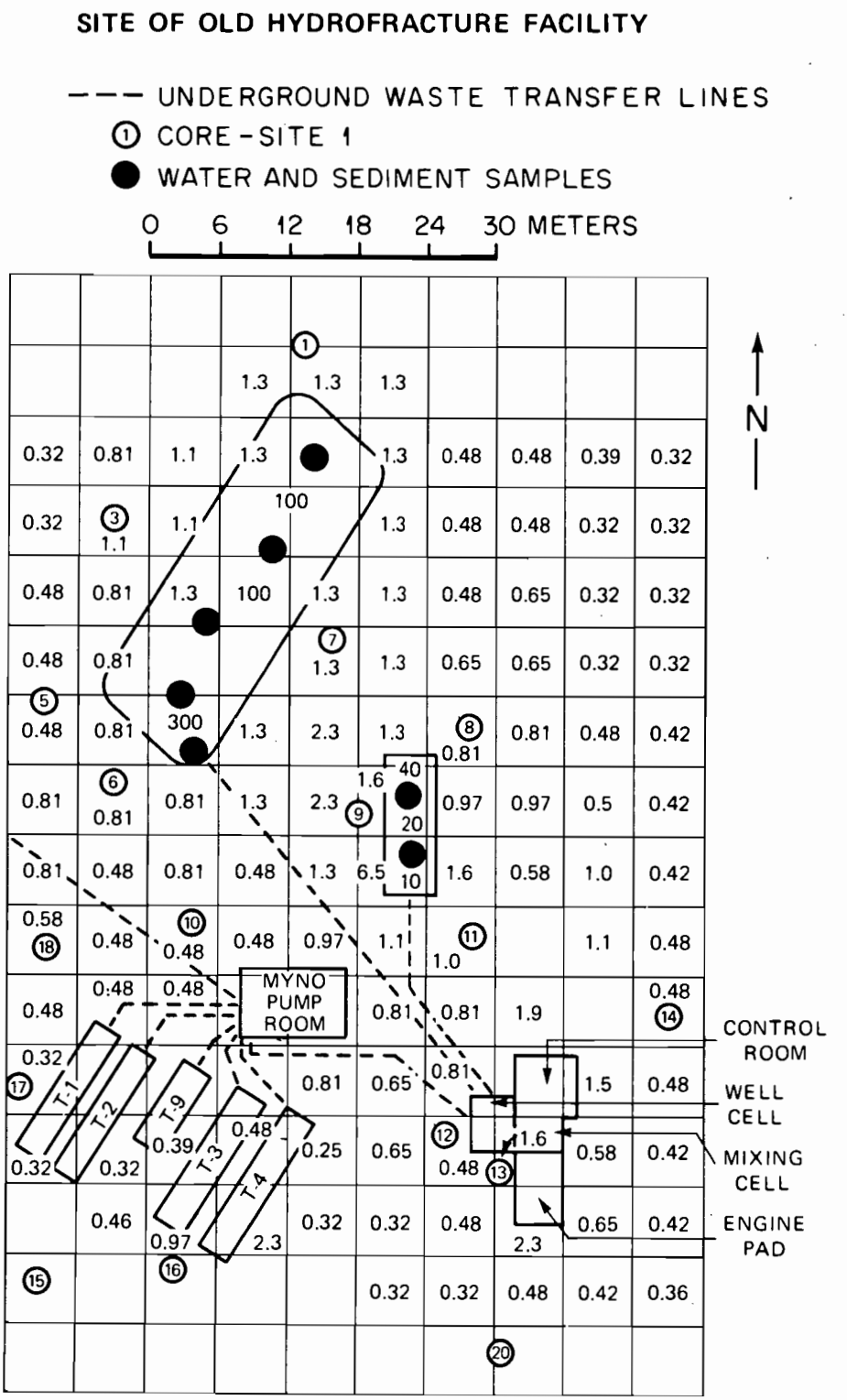


Fig. 25. Beta-gamma direct readings exceeding 0.3 mrad/h (1 mrad = 10 μGy) at 1 to 3 cm (0.4 to 1.2 in.) above the surface at the OHF. From Francis and Stansfield (1986a).

in Fig. 25 are the locations of 17 deep soil cores taken near potential radiation hazards. Sections of these soil cores, of varying soil depths, were counted on a 15 by 15-cm NaI(Tl) detector for 5 min. The gamma-ray spectrum (and total integral counts) over the energy range of 100 to 1500 keV was obtained from the results.

3.1.6.5 Waste Pits

In January of 1984, S. F. Huang measured absorbed dose rates ranging from 0.1 to 0.4 mGy/h (10 to 40 mrad/h) under the roof of the waste pit. In the south pit, 45 cm of water covered a 10-cm (4-in.) layer of sediment. In the north pit, approximately twice as much water (90 cm or 3 ft) covered a 10-cm (4 in) layer of sediment. The total radioactivity in the water and sediment was estimated to be 5 GBq (0.1 Ci) and 10 GBq (0.3 Ci), respectively. The concentrations and inventories of the various radionuclides measured in the water and sediment taken from these pits are listed in Appendix D.

3.1.6.6 Waste Tanks

S. F. Huang estimated the radioactivity in each tank to be between 22 and 37 TBq (600 to 1000 Ci). The total quantity of sludge in the tanks was estimated to be $2 \times 10^6$ L ($5.3 \times 10^5$ gal), containing on the order of 170 TBq (4.6 kCi). An estimate of the activity in each of the tanks and the assumptions used in making these estimates are presented in Appendix D. Water taken from the "dry wells" (monitoring wells located within the concrete enclosure built to contain each of the tanks) have shown slightly elevated levels of beta activity (maximum of 1.2 Bq/mL). Also, the soil core taken directly to the southwest of tank T-4 (soil core 16) showed some elevated levels of gamma activity at soil depths of approximately 5 m (16.5 ft). The possibility (or likelihood) has to be taken into consideration that the carbon steel tanks, which are inclined to rust (although cathodically protected), may have developed leaks over the years.

## 3.2 LLW WASTE CONCENTRATED STORAGE TANKS (MELTON VALLEY STORAGE TANKS)

The LLW waste concentrate storage tanks W-24 through W-31, 3.7 m (12 ft) in diameter by 18.3 m (60 ft) long are horizontally mounted stainless steel tanks in stainless steel-lined vaults (Fig. 26). The eight 190,000-L (50,000-gal) stainless steel tanks installed in 1976 are located at Building 7830 near the hydrofracture facility in Melton Valley. The vaults are equipped with appropriate HEPA-filtered off-gas systems.

These tanks were previously used for storage of concentrated LLW from the evaporator by way of tanks W-23, C-1, and C-2, until their contents were disposed by hydrofracture. Since the hydrofracture process is not currently in use, these tanks serve as the primary storage facility for ORNL's liquid LLW until an alternate disposal technology is placed in operation.

Two samping campaigns were initiated, in July and November 1985, to attempt to characterize the contents of each tank. During the July sampling, liquid samples were taken through the plummet level device penetration (a 5-cm- or 2-in.-diam hole in the top of the tank) (Fig. 27). The samples, which were collected through a hose inserted through this opening, were drawn from near the top, the middle, and the bottom of the liquid layer in each tank. Liquid was also drawn from the sludge region of each tank. Only tanks W-24 through W-28 were sampled at this time. Aeration and circulation were used to mix the contents during sampling.

A second sampling was undertaken in November 1985 of all eight tanks. A liquid sample was taken from the middle of the liquid phase, and solid samples were taken from the sludge layer. No mixing of the tank was occurring at this time; however, aeration allowed liquid-phase mixing. Estimates of the amount of sludge, its character, and volume are given in Table 5.

Extensive radiochemical analyses, physical properties, ICP and anion analyses, and spark-source spectrometry data for these tanks are presented in Appendix E. These data should be considered as indicative of the inventory and conditions only at the time of sampling.

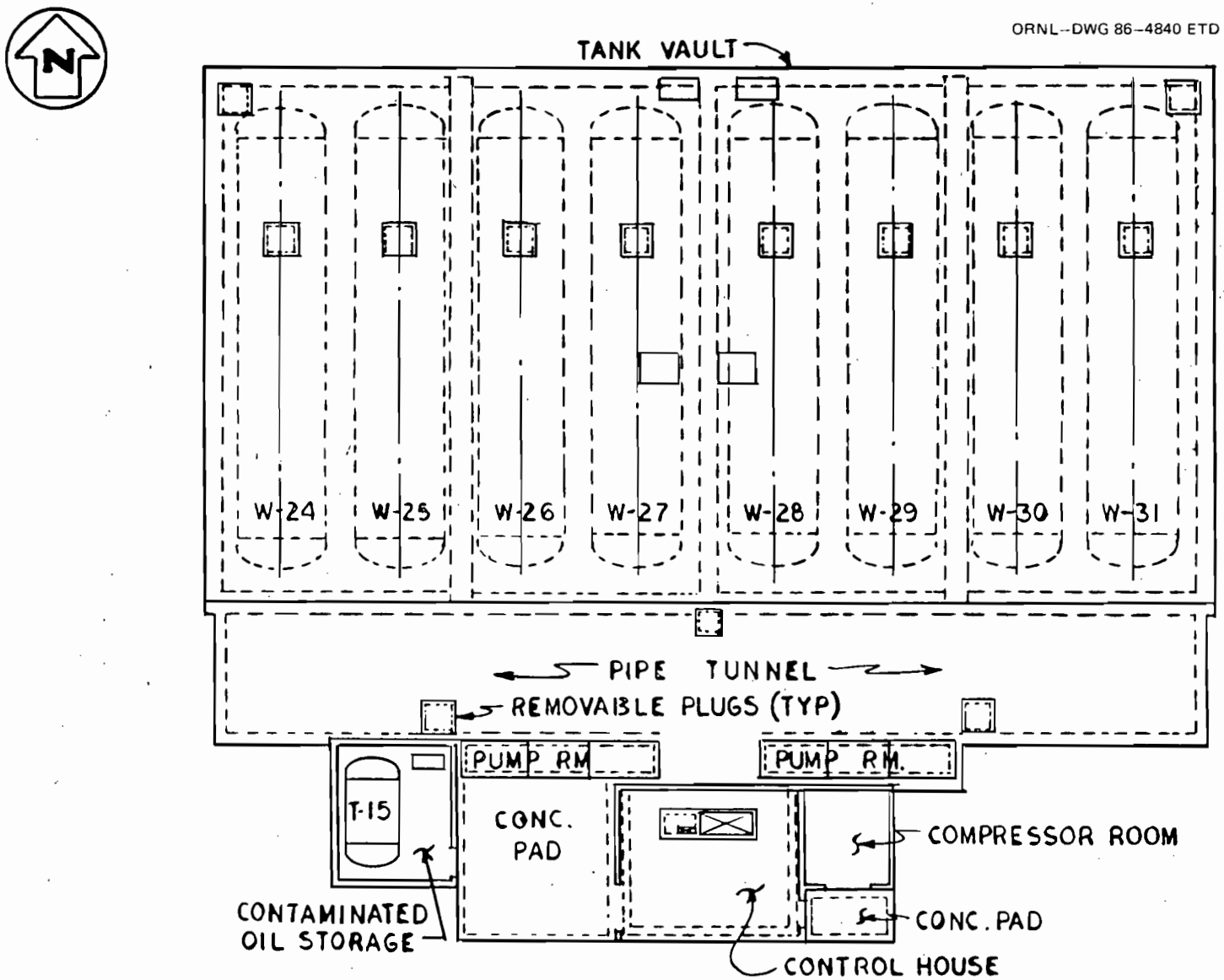


Fig. 26. Layout of the Melton Valley Storage Tanks. From Peretz et al. (1986).

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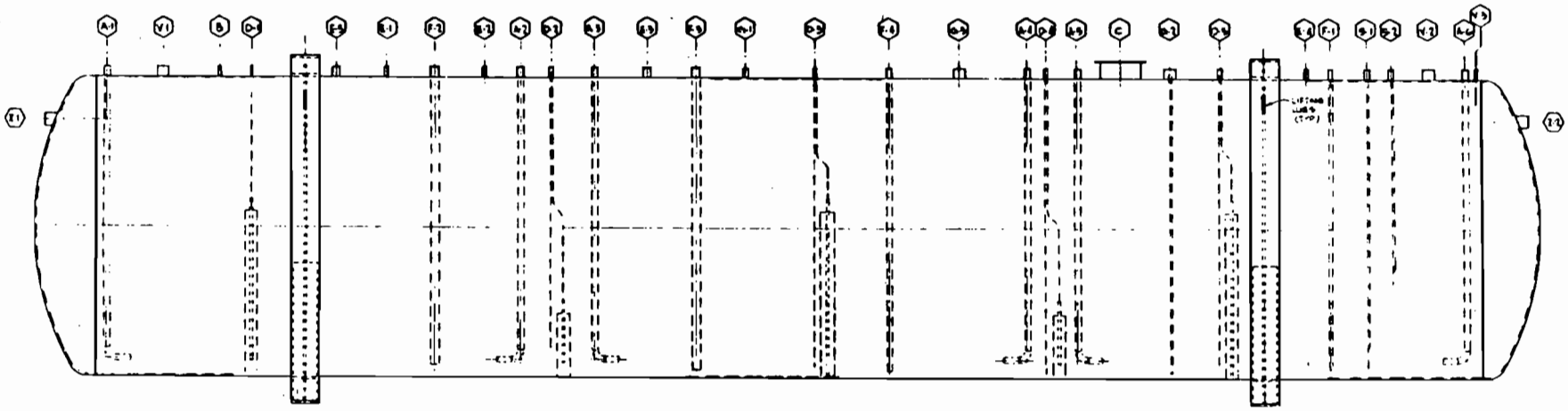

Nozzle Schedule:

| ID | Size | Usage | ID | Size | Usage |
|---|---|---|---|---|---|
| A-1 | 3" Sch. 40 | Sludge jet | F-1 | 6" Sch. 40 | Pump suction |
| A-2 | 3" Sch. 40 | Sludge jet | F-2 | 6" Sch. 40 | Spare |
| A-3 | 3" Sch. 40 | Sludge jet | F-3 | 4" Sch. 40 | Spare |
| A-4 | 3" Sch. 40 | Sludge jet | F-4 | 4" Sch. 40 | Sludge suction spare |
| A-5 | 3" Sch. 40 | Sludge jet | G-1 | 2" Sch. 40 | Plummet level device |
| A-6 | 3" Sch. 40 | Sludge jet | G-2 | 6" Sch. 40 | Density and level probe |
| B | 2" Sch. 40 | Chemical addition | G-3 | 6" Sch. 40 | Sludge level detector |
| C | | Flanged manhole | S-1 | 4" Sch. 40 | Low point sample suction |
| D-1 | 2" Sch. 40 | Tall air sparger | S-2 | 4" Sch. 40 | 25% full sample suction |
| D-2 | 2" Sch. 40 | Short air sparger & temp. sensor well | V-1 | 6" Sch. 40 | Vent inlet |
| D-3 | 2" Sch. 40 | Short air sparger & temp. sensor well | V-2 | 6" Sch. 40 | Vent outlet |
| D-4 | 2" Sch. 40 | Short air sparger & temp. sensor well | V-3 | 1" Sch. 40 | Demister drain |
| D-5 | 2" Sch. 40 | Tall air sparger & temp. sensor well | Z-1 | 6" Sch. 40 | Overflow (W-25 and W-30 only) |
| E-1 | 2" Sch. 40 | Sample return | Z-2 | 6" Sch. 40 | Overflow |
| E-2 | 2" Sch. 40 | Spare | | | |
| E-3 | 4" Sch. 40 | Spare | | | |
| E-4 | 2" Sch. 40 | Sump discharge (pump room) | | | |
| E-5 | 4" Sch. 40 | Pump discharge | | | |

Nozzle configuration shown for W-25, W-27, W-28 and W-31.

Nozzles E-5 and F-1 reversed on W-24, W-26, W-29 and W-31.

Fig. 27. Description and nozzle schedule for a typical 50,000 gal storage tank. From Peretz et al. (1986).

Table 5. Descriptions and volume estimates of sludges in the Melton Valley Storage Tanks[a]

| Tank | Sludge description[b] | Radiation level | Estimated volume (gal) | ($m^3$) |
|---|---|---|---|---|
| W-24 | Approximately 0.45 (1.5 ft) of a soft, fluid sludge | 200 mR/h at 6 in. | 3,600 | 13.6 |
| W-25 | About 1.2 m (4 ft) of sludge similar to that in W-24 but containing noticeable amounts of sand (possibly from hydro-fracture slotting); higher radiation levels than W-24 | About 1 R/h at 1 ft | 14,600 | 55.3 |
| W-26 | About 0.8 m (2.5 ft) of soft sludge containing more sand than found in W-25; radiation levels similar to W-24 | 200 mR/h at 6 in. | 7,500 | 28.2 |
| W-27 | A hard, crusty layer about 8 cm (3 in.) thick was found 2.5 ft from the bottom of the tank; sludge under the crust was similar to that in W-24; a somewhat thicker consistency may have ben due to the crust breaking off into the sample | Not reported | 7,500 | 28.2 |
| W-28 | About 20 cm (8 in.) of sludge similar to that found in W-24 | Not reported | 1,100 | 4.2 |
| W-28 | About 0.45 m (1.5 ft of soft sludge a little thicker than in W-24 but with similar radiation levels | 200 mR/hr at 6 in. | 3,600 | 13.6 |
| W-30 | Same as W-29 | 200 mR/h at 6 in. | 3,600 | 13.6 |
| W-31 | About 1 m (3 ft)of extremely thick sludge; the sampler rod had to be hammered through the sludge to reach the tank bottom; the sludge was not at all fluid and was much "hotter" than the other tanks | 4 R/h at 4 in. | 9,800 | 37.1 |

[a]From Peretz et al. (1986).

[b]It is generally believed that there is more sludge on the discharge side of the tanks than on the suction side, relative to the depth at the center. The tank contents were not circulated during sampling, but the aerators were left on. A liquid sample was not taken from W-31 because the contents consisted mainly of sludge.

## 3.3 RADIOACTIVELY CONTAMINATED WASTE-OIL STORAGE TANK

This tank, used for the storage of low-level contaminated oil, is an approximately 18,900 L stainless steel vessel located in a vault near Building 7860 at the New Hydrofracture Site. The vault is equipped with a HEPA-filtered off-gas system. The present inventory of this tank consists of a few thousand liters of mixed waste which may qualify for disposal by the TSCA incinerator at ORGDP (L. Lasher, personal communication, 1987).

## 3.4 NEW HYDROFRACTURE SITE SURFACE FACILITIES

The New Hydrofracture Site is within the boundaries of SWSA-5 just southwest of the OHF across Melton Branch. Access is restricted to the approximately 180-m (600-ft) by 120-m (400-ft) fenced area. This site was placed in operation in 1982 to replace the OHF for the disposal of concentrated low-level waste from LLW evaporator bottoms and sludges sluiced from the South Tank Farm gunite tanks. The new facility was last used for the injection of wastes in January 1984; performance problems and regulations now probably relegate it to a permanently inactive status.

Building 7860 consists of three hot cells (the well cell, mixing cell, and pump cell), an operating area, compressor room, change houses for men and women, an office, storage space, an equipment room, a waste tank in a pit, a roof area supporting solids transfer equipment, and a contaminated storage area (penthouse).

The hot cell known as the well cell contains the well head used in the injection process and a high-pressure pipe manifold. Ventilation is through a HEPA filter system. The general background radiation in this cell is approximately 200 mR/hr; the well reading is about 2 R/hr. A system is under design for constant surveillance of well pressure and for sampling the liquid in the well.

The hot cell known as the mixing cell contains the mixing hopper and the mixing tub. Ventilation is through a HEPA filter. The general background radiation in this cell is comparable to that of the well cell; however, the interior of the mixing tub is approximately an order of magnitude higher.

The hot cell known as the pump cell contains the pump suction and discharge manifold. This cell is also ventilated through a HEPA filter.

The general background radiation in the pump cell which varies with the distance from the pump manifold ranges from 400 mR/hr to 50 mR/hr.

The slotting waste pit is the central collection point for all Building 7860 cells and contains the slotting waste tanks and two transfer pumps. One pump, located in the pit sump, pumps any liquid collected in the sump back to the slotting waste tank. The second pump transfers liquid from the slotting waste tank through the Melton Valley Waste Storage Facility (Bldg. 7830) to the Liquid Low-Level Waste Evaporator for concentration and storage for ultimate storage. Radioactive contamination levels in the slotting waste pit and slotting waste tank are comparable to these levels in the mixing cell. The tank contains about 3.8 $m^3$ (1000 gal) of contaminated sand and shale cuttings from slotting and well recovery operations.

The interiors of the cells and slotting pits are contaminated primarily with mixed fission and activation products ($^{137}Cs$, $^{90}Sr$, $^{60}Co$, etc.) and small amounts of transuranic isotopes.

The penthouse contains a large amount of well tubing and drilling equipment that is radioactively contaminated to varying degrees. The general background radiation level in the penthouse is 5 to 10 mR/h.

The roof area supports the system for feeding solids to the mixing cell. Some of the internals of this system are radioactively contaminated, and others contain cement residues. All contaminated internals are vented through the mixing tub.

The compressor room houses three air compressors, a hot water heater, and two air dryers.

The office, operating area, storage room, and change rooms are noncontaminated areas typical of any operating facility. A normal building HVAC system is in operation.

The building is routinely checked at least one time per shift for abnormal conditions and to ensure security (C. B. Scott, personal communication, May 1987).

## 3.5 LOW-LEVEL WASTE (LLW) LINES AND LEAK SITES

### 3.5.1 OHF Observation Well Leak

The first of two leak sites associated with WAG-5 is located at ORNL coordinates N17,050, E28,620 (see Fig. 18) and is the result of

water leakage from an observation well (S220a) at the southern part of the site.

Hydraulic testing at the site left water under pressure that had been pumped into the formation. Upon drilling the observation well, the pressure was relieved through the well. The spill (contaminated water flow) first happened in 1964; however, the volume of the $^{90}Sr$ contaminated water released is not known. It was determined that, from Station No. 4 monitoring data, approximately 0.7 Ci of $^{90}Sr$ was released to Melton Branch.

3.5.2 OHF Grout Release

The second WAG-5 associated leak is located at ORNL grid coordinates N17,200, E28,500 (see Fig. 18) and is the result of a contaminated grout leak at the OHF.

This leak occurred on June 30, 1977 and was caused by valve failure requiring LLW-grout slurry to be directed to the OHF waste pit. Approximately 8700L (2300 gal) of slurry was released. Such a slurry, containing evaporator concentrated LLW, would be expected to contain $^{90}Sr$, $^{137}Cs$, $^{106}Ru$, $^{60}Co$, rare earths, plutonium, uranium, and transuranium isotopes.

Upon release of the slurry, the injection was terminated. After the facility was placed on standby, valves were inspected and repaired and the contents of the waste pit were included in the next injection on July 2, 1977 (Lasher, 1987).

## 4. ADDITIONAL INFORMATION NEEDED

An initial evaluation of the information presented in the previous sections indicates that data gaps exist that will require further investigation in order to complete the RI/FS planning stages. Although more detailed evaluations will be required to determine the need and extent of remedial actions in WAG5, it is apparent that data gaps exist in the areas of waste inventories and source terms, hydrology, and geology and geochemistry.

Source Term and Wsate Inventory

- Precise locations of waste trenches in "undefined areas."
- Trench water analyses (as suggested in Davis and Shoun, 1986).
- Additional contamination surveys in and around the OHF.
- Characterization of solidified grout in OHF waste pit.
- Characterization of OHF waste tank sludge.
- Determine trench wall characteristics such as permeability.

Hydrology

- Install at least two additional water quality wells on northwest boundary of SWSA-5 and one well on northwest side of the TRU Waste Storage Areas.
- Determine the geologic permeability on southeast side of SWSA-5.
- Reversible pump test(s) in SWSA-5 to better determine hydraulic conductivity.
- Additional monitoring wells near OHF impoundment to define plume shape of contamination.
- Determine leakage around 30-cm (8-in.) OHF impoundment drain line.
- Additional shallow (10 m or 32 ft) groundwater monitoring wells on the west side of the OHF impoundment.

Geology and Geochemistry

- Soils map for SWSA-5.
- Subsurface soil sampling near OHF impoundment and characterization of sediment.
- Soil sorption-desorption studies with known contaminants.
- Deep coring [40 m (130 ft)] in the OHF area.

The above are not an exhaustive list, but should serve as an indication of possible needed data and information in the WAG5 area.

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# Appendix B. HYDROLOGY

Table B-1. Data of observation wells in Burial Ground 5, Oak Ridge National Laboratory, Roane County, Tennessee

| Well number | Location | | | Depth of well | Year completed | Casing | | Finish | | Altitude of land surface (ft above NGVD) | Measuring Point | | Depth to Water below land surface | | | Status of well 12/79 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Latitude (deg., m, s) | Longitude (deg., m, s) | ORNL Grid (ft) (ft) | (ft) | | Diameter (in) | Type | Character | Depth interval (ft) | | Distance above land surface (ft) | Date determined (m/d/yr) | Period of record (yrs) | Minimum (ft) | Maximum (ft) | |
| 130 | 35 54 54 | 84 18 52 | N18248 E29136 | 5 | 1958 | 6 5/8 | S | Prf | 0-5 | 764.68 | 1.92 | 8/23/76 | 1975-79 | 1.65 | 4.47 | A |
| 132 | 35 54 50 | 84 18 54 | N18030 E28872 | 9 | 1958 | 6 5/8 | S | Prf | 0-9 | 763.43 | 1.67 | 8/23/76 | 1975-79 | 0.50 | 6.00 | B |
| 133 | 35 54 49 | 84 18 54 | N17934 E28795 | 7 | 1958 | 6 5/8 | S | Prf | 0-7 | 761.40 | 1.80 | 4/08/75 | 1975-76 | +0.04 | 3.69 | D |
| 134 | 35 54 48 | 84 18 54 | N17827 E28733 | 8 | 1958 | 6 5/8 | S | Prf | 0-8 | 760.73 | 1.27 | 8/23/76 | 1975-76 | 0.84 | 4.49 | D |
| 136 | 35 54 49 | 84 18 53 | N17464 E28578 | 10 | 1958 | 6 5/8 | S | Prf | 0-10 | 768.00 | 2.40 | 4/08/75 | 1975-76 | 1.97 | 8.45 | D |
| 143 | 35 54 50 | 84 18 46 | N17686 E29350 | 25 | 1958 | 6 5/8 | S | Prf | 0-25 | 823.49 | 1.51 | 8/23/76 | 1975-79 | 18.82 | DRY | B |
| 144 | 35 54 42 | 84 18 46 | M17794 E29420 | 3 | 1958 | 6 5/8 | S | Prf | 0-? | 838.42 | 2.00 | 4/08/75 | 1975-75 | - | - | B |
| 145 | 35 54 43 | 84 18 45 | N17879 E29644 | 11 | 1958 | 6 5/8 | S | Prf | 0-11 | 837.50 | 3.30 | 8/23/76 | 1975-79 | 5.61 | DRY | A |
| 146 | 35 54 56 | 84 18 43 | N18029 E29872 | 17 | 1958 | 6 5/8 | S | Prf | 0-17 | 825.40 | 2.00 | 4/08/75 | 1975-75 | - | - | D |
| 147 | 35 54 55 | 84 18 43 | N17931 E29843 | 20 | 1958 | 6 5/8 | S | Prf | 0-20 | 817.61 | 3.29 | 4/08/75 | 1975-79 | 4.35 | 10.58 | A |
| 149 | 35 54 51 | 84 18 43 | N17561 E29641 | 4 | 1958 | 6 5/8 | S | Prf | 0-4 | 790.07 | 2.43 | 4/08/75 | 1975-79 | +0.07 | 1.57 | A |
| 157 | 35 54 53 | 84 18 31 | N17151 E30555 | 6 | 1958 | 6 5/8 | S | Prf | 0-6 | 778.53 | 0.77 | 8/23/76 | 1975-79 | 1.46 | 4.85 | A |
| 159 | 35 54 56 | 84 18 33 | N17535 E30610 | 6 | 1958 | 6 5/8 | S | Prf | 0-6 | 794.46 | 0.84 | 8/23/76 | 1975-79 | 2.80 | DRY | A |
| 160 | 35 54 58 | 84 18 34 | N17744 E30617 | 9 | 1958 | 6 5/8 | S | Prf | 0-9 | 803.41 | 1.29 | 8/23/76 | 1975-79 | 0.77 | DRY | A |
| 161 | 35 54 59 | 84 18 35 | N17873 E30578 | 8 | 1958 | 6 5/8 | S | Prf | 0-8 | 810.88 | 1.02 | 8/23/76 | 1975-79 | 0.42 | 6.28 | A |
| 162 | 35 54 57 | 84 18 37 | N17809 E30360 | 9 | 1958 | 6 5/8 | S | Prf | 0-9 | 869.03 | 2.00 | 4/08/75 | 1975-75 | - | - | A |
| 165 | 35 54 51 | 84 18 51 | N17939 E29112 | 17 | 1958 | 6 5/8 | S | Prf | 0-17 | 811.76 | 2.44 | 8/23/76 | 1975-79 | 11.05 | DRY | B |
| 167 | 35 54 53 | 84 18 49 | N18074 E29334 | 12 | 1958 | 6 5/8 | S | Prf | 0-12 | 838.81 | 2.40 | 4/08/75 | 1975-79 | 8.86 | DRY | B |
| 169 | 35 54 50 | 84 18 41 | N17371 E29699 | 16 | 1958 | 6 5/8 | S | Prf | 0-16 | 809.42 | 2.28 | 8/23/76 | 1975-79 | 11.09 | DRY | B |
| 172 | 35 54 57 | 84 18 36 | N17795 E30418 | 7 | 1958 | 6 5/8 | S | Prf | 0-7 | 867.63 | 3.70 | 4/08/75 | 1975-75 | - | - | A |
| 173 | 35 54 55 | 84 18 39 | N17779 E30123 | 17 | 1958 | 6 5/8 | S | Prf | 0-17 | 847.44 | 2.26 | 8/23/76 | 1975-79 | 14.81 | DRY | A |
| 174 | 35 54 57 | 84 18 37 | N17829 E30382 | 125 | 1958 | 8 1/8 | S | Opn | 14-125 | 870.40 | 1.60 | 8/23/76 | 1975-79 | 42.17 | 60.74 | A |
| 175 | 35 54 54 | 84 18 37 | N17521 E30214 | 148 | 1958 | 6 1/8 | S | Opn | 36-148 | 831.50 | 0.10 | 8/23/76 | 1975-79 | 12.67 | 25.80 | B |
| 176 | 35 54 51 | 84 18 48 | N17829 E29329 | 143 | 1958 | 6 1/8 | S | Opn | 36-143 | 827.53 | 2.77 | 8/23/76 | 1975-79 | 0.36 | 35.25 | A |
| 177 | 35 54 49 | 84 18 45 | N17529 E29358 | 149 | 1958 | 6 1/8 | S | Opn | 44-149 | 827.93 | 1.77 | 8/23/76 | 1975-79 | 32.68 | 38.23 | A |
| 178 | 35 54 47 | 84 18 51 | N17572 E28864 | 153 | 1958 | 6 1/8 | S | Opn | 42-153 | 804.77 | 0.83 | 8/23/76 | 1975-79 | 28.54 | 34.79 | A |
| 419 | 35 54 44 | 84 18 43 | N17008 E29218 | 17 | 1975 | 6 5/8 | S | Prf | 0-17 | 779.57 | 0.03 | 12/05/75 | 1975-79 | 9.36 | 14.19 | A |
| 420 | 35 54 55 | 84 18 50 | N18258 E29371 | 10 | 1975 | 6 5/8 | S | Prf | 0-10 | 774.20 | 0.20 | 12/05/75 | 1975-79 | 1.37 | 3.99 | A |
| 421 | 35 54 52 | 84 18 54 | N18197 E28991 | 9 | 1975 | 6 5/8 | S | Prf | 0-9 | 763.60 | 0.00 | 12/05/75 | 1975-79 | 1.41 | 8.60 | A |
| 422 | 35 54 41 | 84 18 52 | N17166 E28450 | 12 | 1975 | 6 5/8 | S | Prf | 0-12 | 769.48 | 0.72 | 12/05/75 | 1975-79 | 7.00 | DRY | A |
| 423 | 35 54 43 | 84 18 45 | N17038 E29056 | 18 | 1975 | 6 5/8 | S | Prf | 0-18 | 782.41 | 1.09 | 12/05/75 | 1975-79 | 7.92 | 13.46 | A |
| 424 | 35 54 50 | 84 18 46 | N17683 E29348 | 39 | 1976 | 3 | S | Prf | 29-39 | 823.50 | 0.80 | 3/01/76 | 1976-79 | 18.03 | 31.41 | C |
| 425 | 35 54 51 | 84 18 43 | N17576 E29620 | 8 | 1975 | 6 5/8 | S | Prf | 0-8 | 796.35 | 2.25 | 12/05/75 | 1975-79 | 4.11 | DRY | A |
| 426 | 35 54 49 | 84 18 43 | N17383 E29497 | 4 | 1975 | 6 5/8 | S | Prf | 0-4 | 785.80 | 2.20 | 12/05/75 | 1975-79 | 1.83 | 4.01 | A |
| 427 | 35 54 45 | 84 18 41 | N16989 E29425 | 10 | 1975 | 6 5/8 | S | Prf | 0-10 | 768.27 | 0.03 | 12/05/75 | 1975-79 | 1.75 | 4.70 | A |

## Table B-1 (Continued)

| Well number | Location: Latitude (deg., m, s) | Location: Longitude (deg., m, s) | Location: ORNL Grid (ft) (ft) | Depth of well (ft) | Year completed | Casing: Diameter (in) | Casing: Type | Finish: Character | Finish: Depth interval (ft) | Altitude of land surface (ft above NGVD) | Measuring Point: Distance above land surface (ft) | Measuring Point: Date determined (m/d/yr) | Depth to Water below land surface: Period of record (yrs) | Depth to Water below land surface: Minimum (ft) | Depth to Water below land surface: Maximum (ft) | Status of well 12/79 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 428 | 35 54 47 | 84 18 36 | N16934 E29892 | 4 | 1975 | 6 5/8 | S | Prf | 0-4 | 772.90 | 0.40 | 11/20/75 | 1975-79 | 0.10 | 2.94 | A |
| 429 | 35 54 52 | 84 18 34 | N17251 E30291 | 22 | 1975 | 6 5/8 | S | Prf | 0-22 | 812.68 | 3.82 | 8/23/76 | 1975-79 | 5.43 | 14.30 | B |
| 430 | 35 54 57 | 84 18 43 | N18083 E29962 | 29 | 1976 | 3 | P | Slt | 19-29 | 824.75 | 3.15 | 4/02/76 | 1976-79 | 0.96 | 20.96 | B |
| 431 | 35 54 55 | 84 18 46 | N18059 E29675 | 35 | 1976 | 3 | P | Slt | 25-35 | 833.30 | 0.30 | 8/23/76 | 1976-79 | 17.91 | 31.06 | A |
| 432 | 35 54 51 | 84 18 51 | N17958 E29101 | 27 | 1976 | 3 | P | Slt | 17-27 | 808.92 | 2.78 | 4/02/76 | 1976-79 | 17.12 | DRY | A |
| 433 | 35 54 47 | 84 18 48 | N17488 E29071 | 44 | 1976 | 3 | P | Slt | 34-44 | 829.12 | 1.88 | 6/09/76 | 1976-79 | 36.20 | 43.01 | A |
| 434 | 35 54 47 | 84 18 47 | N17393 E29119 | 32 | 1976 | 3 | P | Slt | 22-32 | 816.13 | 2.97 | 6/24/76 | 1976-79 | 20.45 | 27.47 | A |
| 435 | 35 54 45 | 84 18 47 | N17232 E28990 | 30 | 1976 | 3 | P | Slt | 20-30 | 799.47 | 2.73 | 6/24/76 | 1976-79 | 9.42 | 16.51 | A |
| 436 | 35 54 44 | 84 18 45 | N17081 E29080 | 31 | 1976 | 3 | P | Slt | 21-31 | 785.66 | 2.74 | 6/24/76 | 1976-79 | 5.96 | 15.52 | A |
| 437 | 35 54 46 | 84 18 45 | N17270 E29209 | 36 | 1976 | 3 | P | Slt | 26-36 | 804.40 | 2.80 | 6/24/76 | 1976-79 | 13.94 | 18.79 | A |
| 438 | 35 54 48 | 84 18 45 | N17418 E29317 | 37 | 1976 | 3 | P | Slt | 27-37 | 819.62 | 2.68 | 6/24/76 | 1976-79 | 28.14 | 32.59 | A |
| 439 | 35 54 45 | 84 18 43 | N17134 E29297 | 34 | 1976 | 3 | P | Slt | 24-34 | 795.19 | 2.71 | 6/24/76 | 1976-79 | 15.64 | 23.23 | A |
| 440 | 35 54 47 | 84 18 43 | N17280 E29382 | 36 | 1976 | 3 | P | Slt | 26-36 | 804.97 | 4.13 | 7/09/76 | 1976-79 | 19.17 | 26.12 | A |
| 441 | 35 54 53 | 84 18 45 | N17822 E29604 | 42 | 1976 | 3 | P | Slt | 32-42 | 836.55 | 2.35 | 7/29/76 | 1976-79 | 22.93 | 33.58 | A |
| 442 | 35 54 45 | 84 18 51 | N17433 E28747 | 48 | 1976 | 3 | P | Slt | 38-48 | 808.60 | 2.70 | 10/27/76 | 1976-79 | 28.02 | 37.53 | A |
| 443 | 35 54 43 | 84 18 49 | N17185 E28723 | 47 | 1976 | 3 | P | Slt | 37-47 | 791.81 | 2.69 | 10/27/76 | 1976-79 | 19.49 | 29.45 | A |
| 444 | 35 54 50 | 84 18 36 | N17149 E30017 | 21 | 1976 | 3 | P | Slt | 11-21 | 796.50 | 1.90 | 10/27/76 | 1976-79 | 5.85 | 10.07 | A |
| 445 | 35 54 55 | 84 18 37 | N17652 E30286 | 64 | 1976 | 3 | P | Slt | 54-64 | 845.72 | 2.08 | 1/31/77 | 1976-79 | 22.00 | 35.30 | A |
| 446 | 35 54 47 | 84 18 41 | N17184 E29520 | 29 | 1976 | 3 | P | Slt | 19-29 | 786.70 | 2.50 | 1/31/77 | 1976-79 | 12.13 | 14.06 | A |
| 447 | 35 54 49 | 84 18 51 | N17778 E28992 | 8 | 1976 | 3 | P | Slt | 3-8 | 777.95 | 2.75 | 1/31/77 | 1976-79 | 0.25 | 2.35 | A |
| 448 | 35 54 53 | 84 18 49 | N18056 E29325 | 60 | 1976 | 3 | P | Slt | 50-60 | 839.45 | 3.40 | 1/31/77 | 1976-79 | 36.31 | 49.88 | B |
| 449 | 35 54 57 | 84 18 47 | N18285 E29658 | 40 | 1976 | 3 | P | Slt | 30-40 | 814.12 | 3.28 | 1/31/77 | 1976-79 | 27.41 | 39.37 | A |
| 450 | 35 54 56 | 84 18 40 | N17850 E30073 | 34 | 1976 | 3 | P | Slt | 24-34 | 838.70 | 2.50 | 1/31/77 | 1976-79 | 17.22 | 24.36 | A |
| 451 | 35 54 53 | 84 18 40 | N17581 E29962 | 34 | 1976 | 3 | P | Slt | 24-34 | 829.04 | 2.46 | 1/31/77 | 1976-79 | 15.96 | 27.97 | A |
| 452 | 35 54 50 | 84 18 39 | N17341 E29827 | 30 | 1977 | 3 | P | Slt | 20-30 | 818.80 | 3.00 | 1/31/77 | 1977-79 | 14.21 | 23.80 | A |
| 453 | 35 54 52 | 84 18 34 | N17223 E30290 | 29 | 1977 | 3 | P | Slt | 19-29 | 810.74 | 3.03 | 1/19/81 | 1977-79 | 9.07 | 24.66 | A |
| 454 | 35 54 54 | 84 18 32 | N17344 E30554 | 22 | 1977 | 3 | P | Slt | 12-22 | 801.50 | 0.70 | 2/16/77 | 1977-79 | 13.43 | 20.29 | A |
| 455 | 35 54 58 | 84 18 40 | N18007 E30198 | 36 | 1977 | 3 | P | Slt | 26-36 | 839.54 | 3.86 | 3/14/77 | 1977-79 | 13.25 | 25.29 | A |
| 456 | 35 54 44 | 84 18 53 | N17498 E28577 | 11 | 1977 | 3 | P | Slt | 1-11 | 768.53 | 3.37 | 5/10/77 | 1977-79 | *3.66 | 9.28 | B |
| 457 | 35 54 48 | 84 18 54 | N17850 E28719 | 10 | 1977 | 3 | P | Slt | 1-10 | 759.71 | 2.59 | 5/10/77 | 1977-79 | 0.49 | 3.13 | A |
| 501 | 35 54 43 | 84 18 48 | N17176 E28867 | 19 | 1964 | 6 7/8 | S | Prf | 0-19 | 799.08 | 0.82 | 8/23/76 | 1975-79 | 7.15 | DRY | B |
| 502 | 35 54 45 | 84 18 48 | N17301 E28895 | 18 | 1964 | 6 7/8 | S | Prf | 0-18 | 807.01 | 1.99 | 8/23/76 | 1975-79 | 14.54 | DRY | A |
| 504 | 35 54 54 | 84 18 41 | N17806 E29936 | 16 | 1964 | 6 7/8 | S | Prf | 0-16 | 827.20 | 0.00 | 4/08/75 | 1975-79 | 10.89 | DRY | C |
| 505 | 35 54 54* | 84 18 40* | N17700 E30000* | 18 | 1964 | 6 7/8 | S | Prf | 0-18 | -- | 0.00 | 4/08/75 | 1975-75 | - | - | D |
| 506 | 35 54 50 | 84 18 41 | N17410 E29697 | 18 | 1964 | 6 7/8 | S | Prf | 0-18 | 811.08 | 1.62 | 4/08/75 | 1975-79 | 13.06 | DRY | B |

* Approximate

## Table B-1 (Continued)

| Well number | Location | | | Depth of well | Year completed | Casing | | Finish | | Altitude of land surface | Measuring Point | | Depth to Water below land surface | | | Status of well 12/79 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Latitude (deg., m, s) | Longitude (deg., m, s) | ORNL Grid (ft) (ft) | (ft) | | Diameter (in) | Type | Character | Depth interval (ft) | (ft above NGVD) | Distance above land surface (ft) | Date determined (m/d/yr) | Period of record (yrs) | Minimum (ft) | Maximum (ft) | |
| 507 | 35 54 51 | 84 18 37 | N17316 E30064 | 19 | 1964 | 6 7/8 | S | Prf | 0-19 | 819.70 | 0.10 | 4/08/75 | 1975-78 | 5.52 | DRY | D |
| 508 | 35 54 53 | 84 18 37 | N17506 E30138 | 19 | 1964 | 6 7/8 | S | Prf | 0-19 | 834.16 | 0.64 | 4/08/75 | 1975-78 | 17.54 | DRY | D |
| 510 | 35 54 53 | 84 18 42 | N17730 E29766 | 13 | 1964 | 6 7/8 | S | Prf | 0-13 | 802.00 | 2.60 | 4/02/76 | 1976-79 | 0.58 | 5.53 | A |
| 511 | 35 54 51 | 84 18 41 | N17500 E29801 | 16 | 1964 | 6 7/8 | S | Prf | 0-16 | 804.28 | 3.92 | 4/08/75 | 1975-79 | 8.30 | 12.01 | A |
| 512 | 35 54 54 | 84 18 42 | N17828 E29850 | 13 | 1964 | 6 5/8 | S | Prf | 0-13 | 809.05 | 2.45 | 4/02/76 | 1975-79 | 2.93 | 7.64 | A |
| T29-1 | 35 54 56 | 84 18 36 | N17695 E30419 | 12 | 1959 | 6 5/8 | S | Prf | 0-12 | 858.01 | 2.59 | 4/08/75 | 1975-79 | 3.67 | 9.44 | A |
| T30-1 | 35 54 56 | 84 18 35 | N17640 E30403 | 11 | 1959 | 6 5/8 | S | Prf | 0-11 | 847.86 | 3.84 | 4/08/75 | 1975-79 | 4.06 | DRY | A |
| T31-1 | 35 54 52 | 84 18 37 | N17389 E30078 | 14 | 1977 | 3 | P | Slt | 4-14 | 826.46 | 2.60 | 2/16/77 | 1977-79 | 13.43 | DRY | A |
| T60-1 | 35 54 44 | 84 18 45 | N17075 E29094 | 14 | 1976 | 3 | P | Slt | 4-14 | 784.87 | 3.53 | 7/05/76 | 1976-79 | 4.58 | DRY | A |
| T64-1 | 35 54 47 | 84 18 42 | N17061 E29511 | 15 | 1977 | 3 | P | Slt | 5-15 | 779.12 | 2.08 | 3/14/77 | 1977-79 | 3.84 | 10.29 | A |
| T66-1 | 35 54 44 | 84 18 45 | N17095 E29073 | 17 | 1976 | 3 | P | Slt | 7-17 | 788.47 | 2.73 | 7/05/76 | 1976-79 | 5.57 | DRY | A |
| T83-1 | 35 54 46 | 84 18 46 | N17323 E29153 | 16 | 1975 | 4 | S | Prf | 1-16 | 807.90 | 0.00 | 11/05/75 | 1975-79 | 15.09 | DRY | A |
| T83-2 | 35 54 46 | 84 18 46 | N17306 E29140 | 10 | 1975 | 4 | S | Prf | 1-10 | 805.90 | 0.00 | 11/05/75 | 1975-79 | DRY | DRY | A |
| T83-3 | 35 54 45 | 84 18 46 | N17253 E29096 | 14 | 1975 | 4 | S | Prf | 1-14 | 799.10 | 0.00 | 11/05/75 | 1975-79 | 7.79 | DRY | A |
| T83-4 | 35 54 45 | 84 18 46 | N17235 E29085 | 14 | 1975 | 4 | S | Prf | 1-14 | 798.16 | 2.54 | 11/05/75 | 1975-79 | 10.45 | DRY | A |
| T83-5 | 35 54 44 | 84 18 46 | N17138 E29026 | 11 | 1975 | 4 | S | Prf | 1-11 | 790.78 | 3.02 | 3/01/76 | 1975-79 | 6.96 | DRY | A |
| T105-1 | 35 54 46 | 84 18 46 | N17333 E29138 | 14 | 1975 | 4 | S | Prf | 1-14 | 808.60 | 0.00 | 11/05/75 | 1975-79 | 9.49 | DRY | A |
| T105-2 | 35 54 46 | 84 18 46 | N17316 E29125 | 15 | 1975 | 4 | S | Prf | 1-15 | 806.60 | 0.00 | 11/05/75 | 1975-79 | 12.87 | DRY | A |
| T105-3 | 35 54 45 | 84 18 46 | N17259 E29083 | 14 | 1975 | 4 | S | Prf | 1-14 | 798.80 | 0.00 | 11/05/75 | 1975-79 | 7.17 | DRY | A |
| T105-4 | 35 54 45 | 84 18 46 | N17242 E29070 | 13 | 1975 | 4 | S | Prf | 1-13 | 797.75 | 2.45 | 11/05/75 | 1975-79 | 2.10 | 7.10 | A |
| T105-5 | 35 54 44 | 84 18 46 | N17149 E29010 | 14 | 1975 | 4 | S | Prf | 1-17 | 790.29 | 2.91 | 3/01/76 | 1975-79 | 6.27 | 14.30 | A |
| T105-6 | 35 54 44 | 84 18 46 | N17119 E28997 | 16 | 1975 | 4 | S | Prf | 1-19 | 788.62 | 2.98 | 3/01/76 | 1975-79 | 4.80 | 14.52 | A |
| T117-1 | 35 54 48 | 84 18 36 | N16987 E29933 | 7 | 1975 | 3 | P | Slt | 0-7 | 778.36 | 2.24 | 3/01/77 | 1977-79 | +0.45 | DRY | A |

Table B-2. Summary of annual precipitation at Burial Grounds 5 and 6, Oak Ridge National Laboratory, Roane County, Tennessee[a]

| Year | Burial Ground 5 (in.) | Burial Ground 6 (in.) |
|---|---|---|
| 1976 | 46.17 | 44.13[b] |
| 1977 | 54.62 | 54.68 |
| 1978 | 47.91[b] | 51.78 |
| 1979 | 63.26[b] | 57.19[b] |
| 1980 | 37.90[b] | 37.02 |
| Mean[c] | 51.96 | 49.60 |

[a]From Webster et al. (1982).
[b]Incomplete record.
[c]This value is the summation of the monthly means calculated for each gage.

Table B-3. Release of $^{90}Sr$ from operations and buried waste at ORNL from 1964 to 1983

[$^{90}Sr$ releases are for calendar year; rainfall is for water year]

| Water year[a] | Precipitation (cm) | Total $^{90}Sr$ discharge (Ci) | Discharge of $^{90}Sr$ (mCi/cm) |
|---|---|---|---|
| 1967 | 153.8 | 0.89 | 5.8 |
| 1968 | 114.3 | 2.84 | 24.8 |
| 1969 | 101.8 | 0.88 | 8.7 |
| 1970 | 121.7 | 0.93 | 7.6 |
| 1971 | 122.6 | 0.58 | 4.7 |
| 1972 | 120.4 | 0.81 | 6.7 |
| 1973 | 181.0 | 1.43 | 7.9 |
| 1974 | 174.7 | 1.39 | 7.9 |
| 1975 | 146.6 | 2.07 | 14.1 |
| 1976 | 123.9 | 0.75 | 5.8 |
| 1977 | 129.1 | 0.43 | 3.4 |

[a]Water year is September 1 through August 31.
From Tamura et al. (1980).

Table B-4. Release of $^{90}Sr$ from operations and buried waste at ORNL from 1964 through 1983[a]

[$^{90}Sr$ releases are for calendar year; rainfall is for water year]

| Year | Precipitation (cm/y) | White Oak Dam (Ci/y) | Burial Grounds 1, 3, and 4 and 7500 floodplains[b] (Ci/yr) | Burial Ground 5 (Ci/y)[c] |
|---|---|---|---|---|
| 1964 | | 7 | 3.3 | 0.7 |
| 1965 | | 3 | 3.4 | 0.3 |
| 1966 | | 3 | 2.0 | 0.5 |
| 1967 | 154 | 5 | 2.7 | 1.0 |
| 1968 | 115 | 3 | 1.7 | 2.8[d] |
| 1969 | 103 | 3.1 | 1.3 | 0.9 |
| 1970 | 122 | 3.9 | 1.4 | 0.7 |
| 1971 | 123 | 3.4 | 1.7 | 0.6 |
| 1972 | 120 | 6.5 | 2.2 | 0.9 |
| 1973 | 180 | 6.7 | 2.0 | 1.3 |
| 1974 | 175 | 6.0 | 5.4 | 1.3 |
| 1975 | 148 | 7.2 | 3.6 | 2.1 |
| 1976 | 125 | 4.5 | 4.3 | 0.7 |
| 1977 | 130 | 2.7 | 2.6 | 0.5 |
| 1978 | 156 | 2.0 | 1.2 | 0.5 |
| 1979 | 170 | 2.4 | 1.7 | 0.7 |
| 1980 | 97 | 1.5 | 0.9 | 0.6 |
| 1981 | 110 | 1.5 | 0.8 | 0.2 |
| 1982 | 155 | 2.7 | 1.5 | 0.5 |
| 1983 | 105 | 2.5 | 1.6 | 0.9 |
| 20-year total | | 77.6 | 45.3 | 17.7 |
| Average Ci/y | | 3.9 | 2.3 | 0.9 |
| Contribution, % of White Oak Dam total | | | 58 | 23 |

[a]From National Research Council (1985).
[b]Calculated by difference, monitoring station 3-ORNL operations.
[c]As measured at monitoring station 4-Melton Branch.
[d]The result of an accident.

# Appendix C. SOLID WASTE

Table C-1. Land used for solid waste disposal

| | Total (all SWSA) | | SWSA-5 | | SWSA-6 | |
|---|---|---|---|---|---|---|
| | $m^2$ | Acres | $m^2$ | Acres | $m^2$ | Acres |
| Prior to FY 1982 | 356,744[a] | (88.17)[a] | 202,452[a] | (50.04)[a] | 30,466[a] | (7.53)[a] |
| FY 1981 | 1,875 | (0.46) | 63 | (0.02) | 1,510 | (0.38) |
| FY 1980 | 2,840 | (0.70) | 8 | (0.002) | 2,832 | (0.70) |
| FY 1979 | 3,277 | (0.81) | 81 | (0.02) | 3,196 | (0.79) |
| FY 1978 | 3,237 | (0.80) | 81 | (0.02) | 3,156 | (0.78) |
| FY 1977 | 3,196 | (0.79) | 202 | (0.05) | 2,994 | (0.74) |
| TQ 1976[b] | 1,052 | (0.26) | 41 | (0.01) | 1,012 | (0.25) |
| FY 1976 | 4,046 | (1.00) | 364 | (0.09) | 3,682 | (0.91) |
| FY 1975 | 4,248 | (1.05) | 41 | (0.01) | 4,208 | (1.04) |

[a]Corrected to most recent civil engineering data.
[b]Third quarter, FY 1976.

Table C-2. Estimates of total annual activity, volume, and weight of solid waste buried or stored at ORNL[a]

| Fiscal year | Activity (Ci) | Volume ($m^3$) | Weight (kg) | SWSA |
|---|---|---|---|---|
| 1943 | 2,000 | 700 | $1.4 \times 10^5$ | 1 |
| 1944 | 2,000 | 700 | $1.4 \times 10^5$ | 1,2 |
| 1945 | 2,000 | 700 | $1.4 \times 10^5$ | 2 |
| 1946 | 2,000 | 700 | $1.4 \times 10^5$ | 2,3 |
| 1947 | 10,000 | 3,960 | $1.4 \times 10^5$ | 3 |
| 1948 | 10,000 | 3,960 | $1.4 \times 10^5$ | 3 |
| 1949 | 10,000 | 3,960 | $1.4 \times 10^5$ | 3 |
| 1950 | 10,000 | 3,960 | $1.4 \times 10^5$ | 3 |
| 1951 | 10,000 | 3,960 | $1.4 \times 10^5$ | 3,4 |
| 1952 | 10,000 | 5,660 | $1.4 \times 10^5$ | 4 |
| 1953 | 10,000 | 5,660 | $1.4 \times 10^5$ | 4 |
| 1954 | 10,000 | 5,660 | $1.4 \times 10^5$ | 4 |
| 1955 | 10,000 | 5,660 | $1.4 \times 10^5$ | 4 |
| 1956 | 10,000 | 5,660 | $1.4 \times 10^5$ | 4 |
| 1957 | 20,000 | 9,060 | $1.8 \times 10^6$ | 4 |
| 1958 | 20,000 | 9,060 | $1.8 \times 10^6$ | 4 |
| 1959 | 20,000 | 9,060 | $1.8 \times 10^6$ | 4,5 |
| 1960 | 20,000 | 9,060 | $1.8 \times 10^6$ | 5 |
| 1961 | 20,000 | 15,000 | $2.7 \times 10^6$ | 5 |
| 1962 | 30,000 | 12,000 | $2.3 \times 10^6$ | 5 |
| 1963 | 20,000 | 9,430 | $1.8 \times 10^6$ | 5 |
| 1964 | 20,000 | 9,090 | $1.8 \times 10^6$ | 5 |
| 1965 | 10,000 | 5,350 | $9.1 \times 10^5$ | 5 |
| 1966 | 10,000 | 4,500 | $9.1 \times 10^5$ | 5 |
| 1967 | 10,000 | 5,640 | $9.1 \times 10^5$ | 5 |
| 1968 | 20,000 | 6,850 | $1.4 \times 10^6$ | 5 |
| 1969 | 10,000 | 5,440 | $9.1 \times 10^5$ | 5 |
| 1970 | 10,000 | 3,630 | $4.5 \times 10^5$ | 5 |
| 1971 | 10,000 | 4,730 | $1.0 \times 10^6$ | 5 |
| 1972 | 9,000 | 3,650 | $8.6 \times 10^5$ | 5,6 |
| 1973 | 8,000 | 3,030 | $7.1 \times 10^5$ | 5,6 |
| 1974 | 8,000 | 3,400 | $7.0 \times 10^5$ | 5,6 |
| 1975 | 1,200 | 3,170 | $6.4 \times 10^5$ | 5,6 |
| 1976[b] | 7,000 | 3,540 | $6.8 \times 10^5$ | 5,6 |
| 1977 | 4,046 | 2,200 | $1.7 \times 10^5$ | 5,6 |
| 1978 | 3,810 | 2,360 | $4.2 \times 10^5$ | 5,6 |
| 1979 | 5,398 | 2,110 | $6.1 \times 10^5$ | 5,6 |
| 1980 | 58,400 | 2,350 | $6.0 \times 10^5$ | 5,6 |
| 1981 | 113,700 | 1,800 | $7.6 \times 10^5$ | 5,6 |
| 1982 | 7,905 | 1,491 | $3.7 \times 10^5$ | 5,6 |
| 1983 | 6,299 | 2,238 | $7.6 \times 10^5$ | 5,6 |
| 1984 | 11,500 | 2,444 | $7.0 \times 10^5$ | 5,6 |
| Total | 602,258 | 202,583 | $3.233 \times 10^7$ | |

[a]From Grizzard (1986).

[b]July 1, 1975 through September 30, 1976 reflects change in fiscal year to begin in October.

Table C-3. High-radiation-level alpha wastes in retrievable below-grade storage — Buildings 7827 and 7865 and trenches[a]

| | Total volume | | Transuranium isotopes and $^{233}U$ (g) | Volume in SS liners[d] | | Number of casks |
|---|---|---|---|---|---|---|
| | $m^3$ | $ft^3$ | | $m^3$ | $ft^3$ | |
| Prior to FY 1982 | 586.6 | (20,716) | 4,049[b] | 3.7 | 130 | 202 |
| FY 1981 | 25.5 | (900) | 0 | 0 | (0) | 9 |
| FY 1980 | 25.5 | (900) | 0 | 0 | (0) | 7 |
| FY 1979 | 42.5 | (1,502) | 9 | 0.01 | (2) | 15 |
| FY 1978 | 40.9 | (1,443) | 151 | 0.8 | (27) | 14 |
| FY 1977 | 69.0 | (2,438) | 565 | 1.1 | (38) | 24 |
| TQ FY 1976 | 22.9 | (808) | 34 | 0.2 | (8) | 8 |
| FY 1976 | 45.3 | (1,601) | 168 | 0.9 | (31) | 15 |
| FY 1975 | 70.8 | (2,500) | 15 | NA | NA | 25 |
| FY 1974 | 82.2 | (2,905) | 140 | NA | NA | 29 |
| FY 1973 | 124.6 | (4,400) | 889[b] | NA | NA | 44 |
| FY 1972 | 34.0 | (1,200) | 2,066[b] | NA | NA | 12[b] |
| FY 1971 | 2.8 | (100) | 12[b] | NA | NA | a[c] |

[a]From Grizzard (1986).

[b]Quantities of isotopes present were most often given as less than the maximum quantity approved for the specific container used; best estimates are now required.

[c]Forty-three casks for FY 1971 and 44 casks for FY 1972 are buried nonretrievably.

[d]An additional 2.0 $m^3$ (70 $ft^3$) in FY 1976 and 0.45 $m^3$ (16 $ft^3$) in FY 1978 are retrievably stored.

Table C-4. Low-level alpha wates in retrievable storage in Buildings 7826 and 7834 at Solid Waste Storage Area 5[a]

| Period | Volume ($m^3$) | Transuranium isotopes and $^{233}U$ (g) | Number of stainless steel drums |
|---|---|---|---|
| Prior to FY 1974 | 124.7 | 2,138 | 282[b] |
| FY 1974 | 30.7[c] | 1,176 | 137 |
| FY 1975 | 42.1 | 1,761 | 190 |
| FY 1976 | 46.3 | 2,352 | 205 |
| Adj. Quar. FY 1976 | 12.9 | 1,053 | 57 |
| FY 1977 | 15.5 | 1,294 | 69 |
| FY 1978 | 34.1 | 585 | 151 |
| FY 1979 | 32.7 | 818 | 145 |
| FY 1980 | 30.0 | 335 | 133 |
| FY 1981 | 35.4 | 814 | 129 |
| FY 1982 | 20.3 | 103.4 | 86 |
| FY 1983 | 25.0 | 480.6 | 106 |
| FY 1984 | 53.3[d] | 795.1 | 85 |
| Total | 503.0 | 13,705.4 | 1,775 |

[a]From Grizzard (1986).

[b]An additional 277 black iron drums were stored prior to FY 1974.

[c]Volumes correctd for blue boxes of low-level alpha waste buried in previous years.

[d]This includes 23 metal boxes stored retrievably.

Table C-5. High-radiation level alpha wastes in retrievable below-grade storage in Buildings 7827 and 7833, and trenches in Solid Waste Storage Area 5[a]

| Period | Total volume ($m^3$) | Transuranium isotopes and $^{233}U$ (g) | Volume in stainless steel liners ($m^3$) | Number of casks |
|---|---|---|---|---|
| FY 1971 | 2.8 | 12[b] | NA | –[2] |
| FY 1972 | 34.0 | 2066[b] | NA | 12[2] |
| FY 1973 | 124.6 | 889[b] | NA | 44 |
| FY 1974 | 82.2 | 140 | NA | 29 |
| FY 1975 | 70.8 | 15 | NA | 25 |
| FY 1976 | 45.3 | 168 | 0.9 | 15 |
| Adj. Quar. FY 1976 | 22.9 | 34 | 0.2 | 8 |
| FY 1977 | 69.0 | 565 | 1.1 | 24 |
| FY 1978 | 40.9 | 151 | 0.8 | 14 |
| FY 1979 | 42.5 | 9 | 0.01 | 15 |
| FY 1980 | 25.5 | 9 | 0 | 7 |
| FY 1981 | 25.5 | 2 | 0 | 9 |
| FY 1982 | 31.1 | 1 | 0 | 11 |
| FY 1983 | 25.5 | 13 | 0 | 13 |
| FY 1984 | 37.1 | 27 | 0.33 | 9 |
| Total | 448.6 | 4101 | 3.34 | 235 |

[a]From Grizzard (1986).

[b]Quantities of isotopes present were most often given as less than the maximum quantity approved for the specific container used; best estimates are now required.

[c]Forty-three casks for FY 1971 and 44 casks for FY 1972 are buried nonretrievably.

Table C-6. Fissile waste in SWSAs[a]

| | Volume | | Fissile isotopes (g) | Number of | |
|---|---|---|---|---|---|
| | $m^3$ | $ft^3$ | | Auger holes | Trenches |
| Prior to FY 1982 | 325.4 | (11,494) | 22,833 | 222 | 8 |
| FY 1981 | 0.4 | (12) | 210 | 3 | 0 |
| FY 1980 | 2.7 | (60) | 958 | 3 | 0 |
| FY 1979 | 0.4 | (13) | 39 | 2 | 0 |
| FY 1978 | 2.5 | (87) | 1,261 | 14 | 0 |
| FY 1977 | 5.7 | (200) | 1,728 | 8 | 0 |
| FY 1976 | 3.5 | (123) | 1,225 | 6 | 1 |
| FY 1975 | 50.5 | (1,784) | 1,992 | 7 | 4 |
| FY 1974 | 58.9 | (2,082) | 1,915 | 9 | 1 |
| FY 1973 | 33.8 | (1,195) | 2,128 | 40 | 0 |
| FY 1972 | 101.2 | (3,576) | 7,289 | 76 | 1 |
| FY 1971[b] | 48.3 | (1,705) | 2,784 | 36 | 1 |
| FY 1970[c] | 17.4 | (613) | 1,302 | 16 | 0 |

[a]From Grizzard (1986).

[b]Transuranium Waste Storage Facility initiated October 1970.

[c]First year of separation of transuranic from nontransuranic waste. Prior to this, wastes containing isotopes $^{233}U$, $^{235}U$, and $^{239}Pu$ were placed below grade in the same section, SWSA-5.

# Appendix D. OLD HYDROFRACTURE IMPOUNDMENT AND SURFACE FACILITIES

Table D-1. Waste pit inventories of radionuclides[a]

| | Average depth and volume | Radionuclide | Concentration (Bq/mL or BQ/g) | Inventory GBq | Inventory mCi |
|---|---|---|---|---|---|
| South cell water | 45 cm<br>$6.3 \times 10^3$ L | $^{135}Cs$ | $1.2 \times 10^2$ | 0.8 | 20.0 |
| | | $^{239}Pu$ | 1.1 | 0.007 | 0.2 |
| | | $^{238}Pu$ | 2.2 | 0.01 | 0.4 |
| | | $^{241}Am$ | 1.0 | 0.006 | 0.2 |
| | | $^{244}Cm$ | 1.0 | 0.006 | 0.2 |
| | | $^{90}Sr$ | 15.0 | 0.09 | 3.0 |
| South cell sediment | 10 cm<br>$1.4 \times 10^3$ L | $^{137}Cs$ | $4.0 \times 10^3$ | 6.0 | 200.0 |
| | | $^{60}Co$ | 31.0 | 0.04 | 1.0 |
| | | $^{239}Pu$ | 97.0 | 0.1 | 4.0 |
| | | $^{238}Pu$ | 30.0 | 0.04 | 1.0 |
| | | $^{241}Am$ | 17.0 | 0.02 | 0.6 |
| | | $^{244}Cm$ | 54.0 | 0.08 | 2.0 |
| | | $^{90}Sr$ | $7.8 \times 10^2$ | 1.0 | 30.0 |
| North cell water | 90 cm<br>$1.3 \times 10^4$ L | $^{137}Cs$ | $2.1 \times 10^2$ | 3.0 | 80.0 |
| | | $^{239}Pu$ | 1.0 | 0.01 | 0.4 |
| | | $^{238}Pu$ | 1.5 | 0.02 | 0.5 |
| | | $^{241}Am$ | 1.0 | 0.01 | 0.4 |
| | | $^{244}Cm$ | 1.0 | 0.01 | 0.4 |
| | | $^{90}Sr$ | 16.0 | 0.2 | 6.0 |
| North cell sediment | 10 cm<br>$1.4 \times 10^3$ L | $^{137}Cs$ | $3.1 \times 10^3$ | 4.0 | 100.0 |
| | | $^{60}Co$ | 14.0 | 0.02 | 0.6 |
| | | $^{239}Pu$ | 42.0 | 0.06 | 2.0 |
| | | $^{238}Pu$ | 17.0 | 0.02 | 0.6 |
| | | $^{241}Am$ | 13.0 | 0.02 | 0.6 |
| | | $^{244}Cm$ | $6.0 \times 10^2$ | 0.8 | 20.0 |
| | | $^{90}Sr$ | $4.0 \times 10^2$ | 0.6 | 20.0 |

[a]Taken from S. F. Huang [EDSD, personal communication, September 1984, in Francis and Stansfield (1986a)].

[b]Inventory in the sediment was estimated by assuming that the total volume was equal to the total dry weight.

Table D-2. Radiation levels in Building 7852 and in Pump House[a]

| Location | Direct β-γ (mrad/h) | Radiation level Smearable (per 100 $cm^2$ α (dpm) | β-γ (mrad/hr)[b] |
|---|---|---|---|
| | | Building 7852 | |
| Mixing cell | Avg. 2500<br>Max. 4000 | Generally <20<br>Max. 102 (1 location) | Avg. 16<br>Max. 30 |
| Pump cell | Avg. 625<br>Max. 2000 | <20 | Avg. 2.4<br>Max. 5 |
| Well cell | Avg. 1320<br>Max. 3000 | <20 | Avg. 23<br>Max. 36 |
| Engine pad | Avg. 130<br>Max. 300 | Generally <20<br>Max. 27 (1 location) | Avg. 0.85<br>Max. 1 |
| Control room | Avg. 75-80 except max. 600 (at stored items) | 21-36 | 21,000-49,000 dpm |
| | | Pump House | |
| Pump room | Avg. 1340 except for max. 8000 (under lead shield) | <20 | 0.5-16 mrad/h |
| Valve pit | 5 | Not given | Not given |

[a]From Reed, 1984 in Francis and Stansfield (1986a).
[b]Except as noted.

Table D-3. Estimate of residual radioactivity in waste tanks at the Old Hydrofracture Facility[a]

| Tank | Tank capacity (L) | Tank diameter (m) | Tank length (m) | Sludge volume (L) | Sludge activities | |
|---|---|---|---|---|---|---|
| | | | | | TBq | kCi |
| T-1 | $5.9 \times 10^4$ | 2.4 | 13.0 | $4.2 \times 10^3$ | 40 | 1.0 |
| T-2 | $5.9 \times 10^4$ | 2.4 | 13.0 | $4.2 \times 10^3$ | 40 | 1.0 |
| T-9 | $4.4 \times 10^4$ | 3.1 | 5.9 | $2.2 \times 10^3$ | 30 | 0.6 |
| T-3 | $1.1 \times 10^5$ | 3.2 | 13.0 | $4.9 \times 10^3$ | 40 | 1.0 |
| T-4 | $1.1 \times 10^5$ | 3.2 | 13.0 | $4.9. \times 10^3$ | 40 | 1.0 |

[a]From S. F. Huang (EOSD, personal communication, September 1984) in Francis and Stansfield (1986a). The estimate was based on the assumption of 30-cm thickness of residual sludge (a rough estimate from operational experience) at a concentration of 0.26 Ci/L.

Table D-4. Concentrations and inventory of nonradioactive contaminants in OHF pond water[a]

| Constituent | Concentration (mg/L) Pond | NIPDWS | Inventory[b] (g) |
|---|---|---|---|
| | | **Metals** | |
| Antimony | <0.3 | ND[c] | <74 |
| Arsenic | <0.001 | 0.05 | <1 |
| Barium | 0.539 | 1 | 132 |
| Beryllium | 0.0021 | ND | 1 |
| Boron | <0.1 | ND | <25 |
| Cadmium | 0.0015 | 0.01 | <1 |
| Calcium | 26.3 | ND | 6664 |
| Chromium | 0.0219 | 0.05 | 5 |
| Cobalt | <0.02 | ND | <5 |
| Copper | <0.02 | ND | <5 |
| Iron | 9.25 | ND | 2266 |
| Lead | <0.001 | 0.05 | <1 |
| Lithium | <0.2 | ND | <49 |
| Magnesium | 8.99 | ND | 2203 |
| Manganese | 0.2 | ND | 49 |
| Mercury | 0.0001 | 0.002 | <1 |
| Molybdenum | <0.02 | ND | <5 |
| Nickel | <0.06 | ND | <15 |
| Potassium | 6.5 | ND | 1593 |
| Selenium | 0.016 | 0.01 | 4 |
| Silver | <0.07 | 0.05 | <17 |
| Sodium | <0.5 | ND | <123 |
| Strontium | 0.316 | ND | 77 |
| Titanium | <0.02 | ND | <5 |
| Vanadium | <0.03 | ND | <7 |
| Zinc | 0.134 | ND | 33 |
| | | **Anions** | |
| Chloride | 64 | ND | 15,680 |
| Fluoride | 1 | 1.2-2.4 | 245 |
| Nitrate-N | <1 | 10 | <245 |
| Phosphate | <0.93 | ND | <228 |
| Sulfate | 19 | ND | 4655 |

[a]Data taken from R. G. Stansfield and C. W. Francis (1986a).
[b]Based on a total volume of $2.4 \times 10^5$ L.
[c]ND = level not defined by NIPDWS (National Interim Primary Drinking Water Standards).

Table D-5. Concentrations and inventory of organic chemicals in OHF pond water[a]

| Constituent | Concentration (mg/L) Pond | NIPDWS | Inventory[b] (g) |
|---|---|---|---|
| | **Herbicides/pesticides** | | |
| Endrin | <0.0001 | 0.002 | <0.1 |
| Lindane | <0.0001 | 0.004 | <0.1 |
| Methoxychlor | <0.0002 | 0.1 | <0.1 |
| Toxaphene | <0.002 | ND[c] | <0.5 |
| | **Organic Compounds[d]** | | |
| PCBs | 0.0001 | ND | <0.1 |
| Phenols | <0.0001 | ND | <0.1 |
| TOC | 16.5 | ND | 4043 |
| TOX | 0.132 | ND | 32 |

[a]Data taken from R. G. Stansfield and C. W. Francis (1986).
[b]Inventory based on pond water volume of $2.45 \times 10^5$ L.
[c]ND = limit not defined by NIPDWS (Naional Interim Primary Drinking Water Standards).
[d]PCBS = polychlorinated biphenyls; TOC = total organic carbon; TSX = total organic halides.

Table D-6. Concentrations and inventory of radionuclides in OHF pond water[a]

| Radionuclide | Stansfield and Francis (1986)[b] Concentration (Bq/L) | Inventory (MBq) | Inventory (mCi) | S. F. Huang[c] Concentration (Bq/L) | Inventory (MBq) | Inventory (mCi) |
|---|---|---|---|---|---|---|
| Gross alpha | 11 | 2.7 | 0.07 | NC[d] | NR | NR |
| Gross beta | 9400 | 2303 | 63 | NR | NR | NR |
| Americium-241 | 0.24 | 0.1 | <0.01 | NR | NR | NR |
| Cesium-137 | 3900 | 956 | 26 | 29,000 | 2100 | 57 |
| Cobalt-60 | 27 | 6.6 | 0.18 | 27 | 2 | 0.05 |
| Curium-244 | 6.8 | 1.7 | 0.05 | NR | NR | NR |
| Plutonium-238 | 0.17 | <0.1 | <0.1 | NR | NR | NR |
| Plutonium-239 | 0.052 | <0.1 | <0.1 | NR | NR | NR |
| Radium-226 | 0.015 | <0.1 | 1080 | NR | NR | NR |
| Strontium-90 | 4400 | 1080 | 29 | 7100 | 514 | 14 |
| Uranium-234 | 1.5 | 0.4 | 0.01 | NR | NR | NR |
| Uranium-238 | 0.375 | 0.1 | <0.1 | NR | NR | NR |

[a]Taken from Francis and Stansfield (1986a).

[b]Value used for pond volume, $2.45 \times 10^5$ L (R. G. Stansfield and C. W. Francis (1986).

[c]Value used for pond volume, $7.24 \times 10^4$ L (S. F. Huang, EOSD, personal communication, September 1984, in Stansfield annd Francis (1986).

[d]NR = not reported.

Table D-7. Concentrations of RCRA-regulated constituents in EP extracts of sediment from the OHF impoundment

| Constituent | Maximum allowable concentration (mg/L) | Measured concentration[a] (mg/L) |
|---|---|---|
| Arsenic | 5 | <0.60 |
| Barium | 100 | 0.307 |
| Cadmium | 1 | 0.0092 |
| Chromium | 5 | 0.0492 |
| Lead | 5 | <0.0232 |
| Mercury | 0.2 | 0.065 |
| Selenium | 1 | <1.2 |
| Silver | 5 | <0.2 |
| Endrin | 0.02 | <0.0001 |
| Lindane | 0.04 | 0.0001 |
| Methoxychlor | 10 | <0.0002 |
| Toxaphene | 0.5 | <0.002 |
| 2,4-D | 10 | <0.005 |
| 2,4,5-DTP | 1 | <0.005) |

[a]Taken from R. G. Stansfield and C. W. Francis, in Francis and Stansfield (1986a). Mean concentrations from six replicated PE extracts for metals (sediment from three sample locations at two dates). For the herbicides/pesticides, the concentrations are mean concentrations from three replicated EP extracts (sediment from three sample locations at a single date).

Table D-8. Concentrations and inventory of nonradioactive contaminants in sediment from the OHF impoundment

| Contaminant | Stansfield and Francis (1986)[a] Concentration (mg/kg) | Stansfield and Francis (1986)[a] Inventory (kg) | S. F. Huang[b] Concentration (mg/kg) | S. F. Huang[b] Inventory (kg) |
|---|---|---|---|---|
| Antimony | <194 | <3.69 | <1.0 | <0.08 |
| Arsenic | >120 | <2.28 | 1.1 | 0.09 |
| Barium | 320 | 6.07 | NR[c] | NR |
| Boron | 132 | 25 | NR | NR |
| Cadmium | >6.1 | <0.12 | NR | NR |
| Chromium | 342 | 6.50 | 17.0 | 1.30 |
| Cobalt | 22.4 | 0.43 | NR | NR |
| Copper | 140 | 2.66 | 18.0 | 1.40 |
| Iron | 11,200 | 403 | NR | NR |
| Lead | <156 | <2.97 | 6.0 | 0.48 |
| Manganese | 370 | 7.03 | NR | NR |
| Mercury | NR | NR | <2.3 | <0.18 |
| Molybdenum | <15.5 | <0.29 | NR | NR |
| Nickel | 149 | 2.84 | NR | NR |
| PCB | 2.9 | 0.05 | 3.5 | 2.80 |
| Selenium | <240 | <4.55 | <0.8 | <0.06 |
| Silver | <40.9 | <0.78 | NR | NR |
| Vanadium | 79.1 | 1.50 | NR | NR |
| Zinc | 162 | 3.07 | 16.0 | 1.20 |

[a]Sediment concentrations by R. G. Stansfield and C. W. Francis, in Francis and Stansfield (1986a).

[b]Sediment concentrations by S. F. Huang (EOSD, personal communication, September 1984) are on dry-weight basis and represent a mean of three sediment samples taken from the north, center, and south sections of the impoundment. Inventory calculated by Stansfield and Francis was based on a total volume of sediment equal to $5.5 \times 10^4$ L, a wet bulk density of 1.2 kg/L, and a moisture content of 71%.

[b]Sediment concentrations by Huang et al. are on a wet-weight basis and represent a mean of five sediment samples taken from the center of the pond from a southwest to northeast direction. Inventory calculated by Huang et al. was based on a total volume of sediment equal to $3.7 \times 10^4$ L and a wet bulk density of 2.16 kg/L.

[c]NR = not reported.

Table D-9. Concentrations and inventory of radionuclides in sediment from the OHF impoundment

| | Stansfield and Francis (1986)[a] | | | S. F. Huang[b] | | |
|---|---|---|---|---|---|---|
| | Concentration | Inventory | | Concentration | Inventory | |
| | (Bq/g) | (GBq) | (Ci) | (Bq/g) | (GBq) | (Ci) |
| Gross alpha | 102 | 1.93 | 0.05 | NR[c] | NR | NR |
| Gross beta | 92,700 | 1761 | 48 | NR | NR | NR |
| Cesium-134 | <20 | <0.38 | 0.01 | 100 | 8.1 | 0.22 |
| Cesium-137 | 125,000 | 2370 | 64 | 180,000 | 14,000 | 388 |
| Europium-154 | <22.7 | <0.43 | <0.01 | 390 | 31 | 1 |
| Uranium-234 | <33.3 | <0.63 | <0.01 | NR | NR | NR |
| Uranium-238 | <612 | <11.6 | <1 | 0.23 | 0.0055 | <0.01 |
| Americium-241 | <20.0 | <0.38 | <0.01 | 2.8 | 0.22 | <0.01 |
| Cobalt-60 | 608 | 11.6 | 0.31 | 740 | 60 | 1.6 |
| Strontium-90 | 38,800 | 737 | 20 | 9700 | 770 | 21 |

[a]Sediment concentrations by R. G. Stansfield and C. W. Francis, in Francis and Stansfield (1986a), are on dry-weight basis and represent a mean of three sediment samples taken from the north, center, and south sections of the impoundment. Inventory calculated by Stansfield and Francis was based on a total volume of sediment equal to $5.5 \times 10^4$ L, a wet bulk density of 1.2 kg/L, and a moisture content of 71%.

[b]Sediment concentrations by S. F. Huang (EOSD, personal communication, September 1984) are on a wet-weight basis and represent a mean of five sediment samples (except the Europium-154 analysis, which is from a single sediment sample) taken from the center of the pond from a southwest to northeast direction. Inventory calculated by Huang was based on a total volume of sediment equal to $3.7 \times 10^4$ L and a wet bulk density of 2.16 kg/L.

[c]NR = not reported.

Table D-10. Summary of monitoring well location, construction data, and water levels at the OHF impoundment[a]

| | MW-1 | MW-2 | MW-3 | MW-4 |
|---|---|---|---|---|
| North grid coordinate, ft | 17,325.24 | 17,236.06 | 17,298.86 | 17,339.13 |
| East grid coordinate, ft | 28,600.38 | 28,504.80 | 28,496.78 | 28,519.01 |
| Top of well casing elevation, ft | 782.11 | 776.89 | 773.46 | 773.50 |
| Height of casing above ground, ft | 2.80 | 2.70 | 2.90 | 2.90 |
| Ground surface elevation, ft | 779.30 | 774.20 | 770.60 | 770.60 |
| Top of well screen elevation, ft | 760.10 | 761.20 | 760.40 | 760.50 |
| Bottom of well screen elevation, ft | 750.10 | 751.90 | 750.40 | 750.50 |
| Top of sand pack elevation, ft | 769.80 | 768.20 | 764.70 | 762.60 |
| Bottom of well hole elevation, ft | 744.30 | 750.20 | 746.60 | 746.60 |
| Diameter of well pipe/screen, in. | 3.00 | 3.00 | 3.00 | 3.00 |
| Type material of pipe/screen | Fiberglass | | | |
| Width of screen opening, in. | 0.20 | 0.20 | 0.20 | 0.20 |
| Water level elevation, 4/8/85, ft | 770.92 | 756.58 | 757.38 | 760.87 |
| Water level elevation, 6/4/85, ft | 768.92 | 755.37 | 756.14 | 759.36 |
| Water level elevation, 7/1/86, ft | 768.23 | 755.34 | 756.30 | 759.46 |
| Water level elevation, 7/30/85, ft | 768.04 | 755.47 | 756.50 | 759.66 |

[a]Taken from R. G. Stansfield and C. W. Francis, in Francis and Stansfield (1986a).

Table D-11. Mean groundwater concentrations measured in monitoring wells at the Old Hydrofracture Facility impoundment[a]

| Parameter | Maximum allowed[b,c] | Measured[b] Upgradient | Measured[b] Downgradient |
|---|---|---|---|
| **National Interim Primary Drinking Water Stndards (NIPDWS)** | | | |
| Arsenic | 0.05 | <0.0028 | <0.0033 |
| Barium | 1 | 0.45 | 0.57 |
| Cadmium | 0.01 | <0.0011 | <0.0020 |
| Chromium | 0.05 | <0.027 | <0.031 |
| Coliform bacteria, count/100 mL | 1 | 5.2 | <6.4 |
| Endrin | 0.0002 | <0.0001 | <0.0002 |
| Fluoride | 1.4-2.4 | <1.0 | <1.0 |
| Gross alpha, bq/L | 0.556 | <1.2 | <58 |
| Gross beta, bq/L | 0.13[d] | 4.8 | 710 |
| Lead | 0.05 | <0.01 | <0.0420 |
| Lindane | 0.004 | <0.0009 | <0.0011 |
| Mercury | 0.002 | <0.0001 | <0.0011 |
| Methoxychlor | 0.1 | <0.0033 | <0.0041 |
| Nitrate-N | 10 | 2.7 | <3.8 |
| $^{226}Ra$, Bq/L | 0.19 | <0.11 | <0.19 |
| Selenium | 0.01 | 0.0033 | <0.0037 |
| Silver | 0.05 | <0.042 | <0.036 |
| Toxaphene | 0.005 | <0.0032 | <0.0035 |
| 2,4,5-TP Silvex | 0.01 | <0.0070 | <0.0075 |
| 2,4-D | 0.1 | <0.0070 | <0.0075 |
| **Parameters Establishing Groundwater Quality** | | | |
| Chloride | ND | 12 | 19 |
| Iron | ND | 2.7 | 17 |
| Manganese | ND | 0.20 | 2.9 |
| Phenols | ND | <0.0012 | <0.0012 |
| Sodium | ND | 13 | 24 |
| Sulfate | ND | 20 | 16 |
| **Parameters Used as Indicators of Groundwater Contamination** | | | |
| pH | ND | 6.5 | 6.3 |
| Specific conductannce, μS/cm | ND | 710 | 450 |
| Total organic carbon | ND | 4.5 | 5.7 |
| Total organic halides | ND | 0.11 | 0.13 |

Table D-11 (Continued)

| Parameter | Maximum allowed[b,c] | Measured[b] Upgradient | Measured[b] Downgradient |
|---|---|---|---|
| | Nonregulated Parameters | | |
| Copper[e] | 1 | <0.0200 | <0.0261 |
| $^{137}Cs$, Bq/L | ND | 1.2 | 1.7 |
| Dissolved oxygen | ND | 6.9 | 7.4 |
| Nickel[e] | 5 | <0.06 | <0.06 |
| Polychlorinated biphenyls (PCBs) | ND | 0.0001 | 0.0001 |
| $^{90}Sr$, Bq/L | 0.13[d] | 1.9 | 460 |
| Temperature, °C | ND | 16 | 16 |
| Tritium, Bq/L | 670[d] | 91,000 | 80,000 |
| Zinc[e] | 5 | <0.06 | <0.1476 |

[a]From Francis and Stansfield (986b).
[b]Concentrations are in mg/L unless otherwise stated.
[c]ND = maximum level for that parameter not defined.
[d]Level of activity necesary to give a total body dose of 4 mR/y to a prson drinking 2.2 L of water per day for a year.
[e]Hazardous substance guidelines issued by the State of Tennessee (L. W. Gregory, Division of Solid Waste Management, Department of Health and Environment, State of Tennessee, personel communication, 1985).

Table D-13. Water levels (m) in monitoring wells[a]

| Date | Monitoring well | | | | |
|---|---|---|---|---|---|
| | 1A | 1 | 2 | 3 | 4 |
| 4/8/85 | | 235.0 | 230.6 | 230.8 | 231.9 |
| 5/23/85 | | 234.5 | 230.3 | 230.7 | 231.6 |
| 6/4/85 | | 234.4 | 230.2 | 230.5 | 231.5 |
| 7/1/85 | | 234.2 | 230.2 | 230.5 | 231.5 |
| 7/30/85 | | 234.1 | 230.3 | 230.6 | 231.5 |
| 9/17/85 | | 234.2 | 230.4 | 230.6 | 231.6 |
| 1/6/86 | | 234.2 | 230.2 | 230.6 | 231.6 |

[a]From Francis and Stansfield (1986b).

Table D-14. List of samples whose detection levels exceeded Resource Conservation and Recovery Act (RCRA) limits[a]

| Parameter | Unit | RCRA limit | Well No. | Sampling quarter | Detection level |
|---|---|---|---|---|---|
| Gross alpha | Bq/L | 0.55 | 2 | 2 | 2.0 |
| Gross alpha | Bq/L | 0.55 | 4 | 2 | 3.0 |
| $^{226}Ra$ | Bq/L | 0.19 | 1 | 3 | 0.40 |
| $^{226}Ra$ | Bq/L | 0.19 | 2 | 1 | 0.20 |
| $^{226}Ra$ | Bq/L | 0.19 | 3 | 1 | 0.20 |
| $^{226}Ra$ | Bq/L | 0.19 | 3 | 3 | 0.60 |
| $^{226}Ra$ | Bq/L | 0.19 | 3 | 4 | 0.20 |
| $^{226}Ra$ | Bq/L | 0.19 | 4 | 1 | 0.20 |
| $^{226}Ra$ | Bq/L | 0.19 | 4 | 3 | 0.60 |
| Silver | mg/L | 0.05 | 1 | 1 | 0.07 |
| Silver | mg/L | 0.05 | 1 | 2 | 0.07 |
| Silver | mg/L | 0.05 | 2 | 1 | 0.07 |
| Silver | mg/L | 0.05 | 2 | 2 | 0.07 |
| Silver | mg/L | 0.05 | 3 | 1 | 0.07 |
| Silver | mg/L | 0.05 | 3 | 2 | 0.07 |
| Silver | mg/L | 0.05 | 4 | 1 | 0.07 |
| Silver | mg/L | 0.05 | 4 | 2 | 0.07 |

[a]From Francis and Stansfield (1986b).

# Appendix E. WASTE CONCENTRATE STORAGE TANKS (MELTON VALLEY STORAGE TANKS)

Table E-1. Spark-source spectrometry and anion data on samples from the Melton Valley Storage Tanks[a] (From Peretz et al. (1986).)

| Anion[b] | Sample | | | | |
|---|---|---|---|---|---|
| | W-24 T | W-24 M | W-24 B | W-24 S | W-25 T |
| | | (mg/mL) | | | |
| Nitrate | 260 | 260 | 260 | 270 | 210 |
| Chloride | 4.2 | 3.5 | 3.4 | 3.5 | 2.1 |
| Sulfate | <1 | <1 | <1 | <1 | 1.2 |
| Element[d] | | (μg/mL) | | | |
| Sodium | Major | Major | Major | Major | Major |
| Potassium | 5000 | 5000 | <1% | 9000 | 7000 |
| Calcium | 500 | 2000 | 4000 | 1% | 700 |
| Boron | 300 | 500 | 3000 | <1% | 100 |
| Aluminum | 40 | 40 | 7000 | 2000 | 100 |
| Iron | 200 | 50 | 3000 | 3000 | 200 |
| Phosphorus | 30 | 20 | 3000 | 2000 | 100 |
| Barium | 70 | 40 | 6000 | 100 | 30 |
| Magnesium | 200 | 300 | 1000 | 700 | 50 |
| Sulfur | 200 | 200 | 1000 | 300 | 200 |
| Zinc | 20 | 20 | 300 | 30 | 10 |
| Silicon | 20 | 30 | 100 | 100 | 50 |
| Manganese | 5 | 5 | 50 | 100 | 5 |
| Chromium | 5 | 5 | 50 | 100 | 10 |
| Uranium | 200 | 300 | | | |
| Thorium | 50 | 100 | | | |
| Nickel | 50 | 10 | 5 | 200 | 10 |
| Bismuth | 5 | 10 | 200 | 100 | <3 |
| Lead | <10 | 10 | 200 | 100 | 10 |
| Titanium | 10 | 5 | 10 | 50 | 5 |
| Strontium | 10 | 5 | 50 | 50 | 10 |
| Copper | <10 | <10 | 40 | 30 | 5 |
| Zirconium | <3 | <3 | 500 | 5 | <1 |
| Vanadium | 3 | 3 | 3 | 5 | 3 |
| Tungsten | | | <30 | 30 | 30 |
| Cobalt | <3 | <3 | 5 | 1 | 1 |
| Molybdenum | <3 | <3 | <5 | <5 | <5 |
| Lanthanum | <1 | <1 | <10 | 10 | <10 |
| Cerium | 5 | <3 | <3 | 3 | <3 |

Table E-1 (continued)

| Anion[b] | Sample | | | | |
|---|---|---|---|---|---|
| | W-25 M | W-25 B | W-25 S | W-26 T | W-26 M |
| | | (mg/mL) | | | |
| Nitrate | 210 | 230 | 180 | 320 | 330 |
| Chloride | 2.2 | 2 | 2.1 | 2.4 | 2.4 |
| Sulfate | 1.2 | 1.2 | 1.2 | <1 | <1 |
| Element[d] | | (µg/mL) | | | |
| Sodium | Major | Major | Major | Major | Major |
| Potassium | 5000 | 9000 | 9000 | Major | Major |
| Calcium | 500 | 2000 | 2000 | Major | Major |
| Boron | 100 | Major | Major | 700 | 700 |
| Aluminum | 200 | 700 | 600 | 600 | 600 |
| Iron | 50 | 1000 | 1000 | 100 | 100 |
| Phosphorus | 100 | 1000 | 1000 | 100 | 100 |
| Barium | 30 | 50 | 50 | 200 | 100 |
| Magnesium | 100 | 600 | 1000 | 600 | 700 |
| Sulfur | 200 | 600 | 600 | 100 | 100 |
| Zinc | 10 | 50 | 100 | 30 | 30 |
| Silicon | 50 | 200 | 100 | 10 | 10 |
| Manganese | 5 | 50 | 100 | 10 | 10 |
| Chromium | 10 | 50 | 50 | 10 | 10 |
| Uranium | | | | <1100 | <=1000 |
| Thorium | | | | 100 | 200 |
| Nickel | 5 | 500 | 500 | 10 | 20 |
| Bismuth | <3 | 40 | 50 | 5 | <5 |
| Lead | <10 | 50 | 100 | 5 | <5 |
| Titanium | 10 | 100 | 100 | 10 | 30 |
| Strontium | 5 | 50 | 50 | 40 | 30 |
| Copper | 5 | 20 | 30 | <3 | <3 |
| Zirconium | <1 | <1 | 3 | 3 | <3 |
| Vanadium | 5 | 10 | 10 | 3 | 5 |
| Tungsten | <30 | | | | |
| Cobalt | 3 | 10 | 10 | 1 | 1 |
| Molybdenum | <5 | <3 | <3 | <3 | <3 |
| Lanthanum | <10 | 5 | 5 | <1 | <1 |
| Cerium | | 5 | <5 | 10 | <3 |

Table E-1 (continued)

| Anion[b] | Sample | | | | |
|---|---|---|---|---|---|
| | W-26 B | W-26 S | W-27 T | W-27 M | W-27 B |
| | | (mg/mL) | | | |
| Nitrate | 330 | 340 | 140 | 130 | 130 |
| Chloride | 2.4 | 2.5 | c | | |
| Sulfate | <1 | <1 | 2.2 | 2 | 1.9 |
| Element[d] | | (μg/mL) | | | |
| Sodium | Major | Major | Major | Major | Major |
| Potassium | Major | 6000 | 5000 | 5000 | 5000 |
| Calcium | Major | Major | 2000 | 2000 | 3000 |
| Boron | 50 | <10,000 | 200 | 500 | 500 |
| Aluminum | 500 | 2000 | 300 | 600 | 800 |
| Iron | 200 | 1000 | 200 | 200 | 300 |
| Phosphorus | 500 | 2000 | 300 | 600 | 1000 |
| Barium | 20 | 70 | 200 | 100 | 100 |
| Magnesium | 1000 | 1000 | 500 | 600 | 1000 |
| Sulfur | 200 | 300 | 600 | 500 | 600 |
| Zinc | 30 | 50 | 100 | 50 | 100 |
| Silicon | 40 | 1000 | 100 | 20 | 20 |
| Manganese | 10 | 50 | 20 | 10 | 20 |
| Chromium | 20 | 100 | 20 | 20 | 40 |
| Uranium | >2000 | >6000 | >2000 | >2000 | <5000 |
| Thorium | 500 | >3000 | 200 | 300 | 500 |
| Nickel | 10 | 100 | 30 | 20 | 30 |
| Bismuth | 10 | 10 | <10 | <5 | 10 |
| Lead | 10 | 10 | <10 | <10 | 10 |
| Titanium | 20 | 10 | 20 | 10 | 20 |
| Strontium | 30 | 30 | 10 | 5 | 10 |
| Copper | <3 | <3 | <10 | <10 | <10 |
| Zirconium | <3 | 10 | <3 | <3 | <3 |
| Vanadium | | | | | |
| Tungsten | | | | | |
| Cobalt | 1 | 1 | <3 | 10 | <3 |
| Molybdenum | <3 | <3 | <3 | <3 | <3 |
| Lanthanum | 1 | <1 | <1 | <1 | <1 |
| Cerium | <3 | <3 | <3 | <3 | <3 |

Table E-1 (continued)

| Anion[b] | Sample | | | | |
|---|---|---|---|---|---|
| | W-27 S | W-28 T | W-28 M | W-28 B | W-28 S |
| | | (mg/mL) | | | |
| Nitrate | 130 | 330 | 320 | 330 | 330 |
| Chloride | | | | | |
| Sulfate | 1.8 | <1 | <1 | <1 | <1 |
| Element[d] | | (μg/mL) | | | |
| Sodium | Major | Major | Major | Major | Major |
| Potassium | 5000 | 8000 | 9000 | 5000 | 5000 |
| Calcium | 4000 | 2000 | 3000 | 8000 | 5000 |
| Boron | 400 | 10 | 10 | 30 | 30 |
| Aluminum | 300 | 20 | 10 | 200 | 200 |
| Iron | 400 | 20 | 20 | 300 | 300 |
| Phosphorus | 400 | 5 | 5 | 50 | 50 |
| Barium | 100 | 3 | 10 | 30 | 20 |
| Magnesium | 1000 | 100 | 100 | 2000 | 2000 |
| Sulfur | 800 | 200 | 100 | 200 | 200 |
| Zinc | 100 | 10 | 10 | 100 | 50 |
| Silicon | 100 | 10 | 10 | 50 | 100 |
| Manganese | 30 | 1 | <1 | 30 | 30 |
| Chromium | 30 | 3 | 3 | 20 | 20 |
| Uranium | >6000 | <30 | <30 | 5000 | 7000 |
| Thorium | 600 | <10 | <10 | 500 | 500 |
| Nickel | 30 | 30 | 30 | 100 | 200 |
| Bismuth | 10 | <3 | <3 | <10 | <10 |
| Lead | 20 | <3 | <3 | <10 | 50 |
| Titanium | 20 | <10 | <10 | 30 | <10 |
| Strontium | 10 | 30 | 20 | 30 | 20 |
| Copper | <10 | 20 | 10 | 20 | 20 |
| Zirconium | <3 | <3 | <3 | <3 | <3 |
| Vanadium | 10 | 1 | 3 | 5 | 3 |
| Tungsten | | | | | |
| Cobalt | <3 | <1 | <3 | <3 | <3 |
| Molybdenum | <3 | <3 | <3 | <3 | <3 |
| Lanthanum | <1 | <1 | <1 | <1 | <1 |
| Cerium | <3 | <3 | <3 | <3 | <3 |

[a]July sampling.

[b]Anion data: Request Nos. 52879 and 52900; sample received 7/17/85, analyses complete 8/9/85.

[c]A blank space means no data available.

[d]Elemental data: Request Nos. 33312 (7/29/85), 33314 (8/2/85), and 33318 (8/8/85).

Table E-2. Physical properties of samples from the Melton Valley Storage Tanks[a] (From Peretz et al. (1986).)

| Tank | Sample date[b] | Sample location | Specific gravity | Total dissolved Solids | Total dissolved Solids | OH- | Total alkalinity |
|---|---|---|---|---|---|---|---|
| (Liquid sample units): | | | (none) | (g/L) | (g/L) | (normal) | (ppm) |
| (Solids sample units): | | | | (mg/g) | | (meq/g) | |
| W-24 | July 85 | Top | 1.2755 | 469 | 576 | 1.15 | 6.10E+04 |
| | July 85 | Middle | 1.2714 | 539 | 493 | 1.18 | 6.20E+04 |
| | July 85 | Bottom | 1.3016 | 697 | 565 | 1.23 | 7.25E+04 |
| | July 85 | Sludge | 1.3850 | 469 | 502 | 0.91 | 1.28E+05 |
| | Nov. 85 | Liquid | 1.2775 | 487 | 427 | 0.92 | |
| | Nov. 85 | Solids | | 454 | | 0.65 | |
| W-25 | July 85 | Top | 0.9714 | 517 | 278 | 0.67 | 3.70E+04 |
| | July 85 | Middle | 0.9912 | 499 | 279 | 0.65 | 3.85E+04 |
| | July 85 | Bottom | 1.0814 | 430 | 290 | 1.00 | 6.40E+04 |
| | July 85 | Sludge | 1.0512 | 515 | 297 | 1.14 | 8.40E+04 |
| | Nov. 85 | Liquid | 1.2314 | 469 | 362 | 0.61 | |
| | Nov. 85 | Solids | | 580 | | 0.26 | |
| W-26 | July 85 | Top | 1.2994 | 618 | 547 | 0.01 | 2.70E+03 |
| | July 85 | Middle | 1.3036 | 655 | 488 | 0.01 | 3.20E+03 |
| | July 85 | Bottom | 1.2986 | 653 | 485 | <0.01 | 5.00E+03 |
| | July 85 | Sludge | 1.3404 | 742 | 485 | <0.01 | 5.20E+03 |
| | Nov. 85 | Liquid | 1.2450 | 429 | 383 | 0.01 | |
| | Nov. 85 | Solids | | 413 | | <0.01 | |
| W-27 | July 85 | Top | 1.1438 | 287 | 255 | 0.24 | 3.30E+04 |
| | July 85 | Middle | 1.1541 | 310 | 241 | 0.25 | 3.20E+04 |
| | July 85 | Bottom | 1.1558 | 326 | 240 | 0.26 | 4.40E+04 |
| | July 85 | Sludge | 1.1662 | 323 | 241 | 0.28 | 4.50E+04 |
| | Nov. 85 | Liquid | 1.2182 | 405 | 337 | <0.01 | |
| | Nov. 85 | Solids | | 408 | | 0.11 | |
| W-28 | July 85 | Top | 1.2403 | 434 | 467 | 0.02 | 2.00E+03 |
| | July 85 | Middle | 1.2521 | 438 | 445 | 0.02 | 2.00E+03 |
| | July 85 | Bottom | 1.2703 | 490 | 470 | 0.40 | 5.15E+04 |
| | July 85 | Sludge | 1.2357 | 494 | 450 | 0.50 | 6.65E+04 |
| | Nov. 85 | Liquid | 1.3250 | 597 | 509 | 0.04 | |
| | Nov. 85 | Solids | | 450 | | 0.56 | |
| W-29 | Nov. 85 | Liquid | 1.2688 | 442 | 415 | 0.80 | |
| | Nov. 85 | Solids | | 428 | | 0.01 | |
| W-30 | Nov. 85 | Liquid | 1.2577 | 492 | 386 | 1.00 | |
| | Nov. 85 | Solids | | 342 | | 0.04 | |
| W-31 | Nov. 85 | Solids | | 344 | | 0.03 | |

[a]All data from the Radioactive Materials Analytical Laboratory (RMAL).
[b]July data: Request No. 34380, received 7/1/85, completed 2/5/86.
Nov. data: Request NNo. 34523, received 11/7/85, completed 11/26/85.

Table E-3. ICP and anion analyses of liquid in the Melton Valley Storage Tanks[a,b] (From Peretz et al. (1986).)

| Element or anion | Sample (μg/mL) | | | | |
|---|---|---|---|---|---|
| | W-24 M | W-25 M | W-26 M | W-27 M | W-28 M |
| Sodium | 120,000 | 83,000 | 79,000 | 53,000 | 82,000 |
| Calcium | <30 | <30 | 14,000 | <30 | 5,100 |
| Magnesium | <75 | <75 | 1,200 | <75 | 220 |
| Silicon | 160 | 90 | <30 | 68 | <30 |
| Lithium | 150 | 61 | 75 | 60 | 90 |
| Zinc | 55 | 50 | 31 | 13 | 6.2 |
| Phosphorus | <45 | <45 | <45 | 52 | <45 |
| Aluminum | <30 | 41 | <30 | <30 | <30 |
| Strontium | <0.75 | <0.75 | 35 | <0.75 | 22 |
| Copper | 14 | 11 | 23 | 10 | 3.4 |
| Barium (100)[c] | <3.0 | <3.0 | 8 | <3.0 | 8.5 |
| Chromium (5)c | <6.0 | <6.0 | <6.0 | 6.3 | <6.0 |
| Cadmium (1)[c] | <0.75 | <0.75 | <0.75 | 1.4 | <0.75 |
| Silver (5)[c] | <7.5 | <7.5 | <7.5 | <7.5 | <7.5 |
| Arsenic (5)[c] | <15 | <15 | <15 | <15 | <15 |
| Boron | <12 | <12 | <12 | <12 | <12 |
| Beryllium | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 |
| Cobalt | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Iron | <4.5 | <4.5 | <4.5 | <4.5 | <4.5 |
| Gallium | <45 | <45 | <45 | <45 | <45 |
| Hafnium | <6.0 | <6.0 | <6.0 | <6.0 | <6.0 |
| Manganese | <0.75 | <0.75 | <0.75 | <0.75 | <0.75 |
| Molybdenum | <6.0 | <6.0 | <6.0 | <6.0 | <6.0 |
| Nickel | <9.0 | <9.0 | <9.0 | <9.0 | <9.0 |
| Lead (5)[c] | <30 | <30 | <30 | <30 | <30 |
| Antimony | <30 | <30 | <30 | <30 | <30 |
| Selenium (1)[c] | <30 | <30 | <30 | <30 | <30 |
| Titanium | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| Vanadium | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 |
| Zirconium | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| Nitrate | 240,000 | 180,000 | 260,000 | 89,000 | 200,000 |
| Chloride | 4,100 | 2,900 | 2,900 | 2,700 | 2,900 |
| Sulfate[d] | | | | | |
| Fluoride[d] | | | | | |
| Bromide[d] | | | | | |
| Phosphate[d] | | | | | |

[a]July sampling.
[b]Request No. 53607, received 1/14/86, completed 1/21/86.
[c]EP Toxicity levels follow constituent names in parentheses.
[d]Could not analyze in presence of nitrates.

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