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Environmental Data Package for the ORNL Seepage Pits and Trenches Waste Area Grouping

B. P. Spalding

Environmental Sciences Division
Publication No. 2889

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ENVIRONMENTAL DATA PACKAGE FOR THE ORNL SEEPAGE PITS AND TRENCHES WASTE AREA GROUPING

B. P. Spalding

Environmental Sciences Division
Publication No. 2889

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Abstract

The Oak Ridge National Laboratory Remedial Action Program has determined through its organizational knowledge of past operations and environmental studies that the seepage Pits and Trenches Waste Area Grouping (WAG) continues to release radioactivity to White Oak Creek. The area, therefore, requires application of the site stabilization and remedial action provisions under section 3004(u) of the 1984 amendments to the Resource Conservation and Recovery Act of 1976. This recent section requires that any facility permit for handling or storing hazardous substances issued after November 8, 1984, include planned corrective actions for all continuing releases of hazardous waste or constituents from any disposal unit at the facility regardless of when the waste was placed at the disposal unit. Under this provision, a Remedial Investigation/Feasibility Study (RI/FS) forms the basis for determining the necessity for and/or extent of actions. This report assembles the known information on all waste management units within the seepage Pits and Trenches WAG as an initial step in the RI/FS process for this area.

The seven ORNL seepage pits and trenches were used for the disposal of about 42 million gallons of radioactive liquid waste between 1951 and 1966. At the time of transfer to these pits and trenches, a total of about 1.2 million curies of hard-beta activity were disposed although much of the short-lived isotopes, particularly the large amounts of ^{106}Ru and the trivalent rare earths, have decayed. However, there is a legacy of about 200,000 Ci of ^{90}Sr and 600,000 Ci of ^{137}Cs and a much smaller amount of U and transuranic isotopes which will remain a potential source of groundwater and surface water contamination for several hundred years. Past operational records, engineering designs, and characterization/performance investigations have been summarized. Appendices of reports, photographs, line drawings, and engineering drawings have been included. The planning and operational history have been presented in the context of the Laboratory's liquid waste disposal problems through the years. Concerns for both the long- and short-term radiological hazards posed by the operation of the pits and trenches led to their abandonment in 1966 when the hydrofracturing disposal technique became operational.

The Pits and Trenches WAG also contains several other waste management units which need to be considered in evaluating the potential performance of the area. These include the contaminated equipment storage area (7841), the first experimental hydrofracture test site, two significant leak sites in the old liquid waste transfer line in the area, the surplus decontamination building (7819), and seven special waste disposal wells near seepage trench 5. The inventory of radioactivity in these other units is small by comparison to that in the seepage pits and trenches.

Although there is considerable existing characterization information about these areas, many additional information needs were identified which will be required to plan their closure. Empirical

leach rate data for the waste forms in each pit and trench will be required. Some improvement in the sites' groundwater and surface water monitoring system has been suggested including flow-proportional sampling and discharge monitoring in the one presently unmonitored drainage basin. In addition, the known active groundwater seeps in the area should be monitored for a two-year characterization period until their seasonal contributions to the areas' surface water discharges can be quantified. Other geologic, pedologic, and hydrologic characterizations of the area appear to be quite adequate for planning closure. However, the spatial distribution of radioactivity in and around each pit and trench needs to be determined with much more resolution than is available at present. The use of an in situ radiation detector, fitted on a retrievable and hydraulically inserted lance, is proposed as a tool to achieve this detailed contamination mapping.

Hydrologic and soil chemical speciation modeling needs are presented. Such models will be required to predict radionuclide migration into the future so that the radiological impacts of these sites can be determined. The techniques for the stabilization and closure of each pit and trench will depend strongly on the magnitude of these predicted radiological doses when these sites are no longer under the institutional control of ORNL.

1. Objectives

The objectives of this report are twofold. The first objective is to assemble in one document the ORNL organization's knowledge of the operation and performance of the seven pits and trenches, used to dispose of liquid wastes between 1951 and 1966, and other waste management units contained within this area (Figure 1). These other units, all of which contain considerably less radioactivity than the pits and trenches, include the contaminated equipment storage area (7841), the first experimental hydrofracture site (the Four Acre site), the surplus decontamination facility (7819), two significant leak sites in the old liquid waste transfer lines to the pits, trenches, and old hydrofracture site, and seven special waste disposal wells near seepage trench 5 (Figure 2). To this end, a rather thorough search of official reports, line drawings, engineering drawings, and photographs has been completed. Both publicly-available and official-use-only documents were surveyed. The reporting of pits' and trenches' operations have been continuously documented in various Operations Division's report series. Excerpts from this variable-frequency chronological record have been assembled in Appendix B with editorial comments required for the reader's clarification. Other documents used for this report relate either directly to the performance evaluation of the various pits and trenches or indirectly through studies of soils, sediments, or groundwater whose information has an obvious extrapolation to or inclusion of the pits' and trenches' areas. Occasionally, interviews with present or retired personnel were used to identify tangible records; personal files and log books of operators and researchers were not used although this strategy may be needed at a later time to better understand the nuances and deviations from routine operations of particular pits or trenches or the other waste disposal units.

The second objective of this report is to identify any additional information about these units which is needed to plan their closure in an environmentally sound and regulatively correct manner. This second objective has been more difficult to achieve than the first for two reasons. Firstly, the detailed needs of each of the disposal units, because of their quite different designs, inventories, and physical settings, are likely to be quite different. The scope of this report is, of necessity, limited to general or generic needs of all of these sites. Secondly, site characterization information needs are never really generic and, to a large extent, depend on the stabilization and closure techniques to be considered. For example, if grouting were envisioned as a stabilization technique, the compatibility of the waste form (e.g., sludge) with the grout's set chemistry, would be a critical information need. This would not be a pertinent need if simple trench capping were considered as the stabilization technique. Similarly, the volatility of the waste's radionuclides would be a crucial need for stabilization via in situ vitrification but would be useless

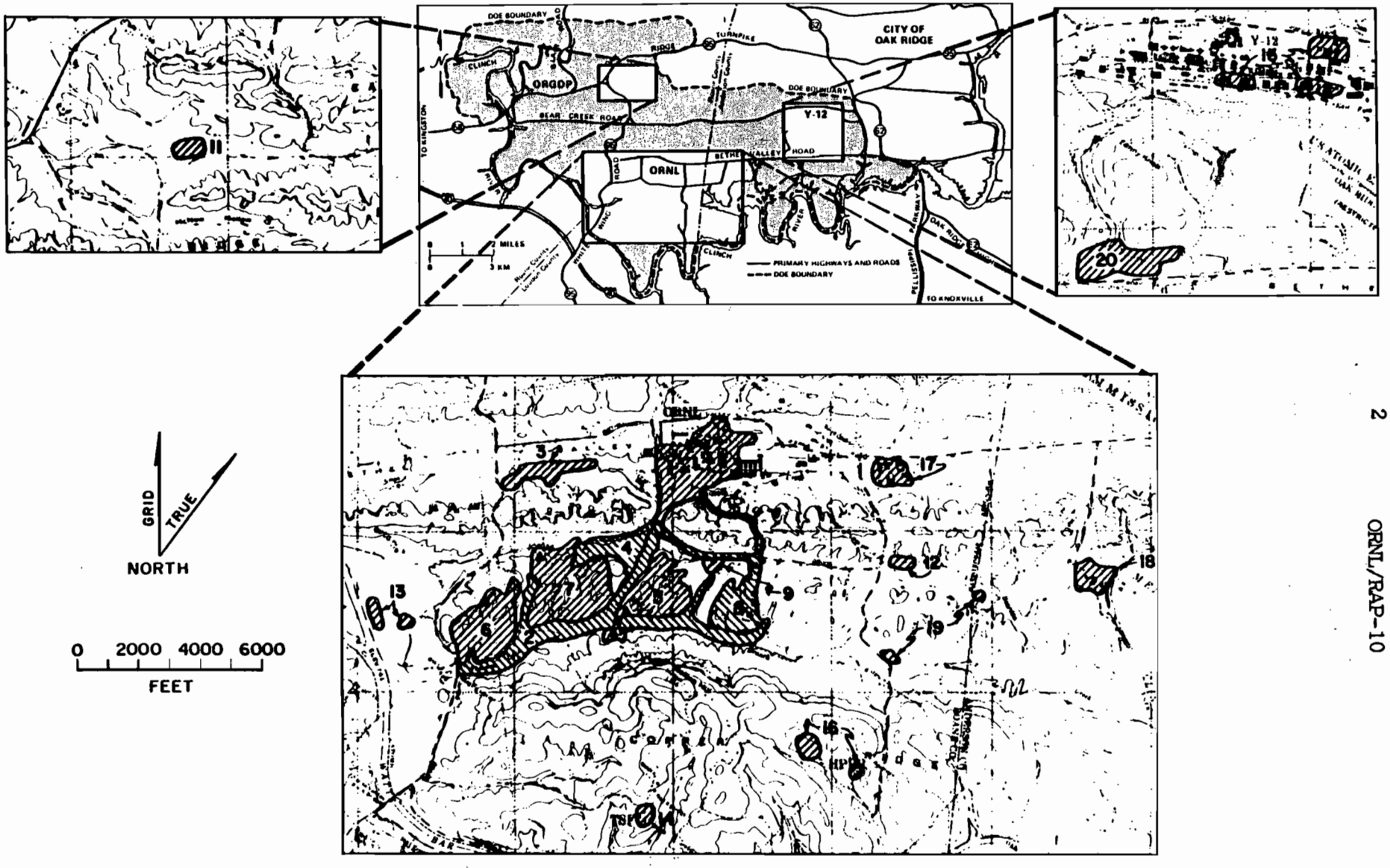
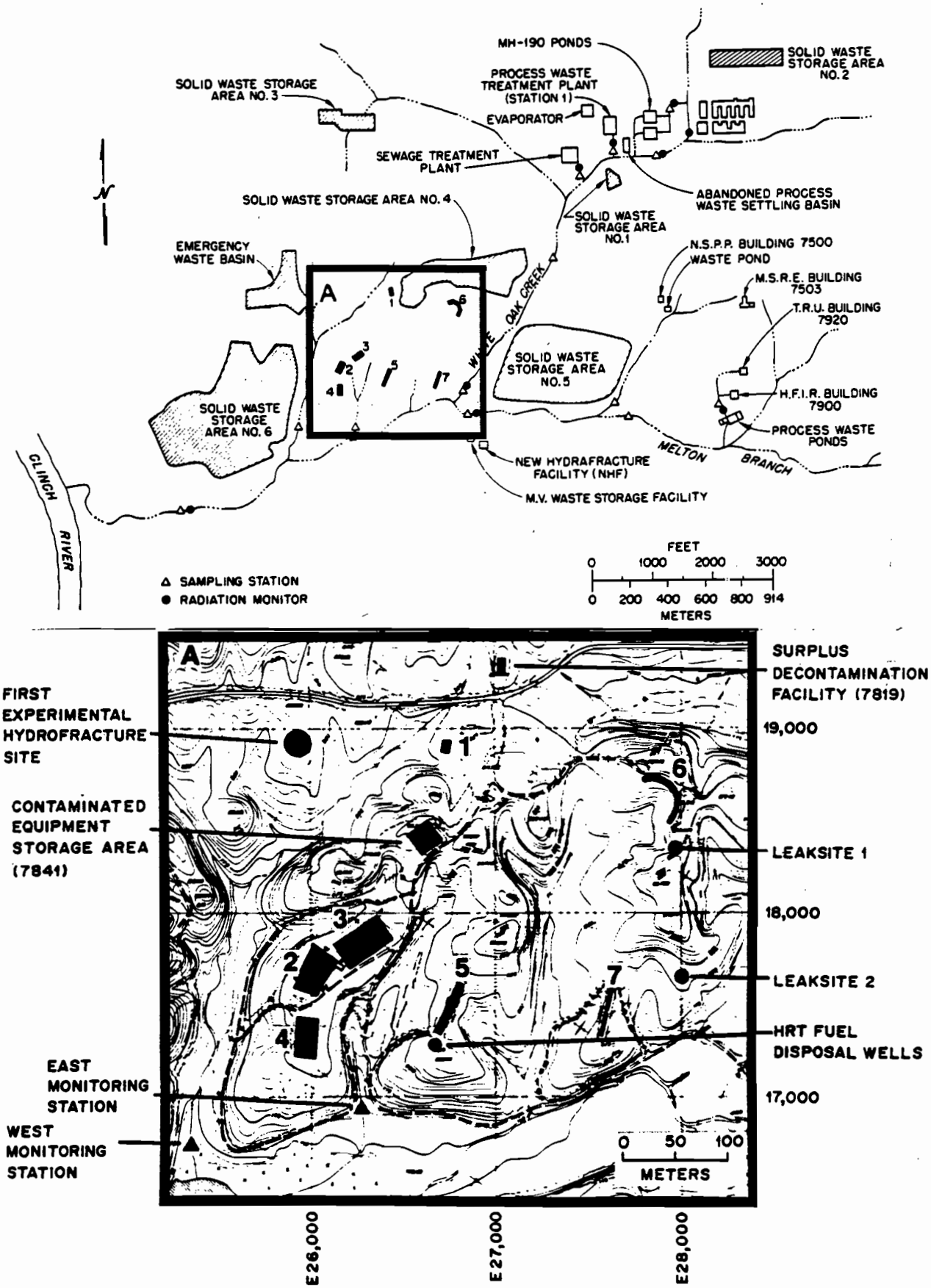


Figure 1. Waste Area Groupings (WAGs) at the ORNL site.
Area No. 7 delineates the seepage pits and trenches WAG.

ORNL-DWG 87-1319



information for some in situ deep dynamic compaction technique. Thus, for the purposes of this report, the identified information needs have been limited to those required to answer the simple yet difficult question: What needs to be known to determine the risks associated with the continuation of the current site conditions? Obviously, our present body of knowledge cannot provide a definitive answer to this question. This situation does not reflect any inadequacies of ORNL's operations or research planning efforts through the years, but only the fact that the question has never been addressed previously in anything but necessary expedients.

2. Introduction

The use of the seven seepage pits and trenches at ORNL between 1951 and 1966 for the disposal of liquid radioactive wastes as well as the use of the other waste management units within the area was quite strongly linked to the changing missions and needs of the laboratory. Any judgment concerning the appropriateness of their use during that time, by imposing present-day environmental standards and regulations, would be both moot and unfair. This legacy of about a million curies of mixed fission products contained in the near surface soil poses perhaps the largest risk of future environmental contamination for ORNL. The questions about these seepage pits and trenches, which need to be answered, are really quite simple to formulate. Which radionuclides and how much activity were disposed in them? How is it presently distributed spatially within and around them? When and how much activity will find its way into White Oak Creek before decay? Answers to these questions will dictate what, if anything, needs to be done about these areas. As a first step in answering these questions, an understanding is required of ORNL's liquid waste disposal needs and resulting operations as they evolved historically. In several instances, the rationale for certain decisions in the planning and operation of the pits and trenches is not explicit and the logical process leading to those decisions had to be reconstructed. It is sincerely hoped that this has been done fairly and apologies are extended in advance for the errors inherent in any interpretation of historical perspective.

3. Operational History of ORNL Liquid Waste Disposal

The detailed history of radioactive liquid waste disposal at ORNL is available in a number of sources (See Appendix A and LR-DWG-52352, p. C-57). Browder (1959) compiled the first detailed record covering the period from the initiation of liquid waste production up to the period of the most intensive use of the seepage pits in 1959. The primary mission of ORNL at that time was to test plutonium and uranium recovery techniques on a pilot scale as a model for the Hanford, Washington, plutonium production facilities. Since it was anticipated that the Laboratory would be a temporary facility, the volumes of liquid waste

were envisioned to be comparatively small. These wastes, therefore, were to be stored in several sprayed-concrete (gunite) tanks. However, in 1943, the mission of ORNL was expanded into a state of indefinite continuation. The quantities of waste soon exceeded the limited gunite tank storage facilities and it was decided to precipitate radioactivity and uranium within the tanks by caustic addition. The resulting sludges were stored in the tanks and the supernatants decanted, with dilution by the large volume of process waste water, into White Oak Creek. To further aid in retention of radioactivity, a dam was built across White Oak Creek about 1.7 miles from its confluence with the Clinch River to function as an additional sediment trap for any radioactive suspended solids entering White Oak Creek. Apparently the levels of radioactivity in White Oak Creek were not acceptable so in June 1944 a 1.5 million gallon capacity settling basin (3513 pond) was completed to serve as a collection, sampling, and stilling pond for gunite tank supernatants to permit radioactive solids to settle from the waste before discharge to White Oak Creek.

After caustic treatment, wastes were typically held in one of the large gunite tanks as long as storage space was available to allow for sludge settling and decay of short-lived radioisotopes. Aged waste supernatant was decanted to the 3513 pond from other tanks on a rotating basis. ORNL was producing about 7,000 gallons per day of these high activity wastes which were given a precipitation-scavenging in the gunite tanks, about one month holdup for decay, and three solids-settling steps (in the gunite tank, the settling basin, and the sediment pond on White Oak Creek). It was calculated, based on the ultimate dilution by the Clinch River, that 5 curies per day of mixed fission products could be safely discharged to White Oak Creek. An average total discharge of 284 curies per year was maintained up to 1957 when the process waste treatment plant began operations; radionuclide discharges to White Oak Creek were greatly reduced due to operation of this plant.

However, highly radioactive liquid waste volumes continued to increase until, in June 1949, an evaporator was added to reduce volumes stored in the gunite tanks. During the operation of this first ORNL wastewater evaporator until its shutdown in 1954, 11,560,000 gallons of liquid waste were reduced to 423,000 gallons of concentrate yielding a 27:1 volume reduction. Nevertheless, storage space for this concentrate was limited to two of the gunite tanks so that alternate storage space was needed. The other gunite tanks had been dedicated to uranium waste storage for recovery operations. This lack of storage space for high-activity liquid waste concentrate led to the first use of the disposal pits in 1951. Further historical information on the complete ORNL liquid waste disposal system can be found in Feige et al. (1960), Struxness (1960), Manneschmidt and Witkowski (1962), Browder (1960), Manneschmidt and Witkowski (1967), Burch (1972), and Boyle et al. (1982).

3.1. Waste Pit No. 1

According to de Laguna et al. (1958), the first waste pit at ORNL was designed as a storage basin for liquid waste. Not surprisingly its capacity of 180,000 gallons was similar to that of a gunite tank. Pit 1 was located just west of Solid Waste Storage Area (SWSA) 4 in Melton Valley (see DWG-83-12602, p. C-105, and PHOTO-15895, p. E-48). Struxness (1960) described the rationale regarding the construction of Pit No. 1 (PHOTO-14844, p. E-24) as follows, "About 10 years ago the Laboratory began to discharge medium-level liquid waste into pits dug into the weathered Conasauga shale. The first pit was thought of as a tank, dug into an impermeable formation, where value could be measured by its volumetric capacity and safety by the inability of the contents to leak out. The first pit did leak, although very slowly, and analysis of liquid in seeps which formed below the pit showed that the only radionuclide coming through was ruthenium and this only in greatly decreased concentration. The rest of the fission products were adsorbed by the soil and weathered rock".

This rationale was further documented in the Operations Division monthly report for July, 1951 (ORNL-1109), "This location provides a shale which will allow very little seepage over geologically long periods of time. This is expected to be a much safer and cheaper way of permanently disposing of liquid wastes. This project is considered to be an experiment at the present time". Such a rationale would seem quite unfounded given what is known about the hydrologic characteristics of the Conasauga formation today. However, at that time (1950-51), potential radioactive contamination problems associated with the use of the Chickamauga limestone areas at the main X-10 site seemed severe enough to warrant the following recommendation that soils in another formation be used for liquid and solid waste disposal: (Stockdale 1951), "From the viewpoint of a geologist, a preferred site for the burial of radioactive solid wastes and contaminated materials in the Oak Ridge vicinity would be at a place underlain by a shale. Such rock is generally quite impermeable and is not subject to solution which might lead to the development of underground channels to permit free transfer of ground waters. In the Oak Ridge area, the most extensive geologic formation which is composed of shale is the Conasauga." Based on these recommendations of the United States Geological Survey and the University of Tennessee (ORNL employed no geologists or hydrologists at the time), SWSA 4 was opened in 1951 in the Conasauga shale. Stockdale (1951) also recommended that no new waste ponds be constructed in the Chickamauga (underlying the main X-10 site). It would, therefore, seem logical to utilize this same geologic formation, with such great potential, for disposal of liquid wastes.

Waste Pit No. 1 was constructed in July 1951 with a capacity of about 180,000 gallons and overall dimensions of 100 by 20 by 15 feet deep. About 123,000 gallons of concentrated liquid waste were hauled to the pit in 500 gallon tanks fitted on a Dempster Dumpster truck. With

the discovery of leakage of radioactivity from the pit, waste transfers were terminated on October 5, 1951. The amount of activity added to Pit 1 was estimated at 389 curies of gross beta activity. Operations records indicate that Pit 1 also received 196 kg of uranium and 266 mg of plutonium. Struxness et al. (1955) described the waste added to Pit 1 as highly alkaline (pH approximately 12.5) containing mainly cesium and ruthenium (60% ^{137}Cs and 40% ^{106}Ru).

From 1962 through 1970 Pit 1 received discharges from the drains of the decontamination building 7819. Building 7819 also had a separate septic drain field installed in 1964 (ENG-DWG-S10953, p. D-60) and, presumably, no radioactivity was discharged through it. However, the nature of these discharges to Pit 1 is unknown although the total activities were probably small because it was an unshielded decontamination operation. What, if any, effect decontamination agents, e.g., soaps, acids, and chelates, would have on the mobility of the limited inventory of radioactivity in Pit 1 is also unknown. In 1981, Pit 1 was filled with Conasauga shale and capped with asphaltic concrete.

Although Pit 1 obviously leaked, a fact admittedly contrary to the stated site selection criteria noted above, the selectivity of the radionuclide seepage became apparent. The seeping radioactivity was found to be mainly ^{106}Ru, whose approximately 1 year half-life, made it a radionuclide of far less concern from a radiological protection perspective than the longer-lived ^{137}Cs or ^{90}Sr (30 and 28 year half-lives, respectively). Pit 1 probably contained little ^{90}Sr as this would be precipitated as a carbonate during caustic addition to the gunite tanks before transfer of the supernatant. The conclusion to this serendipitous situation was the concept of 'seepage disposal' where radioactivity could be removed by the soil formation, which was not so impermeable after all, and large volumes of decontaminated water allowed to seep to White Oak Creek.

3.2. Waste Pit No. 2

Pit 2 was constructed in 1952 on a hillock southwest of Pit 1 (see PHOTO-15898, p. E-49A-E). The pit had the shape of a frustum of an inverted rectangular pyramid, 200 by 100 ft at the ground surface and 15 ft deep. The walls were sloped back at about a 30° angle to the horizontal (see ENG-DWG-12249, p. D-6, and 12323, p. D-7). At a depth of 12 feet from its bottom, the pit had a volumetric capacity of 1,000,000 gallons. Initially, wastes were transferred to the pit in 500-gallon tanks on a Dempster Dumpster truck but a 4,000-gallon tank trailer was used beginning in February 1953 (see PHOTO-12115-12117, p. E-9-11). In 1954, a pipeline was constructed from the gunite tanks to Pit 2 and the waste evaporator was shut down. The evaporator shutdown was a logical consequence of the seepage concept because volume reduction made no sense unless substantial hauling expenses were involved. The tank trailer continued to be used, however, to transfer inactive chemical wastes, mainly aluminum and ammonium nitrates, from

special buildings.

The average waste generation rate during the period when Pit 2 was operating by itself was about 7,000 gal/day. Typically, 3,000 to 7,000 gal/day were pumped to Pit 2. Through December, 1954, when Pit 2 was operating alone, 1,294,000 gallons of liquid waste containing 16,600 curies of beta activity were disposed. As was the case for Pits 3 and 4, Pit 2 also received some sludge which was hauled by tank trailer from the Process Waste Treatment Plant after it began operations in 1957. This older Process Waste Treatment Plant should not be confused with the present one which began operations in April, 1976. The sludge, which was a mixture of illitic clay and calcium carbonate generated from a lime-soda water softening process, contained little radioactivity by comparison to the activities transferred to the pits in the intermediate-level liquid waste.

After January, 1955, when Pit 3 was opened, the inventory of wastes discharged to individual pits, both in volume and quantity of radioactivity, became harder to measure or estimate. Pit 3 was used for the initial discharge of the liquid waste and, when it became full, its overflow was piped downhill to Pit 2. Based on observed stage heights in the pits (LR-DWG-28382, p. C-39), Pit 2 probably received no waste in 1955 because it required most of that year for Pit 3 to fill. In 1956, Pit 4 was added to receive overflow from Pit 2 which was approaching its capacity. Thus, although the total volumes and gross beta activities discharged during this latter interval were reported, their distribution among the three pits cannot be determined exactly.

During the period between 1959 and 1961, rather large quantities of ^{106}Ru were transferred to all the pits. Pit 2 was found to be seeping considerable ^{106}Ru on its west side (see PHOTO-15895, p. E-48A-D). An interceptor trench was dug on its west side and its seepage pumped back into Pit 2. Sodium sulfide was added in an attempt to decrease the soluble ^{106}Ru complex; this technique had dubious results, and a mounting ^{106}Ru release problem (Cowser 1960) led to a curtailment of ^{106}Ru transfer to the pits. During 1961, when isotope-specific discharges from the two pits' area drainages were routinely reported, ^{106}Ru discharges were several hundred curies per month in both streams.

Pit 2 was taken out of service and backfilling with soil was begun in November, 1962, after Trench 7 became operational. Backfilling and grading were completed in late 1963 (see ENG-DWG-10830, p. D-57) because considerable time was required for it to drain. An asphalt cover was constructed in 1970 (see ENG-DWG-20932, p. D-64) and in this condition it has remained to the present.

3.3. Waste Pit No. 3

Soon after the operation of Pit 2 began, it became apparent that the volume of waste produced would soon exceed the seepage capacity of the pit. A new pit having the same dimensions was constructed northeast of Pit 2 in January 1955. Pit 3, because it was constructed by an outside contractor, was planned in much more detail (see ENG-DWG-

14897-14900, p. D-8-11). Apparently because ORNL now employed a geologist, the stratigraphic exposure revealed by the digging was curious enough to have resulted in the first photographs of the area's regolith (see PHOTO-13395-13399, p. E-12-16). Pit 3 also had improvements in its liquid level monitoring devices and a sampling platform extending over it (see PHOTO-13852-13855, p. E-17-20). In addition, some of the mechanisms involved in the removal of radioisotopes by the soil were studied in an effort to estimate the capacity of these areas for radioactivity disposal (Brockett et al. 1954, three publications - see Appendix A).

Pit 3 was operated as the initial discharge point for the transfer pipeline and its overflow was routed to Pit 2 as discussed above. The quantity of waste actually placed in Pit 3 would be difficult to estimate. Lomenick et al. (1967) concluded that Pits 2 and 3 contain essentially all of the ^{90}Sr and about 85% of the ^{137}Cs discharged to the pits. His conclusion was based on a detailed analyses of several cores taken from Pits 2 and 3 (see PHOTO-66443-66446, p. E-106-109 and 69705-69708, p. E-110-113) which, apparently, are still stored in a temporary building between SWSA 4 and Pit 1 in the Pilot Pit Area. Obviously, radionuclides like ^{90}Sr, which would be associated with suspended solids in the transferred liquids, would tend to settle in the first discharge pond. An isotope like ^{137}Cs, which has a strong affinity for illitic clays in the Conasauga formation, would be expected to be rapidly sorbed from the liquid on contact with soil in the first pit. This scenario apparently operated and was supported by the findings of Lomenick et al. (1967). Cowser et al. (1961) made some estimates of the inter-pit transfers for the period through 1958. They also summarized the radioisotopic composition of the various wastes added to the pits in this period; ^{137}Cs, ^{106}Ru, and the trivalent rare earths isotopes were estimated as the principle contributors to the gross beta activity. Lesser amounts of ^{89}Sr, ^{90}Sr, ^{60}Co, and ^{125}Sb were also present. Generally, ^{137}Cs and ^{106}Ru accounted for 90% of the radioactivity (LR-DWG-11921, p. C-15, 11946, p. C-26, 52799, p. C-58, and 54430, p. C-59). However, neither ^{3}H nor ^{99}Tc, being soft beta emitters, were measured at that time. About 930 tons of sodium and 1,360 tons of nitrate, the principle chemical constituents in the waste, were released to the pits through 1958 (LR-DWG-11922, p. C-16, and 73482, p. C-76).

Seepage rates from Pit 3 as well as the other pits were difficult to calculate. Although the inputs to the pits from the waste discharges and rainfall were measured, corrections for evaporative losses were difficult at best. An open pan filled with water was used to estimate evaporation (PHOTO-17488, p. E-31) and tenuous corrections were necessary to estimate actual evaporation from the pits (see Cowser et al. 1961 and LR-DWG-11943, p. C-22, and 11943A, p. C-23). Given these caveats, the seepage rates estimated by Cowser et al. (1961) of 700-1700 gallons per day for Pit 3 and 1900-3900 gallons per day for Pit 2 are about what one would expect from the hydraulic heads maintained within the pits and the hydraulic conductivity of the Conasauga formation

soils, ca. 6 x 10^{-5} cm/s (Davis et al. 1984). Thus, the total seepage of Pits 2 and 3 was between 4,000 and 5,000 gallons per day. This rate of seepage was less than the rate of production of liquid waste, i. e., ca. 7,000 gallons per day. Thus, the immediate need for another seepage pit became apparent after Pit 3 was in operation for less than one year (see LR-DWG-28382, p. C-39) as Pit 3 neared full stage.

Groundwater seeps were observed on the east side of Pit 3 (see PHOTO-15895, p. E-48A-D) although these were not as severe as those of Pit 2 or later ones found originating from Pit 4. No corrective actions were taken. Pit 3 was taken out of service in September, 1961, and backfilling and grading were completed in 1963 (see ENG-DWG-10166, p. D-56) along with an asphalt cap.

3.4. Waste Pit No. 4

In April of 1956, Pit 4 received its first overflow of liquid waste from Pit 2. This seepage pit was identical in design to Pits 2 and 3 (see ENG-DWG-23690 to 23696, p. D-13-17) and was located just downhill from Pit 2. By this time, the Laboratory depended heavily on the pits for disposal of its liquid waste. A considerable research effort was initiated at this time and was maintained well into the 1960's to support the technical basis of why the pits seemed to work. Before Pit 4 was used, geologic and hydrologic characterization were performed unlike the previous two pits. A pump test was performed which showed dramatically how drawdown was channeled by the stratigraphic structure (LR-DWG-28161, p. C-38). Extensive depth permeability testing was also performed (LR-DWG-11942, p. C-21) to establish that little movement of the liquid to depth was occurring. Extensive water table response data were collected (LR-DWG-13396A, p. C-28) and grouted cased wells were used (LR-DWG-11923, p. C-17) to monitor the movement of radioactivity beneath and lateral to the pit. Permanent weirs were installed (PHOTO 18474-18475, p. E-33-34) in the drainages from the area. Sophisticated well logging equipment was fabricated (PHOTO-40690-40694, p. E-35-39) for use in the area. An extensive grid of monitoring wells was installed (LR-DWG-11924A, p. C-19) in the pits area. Even trees were used for the first time as integrating groundwater samplers (LR-DWG-25311, p. C-35).

For the first time, the control of geologic structure over the seepage pattern of the wastes became apparent as maps of geologic strikes and dips were prepared (LR-DWG-28158, p. C-36). Excellent photographs of the eastern and western walls of Pit 4 (PHOTO-15647-15654, p. E-40-47) demonstrated this stratigraphic control of seepage. Given the amount of effort that went into trying to understand Pit 4, it seems ironic that it had the poorest performance of any of the three million-gallon-capacity pits.

Pit 4 leaked very rapidly (LR-DWG-28382, p. C-39) and never held liquid to a degree anything like Pits 2 or 3. However, because it was at the end of the overflow train, it did not receive much waste volume and proportionally even less radioactivity. However, in 1959 when there

occurred some large discharges of ^{106}Ru to the pits, some rather severe seepage was noted on the east side of this pit (see PHOTO-15895, p. E-48A-D with labelled locations of these seeps). An interceptor trench was dug on the east side (PHOTO-49011-49013, p. E-75-77) which was 10 feet deep and 175 feet long; the intercepted seepage was collected at the downslope foot of the trench and pumped back to Pit 4. For awhile, approximately 50 curies of ^{106}Ru and 8,000 gallons per day were pumped back to Pit 4. Efforts were made to reduce the amounts of ^{106}Ru in the liquid waste system. Copper compounds were put into Pit 4 in an effort to reduce the solubility of ^{106}Ru and sorb it to the soil. However, none of these in situ chemical treatments seemed to work within the pits although there was good success in applying them while the wastes were in the gunite tanks. Although the ^{106}Ru transfer to the pits was curtailed about this time, releases of ^{106}Ru through the pits' area drainages would remain high for several years to come. In 1961, in an effort to further reduce this ^{106}Ru release, another interceptor trench was dug on the west side of Pit 4 and its collected seepage was pumped back to Pit 4. This was also the time when ten tons of sodium sulfide were placed into the pits system in an effort to enhance ^{106}Ru adsorption. Although trench 5 was now in operation, it would accept only about 4,000 gallons per day while waste was being generated at a rate of 7,000 to 8,000 gallons per day. Further, because it was desired to keep discharges to Pit 4 to a minimum because of its seepage problems, the three pits and trench 5 in late 1960 and early 1961 were operating at near capacity. Pit 4 remained open even when trenches 6 and 7 became operational as a standby pit and also to receive sludge from the Process Waste Treatment Plant. When the new Process Waste Treatment Plant became operational in 1976, Pit 4 was gradually backfilled and eventually paved with asphalt in 1980 (see ENG-DWG-20938, p. D-84).

During their operational period up to November, 1962, the three pits (2,3, and 4) received a total inventory of 522,565 curies of gross beta activity. Of this total, Lomenick estimated that it contained 42,000 Ci of ^{90}Sr, 184,000 Ci of ^{137}Cs, and 230,000 Ci of ^{106}Ru with about 70,000 Ci of trivalent rare earths. In total, these three pits received about 21 million gallons of liquid waste containing the above radionuclides.

3.5. Waste Trench No. 5

To meet the increasing demands for liquid waste disposal volumes at ORNL, Trench No. 5 was constructed in May, 1960. The design of this trench was quite different from the previous three seepage pits (see ENG-DWG-38201-38205, p. D-23-27, and LR-DWG-62129, p. C-66). The major design changes were effected to overcome several operational problems experienced with the three seepage pits. First, intense external radiation fields around the three open pits, particularly when they were at low stage height, limited personnel activities near them (see LR-DWG-14172, p. C-29); the earthen cover over trench 5 was designed to obviate

this problem. Second, the open pits also required protective netting drawn over their surface to prevent wild fowl from landing on them and transporting radioactivity away from the pits; these protective barriers were also required to safeguard personnel from accidental falls when working in the vicinity. Thirdly, although there was some desirable evaporative loses of water from the pits during the summer, on an annual basis in this region of the country, there is a net gain of almost 2:1 of direct precipitation per unit of evaporative loss; thus, a covered trench design, to prevent any trapping of precipitation, more than compensated for the reduction in any evaporative losses. In this same line, seepage rates from the open pits were quite hard to estimate because both additions due to precipitation and losses due to evaporation had to be figured in a tenuous manner. By operating a covered trench, seepage rates and particularly their changes with continued operation, could be measured directly. Fourthly, during the operation of the pits, it became apparent that the seepage occurred mainly along the bedding planes following the strike of the geologic formation; little seepage was observed perpendicular to strike or directly down to deeper strata. Thus, only the side walls of the pits, which were generally normal to strike, were contributing significantly to the seepage capacity of the pits. Therefore, the width of the trench would have little effect on its seepage rate. The narrower the width, the more soil formation remained for adsorption of the seeping radionuclides. Thus, for all these reasons, a narrow covered trench oriented perpendicular to strike seemed a tremendous improvement in design over the open pits.

Waste Trench 5 was photographed during its construction (PHOTO-49219-49221, p. E-78-80) and was located based on geologic advice concerning both the dip and strike orientation and water table contours in the area. The 300 ft long by 15 ft deep trench was pretreated with 1800 pounds of copper sulfate and 1000 pounds of sodium sulfide in an attempt to overcome the ^{106}Ru mobility problem discussed above. It was also pretested by filling with water and its maximum seepage rate determined to be about 4,000 gallons per day. The trench was operated near this capacity during most of its life until liquid discharges to these seepage trenches were stopped in 1966 when the hydrofracture facility became operational. However, the liquid waste generation rate at the Laboratory was still about 7,000 to 8,000 gallons per day which required the continued use of the pits. It was the stated desire of the Laboratory to remove the open pits from service as soon as possible because of the ^{106}Ru discharge problem. Thus, within a year, Trench 6 was constructed and its operation attempted.

Perhaps waste trench 5 performed the best of any of the pits and trenches judging by the amount of contamination of its environs (see LR-DWG-74624A, p. C-78). No point source groundwater seeps were ever observed during its operation. The operational records for this trench are quite clear; it received about 9.5 million gallons of waste with a total inventory of 311,824 gross beta curies. Also, from its initiation of operation, isotopic compositions of its radioactivity were also kept;

it received 96,750 curies of $^{89-90}Sr$, 205,600 curies of ^{137}Cs, 6,385 curies of ^{106}Ru, and 3,045 Curies of ^{60}Co. Its mounded earthen surface was paved with asphalt in 1970 (see ENG-DWG-20941, p. D-62) about four years after it was last used for liquid discharges.

3.5. Waste Trench No. 6

Soon after Trench 5 became operational, it became apparent that it could only handle about 40 to 50% of the liquid waste volume needs of the laboratory. A new trench was needed so that the open pits could be taken out of service as soon as possible due to their seepage problems with ^{106}Ru. A 500 ft long trench was designed, about 50% larger than Trench 5, so that all of the Laboratory's waste could be handled with a 50% over-capacity factor to allow for contingencies. It was also apparent at this time that the variability in seepage rates of the pits and trenches required that a bigger trench be constructed to assure that a certain minimum seepage rate could be attained. Trench 6, however, was not located with geologic advice or preconstruction coring and water table monitoring (Kertesz 1961 and LR-DWG-63051, p. C-73, and 70508, p. C-75). It was located on a ridgetop like trench 5 but the particular ridge apparently was selected because of its proximity to the end of the liquid waste transfer line (Kertesz 1961).

Trench 6 was constructed in June 1961. It was almost U-shaped (see ENG-DWG-43165-43171, p. D-30-36, 43136, p. D-28, and 43190, p. D-29) and only portions of it would have been perpendicular to strike as per design criteria for Trench 5. It was pretreated with 20,000 pounds of copper sulfate in 140,000 gallons of water; again, this was an attempt to obviate the ^{106}Ru seepage problem so common at that time. On September 7, 1961, it received its first waste discharge. It was taken out of service on October 10, 1961 when significant seepage of 0.15 gallons per min containing ^{90}Sr and ^{137}Cs was found south of the trench (see LR-DWG-63051, p. C-73). In the contaminated area the radiation field was 20 mr/hr and the nature of the seeping radionuclides indicated a serious leakage problem through some open fissure. Various attempts to study or remedy the problem went on for a few months (Kertesz 1961) but the trench was finally given up and a new trench constructed within a year. Trench 6 received only about 130,000 gallons containing 145 Ci ^{90}Sr, 665 Ci ^{137}Cs, 501 Ci ^{106}Ru, and 24 Ci ^{60}Co. It was finally covered with asphalt in 1981 (see ENG-DWG-20944, p. D-86).

3.7. Waste Trench No. 7

The problems with leakage of trench 6 led to the immediate need for a new seepage trench. This trench was located and oriented based on geologic advice with preconstruction water table monitoring and coring. To overcome the potential for complete loss of service as was experienced with trench 6, the design of trench 7 delineated three 100 ft long segments to be operated independently (see ENG-DWG-52844-52848, p. D-40-44, 52858-52859, p. D-45-46, and 53000, p. D-38). In case a

leak were found in one segment, the remaining segments could still be operational. With its planned capacity, successful operation of trench 7 would allow the two remaining pits, 2 and 4, to be removed from service. The third or northern-most segment of trench 7 was not constructed because preconstruction groundwater monitoring revealed a water table elevation in the area near the bottom of the planned segment. Construction of two segments was completed in August, 1962 (see PHOTO-58412-58421, p. E-90-99). The trench was pretreated with 50,000 gallons of 4% sodium hydroxide; presumably, this was done to enhance the adsorption of ^{90}Sr should any leakage occur like trench 6. The trench was not pretreated with copper sulfate or sodium sulfide as were trenches 5 and 6; there were probably two reasons for not doing this. First, the amounts of ^{106}Ru in the liquid waste had been greatly decreased as a result of the ^{106}Ru discharge problems in the seepage pits. Secondly, the inefficacy of these in situ chemical treatments probably became apparent about this time. Trench 7 was found to have a seepage capacity about four times that of trench 5. Thus, the combined seepage capacities of trenches 5 and 7 far superseded the generation rates of the Laboratory and the period of seepage trench construction ended.

Trench 7 was found to leak minor amounts of ^{106}Ru particularly on its eastern side (see DWG-74-9604, p. C-86). However, the levels were generally quite small. In general, Trench 7 performed well in handling the 9.5 million gallons of waste transferred to it. This waste contained about 48,000 Ci of ^{90}Sr, 231,000 Ci of ^{137}Cs, 3,400 Ci of ^{106}Ru, and 1,500 Ci of ^{60}Co. These inventories are also subdivided into the two trench segments, 7A and 7B, about equally. When hydrofracture disposal became operational in 1966, trenches 5 and 7 were used for the last time. Although the hydrofracture operation required that liquid waste be reduced in volume by a new evaporator and stored before injection, it was considered much safer than seepage pit disposal. The continuing problems of groundwater contamination, both major and minor, with all of the pits and trenches compromised the acceptability of this disposal technique (National Academy of Sciences 1957). Trench 7 was eventually paved with asphalt in 1970 (see ENG-DWG-20965A001, p. D-63) when pit 2 and trench 5 were also covered with asphalt.

Several interim corrective actions were taken at Trench 7 in 1985 and 1986 in an effort to reduce the discharge at a groundwater seep on the eastern side of its drainage area. These actions included expansion of the 1970 asphalt cap, excavation and sealing of the waste transfer line just north of the trench, and installation of a grout curtain on the eastern and northern perimeter of the site (see ENG-DWG-C3E20965A010, p. D-87, and C3E20965A011, p. D-88). Before cap extension in June 1985, the asphalt cap covered 18% of the site drainage area but its runoff was infiltrating the soil at its perimeter and recharging groundwater at the site. After cap extension and recontouring (PHOTO-5733-85 through 5743-85, p. E-124-130), the cap covered approximately 36% of the site area and its runoff was routed via a drain and culvert to an ephemeral stream about 30 m down-gradient on the western side of

the site. Site runoff was increased by this corrective action although only the initial 41-day period after cap expansion has been reported to date (Mulholland 1985, see PHOTO-4383-85, p. E-123). The response of the groundwater table at the site is still undergoing monitoring to determine the effect of recharge interception.

Between November 1985 and April 1986, a grout curtain was installed on the eastern and northern sides of the site. A mixture of hydrated lime and fly ash suspended in water was pumped into the ground at varying depths at pressures up to 100 psi. The grout was injected through 1-inch pipe, fitted with penetrometer points, which had previously been hammered into the ground with a vibratory air hammer. Variable grouting depths were experienced due to refusal of pipe insertion by hard rock. Several grout breakthroughs were noted along the eastern slope of the site indicating that the grout had moved at least up to 30 m from its point of injection. A detailed evaluation of this project is underway with a report scheduled for June of 1987. The goal of the grout curtain was not to provide groundwater intrusion protection to the site but rather to fill up relict contamination strata which are known to exist on the eastern slope of the site (Olson et al. 1986).

4. Other Waste Management Units in the Pits and Trenches Area

Other waste management units and facilities, which have a potential influence on the surface and groundwater discharges, are located within the Pits and Trenches Waste Area Grouping. Although none of these other units contains a significant inventory of radioactivity when compared to the seepage pits and trenches, their influence cannot be separated hydrologically from these presumably more important units.

4.1. Decontamination Facility (7819)

The need for a decontamination facility at ORNL had been discussed for several years in the late fifties and early sixties in Operations Division reports. In January 1964 (PHOTO-64056, p. E-105, and 62216, p. E-104) this facility was completed in an area just north of Lagoon Road near Waste Pit No. 1. All decontamination solutions were drained via an underground vitrified pipe line into Waste Pit No. 1 which, at that time, was still an open pit although covered with a wooden roof. Details of the drainage system can be found in ENG-DWG-D-54729 (p. D-47) and D-54730 (p. D-48). In March 1964, a drain system was added to the west of the building to facilitate nonradioactive discharges from the change room within 7819 (see ENG-DWG-S-10953 A001D, p. D-60). Because this septic system was connected only to the toilet, wash sinks and drains in the change room, it is presumed to have received no radioactive discharges. The facility did have electrical power (see ENG-DWG-D-42869-42871, p. D-52-54) and hot and cold process water piping (see ENG-DWG-D-46919, p. D-49) although the water was delivered to an

outside holding tank rather than piped from the main plant (see ENG-DWG-D-52357-52358, p. D-50-51). There were plans to install a monorail hoist system in the building (see ENG-DWG-S-20968 F001, p. D-59) as an aid in loading and unloading equipment to be decontaminated but this was never installed. An extension pad was installed in 1967 just to the north and outside 7819. This pad contained a drain which tapped into the vitrified pipe drain to Waste Pit No. 1.

Decontamination operations within and outside 7819 were extremely varied in both procedures and agents employed. Verbal comments from both Operations Division and Health Physics personnel, who were involved in the operation of the facility, indicated that equipment was both sprayed and scrubbed both within the pit area and on the external pad. Decontamination solutions were generally whatever worked and included nitric acid, alkalis and caustics, soaps, chelating agents including EDTA (ethylenediaminetetraacetic acid) and oxalates. Judging from the residues of blasting sand and contamination to the north of the building, it appears that sand blasting was also used for decontamination on the external pad (R. E. Norman, personal communication). All or, at least, most of these decontamination solutions were drained to Waste Pit No. 1 where the acids, in particular, could mobilize radionuclides. This may be the reason why ^{90}Sr was observed in the drainage from Waste Pit No. 1 in the 1978 streambed sediment survey of Cerling and Spalding (1985). It is presumed that the amount of radioactivity actually delivered to Waste Pit No. 1 from the operation of 7819 was quite small because it was an unshielded and uncontained facility.

The drain line to Waste Pit No. 1 was found to be leaking in 1968-69 when trees began dying along and down drainage from the line. This tree damage was presumed to be due to the harsh acids and alkalis used in decontamination operations in 7819. An AEC directive was issued to ORNL in late 1969 or early 1970, to either upgrade the facility or abandon it. The latter course of action was followed because of the other shortcomings of the facility (no water line, no air and no atmospheric containment).

The facility has been in a state of benign neglect since that time. Presently, there is quite a variety of abandoned equipment in and around the facility (PHOTO-0034-86, 0038-86, 0039-86, and 0067-86, p. E-131-134). Radiological surveys of this equipment and the surrounding soil surface have just been completed in an effort to determine its radioactive inventory and need for corrective action as part of the Surplus Facilities Management Program (Williams et. al 1987). Several small areas around the building have been found to be contaminated with ^{137}Cs and ^{90}Sr with the highest concentration of ^{137}Cs at 2300 pCi/g of soil and an average concentration of 270 pCi/g in these contaminated surface areas. Several of these soil samples were tested for RCRA hazardous waste characteristics (extraction procedure toxicity, ignitability, corrosivity, and reactivity) and did not meet any hazardous criteria.

As part of the Solid Waste Storage Area 4 surface runoff

diversion project (Melroy and Huff 1985), approximately 40 feet of the vitrified pipe drain line from 7819 to Waste Pit No. 1 was excavated in 1983. Disposal records indicate that approximately 200 ft^3 of contaminated soil (reading about 5 mrem/hr beta-gamma activity) and the pipe sections (reading about 120 mrem/hr beta-gamma activity) were disposed in trench 398 in SWSA 6. Exposed ends of the pipe were plugged in the ground as was the exterior drain north of 7819 to prevent further leaking of contaminants. This drain section had to be removed to make room for the drain from the SWSA 4 surface runoff collector just to the east of the site. This runoff is now routed through the east weir drainage of the pits and trenches area.

4.2. Contaminated Equipment Storage Area (7841)

In December 1979, a security-type fence was installed around the perimeter of a 3,000 m^2 (0.75 acre) area southwest of SWSA 4 (see ENG-DWG-C3E21291 A002, p. D-83). This area was designed for above-ground storage of radioactively contaminated equipment, including equipment from SWSA 3 that was considered reuseable. At that time, ORNL was under DOE directive to clean up the abandoned equipment which had resided on the surface of SWSA 3. Most of this equipment was disposed in a landfill operation in SWSA 5 while the more contaminated pieces were disposed in SWSA 6. Presently, there is a considerable amount of potentially salvageable equipment at the site (PHOTO-8485-86 and 8486-86, p. E-139-140) although an itemized inventory does not appear to exist. Included among this equipment are a few designated surplus facilities, i.e., the shielded transfer tanks (LR-DWG-63529R, p. C-60, and DWG-79-20020, p. C-95). Five of these heavily shielded tanks are contained within 7841. They were used repeatedly during the 1960s for shipment of ^{137}Cs-loaded ion exchange resins from Hanford Atomic Products Operations to ORNL. Prior to that , they had been used in the late 1950s to transport lower concentrations of cesium and strontium waste from Arco, Idaho to ORNL. All were removed from service in 1967 except one which was used in 1970-71 at ORNL for transferring caustic solution containing high-level fission product waste. The principal contaminant remaining in these tanks is ^{137}Cs which is estimated to be between 50 and 700 Ci each (Edwards and Taylor 1986). These tanks still appear to be quite sound with no evidence of leakage. There is no foreseeable future use for these tanks and they are awaiting disposal. Other equipment at the 7841 site includes over 500 empty stainless steel barrels, a variety of tanks, an old blower from the isotope area venting system, and the old ORNL liquid waste evaporator.

4.3. First Experimental Hydrofracture Site

Prior to the use of this site (often referred to as the Four Acre Site) for the first experimental hydrofracture study, this site was employed for detailed hydrologic and geologic investigation related to the seepage pits and trenches. A groundwater tracer test was conducted

(LR-DWG-11944 and 11944A, p. C-24-25) in 1955 where 50 pounds of NaCl, 50 pounds of $NaNO_3$, 50 gallons of methanol, and 50 gallons of water were mixed into well 71 (LR-DWG-11924, p. C-18) and well 73 was pumped (200 feet to east along strike) to observe tracer arrival. At that time, a 700 foot long cut was made with a bulldozer along the eastern edge of the site. From this exposed cut, a detailed north-south structure section was prepared (LR-DWG-11880, p. C-11, and 11882, p. C-13). This information when coupled with the logs of four core holes at the site provided the information to construct this geologic structure. Such detailed information was perhaps why the site was selected in 1959 for the hydrofracture experiment.

During this same time interval (1954-1957), when detailed studies were underway at the Four Acre site and in the region of what was to become Waste Pit No. 4, there is frequent reference (Struxness et al. 1955 and Cowser et al. 1955) to an asphalt lined and unlined test pit. Although these two test pits are definitely outside the Pits and Trenches Waste Area Grouping, they are discussed here because of potential confusion with waste pit hydrologic studies which were conducted within the WAG. The location of these two pits is not documented in any of these reports but a map (with an incorrect ORNL LR-DWG-number) appears in Witkowski (1956) which depicts two experimental pits within what is now SWSA 6. Each of these pits was approximately 30 feet in diameter and 5 feet deep. On June 9, 1954, the unlined pit received 741 gallons of a simulated acid dissolver [nuclear fuel] solution containing 3.4 g/L of U and 344 g/L of nitrate. Results of nitrate and uranium breakthroughs and water table response were reported (LR-DWG-4964A-4966A, p. C-8-10). The asphalt-lined pit apparently received only water. Because it leaked significantly, it was never used for actual waste evaporation studies.

On October 16, 1959, radioactive grout was added to well 73 to initiate the first hydrofracture experiment. The original experimental plan called for injecting 50-100 curies of ^{137}Cs. At the last minute only 35 curies of ^{137}Cs were available to which was added 8.7 curies of ^{144}Ce in an attempt to make up the difference. Detailed descriptions of the field operations of this first experimental hydrofracture can be found in de Laguna (1966) and de Laguna et al. (1968). A total of 27,000 gallons of grout was injected containing 130,000 pounds of Class A Portland cement, 23,000 pounds of diatomaceous earth, and 713 pounds of fluid loss additive [bentonite?]. The ^{137}Cs was metered into the well head from a shielded storage bin (PHOTO-48428, p. E-60). The cement and diatomaceous earth were brought in dry in transit-mix concrete delivery trucks and were mixed and pumped into well 73 by personnel of the Dowell division of the Dow Chemical Company using standard truck-mounted oil-well fracturing equipment (PHOTO-48429-48438, p. E-61-70).

The day before the injection, the fracture was initiated with water after cutting a slot in the casing at a depth of 290 feet using an 'Abrasajet' hydraulic sand jet (PHOTO-48439-48441, p. E-71-73) with 2,000 gallons of water containing 100 pounds of 20-40 mesh sand under

3,000 psi pressure. The pressure was built up slowly to 2,300 psi, at which point the shale fractured and the pressure fell abruptly to 1,000 psi and, in 15 min, to 700 psi. A total of 1,400 gallons of water was used to initiate the fracture.

Twenty-one core holes were subsequently drilled in the area and, from these cores, from gamma-ray logs of the core holes, and from surface geologic mapping, the cross sections and areal map of the grout sheet were prepared (LR-DWG-46566, p. C-56, and 64047-64051, p. C-61-65). These show that the grout-filled fracture followed the bedding closely, moving in general north up-dip, and to the east and north east. To the west the movement was apparently blocked by sharp folding and a hard sandy lens in the shale. The smaller drag folds and the few minor faults appear to have had but little influence on the fracture, although two larger overturned drag folds appear to have caused the sheet to split in two. Down-dip, the sheet appears to have broken upward a short distance across the bedding.

The elevations of a network of bench marks in the area were determined before and after the injection. High-precision equipment was not available, and the results were only sufficient to suggest that the rock over the grout sheet had been uplifted by about the thickness of the grout, which in the cores recovered (PHOTO-50391, p. E-74) ranged from a quarter-inch near the injection well to paper-thin about 400 feet to the north.

In an unpublished manuscript, de Laguna (1961) reported that, after the grout mixture had been injected, 400 gal of water were pumped down the injection well to flush the last of the grout. As the last of this water was being pumped, grout was observed flowing very slowly out of the 3-inch core hole 199 ft to the north of the injection well (LR-DWG-64050, p. C-64). Pumping was immediately stopped and, while no measurements were made, it was estimated that 200 gal of grout came out over a period of a few hours. The next morning, the core hole was flowing clear water very slowly and it continued to flow at a slowly decreasing rate for about two months. The total volume of water that came out was not measured but was estimated to be 2000 gal, or as much as 10% of the fluid volume pumped in. This north well, like the other pre-existing core holes, had been plugged with clean sand before injection. It must have held back most of the grout for the fracture, which intercepted the very bottom of this hole, continued on some 200 ft further up-dip to the north. The sand must have been washed out of the core hole as evidenced by both the sand and grout which was subsequently observed in the down hill flow after the grout had set. The flow of water and grout from the well did not travel far as the ground was dry and the continued seepage from the well was caught in a small pit dug early the next day and later filled in. The grout and the soil around the well were dug up a few days later, after the grout had set, and were disposed in SWSA 5. No detectable activity escaped from the immediate vicinity of the core hole.

No subsurface work has been done at the Four Acre site since the characterization of the grout sheet. A recent airborne radiation survey

of the White Oak Creek area (Huff 1987 personal communication) revealed a ^{137}Cs-contaminated area within this area which may correspond to the contaminated core hole discussed above. Presently, it has grown back to pine trees (PHOTO-8488-86, p. E-141) and most of the well casings and survey monuments are still present although overgrown with vegetation. The ^{144}Ce has decayed to trivial levels in 1987 and the ^{137}Cs has decreased to about 18 Ci. Considering this relatively small amount of residual radioactivity and the fact that most of it appears to have been immobilized in a cement grout sheet, the site would have virtually no influence on the pits and trenches area. Cerling and Spalding (1982) found no detectable ^{137}Cs in the bed of the ephemeral stream draining this site.

4.4. Leak Sites in the Liquid Waste Transfer Line

The liquid waste transfer line to the pits and trenches and the first operational hydrofracture site runs through the pits and trenches area (DWG-74-8966R, p. C-85). This transfer line, often referred to as the Intermediate-Level Waste (ILW) transfer line, was first put into operation in 1952 to service Waste pits No. 2 and 3. The line was modified and extended during its operating life and was ultimately used to deliver waste to the hydrofracture facility in SWSA 5. The ILW transfer line was removed from service in 1975 when a new ILW transfer line was put into operation over Haw ridge east of White Oak Creek and outside the seepage pits and trenches area. The old ILW line was accepted into the Surplus Facilities Management Program in 1976.

Two significant leak sites in this line were identified by Duguid and Sealand (1975) due to abnormal radiation fields at the ground surface over the buried line. In February of 1979, a detailed surface radiation survey of the entire old ILW line between the old hydrofracture site and a manhole at the intersection of Lagoon and Melton Drives was completed (Ohnesorge et al. 1981). This survey confirmed that only two major leak sites (DWG-81-11565R, p. C-96, and 11566R, p. C-97) were detectable along the line. Due to the presence of contaminated soil at these two known leak sites as well as concerns for residual radioactivity within the line potentially migrating into White Oak Creek, the ILW line was given high priority for decommissioning in 1979 and decommissioning was completed in 1983. The two leak sites within the pits and trenches area are depicted in LR-DWG-24800R (p. C-116) and DWG-74-8966R (p. C-85).

Leak Site No. 1 (also referred to as the North Leak Site) is located along the ILW line some 150 feet south of Waste Trench No. 6. At this location (ORNL coordinates N 18,363 and E 27,976), the liquid waste had reached the ground surface and had spread laterally for several feet. Surface radiation surveys detected the movement of the contamination to the southwest, in the direction of surface runoff. Beta-gamma exposure rates measured at three feet above the ground surface ranged from 240 mR/hr up to 1 R/hr, with the majority of the radiation localized in a 20 foot by 20 foot area.

Analysis of soil samples taken in the 1973 survey (Duguid and Sealand 1975) showed that the surface soil in the immediate vicinity of the leak was significantly contaminated with mixed fission products. Radionuclide concentrations in nine samples taken from the site ranged from 0.01 to 50 microCi/g of beta-gamma activity with gross alpha levels of up to 1 nCi/g. The beta-gamma activity was due primarily to ^{137}Cs and ^{90}Sr. The primary alpha emitter was ^{244}Cm, with minor amounts of ^{241}Am, ^{238}Pu, and ^{239}Pu.

The depth to groundwater at this site was approximately 12 feet. Although no monitoring wells were installed at this site, groundwater contamination has probably occurred. The extent of this contamination would be difficult to determine because the nearby Waste Trench No. 6 is also known to have leaked in the area. The North leak site was located in an area of gradual topographic relief. The site sloped 15% to the southwest. The area was heavily vegetated with trees and shrubs (PHOTO-4621-83, p. E-118).

The South Leak Site (Leak Site No. 2) is located along the cast-iron pipe extension leading down to White Oak Creek approximately 200 feet west of the creek bank (ORNL coordinates N 17,680 and E 28,000). At this location, which may reside outside the boundary of Pits and Trenches WAG and in the White Oak Creek/Lake WAG, the surface and groundwater drainage is in an easterly direction paralleling the pipeline. The site slopes 15% to the southeast and was covered with trees and shrubs prior to corrective actions. At this site, the liquid waste had leaked from a pipe coupling and had reached the ground surface where it spread laterally over a small area. Soil samples, analyzed as part of the 1973 survey (Duguid and Sealand 1975), contained from approximately 2 nCi/g to 0.6 mCi/g of beta-gamma activity with the highest levels observed right at the leak site. Surface contamination was observable from the leak all the way to White Oak Creek. The highest total alpha concentration was 3700 nCi/g, composed of ^{244}Cm, ^{241}Am, ^{238}Pu, and ^{239}Pu.

Two groundwater monitoring wells were installed along the creek bank in the vicinity of the leak site to establish whether groundwater contamination was occurring. During July and August 1973, approximately 3,415 ft^3 of contaminated soil was moved from the site and disposed in SWSA 6. Sampling of the two wells through October 1973 indicated that the levels of both ^{137}Cs and ^{90}Sr declined after removal of the large contaminant source. However, the 1979 survey (Ohnesorge et al. 1981) revealed that surface soil contamination still existed due either to additional leakage after the 1973 cleanup or to inadequate removal in 1973. Beta-gamma exposure rates measured along the line ranged from 240 mR/h to 800mR/h at three feet above the surface. The most significant area of contamination was contained in an area of approximately 10 x 25 feet.

The entombment efforts at these two leak sites began in May 1983 and were designed to restrict the movement of surface water through the leak areas. A subsurface bentonite clay cap and surface asphaltic concrete cap were installed at each site (DWG-83-15537 and 15538, p. C-

111-112). The planned areal extent of these asphalt covers and their design contours are depicted in DWG-83-15535 and 15536 (p. C-109-110). Modifications to these designs were accommodated during field installation due to specific site conditions.

The leak sites were first isolated by digging down to the line on either side of the leak area and installing permanent pipe caps (PHOTO-4623-83, p. E-119). The lines were cut, short sections of pipe removed, the entrained water collected for disposal, and the open ends sealed. The excavations were then closed and the surrounding area cleared of all vegetation (PHOTO-4616-83, p. E-115). In the areas directly over the leak sites, gamma exposure levels of up to 10 R/h were measured in the disturbed soil. To minimize personnel exposures during the vegetation removal operations, noncontaminated fill was hauled and placed over the areas to reduce the radiation field while providing access for vegetation removal equipment. During this removal process, over 100 yd^3 of vegetation and contaminated soil was excavated and disposed in SWSA 6.

Herbicide (sodium borate) was applied to the areas to be paved and several days allowed for adsorption into the soil. Adequate rainfall provided for herbicide transport into the soil at the north leak site but at the south leak site water had to be hauled and applied. Clean clay fill was then brought in and placed over the leak sites. Bentonite clay was then mixed into this fill with a garden rototiller at a rate of approximately 4 lb/ft^2. Earth fill was then applied over the bentonite clay cap and contoured to specifications (PHOTO-4617-83, p. E-116). The fill was then covered with 6 in of crushed stone base (PHOTO-4620-83, p. E-117) and covered with a minimum of 1.5 in of asphaltic concrete (PHOTO-4625-83, p. E-120) and sealed. The covered areas were fenced with 3-strand barbed wire, with additional rip-rap applied around the base of the asphalt, and the remaining disturbed areas seeded to grass for stabilization. The covered final site conditions are documented in PHOTO-4708-83 (p. E-121) and 4711-83 (p. E-122). In 1987, these leak sites still look similar to their 1983 conditions.

4.5. Special Disposal Wells near Waste Trench No. 5

Seven special auger holes were prepared near the south end of Waste Trench No. 5 (see ENG-DWG-D 38204, p. D-26) in 1964 for the disposal of residual Homogeneous Reactor Test (HRT) fuel. A description of this waste is presented in a series of Intra-Laboratory Correspondence at that time (Schaich 1964; Bruce 1964; Lyon 1964; Acree 1963;and Roller 1964). These auger holes were 12 in diam., 17 ft deep, and 10 ft apart and were used to dispose of 510 liters of an approximately 4M H_2SO_4 solution containing 4,654 g of irradiated uranium (3988 g of ^{235}U) sulfate. Each well is fitted with a brass plaque describing its contents:

S1 6 bottles of 6.1,10.0, 8.81 liters
solution 92, 148, 70 g ^{235}U

S2 60.7 liters
solution 528 g ^{235}U
S3 82.5 liters
solution 704 g ^{235}U
S4 82.5 liters
solution 704 g ^{235}U
S5 84.0 liters
solution 717 g ^{235}U
S6 85 liters
solution 730 g ^{235}U
S7 35 liters
solution + 69.5 L water 296 g ^{235}U

The total of 510 liters of this solution was also stated to contain 20 curies each of strontium and ruthenium. The holes were apparently filled with soil and monumented as described above and abandoned. Nothing is known about the movement, if any, of this waste. The acidity would certainly enhance the movement of ^{90}Sr but the total acidity added is not large in relation to the buffering capacity of the soil.

4.6. Other Minor Operational Influences on the Pits and Trenches Area

Several other ORNL activities have been or are being carried out in the pits and trenches area which may have a potential impact on surface and/or ground water discharges or quality. Just to the north of the Contaminated Equipment Storage Area, is the new (February 1987) Building 7874 for the storage of field equipment used by the Environmental Sciences Division. It is not anticipated that the building will house either contaminated equipment or samples. Secondly, there is a large cleared area several hundred feet north of Waste Trench No. 7 which is used as a staging area by ORNL drilling subcontractors. Although the area is graveled, it represents an erosion hazard and will likely increase runoff in the east weir drainage of the pits and trenches area. Also contributing to the increased runoff of the east weir drainage is the discharge from the SWSA 4 surface runoff drain (Melroy and Huff 1985). Although the discharge from this drain is from upslope and uncontaminated areas above SWSA 4, it will increase the discharge from the pits and trenches area. What effects this may have on water quality has not yet been investigated.

On the hillock just to the west of the first experimental hydrofracture site, an infiltration study was performed on the Conasuaga subsoil by Luxmoore et al. (1981). Approximately 800 m^2 was cleared of vegetation and 1 to 2 m of the topsoil removed to reveal the residuum for infiltration measurements. Small amounts (about 2 pounds each) of NaOH, KOH, $NaAlO_2$, Na_2SiO_3, and NaF were applied to each of six cylindrical 1,250 cm^2 areas in an effort to measure their influence on infiltration. The site has been abandoned since that time and is now supporting a sparse stand of pine seedlings. The small amounts of chemicals used would certainly not have a significant influence on the

pits and trenches area.

In the summer of 1987, a test trench in the pits and trenches area will be used for a demonstration of in situ vitrification. The site selected for this trench is directly east of the Contaminated Equipment Storage Area on a noncontaminated hillock. The trench will be 30 feet long by 3 feet wide by 5 feet deep. Only its central region will be vitrified. No radioactivity will be used in this test. However, the test trench will contain approximately 155 pounds of nonradioactive Cs and 513 pounds of nonradioactive Sr, both as their carbonates. The objective of the demonstration will be to determine any off-gas releases of Cs and Sr during vitrification so that an assessment of the safety of the technique can be performed prior to either a radioactive demonstration or an actual campaign on one of the pits or trenches.

Also included in the pits and trenches area are numerous monitoring wells (see ENG-DWG-C3E20004-SKC not included in Appendix D) and hydrostatic head measuring wells (Dreier 1987). Details of their locations and construction can be found elsewhere and, presumably, their influence on site performance will be beneficial.

5. Site Performance Monitoring

Site performance is best judged through the integration of groundwater and surface water monitoring information into a model of water dynamics of an area. Because there are no developed groundwater models, either of the crude water-budgeting or of the detailed finite element types, of the pits' and trenches' area, the present evaluation of its site performance must be based on a rather irregularly-collected set of data of ground and surface water radionuclide concentrations. A review of this existing data would seem most useful to identify future needs. The radionuclides of concern are listed in Table 1 along with their current maximum permissible concentrations (MPC's) for the unrestricted use of water (USNRC 1979); these MPC's are presented in three different units as a guide to the reader in interpreting the significance of concentrations reported by various investigators in differing units.

The initial network of groundwater monitoring wells (LR-DWG-11924A, P. C-19, and ENG-DWG-D-23680, p. D-58) was set up in 1955 and the distribution of gross beta activity within it reported by Cowser and Parker (1958) and Cowser (1960). The observed results, at various times between 1957 and 1959, are depicted in LR-DWG-21602 (p. C-31), 28384R (p. C-41), 43912 (p. C-51), 44013 (p. C-52), and 44387 (p. C-53). The response of the water table to liquid seepage from the pits is depicted in LR-DWG-13396A (p. C-28) and 28159 (p. C-37). These distributions of radioactivity and water tables in the pits' area, as well as those presented by de Laguna et al. (1958), were not based on mathematical modeling outputs; they were hand-drawn interpolations of activity and water table measurements in the monitoring well network. Before 1959, groundwater concentrations of ^{106}Ru, i.e., gross beta counts, went as high as 0.01 mCi/L which level was actually equivalent to the MPC in use

at that time but about three orders of magnitude greater than the present day MPC (Table 1). It should be borne in mind that the explicit management objective at that time was to release as much radioactivity as the ultimate dilution by the Clinch river would allow to remain within safe limits as determined by MPC's (Cowser 1960). This philosophy is quite different from present day objectives of containment and keeping discharges as low as reasonably achievable.

Prior to July 1961, the sampling of the two streams draining the pits and trenches area was carried out by weekly grab sampling performed by Health Physics Division personnel. Actually, the present weirs were designed by Health Physics Division personnel and installed in 1956 (PHOTO 18474-18475, p. E-33-34) and it was at these points that these grab samples were taken. Records of these measurements (LR-DWG-29284, p. C-42, 29285, p. C-43, 39812, p. C-45, and 43421, p. C-50) can be obtained from Health Physics Division publications during that period (Cowser et al. 1961). Operations Division collected discharge data for other monitoring stations within White Oak Creek (LR-DWG-42822, p. C-49). In July 1961, flow proportional samplers were installed at the east and west weirs and the collection of samples was then transferred to Operations Division personnel. The discharge record (as reported in Operations Division Monthly Discharge reports, i.e., ORNL/CFs) is presented in Appendix F from July 1961 until sampling was stopped in June 1968. In February 1980, sampling of these monitoring stations was resumed after substantial upgrading and procurement of new discharge monitoring and sampling equipment (see ENG-DWG-20016 012 to 021, and A016 to A020, and X014 to X015, p. D-66-82). Presently, only ^{90}Sr discharge is reported from these two drainages. However, the flow measuring and sampling apparatus are adequate to collect samples for other analyses if desired.

Operational and monitoring records indicate that seeps around the pits often exhibited ^{106}Ru concentrations similar to those of the liquid within the pits indicating that there was little retardation of this radionuclide by the soil formation. This situation was the impetus for the construction between 1959 and 1961 of the three interceptor trenches (PHOTO 49011-49013, p. E-75-77) which were placed along the sideslopes of the pits to intercept, collect, and pump back highly contaminated groundwater to the pits. During this same period, the concentration of ^{106}Ru in the streams draining either side of the pits area were about the same order of magnitude (LR-DWG-39812, p. C-45). Cowser et al. (1961) reported that, for the period 1953-1956, the waste pits contributed an average of 23 curies of ^{106}Ru per year to White Oak Creek. By integrating the area under the total transport curves for each stream-monitoring station, it was found that about 200 and 160 curies of ^{106}Ru escaped from the pits to White Oak Creek during 1957 and 1958, respectively. Ruthenium release to the Clinch River was about 60 curies in 1957 and 42 curies in 1958 due to hold up in White Oak Lake and its bed. During this 1953 to 1958 period the waste pits contributed about ten times as much ^{106}Ru as other ORNL sources. These discharge concentrations rose dramatically in the 1959 to 1961 period when the

Table 1
Maximum Permissible Concentrations, in various units, of Radionuclides Contained in the Pits and Trenches (USNRC 1979).

Isotope	Half-Life	mCi/L	Bq/L	dpm/mL
^{3}H	12.3 yr	3×10^{-3}	111,000	6660
^{60}Co	5.3 yr	5×10^{-5}	1,850	111
^{90}Sr	28 yr	3×10^{-7}	11	0.7
^{99}Tc	210,000 yr	3×10^{-4}	11,100	666
^{106}Ru	1.0 yr	1×10^{-5}	370	22.2
^{125}Sb	2.7 yr	1×10^{-4}	3,700	222
^{137}Cs	30 yr	2×10^{-5}	740	44.4
^{233}U	162,000 yr	3×10^{-5}	1,110	66.7
^{235}U	7×10^{9} yr	3×10^{-5}	1,110	66.7
^{238}U	4×10^{8} yr	4×10^{-5}	1,480	88.8
^{238}Pu	89 yr	5×10^{-6}	185	11.1
^{239}Pu	24,000 yr	5×10^{-6}	185	11.1
^{240}Pu	6,580 yr	5×10^{-6}	185	11.1
^{241}Pu	14 yr	2×10^{-4}	7,400	444
^{241}Am	458 yr	4×10^{-6}	148	8.9
^{244}Cm	18 yr	7×10^{-6}	259	15.5

Note: These MPC's were back-calculated by USNRC using an allowable dose limit of 500 millirem/yr to a critical organ or whole body. Presently, this exposure limit is undergoing regulatory review and undoubtedly will be lowered by an order-of-magnitude or more. This will probably result in an order-of-magnitude reduction in these tabulated MPC's.

large ^{106}Ru transfers to the pits were made; during this period, ^{106}Ru discharges through the east and west weirs in the pits area reached monthly highs of 408 and 788 Ci, respectively, in September, 1961. These discharges contained only trace fractions of ^{90}Sr and ^{137}Cs during this same interval. The concentrations of ^{106}Ru continued to fall off until only a fraction of a curie per month was being observed when routine reporting of the monitoring of these drainages stopped in June, 1968 (Appendix F). By this time, much of the ^{106}Ru had either leached away or had decayed. During 1967, ^{90}Sr and ^{137}Cs concentrations were usually reported as <0.01 Ci/month, the apparent detection limit at that time.

By 1980, it had become apparent that the major contributor to the calculated dose of White Oak Creek water, from all Laboratory sources, was ^{90}Sr. The routine reporting of the monitoring of the east and west pits' drainages was resumed because these are a potential source of ^{90}Sr. The monthly discharges of ^{90}Sr to the present have generally been less than or equal to 0.1 mCi for the eastern drainage and between 1 and 10 mCi for the western drainage depending on the season. The origin of the present day ^{90}Sr discharges through the eastern and western drainages is most likely associated with trench 6 (or the nearby ILW line leak site) and pit 1, respectively, based on other monitoring evidence to be presented later. By the present time (1987), all of the ^{106}Ru can be presumed to have decayed because more than twenty half-lives of this isotope have elapsed since disposal.

The sampling of trees in the vicinity of pits 2-4 and trench 5 was used for a brief period in the late 1950's to determine the distribution of radionuclides in groundwater (Cowser et al. 1958). Aside from occasional trees proximate to a trench, these findings confirmed the groundwater observations that ^{106}Ru was the dominant mobile radionuclide. Tree sampling had the ostensible attribute that a tree would sample a rather large groundwater volume and integrate this into a convenient sample, the leaves or needles. However, these analyses generally found concentrations of radionuclides close to background levels associated with atmospheric fallout for isotopes other than ^{106}Ru. The analyses were also complicated by the known airborne drift of dust from the open pits.

Garten et al. (1986) studied the uptake of ^{99}Tc by trees which were growing in contaminated groundwater of the eastern drainage between pit 2 and trench 5. The ^{99}Tc in these groundwaters behaved similarly to pertechnetate anion with concentrations averaging between 2 and 18 nCi/L during the 1984 study period. However, relatively large amounts (83-92%) of the ^{99}Tc in soil samples was not extractable indicative of an organic matter association and reducing conditions at the site. The highest average ^{99}Tc concentrations in vegetation were found in herbaceous plants (18.5 nCi/g dry wt.). Tree wood was found to be the major above-ground pool for ^{99}Tc because of the high concentration in wood as well as the large amount of wood relative to other biomass at the site. Trees tended to conserve ^{99}Tc in their woody parts. These observations of Garten et al. (1986) demonstrate the mobility of ^{99}Tc in

groundwater of the pits and trenches system. Because ^{99}Tc is a very soft-beta emitter, it was not monitored during the period of pit and trench use at ORNL.

Duguid (1975) looked at the concentrations of ^{90}Sr, ^{60}Co, ^{137}Cs, ^{125}Sb, and ^{106}Ru in the still active groundwater seeps within the pits' and trenches' area (Table 2). The location of these eight seeps are depicted in DWG-74-9604 (p. C-86). By comparison with each radionuclide's MPC, only seep 8, draining from trench 6, would seem to be a significant source of ^{90}Sr and only seep 7, draining east of trench 7, would be a significant source of ^{60}Co. By 1981-1982, Olsen et al. (1983) found this same trench 7 seep to have an average ^{60}Co concentration of 53 dpm/mL, a decrease which could be due to a combination of leaching and decay of the ^{60}Co.

Cerling and Spalding (1981 and 1982) surveyed streambed gravels in the pits' and trenches' drainage areas for ^{90}Sr, ^{137}Cs, and ^{60}Co. They found pit 1 and trench 6 to be the only identifiable sources of ^{90}Sr in the area; ^{90}Sr streambed gravel concentrations were highest in the primary and seasonally-ephemeral streams draining these two sources (Figures 3, 4, and 5). These drainages showed no further downstream inputs as they drained past pits 2-4 or trenches 5 and 7. For ^{60}Co, dominant sources includes trench 7 and the eastern drainage of pits 2-4. Thus, the present day observations of ^{90}Sr discharges through the eastern pits' area drainage is most likely originating from pit 1 (Figure 4). Whether this is due to the actual waste transfer to the pit in 1951 or results from discharges into pit 1 from the decontamination facility, building 7819, cannot be determined at present. Only pit 6, with its known leakage problem, seemed to be a detectable source of ^{137}Cs.

More recent groundwater monitoring in the pits' and trenches' area has been reported by Olsen et al. (1983) which focused on the trench 7 area. Olsen and Lowry have recently performed some detailed analyses of wells throughout the pits' and trenches' area (unpublished observations) and they have generously allowed some of these results to be presented (Table 3). These data include some of the first reports of ^{3}H and ^{99}Tc in the area groundwater although the levels of both radionuclides were always well below their MPC's. Only in the trench 7 area did ^{60}Co activity approach its MPC. Considering the half-life of ^{60}Co (5.25 years), this problem could be addressed by simply allowing further time for radioactive decay. Of more concern, are some of the ^{90}Sr concentrations proximate to trench 7 which were well above its MPC. Although the volume of groundwater with these ^{90}Sr concentrations is likely to be quite small and, hence, the total discharge of ^{90}Sr from this source trivial by comparison to other ORNL sources (Figure 4), the inventory of ^{90}Sr in trench 7 causes concern for how these concentrations and discharges might change in the future. Actually most of the high ^{90}Sr concentrations could well have resulted from the transfer line breakage and spill just north of trench 7 in 1966 (DWG-83-1514A, p. C-107). Several points, within the general pits' and trenches' area, have been contaminated as a result of leaks in the waste

Table 2
Concentrations of Radionuclides Observed in Groundwater Seeps in the Pits' and Trenches' Area (Duguid 1975).

Number	Location	^{90}Sr	^{60}Co	^{137}Cs	^{125}Sb	^{106}Ru
		(dpm/mL)				
1	NW-Pit 3	<0.3	<0.2	<0.1	<0.2	<0.7
2	West-Pit 2	<1.1	38.5	<0.3	<0.4	<5.0
3	West-Pit 4	<0.3	10.3	<0.2	<0.2	<2.0
4	SE-Pit 4	0.08	11.5	<0.3	0.7	<2.0
5	NE-Pit 4	<0.01	23.5	<0.5	8.7	4.5
6	South-Pit 3	0.07	13.4	<0.3	<0.3	<3.0
7	East-Trench 7	0.07	240.0	<3.0	<2.0	<10.0
8	South-Trench 6	2.0	<0.5	3.8	<0.5	<0.7
MPC	(USNRC 1979)	0.7	66.7	44.4	222	22.2

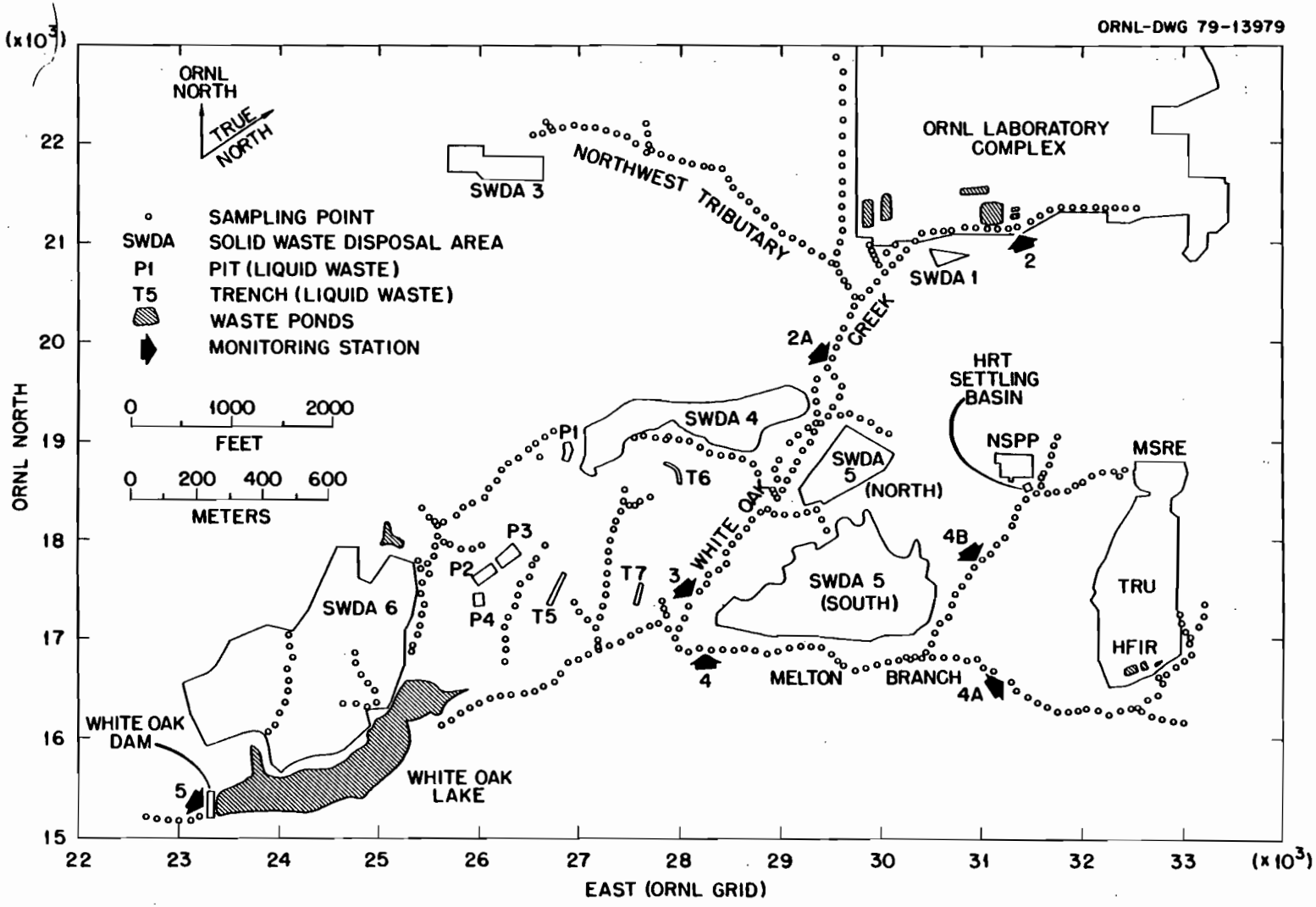


Figure 3. White Oak Creek watershed indicating solid waste storage areas, liquid waste pits and trenches, permanent monitoring stations, and streambed gravel sampling points (Cerling and Spalding 1981).

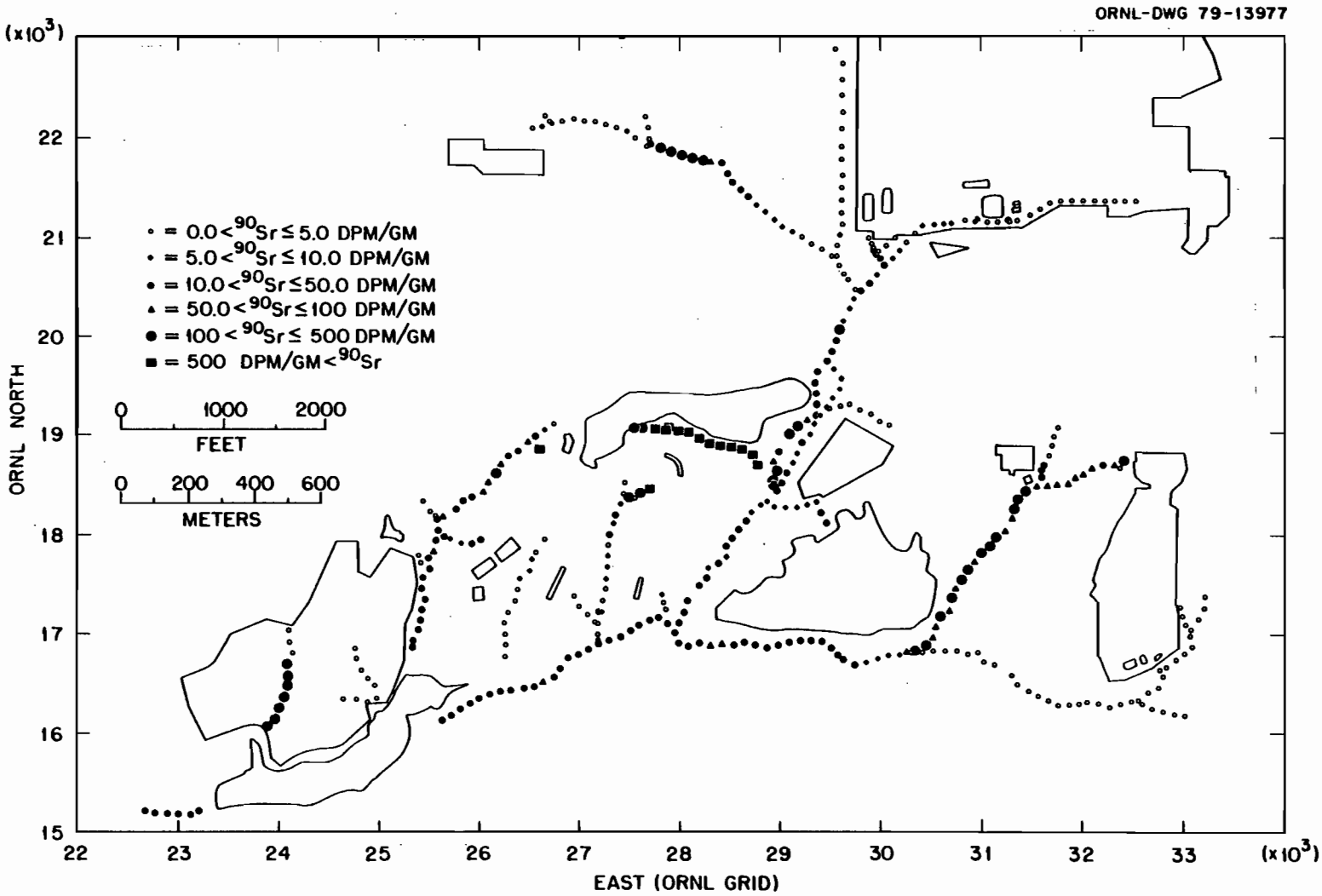


Figure 4. Areal distribution of ^{90}Sr activity in streambed gravels of White Oak Creek watershed from Cerling and Spalding (1981).

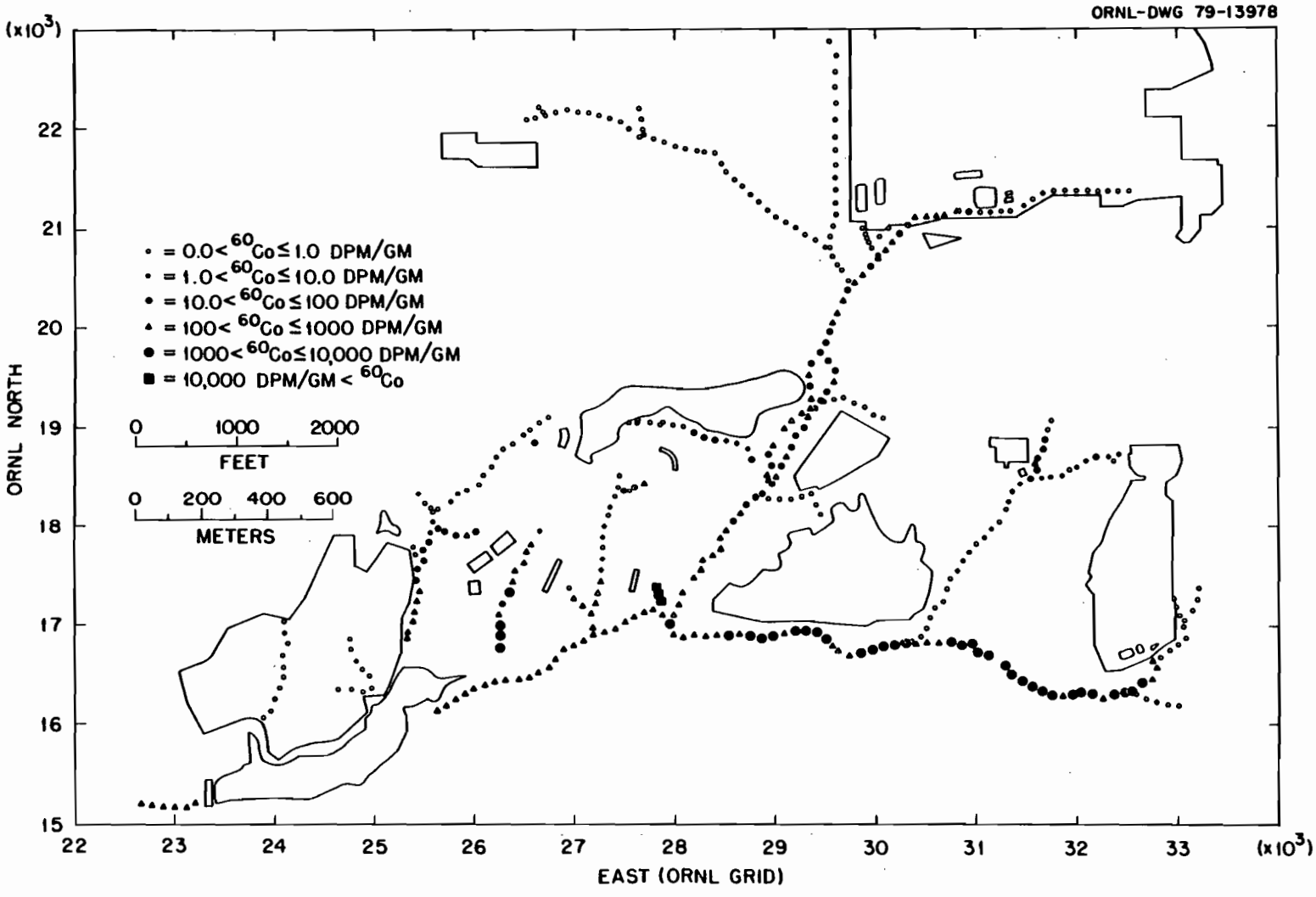


Figure 5. Areal distribution of ^{60}Co activity in streambed gravels of White Oak Creek watershed from Cerling and Spalding (1981).

transfer lines. Two of these have recently been corrected (Walls et al. 1983) and others are likely to be found during site characterization activities in the area.

Although all the radionuclides in, or presumed to be in, the pits and trenches are all of concern due to their potential for groundwater and surface water contamination, the shorter half-life isotopes, including ^{3}H, ^{125}Sb, ^{60}Co, ^{106}Ru, other trivalent rare earths (^{144}Ce, ^{154}Eu, and ^{155}Eu), ^{241}Pu, ^{242}Cm, and ^{244}Cm, will all decay to insignificant levels during a hypothetical period of ORNL institutional control of the area. The longer-lived isotopes pose a much greater radiation protection concern since residuals of these will have to be left in a state which will not result in doses to future populations and individuals above certain regulatory limits. Although the inventories of ^{90}Sr and ^{137}Cs are probably fairly accurate, at least for trenches 5-7, the inventories of uranium and all the transuranic isotopes are, at best, poorly defined. Olsen et al. (1983) made some of the best estimates of these by analyzing sludge samples from trench 7 and normalizing the observed concentrations to those of ^{90}Sr and ^{137}Cs whose disposal inventories were available. The inventory of transuranic isotopes in trench 7, prepared by Olsen et al. (1983 and 1986), depends on whether the analyses of the sludge samples are scaled up to the recorded inputs of ^{90}Sr or ^{137}Cs. It is probably more accurate to use the lower transuranic inventory (i.e., the one prepared relative to ^{90}Sr) for trench 7 because ^{90}Sr, which was placed into the trench as a suspended particulate in the form of a coprecipitate with $CaCO_3$, would likely be better conserved in the sludge samples (Lomenick et al. 1967). Any migration of ^{137}Cs from the sludge into the soil formation, even a very short distance, would lead to an overestimate of the transuranic inventory when used as a reference. Similar information for the other pits and trenches is lacking. The observed concentrations of ^{233}U in several monitoring well samples in the trench 7 area were all orders of magnitude below its MPC (Olsen et al. 1983 and 1986). They also observed that ^{238}Pu, $^{239-240}Pu$, ^{244}Cm, and ^{241}Am, in two monitoring wells and the seep on the eastern side of trench 7, were orders of magnitude below their MPC's.

The present site performance monitoring of the pits and trenches is marginally adequate for the period of institutional control, i.e., a hypothetical 100-year-period. During this time, occasional monitoring of groundwater wells will need to be performed probably no more frequently than once a year and routine stream water sampling continued. Most of these activities are covered in the recommended groundwater quality survey for the SWSA and pits' and trenches' area (Switek 1981). What is lacking in the current plan is some provision to measure the water discharges as well as the radionuclide concentrations of the eight known seeps in the area (DWG-74-9604, p. C-86). Perhaps this might be achieved by insertion of culverts into the seeps and digging of spillways so that these culverts could be bucket-gaged or stage-height-recorded. These seeps obviously contribute most of the activity to these drainage areas and both their storm-event-related and

Table 3
Concentrations of Radionuclides in Monitoring Wells of the Pits' and Trenches' Area in 1982 (Olsen and Lowry, unpublished).

Well No.	Location	^{90}Sr	^{137}Cs	^{60}Co	^{3}H	^{99}Tc
		(Bq/L)				
W113	NE-Pit 3	1.4	.066	0.6	<35	nd
W125	West-Pit 3	.54	<.07	8.1	380	nd
W117	West-Pit 2	.11	<.1	<.2	5100	1.9
W126	West-Pit 2	.47	<.08	1.9	150	nd
W106	SW-Pit 2	.48	<.07	2.0	110	250
W105	West-Pit 4	.06	<.8	190	3500	nd
W104	SW-Pit 4	.05	.045	0.8	67	47
W94	South-Pit 4	.04	.054	0.1	570	nd
W95	West-Pit 4	.51	<.6	200	6200	140
W85	SE-Pit 4	.88	<.3	34	2400	nd
W84	East-Pit 4	.30	.23	32	1500	61
W83	East-Pit 4	.32	<.3	15	510	nd
W96	SE-Pit 2	.29	<.08	6.6	360	180
WT-5-3	West-Tr 5	.32	<.08	7.3	110	270
WT-5-5	West-Tr 5	.06	<.08	11	4800	470
WT-5-6	South-Tr 5	.29	<.05	0.6	150	nd
W97	SE-Pit 3	.38	<.2	5.5	620	nd
W98	SE-Pit 3	.46	<.1	0.5	89	nd
T5-3	East-Tr 5	.36	<.2	37	150	nd
T7-10	East-Tr 7	1.7	<.2	41	2500	nd
T7-13	East-Tr 7	.26	<1	430	1000	1500
T7-3	East-Tr 7	.30	<2	1200	7500	1000
T7-5	SW-Tr 7	.56	<3	1500	300	nd
T7-6	West-Tr 7	1.1	<.2	32	56	nd
T7-7	North-Tr 7	2900	2.2	8.2	67	nd
WT-7-7	West-Tr 7	22	<.2	26	78	39
WT-7-5	West-Tr 7	90	.26	9.4	130	120
MPC	USNRC(1979)	11	740	1850	111000	11000

nd = not determined.
See ENG-DWG-D-23680 (p. D-58) and DWG-76-1519 (p. C-89) for well locations.

longer-term-baseline discharges should be determined for some period of time, probably two years, until their discharge role can be quantified. These point sources might well be easier to remedy than more diffuse groundwater seepage into the surface streams within the area. In addition, the nature of the discharges from pit 1 needs to be identified. Is it presently a groundwater seep, which is fed by recharge to the pit via the trench dug for the transfer drain from building 7819, or is it a result of surface runoff flowing over soil contaminated during its 1951 operation?

Streambed gravel surveys, similar to those of Cerling and Spalding (1981 and 1982), should prove useful at about five-year intervals. This type of monitoring should give ample warning of potential problems and provide the time required to plan and implement corrective actions. As an example, the proposed corrective actions at trench 7 (Stansfield 1984) were carried out in 1985 and early 1986 to alleviate the seep discharge problem on its eastern drainage.

The longer-term monitoring system for the pits' and trenches' area will depend very strongly on the stabilization measures ultimately taken. If covers and diversion ditches for surface runoff were to be required, the area, which these are designed to protect, will need to be monitored for water intrusion. If the closure plan were to reach the unlikely conclusion that the site can be left alone, then the present monitoring system would be adequate with the improvements and additions noted above.

6. Waste Forms of Radionuclides in the Pits and Trenches

Relatively little is known of the chemical waste forms per se transferred to the pits. This represents the most salient information need of the pits' and trenches' area. Quite a substantial amount of research has been done concerning the retention mechanisms and capacities of the Conasauga shale for the various major radionuclides in the liquid waste solutions (Brockett et al. 1954; Lacy 1957; Mohan et al. 1962). Many of these findings have been summarized in the Health Physics Annual Reports in the years between 1954 and 1960. Basically these studies confirmed what was found during the operation of the pits, i.e., ^{106}Ru was very poorly retained by the Conasauga shale while other radionuclides were retained more strongly. More recent work with ^{60}Co indicated that, if it complexes with EDTA, it is poorly adsorbed by soils whereas uncomplexed ^{60}Co is strongly adsorbed (Means et al. 1978). This complexation of ^{60}Co by EDTA probably contributed to the ^{60}Co leakage on the east side of trench 7 although there are confounding circumstances at that site.

Operational procedures and records are not precise enough to unambiguously conclude what the chemical form of each radionuclide is in each of the seven seepage pits and trenches. These forms can be inferred, in general, from the chemical processing of the liquid waste. As discussed previously, the transferred liquid waste was essentially a decantate from the pH-adjusted and settled contents of the gunite tanks.

The settled solids would be expected to carry down the U and much of the Sr, Co, and trivalent rare earth isotopes. However, ^{90}Sr, ^{60}Co, and the trivalent rare earths would be only partially scavenged into the settled sludge. In addition, the separation of sludge and supernatant would be far from absolute employing only gravity-induced sedimentation within a gunite tank. Thus, considerable amounts of fine solids and suspended sludge, with its associated radionuclides, were also likely transferred to the pits and trenches. As Lomenick et al. (1967) pointed out, the suspended solids which were transferred tended to settle out in the first pit (No. 3) of the three pit drainage train. Thus, most of the ^{90}Sr will probably be contained within pits 2 and 3 and be in the form of a calcium carbonate-^{90}Sr coprecipitated sludge. From 1956 until the pits were finally covered, large quantities of the sludge from the Process Waste Treatment Plant were dumped into these pits; that sludge could also be scavenging ^{90}Sr from the liquid wastes. When ^{106}Ru releases from the pits became serious in 1959-1960, sodium sulfide and copper sulfate were added to the chemical precipitation processing of the liquid wastes in the gunite tank to scavenge ^{106}Ru into the sludge. Prior to this change, ^{106}Ru, as well as ^{3}H, ^{99}Tc, and ^{137}Cs, would be expected to remain in the supernatant phase.

Lomenick et al. (1967) obtained samples of the sludges from pits 2 and 3 and its surrounding weathered shale. They observed that strong nitric acid was required to remove ^{90}Sr from the sludge while either water or dilute calcium chloride were not effective. This behavior strongly indicates that the form of the ^{90}Sr was a coprecipitate with calcium carbonate (Spalding 1985). In contrast, the ^{90}Sr in the weathered shale was partially leachable by calcium chloride indicating that most of it was retained on the soil as exchangeable cations. Varga and Jacobs (1970) and Lomenick et al. (1967) assessed the potential for this $Ca(^{90}Sr)CO_3$ sludge to dissolve in groundwater of the Conasauga and concluded that, under natural conditions, the process would be quite slow; the quantities of acid, required to dissolve the estimated quantities of calcium carbonate, would only become available over hundreds of years of geologic weathering. They also found that most of the ^{90}Sr in the pits' cores was contained in the sludge and had penetrated only a few inches into the unperturbed formation. However, since ^{90}Sr is the radionuclide most likely to compromise the performance of the pits and trenches, these qualitative conclusions need to be quantified by collecting actual leach data on the waste sludges and soil samples. The ^{137}Cs in both the sludge and the weathered shale samples of Lomenick et al. (1967) was not leachable by neutral salt solutions or water and required strong acid (6N) to remove most of it. This strong fixation of ^{137}Cs by illitic minerals within the Conasauga soils has been demonstrated by Tamura and Jacobs (1960). This empirical evidence, coupled with the operational experience that no significant ^{137}Cs, other than the leak at trench 6 through some large fissure, has been observed from the pits' area (Cerling and Spalding 1981 and 1982), is strong evidence that movement of this isotope is almost imperceptible in the Conasauga formation.

The form and leachability of other radionuclides, particularly the long-lived U and transuranic isotopes, and their subsequent retardation within the soil formation, are almost completely unknown. This information is one of the most crucial needs for the closure planning of the pits' and trenches' area. Empirical leach data for each isotope of concern (Table 1) for waste samples from each pit and trench would be required. These source terms can then be coupled to leach data for contiguous contaminated soil so that estimates of groundwater concentrations of each isotope can be determined. From this information, doses to hypothetical people, who might use this groundwater or its discharges to surface waters, can be calculated. The migration of isotopes like ^{90}Sr, once it is leached from the waste, can be described quantitatively using chemical equilibria models. If predicted groundwater concentrations remain below MPC, during the interval when the large inventory of ^{90}Sr decays, then no closure action would be required; other isotopes may dictate other required actions. It must be reemphasized that the only method to reach such a decision about the needs for closure will be to couple empirical leach data, chemical speciation models of soil, and hydrologic models of the area. Because the nature of the wastes in each pit or trench will likely be somewhat different, these leach data will need to be obtained for each location whereas the soil chemical speciation model soil inputs can be more generic for the entire area.

Because much time and effort will be expended to obtain samples of the wastes from each pit and trench, these samples should also be screened for EPA priority pollutants (non-radioactive). Although there were non-radioactive waste transfers of aluminum and ammonium nitrates and sludges from the process waste water treatment plant, the pits and trenches are not likely to contain significant amounts of non-radioactive hazardous wastes. This condition would be most explicitly supported by the analyses of the pits' and trenches' contents.

7. Site Characterization

The pits' and trenches' area is one of the most well studied sites on the Oak Ridge Reservation in terms of its geologic and hydrologic characteristics. The studies of de Laguna et al. (1958) produced some of the most definitive relationships between geologic structure and seepage patterns (LR-DWG-28158, p. C-36, and 28384R, p. C-41). de Laguna (1962) did extensive coring and augering around pits 2 and 4 showing that particular bedding planes conducted most of the pits' seepage (LR-DWG-62143-62148, p. C-67-72). This type of geologic input led to the improved design of trenches 5 and 7 which were oriented perpendicular to geologic strike. These geologic studies have probably told as much as can be learned in this complicated sedimentary formation, the Conasauga. More recent studies in adjoining areas (Davis et al. 1984 in SWSA 6; and Rothschild et al. 1984 in the proposed SWSA 7 site) have added some details. The details of the geologic column of

the Conasauga Group formation have been extended further (DWG-83-13887R2, p. C-106, and 82-13318, p. C-101) than what was available in 1958 (LR-DWG-6631, p. C-27, and 28383, p. C-40). Two pictures summarize the complexity of the secondary folding and faulting of the stratigraphic column in the area of the pits' and trenches: PHOTO-15654 (p. E-47) of the southern portion of the east wall of pit 4 and DWG-81-21573B (p. C-100) of the stratigraphic exposure along a roadcut on the eastern side of trench 7. This structure is so complicated, on the scale of the pits and trenches, that it has generally been concluded that the identification of precise flowpaths for seepage from the pits and trenches may be close to impossible or economically prohibitive using conventional coring and augering in these areas (de Laguna et al. 1958; Olsen et al. 1983). Clearly the work of Olsen et al. (1983 and 1986) has demonstrated that discrete fractures, conduits, or strata carried most of the seepage of radioactivity (DWG-83-1555 and 83-1556, p. C-113-114). But without much more extensive coring or augering with borehole-logging, the assurance that all conducting structures have been identified cannot be guaranteed. If a complete picture of these conducting strata or features could be attained, then a monitoring system for the area could be recommended with confidence and accurate fracture-flow groundwater models of each trench could be produced to describe site performance. More pragmatically, such detailed knowledge of the spatial distribution of residual activity in and around the pits and trenches would put the planning of corrective actions on a more accurate basis; areas needing the protection of engineered barriers could be more accurately planned.

Such detailed knowledge of the spatial distribution of radioactivity in, around, and under each pit and trench might be obtained without the large expense and site disruption associated with coring, augering, and sample retrieval for expensive radiochemical analyses. The gross-beta and gamma activity of soil profiles could well be obtained in situ by placing a GM tube detector in the ground. This technique has been used to log boreholes which were previously constructed by augering or coring (Olsen et al. 1983; Struxness and Morton 1956). A recent demonstration of grout-injection machinery at ORNL clearly demonstrated that 1-inch diameter pipe, fitted with a well point to form a lance, could be inserted into the soil formation by a hydraulic driver using track guides. If the well point were fitted with an adapted GM-type detector, depth increments of the soil formation could be logged without previous augering or coring. Measurements could be taken in the field either during insertion or, more likely, on withdrawal of the lance. Insertions to depths of 20 feet could be performed in a few minutes so that borehole logging times would be determined by the radioactivity detection sensitivity desired; many depth logs could in theory be produced in one day. With such techniques, an entire pit or trench could be circumscribed; such perimeter surveys could be performed at several distances from the pit or trench to yield a detailed three-dimensional image of the distribution of gross-beta and gamma activity. Selected salient 'hot'

spots could be cored subsequently so that radionuclide-specific analyses could be generated and correlations between known species and activities and the gross counts developed. Likewise, the distribution of activity within a pit or trench could be determined. Because the spatial resolution of the technique is potentially high, detailed mapping of the functional stratigraphic features, responsible for groundwater flow, may be possible for the first time due to the radioactive 'label' contained in this region of the Conasauga. This could be implemented by employing existing ORNL drilling equipment with a hydraulic-feed drill-head (i.e., the Holegator Drill rig) and development of GM detector-equipped 'drive point'. A contract for the development of such an in situ radiation detector will be issued in 1987. Thus, the detailed characterization of the three dimensional distribution of radioactivity around each pit and trench may then be possible.

The hydrologic characteristics of the pits' and trenches' area have also been very extensively studied. The work of de Laguna et al. (1958) described the results of pump tests (LR-DWG-28161, p. C-38) at the pit 4 site, seepage rate determinations for the formation (LR-DWG-21681 and 28382, p. C-33-34), pressure testing of the formation to depths of 200 feet (LR-DWG-11942, p. C-21), and water table elevation maps (LR-DWG-13396A, p. C-28, and 28159, p. C-37) based on an extensive monitoring well network (LR-DWG-11924A, p. C-19). These distributions of radioactivity at points in time (LR-DWG-21602, p. C-32) and as a function of time (LR-DWG-21603R, p. C-32) could well be interpreted as a detailed groundwater tracer test. Radioactivity was logged with depth below pit 4 as a function of pit usage (LR-DWG-15480A, p. C-30). Extensive tracer tests were run (LR-DWG-11944A, p. C-25) at the nearby Four Acre Site (see PHOTO-15895 with labels) which was a candidate site for a new seepage pit but was eventually used as a test site for hydrofracturing experiments. The movement of nitrate tracer from an experimental unlined seepage pit (LR-DWG-4964A-4966A, p. C-8-10) as well as water table responses to seepage were also studied in 1954 on an adjoining hillock later to become part of SWSA 6; the location of this covered experimental pit can be seen in PHOTO-15903 (p. E-52). The movement of tritiated water at the pit 4 site was later studied (DWG-64-7897, p. C-79) and groundwater velocities of 0.5 ft/day were observed (Lomenick et al. 1964).

The streams draining the pits' area were also extensively investigated under low-flow conditions (LR-DWG-29285, p. C-43) and in response to storm events (LR-DWG-29284, p. C-42). The radioactivity discharges of these streams were followed in detail in 1957-1958; routine monitoring, with flow-proportional sampling, continues to the present although records were not kept between 1968 and 1980. Discharges of seeps in the area were updated only once by Duguid (1975). Olsen et al. (1983) described the water table dynamics of the trench environs during a period of characterization in 1981-1982 for potential corrective actions to its ^{60}Co-contaminated groundwater seep.

In terms of surface water discharge characteristics, information is presently being obtained for the eastern and western drainages in the

pits' area. Surface runoff channels immediately east and west of trench 7 have been continuously monitored as part of a project to evaluate the effectiveness of the corrective actions taken at trench 7 in 1985-86. These actions include widening the asphalt cap on the trench, rerouting surface runoff away from the trench, and grouting the soil formation between the trench and its eastern seep (Stansfield 1984). The only unmonitored drainage remaining in the area will be the remainder of the 14 ha area between trenches 5, 6, and 7. If a weir were installed on this drainage, a complete surface water monitoring network would be available for the area. Provisions would have to be made for a central data collection and storage system and a hydrologic interpretation of this data would need to be made to summarize the output into a water budget. If this activity were to include water table elevation monitoring and seep discharge monitoring, as described previously, then the complete hydrologic characterization of the area could be completed in a two year observation period. This observation period would provide the information required to construct the needed hydrologic models of the area.

Detailed investigations of the soils in the pits' and trenches' area would be largely a superfluous effort. Detailed information is already available for two proximate sites: one in SWSA 6 (Davis et al. 1984) and another in proposed SWSA 7 (Rothschild et al. 1984). Both these sites have soils developed in the same portion of the Conasauga and have essentially identical geomorphology and vegetation. Similarly, meteorological characterization of the area would not be required because adequate data continues to be obtained in SWSA 6 and SWSA 5 and at several other sites on the Oak Ridge Reservation. Similarly, regional characteristics for such things as seismic activity, severe storms, flooding, ecology, and social, economic, and political characteristics can be used verbatim from other recent studies (e.g., Boyle et al. 1982).

8. Modeling Status and Needs

The simulation modeling of the hydrologic transport of radionuclides in the pits' and trenches' area is in an embryonic state. The application of finite element models to trench 7 was initially made by Duguid and Reeves (1976) and Duguid (1979). These efforts were later developed more generally by Yeh and Tamura (1982). Experimentally-determined parameters for these models (DWG-76-7075, p. C-90) were finally reported by Luxmoore (1982); the suction, hydraulic conductivity, and moisture content relationships were gathered during flooding of a specially-constructed undisturbed soil block near trench 7 (ENG-DWG-20965, p. D-87). The distribution of a hypothetical species, with a distribution coefficient of 100 L/kg (probably ^{90}Sr) was simulated (DWG-76-7077, p. C-92) under transient and steady-state rainfall conditions (DWG-76-7076, p. C-91) through a cross-section of a hill dimensionally equivalent to trench 7 (DWG-76-7080, p. C-94); the distribution of the hydraulic head and the water table was also

simulated (DWG-76-7078, p. C-93). These modeling efforts were an excellent beginning for hydrologic models of the area and were state-of-the-art for that time. However, they are based on the assumption that the aquifer is a homogeneous porous medium which is a considerable, but necessary, deviation from the reality of the site (Olsen et al. 1983).

Similar cross-sectional models (two dimensional) should be attempted for all the pits and trenches as well as cross-sections parallel to the length of each pit and trench up to real site boundaries, i.e., surface streams. Likewise, two-dimensional water table models would be extremely useful to define fluxes of water, moving through the soil profile and leaching the waste, as it varies both seasonally and transiently during storm events. The fluxes of water to surface streams, which are simulated by these models, need to be calibrated to the actual surface water discharges observed during site characterization.

Given good modeling estimates of the fluxes of water through the various waste pits and trenches, soil chemical models of radionuclide adsorption and dissolution will need to be developed so that the migration of radionuclides can be simulated. A modeling approach for the speciation of ^{90}Sr in soil has been discussed in section 6. Input characteristics of the quality of the water leaching the waste will also be needed; such characteristics include pH, hardness, electrical conductivity, acidity, and alkalinity. These attributes are adequate to describe the dissolution and precipitation of $Ca(^{90}Sr)CO_3$ and its retention by soil cation exchange mechanisms. Other characteristics may be required to simulate the movement and adsorption of other radionuclides. A few laboratory-measured distribution coefficient determinations of these radionuclides between a typical groundwater and soils of the area will probably be all that is required for these simulations. The empirical leach data of the waste itself will be needed to formulate source terms for the models. These inputs of radionuclides to the surrounding soil will be attenuated by the processes in the various soil chemical models for each radionuclide so that groundwater concentrations as a function of time can be simulated.

Without a verified chemical model of the radioisotope processes in the soil and groundwater, it would seem plausible to postulate a worst case scenario where the entire inventory of radioactivity would suddenly dissolve in the groundwater of the area. This situation is illustrated for the case of trench 7 in Table 4. The radionuclide inventory developed by Olsen et al. (1983), but not corrected for decay, was presumed to completely dissolve and disperse in the area's groundwater which was assumed to have a volume of 7.5×10^7 L(i.e., 150 x 100 x 10 m deep soil/rock aquifer with 50% porosity). This very conservative assumption of complete dissolution has been made for illustrative purposes only. It can be seen that ^{137}Cs and ^{90}Sr show the greatest divergence from their MPC's. The U and transuranic isotopes, except ^{241}Am, would be very close to their MPC's. It is very likely that empirical waste leach data and soil adsorption probably will reduce

these concentrations well below regulatory concern. Thus, if the fore-mentioned characterization efforts demonstrate that the concentrations of ^{137}Cs and, particularly, ^{90}Sr in groundwater will remain below their MPC's, then the sites probably may be abandoned without further stabilization at the end of the institutional control period.

Table 4
Hypothetical Concentrations of Radionuclides in a Shallow Aquifer Beneath Seepage Trench 7 Assuming Complete Dissolution and Dispersion in a Groundwater Volume of 7.5×10^7 Liters.

Radionuclide	Inventory[1]	Concentration	MPC[2]
	(mCi)	(mCi/L)	(mCi/L)
^{90}Sr	29.7×10^6	4.0×10^{-1}	3×10^{-7}
^{137}Cs	13.8×10^7	1.8	2×10^{-5}
^{233}U	594	7.9×10^{-6}	3×10^{-5}
^{238}Pu	3,780	5.0×10^{-5}	5×10^{-6}
^{239}Pu	1,970	2.6×10^{-5}	5×10^{-6}
^{240}Pu	1,240	1.7×10^{-5}	5×10^{-6}
^{241}Am	432,000	5.8×10^{-3}	4×10^{-6}

[1] Inventory taken from minimum estimate of Olsen et al. (1983).
[2] Maximum Permissible Concentration from USNRC (1979).

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Appendix B

Excerpts of Operations Division's Reports

Excerpts from Operations Division Monthly Reports Pertaining to the Seepage Pits and Trenches

Month ending July 31, 1951 (ORNL-1109 p. 9)

In cooperation with the Health Physics Division, a site beyond the new burial ground [SWSA 4] has been chosen to locate a 200,000-gallon lagoon for the storage of metal-waste supernatant now stored in tank W-10. This location provides a shale which will allow very little seepage over geologically long periods of time. This is expected to be a much safer and cheaper way of permanently disposing of liquid wastes. This project is considered to be an experiment at the present time. Approximately 100,000 gallons containing about 100 curies of activity will be stored there until this method of disposal is proven to be safe and economically practical.

Month ending August 31, 1951 (ORNL-1122, p. 12)

The transfer of radiochemical metal waste supernate from W-10 to the chemical waste storage pit was begun on August 1, 1951, and discontinued on August 7, 1951, after a total of 26,400 gal, bearing 22.88 curies of beta activity, 134 kg of uranium, and 28.15 mg of plutonium was transferred. The transfer from this tank was discontinued because of the high uranium content. Further precipitation by the addition of 850 gal of 50%-caustic was made.

While the precipitate in tank W-10 was allowed to settle, a total of 15,000 gal of evaporator concentrate was transferred from W-8 to the storage pit. This transfer was started on August 7 and completed on August 10. The material carried 192.4 curies of beta activity, 15.5 kg of depleted uranium, and 8.48 mg of plutonium.

The entire transfer operation was successfully carried out. Two portable 500-gal tanks with the Dempster Dumpster truck were used. The operation presented no undue amount of radiation hazard.

Month ending September 30, 1951 (ORNL-1127, p. 7-8)

The transfer of radioactive metal waste supernate from W-10 to the chemical waste storage pit was resumed on September 24, 1951. The amount transferred from September 24 through September 30 was 43,200 gal, bearing 33.6 curies of beta activity, 17.7 kg of uranium, and 76 mg of plutonium.

The transfer of waste will continue until an adequate amount of free space is made available to transfer the contents of W-7 to W-10.

Month ending October 31, 1951 (ORNL-1156, p. 9)

The transfer of radioactive metal waste supernate from W-10 to the chemical waste storage pit was resumed October 1, 1951, and continued through October 3, 1951. In the 24,600 gal of material transferred, there were 18,622 g of uranium, 65 mg of plutonium, and 8.2 curies of beta activity.

Transfer of chemical waste concentrate from W-8 to the pit was begun on October 3, 1951, and continued through October 5, 1951. This 13,000 gal of waste contained 132.3 curies of beta activity, 8.8 mg of plutonium and 10,238 g uranium.

The volume of waste in the chemical waste storage pit is decreasing at a rate of 500 to 600 gal per day and the plants near the pit have been found slightly radioactive. The Health Physics Division has the area under its surveillance.

Month ending November 30, 1951 (ORNL-1188)

No mention.

Month ending December 31, 1951 (ORNL-1212, p. 23)

At the suggestion of the Health Physics Division, additional storage space was provided last fall by transferring 123,000 gal of a mixture of evaporator concentrate and metal-waste supernatant to a 170,000 gal pit dug for this purpose southwest of the new burial ground [SWSA 4]. This method was to be considered an experiment which, if it proved to be practical, would pave the way for a simple and very economical method of permanent disposal of concentrated evaporator wastes. The pit and the surrounding area are still under Health Physics surveillance; no decision concerning the practicality of this method has yet been made.

Month ending January 31, 1952 (ORNL-1245)

No mention.

Month ending February 28, 1952 (ORNL-1259)

No mention.

Month ending March 31, 1952 (ORNL-1271, p. 12)

Construction of a new chemical-waste storage pit for hot chemical waste was about 50% complete at the end of the month [Pit 2].

Month ending April 30, 1952 (ORNL-1295, p.10)

Work on the new chemical-waste storage pit [Pit 2] has progressed until the project is about 97% complete.

Month ending May 31, 1952 (ORNL-1319, p. 10)

The chemical-waste storage pit [Pit 2] was completed this month.

Month ending June 30, 1952 (ORNL-1334, p. 11)

Approximately 12,000 gal of contaminated chemical waste that contained 187.0 beta curies were transferred from tank W-8 to lagoon No. 2 [Pit 2] this month. The radiation levels are high, so the transfer operation is confined to two shifts per week.

Month ending July 31, 1952 (ORNL-1363)

No mention.

Month ending August 31, 1952 (ORNL-1390)

No mention.

Month ending September 30, 1952 (ORNL-1404)

The movement of concentrated chemical waste from tank W-8 to chemical-waste pit No. 2 was resumed. There was 4200 gal of waste containing 103 curies of beta activity transferred, which brings the total amount transferred to date to 16,200 gal bearing 290 curies of beta activity.

Month ending October 31, 1952 (ORNL-1440, p. 9)

Approximately 900 gal of concentrated chemical waste from tank W-8, which contained 28.3 curies of beta activity, was moved to chemical-waste pit No. 2. The total transferred to this pit to date is 17,100 gal and bears 318 beta curies of activity.

Month ending November 30, 1952 (ORNL-1460, p. 9)

Approximately 16,200 gal of concentrated chemical waste from tank W-8, which contained 400 curies of beta activity, was moved to chemical-waste storage Pit No. 2. The total transferred to date is 33,000 gal bearing 718 curies of beta activity.

Month ending December 31, 1952 (ORNL-1485, p. 19)

Approximately 9600 gal of concentrated chemical waste from tank W-8, which contained 235 curies of activity, was moved to chemical waste pit No. 2. The total transferred to date is 42,600 gal bearing 953 curies of activity.

Month ending January 31, 1953 (ORNL-1502)

No mention.

Month ending February 28, 1953 (ORNL-1522, p. 10)

The tank trailer, with a capacity of about 4000 gal, for hauling concentrated chemical wastes from the tank farm to the waste storage pit was put into service this month. There was 45,600 gal, bearing 1131 curies of beta activity, transferred this month to give a total transferred to the pit to date of 55,200 gal containing 1366 curies of beta activity. The use of this equipment enables transfer of larger volumes of wastes with lower personnel radiation exposure than was encountered with the 500-gal tanks previously used.

Month ending March 31, 1953 (ORNL-1539, p. 9)

A total of 21,600 gal of chemical-waste concentrate bearing 615.28 curies of beta activity was discharged to the chemical-waste storage pit No. 2 from tank W-8. The total transferred to date from the concentrate tank to the pit is 76,800 gal containing 1981 curies. Additional wastes, consisting of 600 gal bearing approximately 15 g of U-235 and 16 curies of beta activity from the Homogeneous Reactor Building and 6500 gal bearing approximately 6.13 curies of beta activity from the washings of the pit excavation at valve group No. 1 in the north tank farm, were also transferred to the same waste pit.

Month ending April 30, 1952 (ORNL-1553, p. 9)

There was 37,800 gal of chemical-waste concentrate containing 1897 curies of beta activity discharged to chemical-waste storage pit No. 2 from tank W-8. The total transferred to date from the concentrate tank to the pit is 114,600 gal bearing 3878 curies.

Month ending May 31, 1953 (ORNL-1564, p. 12)

There was 28,800 gal of chemical-waste concentrate containing 1377 curies of beta activity discharged to chemical-waste storage pit No. 2 from tank W-8. The total transferred to date from the concentrate tank to the pit is 143,400 gal bearing 5255 curies.

Month ending June 30, 1953 (ORNL-1586)

No mention.

Month ending July 31, 1953 (ORNL-1603)

No mention.

Month ending August 31, 1953 (ORNL-1619, p. 14)

A total of 29,400 gal of chemical-waste concentrate bearing 995 curies of beta activity was transferred from waste tank W-8 to waste storage pit No. 2. The total transferred to date is 172,800 gal containing 6250 curies of beta activity.

Month ending September 30, 1953 (ORNL-1635, p. 12)

A total of 32,400 gal of chemical-waste concentrate bearing 899 curies of beta activity was transferred from waste-tank W-8 to chemical-waste storage pit No. 2. The total transferred to date is 205,200 gal containing 7149 curies of beta activity.

Month ending October 31, 1953 (ORNL-1646, p. 12)

A total of 31,200 gal of chemical-waste concentrate bearing 802 curies of beta activity was transferred from waste-tank W-8 to chemical-waste storage pit No. 2. The total transferred to date is 236,400 gal containing 7951 curies of beta activity.

Month ending November 30, 1953 (ORNL-1654)

No mention.

Month ending December 31, 1953 (ORNL-1668, p. 12)

Construction of the pump pit in the south tank farm has been started. This pit is for the waste line from the tank farm to the chemical-waste storage pit No. 2.

Year ending December 31, 1953 (ORNL-1680, p. 14-16)

Approximately 227,000 gal of concentrated radioactive waste containing 7716 curies of beta activity was transferred from the tank farm to the chemical-waste storage pit No. 2. The total transferred to the pit thus far is 270,000 gal containing 8669 curies(Fig. 3) [ORNL-PHOTO-12116].

A speed-up in the transfer of waste to the pit and an appreciable reduction in exposure of man power to radiation was accomplished by using an old, salvaged gasoline trailer which was excessed by the AEC and converted for waste-hauling purposes at the Laboratory. This equipment was far superior to the 500-gal Dempster Dumpster tanks originally used.

Construction of a pipe line connecting the tank farm to the waste-storage pit is expected to be completed early in 1954. This project will eliminate the hazardous hauling of waste by truck, will probably eliminate the need for concentrating wastes by the waste evaporator, and will greatly reduce the amount of effort and money expended in the disposal of liquid wastes.

The construction of the pipe line to the waste-storage pit will eliminate the need for more chemical-waste storage tanks and will provide a safer and cheaper way of permanently disposing of the "hot" chemical wastes.

Month ending January 31, 1954 (ORNL-1683, p. 10)

Construction has been started on the transfer line from the south tank farm to chemical-waste storage pit No. 2. Construction continued on the pump pit for the waste transfer line in the south tank farm.

A total of 12,600 gal of chemical-waste concentrate bearing 262

curies of beta activity was transferred to chemical-waste Pit No. 2 this month. This brings the total transferred to date to 282,600 gal containing 8930 curies.

Month ending February 28, 1954 (ORNL-1699, p. 10-11)

A total of 49,200 gal of concentrated chemical waste bearing 1173 curies of beta activity was transferred to chemical-waste storage pit No. 2. This brings the total transferred to date to 331,800 gal containing 10,104 curies.

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Construction of the waste transfer line from the tank farm to the chemical-waste storage pit has been completed by the contractor. The construction of the pumping station by the Laboratory forces continues and is scheduled to be completed in April, when delivery of the pump is expected.

Month ending March 31, 1954 (ORNL-1710, p. 12)

A total of 11,800 gal of nonradioactive concentrated chemical waste was transferred to chemical waste storage pit No. 2. Of this amount, 5000 gal was $Al(NO_3)_3$ waste from Unit Operations, Building 4505, and 6800 gal was NH_4NO_3 from metal recovery operations, Building 3505.

Month ending April 30, 1954 (ORNL-1730, p. 10)

The trailer used to haul radioactive wastes was temporarily removed from service for emergency repairs after it received serious corrosive attack from acidic wastes. One new surplus trailer has been procured to replace the damaged one since it could not be put back into its original good condition; another surplus trailer was also obtained as a spare.

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A total of 29,160 gal of radioactive and inactive chemical wastes were transferred to chemical-waste storage pit No. 2. Of this amount, only 400 gal, received from the decontamination of the homogeneous reactor, was radioactive; it contained 0.696 beta curies. The remaining volumes were 10,550 gal of $Al(NO_3)_3$ waste from Unit Operations, Building 4505; and 18,210 gal of NH_4NO_3 from metal recovery operations, Building 3505.

Month ending May 31, 1954 (ORNL-1743, p. 8-9)

The trailer used to haul contaminated wastes was removed from service twice for emergency repairs because of leakage. The replacement trailers are at the shops awaiting alterations.

The black-iron drain line from the waste trailer unloading area to the waste storage pit was completely destroyed by low-pH wastes. The drain line was replaced with one made of terra cotta.

The pumping station in the line from the tank farm to chemical-waste storage pit No. 2 is essentially complete. Some minor work remains to be performed before the project is accepted for use. The equipment has been tested and meets the manufacturer's specifications.

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A total of 26,613 gal of waste contaminated with natural uranium was transferred to chemical-waste storage pit No. 2. Of this amount, 4420 gal of $Al(NO_3)_3$ was received from Unit Operations, Building 4505, and 18,193 gal of NH_4NO_3 from metal recovery operations, Building 3505.

Month ending June 30, 1954 (ORNL-1752, p. 9-10)

The installation of the pumping station for the pipe line to the waste pit was completed and the waste transfer pipe line put into service on June 2. The performance of the pump was highly satisfactory; at 120-psi pump discharge pressure, the delivery rate was 1800 gph, 600 gph more than the expected rate.

With the successful beginning of the waste transfer line operation, the waste evaporator was shut down and put in a standby condition. Hot wastes are now being pumped directly to the pit without a reduction in volume. The elimination of this operation is expected to reduce waste handling costs.

With the operation of the pipe line, it was also possible to eliminate usage of the waste trailer for hauling the concentrated NH_4OH wastes from the Metal Recovery Building. This waste is now being discharged to the tank farm storage tanks, where it is pumped to the waste pit along with the radioactive wastes.

A total of 99,460 gal of wastes, containing 1492 curies of beta activity, was transferred to the pit this month. Approximately 88,800 gal was transferred through the new pipeline and contained all the activity; 6700 gal was concentrated NH_4OH transported by tank truck from the Metal Recovery Building, and 3960 gal was $Al(NO_3)_3$ transferred by tank truck from the Unit Operations Building.

Month ending July 31, 1954 (ORNL-1764, p. 9-10)

Radioactive wastes containing 4666 curies (133,800 gal) were pumped from tank W-8 to chemical waste storage pit No. 2. In addition, 4127 gal of highly concentrated inactive $Al(NO_3)_3$ and NH_4NO_3 waste was transferred to the pit from Unit Operations. Building 4505, and the metal recovery operations, Building 3505. The total of all wastes discharged to waste storage pit No. 2 to date is 628,633 gal containing 16,263 curies.

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The trailer tank used to haul wastes to the chemical-waste pit was discarded because of leaks which could not be repaired. Surplus trailer tanks recently acquired are being repaired and their designs are being revised for plant use; one of these trailers should be available next month. Meanwhile, all wastes scheduled for pit disposal are being pumped to the chemical-waste pit.

Month ending August 31, 1954 (ORNL-1787, p. 9)

A 130,200-gal quantity of radioactive wastes containing 415 curies of radioactivity was pumped from tank W-8 to chemical waste storage pit No. 2. In addition, 4025 gal of highly concentrated inactive $Al(NO_3)_3$ waste was transferred to the pit from Unit Operations, Building 4505. The total of all wastes discharged to waste storage pit No. 2 to date is 762,858 gal, containing 16,678 curies.

The pump used to transfer wastes from tank W-8 to waste storage pit No. 2 failed and had to be removed for repair. Inspection revealed a plugging of the suction line and the pump casing with an unidentified white precipitate readily soluble in HNO_3. The pump was reinstalled and now operates satisfactorily.

Month ending September 30, 1954 (ORNL-1804, p. 10)

Radioactive wastes containing 744 curies in a volume of 165,600 gal were discharged into chemical-waste storage pit No. 2 from tank W-8. The total of all wastes discharged to waste storage pit No. 2 to date is 928,458 gal containing 17,422 curies. The chemical-waste system received 113,400 gal of waste during the month.

Alterations to the new hot-waste tank trailer have been completed.

Month ending October 31, 1954 (ORNL-1822, p. 9)

A total of 167,550 gal of wastes, containing 277.0 curies, was transferred to chemical storage pit No. 2 this month. Of the total, 3750 gal was not active and was trucked from Unit Operations Building 4505. The total of all wastes discharged to waste storage pit No. 2 to date is 1,095,708 gal containing 13,661 curies. (The curie figure has been erroneously reported 4038 curies too high since July, 1954, as the result of a calculating error.)

A total of 181,400 gal of waste was put through the chemical-waste system.

An additional line to the pump from the tank farm to chemical-waste storage pit No. 2 was installed from waste tank W-6, but it is not yet working satisfactorily.

Month ending November 30, 1954 (ORNL-1831, p.10)

A total of 49,650 gal of wastes containing 2036 curies was transferred to chemical-waste storage pit No. 2 this month. Of the total, 450 gal was not active and was moved by truck from Unit Operations Building 3503. The remaining wastes were pumped from chemical waste tank W-6. This is the first time that waste has been pumped successfully from this tank. The total of all wastes discharged to the waste storage pit No. 2 to date is 1,145,358 gal containing 15,697 curies.

The chemical-waste system received 73,200 gal of waste during the month.

Another chemical-waste storage pit located adjacent to chemical-waste storage pit No. 2 is under construction. The capacity of this new pit will be 1,000,000 gal, the same as that of pit No. 2. Construction should be completed during December.

Month ending December 31, 1954 (ORNL-1841, p. 9)

A total of 116,400 gal of wastes containing 196 curies was transferred to chemical-waste storage pit No. 2 this month from chemical-waste tank W-6. The total of all wastes discharged to the waste storage pit No. 2 to date is 1,261,758 gal containing 15,893 curies. There was 88,000 gal of waste put into the chemical-waste system.

Chemical-waste storage pit No. 3 is still under construction. The

pit now lacks only a gage board and protective fencing for completion.

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A piece of the transfer pipeline to the waste storage pit from the south tank farm was removed to allow revisions for servicing the new waste storage pit. Visual inspection of this piece of pipe indicated that no undue corrosion or wear has resulted from its use during the first seven months of operations.

End of Series published as ORNL-XXXX Reports.

Excerpts form ORNL Radioactive Waste Disposal Annual Reports
Pertaining to the Seepage Pits and Trenches

Annual Report for 1954 (ORNL-CF-55-1-212, p. 1-2)

The most important change made in the hot-waste disposal operation during the last several years was the installation of a 1.5-mile pipeline and pumping station between the tank farm and the waste disposal pit area. Before the pipeline was put into operation in June of this year, all hot wastes were reduced in volume by evaporation and the concentrate was hauled by truck trailer to the waste disposal pits. The operation was expensive and hazardous because of radiation exposure of operating personnel and the possibility of contamination of roads. Now, the radioactive wastes are temporarily stored in the tank farm until some radioactive decay takes place; then they are pumped directly to the pits through the new pipeline. Operation of the evaporator was discontinued, and the equipment was put in standby condition.

Excavation of New Waste Pit

By shutting down the waste evaporator, the rate of transfer of waste to the 1,000,000-gal pit was increased by a factor of about 15. It became apparent within several weeks that the seepage rate into the soil surrounding this pit was too low to keep up with the Laboratory's waste production rate and the normal rainfall into the pit. To increase the pit disposal capacity, excavation was started on a second 1,000,000 gal pit in the vicinity of the first one. It is expected that the two pits will be adequate for the disposal of the Laboratory's hot wastes for the next several years. Completion of the work on the second pit is expected in January 1955 (see Fig. 3).

Nonradioactive Chemical Wastes

The waste pits were also used this year for the disposal of 87,000 gal of nonradioactive concentrated $Al(NO_3)_3$ and NH_4NO_3 wastes. These wastes were hauled by truck trailer directly from the operating buildings. In the transportation of these wastes, the tank of the converted gasoline tank trailer was corroded by the acidic wastes which had been insufficiently neutralized. The trailer was taken out of service and two AEC surplus gasoline tank trailers were obtained, one to be held as a spare.

After the first tank trailer was taken out of service, an attempt was made to transfer the nonradioactive wastes through the pipeline. This operation ran into difficulty when the pump became gas-bound with ammonia caused by decomposition of NH_4NO_3.

[Table 1 Summary - 997,000 gal containing 7,224 beta curies were transferred to Pit 2. Waste Pit 1 was used in year 1951 only. The stated volume transferred includes 87,000 gal of nonradioactive chemical wastes hauled by truck directly from operation buildings to Pit 2.]

Annual Report for 1955 (ORNL-CF-55-12-170, p. 1-2)

Waste Disposal Operating Costs

The excavation of waste pits was an unusual expense item and

accounts for more than the amount of increase [in operating cost over last year]. Only $10,623, representing a portion of one pit excavation was charged to the operation in the year 1954, while $20,365 was charged in 1955 to complete the excavation begun in 1954 and to almost complete the work on a new one. It is interesting to note that the pit dug by the Laboratory forces and completed early in 1955 cost a total of $14,320, while the new one, which is, for the most part, under contract to a construction company, has already cost $16,668, and several thousand dollars more will have to be spent before the job will be completed.

Waste Volume and Activity

The disposal of wastes into open pits, without evaporation, was continued throughout 1955. A total of 1,674,000 gal of radioactive waste, containing 21,391 "beta curies" of activity, was pumped into the pits. This represents an increase of 84% in volume and 196% in activity over the previous year. Significant waste-disposal data for 1955 are compared with those of the five previous years in Table 1.

The waste evaporator was not operated during 1955. This was the first full year that the evaporator had been shut down since pit disposal was begun in 1951, which accounts for the increase in volume and a large portion of the increase in activity pumped into the pits. Without a reduction in volume, the waste could not be stored in the tank farm for a long period of time to permit decay of short-lived materials prior to transfer to the pits.

The total volume of radioactive waste received was 1,691,000 gal, which is lower by 20% than the average for the five previous years but higher by 7% than the volume in 1954, the lowest on record. The low volume in 1954 was due mainly to a long shutdown of operations at the Hot Pilot Plant.

Excavation of Waste Pits

The second 1,000,000-gal waste pit (No. 3) was completed and put in service in January 1955. The excavation of the third pit (No. 4) was completed by the contractor in October but will not be ready for use until the Laboratory forces install a sampling platform and a screen cover. It is estimated that at the current rate of production the capacity of the two pits used at present will be adequate for several more months. The pits currently used are shown in Fig. 2.

Annual Report for Calendar Year 1956 (ORNL-CF-57-1-172, p. 2)

Waste Volume and Activity

A total of 2,694,000 gal of waste containing 34,989 curies of "beta activity" was pumped to the waste pits in 1956. This was an increase of 61% in volume and 64% in activity over the previous year. The increases were due to the expansion of the operating activities at the Hot Pilot Plant and the Metal Recovery Plant. Other significant waste-disposal data for 1956 are compared with those of six previous years in Table 2.

The increase in volume is viewed with no concern, since the capacity of the waste-disposal system is far greater than the volumes currently produced and can be limited only by the seepage rates in the three waste pits now in use. Present rates appear to be adequate for several more years, and no further excavation of pits or expansion of the hot-waste facilities is anticipated unless the present waste-disposal methods are

found to be unsafe for wastes produced for some future Laboratory programs such as the Power Reactor Fuel Processing now in the proposal stage.

Annual Report for 1957 (ORNL-CF-57-12-143, p. 4-6)

Waste Volume and Activity

The disposal of all hot wastes to waste pits 2, 3, and 4 continued throughout the year. By the end of 1957 the total of all wastes discharged into the pits was 8,546,000 gal containing 114,191 curies (at the time of transfer). There was no indication of a significant loss of pit seepage capacity or breakthrough of activity into White Oak Creek. A total of 41,918 curies was discharged to the waste pits in 1957, an increase of 20% over that in 1956. The increase was due mainly to high radiation levels in processing at the Hot Pilot Plant.

The volume of waste in 1957 was 2,903,000 gal, an increase of 8% over that in 1956. There were two reasons for the increase: a higher discharge from the Hot Pilot Plant and the diversion of some wastes into the system that in previous years were handled by the process waste system. The diversion into the hot waste system, of wastes of lower activity level and of those that had to be analyzed to determine whether they could be handled by the process waste system, helped to reduce the activity discharged to the Creek and eliminated costly analyses. A comparison of volumes as well as activity handled by the system in the last five years is given in Table 2.

End of the Annual Report Series.

Excerpts from Operations Divisions Quarterly Reports Pertaining to the Seepage Pits and Trenches

January-March, 1958 (ORNL-CF-58-2-67, p. 23)

[Routine reporting of transfer of 239,000 gal containing 9,614 curies to Pits 2, 3, and 4 bringing total inventory to 123,805 curies.]

April-June, 1958 (ORNL-CF-6-122)

[Routine reporting of transfer of 735,000 gal containing 19,020 curies to Pits 2, 3, and 4 bringing total inventory to 144,886 curies.]

July-September, 1958 (ORNL-CF-9-88, p. 101)

[Routine reporting of transfer of 941,000 gal containing 11,560 curies to Pits 2, 3, and 4 bring total inventory to 156,446 curies. New waste transfer line to the pits was tested with air pressure and found to be performing well.]

October-December, 1958 (ORNL-CF-12-147, p. 74-75)

[Routine reporting of transfer of 845,000 gal containing 10,540 curies to Pits 2, 3, and 4 bringing total inventory to 166,986 curies.]

January-March, 1959 (ORNL-CF-59-3-1, p. 24)

[Routine reporting of transfer of 914,000 gal containing 12,053 curies to Pits 2, 3, and 4 bringing total inventory to 179,039 curies.]

April-June, 1959 (ORNL-CF-59-6-131, p. 50)

[Routine reporting of transfer of 807,000 gal containing 60,042 curies to Pits 2, 3, and 4 bringing total inventory to 239,081 curies.]

July-September, 1959 (ORNL-CF-59-9-111, p. 59)

[Routine reporting of transfer of 1,163,000 gal containing 166,000 curies to Pits 2, 3, and 4 bringing total inventory to 369,000 curies.]

October-December, 1959 (ORNL-CF-59-12-102, p. 33-34)

A potentially serious break-through of Ru^{106} activity in the bank on the east side of waste pit No. 4 to White Oak Creek occurred during this period. It is estimated that between 300 and 350 curies of activity were released in to the creek; this accounts for about one-fourth of the 11 percent of MPC shown in Table 4.1. Excavation of the area east of the pit revealed that the bulk of the release came through a narrow channel which flowed under the road into the swampy area east of the pit. The activity in the material released approached that contained in the pit itself; approximately 10^5 c/m/ml.

Plans are now being made to discontinue the use of the existing

pits for future high-level wastes by replacing them with a covered soil column and another seepage pit in another location. For the interim period the condition has been corrected by intercepting the leakage and pumping it back into the pit.

The data for high-level waste pumped to the lagoons or pits are given in Table 4.3. [706,000 gal containing 78,000 curies bringing total inventory in pits to 447,000 curies].

January-March, 1960 (ORNL-CF-60-3-148, p. 53-55)

The Laboratory's long-range program for improving liquid waste disposal methods includes the addition of a third system for disposal of extremely active wastes such as those anticipated from the power reactor fuel reprocessing program. The waste to be handled in the new system is now referred to as "high-level waste." Beginning with this report, the waste previously called high-level waste will be termed "intermediate-level waste" to maintain a differentiation between the two types.

The main portion of the Ru^{106} leakage from waste pit No. 4 to White Oak Creek, mentioned in the previous report, has been eliminated since January 6. This was accomplished by digging a 10-ft deep, 175-ft long trench perpendicular to the direction of seepage on the east side of pit No. 4 to intercept the active solution and pumping the solution back into the pit. Approximately 50 curies in 8,000 gal of solution is being returned to the pit daily.

The use of pit No. 4 will be discontinued, and the pit will be sealed when the new trench No. 5 is put in operation. Construction of this trench is now 95% complete. In the meantime, plans are being made to further reduce the discharge of Ru^{106} from the existing pits by fixing the activity in the pits by the addition of copper compounds. The development of the process is essentially complete, and an effort is being made to procure the materials.
[859,400 gal containing 10,150 curies was transferred to pits 2, 3, and 4 bringing the total inventory to 457,150 curies.]

April-June, 1960 (ORNL-CF-60-6-127, p. 55-59)

Construction of seepage trench No. 5 was completed May 20, and metering of solution was immediately started for the purpose of calibration and pretreatment. To enhance the Ru retaining characteristics of the soil and limestone, 1800 lb of $CuSO_4$ and 1000 lb of Na_2S were metered into the 64,000 gal of water required to fill the trench to the 9-ft level, 6 in. below the overflow point. The trench was allowed to empty itself by seepage, in 19 days, and was ready for the first filling with waste at the end of the quarter. The average seepage rate when the trench was full was approximately 4,300 gal per day.

Level recording and control devices are on order and will be installed as soon as they are available. The equipment will give an indication of the liquid level in the trench and will prohibit filling above a preset level to prevent overflow into the creek.

There were two breaks in the waste transfer line to the pits during this quarter; one, approximately 50 ft from the pump in the south tank farm, resulted from corrosion and the other, located where the line crosses the creek near the bridge to the 7500 Area, was due to damage by

heavy equipment. Although neither incident resulted in a serious hazard, the second could have seriously contaminated the creek if it had occurred at a time when a waste transfer was being made. To prevent this possibility in the future and until the replacement line is put into operation, better controls have been established over digging work in the vicinity of the waste lines. The replacement line, now awaiting AEC approval, has been laid out so that it does not cross the creek at any point.

An inspection of the line at the creek, while repairs were being made, indicated that there may be other potential leaks in the line. An X-ray of a weld near the break but not touched by the digging equipment showed that the weld was faulty; the weld was repaired. To forestall any large release into the creek through weak points in the line that are not now apparent, a radiation monitor, similar to that used in the process waste system at the automatic diversion valve, is being installed in the creek downstream from the bridge. The information will be telemetered and recorded at the Process Waste Treatment Plant. During the period while the instrument is being installed, the creek is sampled and analyzed every two hours while waste is being pumped.

A summary of the waste pumped to the waste pits is given in Table 4.3. All waste during this quarter was pumped to pits 2, 3, and 4. Trench No. 5 is scheduled to be put into operation during the first week in June.

[638,400 gal were transferred containing 5,479 gross beta curies bringing total inventory to date to 462,629 beta curies.
First data presented on the isotopic composition of the waste: ^{89}Sr(15.8Cu), ^{90}Sr(291.9Cu), ^{106}Ru(3068.0Cu), ^{137}Cs(708.0 Cu), ^{134}Cs(99.3 Cu), TRE(2149.0 Cu) with average nitrate and phosphate concentration of 0.11 and 0.002 moles/gal, respectively.]

July-September, 1960 (ORNL-CF-60-9-121, p. 53-56)

Trench No. 5 was placed in operation at the beginning of the quarter. An average of 23,000 gallons of waste/week was pumped into the pit. This represents 40 percent of the waste transferred to the lagoon area. Pit No. 4, originally scheduled to be taken out of service, has been used sparingly. An estimated 50,000 gallons were diverted into this pit over the three-month period.

Contracts for the new 2-in. transfer line and the emergency pond are expected to be open for bids in October. Alterations involving the settling basin, a by-pass installation, and basin enlargement have been deferred to a future date.

Table 4.4. summarizes waste transfers to the lagoon area.
[468,000 gal containing 3,485 beta curies to pits 2, 3, and 4.
356,400 gal containing 2,062 beta curies to Trench 5.
Isotopic composition to each trench also presented.]

Seepage Trench No. 6

During the quarter, seepage trench No. 5 was operated continuously at a rate of approximately 3,000 gallons/day, with a maximum seepage rate of 4,000 gallons/day. Since the rate of intermediate-level waste generation approximates 7,000 to 8,000 gallons/day, it has been necessary to use Pits No. 2, 3, and 4 to take the excess. In order to eliminate this necessity and permanently remove these pits from service, it is planned to construct a second closed seepage trench. A location

northeast of trench No. 5 was first chosen because of its accessibility by road and its nearness to the waste pipe line. Some doubt was raised, however, as to the effective operation of a trench located on that particular ridge due to its narrow crest and steep sides. A second site is being investigated and cost estimates are being prepared for each location. The inclusion of a treatment trench was suggested, and plans for this are now being studied. Such a trench would be about 30,000 gal capacity, would have impermeable walls, and would be filled with a variety of materials that would adsorb and remove most of the radioactivity from the incoming waste. The discharge would then go to the seepage trenches where the balance of the activity would be removed by seepage through the soil. At the completion of the necessary Laboratory development work, now under way, the actual engineering of such a trench can proceed.

October-December, 1960 (ORNL-CF-60-12-122, p. 32-33)

There was practically no reduction in the volume of intermediate-level waste, even though substantial reductions were accomplished in some areas by eliminating unnecessary dilution. An abnormally large volume, accounting for about 40% of the Laboratory total, was received from Building 3019 where extensive cell decontamination work was done. The success of efforts made to reduce the volume of waste will not become obvious until the cell decontamination is completed. Other intermediate-level waste data are given in Table 4.6.
[Pits 2, 3, 4 received 424,800 gal containing 2,380 gross beta curies.
Trench 5 received 376,200 gal containing 1,474 gross beta curies.
Isotopic composition for each trench is also presented.]
Seepage Trench No. 6.

Engineering design of seepage trench No. 6 is nearing completion. A site with favorable topographic characteristics was chosen on a ridge northeast of the trench No. 5 area. The new trench will extend approximately 500 ft along this ridge. Trench No. 6, being 50% longer than trench No. 5, should have sufficient capacity to dispose of all the intermediate-level waste now going to Pits No. 2, 3, and 4. The estimated cost of the new trench, including access road, is $30,000; construction is expected to begin in early May, 1961.

January-March, 1961 (ORNL-CF-61-3-138, p. 32-34)

The waste pits and trench No. 5 were maintained at maximum levels during this quarter because of heavy rainfall and high volumes received (see Figure 4.2.), mainly from Building 3019. During this period, two seeps were detected on the west side of pit No. 2. It is evident that the operation of the pits at the high levels was responsible for the development of the new seeps.

In an effort to reduce the amount of ruthenium activity released from the new seeps, a trench, similar to the one on the east side of pit No. 4, was dug on the west side of pit No. 2. The trench intercepts the seeps, and the liquid is pumped back into the pit. To fix the activity in the soil, ten tons of sodium sulfide was introduced into the three open pits.

The monitoring wells at trench No. 5 were sampled, and the analytical results were turned over to the Health Physics Division for appraisal.

Monthly samples taken from the creek on the west side of trench No. 5 gave no indication of activity released in that direction.

A contract for construction of trench No. 6 has been awarded. The scheduled completion date is August 8. This, along with trench No. 5, will provide enough capacity for the Intermediate-Level Waste, allowing the open pits to be sealed.

The activity transferred to the pits and trench is given in Table 4.4. [1,368 curies to trench 5 for a total to date of 4,904 curies. 1,498 curies to pits 2, 3, and 4 for a total to date of 469,993 Ci. From Fig. 4.2, 150,000, 280,000, and 275,000 gal of waste were transferred in January, February, and March respectively.]

April-June, 1961 (ORNL-CF-61-6-115, p. 40-42)

The waste pits and trench No. 5 operated at full capacity for the entire quarter. Heavy rainfall and continued high-volume releases from Building 3019 resulted in a maximum inventory of the system (see Figure 4.2 and Table 4.3).
[1,958 Ci to trench 5 raising total inventory to 6,862 Ci and 1,992 Ci to pits 2, 3, and 4 raising total inventory to 471,985 Ci. Isotopic compositions of these discharged activities is also presented. From Fig. 4.2, it is estimated that 300,000, 305,000 and 190,000 gal of waste were discharged in April, May, and June, respectively.]

Two leaks developed in the west bank of pit No. 4. An intercepting trench was excavated at the junction of these leaks and liquid accumulations are pumped back to the pit.

The excavation and filling of the new waste trench No. 6 has been completed; and the installation of an access road, power line, and connecting pipeline by August 1 will complete the project. The new 2-in. waste line is currently being held in standby pending the installation of valve stations for future facilities. In the meantime, the old waste line is being used.

End of this Series. The next two Operations Division Quarterly Reports (ORNL-CF-61-9-68 and ORNL-CF-61-12-78) contain no information on radioactive waste management operations.

Excerpts from Laboratory Facilities - Waste Disposal Monthly Reports

Pertaining to the Seepage Pits and Trenches.

The first five monthly reports do not bear ORNL-CF-numbers but copies were obtained from the files of L. C. Lasher (ORNL Operations Division). These reports were prepared by J. F. Manneschmidt until February, 1963, when L. C. Lasher assumed responsibility for their production.

July, 1961 (p. 2)

The waste pits and Trench No. 5 continue to operate at maximum inventory. Major contributors of intermediate level waste for the month of July were as follows: Building 3019 (37,000gal), Reactor Operations (29,000gal), Fission Products Development Laboratory, Bldg. 3517 (27,000gal), Radioisotopes Processing Area (24,000gal), and Segmenting Cells, Bldg. 3026 (13,000gal). Activity transfer data for the system are given in Table 3; volumes are shown in Figure 2.
[Fig. 2. indicates 140,000 gal to pits and trench 5; 477 Ci to trench 5 and 482 Ci to pits 2, 3, and 4; isotopic data by ^{89}Sr, ^{90}Sr, ^{106}Ru, ^{137}Cs, and TRE presented.]

Chemical treatment of Trench No. 6 was initiated this month. The trench was filled with 0.07 M copper sulfate solution and will be allowed to seep dry before the introduction of radioactive waste. A total of 20,000 lbs. of $CuSO_4 \cdot 5H_2O$ in approximately 140,000 gals of water was used in this operation. Normal usage of the trench is anticipated by mid-September. At that time, filling and sealing of the open pits will proceed.

August, 1961

[Report not located.]

September, 1961 (p. 1-2)

Over 240,000 gallons of intermediate level waste containing 1300 curies of activity were disposed of during the month. This volume is slightly less than that processed during July or August and is about equal to the monthly average for 1961. Major contributors to the system during September were as follows:.....
Activity transfer data for the system are given in Table 3; volumes are shown in Figure 2.
[Fig. 2 indicates that in August, 1961 (the previous month for which a report was not located) 260,000 gal were disposed. Also, by subtracting the year-to-date total curies for this month from that reported in July, 1961, the activities discharged in August were obtained: 5,014 - 4,487 = 527 Ci to trench 5 and none to pits 2, 3, or 4. Table 3 indicates 666 curies were discharged to trench 6.]

Trench No. 6 assumed operational status on September 7 and during the balance of the month received 125,000 gallons of waste. Approximately 25% of Pit No. 3 was backfilled during September and it is estimated that filling and sealing will be completed by February 1962.

October, 1961 (p. 1-2)

The break-through of activity was located on the slope south of Trench No. 6 early this month. The radiation field in the contaminated area was greater than 20 mr/hr at contact and abnormal amounts of Sr and Cs were detected in the seepage. The trench was taken out of service at this time, and waste was rerouted to Pits Nos. 2 and 4. The total volume of intermediate level waste transferred during the month was 309,000 gals. (Figure 2), with the major contributors, as follows:....
[Trench 5 received 6,034 Ci., trench 6 378 Ci., and Pits 2 and 4 received 5,777 Ci. Trench 6 was in operation from September 7 to October 10, 1961 only. Isotopic data for the discharges to each trench is also given and, since September, 1961, includes differentiation of ^{60}Co.]

November, 1961 (p. 1-2)

A total of 240,000 gals. of intermediate level waste was transferred to Pits 2 and 4 and to Trench No. 5 during the month of November. (Figure 2). Trench No. 6 remains out of service due to the activity break-through reported last month. This break-through is being studied by the E & M Division and, if corrective measures can be taken to insure safe operation, Trench No. 6 may again become operable. Major contributors to the intermediate level waste system were as follows:
.....
More complete data on the activity transferred to the pits and trenches are given in Table 3.
[Table 3 indicates that 4,773 Ci went to trench 5 and 3,600 Ci went to Pits 2 and 4 this month. Isotopic data on these waste transfers is also presented.]

Report for December 1961 (ORNL-CF-62-2-55, p. 1-2)

A total of 409,000 gals. of intermediate level waste were transferred to the soil disposal areas during the month (Figure 2). This represents a volume increase of 70% over the total reported for November. Heavy rainfall and clean-up activities the building 3505 storage canal contributed to this surge. Major users of the system were as follows: .....
More complete data on the intermediate level waste activity transfers are given in Table 3.
[372 Ci went to trench 5 and 2,469 Ci went to pits 2 and 4 yielding total inventories to date of 19,717 and 500,360 Ci, respectively. Isotopic data for Sr, Ru, Cs, and TRE is also given.]

Report for January 1962 (ORNL-CF-62-3-38, p. 5)

[Routine reporting of 340,000 gals transferred; 569 Ci to trench 5 and 1,516 Ci to pits 2 and 4 with isotopic composition.]

Report for February 1962 (ORNL-CF-62-4-49, p. 6)

[Routine reporting of 240,000 gal transferred; 1,717 Ci to trench

5 and 1,418 Ci to pits 2 and 4 with isotopic data including ^{60}Co.]

Report for March 1962 (ORNL-CF-62-5-64, p. 5)

Storage facilities for intermediate level waste remained filled to capacity and nearly 400,000 gallons were transferred to the disposal area. This represents an increase of 70% over the month of February. Major contributors to the ILW system were as follows:.....

A site was selected for a new covered storage trench [No. 7] and preliminary design of the facility was begun. ILW volumes are shown in Figure 2; transfer data are given in Table 3.
[2,448 Ci to trench 5 and 5,778 Ci to pits 2 and 4 with isotopic composition.]

Report for April 1962 (ORNL-CF-62-6-10, p. 7-9)

275,000 gallons of intermediate level waste was transferred to the disposal area during the month of April. (See Liquid Waste Volumes, Fig. 2). This is a 30% reduction below the volume pumped in March and is attributed to a decrease in rainfall during the month and completion of repair work on leaking waste lines in the Radioisotopes Processing Area. The volume of waste received into the system invariably goes up during wet weather because of leakage into lines, accumulation of water in pump pits, and for other reasons. Discharges from the Metal Recovery Building canal continue to be abnormally high and will probably remain so until the present temporary operations being carried out at that laboratory are completed. In spite of the reduction in intermediate level waste volume experienced during this month, the volume was still above the monthly average for 1960 and 1961. Transfer data on ILW disposal is given in Table 3.
[2,366 Ci to trench 5 and 2,748 Ci to pits 2 and 4 with isotopic composition including ^{60}Co.]

The back filling of waste pit No. 3 was resumed this month and only 300 sq ft of the surface area remains uncovered. The preliminary design work for trench No. 7 was begun.

Report for May 1962 (ORNL-CF-62-7-16, p.4)

[Routine reporting of 415,000 gallons transferred; 1,302 Ci to trench 5 and 3,470 Ci to pits 2 and 4 with isotopic composition.]

Report for June1962 (ORNL-CF-62-8-7, p. 5)

[Routine reporting of 380,000 gallons transferred; 968 Ci to trench 5 and 1,800 Ci to pits 2 and 4 with isotopic composition.]

Report for July 1962 (ORNL-CF-62-8-78, p. 5)

[Routine reporting of 420,000 gallons transferred; 1,656 Ci to trench 5 and 2,844 Ci to pits 2 and 4 with isotopic composition data.] Open waste pit No. 3 was backfilled and sealed with asphalt during the period, and, late in the month, construction of covered trench No. 7 was started. Completion of this facility is expected by the end of August.

Report for August 1962 (ORNL-CF-62-10-39, p. 5)

[Routine reporting of 265,000 gallons transferred; 221 Ci to trench 5 and 217 Ci to pits 2 and 4 with isotopic compositions.]

Report for September 1962 (ORNL-CF-62-11-24, p. 6)

[Routine reporting of 295,000 gallons transferred; 1,615 Ci to trench 5 and 953 Ci to pits 2 and 4 with isotopic compositions.]

Disposal Trench No. 7 was completed during the month and the Laboratory assumed beneficial occupancy of the facility. The trench was pretreated by filling with 50,000 gallons of 4% NaOH solution which was allowed to seep out. This operation was accomplished in less than a week which indicated a very rapid seepage rate for the trench. By comparison, seepage of pretreatment solution from Trench No. 5 took over a month.

The first pumping of waste into trench No. 7 is scheduled for the first week in October. Open pits Nos. 3 and 4 are now out of service and the use of pit No. 2 will be discontinued when Trench No. 7 becomes operable. ILW transfer data for September is given in Table 4.

Report for October 1962 (ORNL-CF-62-12-2, p. 6)

Transfers totalling approximately 350 thousand gallons were made from the ILW collection system to the soil disposal system during the month of October (See Figure 2). The two units of Trench No. 7 were put into operation on October 4 and during the remainder of the month 37% of the total volume of waste was pumped to that facility. Only about 13% of the intermediate waste was pumped to the open pit system (Pit No. 2) and in the near future that unit will be taken out of service.

The monitoring wells in the vicinity of the disposal trenches and the drainage system for the immediate area are surveyed on a weekly basis. To date, no significant quantities of radioactivity have been found.

[Routine reporting of the activity discharges is presented; 685 Ci to pit 2, 3,110 Ci to trench 5, 910 Ci to trench 7A, and 937 Ci to 7B with isotopic compositions.]

Report for November 1962 (ORNL-CF-63-1-23, p. 6)

November transfers of intermediate-level waste to the soil disposal area totalled 340 thousand gallons (See Figure 2).

Distribution was made to the pits and trenches , as follows: [pit No. 2 = 78,660, trench 5 = 160,200, trench 7A = 50,400, and Trench 7B = 51,600 gallons]

The operation of trench 7 has been continued at a rate far below its capacity. Small amounts of radioactivity have been detected in two monitoring wells located on the east side of the north (A) section of Trench No. 7. Although the level of activity, which is predominantly ruthenium, was almost insignificant, continuing surveillance of the wells will be maintained.

Pit No. 2 was taken out of service late in the month and back-fill operations started. Pit No. 4 will continue to be used for the disposal of sludge from the Waste Treatment Plant and as a stand-by facility.

[pit 2 received 716 Ci, trench 5 923 Ci, Trench 7A 222 Ci, and Trench 7B 485 Ci with isotopic compositions.]
[This month was the last use of pits 2, 3, and 4 area. The total activity discharged to pit 2 during 1961 is given: 1,657 Ci of ^{90}Sr, 757 Ci of ^{106}Ru, 12,889 Ci of ^{137}Cs, 855 Ci of TRE, and a total of 16,148 Ci. The 1962 totals are also given: 1513 Ci of ^{90}Sr, 741 Ci of ^{106}Ru, 17,561 Ci of ^{137}Cs, 111 Ci of ^{60}Co, and 21,070 Ci total. The total activity discharged to the pits in the period of use is stated as 522,505 Ci but this cannot be subdivided among the pits because of their method of operation; this figure cannot be subdivided into isotopes either since previous to 1960 only gross beta counts were determined.]

Report for December 1962 (ORNL-CF-63-1-73, p. 6)

[160,500 gal to trench 5, 97,900 gal to trench 7A, and 63,900 gal to trench 7B]
Filling operations at Pit No. 2 are still in progress; completion by late January is anticipated.
Complete transfer data on this system is given in Table 4.
[1,203 Ci to trench 5, 869 Ci to trench 7A, 567 Ci to trench 7B with isotopic compositions. No discharge to pits.]

Report for January 1963 (ORNL-CF-63-3-39, p. 4-8)

[Routine reporting of 169,200 gal (2273 Ci) to trench 5, 87,000 gal (1,663 Ci) to trench 7A, and 84,900 gal (1,629 Ci) to trench 7B with isotopic compositions.]
Pit No. 2 has been completely back-filled and, with Pit No. 3, is now permanently out of service. Pit No. 4 remains open and is used as a disposal facility for sludge from the waste treatment plant.
Complete transfer data on the ILW system is given in Table 4.

Report for February 1963 (ORNL-CF-63-4-3, p. 5-10)

Routine reporting of 135,600 gal (4646 curies) to trench 5, 64,800 gal (2140 Ci) to trench 7A, and 75,600 gal (2497 Ci) to trench 7B with isotopic compositions.]
During the second week of the month, daily samples were taken from two seep streams east and west of the Trench No. 7 area. Analyses of these samples and estimates of the flow rates indicate that approximately 30 millicuries/day of ^{106}Ru and 4 millicuries/day of ^{60}Co are being released by the trench to these two streams. Absorption studies failed to show the presence of ^{90}Sr or other low-energy beta emitters. Periodic monitoring of the area will be continued.

Report for March 1963 (ORNL-CF-63-5-14, p. 8)

[Routine reporting of 98,400 gal (1790 Ci) to trench 5, 108,000 gal (1726 Ci) to trench 7A, and 94,800 gal (1533 Ci) to trench 7B with isotopic compositions.]
Analyses of samples taken from the trench 7 drainage area indicate that the approximate rates of release of strontium, ruthenium, and cobalt are as listed below:

$Sr^{89\ 90}$	<1.6 microcuries/day
Ru^{106}	20 mc/day
Co^{60}	6 mc/day

Report for April 1963 (ORNL-CF-63-5-75, p. 8)

[Routine reporting of 164,400 gal (112 Ci) to trench 5, 39,000 gal (no total Ci given) to trench 7A, and 97,200 gal (no total Ci given) to trench 7B although there are isotopic compositions.]

Report for May 1963 (ORNL-CF-63-6-44, p. 1-8)

[Routine reporting of 180,000 gal (5376 Ci) to trench 5, 100,800 gal (3221 Ci) to trench 7A, and 109,200 gal (3600 Ci) to trench 7B with isotopic compositions.]
Analyses of composite samples taken at the trench 7 drainage areas indicate that the approximate rates of release of strontium, ruthenium, cesium and cobalt are as listed below:

1. Strontium 3 microcuries per day
2. Cesium 66 microcuries per day
3. Ruthenium 61 millicuries per day
4. Cobalt 24 millicuries per day

Report for June 1963 (ORNL-CF-63-8-4, p. 7)

[Routine reporting of 178,800 gal (2550 Ci) to trench 5, 109,200 gal (2142 Ci) to trench 7A, and 120,000 gal (2255 Ci) to trench 7B with isotopic compositions.]

Report for July 1963 (ORNL-CF-63-8-64, p. 6-10)

[Routine reporting of 189,800 gal (4759 Ci) to trench 5, 230,400 gal (8484 Ci) to trench 7A, and 125,400 gal (4242 Ci) to trench 7B with isotopic compositions.
The abnormally high volumes resulted from accelerated processing activities and a faulty pipe connection to the system in Building 3019. Increased volumes were also received from the Radioisotopes Processing Area and the Reactor Area. A transfer of 49,000 gallons of supernatant from the metal waste system to the intermediate-level system also contributed to the excessive volume.]

Report for August 1963 (ORNL-CF-63-10-5, p. 9)

[Routine reporting of 180,200 gal (12,259 Ci) to trench 5, 77,600 gal (4105 Ci) to trench 7A, and 95,600 gal (5051 Ci) to trench 7B with isotopic compositions mostly ^{137}Cs to trench 5.]

Report for September 1963 (ORNL-CF-63-11-10, p. 8)

[Routine reporting of 173,200 gal (10,209 Ci) to trench 5, 63,800 gal (4403 Ci) to trench 7A, and 90,400 gal (6604 Ci) to trench 7B with isotopic compositions, mostly ^{137}Cs to trench 5.]

Report for October 1963 (ORNL-CF-63-12-11, p. 7)

[Routine reporting of 102,000 gal (7325 Ci) to trench 5, 46,800 gal (1233 Ci) to trench 7A, and 87,000 gal (2311 Ci) to trench 7B with isotopic compositions.]

Report for November 1963 (ORNL-CF-64-1-28, p. 7)

[Routine reporting of 117,600 gal (900 Ci) to trench 5, 95,000 gal (950 Ci) to trench 7A, and 66,000 gal (654 Ci) to trench 7B with isotopic compositions.]

Report for December 1963 (ORNL-CF-64-2-30, p. 8)

[Routine reporting of 72,000 gal (1681 Ci) to trench 5, 99,600 gal (2458 Ci) to trench 7A, and 93,600 gal (2307 Ci) to trench 7B with isotopic compositions.]

Report for January 1964 (ORNL-CF-64-3-21, p. 6-9)

[Routine reporting of 122,400 gal (2520 Ci) to trench 5, 147,600 gal (3979 Ci) to trench 7A, and 108,000 gal (2652 Ci) to trench 7B with isotopic compositions.]

Report for February 1964 (ORNL-CF-64-3-57, p. 6-10)

[Routine reporting of 80,400 gal (807 Ci) to trench 5, 184,000 gal (4258 Ci) to trench 7A, and 88,200 gal (2840 Ci) to trench 7B with isotopic compositions.]
Analyses of grab samples, taken at intervals of approximately two months, indicate that there is no significant movement of radioactive strontium in the seep streams from the covered trenches to the creek and that the ruthenium being released from the same trenches is only a small fraction of the amount being released from the area of the waste pits that have been taken out of service. Two of the waste pits have been filled and will be covered with an asphalt pavement as soon as weather permits the asphalting operation. The third pit [No. 4] remains open and is being used for disposal of the Process Waste Treatment Plant Lime-soda ash-clay sludge.

Report for March 1964 (ORNL-CF-64-4-87, p. 9)

[Routine reporting of 98,200 gal (1105 Ci) to trench 5, 163,800 gal (857 Ci) to trench 7A, and 112,200 gal (572 Ci) to trench 7B with isotopic compositions.]

Report for April 1964 (ORNL-CF-64-5-68, p. 6-9)

[Routine reporting of 91,800 gal (889 Ci) to trench 5, 166,900 gal (4302 Ci) to trench 7A, and 85,400 gal (2868 Ci) to trench 7B with isotopic compositions.]
An additional 52,500 gallons of waste was pumped to the Shale Fracturing Area for experimental disposal.

Report for May 1964 (ORNL-CF-64-7-6, p. 2-3)

[Routine reporting of 150,200 gal (2580 Ci) to trench 5, 176,600 gal (4997 Ci) to trench 7A, and 97,600 gal (3331 Ci) to trench 7B with isotopic compositions.]
An additional 20,000 gallons of waste was pumped to the Shale Fracturing Area for experimental disposal.

Report for June 1964 (ORNL-CF-64-7-63, p. 2)

[Routine reporting of 141,600 gal (1387 Ci) to trench 5, 137,200 gal (1762 Ci) to trench 7A, and 70,400 gal (881 Ci) to trench 7B with isotopic compositions.]

Report for July 1964 (ORNL-CF-64-8-77, p. 2)

[Routine reporting of 150,200 gal (5796 Ci) to trench 5, 137,200 gal (4869 Ci) to trench 7A, and 82,400 gal (2435 Ci) to trench 7B with isotopic compositions.]

Report for August 1964 (ORNL-CF-64-9-63, p. 2)

[Routine reporting of 182,800 gal (9089 Ci) to trench 5, 169,700 gal (6923 Ci) to trench 7A, and 121,600 gal (5014 Ci) to trench 7B with isotopic compositions.]

Report for September 1964 (ORNL-CF-64-10-57, p. 2)

[Routine reporting of 172,432 gal (3500 Ci) to trench 5, 146,735 gal (7128 Ci) to trench 7A, and 92,877 gal (4112 Ci) to trench 7B with isotopic compositions.]

Report for October 1964 (ORNL-CF-64-12-15, p. 2-3)

[Routine reporting of 169,464 gal (34,003 Ci) to trench 5, 144,918 gal (23,911 Ci) to trench 7A, and 102,265 gal (16,937 Ci) to trench 7B with isotopic compositions - mainly ^{137}Cs.]
The total of 73,000 curies of ^{137}Cs shown as transferred during this month, as well as other ^{137}Cs transferred in previous months, cannot be reconciled with the analyses of wastes of the Fission Product Development Laboratory, the main source of ^{137}Cs. Arrangements have been made to isolate and to sample and analyze the FPDL wastes prior to their transfer to the trenches in the future.

Report for November 1964 (ORNL-CF-64-12-47, p. 2-3)

[Routine reporting of 136,703 gal (2543 Ci) to trench 5, 81,771 gal (1315 Ci) to trench 7A, and 81,451 gal (1315 Ci) to trench 7B with isotopic compositions.]
The waste from the Fission Products Development Laboratory is currently stored separately at the South Tank Farm.

Report for December 1964 (ORNL-CF-65-1-57, p. 2-3)

[Routine reporting of 182,850 gal (7027 Ci) to trench 5, 63,320 gal (3162 Ci) to trench 7A, and 69,720 gal (3794 Ci) to trench 7B with isotopic compositions.]
The waste from the Fission Product Development Laboratory is currently stored separately at the South Tank Farm for possible future reprocessing.

Seep streams draining the Trench 5 and Trench 7 areas were sampled during the month. Estimates of discharges of several nuclides are tabulated below:

Nuclides	Curies Discharged in 31 Days
1. Strontium 89-90	3.6×10^{-5}
2. Cesium 137	2×10^{-3}
3. Ruthenium 106	2
4. Cobalt 60	1

Report for January 1965 (ORNL-CF-65-3-11, p. 2)

[Routine reporting of 133,120 gal (953 Ci) to trench 5, 149,570 gal (1807 Ci) to trench 7A, and 105,370 gal (1321 Ci) to trench 7B with isotopic compositions.]

Report for February 1965 (ORNL-CF-65-3-55, p. 3)

[Routine reporting of 119,700 gal (145 Ci) to trench 5, 140,160 gal (321 Ci) to trench 7A, and 88,190 gal (201 Ci) to trench 7B with isotopic compositions.]

Report for March 1965 (ORNL-CF-65-5-15, p. 2-3)

[Routine reporting of 103,619 gal (791 Ci) to trench 5, 184,484 gal (4620 Ci) to trench 7A, and 84,913 gal (2087 Ci) to trench 7B with isotopic compositions.]

Report for April 1965 (ORNL-CF-65-5-52, p. 2-3)

[Routine reporting of 123,853 gal (3944 Ci) to trench 5, 211,464 gal (7713 Ci) to trench 7A, and 81,547 gal (3000 Ci) to trench 7B with isotopic compositions.]

A total of 416,864 gallons of waste was pumped to the ground disposal area this month. Included in this amount was part of the backlog of contaminated water accumulated during heavy rainfall and 10,000 gallons from the Melton Valley area.

Report for May 1965 (ORNL-CF-65-6-53, p. 2)

[Routine reporting of 149,426 gal (4299 Ci) to trench 5, 110,413 gal (2350 Ci) to trench 7A, and 89,348 gal (1852 Ci) to trench 7B with isotopic compositions.]

Curium-242 was detected this month in the east seep stream from trench 7 and in the White Oak Dam discharge to Clinch River. Although the amount released was not significant and will not become serious

because of the small amount (62 curies) put into that trench, it has become apparent that the trench cannot be used for disposal of large quantities of curium. Arrangements have been made to hold curium-bearing wastes in storage tanks until the waste evaporator is put into operation and trench disposal of wastes is discontinued.

Report for June 1965 (ORNL-CF-65-8-11, p. 2)

[Routine reporting of 152,300 gal (1802 Ci) to trench 5, 87,800 gal (835 Ci) to trench 7A, and 112,300 gal (1057 Ci) to trench 7B with isotopic compositions.]

Report for July 1965 (ORNL-CF-65-9-10, p. 2)

[Routine reporting of 137,674 gal (4964 Ci) to trench 5, 89,374 gal (1701 Ci) to trench 7A, and 91,813 gal (1701 Ci) to trench 7B with isotopic compositions.]

Report for August 1965 (ORNL-CF-65-9-62, p. 2)

[Routine reporting of 164,869 gal (26,543 Ci) to trench 5, 53,213 gal (4234 Ci) to trench 7A, and 125,891 (10,349 Ci) to trench 7B with isotopic compositions - a lot of total ^{90}Sr without comments.]

Report for September 1965 (ORNL-CF-65-11-7, p. 2)

[Routine reporting of 168,640 gal (15,538 Ci) to trench 5, 49,310 gal (3994 Ci) to trench 7A, and 100,600 gal (7449 Ci) to trench 7B with isotopic compositions - mainly ^{137}Cs to trench 5.]

Report for October 1965 (ORNL-CF-65-12-18, p. 2)

[Routine reporting of 173,690 gal (72,259 Ci) to trench 5, 60,470 gal (3,967 Ci) to trench 7A, and 100,640 gal (6997 Ci) to trench 7B with isotopic compositions - mainly ^{90}Sr to trench 5.]

Report for November 1965 (ORNL-CF-66-1-20, p. 2)

[Routine reporting of 164,780 gal (5496 Ci) to trench 5, 44,900 gal (1621 Ci) to trench 7A, and 77,800 gal (3,243 Ci) to trench 7B with isotopic compositions - mainly ^{137}Cs.]

Report for December 1965 (ORNL-CF-66-2-21. p. 3)

[Routine reporting of 169,000 gal (3159 Ci) to trench 5, 39,000 gal (1050 Ci) to trench 7A, and 96,000 gal (2624 Ci) to trench 7B with isotopic compositions.]

Report for January 1966 (ORNL-CF-66-3-14, p. 2)

[Routine reporting of a total of 321,000 gallons, without trench breakdown, with 1845 Ci to trench 5, 758 Ci to trench 7A, and 758 Ci to trench 7B with each's isotopic composition.]

Report for February 1966 (ORNL-CF-66-4-19, p. 2)

[Routine reporting of 118,000 gal (2381 Ci) to trench 5, 144,000 gal (3922 Ci) to trench 7A, and 111,000 gal (3105 Ci) to trench 7B with isotopic compositions.]

Report for March 1966 (ORNL-CF-66-5-29, p. 2)

[Routine reporting of 133,000 gal (2481 Ci) to trench 5, 122,000 gal (2321 Ci) to trench 7A, and 111,000 gal (2099 Ci) to trench 7B with isotopic compositions.]

The construction of the 600 gph evaporator was completed this month and test runs, using actual waste, were begun on March 29. The limited operations experienced thus far have been satisfactory.

Report for April 1966 (ORNL-CF-66-6-32, p. 2-3)

At the end of the month, the evaporator completed 33 days of operation. During this period, a number of operating difficulties were experienced which prevented the processing of all of the waste generated. None of them, however, could be considered serious for a startup of a new plant.

The worst of the difficulties was excessive foaming of some of the waste, which led to an accidental discharge of approximately 10 curies of activity to the process waste system. The operator, not having experienced the great variation in the amount of foam that could be produced by different wastes, applied too much heat at the start of a run of waste that had not been previously processed. The contents of the evaporator foamed up so suddenly that some of the waste carried over to the condensate catch-tank even though the steam to the evaporator coils was automatically cut off before the foam reached the top of the evaporator tank. The catch-tank drain valve, which is supposed to automatically close when excessive activity is measured, failed to operate. It was later found that the valve was made inoperable for testing other equipment prior to the startup of the plant, and it had not been returned to service.

The evaporator operation was begun with a large backlog of waste stored in the tank farm; all tanks were practically full. The total volume processed through the evaporator in April was 340,000 gallons, which is roughly equal to the average volume of waste received each month (see Figure 6). During the month of April, however, the volume was approximately 100,000 gallons above normal so that it became necessary to pump 95,000 gallons of waste to the seepage trenches.

Near the end of the waste transfer to the trenches, a section of plastic pipeline ruptured and approximately 3,000 gallons of waste were spilled in an area just north of trench 7. The total activity was estimated at 100 curies, consisting mainly of cesium and cerium and about 10 curies of strontium. The contamination was covered with approximately five feet of soil and the area was contoured to prevent leaching by surface water. None of the contamination was permitted to reach the creek.

[Routine reporting of the final discharges to trenches 5 and 7; 67,000 gal to trench 5 (3588 Ci) and 28,000 gal to trench 7, 3 and 4 Ci to 7A and 7B, respectively.

The final inventories for trenches 5, 7A, and 7B are given with isotopic compositions:

Nuclide	Total to Date Trench 5	Trench 7A	Trench 7B
Total Sr	96755	24681	23633
^{106}Ru	6385	1873	1523
^{137}Cs	205639	123009	107718
^{60}Co	3045	788	766
TOTALS	311824	150351	133640

This ends the reporting of discharges to the pits and trenches although the monitoring data for the east and west weirs in the pits 2, 3, and 4 area is continued in the series.
The discharge monitoring of these drainages continues until July, 1968, (ORNL-CF-68-8-51):

"The routine sampling of seeps from the waste pits area at station 5 and 6 (see Figure 7) has been discontinued because the activity measured at these stations has decreased to an insignificant level since the use of the waste pits was discontinued several years ago. In the future, the seeps will be sampled at six-month intervals to check on possible movement of strontium."

However, no reporting was found until the period of February, 1980, (ORNL-CF-80-67) when the routine reporting of the monitoring of ^{90}Sr at the east and west weirs of the pits' drainage areas was resumed.

Appendix C
ORNL Laboratory Records Drawings Related to Seepage Pits and Trenches

ORNL-LR-DWG-4964A 1954
Experimental Pit - Dispersion of nitrate

ORNL-LR-DWG-4965A 1954
Experimental Pit, water table after recharge

ORNL-LR-DWG-4966A 1954
Experimental Pit, normal water table contours

ORNL-LR-DWG-11880 1955
Geologic structure Four Acre Site

ORNL-LR-DWG-11881 1955
Waste disposal pits and test area

ORNL-LR-DWG-11882 1955
Generalized geologic section Four Acre site

ORNL-LR-DWG-11883 1955
Water table contours around pits, Feb 12, 1956

ORNL-LR-DWG-11921 1955
Average radiochemical constituents in pit waste

ORNL-LR-DWG-11922 1955
Average chemical constituents in pit waste solutions

ORNL-LR-DWG-11923 1955
Design of grouted wells near/in pit 4

ORNL-LR-DWG-11924 1955
Map of waste pit disposal area

ORNL-LR-DWG-11924A 1955
Well locations in pits area

ORNL-LR-DWG-11941 1955
Waste volume and beta activity added to pits

ORNL-LR-DWG-11942 1955
Pressure test results of wells in pit 4 area

ORNL-LR-DWG-11943 1955
Pit 3 seepage determinations

ORNL-LR-DWG-11943A 1955
Early determination of seepage from pit 3

ORNL-LR-DWG-11944 1955
Chloride and nitrate tracer test at 4 Acre site

ORNL-LR-DWG-11944A 1955
Groundwater tracer results at 4 acre site

ORNL-LR-DWG-11946 1955
Chemical constituents in waste pits and wells

ORNL-LR-DWG-6631 1955
Generalized geologic section of waste areas

ORNL-LR-DWG-13396A 1956
Water table cross section of pit 4

ORNL-LR-DWG-14172 1956
External radiation levels in pit area May 1956

ORNL-LR-DWG-15480A 1956
Radioactivity logs of boreholes around pit 4

ORNL-LR-DWG-21602 1957
Dispersion of radioactivity near pits Feb 1957

ORNL-LR-DWG-21603R 1957
Radioactivity in wells of pit 4, 1956-57

ORNL-LR-DWG-21681 1957
Movement of radioactivity under pit 4 - 1956

ORNL-LR-DWG-21682 1957
Conceptual design of new pit (trench 5)

ORNL-LR-DWG-25311 1957
Tree sample locations around pits 2,3,and 4

ORNL-LR-DWG-28158 1958
Geologic structure of waste pit area

ORNL-LR-DWG-28159 1958
Water table contour map of pits area Jan, 1958

ORNL-LR-DWG-28161 1958
Pump test results in pit 4 area

ORNL-LR-DWG-28382 1958
Liquid levels in pits 2,3, 4 - 1955-1957

ORNL-LR-DWG-28383 1958
General geologic cross section in waste areas

ORNL-LR-DWG-28384R 1958
Distribution of radioactivity near pits Feb 1958

ORNL-LR-DWG-29284 1958
Stream flow and radioactivity at pits Apr 4, 57

ORNL-LR-DWG-29285 1958
Stream flow and radioactivity at pits Mar 3, 57
ORNL-LR-DWG-32547R 1958
Tree sample locations around pits 2, 3, 4

ORNL-LR-DWG-39812 1959
Radioactivity discharge in pit area streams 1957

ORNL-LR-DWG-42037 1959
Conceptual diagram of first hydraulic fracturing exp.

ORNL-LR-DWG-42038 1959
Site of proposed fracturing experiment

ORNL-LR-DWG-42670 1959
Water surface elevations of pits 1 and 2 [2 and 3]

ORNL-LR-DWG-42822 1959
Yearly radioactive discharges to White Oak Creek

ORNL-LR-DWG-43421 1959
Concentration of Sr-90 and Ru-106 in waste to pits

ORNL-LR-DWG-43912 1959
Dispersion of radioactivity near pits May 1958

ORNL-LR-DWG-44013 1959
Dispersion of radioactivity near pits Aug 1958

ORNL-LR-DWG-44387 1959
Dispersion of radioactivity near pits Feb 1957

ORNL-LR-DWG-11880R 1960
Geologic structure Four Acre site

ORNL-LR-DWG-11882R 1960
Generalized geologic section Four Acre site

ORNL-LR-DWG-46566 1960
First hydraulic fracturing experiment 4 Acre site

ORNL-LR-DWG-52352 1960
Simplified ORNL radioactive waste flowsheet

ORNL-LR-DWG-52799 1960
Waste pit system radionuclide inventory

ORNL-LR-DWG-54430 1961
Waste pit radionuclide inventory through 1960

ORNL-LR-DWG-63529R 1961
Design of shielded transfer tank

ORNL-LR-DWG-64047 1961
East-West geologic section at 4 Acre site

ORNL-LR-DWG-64048 1961
North-South geologic section at 4 Acre site

ORNL-LR-DWG-64049 1961
First fracturing experiment grout extent

ORNL-LR-DWG-64050 1961
First fracturing experiment Four Acre site

ORNL-LR-DWG-64051 1961
Surface geology Four Acre site

ORNL-LR-DWG-62129 1962
Typical liquid waste disposal trench design

ORNL-LR-DWG-62143 1962
Index map of waste pit boreholes - deLaguna

ORNL-LR-DWG-62144 1962
Log of borehole 1 southwest of pit 2

ORNL-LR-DWG-62145 1962
Log of borehole 2 south end of pit 2

ORNL-LR-DWG-62146 1962
Log of borehole 3 south of pit 2

ORNL-LR-DWG-62147 1962
Log of borehole 4 east of pit 4

ORNL-LR-DWG-62148 1962
Log of borehole 5 southwest of pit 2

ORNL-LR-DWG-63051 1962
Map of proposed areas for trench 7 (deLaguna)

ORNL-LR-DWG-69098 1962
Sources of radioactive contamination in White Oak

ORNL-LR-DWG-70508 1962
Trench 6 groundwater levels June 26, 1962

ORNL-LR-DWG-73482 1962
Stable chemical composition of ORNL ILW stream

ORNL-LR-DWG-74624 1962
Chemical waste pit area topography

ORNL-LR-DWG-74624A 1962
Contamination plume around trench 5 Sep 1962

ORNL-DWG-64-7897 1964
Groundwater tritium tracer movement near pit 3

ORNL-DWG-64-916 1964
Chloride dispersion by Conasuaga shale at 4 Acre site

ORNL-DWG-64-928 1964
Borehole locations in pits 2 and 3

ORNL-DWG-64-929 1964
Longitudinal cross section of pit 3 postclosure

ORNL-DWG-64-929R 1964
Longitudinal section of pit 3 postclosure

ORNL-DWG-64-929R2 1964
Longitudinal section of pit 3 postclosure

ORNL-DWG-74-8966R 1974
Waste line leak sites between ORNL-hydrofracture

ORNL-DWG-74-9604 1974
Seep locations around pits and trenches

ORNL-DWG-75-5575 1975
Trench to dispersion model of Kd=100 species

ORNL-DWG-75-5576 1975
Trench discretization and head to stream model

ORNL-DWG-76-1519 1976
Monitoring well locations near Trench No. 7

ORNL-DWG-76-7075 1976
Pressure, moisture, and conductivity relations

ORNL-DWG-76-7076 1976
Rainfall boundary model conditions May 1972

ORNL-DWG-76-7077 1976
Trench 7 simulated tritium migration

ORNL-DWG-76-7078 1976
Trench 7 water table and head simulations

ORNL-DWG-76-7080 1976
Cross sectional discretization of trench 7

ORNL-DWG-79-20020 1979
Shielded Transfer Tank - Model III

ORNL-DWG-81-11565R 1981
Survey locations and results, leak site 2

ORNL-DWG-81-11566R 1981
Survey locations and results, leak site 1

ORNL-DWG-81-14036ESD 1981
Trench 7 Groundwater Flow Paths to Seep

ORNL-DWG-81-14037ESD 1981
Plan cross section of trench 7

ORNL-DWG-81-21573B 1981
Stratigraphic exposure on roadcut east of T7

ORNL-DWG-82-13318 1982
Generalized Stratigraphy around X-10 (ORNL)

ORNL-DWG-83-12417 1983
Yearly groundwater levels around trench 7

ORNL-DWG-83-12418 1983
Weekly groundwater levels around trench 7

ORNL-DWG-83-12419 1983
233-U vs. Phosphorus/pH at well T7-21 at trench 7

ORNL-DWG-83-12602 1983
Topographic map of pits and trenches area

ORNL-DWG-83-13887R2 1983
Stratigraphic column of Conasauga formation

ORNL-DWG-83-1514A 1983
Map of monitoring well locations around trench 7

ORNL-DWG-83-1515 1983
Stratigraphic exposure east of trench 7

ORNL-DWG-83-15535 1983
Planned boundaries of South leak site asphalt cover

ORNL-DWG-83-15536 1983
Planned boundaries of North leak site asphalt cover

ORNL-DWG-83-15537 1983
Site plan for the North leak site

ORNL-DWG-83-15538 1983
Site plan for the South leak site

ORNL-DWG-83-1555 1983
Gamma activity profiles of wells near trench 7

ORNL-DWG-83-1556 1983
Gamma activity log of well T7-20 at trench 7

ORNL-DWG-83-1558 1983
Lithologic,137-Cs, 60-Co profiles north trench 7

ORNL-LR-DWG-24800R 1983
Contour map showing ILW line leak sites

ORNL-DWG-85-17016 1985
Site plan for asphalt cap expansion of trench 7

ORNL-DWG-85-17017 1985
Rating curves for weirs used for trench 7 runoff

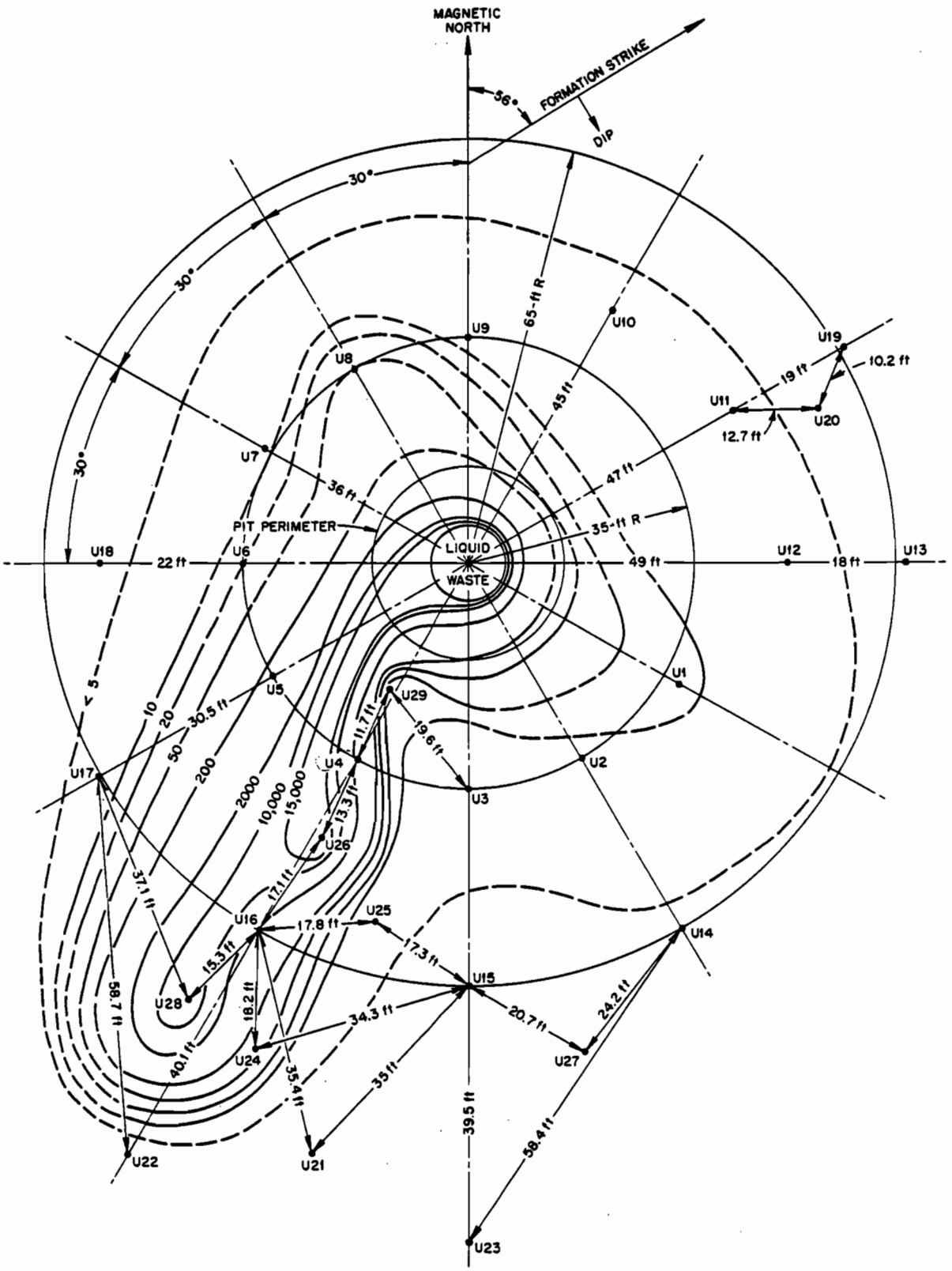
ORNL-DWG-85-17018 1985
Surface runoff gaging station locations trench 7

ORNL-DWG-85-17019 1985
Water table contours around trench 7

ORNL-DWG-86-13109 1986
Map of ORNL waste area groupings

ORNL-DWG-87-1319 1987
Map of pits and trenches waste area grouping

UNCLASSIFIED
ORNL-LR-DWG 4964A

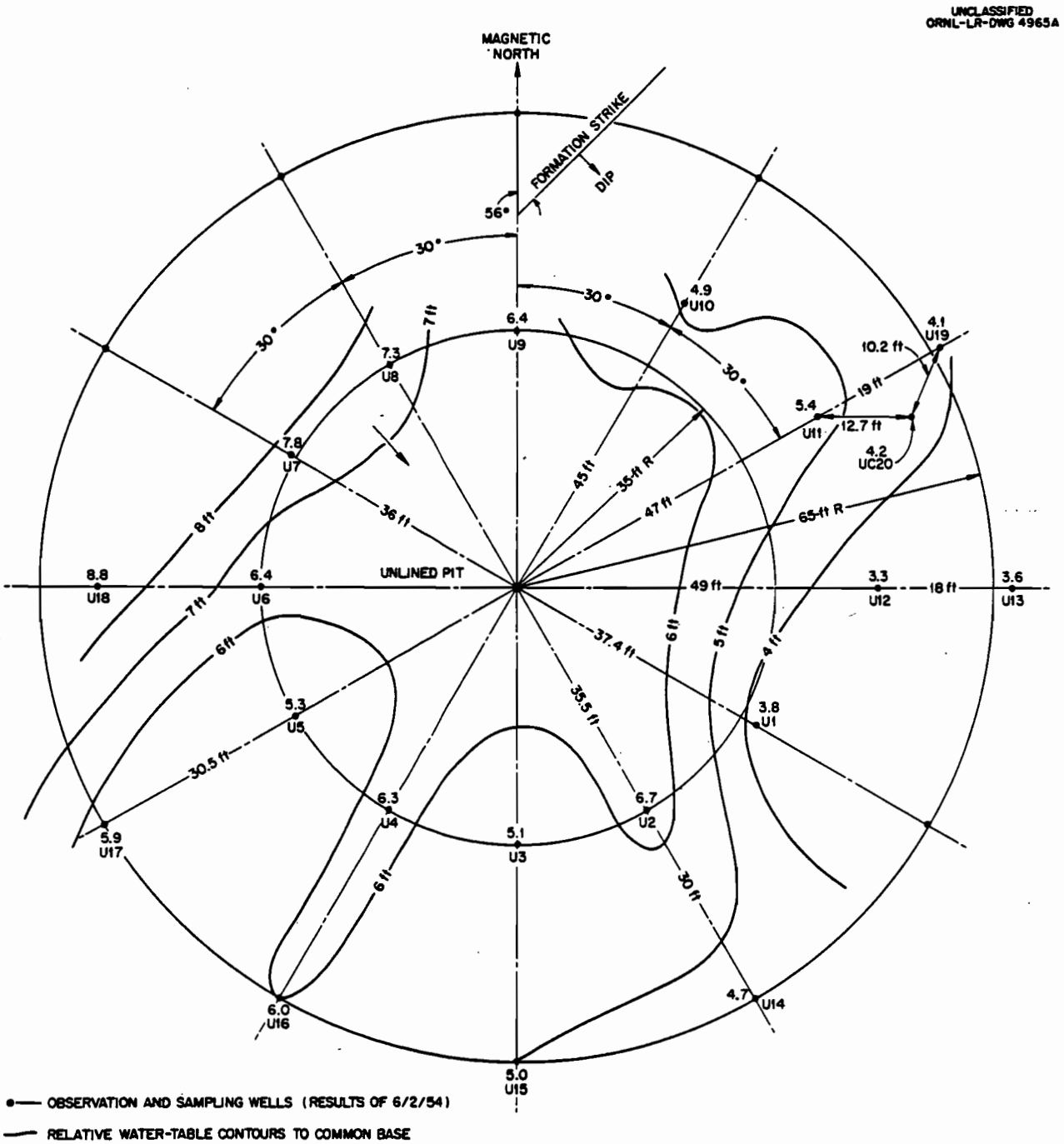


● —— OBSERVATION AND SAMPLING WELLS (RESULTS OF 9/13-14/54)

NITRATE CONTAMINATION CONTOURS IN PARTS PER MILLION BASED ON FIELD AND LABORATORY ANALYSIS — LOCATION APPROXIMATE

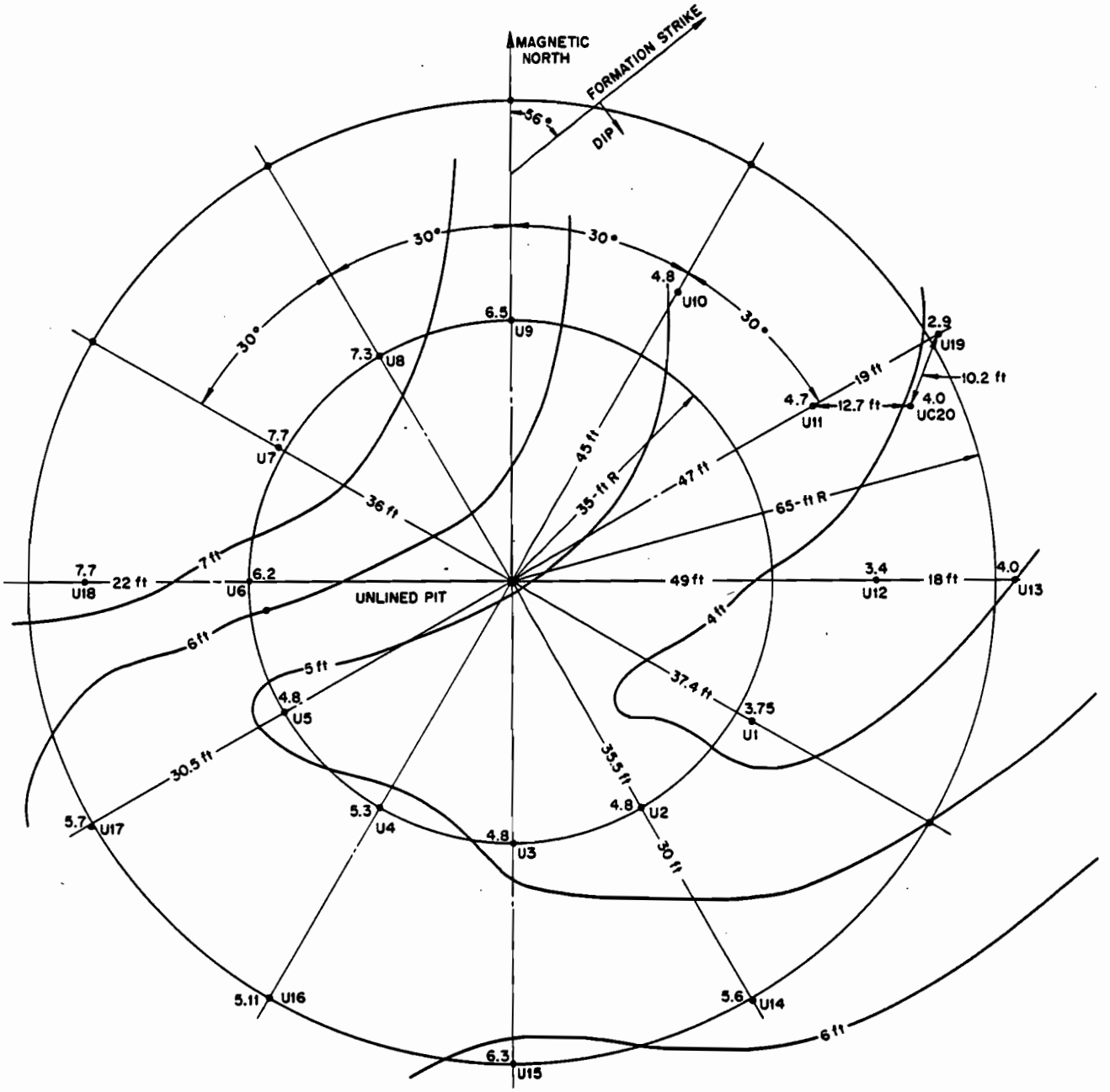
NITRATE CONTAMINATION CONTOURS — LOCATION INFERRED OR PROJECTED

ORNL-LR-DWG-4964A 1954
Experimental Pit - Dispersion of nitrate



ORNL-LR-DWG-4965A 1954
Experimental Pit, water table after recharge

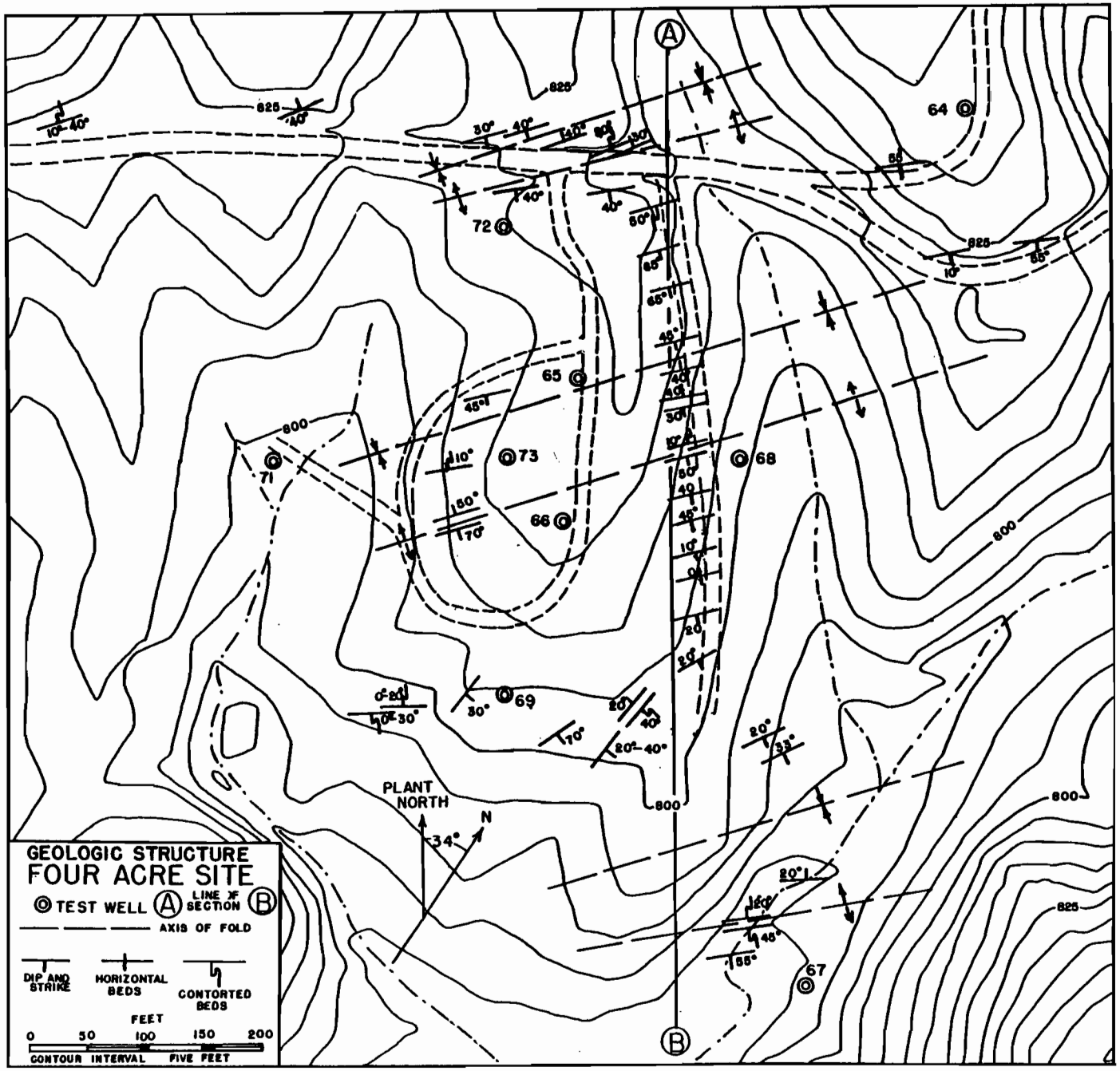
UNCLASSIFIED
ORNL-LR-DWG 4966A



● OBSERVATION AND SAMPLE WELLS (RESULTS OF 5/19/54)
—— RELATIVE WATER-TABLE CONTOURS TO COMMON BASE

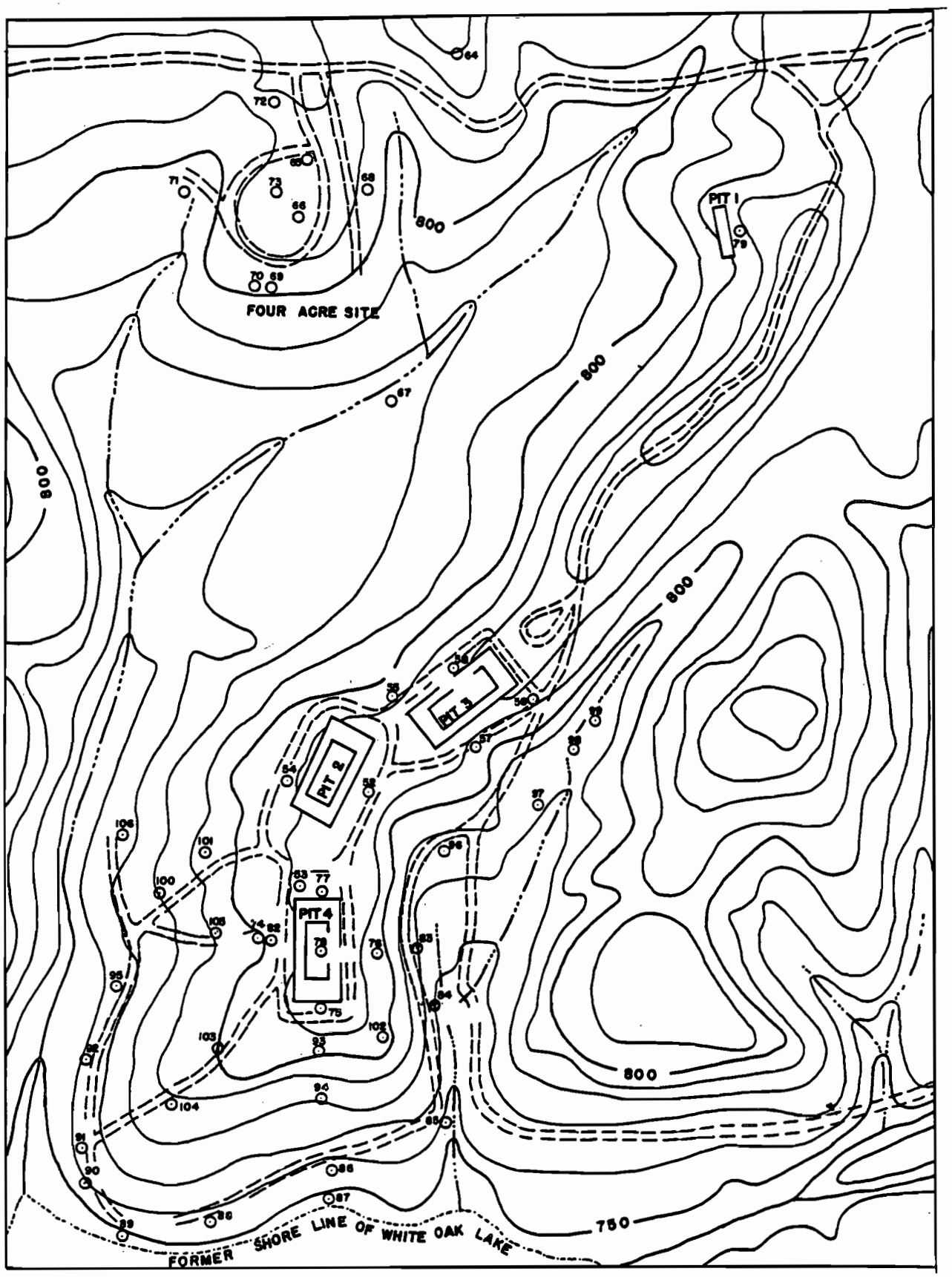
ORNL-LR-DWG-4966A 1954
Experimental Pit, normal water table contours

Unclassified
ORNL-LR-DWG 11880



ORNL-LR-DWG-11880
Geologic structure Four Acre Site 1955

Unclassified
ORNL-LR-DWG 11881

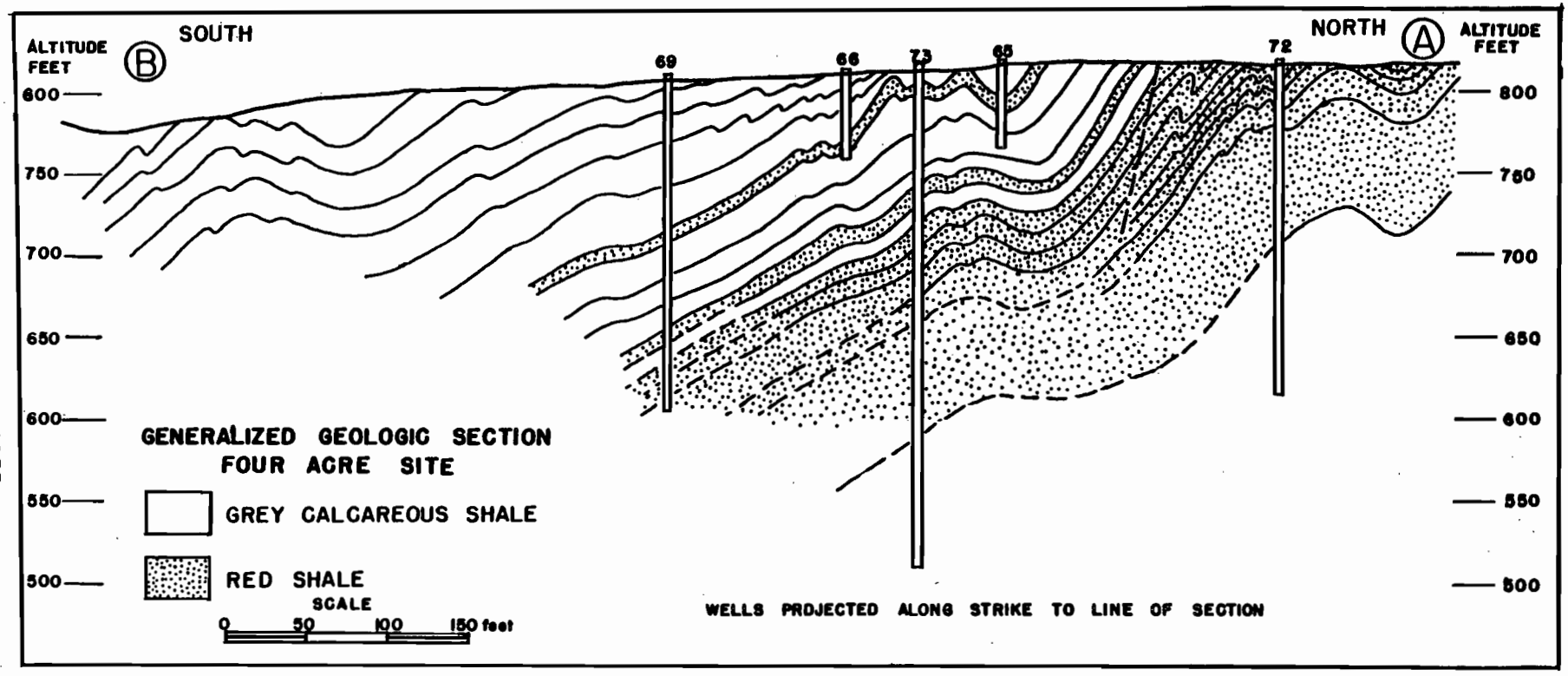


WASTE DISPOSAL PITS AND TEST AREA

SCALE
0 100 200 300 400 FEET
CONTOUR INTERVAL 10 FEET

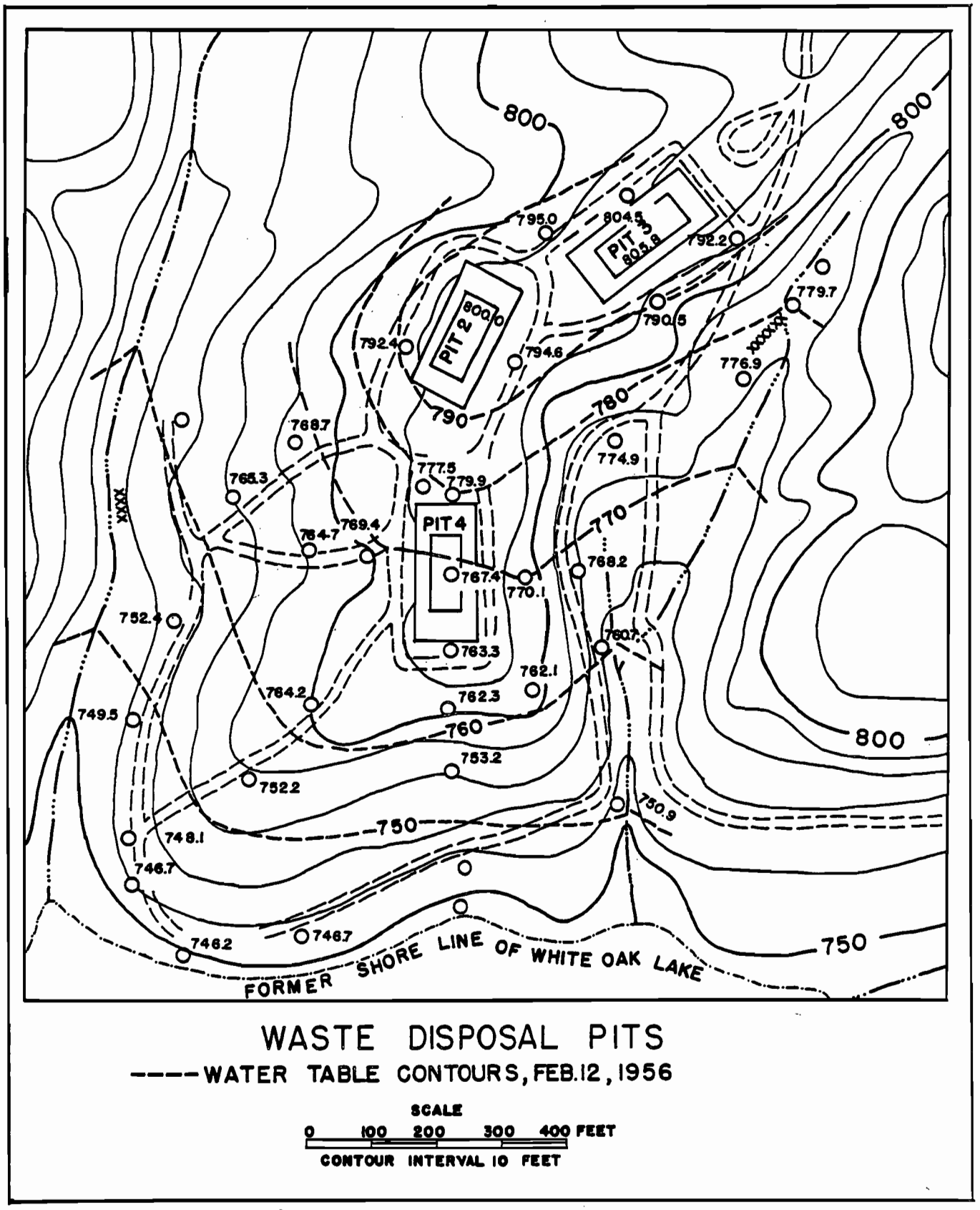
ORNL-LR-DWG-11881 1955
Waste disposal pits and test area

Unclassified
ORNL-LR-DWG 11882



ORNL-LR-DWG-11882
Generalized geologic section Four Acre site
1955

Unclassified
ORNL-LR-DWG 11883



WASTE DISPOSAL PITS

----WATER TABLE CONTOURS, FEB. 12, 1956

SCALE

0 100 200 300 400 FEET

CONTOUR INTERVAL 10 FEET

ORNL-LR-DWG-11883 1955
Water table contours around pits, Feb 12, 1956

Table 3

* Average Radiochemical Constituents in the Waste Solution

	Gross Beta	Cs^{137}	Ru^{106}	Sr	TRE	Total Radionuclides Accounted for
1. Waste Pumped to Pit No.3	7.24×10^5	5.12×10^5	0.916×10^5	0.053×10^5	0.081×10^5	6.17×10^5
Percent of Gross Beta		70.7	12.7	0.7	1.1	85.2
2. Waste Overflowed to Pit No.2	3.06×10^5	2.18×10^5	0.547×10^5	0.010×10^5	0.014	2.75×10^5
Percent or Gross Beta		71.2	17.9	0.3	0.5	89.9
3.** Reduction Factor	2.36	2.35	1.67	5.30	5.78	

* These results are the average values, expressed as counts per minute per milliliter, of three composite samples of the waste pumped to Pit no.3 and the waste overflowed to Pit no.2.

** Reduction factor $= \frac{\text{amount of constituent in pumped waste}}{\text{amount of constituent in overflowed waste}}$

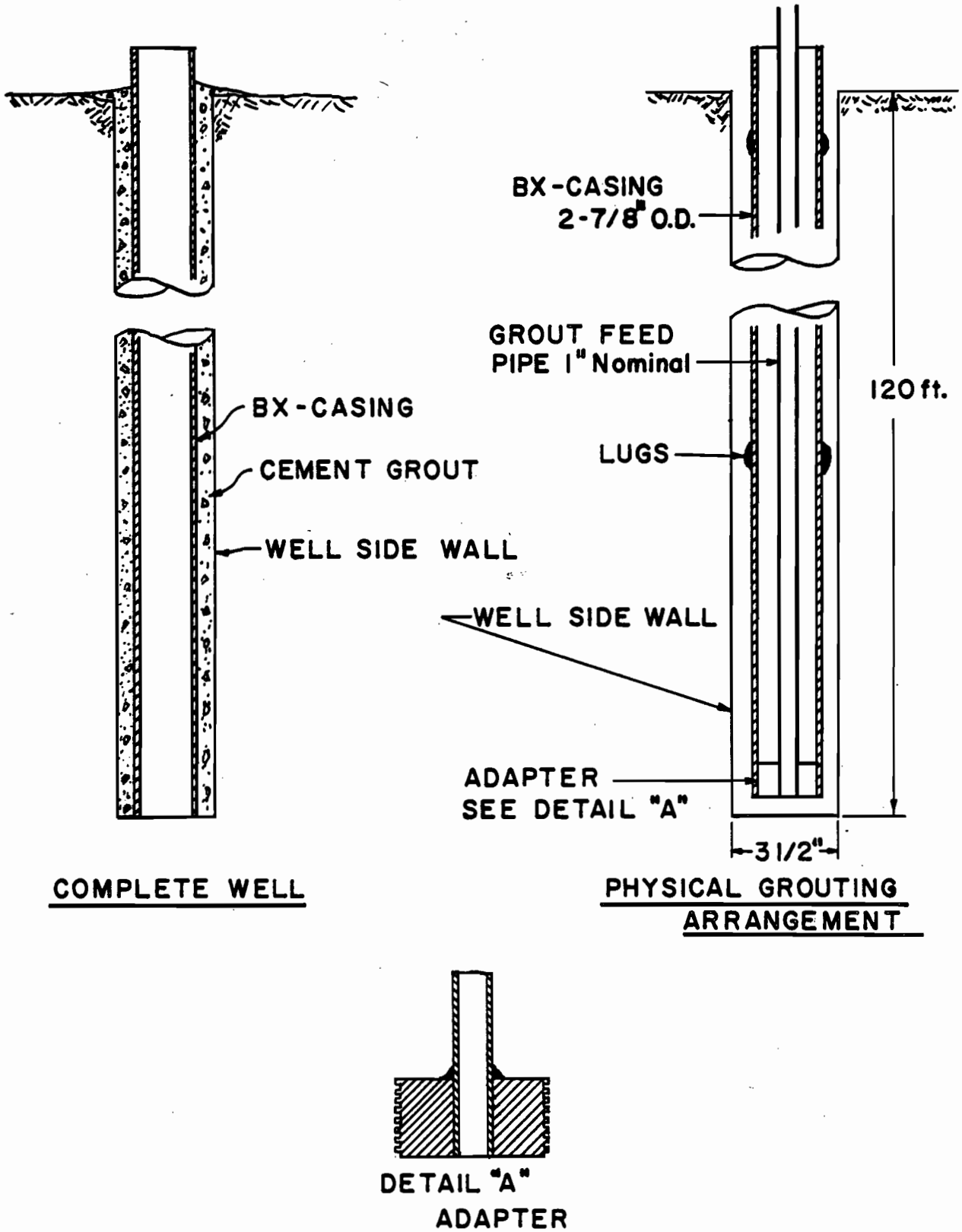
Table 2

*Average Chemical Constituents in the Waste Solution

	Total Solids	Na	NH_3	NO_3	Cl	SO_4	Total Solids accounted for	pH	Specific Gravity
1. Waste Pumped to Pit No.3	61.62	17.17	0.41	29.55	0.19	0.55	47.87	12.5	1.041
Percent of Total Solids		27.9	0.7	48.0	0.3	0.9	77.6		
2. Waste Overflowed to Pit No.2	56.05	16.95	0.38	25.79	0.30	0.91	44.33	11.8	1.037
Percent of Total Solids		30.3	0.7	46.0	0.5	1.6	79.1		
3.** Reduction Factor	1.10	1.01	1.08	1.15	0.63	0.61			

* These results are the average values, expressed as milligrams per milliliter, of three composite samples of the waste pumped to Pit no.3 and the waste overflowed to Pit no.2.

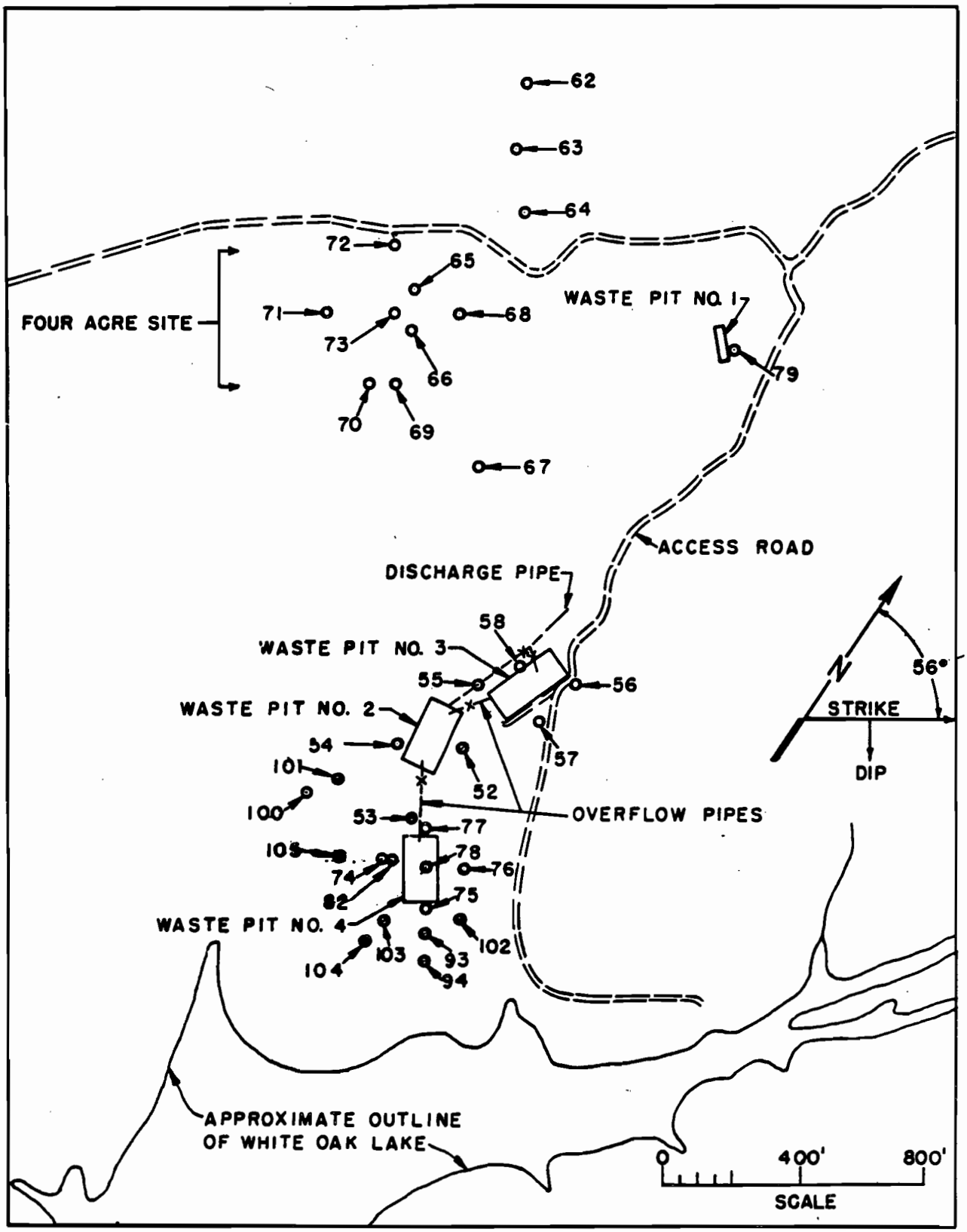
** Reduction factor = $\frac{\text{amount of constituent in pumped waste}}{\text{amount of constituent in overflowed waste}}$



GROUTED WELL DETAILS

ORNL-LR-DWG-11923 1955
Design of grouted wells near/in pit 4

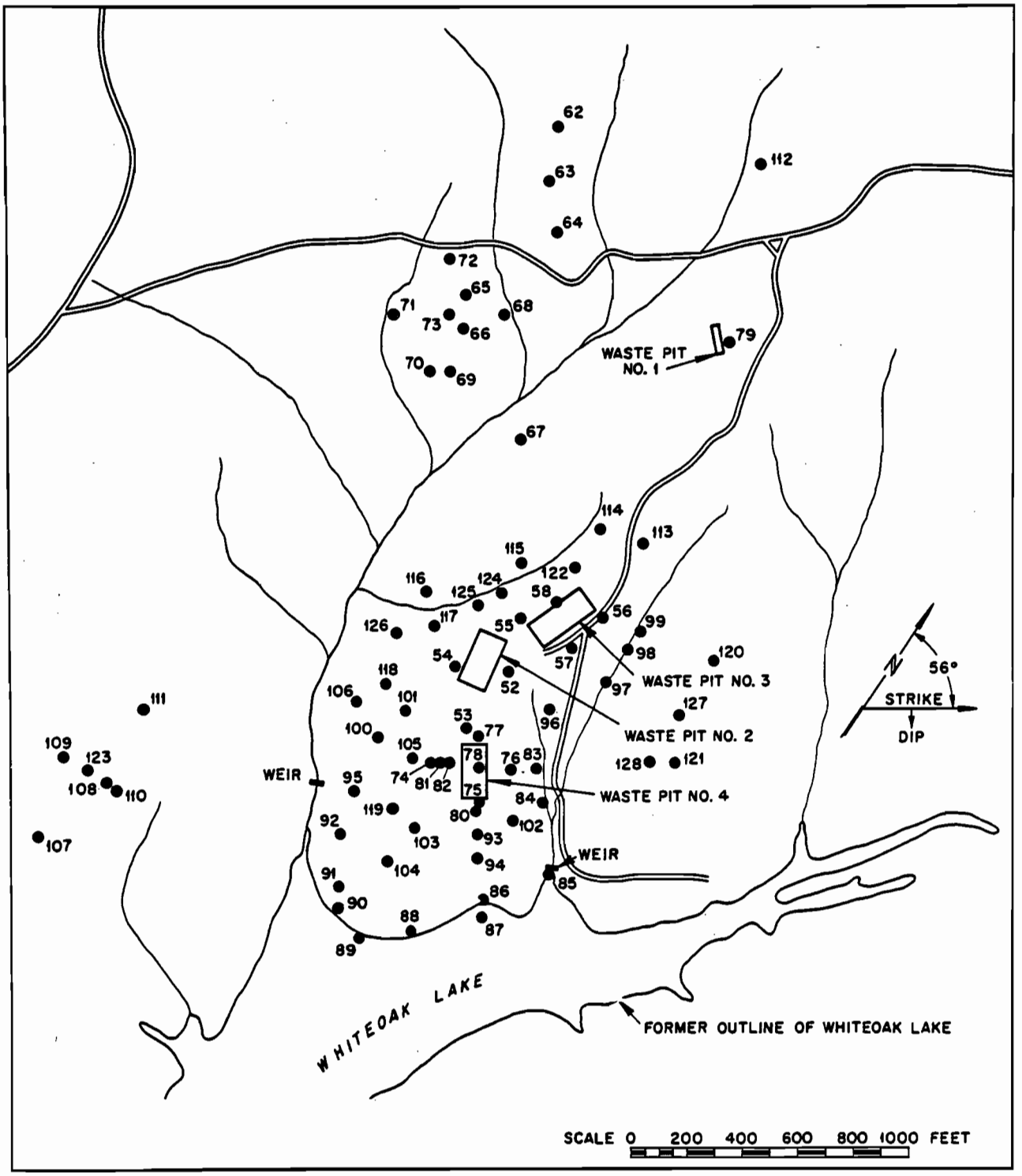
Unclassified
ORNL-LR-DWG 11924



APPROXIMATE LOCATION ONLY: WASTE PIT NO. 4, WELLS 82, 93, 94, 100 THRU 105

ORNL-LR-DWG-11924 1955
Map of waste pit disposal area

UNCLASSIFIED
ORNL-LR-DWG 11924A



Waste Pit Disposal Area.

ORNL-LR-DWG-11924A 1955
Well locations in pits area

Table 1

*Waste Volume and Beta Activity Added to Pits

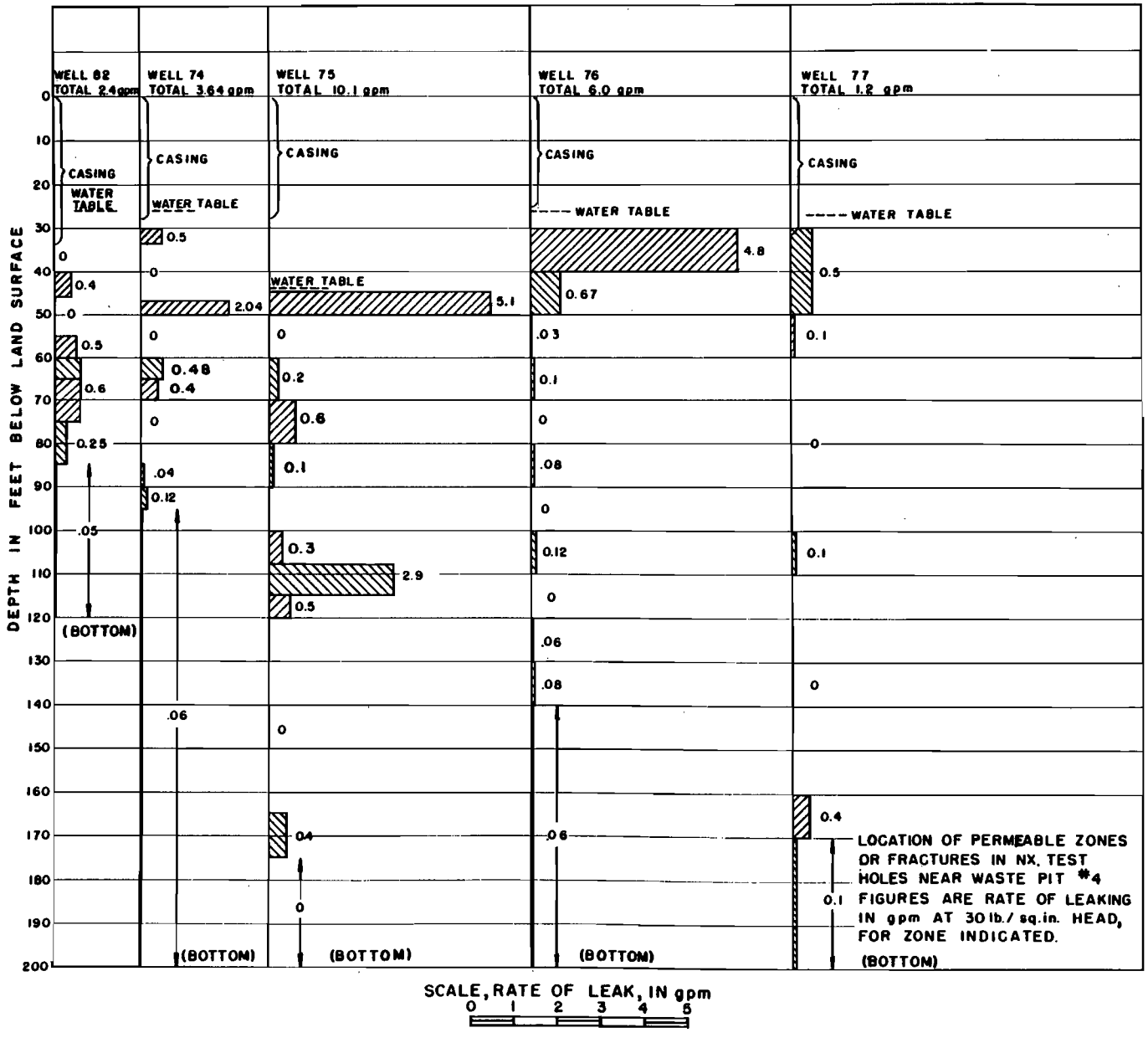
Waste Pit	1	2	3
1. a) Volume of concentrated waste added in gallons	123,000	431,600	
b) Curies of beta activity	123	11,628	
c) Activity - curies/gal		.027	
2. a) Volume of unconcentrated waste added in gallons		812,400	1,620,600
b) Curies of beta activity		4,347	21,343
c) Activity - curies/gal		.0054	.013
3. Non-radioactive waste added in gallons		93,409	
4. a) Volume of waste overflowed in gallons		642,200	-652,200
b) Estimated curies of beta activity overflowed		2,540	- 2,540
5. Total gallons added	123,000	1,979,609	978,400
6. Total curies of beta activity added		18,515	18,803

* All amounts are accumulative through December 1955.

ORNL-LR-DWG-11941
1955
Waste volume and beta activity added to pits

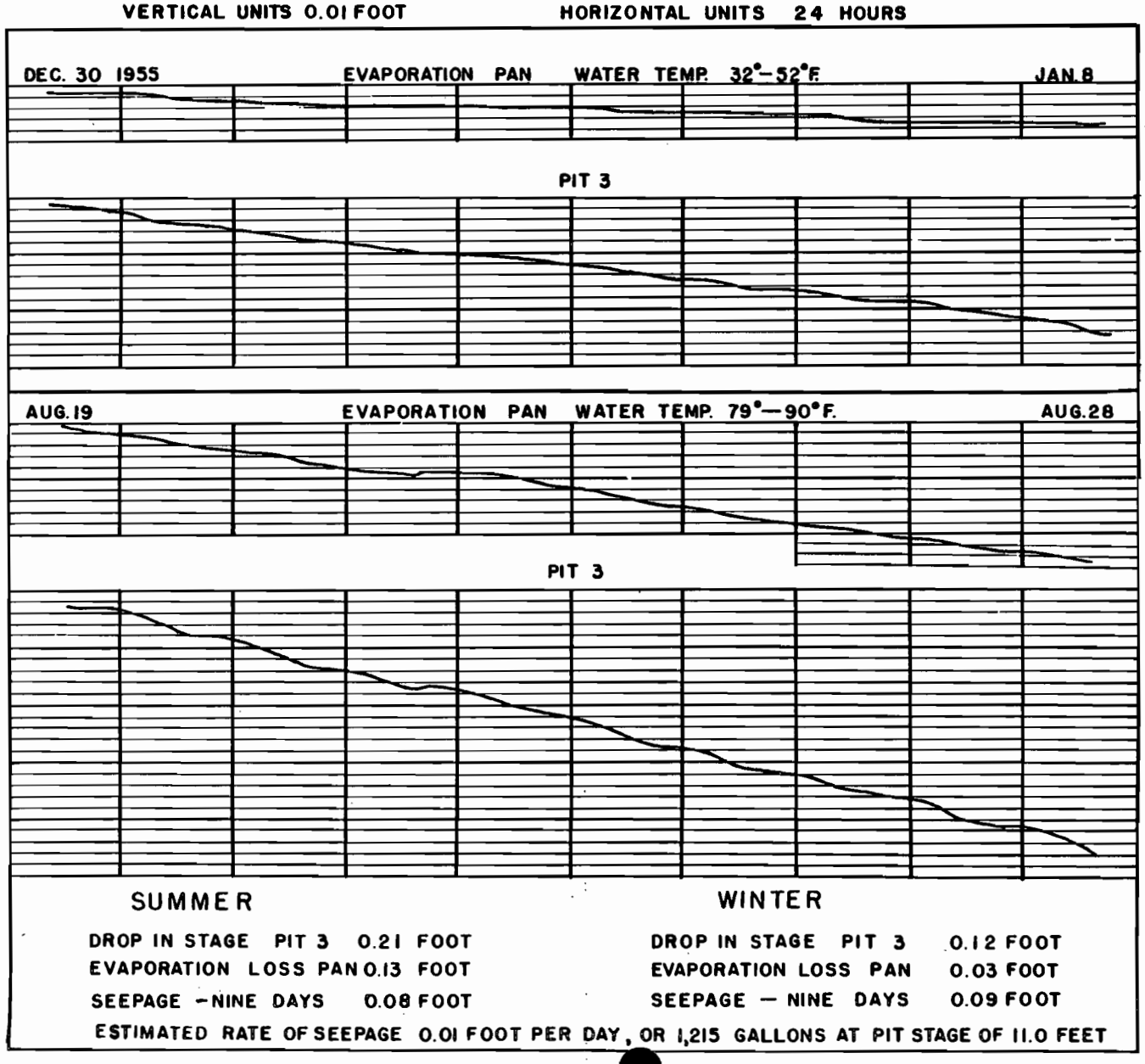
Unclassified
ORNL-LR-DWG 11942

PRESSURE TESTING OF WELLS IN PIT 4 AREA



ORNL-LR-DWG-11942
1955
Pressure test results of wells in pit 4 area

PIT 3
SEEPAGE DETERMINATIONS

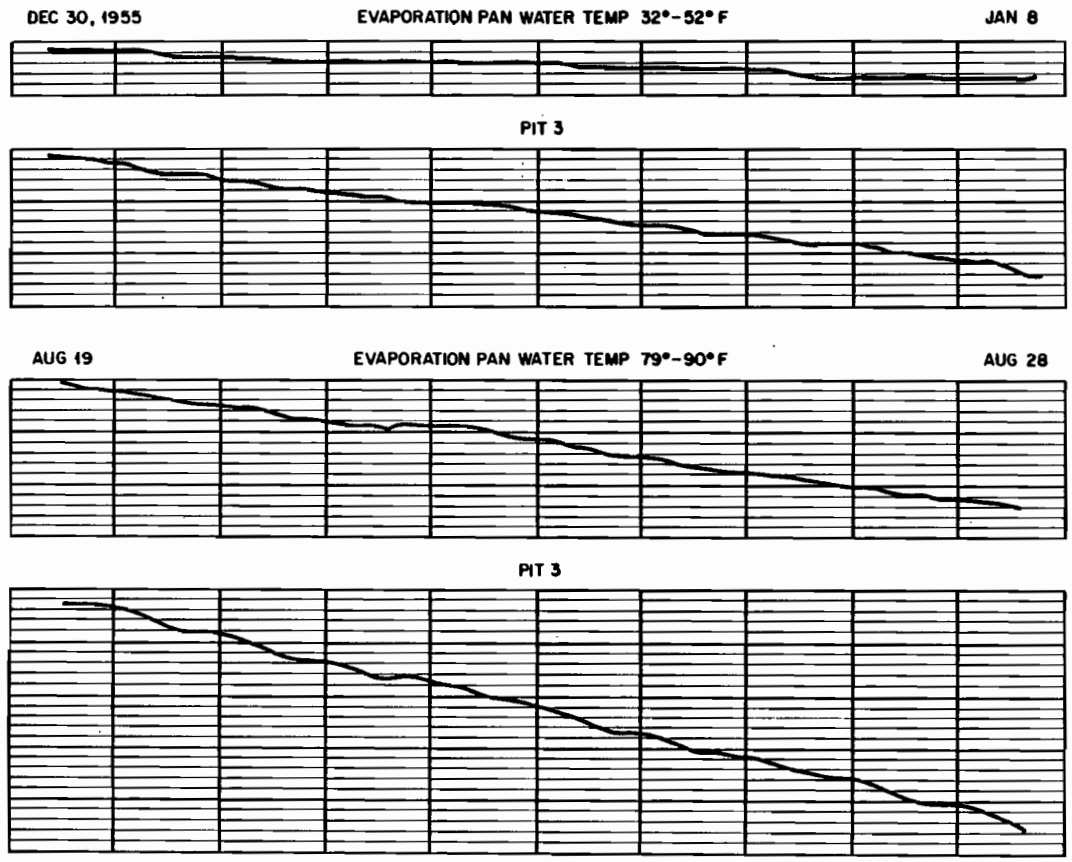


ORNL-LR-DWG-11943 1955
Pit 3 seepage determinations

UNCLASSIFIED
ORNL-LR-DWG 11943A

VERTICAL UNITS = 0.01 foot

HORIZONTAL UNITS = 24 hours

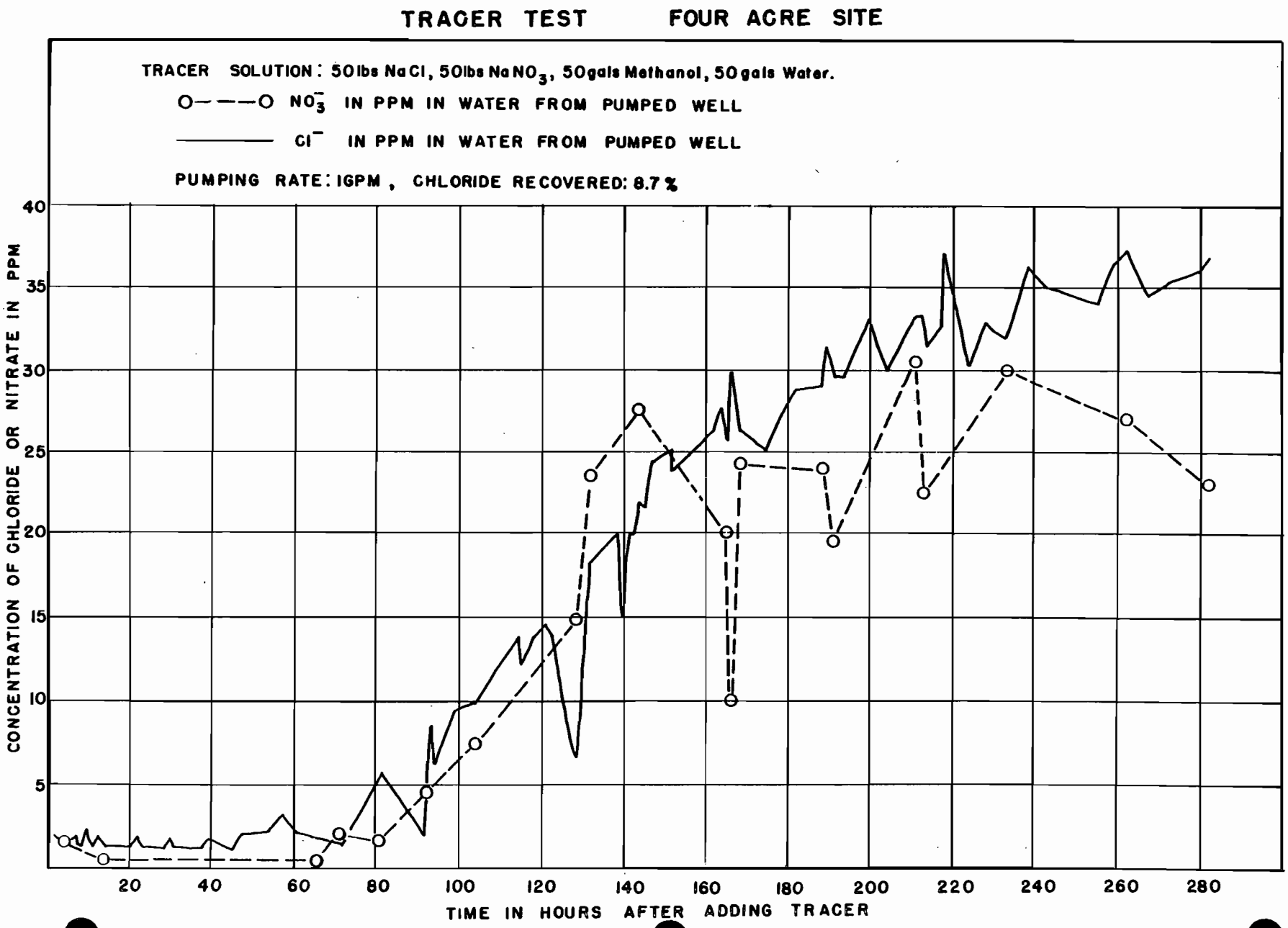


SUMMER	WINTER
DROP IN STAGE PIT 3 = 0.21 foot	DROP IN STAGE PIT 3 = 0.12 foot
EVAPORATION LOSS PAN = 0.13 foot	EVAPORATION LOSS PAN = 0.03 foot
SEEPAGE - NINE DAYS = 0.08 foot	SEEPAGE - NINE DAYS = 0.09 foot

ESTIMATED RATE OF SEEPAGE, 0.01 foot/day, OR 1215 gallons AT PIT STAGE OF 11.0 feet

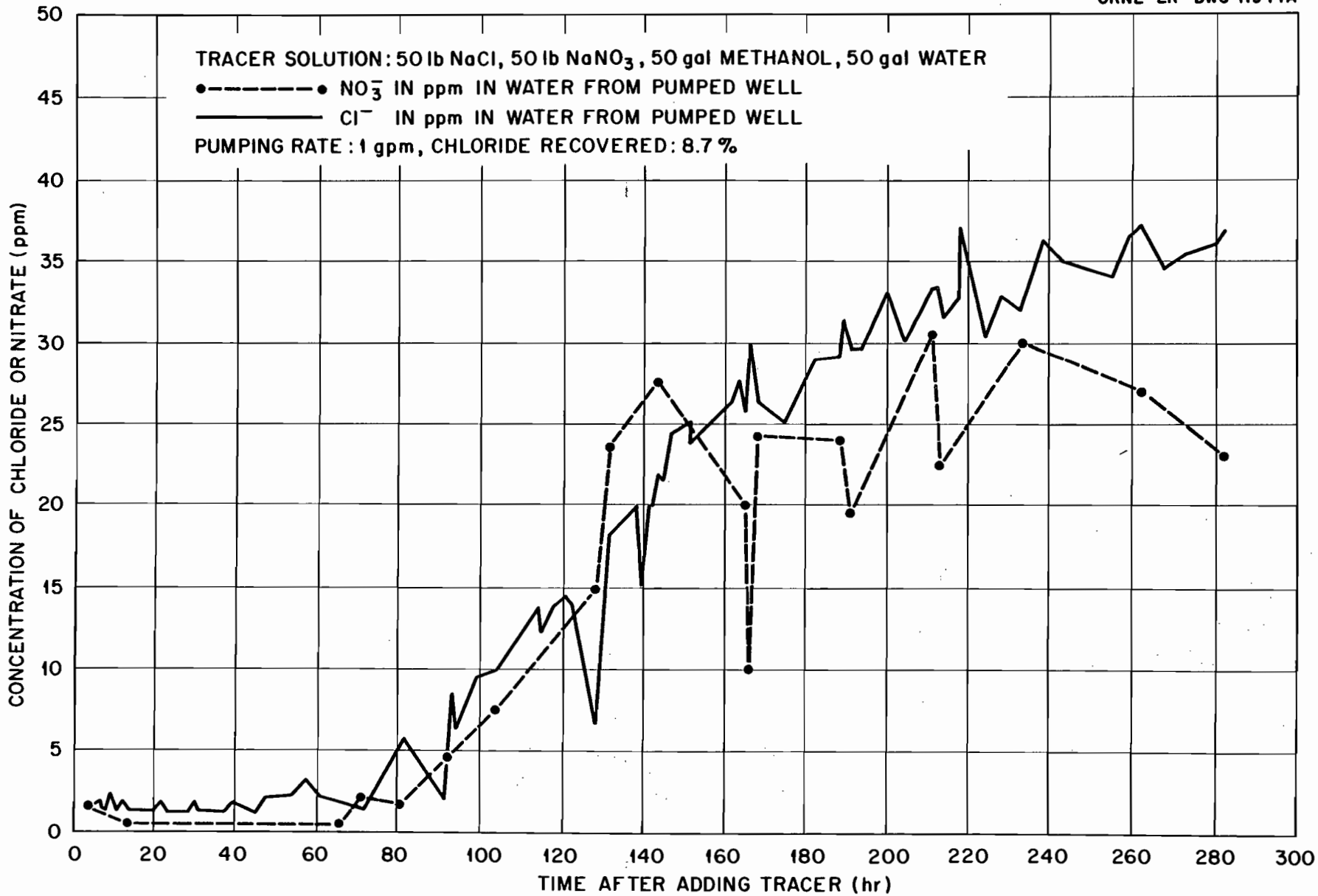
Early Determinations of Seepage Rate. Later work gives smaller values and shows lower rate in winter than in summer.

ORNL-LR-DWG-11943A
Early determination of seepage from pit 3
1955



ORNL-LR-DWG-11944
1955
Chloride and nitrate tracer test at 4 Acre site

UNCLASSIFIED
ORNL-LR-DWG 11944A



Tracer Test, Four Acre Site

ORNL-LR-DWG-11944A
1955
Groundwater tracer results at 4 acre site

Table 4

Chemical Constituents In Waste Pits and Observation Wells

Sample	Date	Depth	Na (mg/ml)	Ca (mg/ml)	NO_3 (mg/ml)	Ru^{106} (μc/ml in Liquid
1. a) Pit No.2	6-1-55	1'below surface	8.00	0.05	23.80	0.19
b) Pit No.2	6-1-55	1'above sludge	22.00	0.21	47.40	0.32
2. Well No.52	5-3-55	45'	24.00	4.8	28.67	0.11
3. Well No.53	4-26-55	41.5'				0.30×10^{-3}
4. Well No.54	5-3-55	20'	31.0	9.6	17.4	0.05
5. Pit No.3	3-5-55	Average of two samples				0.34
6. Well No.56	5-19-55	Surface	0.37	0.68	3.35	0.01
7. Well No.57	6-10-55	31.8'				0.52×10^{-4}
8. Well No.58	5-24-55	26.6'	3.10	1.53	21.39	0.11

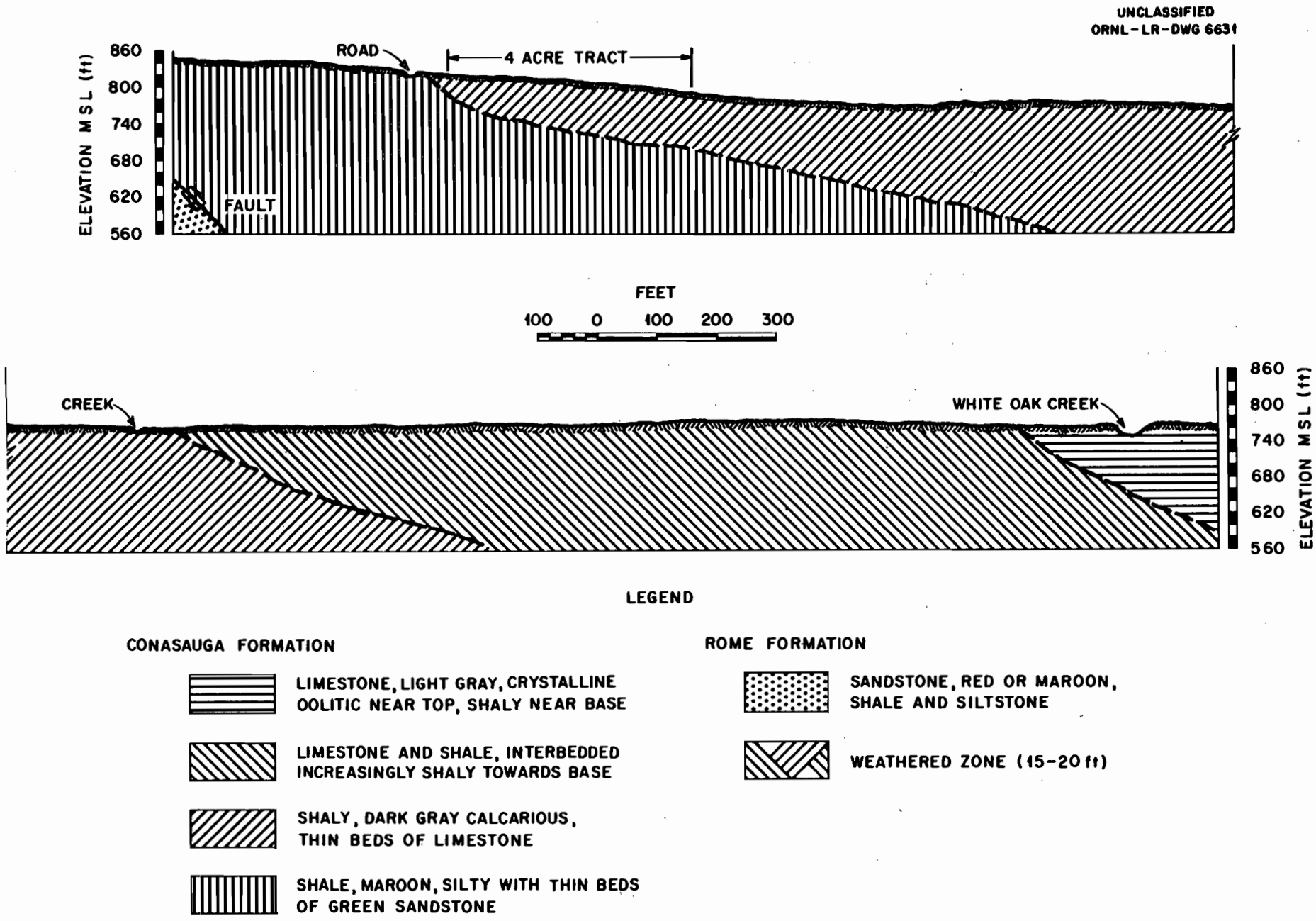
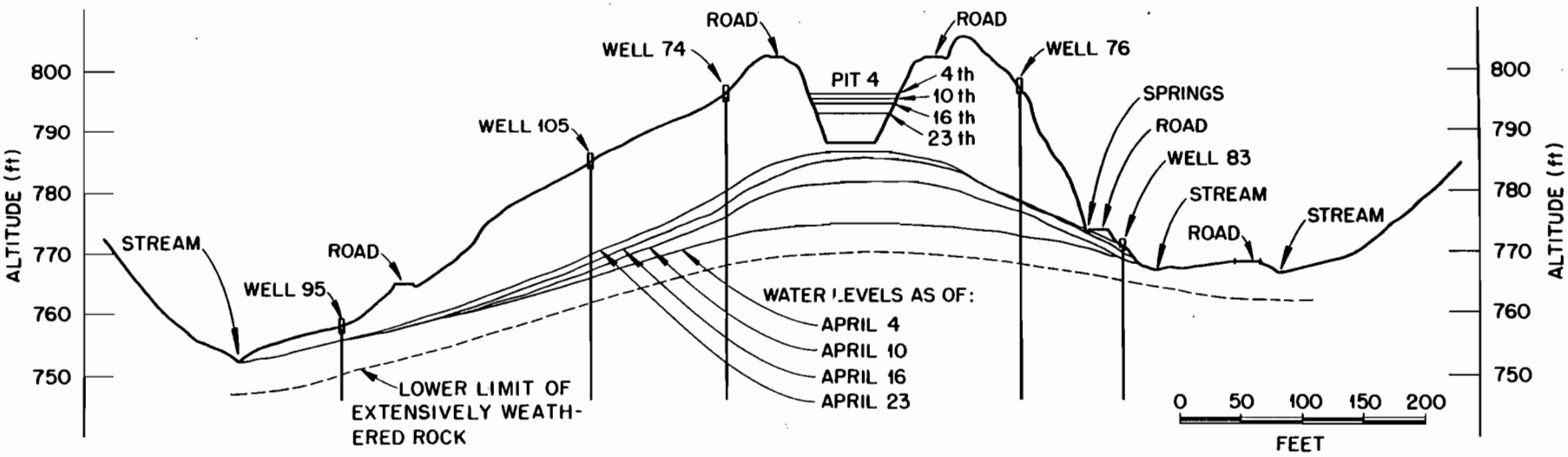


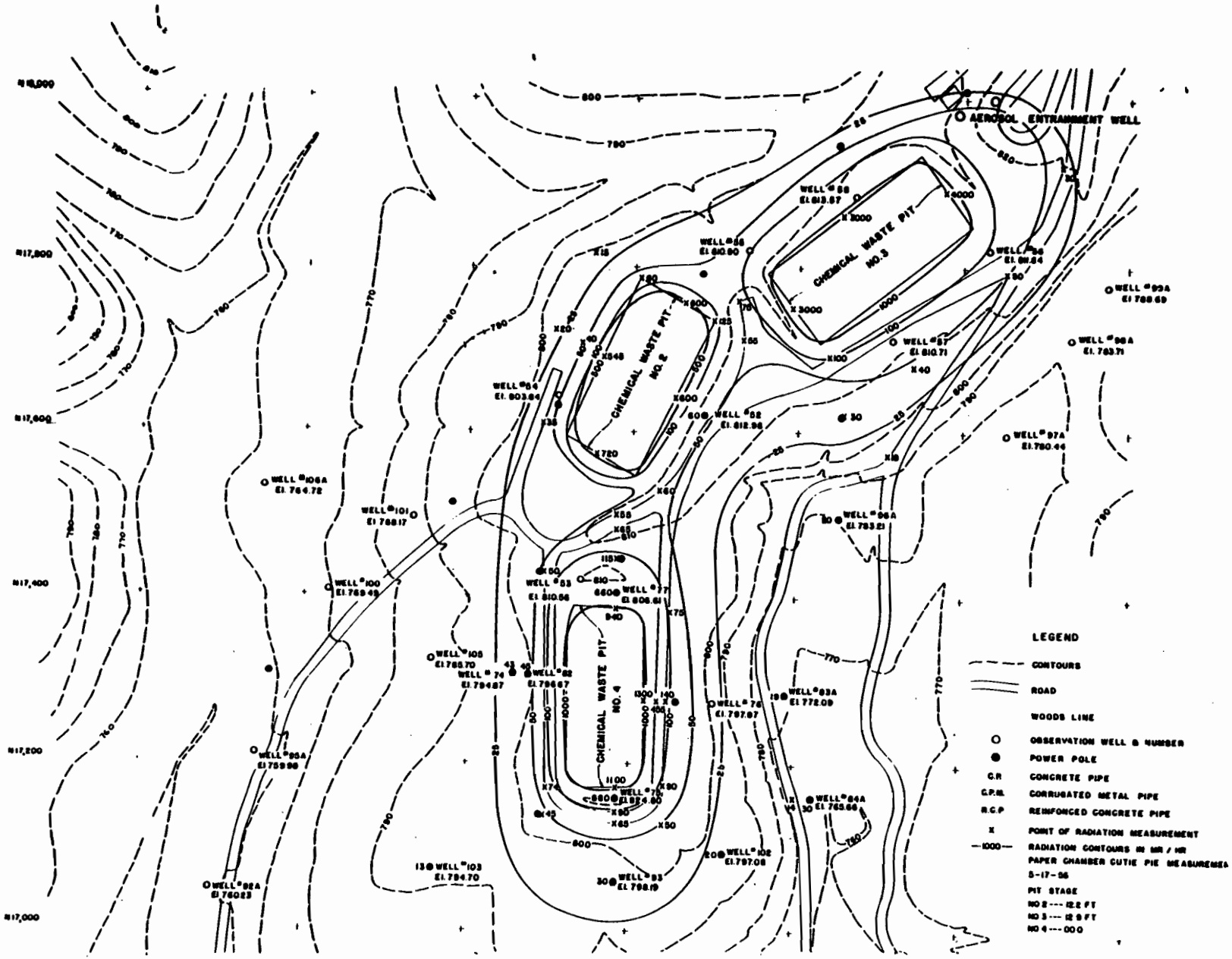
Fig. 2. Generalized Geologic Section—Waste Disposal Area, Oak Ridge National Laboratory.

ORNL-LR-DWG-6631
Generalized geologic section of waste areas
1955

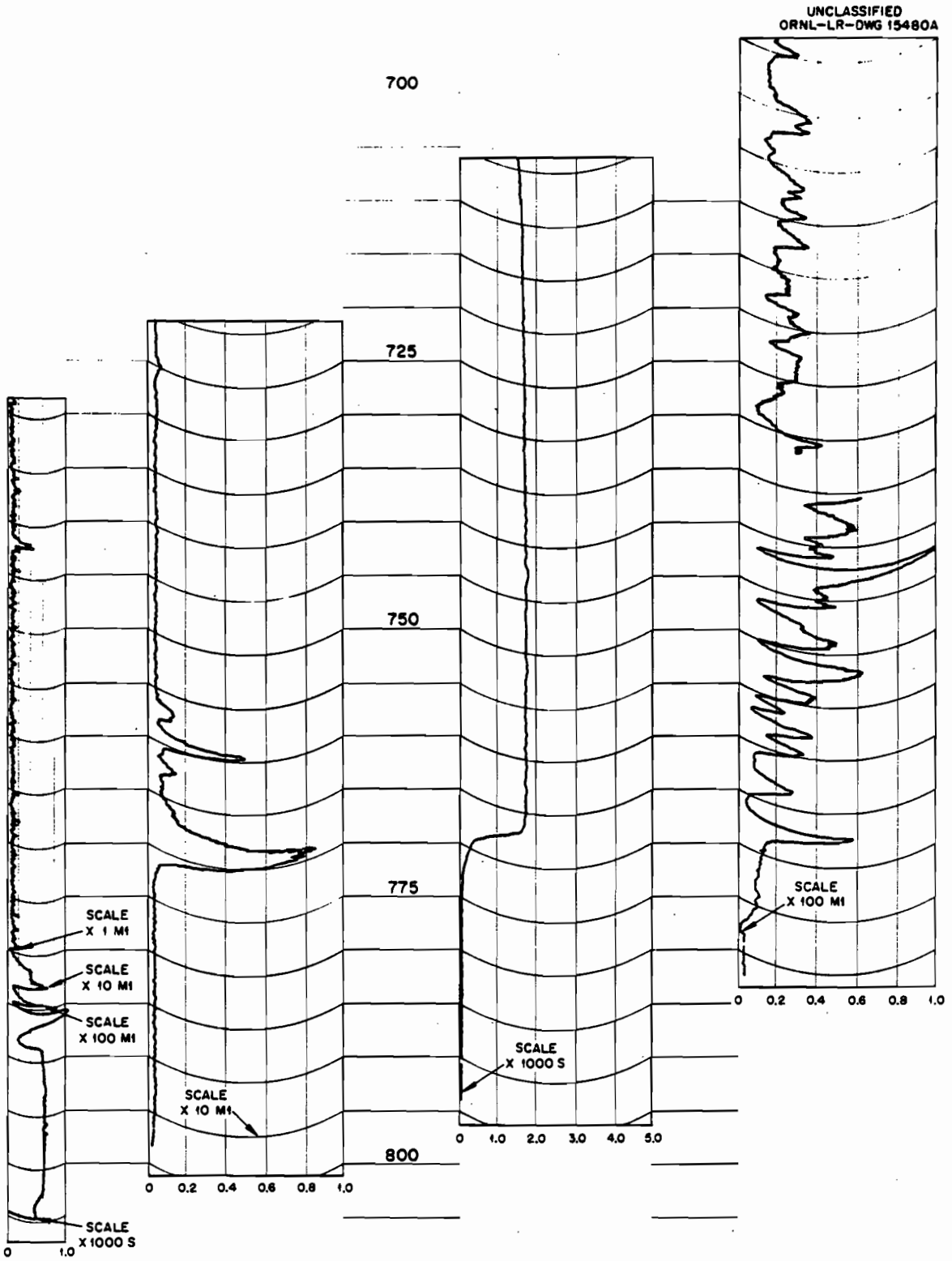
UNCLASSIFIED
ORNL-LR-DWG 13396A



ORNL-LR-DWG-13396A
Water table cross section of pit 4
1956



ORNL-LR-DWG-14172 1956
External radiation levels in pit area May 1956



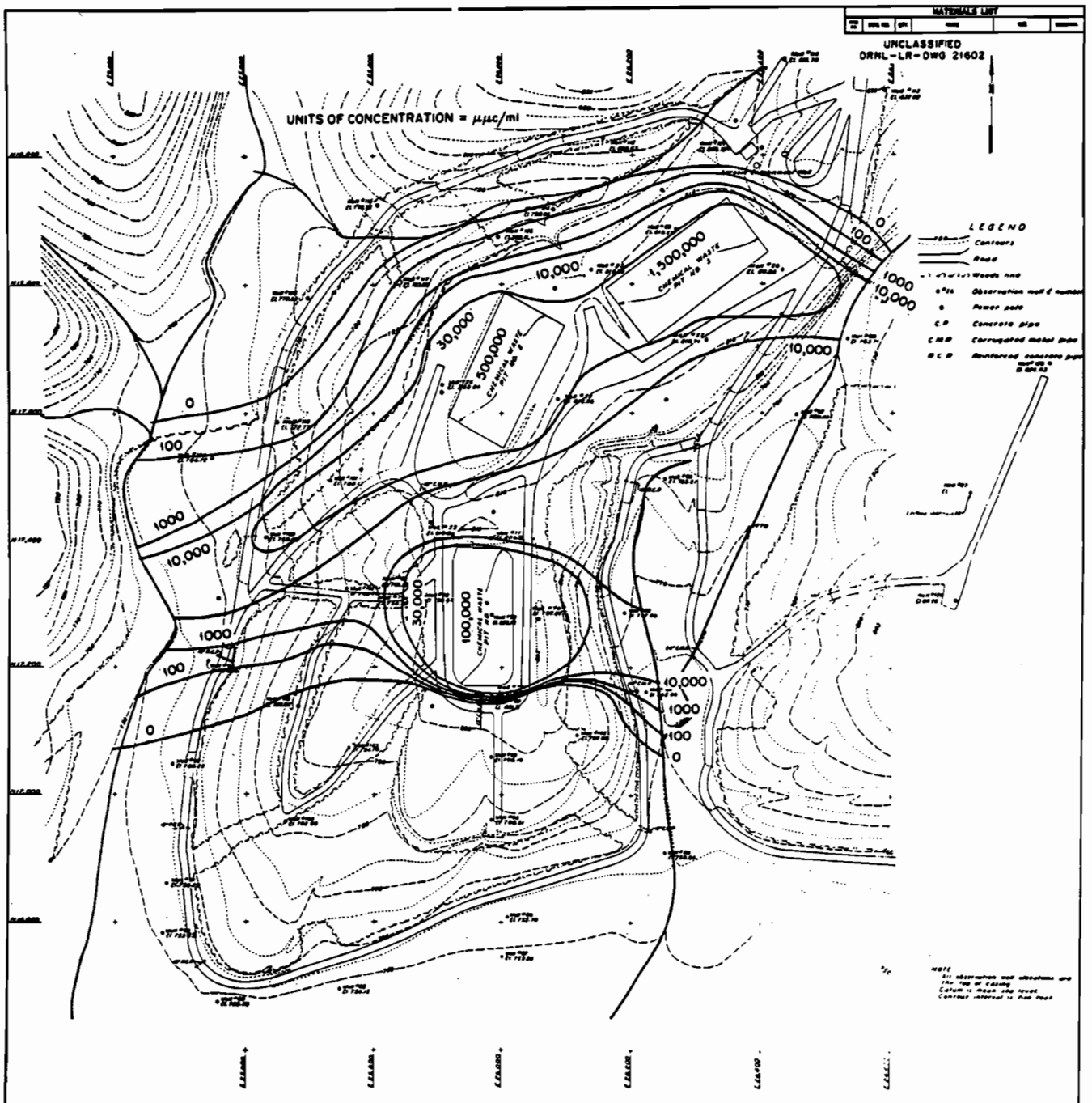
(a) NORMAL RUN WELL NO. 78. GROUT WELL IN PIT NO. 4.

(b) NORMAL RUN WELL NO. 82. GROUT WELL ADJACENT TO PIT NO. 4.

(c) NORMAL RUN WELL NO. 74. OPEN BORING ADJACENT TO PIT NO. 4.

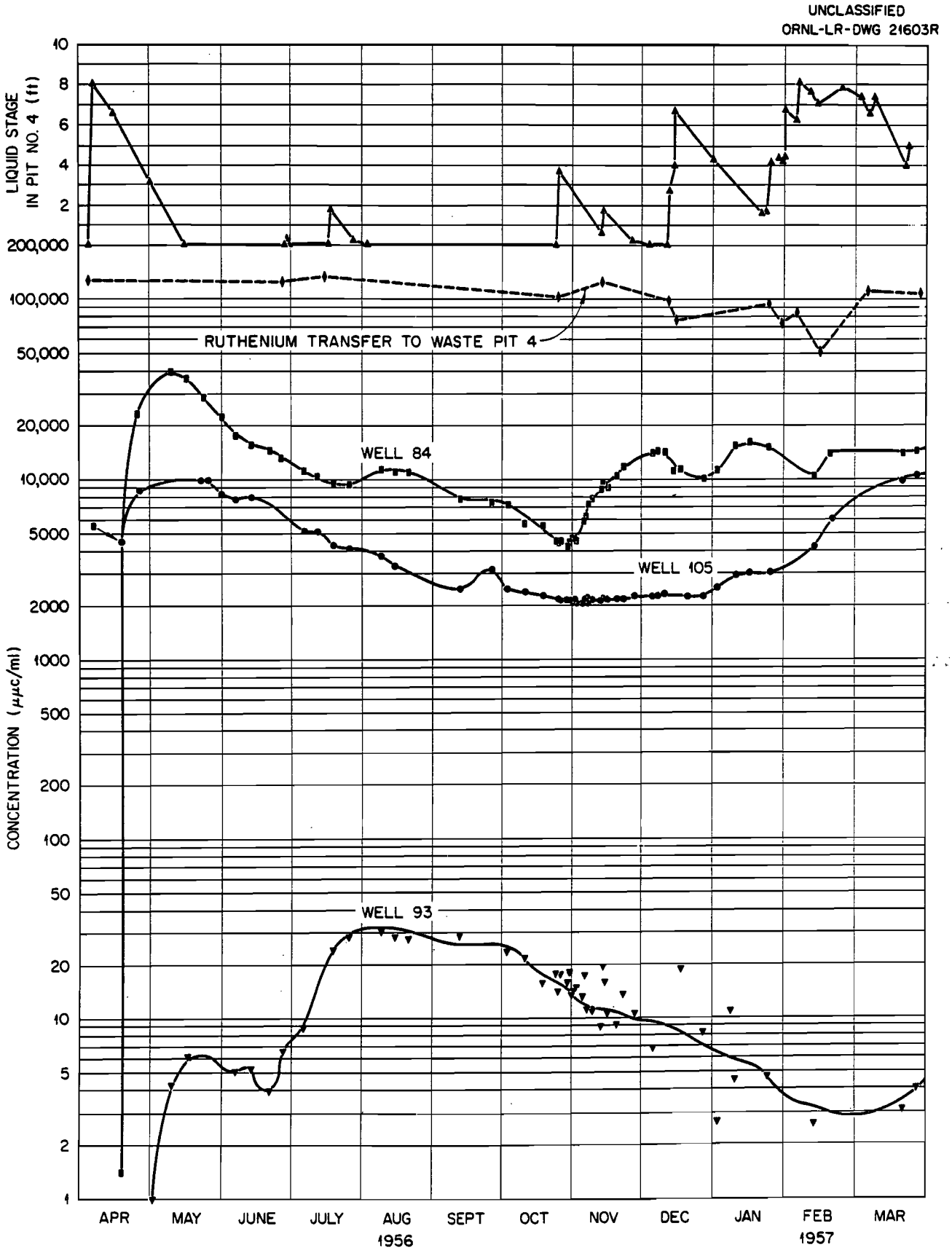
(d) FLUSH RUN WELL NO. 74. OPEN BORING ADJACENT TO PIT NO. 4.

ORNL-LR-DWG-15480A 1956
Radioactivity logs of boreholes around pit 4



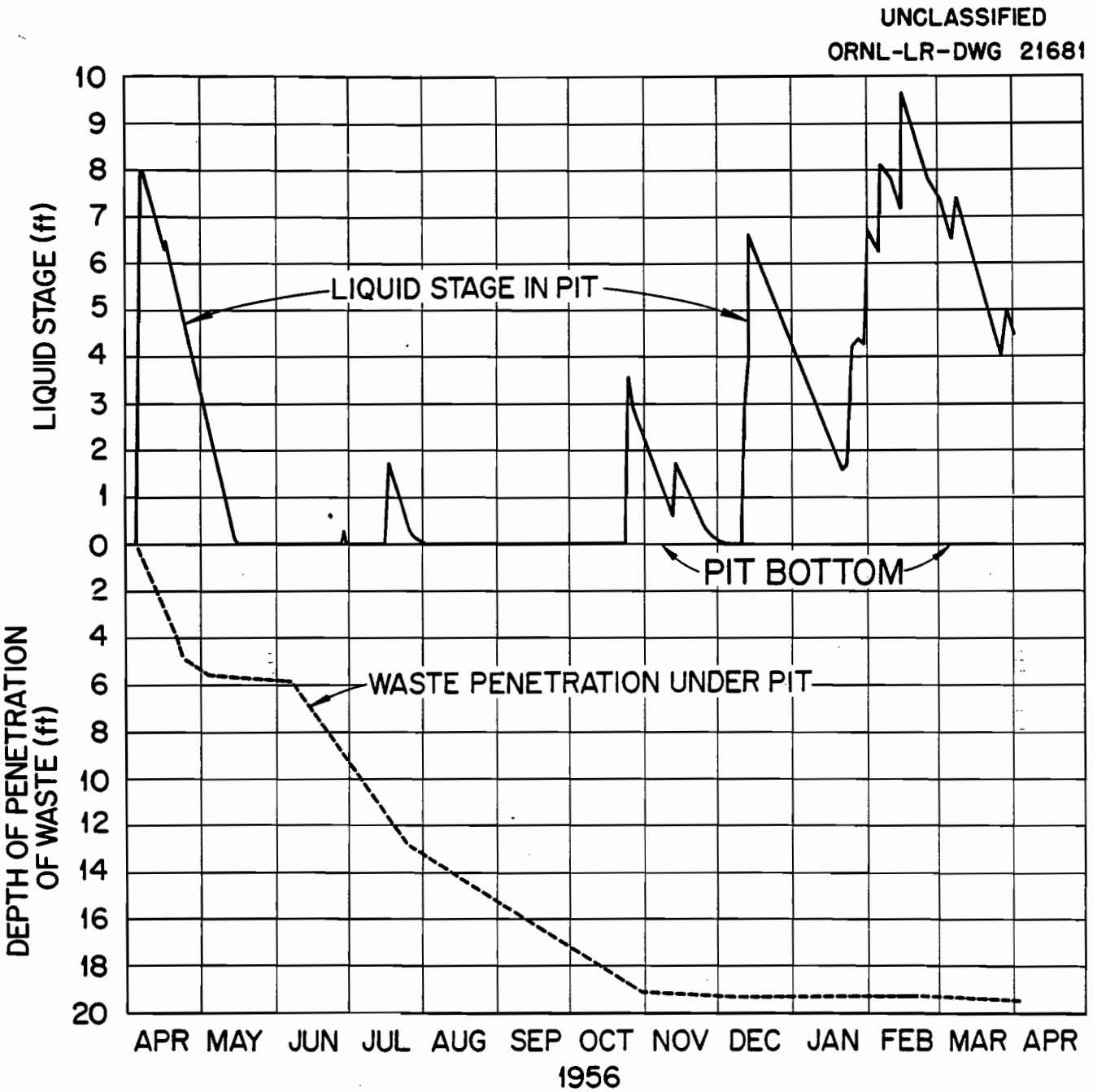
Dispersion of Radioactive Wastes February 1957.

ORNL-LR-DWG-21602 1957
Dispersion of radioactivity near pits Feb 1957



ORNL-LR-DWG-21603R 1957

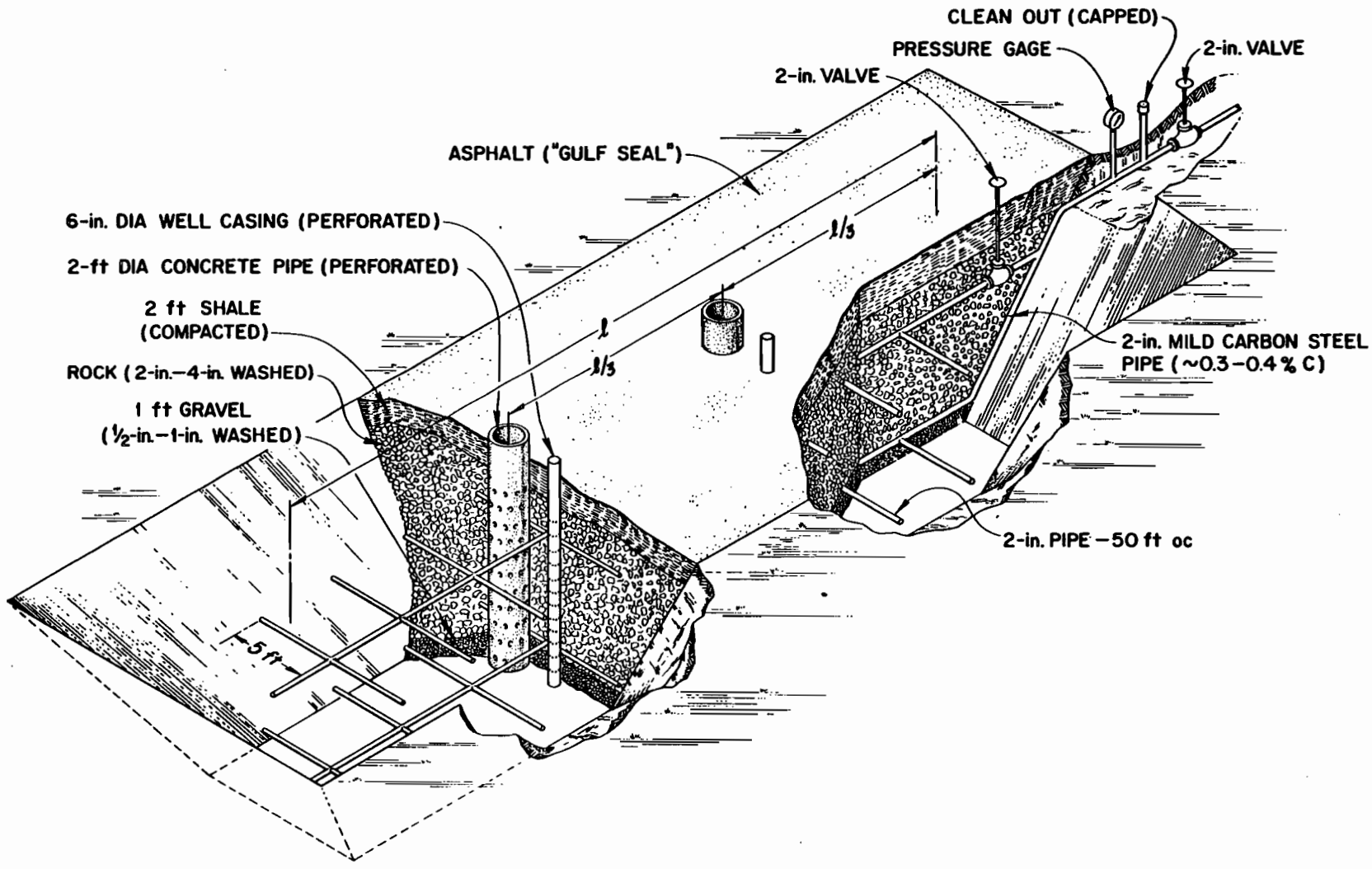
Radioactivity in wells of pit 4, 1956-57



Waste Pit No.4 - Movement of Waste Under Pit.

ORNL-LR-DWG-21681 1957
Movement of radioactivity under pit 4 - 1956

UNCLASSIFIED
ORNL-LR-DWG 21682



Conceptual Pit Design

ORNL-LR-DWG-21682
Conceptual design of new pit (trench 5)
1957

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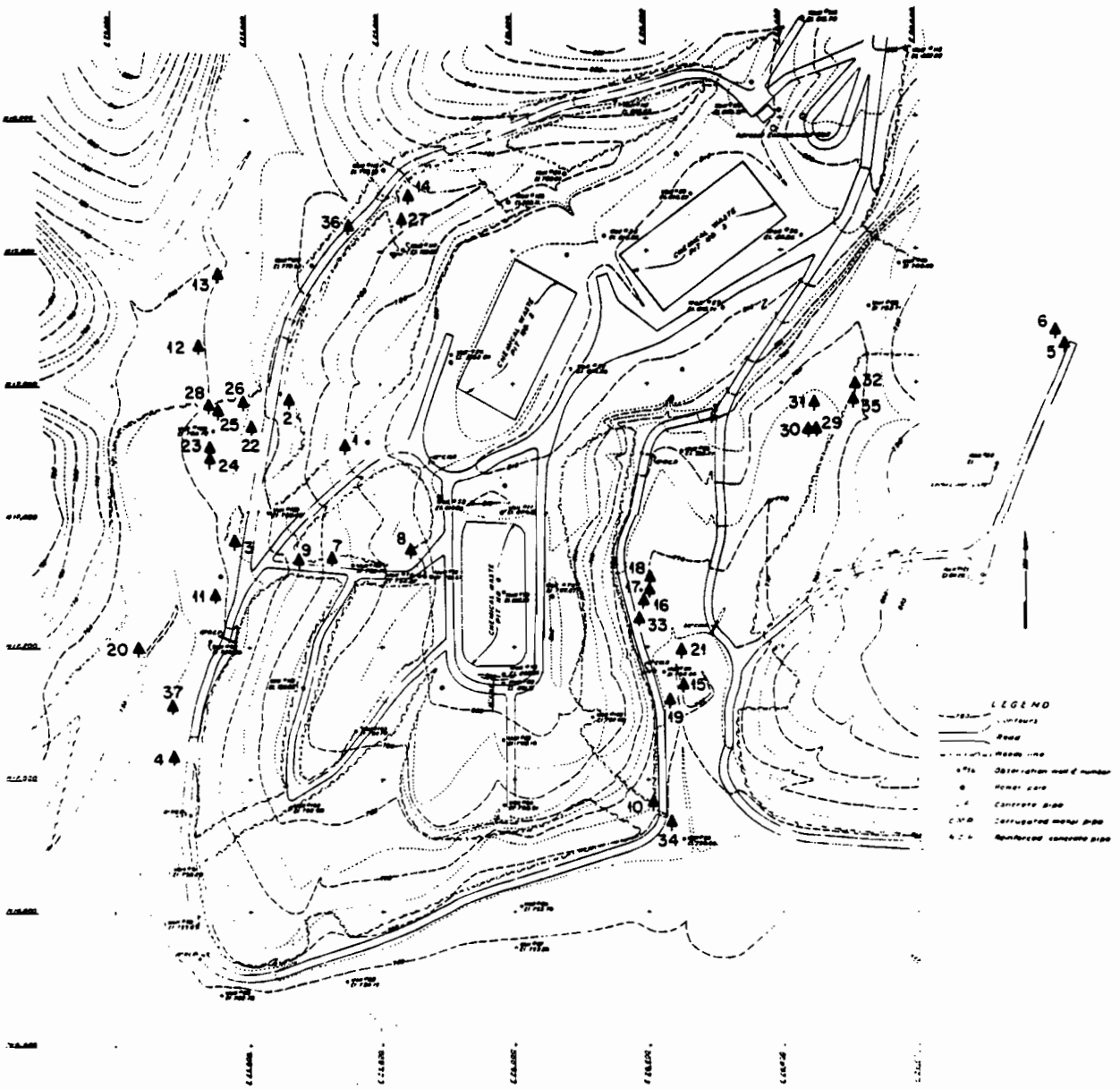
ORNL—LR—DWG 25311



ORNL-LR-DWG-25311 1957
Tree sample locations around pits 2,3,and 4

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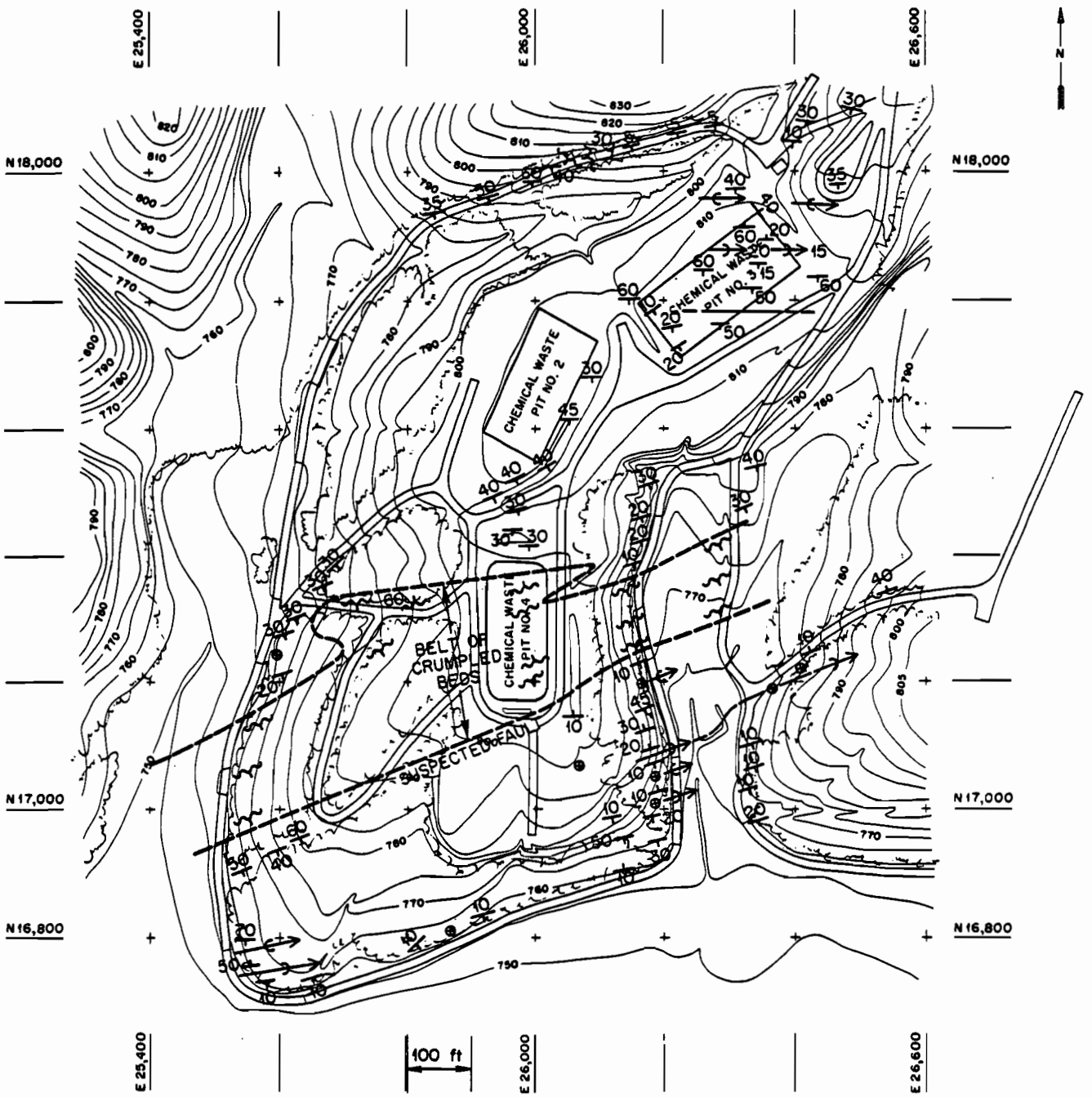
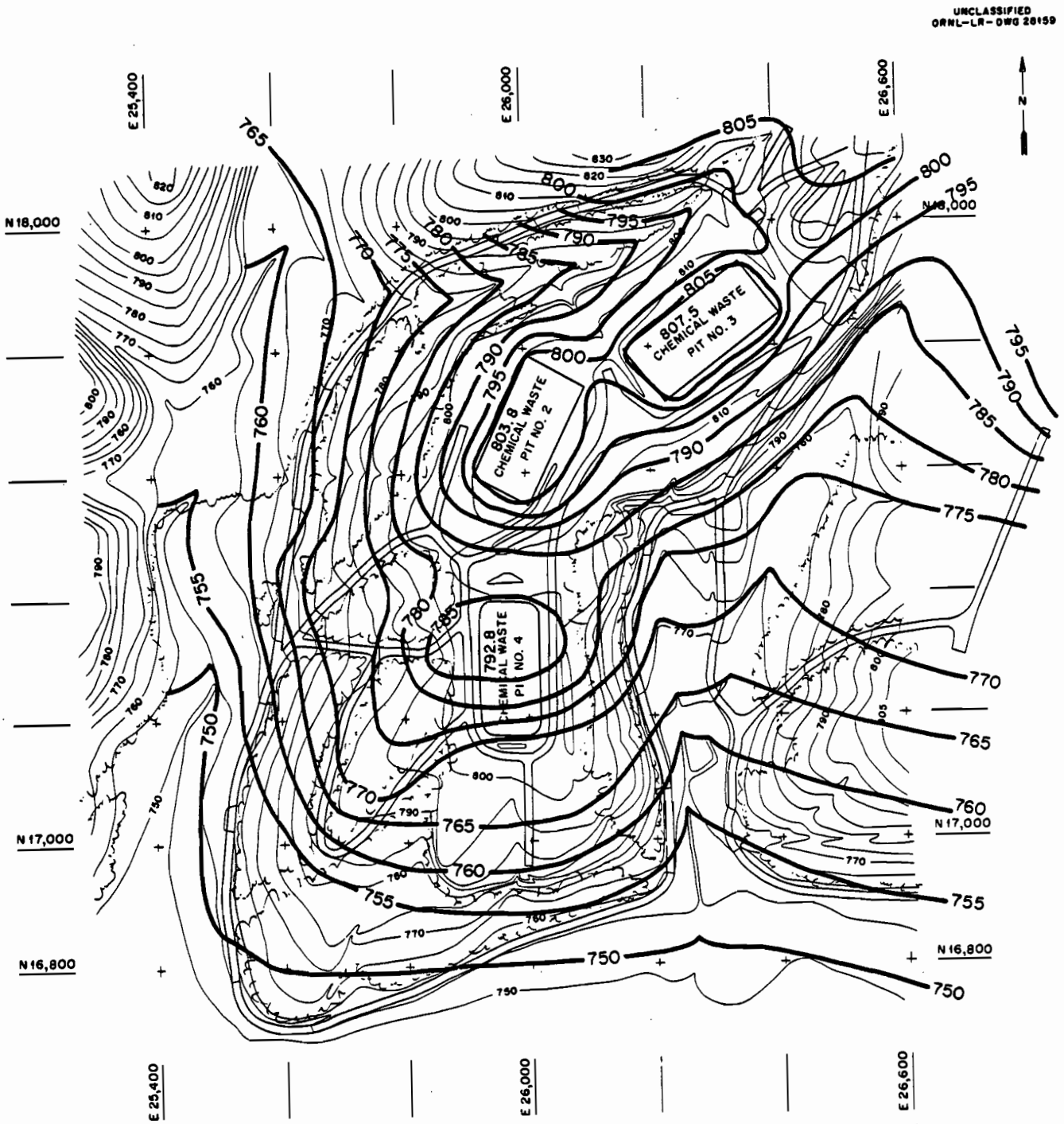
ORNL-LR-DWG 28158



10 STRIKE AND DIP OF BEDS
GENERALIZED STRIKE AND DIP OF CRUMPLED BEDS
HORIZONTAL BEDS
AXIS OF ANTICLINE
AXIS OF SYNCLINE

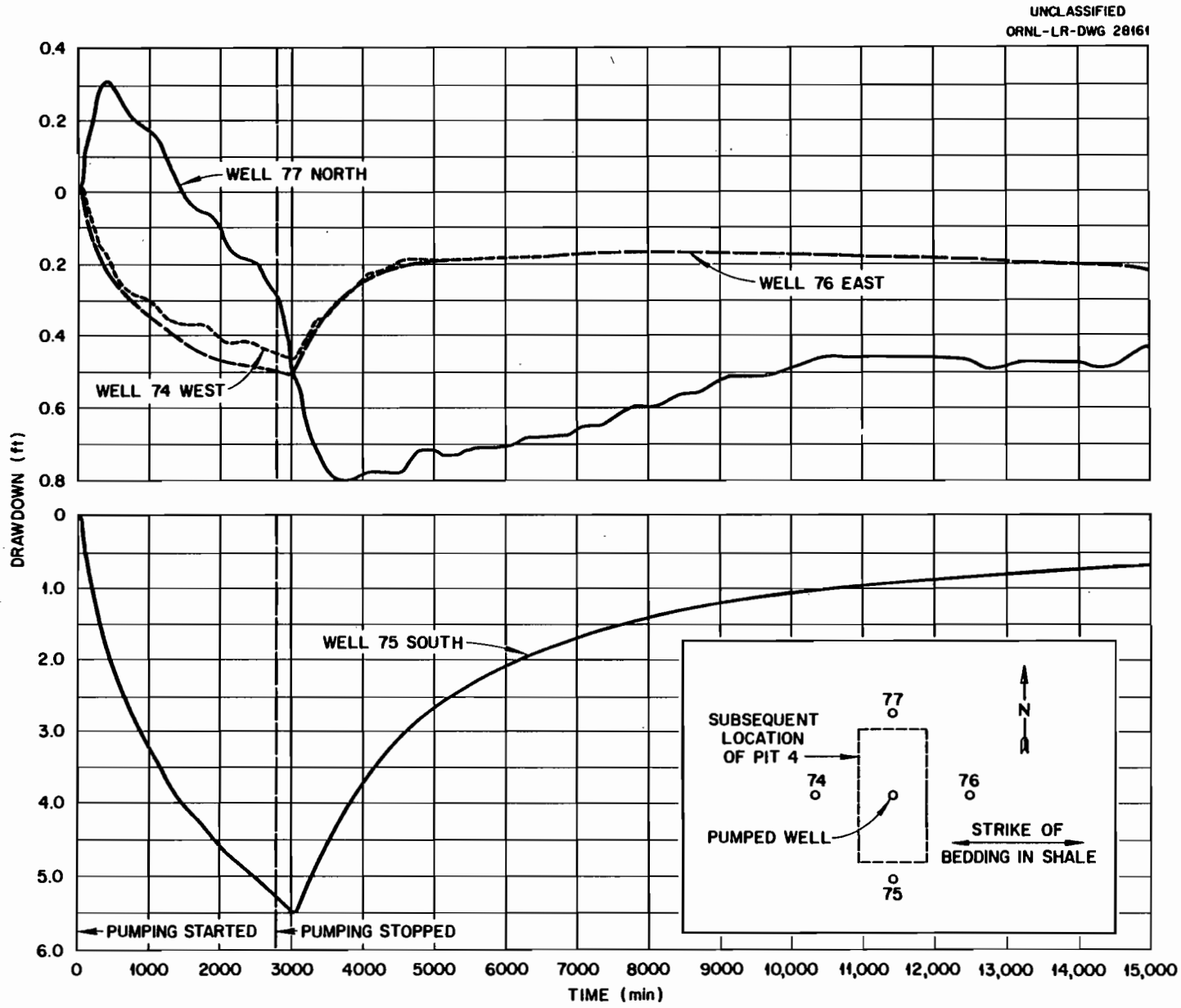
Geologic Structure. Waste Pit Area.

ORNL-LR-DWG-28158 1958
Geologic structure of waste pit area



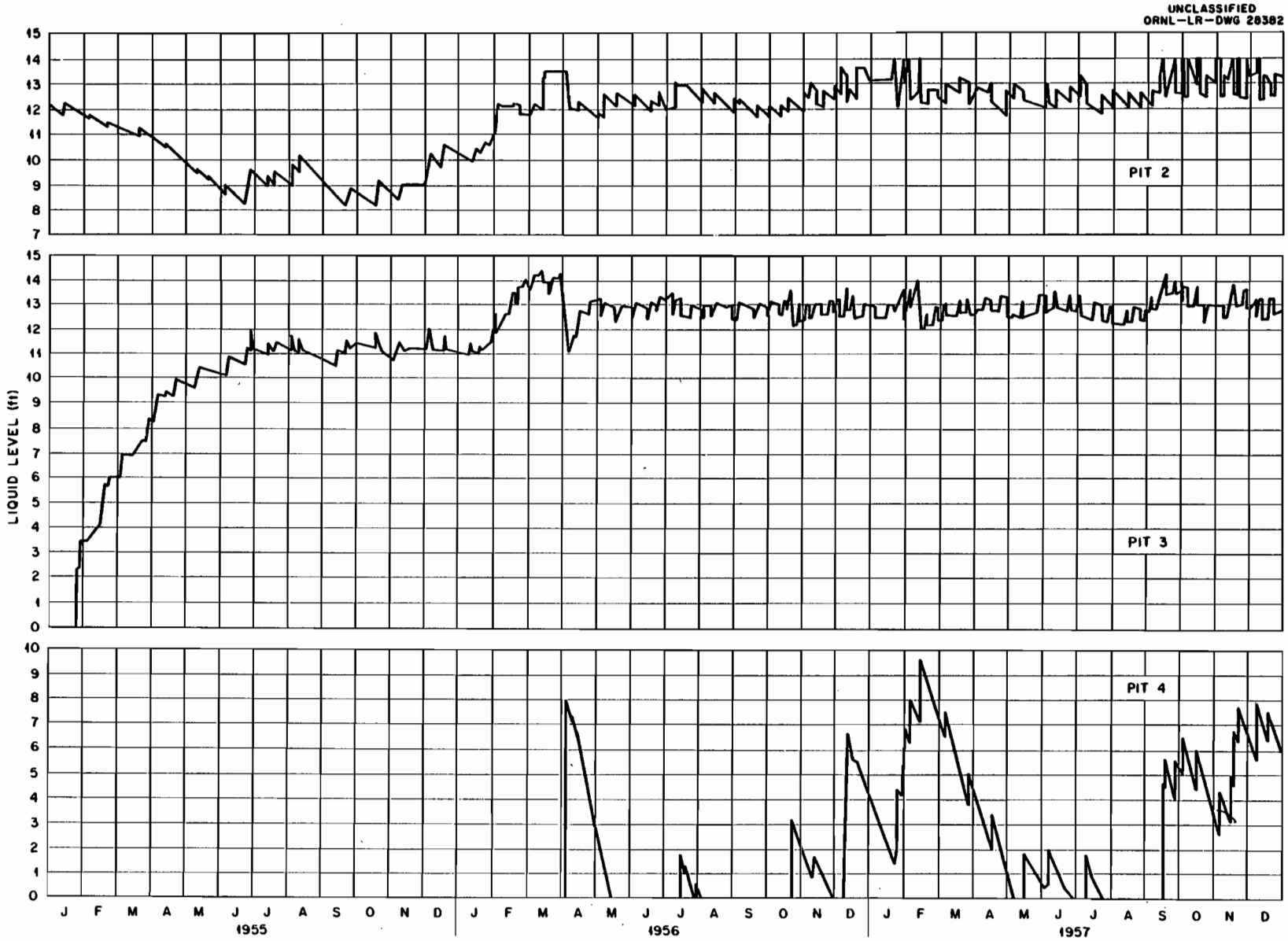
Water Table Contour Map — Janurary 10, 1958.

ORNL-LR-DWG-28159 1958
Water table contour map of pits area Jan, 1958



Pumping Test, Pit 4, Aug. 31 – Sept. 10, 1955.

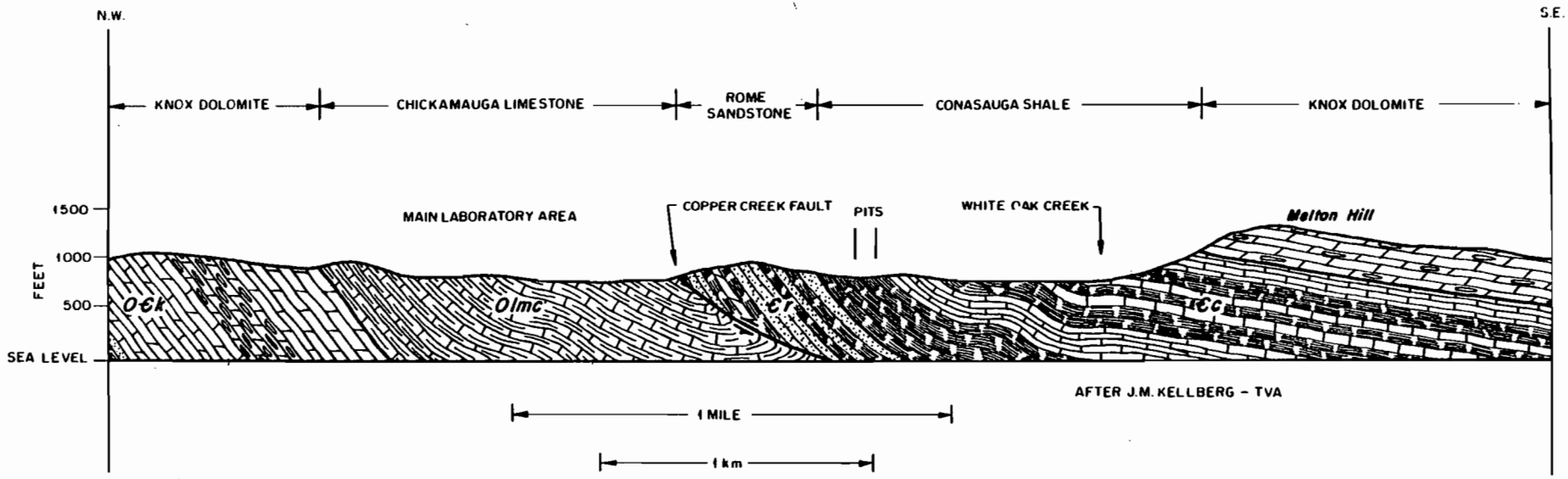
ORNL-LR-DWG-28161
Pump test results in pit 4 area
1958



Liquid Levels in Waste Pits.

ORNL-LR-DWG-28382 1958
Liquid levels in pits 2,3, 4 - 1955-1957

UNCLASSIFIED
ORNL-LR-DWG 28383



Geologic Cross Section of the Oak Ridge National Laboratory Area.

ORNL-LR-DWG-28383 1958
General geologic cross section in waste areas

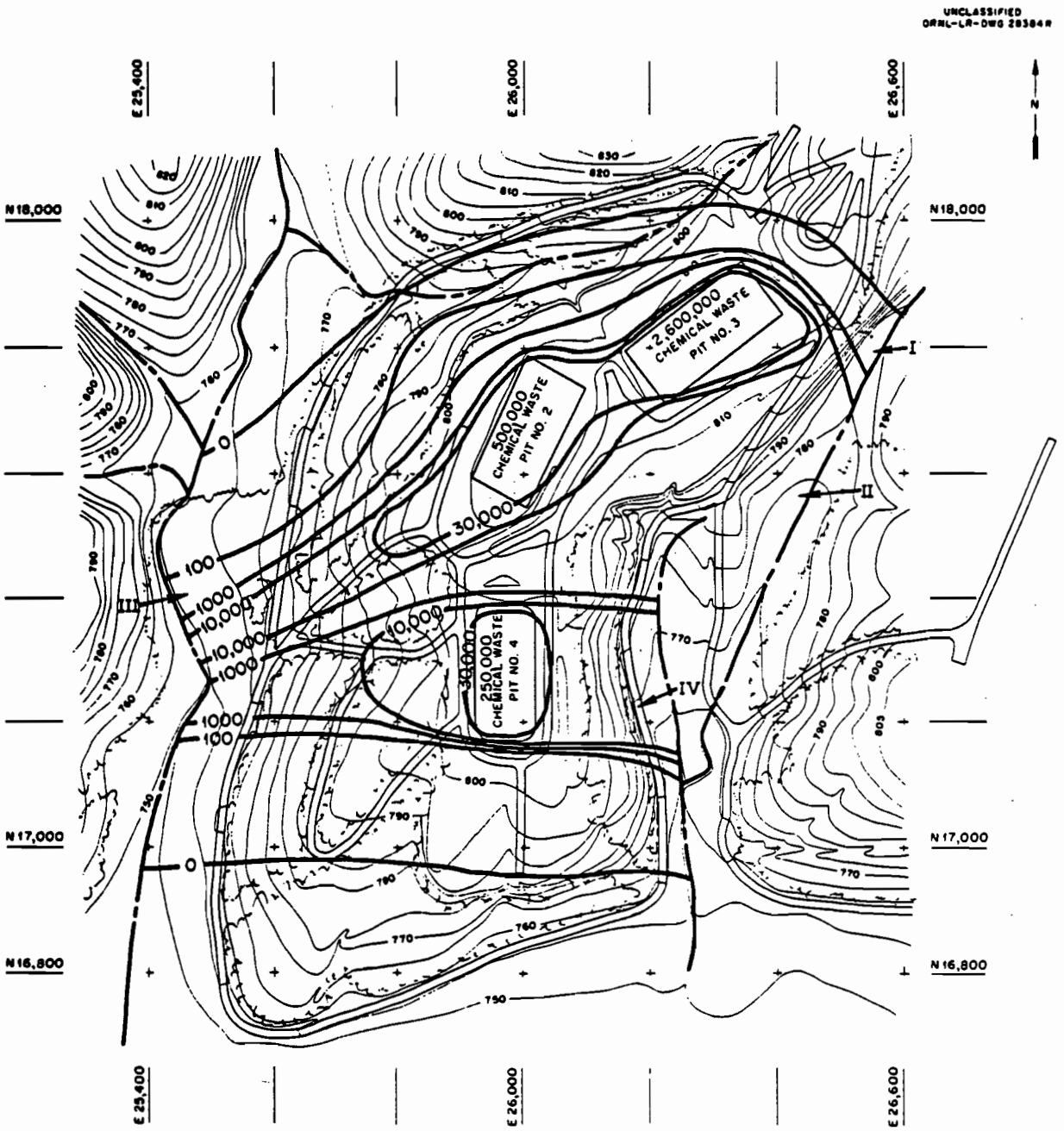
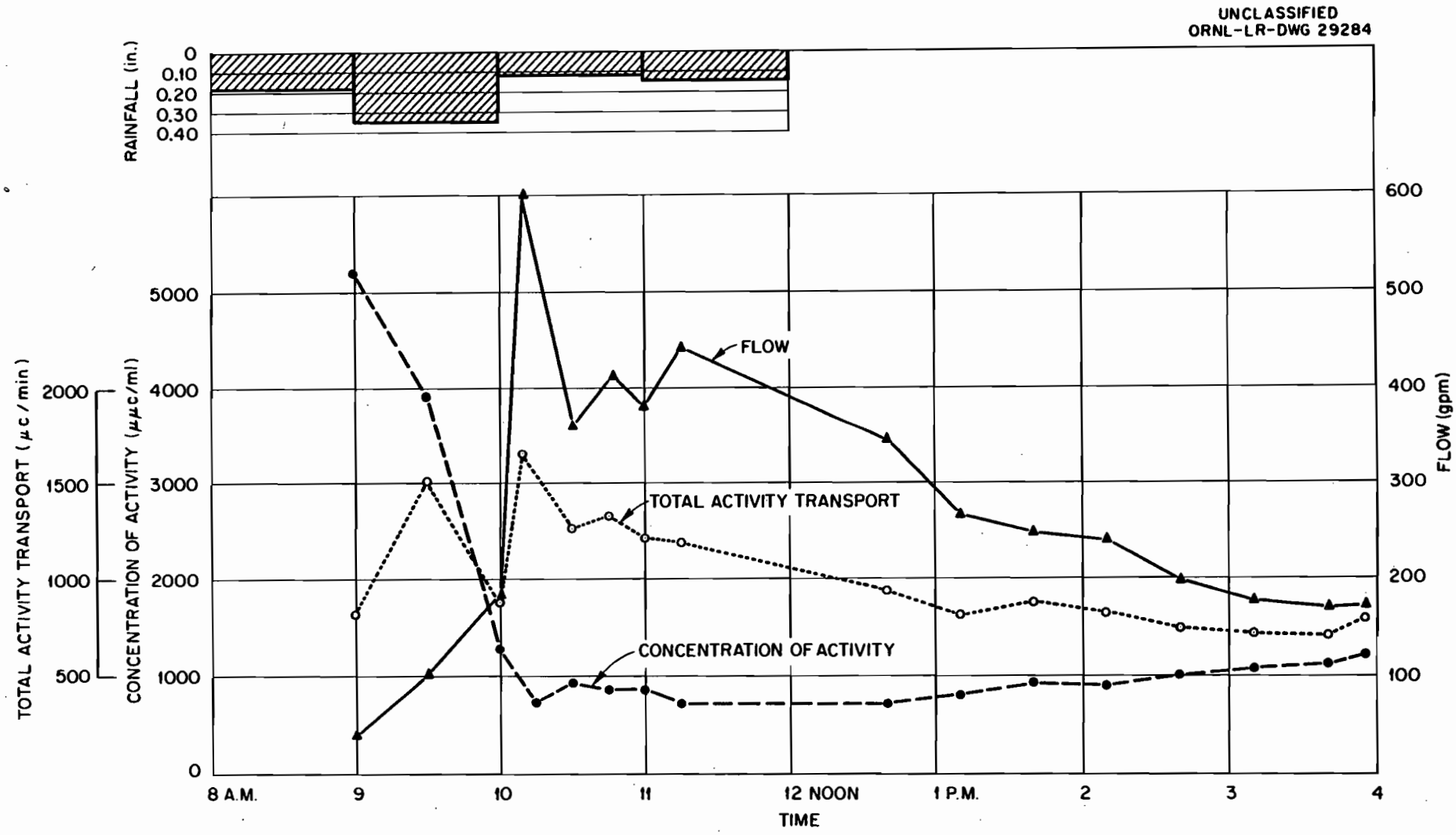


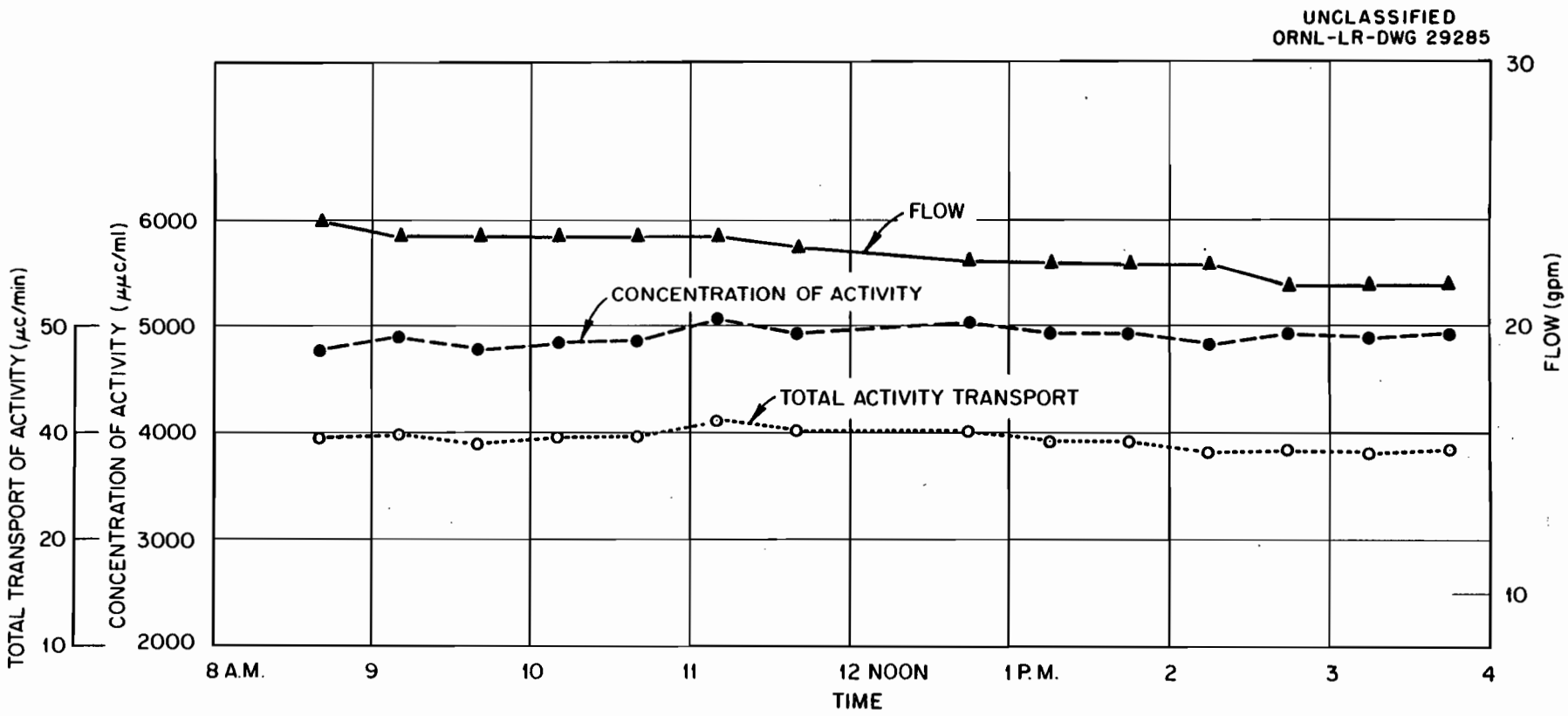
Fig. 11. Dispersion of Radioactive Wastes – February 1958. I, II, III, and IV represent radioactive seeps and springs; unit of concentration is $\mu\mu c/ml$.

ORNL-LR-DWG-28384R 1958
Distribution of radioactivity near pits Feb 1958



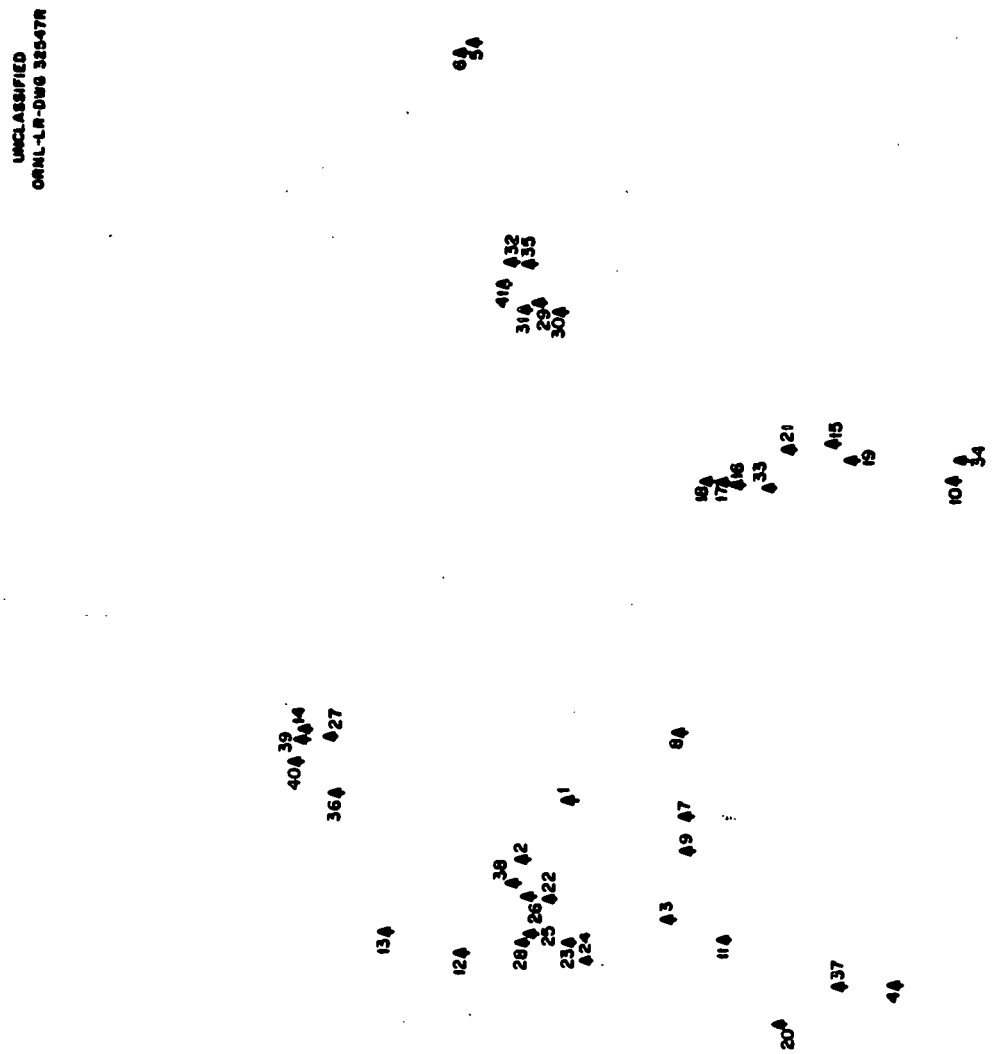
Flow and Radioactivity Transport Past Stream Monitoring Station During Rainfall – April 4, 1957 (Weir at Well 85).

ORNL-LR-DWG-29284
1958
Stream flow and radioactivity at pits Apr 4, 57

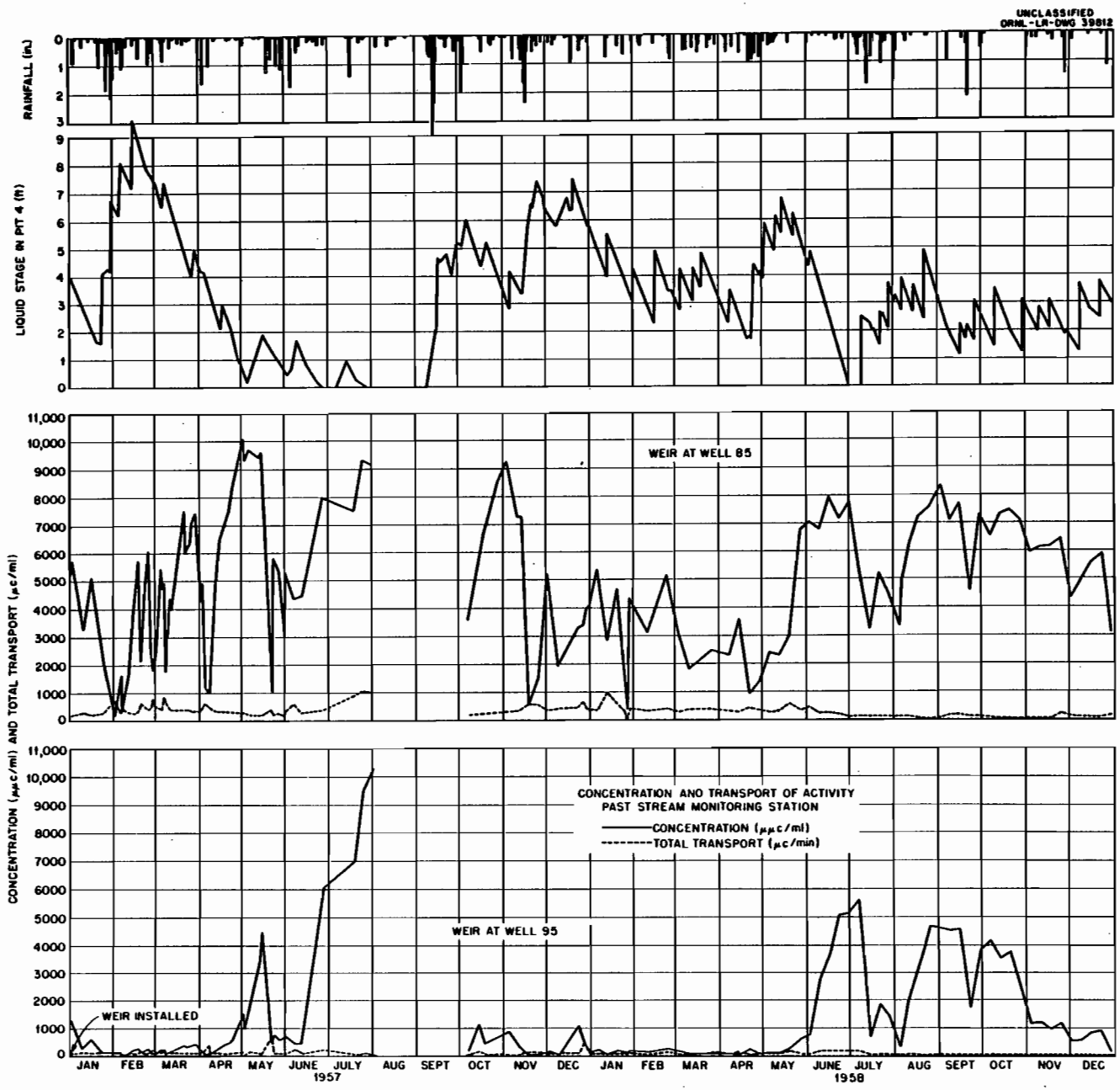


Flow and Radioactivity Transport Past Stream Monitoring Station During Dry Weather—March 3, 1957 (Weir at Well 85).

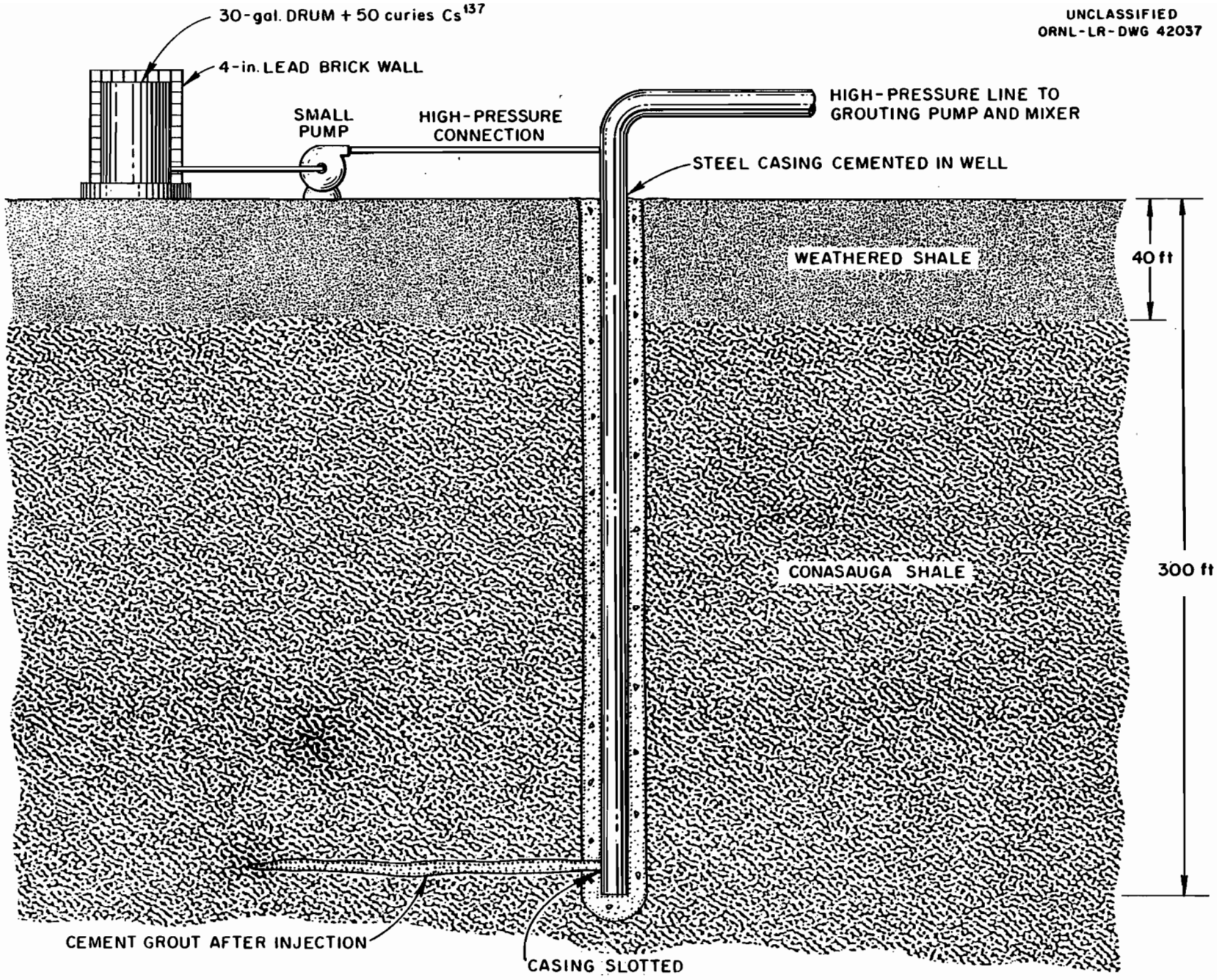
ORNL-LR-DWG-29285 1958
Stream flow and radioactivity at pits Mar 3, 57



ORNL-LR-DWG-32547R 1958
Tree sample locations around pits 2, 3, 4



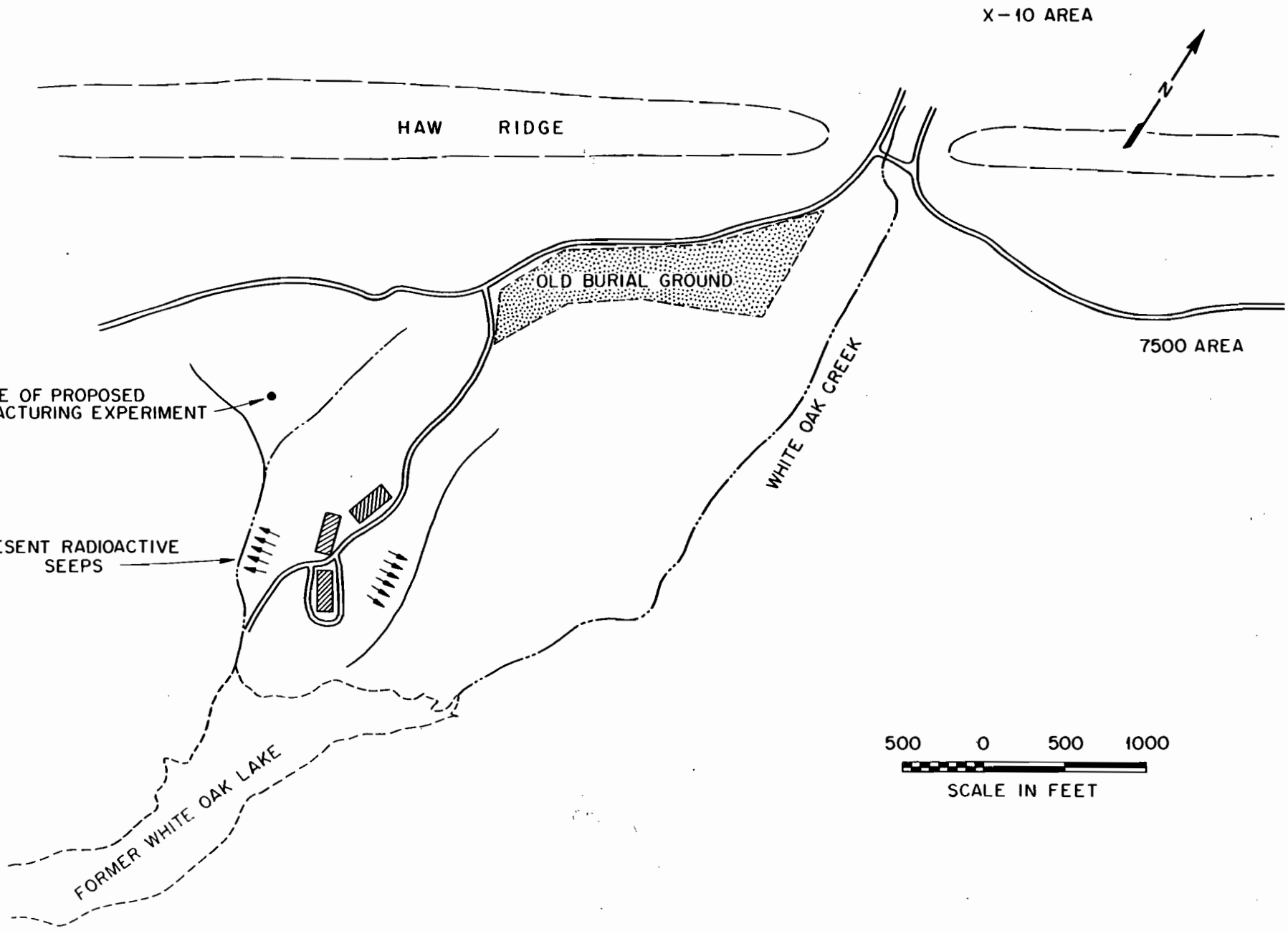
ORNL-LR-DWG-39812
Radioactivity discharge in pit area streams 1957
1959



Fracture Experiment – 4-acre Site.

ORNL-LR-DWG-42037 1959
Conceptual diagram of first hydraulic fracturing exp.

UNCLASSIFIED
ORNL-LR-DWG 42038



ORNL-LR-DWG-42038 1959
Site of proposed fracturing experiment

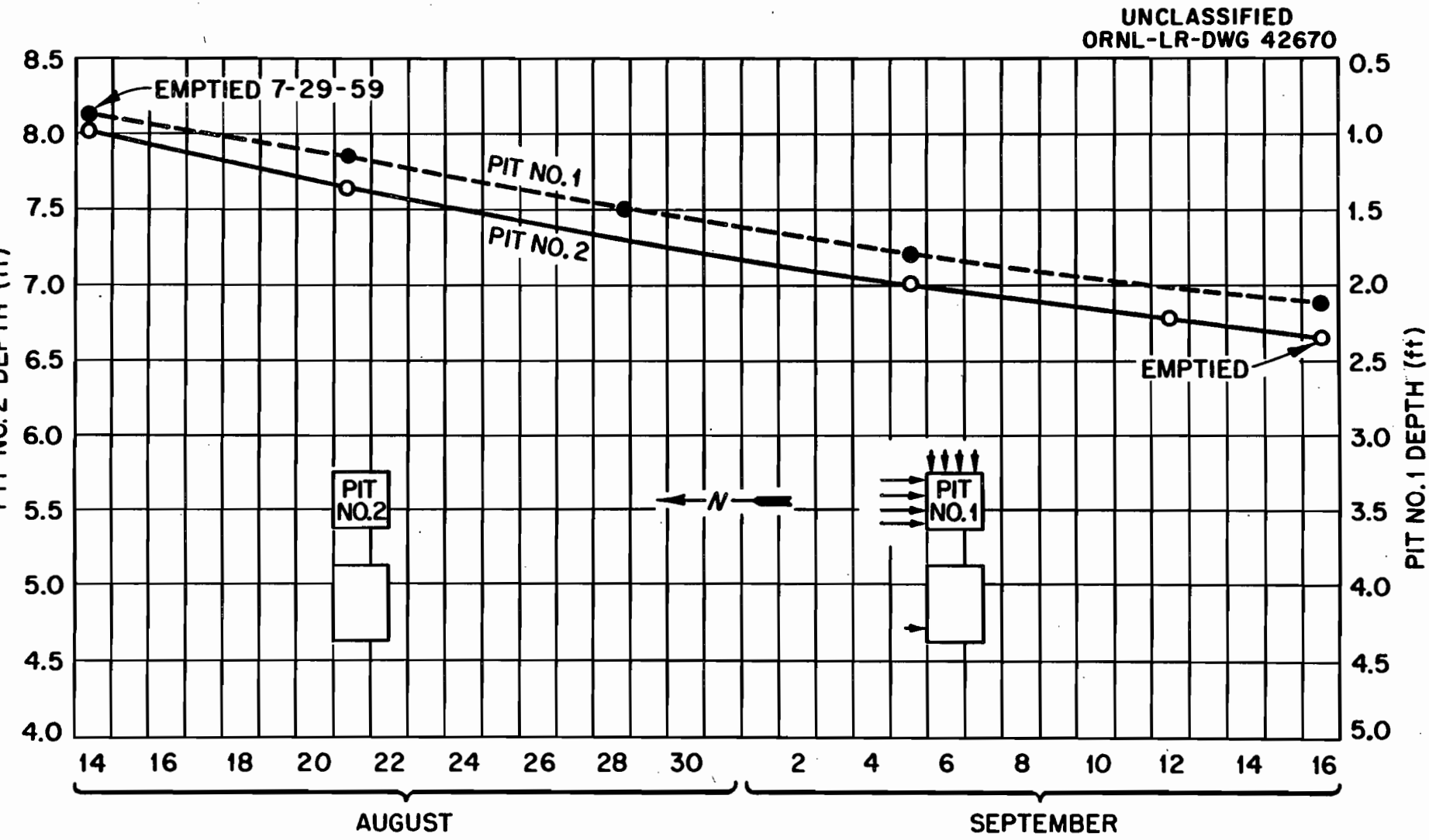


Fig. 13. Water Surface Elevations, Pits 1 and 2.

ORNL-LR-DWG-42670
1959
Water surface elevations of pits 1 and 2 [2 and 3]

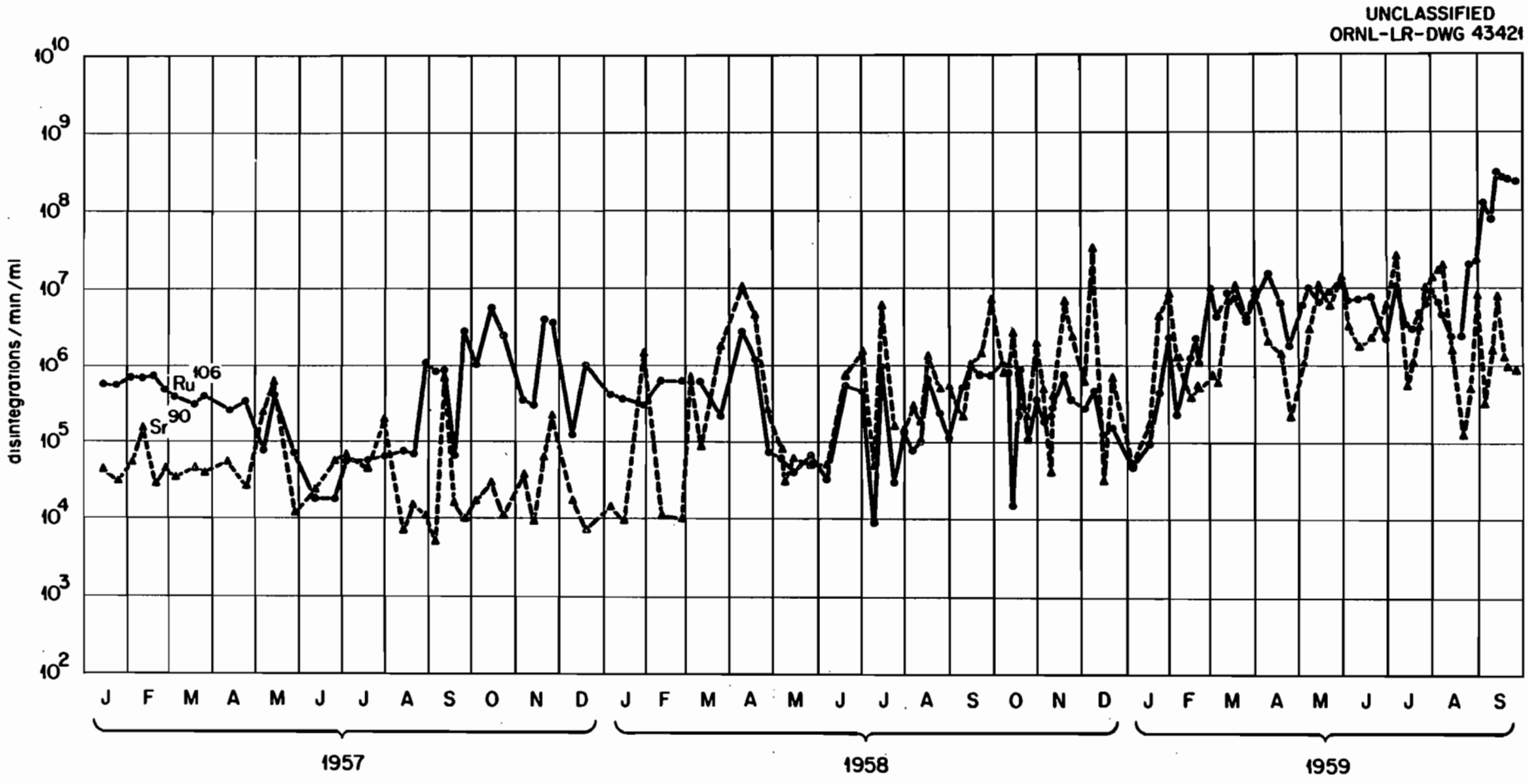
UNCLASSIFIED
ORNL-LR-DWG. 42822

YEARLY DISCHARGES TO WHITE OAK CREEK*

YEAR	TOTAL VOLUME 10^6 gals	CURIES
1950	226	187
1951	298	172
1952	268	498
1953	239	429
1954	164	254
1955	211	267
1956	261	273
1957	272	189
1958	233	92

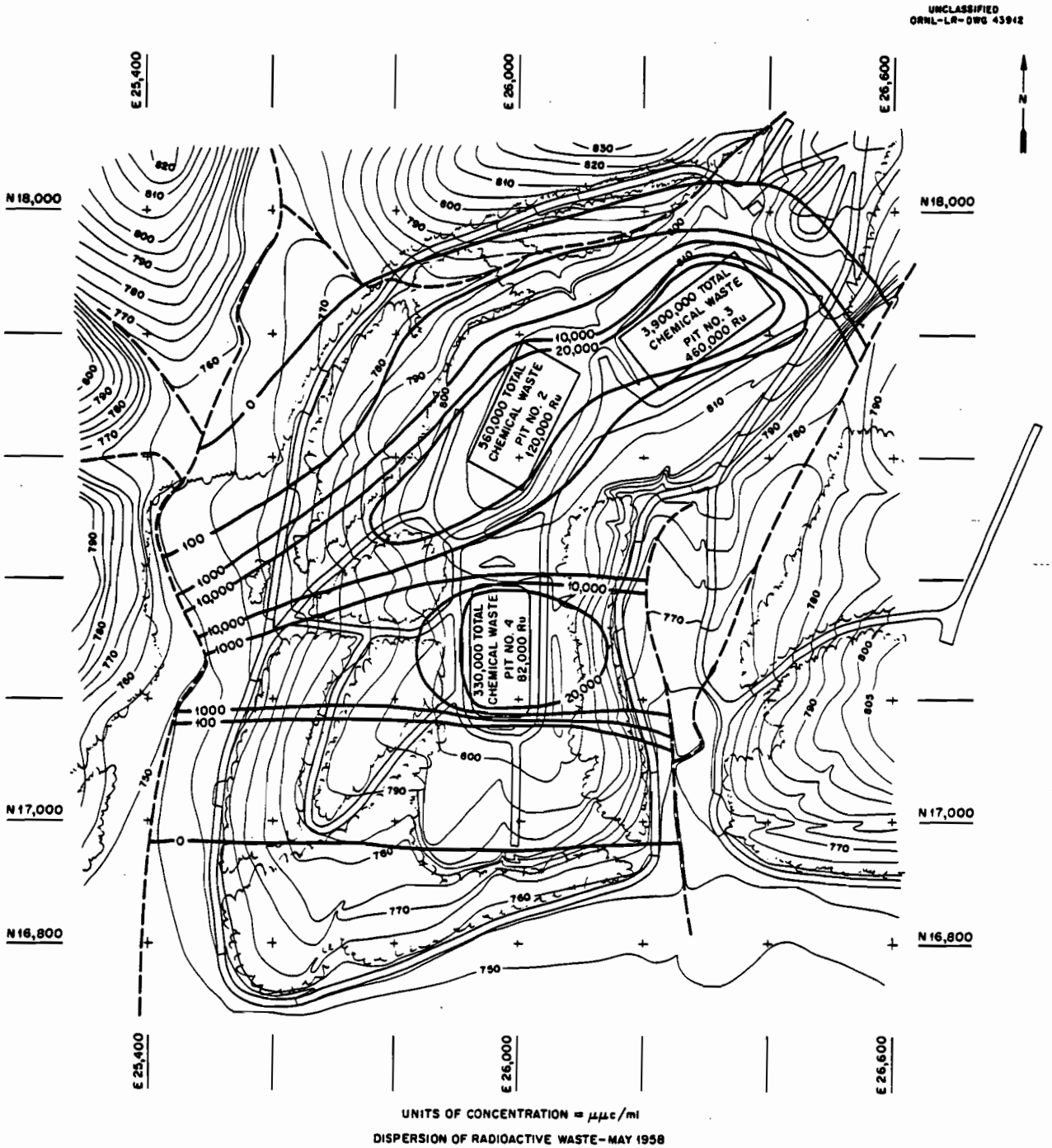
*RESULTS REPORTED BY THE OPERATIONS DIVISION, ORNL

ORNL-LR-DWG-42822 1959
Yearly radioactive discharges to White Oak Creek

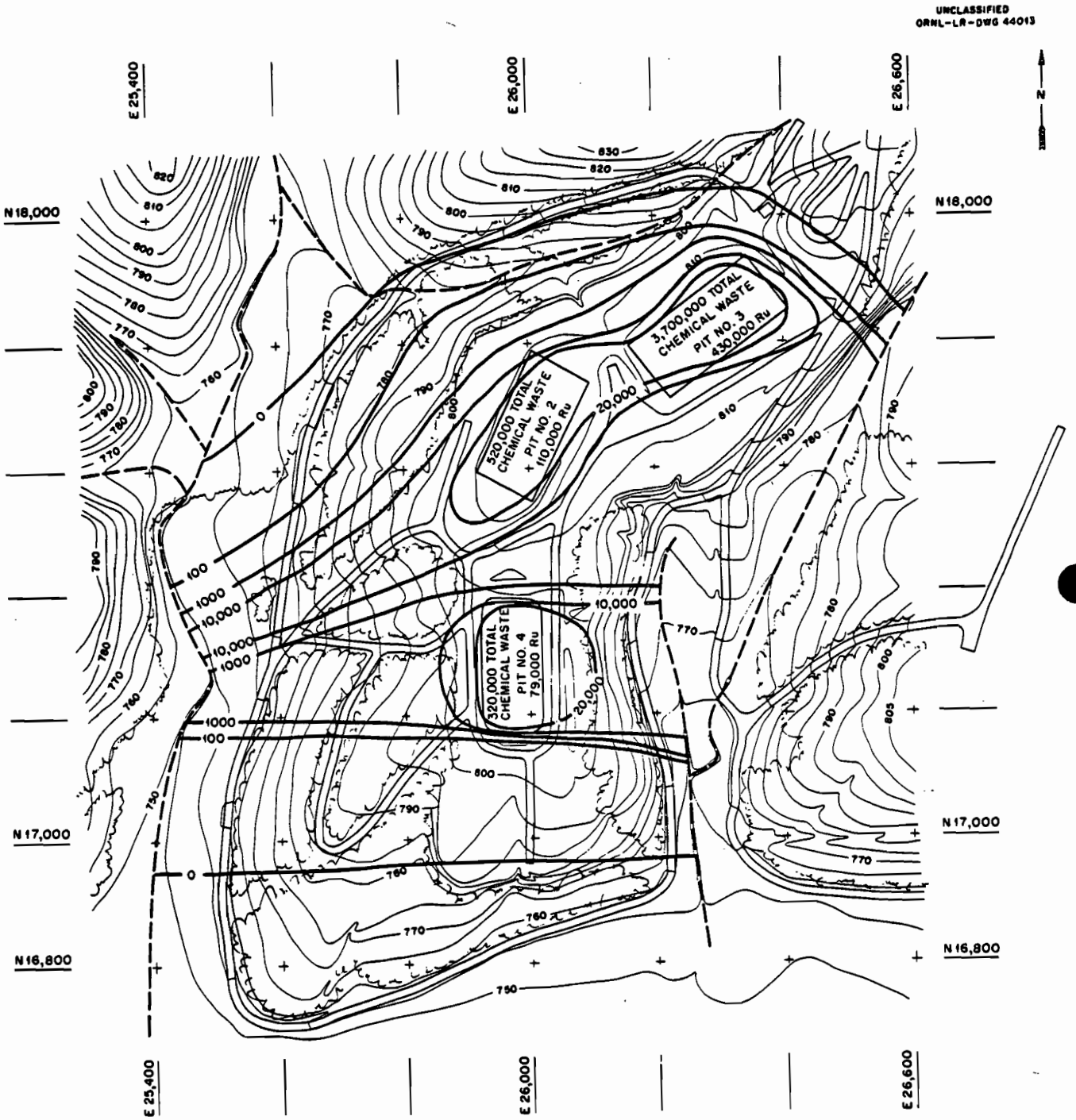


Concentration of Sr^{90} and Ru^{106} in Waste Discharged to Pits.

ORNL-LR-DWG-43421
Concentration of Sr-90 and Ru-106 in waste to pits
1959

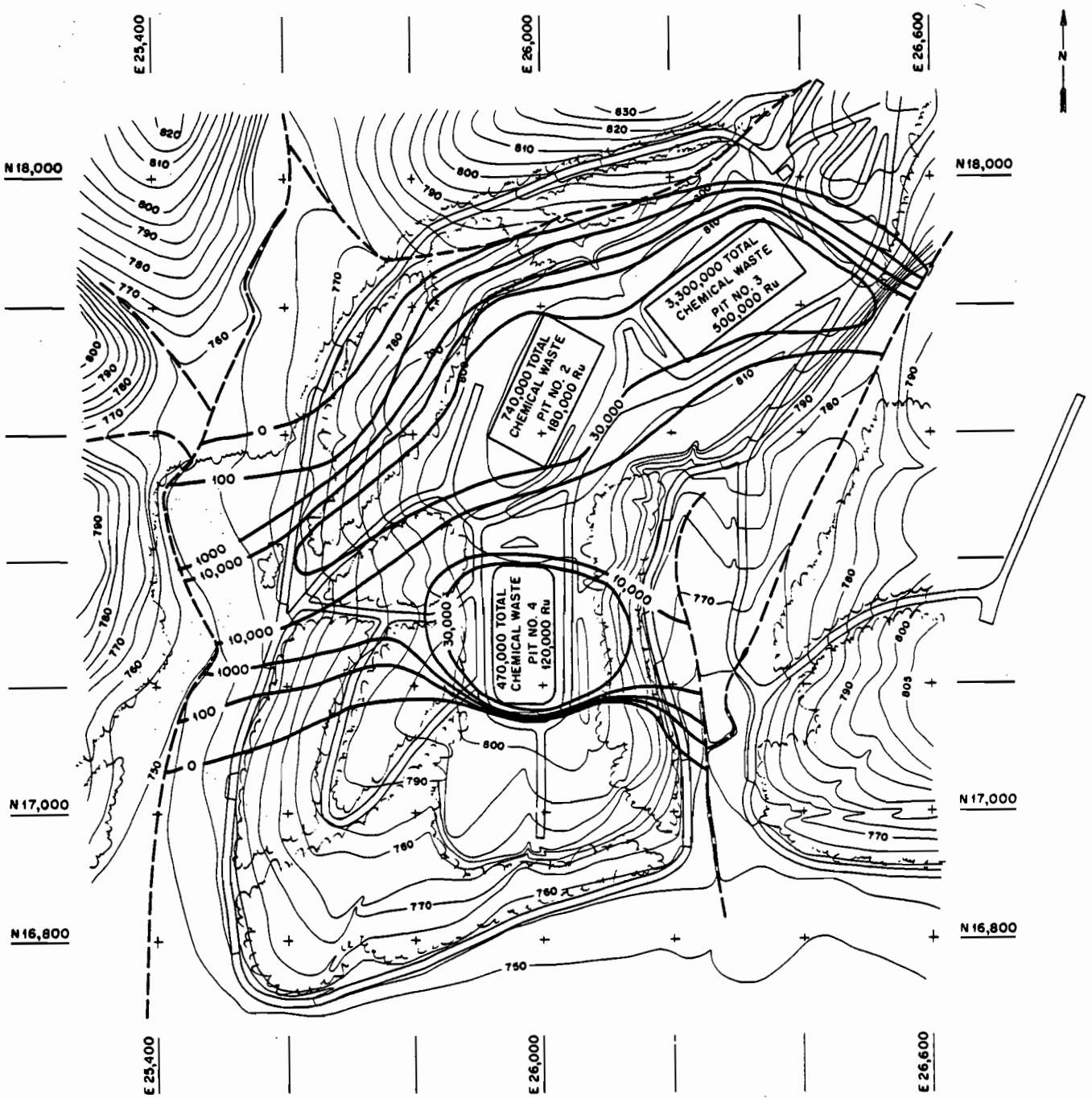


ORNL-LR-DWG-43912 1959
Dispersion of radioactivity near pits May 1958



ORNL-LR-DWG-44013 1959
Dispersion of radioactivity near pits Aug 1958

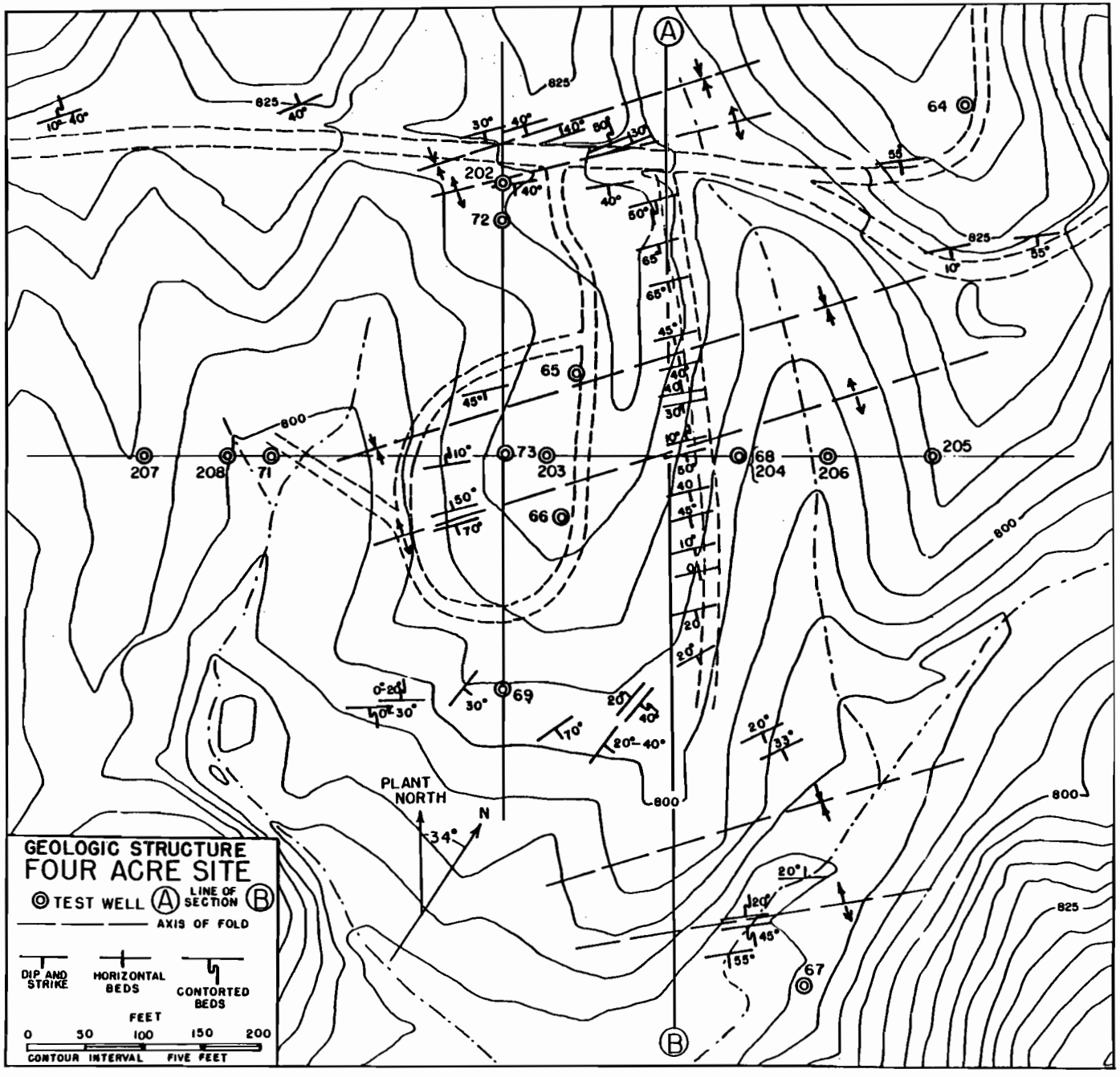
UNCLASSIFIED
ORNL-LR-DWG 44387



UNITS OF CONCENTRATION = $\mu\mu c/ml$

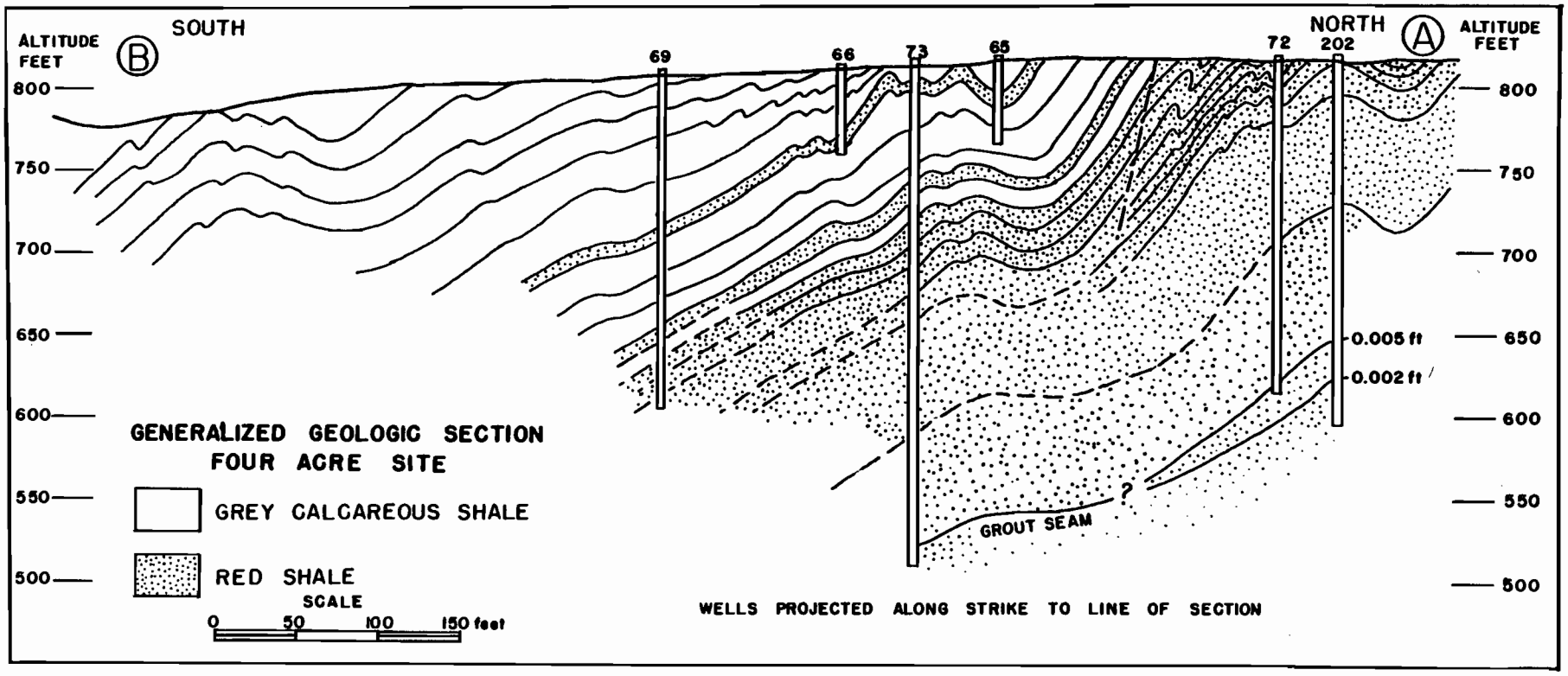
DISPERSION OF RADIOACTIVE WASTE-FEBRUARY 1957

ORNL-LR-DWG-44387 1959
Dispersion of radioactivity near pits Feb 1957



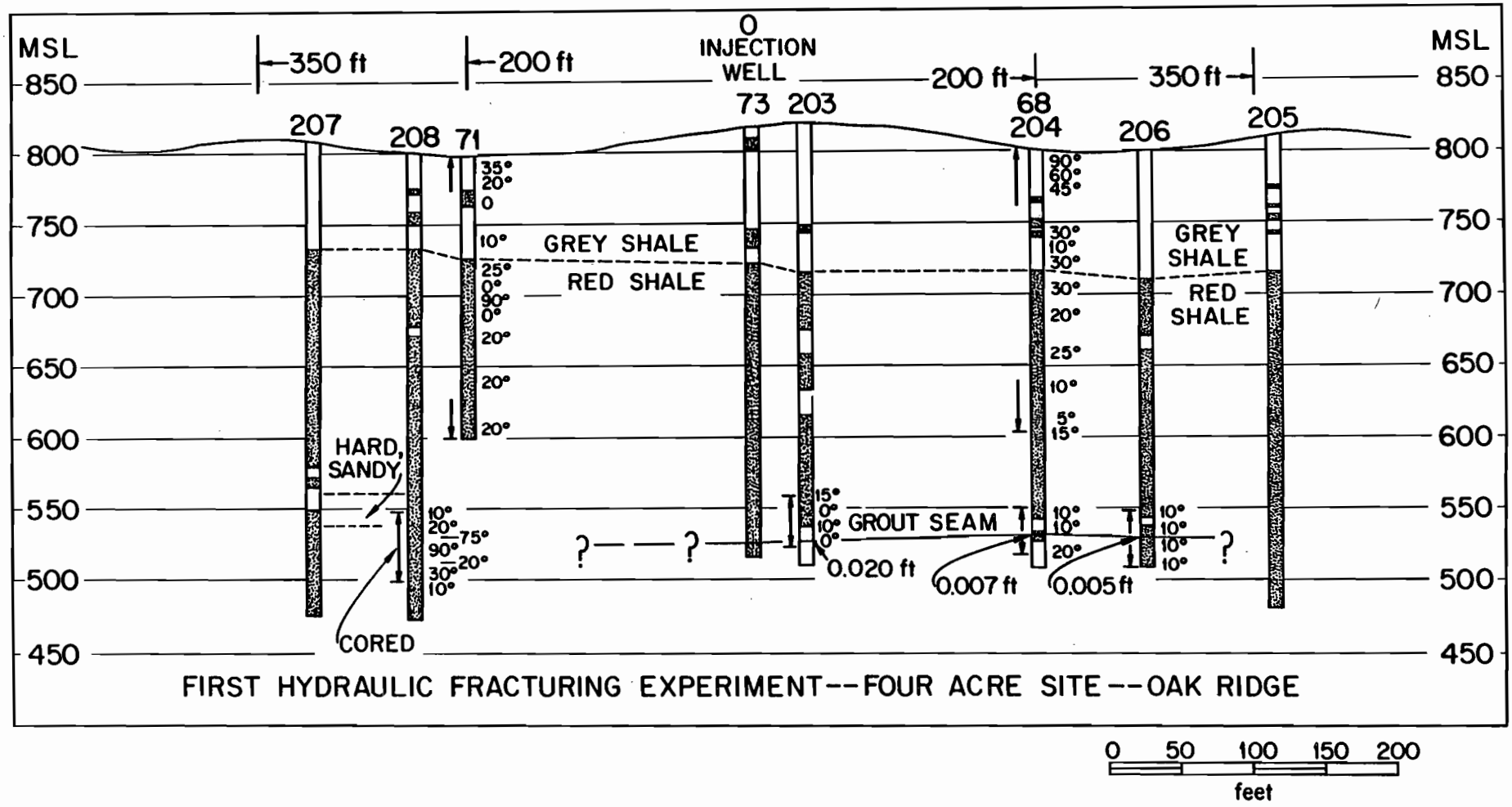
ORNL-LR-DWG-11880R 1960
Geologic structure Four Acre site

Unclassified
ORNL-LR-DWG 11882R

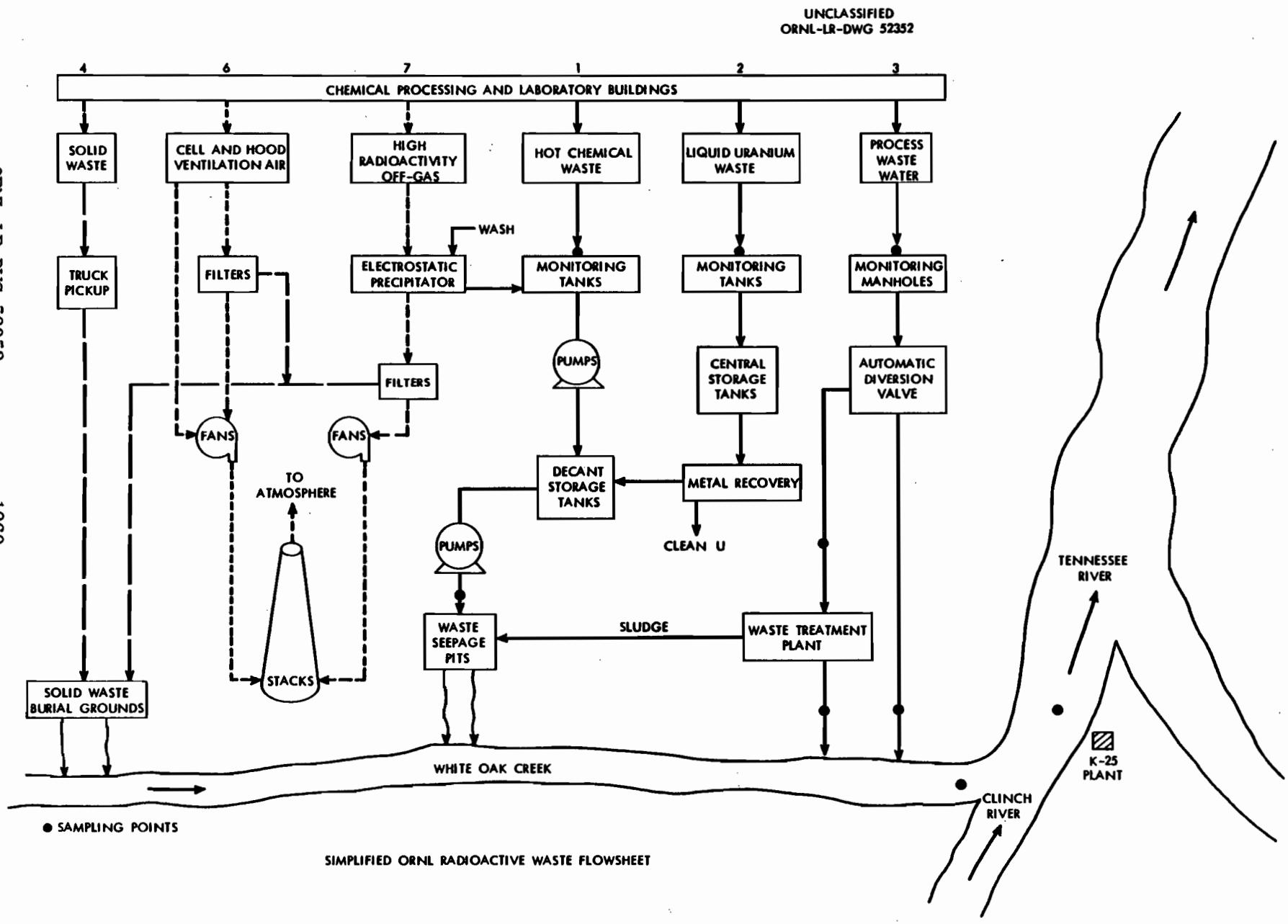


ORNL-LR-DWG-11882R 1960
Generalized geologic section Four Acre site

UNCLASSIFIED
ORNL-LR-DWG 46566



ORNL-LR-DWG-46566
First hydraulic fracturing experiment 4 Acre site
1960



ORNL-LR-DWG-52352 1960
Simplified ORNL radioactive waste flowsheet

WASTE PIT SYSTEM INVENTORY

	GALS ($\times 10^3$)	CURIES						GROSS[b] BETA
		Ru^{106}	Cs^{137}	Sr^{89}	Sr^{90}	TRE[a]	YEAR TOTAL	
JUNE 1952–1955	432[c]	5,000	11,000					11,600
	2,433	4,400	28,000					25,700
1956	2,779	5,500	18,500	730	1,830	5,400	31,960	33,500
1957	2,902	4,500	10,500	110	420	4,000	19,530	41,800
1958	3,156	2,800	17,000	500	9,800	9,000	39,100	45,400
1959	3,590	197,400	65,500	3300	24,700	52,900	399,900[d]	273,900
Total	15,292	219,600	150,500	4640	36,750	71,300		431,900

[a]EXCLUSIVE OF Y^{90}.

[b]BASED ON A COUNTING EFFICIENCY OF 12.6% EMPLOYED BY OPERATIONS DIVISION.

[c]EVAPORATOR CONCENTRATE RELEASED TO PIT 2.

[d]INCLUDES 19,500 CURIES OF Ru^{103}, 14,800 OF Cs^{134}, 9200 OF Zr, AND 12,600 OF Nb (ACCOUNTED FOR AFTER 8/20/59).

ORNL-LR-DWG-52799
Waste pit system radionuclide inventory 1960

UNCLASSIFIED
ORNL-LR-DWG. 54430

TABLE I. WASTE PIT SYSTEM INVENTORY

	Gals (x 10^3)	Curies										(3) GROSS BETA
		(1) Ru^{103}	Ru^{106}	(1) Cs^{134}	Cs^{137}	(1) Zr	(1) Nb	Sr^{89}	Sr^{90}	(2) TRE	YEAR TOTAL	
JUNE 1952-1955	432 (4)	---	5,000	---	11,000	---	---	---	---	---	---	11,600
	2,433	---	4,400	---	28,000	---	---	---	---	---	---	25,700
1956 ----------	2,779	---	5,500	---	18,500	---	---	730	1,830	5,400	31,960	33,500
1957 ----------	2,902	---	4,500	---	10,500	---	---	110	420	4,000	19,530	41,800
1958 ----------	3,156	---	2,800	---	17,000	---	---	500	9,800	9,000	39,100	45,400
1959 ----------	3,590	19,500	197,400	14,800	65,500	9,200	12,600	3,300	24,700	52,900	399,900	273,900
1960 ----------	1,878	---	9,800	---	2,600	---	---	100	1,370	5,900	19,770	18,700
TOTAL --------	17,170	19,500	229,400	14,800	153,100	9,200	12,600	4,740	38,120	77,200		450,600

(1) ACCOUNTED FOR AFTER 8/20/59.

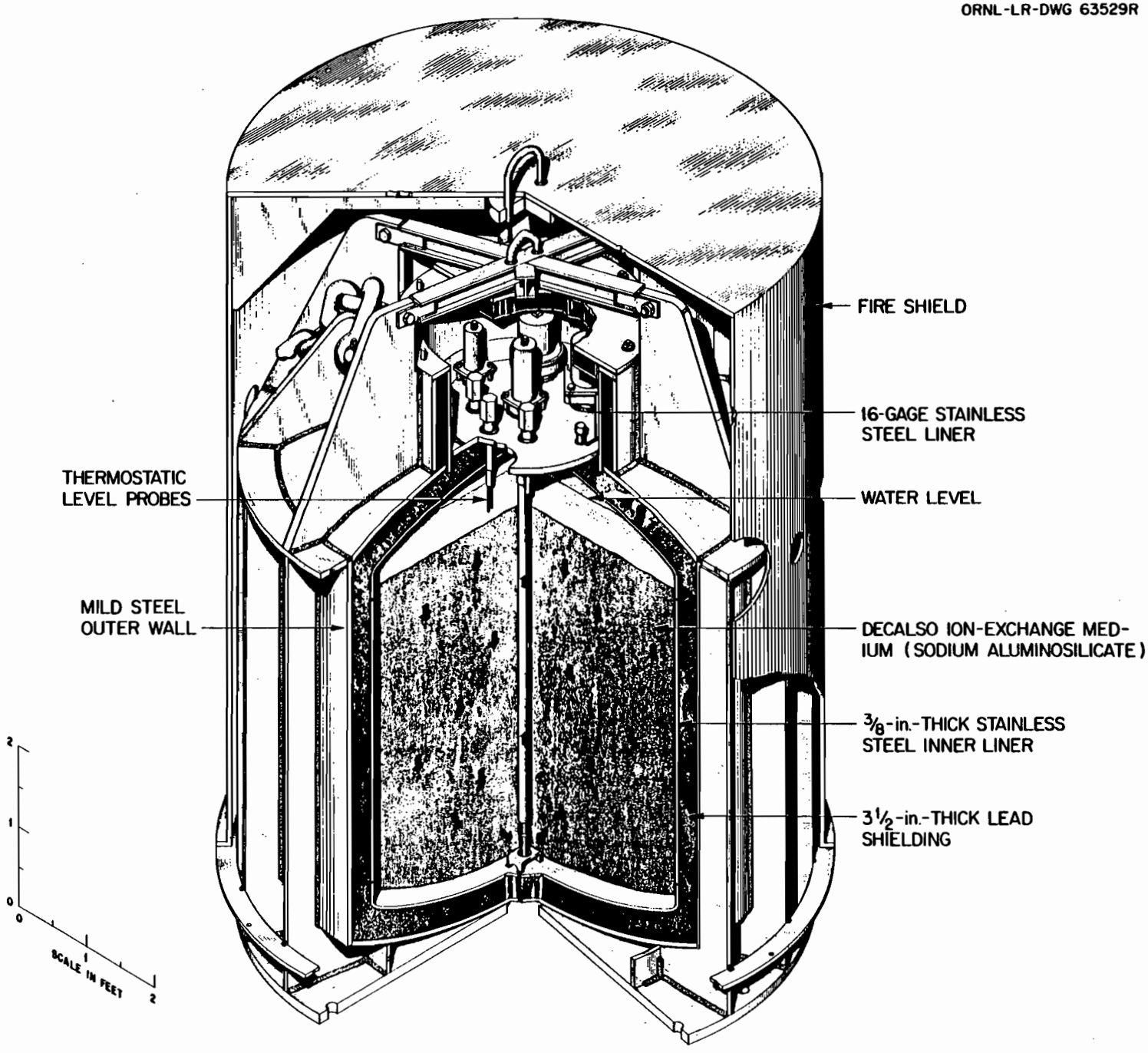
(2) EXCLUSIVE OF Y^{90}.

(3) BASED ON A COUNTING EFFICIENCY OF 12.6% EMPLOYED BY OPERATIONS DIVISION.

(4) EVAPORATOR CONCENTRATE RELEASED TO PIT 2.

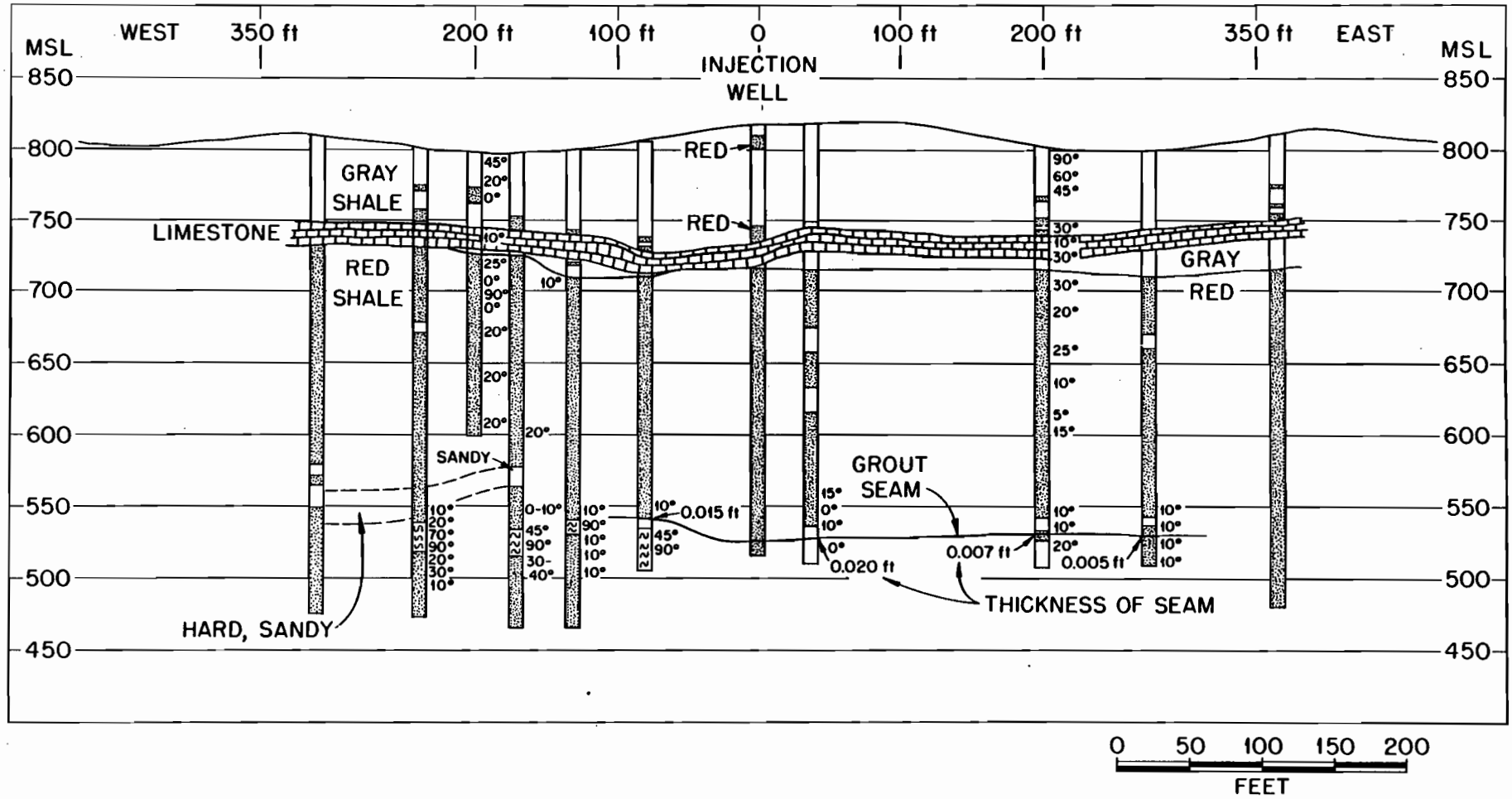
ORNL-LR-DWG-54430
Waste pit radionuclide inventory through 1960
1961

UNCLASSIFIED
ORNL-LR-DWG 63529R



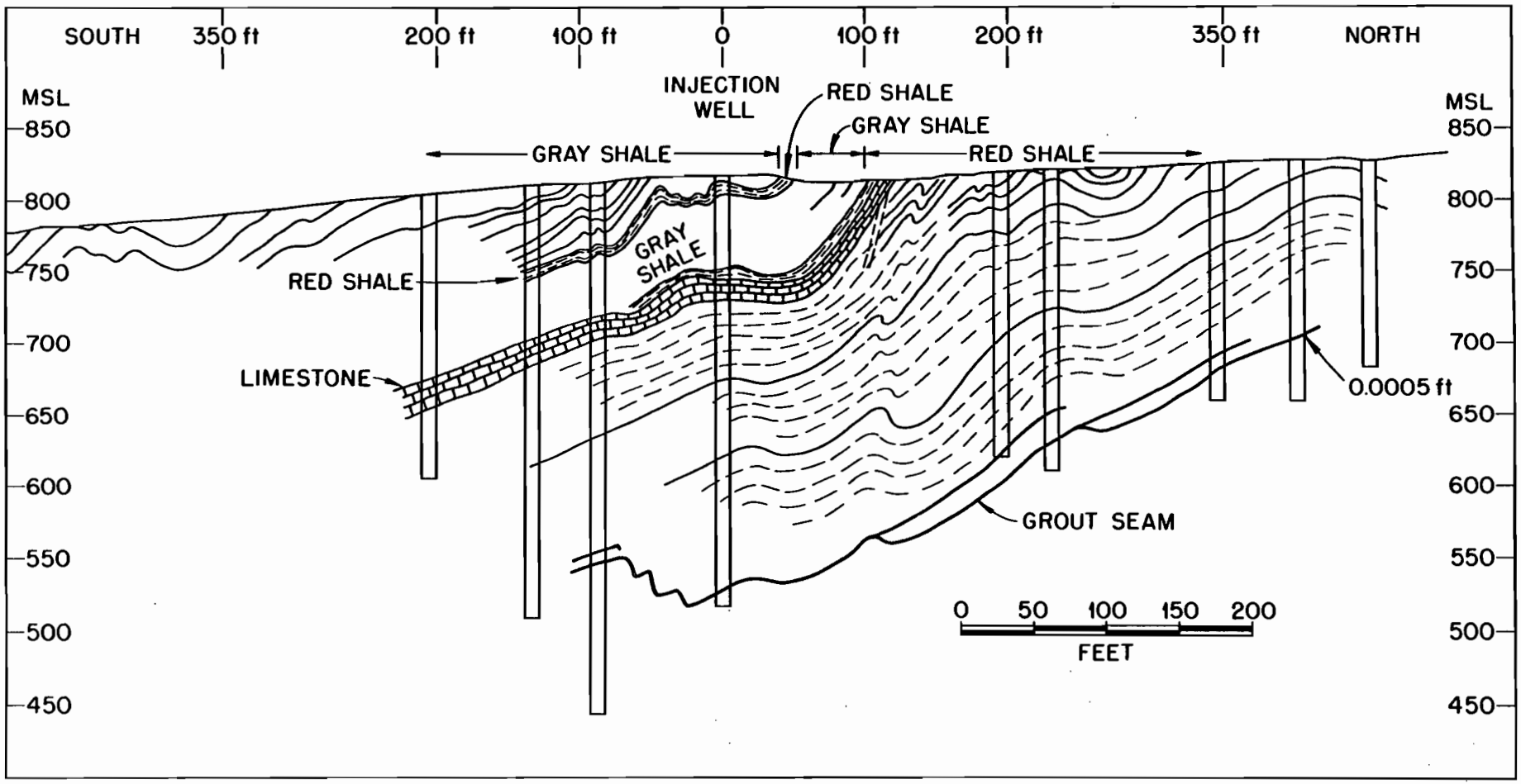
ORNL-LR-DWG-63529R 1961
Design of shielded transfer tank

ORNL-LR-DWG 64047



ORNL-LR-DWG-64047
East-West geologic section at 4 Acre site
1961

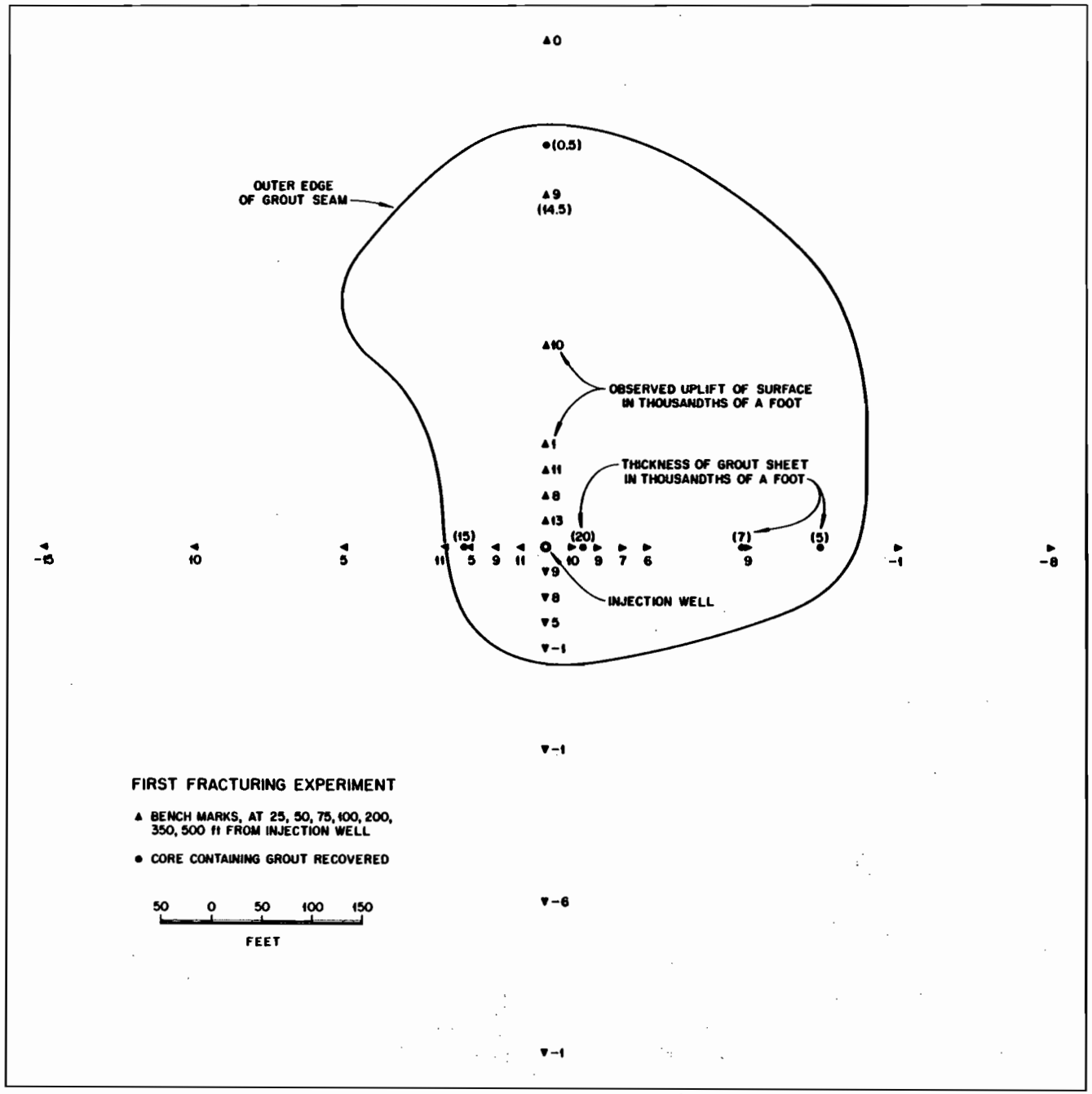
ORNL-LR-DWG 64048



ORNL-LR-DWG-64048

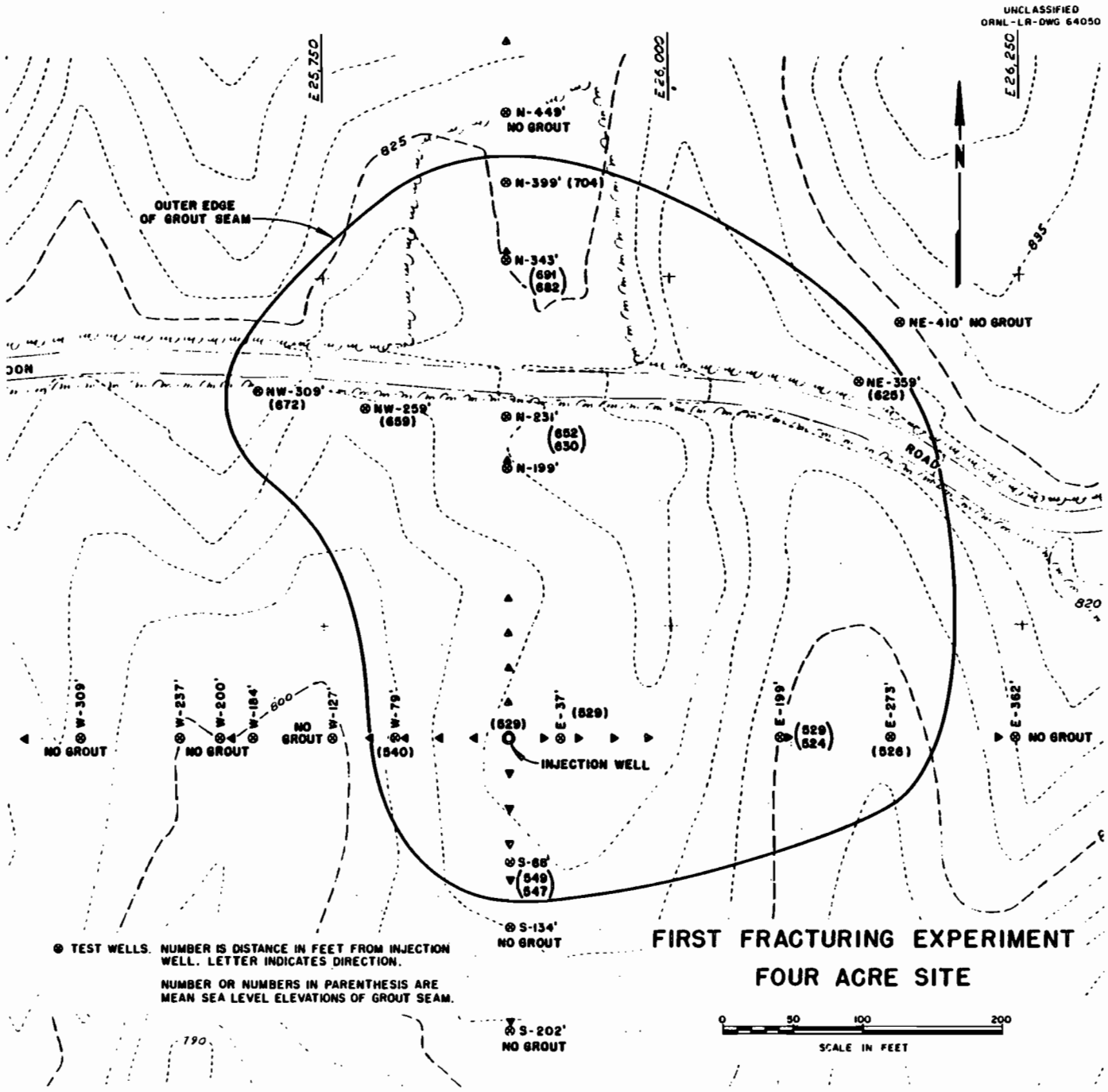
1961

North-South geologic section at 4 Acre site

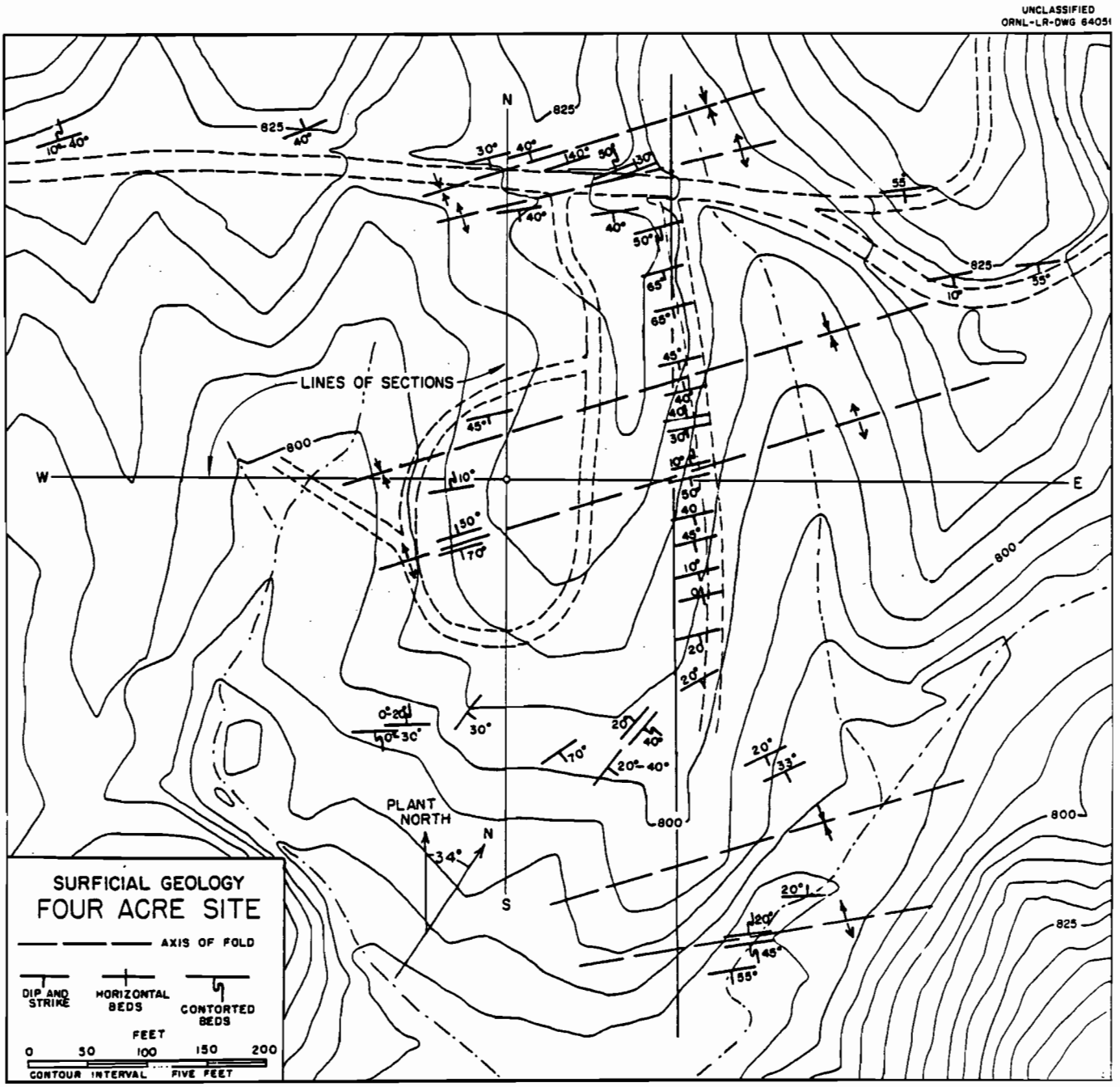


ORNL-LR-DWG-64049 1961

First fracturing experiment grout extent

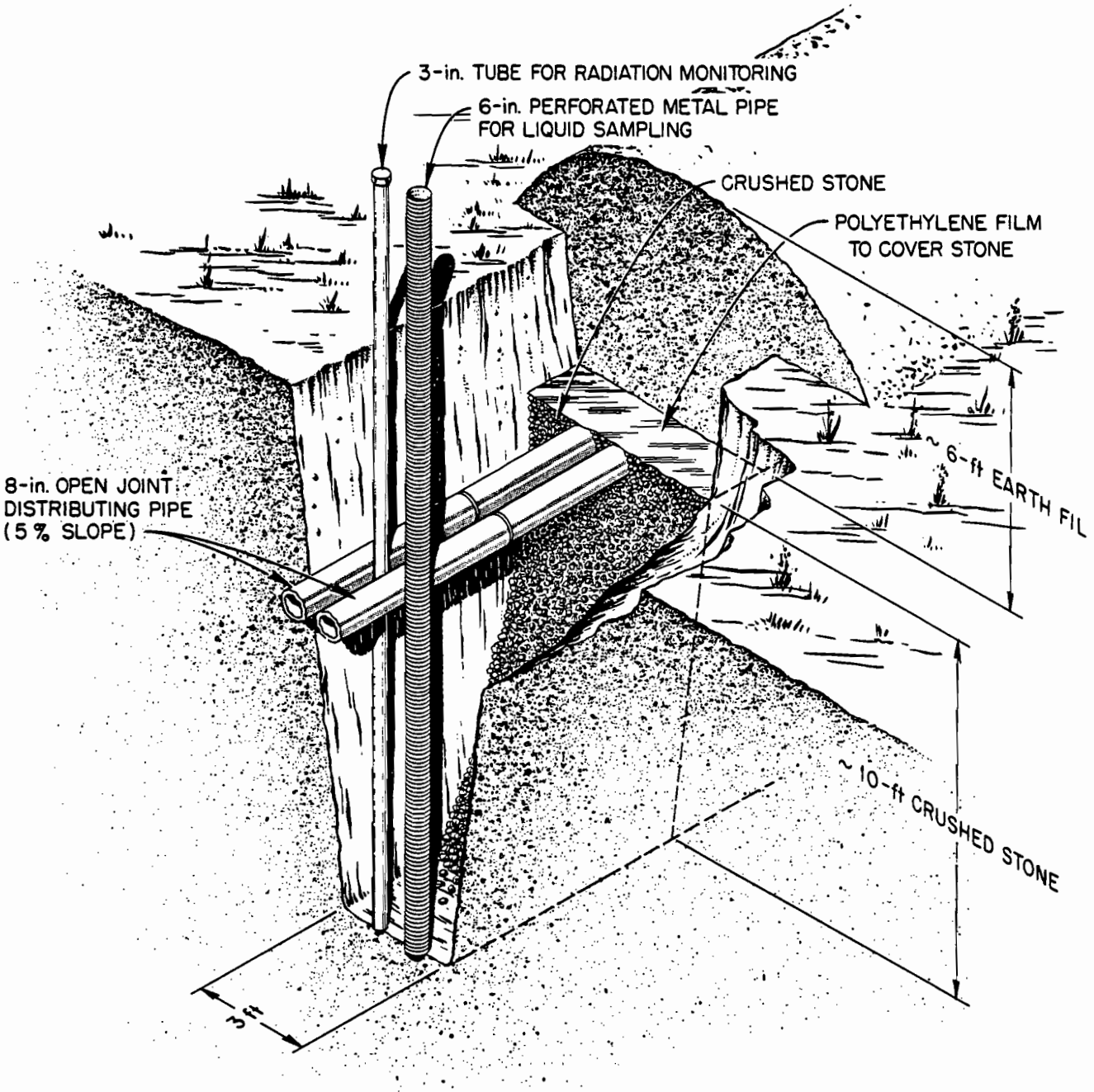


ORNL-LR-DWG-64050 1961
First fracturing experiment Four Acre site



ORNL-LR-DWG-64051 1961
Surface geology Four Acre site

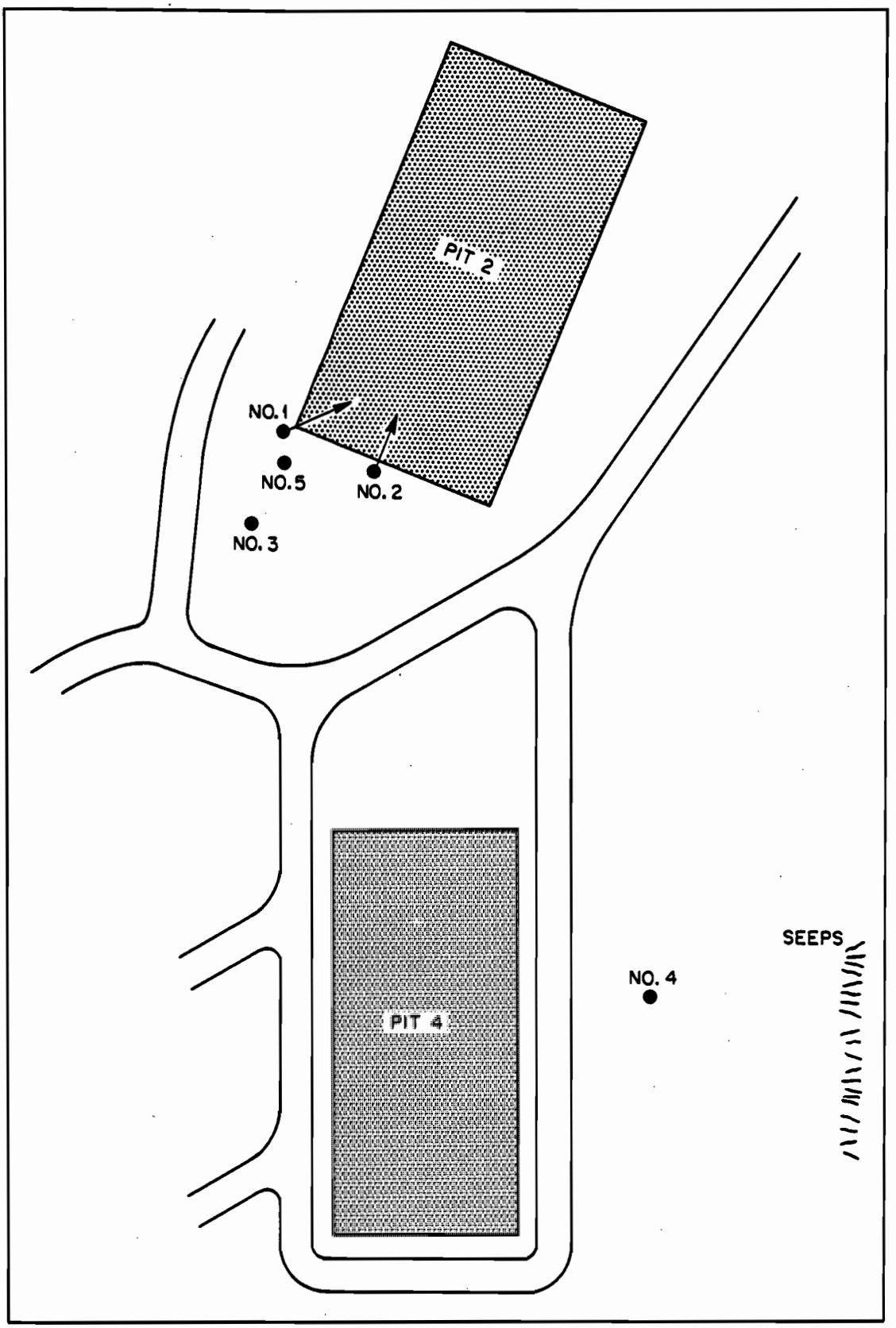
ORNL-LR-DWG 62129



Typical Waste Disposal Trench.

ORNL-LR-DWG-62129 1962
Typical liquid waste disposal trench design

UNCLASSIFIED
ORNL-LR-DWG 62143



Index Map; Test Holes

ORNL-LR-DWG-62143 1962
Index map of waste pit boreholes - deLaguna

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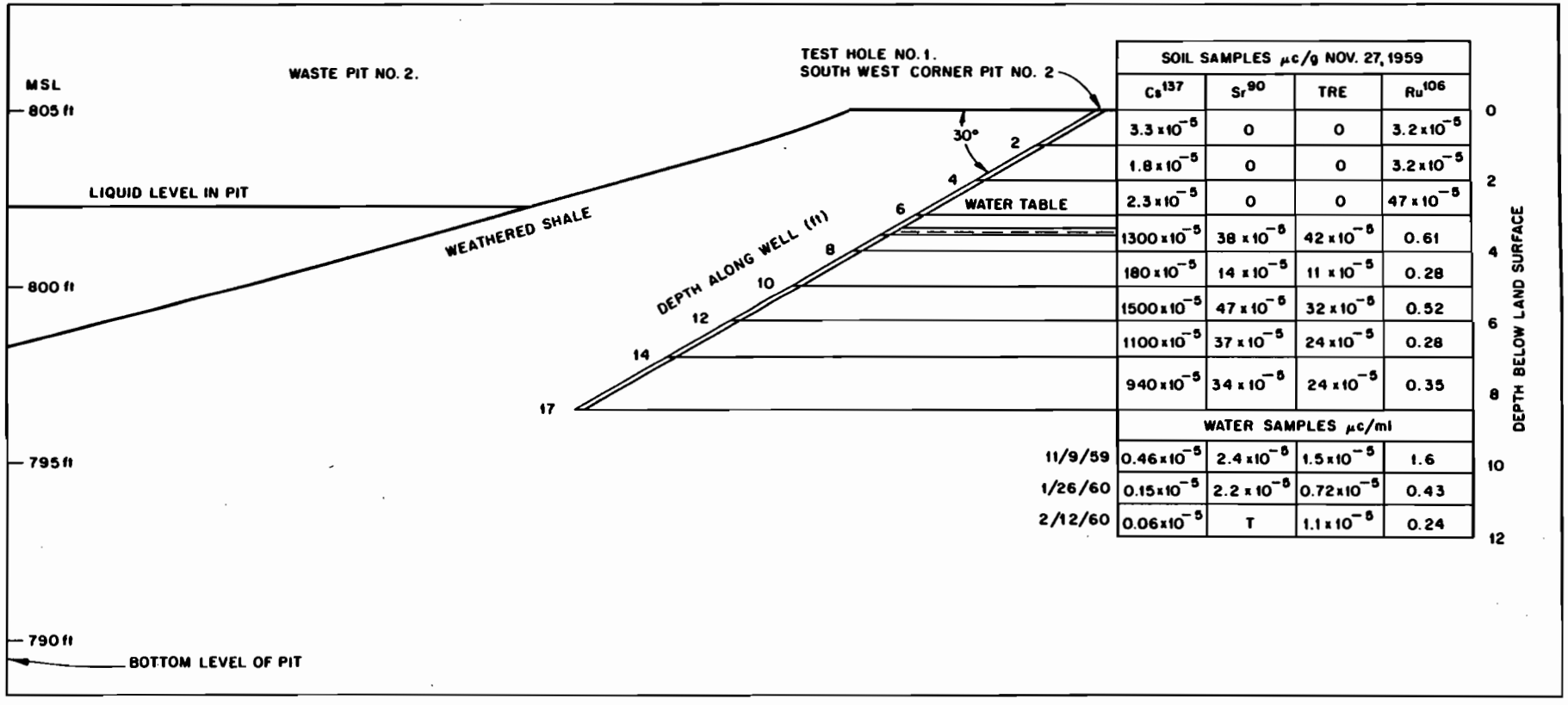
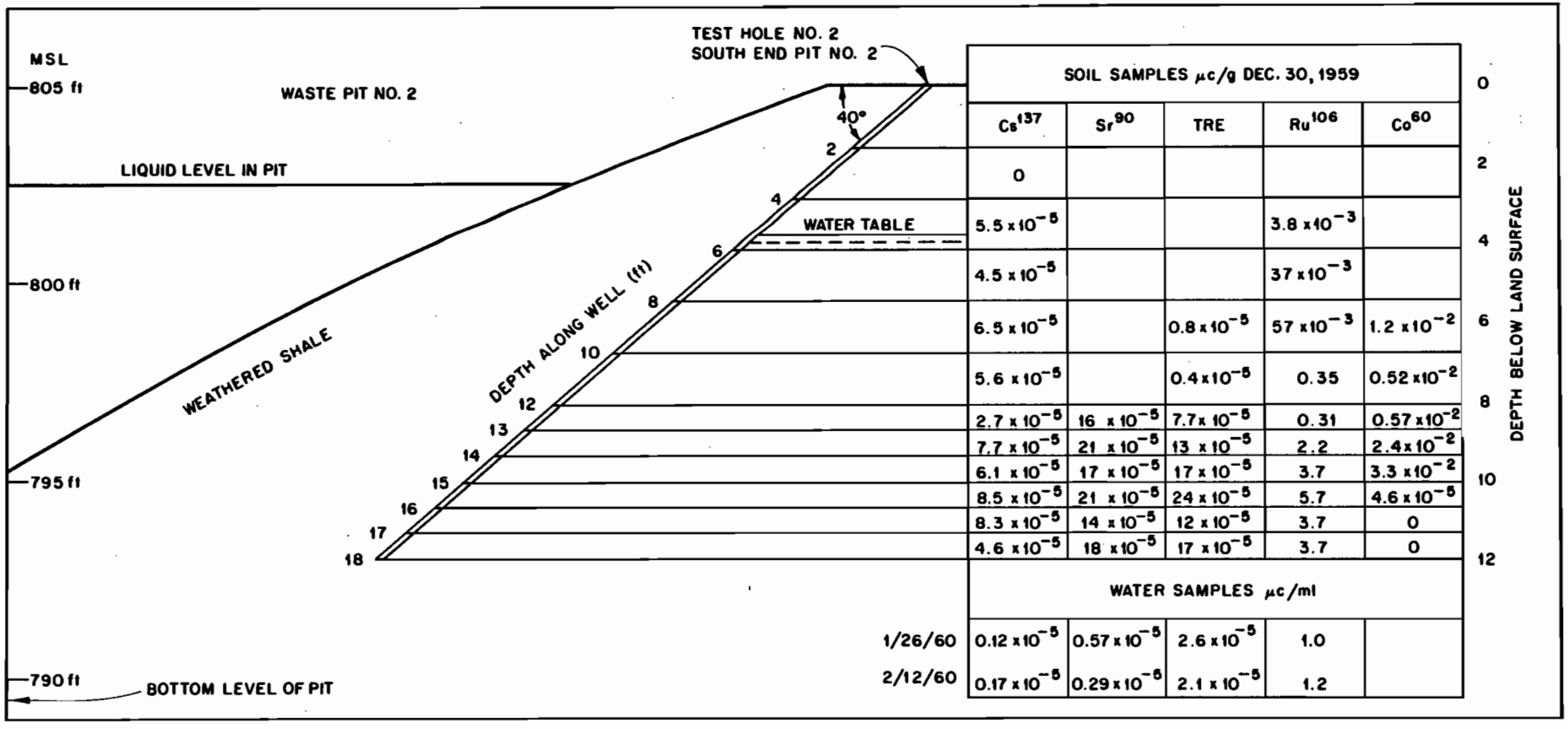
ORNL-LR-DWG 62144



SOIL SAMPLES μc/g NOV. 27, 1959				
	Cs^{137}	Sr^{90}	TRE	Ru^{106}
	3.3×10^{-5}	0	0	3.2×10^{-5}
	1.8×10^{-5}	0	0	3.2×10^{-5}
	2.3×10^{-5}	0	0	47×10^{-5}
	1300×10^{-5}	38×10^{-5}	42×10^{-5}	0.61
	180×10^{-5}	14×10^{-5}	11×10^{-5}	0.28
	1500×10^{-5}	47×10^{-5}	32×10^{-5}	0.52
	1100×10^{-5}	37×10^{-5}	24×10^{-5}	0.28
	940×10^{-5}	34×10^{-5}	24×10^{-5}	0.35
WATER SAMPLES μc/ml				
11/9/59	0.46×10^{-5}	2.4×10^{-5}	1.5×10^{-5}	1.6
1/26/60	0.15×10^{-5}	2.2×10^{-5}	0.72×10^{-5}	0.43
2/12/60	0.06×10^{-5}	T	1.1×10^{-5}	0.24

ORNL-LR-DWG-62144 1962
Log of borehole 1 southwest of pit 2

UNCLASSIFIED
ORNL-LR-DWG 62145



	SOIL SAMPLES μc/g DEC. 30, 1959				
	Cs^{137}	Sr^{90}	TRE	Ru^{106}	Co^{60}
	0				
	5.5×10^{-5}			3.8×10^{-3}	
	4.5×10^{-5}			37×10^{-3}	
	6.5×10^{-5}		0.8×10^{-5}	57×10^{-3}	1.2×10^{-2}
	5.6×10^{-5}		0.4×10^{-5}	0.35	0.52×10^{-2}
	2.7×10^{-5}	16×10^{-5}	7.7×10^{-5}	0.31	0.57×10^{-2}
	7.7×10^{-5}	21×10^{-5}	13×10^{-5}	2.2	2.4×10^{-2}
	6.1×10^{-5}	17×10^{-5}	17×10^{-5}	3.7	3.3×10^{-2}
	8.5×10^{-5}	21×10^{-5}	24×10^{-5}	5.7	4.6×10^{-5}
	8.3×10^{-5}	14×10^{-5}	12×10^{-5}	3.7	0
	4.6×10^{-5}	18×10^{-5}	17×10^{-5}	3.7	0
	WATER SAMPLES μc/ml				
1/26/60	0.12×10^{-5}	0.57×10^{-5}	2.6×10^{-5}	1.0	
2/12/60	0.17×10^{-5}	0.29×10^{-5}	2.1×10^{-5}	1.2	

ORNL-LR-DWG-62145
Log of borehole 2 south end of pit 2
1962

UNCLASSIFIED
ORNL-LR-DWG 62146

WELL NO. 3. OCT. 6, 1959, 70 ft SOUTH OF PIT NO. 2.

MSL	FEET		SOIL SAMPLES μc/g			
			Cs^{137}	Sr^{90}	TRE	Ru^{106}
805 ft	0		0.2×10^{-5}	0	0	3×10^{-5}
	2		2×10^{-5}	0	0	2×10^{-5}
	4		0.2×10^{-5}	0	0	4×10^{-5}
800 ft	6		1.3×10^{-5}	0	0	2×10^{-5}
	8		2×10^{-5}	0	0	2×10^{-2}
795 ft	10		0.5×10^{-5}	0	0	1.3×10
	12	WATER TABLE	2.5×10^{-5}	0	0	7.8×10^{-5}
	14					
790 ft	16	BOTTOM LEVEL OF PIT	1.8×10^{-5}	9.5×10^{-5}	4.7×10^{-5}	13×10^{-5}
	18		2×10^{-5}	17×10^{-5}	11×10^{-5}	18×10^{-5}
785 ft	20		1.8×10^{-5}	13×10^{-5}	9×10^{-5}	18×10^{-5}

ORNL-LR-DWG-62146 1962
Log of borehole 3 south of pit 2

UNCLASSIFIED
ORNL-LR-DWG 62147

TEST HOLE NO. 4. 70 ft EAST OF PIT NO. 4. AUG. 1, 1961

MSL	FEET		GROSS counts/min/g	Ru^{106} μc/g	Co^{60} μc/g	Cs^{137} μc/g	Sr^{90} μc/g	TRE
800 ft	0	CLAY AND SILT DRY						
			65					
	5		50					
790 ft	10	CLAY AND SILT DAMP						
			10					
	15	WATER TABLE						
			1.48×10^4	–	–	1.2×10^{-5}	0.1×10^{-5}	0.4×10^{-5}
			2.0×10^4	0.126	135×10^{-5}	0.4×10^{-5}	T	0.4×10^{-5}
770 ft	20	CLAY AND SILT WET						
		CLAY AND SILT WET						
			3.0×10^4	0.167	232×10^{-5}	0.7×10^{-5}	0.1×10^{-5}	3.5×10^{-5}
	25	80% LIMESTONE, 20% WEATHERED SHALE	0.26×10^4					
		25% LIMESTONE, 75% WEATHERED SHALE						
		50% LIMESTONE, 50% WEATHERED SHALE	2.34×10^4					
		80% LIMESTONE, 20% WEATHERED SHALE	0.75×10^4					
760 ft	30	50% LIMESTONE, 50% WEATHERED SHALE	1.43×10^4					
		50% LIMESTONE, 50% WEATHERED SHALE	0.63×10^4					
		50% LIMESTONE, 50% FRESH SHALE	0.02×10^4					
	34.3	50% LIMESTONE, 50% FRESH SHALE	0.04×10^4					

ORNL-LR-DWG-62147 1962
Log of borehole 4 east of pit 4

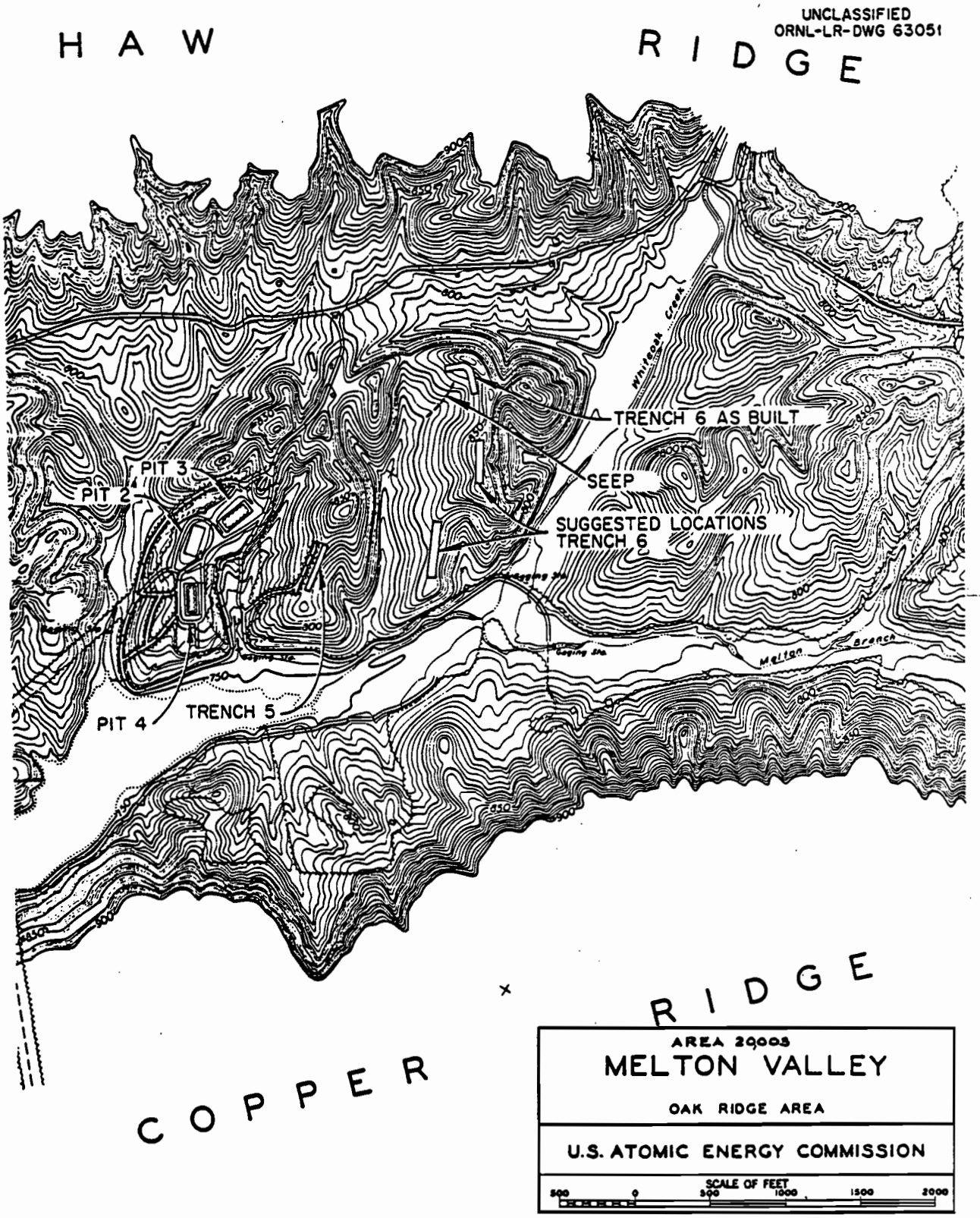
UNCLASSIFIED
ORNL-LR-DWG 62148

TEST HOLE NO. 5. 20 ft SOUTH OF SOUTH-WEST CORNER PIT NO. 2, AUG. 1, 1961

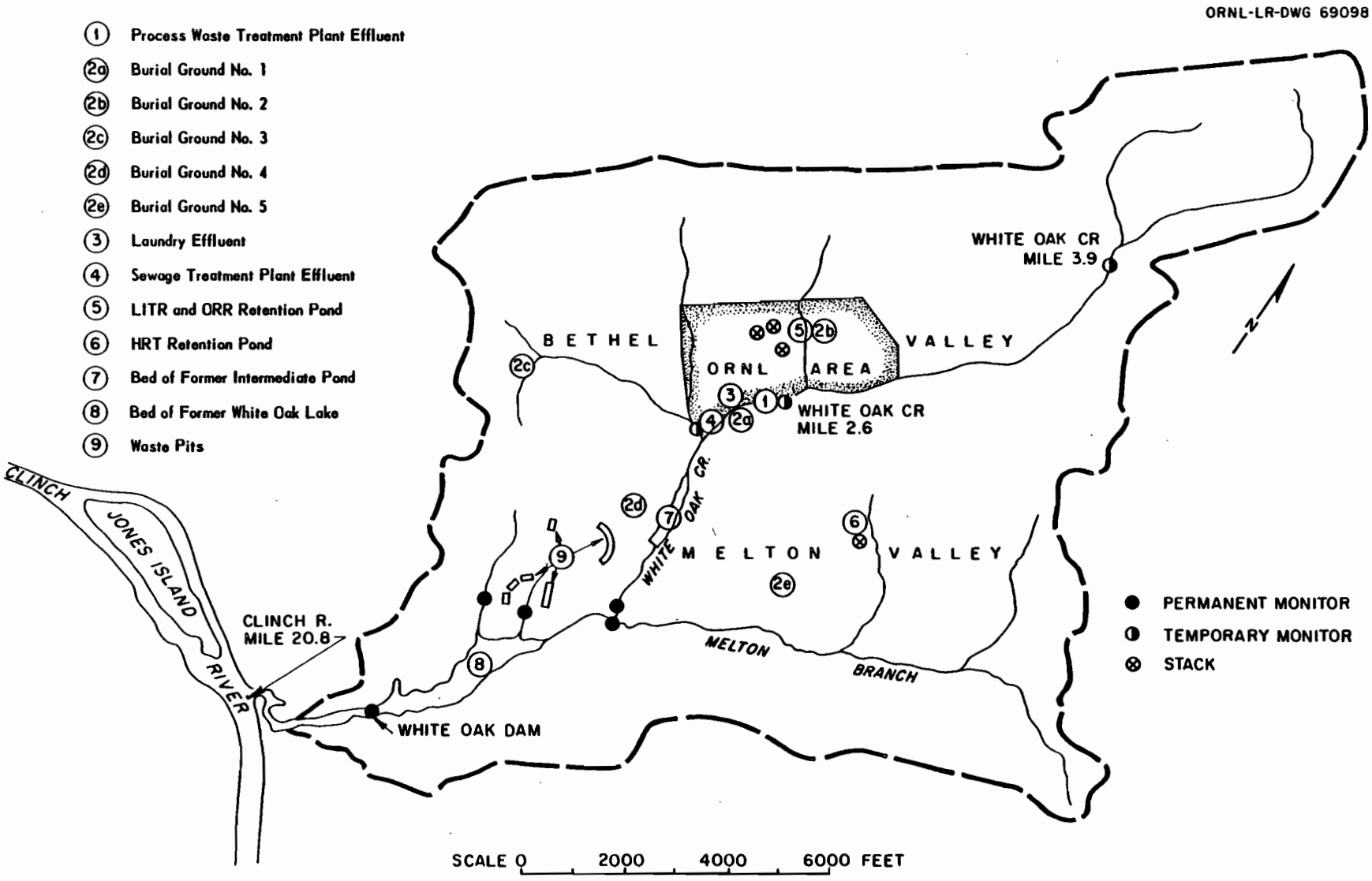
MSL	FEET		GROSS γ counts/min/g	Ru^{106} $\mu c/g$	Co^{60} $\mu c/g$	Cs^{137} $\mu c/g$	Sr^{90} $\mu c/g$	TRE $\mu c/g$
805 ft	0	BROWN CLAY AND SILT DRY						
800 ft	5	BROWN CLAY AND SILT DAMP	4.0×10^4	0.227	197×10^{-5}	0.4×10^{-5}	1.3×10^{-5}	2.3×10^{-5}
			1.95×10^4					
		BROWN CLAY AND SILT WET						
795 ft	10	WATER TABLE	1.43×10^4	0.088				
		BROWN CLAY AND SILT	1.42×10^4	0.119	491×10^{-5}			
		CLAY AND SILT SOFT						
790 ft	15	BROWN CLAY AND SILT	0.83×10^4	0.0617	191×10^{-5}			
		BROWN CLAY AND SILT VERY SOFT						
785 ft	20		0.65×10^4	0.0385				
		GRAY CLAY AND SILT AND WEATHERED SHALE	0.4×10^4	0.022	94×10^{-5}			
		GRAY WEATHERED SHALE	4.9×10^4	0.278	273×10^{-5}	0.1×10^{-5}	1.3×10^{-5}	0.2×10^{-5}
780 ft	25	LIMESTONE AND WEATHERED SHALE	5.1×10^4	0.308	262×10^{-5}	0.1×10^{-5}	3.5×10^{-5}	0.3×10^{-5}
			1.1×10^4					
		LIMESTONE AND PARTLY WEATHERED SHALE	0.6×10^4					
775 ft	30	FRESH SHALE	VERY LOW NOT MEASURED					
	31.9							

WATER SAMPLE FROM 19.6 ft 0.119×10^4 counts/min/ml GROSS GAMMA

ORNL-LR-DWG-62148 1962
Log of borehole 5 southwest of pit 2



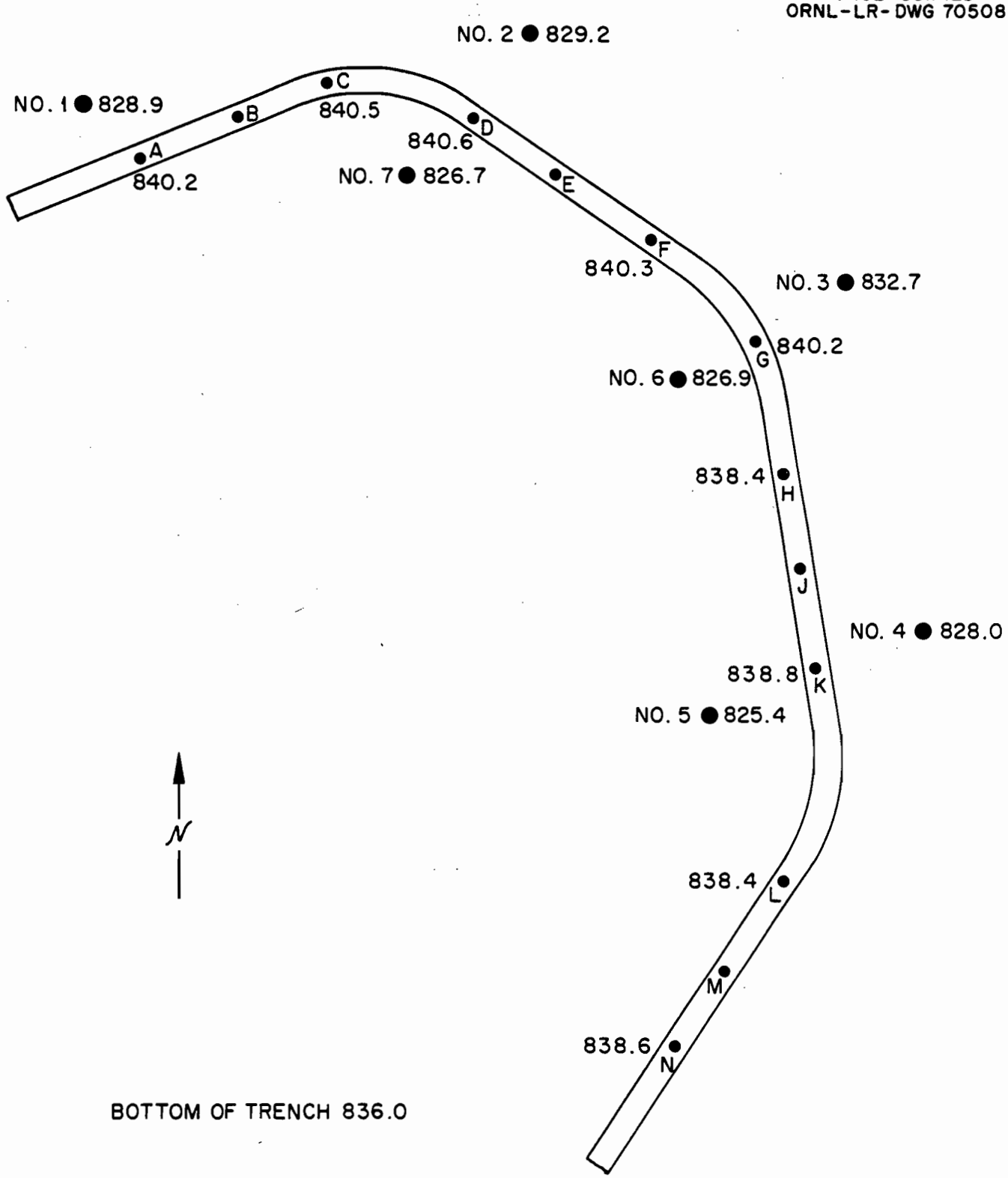
ORNL-LR-DWG-63051 1962
Map of proposed areas for trench 7 (deLaguna)



Map of White Oak Creek Basin Showing Sources of Radioactive Contamination and Stream-Monitoring Stations.

ORNL-LR-DWG-69098 1962
Sources of radioactive contamination in White Oak

UNCLASSIFIED
ORNL-LR-DWG 70508



Trench No. 6 Liquid Level, 6-26-62; MSL Elevations.

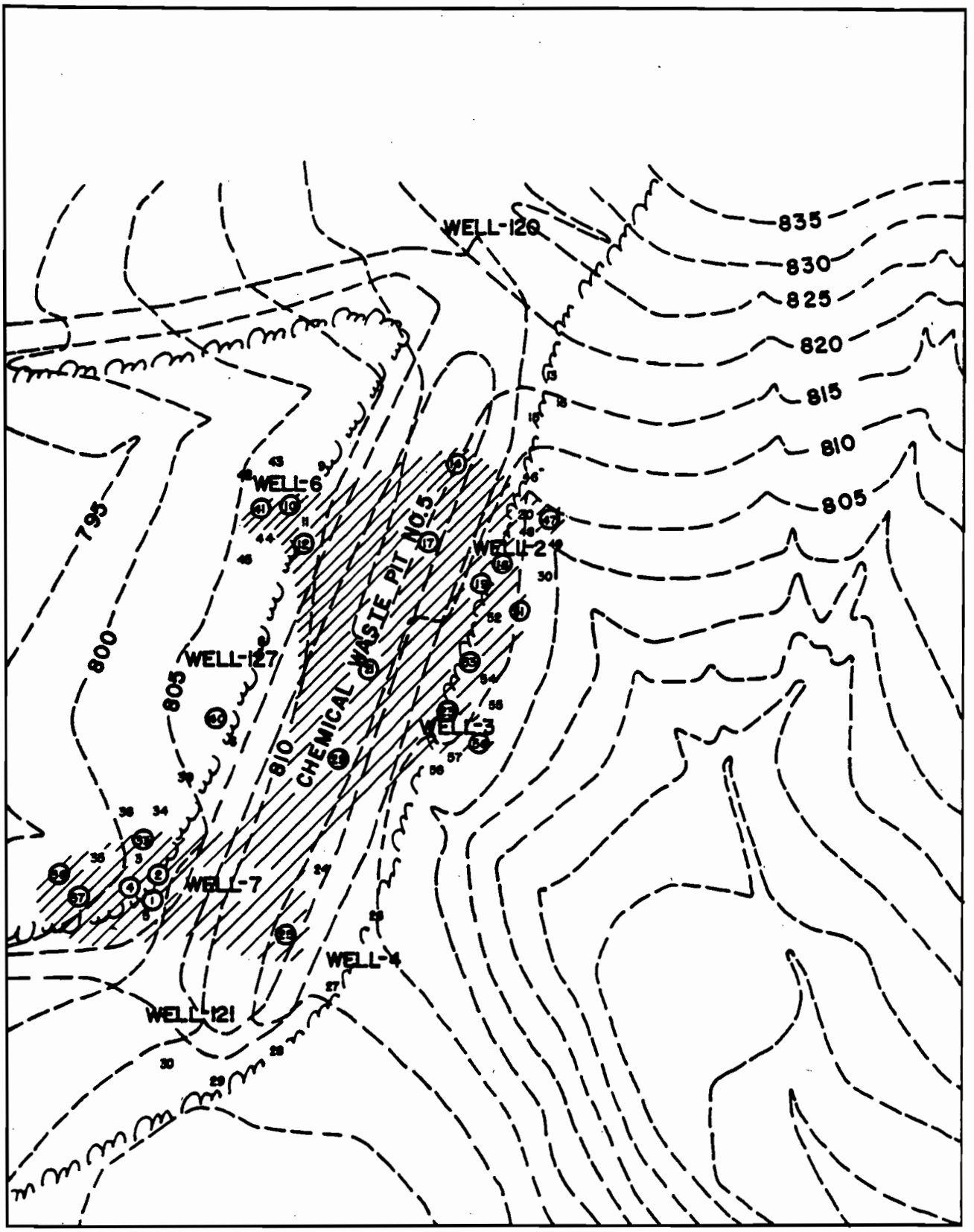
ORNL-LR-DWG-70508 1962
Trench 6 groundwater levels June 26, 1962

TABLE 2B. STABLE CHEMICAL COMPOSITION OF THE ORNL INTERMEDIATE-LEVEL WASTE STREAM

STABLE ION	AVERAGE CONCENTRATION (M)
Na^+	0.615
NH_4^+	0.025
Al^{+++}	0.022
OH^-	0.22
NO_3^-	0.41
SO_4^-	0.037
Cl^-	0.006

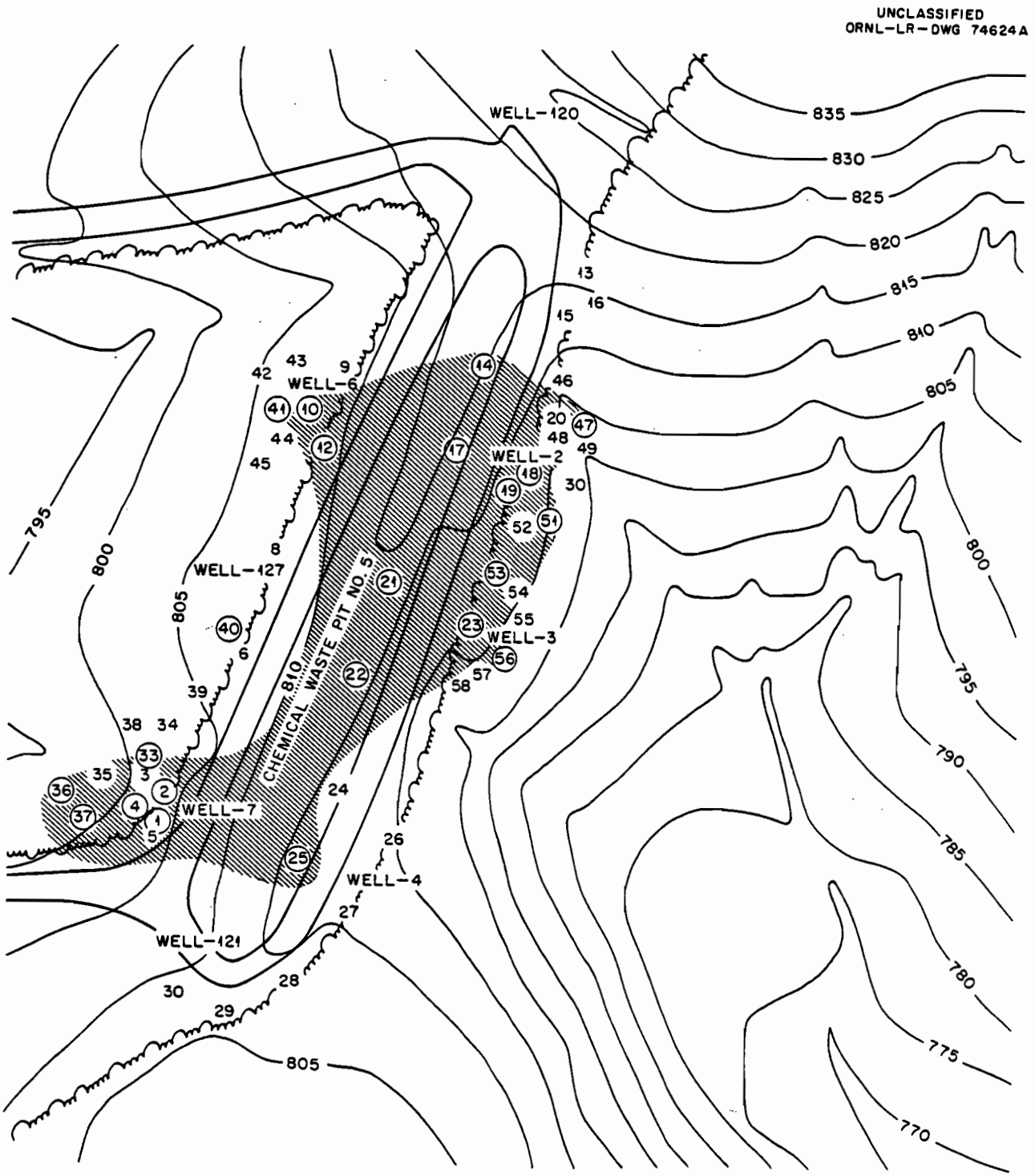
ORNL-LR-DWG-73482
1962
Stable chemical composition of ORNL ILW stream

UNCLASSIFIED
ORNL-LR-DWG 74624

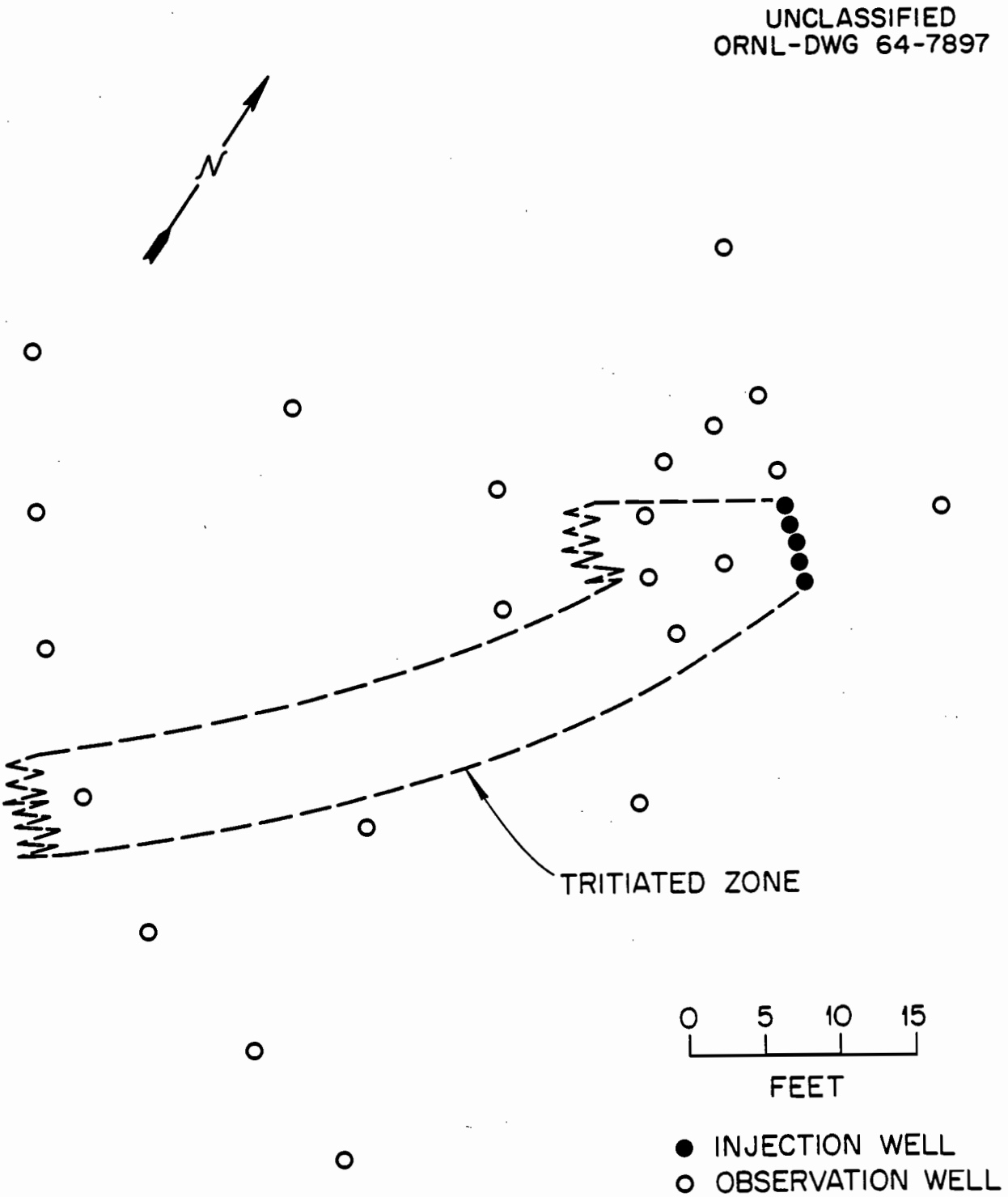


CHEMICAL WASTE PIT AREA
TOPOGRAPHY

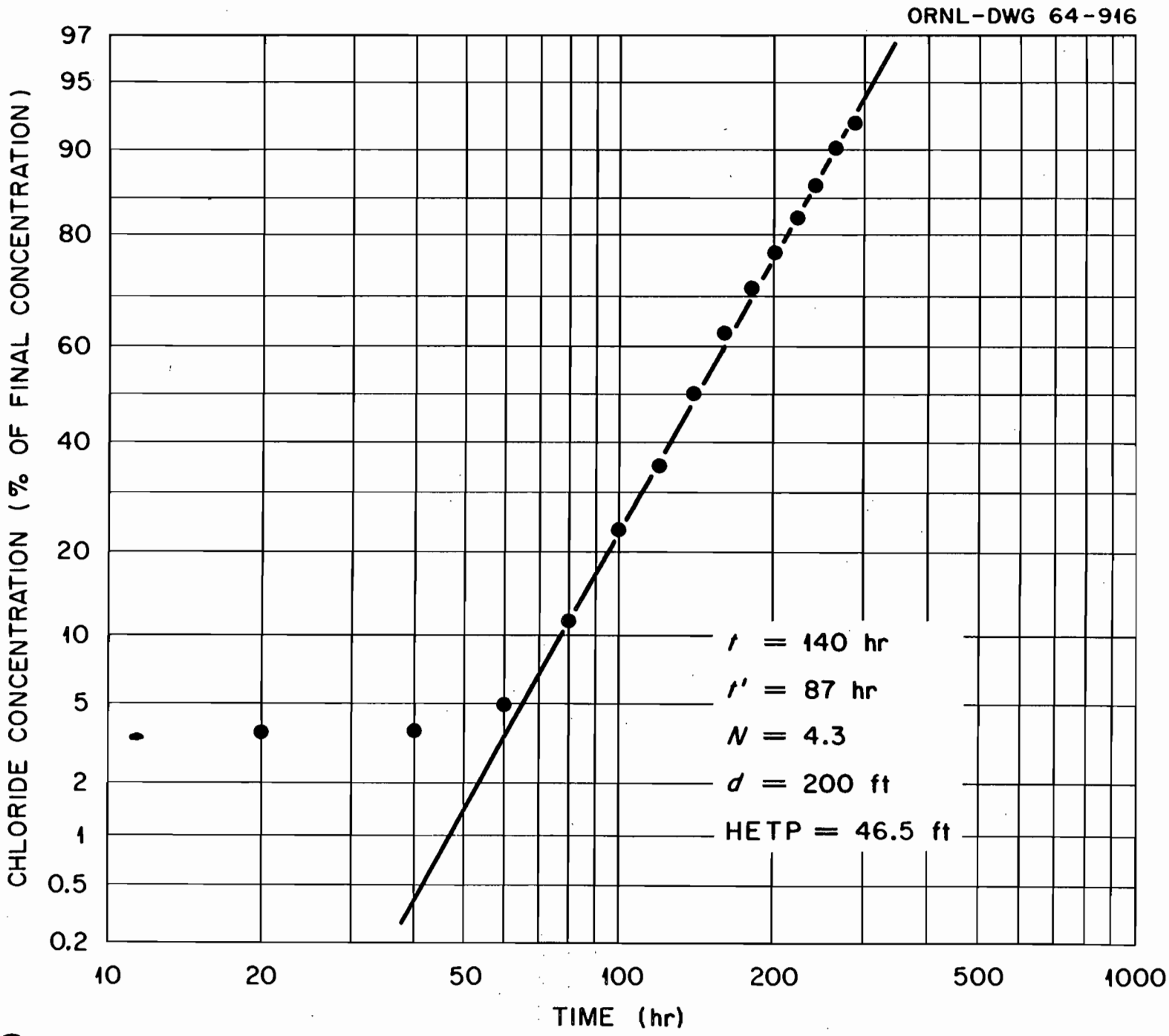
ORNL-LR-DWG-74624 1962
Chemical waste pit area topography



ORNL-LR-DWG-74624A 1962
Contamination plume around trench 5 Sep 1962

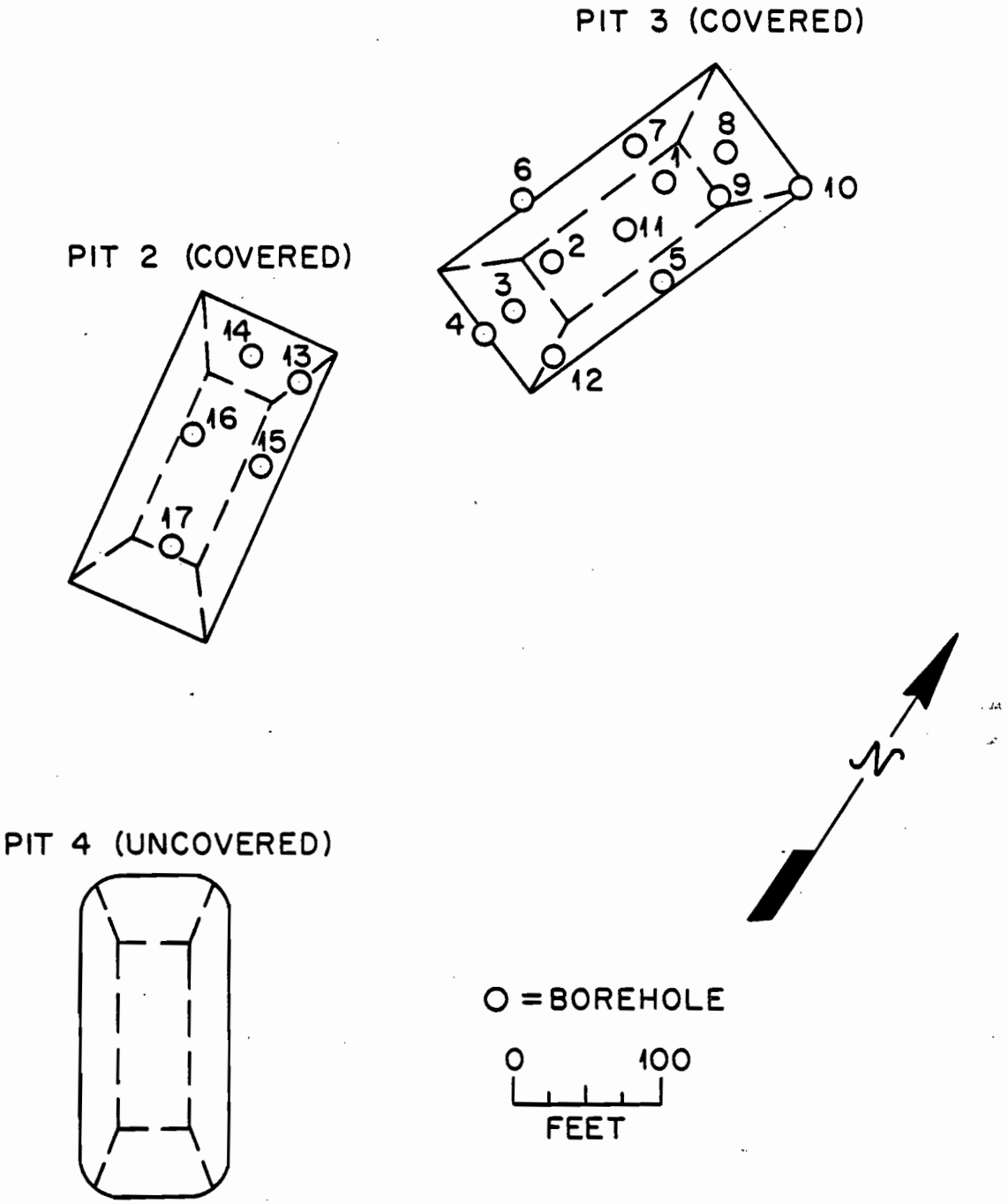


ORNL-DWG-64-7897 1964
Groundwater tritium tracer movement near pit 3



ORNL-DWG-64-916
1964
Chloride dispersion by Conasuaga shale at 4 Acre site

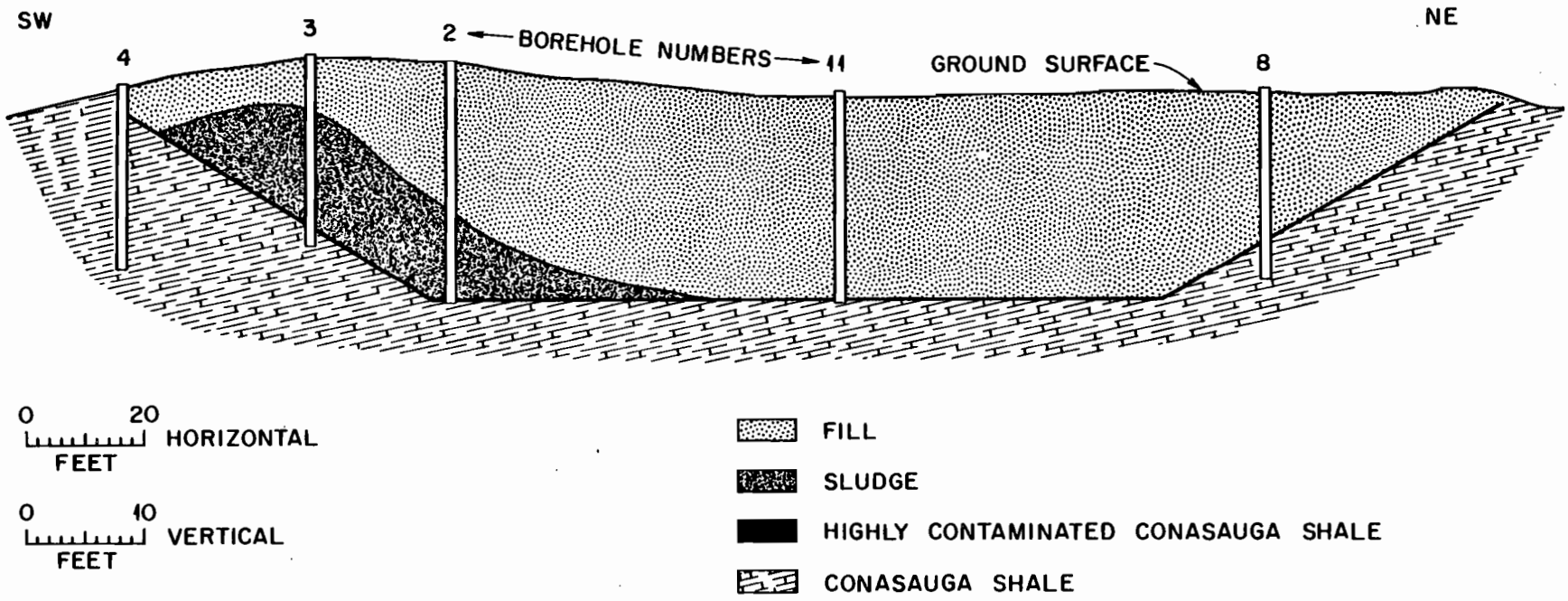
UNCLASSIFIED
ORNL-DWG 64-928



Sketch Map of a Portion of the Waste Pit Area, Showing Locations of the Preliminary Series of Boreholes.

ORNL-DWG-64-928 1964
Borehole locations in pits 2 and 3

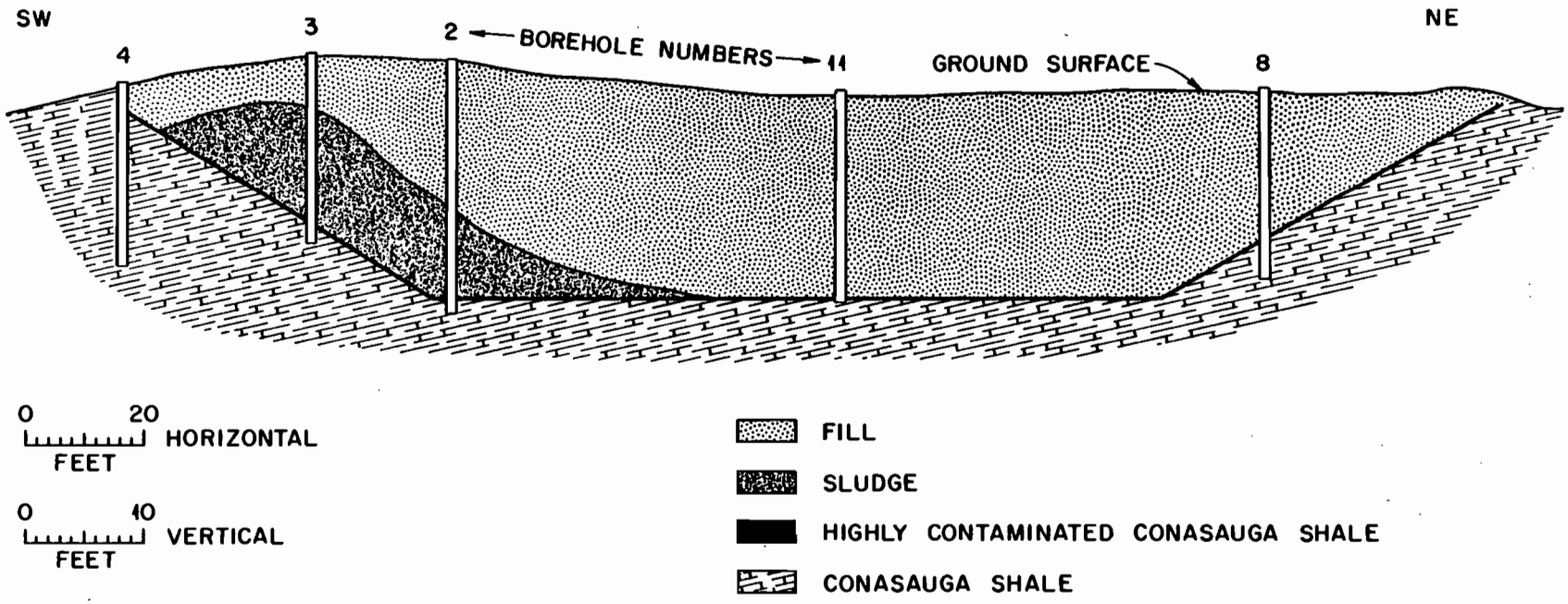
UNCLASSIFIED
ORNL-DWG 64-929



Longitudinal Cross Section Through Waste Pit 3.

ORNL-DWG-64-929
1964
Longitudinal cross section of pit 3 postclosure

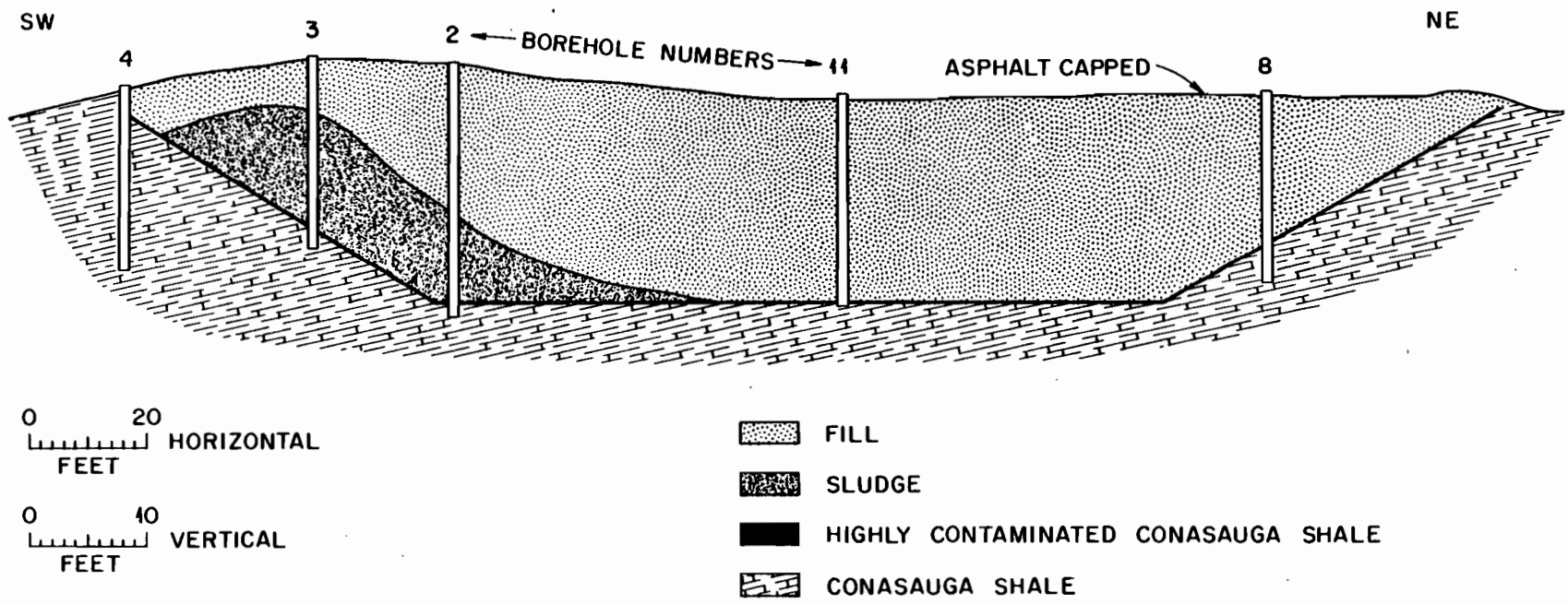
ORNL-DWG 64-929R



Longitudinal Cross Section Through Waste Pit 3.

ORNL-DWG-64-929R
1964
Longitudinal section of pit 3 postclosure

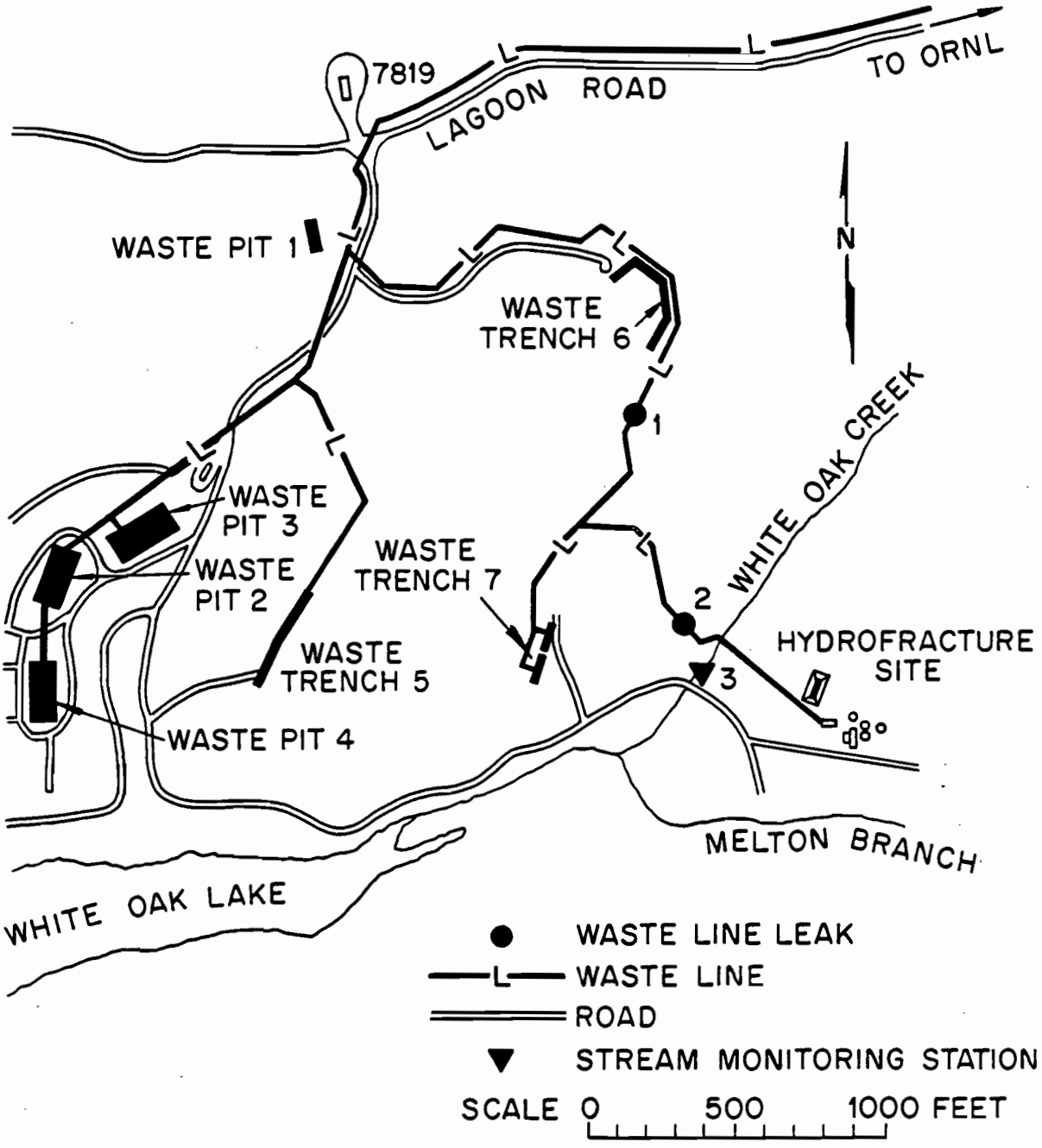
ORNL-DWG 64-929R2



Longitudinal Cross Section Through Waste Pit 3.

ORNL-DWG-64-929R2 1964
Longitudinal section of pit 3 postclosure

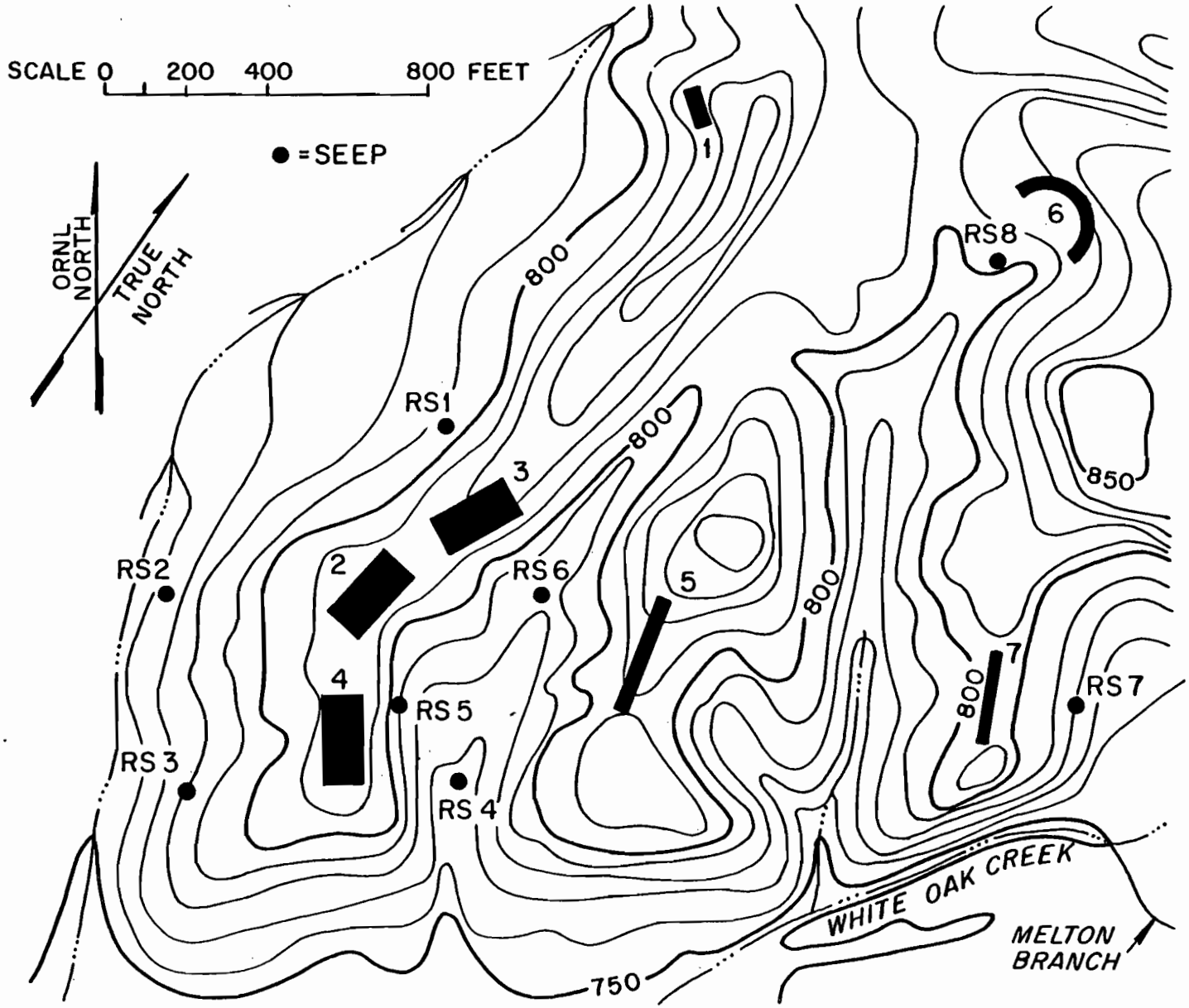
ORNL DWG 74-8966R



Location of Waste Line Leaks on Transfer Line Between ORNL and the Hydrofracture Site.

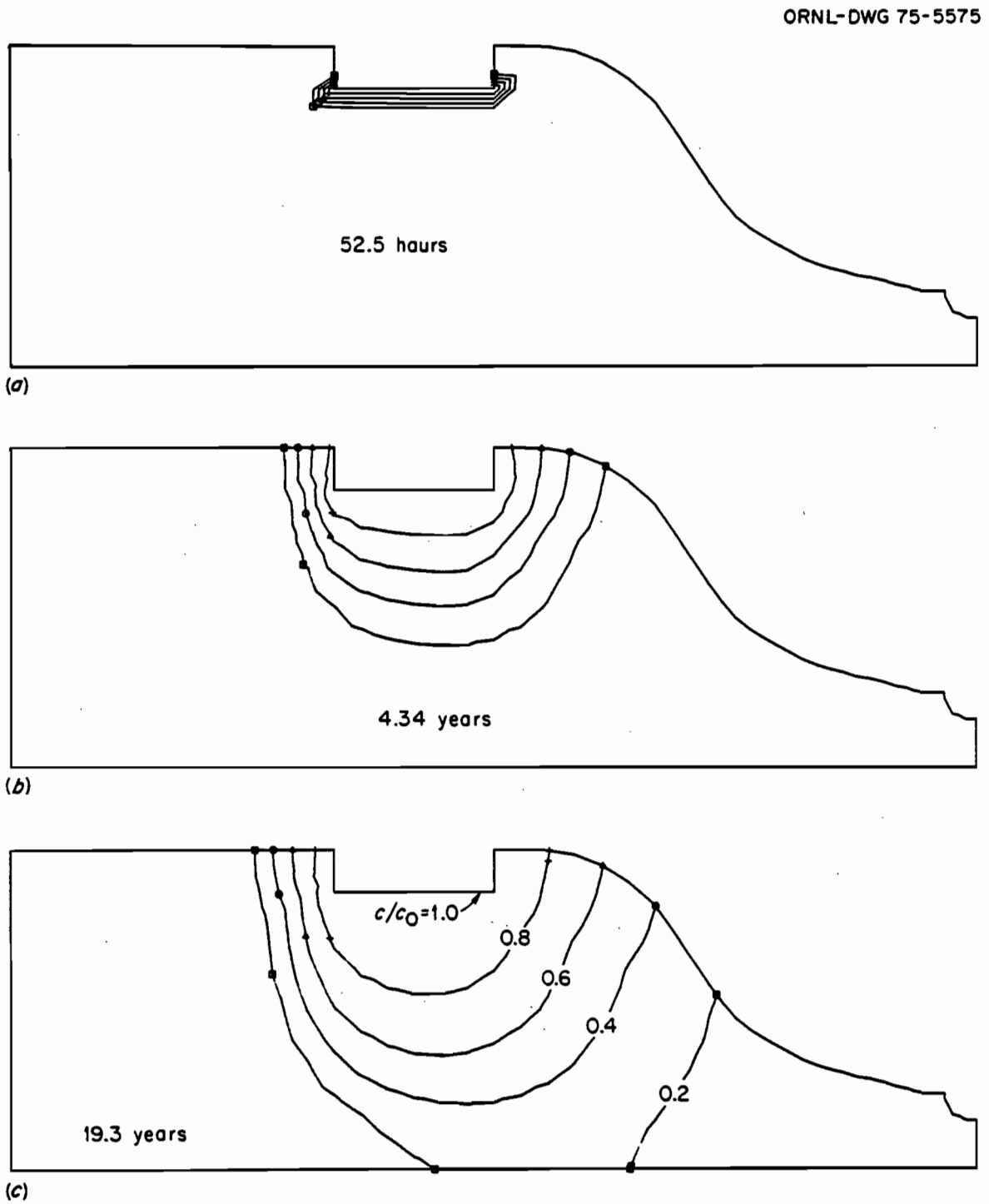
ORNL-DWG-74-8966R 1974
Waste line leak sites between ORNL-hydrofracture

ORNL DWG 74-9604



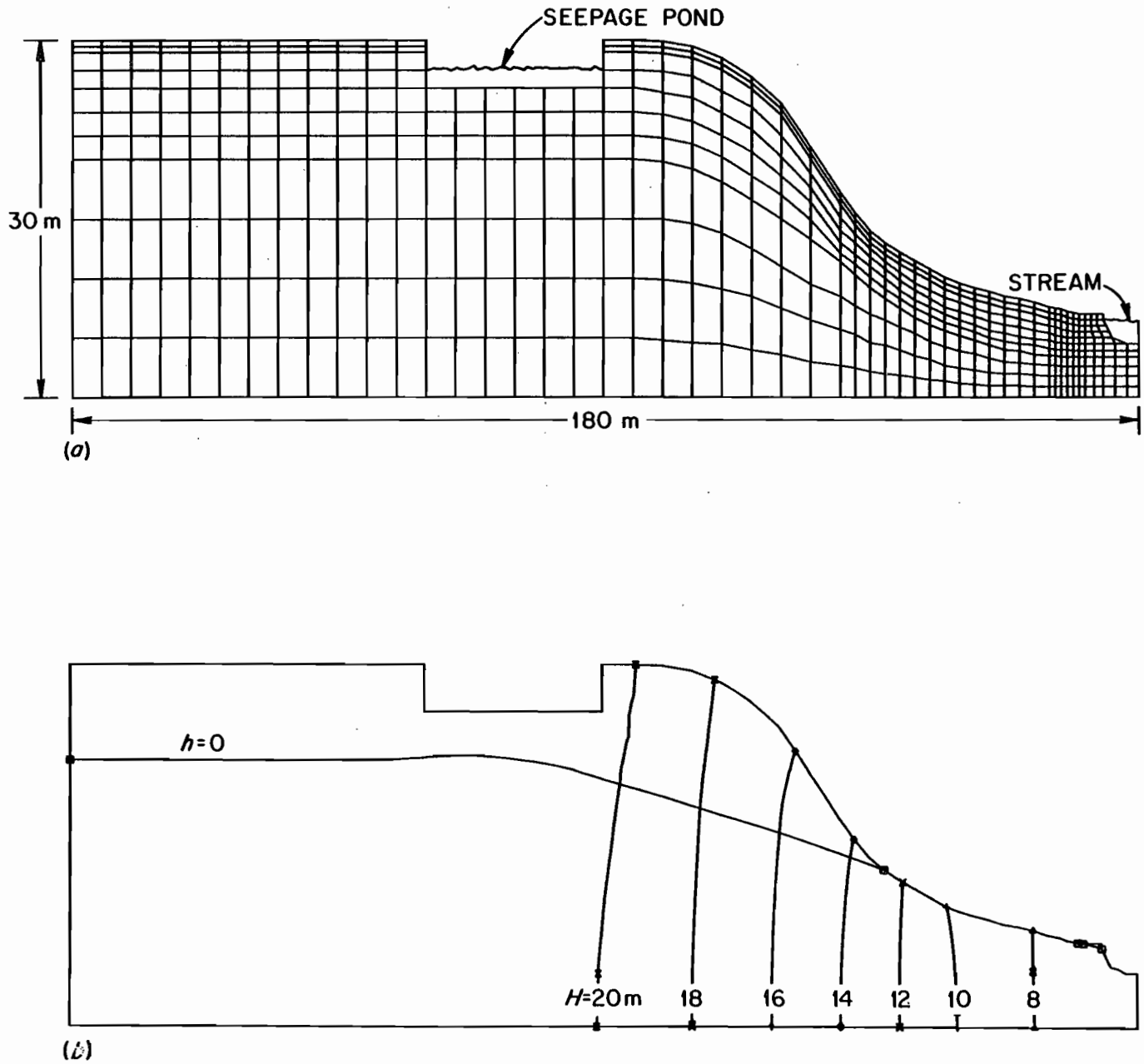
BASE: STONE & WEBSTER, 1943

ORNL-DWG-74-9604 1974
Seep locations around pits and trenches



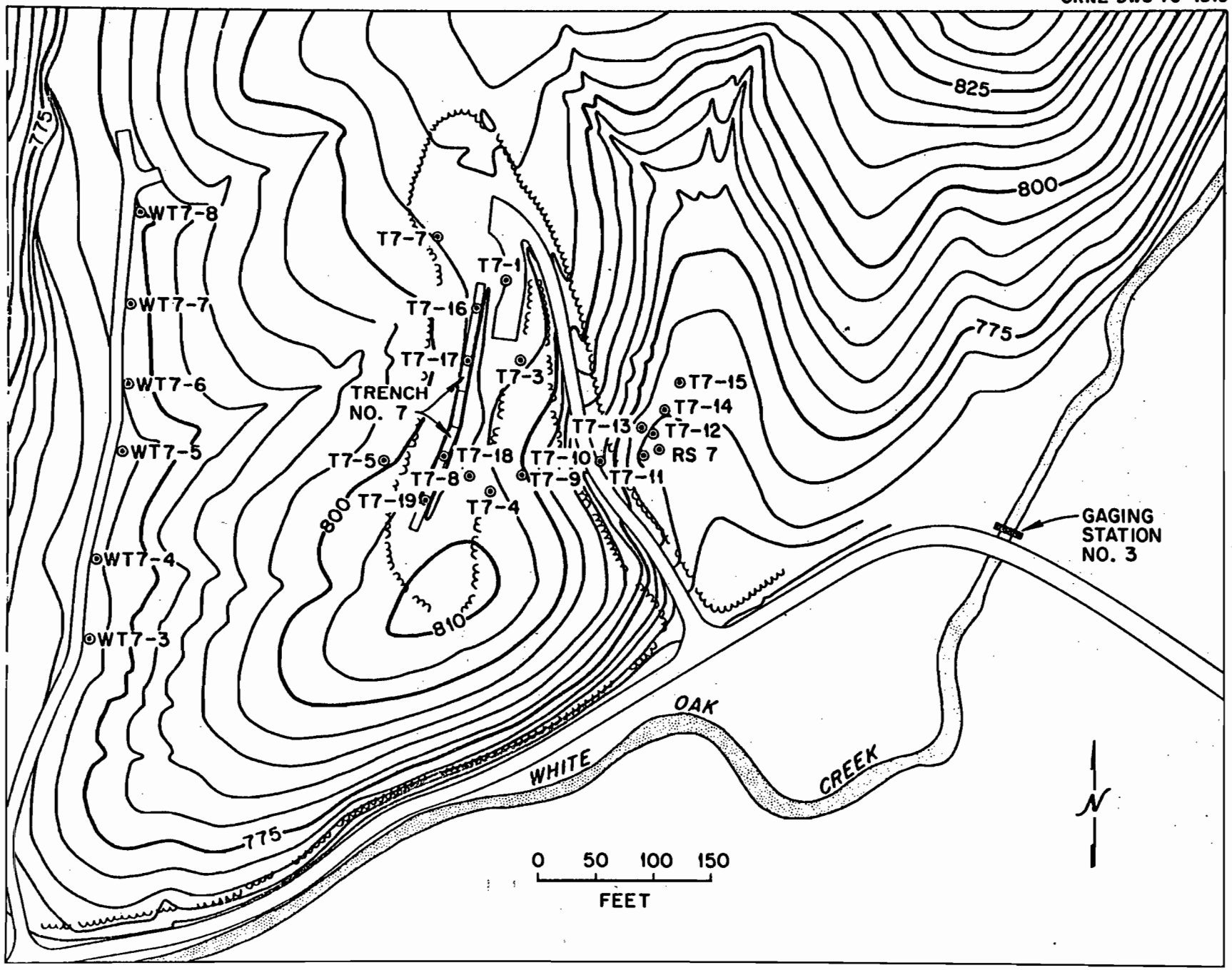
ORNL-DWG-75-5575 1975
Trench to dispersion model of Kd=100 species

ORNL-DWG 75-5576

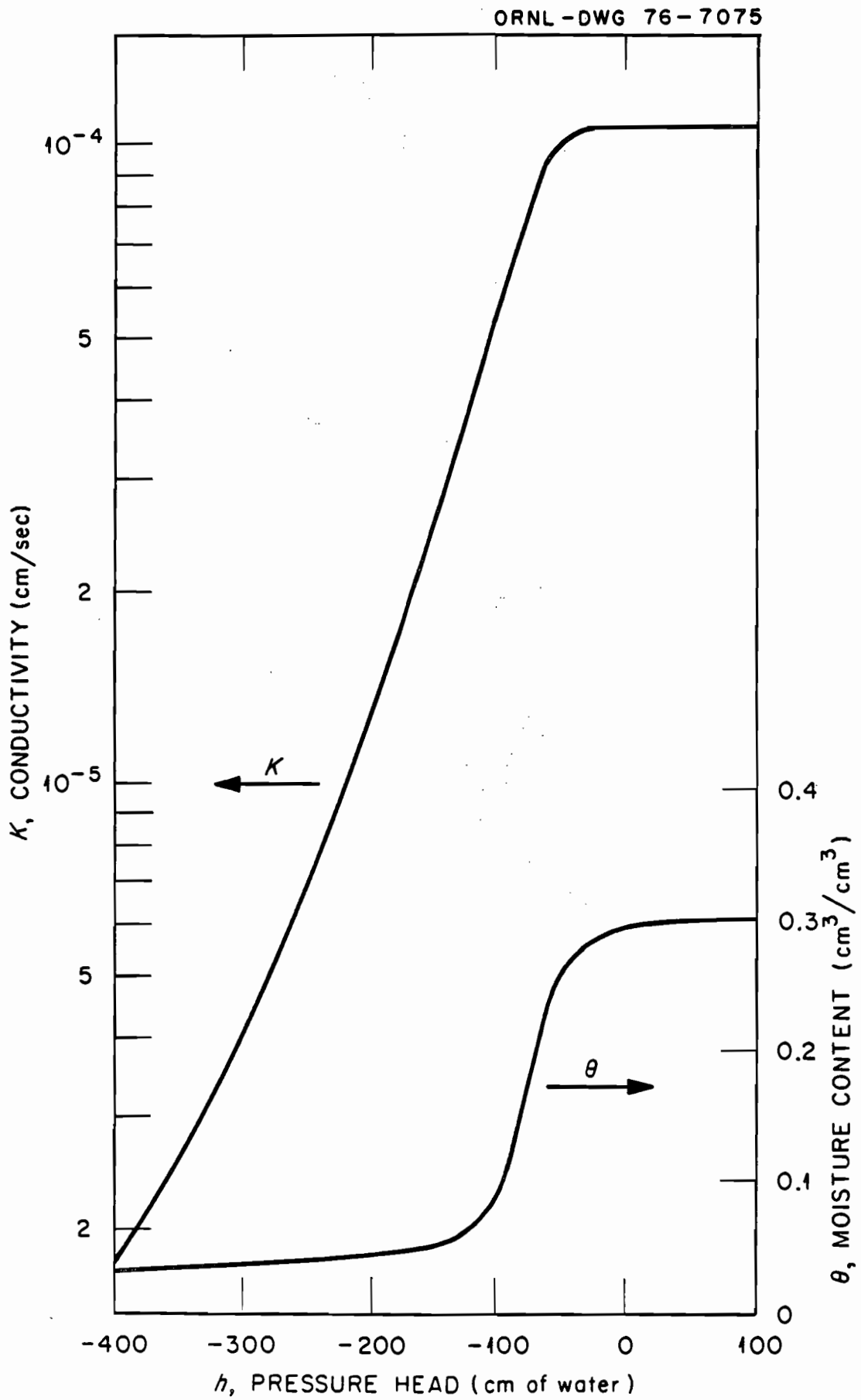


ORNL-DWG-75-5576
Trench discretization and head to stream model
1975

ORNL-DWG 76-1519

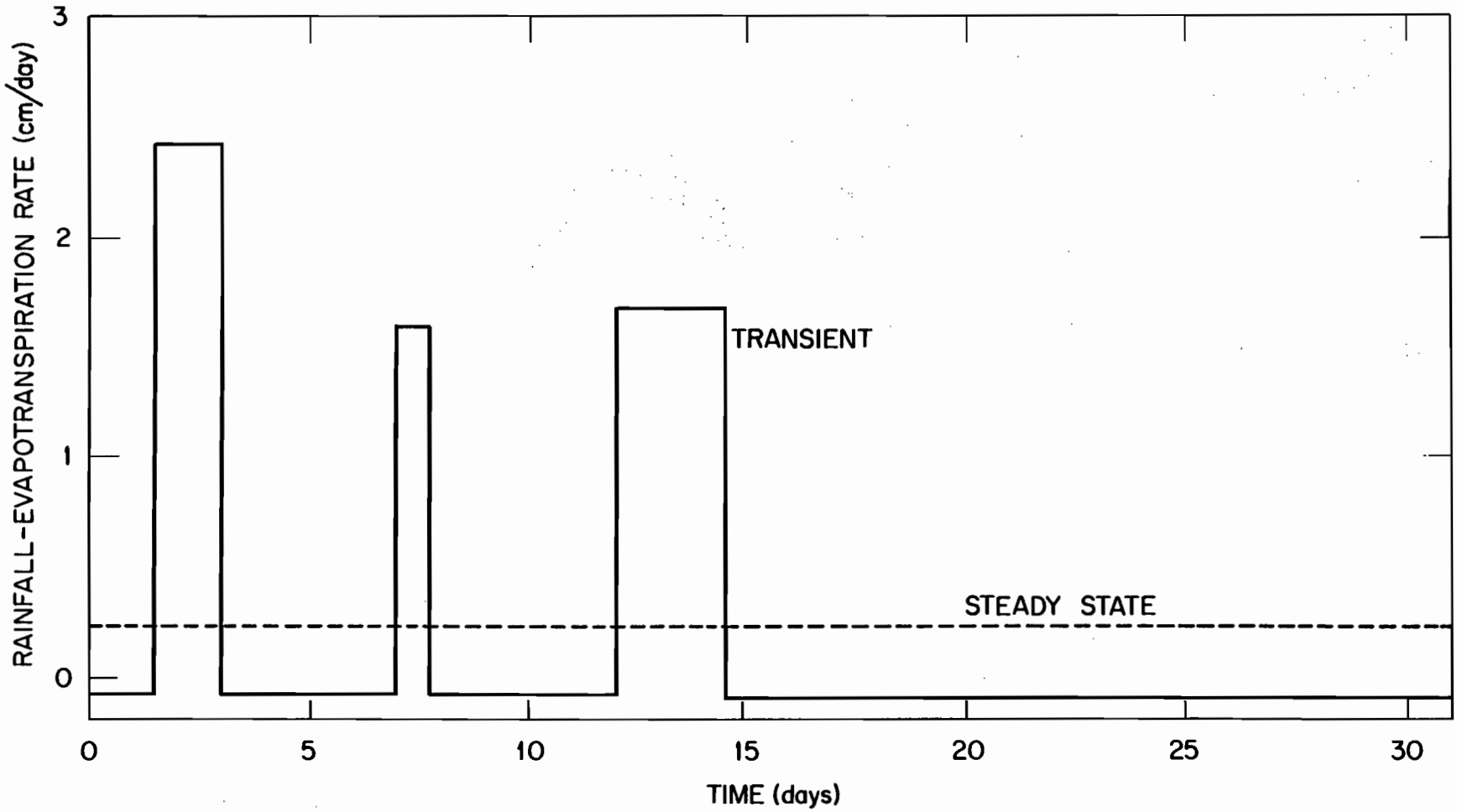


ORNL-DWG-76-1519
Monitoring well locations near Trench No. 7
1976



ORNL-DWG-76-7075 1976
Pressure, moisture, and conductivity relations

ORNL-DWG 76-7076

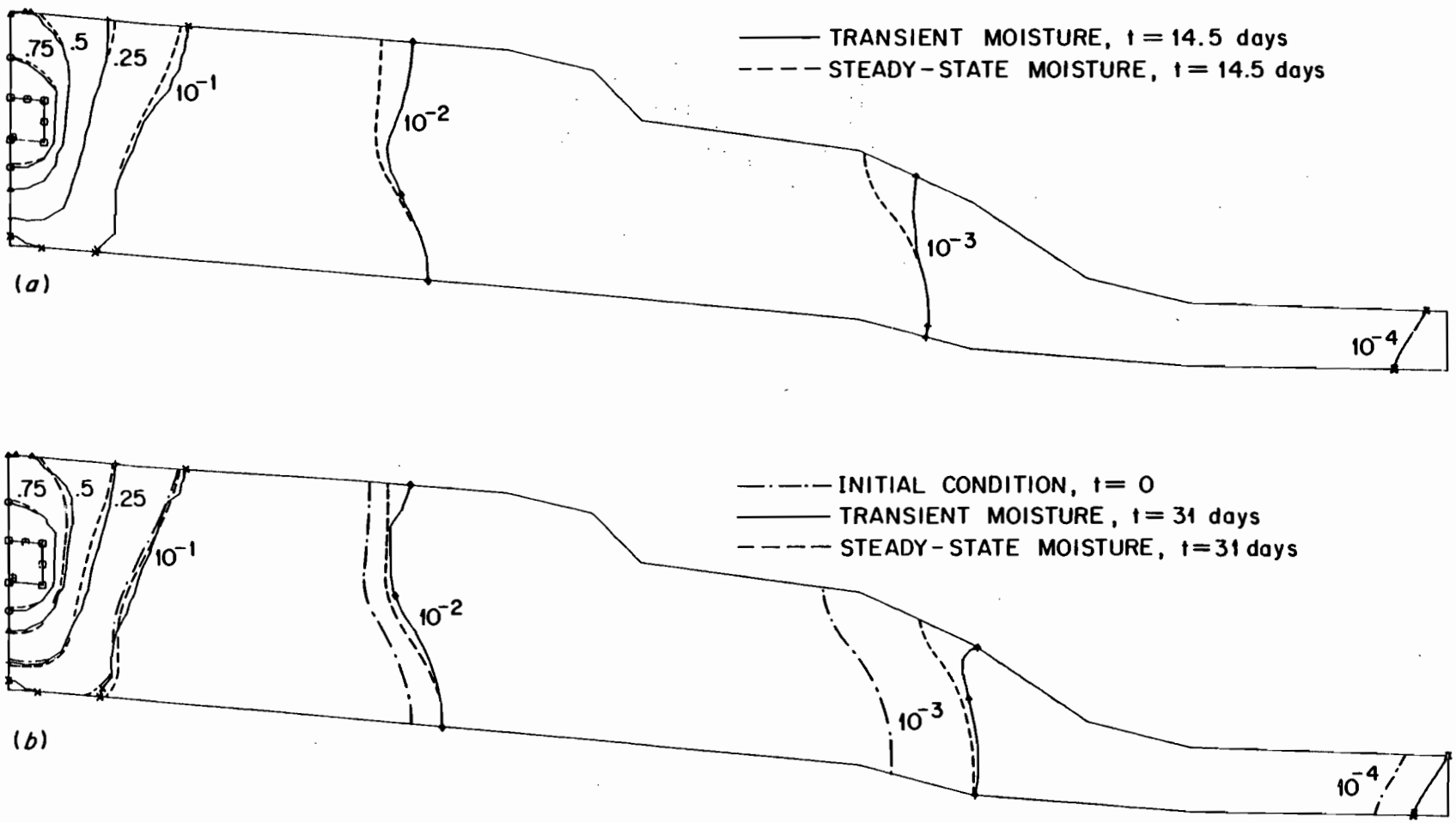


ORNL-DWG-76-7076

1976

Rainfall boundary model conditions May 1972

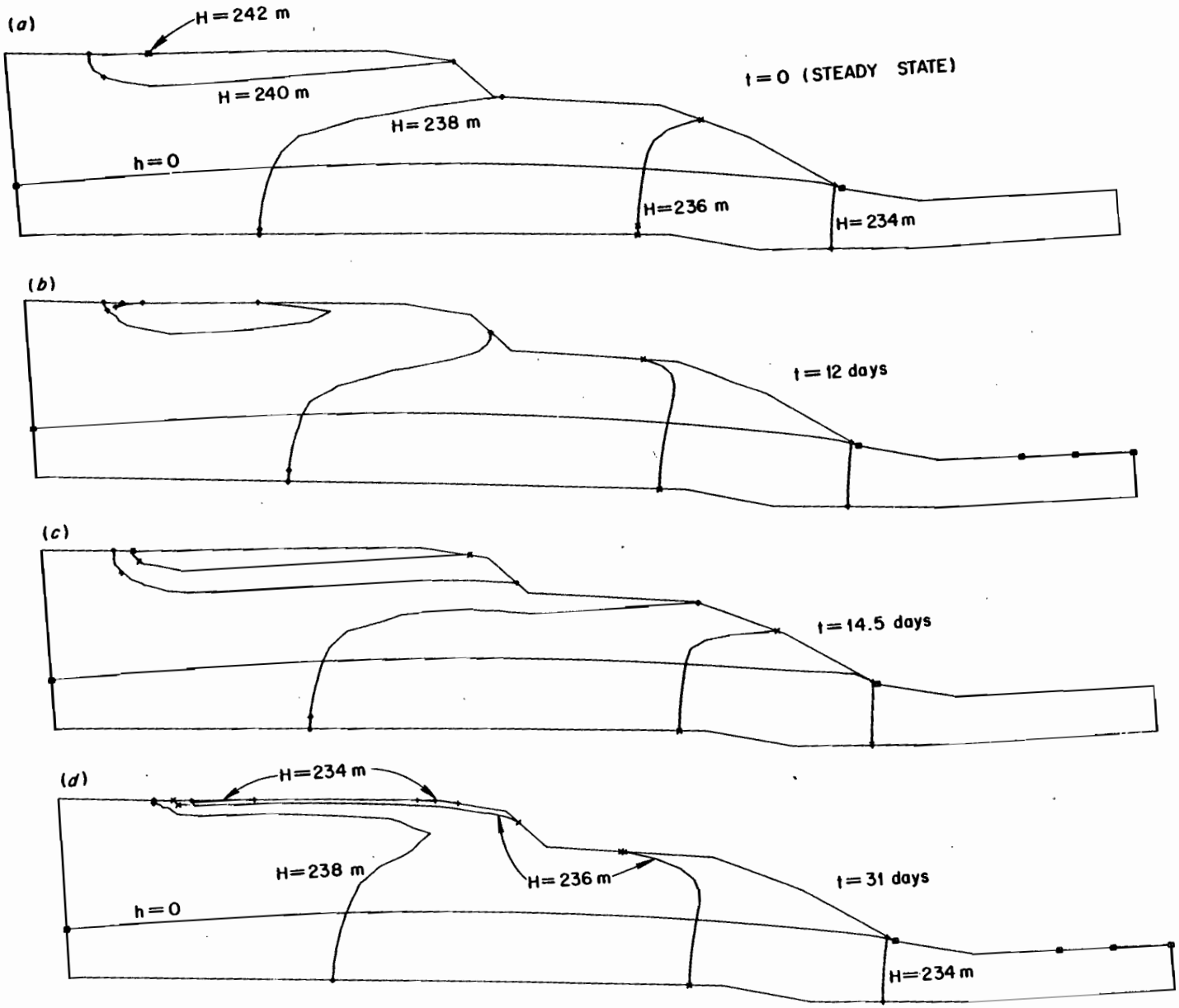
ORNL-DWG 76-7077



ORNL-DWG-76-7077

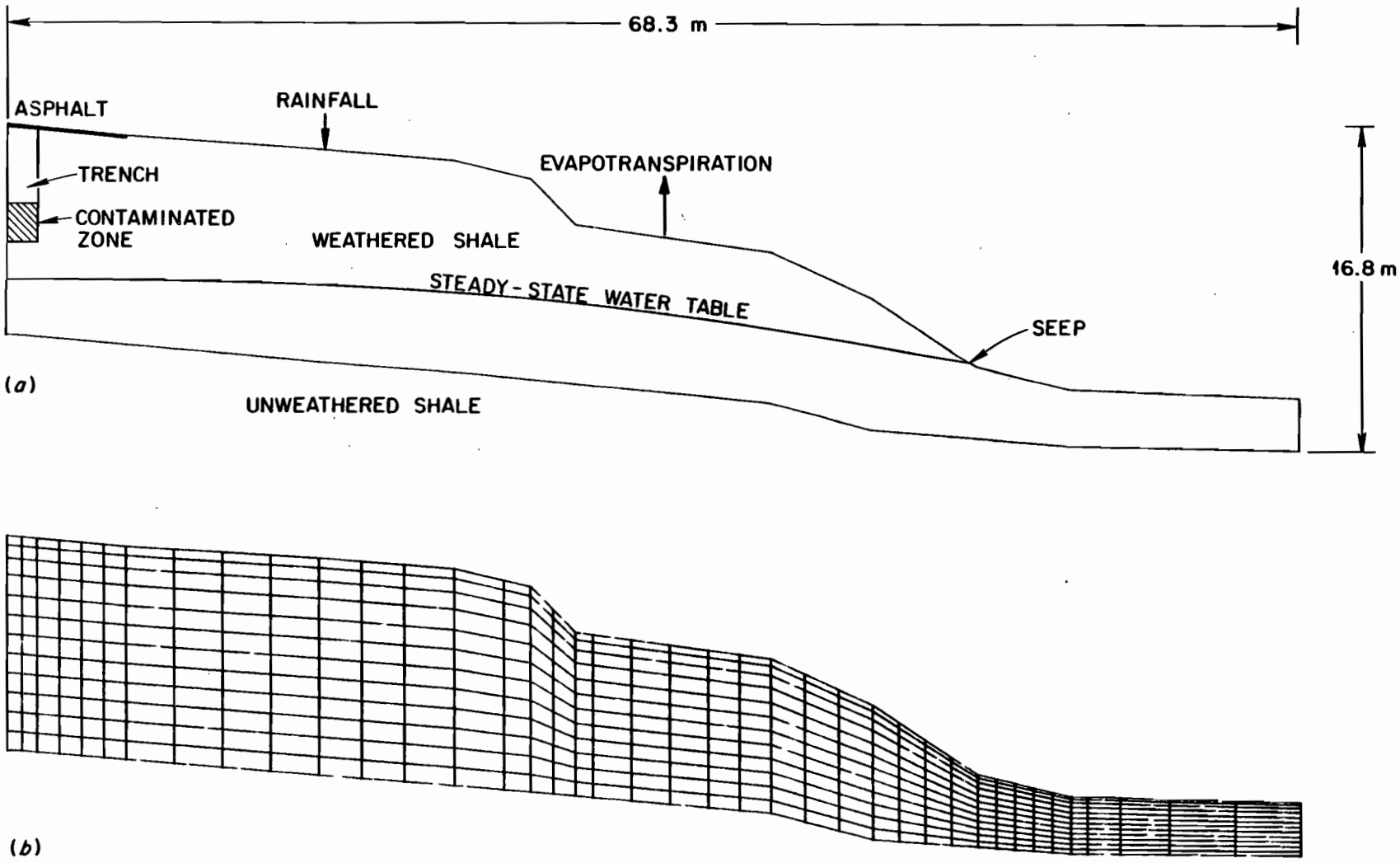
Trench 7 simulated tritium migration 1976

ORNL-DWG 76-7078



ORNL-DWG-76-7078
Trench 7 water table and head simulations
1976

ORNL-DWG 76-7080

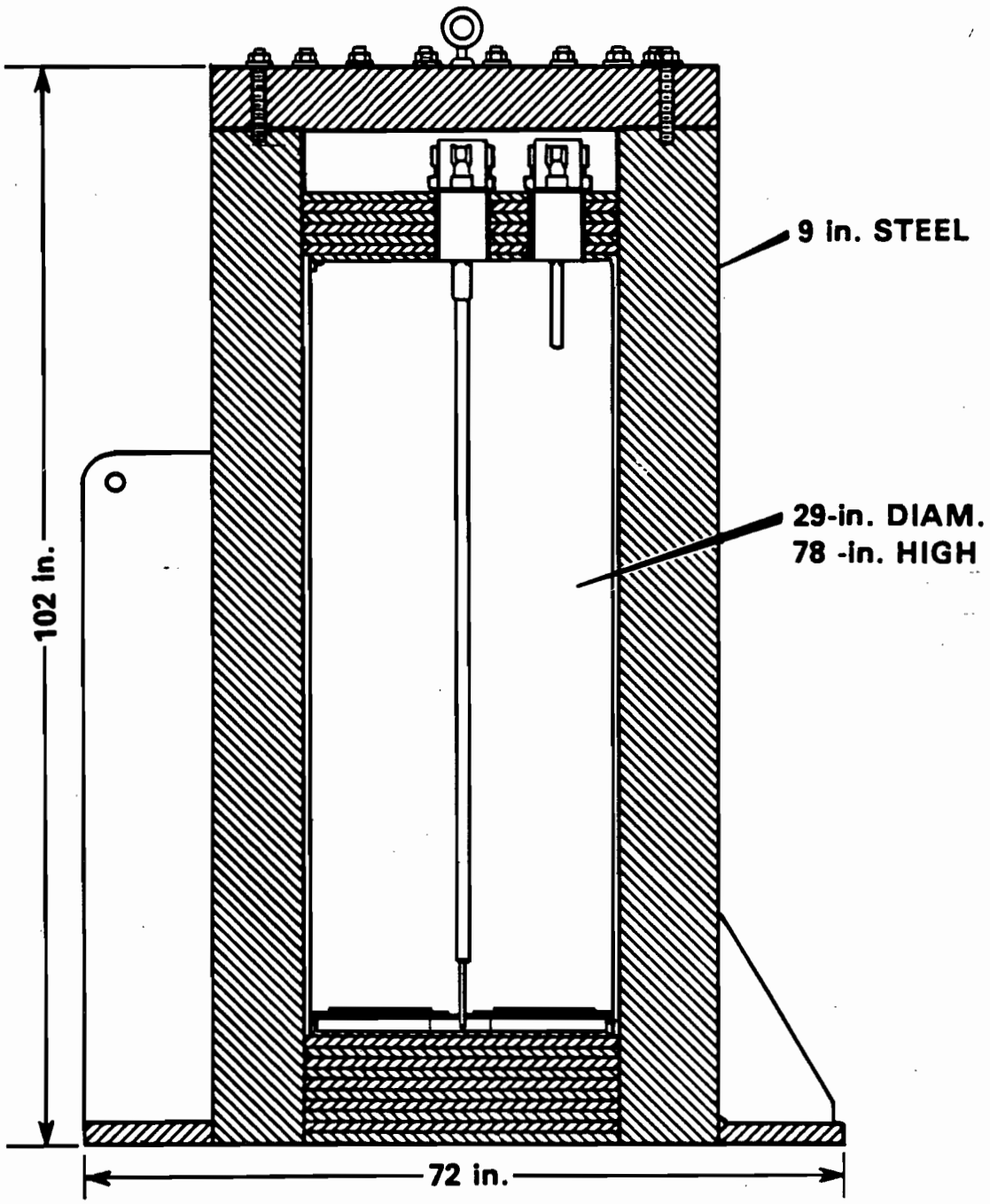


ORNL-DWG-76-7080 1976
Cross sectional discretization of trench 7

ORNL-DWG 79-20020

DOT SP 5174

SHIELDED TRANSFER TANK-MODEL III

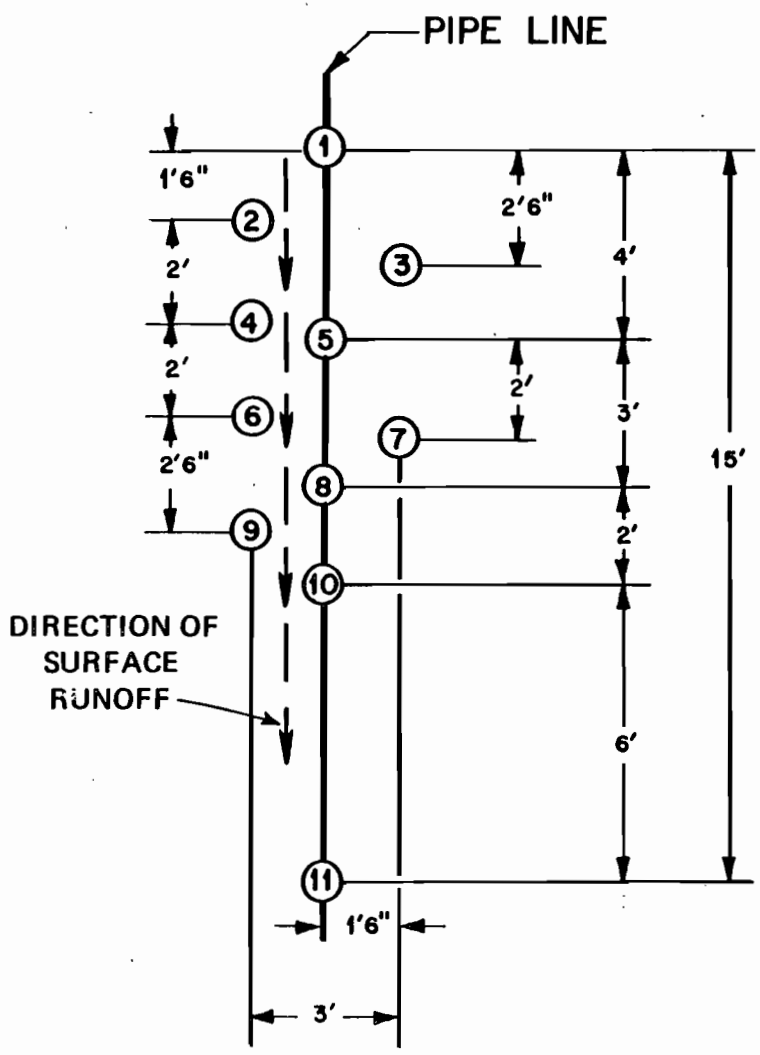


WEIGHT—42,000 lb.
AUTHORIZED CONTENTS—90,000 Ci ^{137}Cs.

ORNL-DWG-79-20020 1979
Shielded Transfer Tank - Model III

ORNL–DWG 81-11565R

LEAK SITE NO. 2



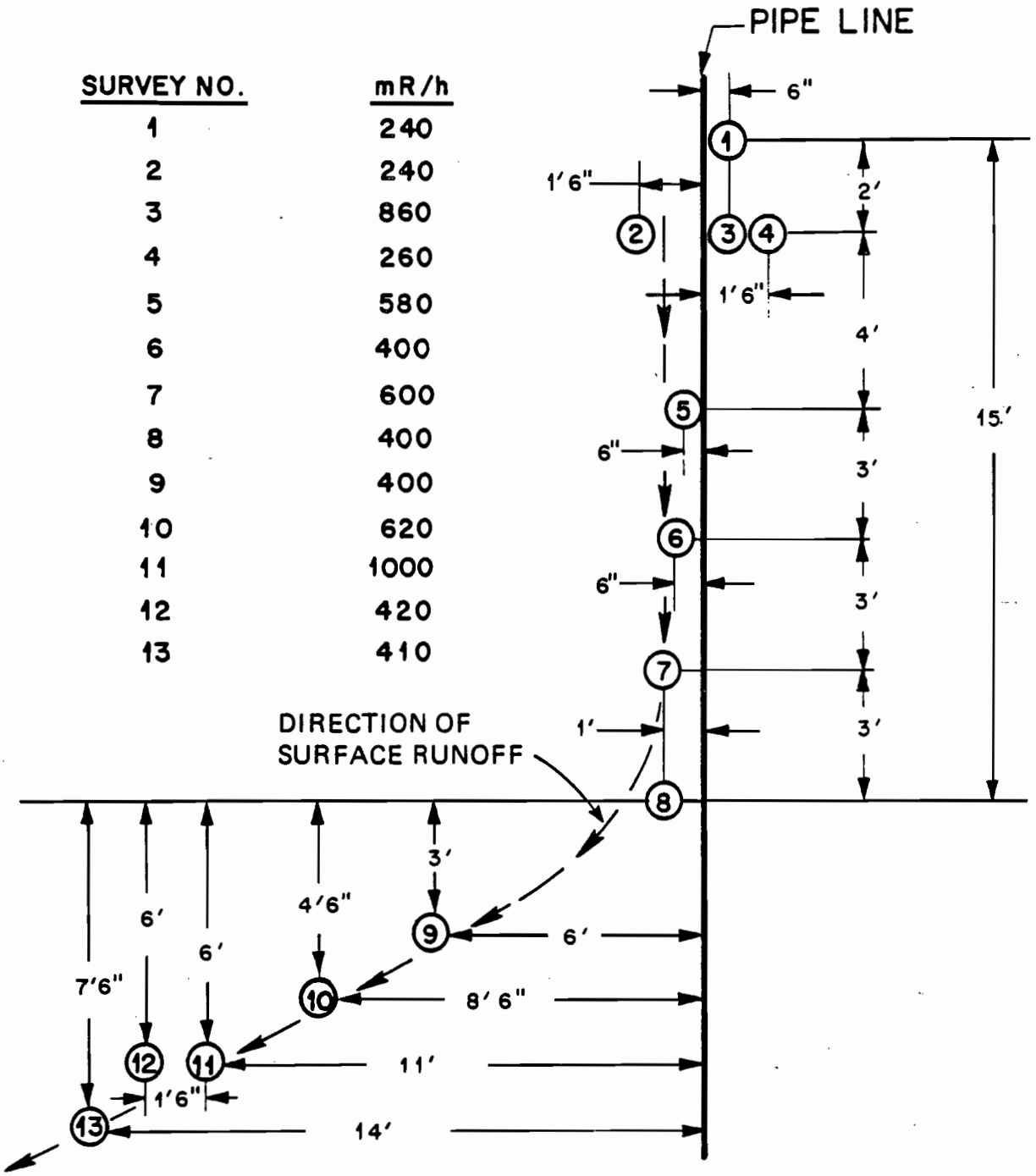
SURVEY NO.	mR/h
1	290
2	250
3	610
4	240
5	800
6	240
7	290
8	270
9	250
10	410
11	240

ORNL–DWG–81–11565R 1981
Survey locations and results, leak site 2

ORNL-DWG 81-11566R

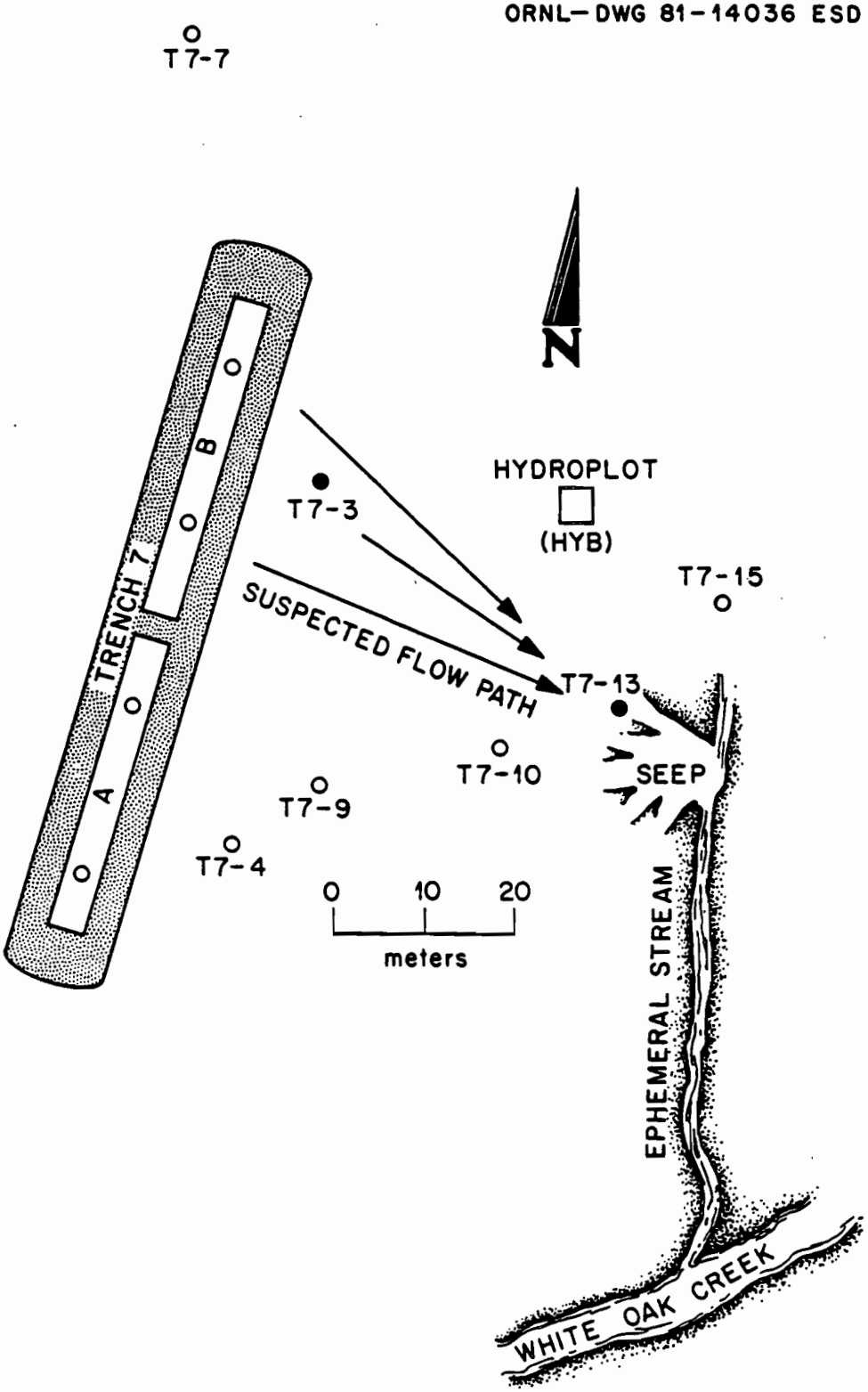
LEAK SITE NO. 1

SURVEY NO.	mR/h
1	240
2	240
3	860
4	260
5	580
6	400
7	600
8	400
9	400
10	620
11	1000
12	420
13	410



ORNL-DWG-81-11566R 1981
Survey locations and results, leak site 1

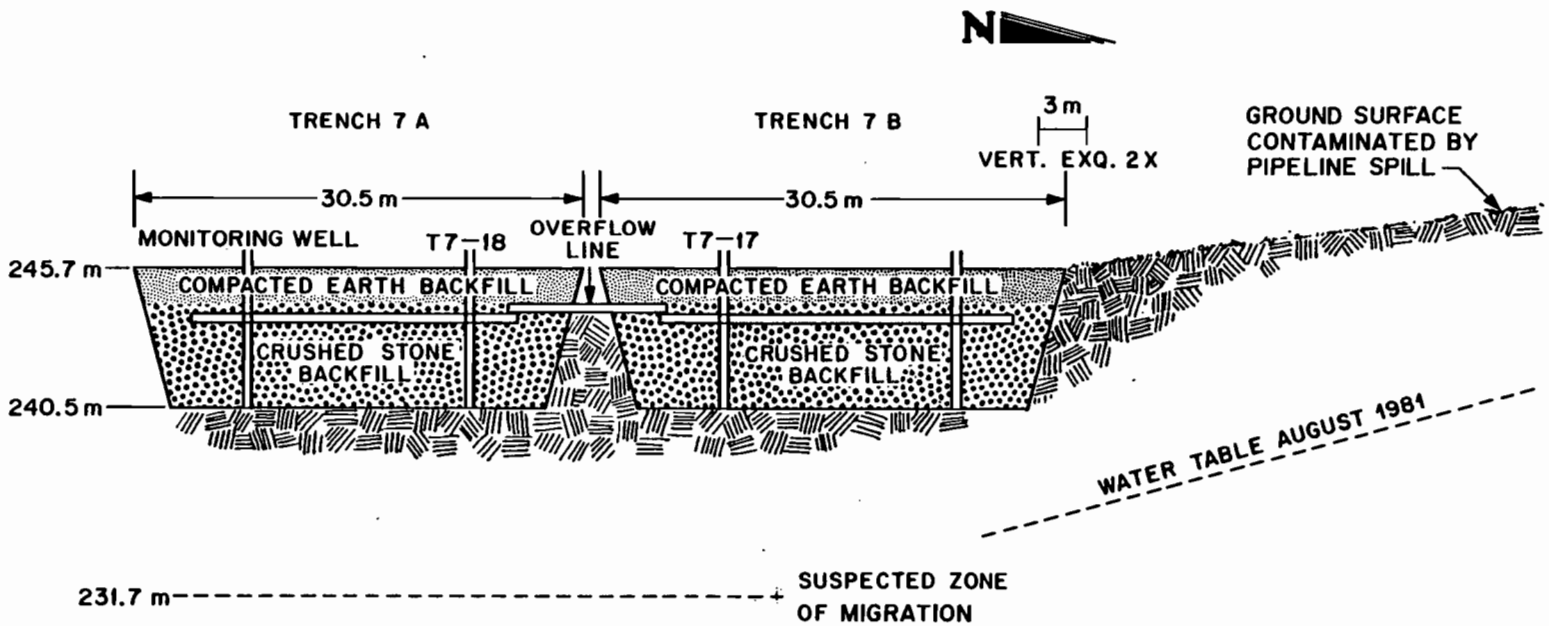
ORNL-DWG 81-14036 ESD



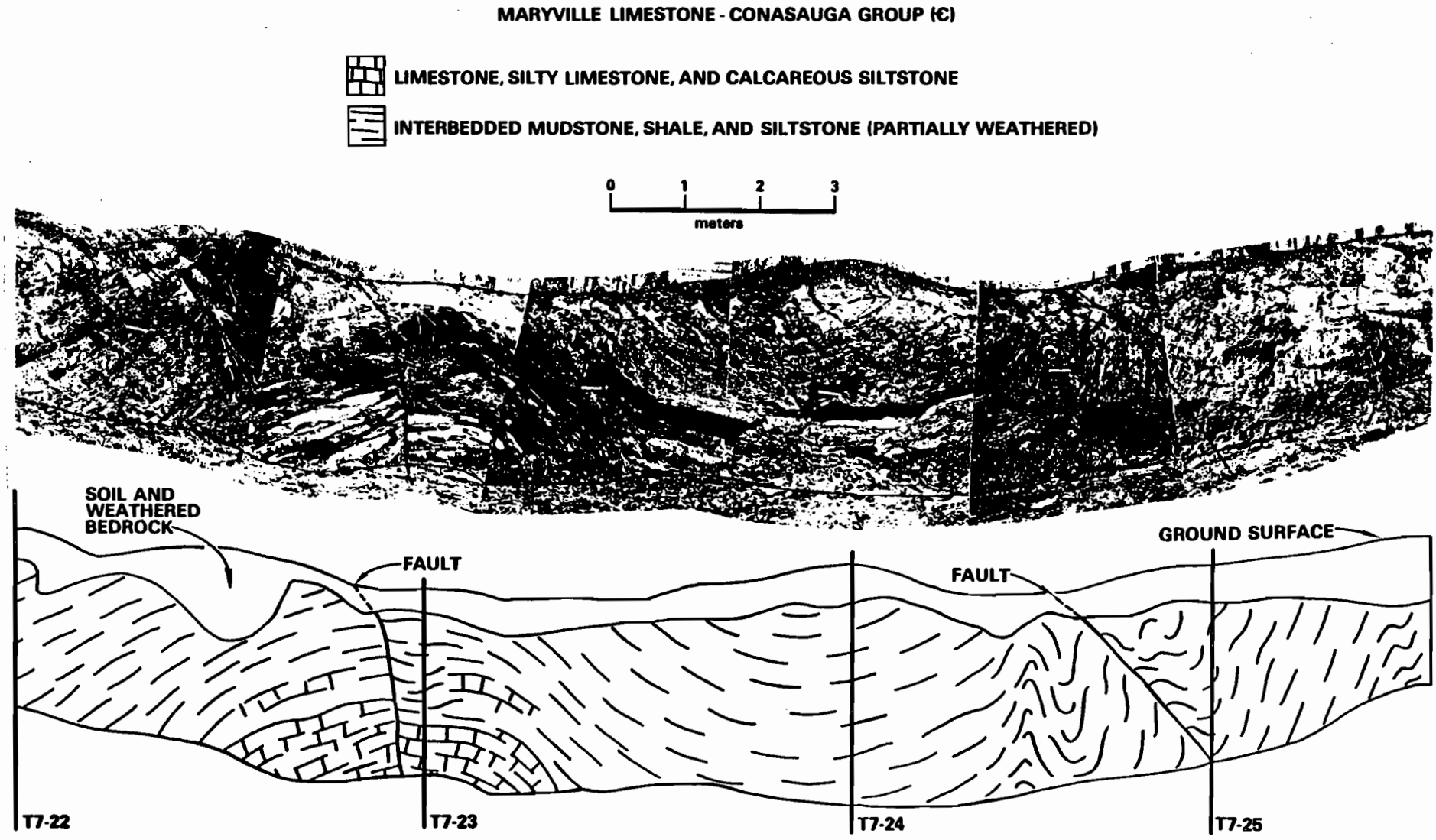
ORNL-DWG-81-14036ESD 1981
Trench 7 Groundwater Flow Paths to Seep

ORNL-DWG 81-14037 ESD

LONGITUDINAL SECTION



ORNL-DWG-81-14037ESD
Plan cross section of trench 7 1981

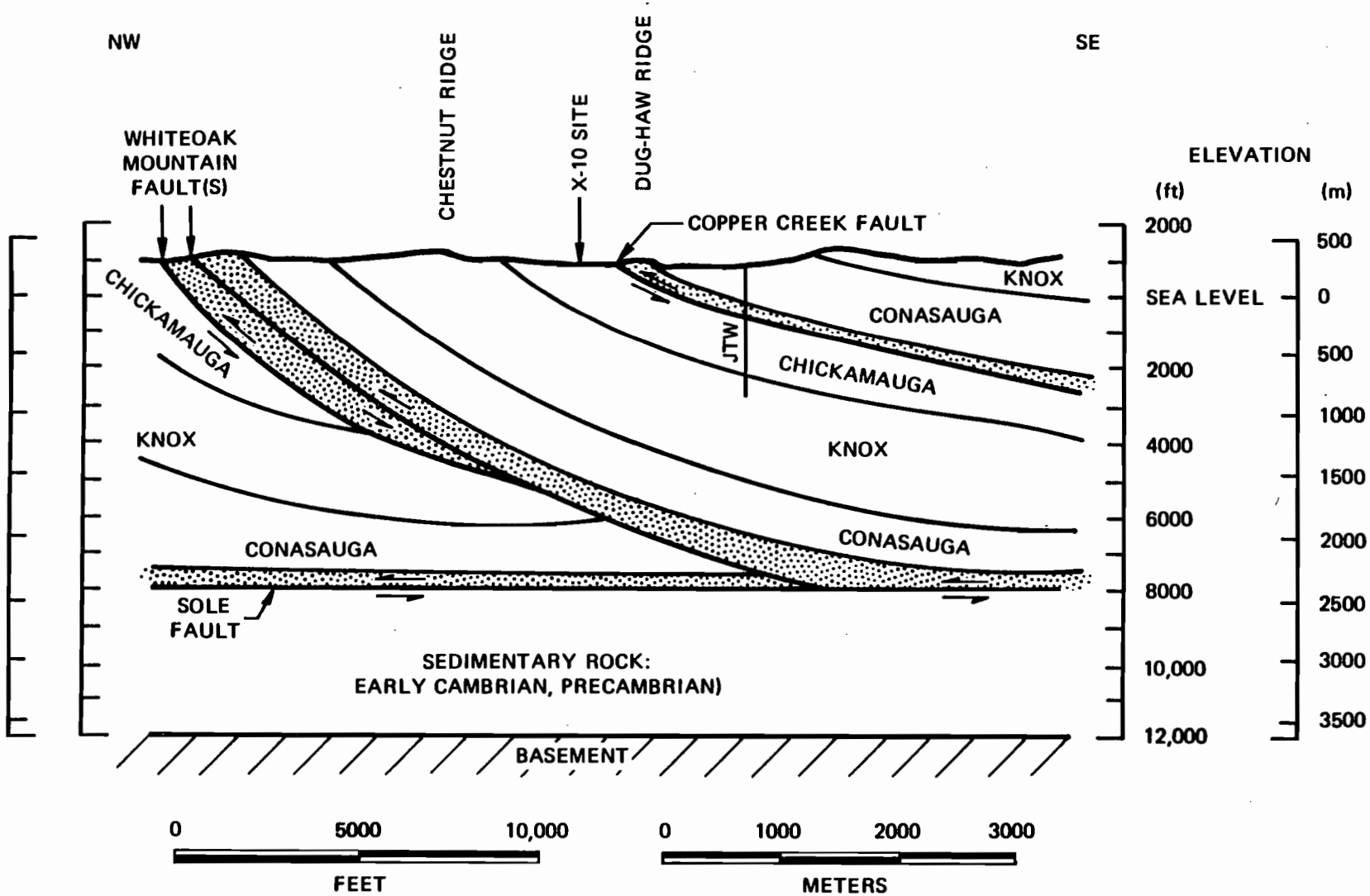


ORNL-DWG-81-21573B

Stratigraphic exposure on roadcut east of T7

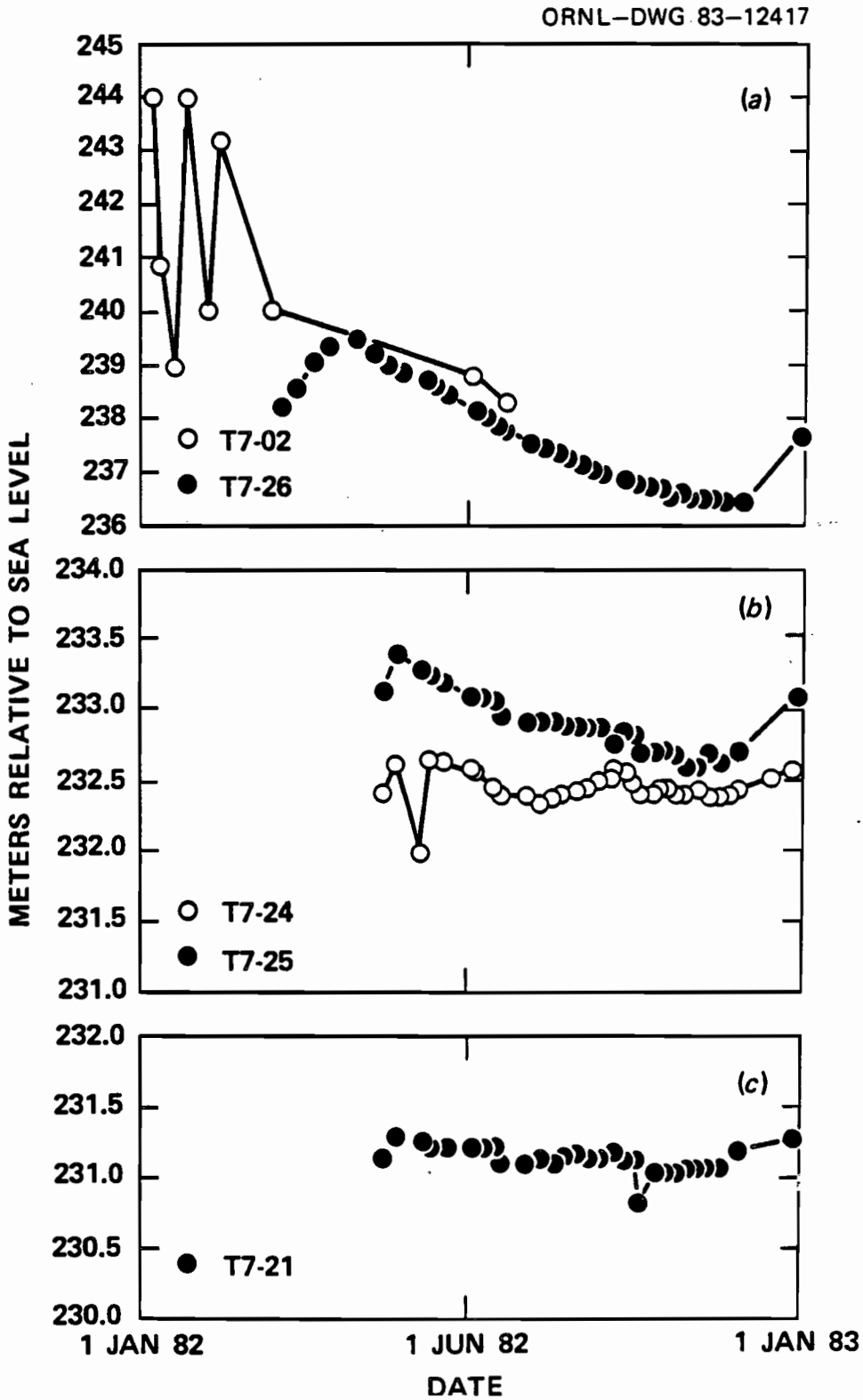
1981

ORNL-DWG-82-13318



ORNL-DWG-82-13318 1982
Generalized Stratigraphy around X-10 (ORNL)

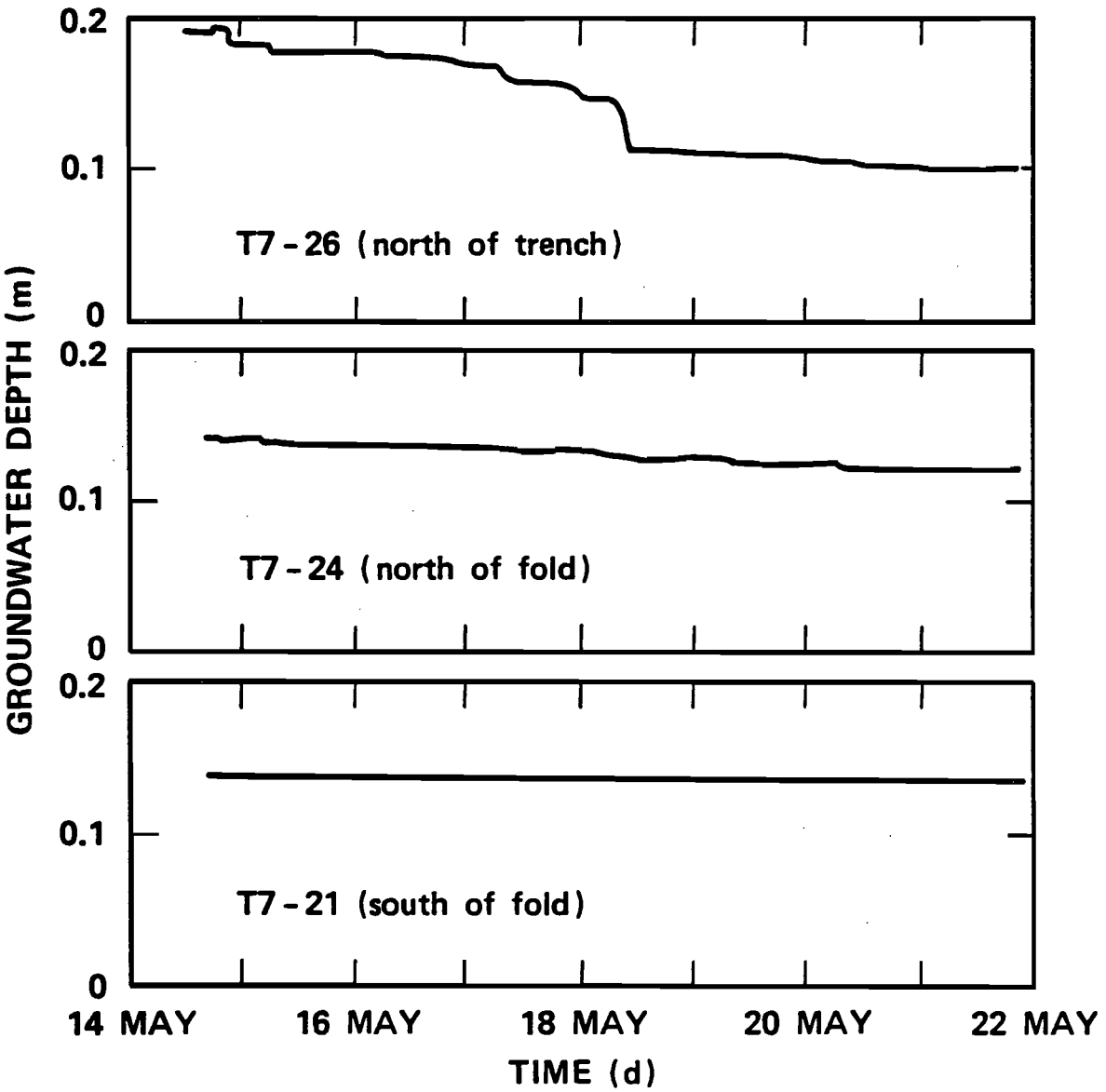
YEARLY FLUCTUATION IN GROUNDWATER LEVELS



ORNL-DWG-83-12417 1983
Yearly groundwater levels around trench 7

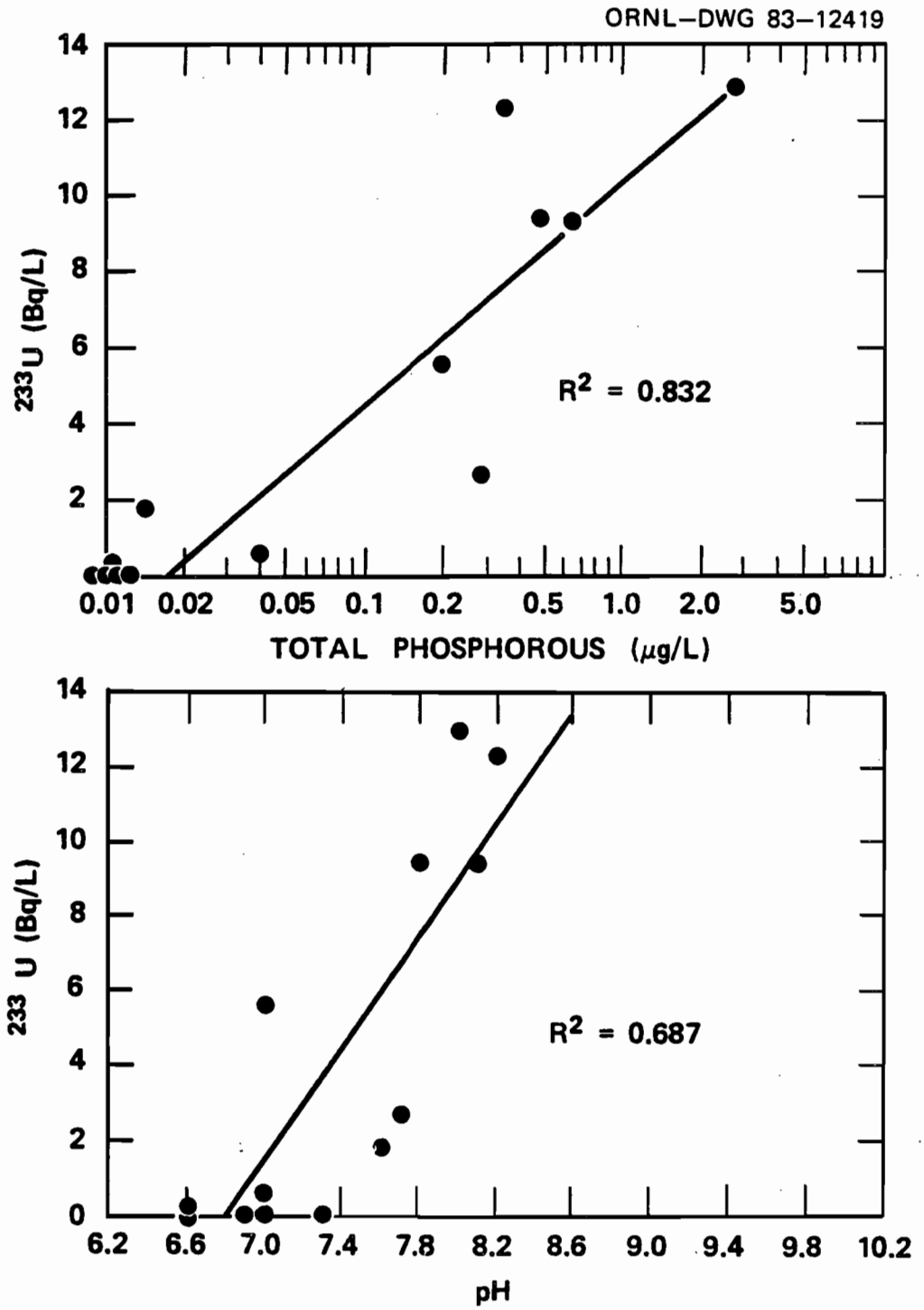
WEEKLY FLUCTUATION IN GROUNDWATER LEVELS

ORNL DWG 83-12418



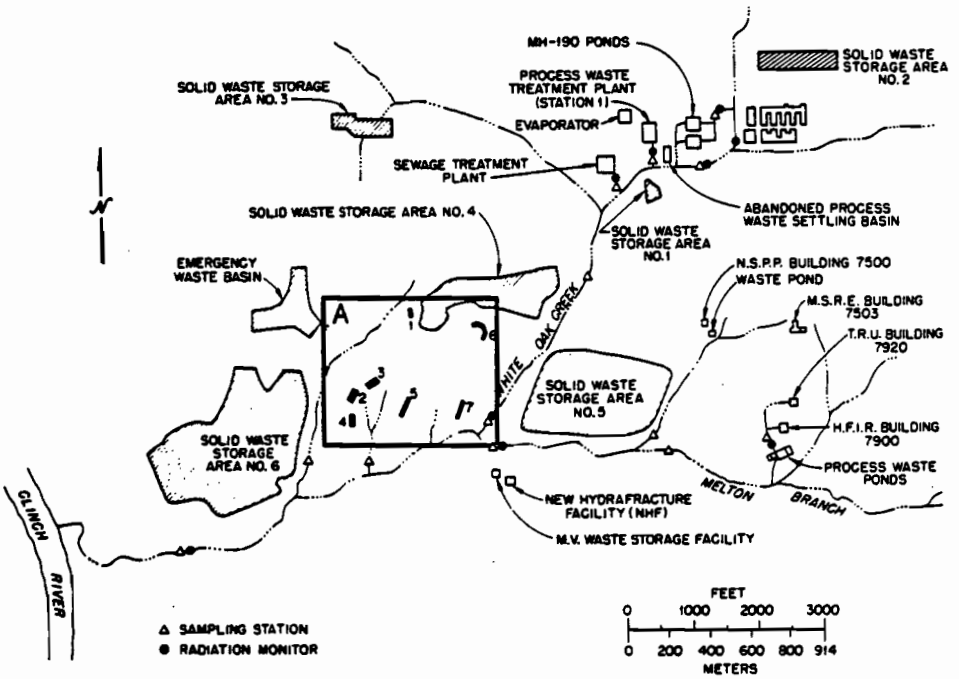
ORNL-DWG-83-12418 1983
Weekly groundwater levels around trench 7

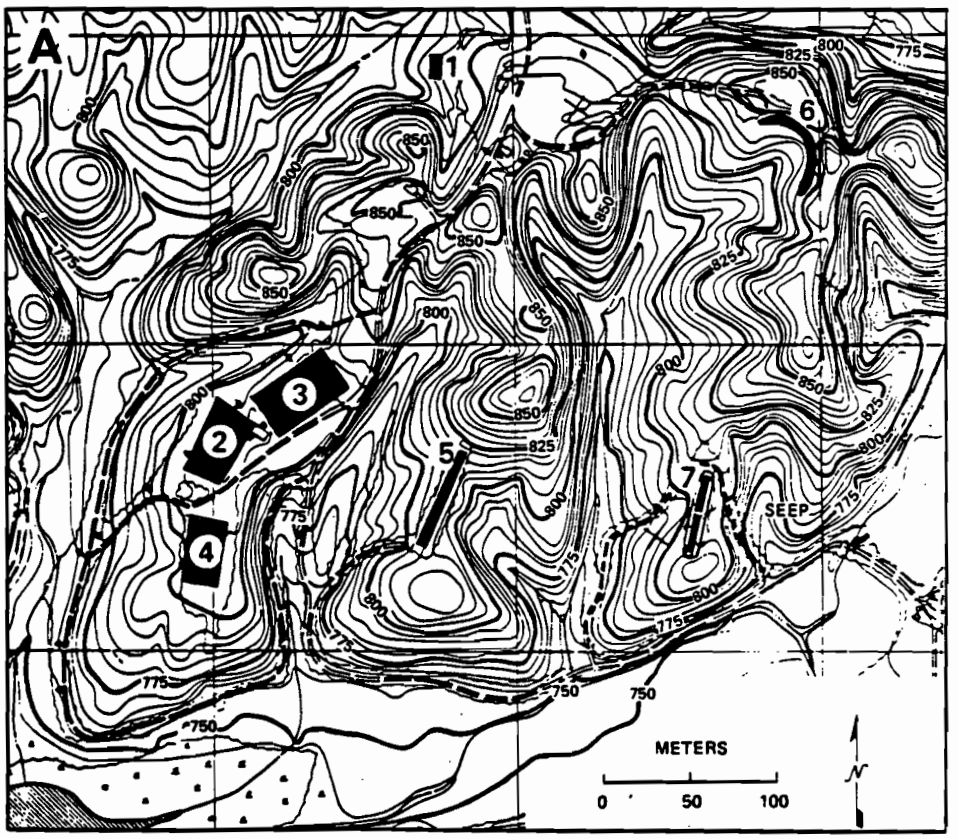
^{233}U CONCENTRATION AS A FUNCTION OF TOTAL PHOSPHOROUS AND pH



ORNL-DWG-83-12419 1983
233-U vs. Phosphorus/pH at well T7-21 at trench 7

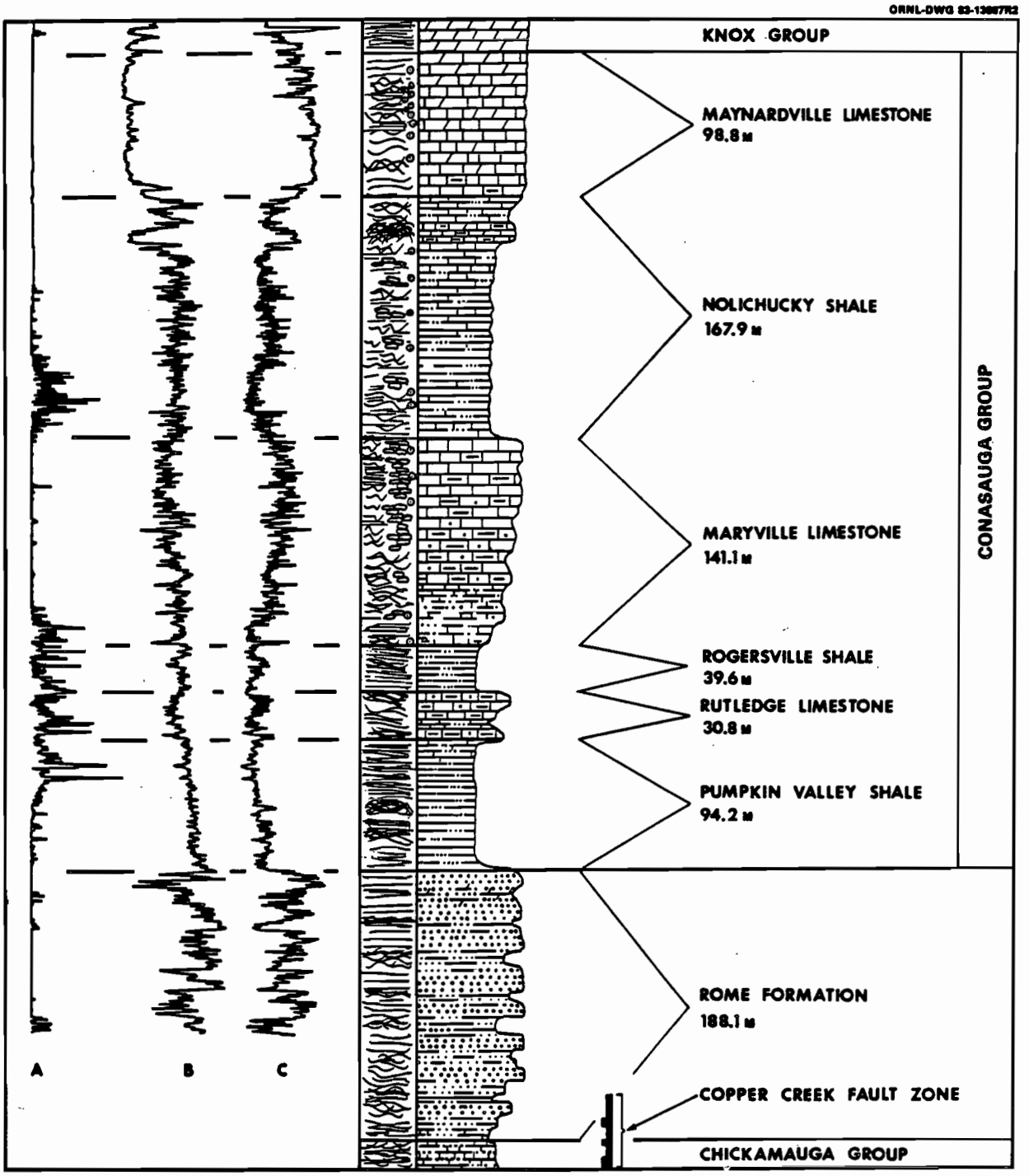
ORNL-DWG 83-12602





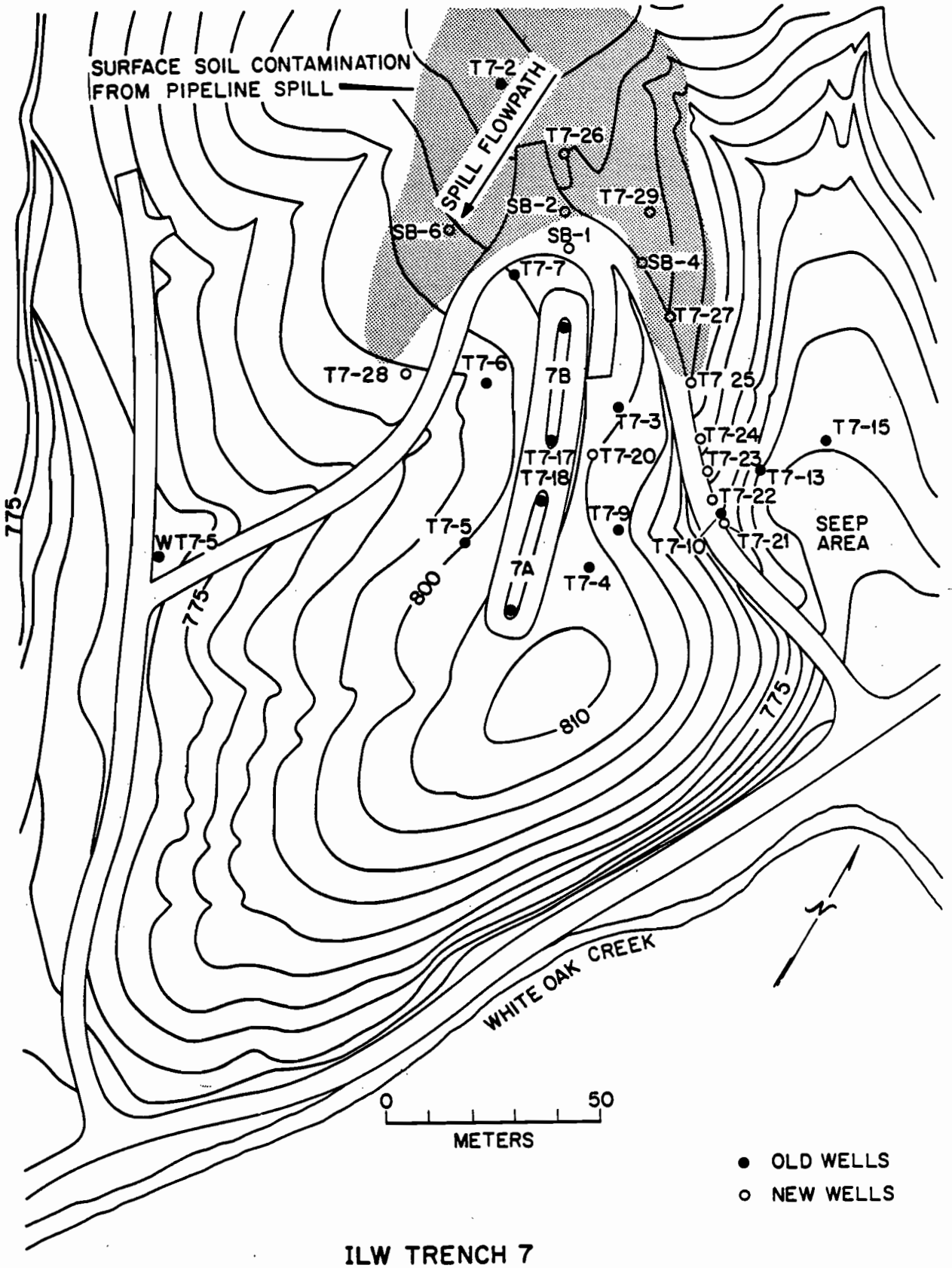
ILW WASTE PITS AND TRENCHES

ORNL-DWG-83-12602 1983
Topographic map of pits and trenches area



ORNL-DWG-83-13887R2 1983
Stratigraphic column of Conasauga formation

ORNL-DWG 83-1514A

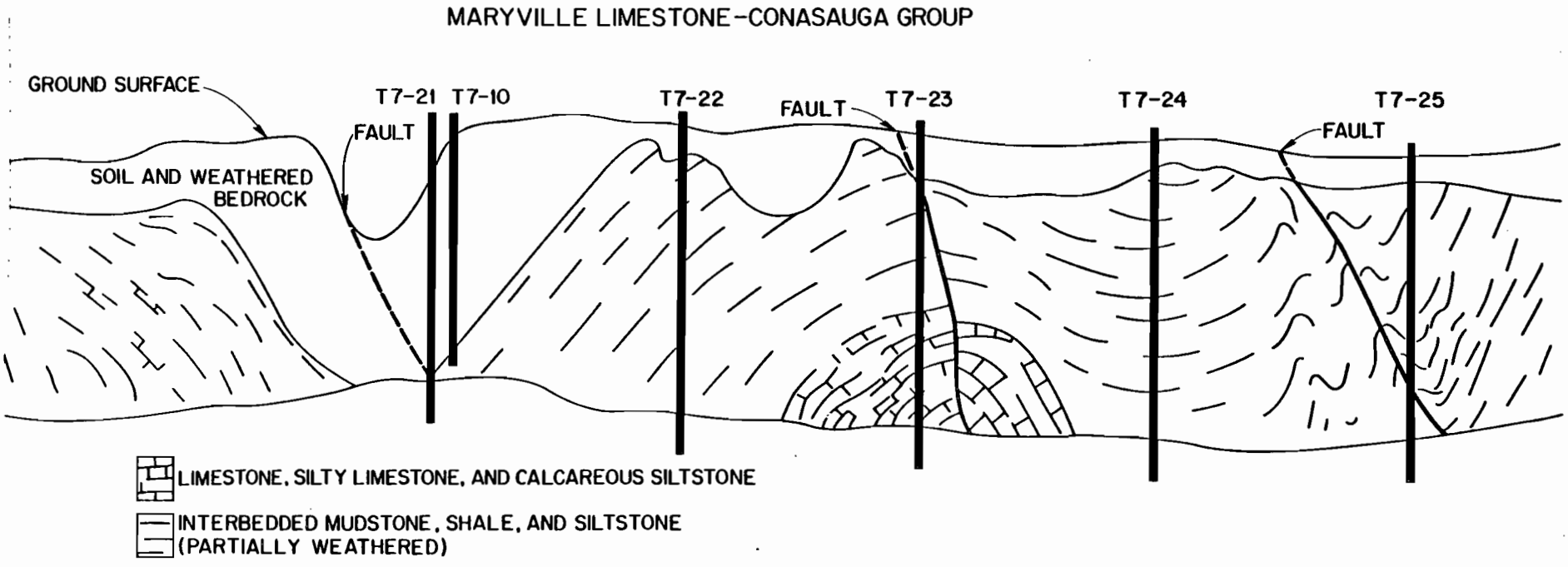


ILW TRENCH 7

ORNL-DWG-83-1514A 1983

Map of monitoring well locations around trench 7

ORNL-DWG 83-1515

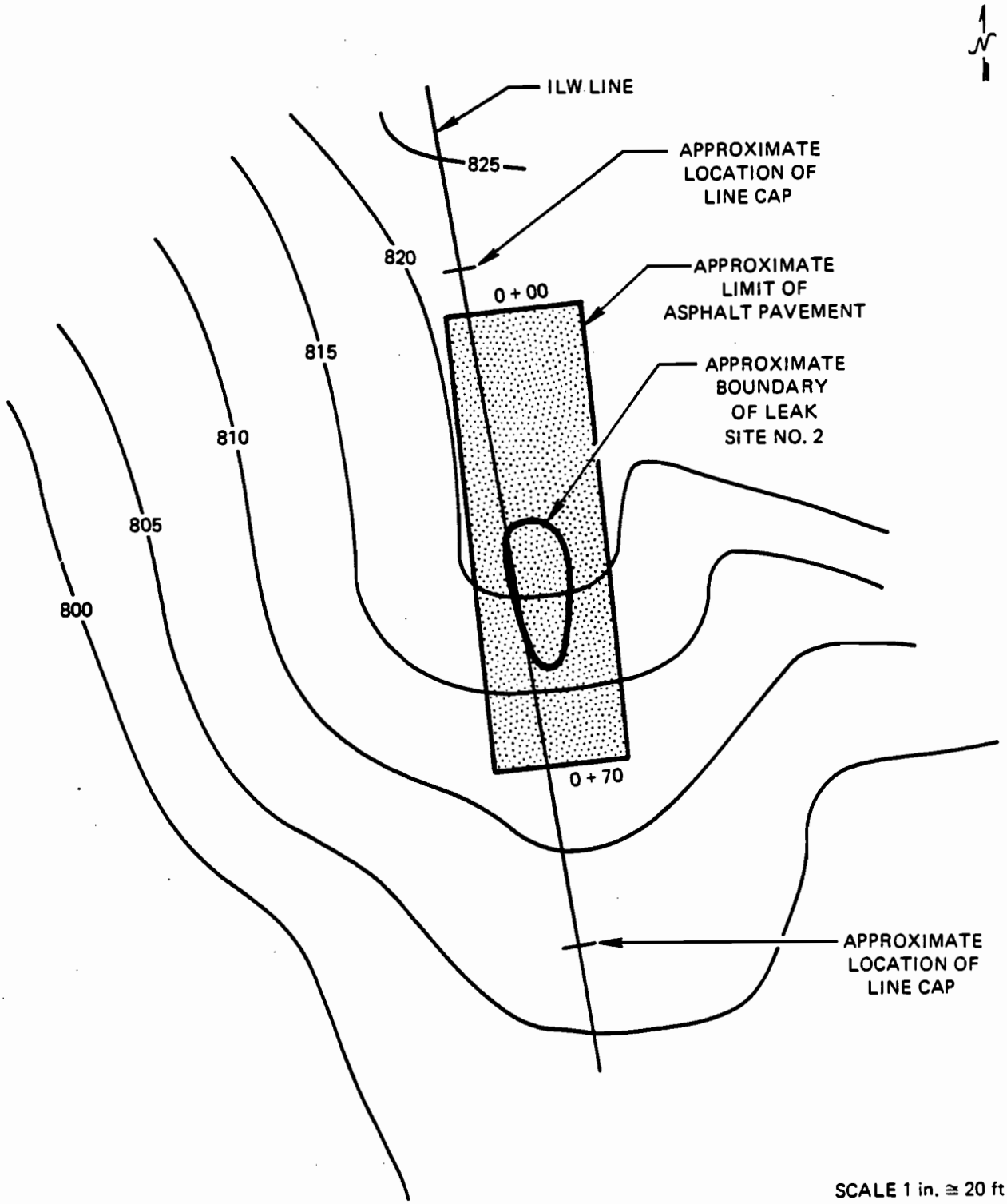


ORNL-DWG-83-1515

Stratigraphic exposure east of trench 7

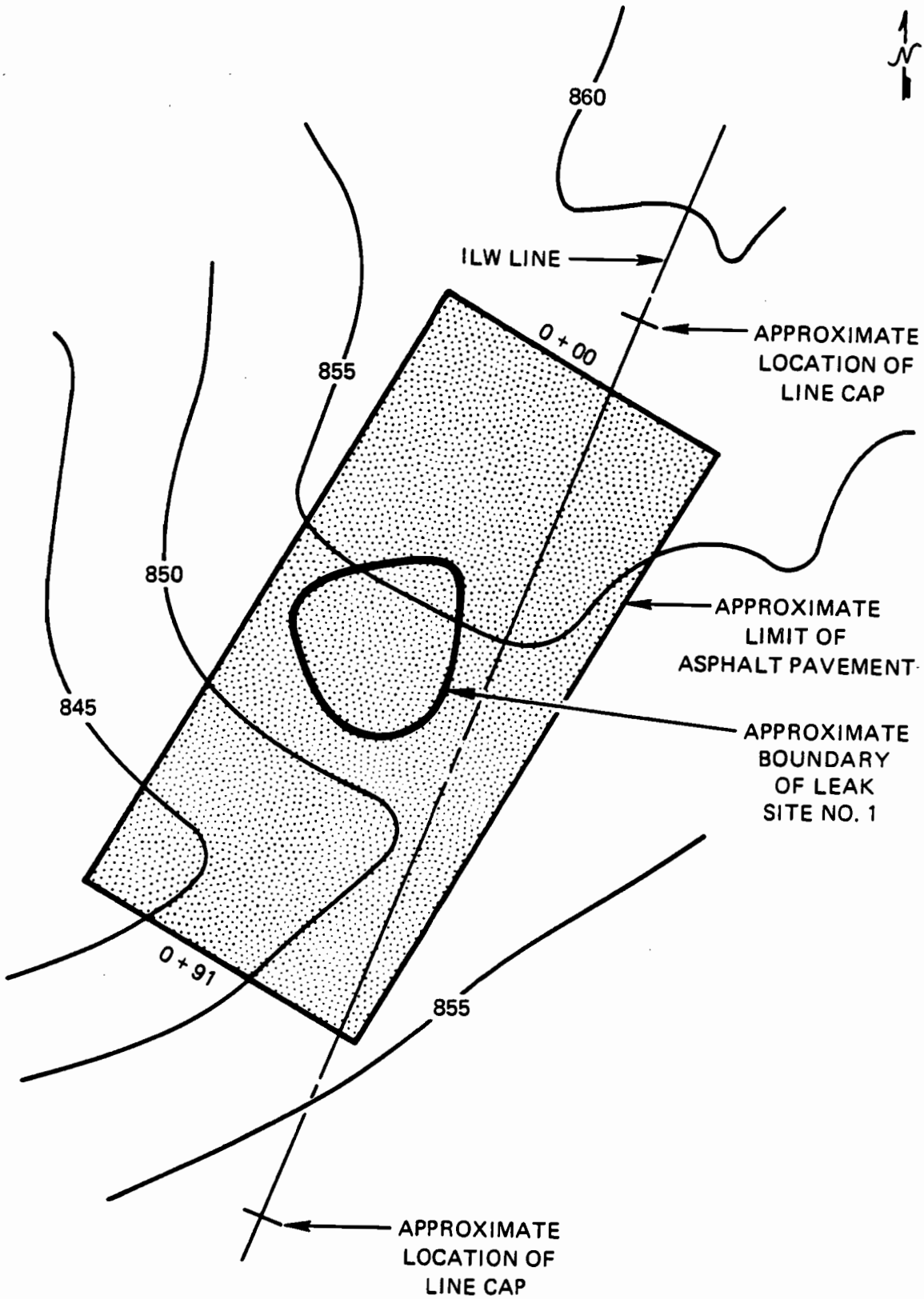
1983

ORNL-DWG 83-15535



ORNL-DWG-83-15535 1983
Planned boundaries of South leak site asphalt cover

ORNL-DWG 83-15536

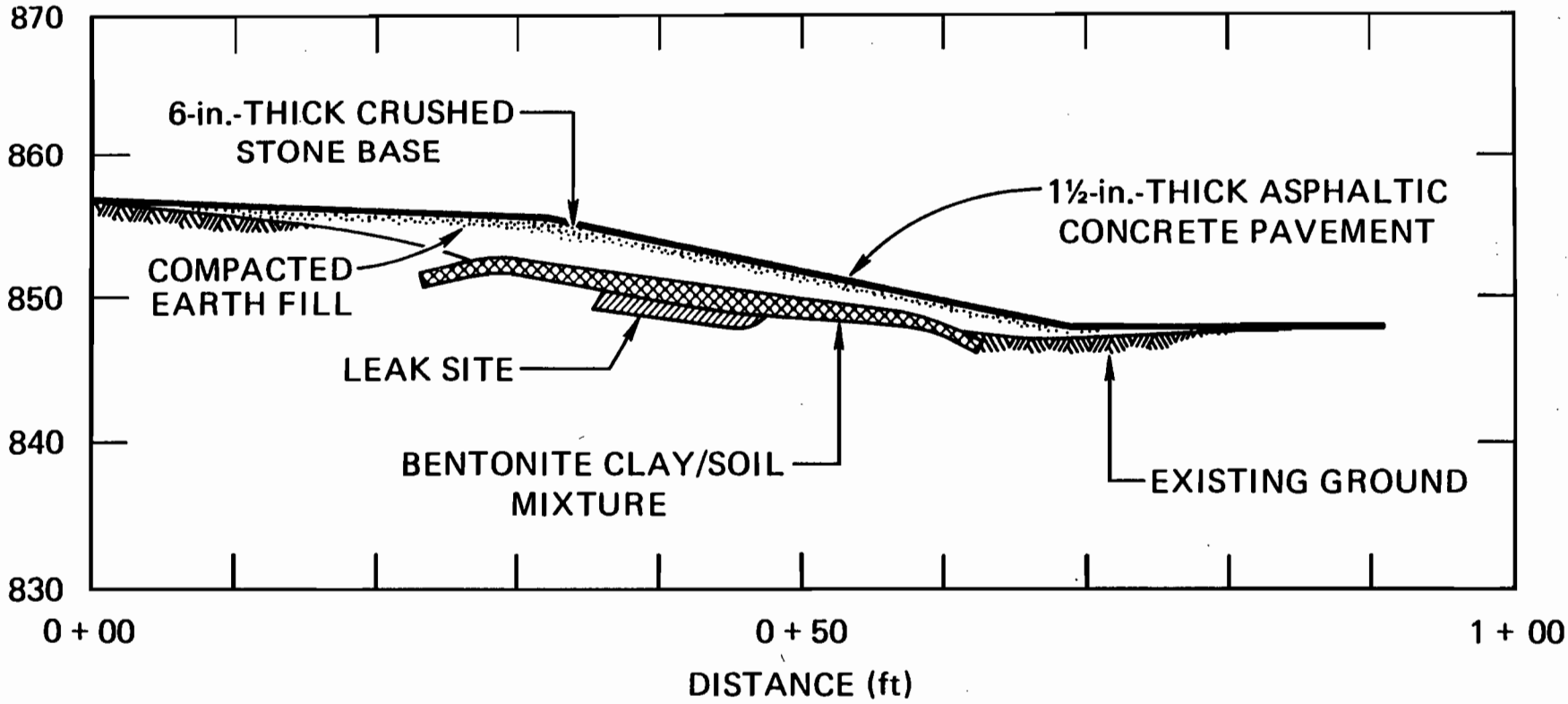


SCALE 1 in. ≅ 20 ft

ORNL-DWG-83-15536 1983
Planned boundaries of North leak site asphalt cover

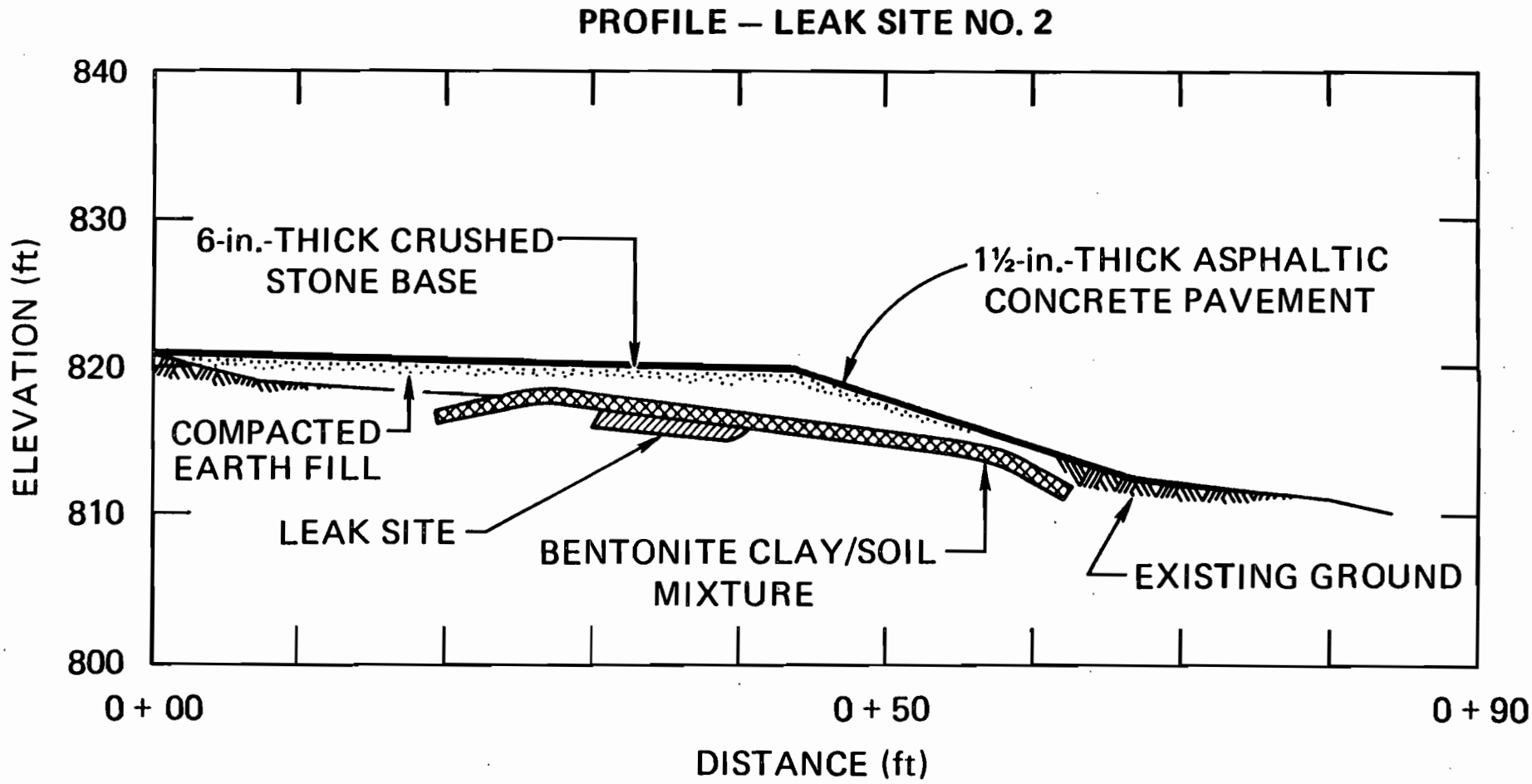
ORNL–DWG 83-15537

PROFILE – LEAK SITE NO. 1



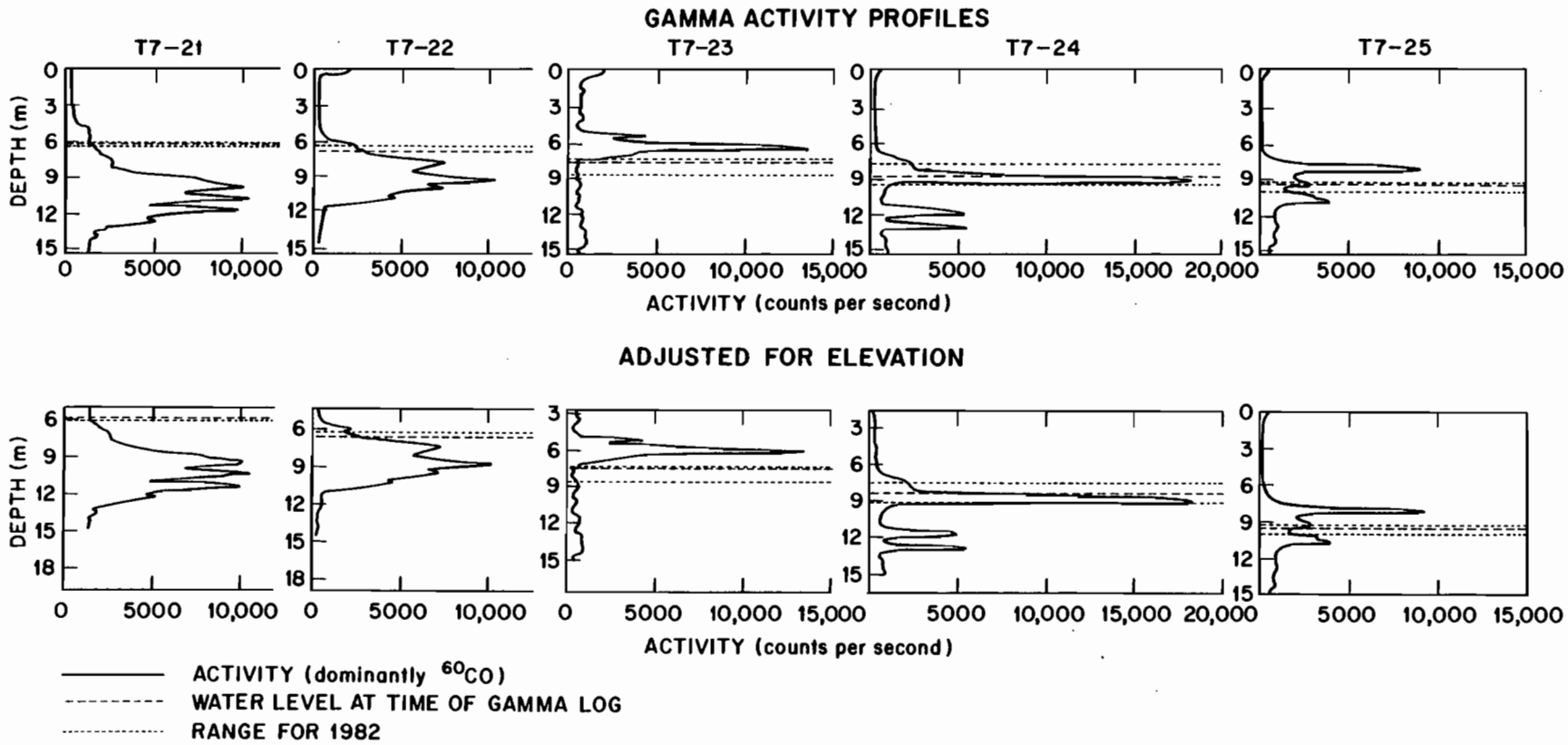
ORNL-DWG-83-15537 1983
Site plan for the North leak site

ORNL–DWG 83-15538



ORNL-DWG-83-15538 1983
Site plan for the South leak site

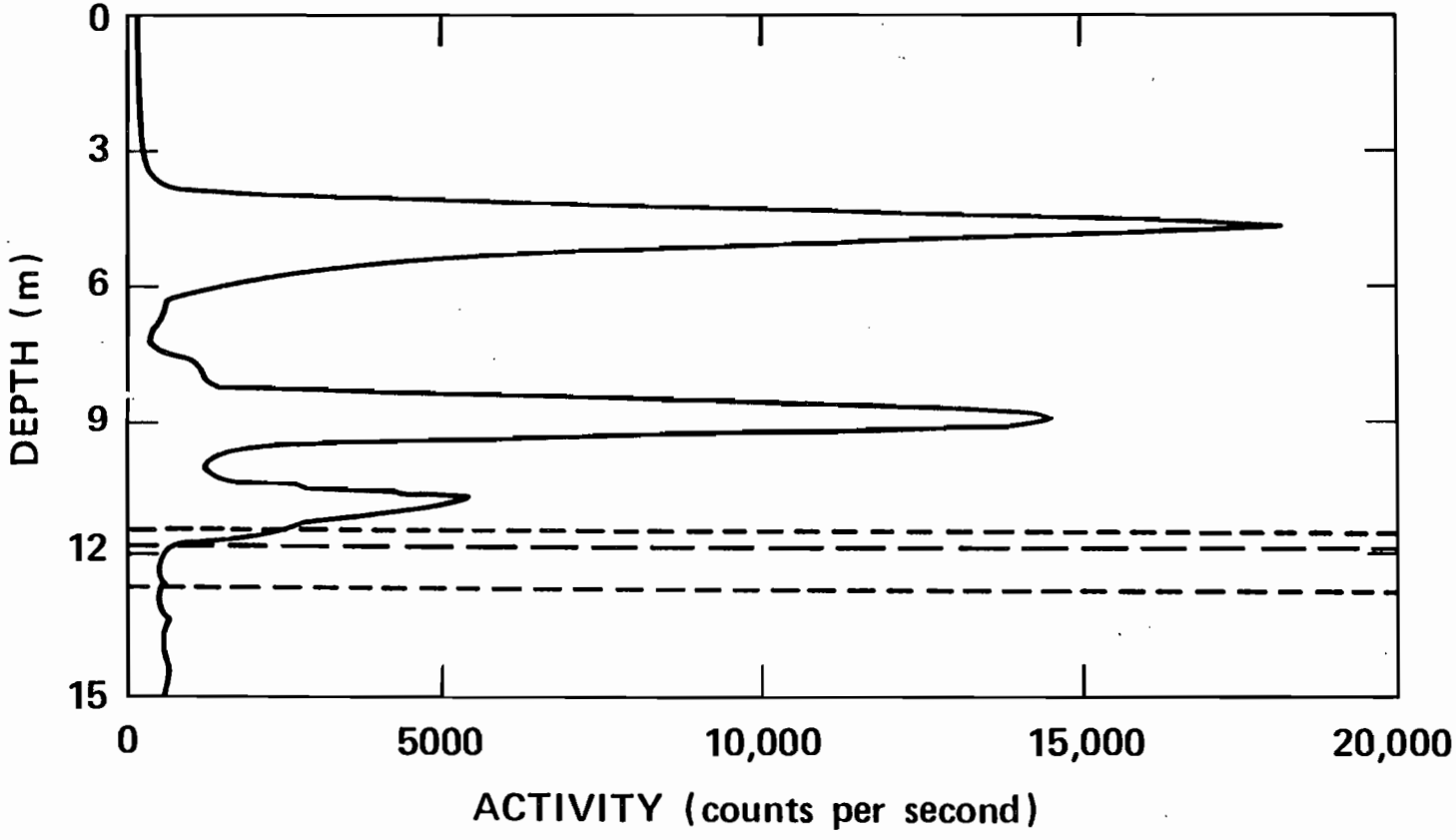
ORNL-DWG 83-1555



ORNL-DWG-83-1555
1983
Gamma activity profiles of wells near trench 7

GAMMA LOG FOR WELL T7-20

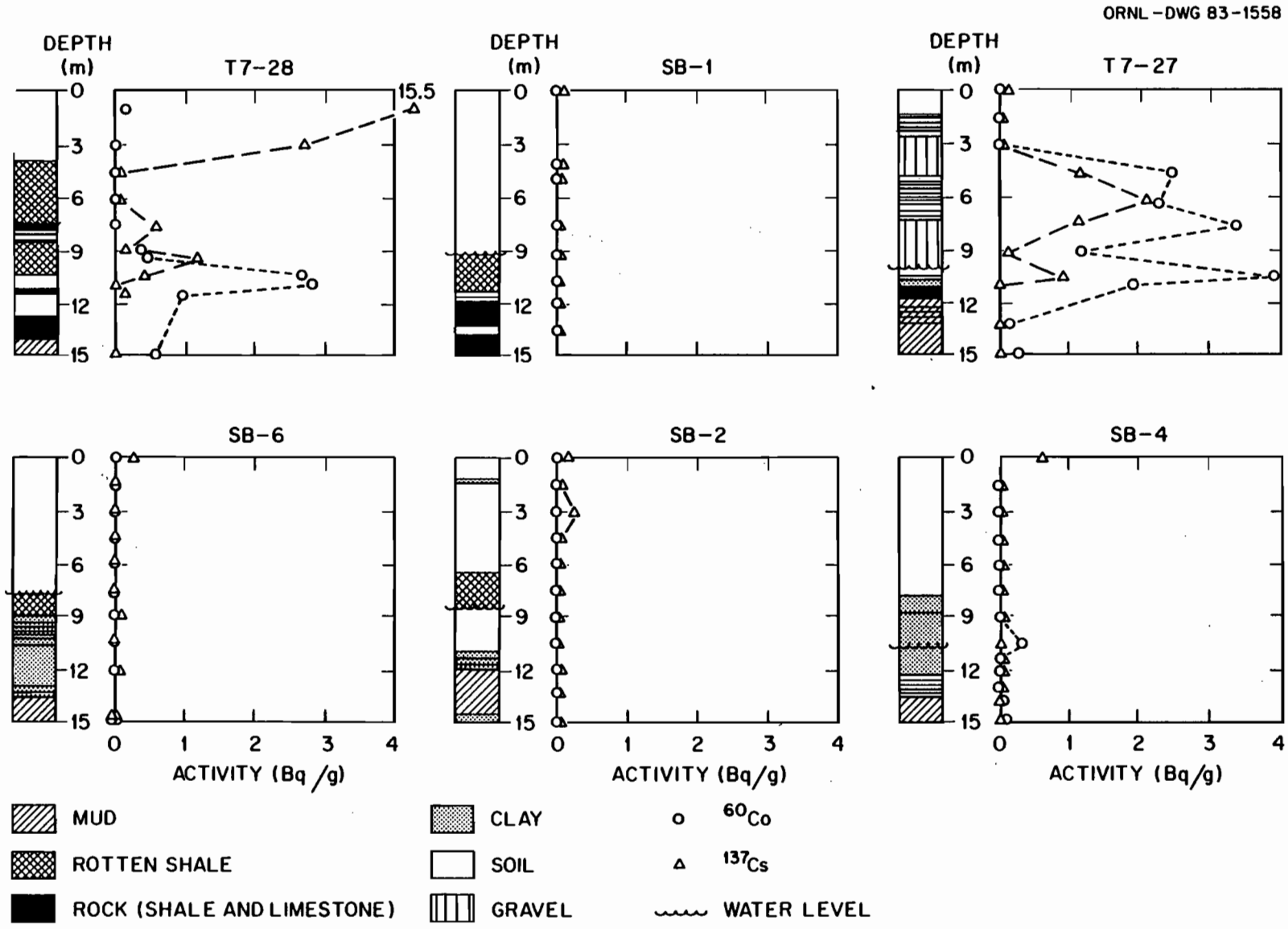
ORNL–DWG 83-1556



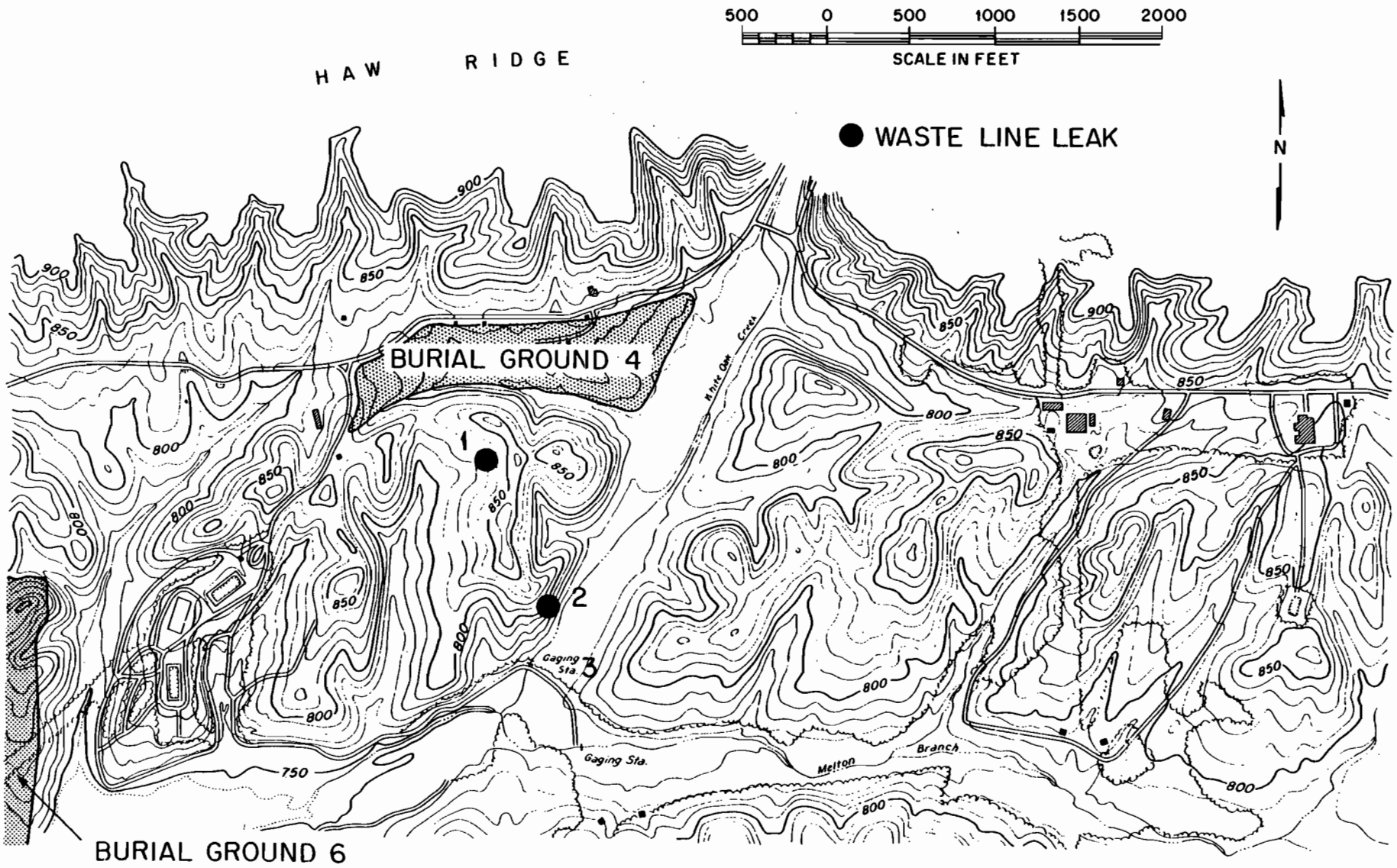
——— ACTIVITY (dominantly ^{60}CO)
— — WATER LEVEL AT TIME OF GAMMA LOG
– – – RANGE FOR 1982

ORNL-DWG-83-1556
Gamma activity log of well T7-20 at trench 7
1983

LITHOLOGIC, ^{137}Cs AND ^{60}Co PROFILES IN SOILS AT THE NORTH END OF ILW TRENCH-7



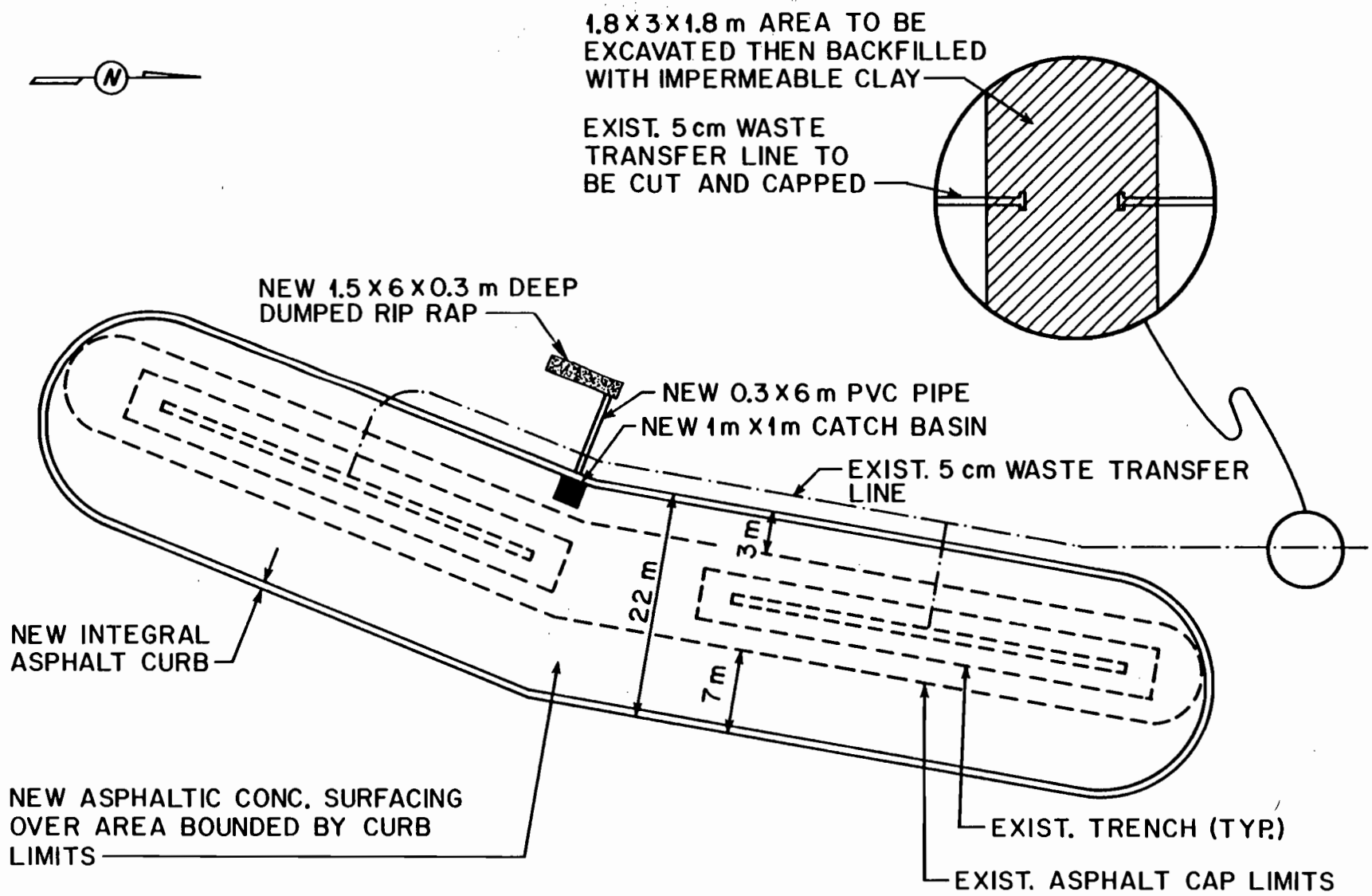
ORNL-DWG-83-1558
1983
Lithologic, 137-Cs, 60-Co profiles north trench 7



Contour Map Showing Location of Waste Line Leaks.

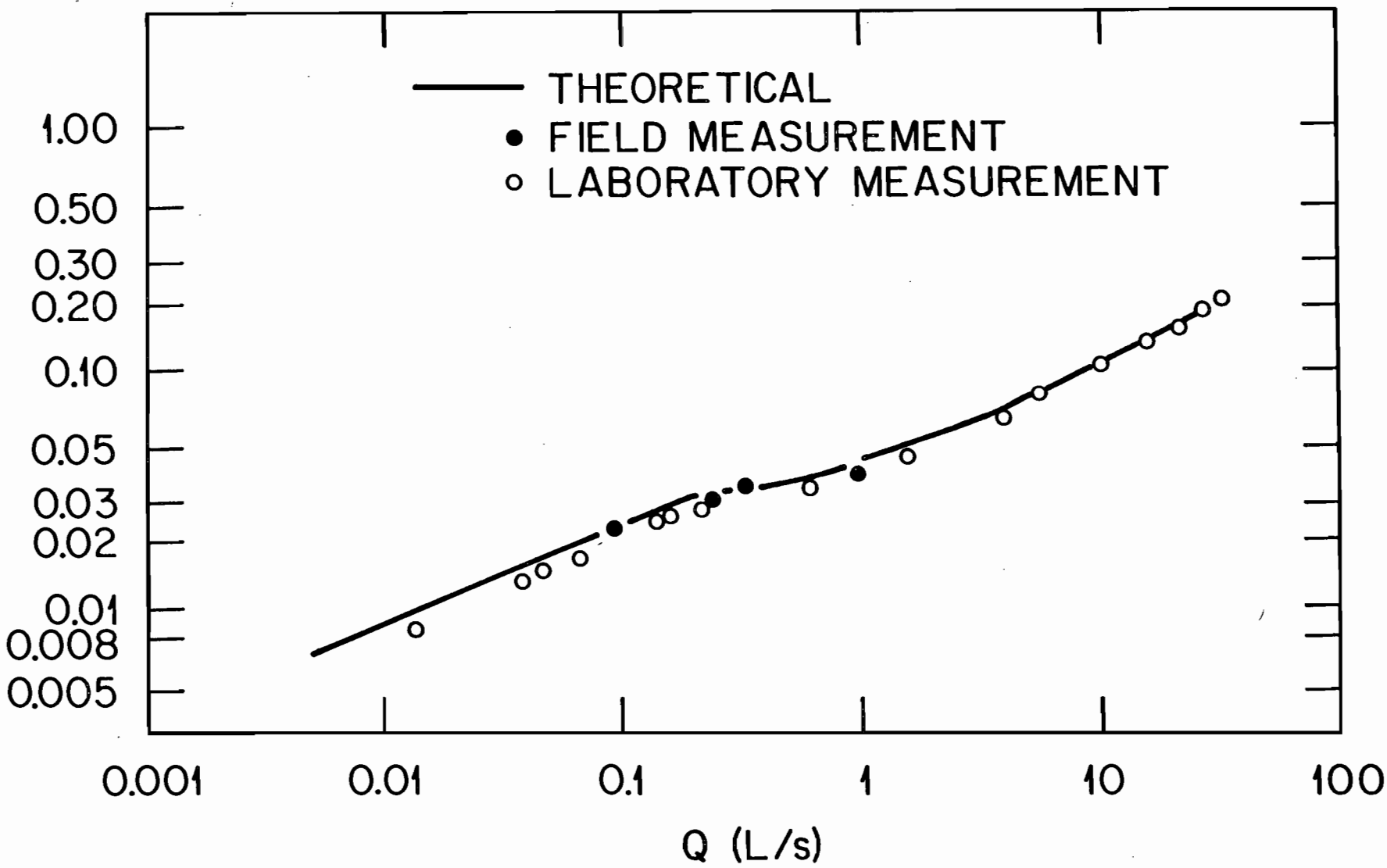
ORNL-LR-DWG-24800R 1983
Contour map showing ILW line leak sites

ORNL-DWG 85-17016



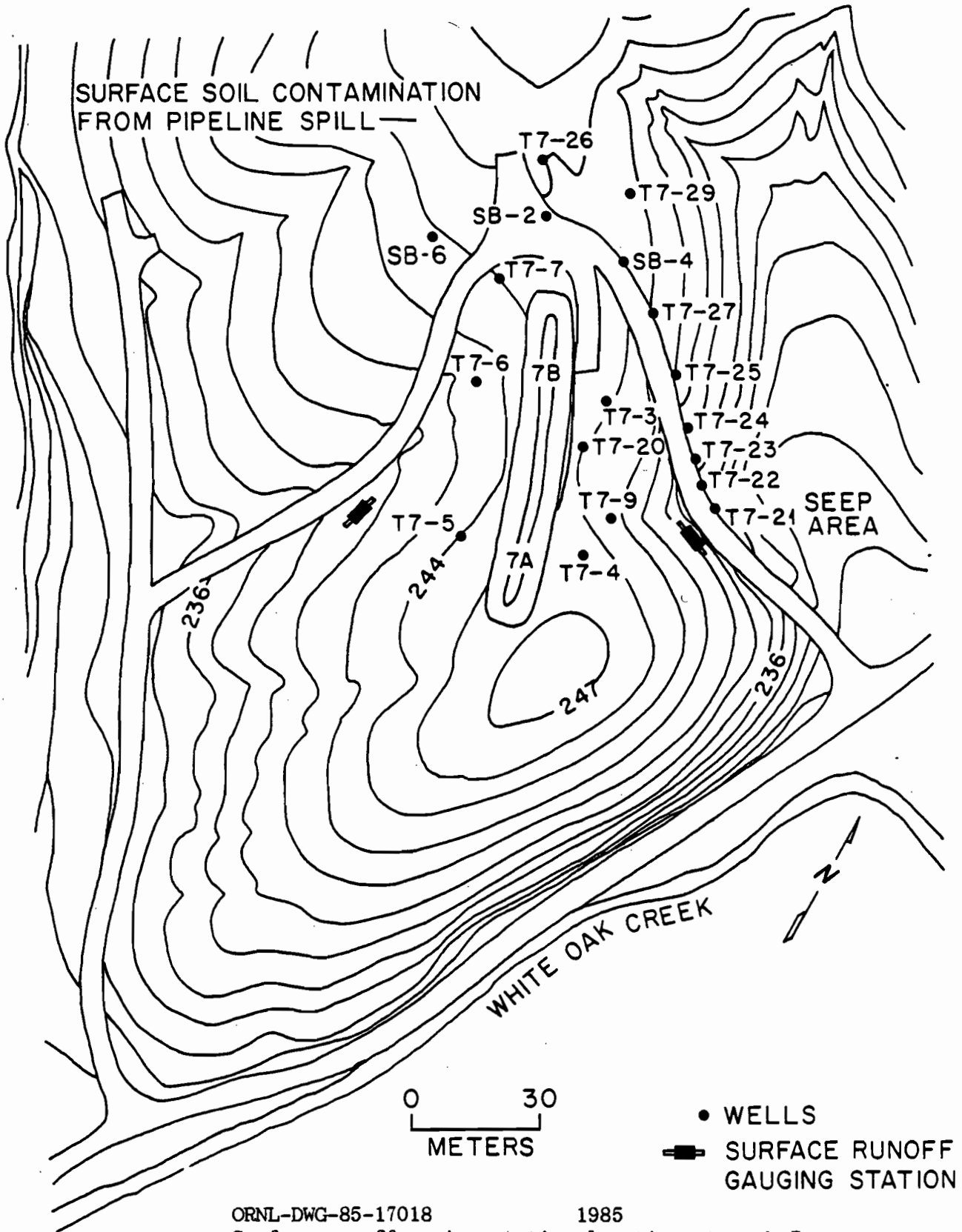
ORNL-DWG-85-17016 1985
Site plan for asphalt cap expansion of trench 7

ORNL-DWG 85-17017



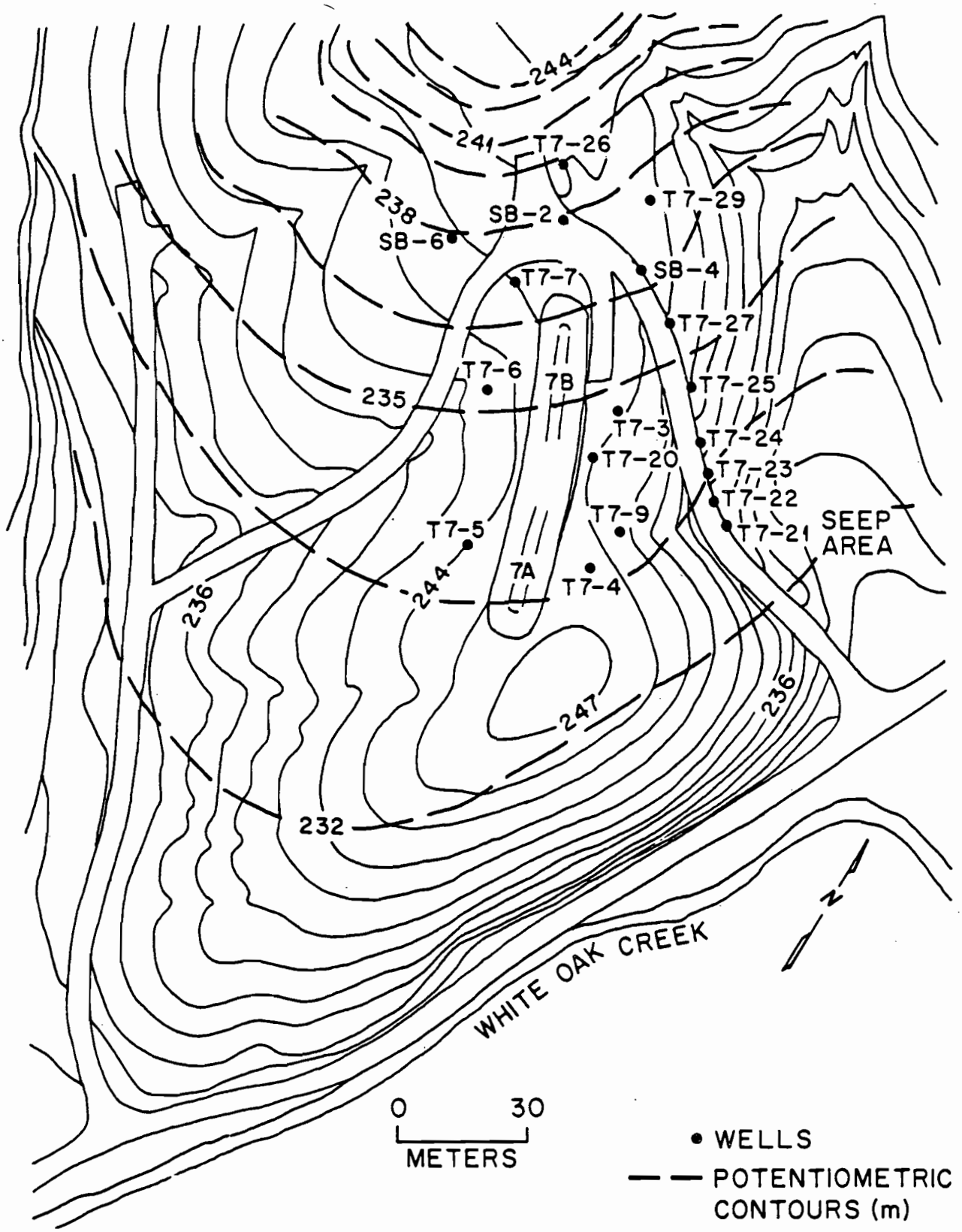
ORNL-DWG-85-17017
1985
Rating curves for weirs used for trench 7 runoff

ORNL-DWG 85-17018

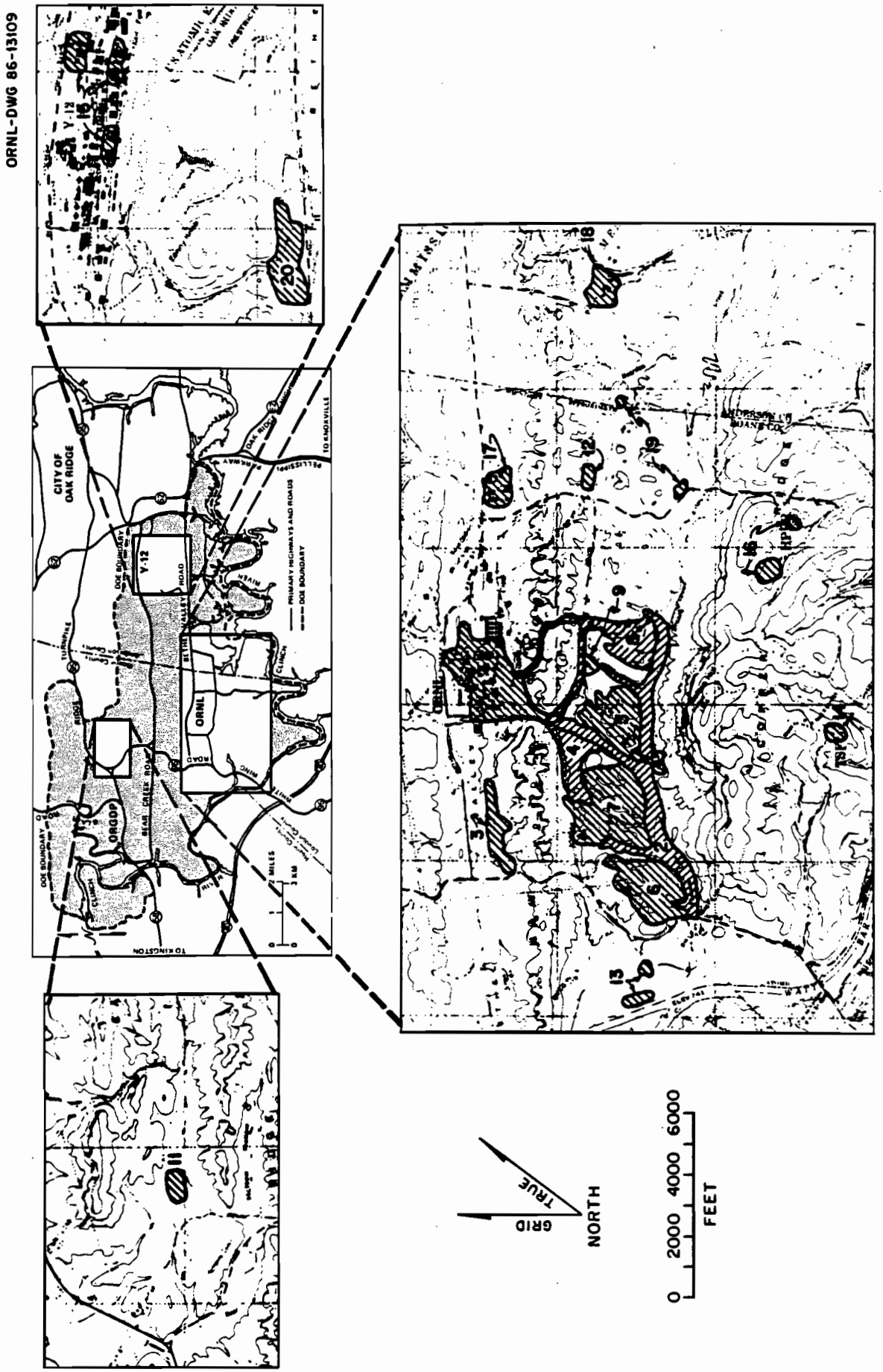


ORNL-DWG-85-17018 1985
Surface runoff gaging station locations trench 7

ORNL-DWG 85-17019

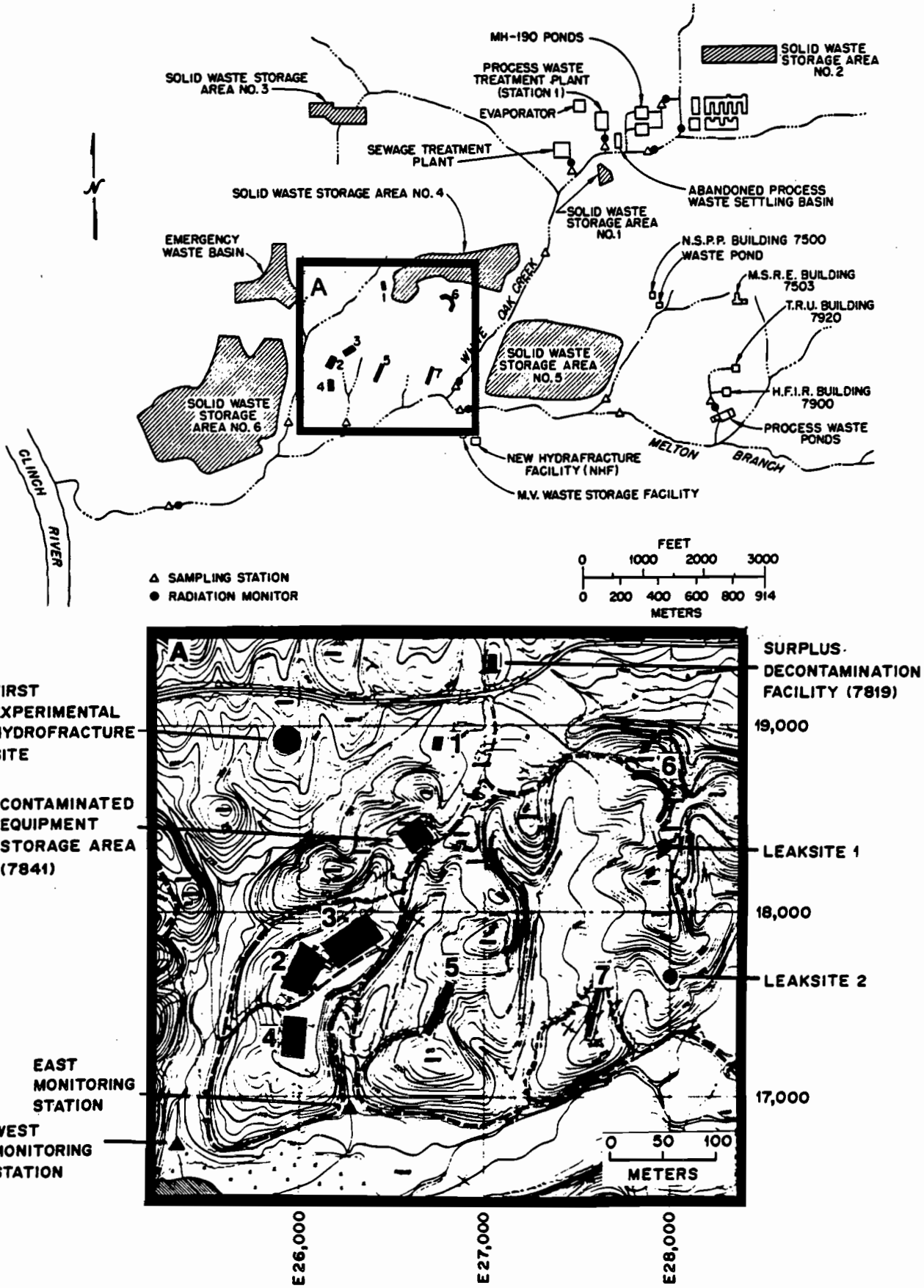


ORNL-DWG-85-17019 1985
Water table contours around trench 7



ORNL-DWG-86-13109 1986
Map of ORNL waste area groupings

ORNL-DWG 87-1319



ORNL-DWG-87-1319 1987
Map of pits and trenches waste area grouping

Appendix D
ORNL Engineering Drawings Related to Seepage Pits and Trenches

D 12249 10APR52
Waste Lagoon No. 2, Topographic Plan

D 12323 29APR52
Waste Lagoon No. 2, Plan and Sections

D 14898 23AUG54
Waste Lagoon No. 3, Plot Plan

D 14897 27AUG54
Waste Lagoon No. 3, Grading Plan

D 14900 31AUG54
Waste Lagoon No. 3, Sampling Bridge, sections

D 14899 03SEP54
Waste Lagoon No. 3, Section,Profile, and Detail

D 15592 08SEP54
Waste Lagoon No. 3, Sections and Detail

D 23691 04AUG55
Chemical Waste Pit 4, Grading Plan

D 23692 04AUG55
Chemical Waste Pit 4, Plot Plan

D 23693 04AUG55
Chemical Waste Pit 4,Sections,Profiles, Details

D 23696 04AUG55
Chemical Waste Pit 4, Specifications

D 23690 10AUG55
Chemical Waste Pit 4, Locality Map

D 23732 31JAN56
Topographic Survey, Waste Pit 4 Area

D 23773 11MAY56
Chemical Waste Pit Area - Topography

D 23774 11MAY56
Chemical Waste Pit Area - Topography

D 23714 09SEP56
Proposed East Ridge Waste Pit(5) Plans

D 27135 28FEB57
Truck Station and Waste Transfer Line Pit 4

D 38201 11JAN60
Location Plan Pit 5

D 38202 22JAN60
Pit 5 Site Topography, Sheet 1

D 38203 22JAN60
Pit 5 Site Topography, Sheet 2

D 38204 22JAN60
Pit 5 Site Topography, Sheet 3

D 38205 22JAN60
Pit 5, Plans, Sections, Elevations, Details

D 43136 21NOV60
Chemical Waste Pit 6, Plans and Sections (Sketch)

D 43190 04JAN61
Chemical Waste Pit 6, Electrical Service

D 43165 23JAN61
Locality Map and Drawing Index, Pit No. 6

D 43166 23JAN61
Chemical Waste Pit 6, Grading Plan, Sheet 1

D 43167 23JAN61
Chemical Waste Pit 6, Grading Plan, Sheet 2

D 43168 23JAN61
Chemical Waste Pit 6, Grading Plan, Sheet 3

D 43169 23JAN61
Chemical Waste Pit 6, Plot Plan, Sheet 1

D 43170 23JAN61
Chemical Waste Pit 6, Plot Plan, Sheet 2

D 43171 23JAN61
Chemical Waste Pit 6, Plans, Sections, Details

D 43172 23JAN61
Chemical Waste Pit 6, Filter Pit, Grading Plot plan

D 53000 24MAY62
Chemical Waste Pit 7, Electrical Plot Plan

D 52856 06JUN62
Chemical Waste Pit Area Extended Topo. Map

D 52844 12JUN62
Chemical Waste Pit 7, Grading Plan

D 52847 12JUN62
Chemical Waste Pit 7, Longitudinal Sections

D 52845 14JUN62
Chemical Waste Pit 7, Plot Plan

D 52846 14JUN62
Chemical Waste Pit 7, Plan and Profile

D 52848 14JUN62
Chemical Waste Pit 7, Plans, Sections,Details

D 52858 18JUL62
Chemical Waste Pit 7, Regional Topography, Sheet 1

D 52859 18JUL62
Chemical Waste Pit 7, Regional Topography, Sheet 2

D 54729 19NOV62
Decontamination Bldg 7819,Locality and Index

D 54730 19NOV62
Decontamination Bldg 7819,Grading and Plot Plan

D 46919 13DEC62
Hot and Cold Process Water Piping 7819

D 52357 07JAN63
Floor Plan, Sections, and Details 7819

D 52358 07JAN63
Foundation Plans, Sections, and Details 7819

D 42869 08JAN63
Electrical Plan and Details 7819

D 42870 08JAN63
Electrical Sections and Details 7819

D 42871 08JAN63
Extension to 2300V Distribution System for 7819

S 10063 A001D 27JUN63
Chemical Waste Pit Area-Site Topography and Wells

S 10166 A001D 15AUG63
Cover Waste Pit 3, Grading Plan-Sections and Details

S 10830 A001D 18OCT63
Cover Waste Pit 2, Grading Plan-Sections and Details

D 23680 30JAN64
Wells plan, elevations, and coordinates

S 20968 F001 13FEB64
5-Ton Hoist Monorail Plan for 7819

S 10953 A001D 11MAR64
Septic Tank and Drain Field 7819, Plan and Section

S 20968EB001 10OCT67
Decontamination Pad Extension Plan for 7819

C 20941EA001D 20MAY70
Chemical Waste Pit 5, Paving Plan and Notes

C 20965EA001D 20MAY70
Chemical Waste Pit 7, Paving Plan and Notes

C 20932EA001D 21MAY70
Chemical Waste Pit 2, Asphalt cover, Grading Paving

C 20935EA001D 21MAY70
Resurface Cover Chemical Pit 3,Paving Plan and Notes

C3E 20016 X014 30JUL78
West Weir Plans, Sections, and Details

I3D 20016 012 08APR79
East Weir Instrument Layout Details

I3D 20016 013 08APR79
East Weir Instrument Layout Elevation View

I3D 20016 014 08APR79
East Weir Instrument Layout Plan View

I3D 20016 015 08APR79
East Weir Instrument Fabrication Details

I3D 20016 016 08APR79
East Weir Instrument Wiring Diagram

I3D 20016 017 08APR79
West Weir Instrument Layout Details

I3D 20016 018 08APR79
West Weir Instrument Layout Elevation View

I3D 20016 019 08APR79
West Weir Instrument Layout Plan View

I3D 20016 020 08APR79
West Weir Instrument Fabrication Details

I3D 20016 021 08APR79
West Weir Instrument Wiring Diagram

C3E 20016 A016 08APR79
Sampling Stations Location Plan and Site Plans

C3E 20016 A017 08APR79
West Tributary Sampling Station Plan and Sections

C3E 20016 A018 08APR79
East Tributary Sampling Station Plan and Sections

C3D 20016 A018 08APR79
East Weir Sampling Station Plans, Sections

C3E 20016 A020 08APR79
Gaging Station Instrument Cabinet Sections

C3E 20016 X015 30JUL79
East Weir Plan, Sections, and Details

C3E 21291 A002 30OCT79
Contaminated Equipment Storage Area Fence Plan

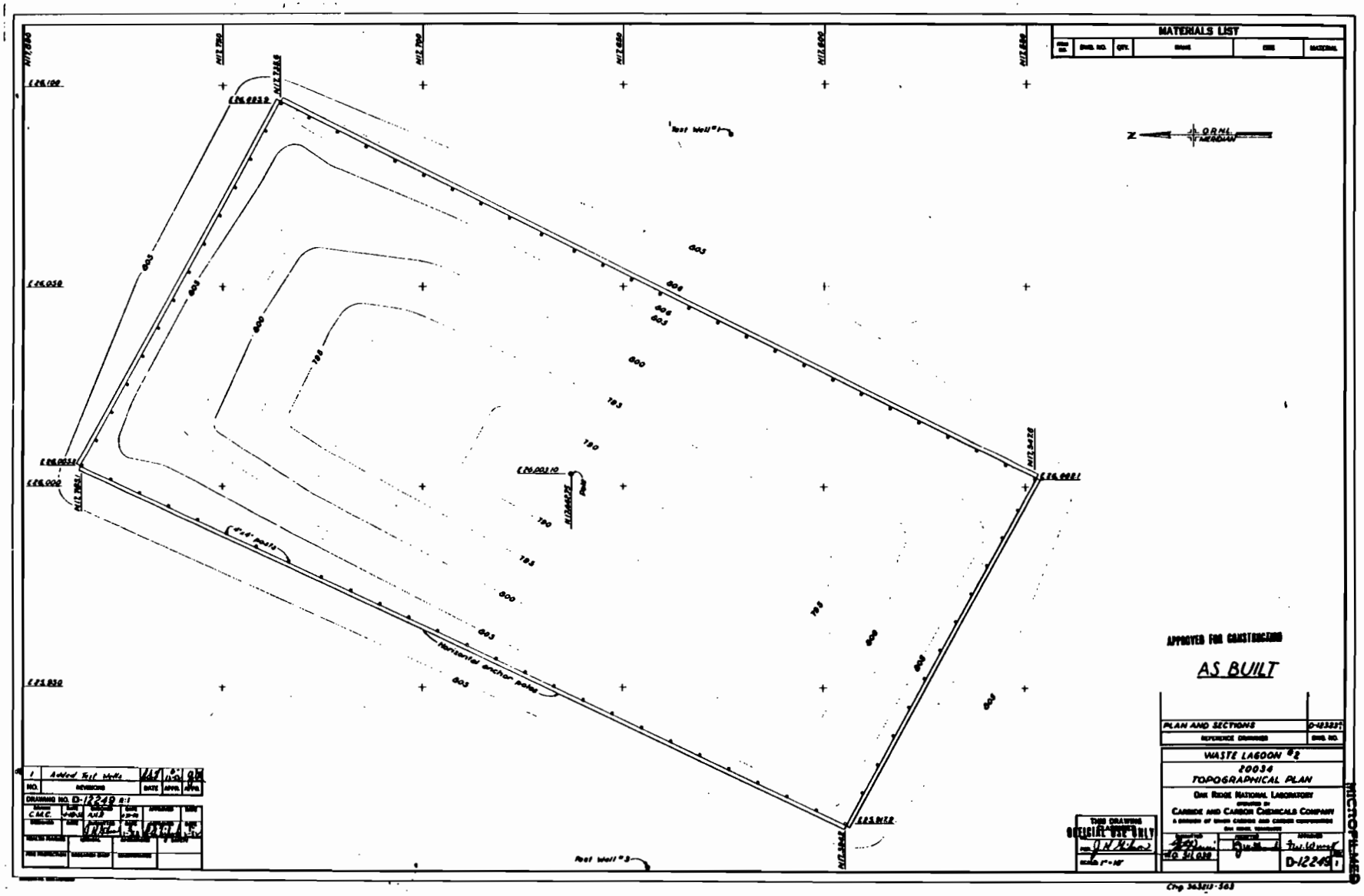
C3E 20938 A001D 15OCT80
Chemical Waste Pit 4, Paving Plan and Site Location

C3D 20929A001D 13JAN81
Waste Pit No. 1 Paving Plan and Locality Map

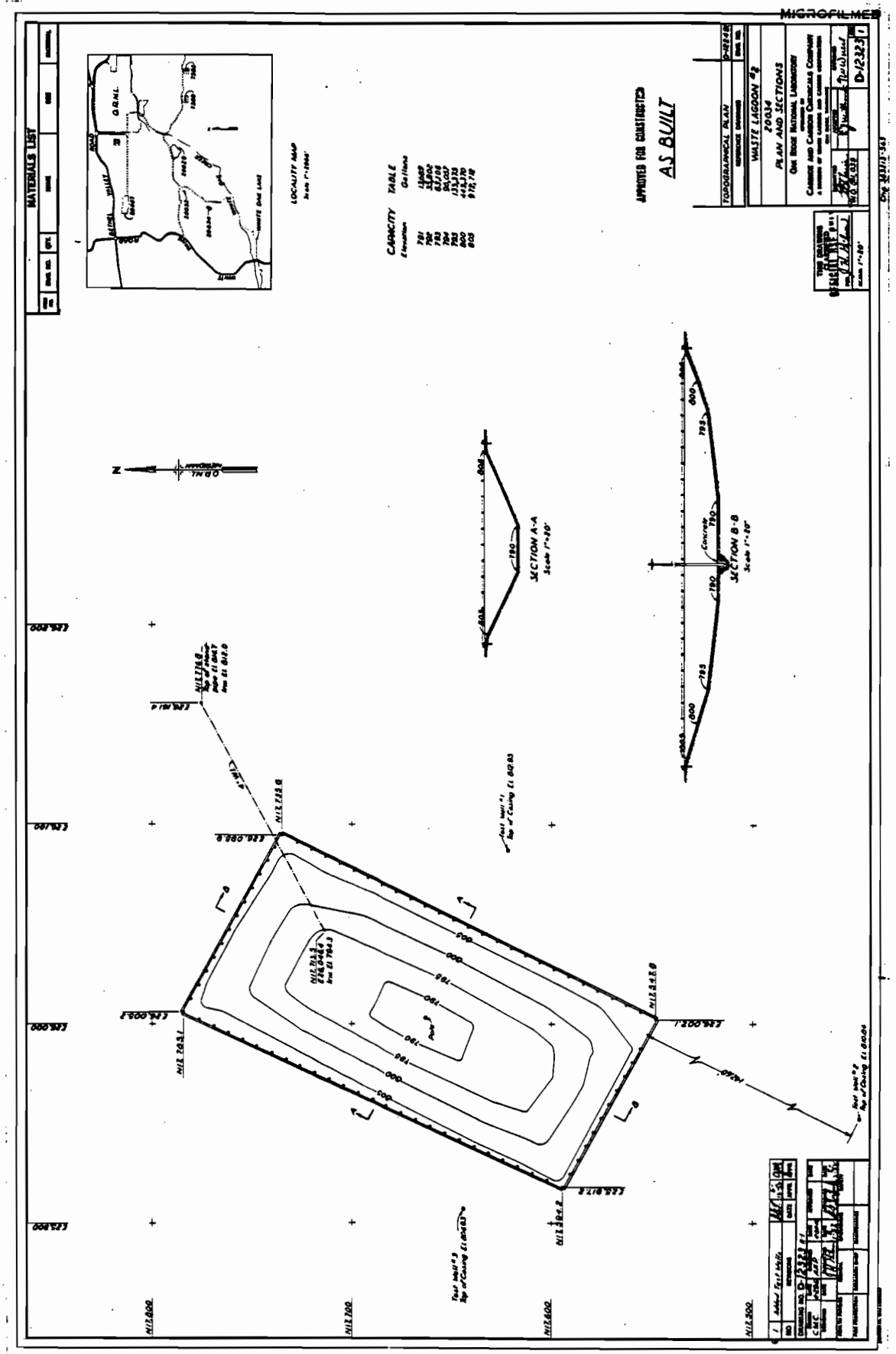
C3E 20944 A0010 13JAN81
Chemical Waste Pit 6, Paving Plan and Pit Section

C3E 20965 A010 29APR85
Trench 7 Remedial Action Plan and Details

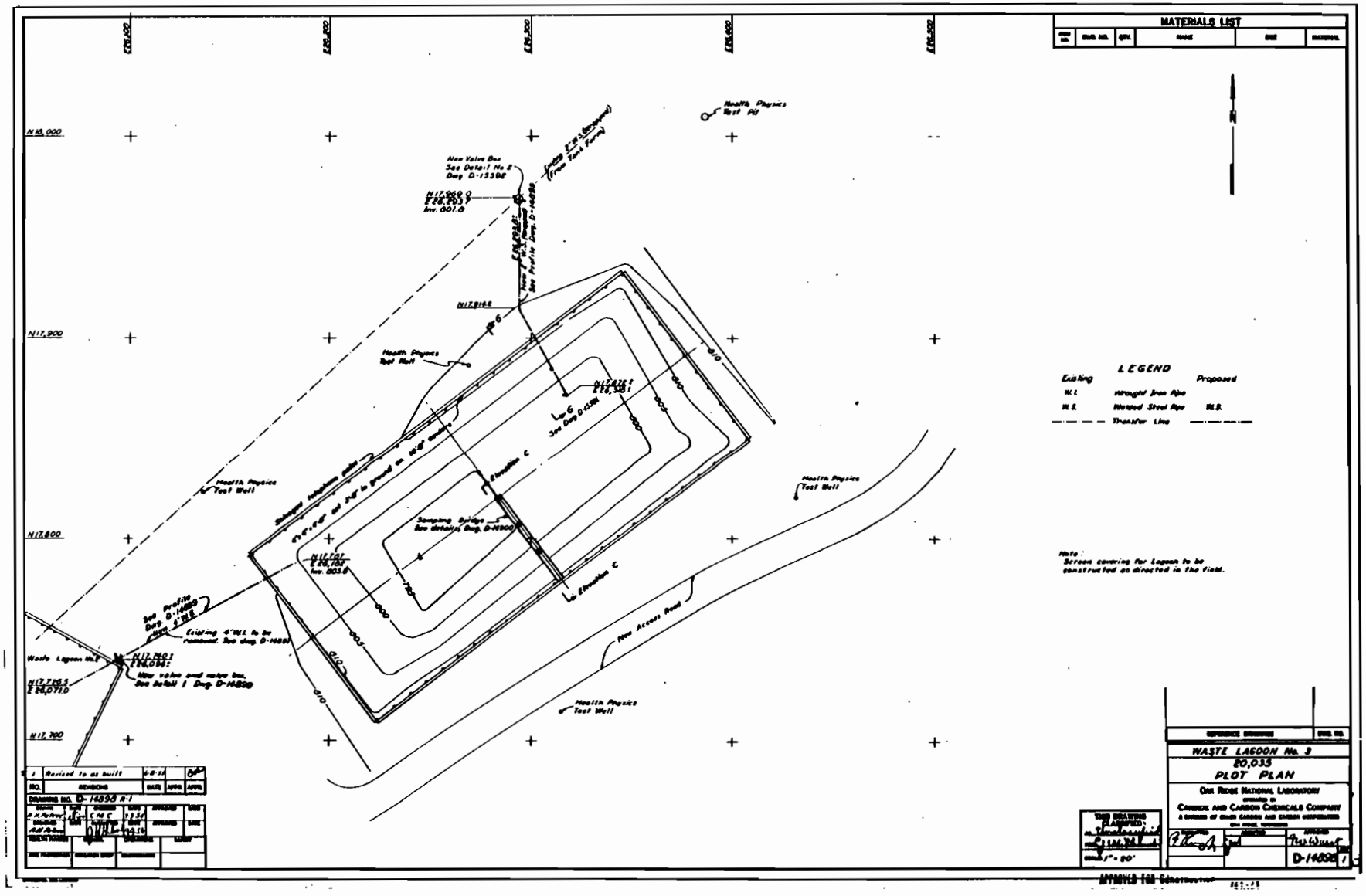
C3E 20965 A011 29APR85
LLW Trench 7 Remedial Action Grout Line Plan



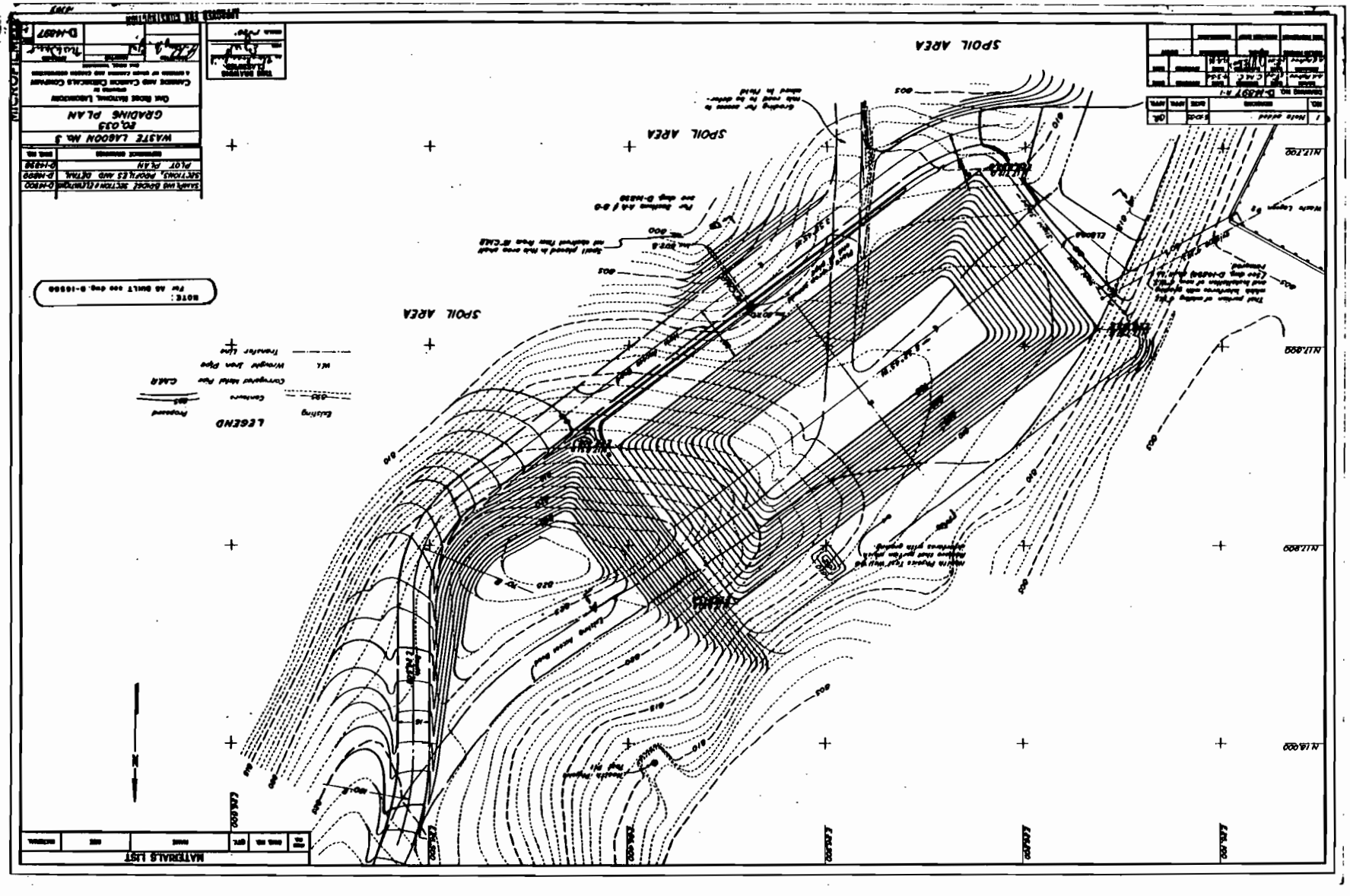
D 12249 10APR52
Waste Lagoon No. 2, Topographic Plan



D 12323 29APR52
Waste Lagoon No. 2, Plan and Sections

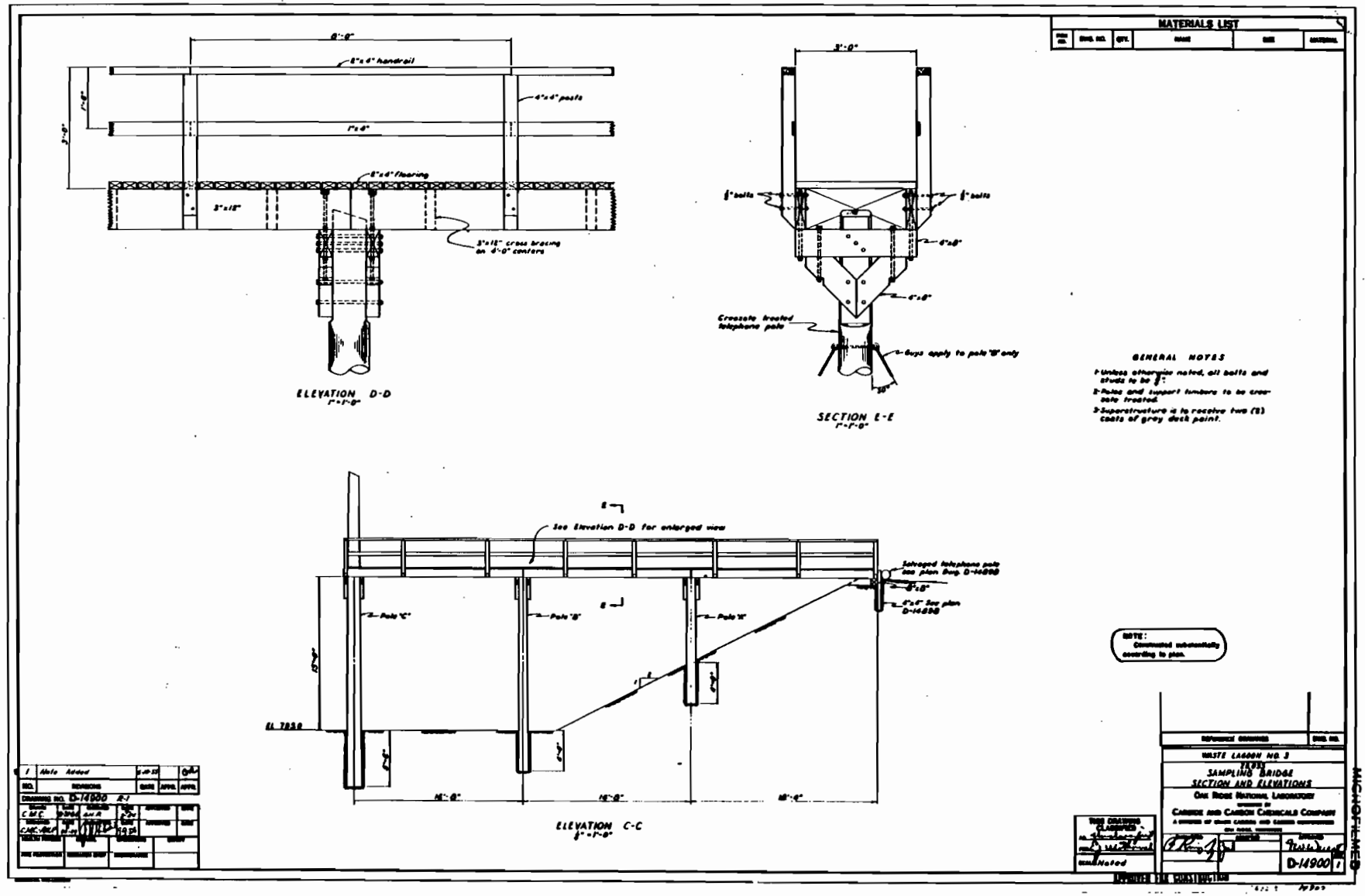


D 14898 23AUG54
Waste Lagoon No. 3, Plot Plan

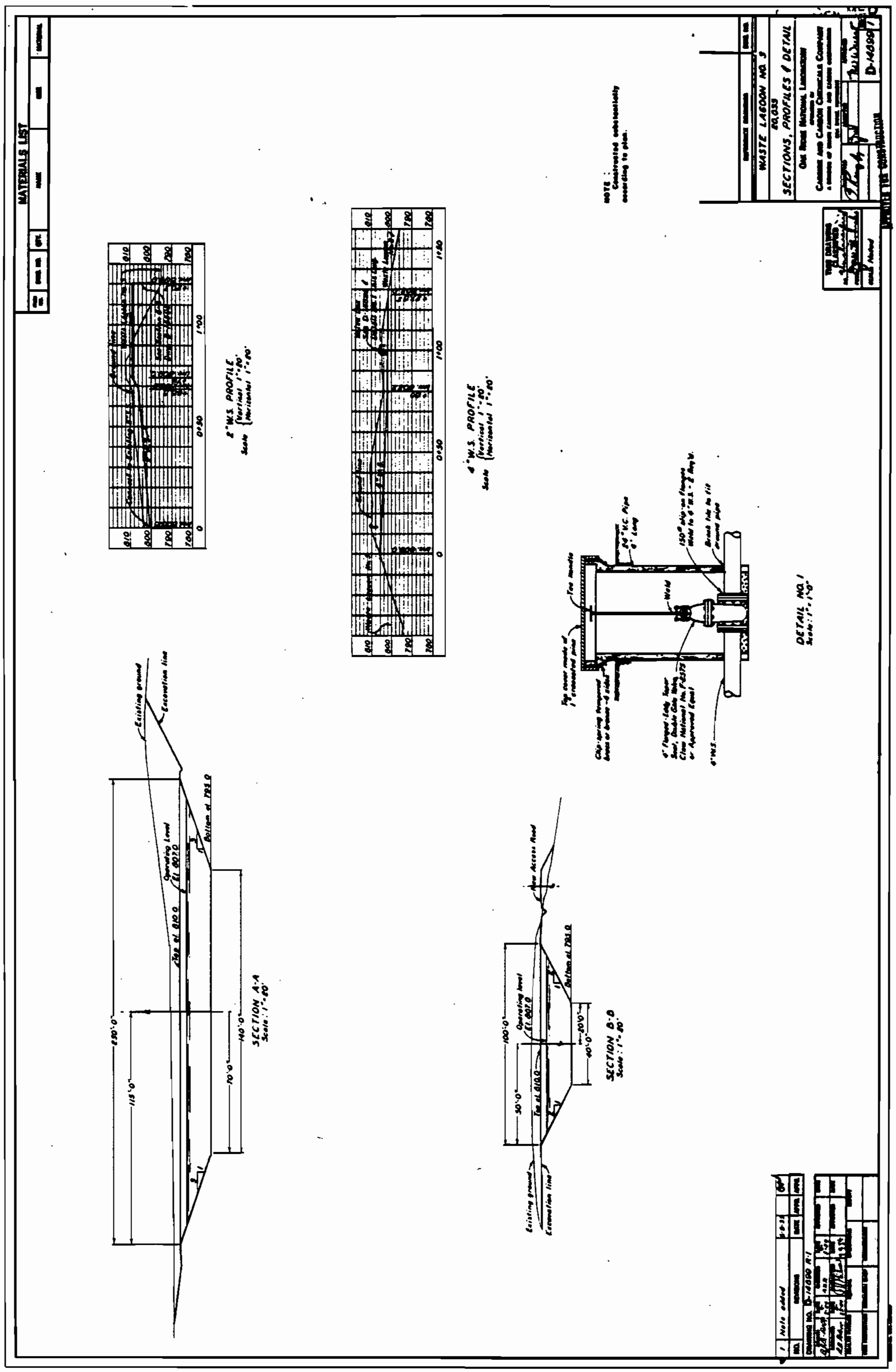


D-9

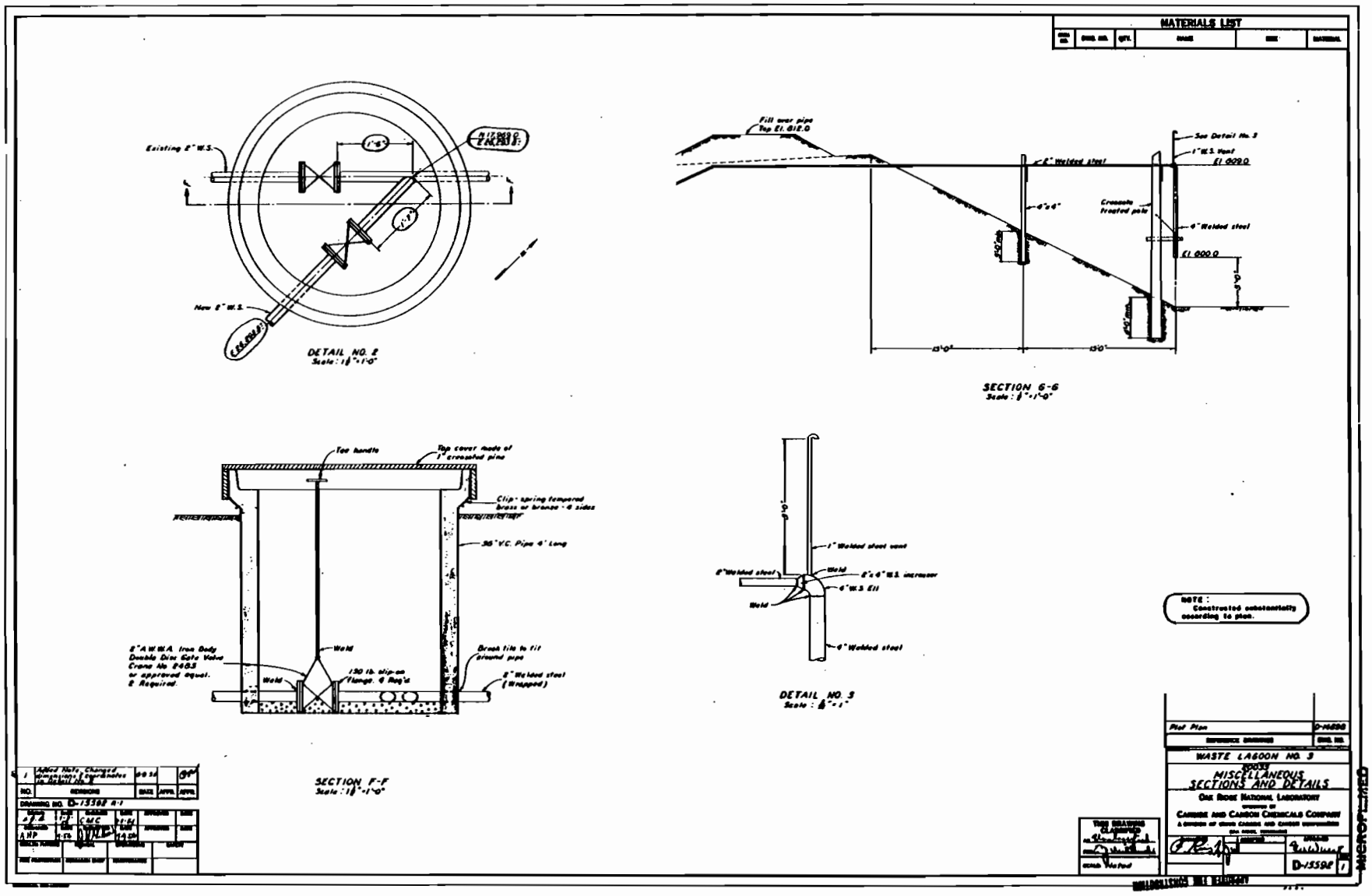
D 14897 27AUG54
Waste Lagoon No. 3, Grading Plan

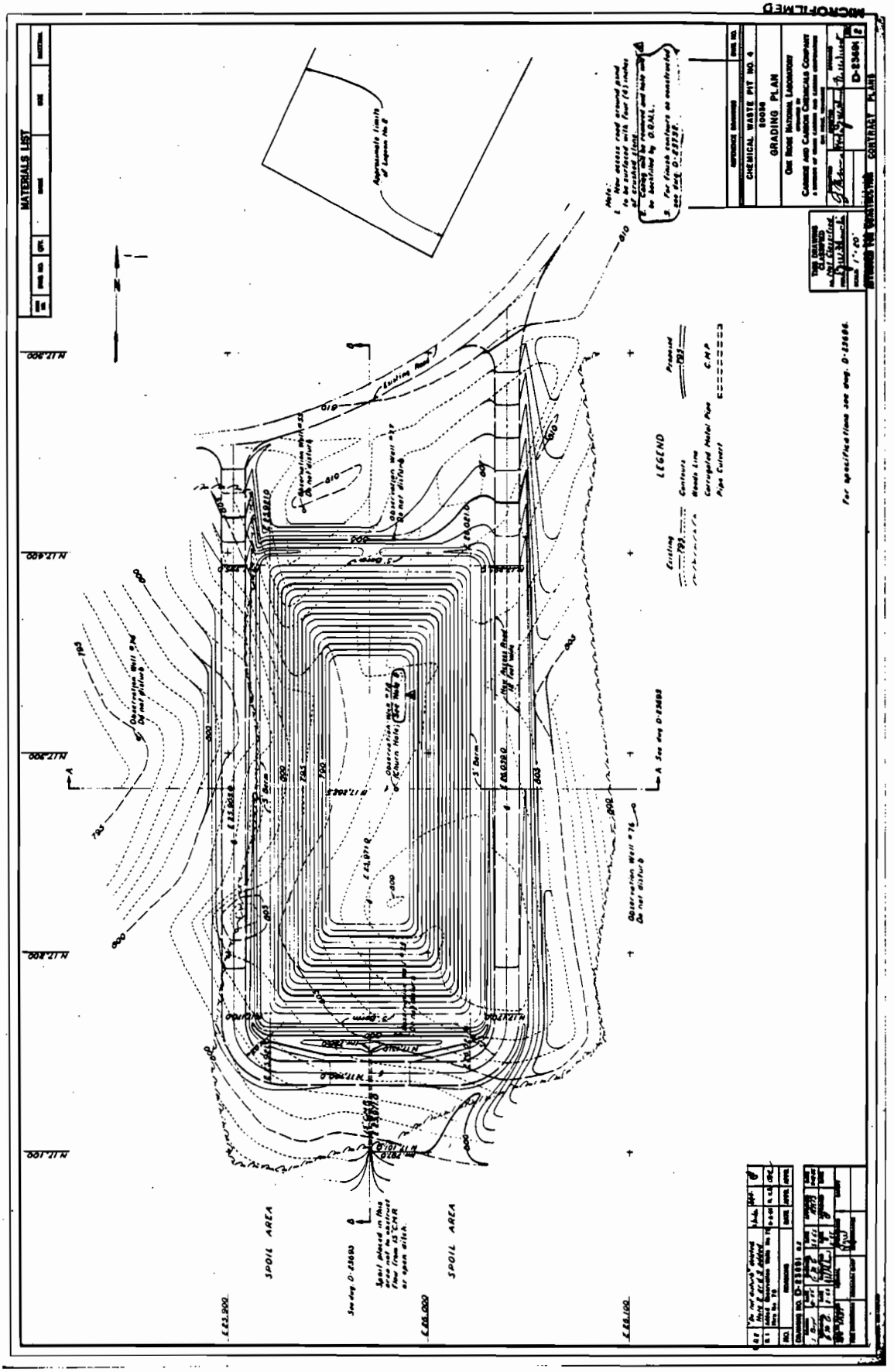


D 14900 31AUG54
Waste Lagoon No. 3, Sampling Bridge, sections

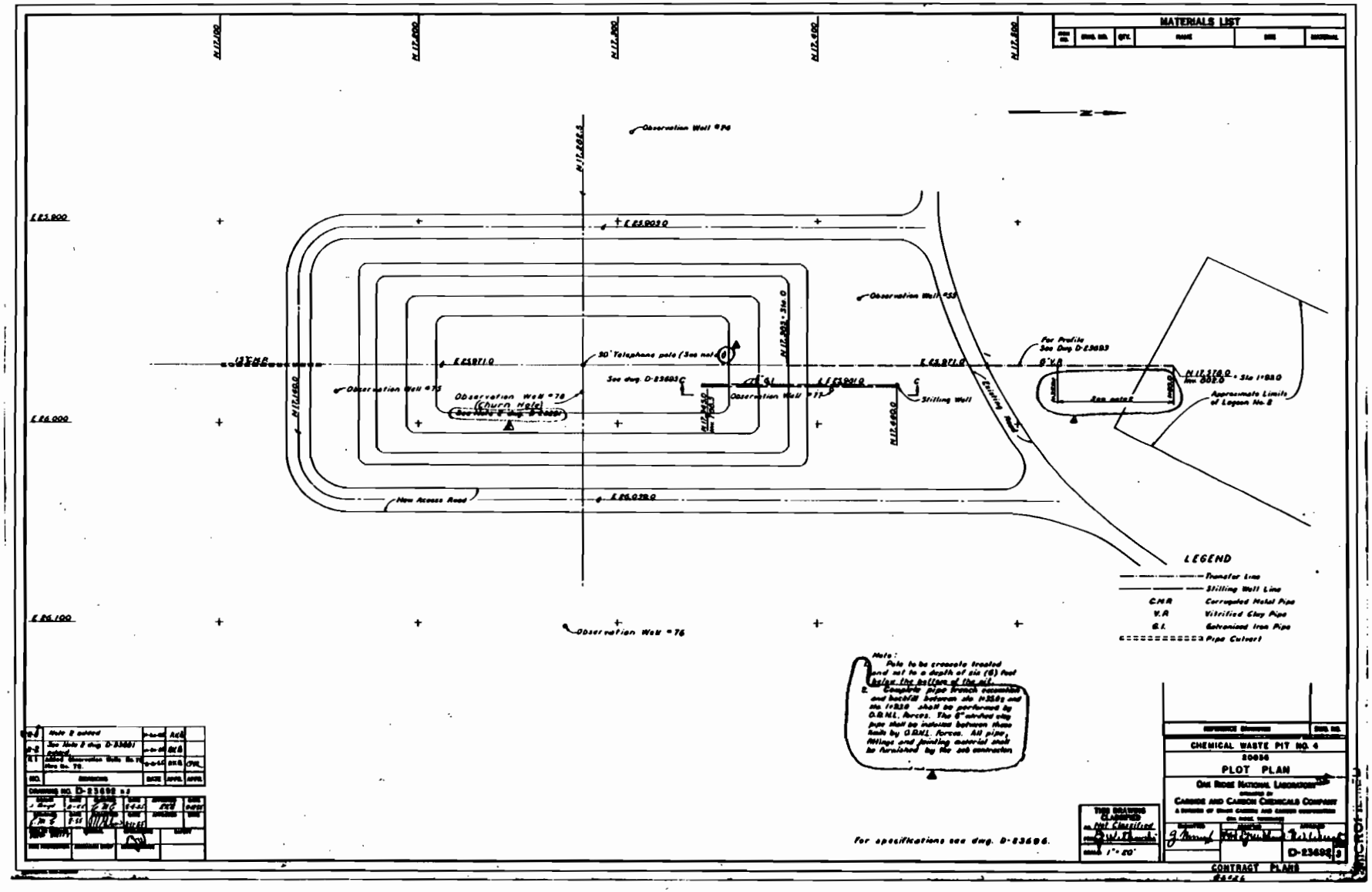


D 14899 03SEP54
Waste Lagoon No. 3, Section,Profile, and Detail

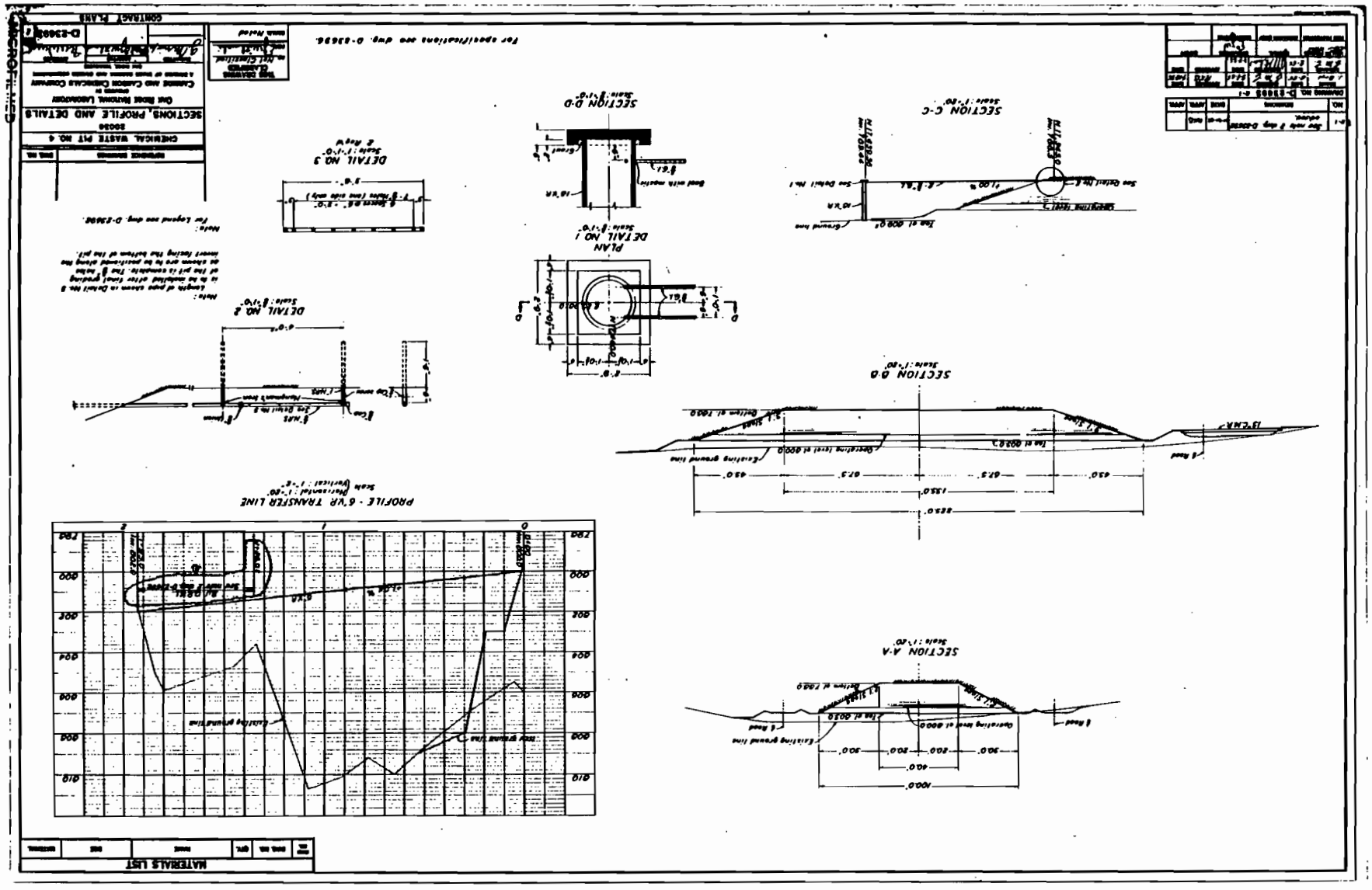

MATERIALS LIST
Existing 8" W.S.
New 8" W.S.
DETAIL NO. 2
Scale: 1½"=1'-0"
Fill over pipe Top El. 812.0
See Detail No. 3
1" W.S. Vent
El 902.0
8" Welded steel
6"x6"
Creosote treated pole
6" Welded steel
El 900.0
SECTION G-G
Scale: ½"=1'-0"
Tee handle
Top cover made of 1" creosoted pine
Clip: spring tempered brass or bronze - 4 sides
36" V.C. Pipe 4' Long
8" A.W.W.A. Iron Body Double Disc Gate Valve Crane No. 2463 or approved equal. 2 Required.
Weld
Weld
150 lb. slip-on flange. 4 req'd.
Break tile to fit around pipe
8" Welded steel (Wrapped)
SECTION F-F
Scale: 1½"=1'-0"
1" Welded steel vent
8" Welded steel
Weld
8"x6" W.S. increaser
6" W.S. Ell
Weld
6" Welded steel
DETAIL NO. 3
Scale: ½"=1'
NOTE: Constructed substantially according to plan.
Plot Plan
WASTE LAGOON NO. 3
MISCELLANEOUS SECTIONS AND DETAILS
OAK RIDGE NATIONAL LABORATORY
CARBIDE AND CARBON CHEMICALS COMPANY
D-15592
DRAWING NO. D-15592 A-1
08 SEP 54
MICROFILMED



D 23691 04AUG55
Chemical Waste Pit 4, Grading Plan



D 23692 04AUG55
Chemical Waste Pit 4, Plot Plan



D-15

D 23693 04AUG55
Chemical Waste Pit 4,Sections,Profiles, Details

MATERIALS LIST

ITEM NO.	DWG. NO.	QTY.	ZONE	SIZE	MATERIAL

SPECIFICATIONS

CLEARING METHODS: Clearing shall include the felling and cutting up of trees and other vegetation and the satisfactory disposal thereof, together with any down timber, snags, brush, rubbish and debris, which may be within the specified limits of clearing. All trees and other vegetation, which are to be removed, and all stumps, roots and brush within the area to be cleared shall be cut off flush with, or slightly below the existing ground line.

LIMIT OF FILL AND SANITARY CLEARING: Fill and complete clearing shall be limited only to that area West of the waste pit enclosed by the waste line and the construction limits of the access road along CD1,002.5.

SPOIL AREA CLEARING: Spoil areas shall be cleared only to the extent necessary for the subcontractor to dispose of the excavated material from the waste pit and access road. Clearing shall be limited to trees, down timber, stumps, etc. that would interfere with the operation of the subcontractor's equipment.

WASTE PIT EXCAVATION: Excavation for the waste pit shall be carried to finished elevations indicated on the drawings and excavated material shall be disposed of at the spoil areas indicated on drawing D-23695.

ROAD EXCAVATION: As far as can be determined from available information, no solid rock should be encountered during excavation.

SPOIL AREAS: Spoil areas shall be graded to permit drainage of surface water and harmony as possible shall blend with the surrounding terrain.

PREPARATION OF ACCESS ROAD SUBGRADE: Subgrade for access road shall be compacted to a depth of at least eight (8) inches below the crushed stone surfacing to assure at a change from rubber. Earth fill required to bring road bed to grade shall be placed in horizontal layers not exceeding six (6) inches in thickness and each layer shall be rolled and thoroughly compacted.

CRUSHED STONE SURFACING: The material to be used above crushed stone surfacing to specified shall be crushed rock stone, cutout if required, and placed in two (2) approximately equal layers, each thoroughly compacted to produce a surface four (4) inches thick.

PIPE TRENCH EXCAVATION: Pipe trenches shall be excavated to exact width and depth as required for the proper bedding of pipe, including anchoring as required for bels, fittings, etc. Minimum depth below final rough grade shall be two (2) feet, unless otherwise indicated on the drawings. Pipe trenches shall be kept free from water.

SHEATING, BRACING AND SHORING: The subcontractor shall provide all sheet piling, shoring and bracing required for the support of earth banks during the excavation and erection of the work. Bracing shall be maintained in place until immediately before backfilling and then shall be removed by stages as the backfilling progresses.

PIPE TRENCH BACKFILLING: Pipe trenches shall be backfilled with selected earth deposited in six (6) inch layers and carefully rammed until pipe has a cover of not less than two (2) feet. Remainder of backfill shall be placed in layers in horizontal layers and more than twelve (12) inches in depth, each mechanical and compacted by power tamper to a density at least equal to that of the surrounding earth.

BACKFILLING BEHIND STILLING WELL: Backfill around stilling well shall be deposited on both sides of the same time to approximately the same elevations. All backfill shall be placed to the level of the original surrounding earth surface (or to new grade lines if edges lines are lower than existing grade) as required at periods for subsequent settlement.

PIPING: (a) Stilling pipe pipe and fittings shall conform to A. S. T. M. specification A-53 for the trench line and stilling well.

(b) Drainage pipe shall be standard straight galvanized corrugated steel pipe as manufactured by the American Rolling Mill Company, or an approved equal.

(c) Stilling well lining shall be galvanized straight steel extension ell, T & G. Fittings shall be galvanized malleable iron, 6000 pounds.

JOINTS IN TILE PIPE: Joints in clay pipe shall be well rolled with joint cushion to form a tight to still leave a space sufficient from the end of the bell of at least one (1) inch for pipe 15 inches and less in diameter and 1½ inches for pipe 18-24 inches in diameter. The remainder of the joint shall be completely filled with rubber O-R compound, "Slip-Seal", as manufactured by Universal Sewer Pipe Corp., or an approved equal.

JOINT SEALING: Packing for vitrified clay connector line and stilling well shall be asbestos rope coating impregnated for chemical service and shall be Garlock Type 120, or an approved equal.

CONCRETE: Concrete for the stilling well base shall develop a minimum compressive strength of 3000 pounds per square inch at 28 days.

REFERENCE DRAWINGS	DWG. NO.

CHEMICAL WASTE PIT NO. 4

SOGSO

SPECIFICATIONS

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
FOR ATOMIC ENERGY COMMISSION

DESIGNED	CHECKED	APPROVED

D-23696

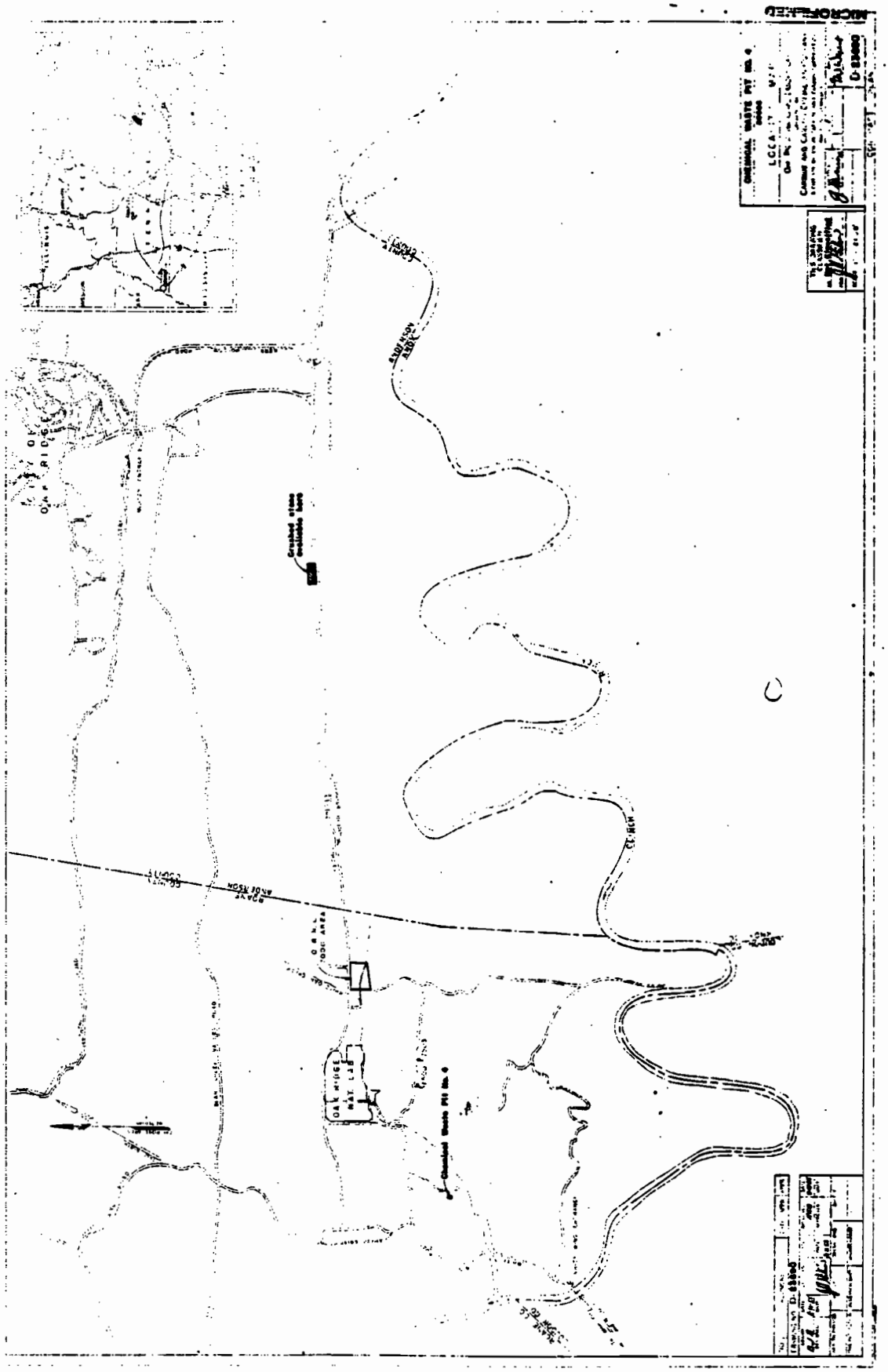
CONTRACT PLANS

THIS DRAWING CLASSIFIED as Not Classified

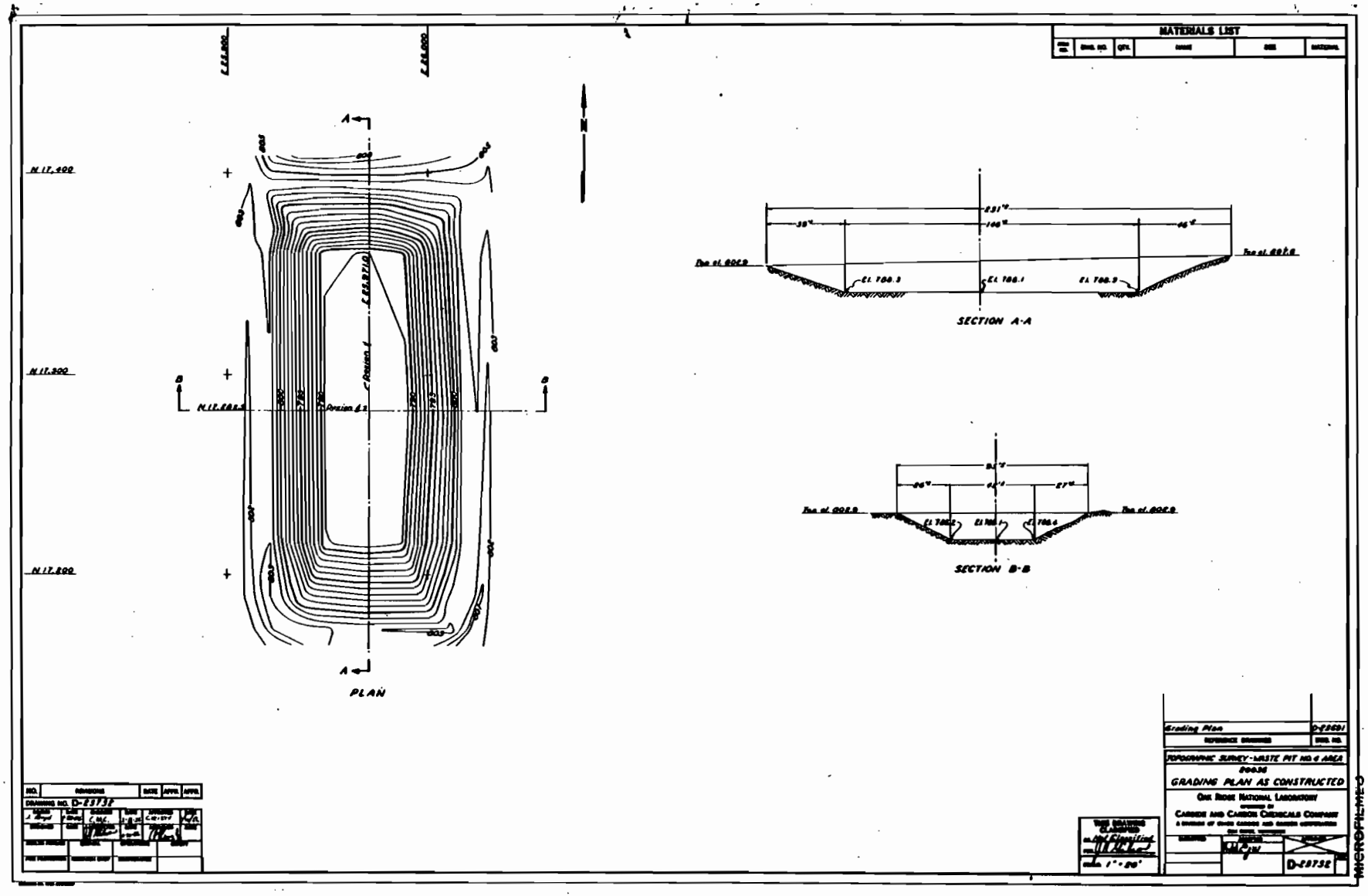
NO.	REVISIONS	DATE	APPR.	APPR.

DRAWING NO. D-23696

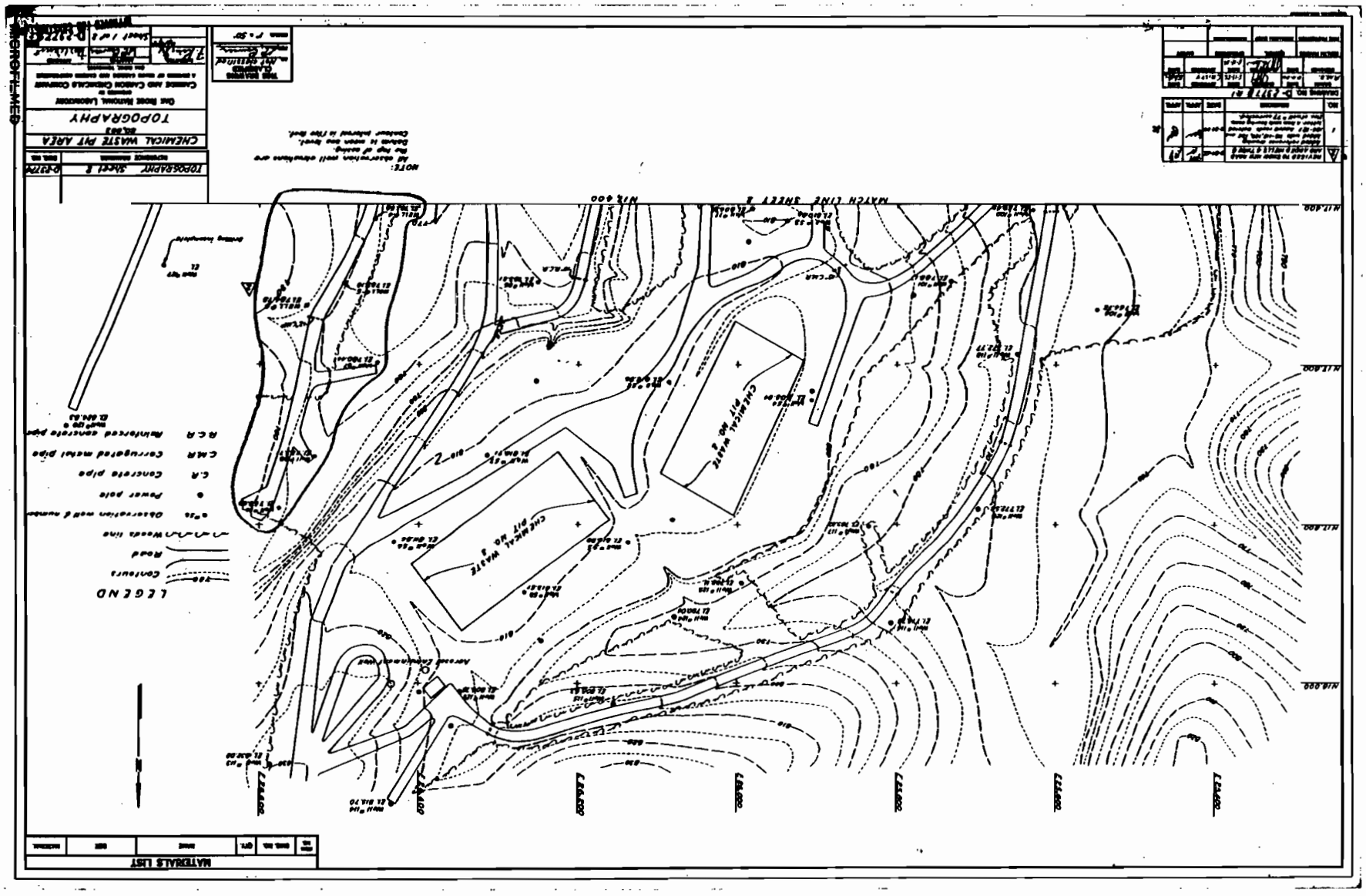
DRAFTED	DATE	DESIGNED	DATE	DRAWING	DATE
DESIGNED	DATE	SUBMITTED	DATE	APPROVED	DATE
HEALTH PHYSICS	MECHANICAL	INSTRUMENTATION	CHEMIST		
FIRE PROTECTION	MECHANICAL SHOP	INSTRUMENTATION			



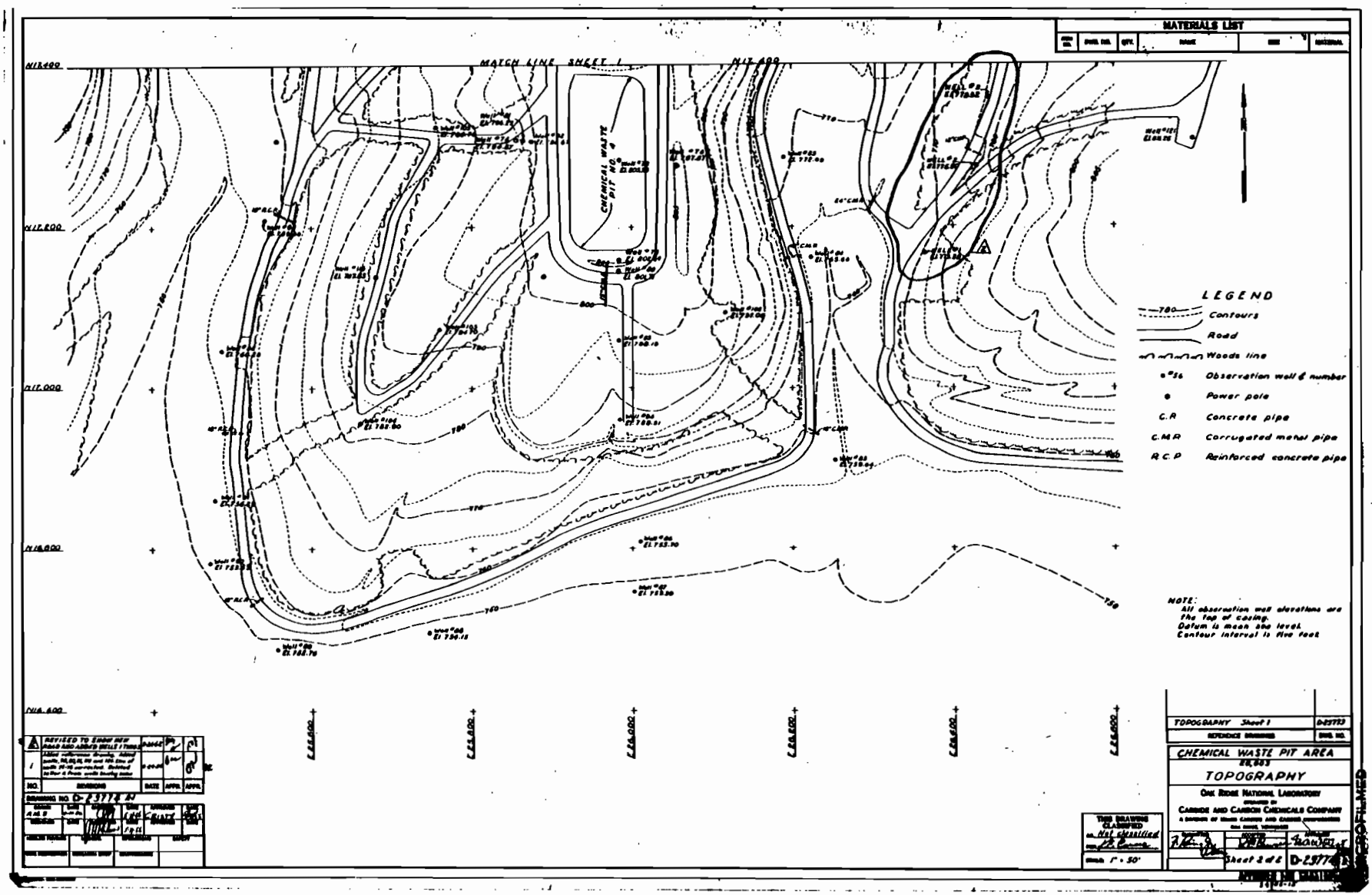
D 23690 10AUG55
Chemical Waste Pit 4, Locality Map



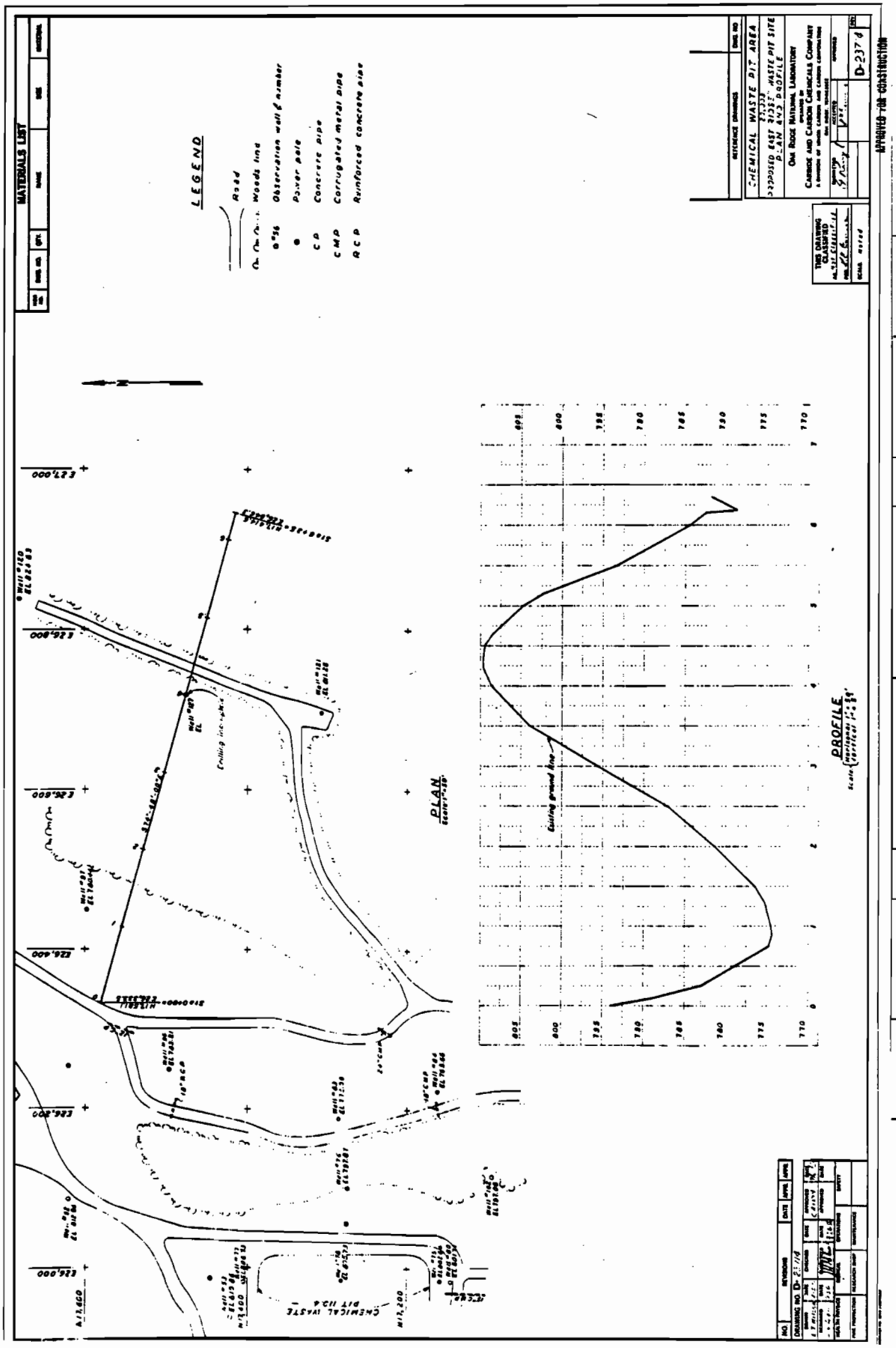
D 23732 31JAN56
Topographic Survey, Waste Pit 4 Area



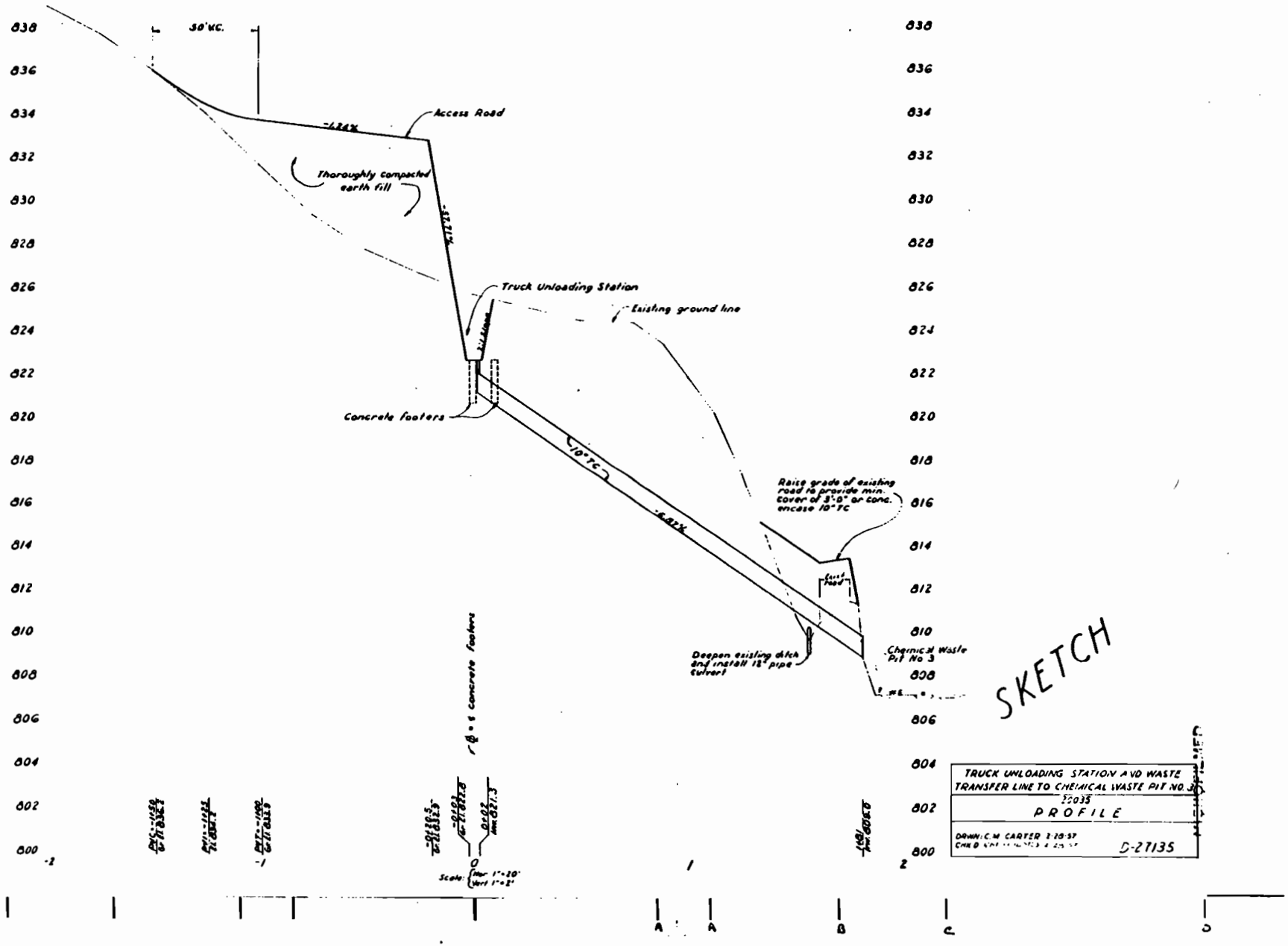
D 23773 11MAY56
Chemical Waste Pit Area - Topography



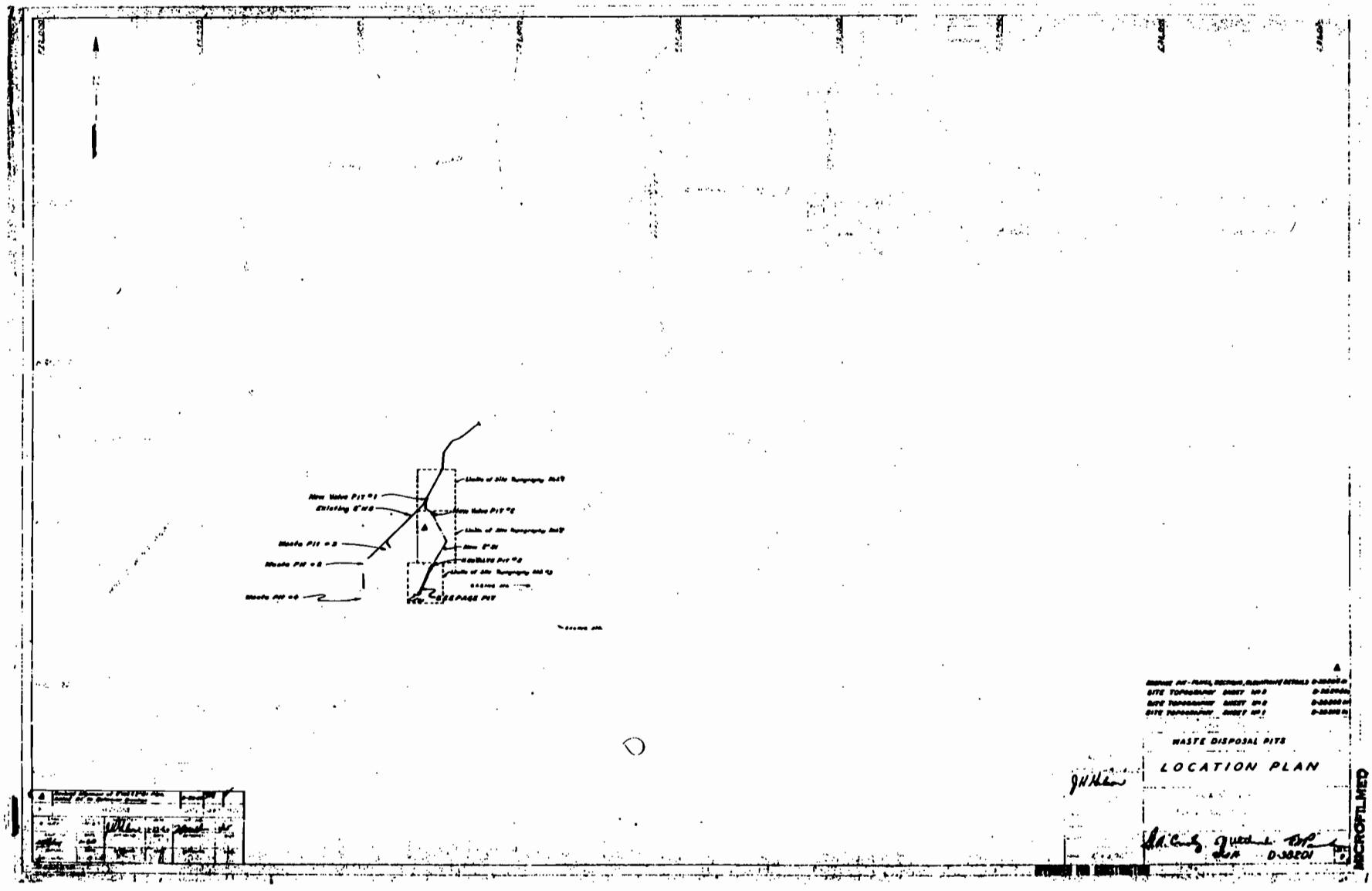
D 23774 11MAY56
Chemical Waste Pit Area - Topography



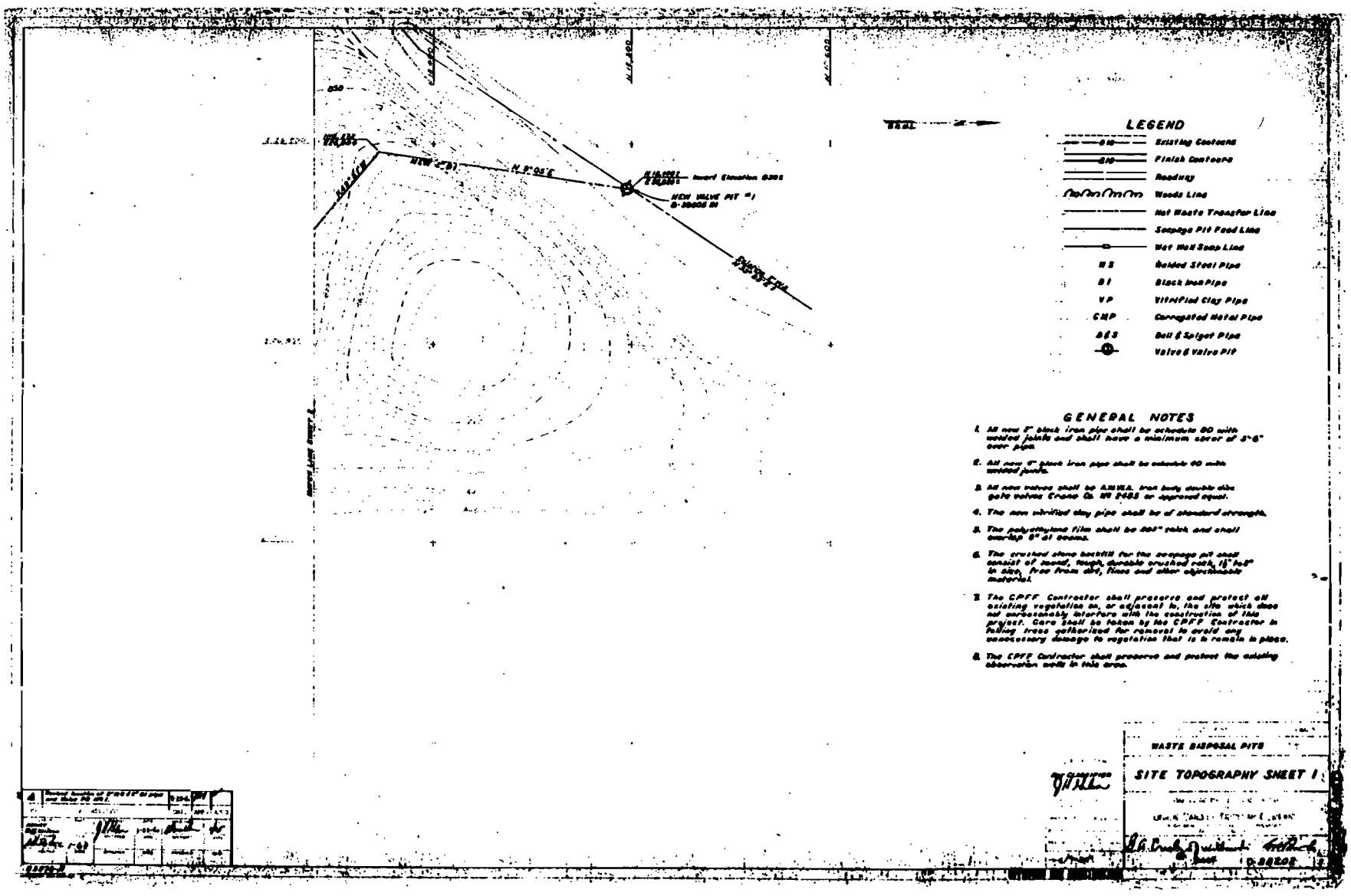
D 23714 09SEP56
Proposed East Ridge Waste Pit(5) Plans



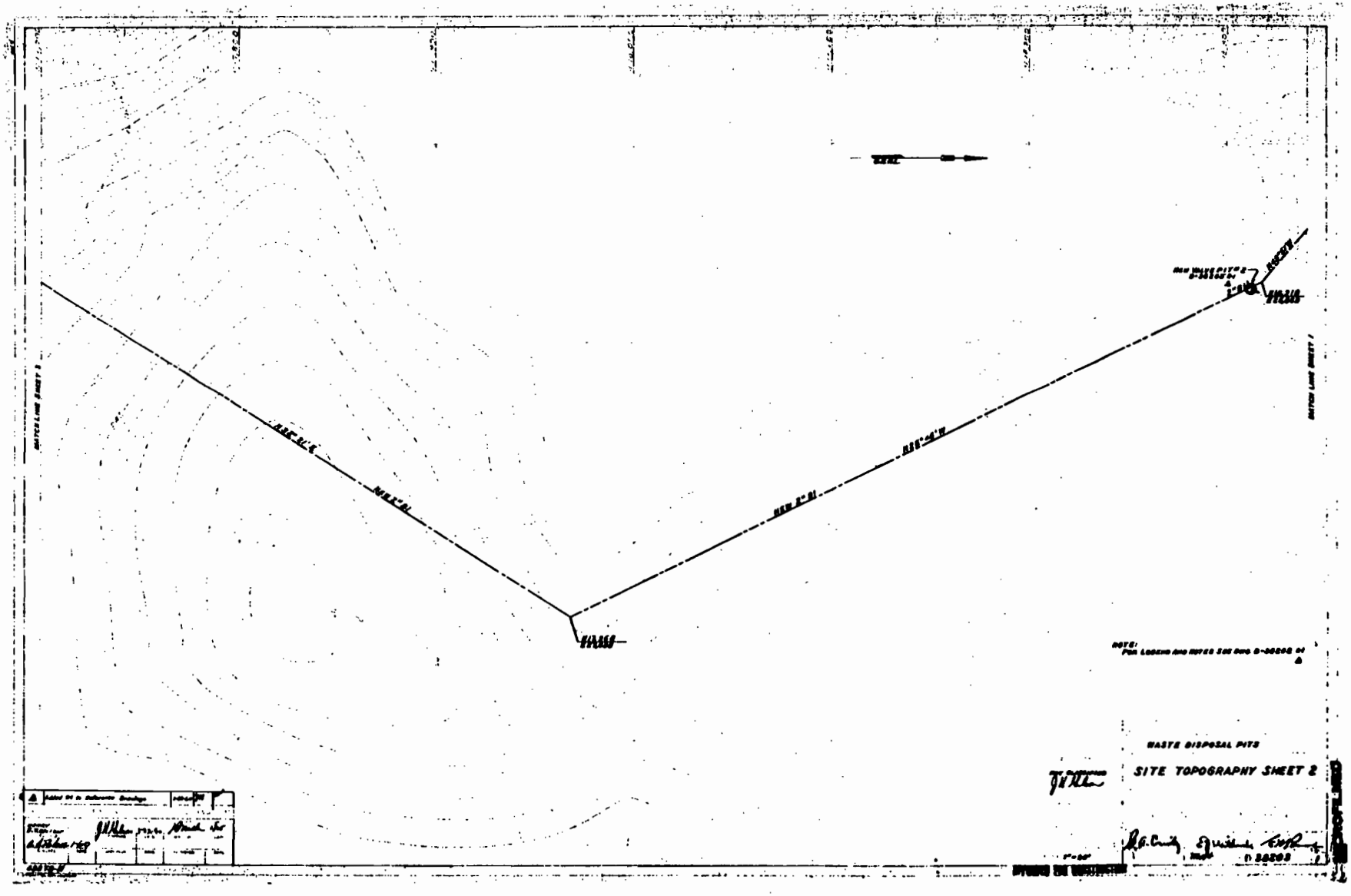
D 27135 28FEB57
Truck Station and Waste Transfer Line Pit 4



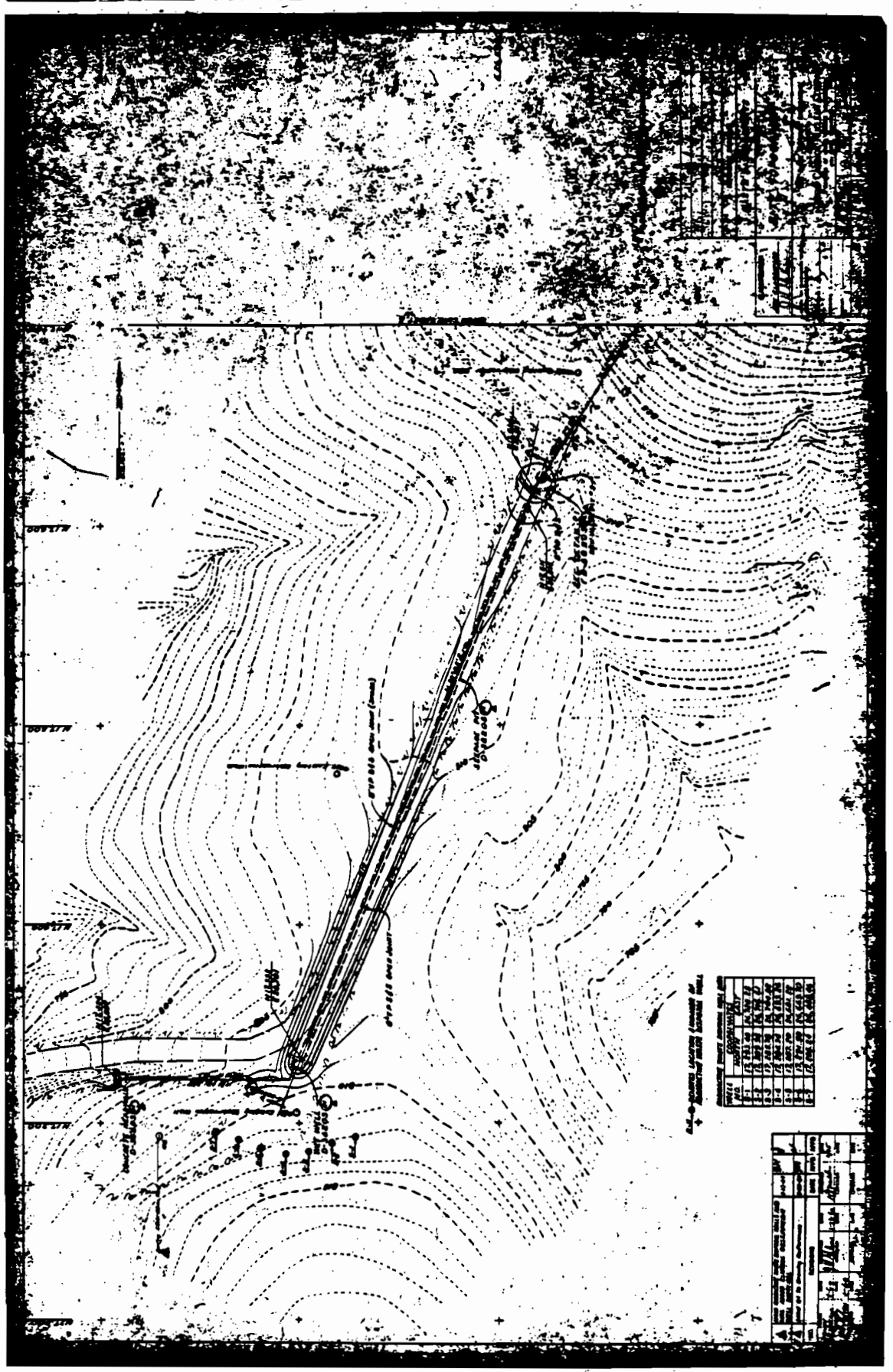
D 38201 11JAN60
Location Plan Pit 5



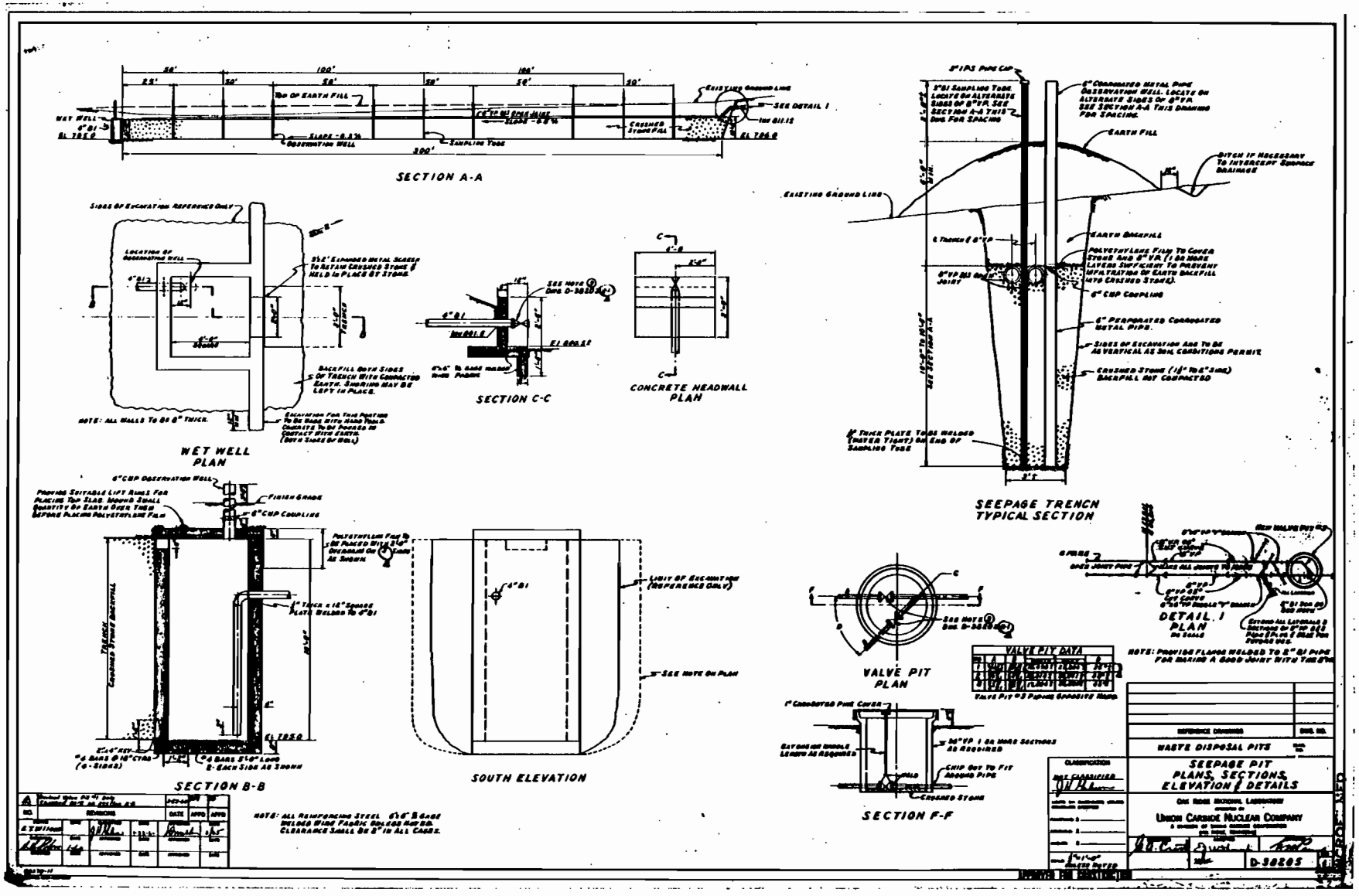
D 38202 22JAN60
Pit 5 Site Topography, Sheet 1



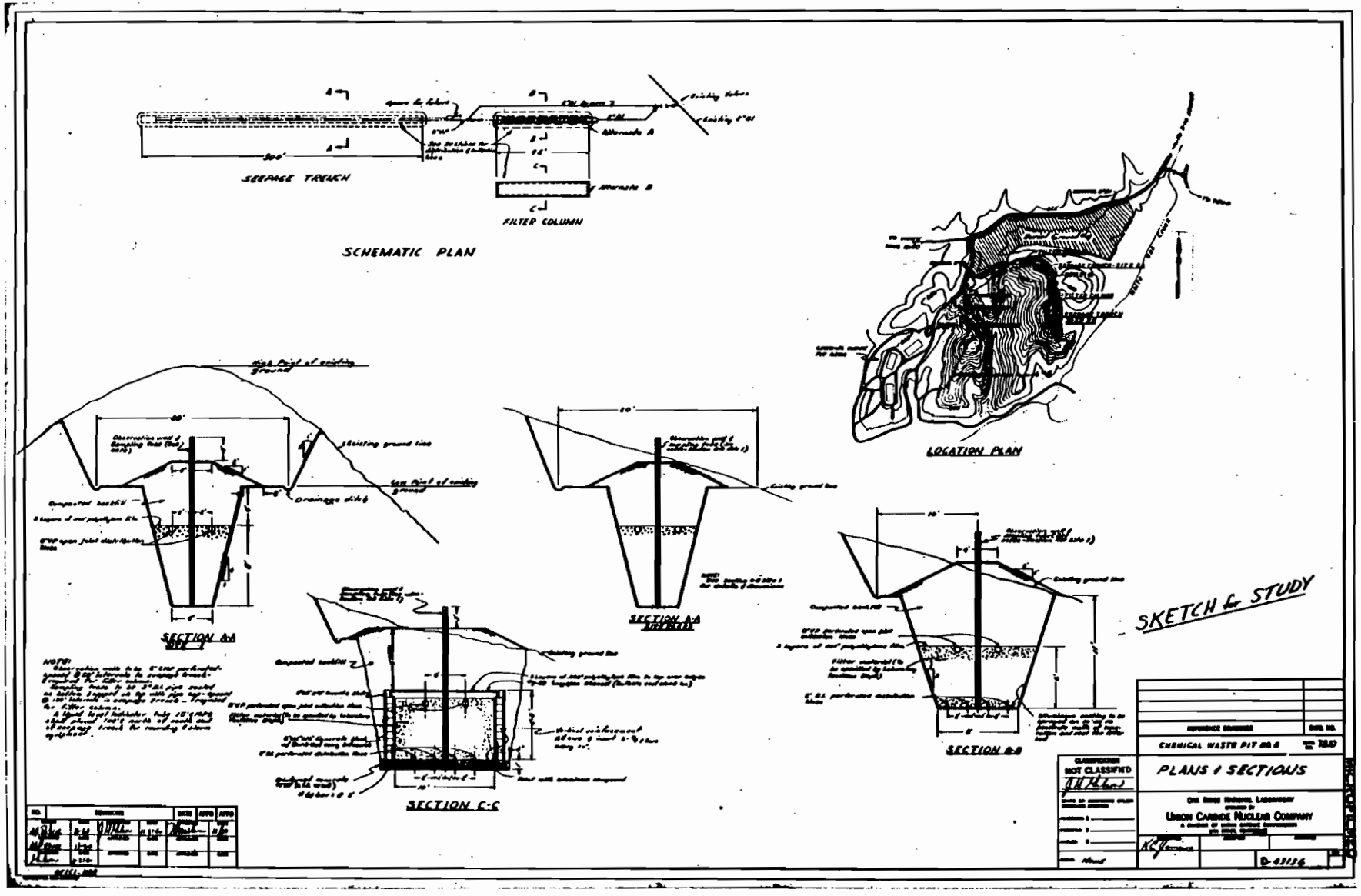
D 38203 22JAN60
Pit 5 Site Topography, Sheet 2



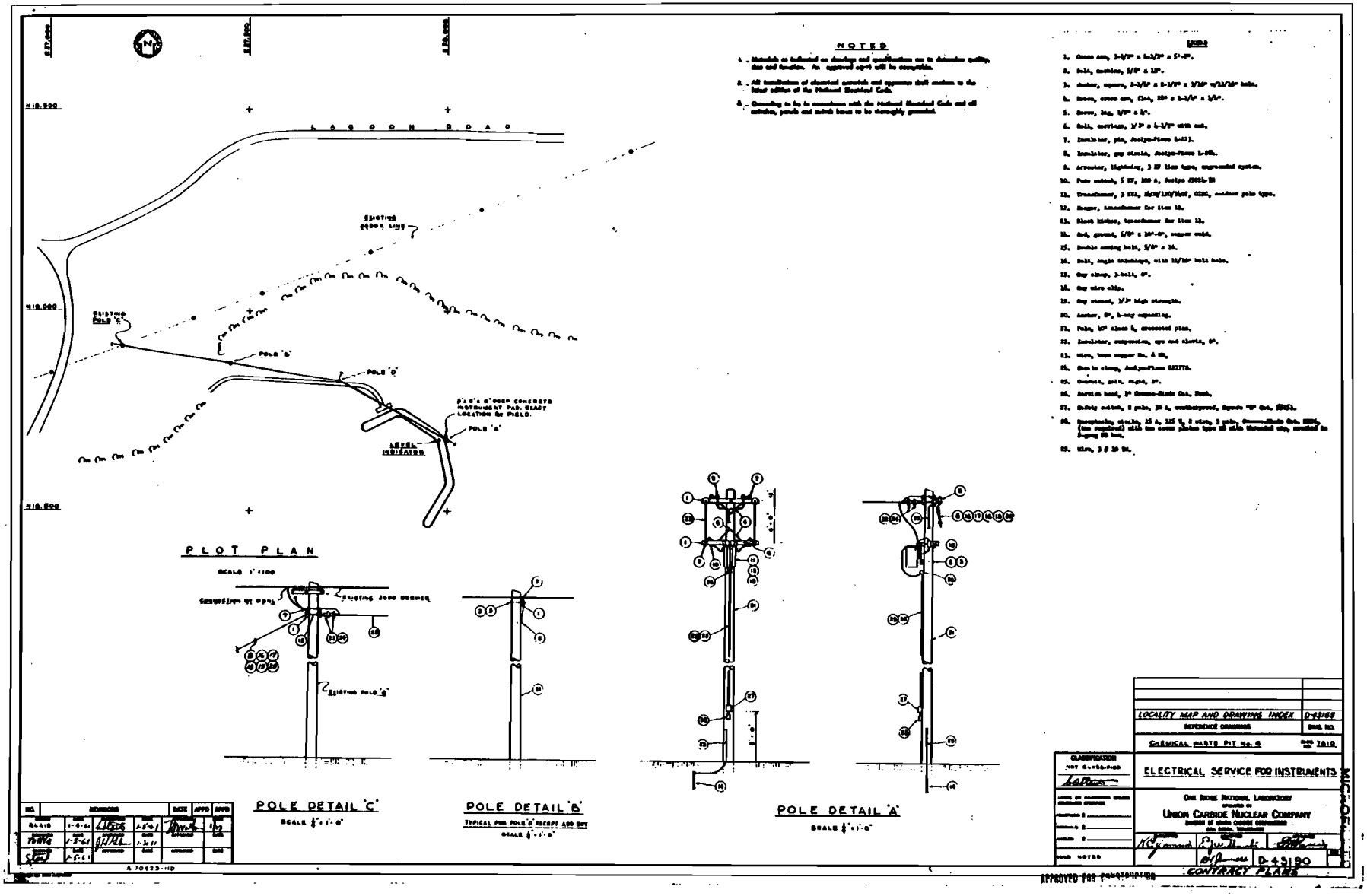
D 38204 22JAN60
Pit 5 Site Topography, Sheet 3



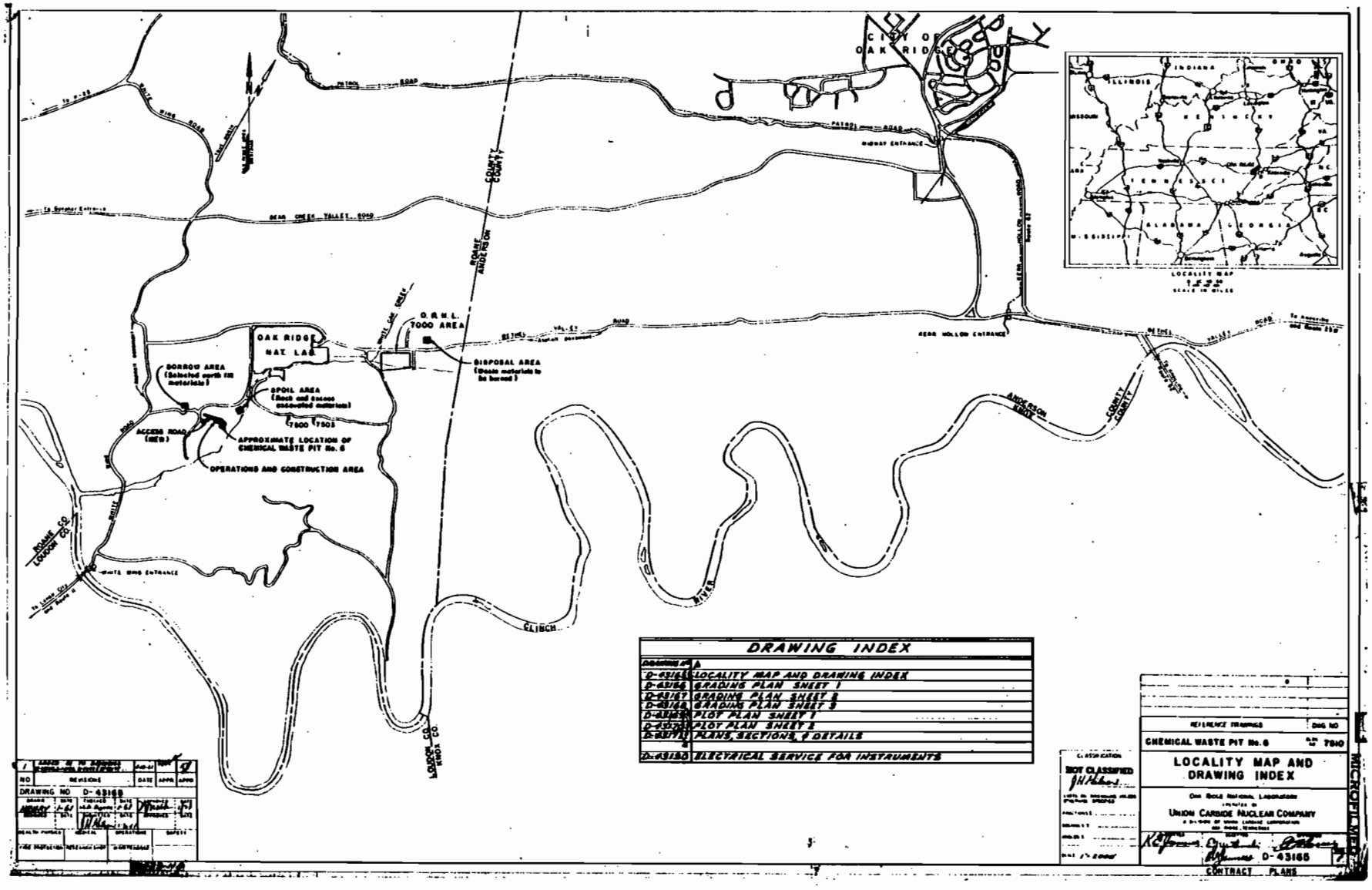
D 38205 22JAN60
Pit 5, Plans, Sections, Elevations, Details



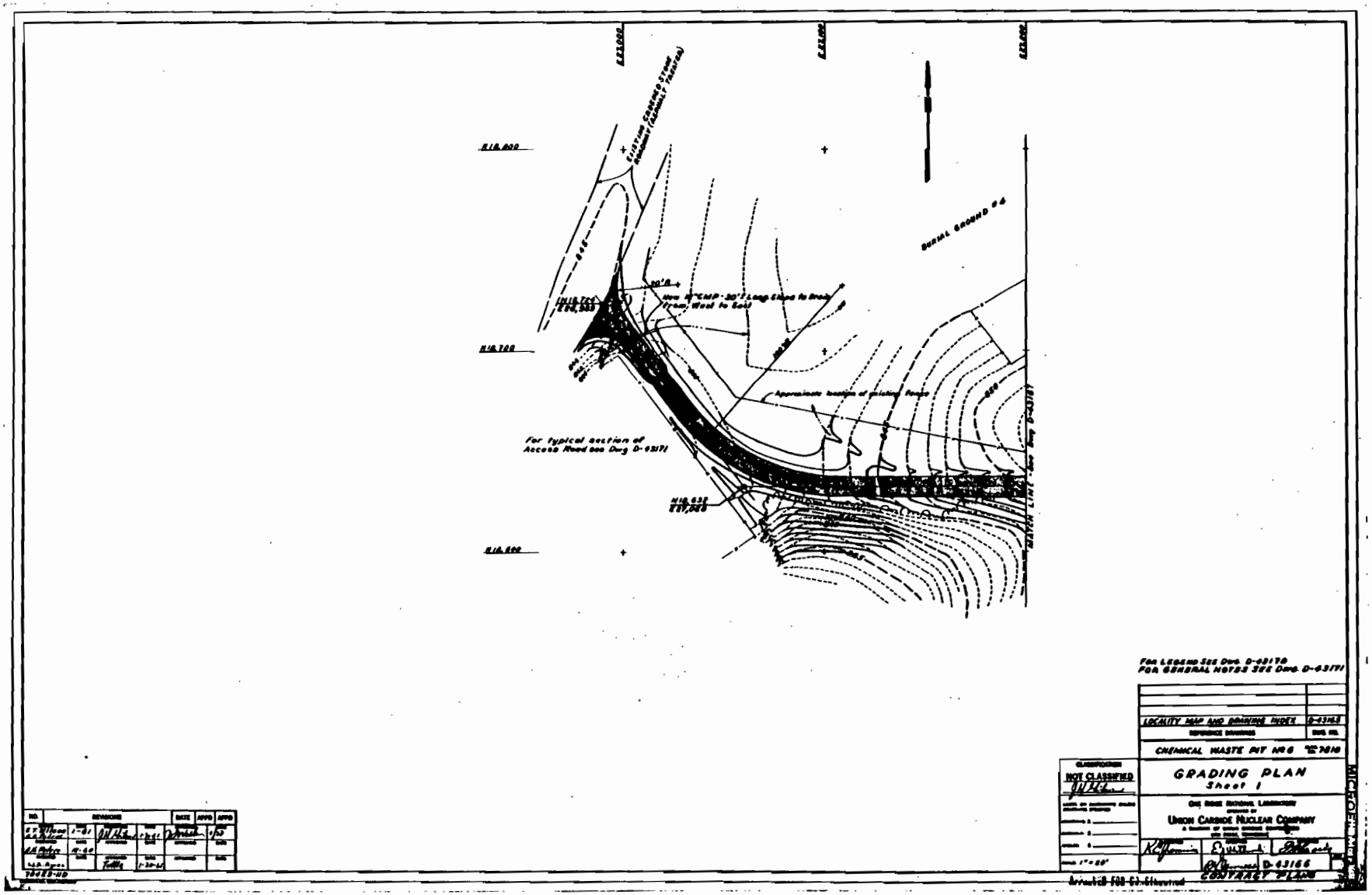
D 43136 21NOV60
Chemical Waste Pit 6, Plans and Sections (Sketch)



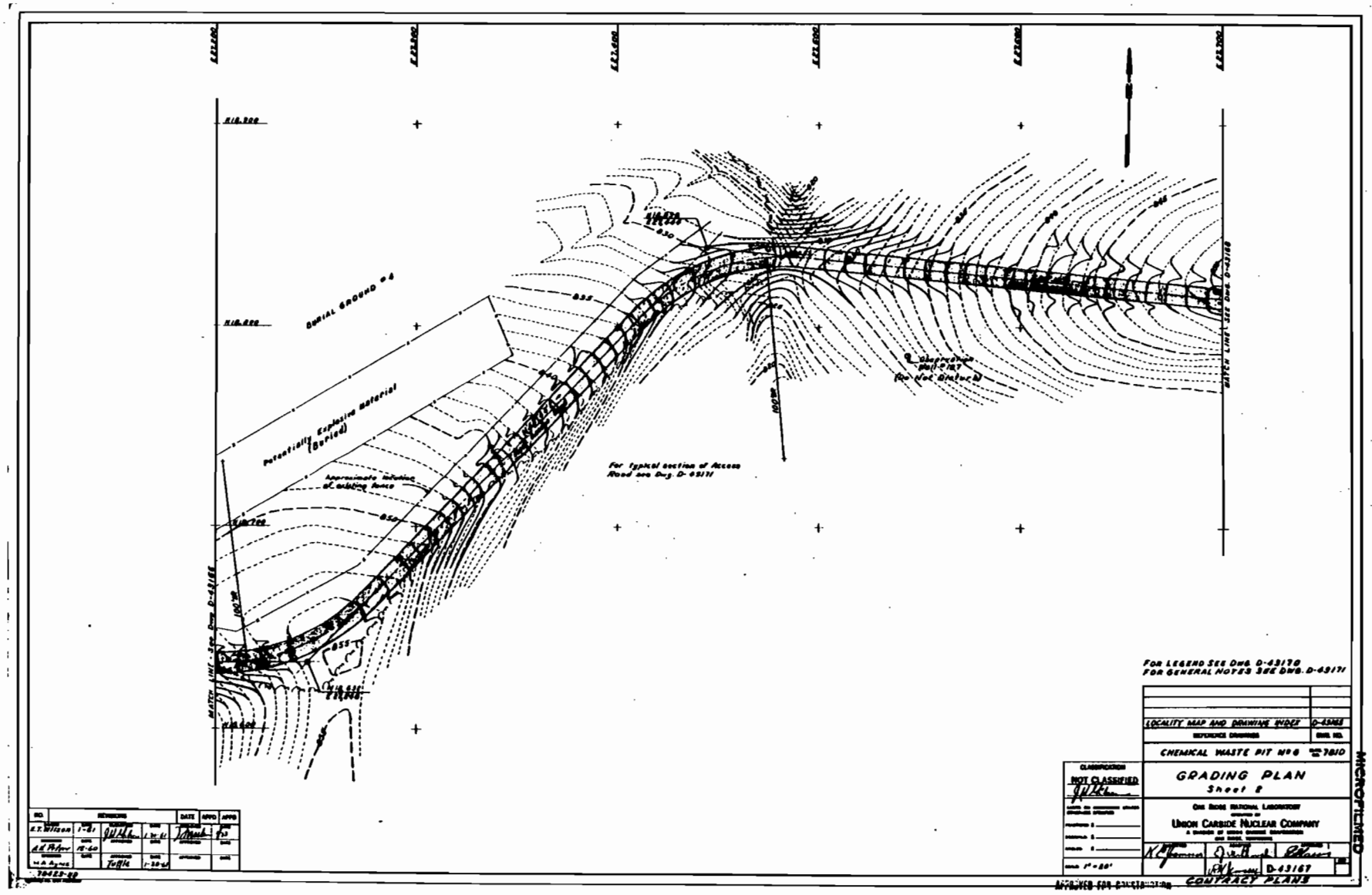
D 43190 04JAN61
Chemical Waste Pit 6, Electrical Service



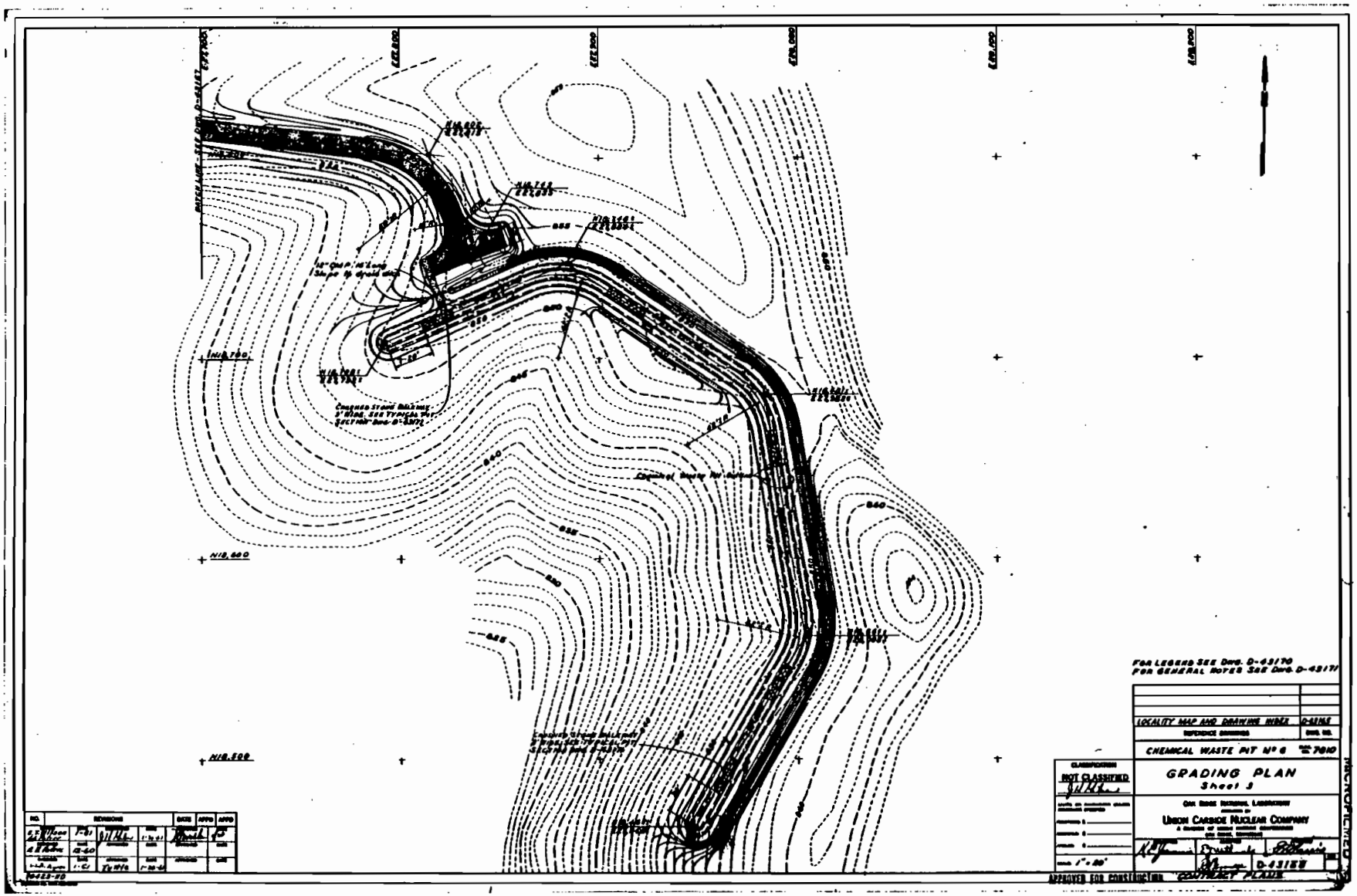
D 43165 23JAN61
Locality Map and Drawing Index, Pit No. 6



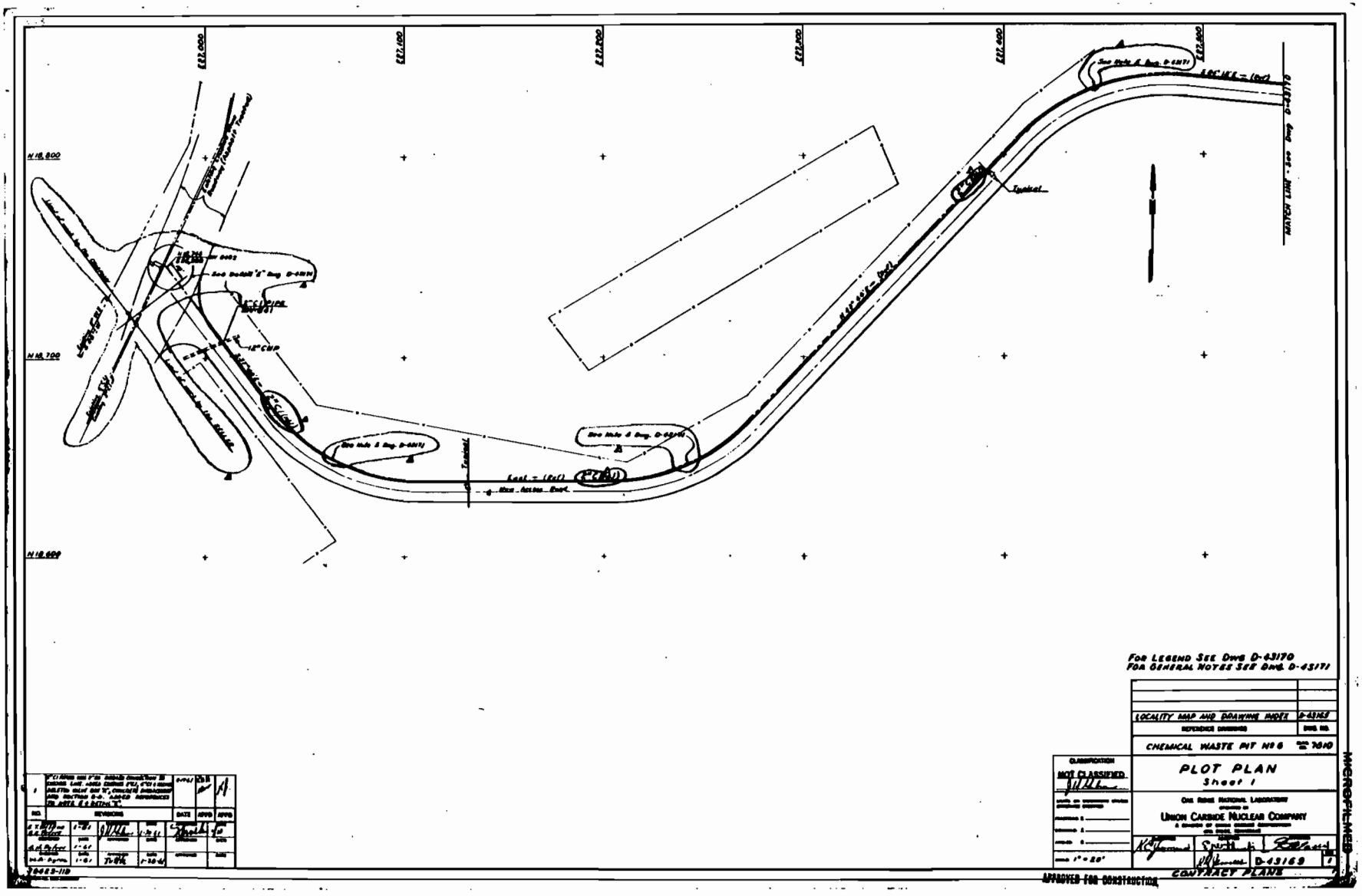
D 43166 23JAN61
Chemical Waste Pit 6, Grading Plan, Sheet 1



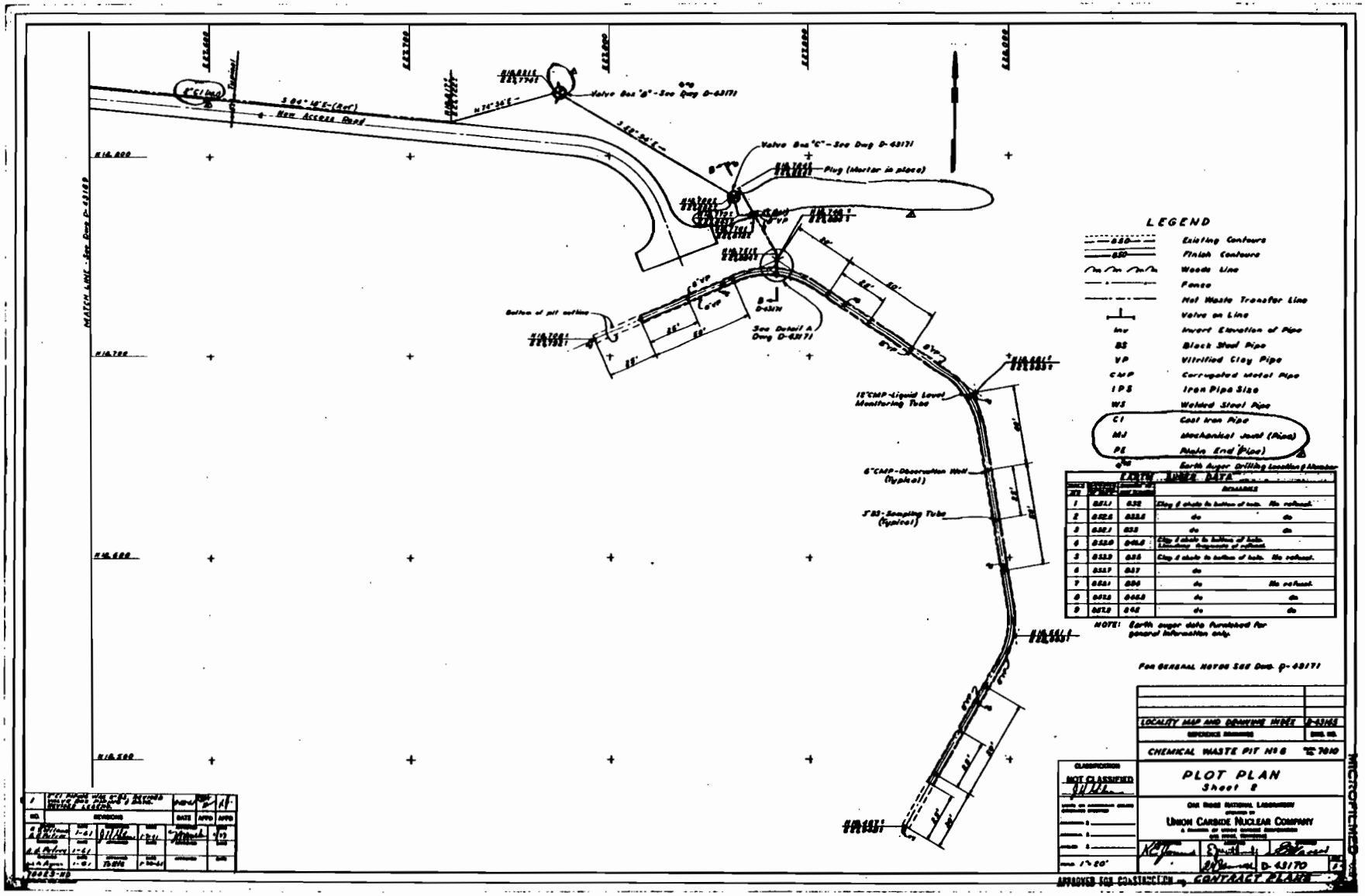
D 43167 23JAN61
Chemical Waste Pit 6, Grading Plan, Sheet 2



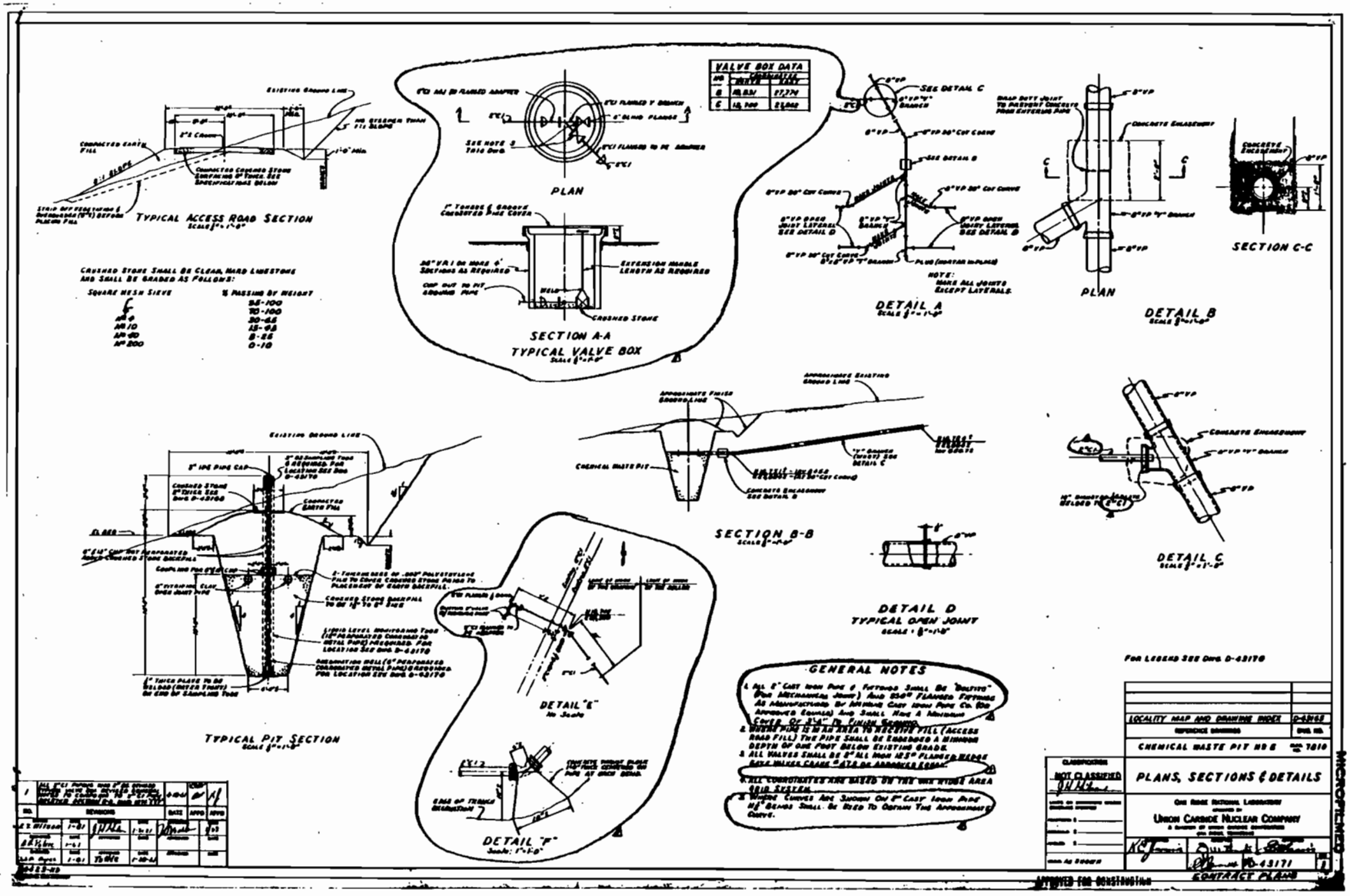
D 43168 23JAN61
Chemical Waste Pit 6, Grading Plan, Sheet 3

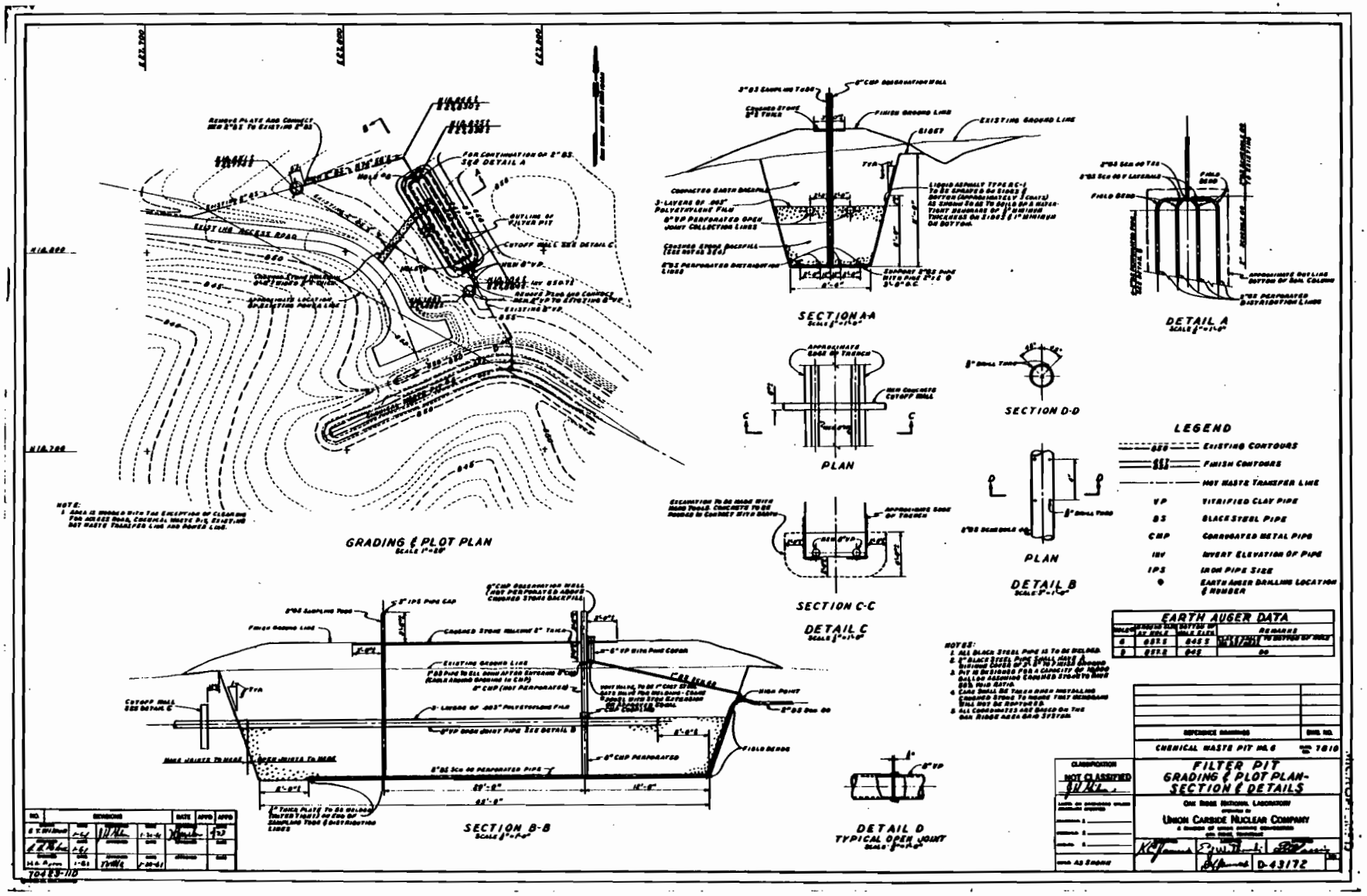


D 43169 23JAN61
Chemical Waste Pit 6, Plot Plan, Sheet 1

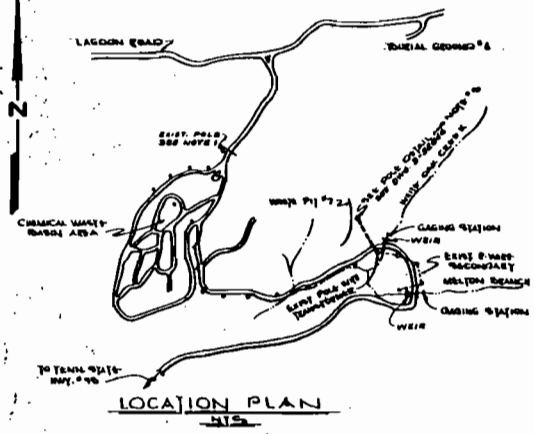


D 43170 23JAN61
Chemical Waste Pit 6, Plot Plan, Sheet 2

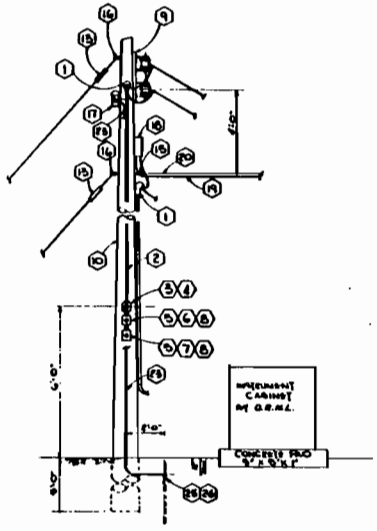

TYPICAL ACCESS ROAD SECTION
CRUSHED STONE SHALL BE CLEAN, HARD LIMESTONE AND SHALL BE GRADED AS FOLLOWS:
SQUARE MESH SIEVE
% PASSING BY WEIGHT
PLAN
SECTION A-A
TYPICAL VALVE BOX
VALVE BOX DATA
DETAIL A
PLAN
DETAIL B
SECTION C-C
SECTION B-B
DETAIL C
DETAIL D
TYPICAL OPEN JOINT
TYPICAL PIT SECTION
DETAIL "E"
DETAIL "F"
GENERAL NOTES
1. ALL 8" CAST IRON PIPE & FITTINGS SHALL BE "BELLITE" (PIPE MECHANICAL JOINT) AND 250# FLANGED FITTINGS AS MANUFACTURED BY DRESSER CAST IRON PIPE CO. (OR APPROVED EQUALS) AND SHALL HAVE A MINIMUM COVER OF 3'-6" IN FINISH GRADING.
2. WHERE PIPE IS IN AREA TO RECEIVE FILL (ACCESS ROAD FILL) THE PIPE SHALL BE EXTENDED A MINIMUM DEPTH OF ONE FOOT BELOW EXISTING GRADE.
3. ALL VALVES SHALL BE 8" ALL IRON 125# FLANGED WEDGE GATE MUELLER CRANE #476 OR APPROVED EQUAL.
4. ALL COORDINATES ARE BASED ON THE OAK RIDGE AREA GRID SYSTEM.
5. WHERE CURVES ARE SHOWN ON 8" CAST IRON PIPE 90° BENDS SHALL BE USED TO OBTAIN THE APPROXIMATE CURVE.
LOCALITY MAP AND DRAWING INDEX
CHEMICAL WASTE PIT NO 6
PLANS, SECTIONS & DETAILS
UNION CARBIDE NUCLEAR COMPANY
D-43171
CONTRACT PLANS
APPROVED FOR CONSTRUCTION



D 43172 23JAN61
Chemical Waste Pit 6, Filter Pit, Grading Plot plan



LOCATION PLAN
NTS



POLE DETAIL
NTS

EQUIPMENT LEGEND

ITEM	DESCRIPTION
1	SERVICE DROPPED CAP - 3/4", CROUSE-HINDS CAT. # [illegible]
2	CONDUIT - 3/4" RIGID, GALVANIZED
3	FUSE CUTOUT CONDUIT - CROUSE-HINDS CAT. # YAC 8308
4	FUSE CUTOUT - ONE POLE, 7.5A, 300A, 12.5KV, BRYANT #80
5	RECEPTACLE - SINGLE, 15A, 125V, 2 WIRE, 2 POLE, HUBBELL #5261
6	BOX - CROUSE-HINDS TYPE FDCG
7	BOX - CROUSE-HINDS TYPE FQB
8	RECEPTACLE PLATE - CAST METAL, HUBBELL #7318
9	SECONDARY RACK - 2-SPOOL, JOSLYN CAT. # J1267
10	POLE - 35', CLASS 4, SOUTHERN PINE, CEDAR POLES
11	ANCHOR - 2 WAY EXPANDING JOSLYN-CRANKS # 124
12	ANCHOR ROD - INTERLYS, 3/4" x 6', JOSLYN #J7916
13	GUY CLAMP - 3 BOLT, 4", JOSLYN CAT. # 4929
14	BOLT - MACHINE, 3/4" x 8"
15	BOLT - EYE, 3/4" x 8"
16	NUT - ANGLE TRIMBLE EYE, 3/4"
17	LIGHTNING ARRESTOR - LOW VOLTAGE, G.E. Co. #9L40A8P08
18	TELEPHONE CABLE TERMINAL - 11 PAIR, COOK # 498-1911
19	TELEPHONE CABLE - 11 PAIR, #19, ANACONDA TYPE ATC-AO
20	GUY STRAND - 3/8" HIGH STRENGTH
21	CABLE RING - 1 1/2" FOR 3/8" STRAND
22	WIRE - #6, R, WEATHERPROOF, MRO
23	WIRE - #6 BARE SOLID
24	WIRE - #10 R, TYPE TW
25	GROUND ROD - 3/4 x 10' COPPERWELD
26	GROUND ROD CLAMP

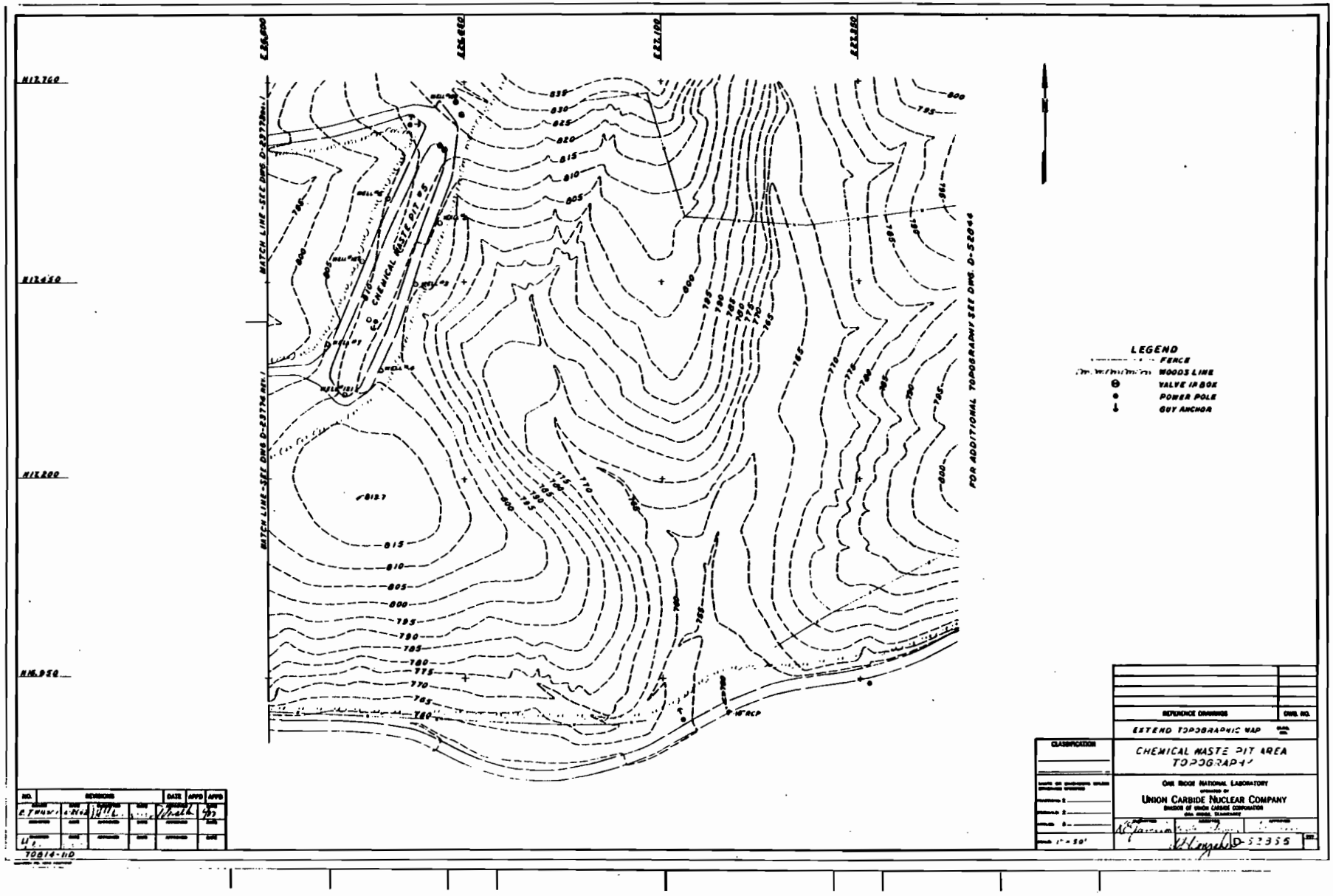
NOTES

1. INSTALL ONE CABLE TERMINAL (ITEM 18) AT PIT #7, ONE ON THE EXISTING TRANSFORMER POLE NEAR WEIR ON GAGING STATION AND ONE NEAR THE ENTRANCE TO THE WASTE BURIAL AREA FOR CONNECTION BY BELL TELEPHONE CO. CONTRACTOR SHALL INSTALL HARDWARE, GUYS AND CABLE (ITEMS 20, 21 AND 22) ALTHOUGH FOR ABOVE POINTS.
2. INSTALL ADDITION GROUND GUYS AT THE TRANSFORMER POLE AND AT THE LAGOON AREA TERMINATION.
3. THE 240-WIRE SECONDARY TO SUPPLY WASTE PIT #7 WILL BE APPROXIMATELY 600' IN LENGTH. IT SHALL BE SUPPORTED BY THE EXISTING TRANSFORMER POLE, THE DEAD-END POLE SHOWN AND TWO INTERMEDIATE POLES. THE INTERMEDIATE POLES SHALL BE LOCATED IN THE FIELD TO MEET THE TERRAIN. A FIVE-FOOT WAY ON EITHER SIDE OF CENTER SHALL BE CLEARED.

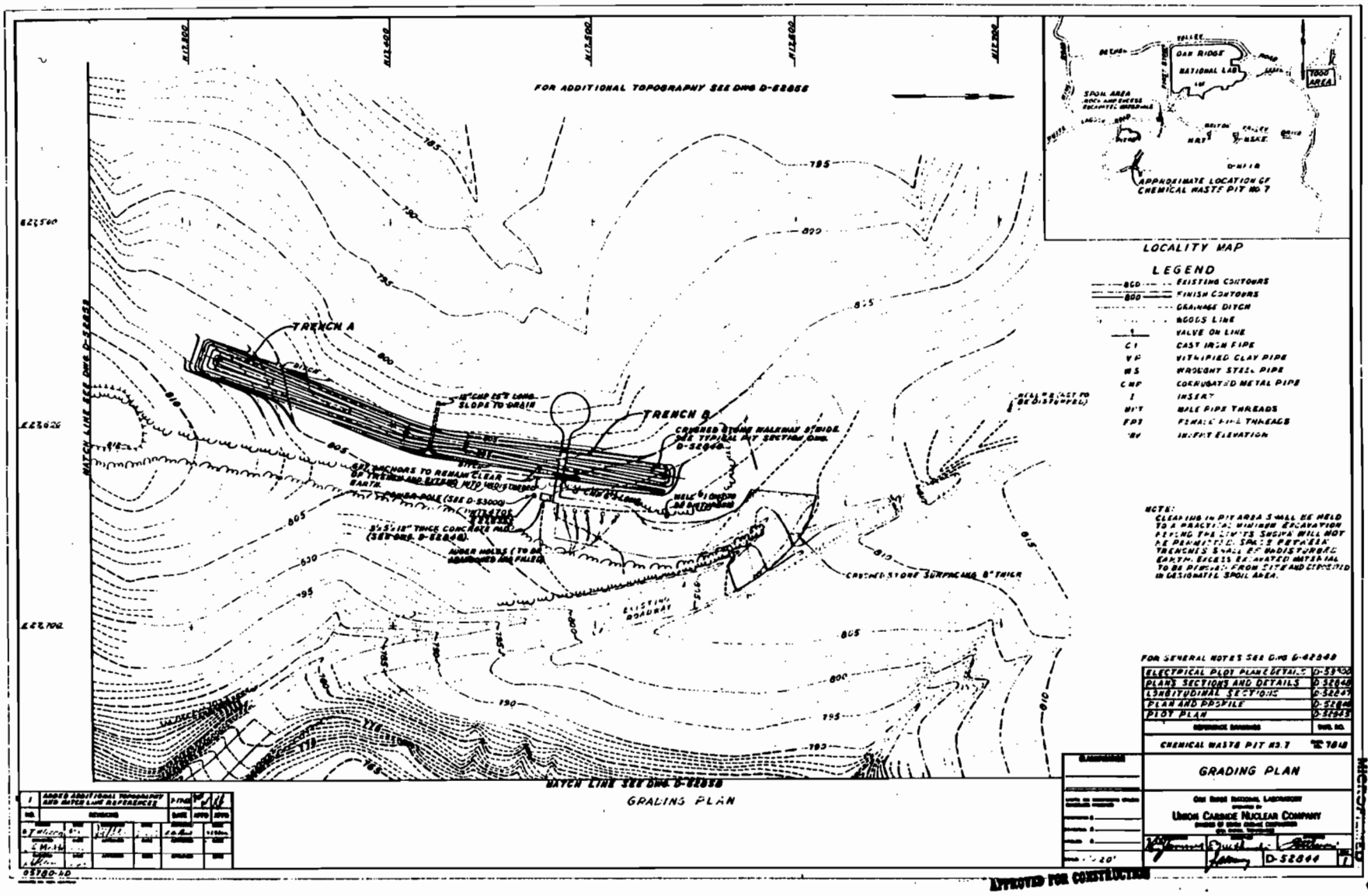
Whenever a manufacturer's name or catalog number is indicated on the drawing, an approved equal may be substituted unless otherwise noted.

GRADING PLAN	D-52844
REFERENCE DRAWINGS	DWG. NO.
CHEMICAL WASTE PIT #7	7/16
ELECTRICAL PLOT PLAN AND DETAILS	
OAK RIDGE NATIONAL LABORATORY OPERATED BY UNION CARBIDE NUCLEAR COMPANY	
AS NOTED	D-53000

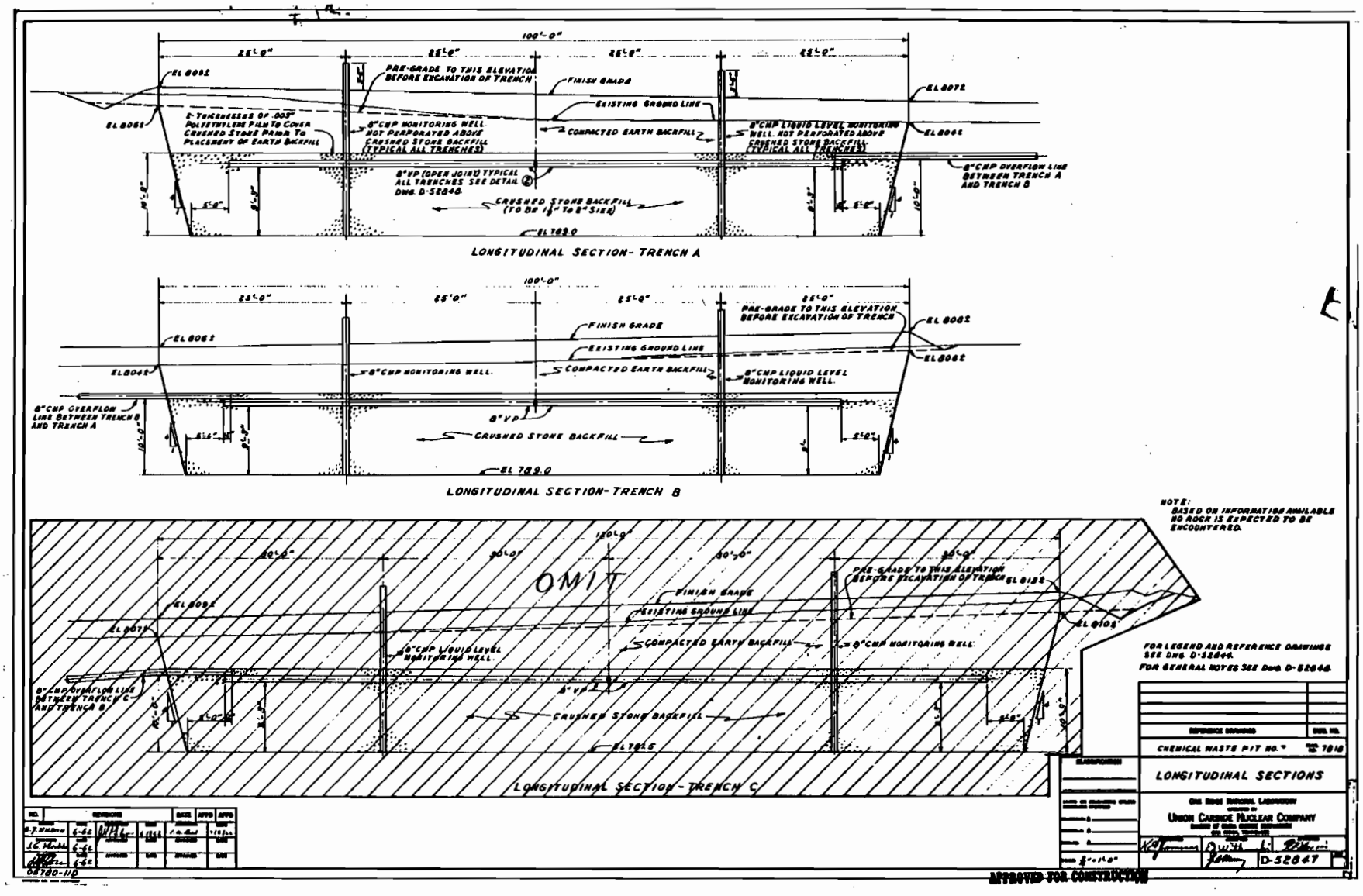
APPROVED FOR CONSTRUCTION



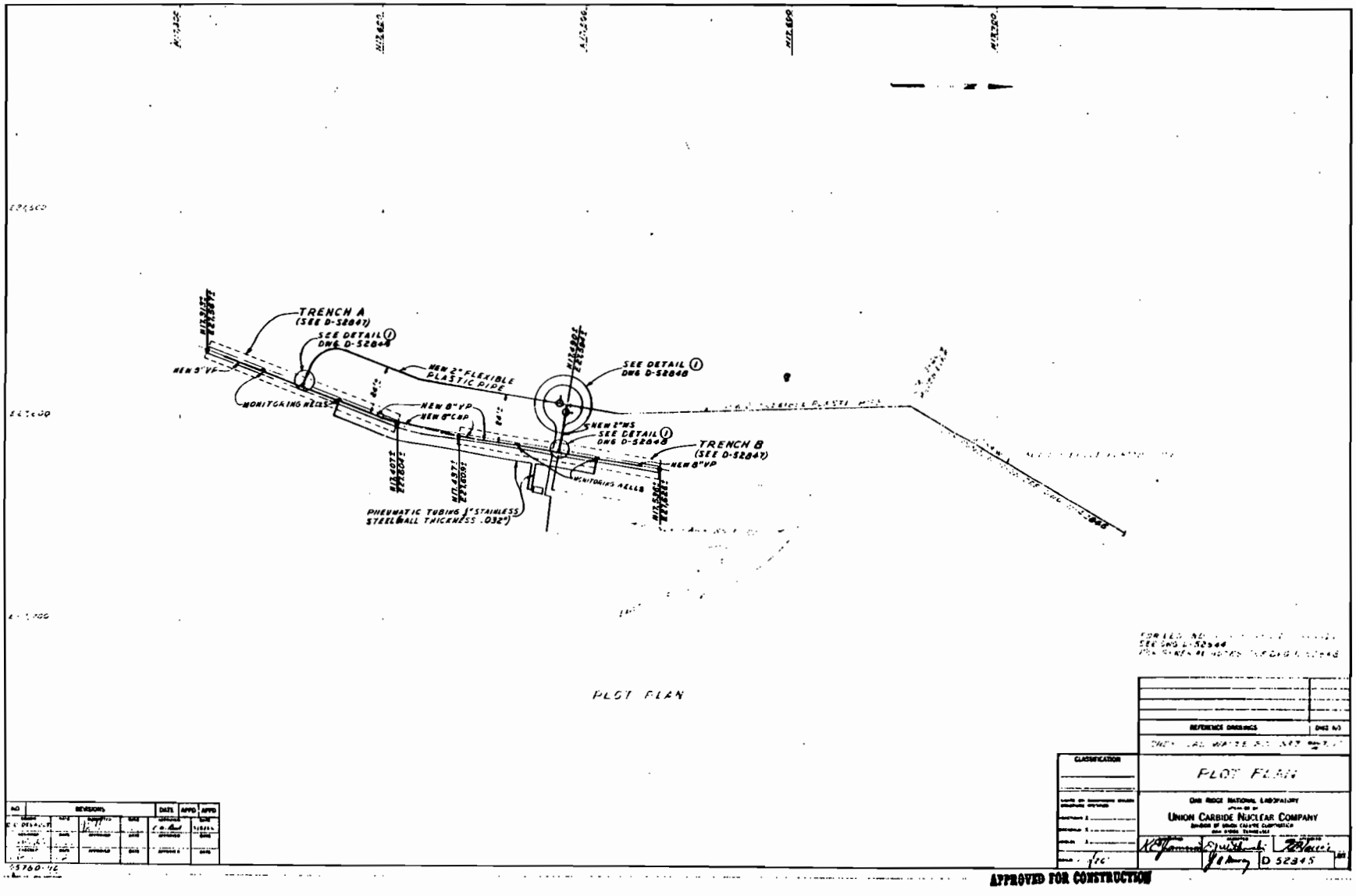
D 52856 06JUN62
Chemical Waste Pit Area Extended Topo. Map



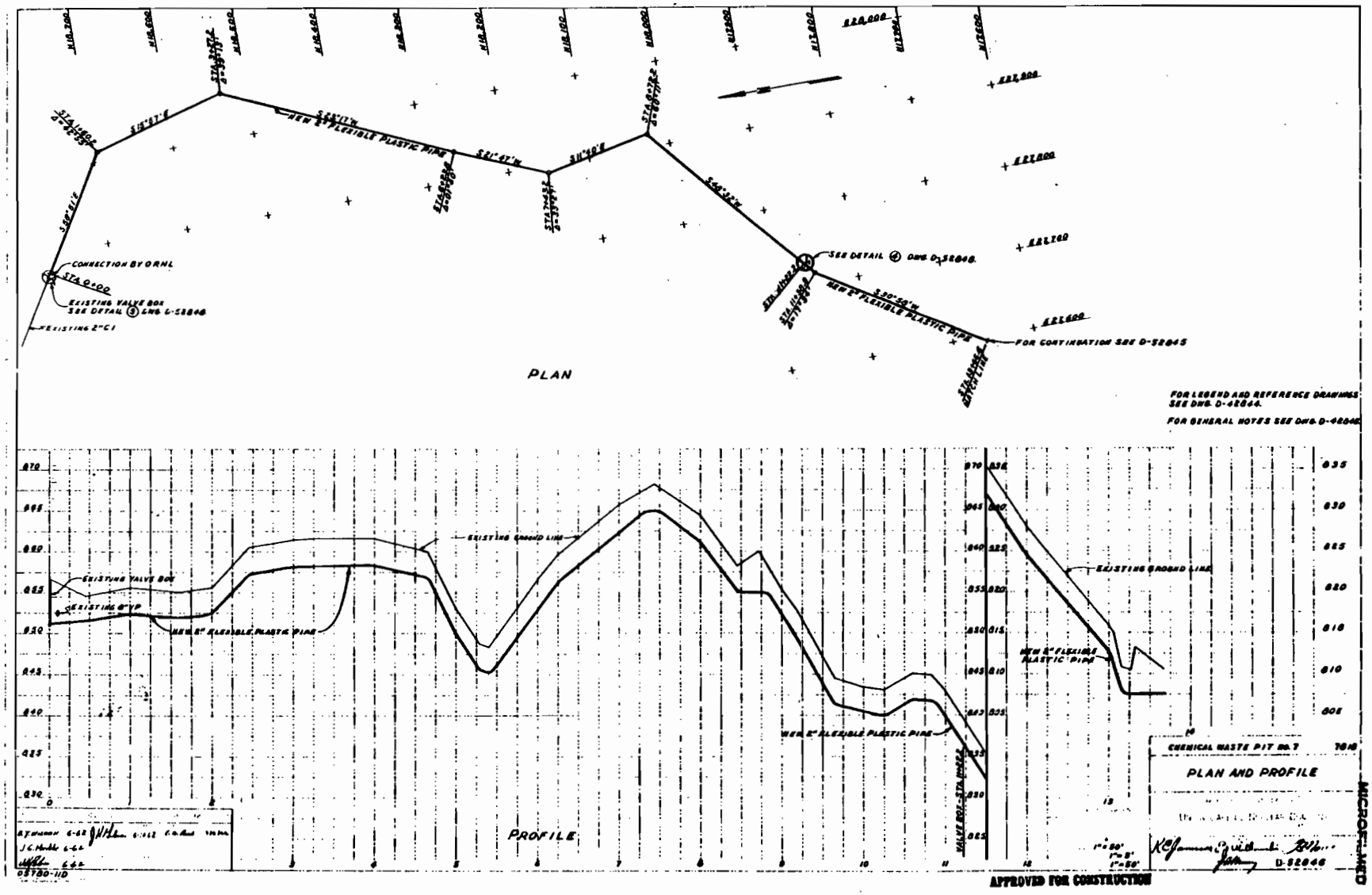
D 52844 12JUN62
Chemical Waste Pit 7, Grading Plan



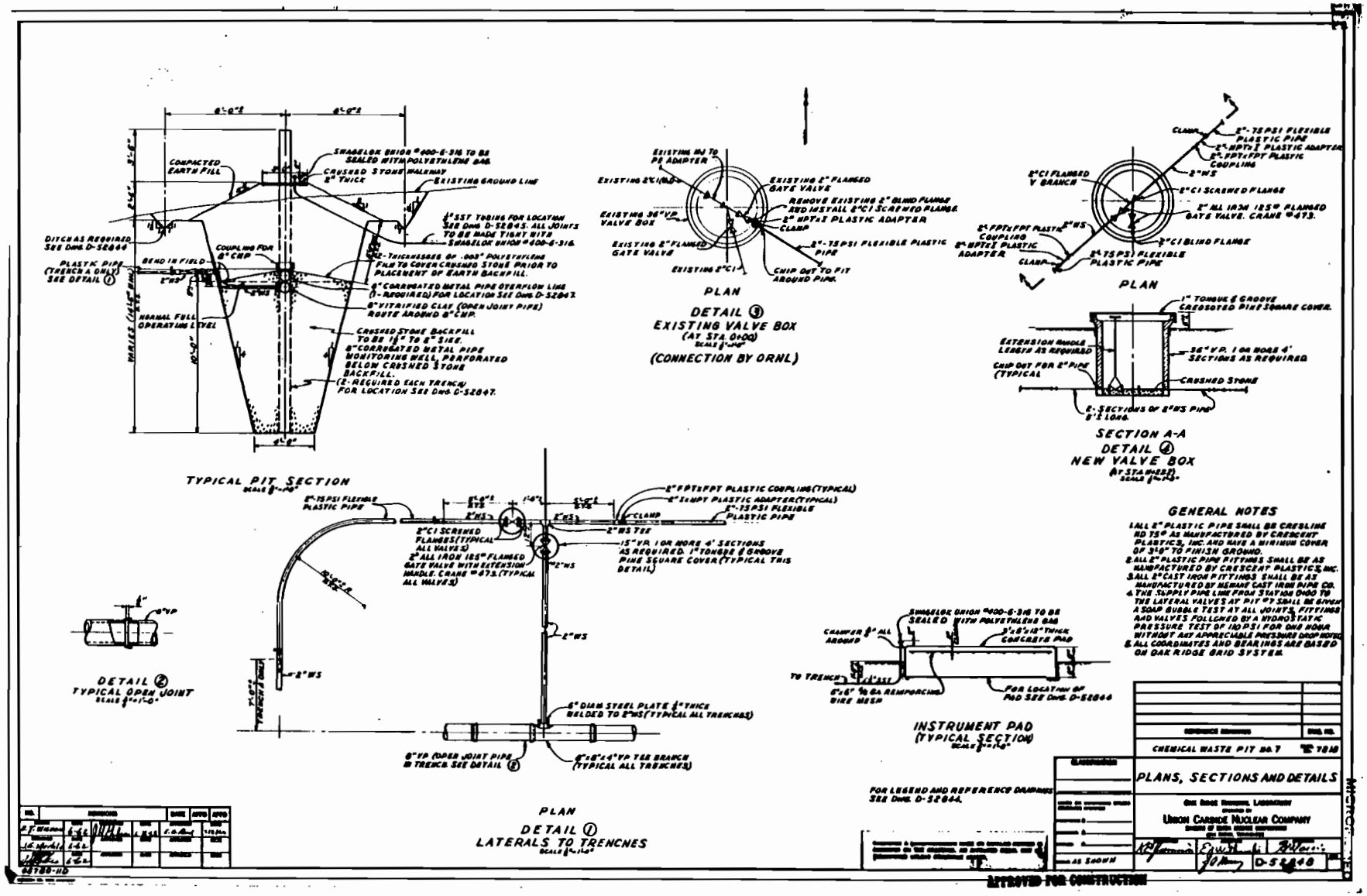
D 52847 12JUN62
Chemical Waste Pit 7, Longitudinal Sections

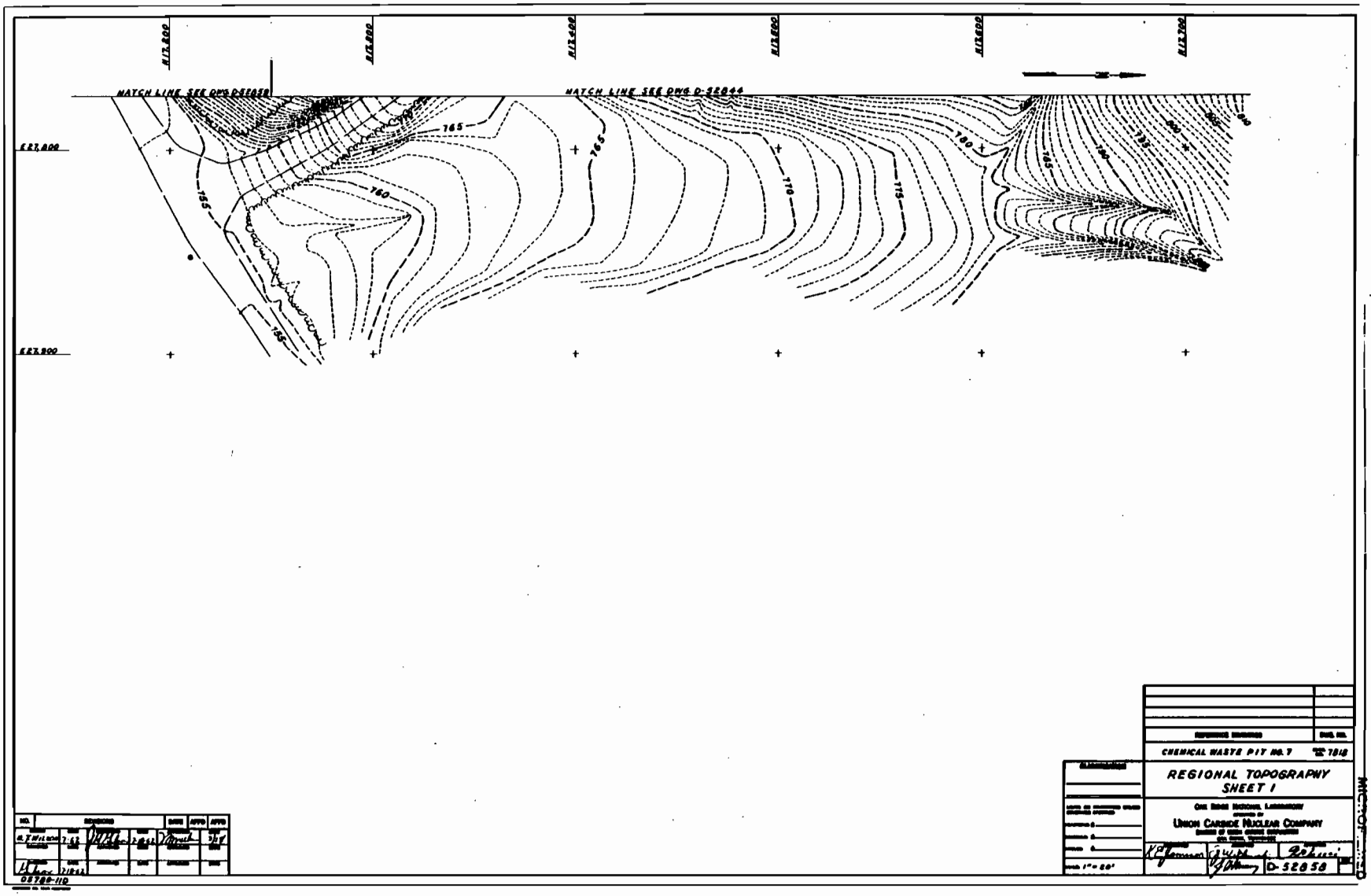


D 52845 14JUN62
Chemical Waste Pit 7, Plot Plan

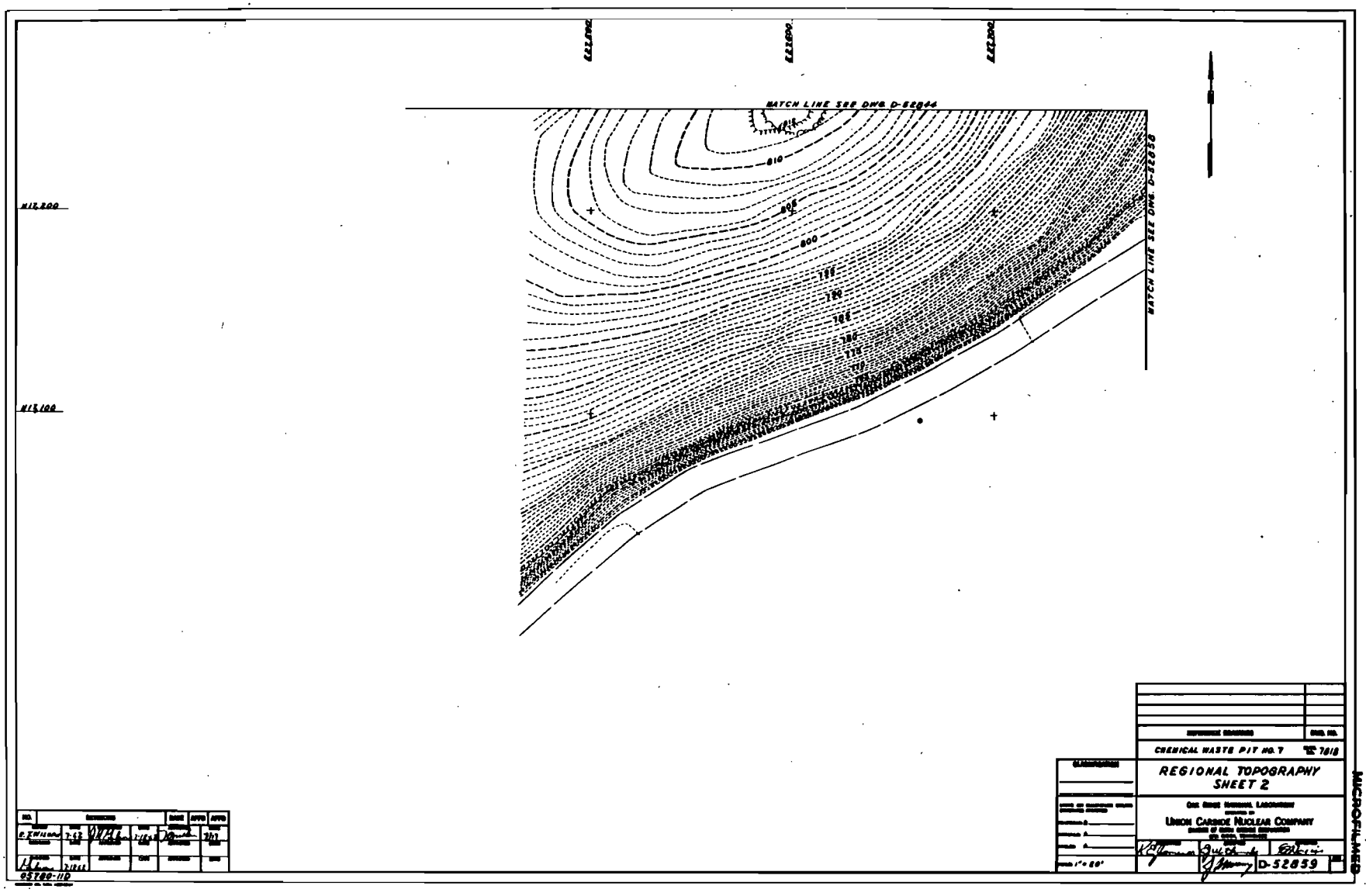


D 52846 14JUN62
Chemical Waste Pit 7, Plan and Profile

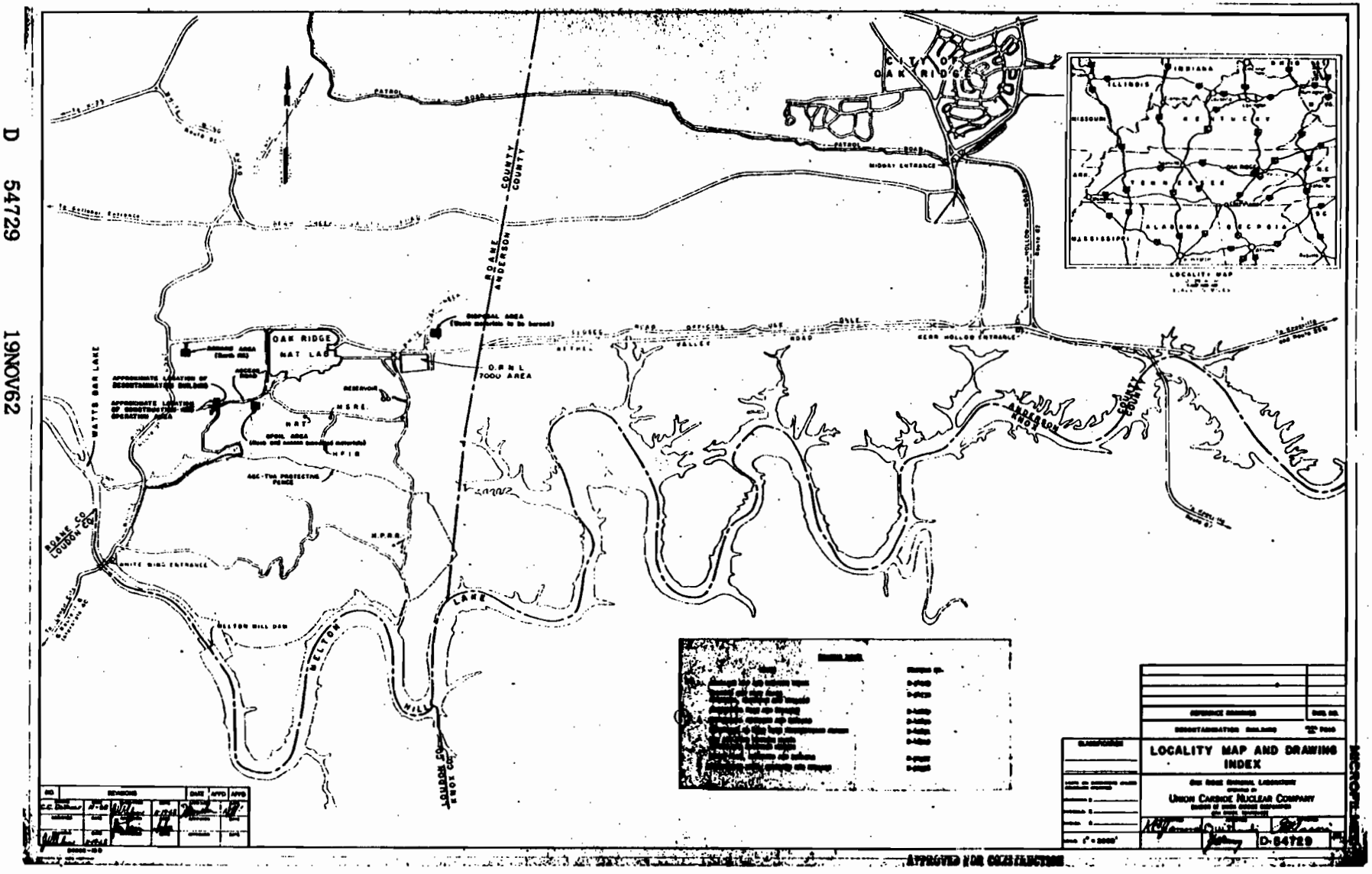

TYPICAL PIT SECTION
DETAIL ③
EXISTING VALVE BOX
(AT STA. 0+00)
(CONNECTION BY ORNL)
PLAN
SECTION A-A
DETAIL ④
NEW VALVE BOX
DETAIL ②
TYPICAL OPEN JOINT
PLAN
DETAIL ①
LATERALS TO TRENCHES
INSTRUMENT PAD
(TYPICAL SECTION)
GENERAL NOTES
1. ALL 2" PLASTIC PIPE SHALL BE CRESLINE HD 75# AS MANUFACTURED BY CRESCENT PLASTICS, INC. AND HAVE A MINIMUM COVER OF 3'-0" TO FINISH GROUND.
2. ALL 2" PLASTIC PIPE FITTINGS SHALL BE AS MANUFACTURED BY CRESCENT PLASTICS, INC.
3. ALL 2" CAST IRON FITTINGS SHALL BE AS MANUFACTURED BY MEMPHIS CAST IRON PIPE CO.
4. THE SUPPLY PIPE LINE FROM STATION 0+00 TO THE LATERAL VALVES AT PIT #7 SHALL BE GIVEN A SOAP BUBBLE TEST AT ALL JOINTS, FITTINGS AND VALVES FOLLOWED BY A HYDRO STATIC PRESSURE TEST OF 110 PSI FOR ONE HOUR WITHOUT ANY APPRECIABLE PRESSURE DROP NOTED.
5. ALL COORDINATES AND BEARINGS ARE BASED ON OAK RIDGE GRID SYSTEM.
CHEMICAL WASTE PIT No. 7
PLANS, SECTIONS AND DETAILS
UNION CARBIDE NUCLEAR COMPANY
D-52848
APPROVED FOR CONSTRUCTION



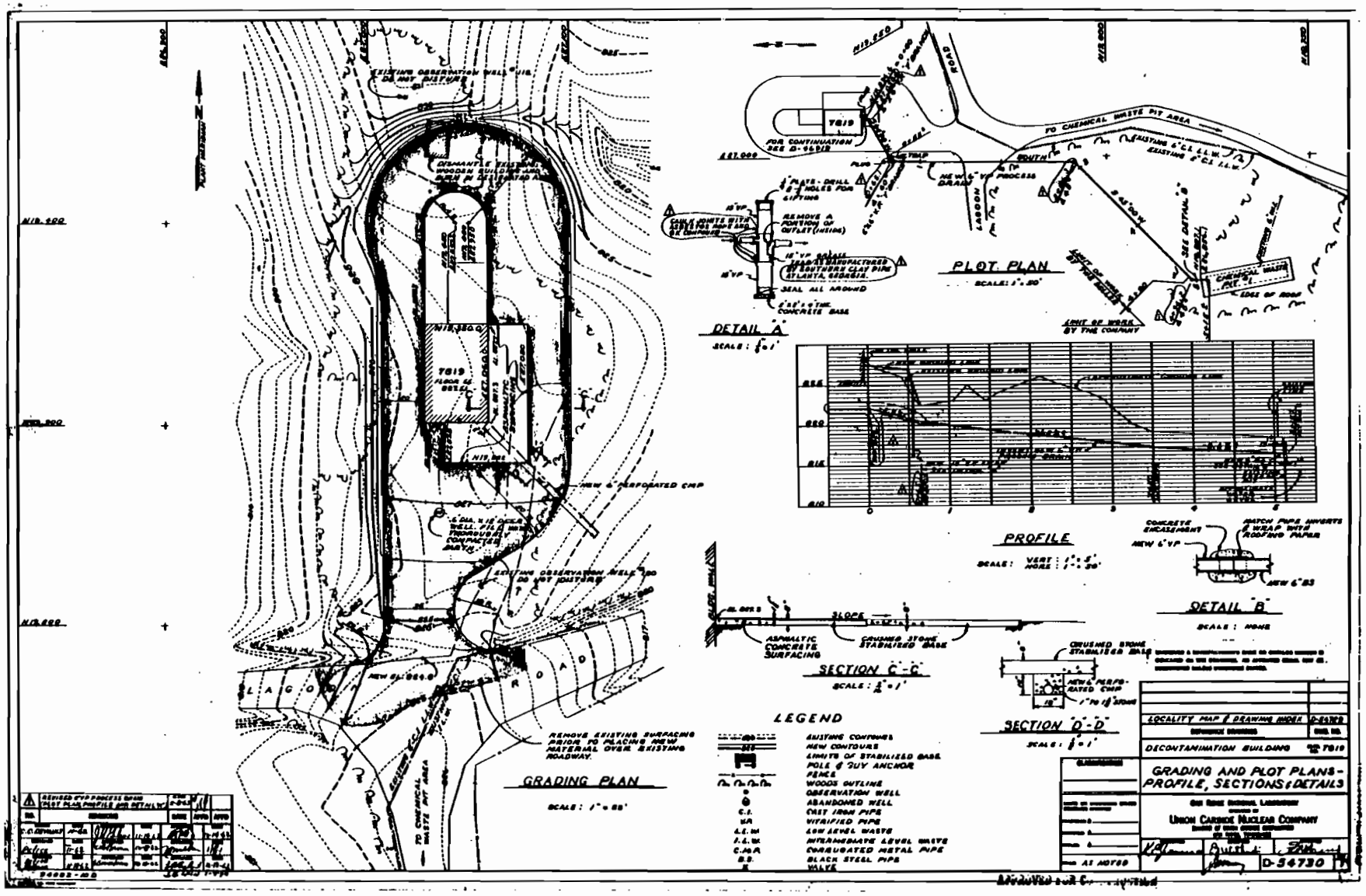
D 52858 18JUL62
Chemical Waste Pit 7, Regional Topography, Sheet 1



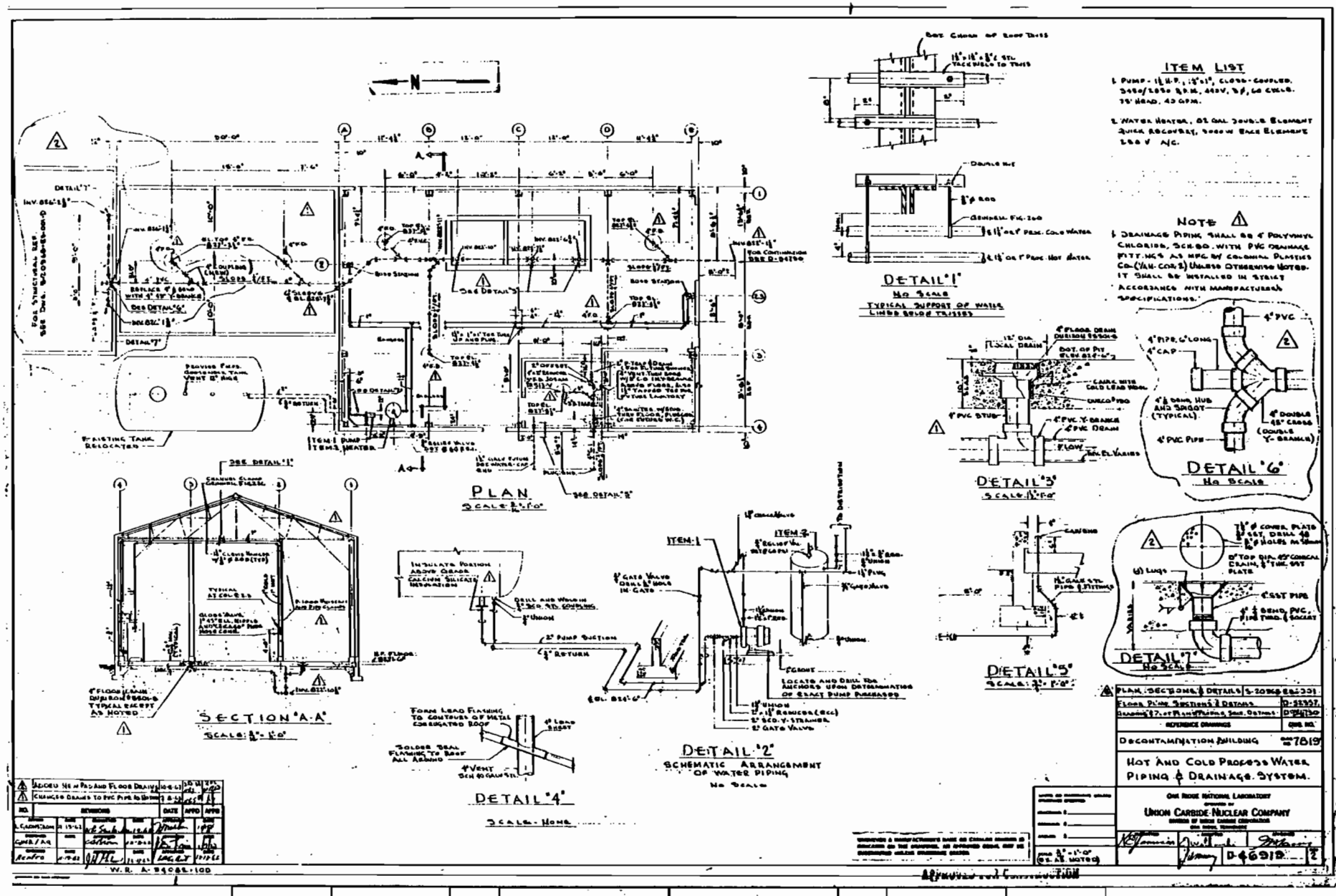
D 52859 18JUL62
Chemical Waste Pit 7, Regional Topography, Sheet 2



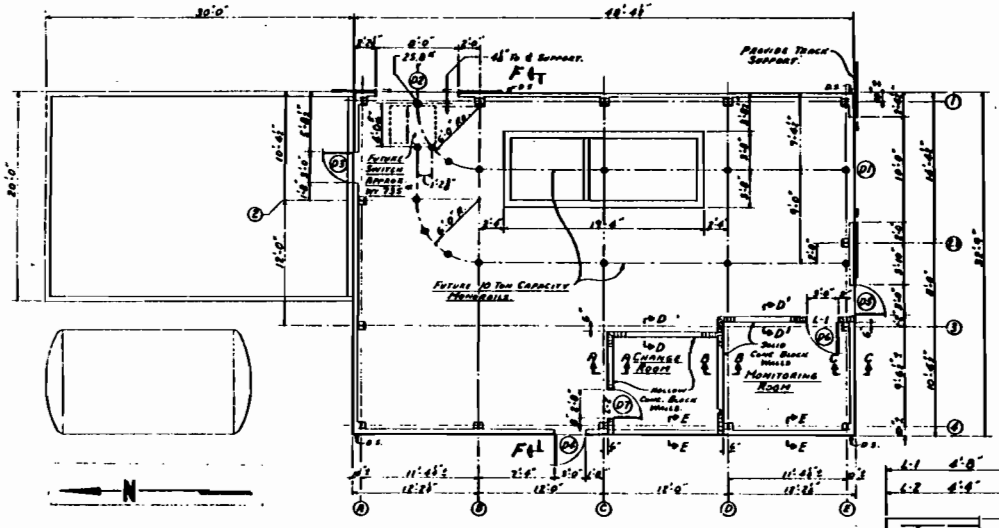
D 54729 19NOV62
Decontamination Bldg 7819, Locality and Index



D 54730 19NOV62
Decontamination Bldg 7819,Grading and Plot Plan



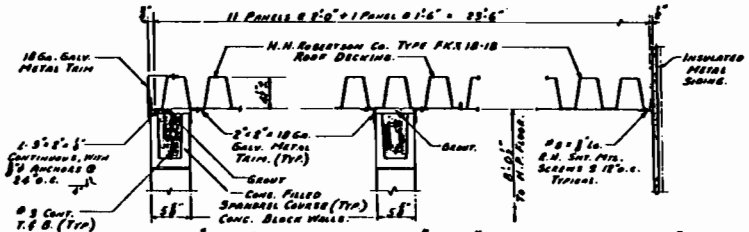
D 46919 13DEC62
Hot and Cold Process Water Piping 7819



FLOOR PLAN

SCALE: ⅛" = 1'-0"

NOTE: ⊕ DENOTES POINT OF MAXIMUM HANGER LOAD. MAX. HANGER LOAD = 22.5K EXCEPT AS INDICATED ON PLAN. SEE SECTION "F-F."



SECTION "A-A"

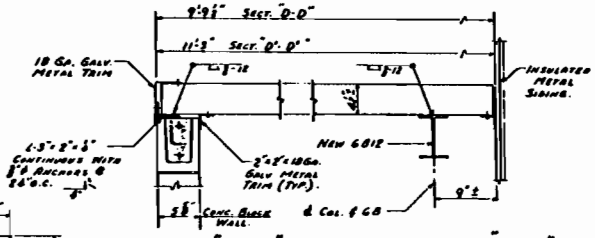
SCALE: 1½" = 1'-0"

SECTION "B-B"

SCALE: 1½" = 1'-0"

SECTION "C-C"

SCALE: 1½" = 1'-0"



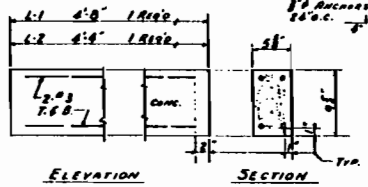
SECTION "D-D"

SECTION "D'-D'"

SCALE: 1½" = 1'-0"

SECTION "E-E"

SCALE: 1½" = 1'-0"



ELEVATION

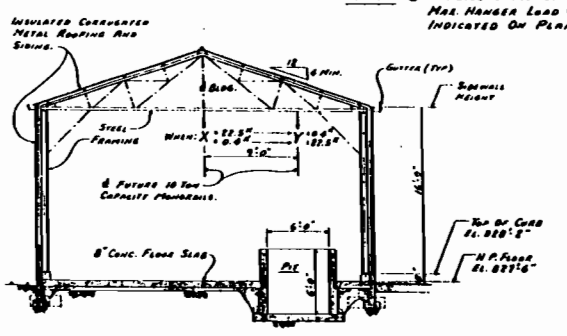
SECTION

LINTEL DETAILS

SCALE: 1½" = 1'-0"

NOTE:

THE BUILDING TRUSSES SHALL BE CAPABLE OF SUPPORTING A 10 TON CAPACITY HOIST. THE MONORAILS AND HOIST ARE NOT A PART OF THIS CONTRACT.



SECTION "F-F"

SCALE: ⅛" = 1'-0"

DOOR SCHEDULE

Mark	Type / Size	Thk.	Action	Material	Frame	Glazing	Remarks	Hdwr. Items Req'd. Additional Mark.
01	10'-0" x 16'-0" S	—	Double Slide	—	Structural Steel	None	Furnished with Building (Insulated)	Complete with Track, Trolleys, Flashing, Door Pulls, Post Bolts, Guides Etc.
02	8'-0" x 16'-0" S							
03	F-3070-62	1¾"	Swing	Hollow Metal		Clear Wire Glass	Furnished With Building	1-2-3-4-8
04								
05								
06	F-3070-62				Pressed Steel		Steelcraft Series S-16	2-6-8-9
07	F-2870-M					None		7-8-9

HARDWARE ITEMS

1. - 1 - "Steelcraft" Mortise Type Panic Exit Device # W-299 (Less Cylinder) ..... US-10.
2. - 1 - Best Universal Lock Co. Cylinder # 1276 On Code 28100 Keying ..... US-13.
3. - 1 - "Steelcraft" Universal Door Closer # W-136 (Gov'y. 3001-1V) ..... Lacquered.
4. - 1 - "Steelcraft" Closer Bracket # W-137 ..... Lacquered.
5. - 1 - "Steelcraft" 5¾" Door Frame Type F-16 ..... Primed.
6. - 1 - "Steelcraft" Mortise Lockset # W-030 (Less Cylinder) ..... US-10.
7. - 1 - "Steelcraft" Push & Pull Plate Kit # W-063 ..... US-10.
8. - 1½ Pr. "Steelcraft" 4½" BB Mortise Hinges # W-405 ..... US-P.
9. - 1 - "Steelcraft" Universal Door Closer # W-130 (Gov'y. 3001-111) ..... Lacquered.

NO.	REVISIONS	DATE	APPD	APPD

Foundation Plan, Sections & Details D-52358

Reference Drawings — Dwg. No.

DECONTAMINATION BUILDING — Date 7819

FLOOR PLAN, SECTIONS & DETAILS

Oak Ridge National Laboratory

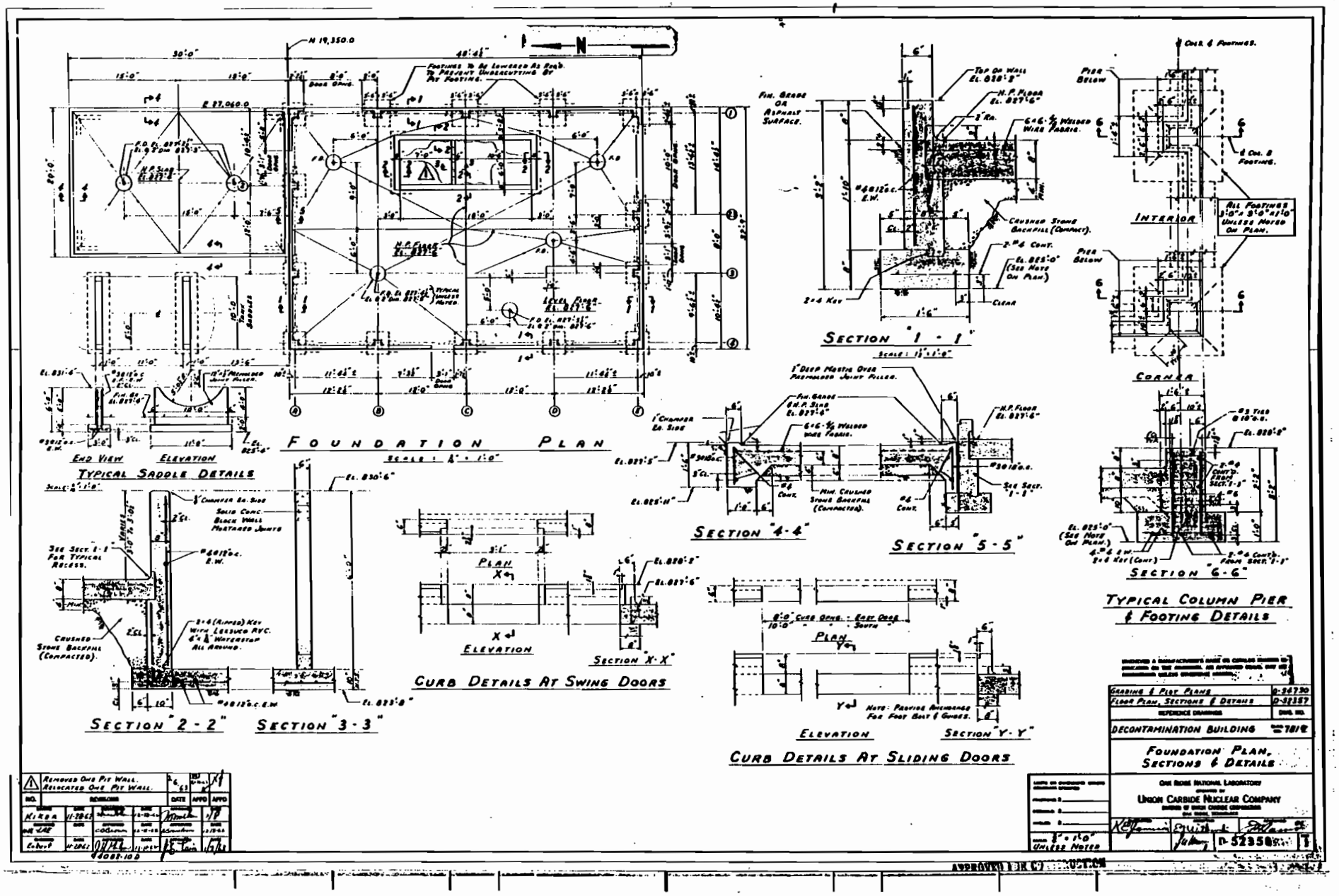
Union Carbide Nuclear Company

As Noted

D-52357

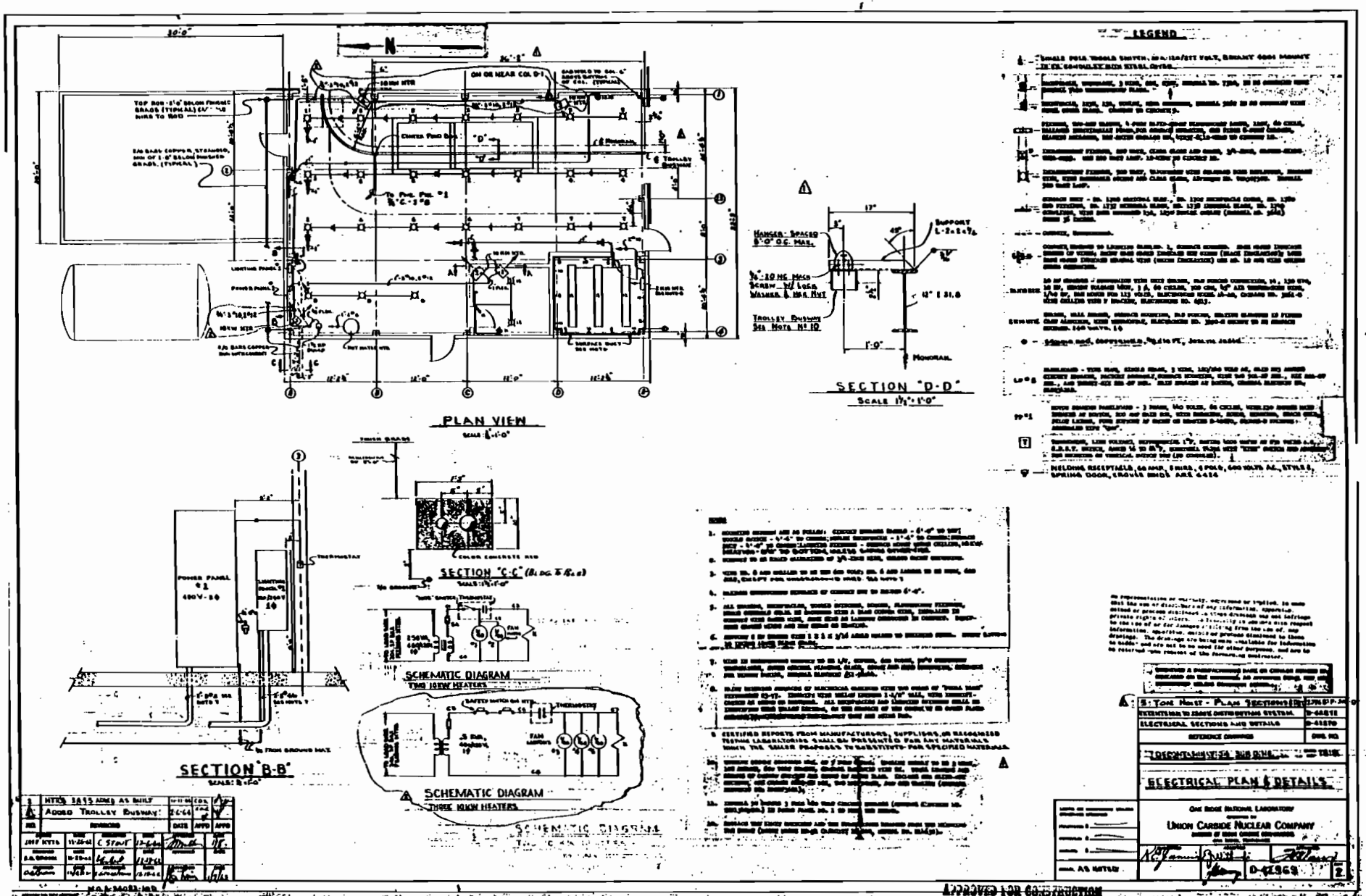
APPROVED FOR CONSTRUCTION

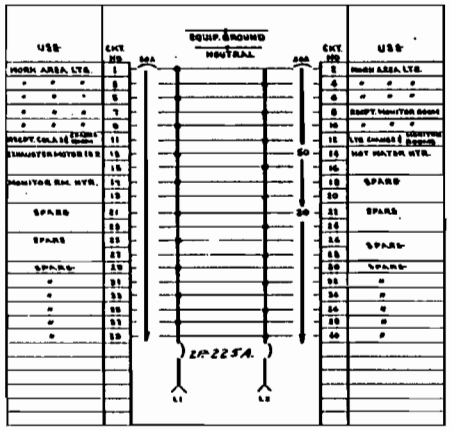
D 52357 07JAN63
Floor Plan, Sections, and Details 7819



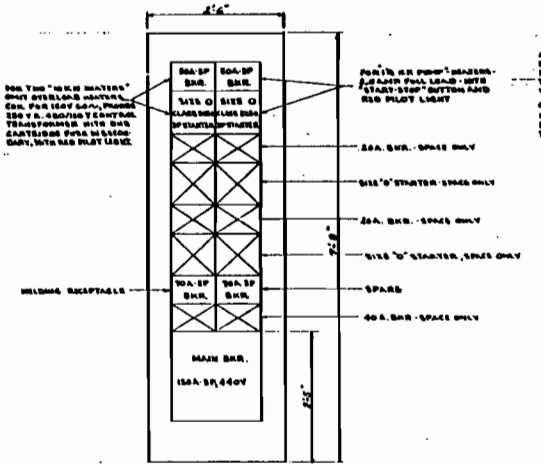
D 52358 07JAN63
Foundation Plans, Sections, and Details 7819

D 42869 08JAN63
Electrical Plan and Details 7819

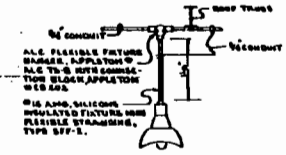




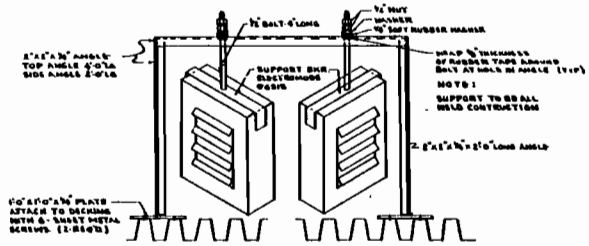
LIGHTING PANEL #1
120/240V-1Φ
NO SCALE



POWER PANEL #1
SCALE: 1"=1'-0"



500 W INCANDESCENT FIXTURE
TYPICAL INSTALLATION
NO SCALE



SECTION "A-A"
NO SCALE

NOTE:
CERTIFIED REPORTS FROM MANUFACTURERS, SUPPLIERS, OR RECOGNIZED TESTING LABORATORIES SHALL BE PRESENTED FOR ANY MATERIAL WHICH THE VENDOR PROPOSES TO SUBSTITUTE FOR SPECIFIED MATERIALS

EXTENSION TO 13.8KV DISTRIBUTION SYSTEM	D-42871
ELECTRICAL PLAN AND DETAILS	D-41868
REFERENCE DRAWINGS	DWG. NO.
DECONTAMINATION BUILDING	DWG. NO. 7819

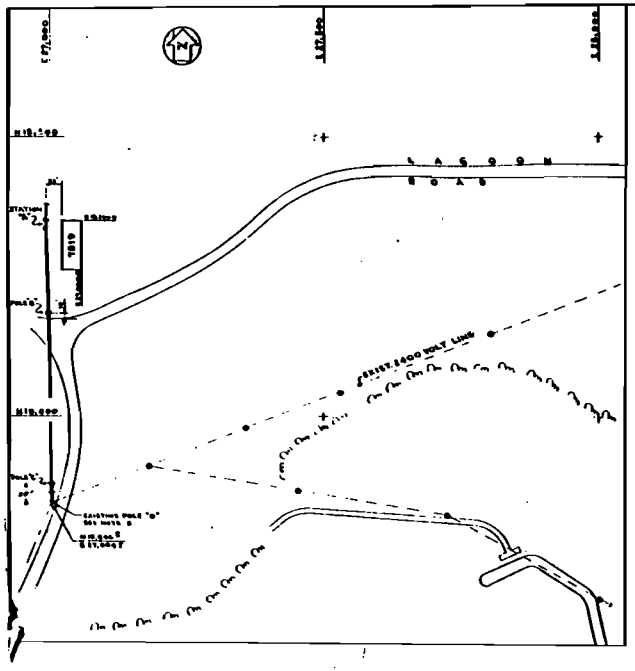
ELECTRICAL SECTIONS & DETAILS

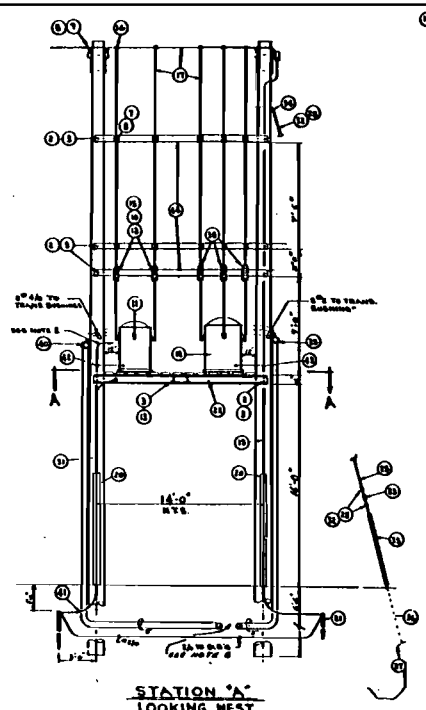
ONE RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
DIVISION OF UNION CARBIDE CORPORATION
OAK RIDGE, TENNESSEE

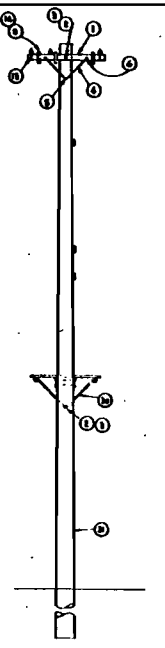
D-42870

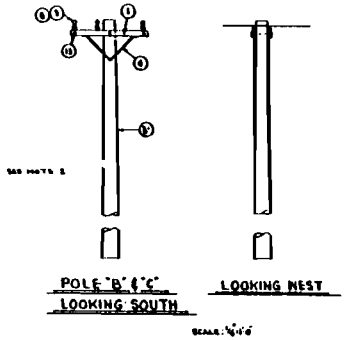
NO.	REVISIONS	DATE	APPD	APPD

APPROVED FOR CONSTRUCTION









NOTES

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
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40. [illegible]
41. [illegible]
42. [illegible]
43. [illegible]
44. [illegible]

NOTES

1. [illegible]
2. POLE "B" IS SAME OUT BACK AS SHOWN FOR POLE "A"
3. AT EXISTING POLE "B" THE 3 WIRES ARE TO BE TIED TO POLE ABOVE GROUND LEVEL. [illegible] OF WIRE ON POLE "B" IS GOOD.
4. [illegible]
5. [illegible]
6. SEE ALSO E-42869 FOR DETAILS OF CONCRETE ENVELOPE ENVELOPE TO RISE UP TO 6" ABOVE GRADE WHERE CONDUIT RISES UP POLE.
7. CERTIFIED REPORTS FROM MANUFACTURERS, SUPPLIERS, OR RECOGNIZED TESTING LABORATORIES SHALL BE PRESENTED FOR ALL MATERIAL MANUFACTURER DEALER PROPOSES TO SUBSTITUTE FOR SPECIFIED MATERIALS

ELECTRICAL SECTIONS AND DETAILS	D-41870
ELECTRICAL PLAN AND DETAILS	D-41869
REFERENCE DRAWINGS	DWG. NO.
DECONTAMINATION BUILDING	TB18

EXTENSION TO 2300V DISTRIBUTION SYSTEM

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE NUCLEAR COMPANY
DIVISION OF UNION CARBIDE CORPORATION
OAK RIDGE, TENNESSEE

D-42871

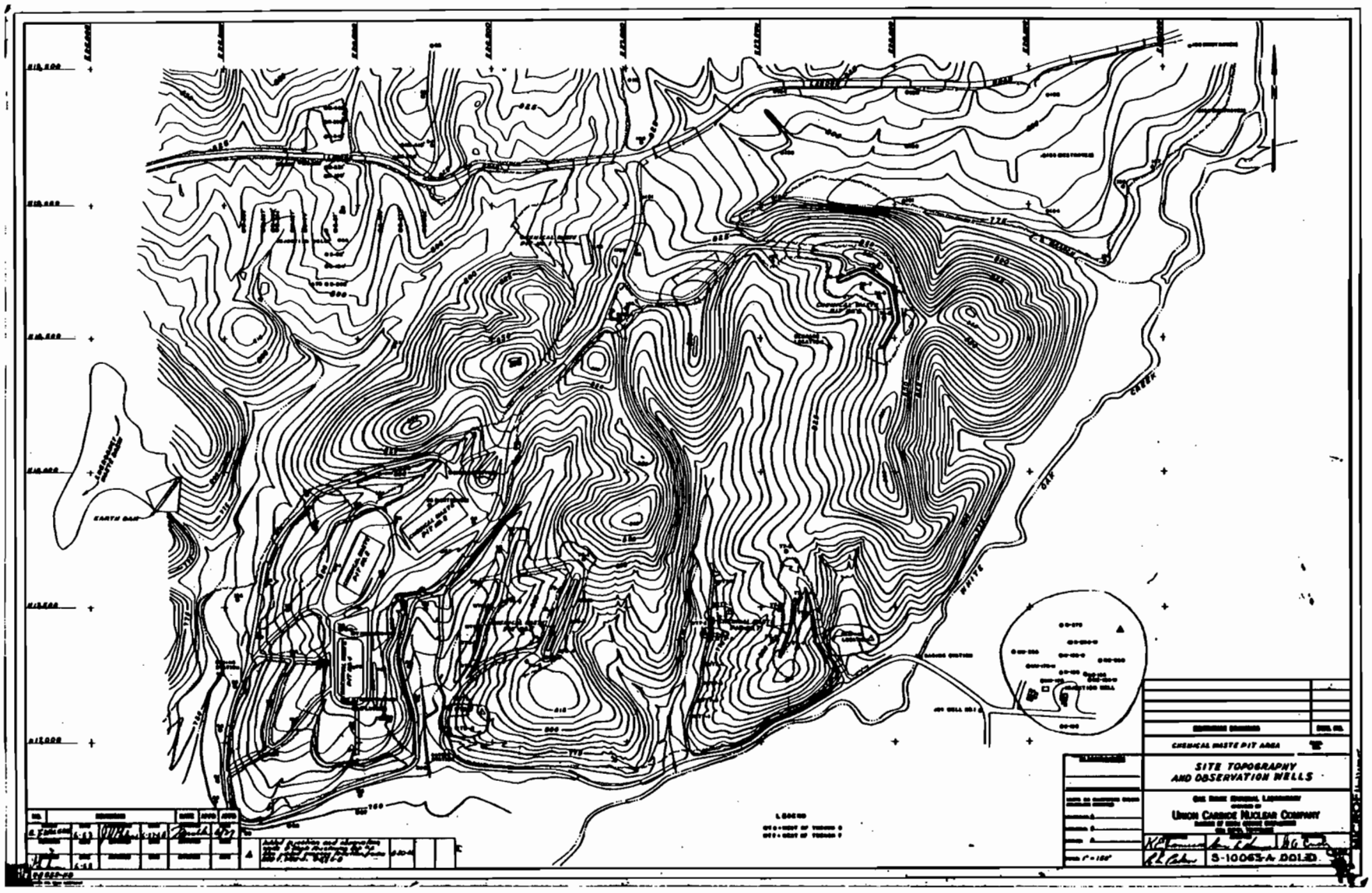
AS NOTED

NO.	REVISIONS	DATE	APPD	APPD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

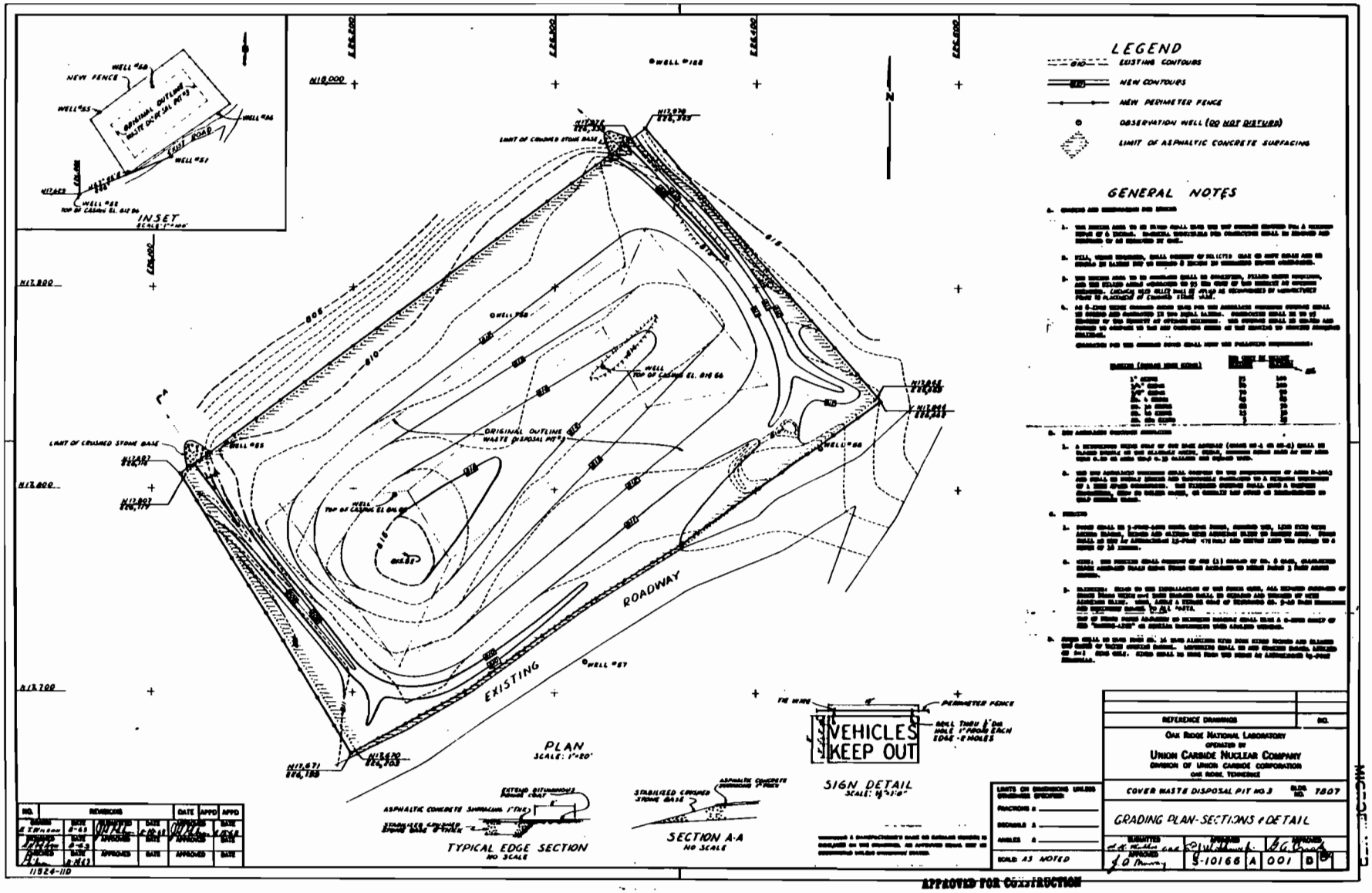
N.O.A. 34081-108

APPROVED FOR CONSTRUCTION

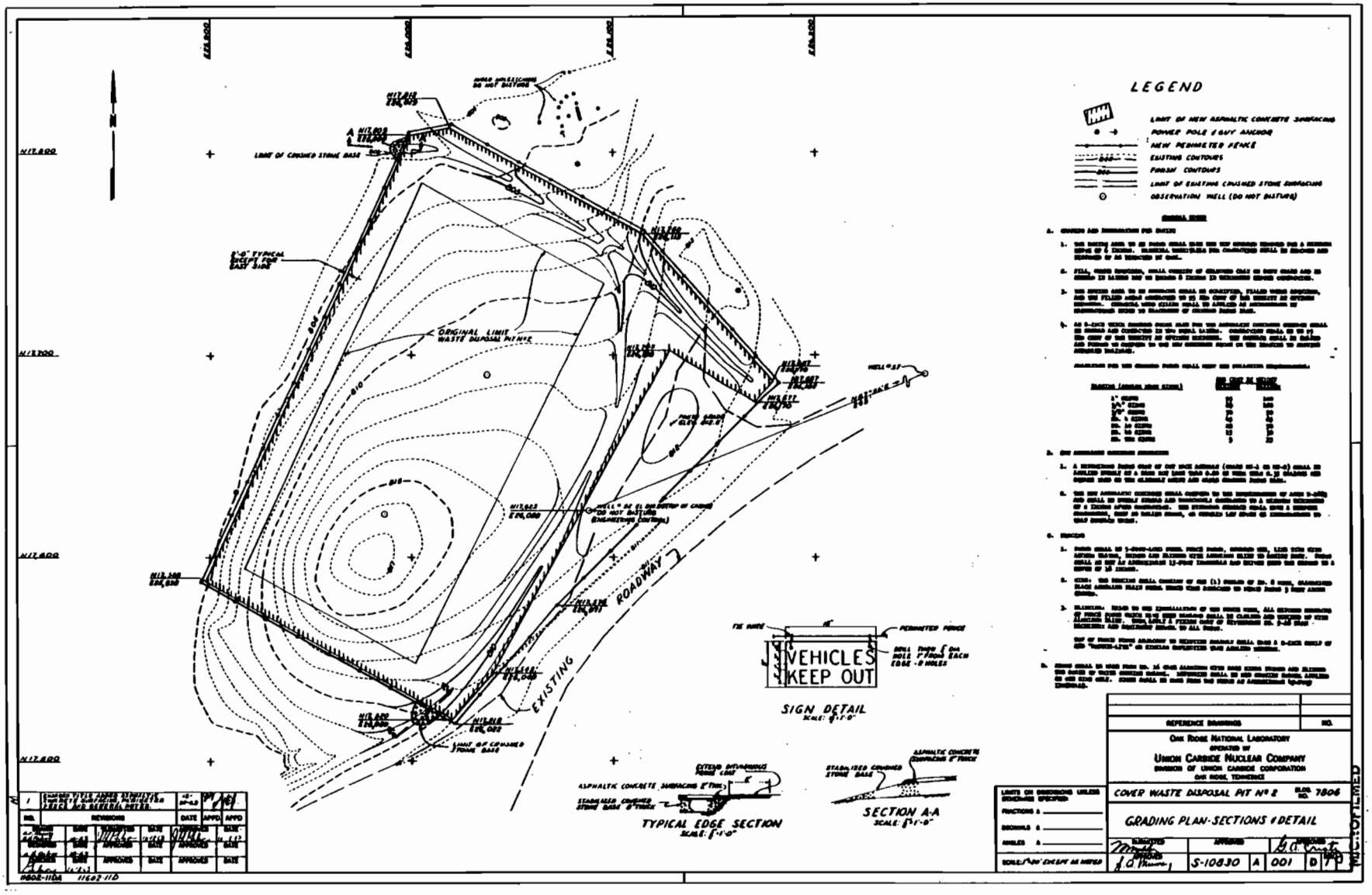
D 42871 08JAN63
Extension to 2300V Distribution System for 7819



S 10063 A001D 27JUN63
Chemical Waste Pit Area-Site Topography and Wells



S 10166 A001D 15AUG63
Cover Waste Pit 3, Grading Plan-Sections and Details

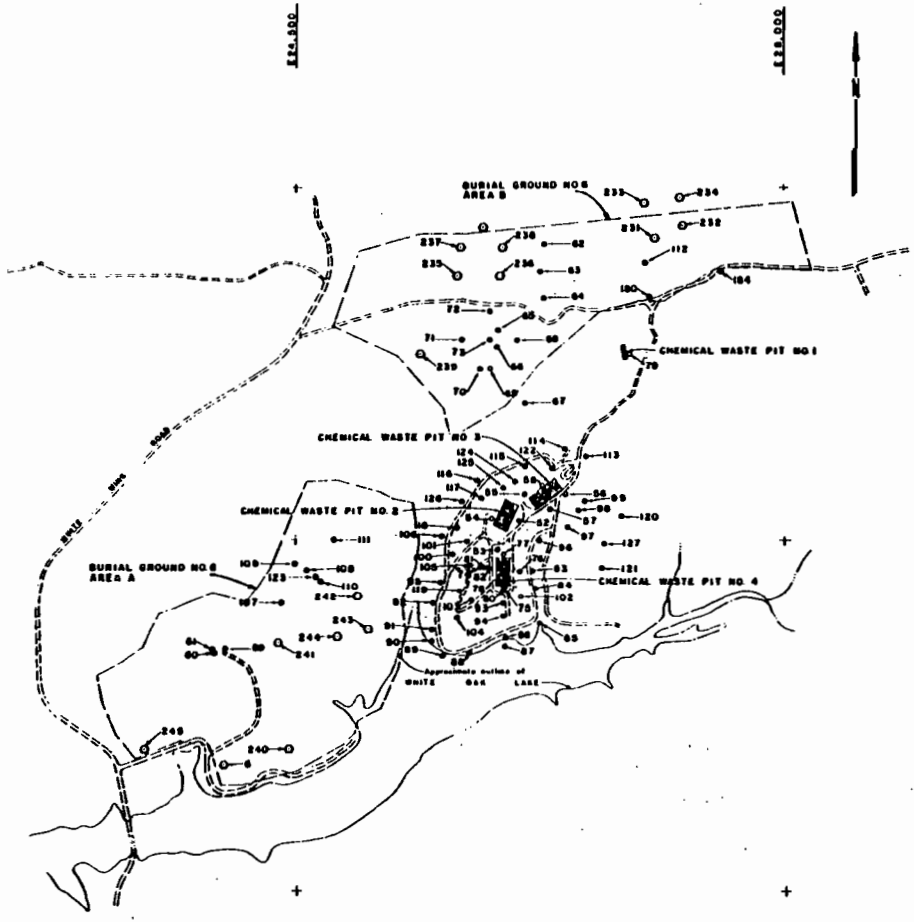


S 10830 A001D 180CT63
Cover Waste Pit 2, Grading Plan-Sections and Details

D 23680 30JAN64

Wells plan, elevations, and coordinates

MATERIALS LIST					
ITEM NO.	DWG. NO.	QTY.	NAME	SIZE	MATERIAL



LEGEND

53 — Observation well and number

240 — Observation well and number (Exact location not established)

Well No	North Coordinate	East Coordinate	Top of Casing Elevation
52	17,623	26,088	812.96
53	17,521	25,938	810.65
54	17,652	25,907	803.84
55	17,823	26,137	810.90
56	17,821	26,422	811.84
57	17,719	26,318	810.71
58	17,696	26,262	813.57
59	16,780	23,998	784.53
60	16,686	23,914	792.57
61	16,715	23,903	782.57
62	19,588	26,280	831.29
63	19,398	26,249	840.70
64	19,213	26,277	833.69
65	18,988	25,845	820.48
66	18,867	25,932	819.83
67	18,458	26,136	781.33
68	18,919	26,083	802.85
69	18,719	25,883	807.47
70	18,719	25,834	805.55
71	18,919	25,683	802.80
72	18,118	25,883	821.02
73	18,919	25,883	816.33
74	17,307	25,956	794.87
75	17,159	25,984	802.64
76	17,274	26,102	797.09
77	17,497	25,984	806.73
78	17,292	25,869	805.73
79	18,037	26,089	829.82
80	17,145	25,984	801.71
81	17,306	26,062	796.23
82	17,304	26,078	798.68
83	17,285	26,191	772.09
84	17,182	26,224	765.68
85	16,910	26,252	759.64
86	16,806	26,009	753.70
87	16,746	26,002	753.39
88	16,695	25,746	754.15
89	16,678	26,856	782.76
90	16,782	26,473	753.95
91	16,850	26,460	756.29
92	17,046	26,460	760.23
93	17,058	26,964	798.19
94	16,960	26,885	785.51
95	17,200	26,842	759.96
96	17,498	26,291	763.21
97	17,598	26,403	780.44
98	17,716	26,931	785.71
99	17,777	26,876	788.69
100	17,408	26,631	765.49
101	17,498	26,732	788.17
102	17,093	26,117	797.06

Well No	North Coordinate	East Coordinate	Top of Casing Elevation
103	17,074	26,760	794.70
104	16,957	26,660	782.90
105	17,326	25,756	785.70
106	17,532	25,850	764.72
107	17,041	24,402	813.08
108	17,278	24,584	832.66
109	17,330	24,429	821.85
110	17,204	24,664	827.12
111	17,802	24,776	842.23
112	19,458	27,012	833.44
113	18,100	26,806	832.02
114	18,148	26,433	815.70
115	18,026	26,195	808.63
116	17,924	25,807	778.78
117	17,802	25,936	783.87
118	17,967	25,646	772.77
119	17,139	25,680	787.68
120	17,676	26,640	824.63
121	17,306	26,688	811.26
122	16,011	26,348	806.78
123	17,234	24,644	827.87
124	17,816	26,079	790.04
125	17,874	25,995	788.11
126	17,779	25,698	772.93
127	17,476	26,719	*incomplete*

NOTE:
Datum is mean sea level. Coordinates refer to the Oak Ridge Area plane coordinate system.

REFERENCE DRAWINGS	DWG. NO.

NO	REVISIONS	DATE	APPR	APPR
3	Added wells 8, 100, 101 and 102 Moved well 5 to side. Added buried ground tub wells 1-7	1-30-64		
2	Wells 88-127 added. Elev. of wells 74-77 corrected. Elev. of well 76 changed. Dwgs. added	9-24-63		
1	Wells 73, 74, 77, & 78 added. Well 79 was 75. Elev. of well 76 corrected. Legend revised.	9-12-63		

DRAWING NO. D-23680 R-3

DRAWN	DATE	CHECKED	DATE	APPROVED	DATE
R.M.S.	6-5-63		6-5-63	RKS	7-2-63
DESIGNED	DATE		DATE	APPROVED	DATE

HEALTH PHYSICS	CHEMICAL	OPERATIONS	SAFETY
FIRE PROTECTION	RESEARCH SHOP	MAINTENANCE	

OBSERVATION WELLS

LOCATION PLAN
ELEVATION & COORDINATE TABULATION

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
NEW YORK, NEW YORK

DRAWN | ACCEPTED | APPROVED

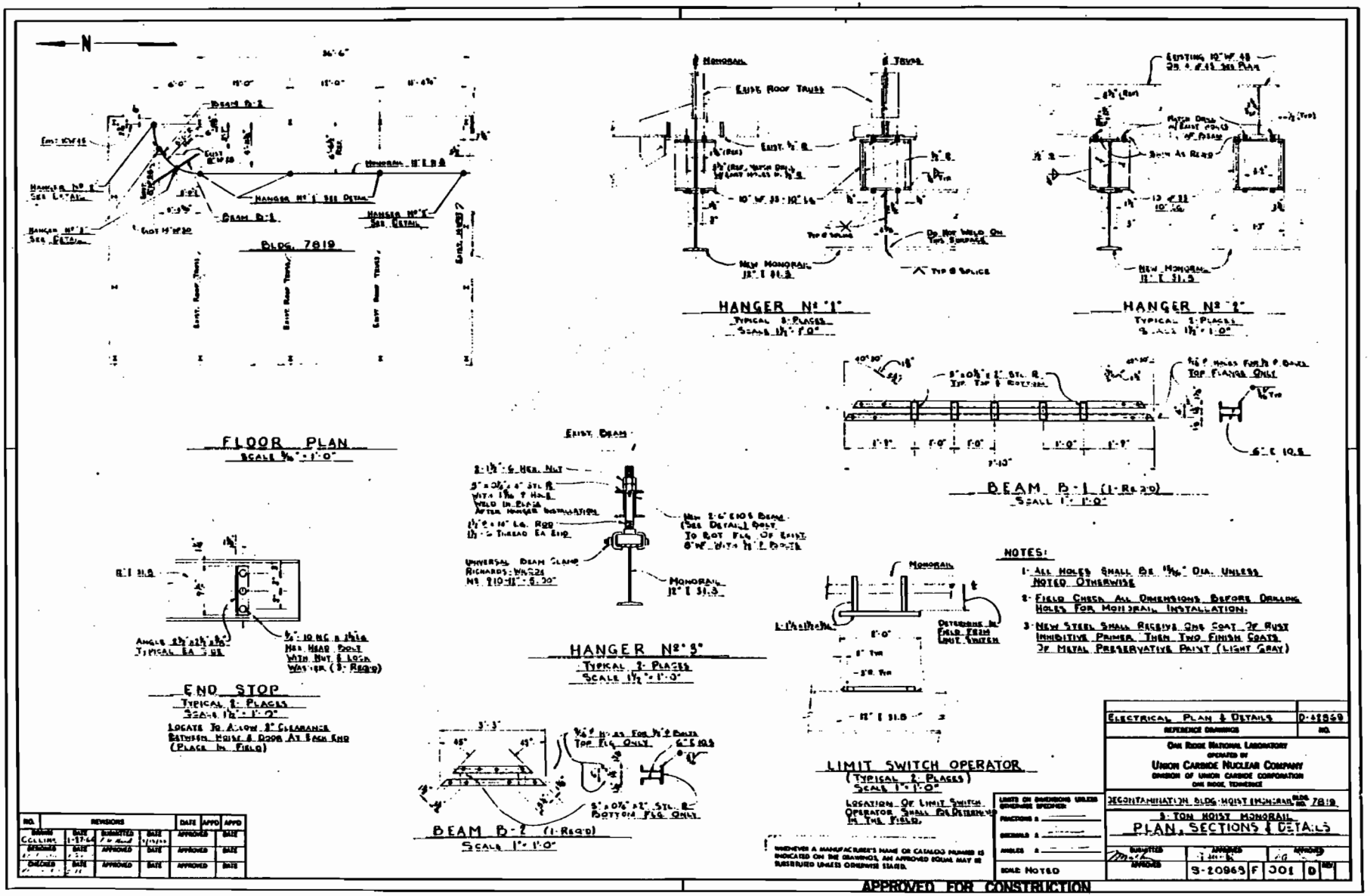
D-23680 | REV. 3

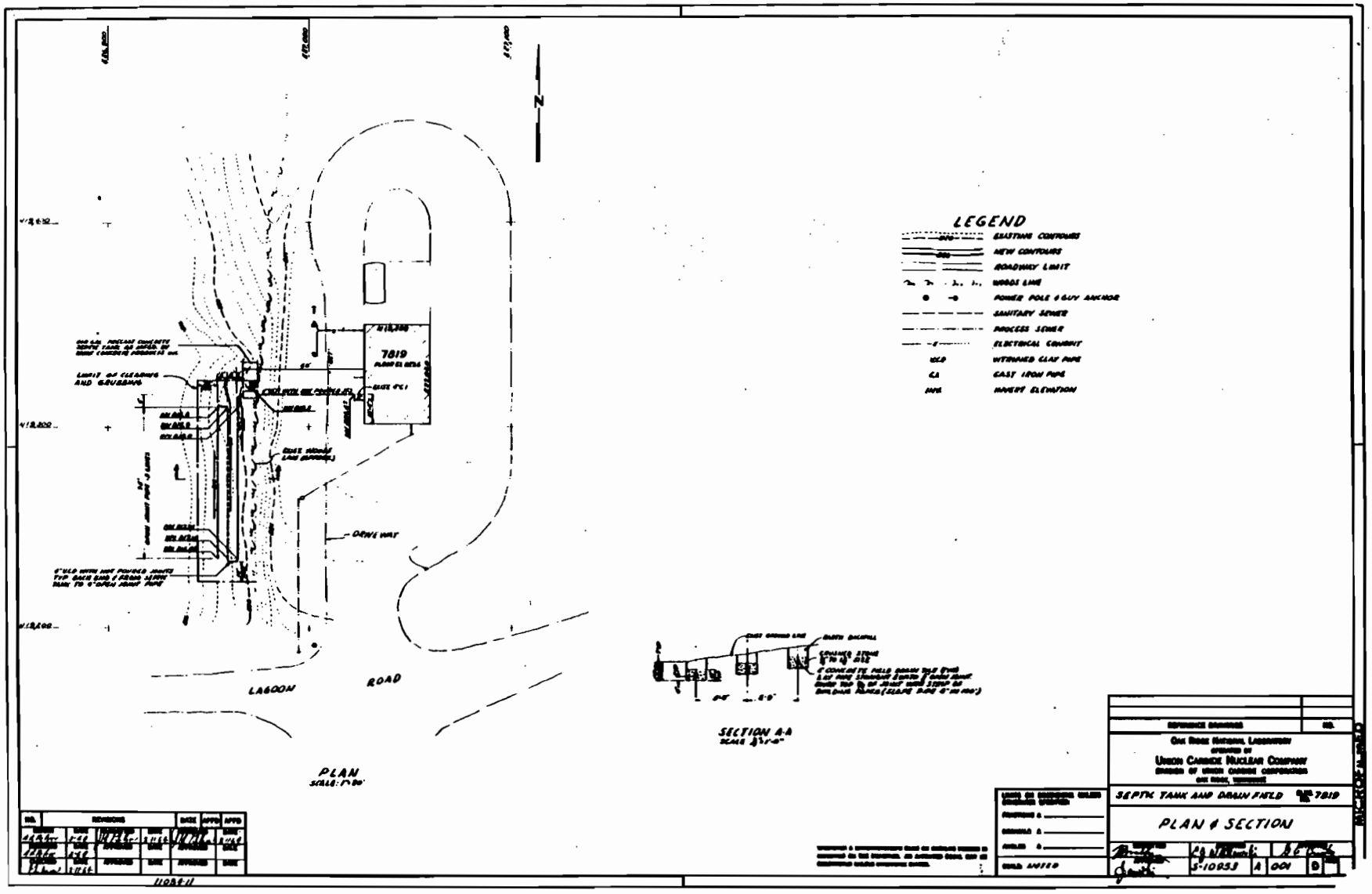
THIS DRAWING CLASSIFIED AS Not classified
PER
SCALE 1" = 400'

No representation or warranty, expressed or implied, is made that the use or disclosure of any information, apparatus, method or process disclosed in these drawings may not infringe private rights of others. No liability is assumed with respect to the use of or for damages resulting from the use of any information, apparatus, method or process disclosed in these drawings. The drawings are being made available for information to bidder and are not to be used for other purposes, and are to be returned upon request of the Operating Contractor.

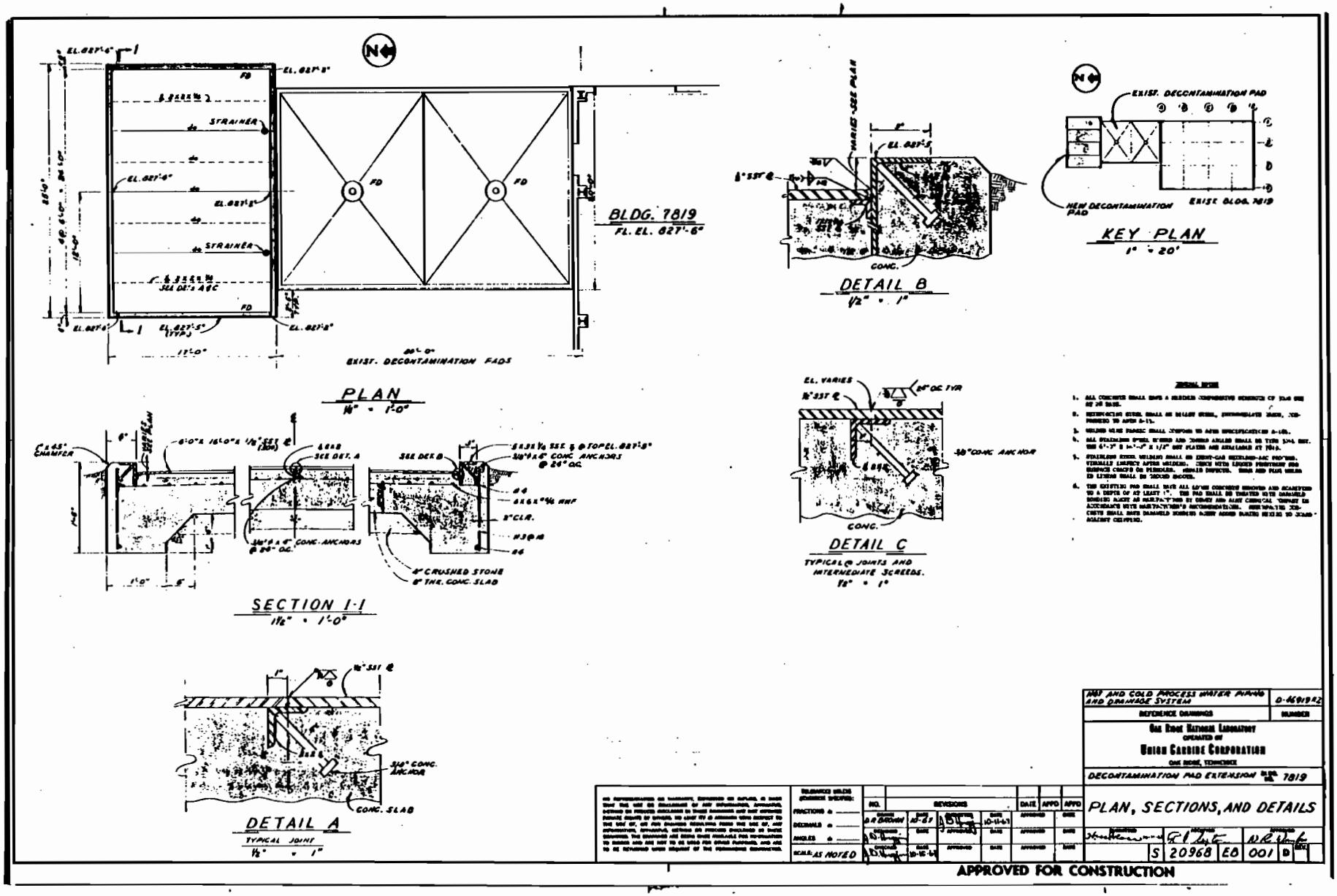
APPROVED FOR CONSTRUCTION

S 20968 F001 13FEB64
5-Ton Hoist Monorail Plan for 7819

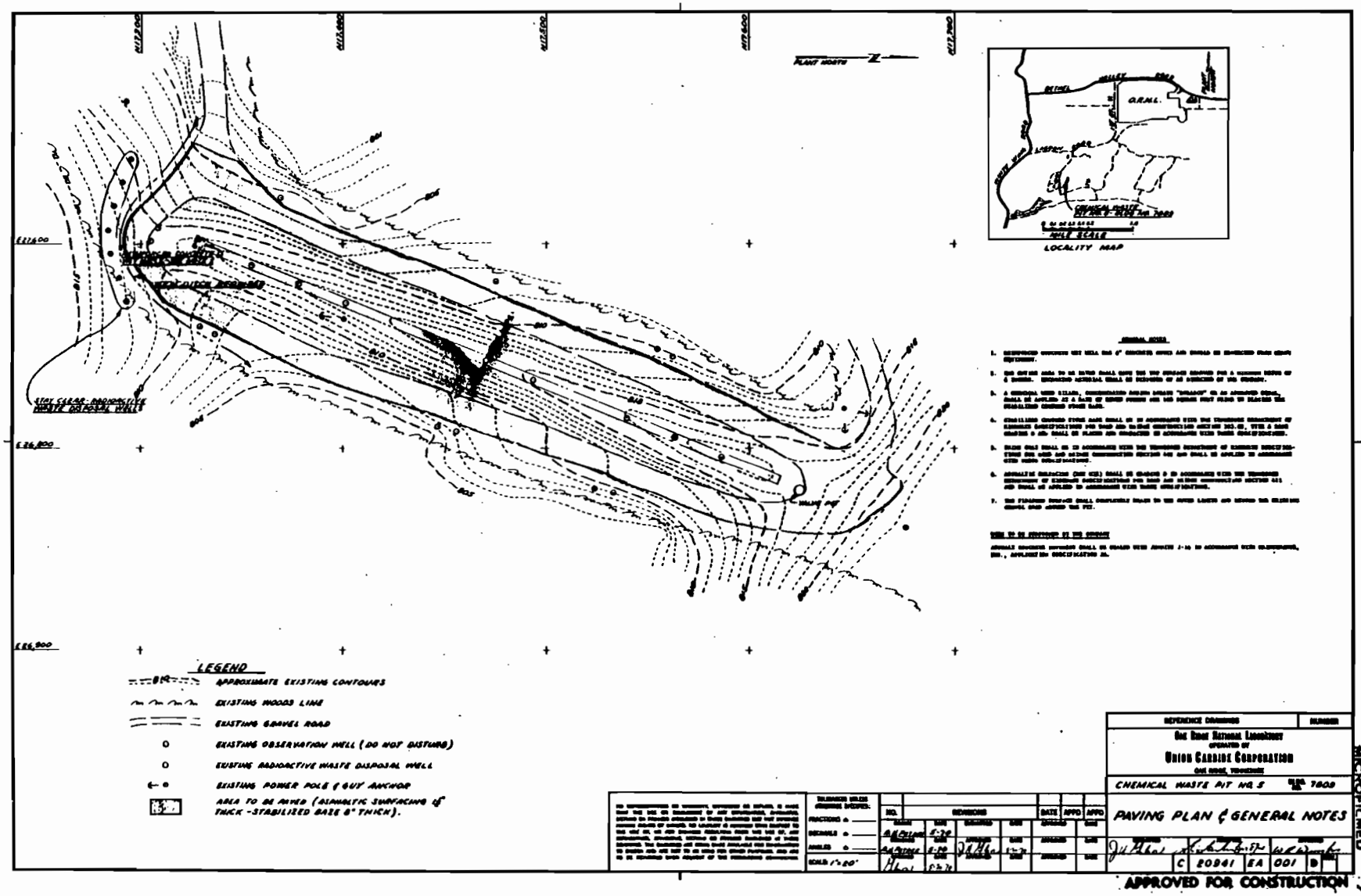




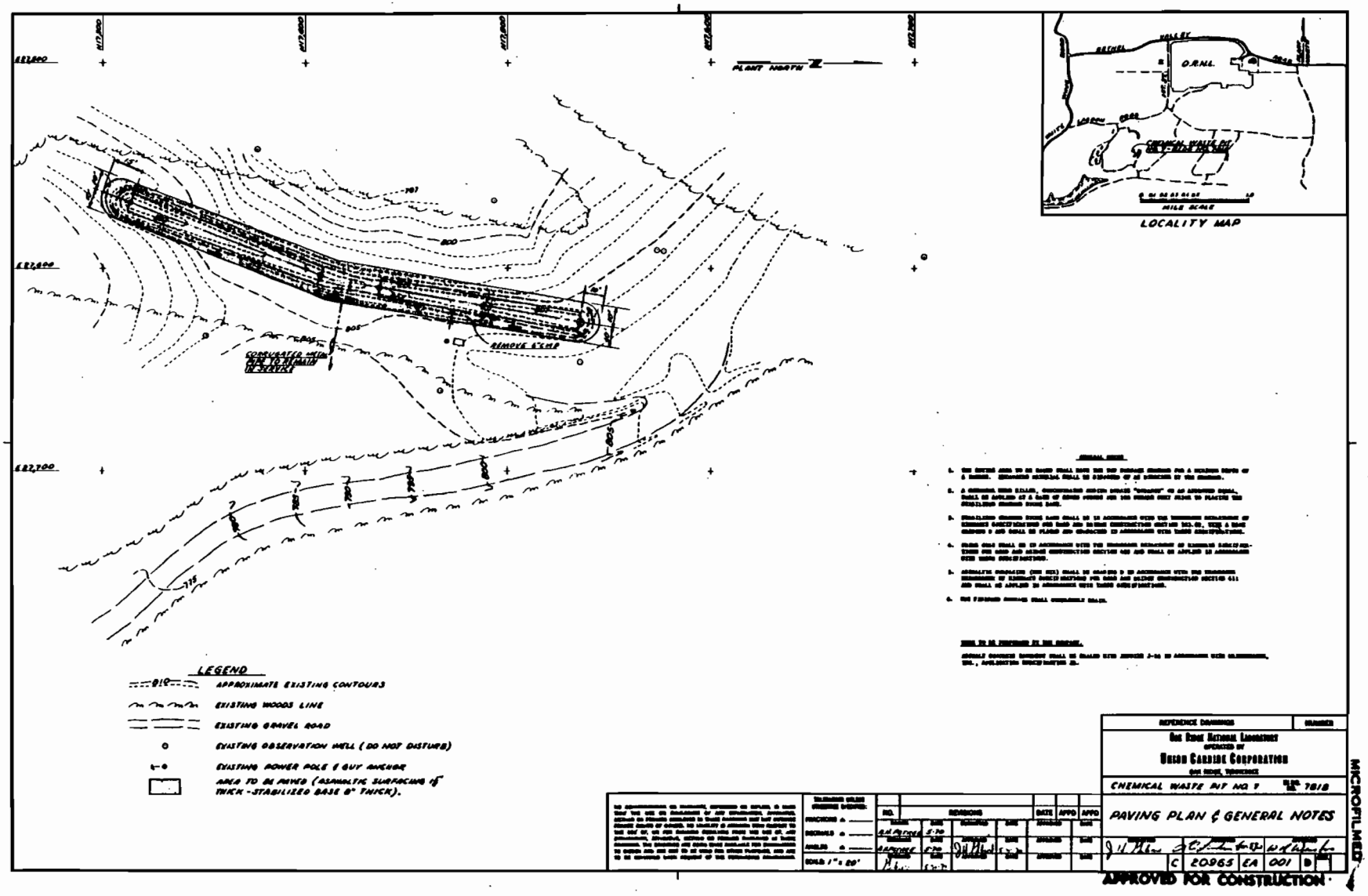
S 10953 A001D 11MAR64
Septic Tank and Drain Field 7819, Plan and Section



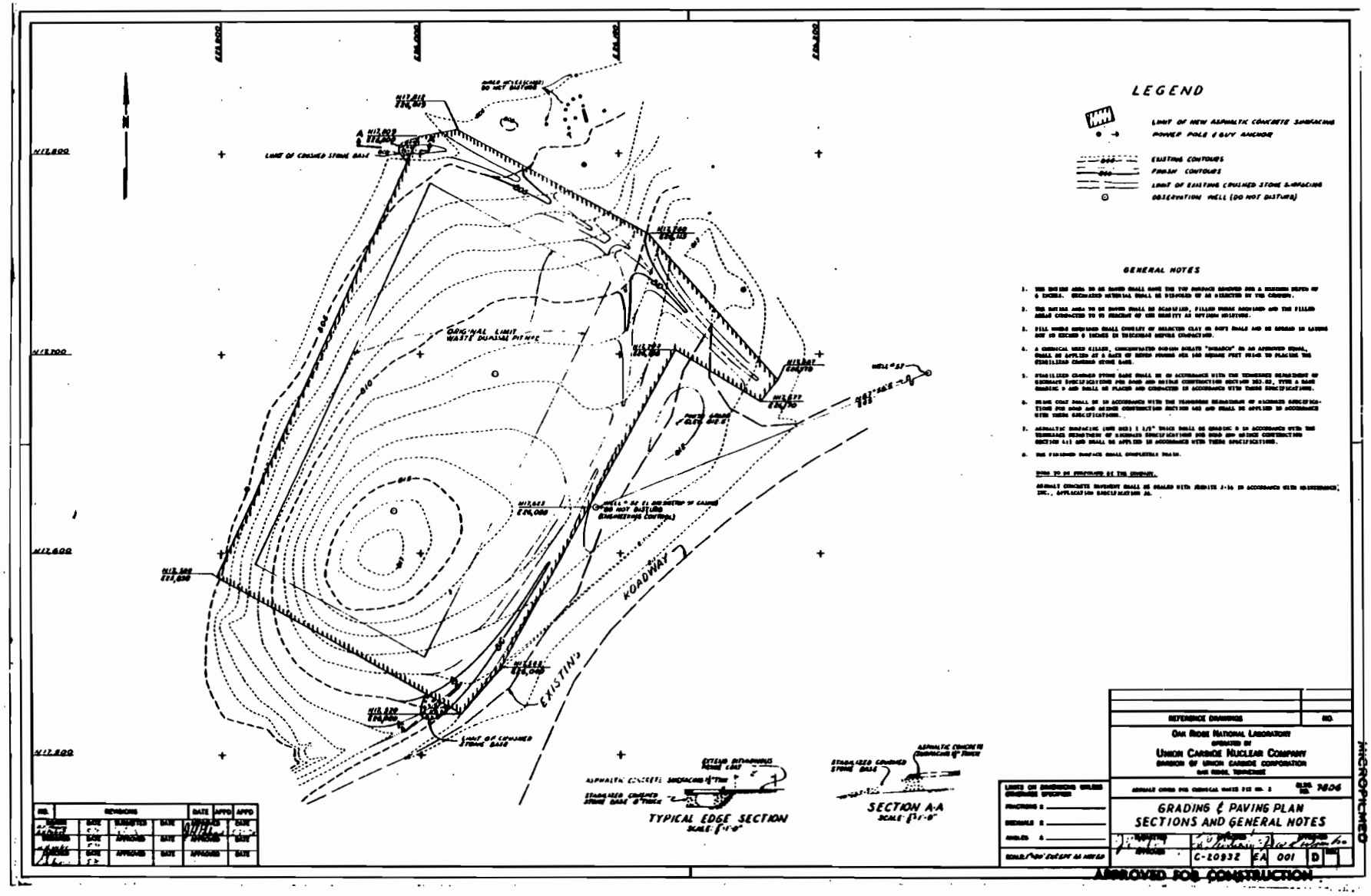
S 20968EB001 . 10OCT67
Decontamination Pad Extension Plan for 7819



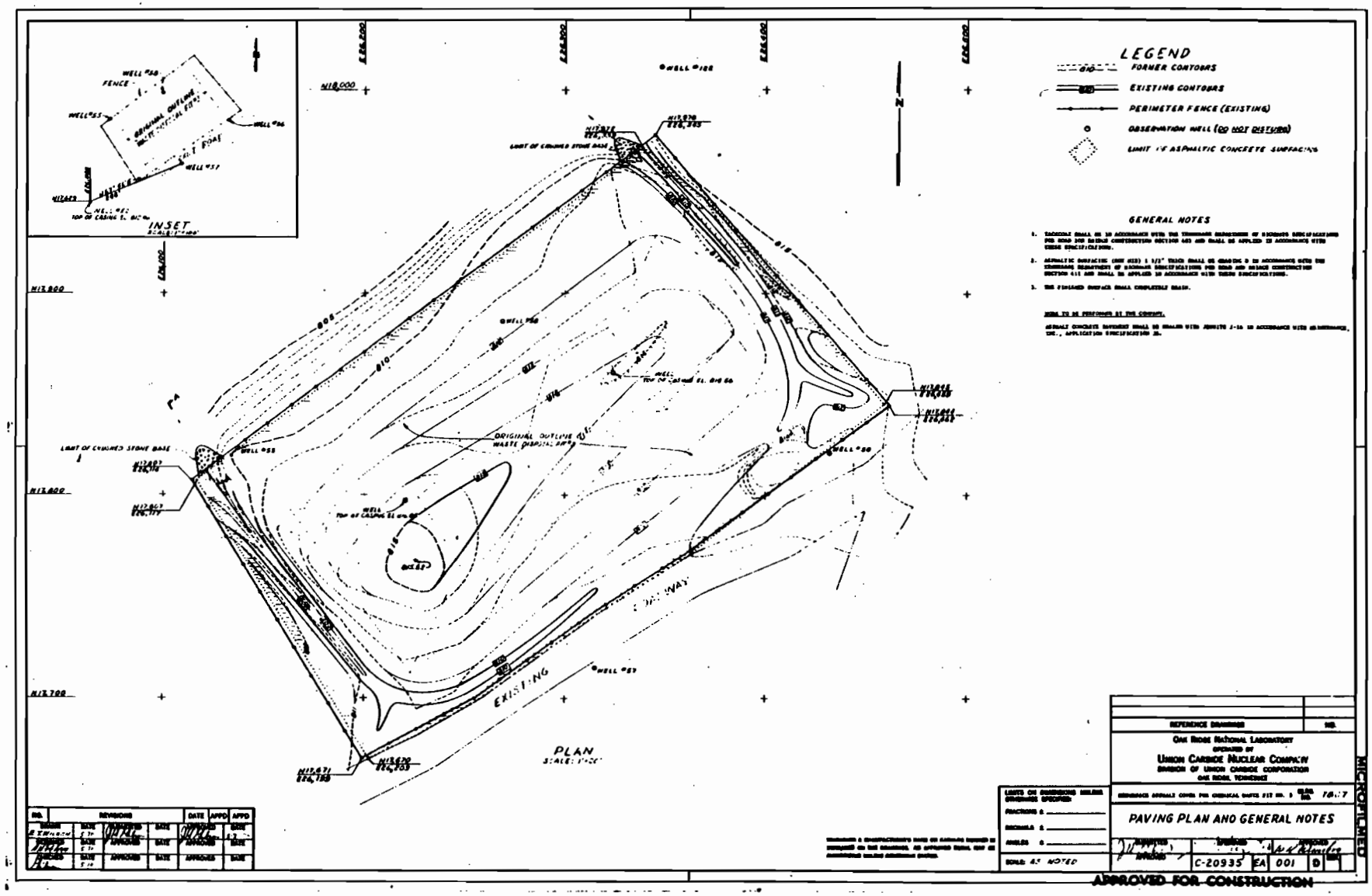
C 20941EA001D 20MAY70
Chemical Waste Pit 5, Paving Plan and Notes



C 20965EA001D 20MAY70
Chemical Waste Pit 7, Paving Plan and Notes

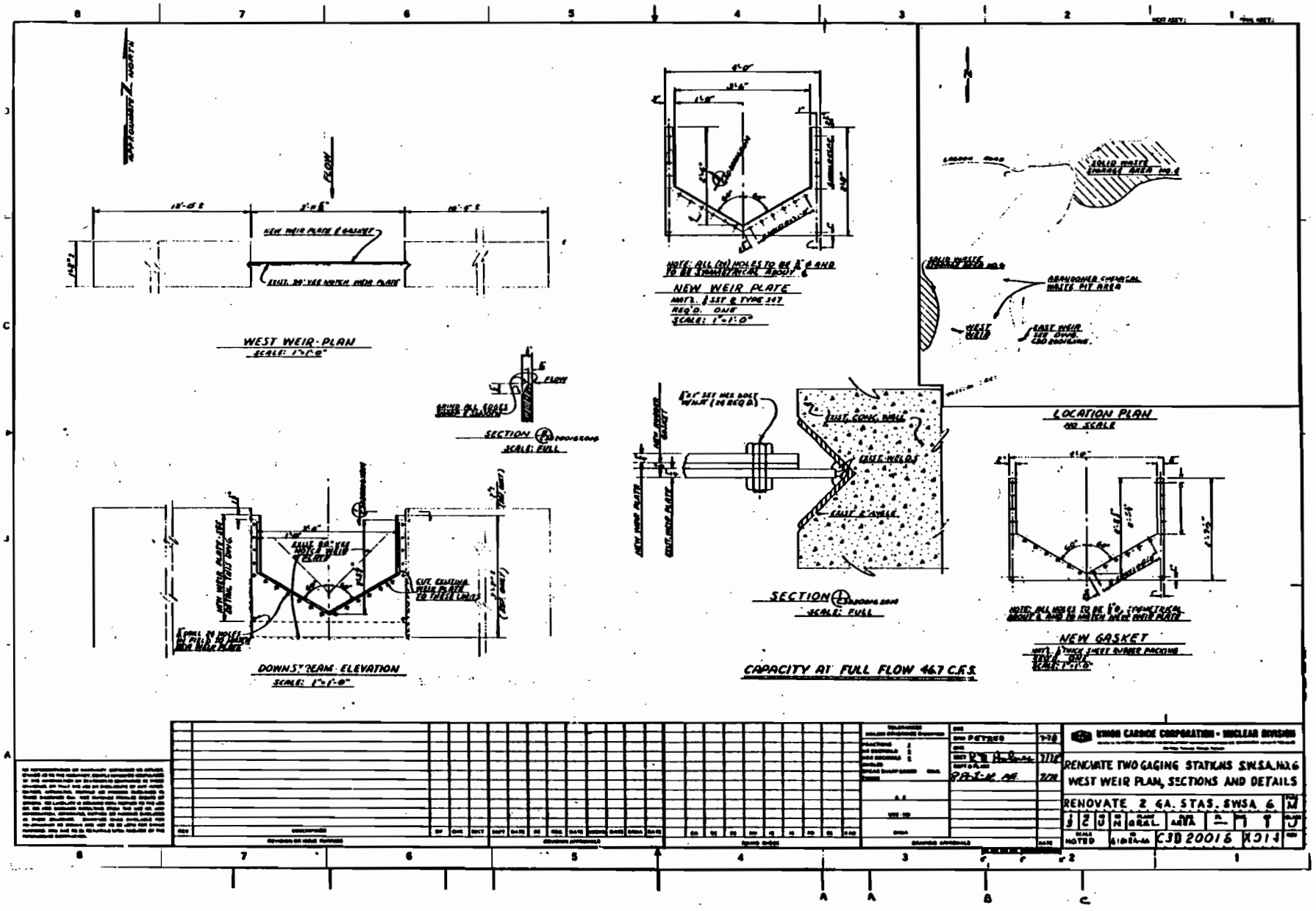


C 20932EA001D 21MAY70
Chemical Waste Pit 2, Asphalt cover, Grading Paving

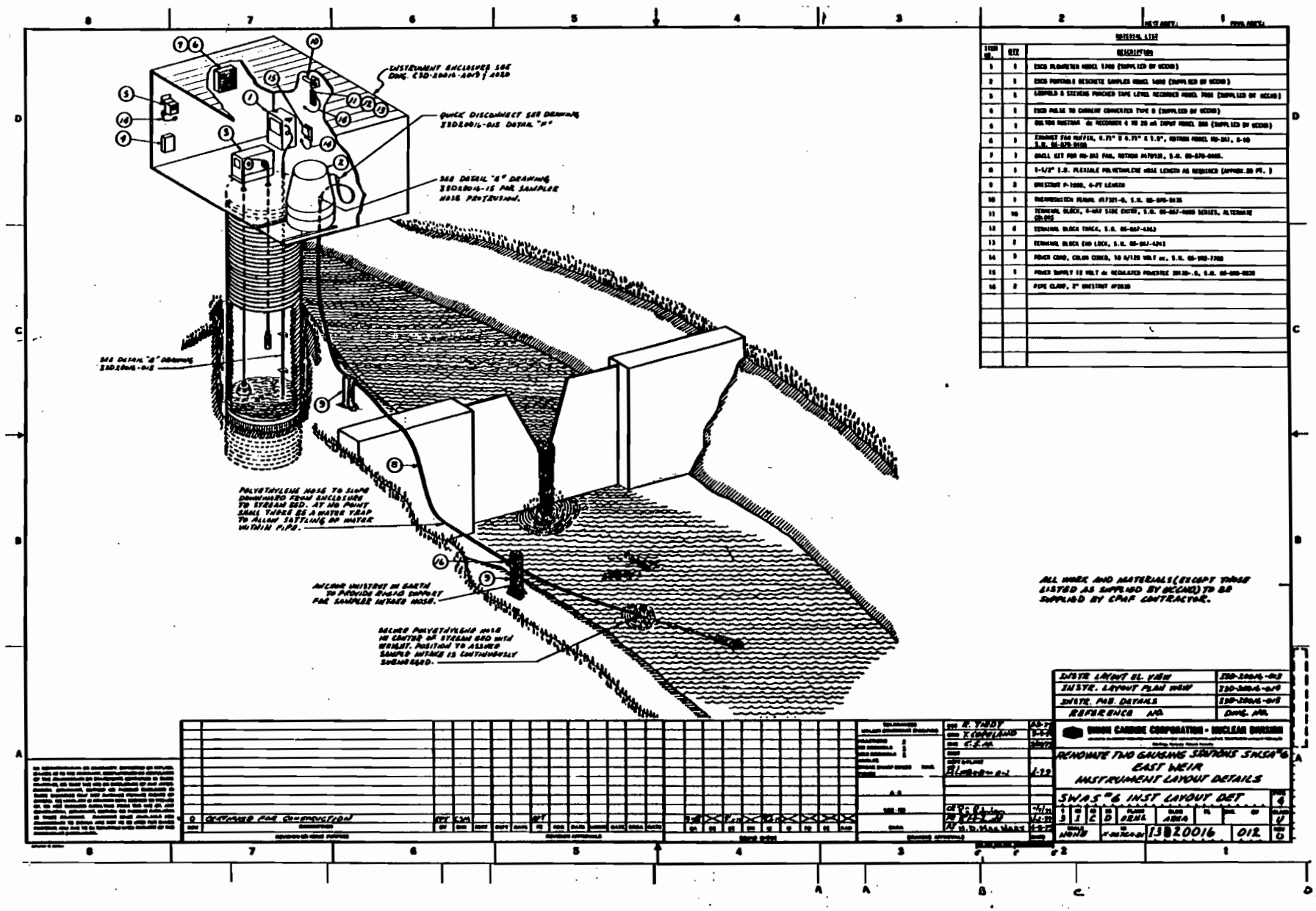


D-65

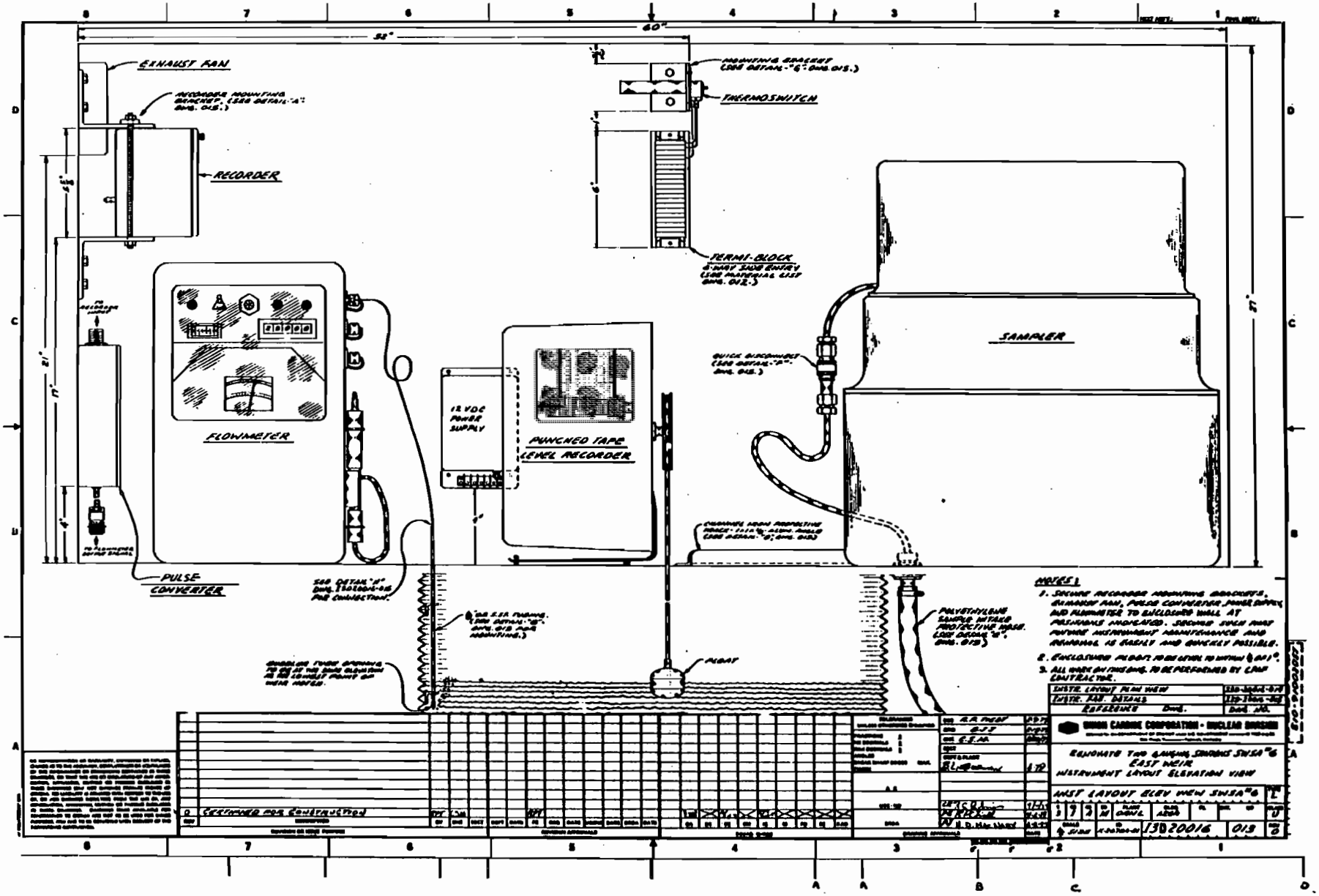
C 20935EA001D 21MAY70
Resurface Cover Chemical Pit 3,Paving Plan and Notes



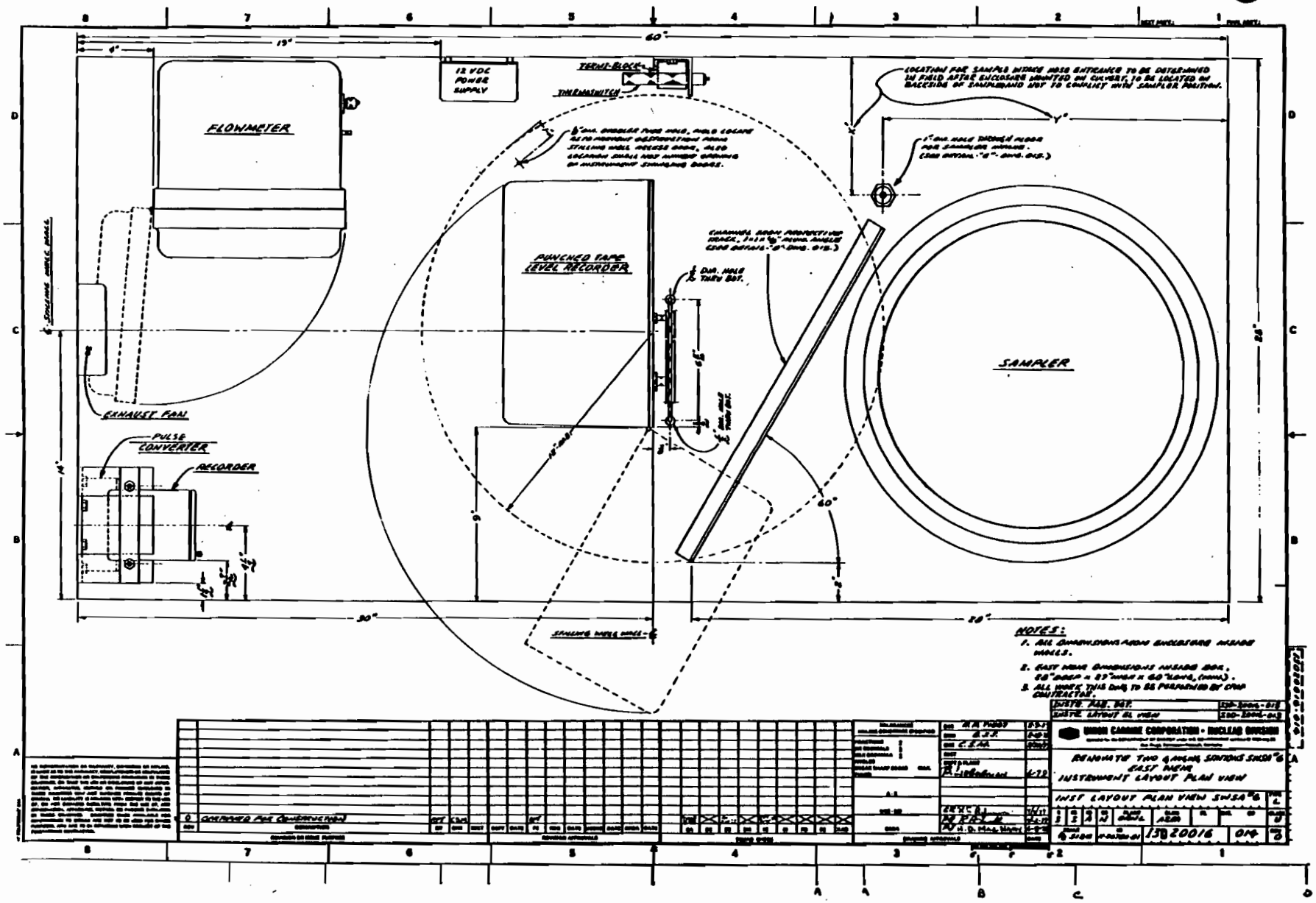
C3E 20016 X014 30JUL78
West Weir Plans, Sections, and Details



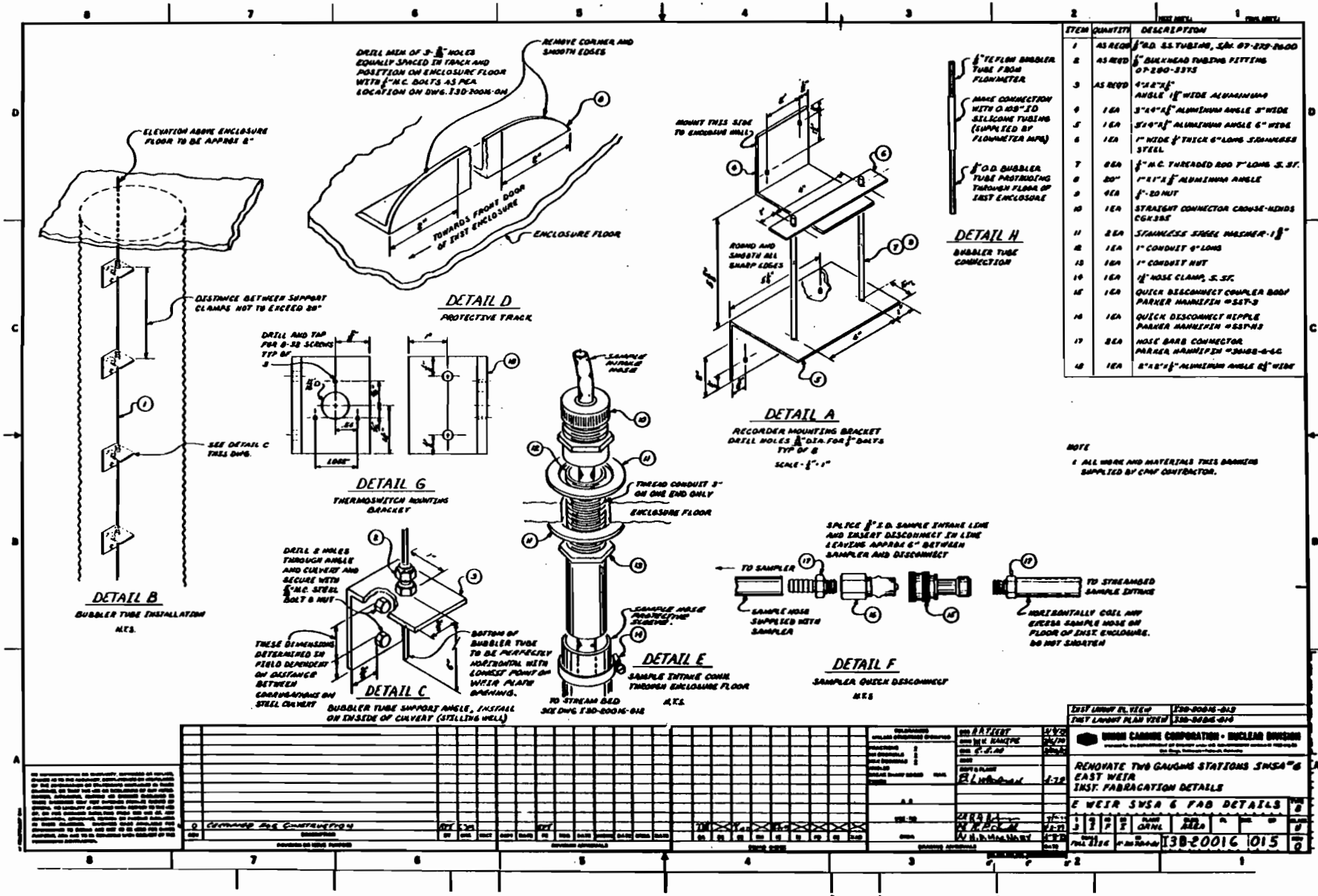
I3D 20016 012 08APR79
East Weir Instrument Layout Details



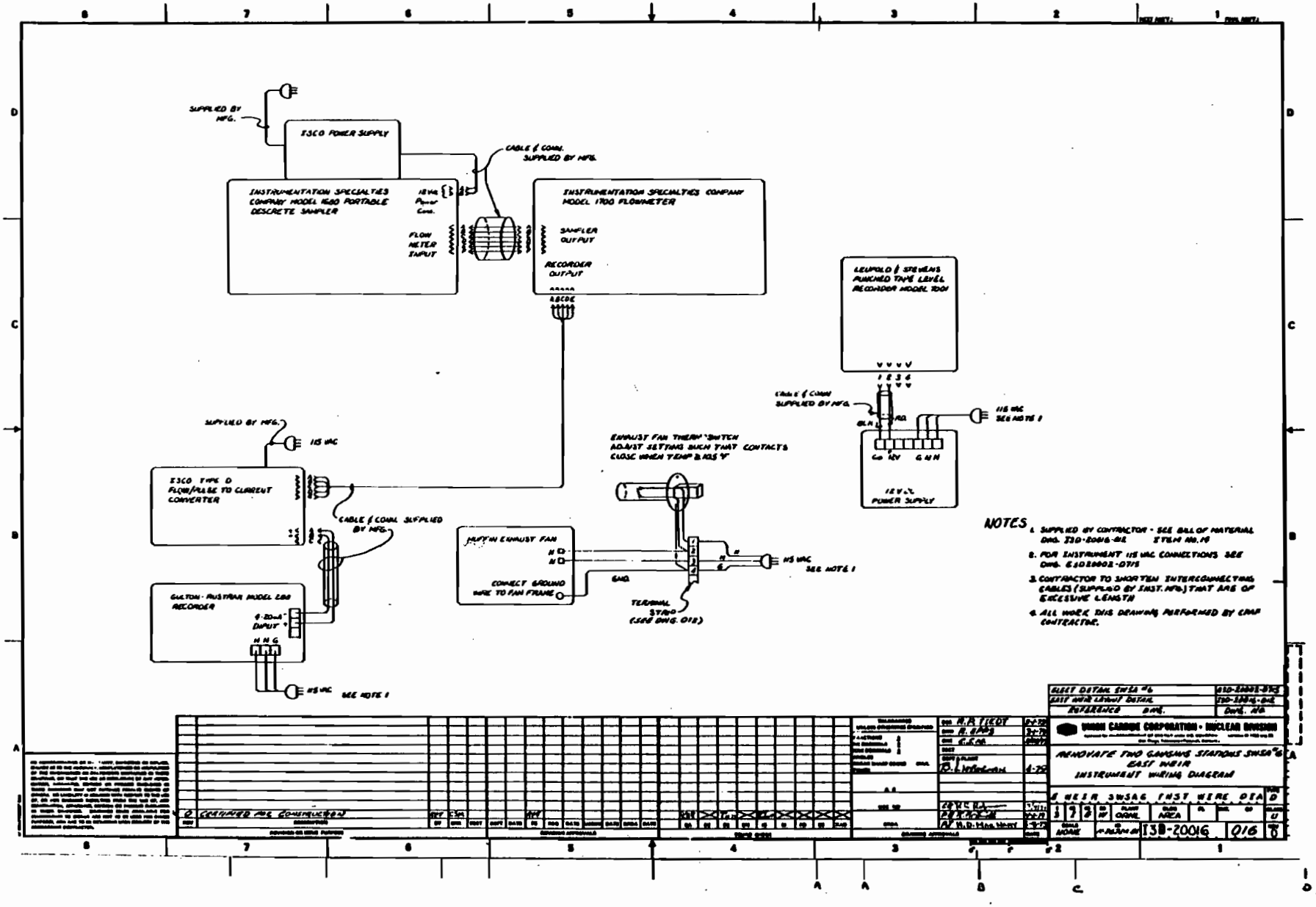
I3D 20016 013 08APR79
East Weir Instrument Layout Elevation View



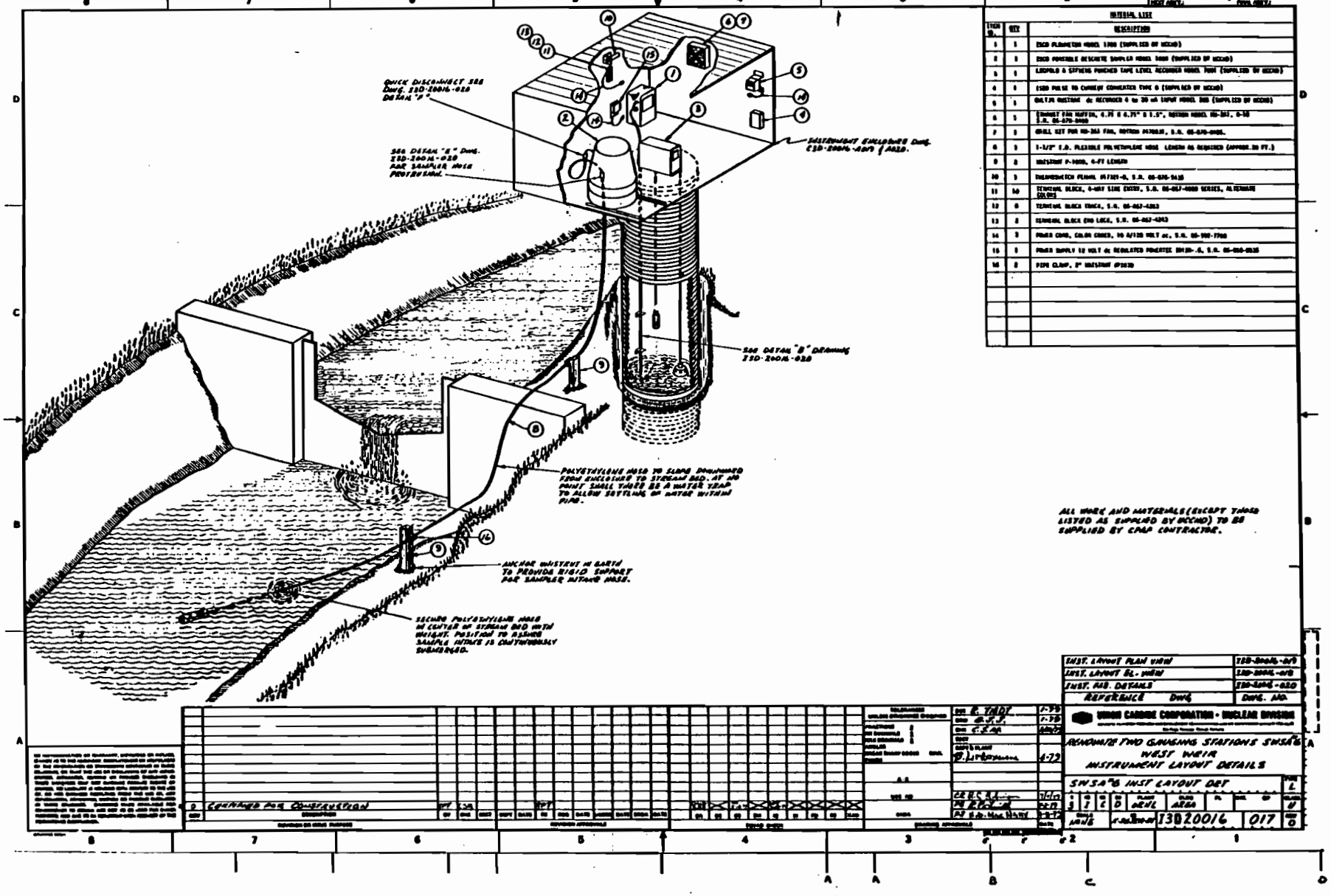
I3D 20016 014 08APR79
East Weir Instrument Layout Plan View



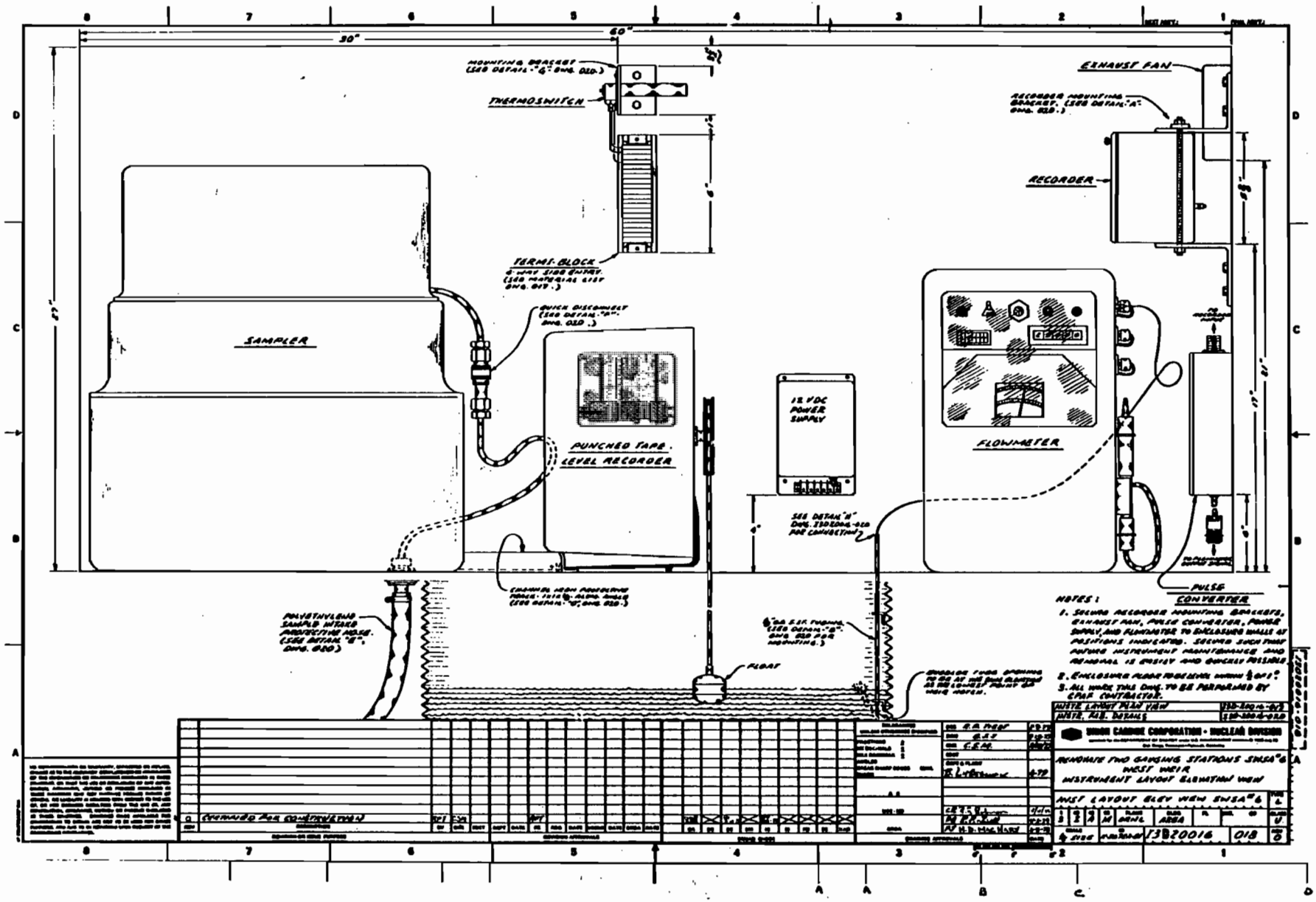
ITEM	QUANTITY	DESCRIPTION
1	AS REQD	3/8" O.D. S.S. TUBING, SPEC. 07-279-2600
2	AS REQD	3/8" BULKHEAD TUBING FITTING 07-280-3375
3	AS REQD	4"x2"x3/8" ANGLE 1 1/2" WIDE ALUMINUM
4	1 EA	3"x4"x3/8" ALUMINUM ANGLE 5" WIDE
5	1 EA	3/4"x3/8" ALUMINUM ANGLE 6" WIDE
6	1 EA	1" WIDE 3/8" THICK 6" LONG STAINLESS STEEL
7	8 EA	3/8" N.C. THREADED ROD 7" LONG S.S. SF.
8	20"	1"x1"x3/8" ALUMINUM ANGLE
9	4 EA	3/8"-20 NUT
10	1 EA	STRAIGHT CONNECTOR CROUSE-HINDS CGK 385
11	2 EA	STAINLESS STEEL WASHER-1 3/8"
12	1 EA	1" CONDUIT 4" LONG
13	1 EA	1" CONDUIT NUT
14	1 EA	1/2" HOSE CLAMP, S. SF.
15	1 EA	QUICK DISCONNECT COUPLER BODY PARKER MANUFSN #SST-3
16	1 EA	QUICK DISCONNECT NIPPLE PARKER MANUFSN #SST-N3
17	2 EA	HOSE BARB CONNECTOR PARKER MANUFSN #2168B-6-6C
18	1 EA	8"x8"x3/8" ALUMINUM ANGLE 2 1/2" WIDE



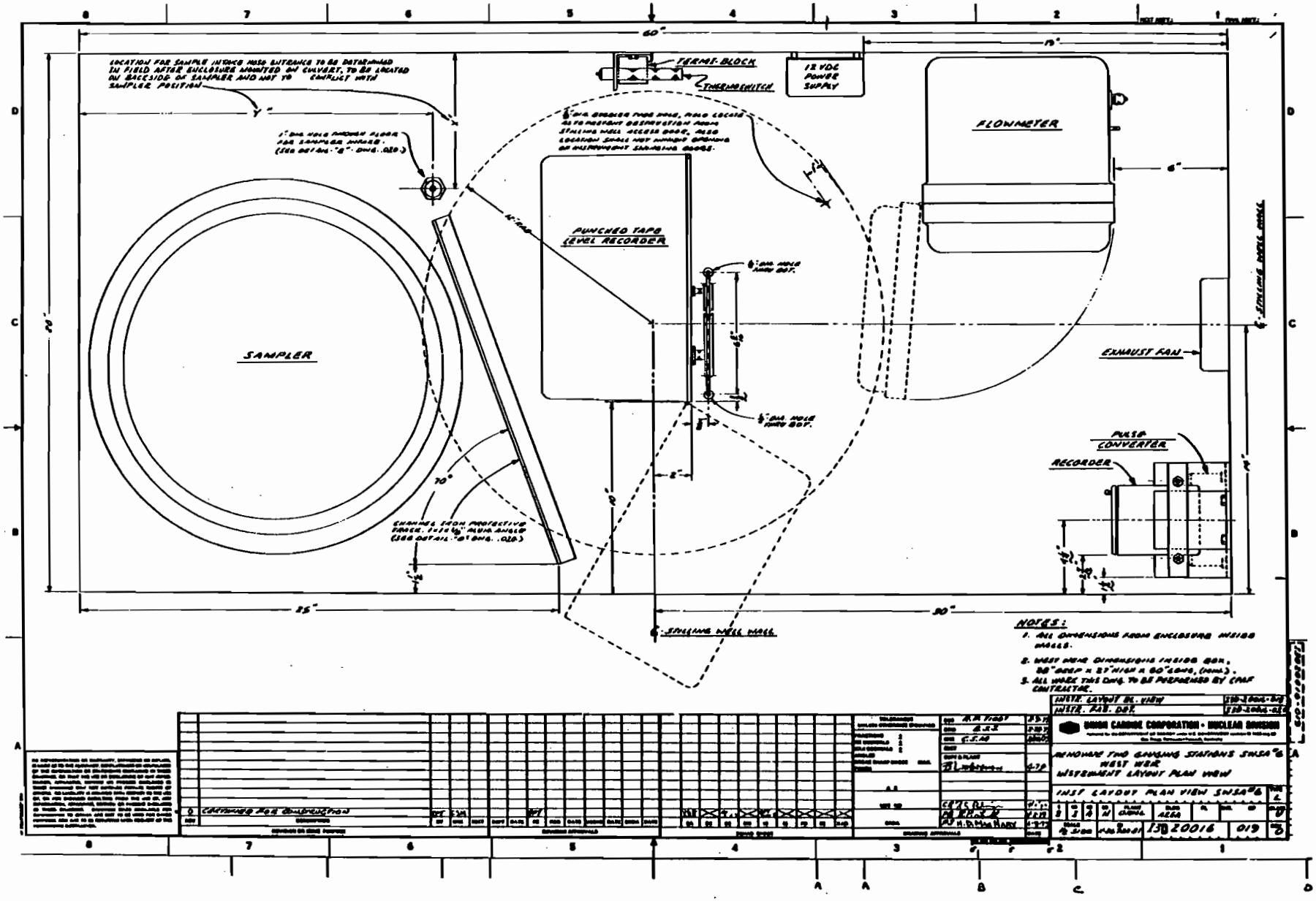
I3D 20016 016 08APR79
East Weir Instrument Wiring Diagram



I3D 20016 017 08APR79
West Weir Instrument Layout Details

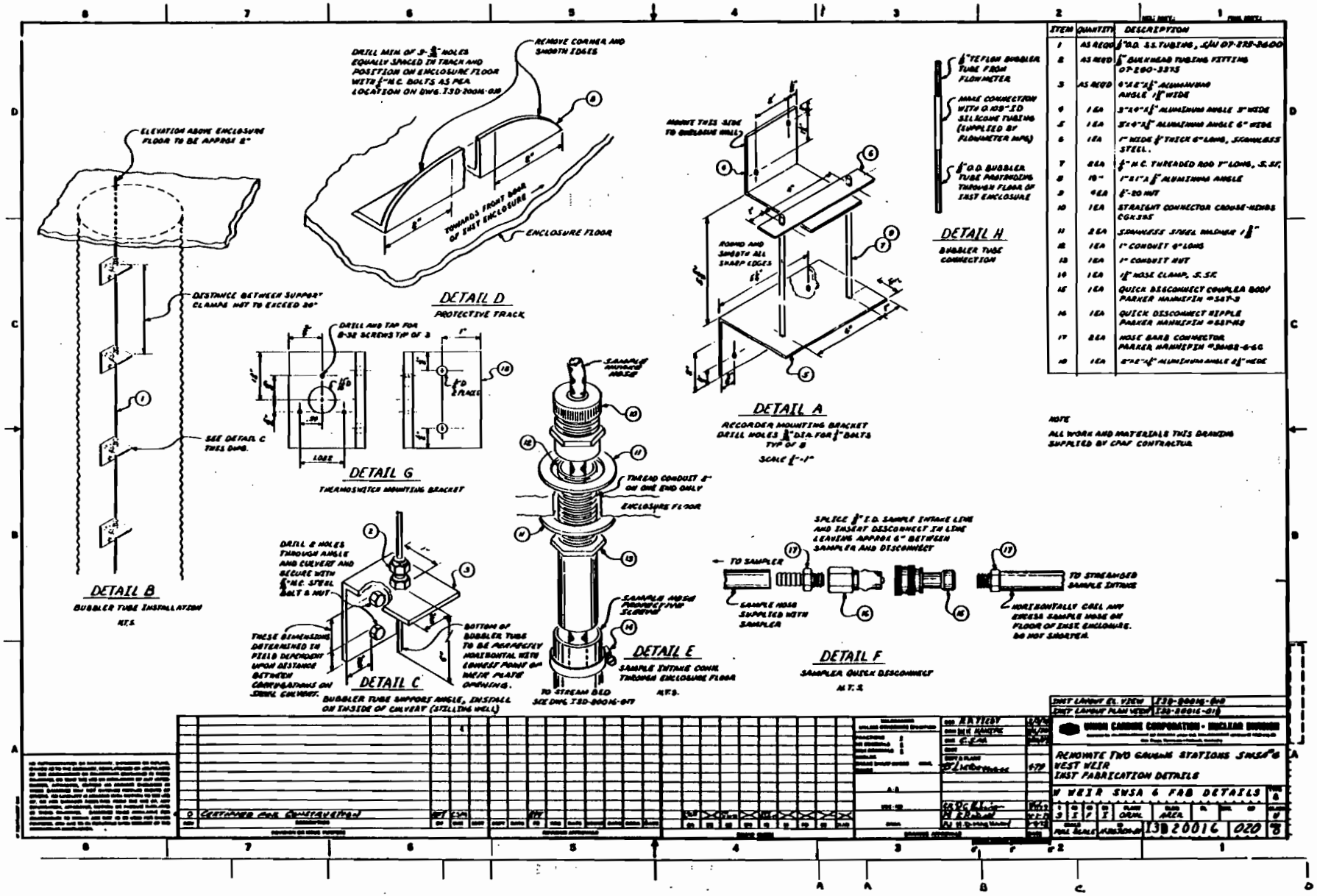


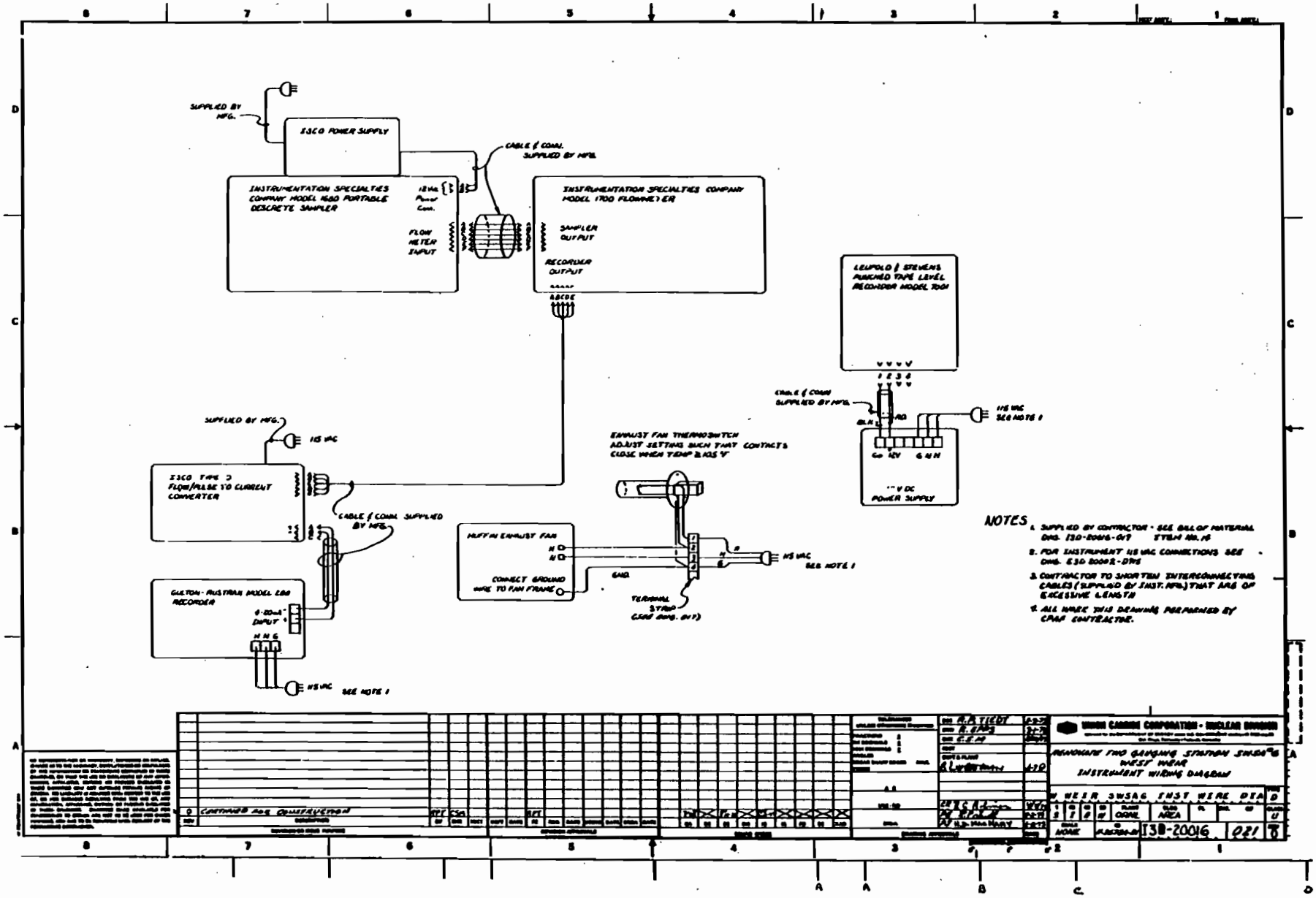
I3D 20016 018 08APR79
West Weir Instrument Layout Elevation View



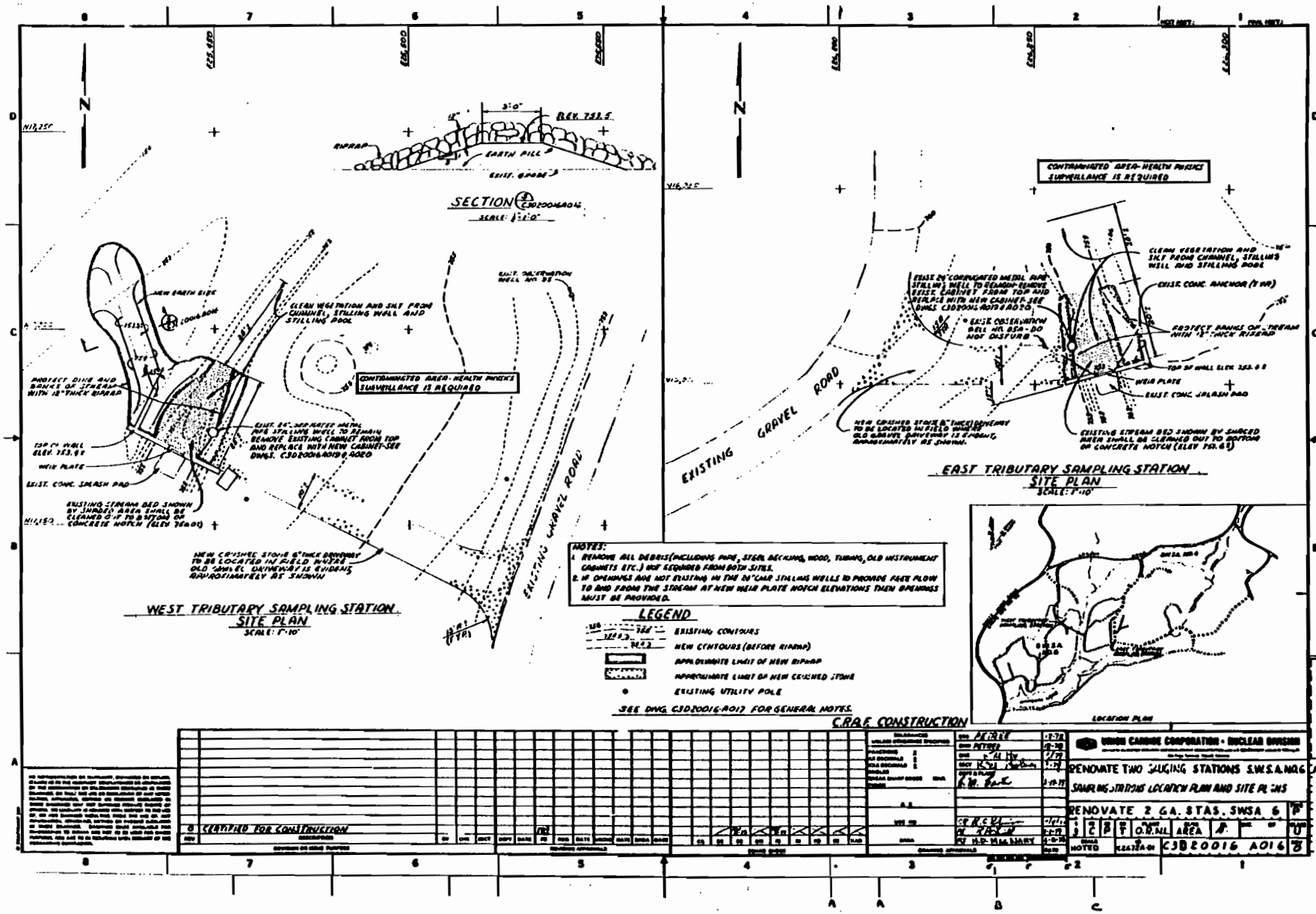
13D 20016 019 08APR79

West Weir Instrument Layout Plan View

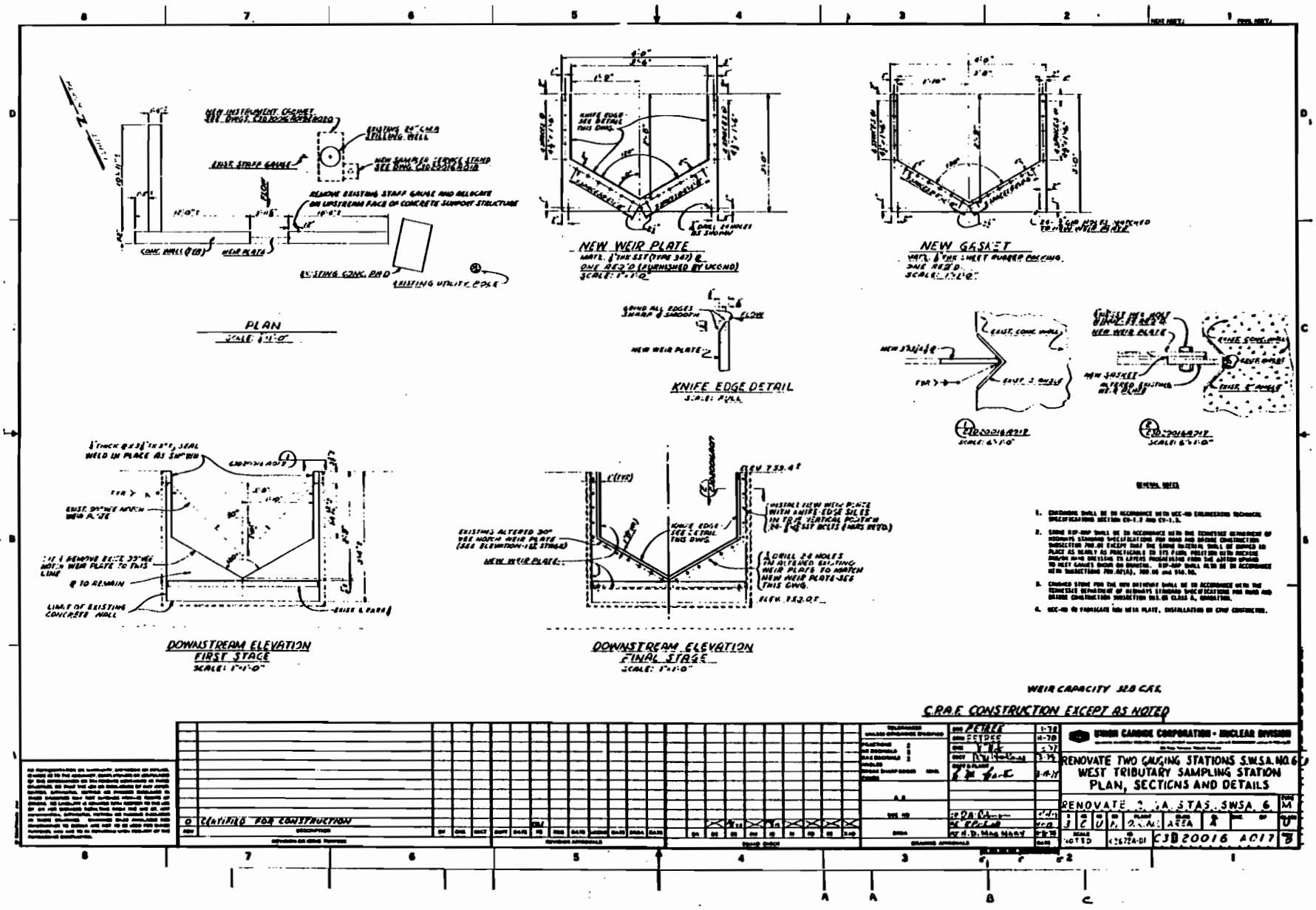

ELEVATION ABOVE ENCLOSURE FLOOR TO BE APPROX 8"
DISTANCE BETWEEN SUPPORT CLAMPS NOT TO EXCEED 30"
SEE DETAIL C THIS DWG.
DETAIL B
BUBBLER TUBE INSTALLATION
N.T.S.
DRILL MIN OF 3-3/8" HOLES EQUALLY SPACED IN TRACK AND POSITION ON ENCLOSURE FLOOR WITH 1/4" H.C. BOLTS AS PER LOCATION ON DWG. I3D-20016-018
REMOVE CORNER AND SMOOTH EDGES
TOWARDS FRONT DOOR OF INST ENCLOSURE
ENCLOSURE FLOOR
DETAIL D
PROTECTIVE TRACK
DRILL AND TAP FOR 8-32 SCREWS TYP OF 3
LOOSE
DETAIL G
THERMOSWITCH MOUNTING BRACKET
DRILL 2 HOLES THROUGH ANGLE AND CULVERT AND SECURE WITH 1/4" H.C. STEEL BOLT & NUT
THESE DIMENSIONS DETERMINED TO YIELD DEPENDENT UPON DISTANCE BETWEEN CORRUGATIONS ON SIDE CULVERT.
BOTTOM OF BUBBLER TUBE TO BE PERFECTLY HORIZONTAL WITH LOWEST POINT ON WEIR PLATE OPENING.
DETAIL C
BUBBLER TUBE SUPPORT ANGLE, INSTALL ON INSIDE OF CULVERT (STILLING WELL)
SAMPLE INTAKE HOLE
THREAD CONDUIT 8" ON ONE END ONLY
ENCLOSURE FLOOR
SAMPLE HOSE PROVIDED FOR SEALING
TO STREAM BED SEE DWG. I3D-20016-017
DETAIL E
SAMPLE INTAKE CONN. THROUGH ENCLOSURE FLOOR
N.T.S.
MOUNT THIS SIDE TO ENCLOSURE WALL
ROUND AND SMOOTH ALL SHARP EDGES
DETAIL A
RECORDER MOUNTING BRACKET
DRILL HOLES 3/8" DIA. FOR 1/4" BOLTS TYP OF 8
SCALE 1/2"=1"
1/4" TEFLON BUBBLER TUBE FROM FLOWMETER
MAKE CONNECTION WITH 0.109" I.D. SILICONE TUBING (SUPPLIED BY FLOWMETER MFG)
1/4" O.D. BUBBLER TUBE PROTRUDING THROUGH FLOOR OF INST ENCLOSURE
DETAIL H
BUBBLER TUBE CONNECTION
SPLICE 1/4" I.D. SAMPLE INTAKE LINE AND INSERT DISCONNECT IN LINE LEAVING APPROX 6" BETWEEN SAMPLER AND DISCONNECT
TO SAMPLER
SAMPLE HOSE SUPPLIED WITH SAMPLER
TO STREAMBED SAMPLE INTAKE
HORIZONTALLY COIL AND SECURE SAMPLE HOSE ON FLOOR OF INST ENCLOSURE. DO NOT SHORTEN.
DETAIL F
SAMPLER QUICK DISCONNECT
N.T.S.
NOTE
ALL WORK AND MATERIALS THIS DRAWING SUPPLIED BY CPAF CONTRACTOR
UNION CARBIDE CORPORATION - NUCLEAR DIVISION
REMOVATE TWO GAUGING STATIONS SWSA 6 WEST WEIR
INST FABRICATION DETAILS
W WEIR SWSA 6 FAB DETAILS
I3D 20016 020



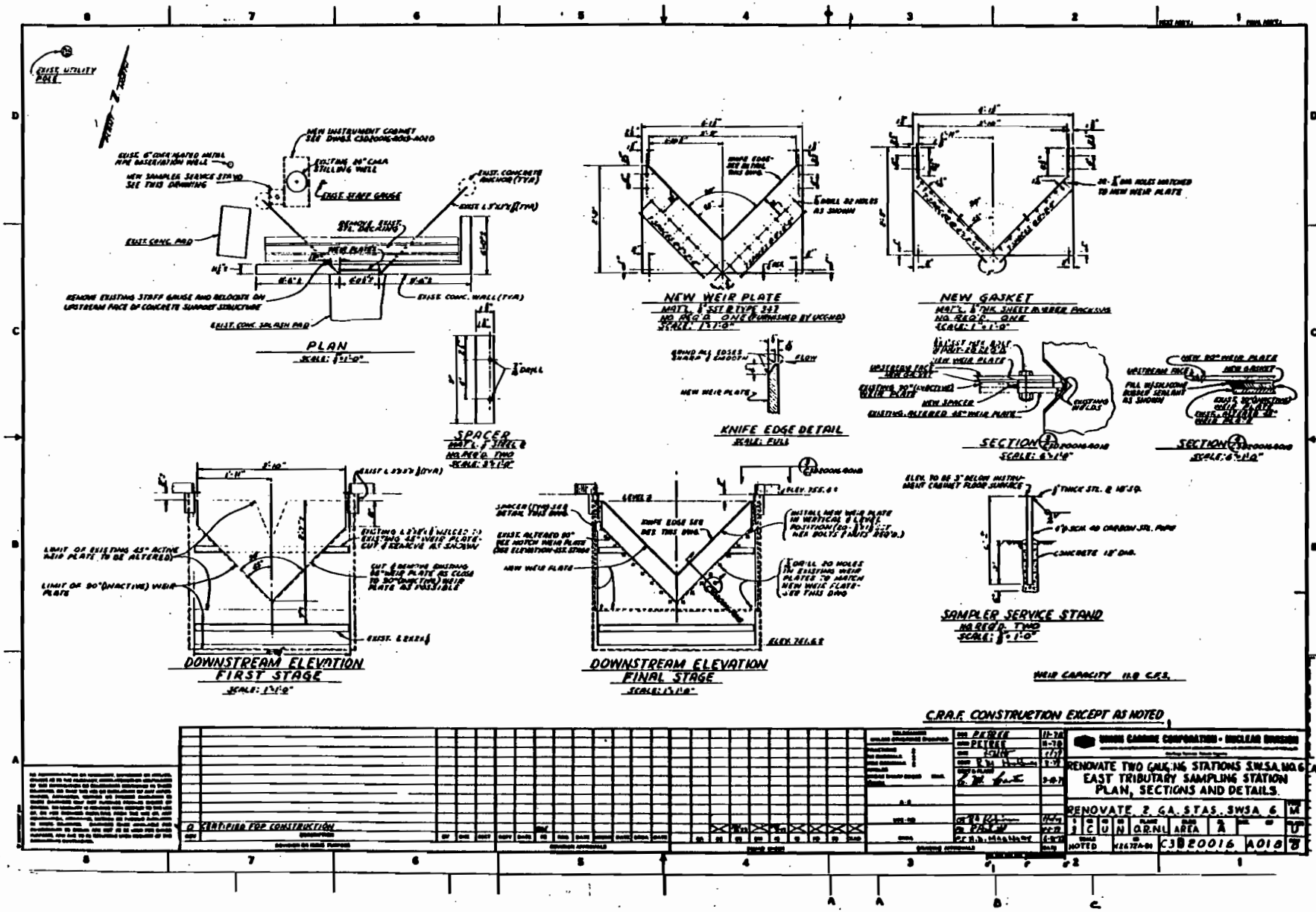
I3D 20016 021 08APR79
West Weir Instrument Wiring Diagram



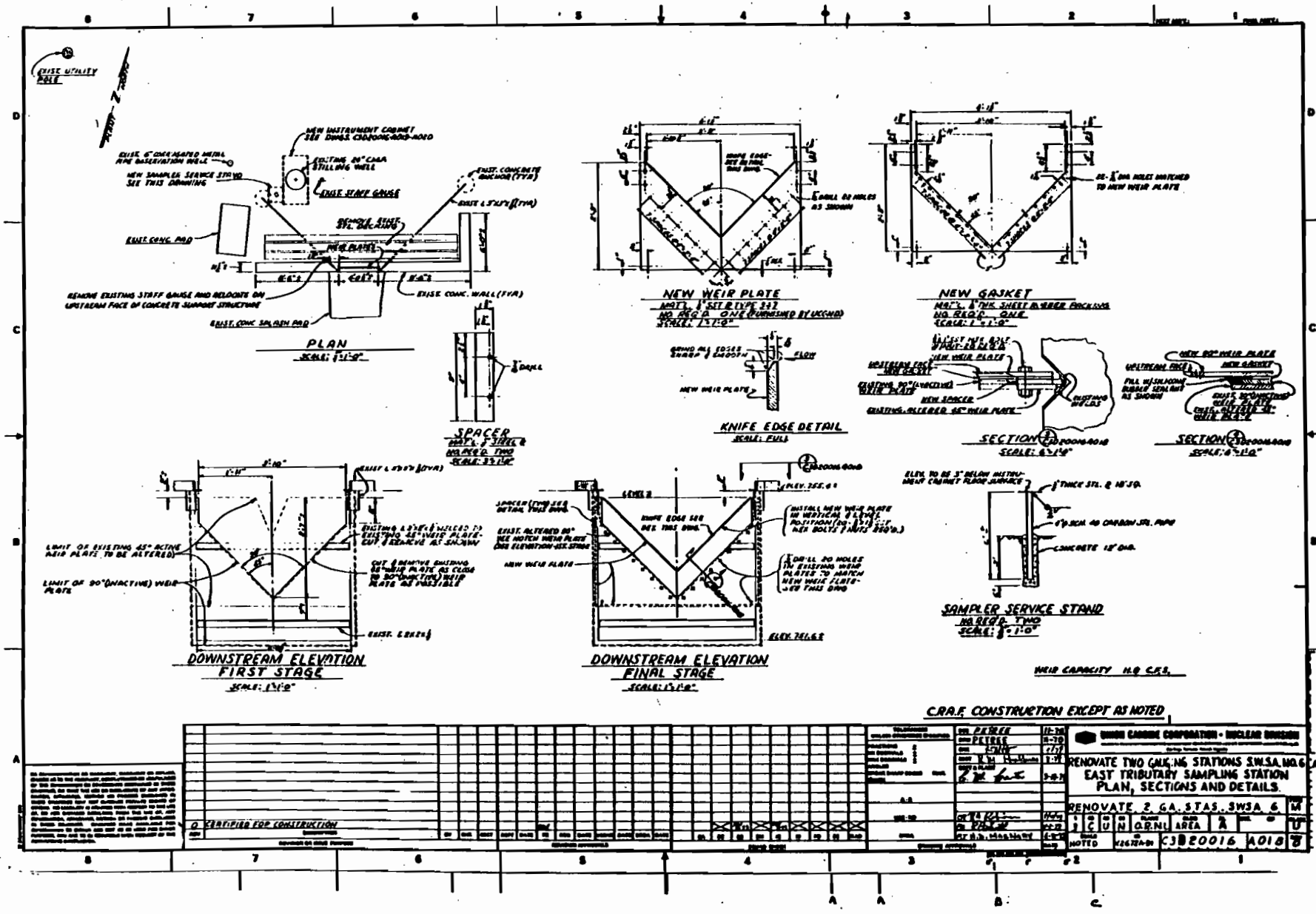
C3E 20016 A016 08APR79
Sampling Stations Location Plan and Site Plans



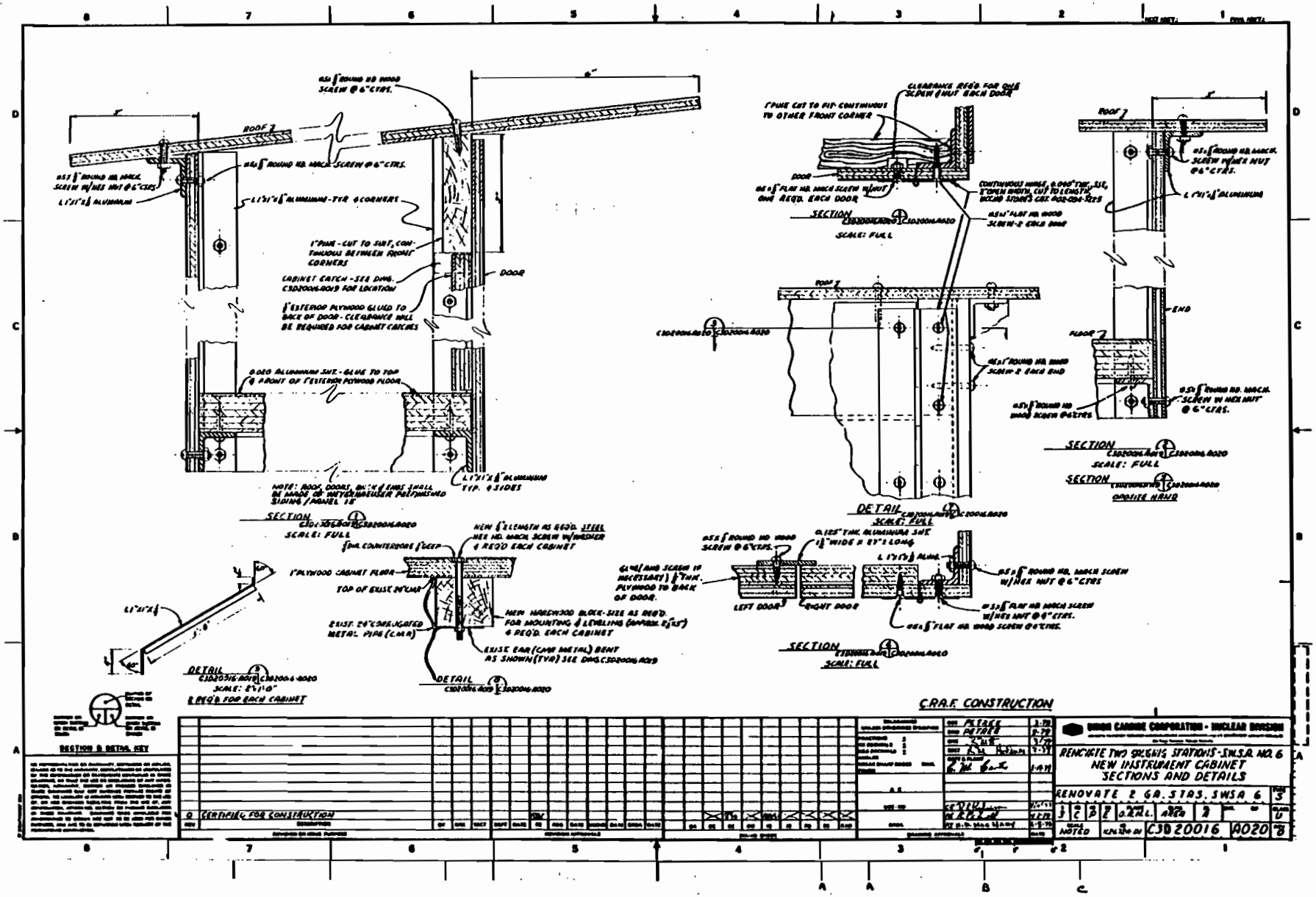
C3E 20016 A017 08APR79
West Tributary Sampling Station Plan and Sections



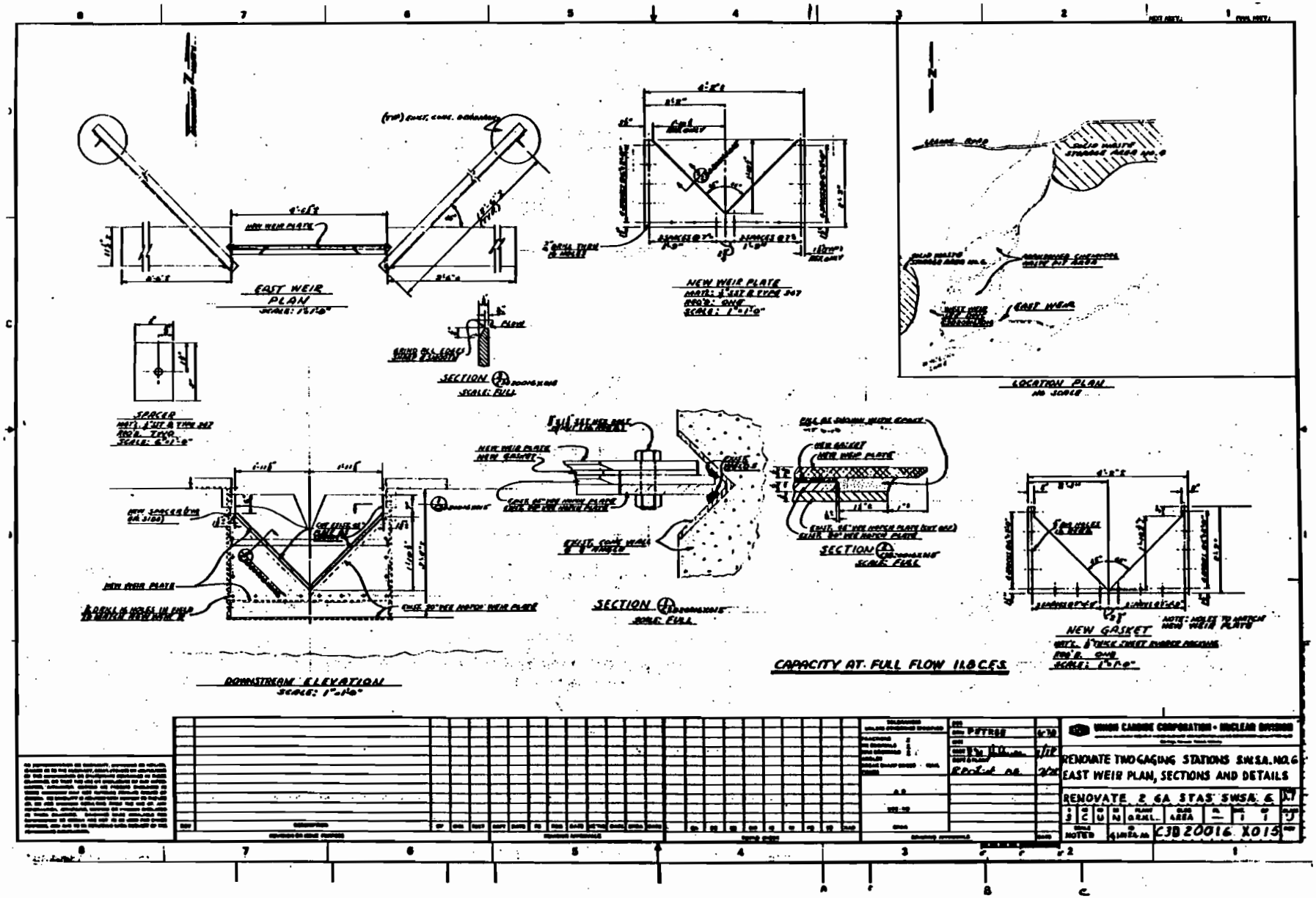
C3E 20016 A018 08APR79
East Tributary Sampling Station Plan and Sections



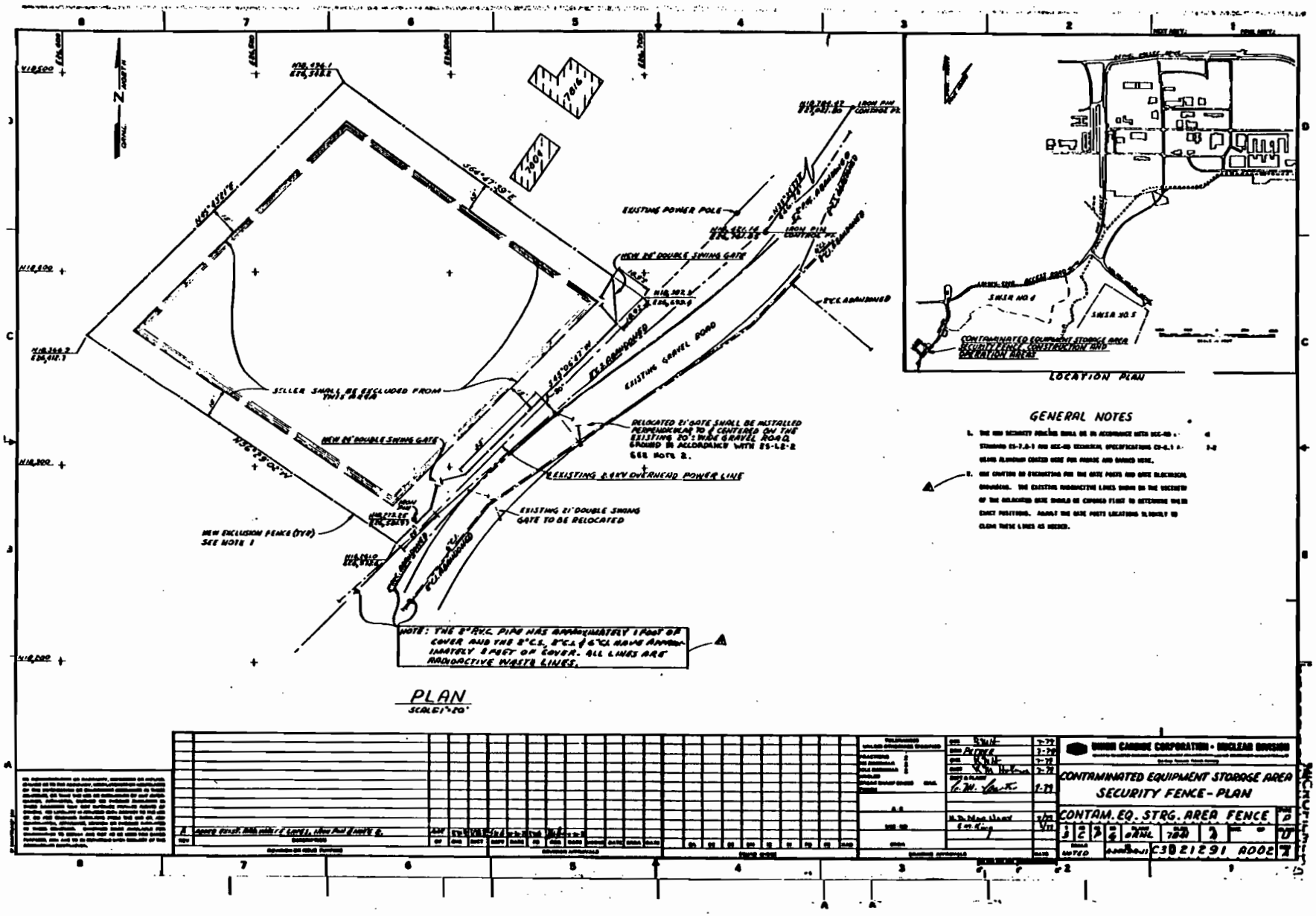
C3D 20016 A018 08APR79
East Weir Sampling Station Plans, Sections

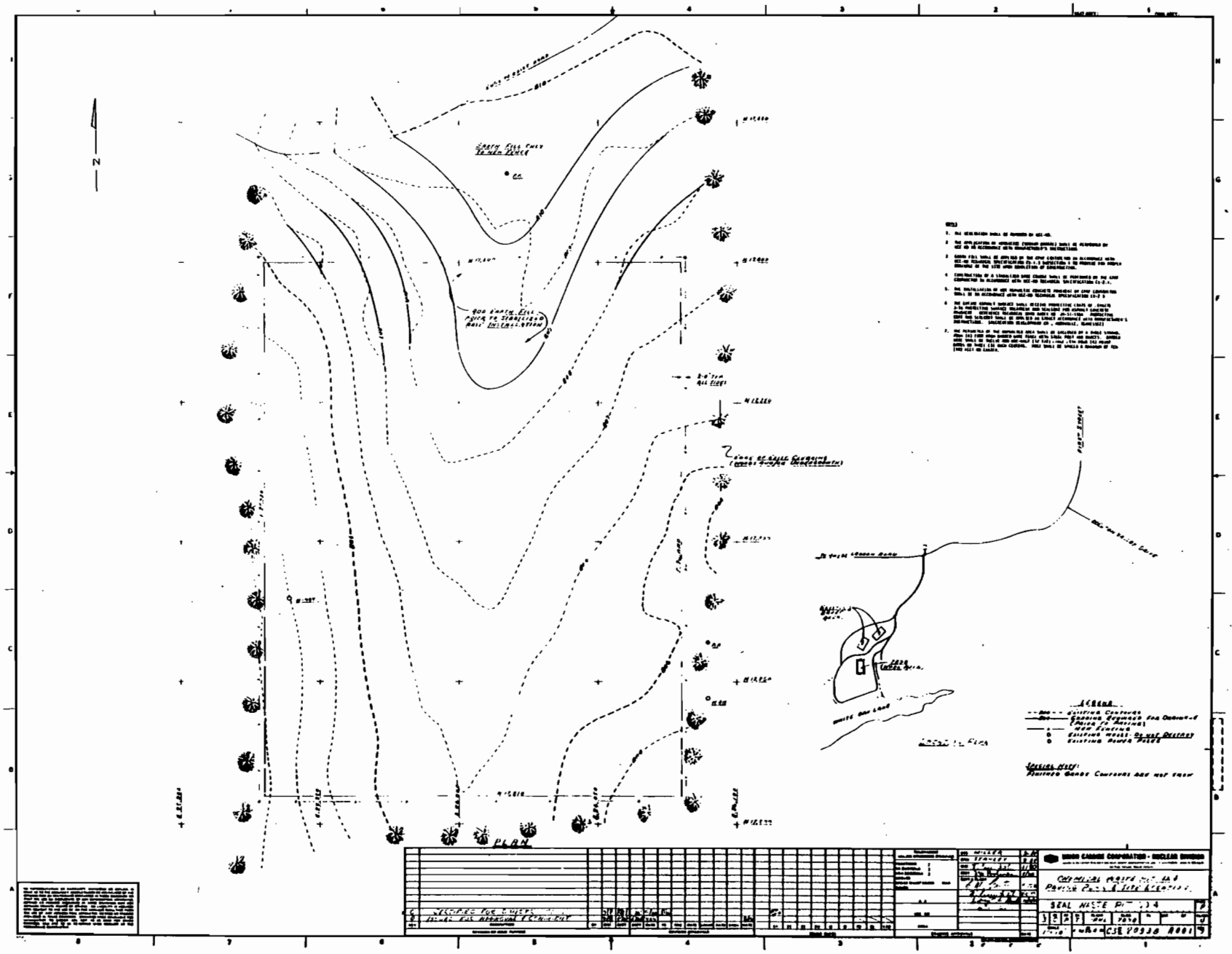


C3E 20016 A020 08APR79
Caging Station Instrument Cabinet Sections

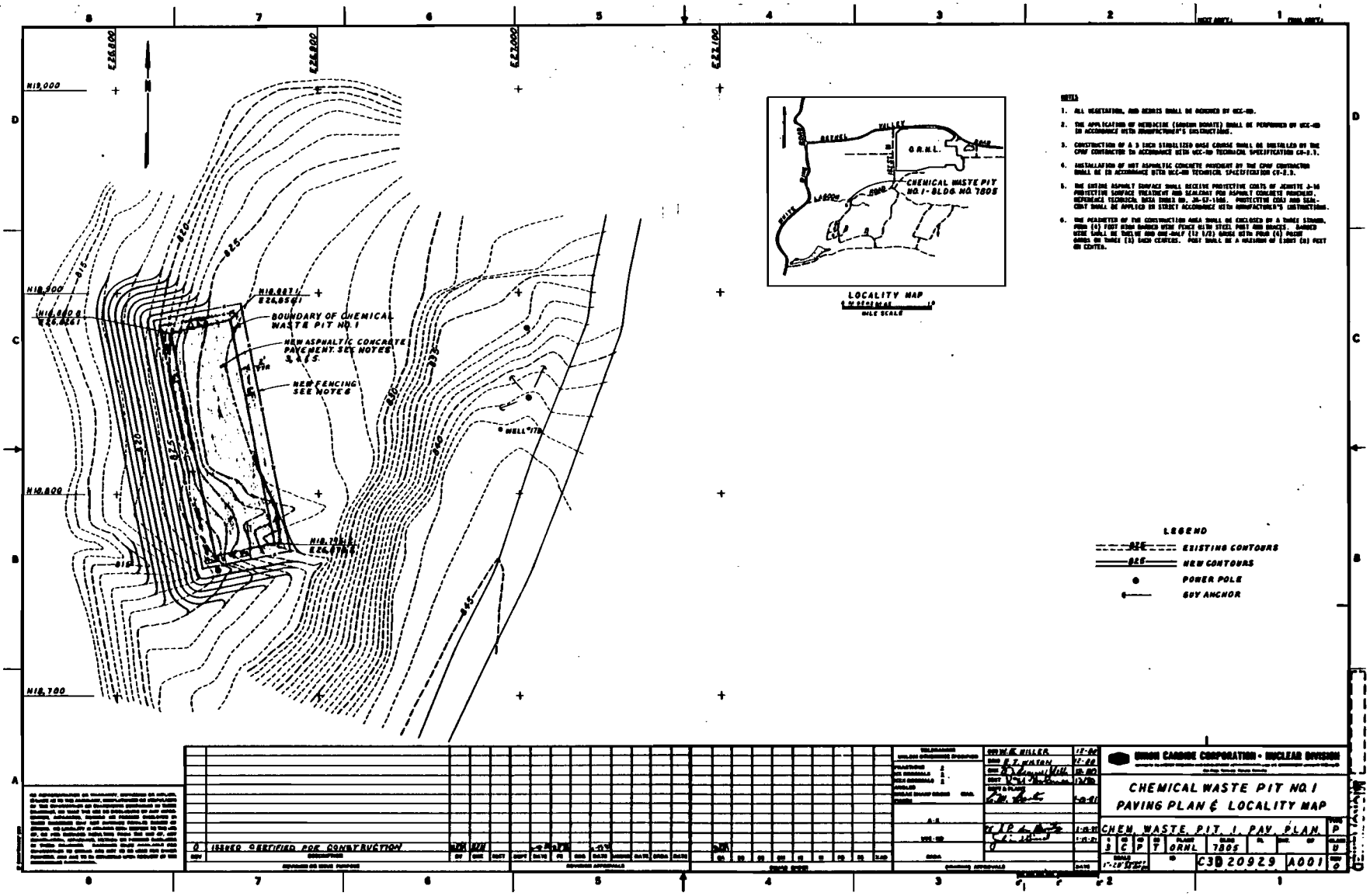


C3E 20016 X015 30JUL79
East Weir Plan, Sections, and Details

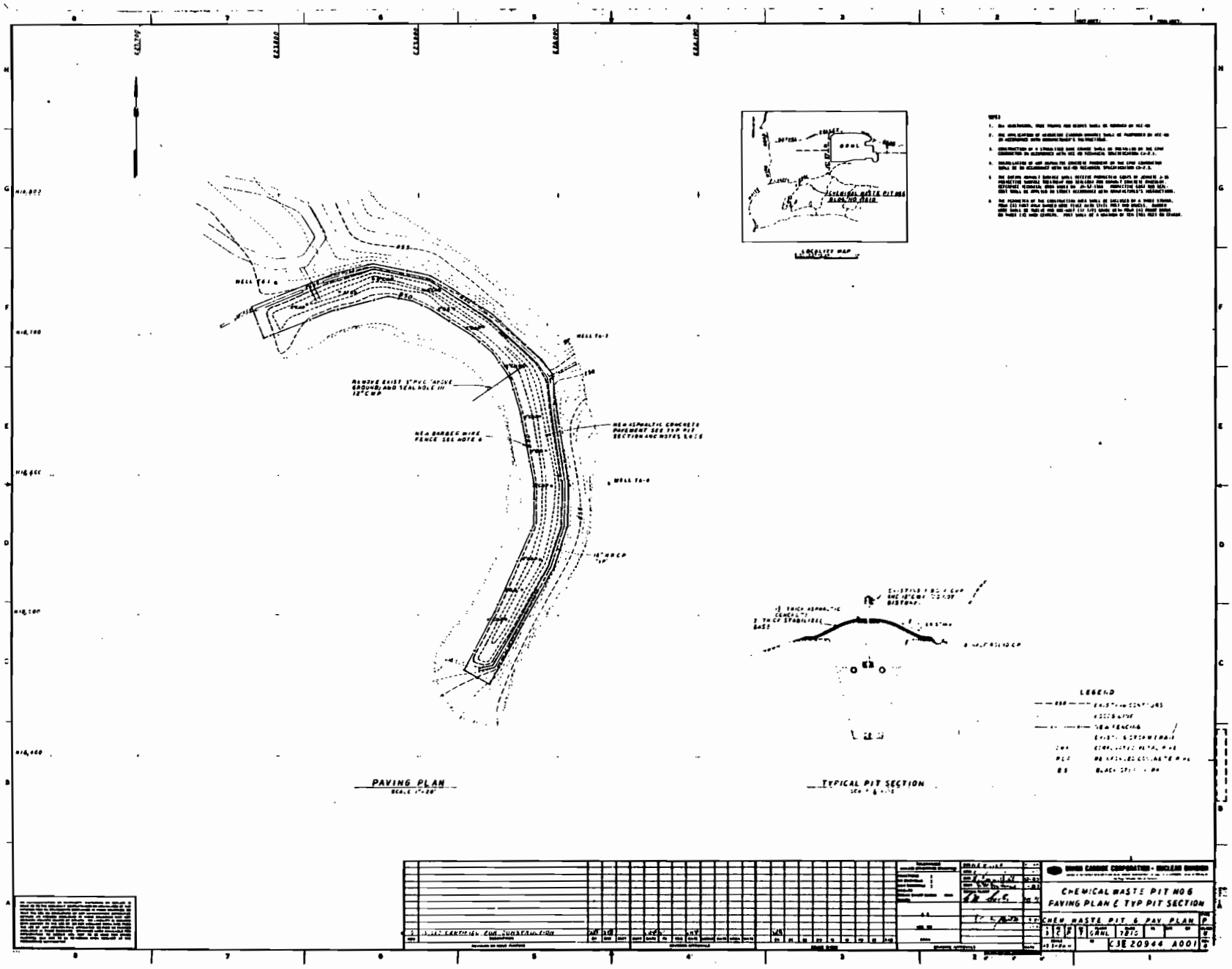

PLAN
SCALE: 1"=20'
NEW 24' DOUBLE SWING GATE
NEW EXCLUSION FENCE (TYP) SEE NOTE 1
SELLER SHALL BE EXCLUDED FROM THIS AREA
EXISTING POWER POLE
EXISTING GRAVEL ROAD
RELOCATED 21' GATE SHALL BE INSTALLED PERPENDICULAR TO ℄ CENTERED ON THE EXISTING 20' WIDE GRAVEL ROAD, GROUND IN ACCORDANCE WITH ES-LE-2 SEE NOTE 2.
EXISTING 2.4KV OVERHEAD POWER LINE
EXISTING 21' DOUBLE SWING GATE TO BE RELOCATED
NOTE: THE 2" PVC. PIPE HAS APPROXIMATELY 1 FOOT OF COVER AND THE 2" C.S., 3" C.S. & 4" C.S. HAVE APPROXIMATELY 3 FEET OF COVER. ALL LINES ARE RADIOACTIVE WASTE LINES.
LOCATION PLAN
SWSA NO 4
SWSA NO 5
CONTAMINATED EQUIPMENT STORAGE AREA SECURITY FENCE CONSTRUCTION AND OPERATION RULES
GENERAL NOTES
UNION CARBIDE CORPORATION • NUCLEAR DIVISION
CONTAMINATED EQUIPMENT STORAGE AREA
SECURITY FENCE - PLAN
CONTAM. EQ. STRG. AREA FENCE
C3E 21291 A002



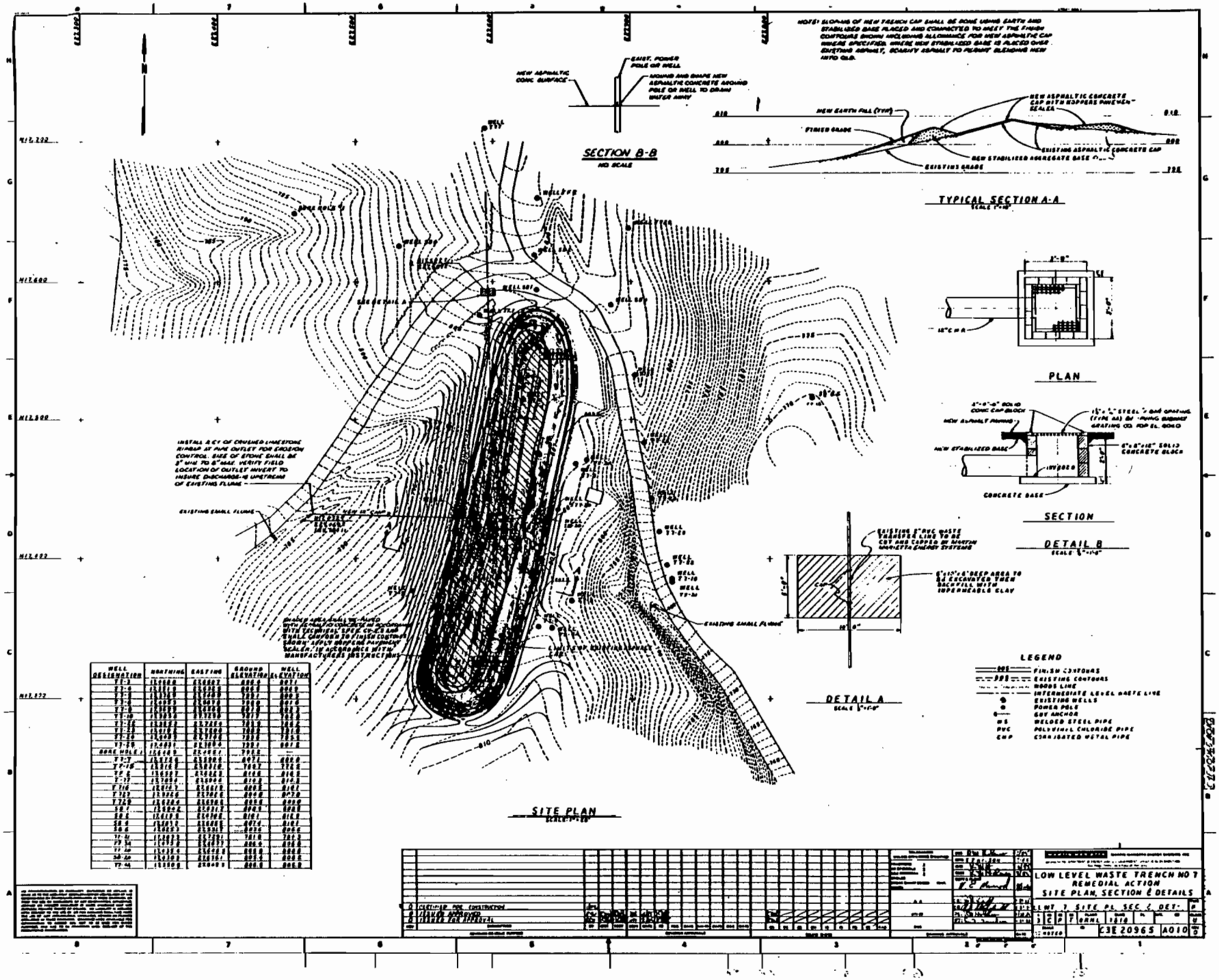
C3E 20938 A001D 15OCT80
Chemical Waste Pit 4, Paving Plan and Site Location



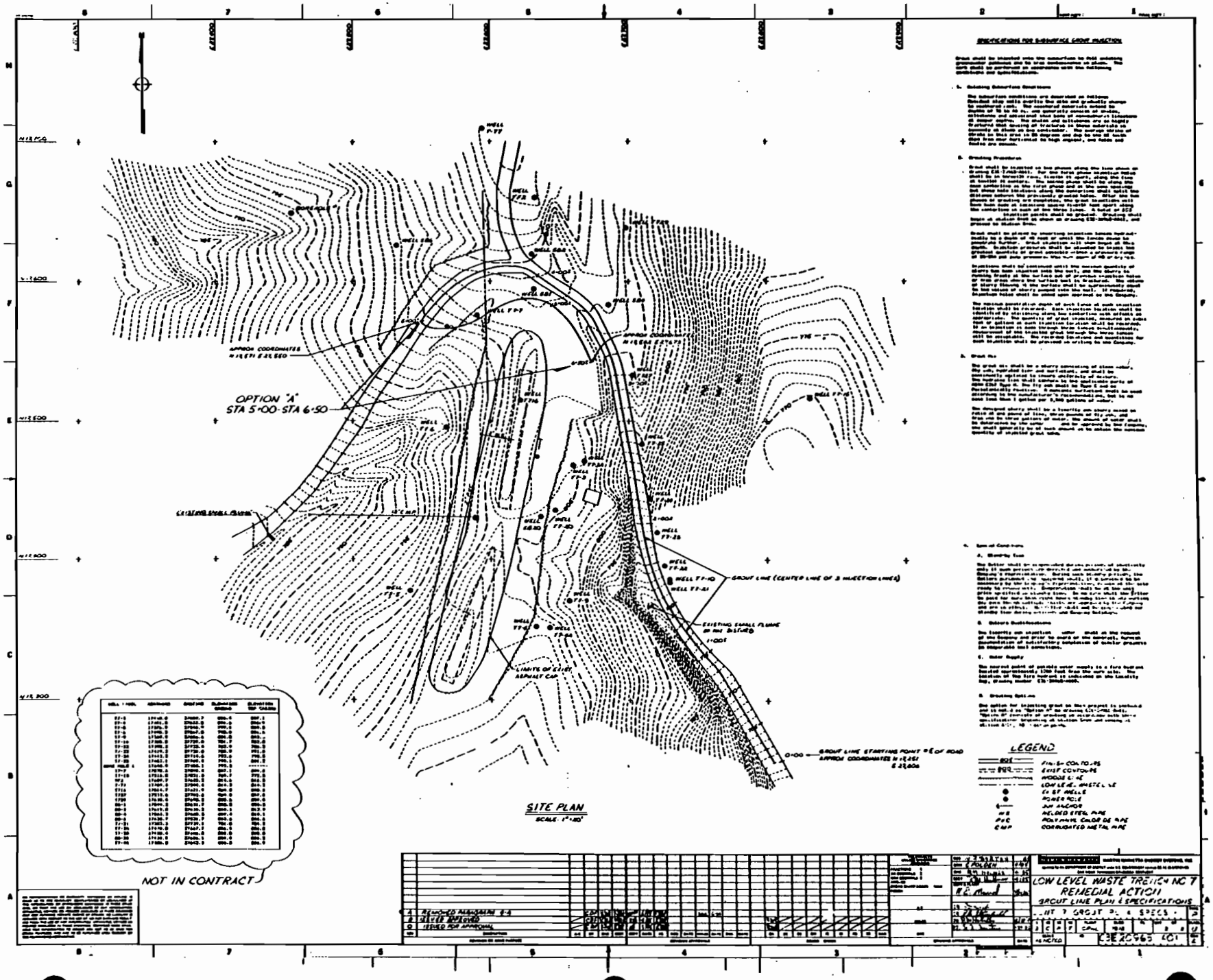
C3D 20929A001D 13JAN81
Waste Pit No. 1 Paving Plan and Locality Map



C3E 20944 A0010 13JAN81
Chemical Waste Pit 6, Paving Plan and Pit Section



C3E 20965 A010 29APR85
Trench 7 Remedial Action Plan and Details


SITE PLAN
SCALE: 1" = 100'
OPTION "A"
STA 5+00-STA 6+50
GROUT LINE (CENTER LINE OF 3 INJECTION LINES)
EXISTING SMALL PLUME
LIMITS OF EXIST. ASPHALT CAP
NOT IN CONTRACT
LEGEND
LOW LEVEL WASTE TRENCH NO 7
REMEDIAL ACTION
GROUT LINE PLAN & SPECIFICATIONS

Appendix E
ORNL Photographs Related to Seepage Pits and Trenches

12115 1954
Witkowski Pit 2 with truck 2-2-54

12116 1954
Witkowski Pit 2 with truck 2-2-54

12117 1954
Witkowski Intermediate-level waste transfer trailer 2-2-54

13395 1954
W.deLaguna Waste pit 3 Sideslope under construction 11-23-54

13396 1954
W.deLaguna Waste pit 3 floor under construction 11-23-54

13397 1954
W.deLaguna Waste pit 3 excavation 11-23-54

13398 1954
W.deLaguna Waste pit 3 excavation completed 11-23-54

13399 1954
W.deLaguna Waste pit 3 stratification exposure 11-23-54

13852 1955
Witkowski New pit 3 and old pit 2 looking southwest 3-4-55

13853 1955
Witkowski New pit 3 and old pit 2 looking southwest 3-4-55

13854 1955
Witkowski New pit 3 and old pit 2 looking northeast 3-4-55

13855 1955
Witkowski pits 2 and 3 looking southwest labeled 3-4-55

14841 1955
W.deLaguna Pit 3 7-15-55

14842 1955
W.deLaguna Pit3 7-15-55

14843 1955
W.deLaguna Observation well construction in pits area 7-15-55

14844 1955
W.deLaguna Pit 1 with its cover 7-15-55

15681 1955
W.deLaguna Solution cavity in core from Pit 4 area 11-7-55

16424 1956
W.deLaguna Evaporation pan in pits area 2-14-56

17481 1956
W.deLaguna drainage area east of pits at well 83 5-1-56

17482 1956
W.deLaguna groundwater seeps east of pit 3 5-1-56

17486 1956
K.Cowser Pit 3 looking northeast 5-2-56

17487 1956
K.Cowser Pit 3 5-2-56

17488 1956
K.Cowser Pits 2 and 3 evaporation apparatus 5-2-56

17489 1956
K.Cowser Pit 3 5-2-56

18474 1956
W.deLaguna Weir construction east of pits area 9-24-56

18475 1956
W.deLaguna Weir construction east of pits area 9-24-56

40690 1957
F.L.Parker well logging equipment for pits area 6-6-57

40691 1957
F.L.Parker roadcut in drainage of pits area 6-6-57

40692 1957
F.L.Parker roadcut in drainage of pits area 6-6-57

40693 1957
F.L.Parker Pit well logging equipment 6-6-57

40694 1957
F.L.Parker Pit well logging equipment 6-6-57

15647 1958
W.deLaguna Construction on south end of east side of Pit 4

15648 1958
W.deLaguna Construction outcrop Pit 4-northern east side

15649 1958
W.deLaguna Construction outcrop Pit 4-southern west side

15650 1958
W.deLaguna Construction outcrop Pit 4-northern east side

15651 1958
W.deLaguna Construction outcrop Pit 4-northwest corner

15652 1958
W.deLaguna Construction outcrop Pit 4-western side

15653 1958
W.deLaguna Construction outcrop Pit 4-southern west side

15654 1958
W.deLaguna Construction outcrop Pit 4-southern east side

15895 1958
W.deLaguna Helicopter photographs of pits looking north-labeled

15898 1958
W.deLaguna Helicopter photographs of pits looking east-labeled

15900 1958
W.deLaguna Helicopter photographs of pits looking southwest

15901 1958
W.deLaguna Helicopter photographs of pits looking northwest

15903 1958
W.deLaguna Helicopter shots of White Oak Lake and SWSA6 site

15904 1958
W.deLaguna White Oak Creek discharging to Clinch River

15911 1958
W.deLaguna White Oak Creek discharge to Clinch River

43626 1958
M. Cobble Waste pits 2 and 3 looking SW

43628 1958
M. Cobble Waste pits 2 and 3 looking NE

48386 1959
W.deLaguna Well drilling operations at 4-Acre site 11/59

48387 1959
W.deLaguna Well drilling operations at 4-Acre site 11/59

48388 1959
W.deLaguna Well drilling operations at 4-Acre site 11/59

48428 1959
W.deLaguna Radiation monitoring during Cs-137 grouting

48429 1959
W.deLaguna 4-Acre site field operations during grouting 10/59

48430 1959
W.deLaguna 4-Acre site after field grouting operations 10/59

48431 1959
W.deLaguna Grout injection well at 4-Acre site 10/59

48432 1959
W.deLaguna Injection wellhead adjustment at 4-Acre site

48433 1959
W.deLaguna Grout injection operations at 4-Acre site 10/59

48434 1959
W.deLaguna Grout pumping truck at 4-Acre site 10/59

48435 1959
W.deLaguna Grout delivery and mixing apparatus at 4-Acre site

48436 1959
W.deLaguna Grout truck used at 4-Acre site 10/59

48437 1959
W.deLaguna Pressure relief technique after hydraulic fracture

48438 1959
W.deLaguna Field equipment for grout injection at 4-Acre site

48439 1959
W.deLaguna Downhole hydraulic fracturing tool

48440 1959
W.deLaguna Downhole hydraulic fracturing tool

48441 1959
W.deLaguna Downhole hydraulic fracturing tool

50391 1959
W.deLaguna Grout sheet in core 345 feet NE at 143 foot depth

49011 1960
H.Wyrick Pit 4 eastern seep interceptor trench 1-28-60

49012 1960
H.Wyrick Pit 4 eastern seep interceptor trench 1-28-60

49013 1960
H.Wyrick Pit 4 site groundwater seep 1-28-60

49219 1960
W.deLaguna construction trench 5 3-10-60

49220 1960
W.deLaguna construction trench 5 3-10-60

49221 1960
W.deLaguna construction trench 5 3-10-60

57395 1962
W.deLaguna well northeast of pit 3 5-18-62

57396 1962
W.deLaguna Pit 3 area 5-18-62

57397 1962
W.deLaguna Pit 3 area 5-18-62

57398 1962
W.deLaguna Pit 3 area 5-18-62

57399 1962
W.deLaguna Pit 3 area 5-18-62

58370 1962
W.deLaguna Trench 7 construction 8-10-62

58371 1962
W.deLaguna Trench 7 construction 8-10-62

58372 1962
W.deLaguna Trench 7 construction 8-10-62

58373 1962
W.deLaguna Pit 3 backfilled looking southwest 8-10-62

58412 1962
W.deLaguna construction activity trench 7 8-15-62

58413 1962
W.deLaguna construction activity trench 7 8-15-62

58414 1962
W.deLaguna Construction activity Trench 7 8-15-62

58415 1962
W.deLaguna Construction activity Trench 7 8-15-62

58416 1962
W.deLaguna Construction activity Trench 7 8-15-62

58417 1962
W.deLaguna Construction activity Trench 7 8-15-62

58418 1962
W.deLaguna construction activity trench 7 8-15-62

58419 1962
W.deLaguna construction activity trench 7 8-15-62

58420 1962
W.deLaguna construction activity trench 7 8-15-62

58421 1962
W.deLaguna construction activity trench 7 8-15-62

58886 1962
Auerbach Vegetation sampling at Trench 5

60145 1963
Struxness Distribution of Ru-106 in groundwater of pits

60148 1963
Struxness Sources of contamination in Whiteoak Basin

60183 1963
Struxness Monthly transfer of Activity in Whiteoak Basin

62216 1963
C.M.Carter Decontamination Facility (7819) under cont. 7/22/63

64056 1964
C.M.Carter Decontamination Facility (7819) finished 1/13/64

66443 1964
T.Lomenick Core drilling rig used on pit 3 Aug. 18, 1964

66444 1964
T.Lomenick Core drill and cuttings pit at pit 3, 8/18/64

66445 1964
T.Lomenick Shielded cuttings wash pit at pit 3, 8/18/64

66446 1964
T.Lomenick Coring device used at pit 3 August 18, 1964

69705 1965
T.Lomenick Core from waste pit 3

69706 1965
T.Lomenick Core from waste pit 3

69707 1965
T.Lomenick Core from Pit 3, May 5, 1965

69708 1965
T.Lomenick Surface of Pit 3, May 5, 1965

80354 1965
Unknown Waste pit 4, July 20, 1965

4616-83 1983
A. A. Walls Removal of vegetation over leak site No. 1

4617-83 1983
A. A. Walls Application of earth fill over bentonite

4620-83 1983
A. A. Walls Leak site No. 1 with crushed stone base

4621-83 1983
A. A. Walls Leak site No. 1 prior to decommissioning

4623-83 1983
A. A. Walls Capping of ILW line at the leak sites

4625-83 1983
A. A. Walls Asphalt cover in place at leak site No. 1

4708-83 1983
A. A. Walls Final site conditions at leak site No. 1

4711-83 1983
A. A. Walls Final site conditions at leak site No. 2

4383-85 1985
B.Spalding East surface runoff monitoring weir trench 7

5733-85 1985
Mulholland Trench 7 during recontouring cap July 1985

5735-85 1985
Mulholland Trench 7 at asphalt cap completion August 1985

5738-85 1985
Mulholland Vegetation removal and grading at trench 7 7/85

5739-85 1985
Mulholland Runoff collection drain in trench 7 cap 8/85

5740-85 1985
Mulholland Gaging station on eastern side of trench 7

5741-85 1985
Mulholland Gaging station on western side of trench 7

5743-85 1985
Mulholland Outlet of trench 7 cap drain to west 8/85

0034-86 1986
R.E.Norman Decontamination Facility (7819) looking SE

0038-86 1986
R.E.Norman Decontamination Facility (7819) looking NW

0039-86 1986
R.E.Norman Decontamination Facility (7819) looking NE

0067-86 1986
R.E.Norman Interior view of decontamination facility(7819)

0856-86 1986
B.Spalding Surface of ILW Trench 7 November 1985

0865-86 1986
B.Spalding Grout lance retraction technique Trench 7 12/85

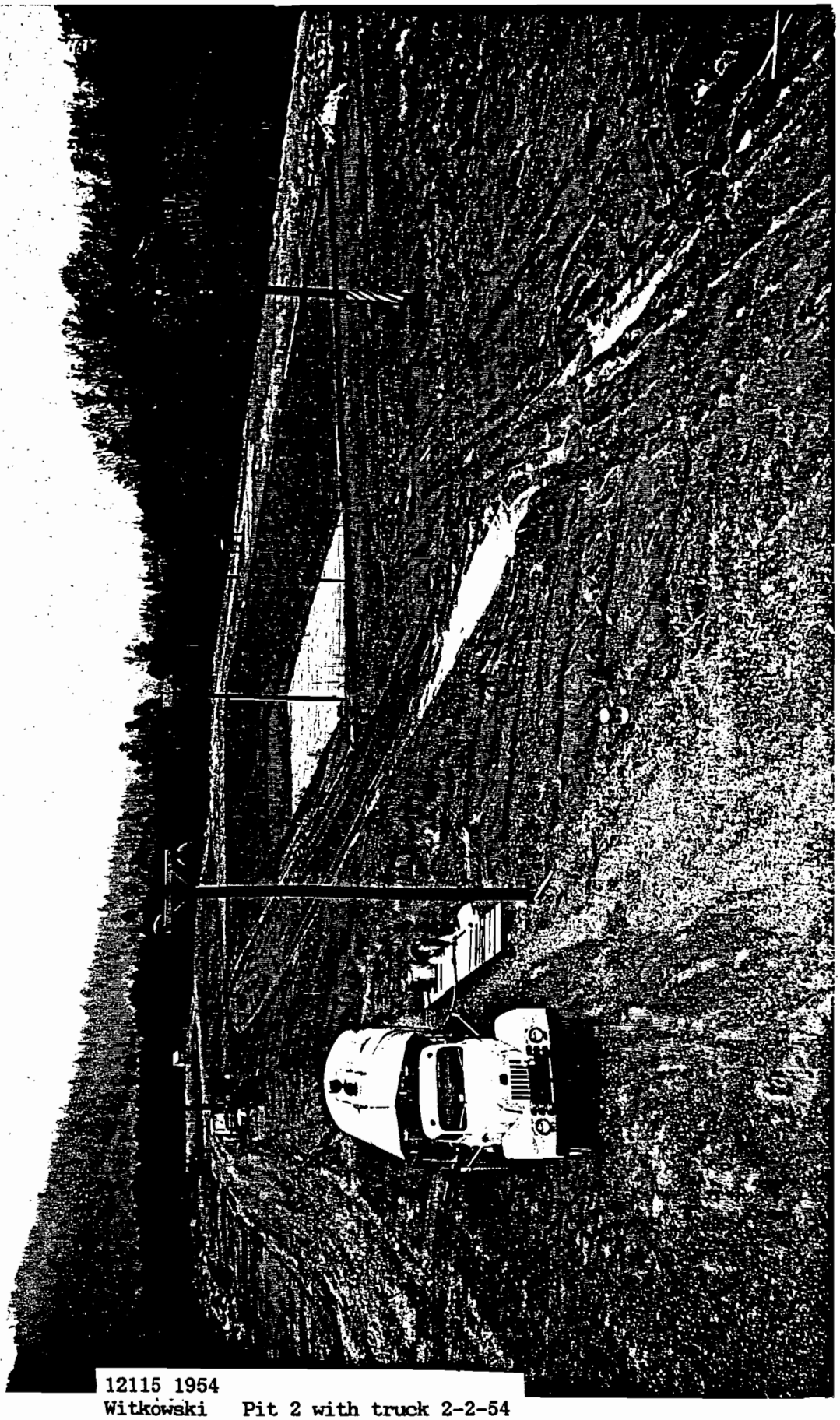
2083-86 1986
Williams Areal view of pits 2,3,4, and 5 March 1986

5556-86 1986
B.Spalding Grout injection manifold at trench 7 Jan 1986

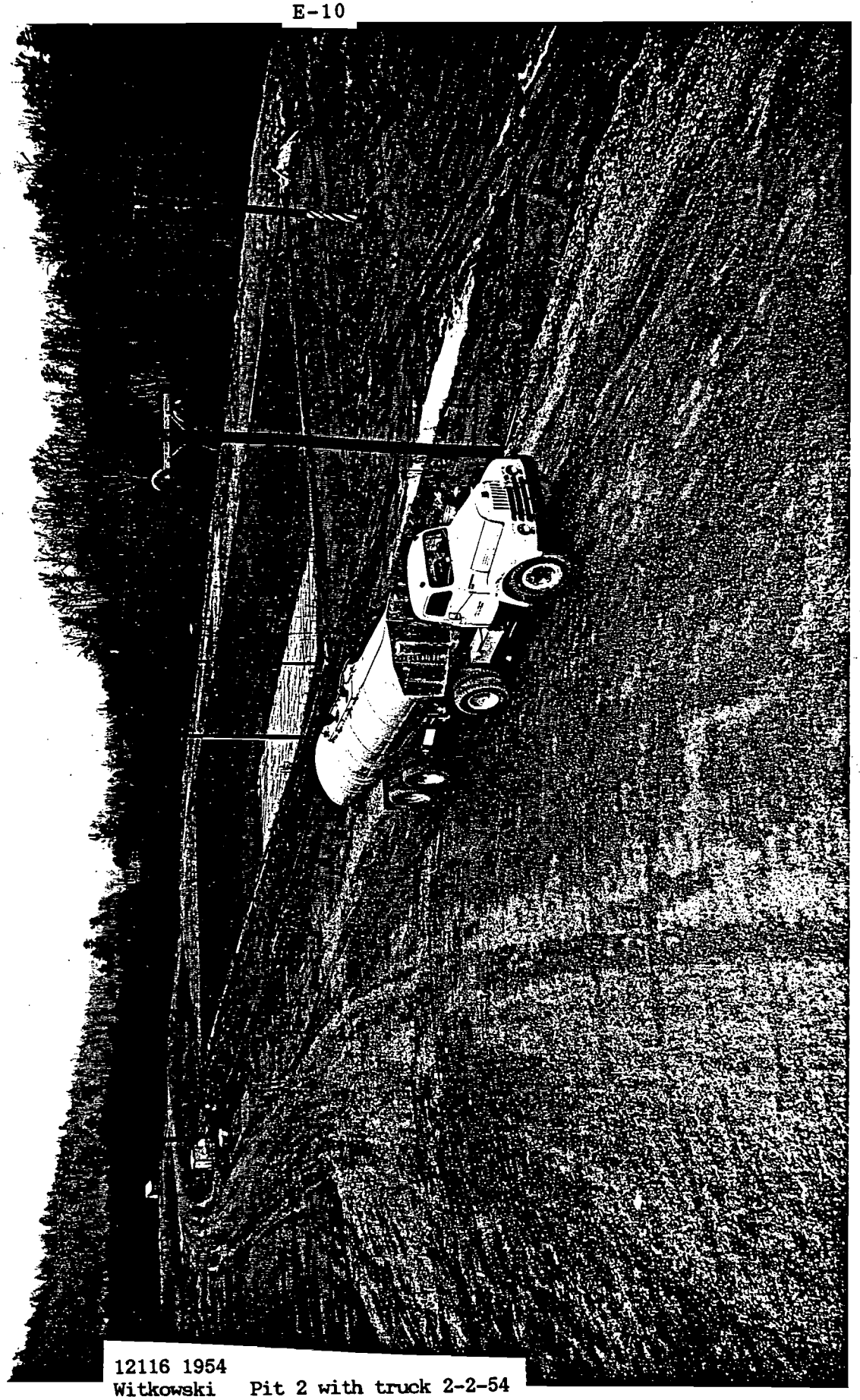
8485-86 1986
B.Spalding Contaminated Equipment Storage Area (7841) 12/4/86

8486-86 1986
B.Spalding Contaminated Equipment Storage Area (7841) 12/4/86

8488-86 1986
B.Spalding 4-Acre site on 12/4/86 after 27 years of abandon



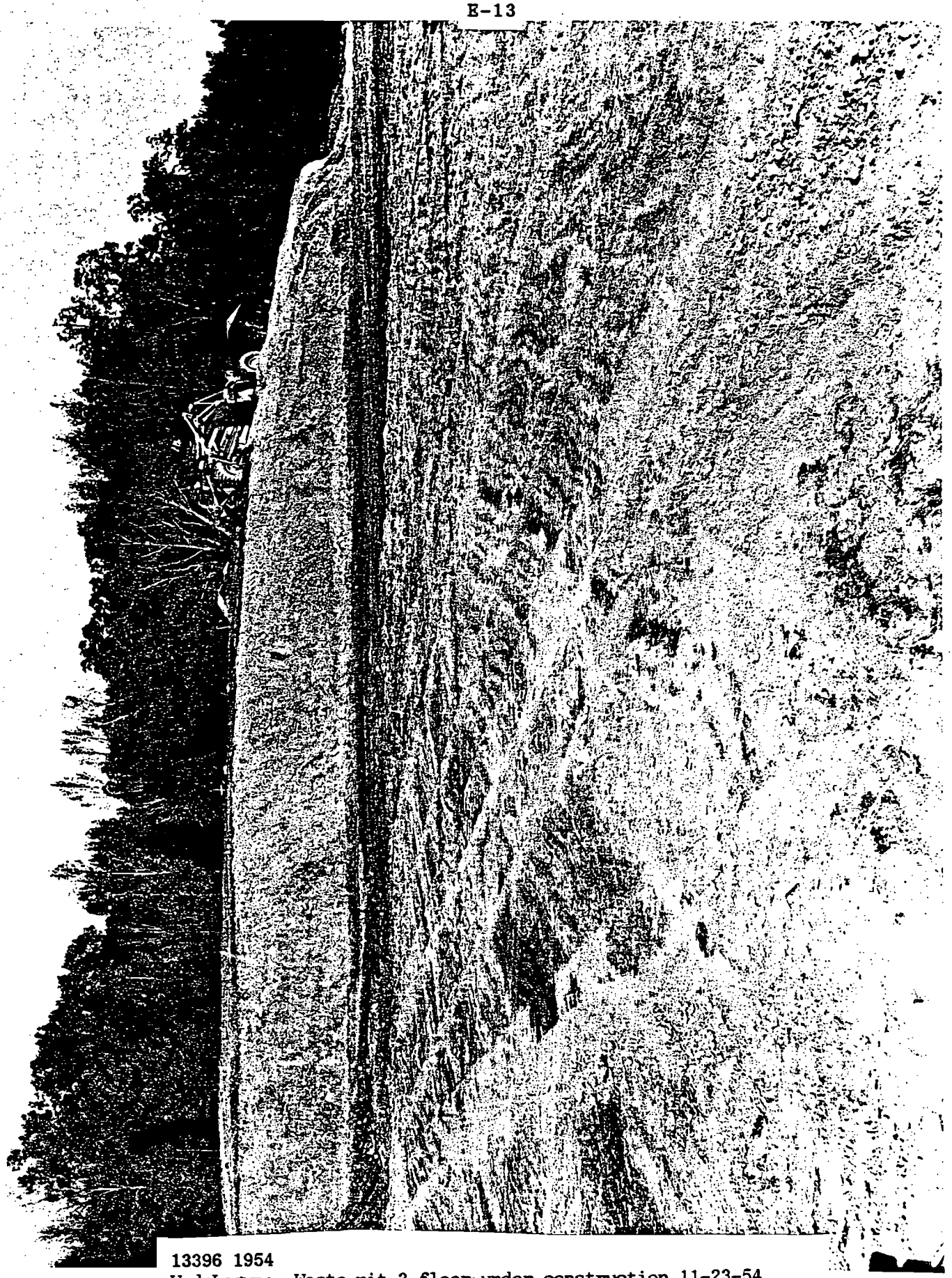
12115 1954
Witkowski Pit 2 with truck 2-2-54



12116 1954
Witkowski Pit 2 with truck 2-2-54

12117 1954
Witkowski Intermediate-level waste transfer trailer 2-2-54

13395 1954
W.deLaguna Waste pit 3 Sideslope under construction 11-23-54

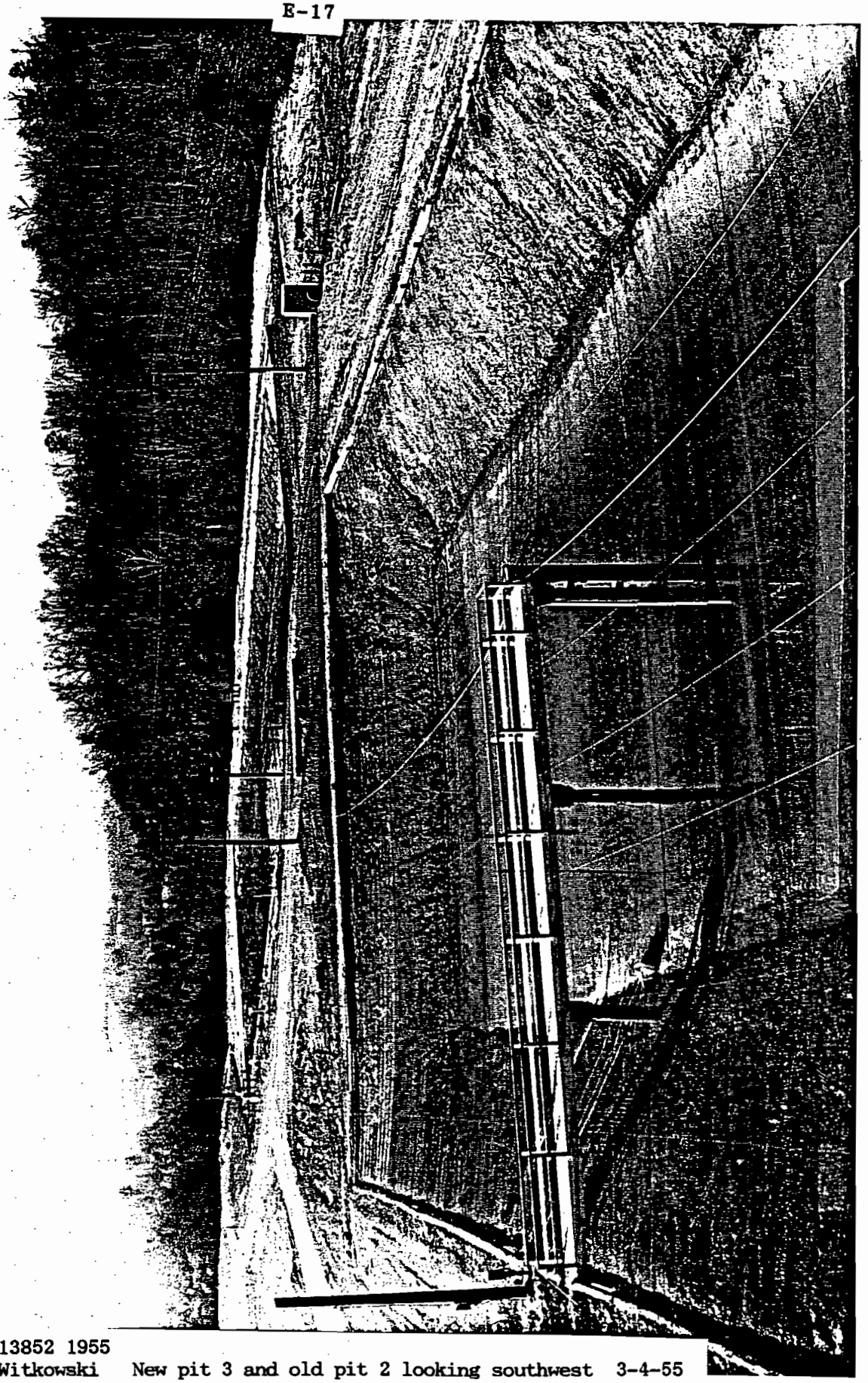


13396 1954
W.deLaguna Waste pit 3 floor under construction 11-23-54

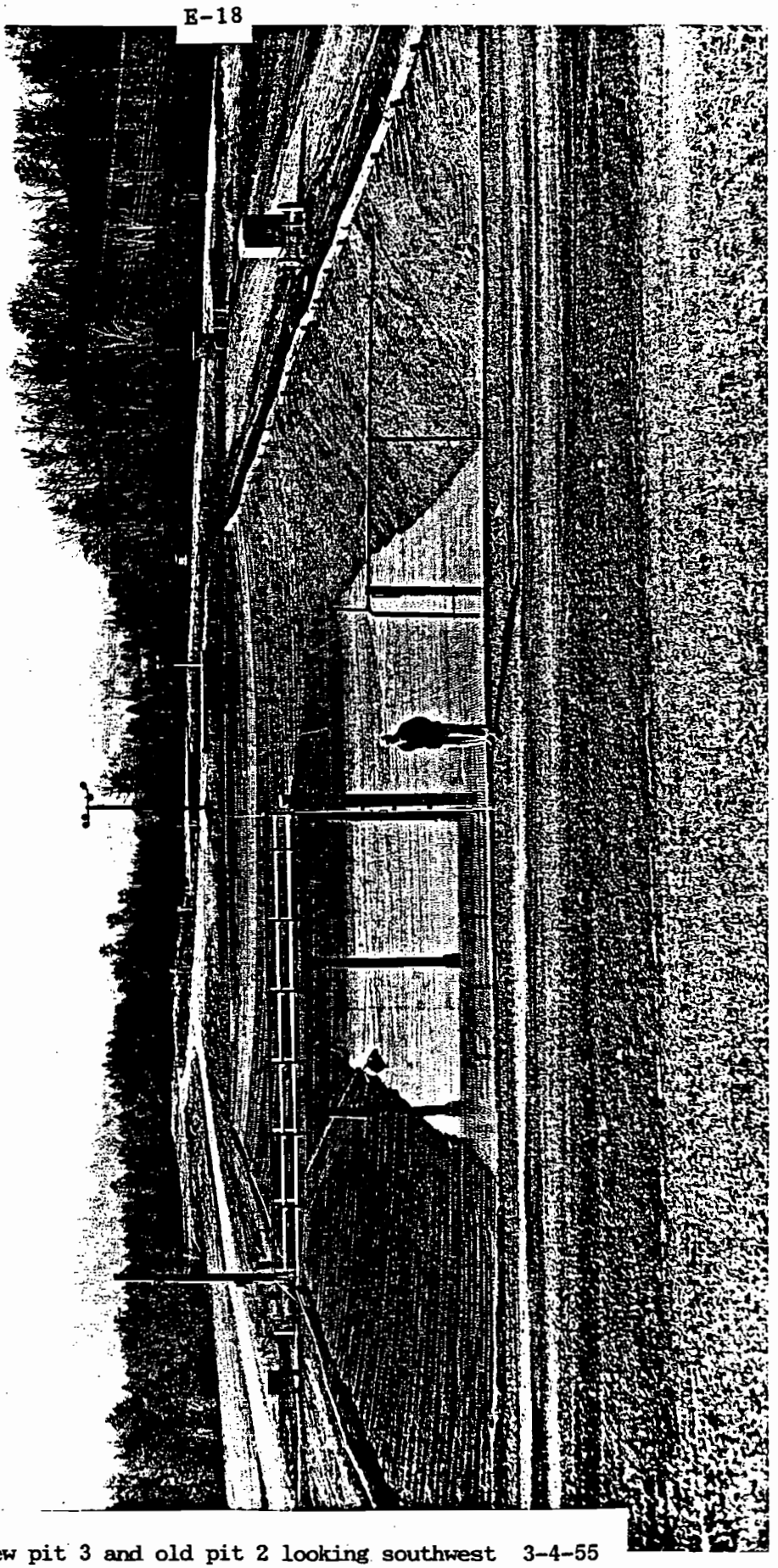
13397 1954
W.deLaguna Waste pit 3 excavation 11-23-54

13398 1954
W.deLaguna Waste pit 3 excavation completed 11-23-54

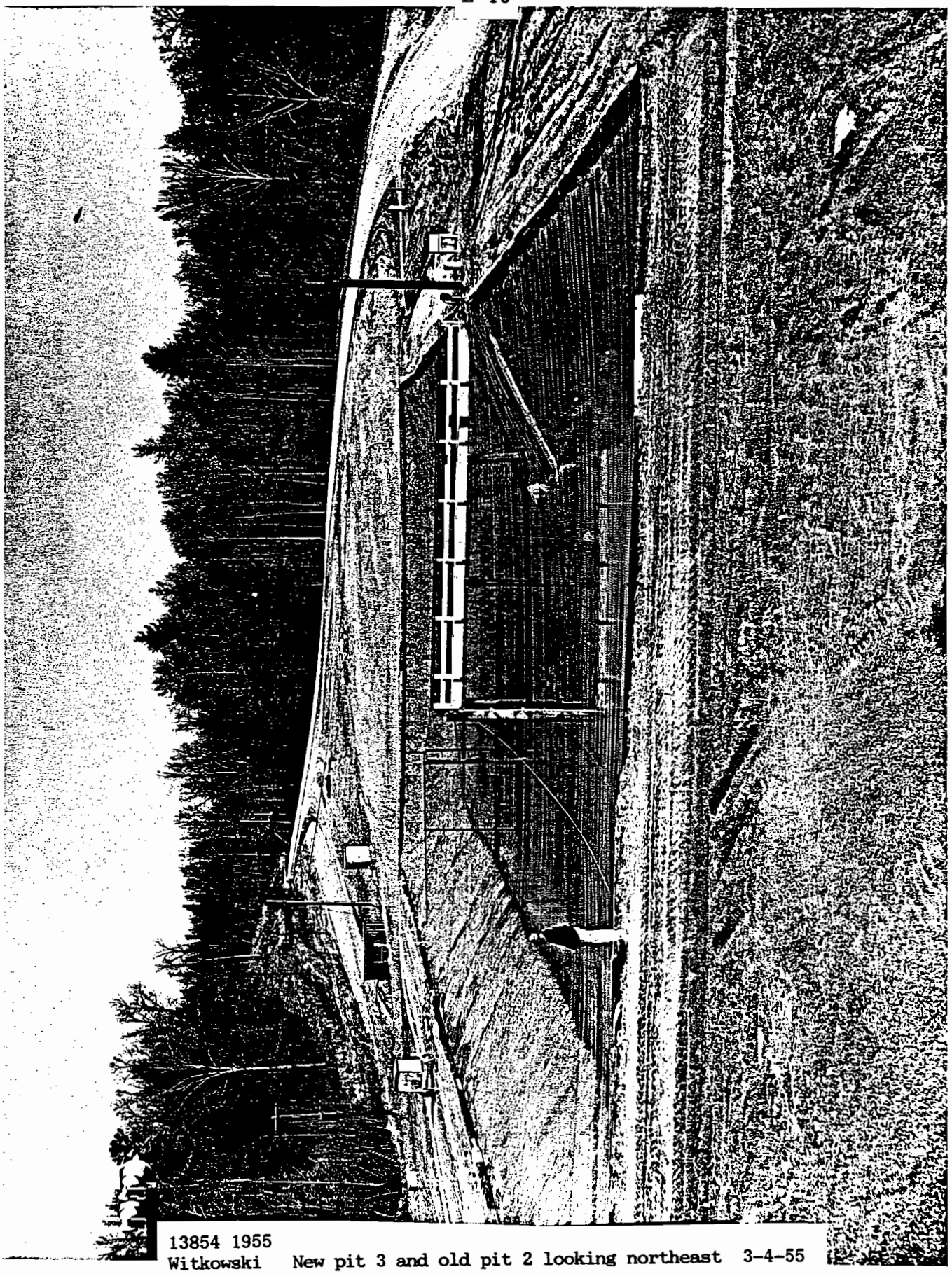
13399 1954
W.deLaguna Waste pit 3 stratification exposure 11-23-54



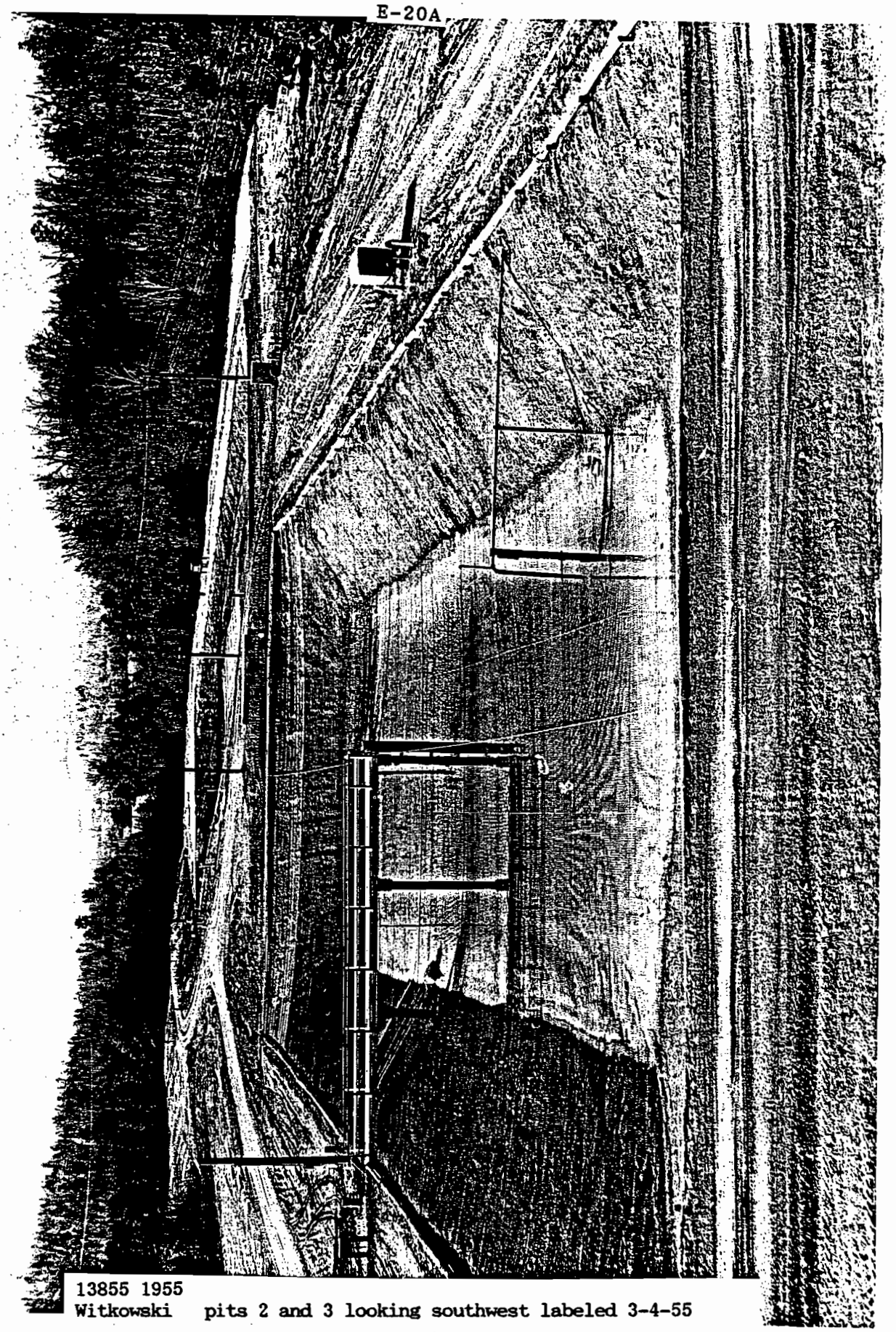
13852 1955
Witkowski New pit 3 and old pit 2 looking southwest 3-4-55



13853 1955
Witkowski New pit 3 and old pit 2 looking southwest 3-4-55



13854 1955
Witkowski New pit 3 and old pit 2 looking northeast 3-4-55



13855 1955
Witkowski pits 2 and 3 looking southwest labeled 3-4-55

PHOTO 45855

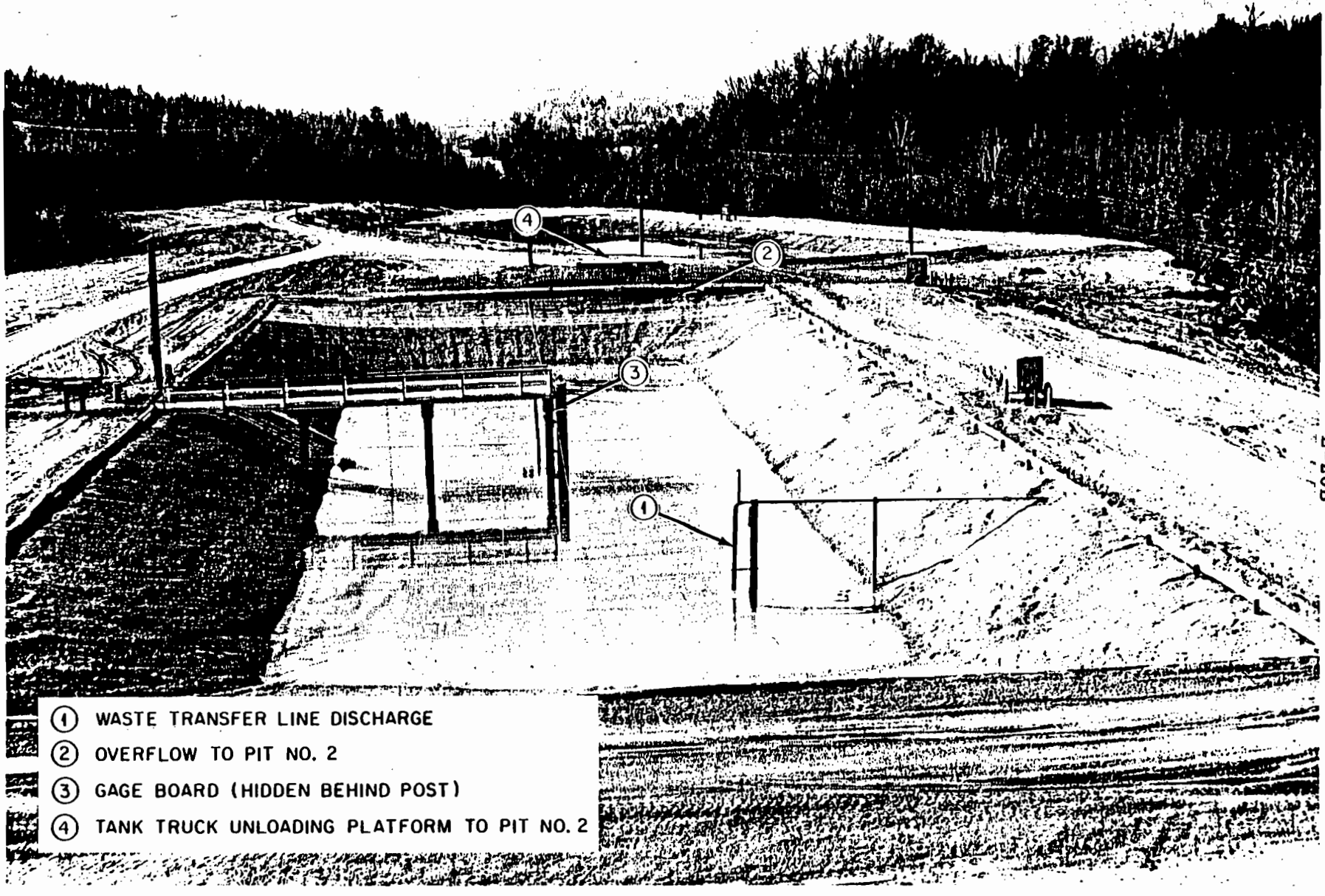
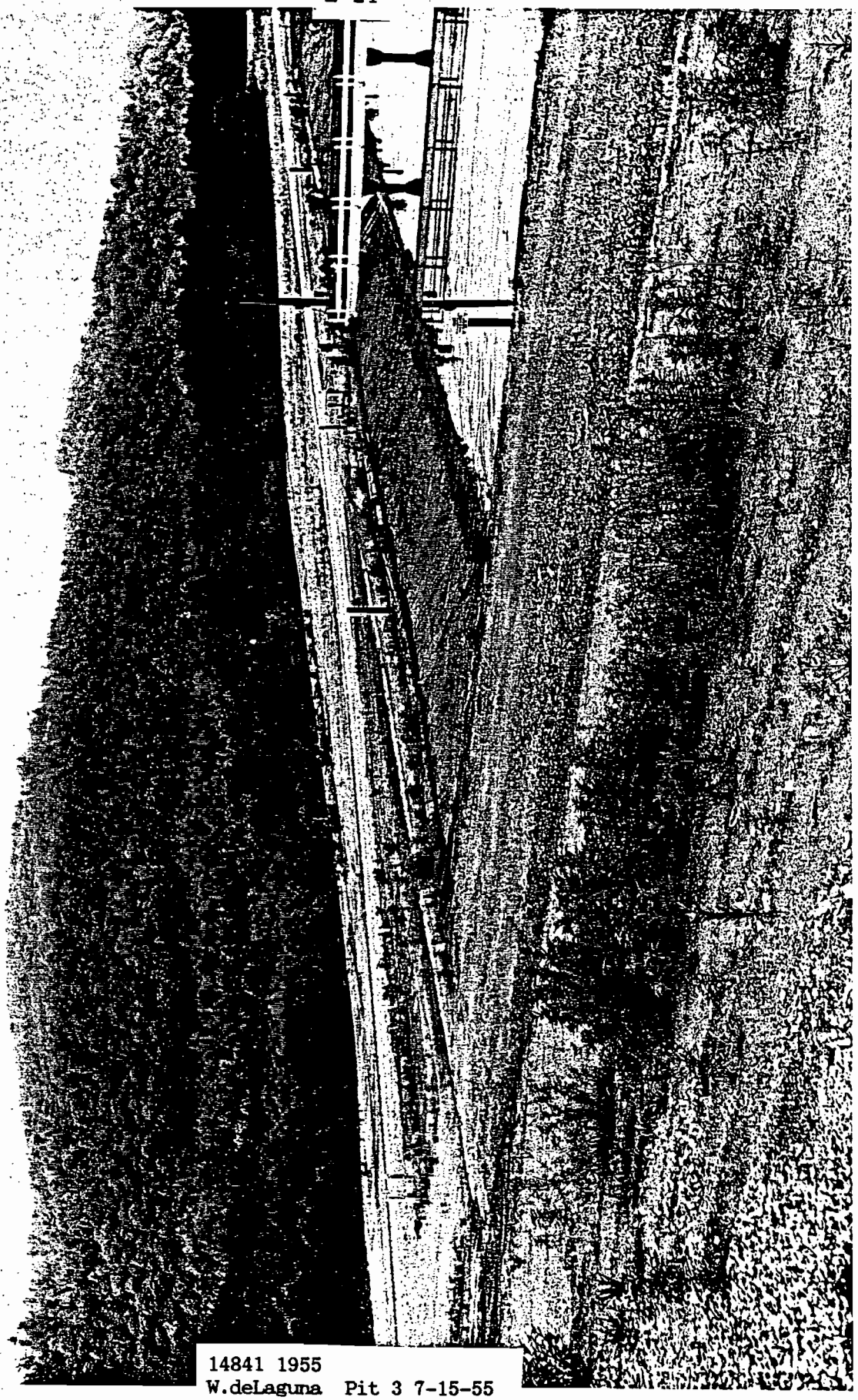
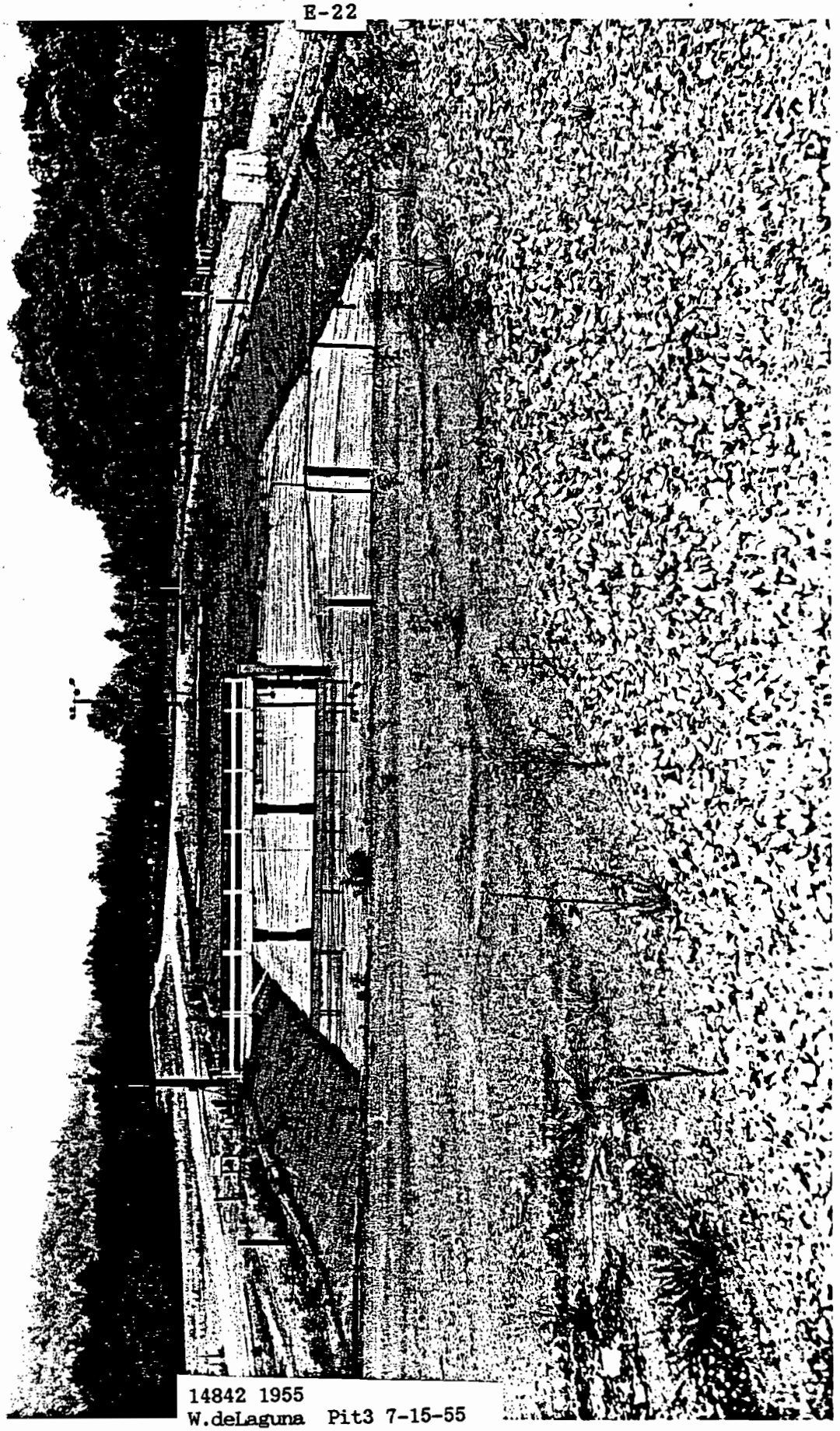


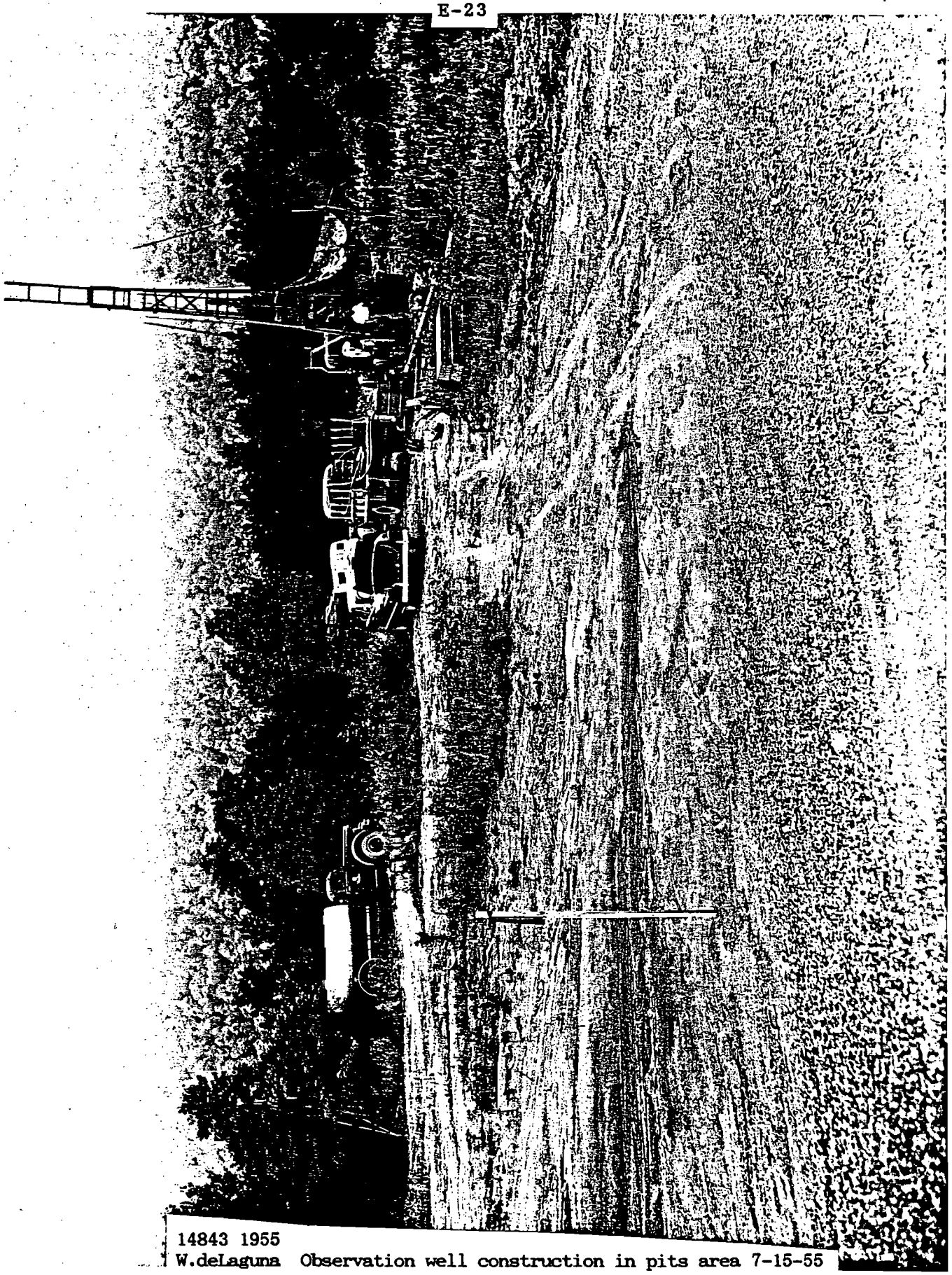
Fig. 2. Waste Disposal Pits Nos. 1 and 2, Facing West (No. 1 in Foreground, No. 2 in Background).



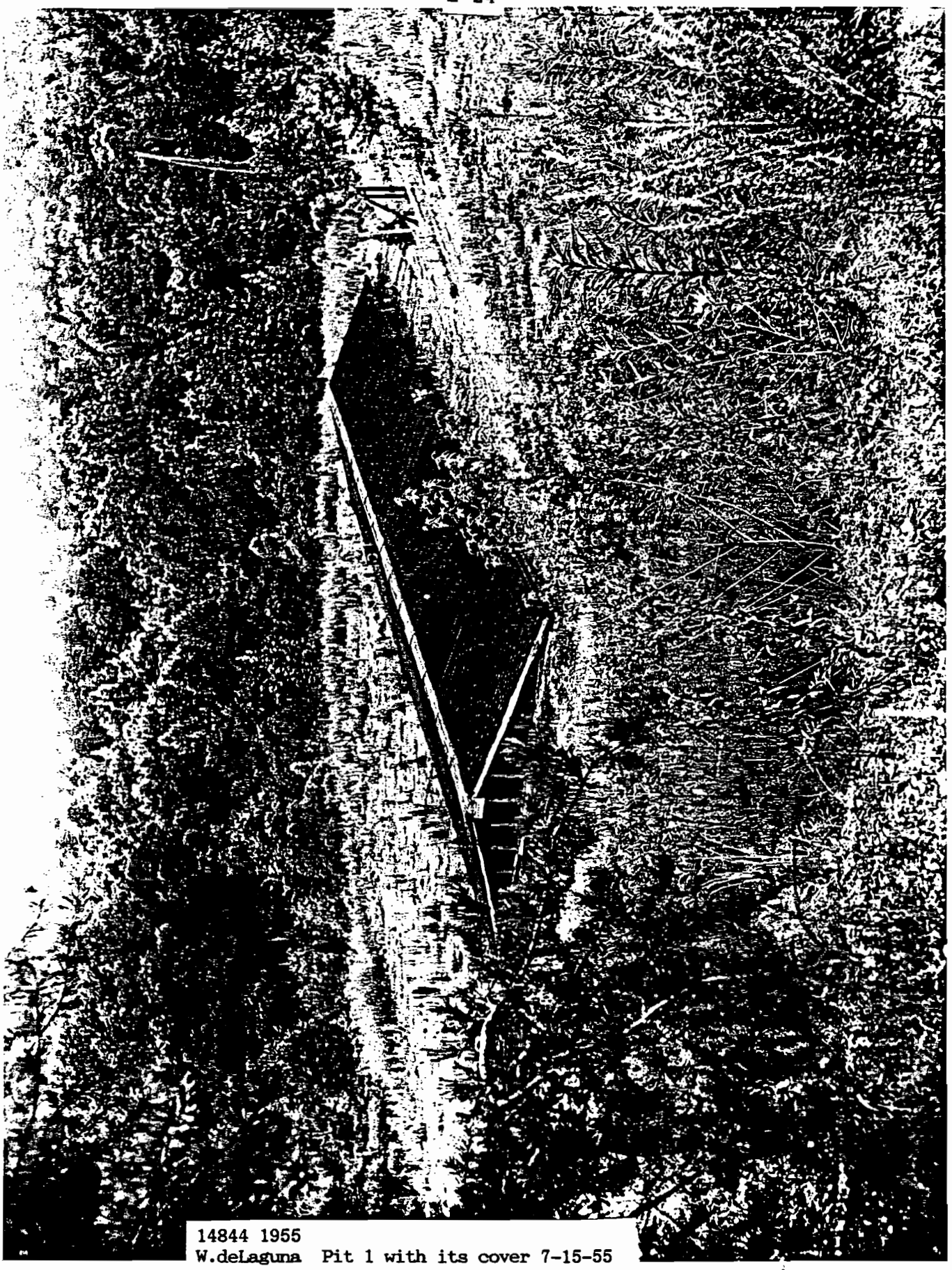
14841 1955
W.deLaguna Pit 3 7-15-55



14842 1955
W.deLaguna Pit3 7-15-55



14843 1955
W.deLaguna Observation well construction in pits area 7-15-55



14844 1955
W.deLaguna Pit 1 with its cover 7-15-55

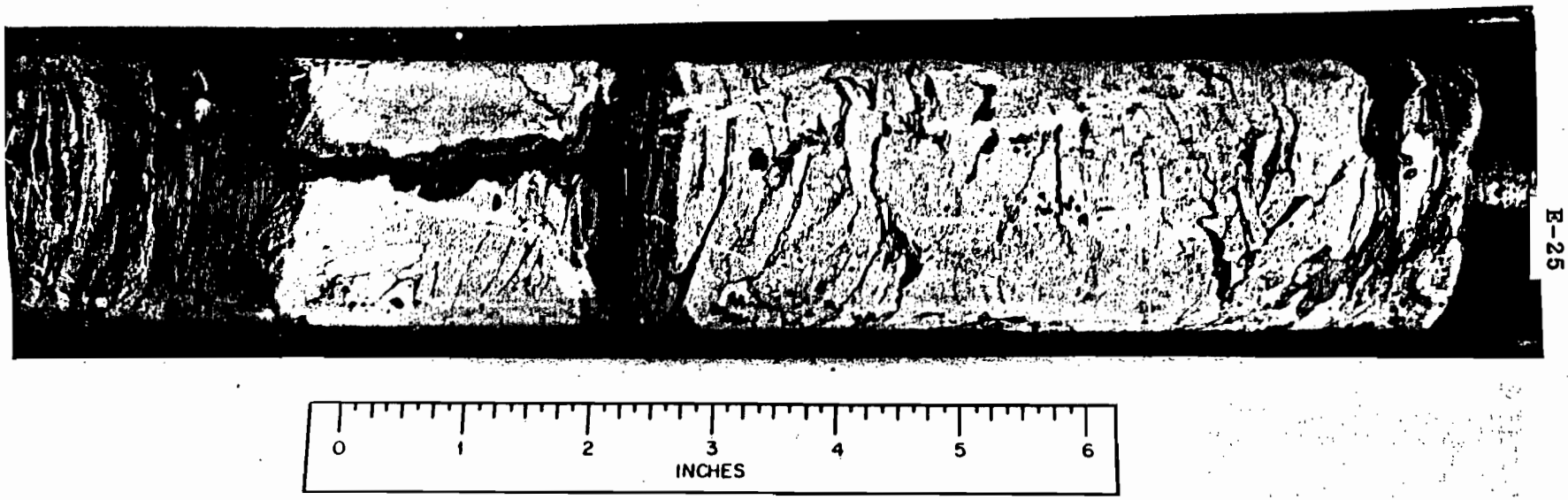
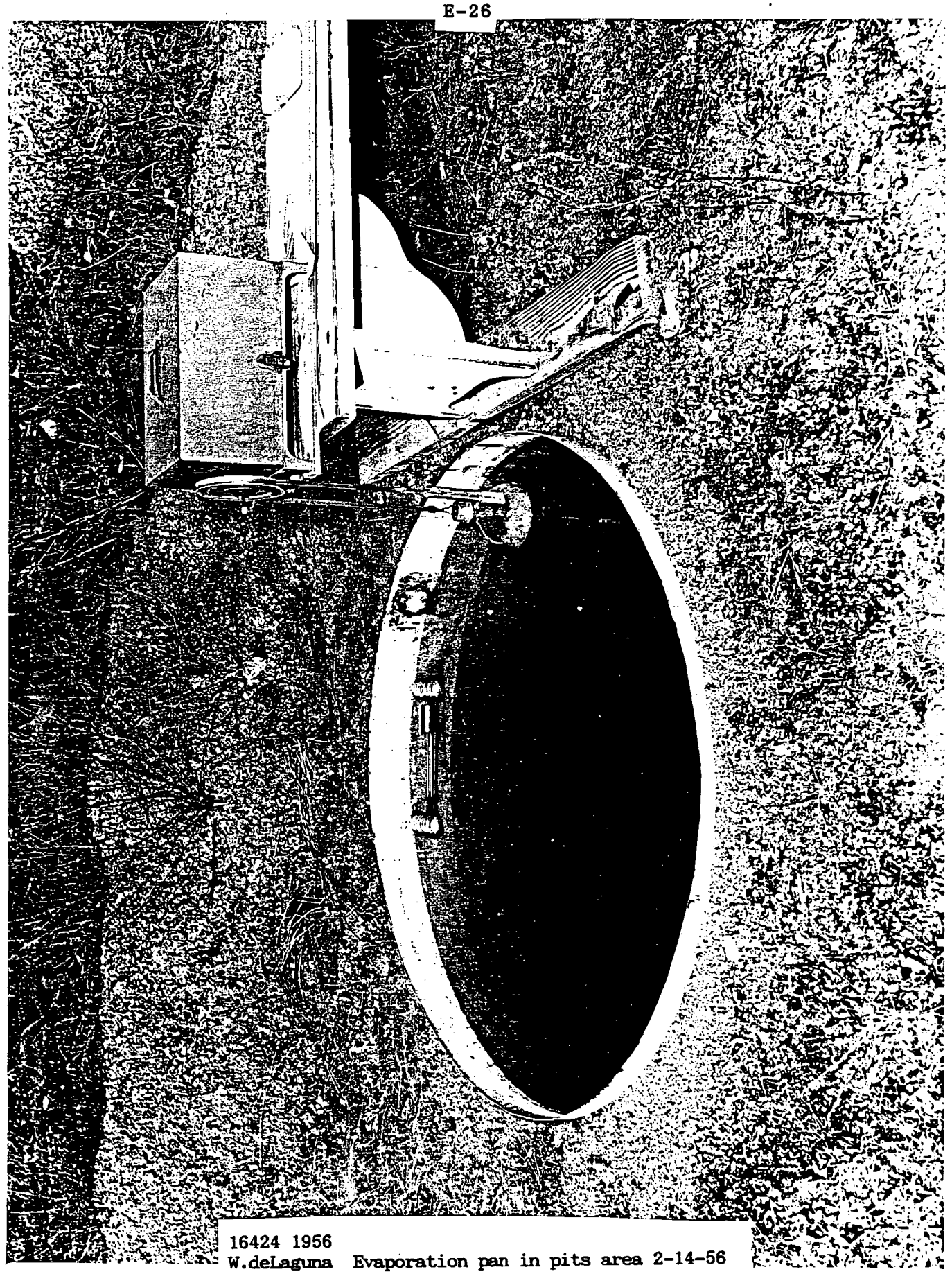


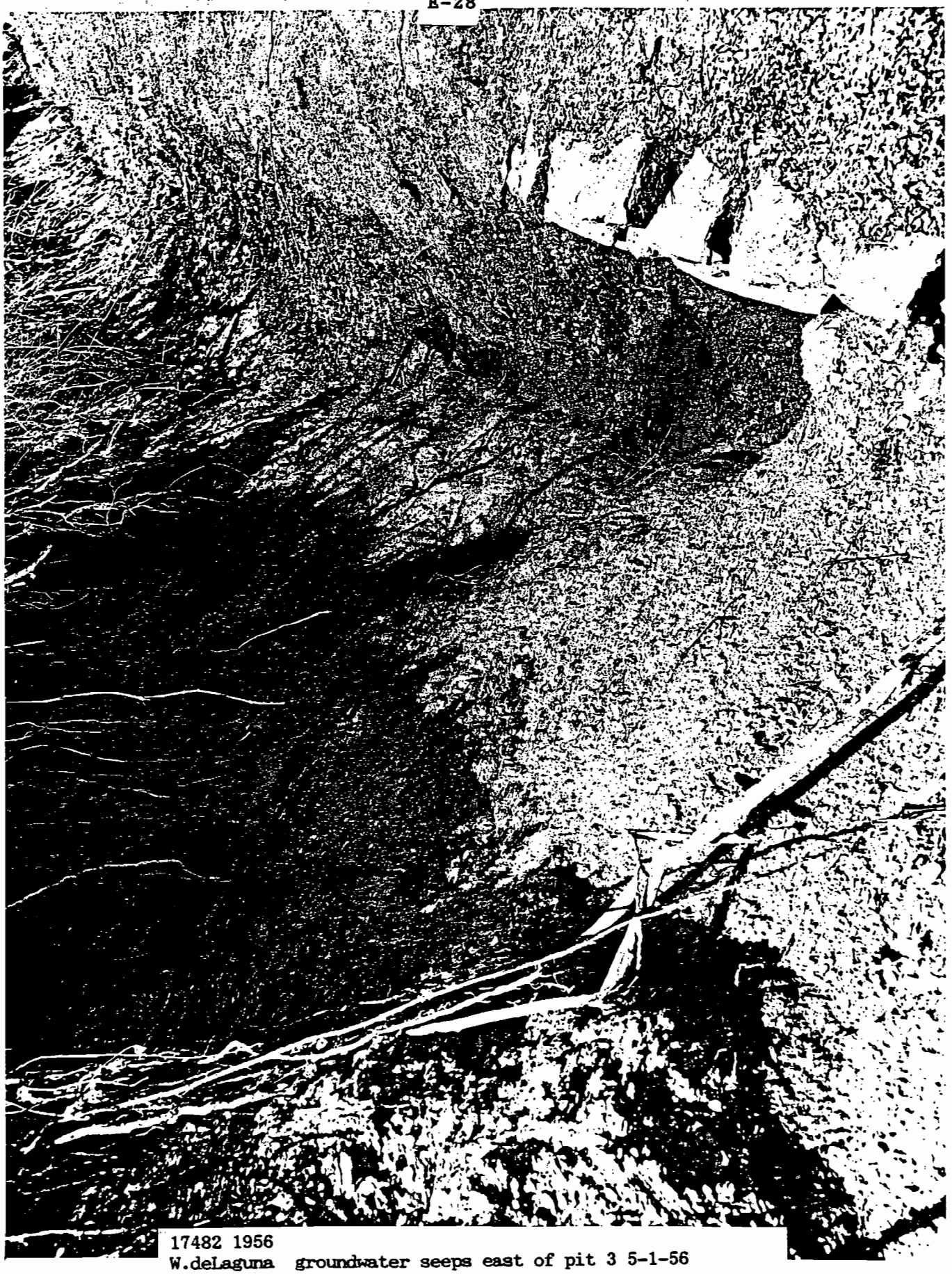
FIG. 2 SOLUTIONALLY ENLARGED FRACTURE IN LIMESTONE OF THE CONASAUGA GROUP

15681 1955
W.delaguna Solution cavity in core from Pit 4 area 11-7-55



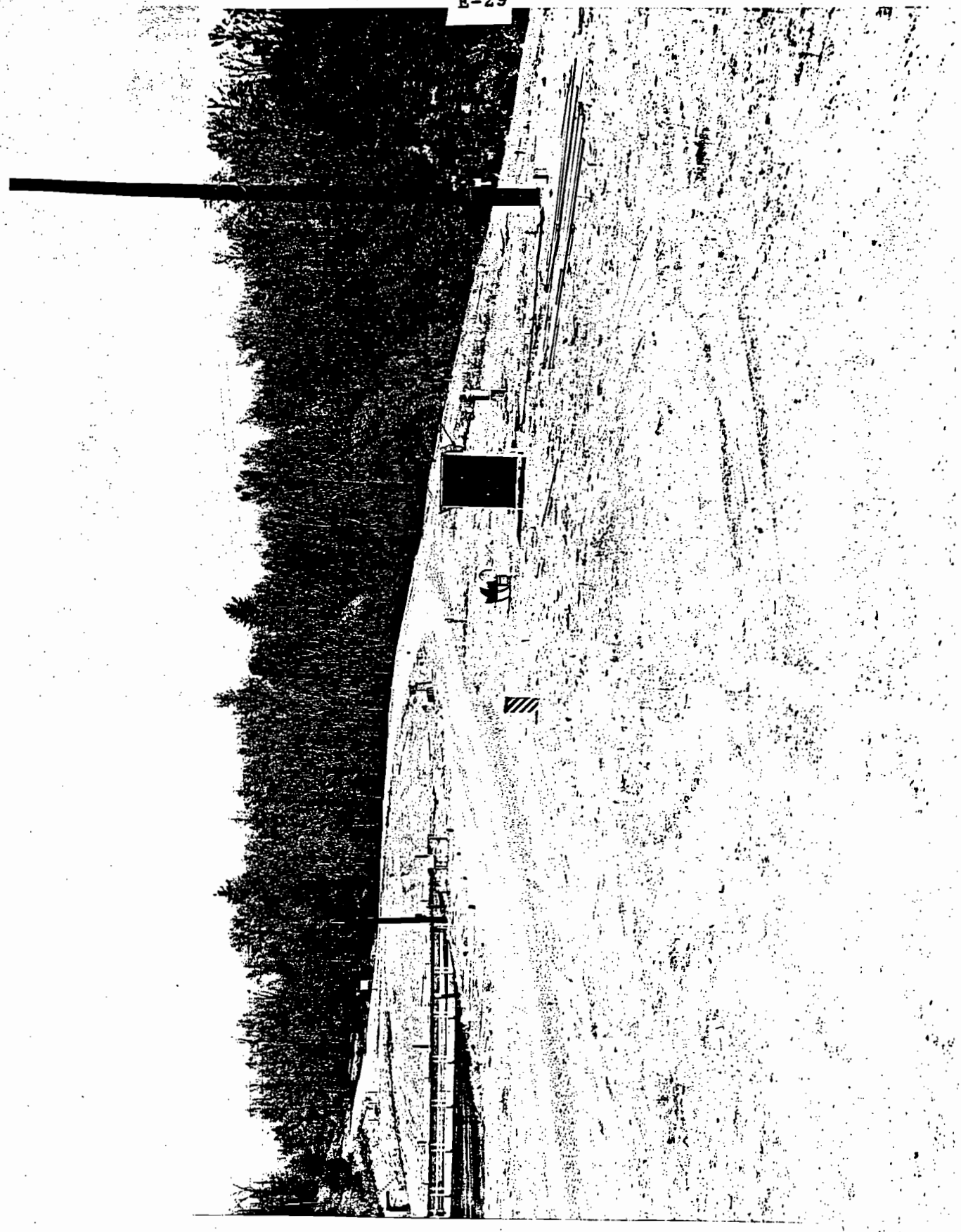
16424 1956
W.deLaguna Evaporation pan in pits area 2-14-56

17481 1956
W.deLaguna drainage area east of pits at well 83 5-1-56

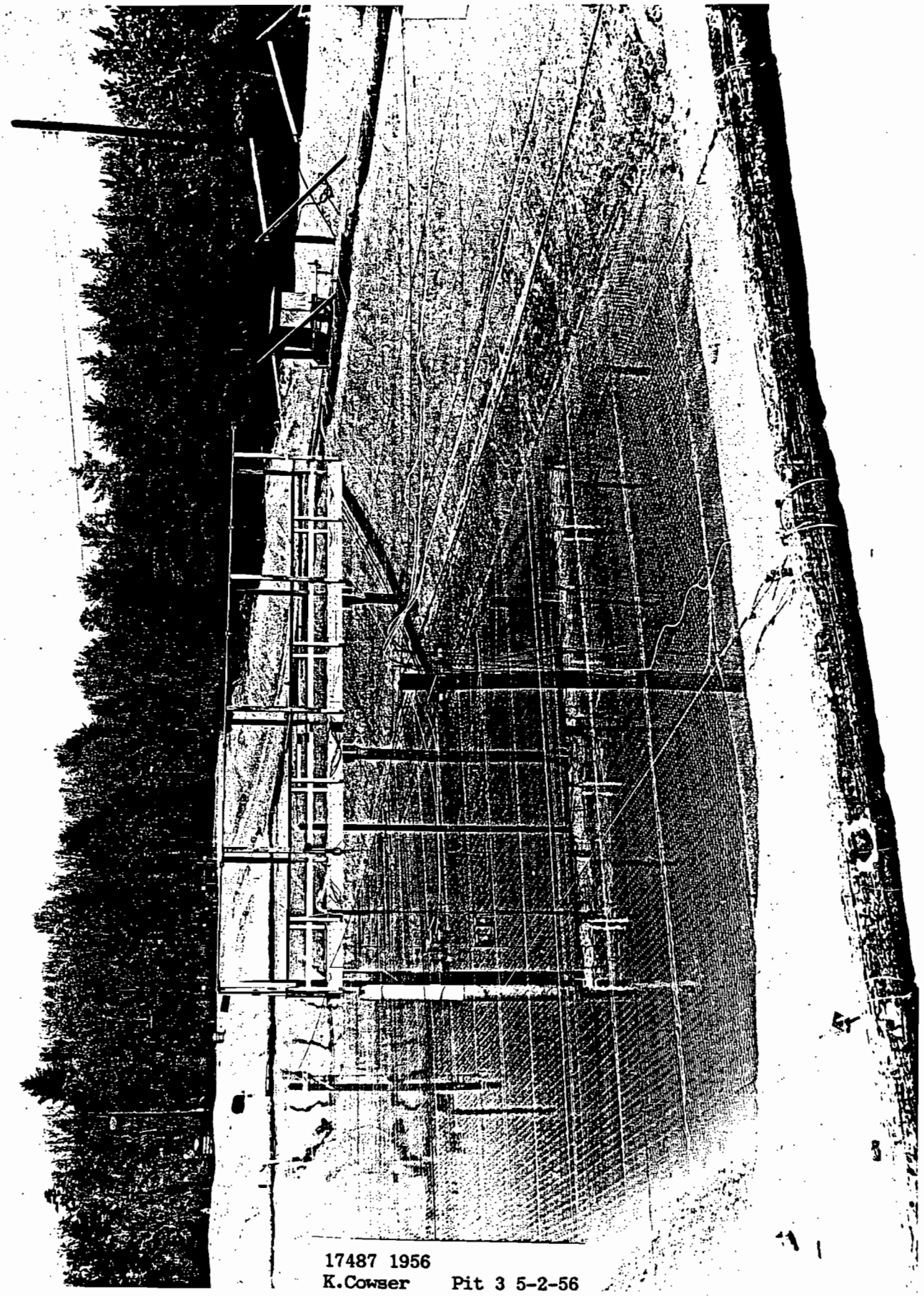


17482 1956
W.deLaguna groundwater seeps east of pit 3 5-1-56

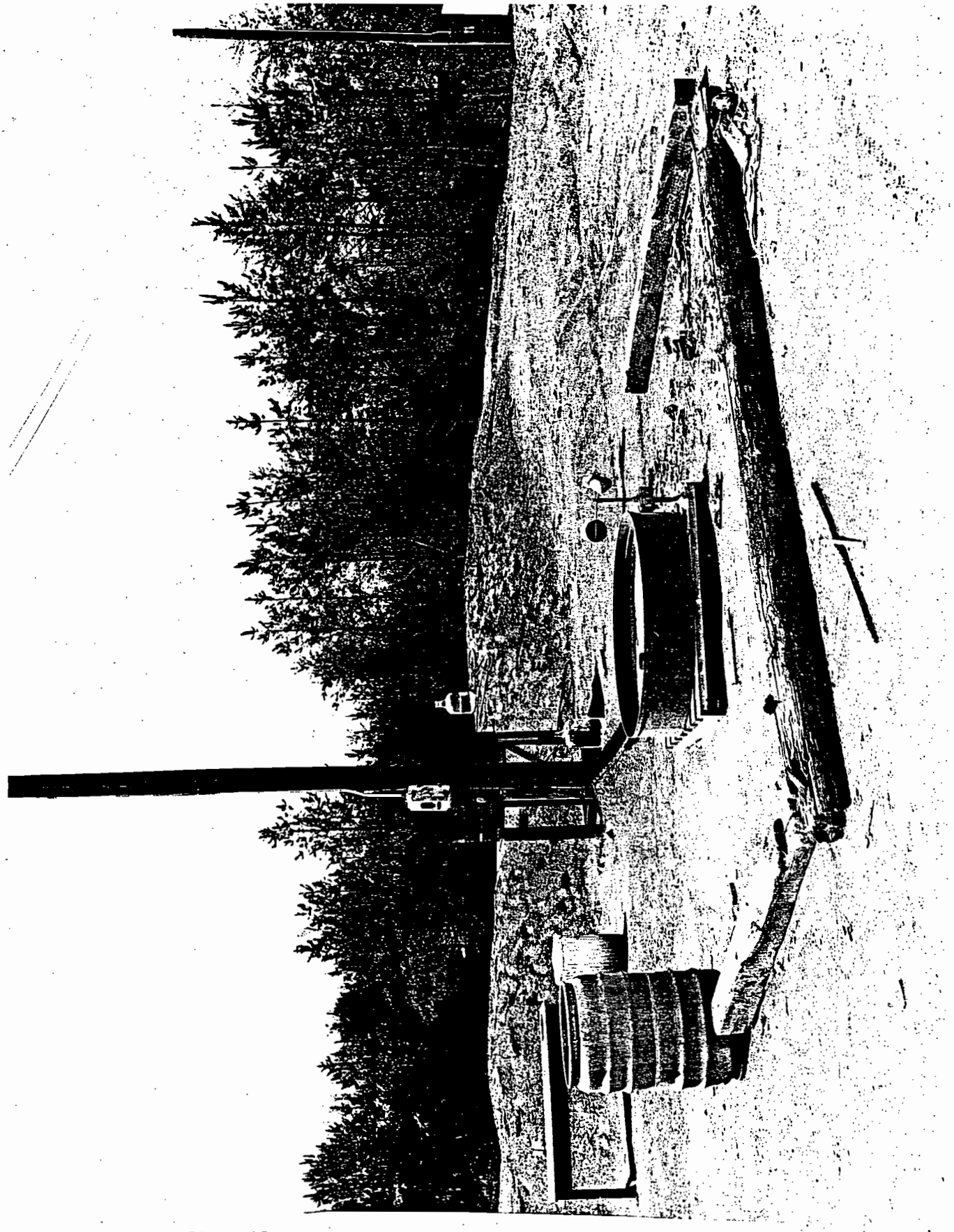
E-29



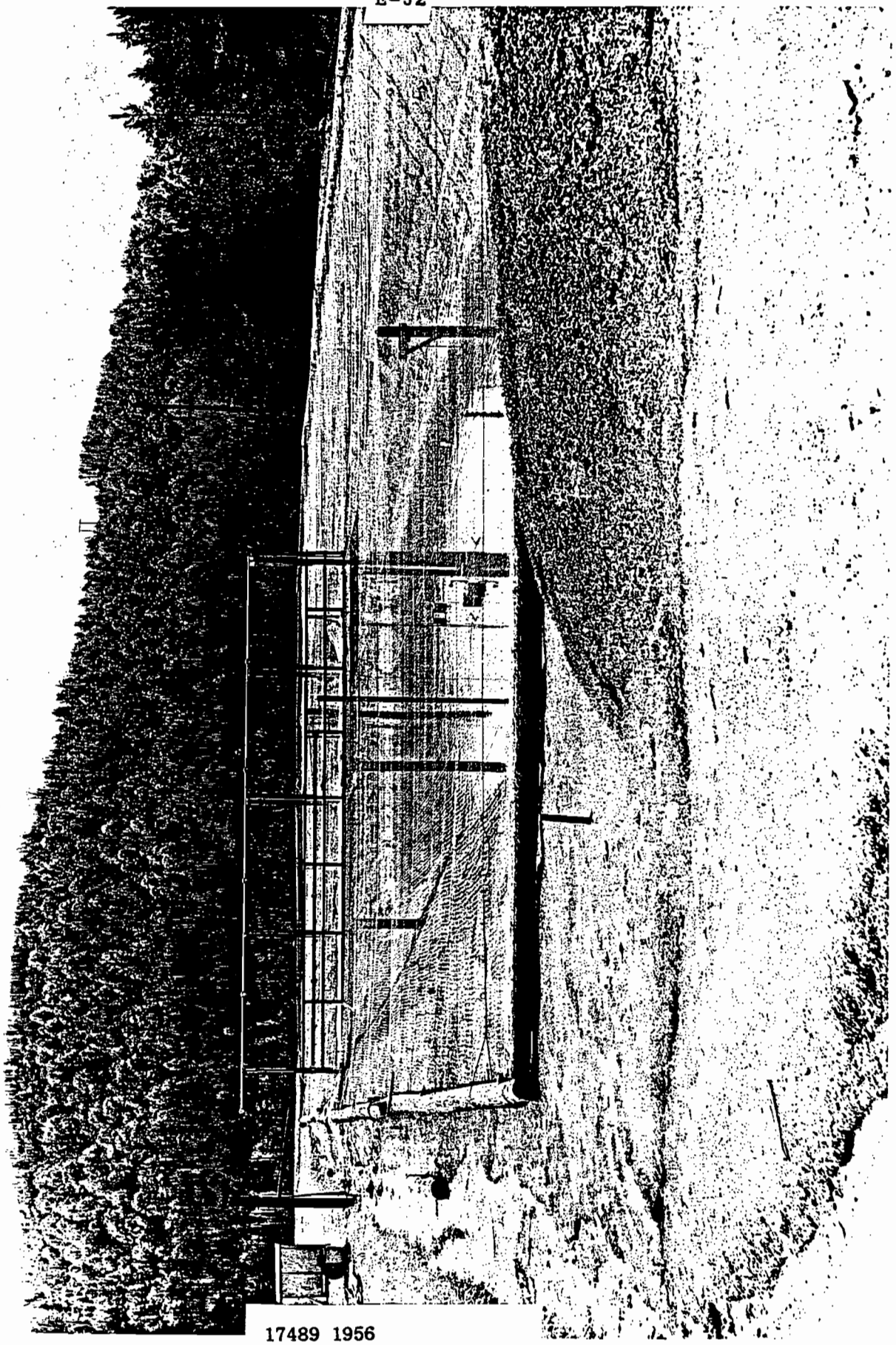
17486 1956
K.Cowser Pit 3 looking northeast 5-2-56



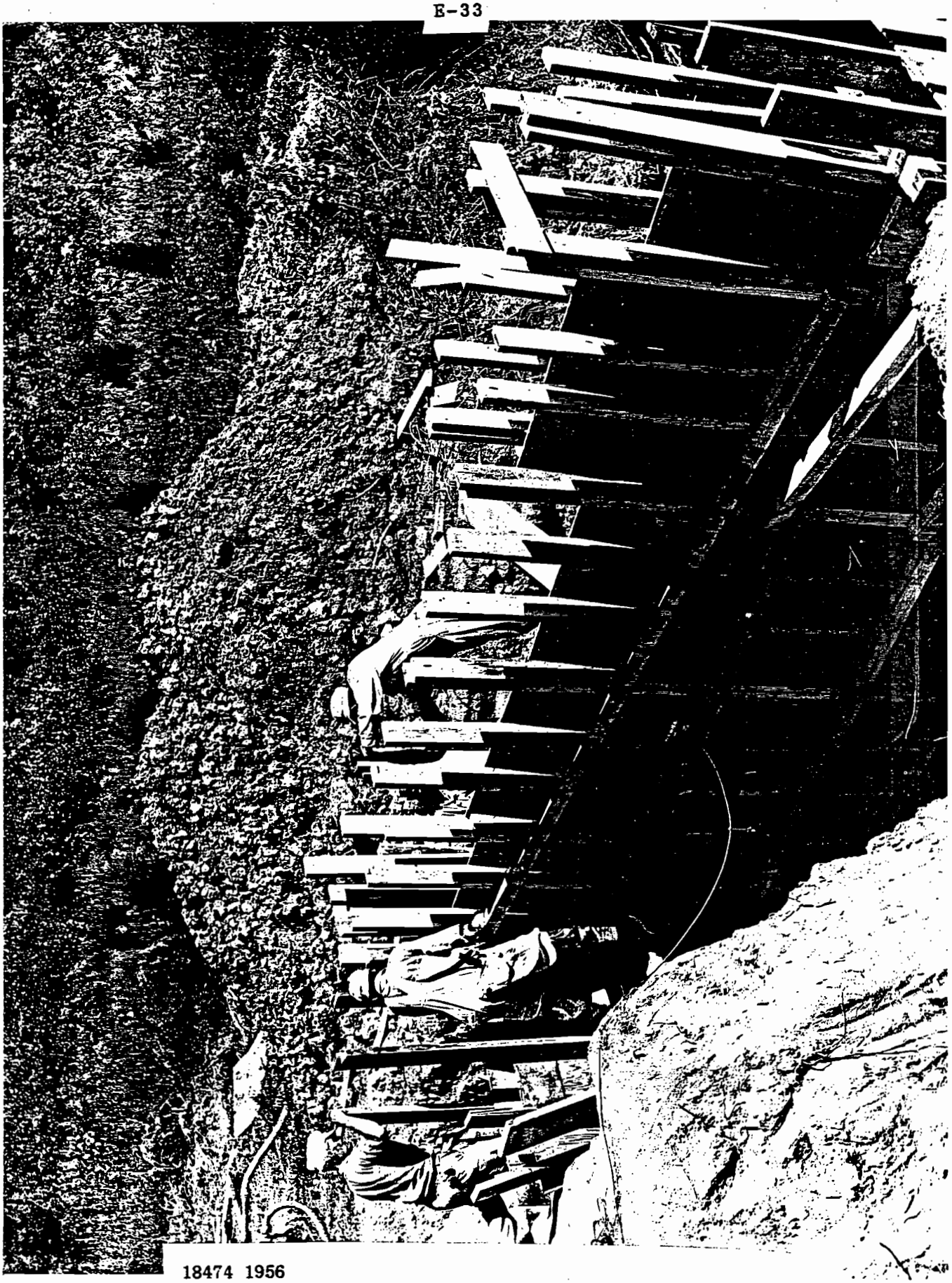
17487 1956
K.Cowser Pit 3 5-2-56



17488 1956
K.Cowser Pits 2 and 3 evaporation apparatus 5-2-56

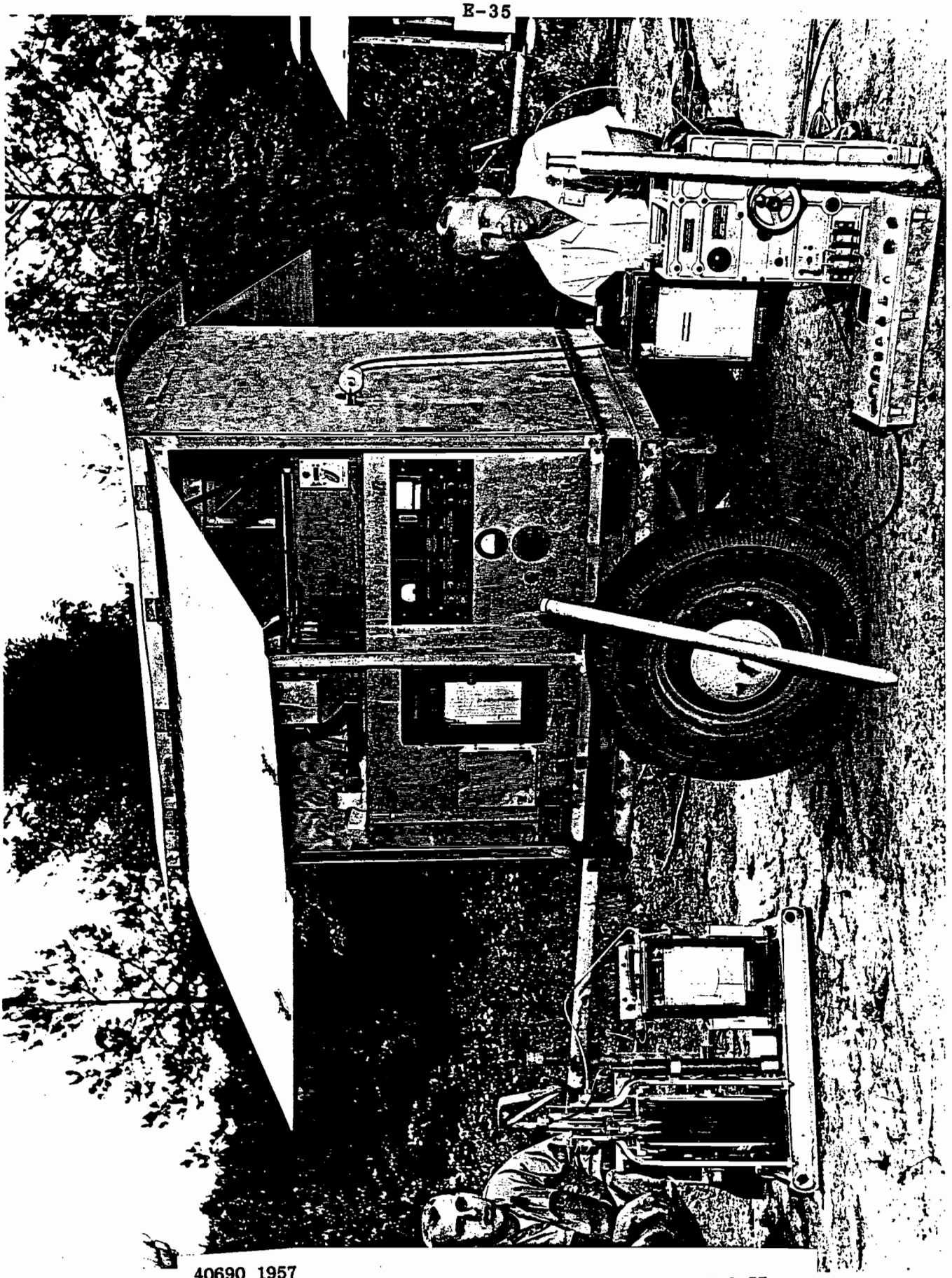


17489 1956
K.Cowser Pit 3 5-2-56



18474 1956
W.deLaguna Weir construction east of pits area 9-24-56

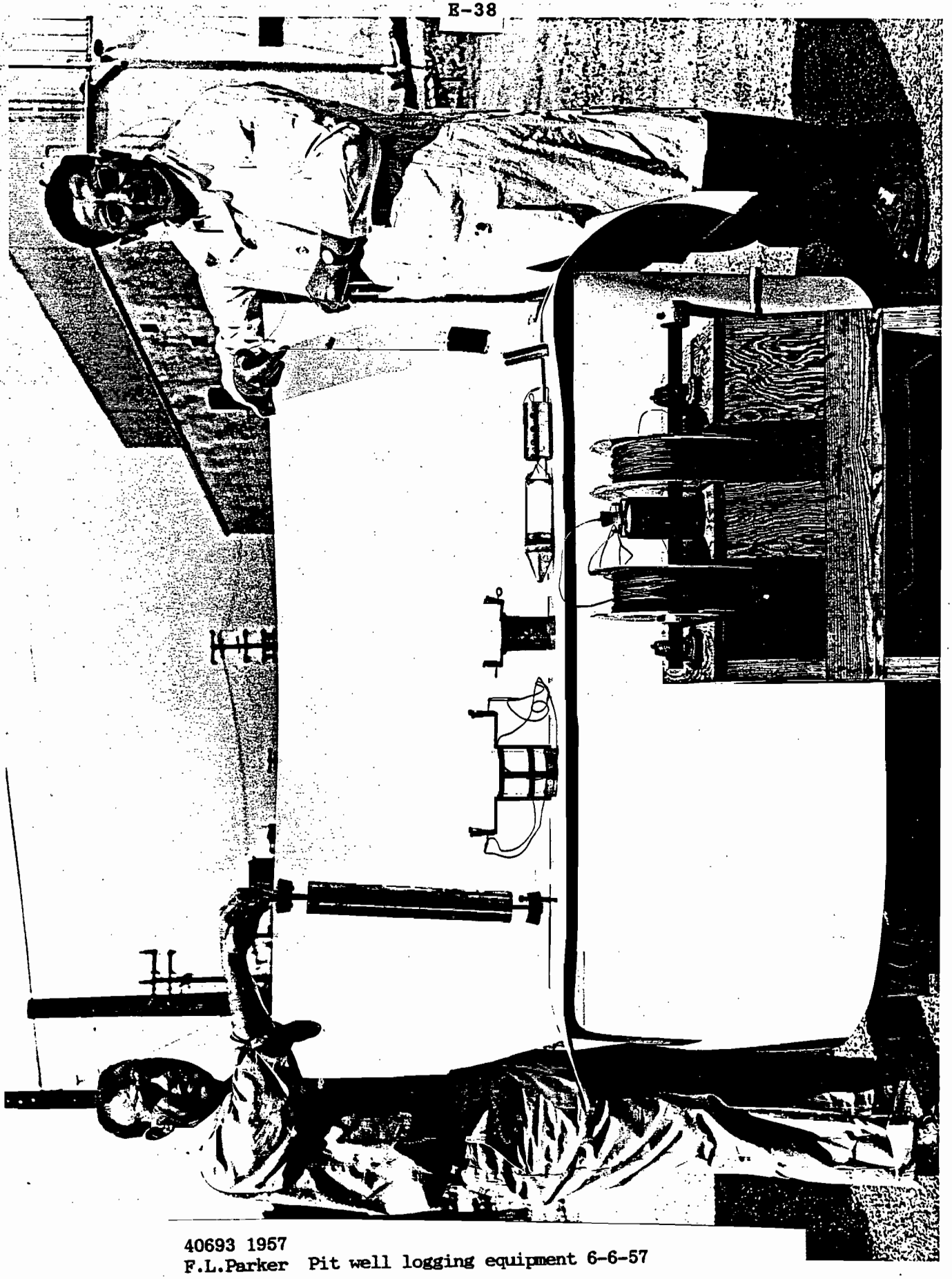
18475 1956
W.deLaguna Weir construction east of pits area 9-24-56



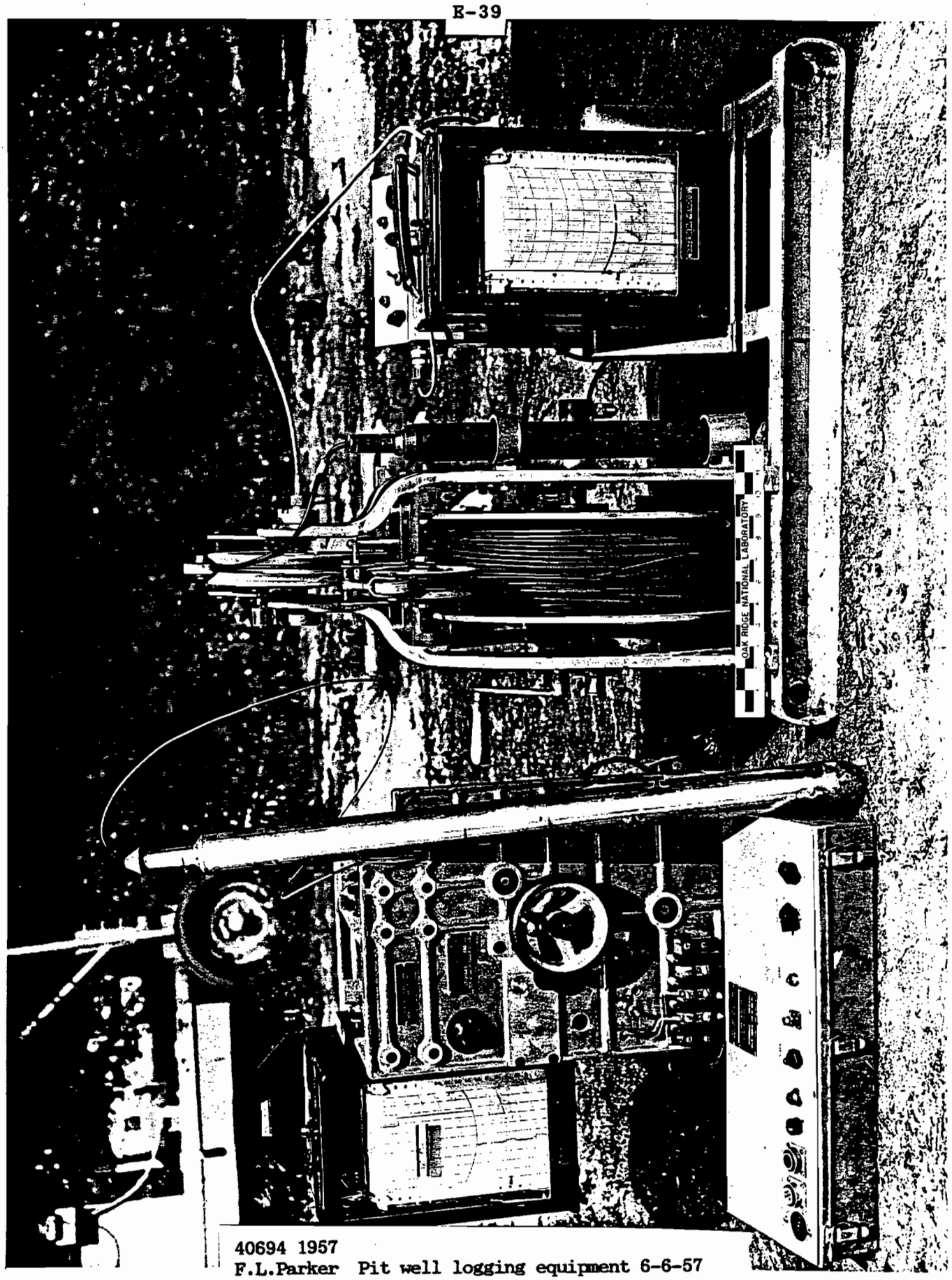
40690 1957
F.L.Parker well logging equipment for pits area 6-6-57

40691 1957
F.L.Parker roadcut in drainage of pits area 6-6-57

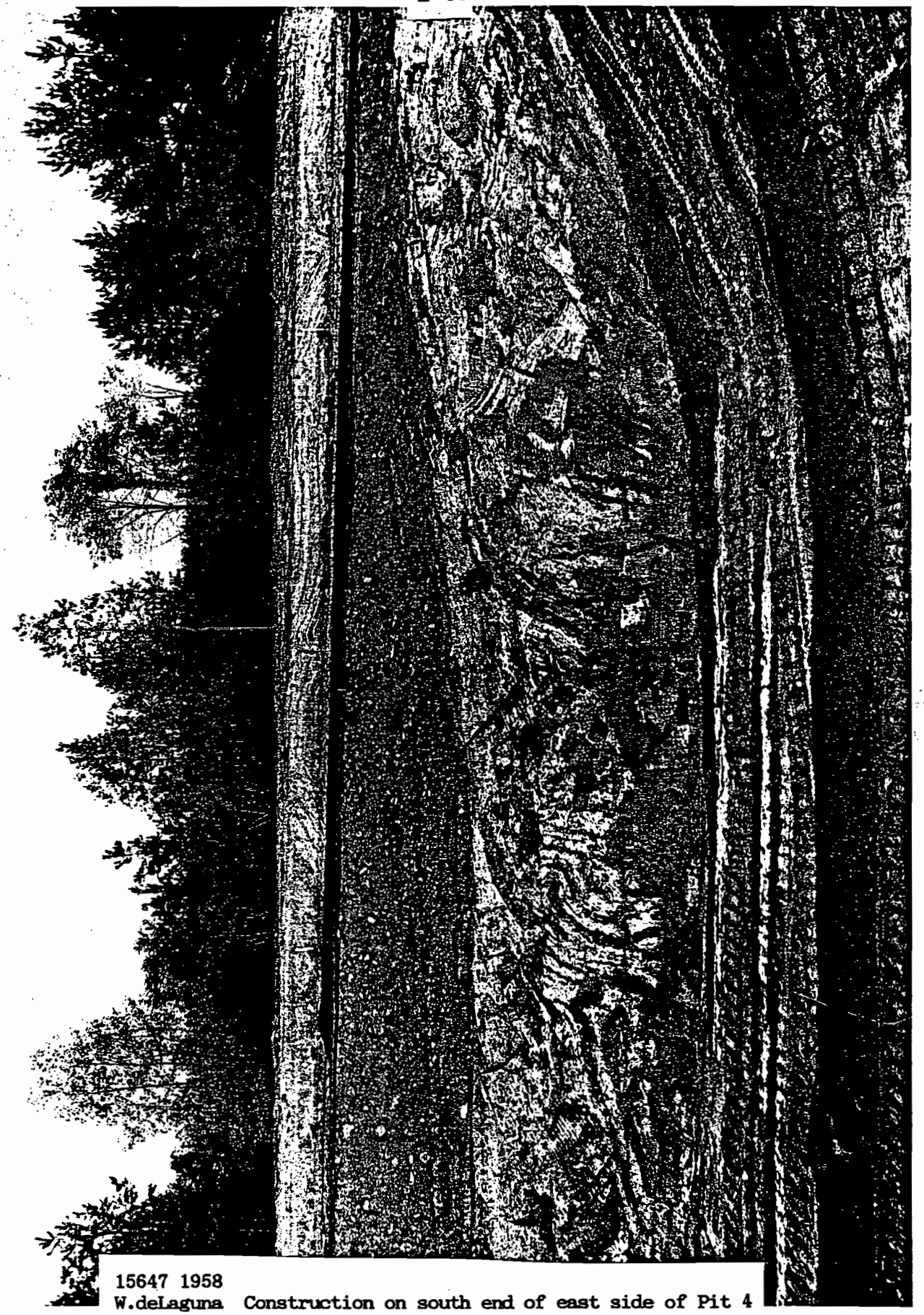
40692 1957
F.L.Parker roadcut in drainage of pits area 6-6-57



40693 1957
F.L.Parker Pit well logging equipment 6-6-57

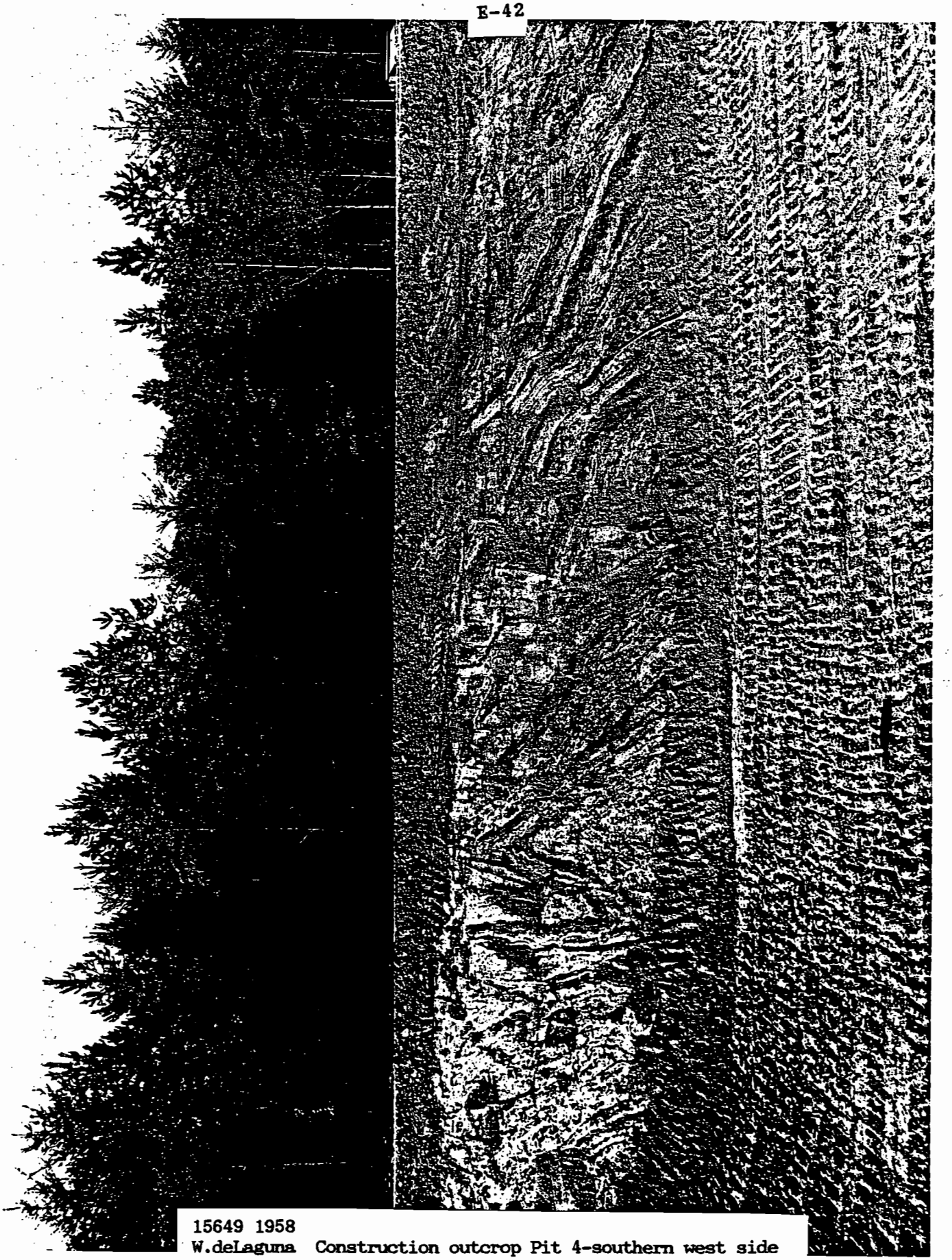


40694 1957
F.L.Parker Pit well logging equipment 6-6-57

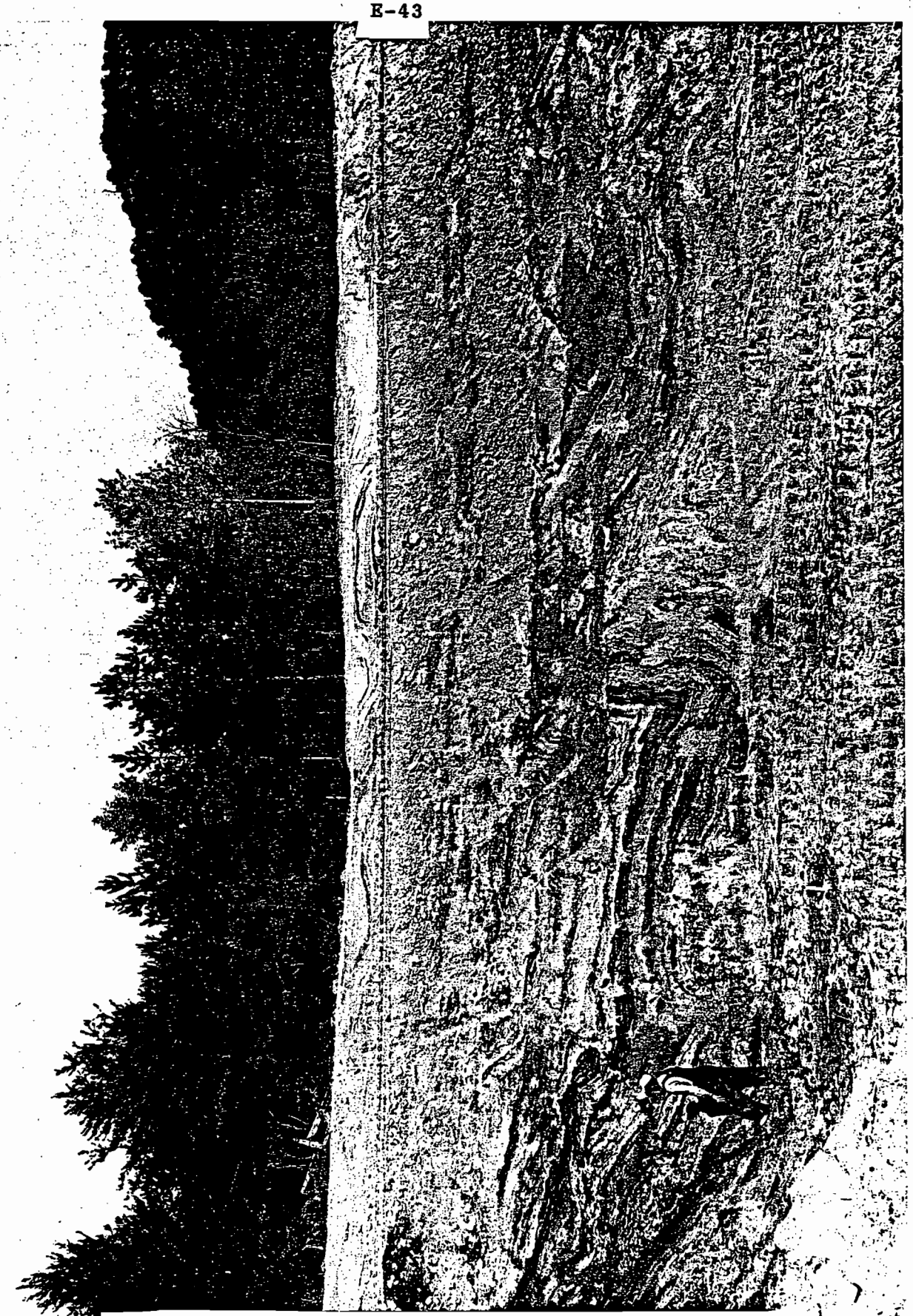


15647 1958
W.deLaguna Construction on south end of east side of Pit 4

15648 1958
W.deLaguna Construction outcrop Pit 4-northern east side

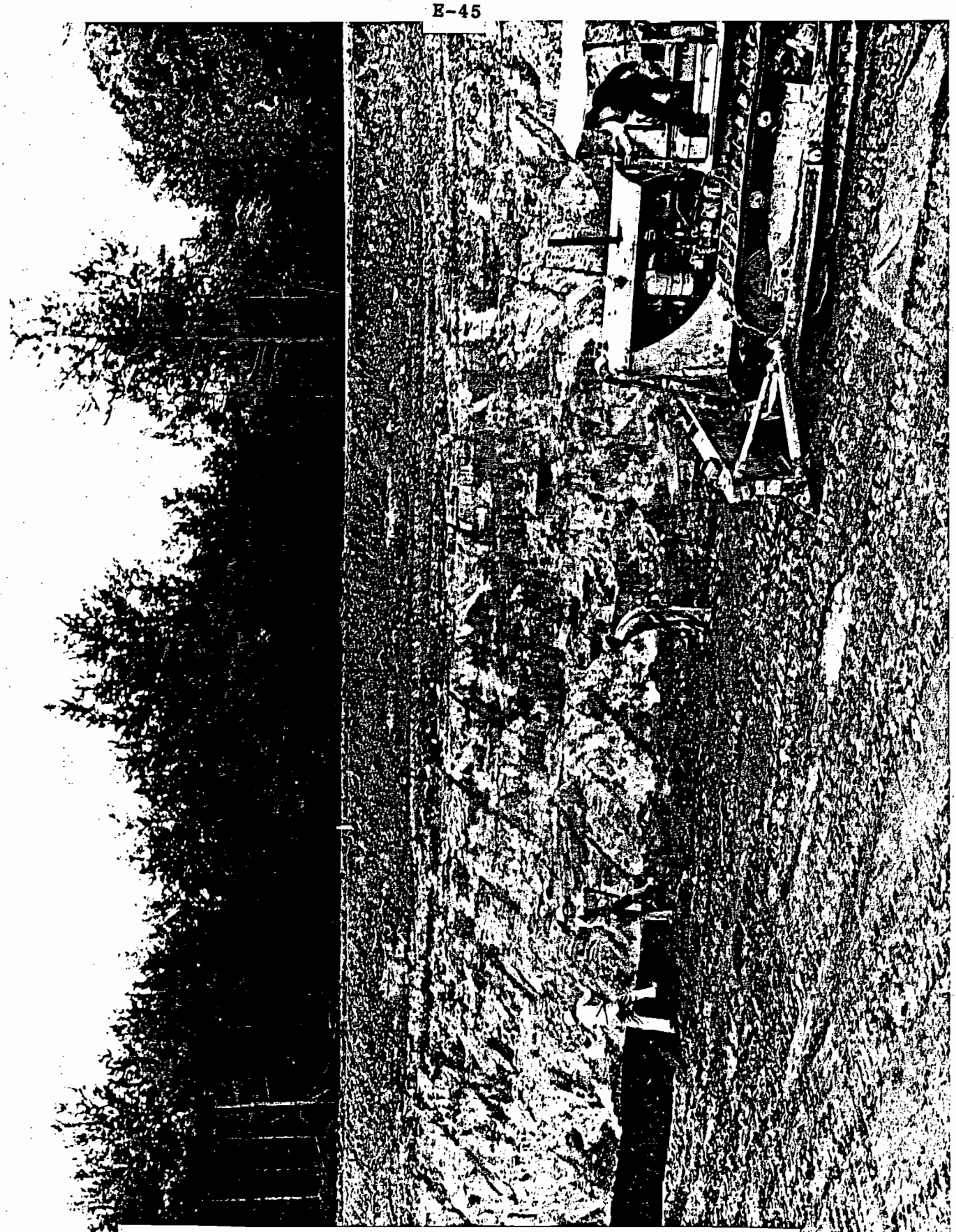


15649 1958
W.deLaguna Construction outcrop Pit 4-southern west side

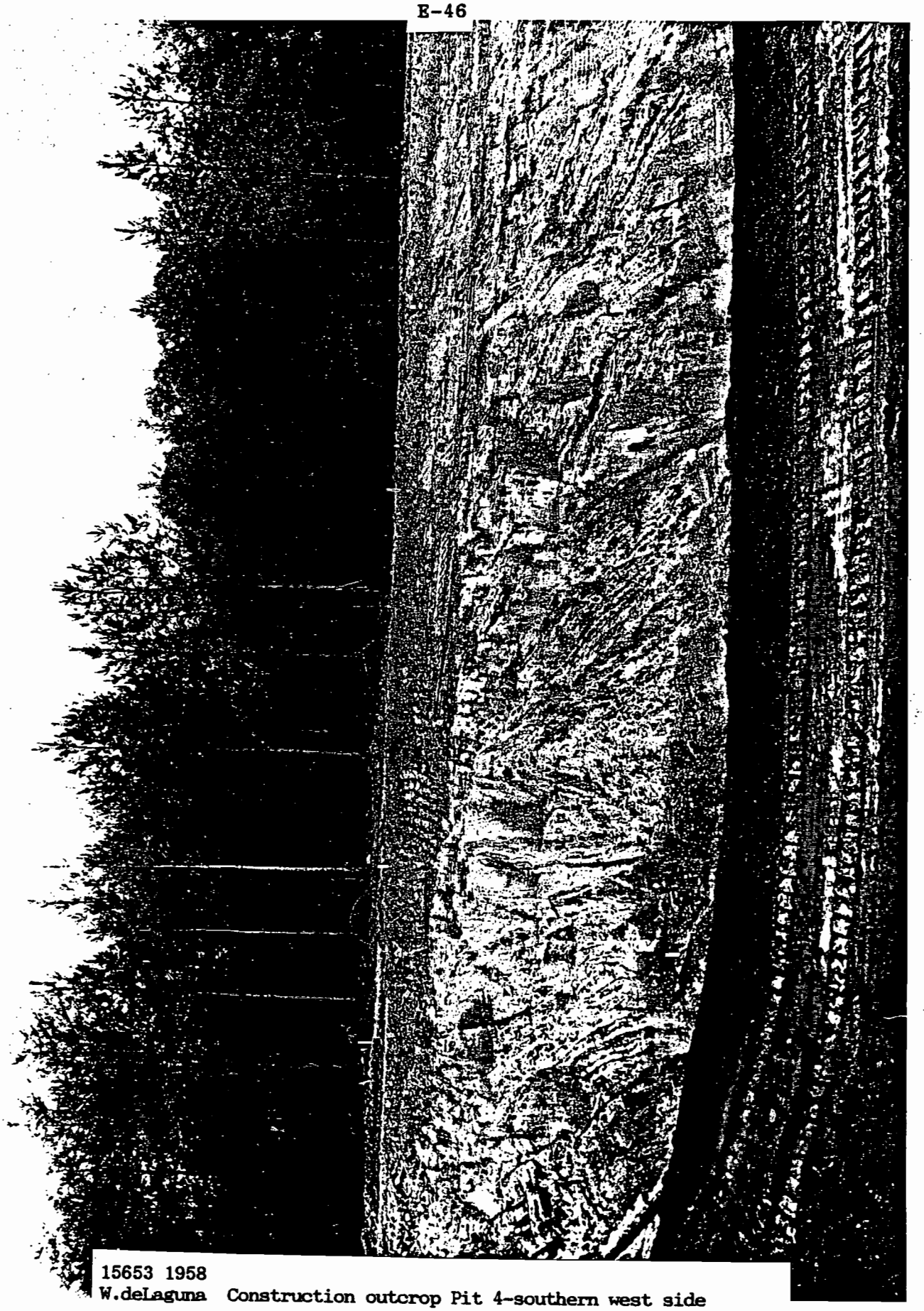


15650 1958
W.deLaguna Construction outcrop Pit 4-northern east side

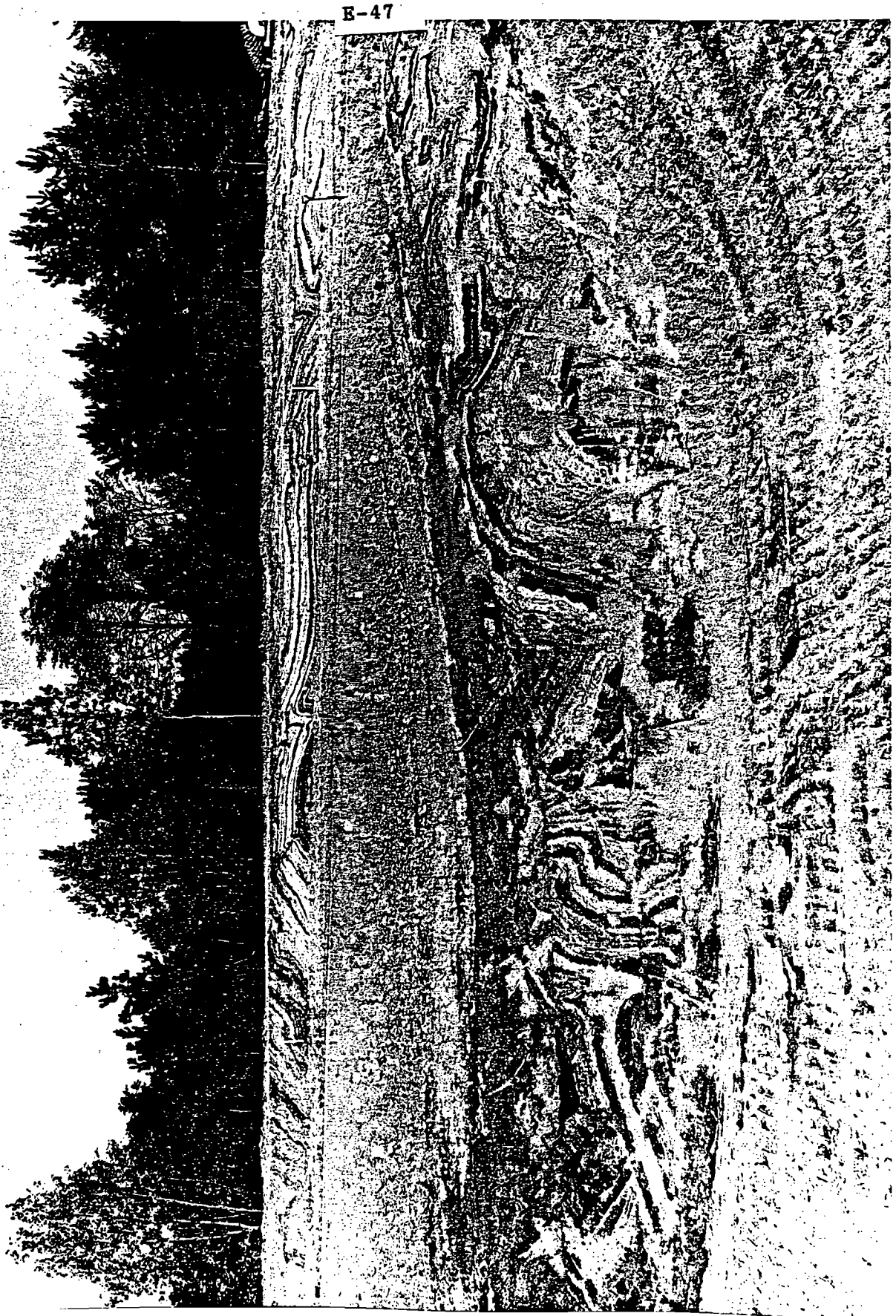
15651 1958
W.deLaguna Construction outcrop Pit 4-northwest corner



15652 1958
W.deLaguna Construction outcrop Pit 4-western side



15653 1958
W.deLaguna Construction outcrop Pit 4-southern west side



15654 1958
W.deLaguna Construction outcrop Pit 4-southern east side

E-48A

15895 1958
W.deLaguna Helicopter photographs of pits looking north-labeled

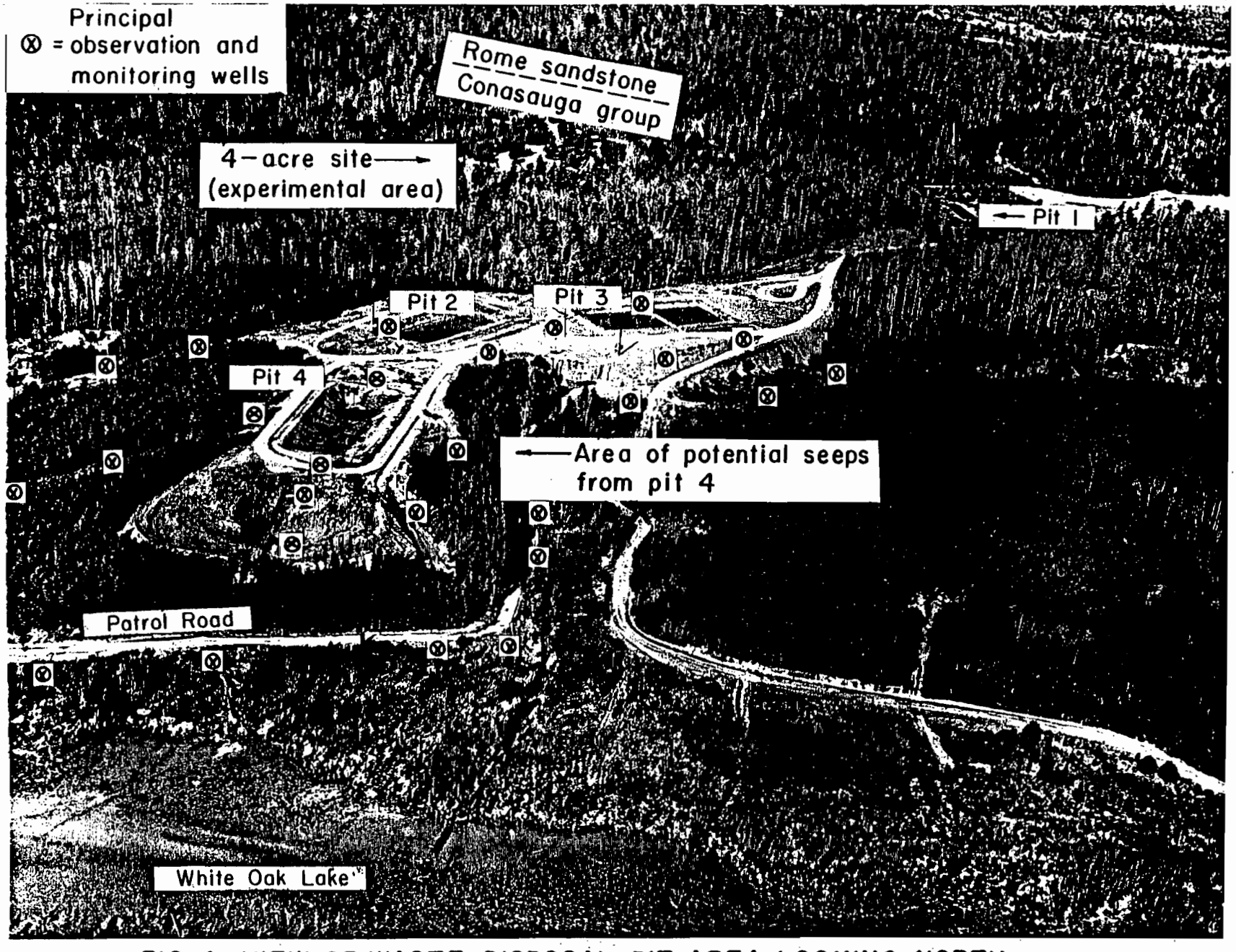
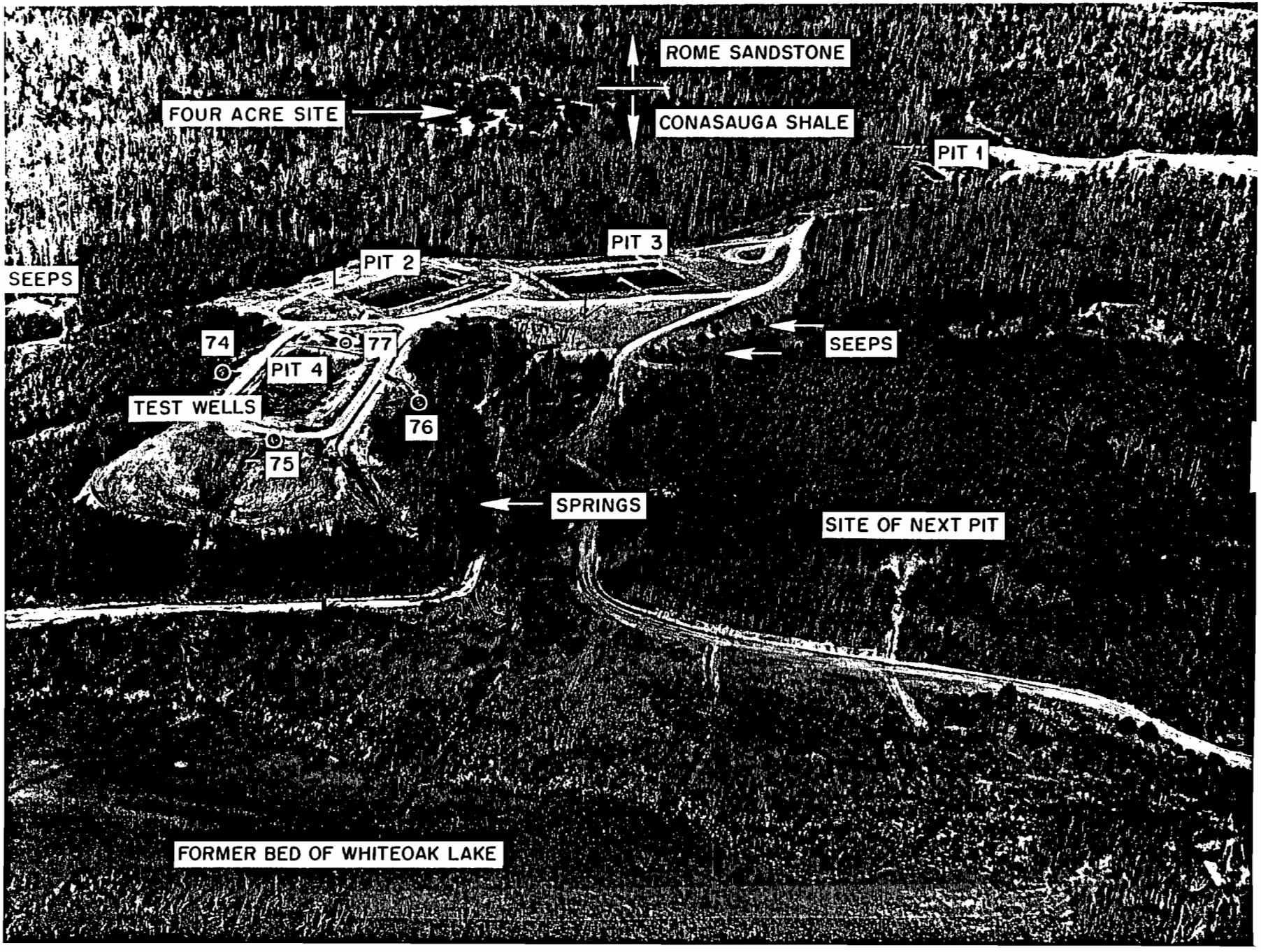


FIG. 4 VIEW OF WASTE-DISPOSAL-PIT AREA, LOOKING NORTH


ROME SANDSTONE
FOUR ACRE SITE
CONASAUGA SHALE
PIT 1
PIT 3
PIT 2
SEEPS
74
77
PIT 4
SEEPS
TEST WELLS
76
75
SPRINGS
SITE OF NEXT PIT
FORMER BED OF WHITEOAK LAKE

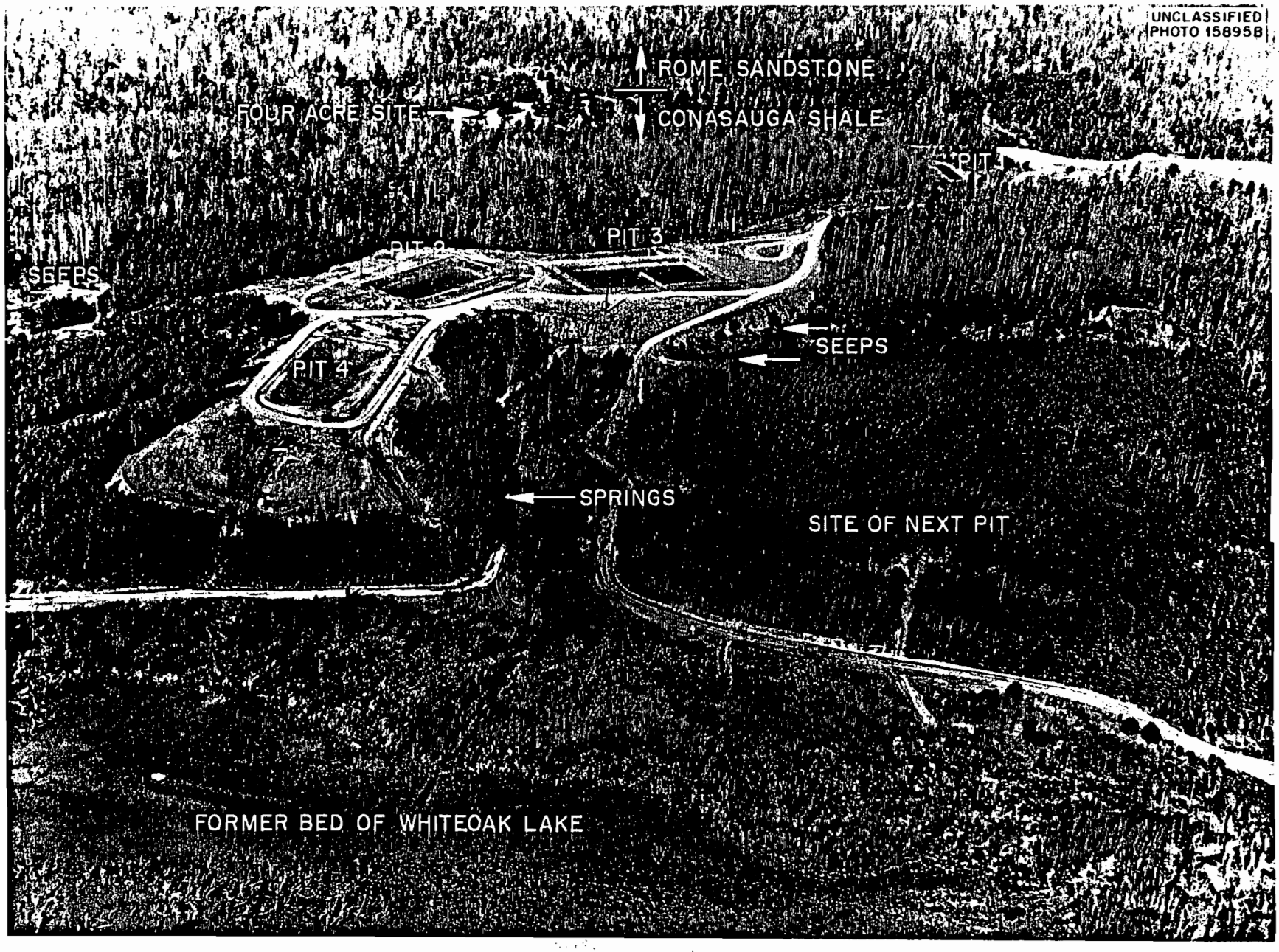
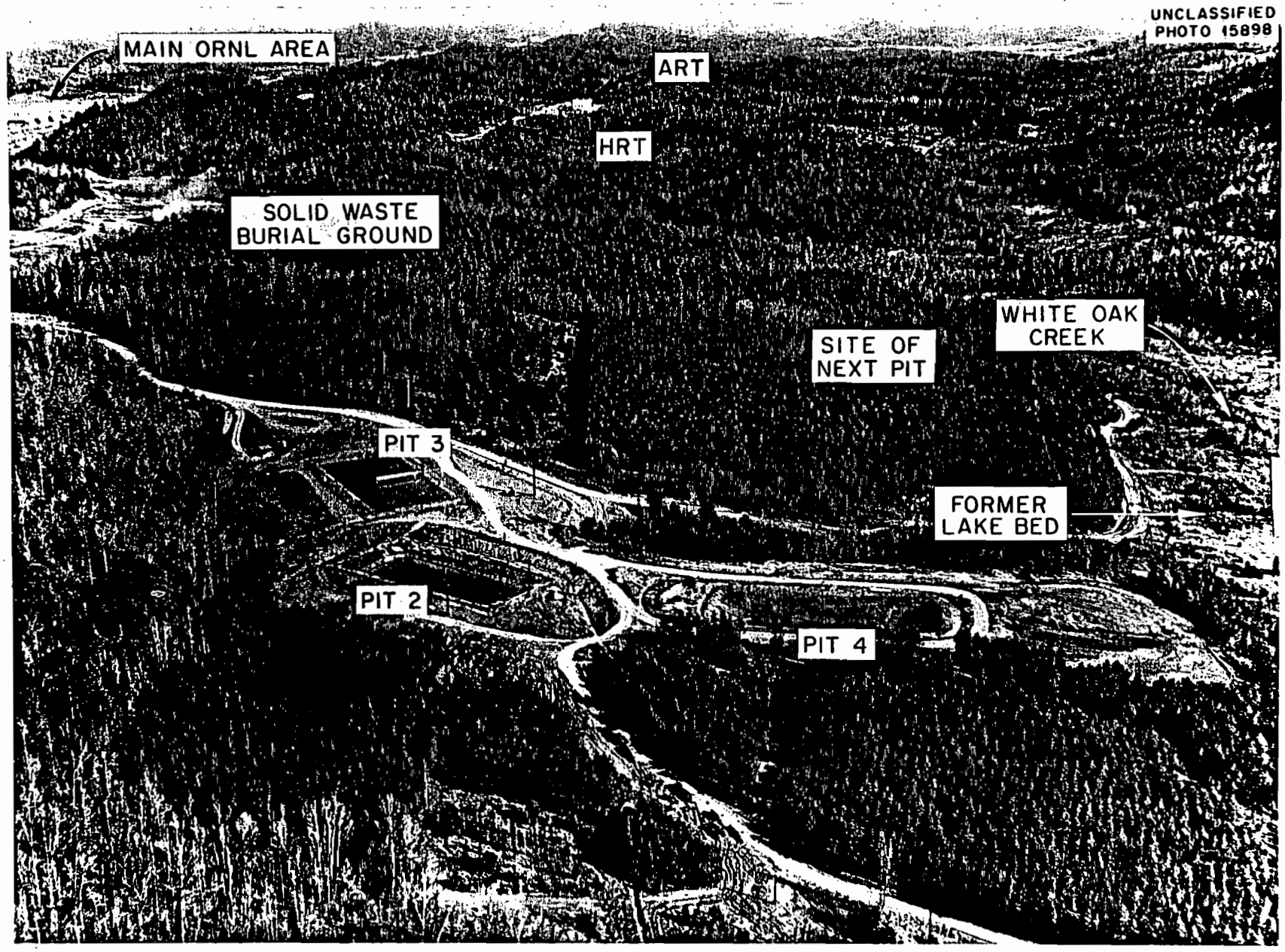


Fig. 1. Aerial View of Waste Pits.

E-49A

15898 1958
W.deLaguna Helicopter photographs of pits looking east-labeled



ORNL WASTE DISPOSAL AREA

UNCLASSIFIED
PHOTO 15898A

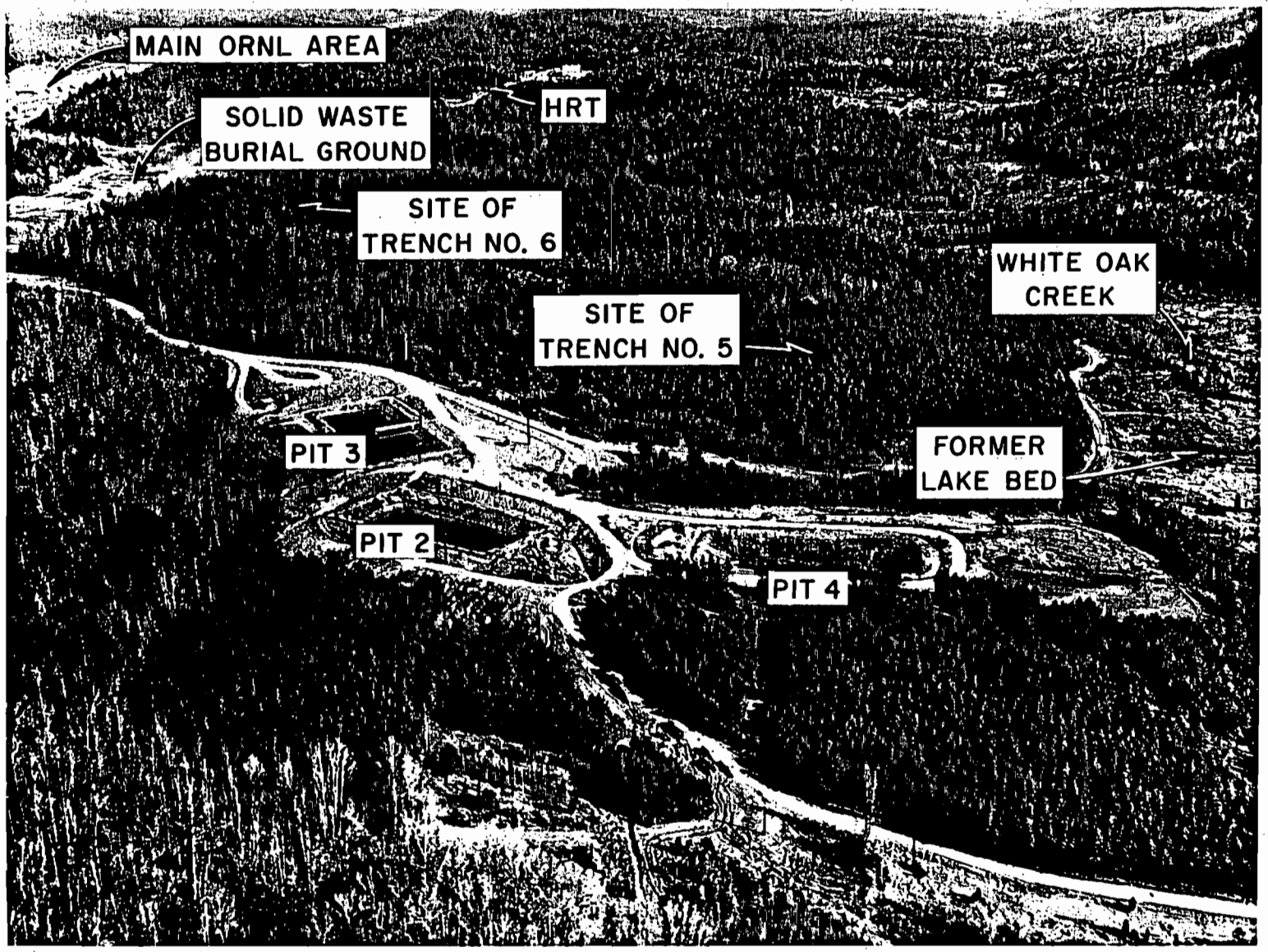


Fig. 3. ORNL Waste Disposal Area.

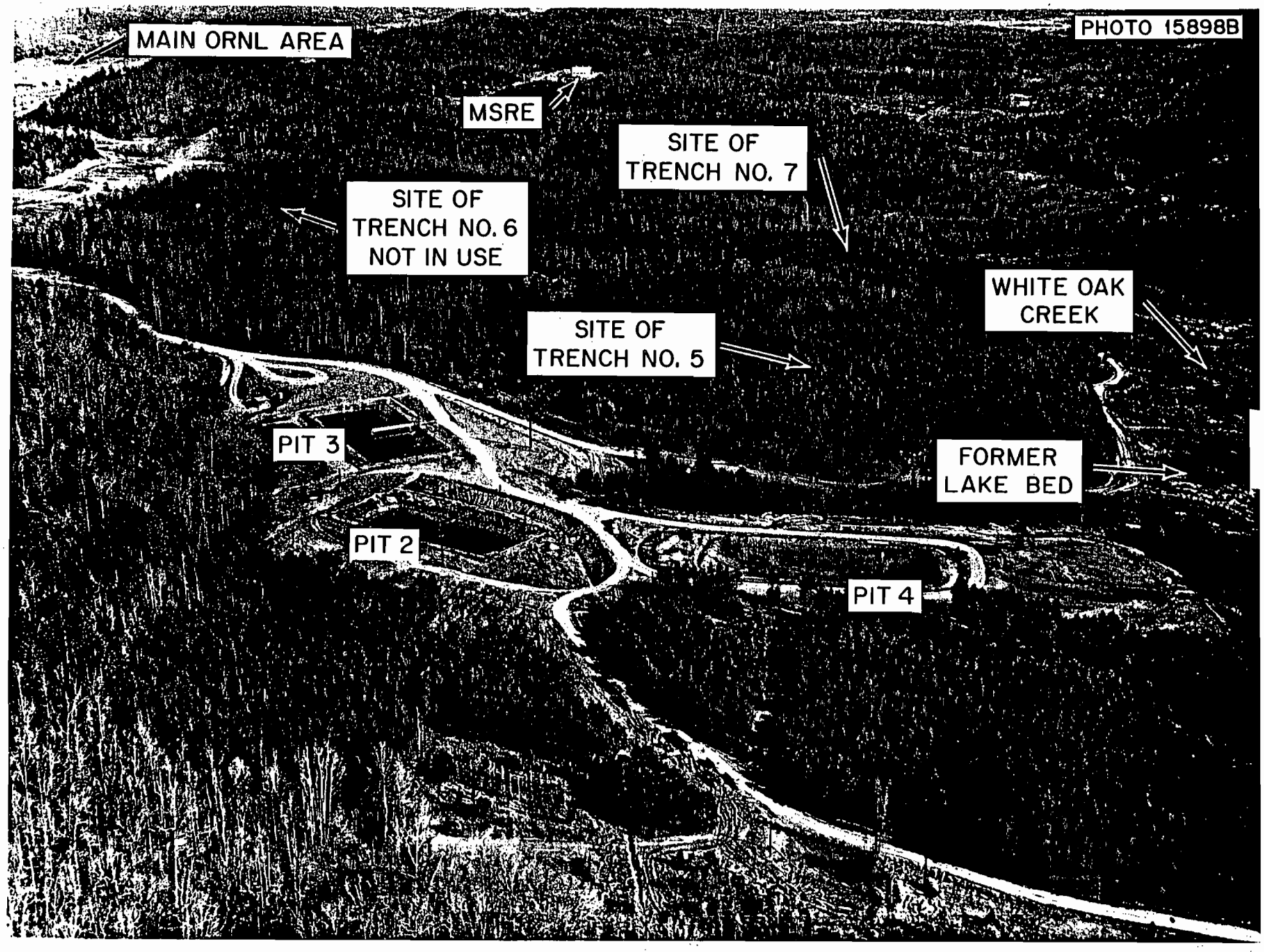


PHOTO 15898B
MAIN ORNL AREA
MSRE
SITE OF TRENCH NO. 7
SITE OF TRENCH NO. 6 NOT IN USE
WHITE OAK CREEK
SITE OF TRENCH NO. 5
PIT 3
FORMER LAKE BED
PIT 2
PIT 4

E-49D

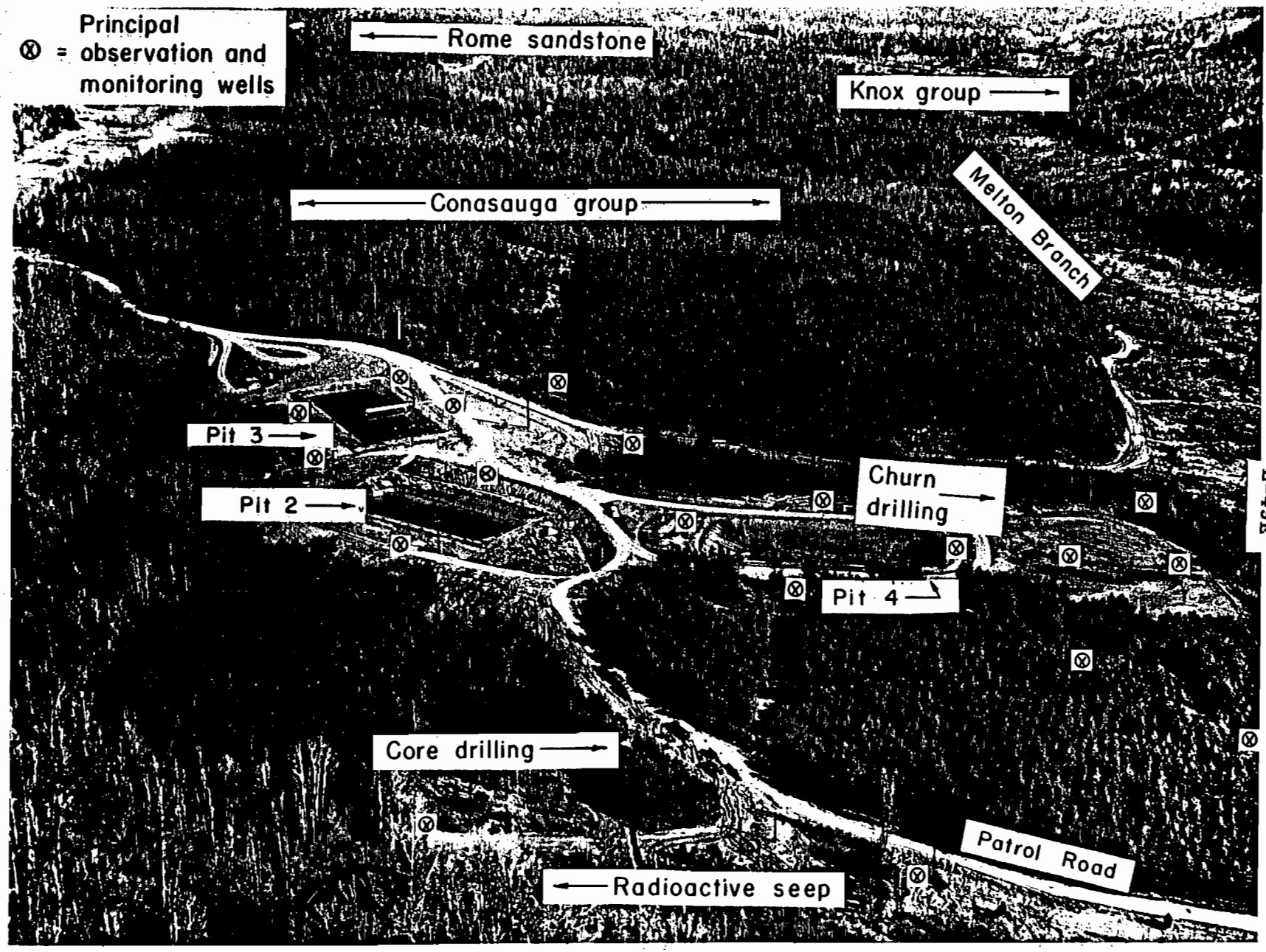
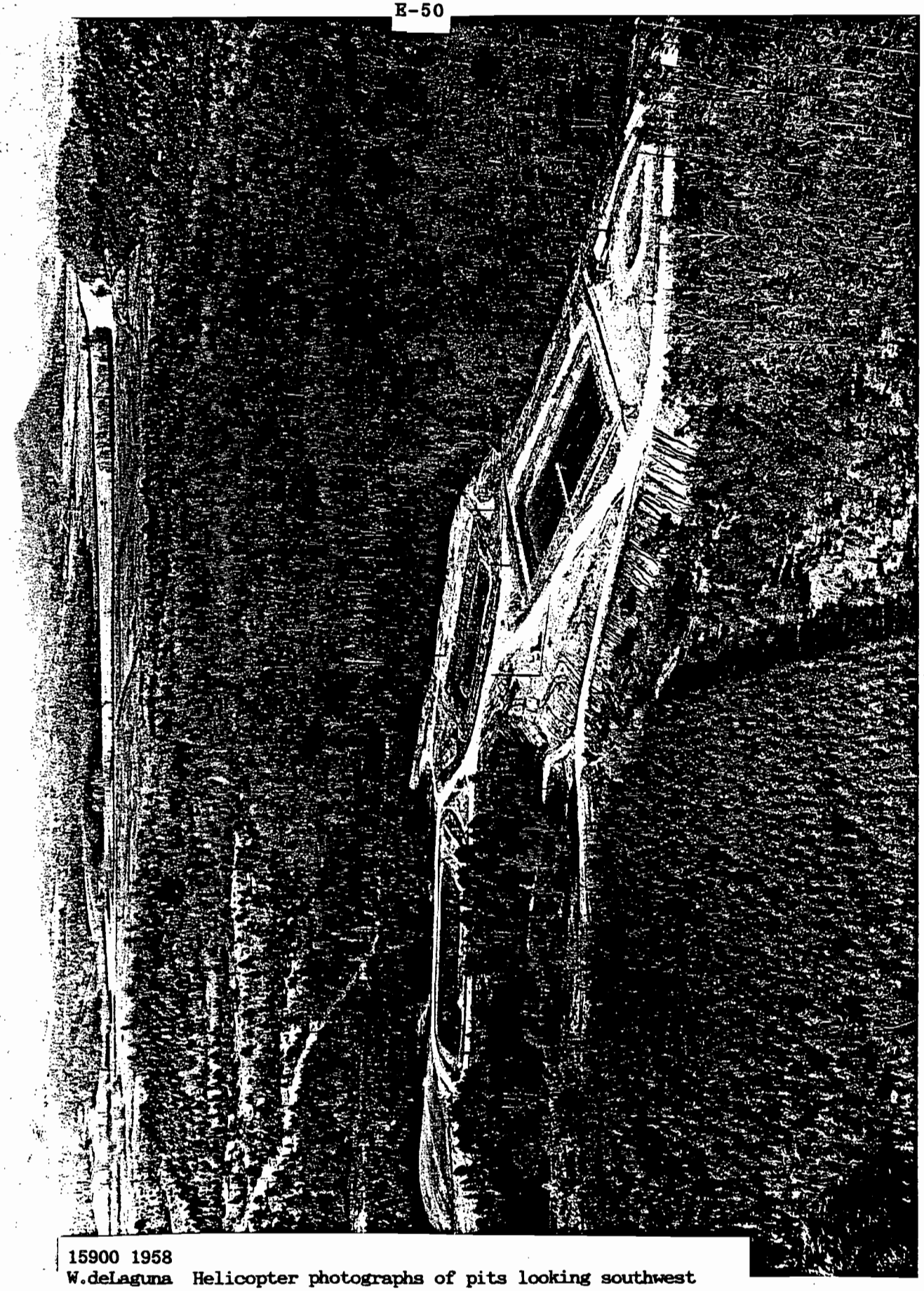


FIG. 3 VIEW OF WASTE-DISPOSAL-PIT AREA, LOOKING NORTHEAST

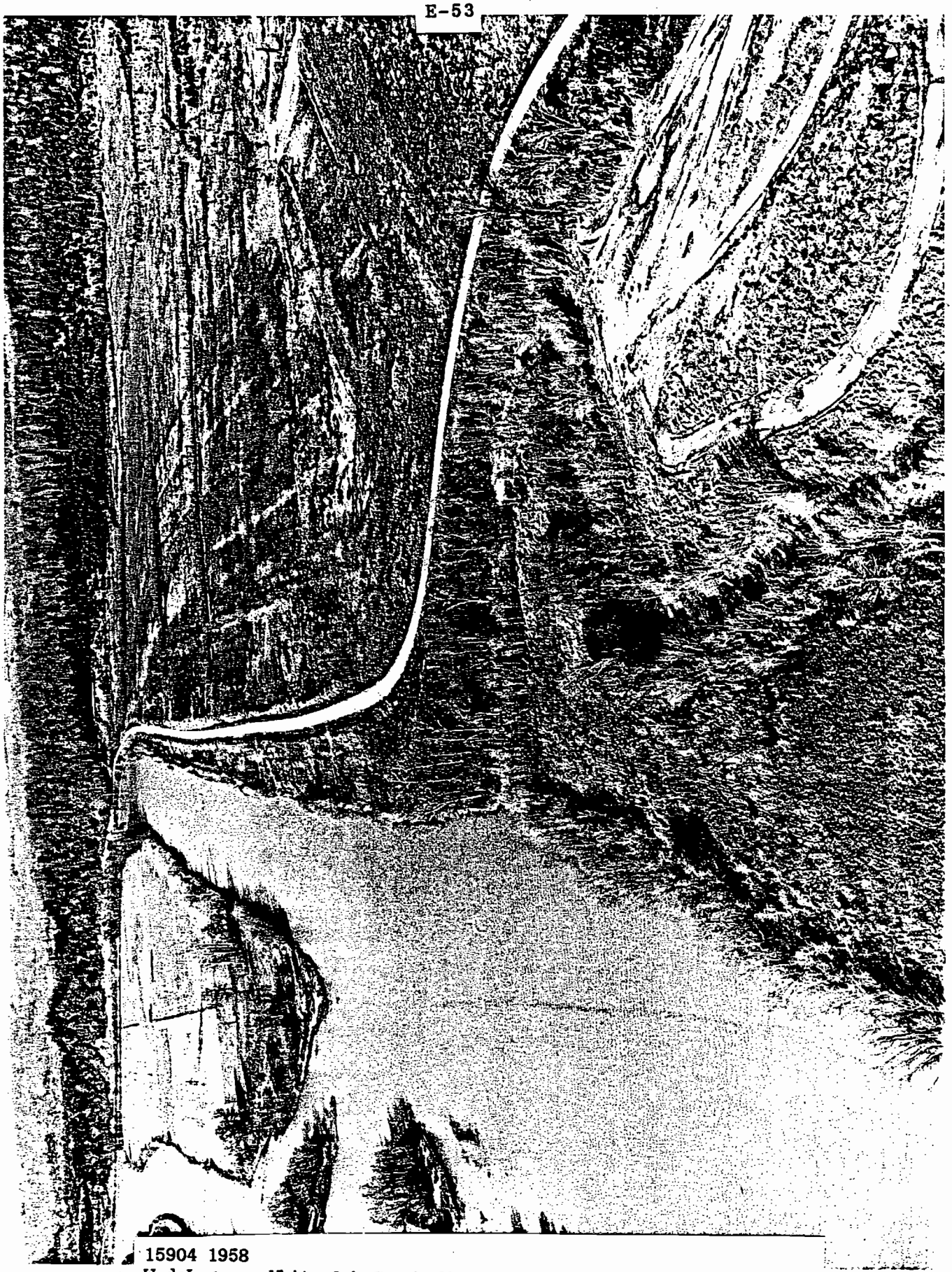
E-49E



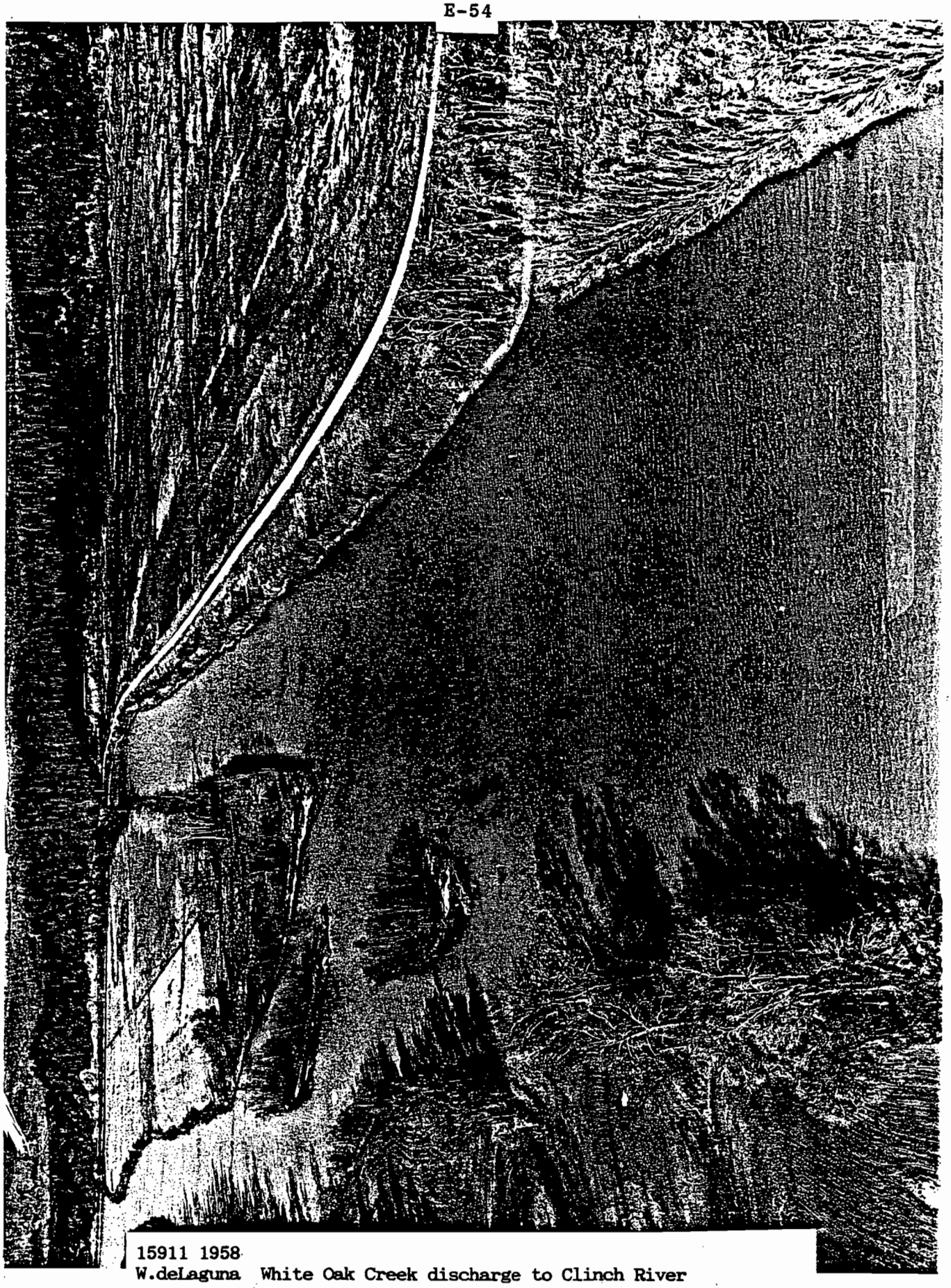
15900 1958
W.deLaguna Helicopter photographs of pits looking southwest

15901 1958
W.deLaguna Helicopter photographs of pits looking northwest

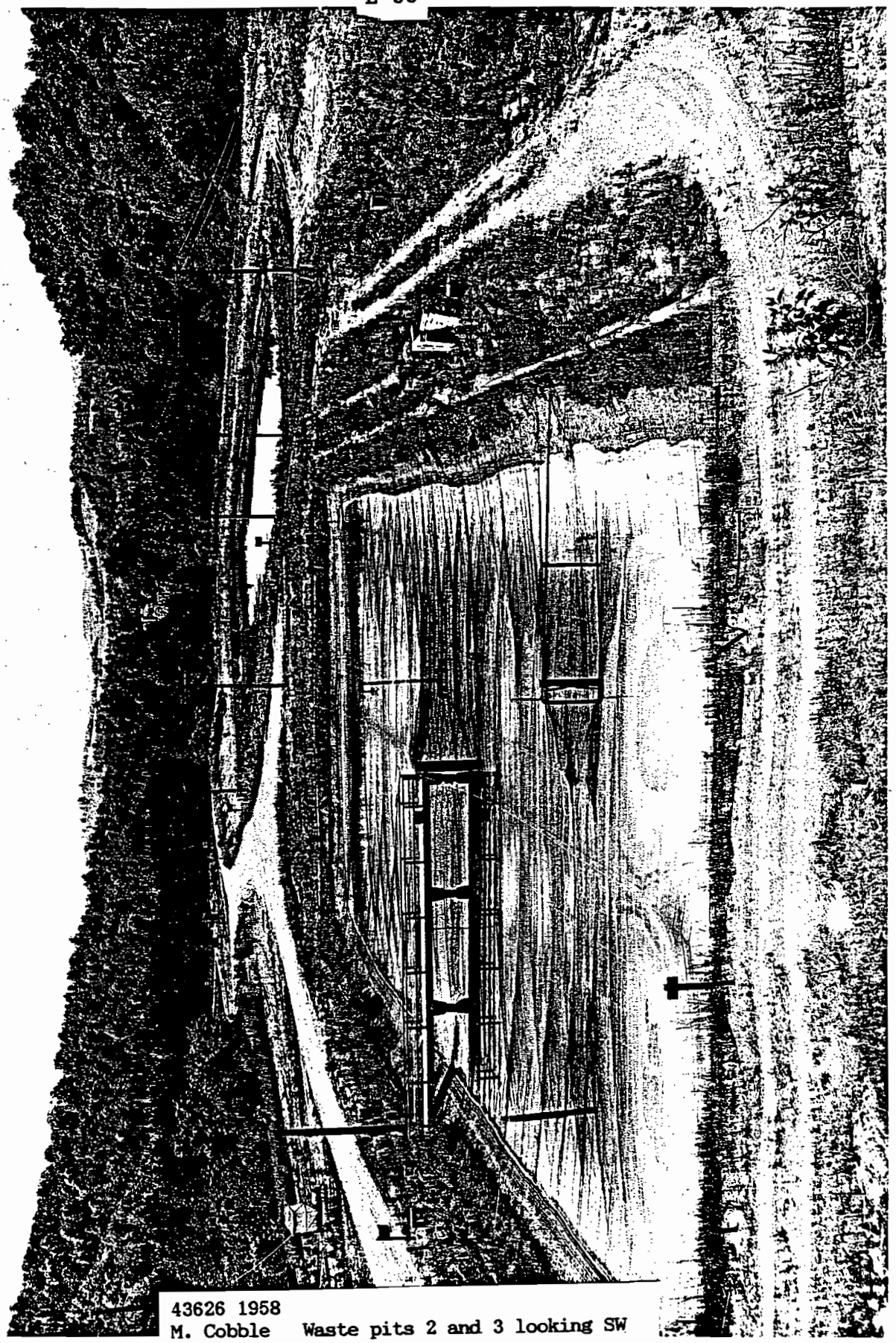
15903 1958
W.deLaguna Helicopter shots of White Oak Lake and SWSA6 site



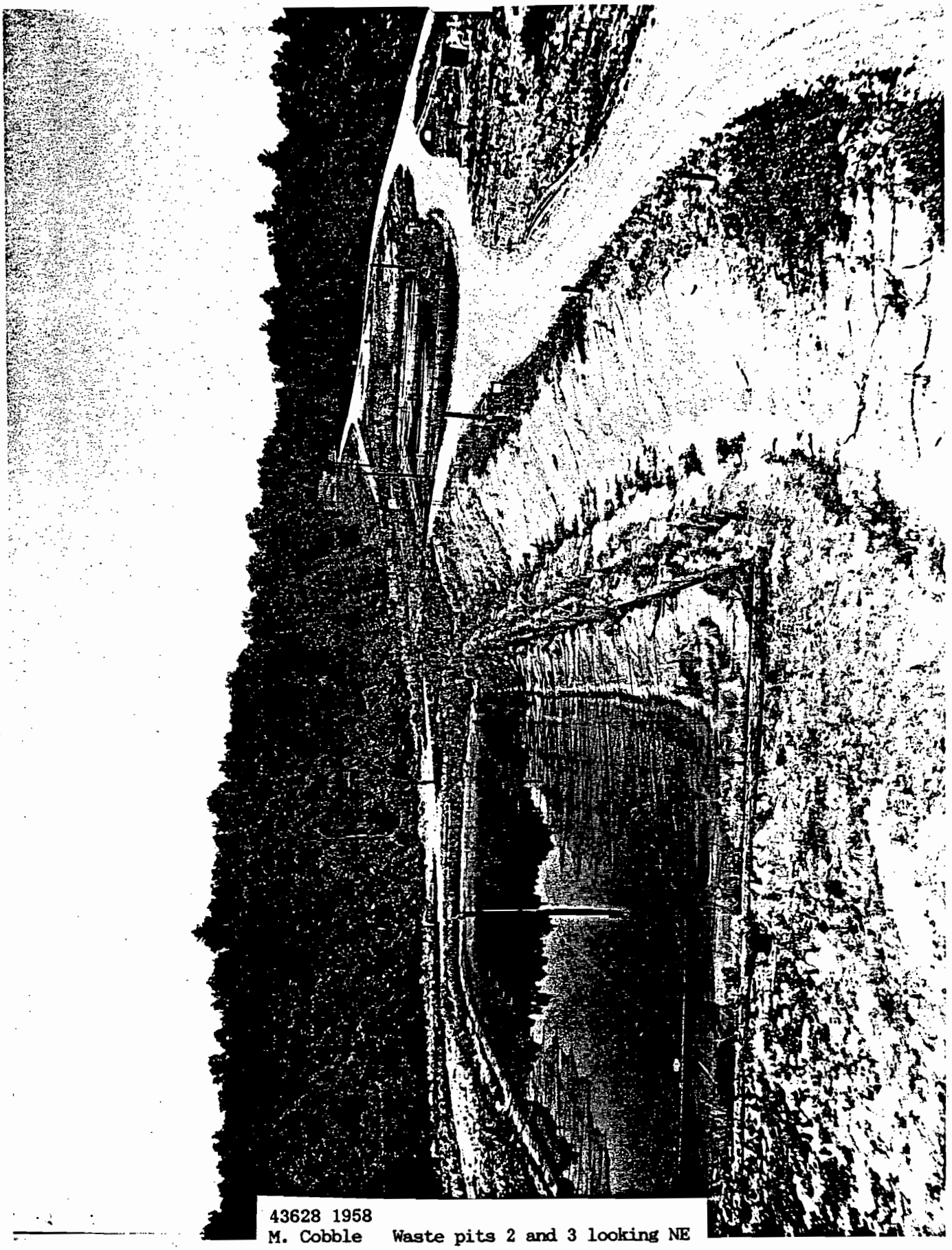
15904 1958
W.deLaguna White Oak Creek discharging to Clinch River



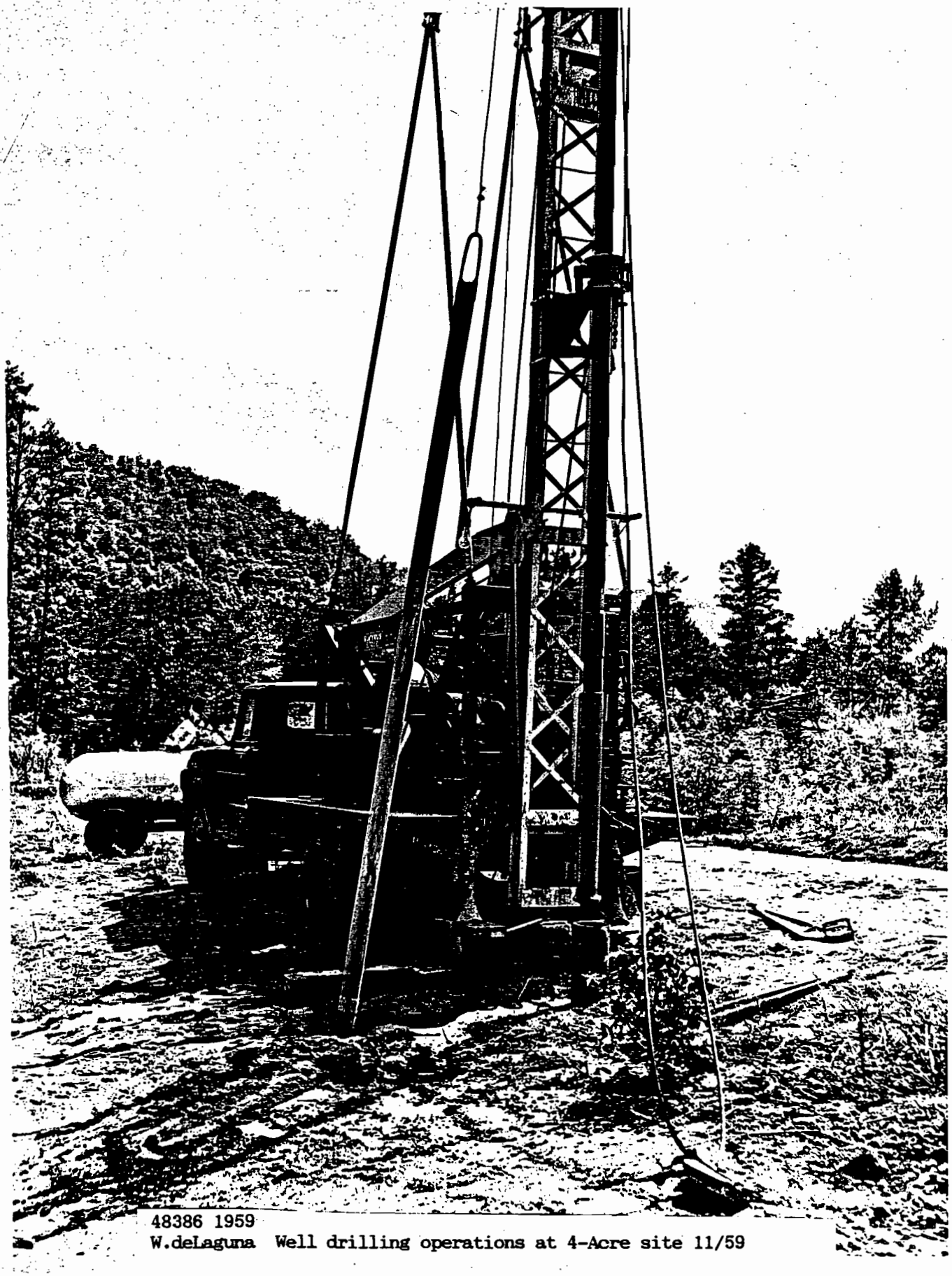
15911 1958
W.deLaguna White Oak Creek discharge to Clinch River



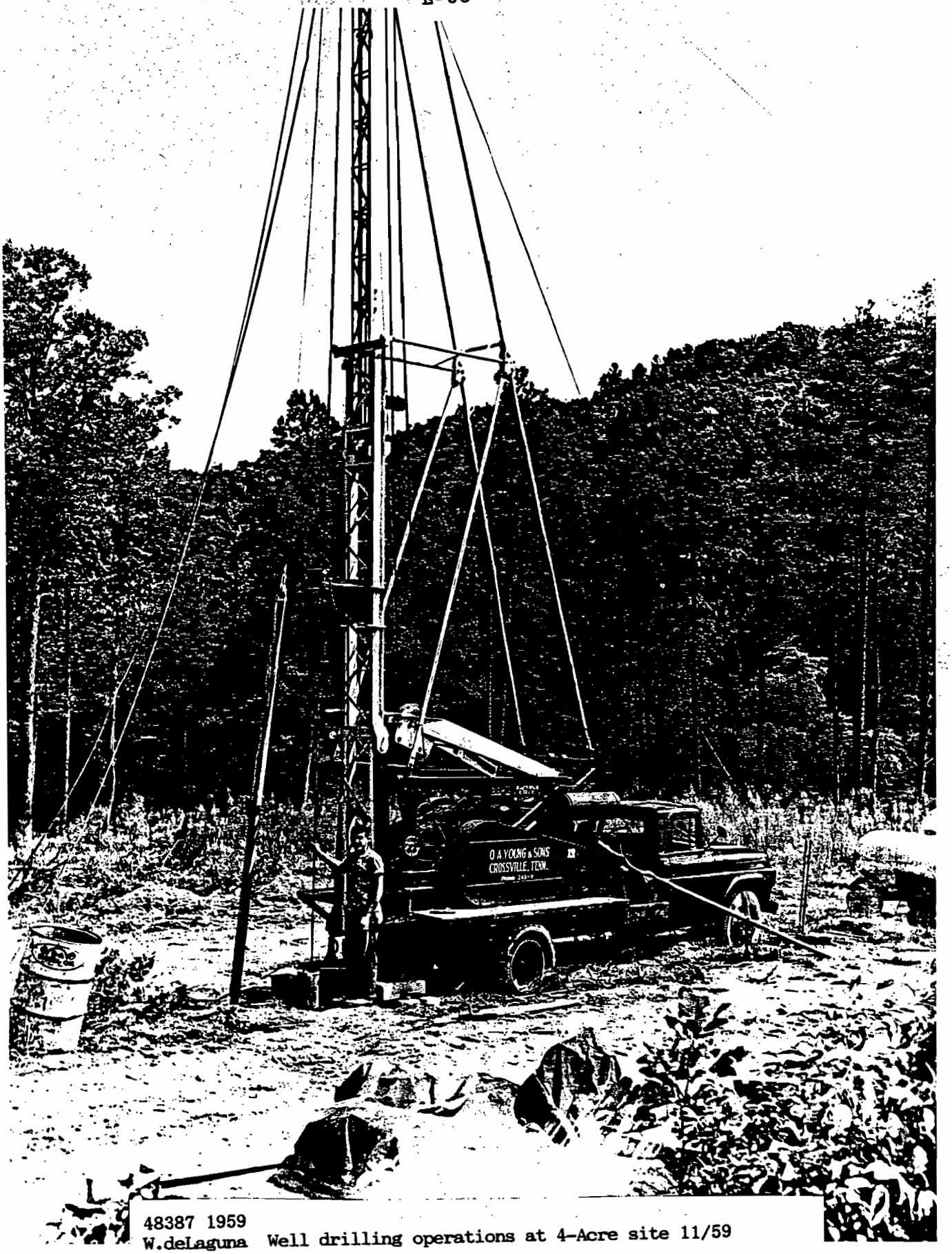
43626 1958
M. Cobble Waste pits 2 and 3 looking SW



43628 1958
M. Cobble Waste pits 2 and 3 looking NE

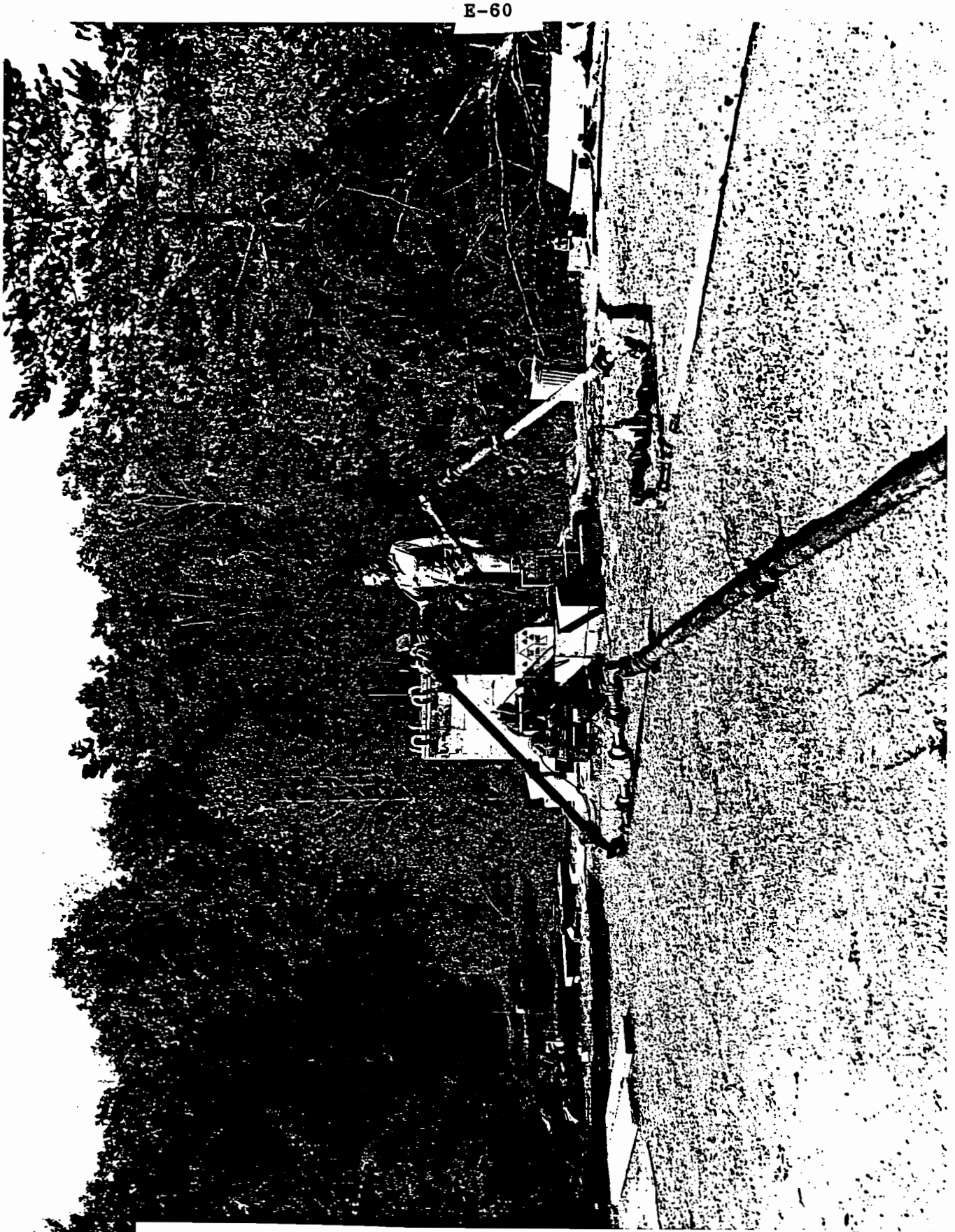


48386 1959
W.deLaguna Well drilling operations at 4-Acre site 11/59

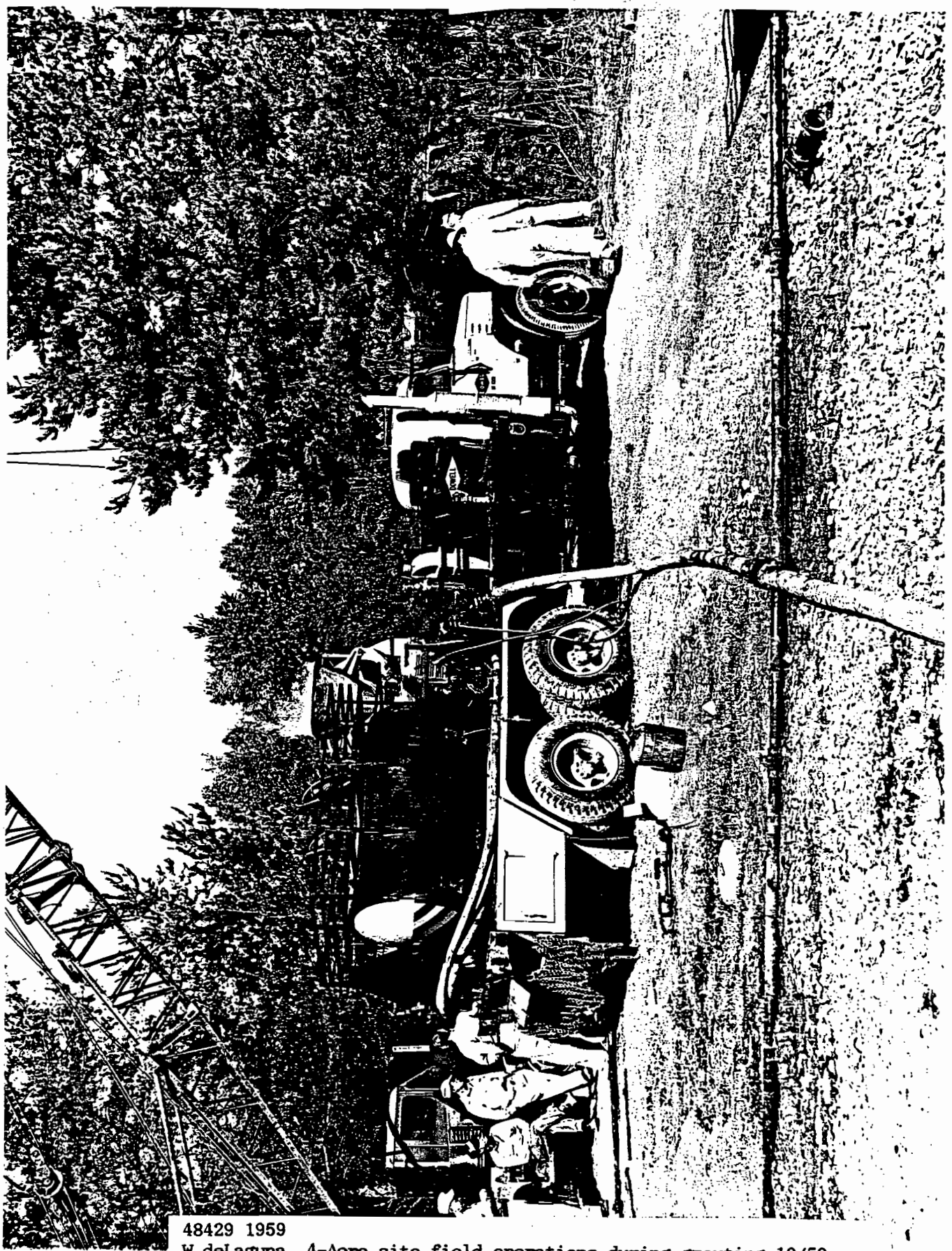


48387 1959
W.deLaguna Well drilling operations at 4-Acre site 11/59

48388 1959
W.deLaguna Well drilling operations at 4-Acre site 11/59

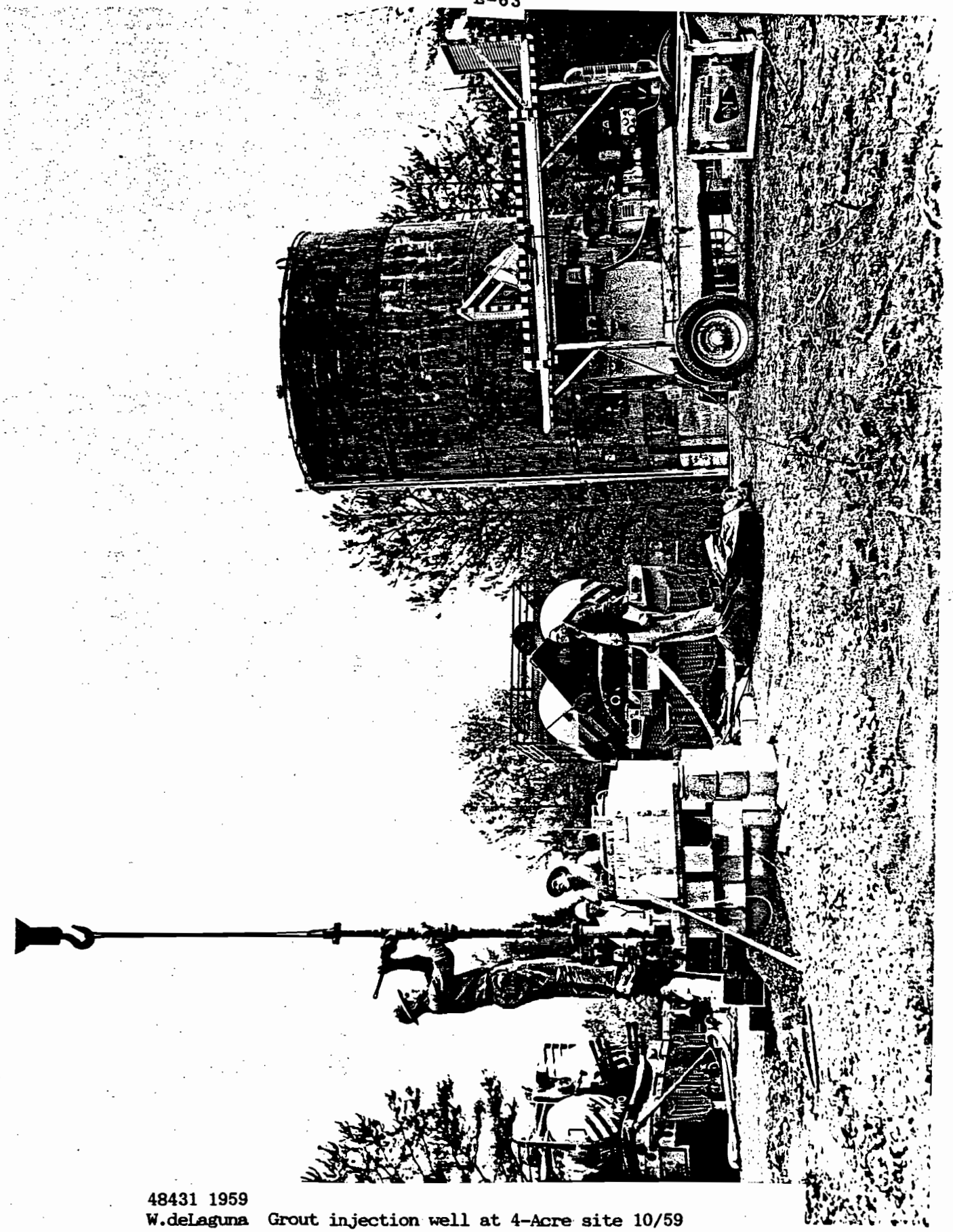


48428 1959
W.deLaguna Radiation monitoring during Cs-137 grouting

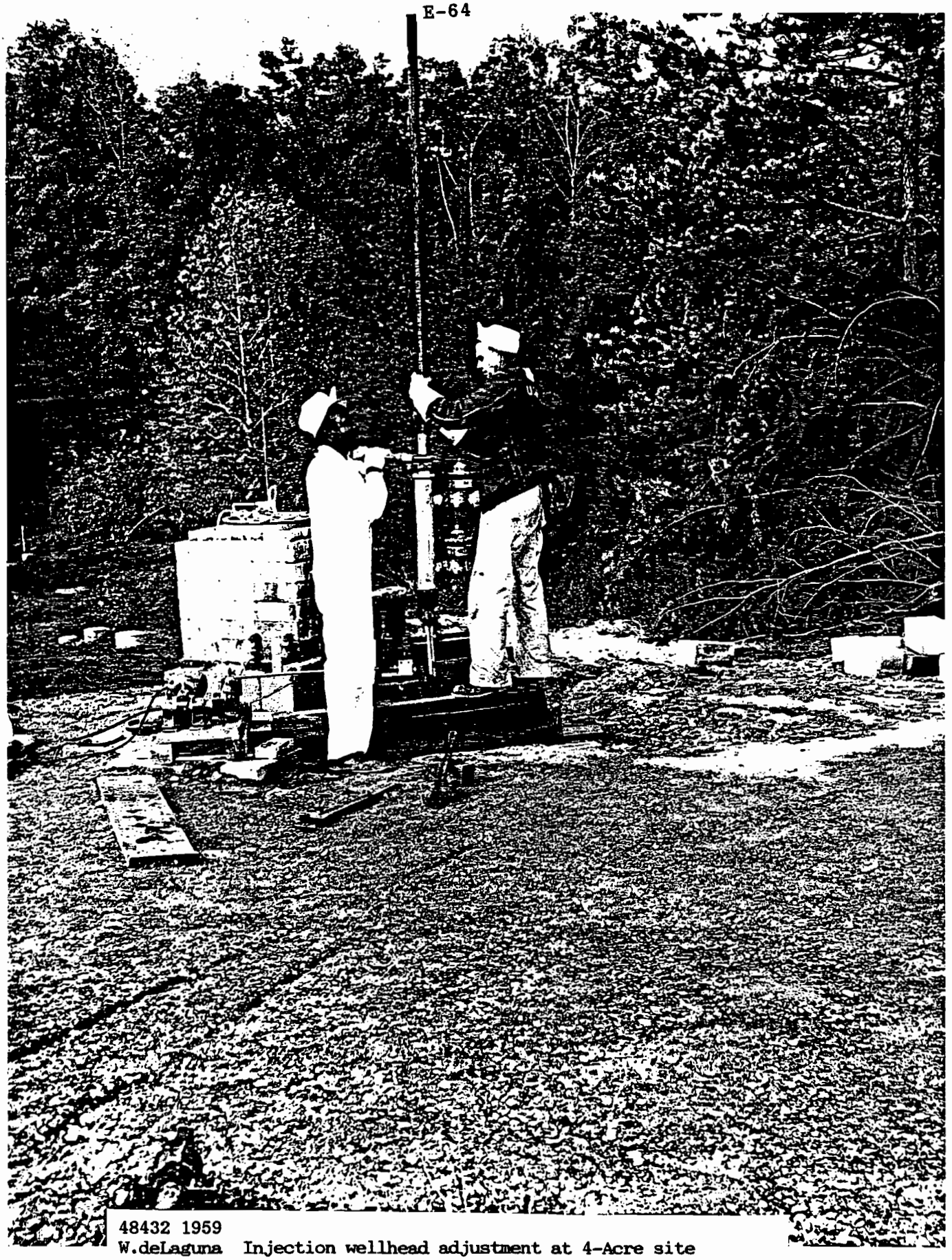


48429 1959
W.deLaguna 4-Acre site field operations during grouting 10/59

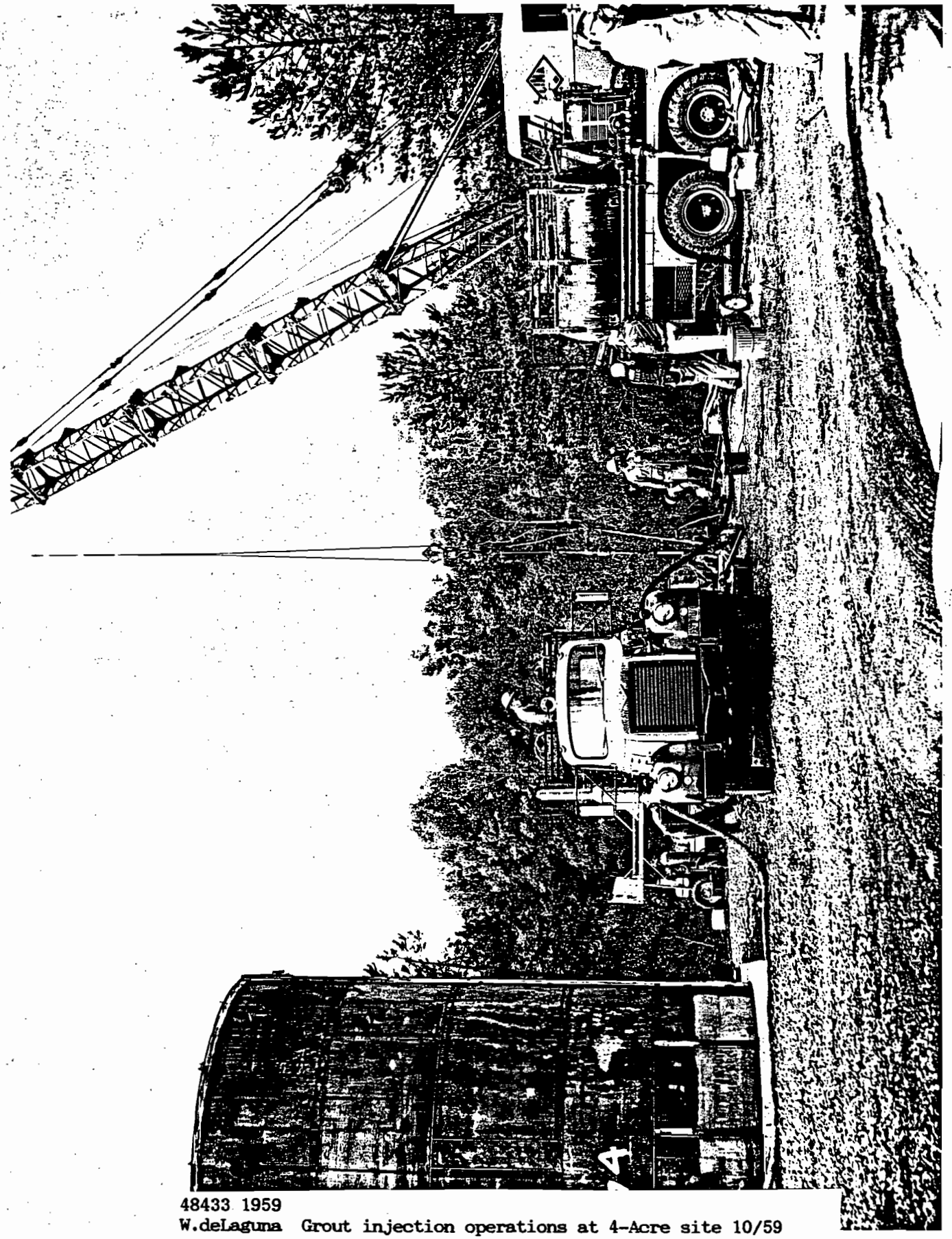
48430 1959
W.deLaguna 4-Acre site after field grouting operations 10/59



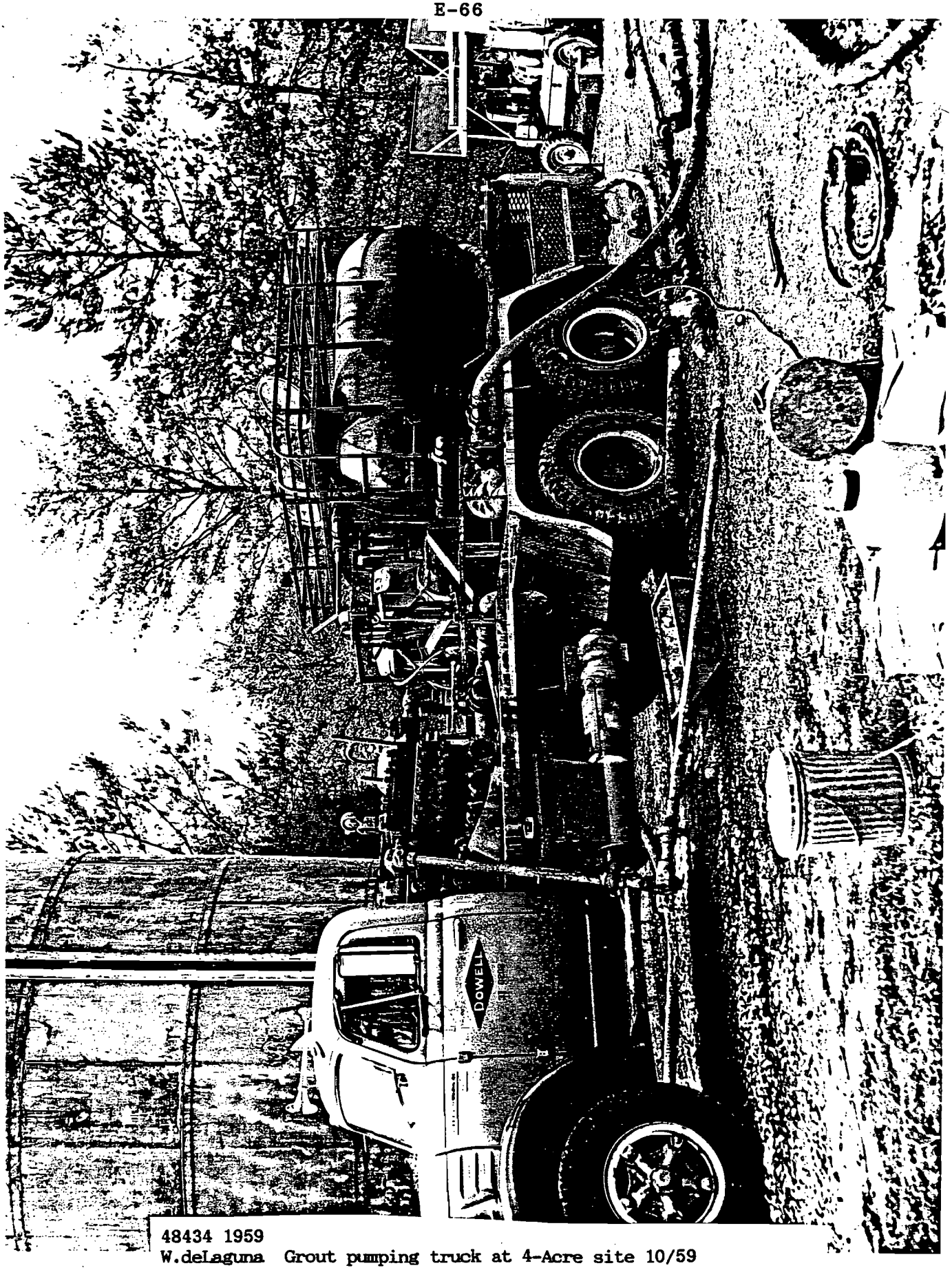
48431 1959
W.deLaguna Grout injection well at 4-Acre site 10/59



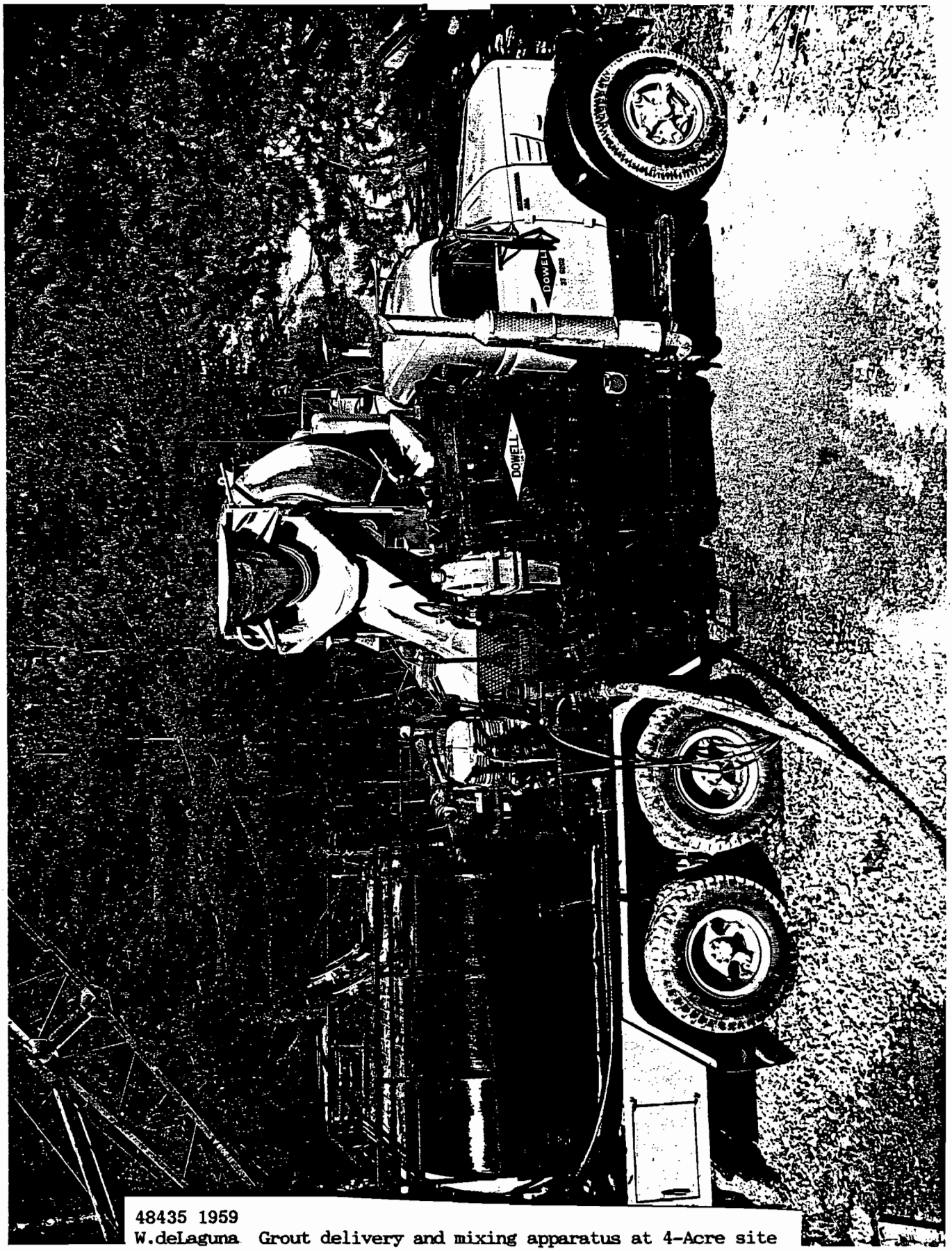
48432 1959
W.deLaguna Injection wellhead adjustment at 4-Acre site



48433 1959
W.deLaguna Grout injection operations at 4-Acre site 10/59

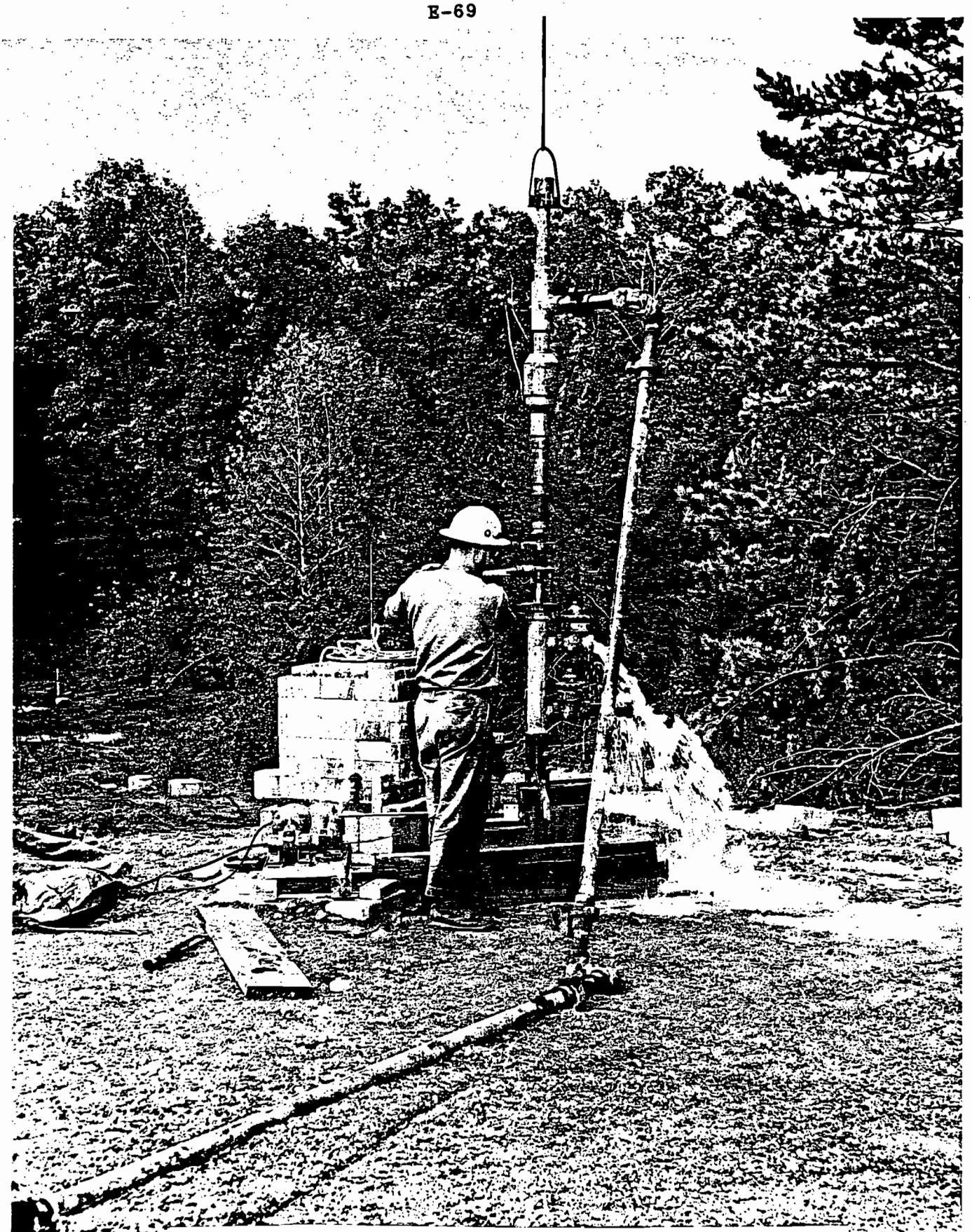


48434 1959
W.deLaguna Grout pumping truck at 4-Acre site 10/59

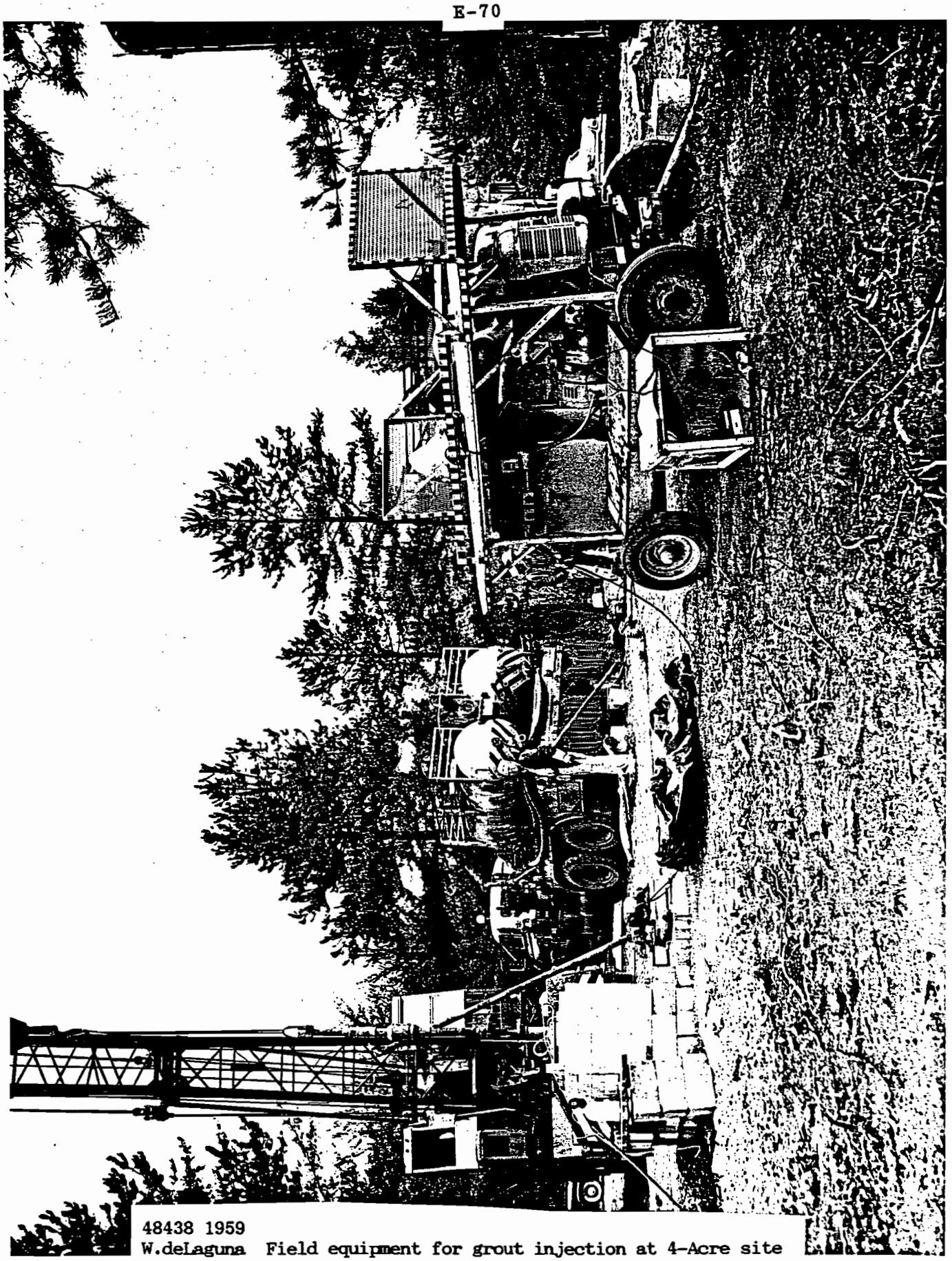


48435 1959
W.deLaguna Grout delivery and mixing apparatus at 4-Acre site

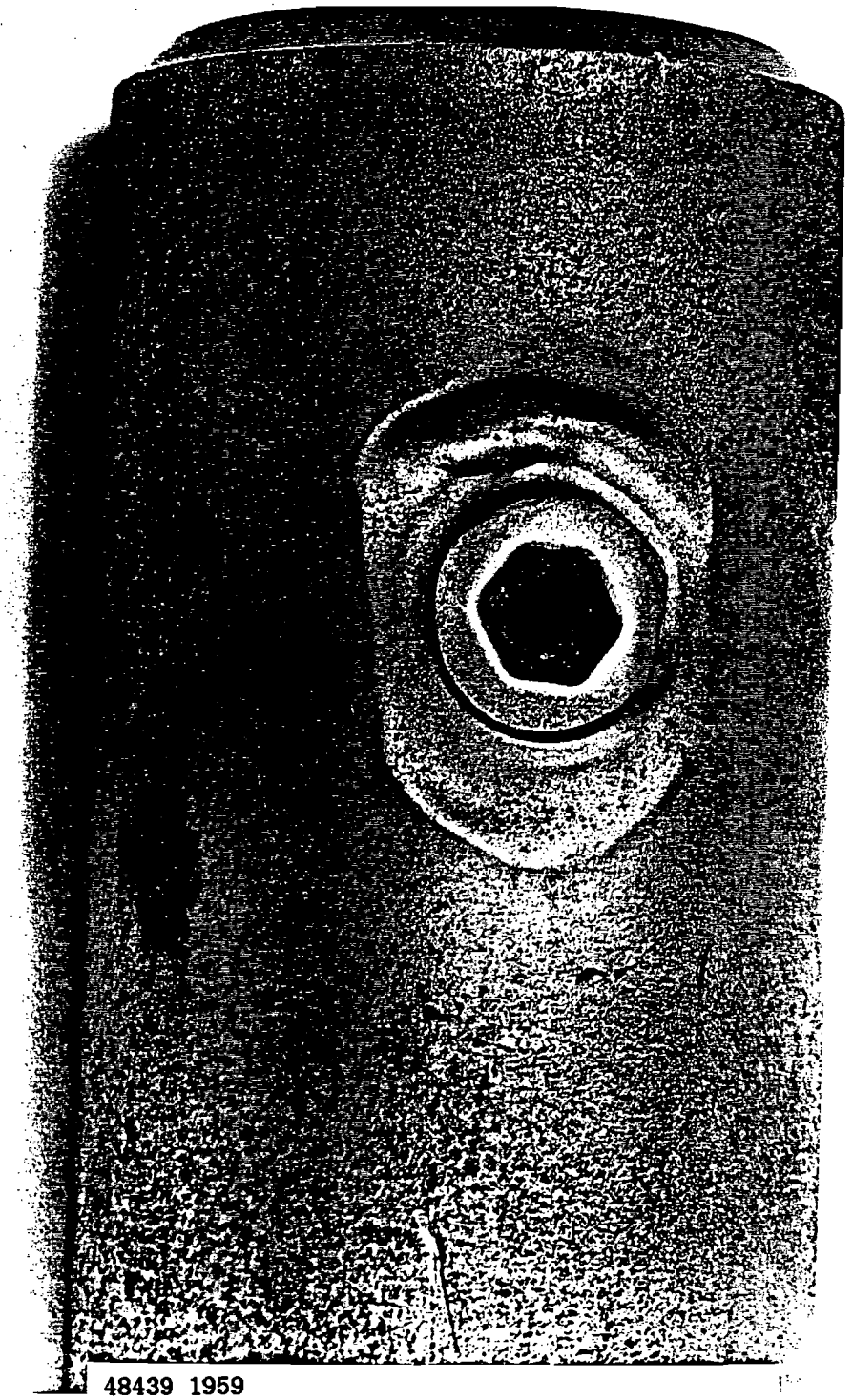
48436 1959
W.deLaguna Grout truck used at 4-Acre site 10/59



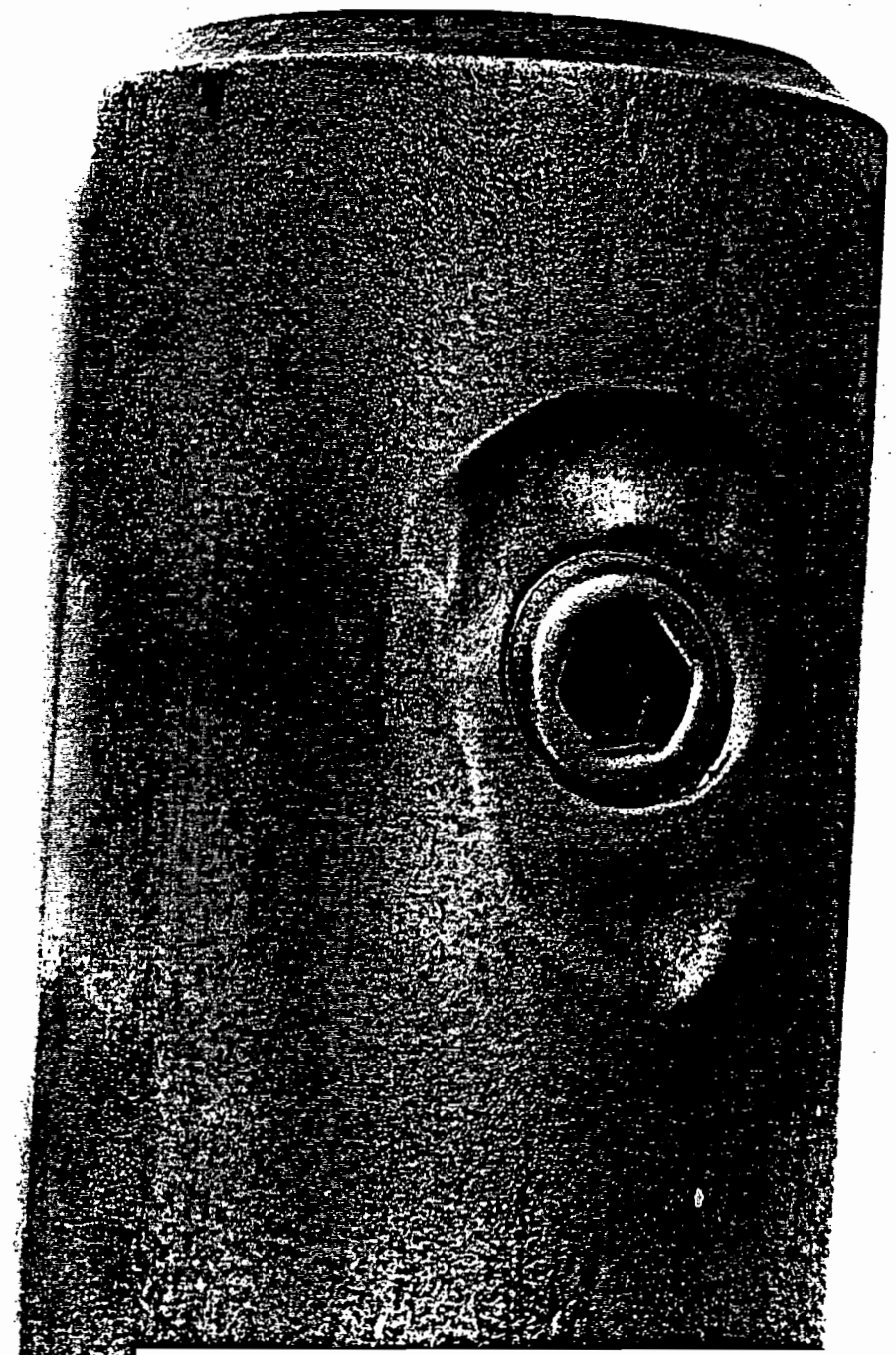
48437 1959
W.deLaguna Pressure relief technique after hydraulic fracture



48438 1959
W.deLaguna Field equipment for grout injection at 4-Acre site

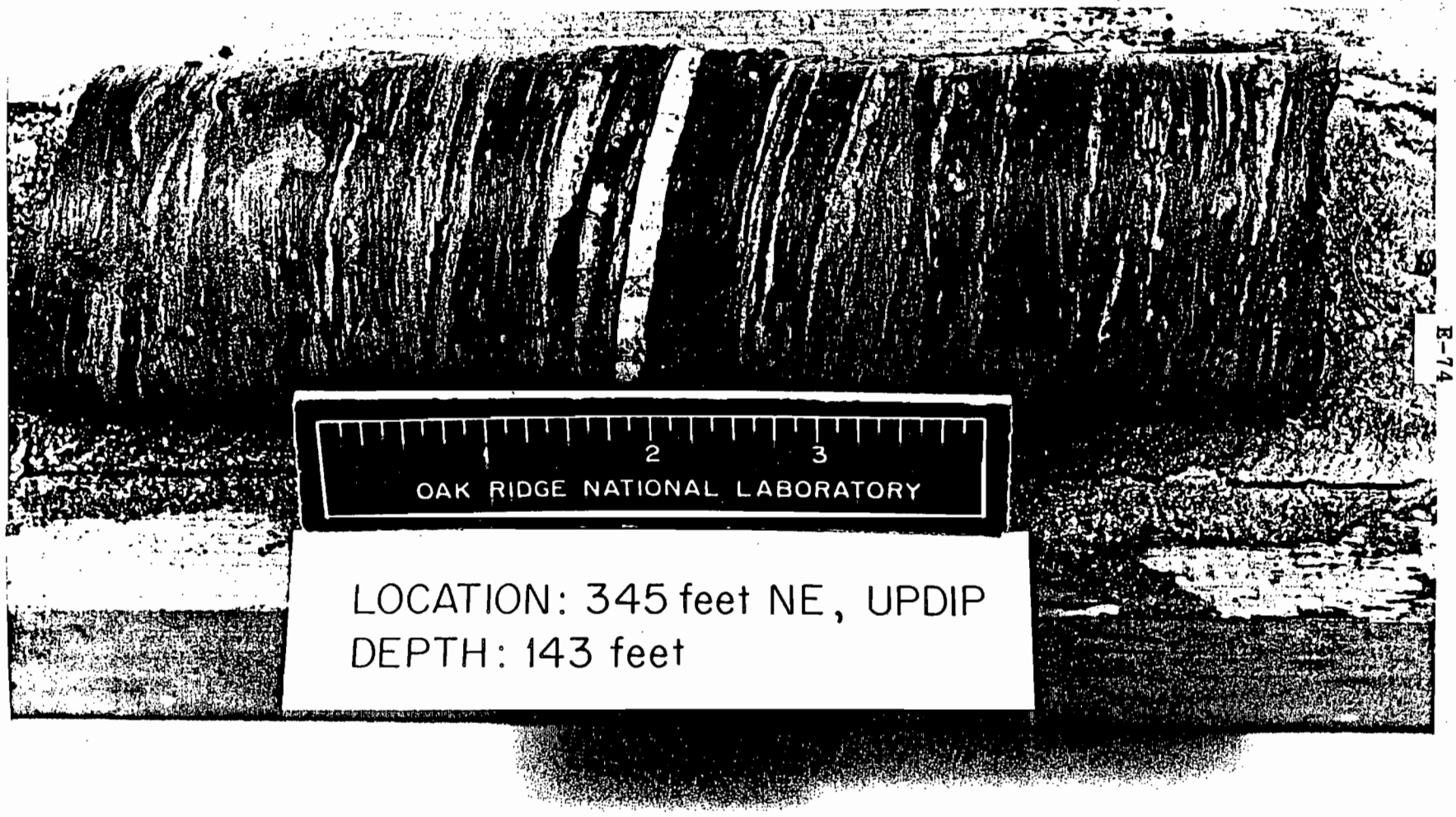


48439 1959
W.deLaguna Downhole hydraulic fracturing tool



48440 1959
W.deLaguna Downhole hydraulic fracturing tool

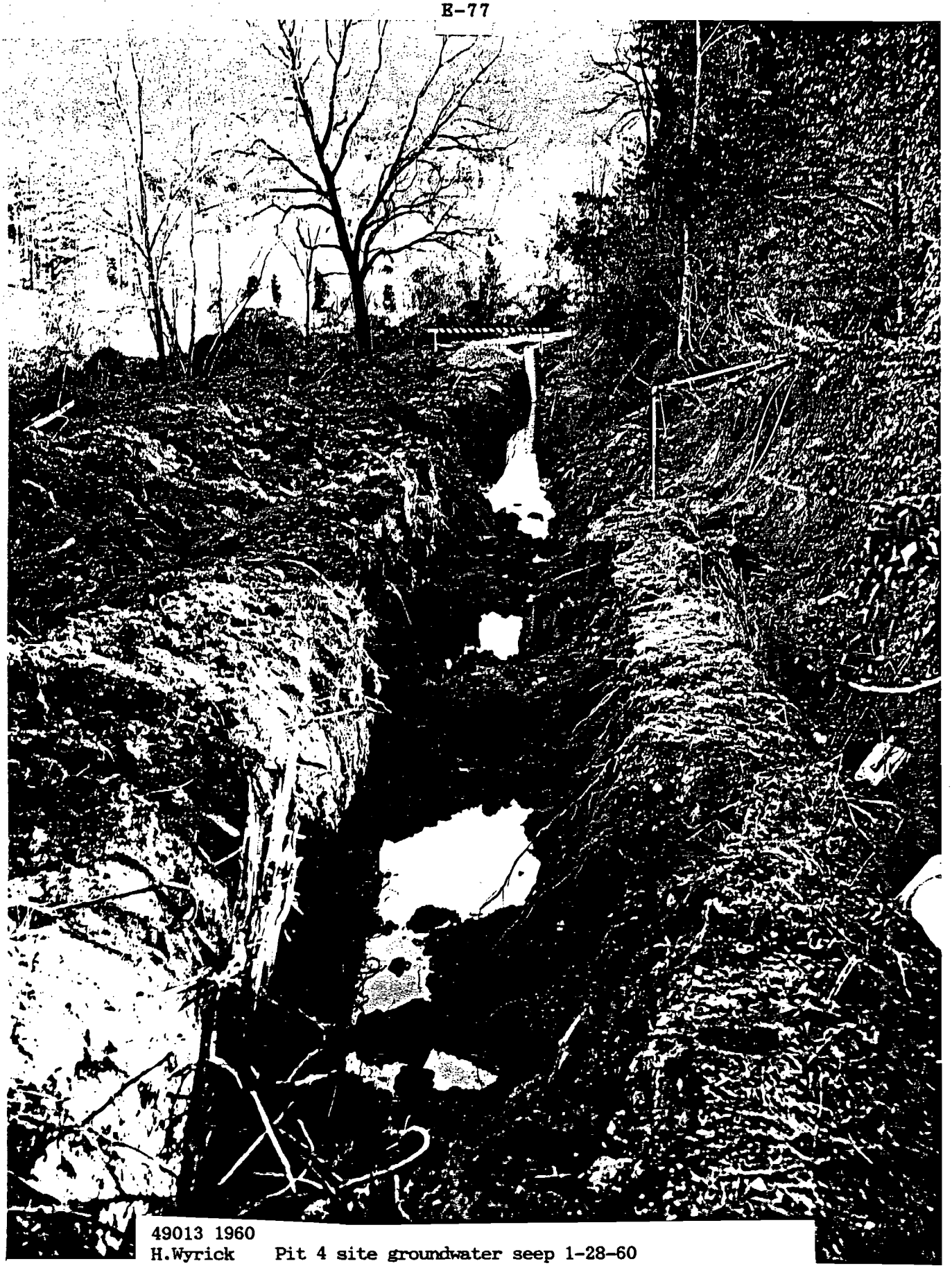
48441 1959
W.deLaguna Downhole hydraulic fracturing tool



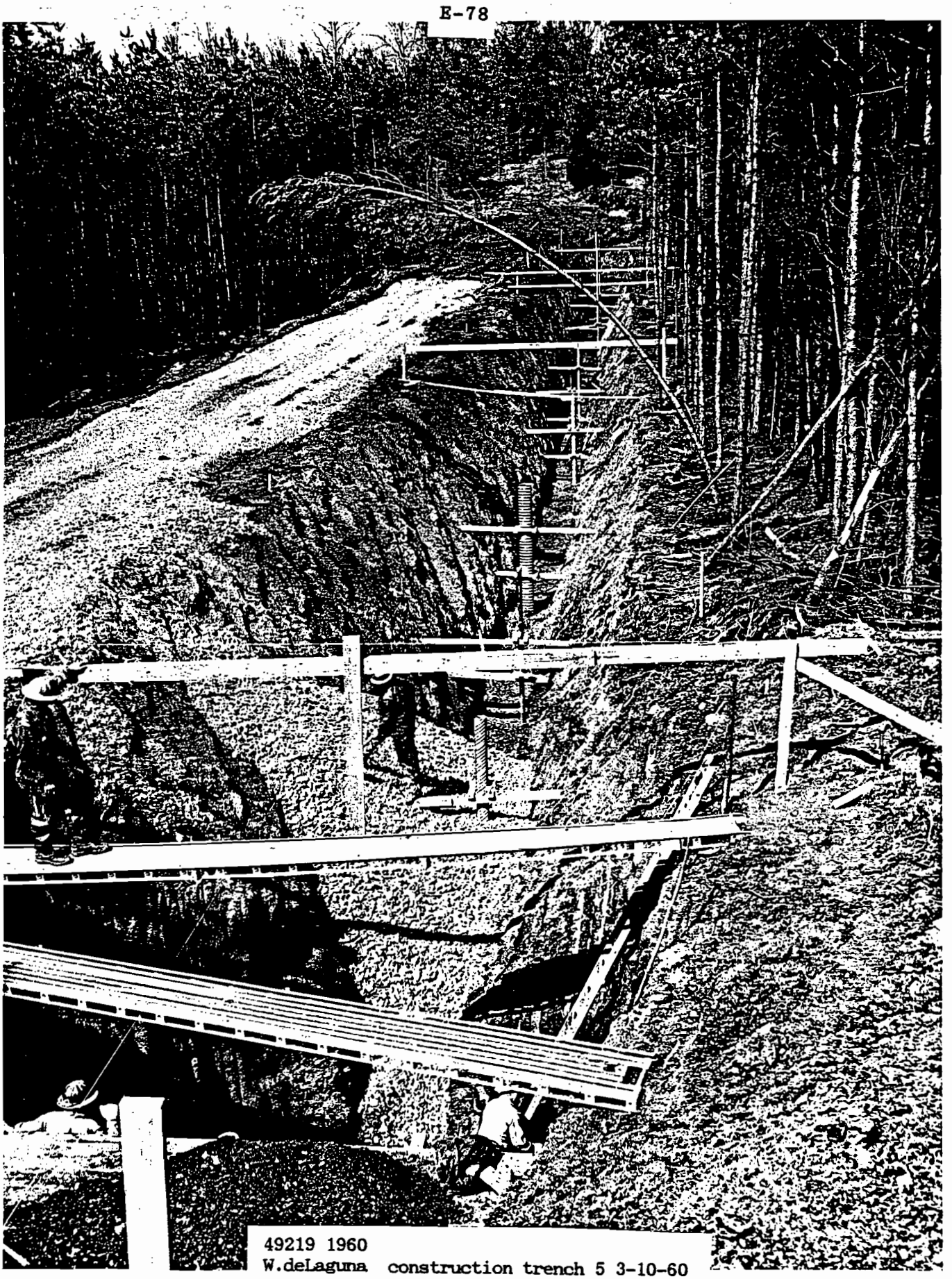
50391 1959
W.deLaguna Grout sheet in core 345 feet NE at 143 foot depth

49011 1960
H.Wyrick Pit 4 eastern seep interceptor trench 1-28-60

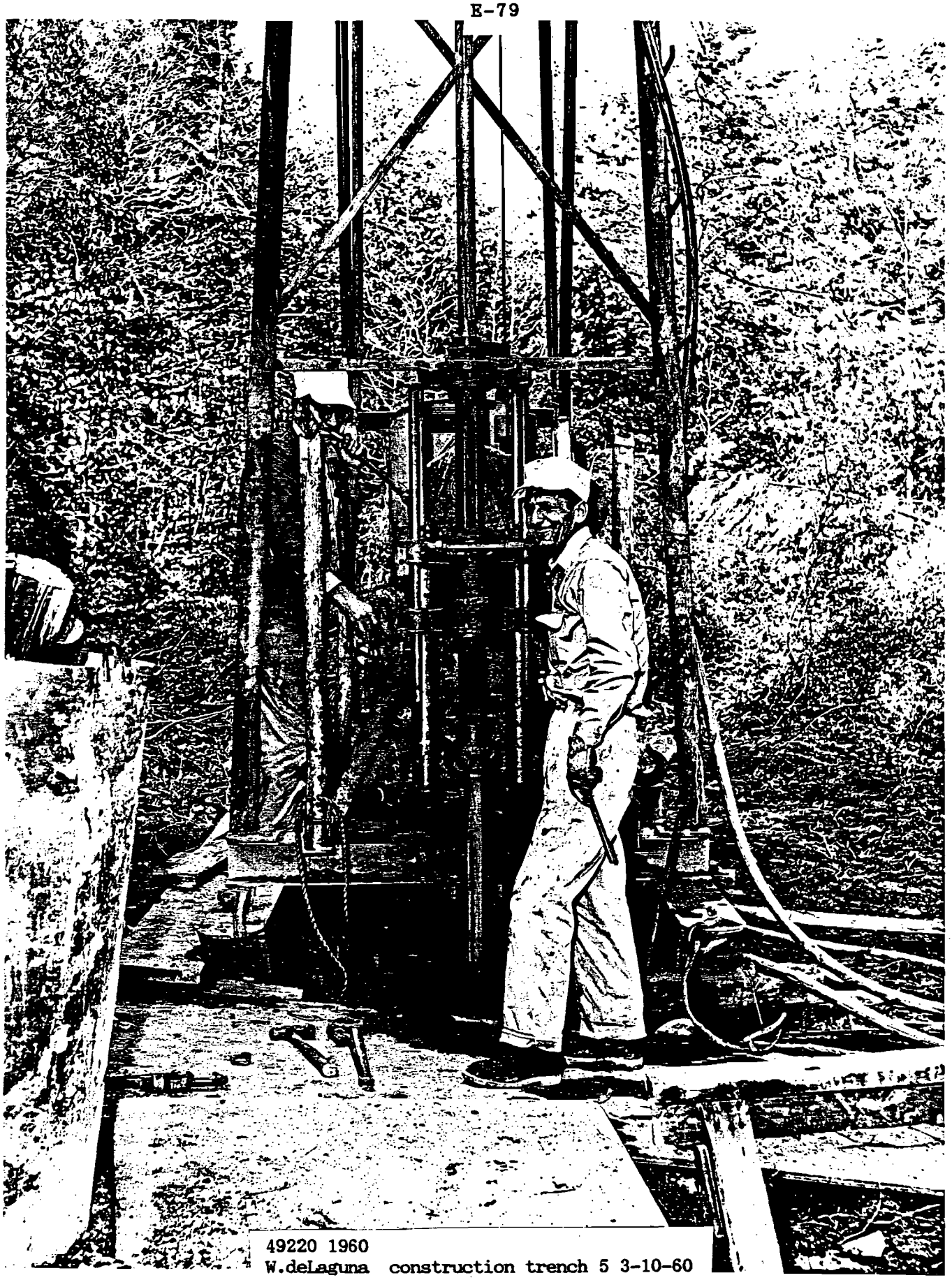
49012 1960
H.Wyrick Pit 4 eastern seep interceptor trench 1-28-60



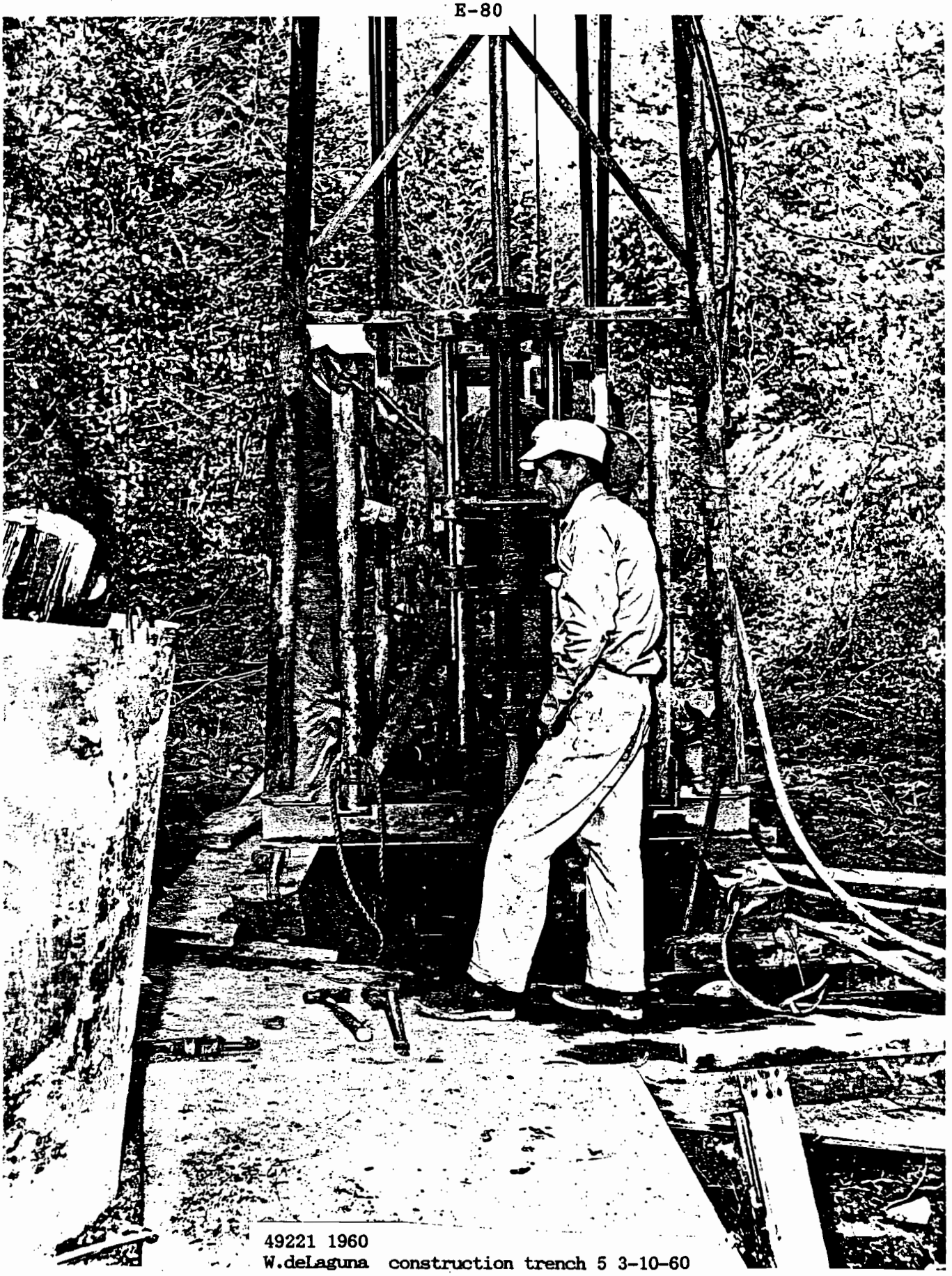
49013 1960
H.Wyrick Pit 4 site groundwater seep 1-28-60



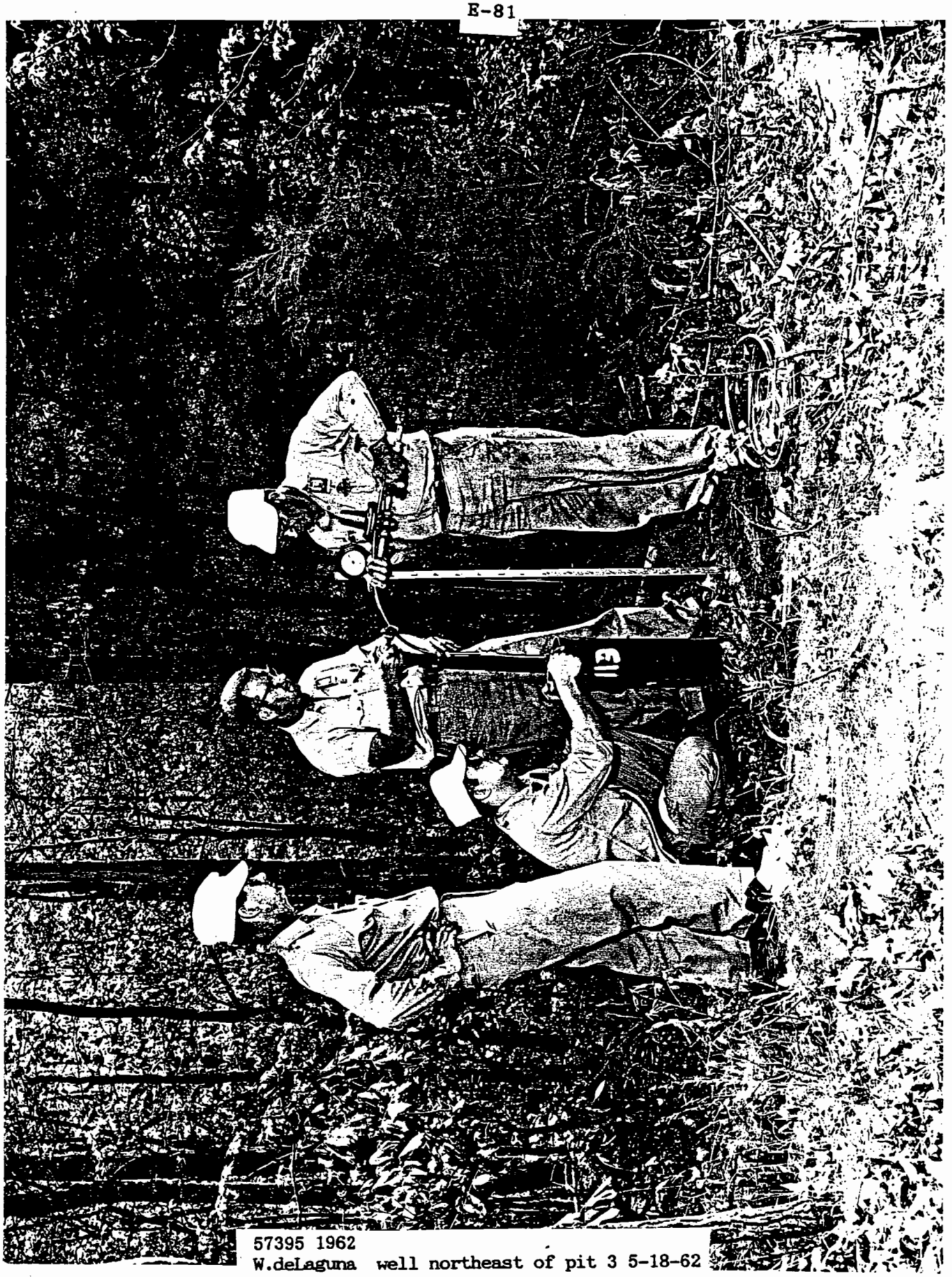
49219 1960
W.deLaguna construction trench 5 3-10-60



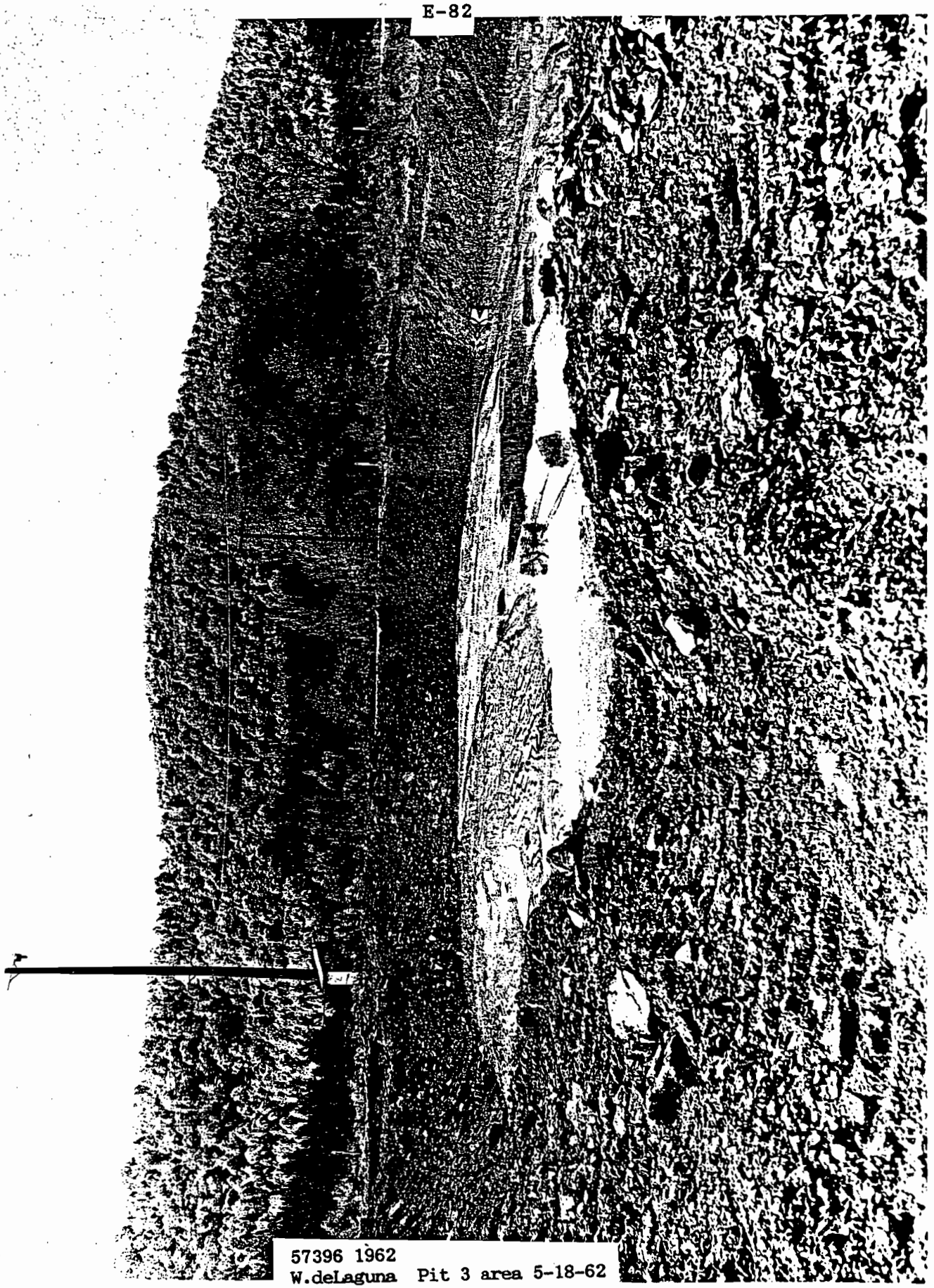
49220 1960
W.deLaguna construction trench 5 3-10-60



49221 1960
W.deLaguna construction trench 5 3-10-60



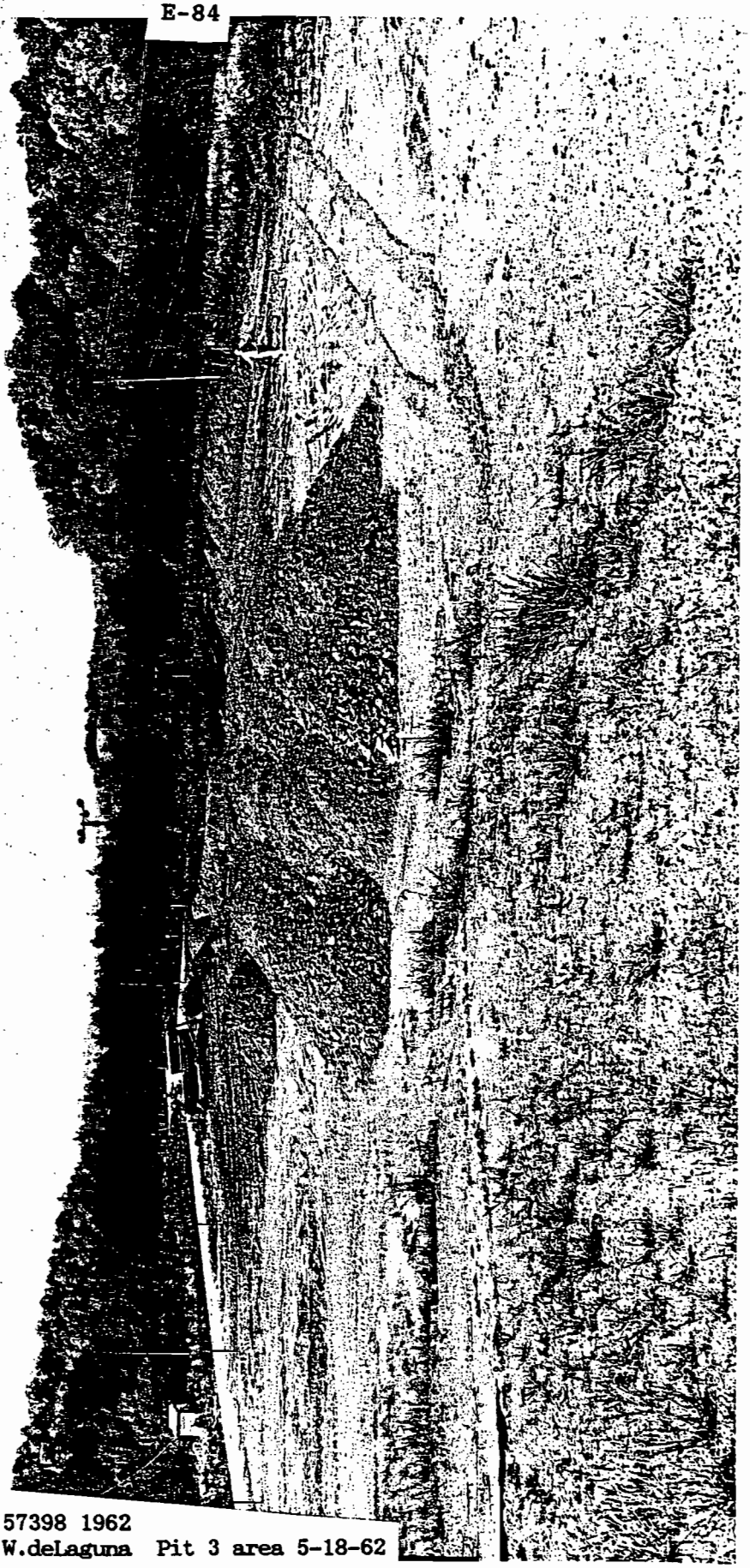
57395 1962
W.deLaguna well northeast of pit 3 5-18-62



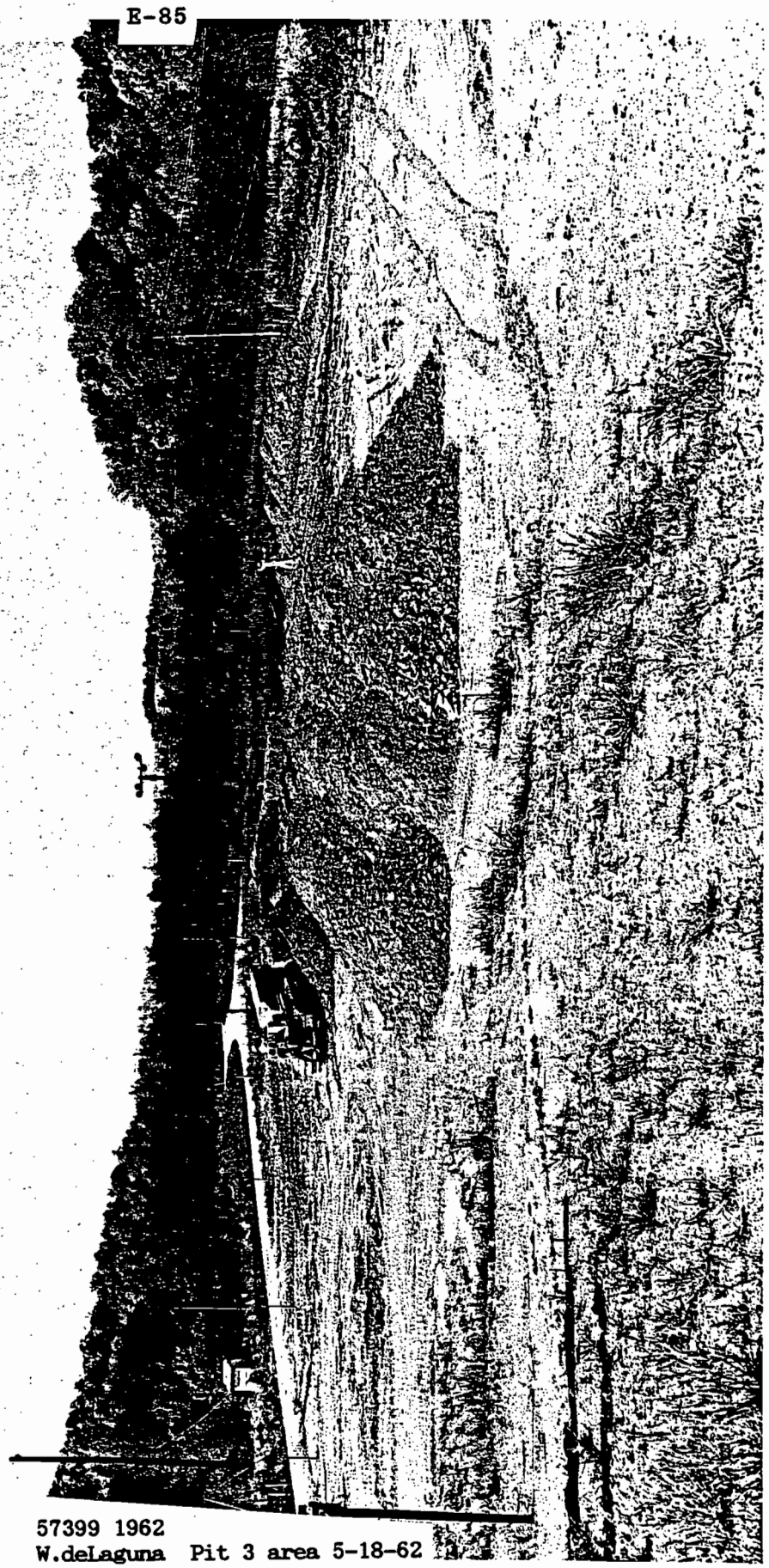
57396 1962
W.deLaguna Pit 3 area 5-18-62

E-83

57397 1962
W.deLaguna Pit 3 area 5-18-62

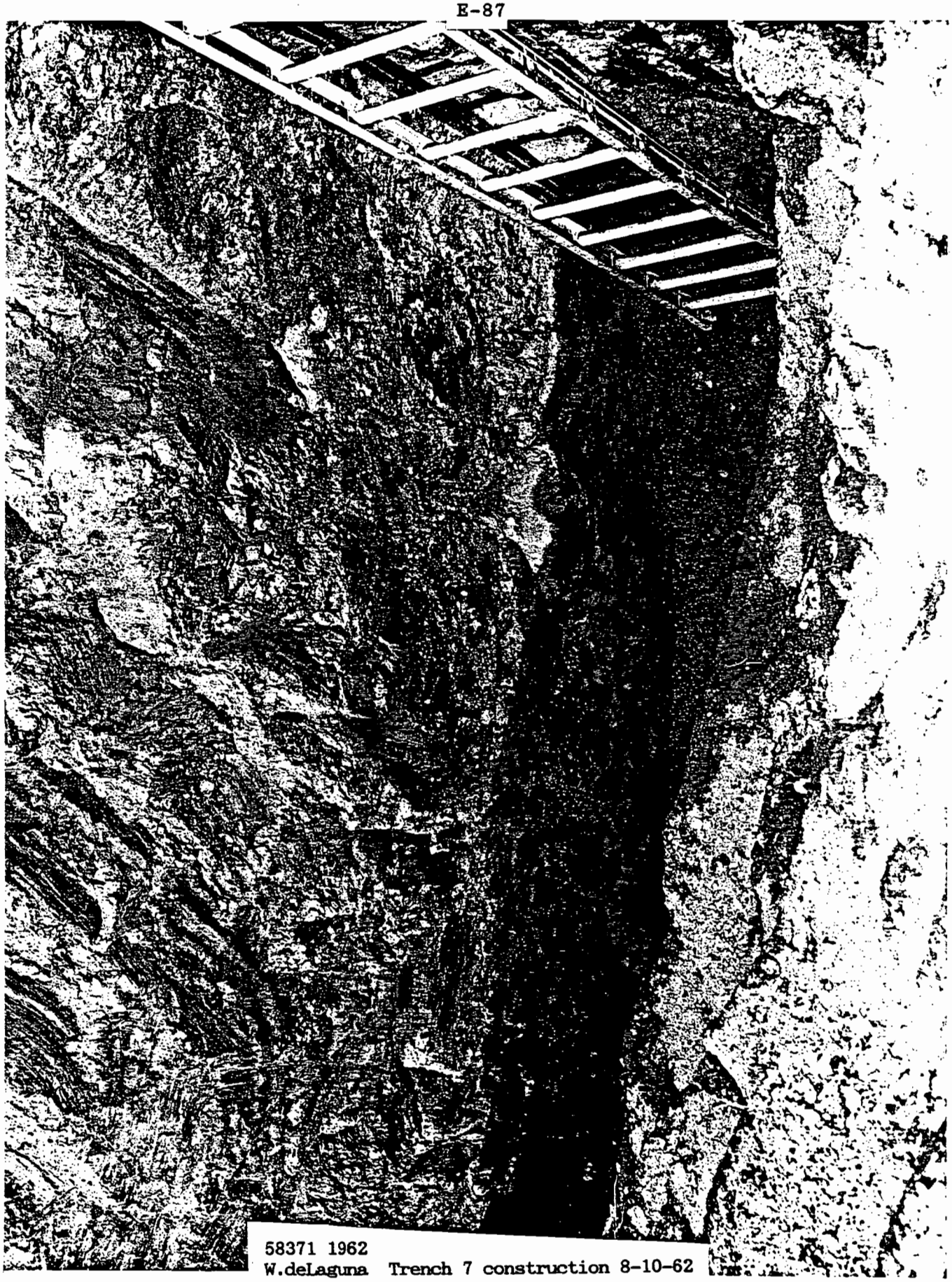


57398 1962
W.deLaguna Pit 3 area 5-18-62



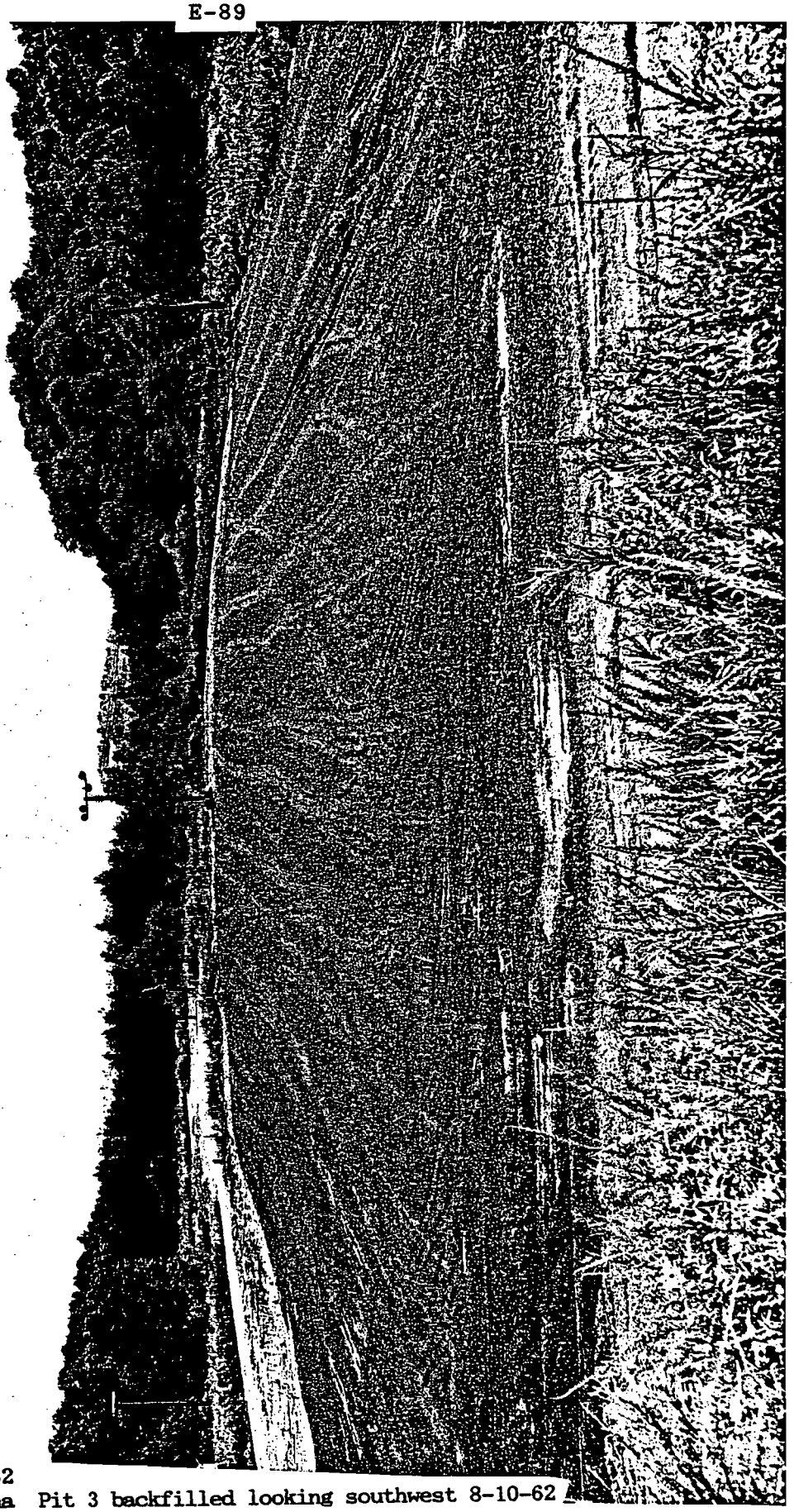
57399 1962
W.deLaguna Pit 3 area 5-18-62

58370 1962
W.deLaguna Trench 7 construction 8-10-62



58371 1962
W.deLaguna Trench 7 construction 8-10-62

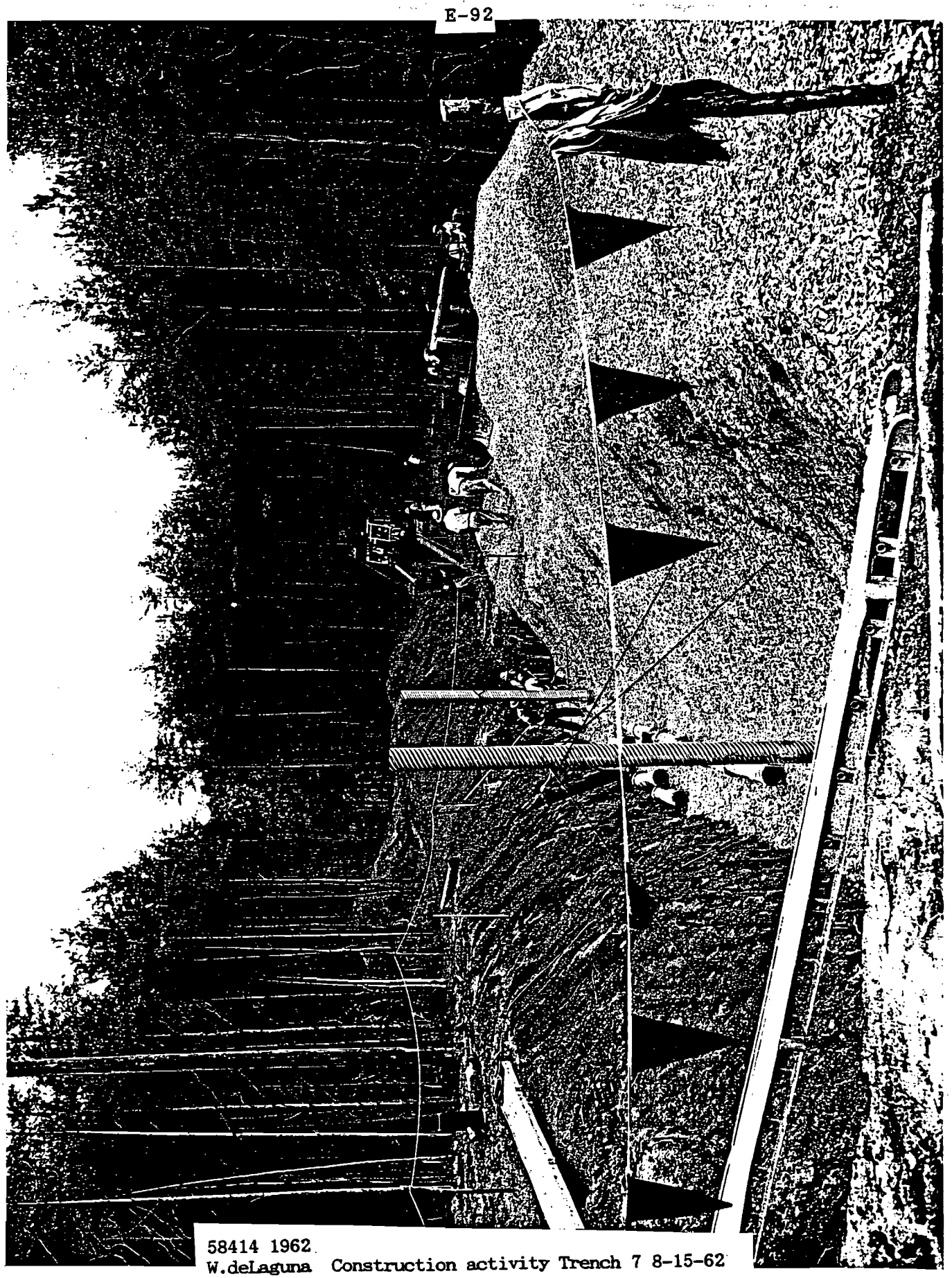
58372 1962
W.deLaguna Trench 7 construction 8-10-62



58373 1962
W.deLaguna Pit 3 backfilled looking southwest 8-10-62

58412 1962
W.deLaguna construction activity trench 7 8-15-62

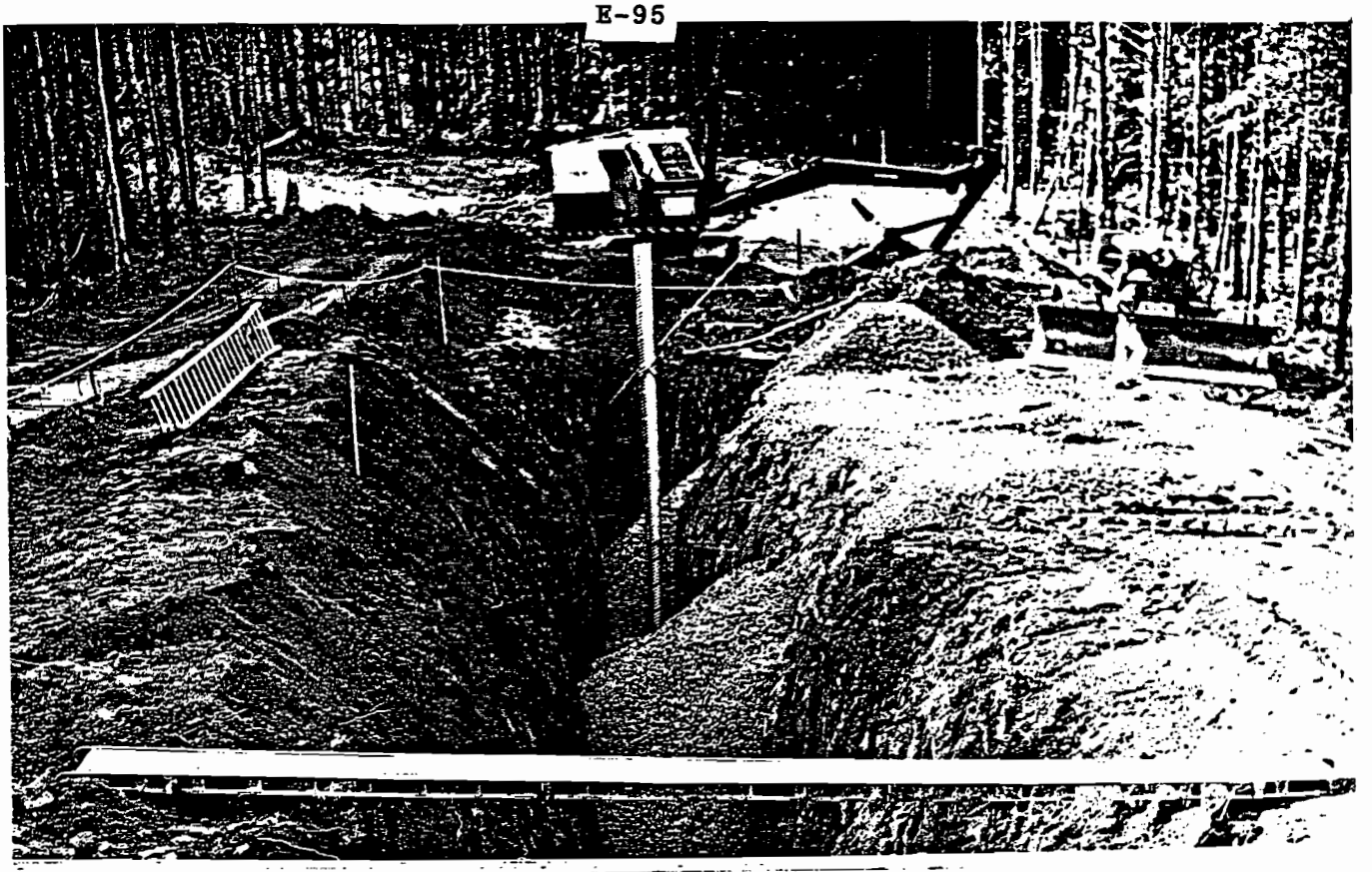
58413 1962
W.deLaguna construction activity trench 7 8-15-62

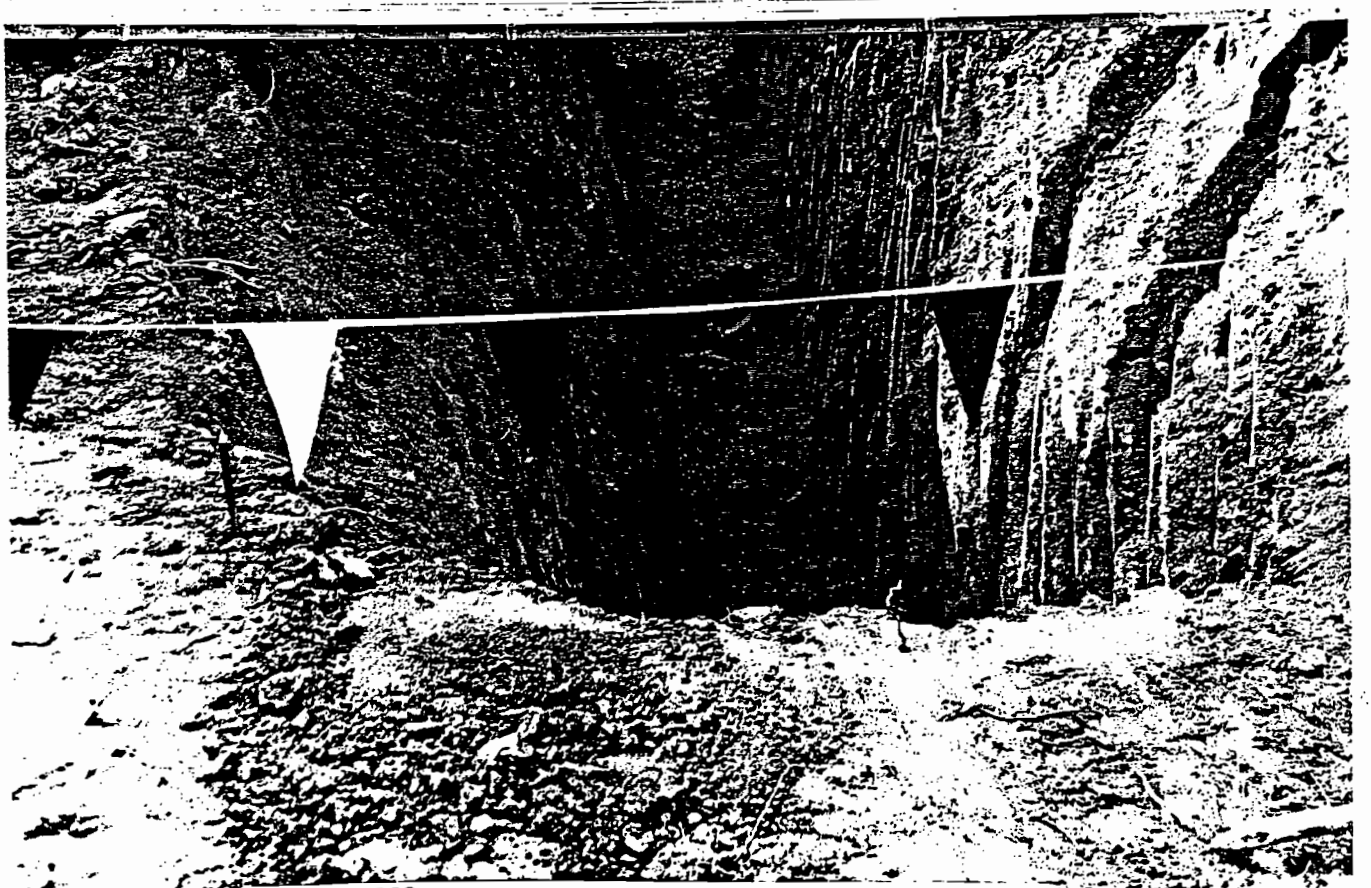


58414 1962
W.deLaguna Construction activity Trench 7 8-15-62

58415 1962
W.deLaguna Construction activity Trench 7 8-15-62

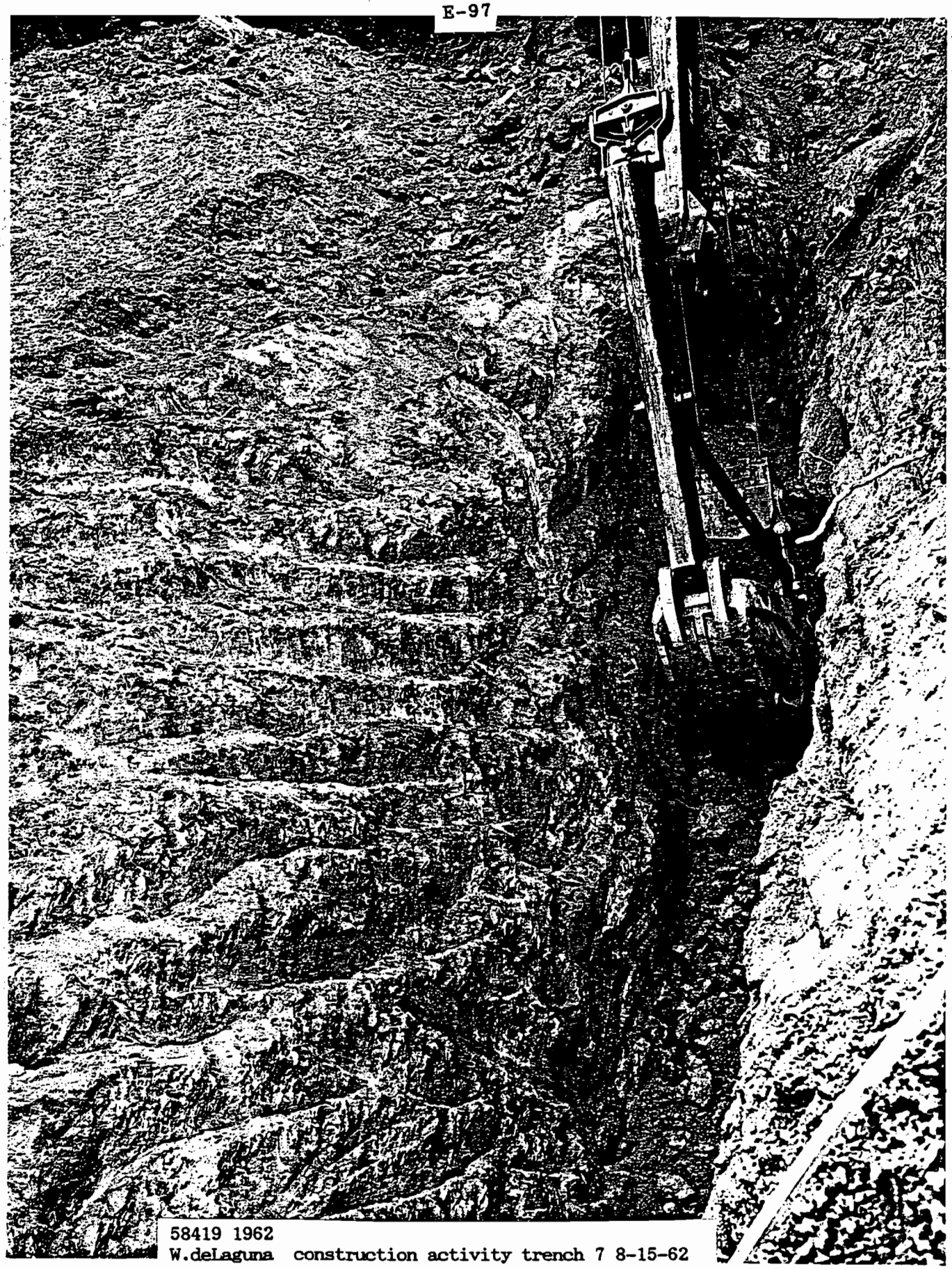
58416 1962
W.deLaguna Construction activity Trench 7 8-15-62



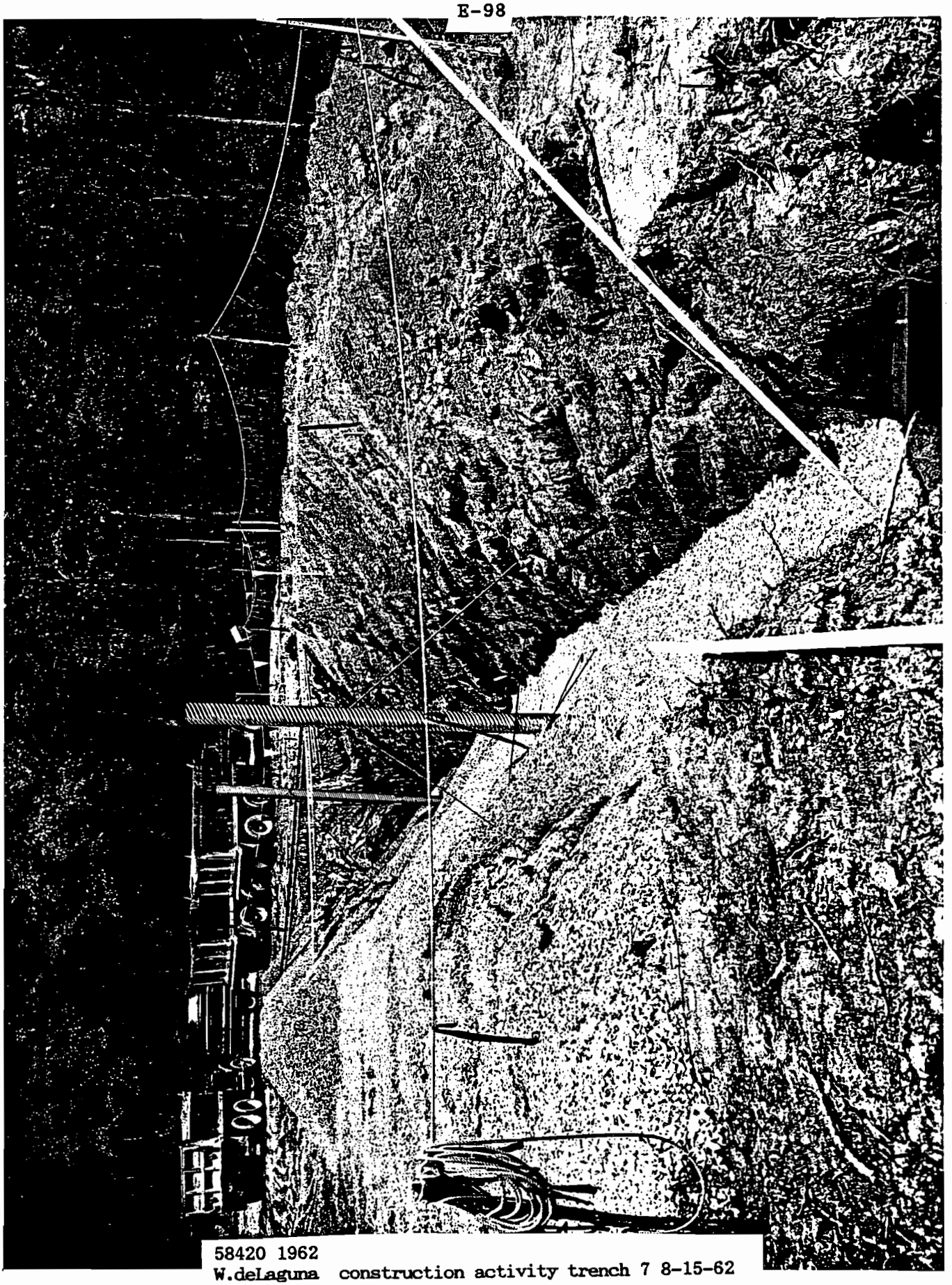


58417 1962
W.deLaguna Construction activity Trench 7 8-15-62

58418 1962
W.deLaguna construction activity trench 7 8-15-62



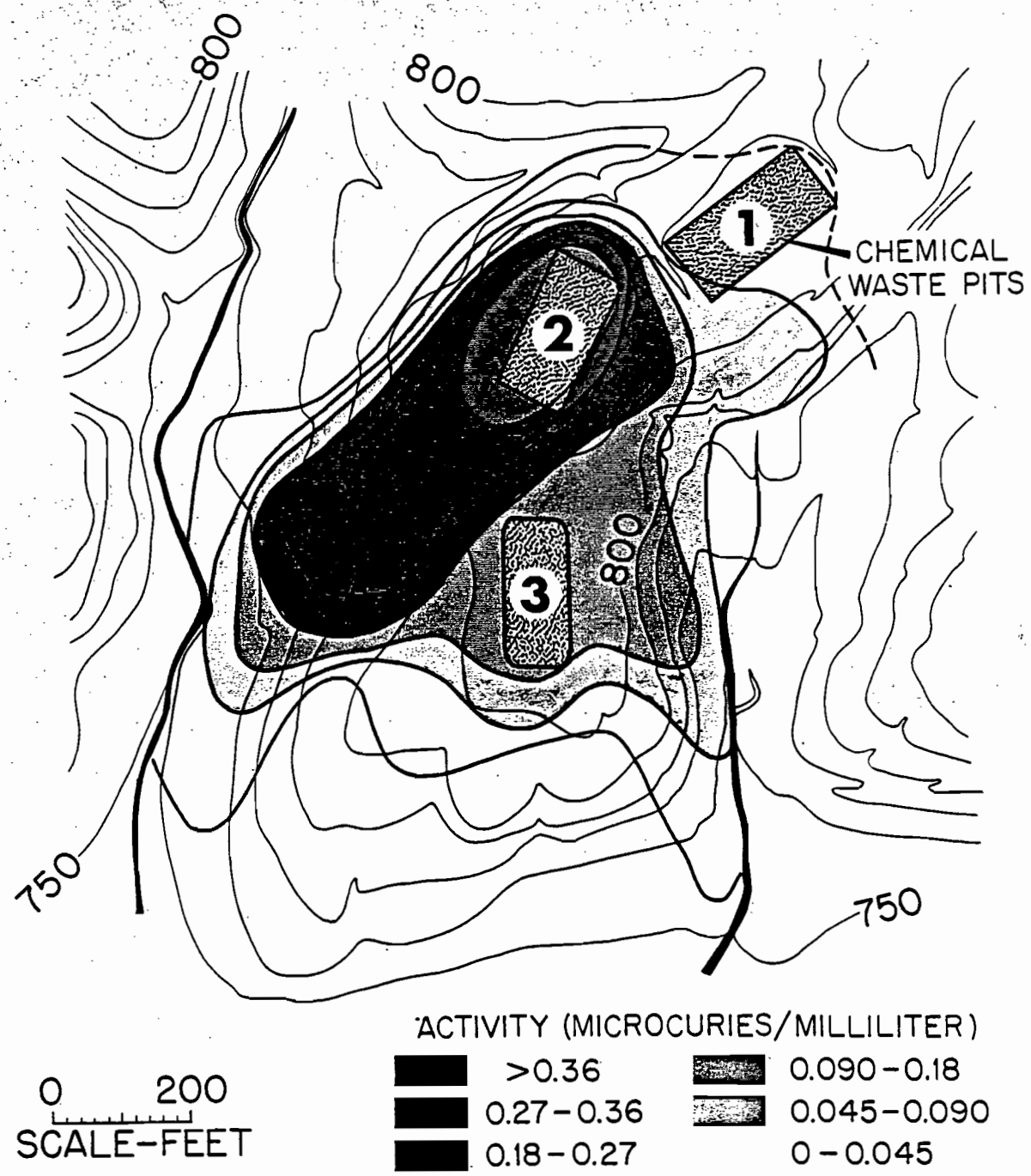
58419 1962
W.deLaguna construction activity trench 7 8-15-62



58420 1962
W.deLaguna construction activity trench 7 8-15-62

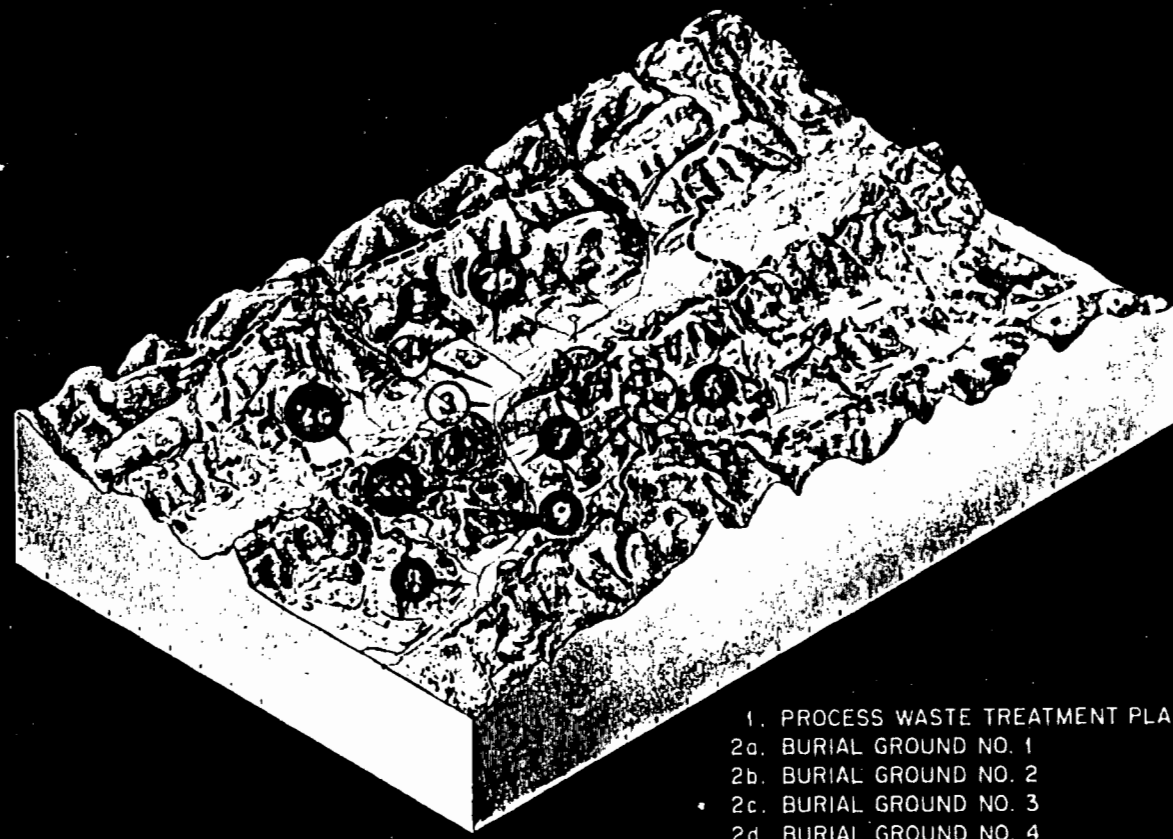
58421 1962
W.deLaguna construction activity trench 7 8-15-62

58886 1962
Auerbach Vegetation sampling at Trench 5



Distribution of Ruthenium^{106} in Ground Water in Vicinity of Waste Pits.

60145 1963
Struxness Distribution of Ru-106 in groundwater of pits



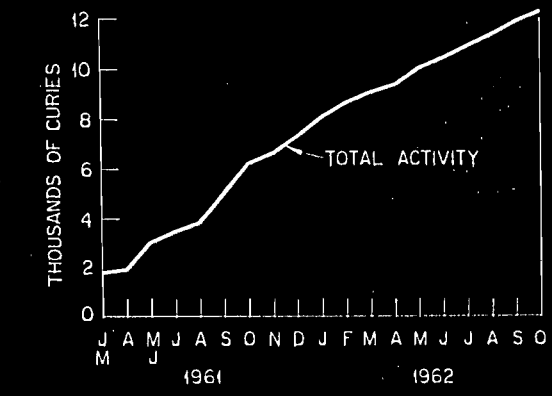
AMOUNTS OF ACTIVITY PRESENT (CURIES)

- > 1000
- 100-1000
- 10-100
- < 10

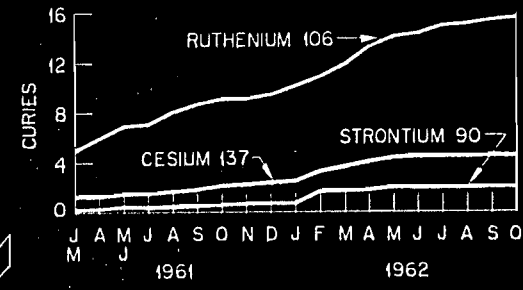
1. PROCESS WASTE TREATMENT PLANT EFFLUENT
2a. BURIAL GROUND NO. 1
2b. BURIAL GROUND NO. 2
2c. BURIAL GROUND NO. 3
2d. BURIAL GROUND NO. 4
2e. BURIAL GROUND NO. 5
3. LAUNDRY EFFLUENT
4. SEWAGE TREATMENT PLANT EFFLUENT
5. LITR AND ORR RETENTION POND
6. HRT RETENTION POND
7. BED OF FORMER INTERMEDIATE POND
8. BED OF FORMER WHITEOAK LAKE
9. WASTE PITS

Sources of Radioactive Contamination in Whiteoak Creek Basin.

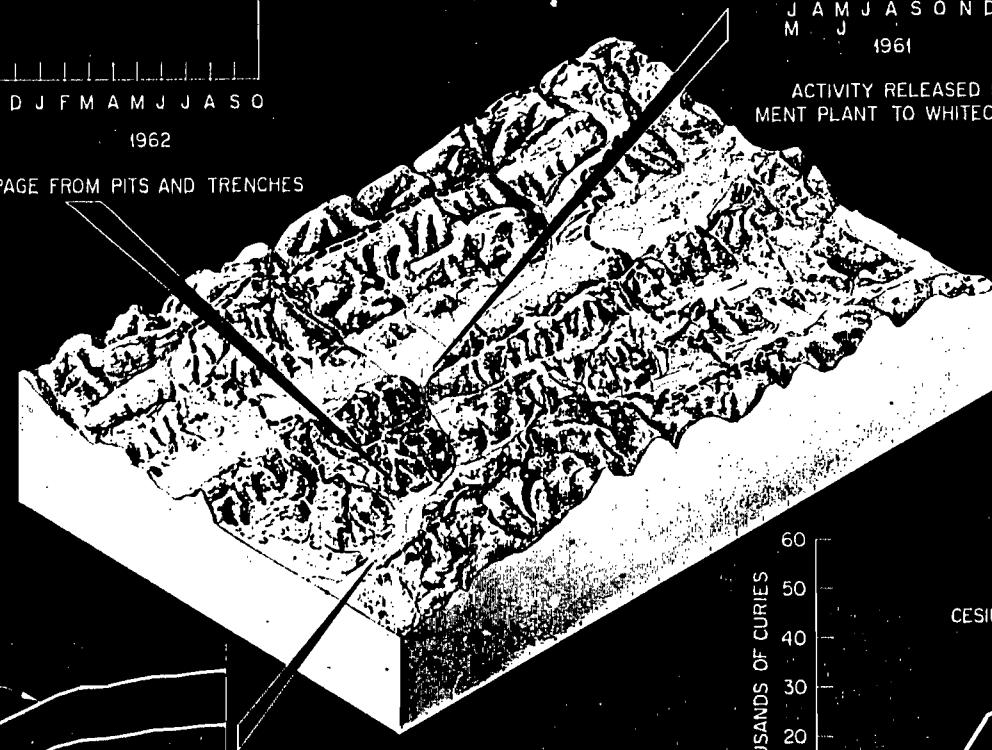
60148 1963
Struxness Sources of contamination in Whiteoak Basin

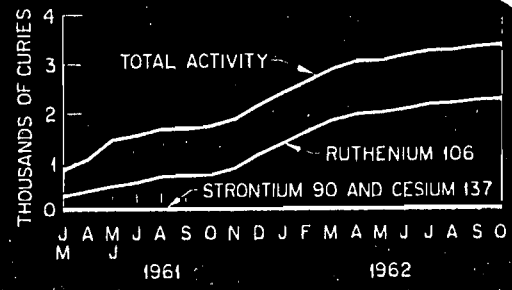


ACTIVITY RELEASED BY SEEPAGE FROM PITS AND TRENCHES

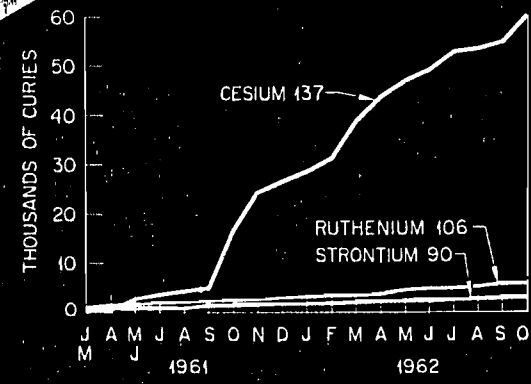


ACTIVITY RELEASED FROM WASTE WATER TREATMENT PLANT TO WHITEOAK CREEK.





ACTIVITY RELEASED FROM WHITEOAK DAM TO CLINCH RIVER

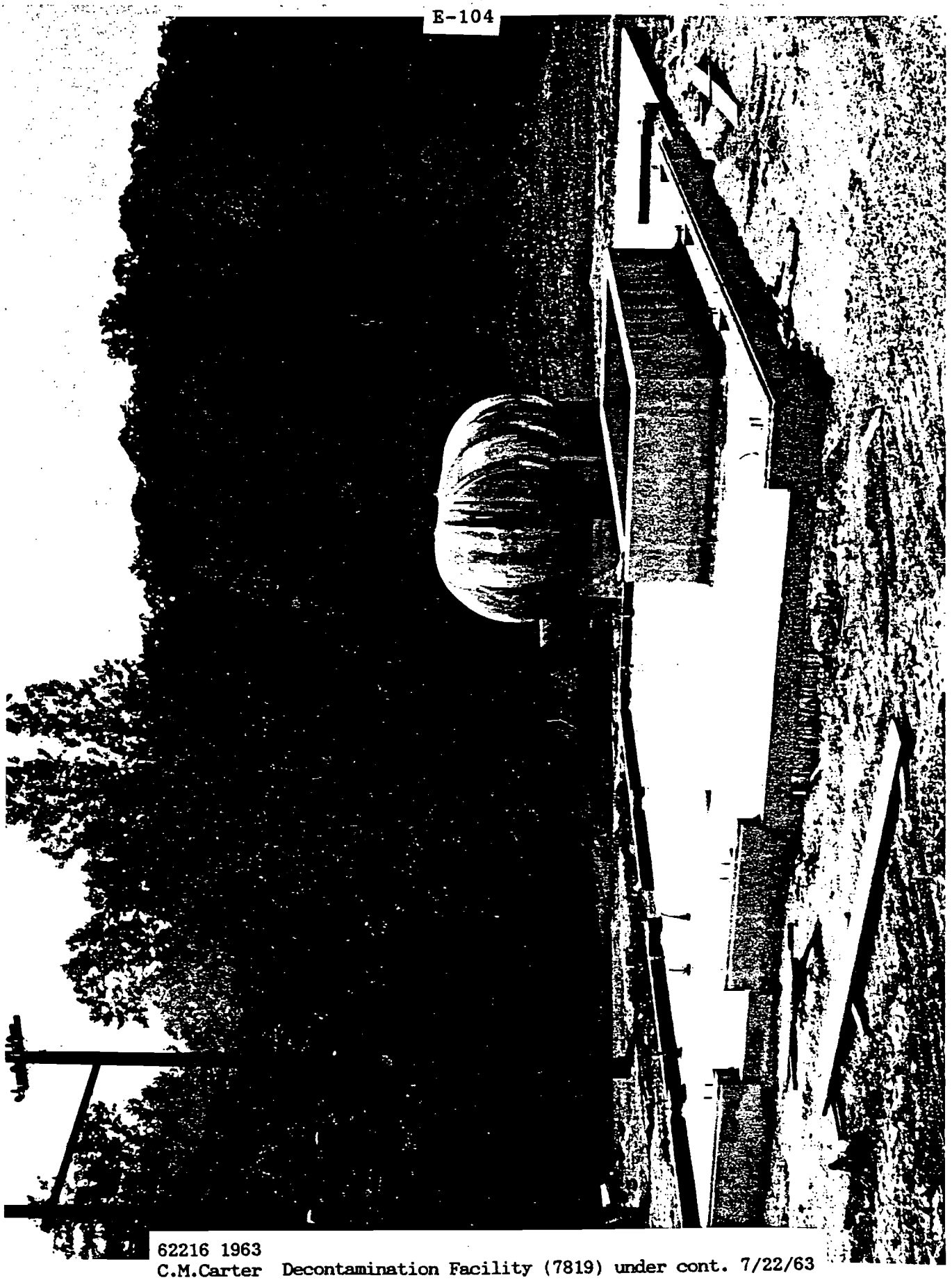


ACTIVITY TRANSFERRED TO PITS AND TRENCHES

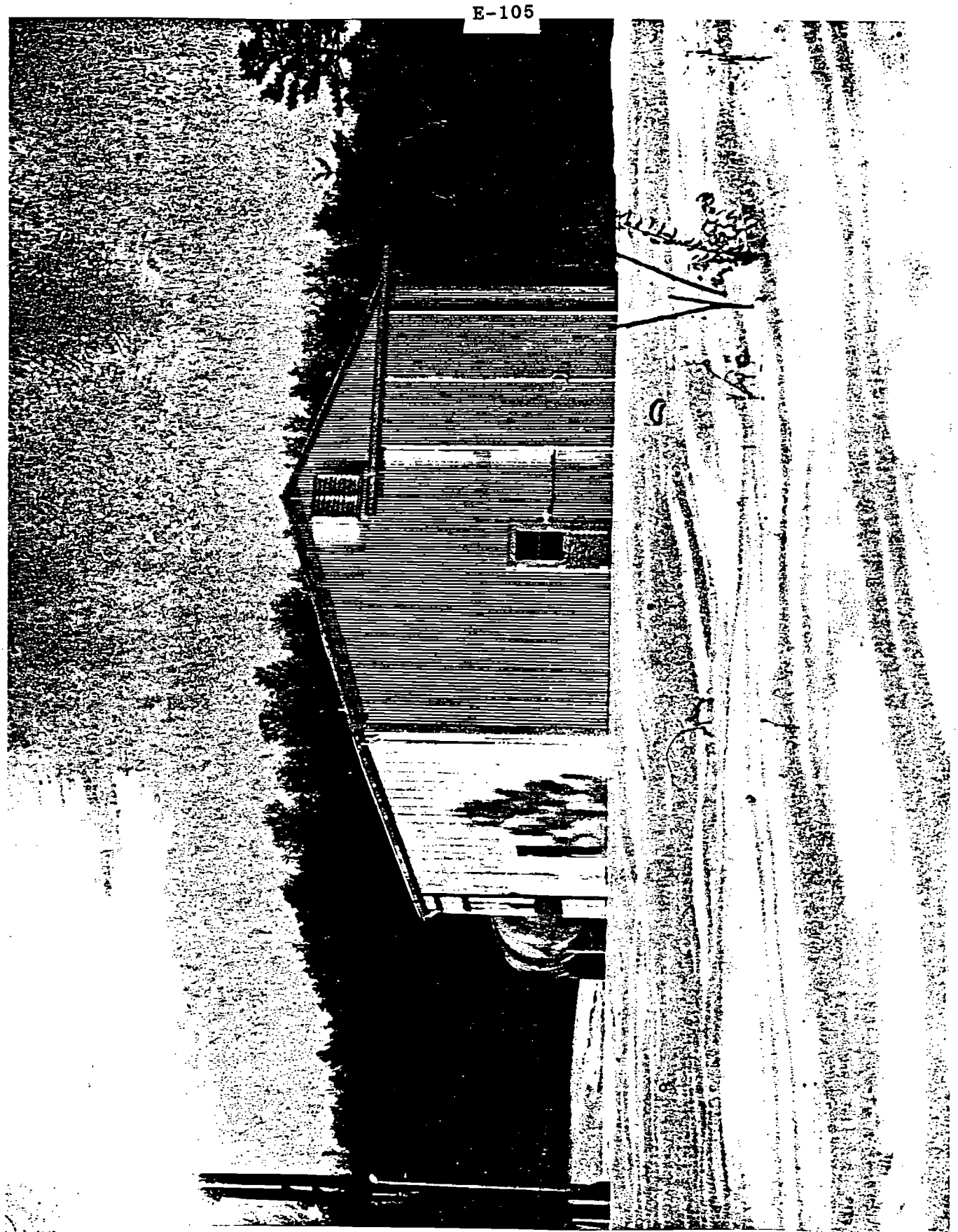
Cumulative Monthly Transfer of Activity in Whiteoak Creek Basin, January 1961 to October 1962

60183 1963
Struxness Monthly transfer of Activity in Whiteoak Basin

E-104

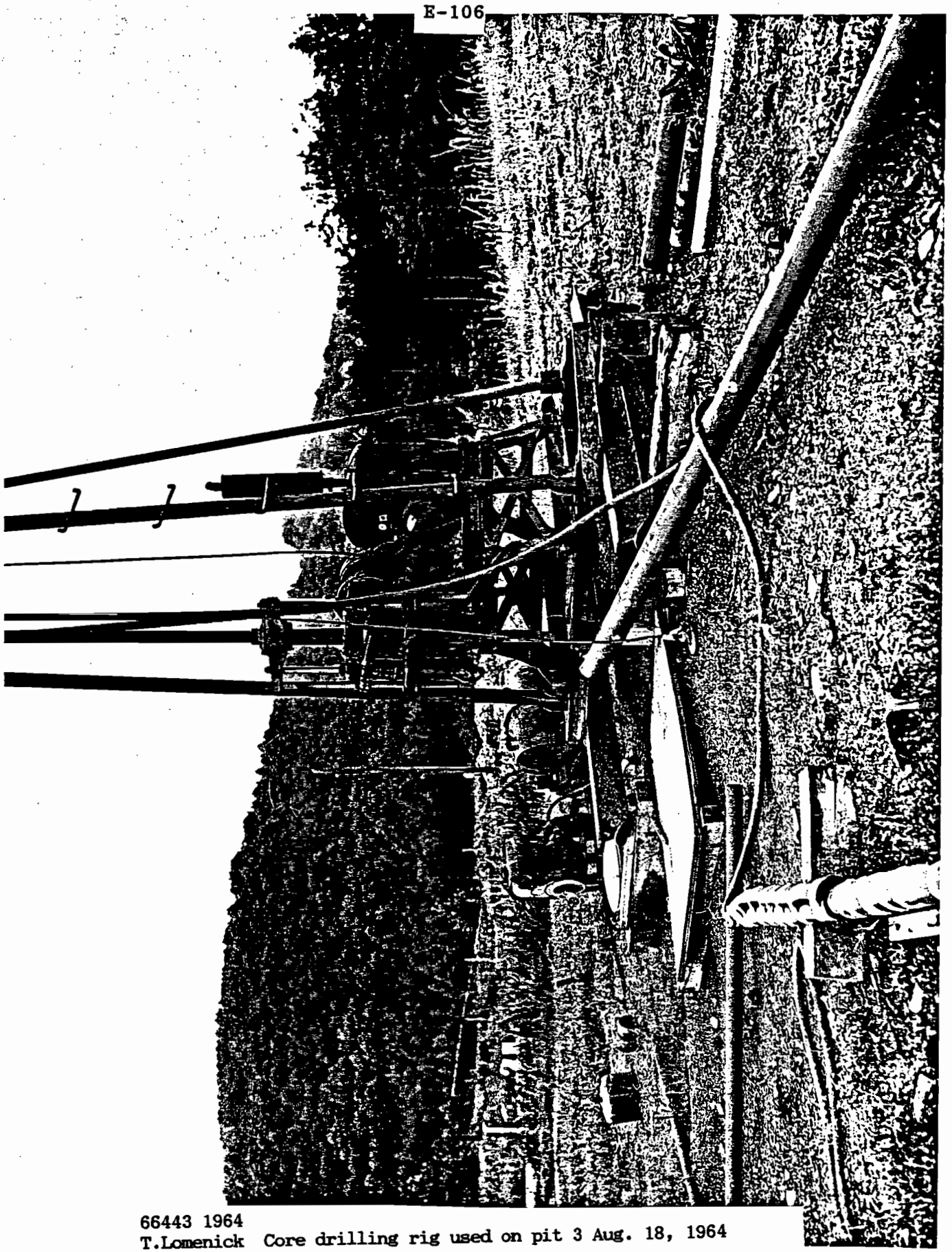


62216 1963
C.M.Carter Decontamination Facility (7819) under cont. 7/22/63



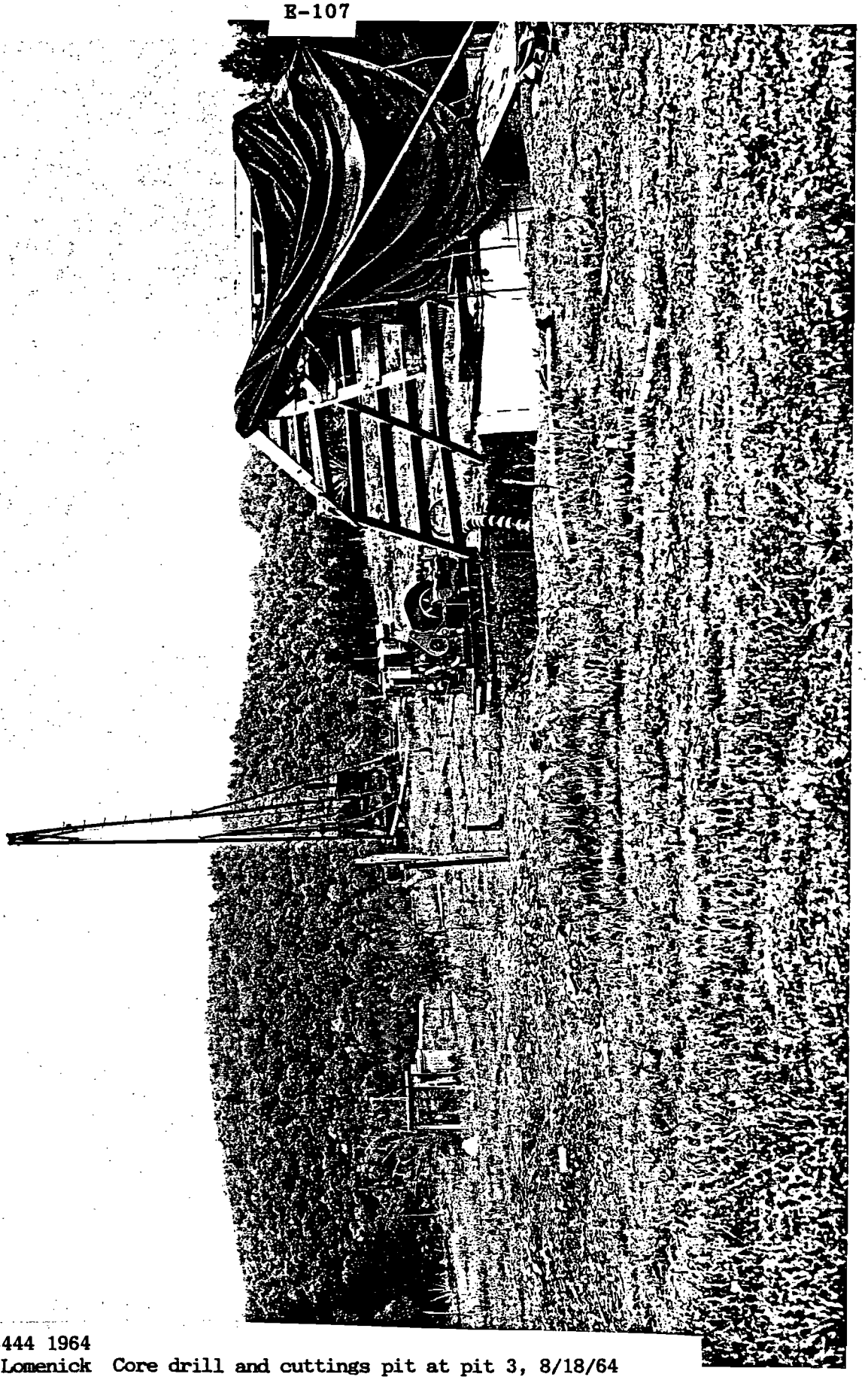
64056 1964
C.M.Carter Decontamination Facility (7819) finished 1/13/64

E-106

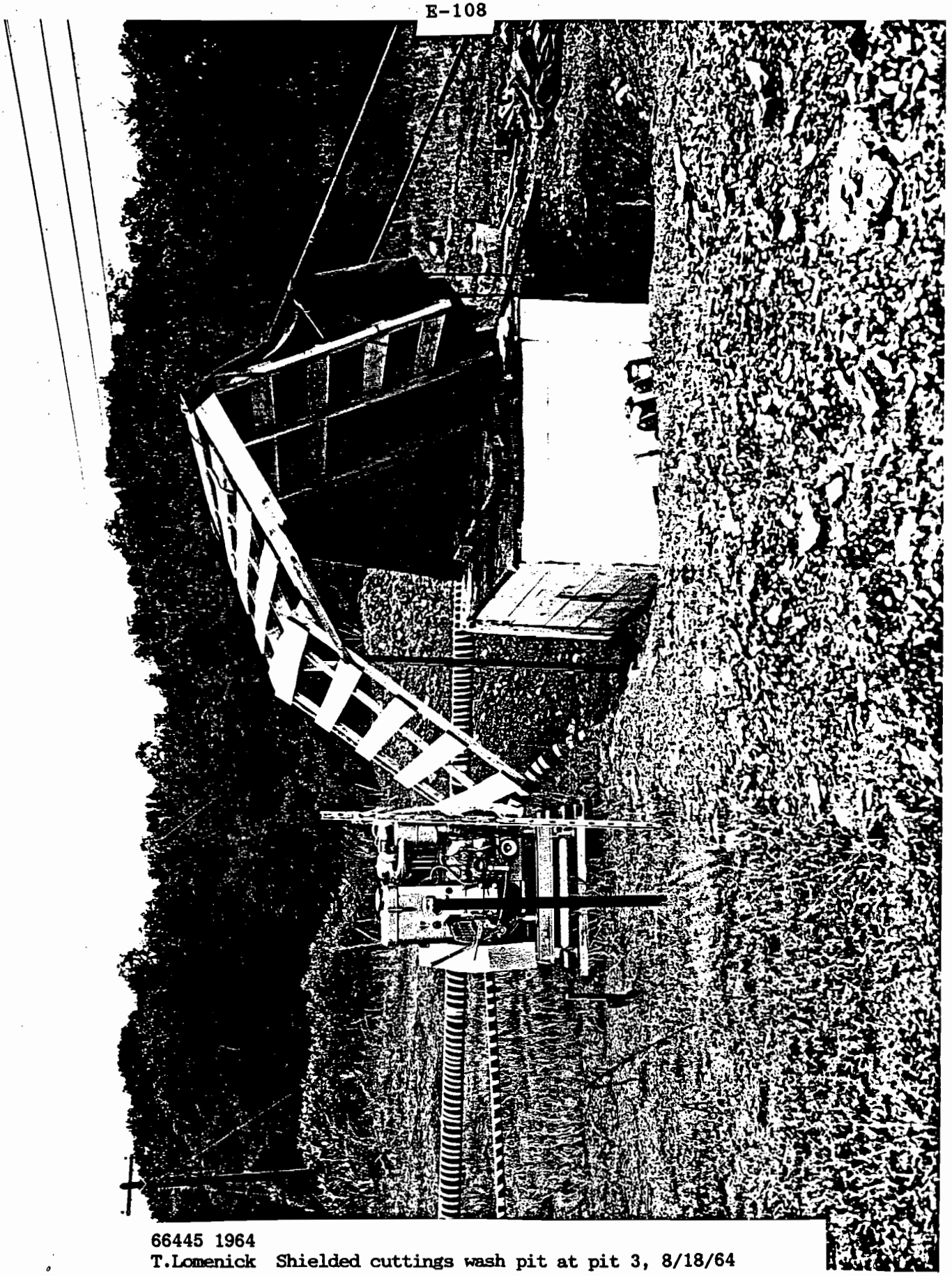


66443 1964
T.Lomenick Core drilling rig used on pit 3 Aug. 18, 1964

E-107



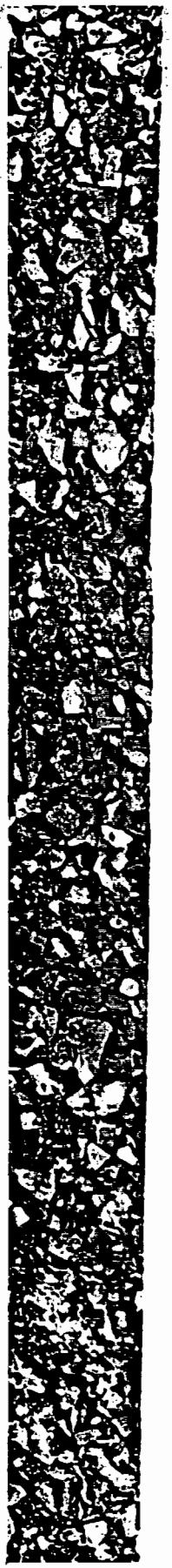
66444 1964
T.Lomenick Core drill and cuttings pit at pit 3, 8/18/64

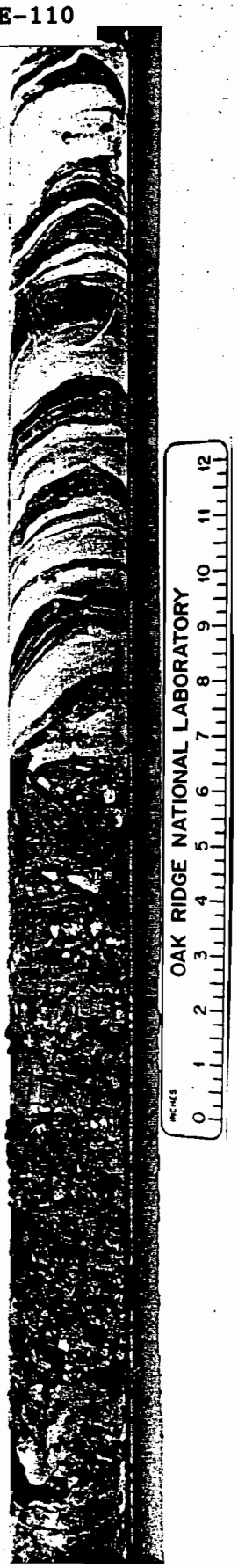


66445 1964
T.Lomenick Shielded cuttings wash pit at pit 3, 8/18/64

66446 1964
T.Lomenick Coring device used at pit 3 August 18, 1964

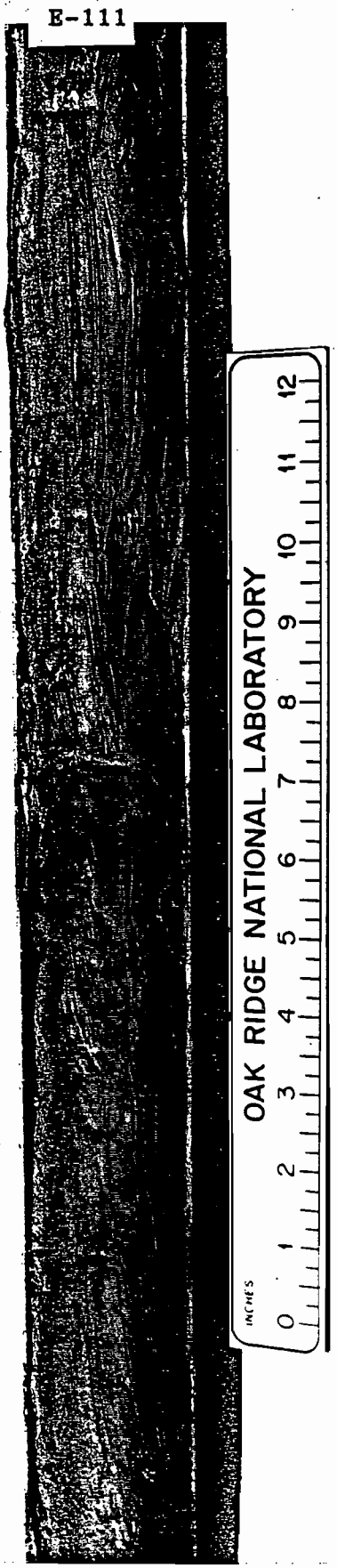
E-110





69705 1965
T.Lomenick Core from waste pit 3

E-111

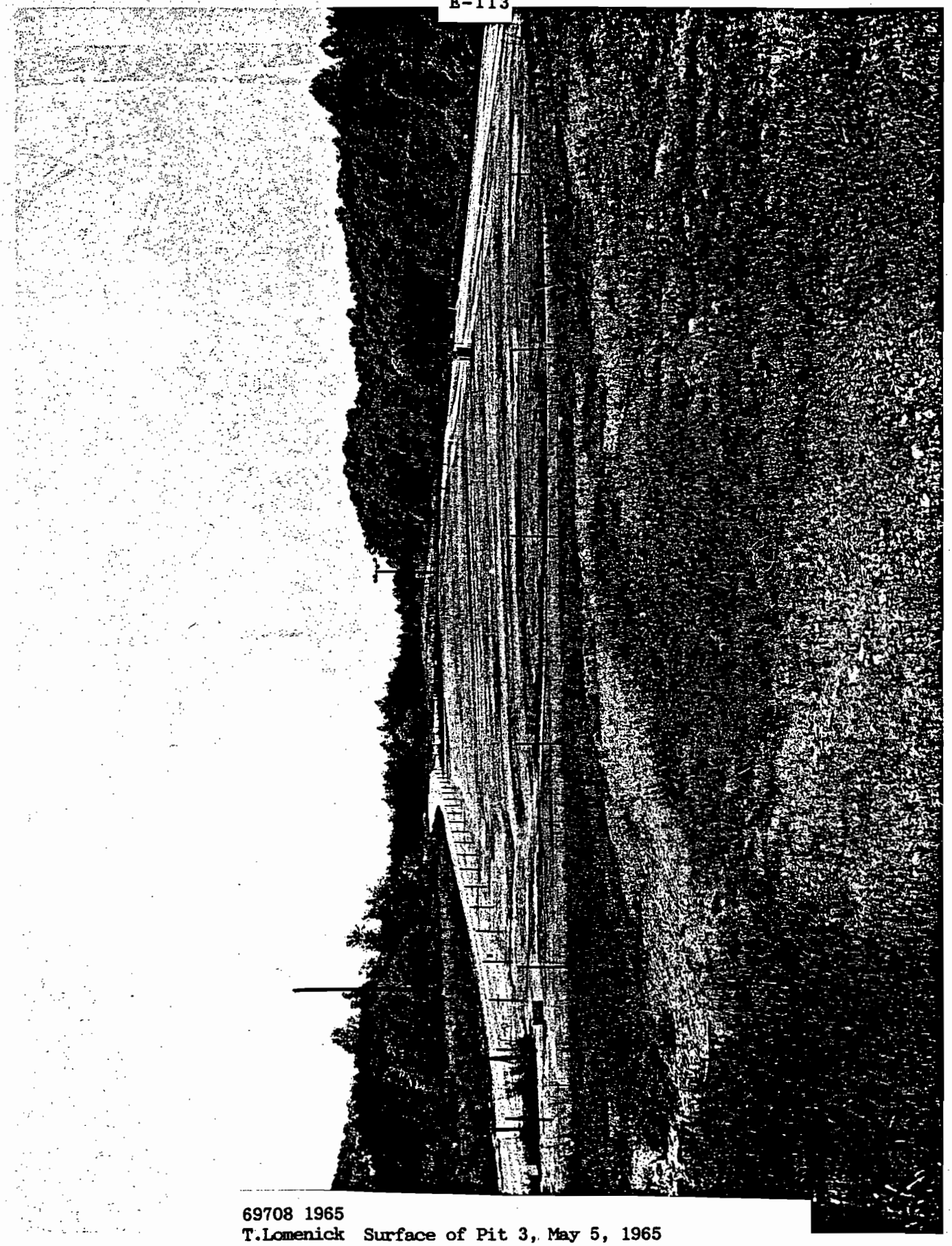


69706 1965
T.Lomenick Core from waste pit 3

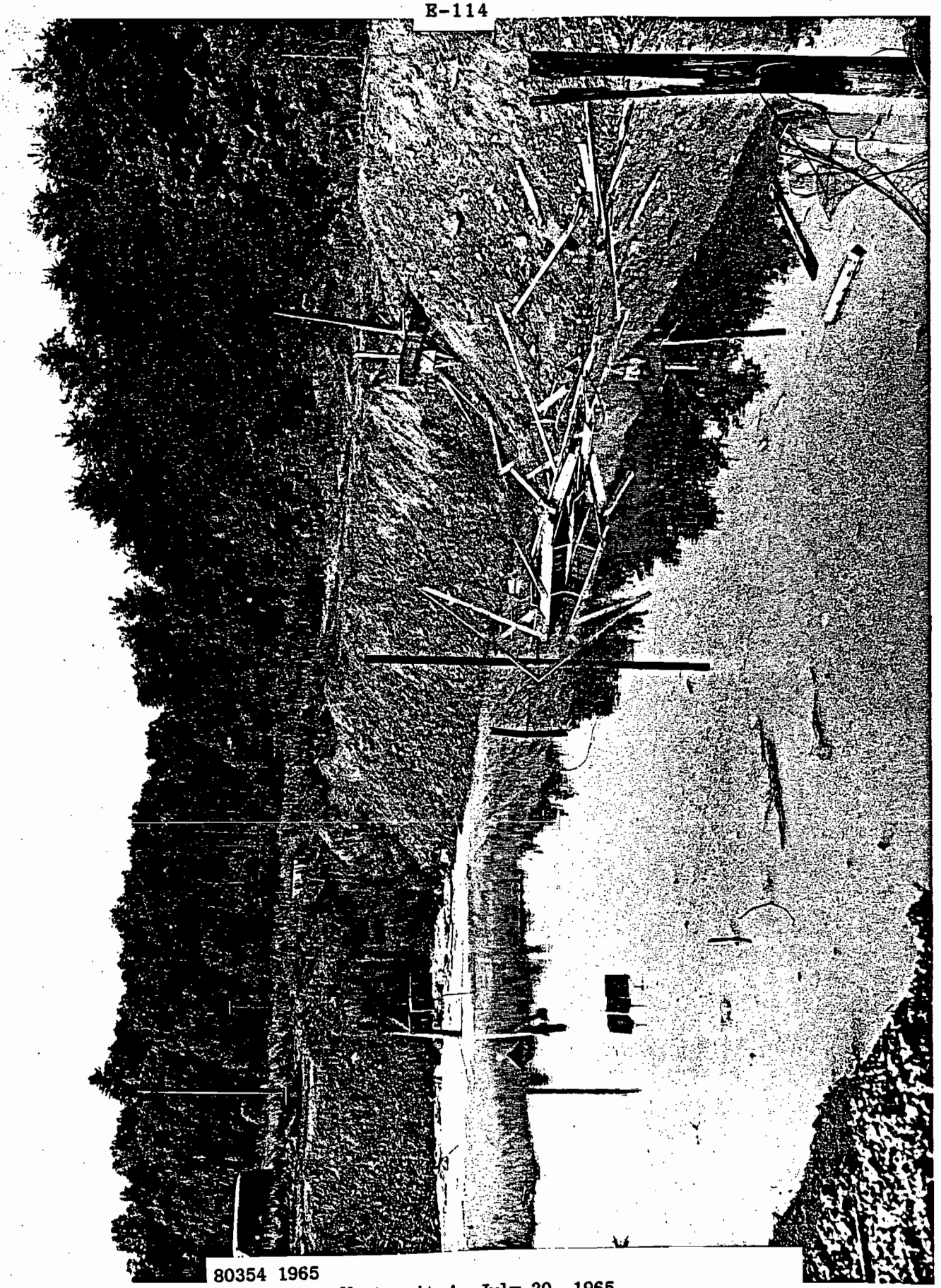
E-112

69707 1965
T.Lomenick Core from Pit 3, May 5, 1965

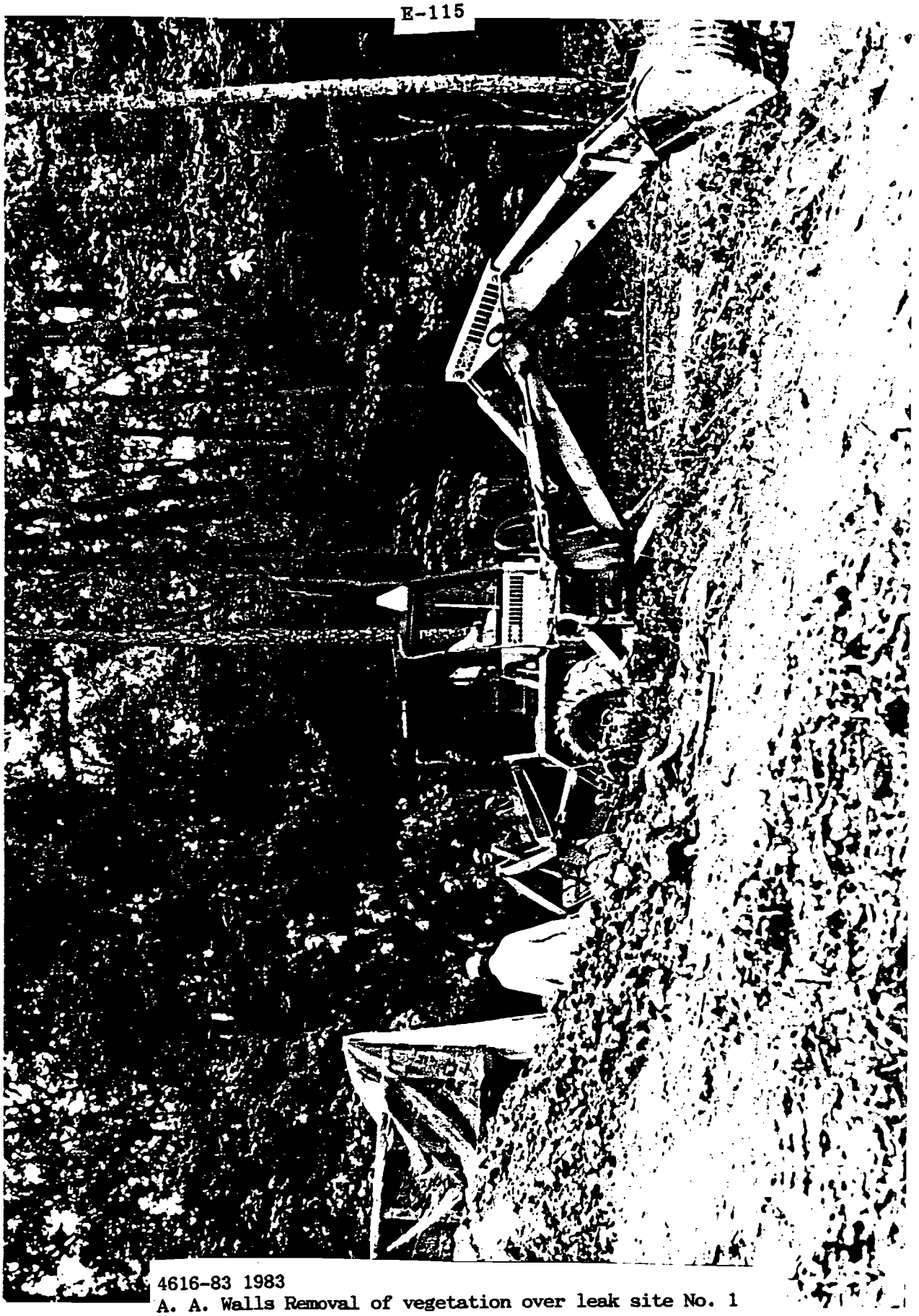
E-113



69708 1965
T.Lomenick Surface of Pit 3, May 5, 1965



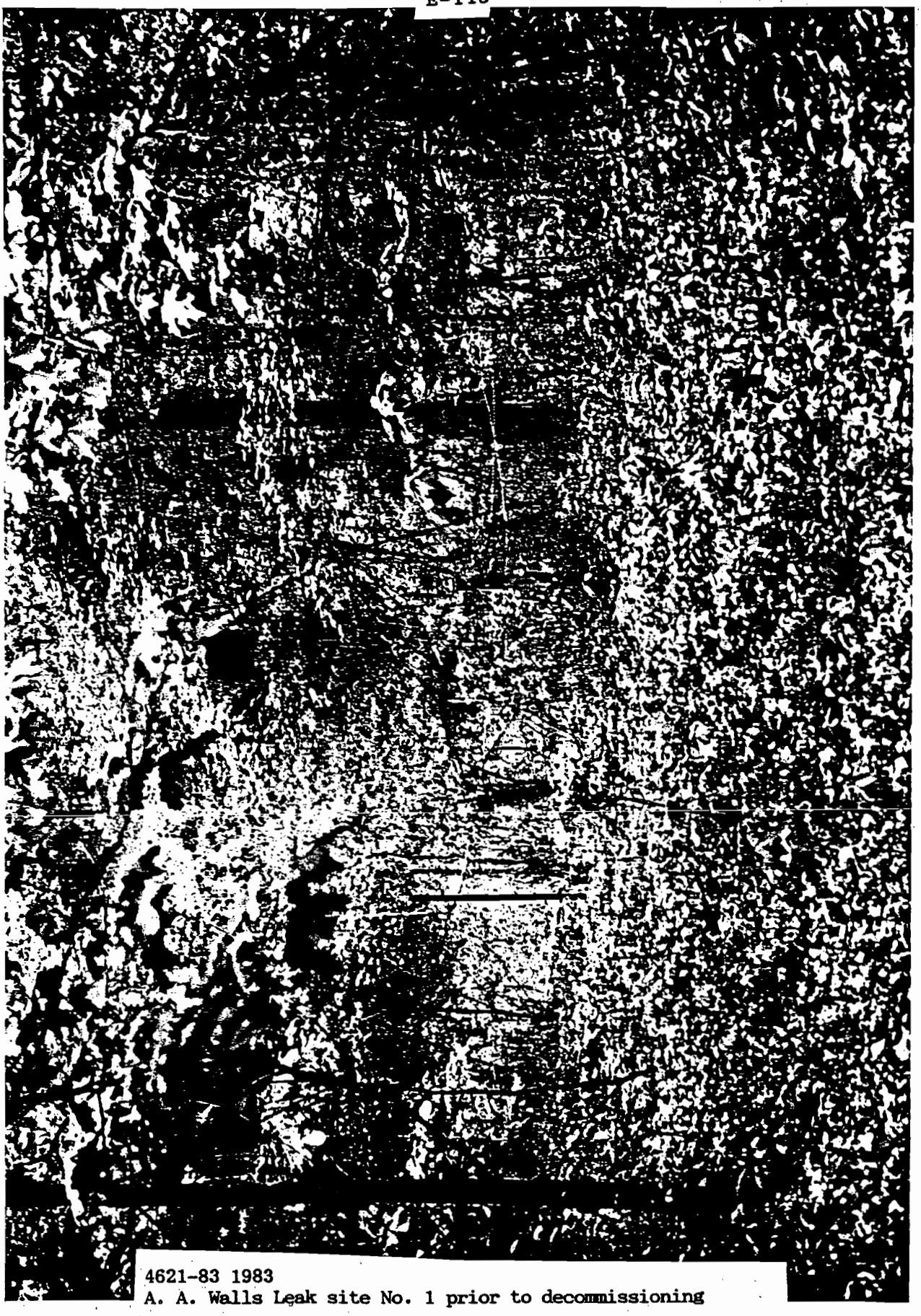
80354 1965
Unknown Waste pit 4, July 20, 1965



4616-83 1983
A. A. Walls Removal of vegetation over leak site No. 1

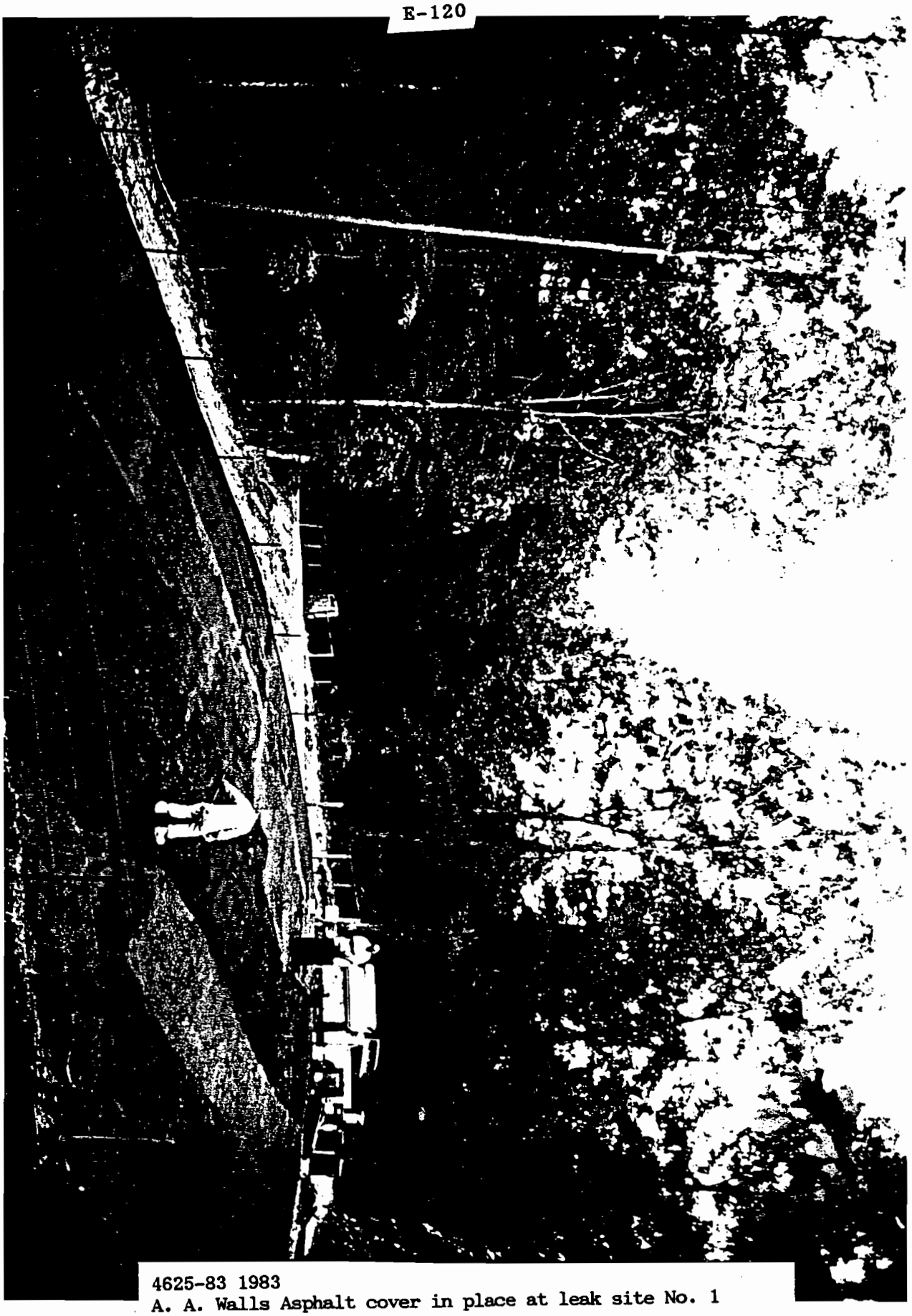
4617-83 1983
A. A. Walls Application of earth fill over bentonite

4620-83 1983
A. A. Walls Leak site No. 1 with crushed stone base

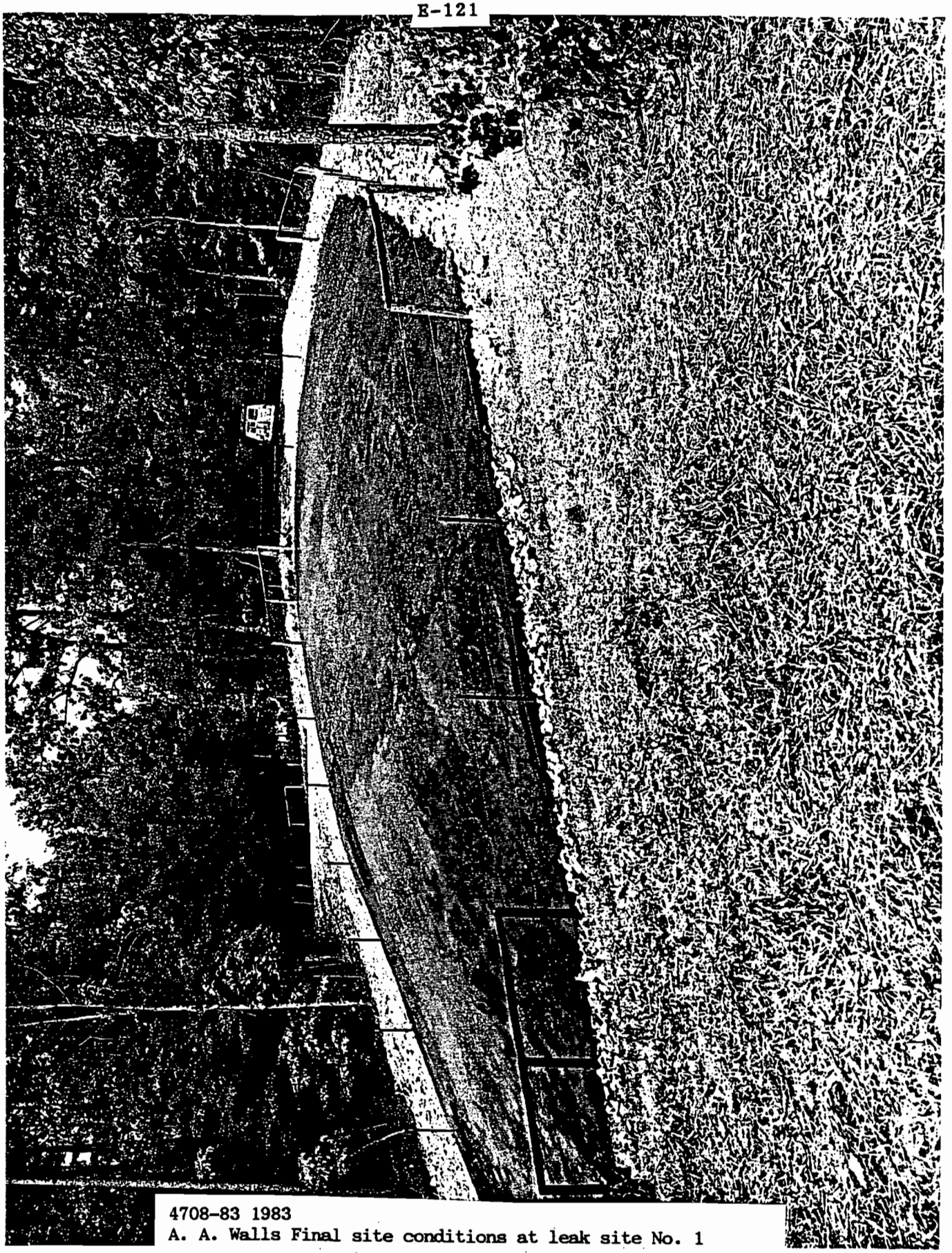


4621-83 1983
A. A. Walls Leak site No. 1 prior to decommissioning

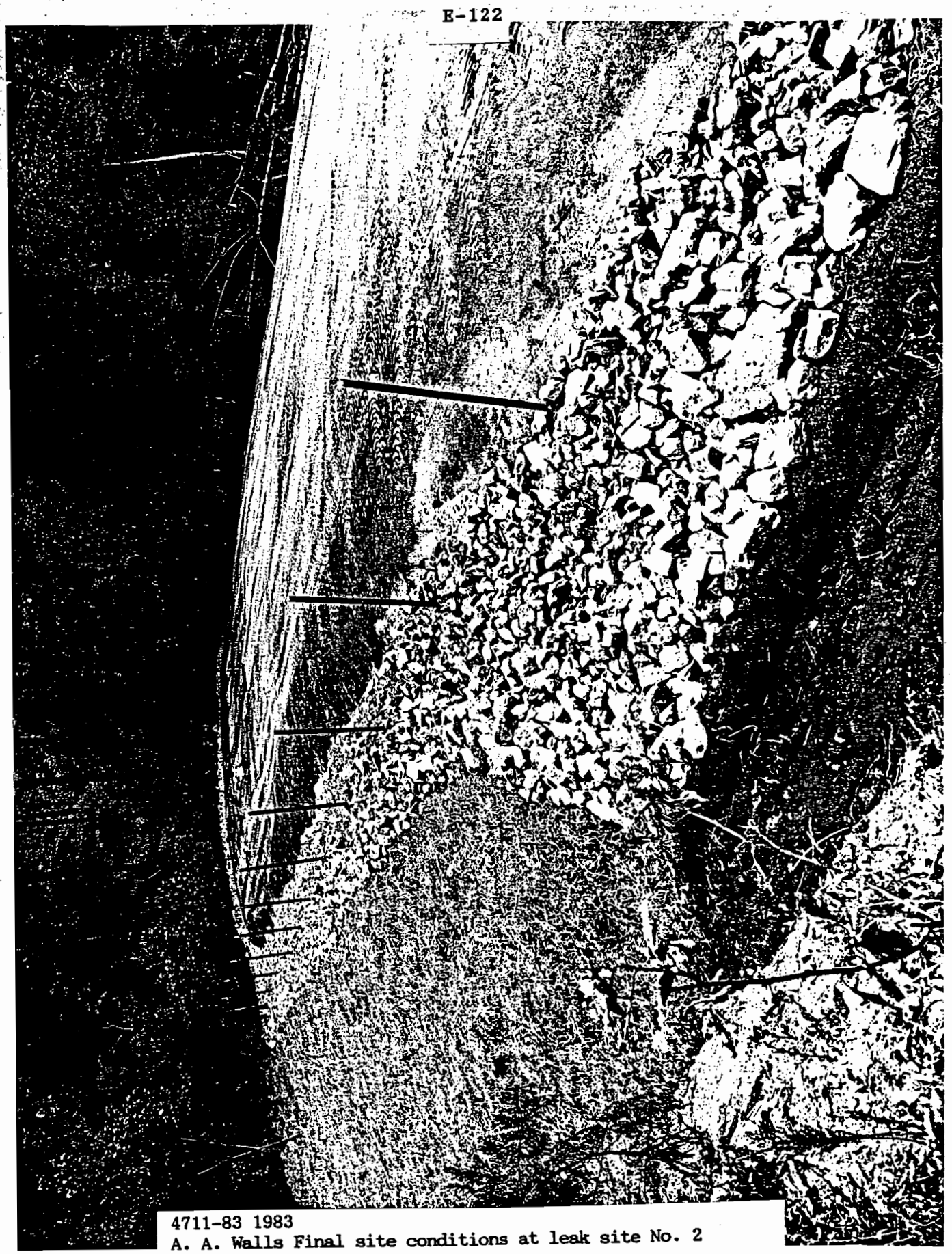
4623-83 1983
A. A. Walls Capping of ILW line at the leak sites



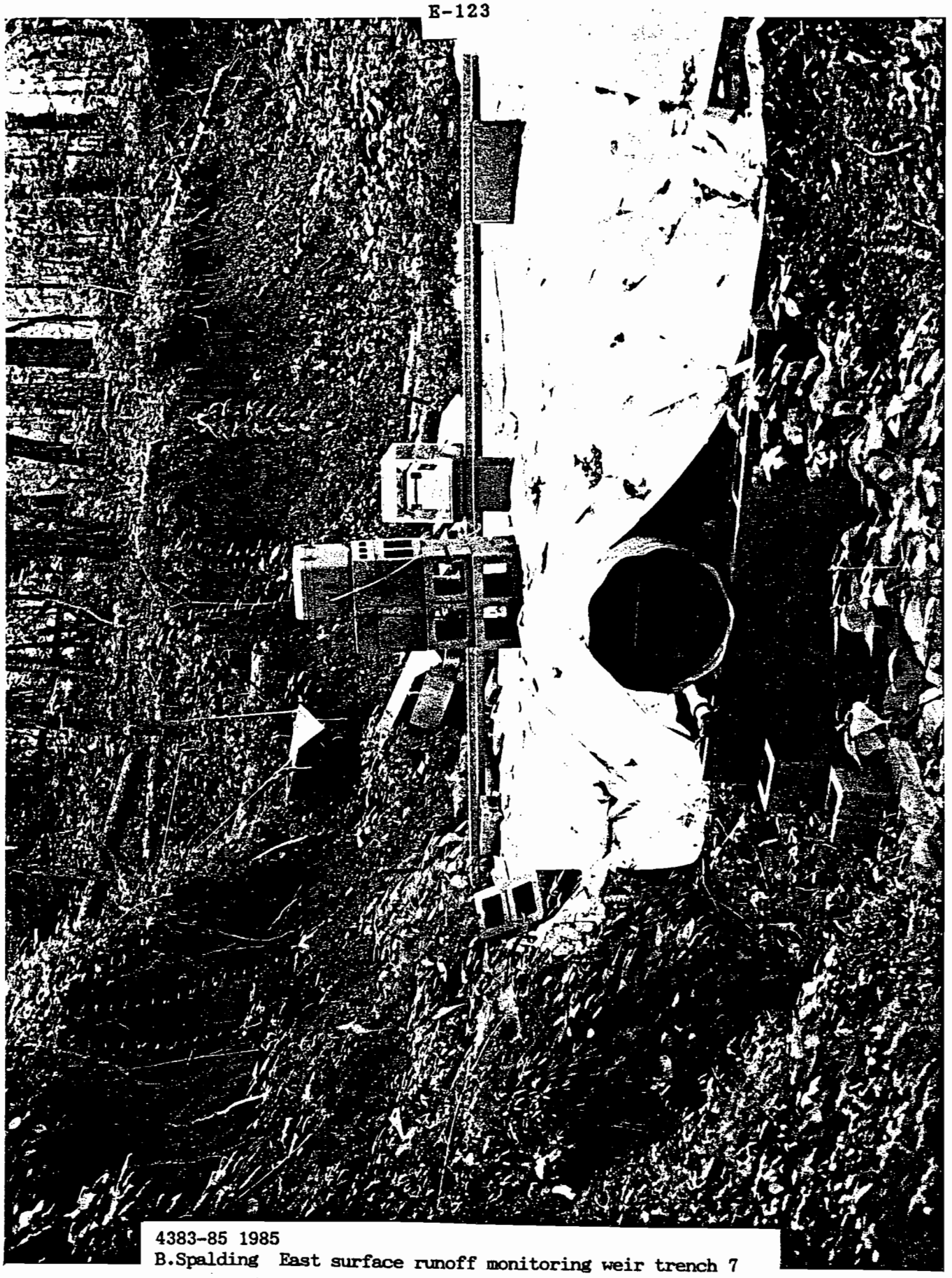
4625-83 1983
A. A. Walls Asphalt cover in place at leak site No. 1



4708-83 1983
A. A. Walls Final site conditions at leak site No. 1

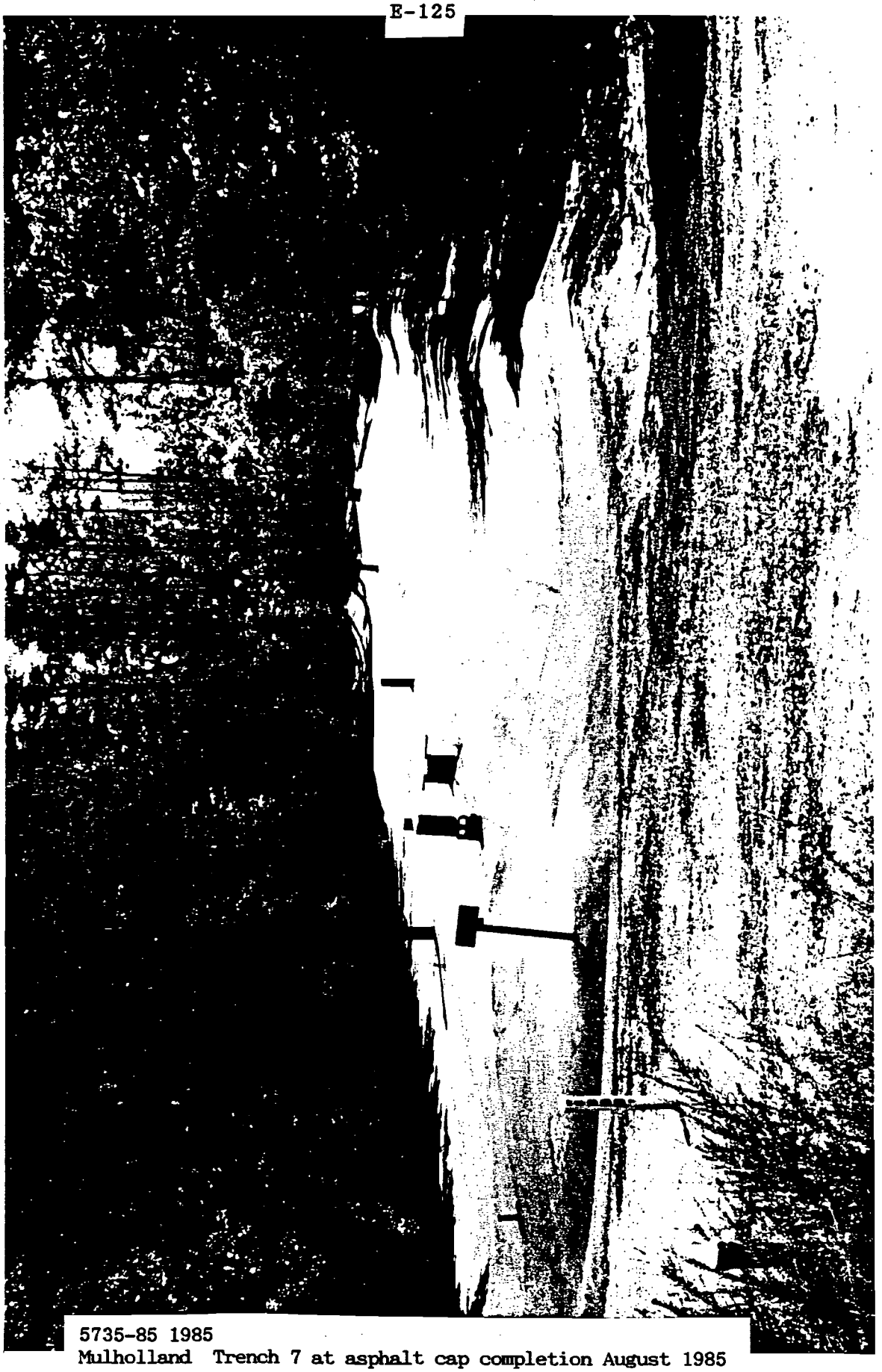


4711-83 1983
A. A. Walls Final site conditions at leak site No. 2

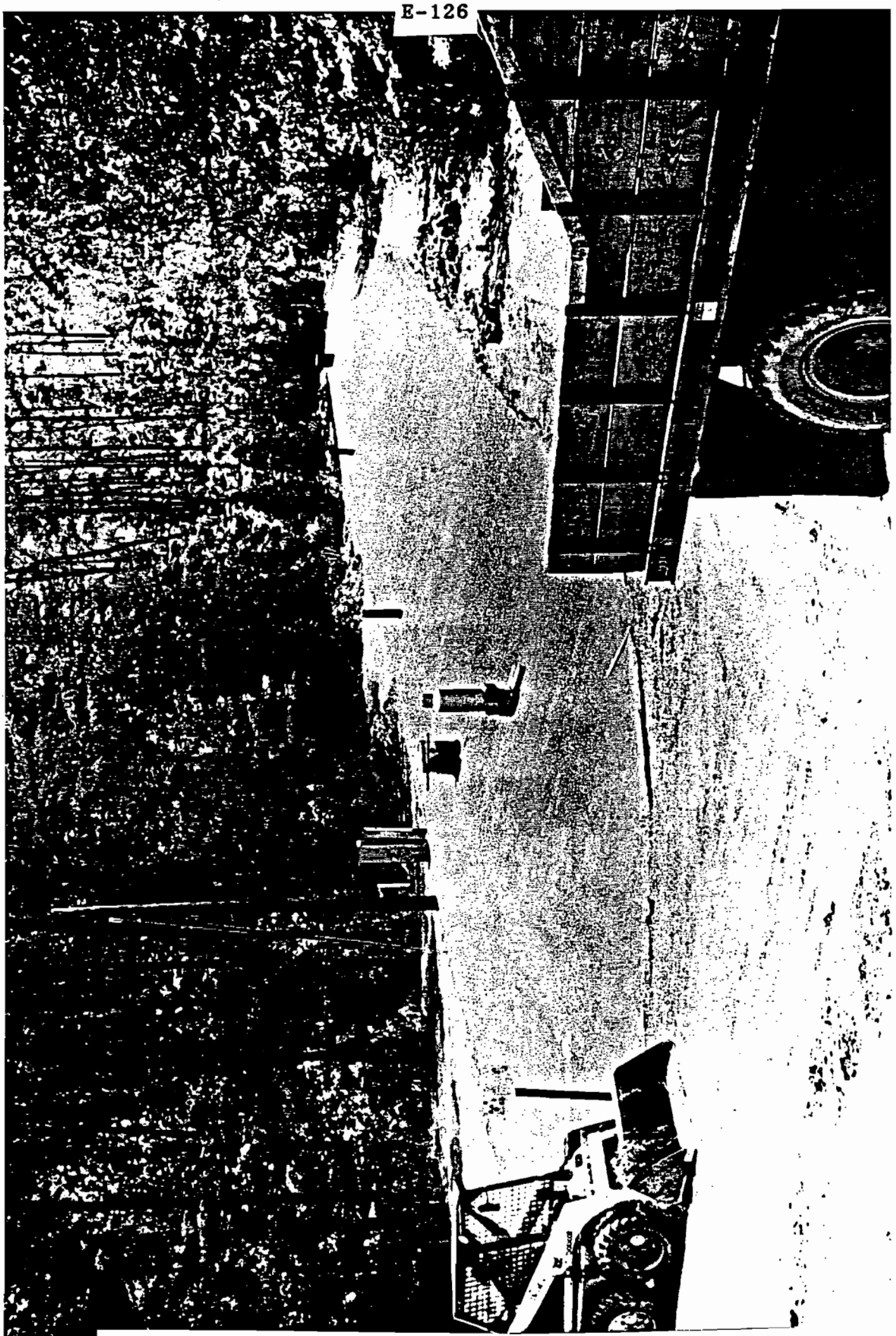


4383-85 1985
B.Spalding East surface runoff monitoring weir trench 7

5733-85 1985
Mulholland Trench 7 during recontouring cap July 1985



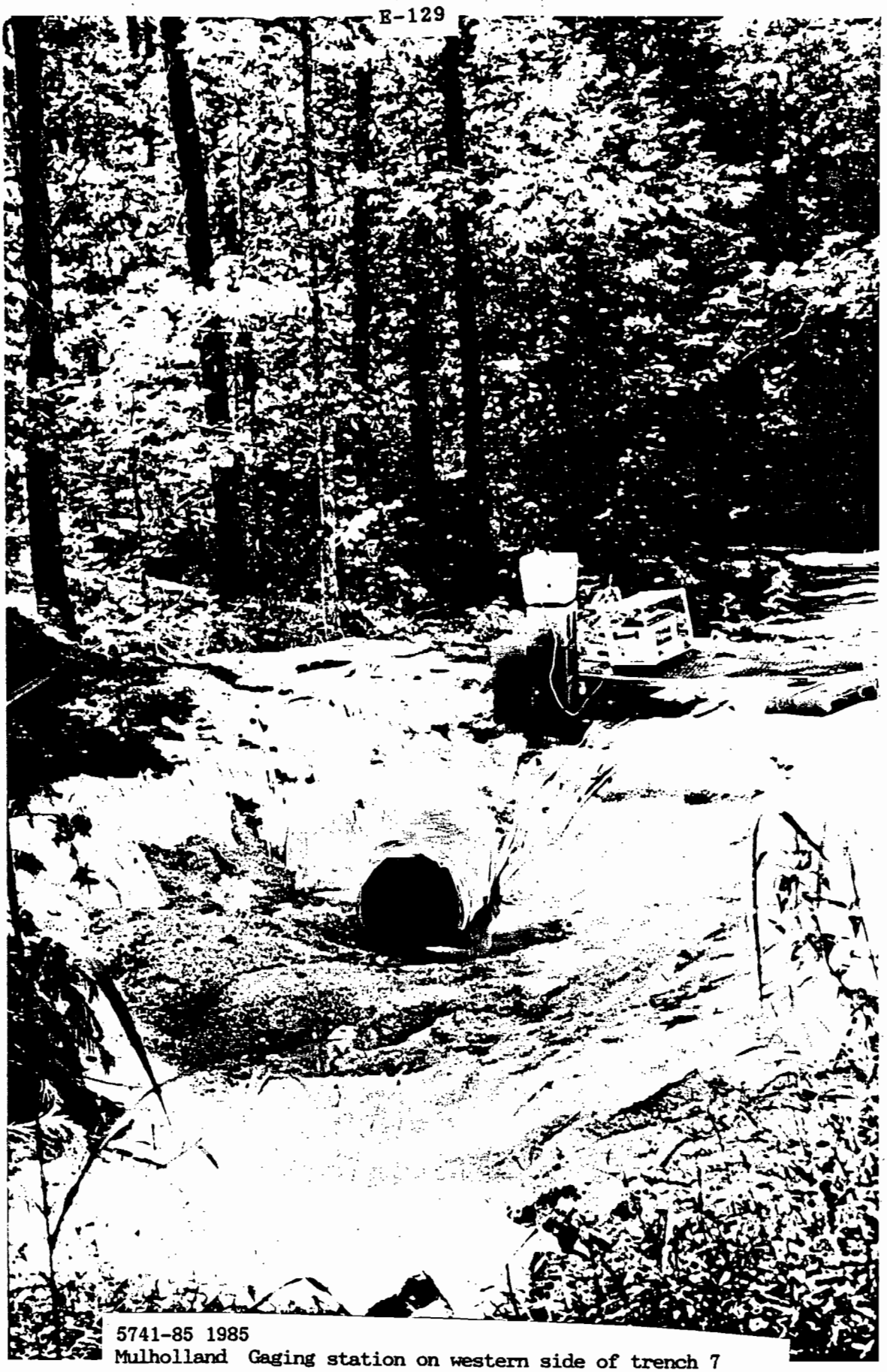
5735-85 1985
Mulholland Trench 7 at asphalt cap completion August 1985



5738-85 1985
Mulholland Vegetation removal and grading at trench 7 7/85

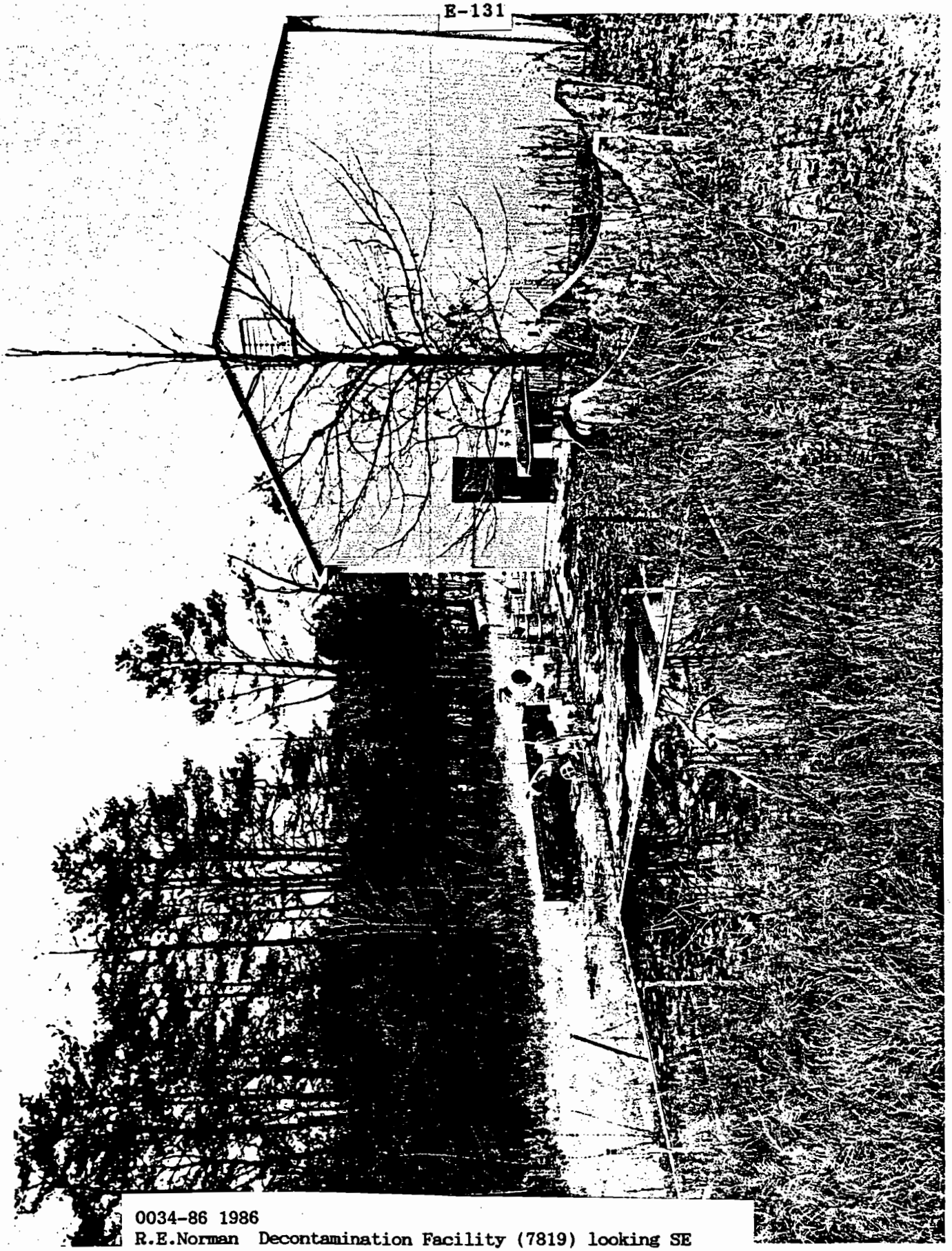
5739-85 1985
Mulholland Runoff collection drain in trench 7 cap 8/85

5740-85 1985
Mulholland Gaging station on eastern side of trench 7

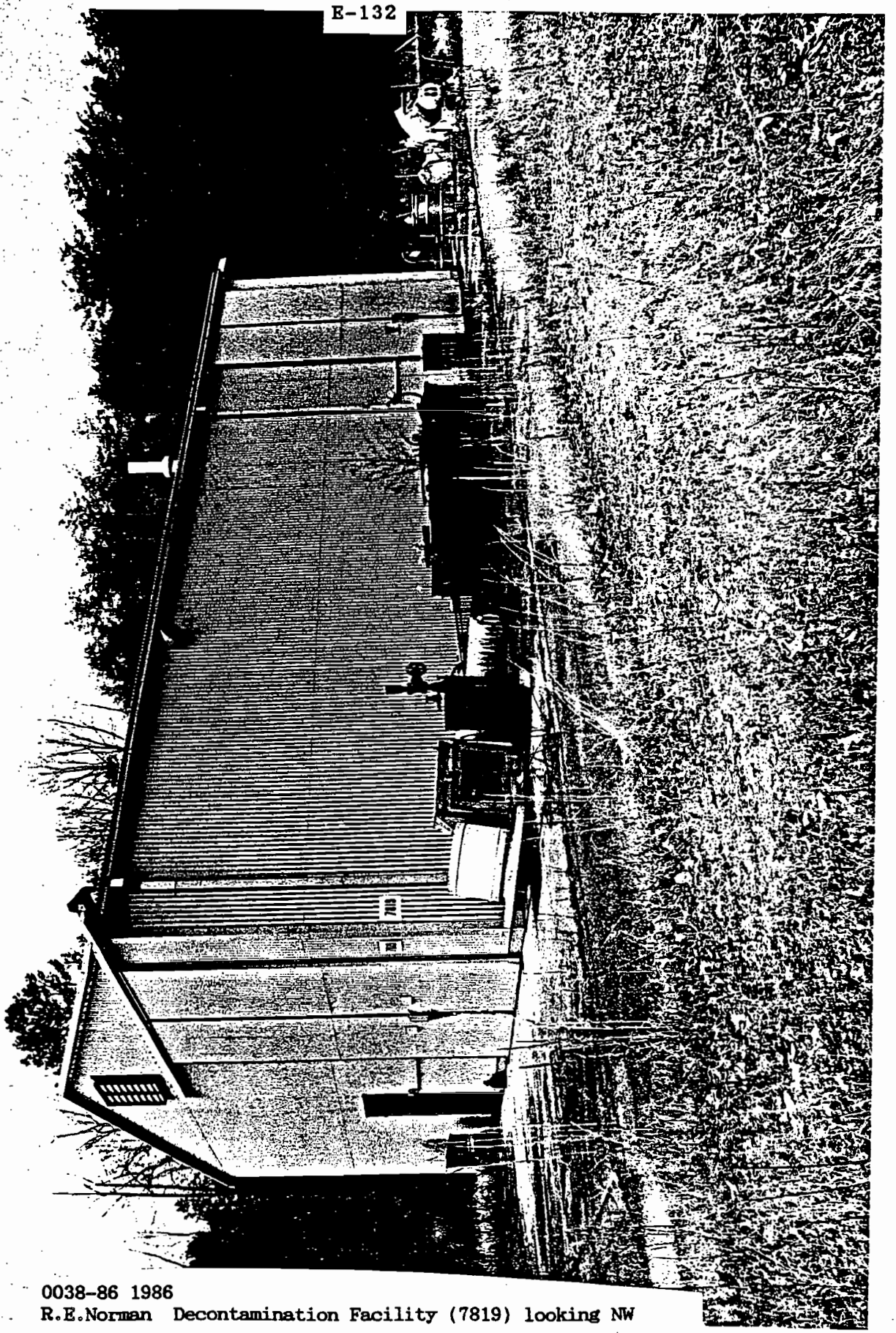


5741-85 1985
Mulholland Gaging station on western side of trench 7

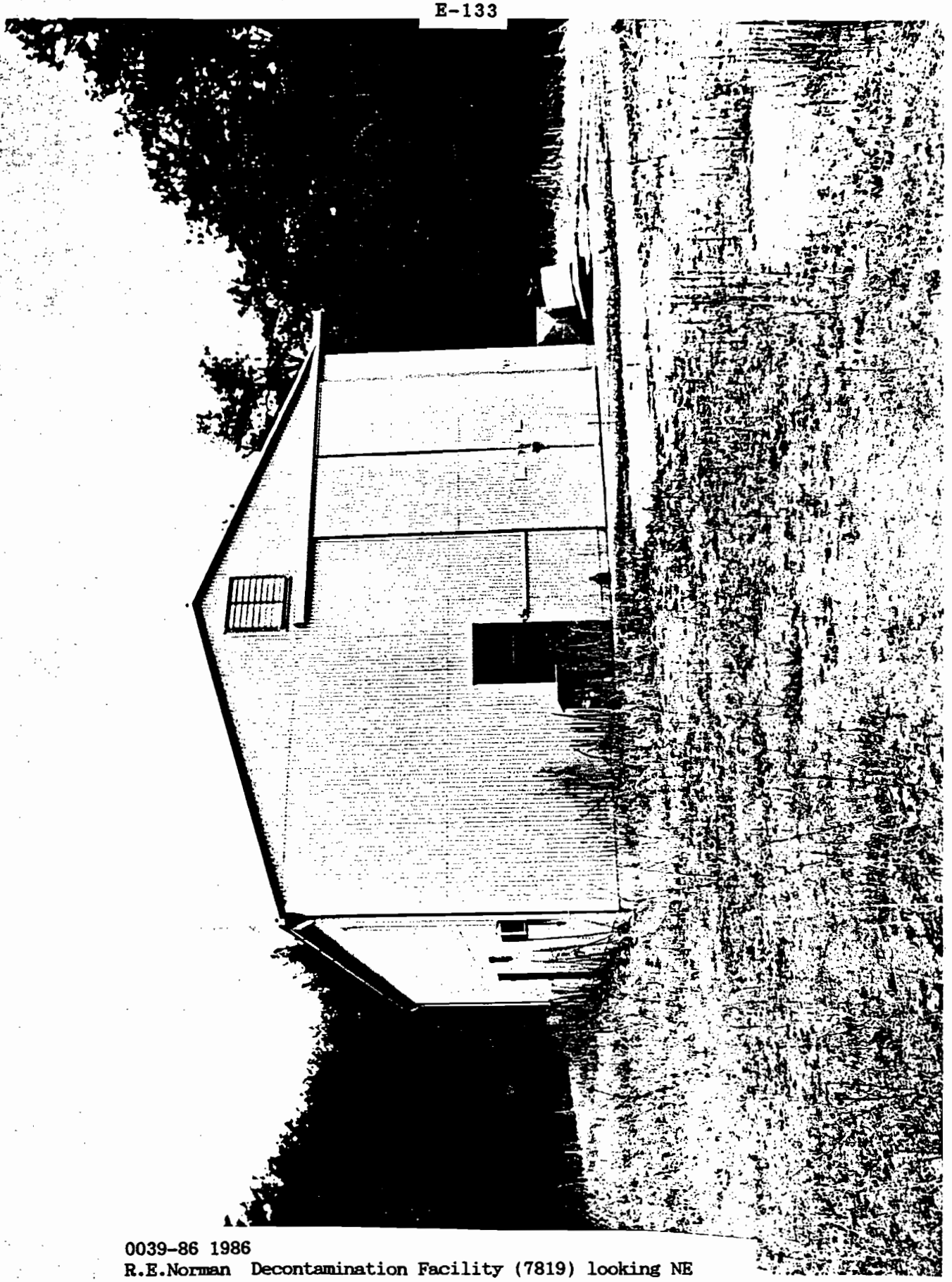
5743-85 1985
Mulholland Outlet of trench 7 cap drain to west 8/85



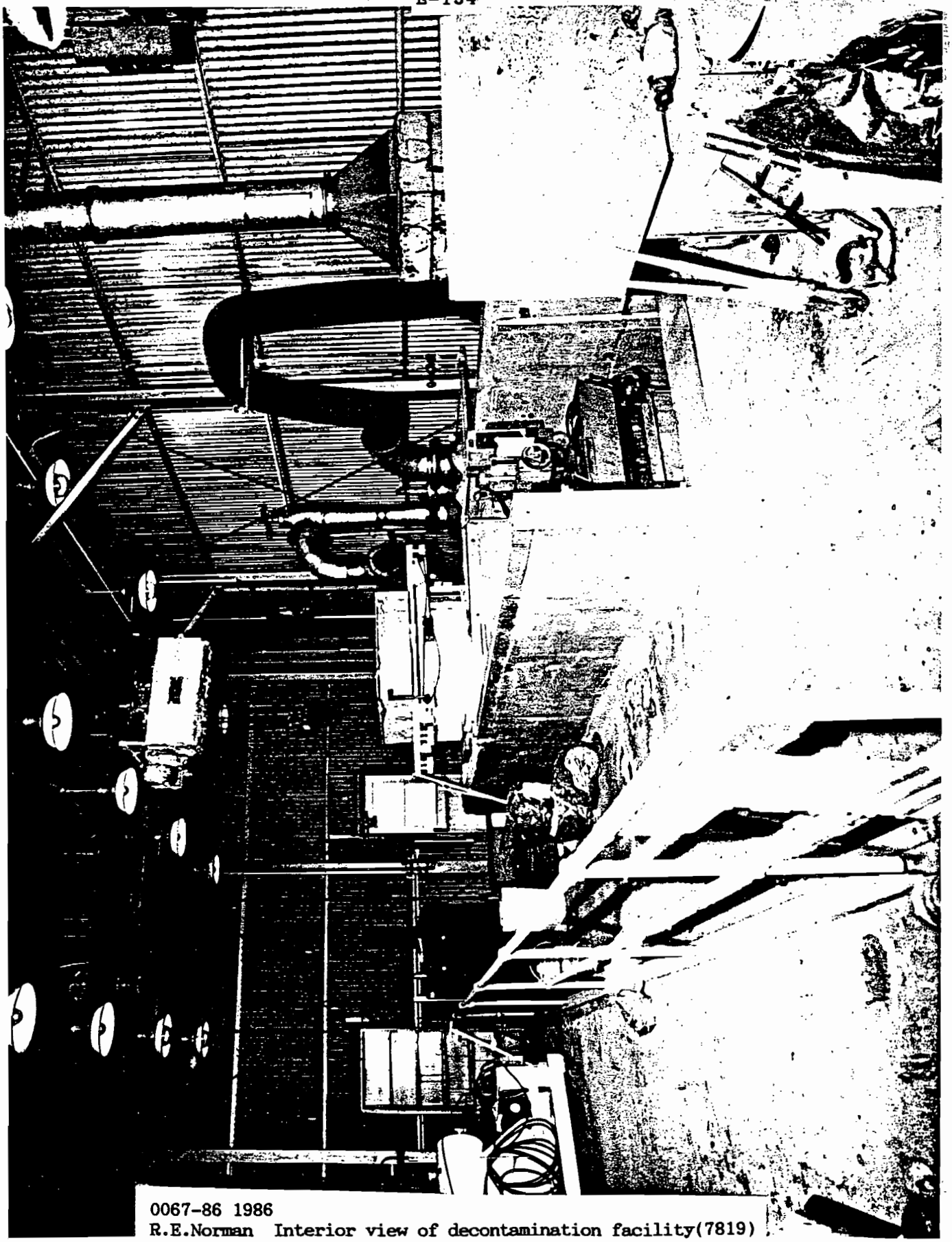
0034-86 1986
R.E.Norman Decontamination Facility (7819) looking SE



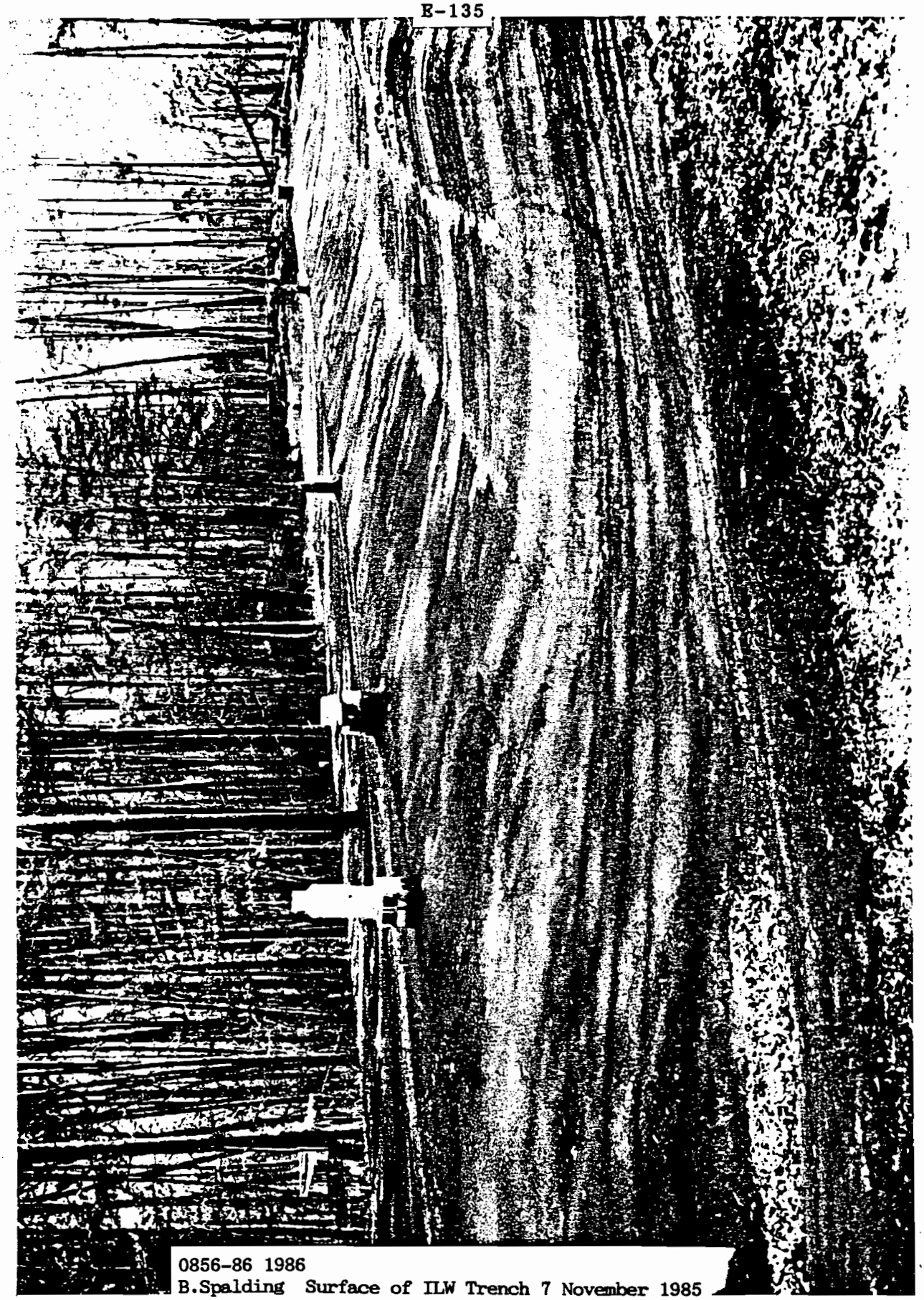
0038-86 1986
R.E.Norman Decontamination Facility (7819) looking NW



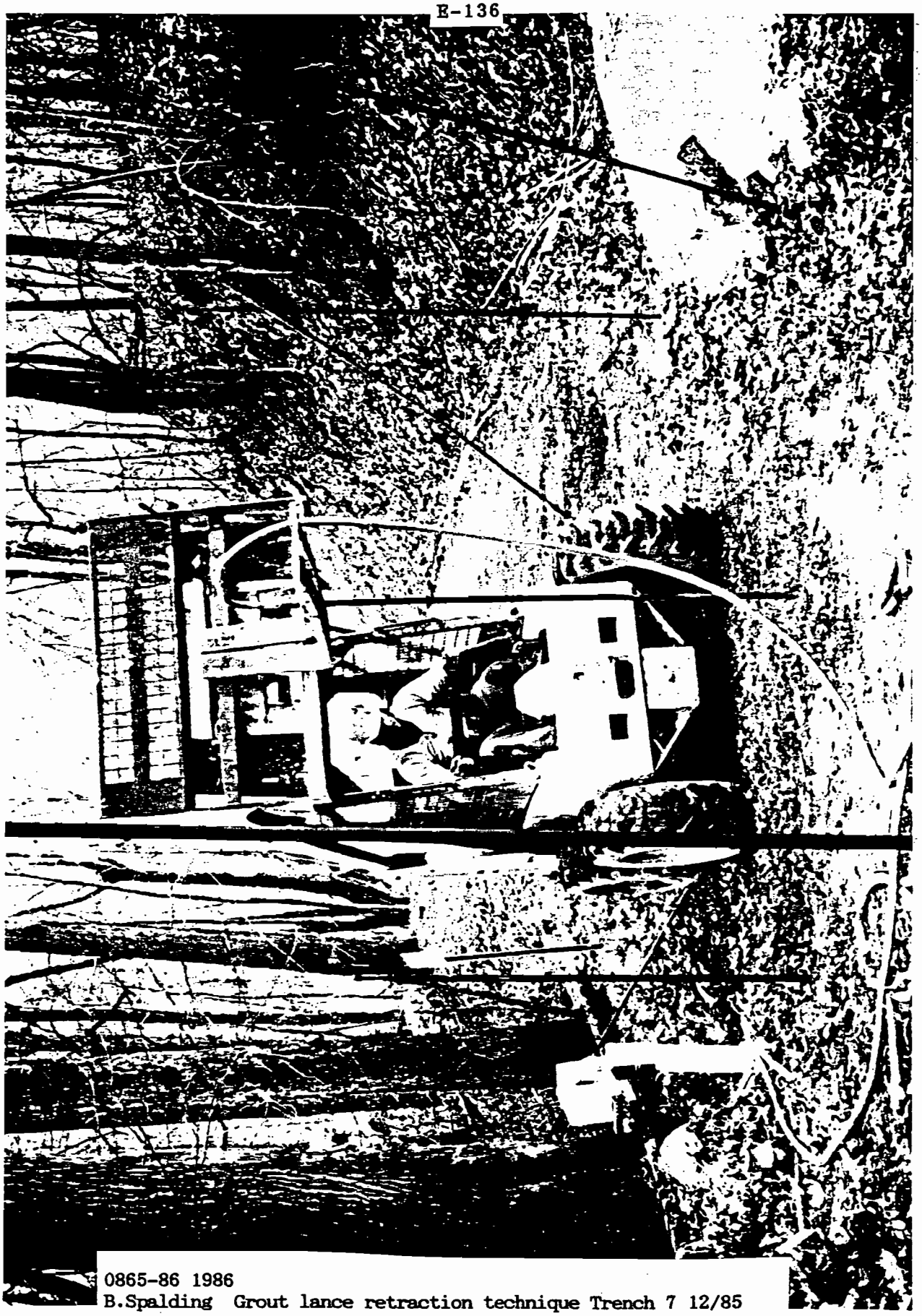
0039-86 1986
R.E.Norman Decontamination Facility (7819) looking NE



0067-86 1986
R.E.Norman Interior view of decontamination facility(7819)

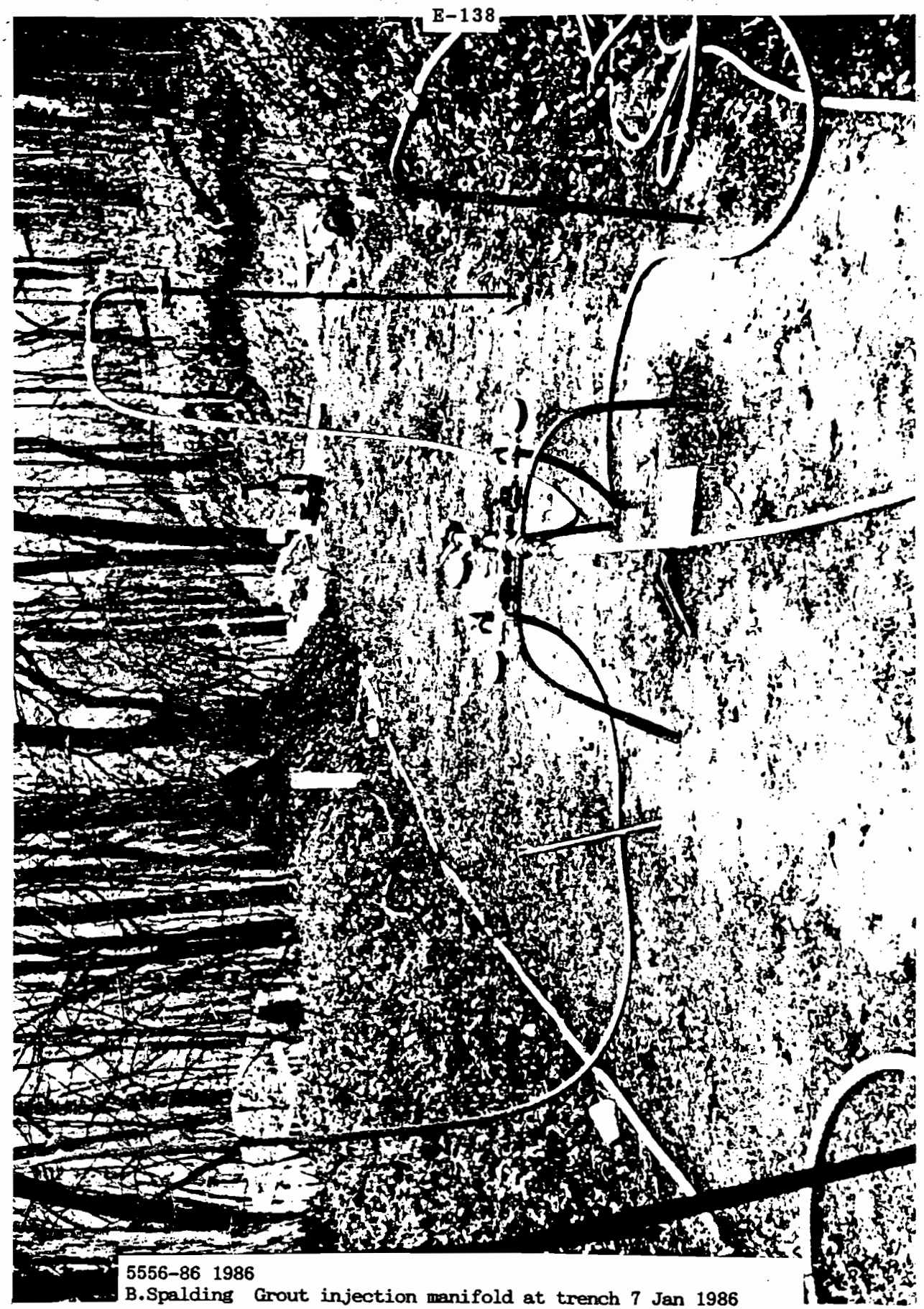


0856-86 1986
B.Spalding Surface of ILW Trench 7 November 1985

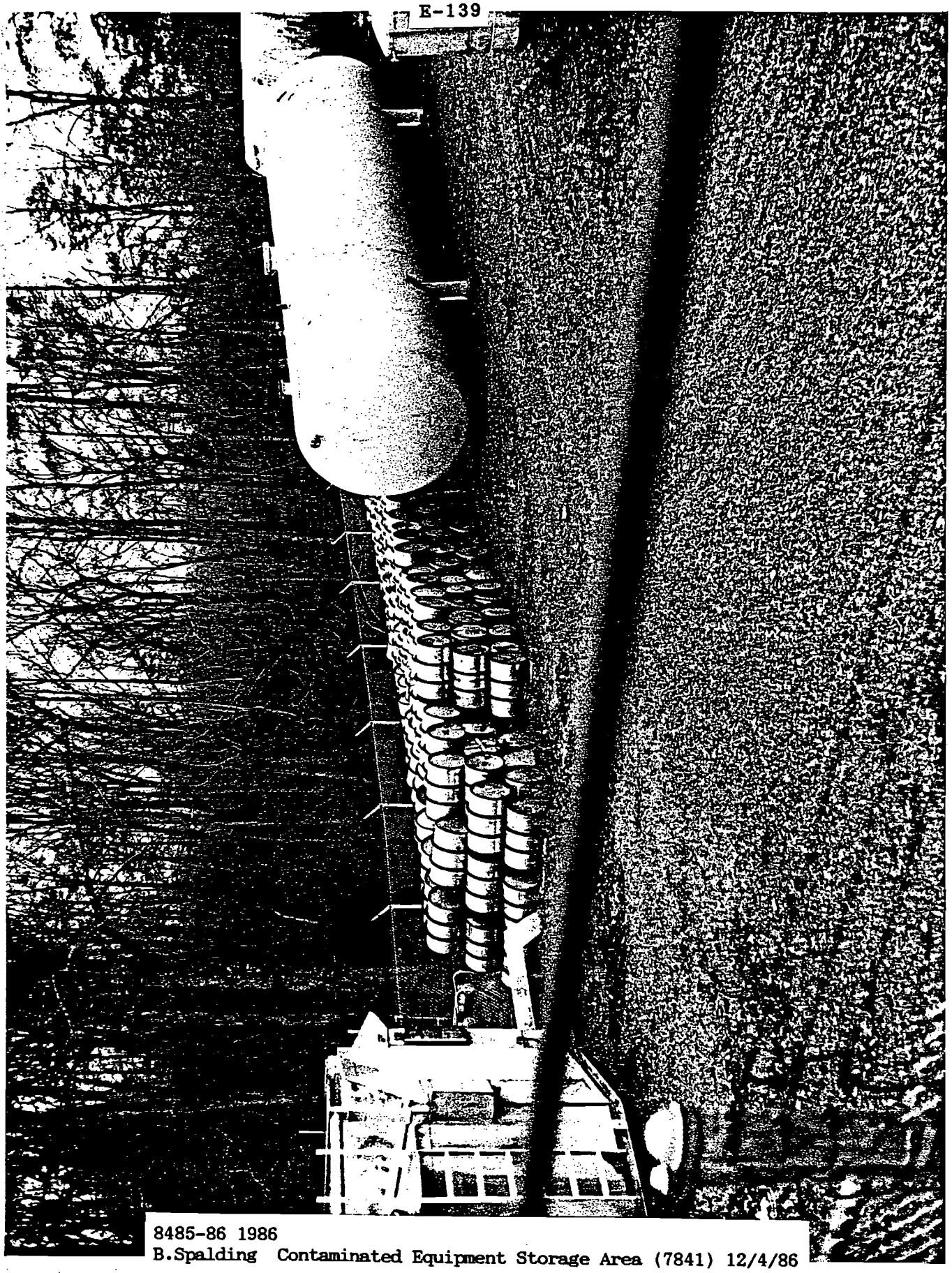


0865-86 1986
B.Spalding Grout lance retraction technique Trench 7 12/85

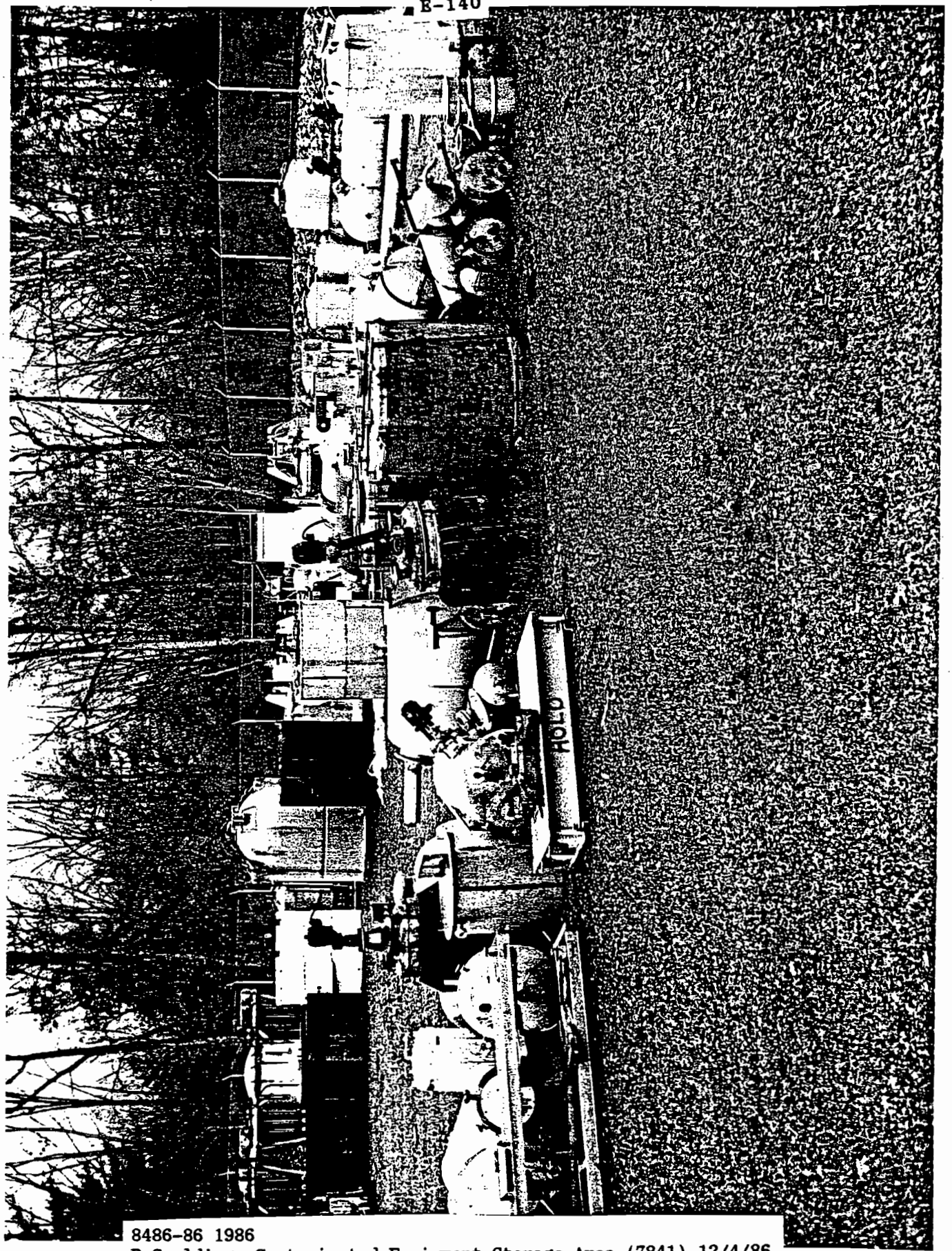
2083-86 1986
Williams Areal view of pits 2,3,4, and 5 March 1986



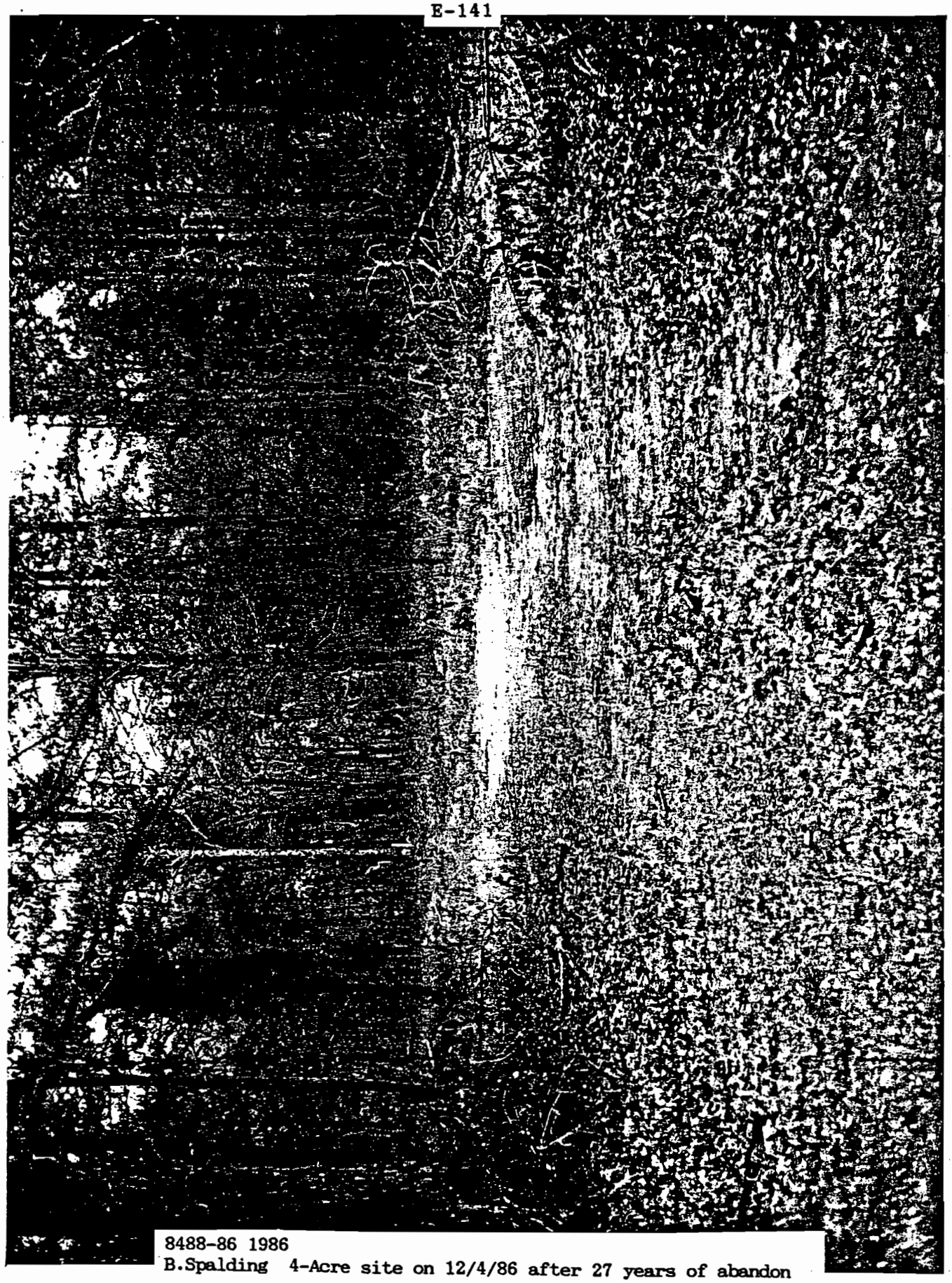
5556-86 1986
B.Spalding Grout injection manifold at trench 7 Jan 1986



8485-86 1986
B.Spalding Contaminated Equipment Storage Area (7841) 12/4/86



8486-86 1986
B.Spalding Contaminated Equipment Storage Area (7841) 12/4/86



8488-86 1986
B.Spalding 4-Acre site on 12/4/86 after 27 years of abandon

Appendix F

Monthly Radioactive Discharges form the Pits and Trenches Area
(E=east weir and W=west weir, units are Ci)

WEIR=E

Year	Month	^{90}Sr	^{106}Ru	^{137}Cs	^{60}Co	Total
1961	7	.	.	.	.	360.00
1961	9	.	.	.	.	408.00
1961	10	0.0003	562.0	0.0300	.	564.00
1961	11	0.0005	264.0	0.0300	.	265.00
1961	12	0.0010	303.0	0.0700	.	305.00
1962	1	0.0010	489.0	0.0300	.	490.00
1962	2	0.0007	363.0	0.0500	.	365.00
1962	3	0.0004	231.0	0.0300	.	233.00
1962	4	0.0004	246.0	0.0800	.	248.00
1962	5	0.0008	341.0	0.0400	.	347.00
1962	6	0.0004	198.0	<0.0500	.	201.00
1962	7	0.0005	294.0	0.0070	.	299.00
1962	8	0.0003	226.0	0.0000	.	230.00
1962	9	0.0004	139.0	0.0000	.	142.00
1962	10	0.0004	109.0	0.0000	.	111.00
1962	11	0.0010	102.0	0.0000	.	104.00
1962	12	0.0009	144.0	0.0000	.	145.00
1963	1	0.0012	147.0	<0.0030	.	150.00
1963	2	0.0020	68.0	0.0000	.	69.00
1963	3	0.0007	79.0	0.0000	.	81.00
1963	4	0.0010	88.0	0.0030	.	88.00
1963	5	0.0003	52.0	<0.0020	.	53.00
1963	6	0.0003	49.0	<0.0020	.	50.00
1963	7	0.0004	38.0	<0.0030	.	39.00
1963	8	0.0003	33.0	<0.0001	.	33.90
1963	9	0.0003	28.0	<0.0010	.	28.80
1963	10	0.0003	39.0	<0.0010	.	41.00
1963	11	0.0004	24.0	0.0000	.	26.00
1963	12	0.0003	33.0	<0.0200	.	34.00
1964	1	0.0009	21.0	<0.0050	.	22.00
1964	2	<0.0010	16.0	<0.0030	.	17.40
1964	3	<0.0010	20.0	<0.0100	.	21.00
1964	4	0.0010	20.0	0.0050	.	20.00
1964	5	0.0002	18.0	<0.0020	.	19.00
1964	6	<0.0001	14.0	<0.0010	.	15.00
1964	7	<0.0010	15.0	<0.0100	.	16.00
1964	8	<0.0010	12.0	<0.0100	.	12.00
1964	9	<0.0010	10.8	<0.0010	.	11.40
1964	10	<0.0100	35.0	<0.0100	.	37.00
1964	11	0.0010	20.0	0.0000	.	22.00
1964	12	<0.0010	8.0	0.0000	.	9.00
1965	1	<0.0100	11.3	0.0000	.	13.22
1965	2	<0.0100	7.5	0.0000	.	8.29
1965	3	<0.0100	9.0	0.0000	.	9.07
1965	4	<0.0100	7.8	<0.0100	.	7.82
1965	5	<0.0100	7.9	<0.0100	.	8.80
1965	6	<0.0100	5.9	0.1900	.	6.87
1965	7	<0.0100	7.1	<0.3300	.	8.36
1965	8	<0.0100	3.9	0.0000	.	4.42
1965	9	<0.0100	5.4	0.3200	.	6.48
1965	10	<0.0100	4.4	0.2400	.	5.44
1965	11	<.0100	4.3	0.2400	.	5.40

Appendix F

Monthly Radioactive Discharges form the Pits and Trenches Area

(E=east weir and W=west weir)

WEIR=E

Year	Month	^{90}Sr	^{106}Ru	^{137}Cs	^{60}Co	Total
1965	12	<0.01	4.1	0.14	.	5.30
1966	1	<0.01	17.4	1.84	.	22.95
1966	2	<0.01	2.7	0.00	0.46	3.22
1966	3	<0.01	3.7	0.15	0.96	4.81
1966	4	<0.01	2.6	0.00	0.86	3.54
1966	5	<0.01	2.2	0.00	0.91	3.12
1966	6	<0.01	1.3	0.05	0.31	1.67
1966	7	<0.01	1.4	0.07	0.41	1.89
1966	8	<0.01	2.9	0.14	0.85	3.90
1966	9	<0.01	2.6	0.09	0.67	3.37
1966	10	<0.01	1.2	0.06	0.47	1.74
1966	11	<0.01	1.3	0.09	0.50	1.90
1966	12	<0.01	1.3	0.11	0.42	1.84
1967	1	<0.01	0.8	0.04	0.43	1.28
1967	2	<0.01	1.3	0.06	0.68	2.05
1967	3	<0.01	0.9	0.05	0.49	1.45
1967	4	<0.01	1.1	0.06	0.52	1.69
1967	5	<0.01	0.9	0.05	0.41	1.37
1967	6	<0.01	0.8	0.06	0.31	1.18
1967	7	<0.01	0.4	0.03	0.24	0.68
1967	8	<0.01	0.4	0.04	0.26	0.71
1967	9	<0.01	0.7	0.04	0.35	1.10
1967	10	<0.01	0.6	0.03	0.33	0.97
1967	11	<0.01	0.4	0.02	0.40	0.83
1967	12	<0.01	0.2	0.02	0.12	0.35
1968	3	<0.01	0.2	0.02	0.18	0.44
1968	4	<0.01	0.1	0.01	0.16	0.35
1968	5	<0.01	0.3	0.03	0.25	0.64
1968	6	<0.01	0.2	0.02	0.24	0.54

WEIR=W

Year	Month	^{90}Sr	^{106}Ru	^{137}Cs	^{60}Co	Total
1961	7	.	.	.	.	63.00
1961	9	.	.	.	.	788.00
1961	10	0.0008	660.0	0.0200	.	660.00
1961	11	0.0004	131.0	0.0200	.	131.00
1961	12	0.0030	390.0	0.1000	.	393.00
1962	1	0.0060	271.0	0.0400	.	272.00
1962	2	0.0030	230.0	0.0900	.	233.00
1962	3	0.0004	121.0	0.0200	.	122.00
1962	4	0.0070	100.0	0.0700	.	100.00
1962	5	0.0450	281.0	0.0100	.	285.00
1962	6	0.0010	171.0	<0.0100	.	172.00
1962	7	0.0020	257.0	0.0200	.	258.00
1962	8	0.0007	181.0	0.0000	.	182.00
1962	9	0.0008	335.0	0.0000	.	342.00
1962	10	0.0020	303.0	0.0000	.	307.00
1962	11	0.0010	88.0	0.0000	.	90.00
1962	12	0.0016	92.0	0.0000	.	93.00

Monthly Radioactive Discharges form the Pits and Trenches Area
(E=east weir and W=west weir)

WEIR=W

Year	Month	^{90}Sr	^{106}Ru	^{137}Cs	^{60}Co	Total
1963	1	0.0017	42.0	<0.0080	.	43.00
1963	2	0.0001	21.0	0.0000	.	21.00
1963	3	0.0014	26.0	0.0000	.	26.00
1963	4	0.0040	38.0	0.0100	.	39.00
1963	5	0.0013	28.0	0.0070	.	28.00
1963	6	0.0003	13.0	<0.0020	.	13.00
1963	7	0.0060	31.0	<0.0110	.	32.00
1963	8	0.0003	13.0	<0.0010	.	13.30
1963	9	0.0001	6.0	<0.0002	.	6.10
1963	10	0.0001	4.0	<0.0010	.	4.00
1963	11	0.0006	17.0	0.0000	.	18.00
1963	12	0.0010	3.0	<0.0020	.	3.00
1964	1	0.0019	2.0	<0.0200	.	2.00
1964	2	0.0200	12.0	<0.0200	.	12.40
1964	3	0.0010	12.0	<0.0300	.	13.00
1964	4	0.0020	8.0	0.0200	.	8.00
1964	5	0.0003	6.0	0.0050	.	6.00
1964	6	<0.0001	5.0	<0.0010	.	5.00
1964	7	<0.0010	17.0	<0.0100	.	18.00
1964	8	<0.0010	18.0	<0.0100	.	18.00
1964	9	<0.0010	2.8	<0.0010	.	3.00
1964	10	<0.0010	7.0	<0.0100	.	7.00
1964	11	0.0010	17.0	0.0000	.	18.00
1964	12	0.0020	6.0	0.0000	.	7.00
1965	1	<0.0100	7.9	0.0000	.	8.94
1965	2	<0.0100	2.6	0.0000	.	2.85
1965	3	<0.0100	6.6	0.0000	.	7.13
1965	4	<0.0100	2.0	<0.0100	.	2.24
1965	5	<0.0100	1.4	<0.0100	.	1.55
1965	6	<0.0100	1.3	0.0100	.	1.50
1965	7	<0.0100	2.4	<0.0100	.	2.70
1965	8	<0.0100	5.0	0.0000	.	5.47
1965	9	<0.0100	3.2	0.1800	.	3.71
1965	10	<0.0100	2.8	0.1100	.	3.18
1965	11	<0.0100	1.6	0.0500	.	1.92
1965	12	<0.0100	1.3	<0.0100	.	1.46
1966	1	<0.0100	0.8	0.0200	.	0.98
1966	2	<0.0100	0.5	<0.0100	0.0800	0.62
1966	3	<0.0100	0.6	0.0200	0.0700	0.71
1966	4	<0.0100	0.2	0.0000	0.0300	0.24
1966	5	<0.0100	1.2	0.0300	0.2100	1.45
1966	6	<0.0100	1.8	0.0600	0.2900	2.16
1966	7	<0.0100	7.2	0.2700	1.3000	8.78
1966	8	<0.0100	4.0	0.1300	0.7600	4.90
1966	9	<0.0100	3.4	0.0300	0.4900	3.93
1966	10	<0.0100	0.4	0.0100	0.1200	0.54
1966	11	<0.0100	0.6	0.0200	0.0500	0.68
1966	12	<0.0100	0.4	0.0100	0.1000	0.52
1967	1	<0.0100	0.2	0.0100	0.0400	0.26
1967	2	<0.0100	0.4	0.0100	0.1600	0.58
1967	3	<0.0100	0.1	<0.0100	0.1300	0.25
1967	4	<0.0100	0.2	<0.0100	0.0400	0.26

Appendix F

Monthly Radioactive Discharges form the Pits and Trenches Area

(E=east weir and W=west weir)

WEIR=W

Year	Month	^{90}Sr	^{106}Ru	^{137}Cs	^{60}Co	Total
1967	5	<0.01	0.2	0.01	0.15	0.37
1967	6	<0.01	0.1	0.01	0.12	0.24
1967	7	<0.01	0.3	0.02	0.10	0.43
1967	8	<0.01	0.2	<0.01	0.12	0.34
1967	9	<0.01	0.2	<0.01	0.03	0.25
1967	10	<0.01	0.1	<0.01	0.05	0.17
1967	11	<0.01	0.2	0.02	0.13	0.36
1967	12	<0.01	0.2	<0.01	0.05	0.27
1968	3	<0.01	0.0	<0.01	0.03	0.09
1968	4	<0.01	0.1	<0.01	0.04	0.19
1968	5	<0.01	0.1	<0.01	0.05	0.16
1968	6	<0.01	0.1	0.01	0.10	0.29

. indicates that no analysis was reported.

Appendix F

Monthly Radioactive Discharges form the Pits and Trenches Area

(E=east weir and W=west weir, units are mCi)

WEIR=E

Year	Month	^{90}Sr
1980	2	1.40
1980	3	0.40
1980	4	0.10
1980	5	0.40
1980	6	0.10
1980	7	<0.10
1980	8	<0.10
1980	9	<0.10
1980	10	<0.10
1980	11	<0.10
1980	12	0.10
1981	1	3.60
1981	2	7.00
1981	3	<0.10
1981	4	0.30
1981	5	<0.10
1981	6	<0.10
1981	7	<0.10
1981	8	0.10
1981	9	0.10
1981	10	0.10
1981	11	0.10
1981	12	0.10
1982	1	0.10
1982	2	0.10
1982	3	0.10
1982	4	0.10
1982	5	0.10
1982	6	0.10
1982	7	0.10
1982	8	0.10
1982	9	0.10
1982	10	0.10
1982	11	0.10
1982	12	0.10
1983	1	0.10
1983	2	0.10
1983	3	0.10
1983	4	0.10
1983	5	0.10
1983	6	0.10
1983	7	0.10
1983	8	0.00
1983	9	0.00
1983	10	0.10
1983	11	0.10
1983	12	<0.01
1984	1	<0.10
1984	2	0.10
1984	3	<0.01
1984	4	<0.01
1984	5	0.20

Appendix F

Monthly Radioactive Discharges form the Pits and Trenches Area
(E=east weir and W=west weir)

WEIR=E

Year	Month	^{90}Sr
1984	6	<0.10
1984	7	<0.30
1984	8	0.10
1984	9	0.10
1984	10	0.07
1984	11	0.20
1984	12	0.40
1985	1	<0.10
1985	2	0.02
1985	3	0.03
1985	4	0.12
1985	5	0.01
1985	6	<0.01
1985	7	.
1985	8	<0.08
1985	9	0.69
1985	10	<0.01
1985	11	<0.01
1985	12	0.03
1986	1	0.07
1986	2	5.72
1986	3	0.05
1986	4	0.04
1986	5	0.02
1986	6	0.22

WEIR=W

Year	Month	^{90}Sr
1980	2	37.20
1980	3	8.70
1980	4	4.80
1980	5	6.80
1980	6	0.90
1980	7	<0.10
1980	8	<0.10
1980	9	<0.01
1980	10	<0.01
1980	11	<0.10
1980	12	0.70
1981	1	0.50
1981	2	0.40
1981	3	3.00
1981	4	2.30
1981	5	0.90
1981	6	0.80
1981	7	1.30
1981	8	0.60
1981	9	0.60

Monthly Radioactive Discharges form the Pits and Trenches Area
(E=east weir and W=west weir)

WEIR=W

Year	Month	^{90}Sr	
1981	10	0.40	
1981	11	0.40	
1981	12	0.50	
1982	1	5.80	
1982	2	5.30	
1982	3	7.20	
1982	4	2.40	
1982	5	1.00	
1982	6	2.20	
1982	7	2.70	
1982	8	2.20	
1982	9	1.50	
1982	10	1.30	
1982	11	3.20	
1982	12	2.50	
1983	1	1.30	
1983	2	2.70	
1983	3	1.50	
1983	4	9.60	
1983	5	6.40	
1983	6	0.10	
1983	7	0.10	
1983	8	0.00	(no flow)
1983	9	0.00	(no flow)
1983	10	0.20	
1983	11	0.20	
1983	12	<0.01	
1984	1	3.60	
1984	2	4.40	
1984	3	5.90	
1984	4	2.90	
1984	5	10.40	
1984	6	6.40	
1984	7	1.20	
1984	8	0.50	
1984	9	1.50	
1984	10	2.90	
1984	11	6.90	
1984	12	11.00	
1985	1	4.30	
1985	2	2.30	
1985	3	0.82	
1985	4	0.79	
1985	5	0.95	
1985	6	0.73	
1985	7	.	
1985	8	3.50	
1985	9	1.30	
1985	10	2.10	
1985	11	1.50	
1985	12	6.90	
1986	1	2.03	

Appendix F

Monthly Radioactive Discharges form the Pits and Trenches Area

(E=east weir and W=west weir)

WEIR=W

Year	Month	^{90}Sr
1986	2	8.80
1986	3	1.30
1986	4	1.95
1986	5	0.90
1986	6	0.32
1986	7	0.32

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