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Oak Ridge Low-Level Waste Disposal Facility Designs

S. D. Van Hoesen, L. S. Jones
Martin Marietta Energy Systems, Inc. Engineering and Central Waste Management Division

The strategic planning process that culminates in the identification, selection, construction, and ultimate operation of treatment, storage, and disposal facilities for all types of low-level waste (LLW) generated on the Oak Ridge Reservation (ORR) was conducted under the Low-Level Waste Disposal Development and Demonstration (LLWDDD) Program. This program considered management of various concentrations of short half-life radionuclides generated principally at Oak Ridge National Laboratory (ORNL) and long half-life radionuclides (principally uranium) generated at the Y-12 Plant and the Oak Ridge K-25 Plant.

The LLWDDD Program is still ongoing and involves four phases: (1) alternative identification and evaluation, (2) technology demonstration, (3) limited operational implementation, and (4) full operational implementation.

Alternative Identification and Evaluation

The alternatives evaluation phase consisted of the identification of the range of technical alternatives to be considered, identification of evaluation criteria for ranking the alternatives, and the actual evaluation and ranking of the alternatives. The technical alternatives considered were narrowed down to seven using broad screening criteria. These criteria considered the technical feasibility of actual implementation (e.g., do the hydrology and geology of the site allow implementation) and the appropriateness of the technology to the types of LLW to be managed. The seven alternatives considered were (1) landfill, (2) shallow land burial, (3) earth covered tumuli, (4) above-grade concrete structures, (5) deep trenches, (6) augured shafts, and (7) below-grade concrete structures.

Criteria used for evaluating the alternatives considered the ability of each technology to meet the fundamental facility performance objectives, the anticipated performance of the technology, the acceptability of the technology to the regulators and the public, and the anticipated cost. Facility performance objectives were based on the requirements of Department of Energy (DOE) Order 5820.2A "Radioactive Waste Management" which defines dose limits to the public and the intruder from LLW disposal facilities. In addition, State of Tennessee groundwater protection standards were

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also considered. In evaluating the anticipated performance of the technologies, the operating record of each technology at other facilities was reviewed and, to the extent practical, extrapolated to the ORR. Maintenance and monitoring requirements, complexity of operation,and actual performance history were reviewed. Regulatory and public acceptability were gauged based on discussions with state and federal regulators, reviews of technology selection processes underway in the state compacts and in foreign countries, and comments received during the public scoping meeting for the project Environmental Impact Statement. Finally, general construction, operation, and maintenance cost information were considered where available.

The analysis resulted in the development of a strategy for the management of four classes of waste. Each waste class reflects a combination of performance derived waste concentration limits and management technology. The four classes of waste are described in the following sections.

Class L-I waste contains low levels of uranium contamination which will be disposed in a state-of-the-art, lined industrial landfill. Class L-I waste is primarily generated at the Y-12 and K-25 Site plants.

Class L-II waste contains primarily short-half life (<30 year half-life) fission product containing waste and will be disposed utilizing the above-grade tumulus disposal concept. Class L-II waste is primarily generated at the ORNL.

Class L-III waste contains concentrations of radionuclides which would require intruder protected disposal. This type of waste is generated at all three Oak Ridge plants and is planned to be stored for the foreseeable future.

Class L-IV waste contains concentrations of radionuclides which are not acceptable for disposal on the ORR. This waste class will be stored until treatment processes are implemented which will produce lower class waste which can be disposed on the ORR and a highly concentrated, low volume stream of waste which will require long-term storage and/or shipment off-site for disposal.

TECHNOLOGY DEMONSTRATION

Class L-I Disposal Technology Description

The Class L-I technology is based on state-of-the-art lined landfill design. At this point in time no demonstrations of this technology are planned or underway. A line item project, the Class L-I Disposal Facility (CIDF), is currently being developed by DOE.

As indicated in Figures 1 and 2 the CIDF disposal technology will employ a low-permeability earth liner overlain by a geogrid, membrane liner, leachate collection system, and stone operating floor. As shown in Figure 3 the CIDF disposal unit will consist of a 210-ft by 630-ft by 30-ft deep below-grade trench. Waste will be placed directly in the trench by transport vehicles then compacted in place and covered with soil. Several "lifts" of waste will be placed to complete loading of approximately 1.6 million ft3 of waste before a low-permeability cover is placed over the unit.

Several facilities are planned to be constructed to support the CIDF operation including a disposal operations control center, a waste staging area, a waste verification station, a vehicle monitoring and decontamination station and a heavy equipment storage building.

The estimated cost of the CIDF, including the support facilities, all site grading for 15 disposal units, and the first two disposal units is $90 million.

Class L-II Disposal Technology Description

Figure 4 provides a schematic of the tumulus disposal technology.

The concrete vaults provide enhanced confinement and structural stability for the waste. The concrete pad provides a "cut-off" for communication with groundwater, thus making this disposal approach suitable for areas with shallow depths to groundwater. The proposed disposal configuration also provides capabilities to monitor all water flows that may come in contact with the waste and facilitates recovery should disposal unit performance not be acceptable.

The Solid Waste Storage Area (SWSA) 6 Tumulus Disposal Demonstration was conducted to develop experience and information to help in evaluating the suitability of this technology for the management of solid LLW on the ORR. Information was developed on environmental and health, operational, and construction aspects of the technology.

The Tumulus demonstration unit was constructed with monitoring features which should ultimately allow measurement of the environmental performance of this technology. The curbed pad on which the waste is placed was designed to collect all water which may come in contact with the waste containers. This water drains from the pad to a monitoring station where the flow is measured and samples collected. In addition, a plastic liner was placed under the pad to allow monitoring of any inadvertent leakage and to provide an additional barrier against groundwater contamination. Monitoring features were also included in the cap design to allow evaluation of its performance. Additional information on the Tumulus Disposal Demonstration is provided later in the paper.

Limited Operational Implementation

As a result of the successful implementation of the technology demonstration phase, limited operational implementation of the technology is being undertaken in the form of the Interim Waste Management Facility (IWMF). Implementation is considered "limited" for several reasons: (1) the IWMF is located in SWSA 6 (the current LLW disposal site at ORNL) and did not require a new site selection process, (2) the space available in SWSA 6 limits the size and the operational life of the IWMF to approximately 5 to 6 years, (3) waste acceptance criteria and characterization programs that will be developed for the new facilities are not yet in place. Within that context, construction is currently being finalized and operation is scheduled to begin in late 1991 or early 1992.

Full Operational Implementation

Full operational implementation will occur in the form of the new Class L-II Disposal Facility (CIIDF) currently planned for SWSA 7 at ORNL, contingent upon completion of the Environmental Impact Statement. As currently planned, facility construction will begin in 1994, and it will provide approximately 20 years of disposal capacity, beginning in 1997.

TUMULUS OPERATING EXPERIENCE AND LESSONS LEARNED

Tumulus disposal technology has been successfully utilized at ORNL for almost four years, and to date approximately 50,000 ft^3 of solid LLW have been disposed of via the Tumulus. The following sections summarize the important "lessons learned" from tumulus operations to date.

Pad Configuration

The size of disposal pads have been reduced from 65-ft by 110-ft on Tumulus I to 60-ft by 90-ft in Tumulus II and IWMF. The pads were reduced in size to eliminate the construction difficulties associated with the integral pour approach which was utilized. The 30-mil plastic liner utilized on Tumulus I was eliminated on later units due to construction difficulties and significant in-leakage of groundwater from the underpad gravel system. The pad thickness was increased to 15-in. for Tumulus II and IWMF to accommodate a three high waste vault stack.

Drain Line Gallery

Difficulties were encountered in both Tumulus I and II with leakage of the below-grade drain piping. A concrete utility tunnel system has been adapted for use as a drain line gallery for the IWMF to provide access to the drain lines for inspection and monitoring. The gallery entrance will be extended to the earthen cover surface to provide access after closure.

Disposal Vaults

The handling mechanisms for the disposal vaults were changed form forklift slots on the Tumulus I vaults to cable lift rings for the Tumulus II. Significant difficulties were encountered with the forklift movements during loading of Tumulus I which resulted in damage to the vault edges and increased vault loading times. No difficulties have been encountered with the removable lift rings which are currently being utilized. Chamfers were added to all edges of the Tumulus II vault which has reduced the chipping and spalling noted during handling of the Tumulus I vaults.

The efficiency of loading of the containerized LLW into the vaults and backfilling with grout has been improved by the development of special hold-down fixtures to prevent container float.

Operational Monitoring

Monitoring has been conducted for worker exposures during vault loading and placement operations. To date worker exposures have been kept within control limits and appear to actually be reduced from exposures experienced during the previously utilized trench loading operations. It appears that the concrete vaults provide significant shielding for the workers once the waste is placed inside.

Gross beta levels from Tumulus I are slightly above background levels, due to the presence of Potassium-40 (K-40). The K-40 is thought to be the result of leaching of naturally occurring materials form the large concrete surface areas present in the tumulus disposal system.

The elevated K-40 levels appear to be consistent with the high pH levels noted in the pad drain water. The pH levels are in the range of 8-10, and appear to be dependent on the number of vaults placed on the pad. The drain lines from both pads have been closed and water is being collected and hauled to treatment since the high pH violates the regulatory discharge limits. The impact of placement of the planned earthen cover on the pH levels is currently being evaluated.

COST SUMMARY

The estimated cost for the alternatives identification and evaluation phase is approximately $7 million. This is a working estimate since the Environmental Impact Statement has yet to be finalized.

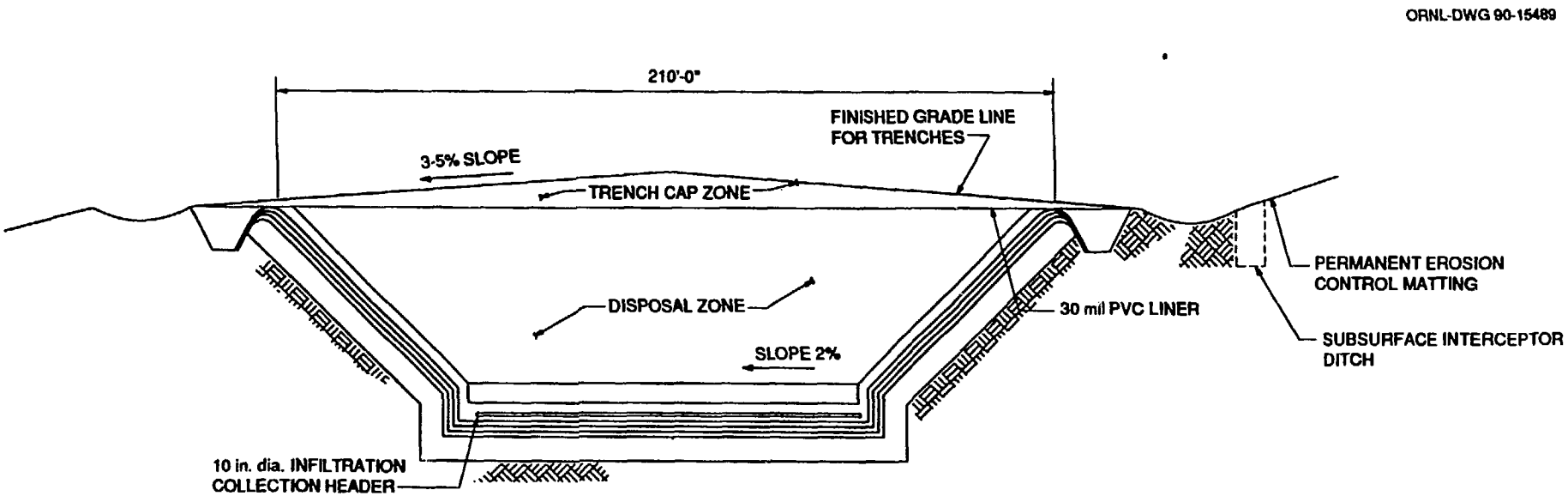
A summary of the cost of the design, construction, and operation and the tumulus demonstration projects is provided in Table 1. Design costs include Title I and II efforts, as well as additional documentation on construction experience that was developed by the demonstration program as a part of Title III design. Construction costs include the fixed price contract for site preparation, tumulus pad and monitoring station construction, as well as in-house costs for monitoring instrument procurement and installation, and utility hookups. The vault costs reflect the fixed price manufacture contract for the vaults currently being utilized. Operating costs include waste container placement in the vaults, concrete backfill, vault lid placement and sealing, and vault placement operations. The cost of the cover is based on estimates developed during a conceptual cover design effort conducted during 1987.

It is estimated that the design, construction, operation, and closure costs for the tumulus demonstration phase are approximately $\$62/ft^3$ on an "as disposed" basis. Projected design, construction, operation, and closure costs for the IWMF on an "as disposed" basis are approximately $\$88/ft^3$. Costs on an "as generated" basis could be much lower, depending on the degree of waste compaction achieved in waste container loading. It should be recognized that these costs may change significantly for future tumuli as a result of site characteristics, technology evolution, and effects of scale.

TABLE 1

TUMULUS DISPOSAL DEMONSTRATION COST SUMMARY

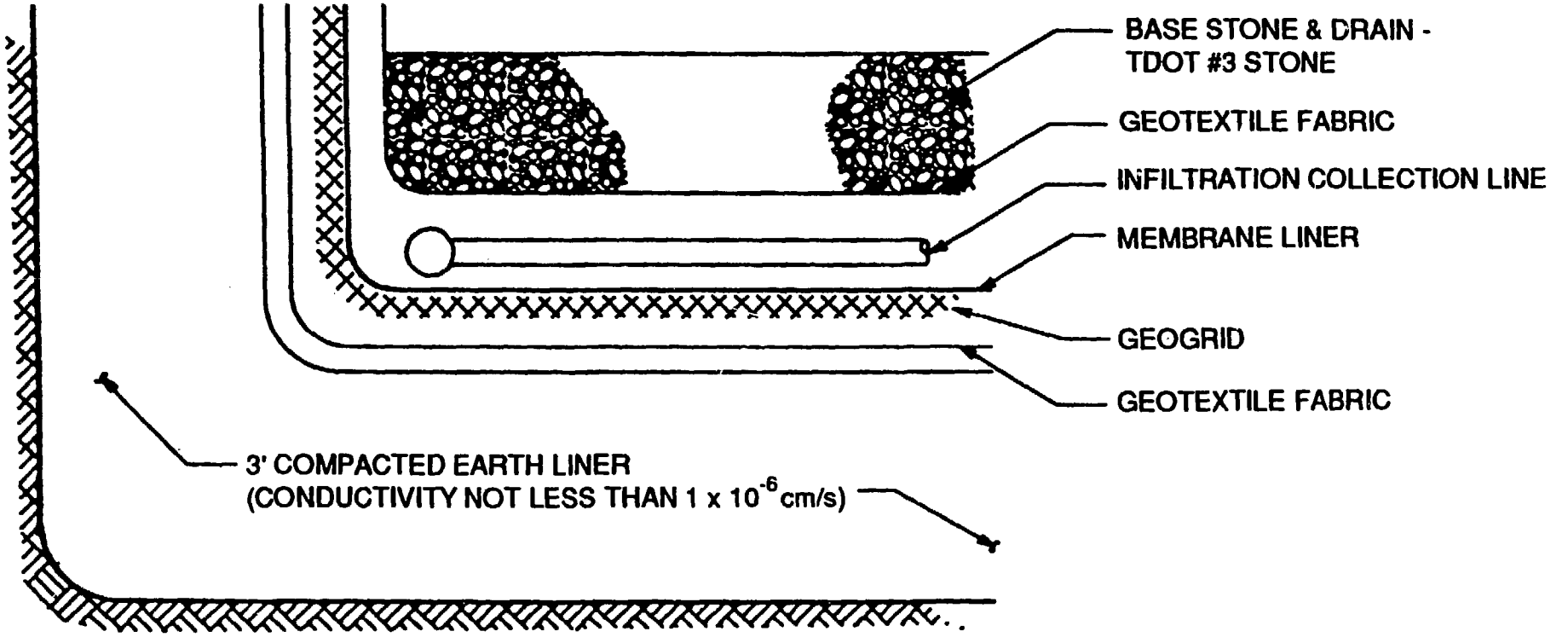
		Tumulus I	IWMF
-	Design	$ 60,000	$ 200,000
-	Tumulus Construction	$ 180,000	$ 2,650,000
-	Vault Manufacture	$ 234,000	$ 4,300,000
-	Tumulus Operations	$ 660,000	$ 4,800,000
-	Tumulus Closure	$ 425,000	$ 2,300,000
	Total	$ 1,559,000	$14,250,000
		$ 62/ft^3	$88/ft^3



Class I Disposal Trench
Cross Section

Figure 1

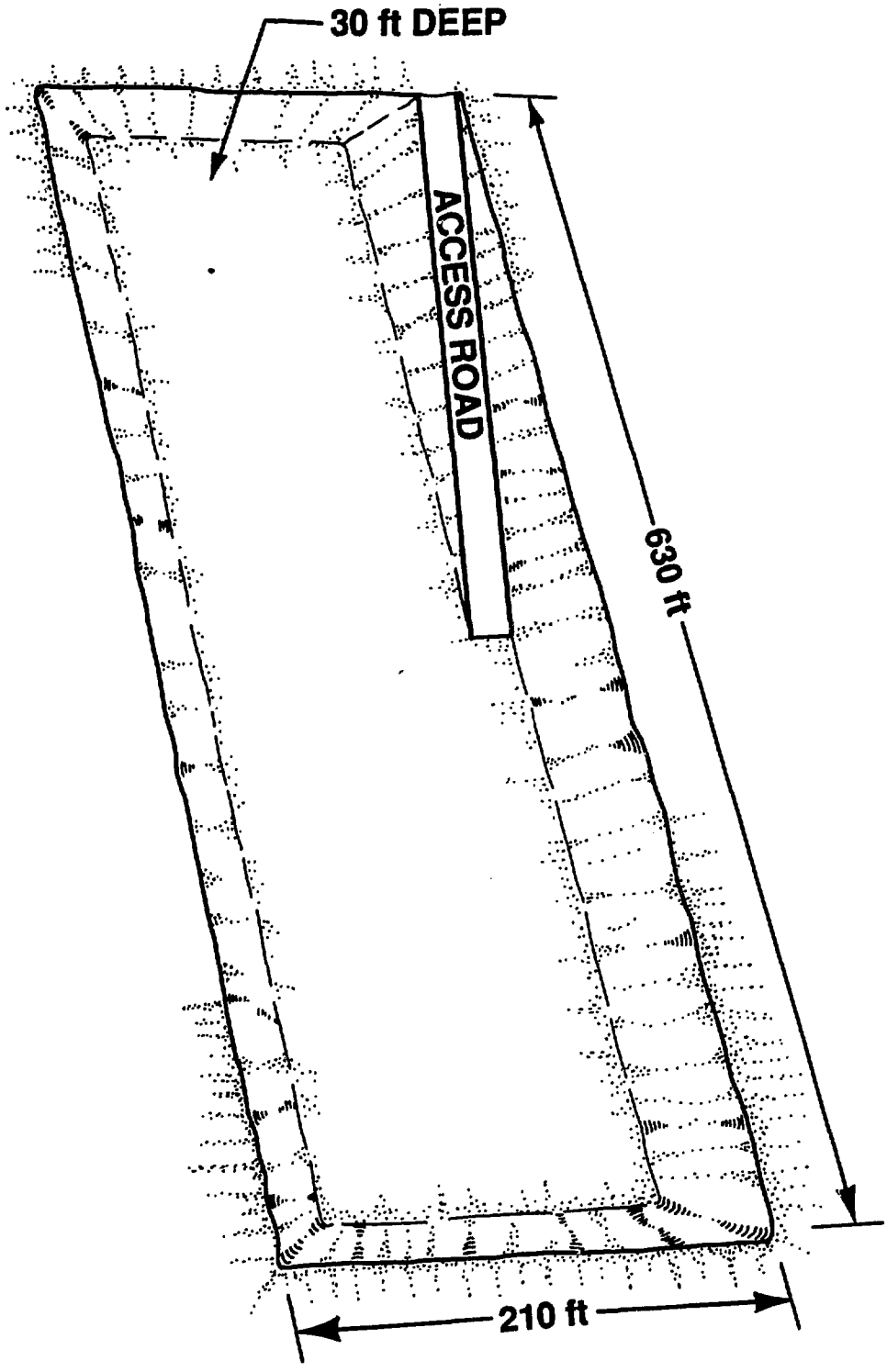
ORNL-DWG 90-15488



Class I Disposal Trench Detail

Figure 2

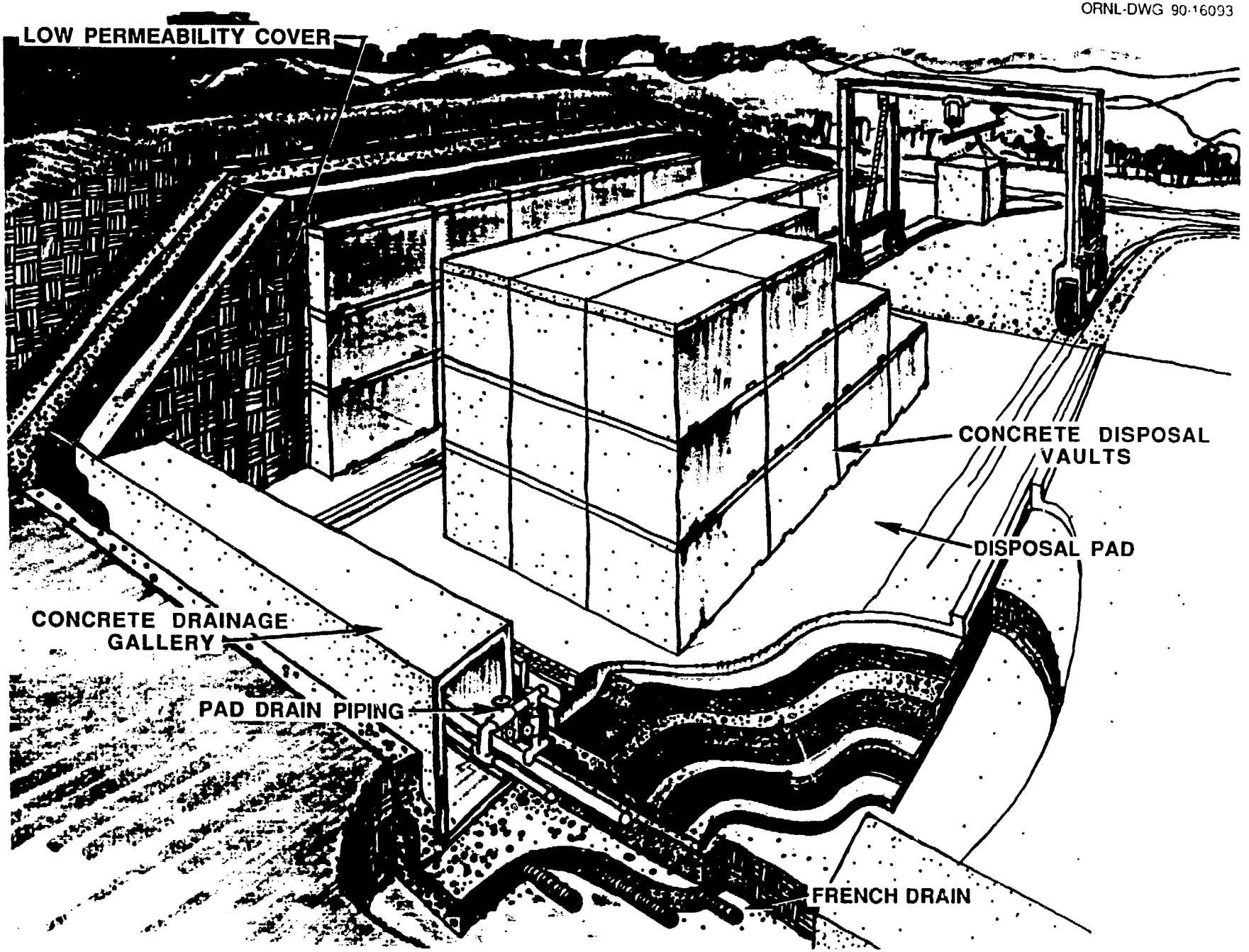
ORNL-DWG 90-15502



Empty Trench

Figure 3

ORNL-DWG 90-16093



TUMULUS DISPOSAL TECHNOLOGY

Figure 4