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UNION CARBIDE

MANAGEMENT OF SOLID WASTE

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UCC-ND Engineering

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ABSTRACT

Compliance with the latest regulatory requirements addressing disposal of radioactive, hazardous, and sanitary solid waste requires the application of numerous qualitative and quantitative criteria in the selection, design, and operation of solid waste management facilities. Due to the state of flux of these regulatory requirements from EPA and NRC several waste management options were identified as being applicable to the management of the various types of solid waste.

This paper highlights the current regulatory constraints and the design and operational requirements for construction of both storage and disposal facilities for use in management of DOE-ORO solid waste. Capital and operational costs are included for both disposal and storage options.

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MANAGEMENT OF SOLID WASTE

1. INTRODUCTION

Management of sanitary, hazardous and radioactive solid waste produced at the Department of Energy-Oak Ridge Operations (DOE-ORO) facilities requires careful waste management planning to provide compliance with applicable regulatory criteria. The criteria are the product of a myriad of proposed or promulgated regulations, including requirements mandated by the Resource Conservation and Recovery Act (RCRA) for sanitary and hazardous waste disposal, and criteria proposed in 10CFR61 by the Nuclear Regulatory Commission (NRC) addressing management of low-level radioactive waste (LLW). Waste management planning covers waste characterization and quantification, transportation and handling, treatment, storage, and disposal. The subject of this paper will be limited to alternatives for waste storage and disposal. Regulations proposed by EPA and NRC addressing management of solid waste will be briefly reviewed. Preliminary designs for two disposal and three storage alternatives will be presented with associated Rough Order of Magnitude (ROM) costs.

2. REGULATORY REQUIREMENTS (CRITERIA)

Solid waste management regulations affecting DOE plants are being promulgated by three agencies - EPA, NRC, and DOE.

EPA has issued guidelines under the RCRA applicable to management of nonhazardous waste in the Federal Register, Vol. 43, No. 25, February 6, 1978, and Vol. 44, No. 59, March 26, 1979. These guidelines provide the detail required to locate, design, and operate sanitary landfills in a manner acceptable for licensing by EPA. Also under the RCRA , criteria to ensure proper management of hazardous wastes from "cradle to grave" were proposed in the December 18, 1978 Federal register, Vol. 43, No. 243, some of which were promulgated in February, 1980. The remainder is expected to be promulgated in April and October of 1980. In addition, EPA proposed general guidelines for management of radioactive waste in the November 15, 1978 Federal Register, Vol. 43, No. 215.

Currently there are bills under consideration that propose to allow NRC to regulate new DOE low-level radioactive waste facilities. NRC has issued proposed criteria for shallow land burial of low-level radioactive waste in 10CFR61. NRC's criteria tend to parallel EPA's criteria for burial of hazardous waste. Both EPA and NRC require that a pathways analysis be completed at the proposed site to verify that radioactivity will not migrate from the disposal area at levels exceeding environmental protection standards.

3. DESIGN OF ALTERNATIVES

The complex and dynamic state of regulatory requirements addressing the disposal of hazardous and radioactive waste may require that temporary storage of waste pending the promulgation of final criteria be included as a process step in comprehensive solid waste management plans.* Additionally if radioactive contamination precludes the release of scrap metal to the public, facilities may be needed for storage of metal scrap until either a resource recovery process is made available or contamination limits acceptable for public release are established.

Summaries of the design and costs of five alternatives, two for waste disposal and three for waste storage are included in this paper.

The two disposal alternatives include the design of a sanitary landfill and the design of a burial trench to comply with the EPA criteria proposed in the December 18, 1978 Federal Register for disposal of hazardous waste**. The three storage options include: the design of a metal building to serve as a warehouse for waste; the design of below grade concrete trenches; and the use of concrete cubes as storage containers.

Criteria common to all storage and disposal options include siting requirements, service extension, design capacity, and security requirements. Suitable sites were assumed available on Federally owned land. Surface preparation, utilities, fencing, lighting, and phased construction for disposal trenches and storage facilities are provided. Disposal volume was assumed to be approximately 3×10^6 ft^3 and storage volume 2×10^6 ft^3. Phased construction of the facilities was designed to provide capacities for storage or disposal of 1/6 of the waste storage or disposal requirements.

Disposal Alternatives

Two disposal systems which utilize shallow land burial (SLB) for disposal of contaminated waste are designed and costed. The major difference between the designs is a leachate control system which is provided for one option. Following are descriptions of the designs for each option.

*In the paper, hazardous refers to the RCRA classification system, radioactive is defined as in the Atomic Energy Act of 1954 and is excluded from the RCRA hazard definition, and sanitary refers to nonradioactive and nonhazardous.

**The NRC criteria for design of a LLW, shallow land burial (SLB) facility listed in 10CFR61 approximately parallel EPA's criteria for hazardous waste disposal.

Unlined Shallow Land Burial

The unlined shallow land burial disposal option will be similar in design and operation to a sanitary landfill. Trenches will be excavated as needed, filled, and covered for waste disposal. The design for disposal of 3 x 10^6 ft^3 will require 28 acres of land and can be layed out as shown in Figure 1.

Surface runoff originating outside the site boundary will be diverted from the site, and a surface runoff collection system will collect precipitation falling within the 28 acres. The surface runoff from the site will flow through a settling pond before being discharged from the site boundary. No provisions for removal of organics and metals from the runoff are included. Leachate from the working section of the disposal trench will be collected for transport to a waste treatment facility (not provided as part of this study). No provisions are included for collection of leachate from a completed trench.

The first trench, when trench and fill operations are completed, will occupy an area 160' x 487' and will contain 1/6 of the total design volume of waste for disposal.

A building to provide for temporary storage of waste during inclement weather or low volume waste generation periods, and a tank for temporary storage of contaminated leachate are provided in the design. Table 1 lists the assumptions made in order to complete engineering studies for unlined shallow land burial.

Table 1. Assumptions Specific to the Design of Unlined and Lined SLB Facility

1. The potentiometric surface will be 25' below grade required for hazardous and radioactive waste facilities only.

2. Mounding of the waste on a 3:1 slope will satisfy regulatory requirements.

3. Groundwater monitoring wells will be provided.

4. A surface runoff diversion structure will be provided around the perimeter of the site.

5. A drainage system will be provided for the collection and discharge of precipitation falling in the site boundary.

6. The access roads will be designed solely for DOE use.

7. The runoff settling pond will be lined with clay obtained off-site.

8. An auxiliary fuel tank, a waste storage facility, and a maintenance pad will be provided.

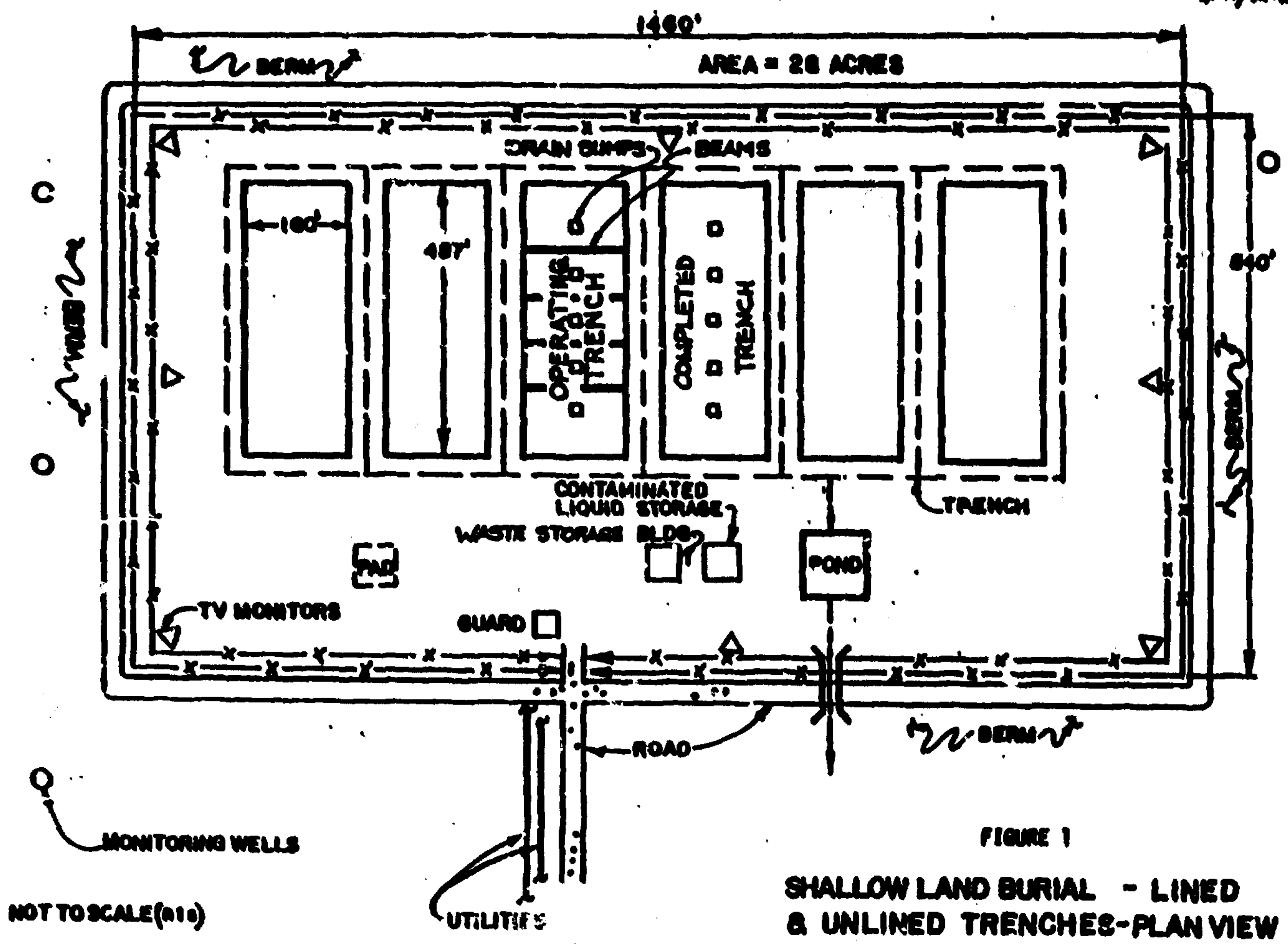


FIGURE 1

SHALLOW LAND BURIAL - LINED & UNLINED TRENCHES-PLAN VIEW

Lined Shallow Land Burial

The lined shallow land burial disposal option is designed to comply with the proposed RCRA guidelines for hazardous waste disposal. Lined shallow land burial will entail all the requirements previously addressed for unlined shallow land burial and will also include trench lining and leachate containment, collection, and transfer systems. The first trench will be constructed about 487' x 160' x 16' to accommodate approximately 1/6 of the total design volume of waste.

Figure 1 shows a plan view of the site and Figure 2 presents an elevation view of the trench with the leachate containment and collection systems identified. Leachate containment is accomplished through the use of a five foot thick clay liner in the trench. One foot of gravel placed on top of the clay liner and sloped at a grade of 1% towards the drainage sumps serves as a leachate collection system. French drains are designed in the gravel layer and extend radially from five sumps equally spaced along the centerline of the trench base.

The 1000 gallon sumps contain pumps which will transfer the leachate to the leachate storage tank. The collected leachate will be transported by tank truck to an offsite treatment facility (not costed in this study).

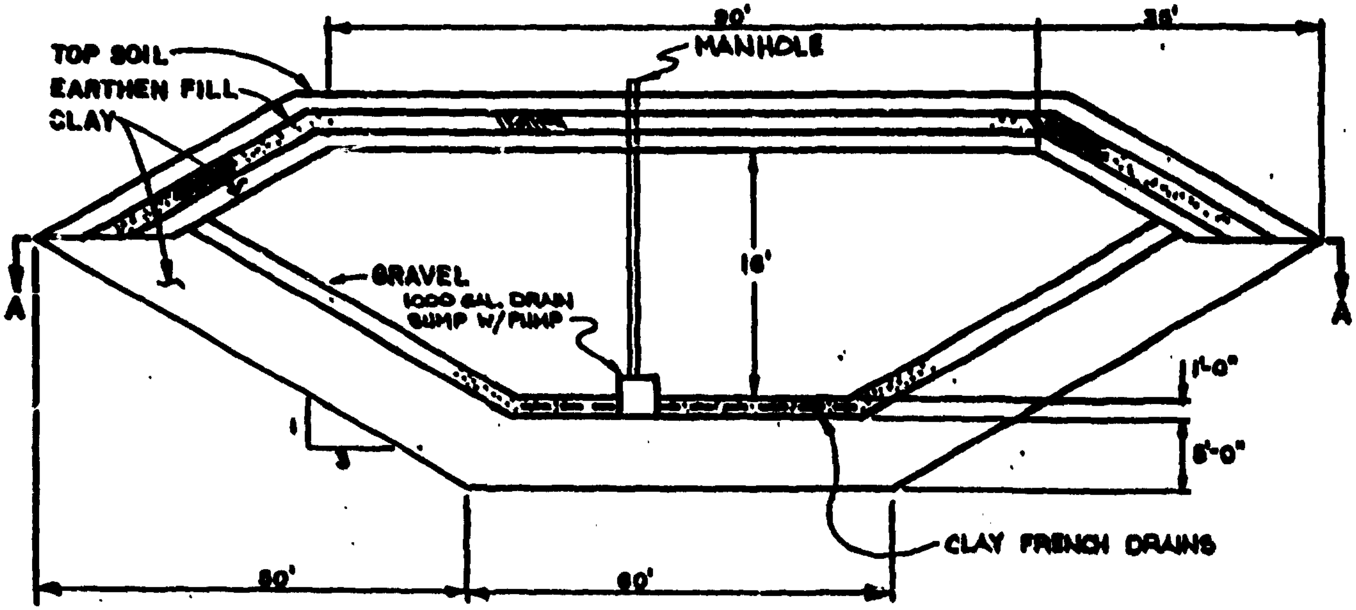
The sides of the trench will slope 3:1 and be lined with the clay and gravel. Ten feet of the usable trench depth will be below grade with the remaining six feet above grade. The waste will be mounded on a 3:1 slope. A clay cap, earthen fill, and a top soil cover will be placed over completed sections of the trench.

The 160' x 487' trench is compartmentalized into five subtrenches by one foot high dikes to allow runoff from working sections to be collected by their individual sump. Runoff from nonworking sections will be discharged through the surface drainage system.

Assumptions that were made for design of the lined shallow land burial facility include those listed in Tables 1 and 2.

FIGURE 2

SHALLOW LAND BURIAL
LINED TRENCHES
ELEVATION VIEW



WTT/MR

Table 2. Assumptions specific to the design of the lined SLB disposal facility.

1. The trench will be designed in accordance with the proposed guidelines for a hazardous waste disposal facility required by EPA and discussed in F. R. Vol. 43, No. 243, pp 58946 - 59028, 12/18/78.

2. Thirty percent of the trench volume will be allowed for daily cover and void space.

3. The clay will be obtained off-site.

4. The bottom of the clay liner will be a minimum of five feet above the maximum groundwater level.

5. Mounding of the waste above ground will comply with all regulatory requirements.

Waste Storage Alternatives

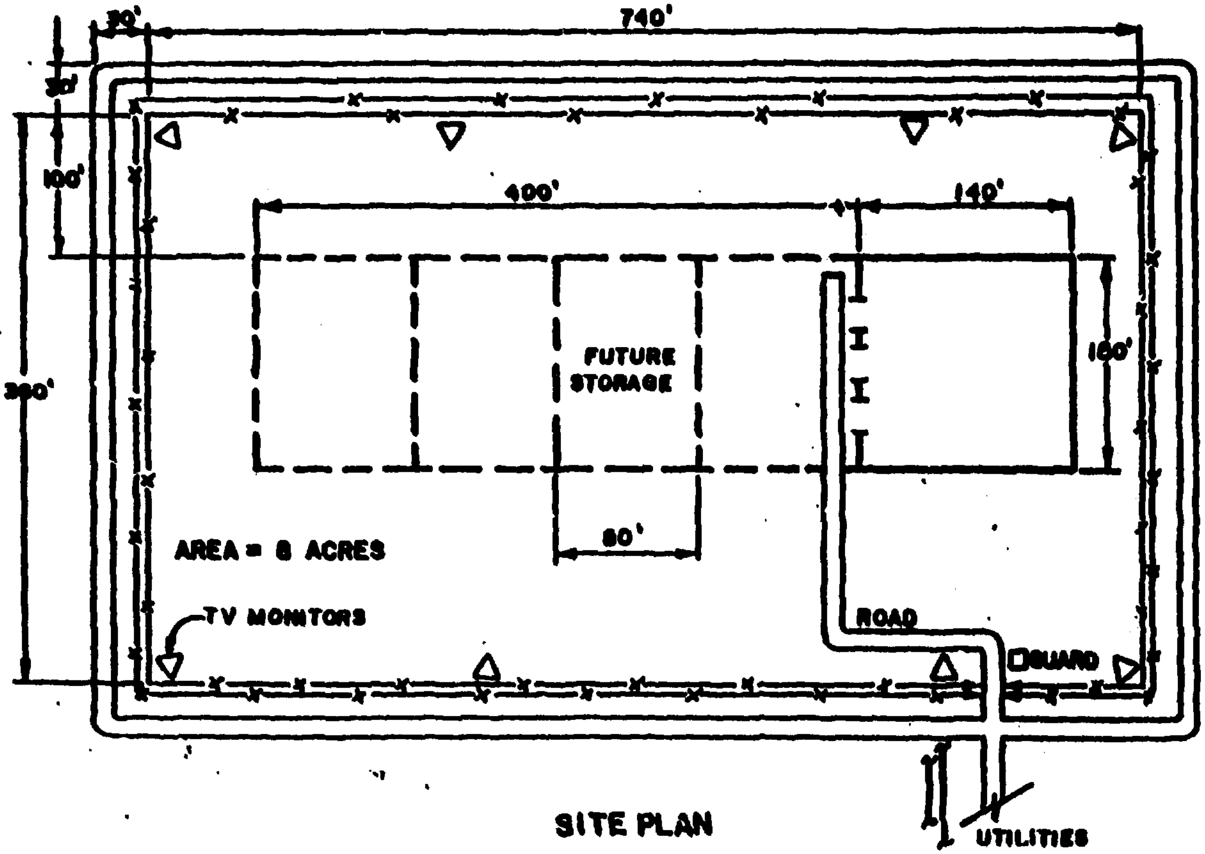
Three storage options are identified as being amenable to the storage of hazardous/radioactive waste or contaminated metals. Some of the general design features are the same for each of the options, most noteably utilities and road access, and the application of phased construction. The design of pretreatment and packaging facilities is not included in the analysis of storage alternatives.

Storage in a Metal Building

A large prefabricated metal building constructed on eight acres of land is one option costed for storage of 2 x 10^6 ft^3 of waste. The building shown in Figures 3 and 4 is designed so that waste could be stacked to a maximum height of 30 feet on a slope of 2:1 by the use of a skip hoist and front end loader. The building dimensions of 140' x 180' provide for the utilization of a large width, to minimize volume wastage due to stacking. Another benefit of this design is the relative ease of expanding the facility to accommodate additional waste. Three large roll-up metal doors are included in the building design to facilitate unloading and stacking operations. The walls of the facility are not designed to handle a bearing load brought on by the placement of waste against the sides. Ventilation will be supplied by roof ventilators with lighting provided to meet the minimum safety requirements for a warehouse storage structure.

FIGURE 3

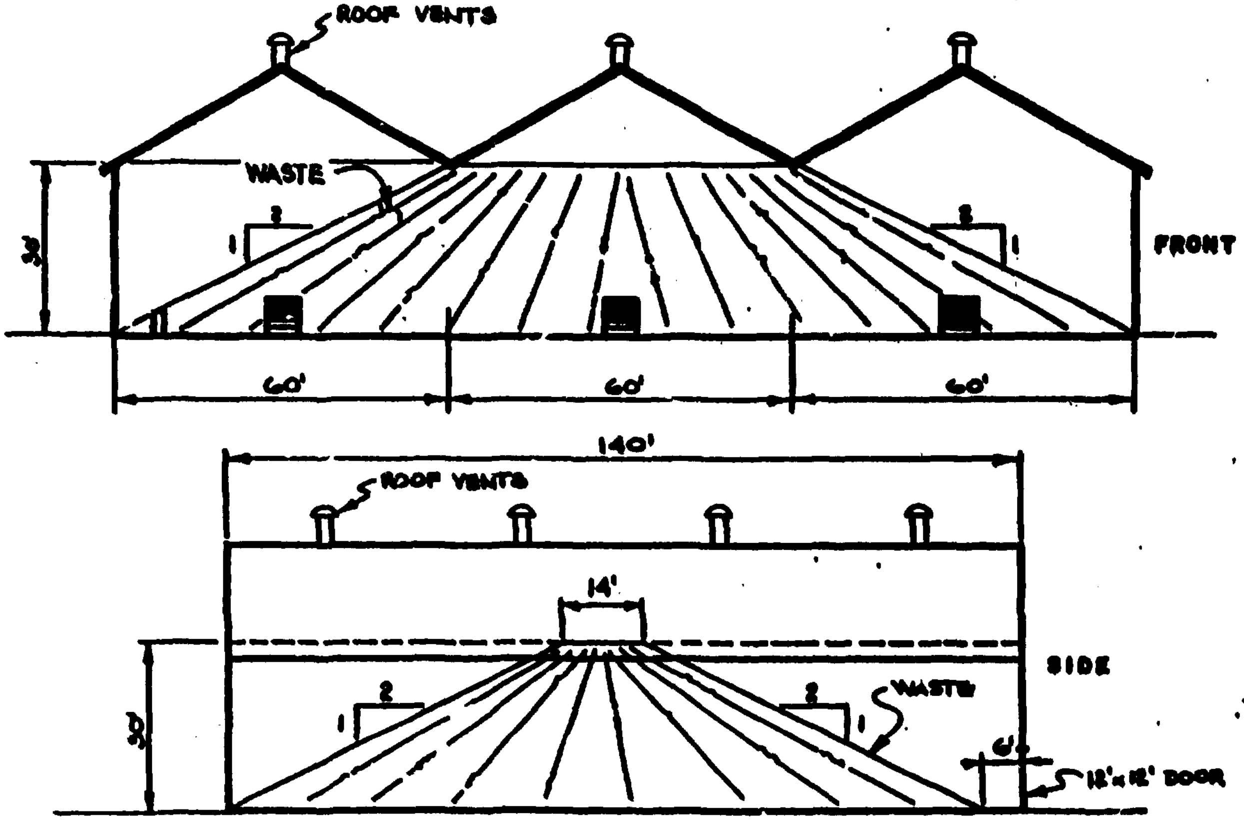
METAL BUILDING FOR METAL SCRAP STORAGE



SITE PLAN

FIGURE 4

METAL BUILDING FOR METAL SCRAP STORAGE



ELEVATION

W.T.T/W6

There are no provisions in the design for diversion or collection of any surface drainage.

Storage in Concrete Trenches

Storage in concrete trenches was identified as a second option. The design of these facilities provides the most secure containment afforded by any of the three storage alternatives. Figure 5 shows the site plan and Figures 6 and 7 show sectional views of the storage trench.

To minimize hydrostatic head on the exterior surfaces of the trench a french drain system will be provided. Both interior and exterior drains will flow by gravity to two separate 1000-gallon sumps. Contaminated liquid will have to be collected and treated.

Noncontaminated water will be pumped to a settling pond and discharged from the site.

Table 3 lists assumptions applicable to the design of the concrete trench storage facility.

Table 3. Assumptions Pertaining to the Design of Concrete Trench Storage Facilities

1. The potentiometric surface will be 15' below grade.

2. The area required will be 15 acres.

3. A temporary waste storage building will be provided.

4. Additional trenches may be constructed with a common wall.

5. Monitoring wells for ground water sampling will be provided.

6. A surface water diversion system will be provided.

7. The design will include a conveyor to dump the waste across the 30' span of the trench.

Storage in Concrete Cubes

The third option consists of storage in concrete cubes. The cubes are to be constructed of six inch reinforced concrete and have a five foot cubical interior dimension. Site layout is shown in Figure 8. It is estimated that 11 acres will be required for storage of 2 x 10^6 ft^3 of waste assuming that the cubes will be stacked two high and allowing the void area between cubes to equal 30% of the area of the cubes. The design requires that the cubes be purchased offsite and received on-site ready for filling. Full cubes will have prefabricated caps grouted in place. Assumptions pertaining to the design for storage of scrap in cubes are listed in Table 4.

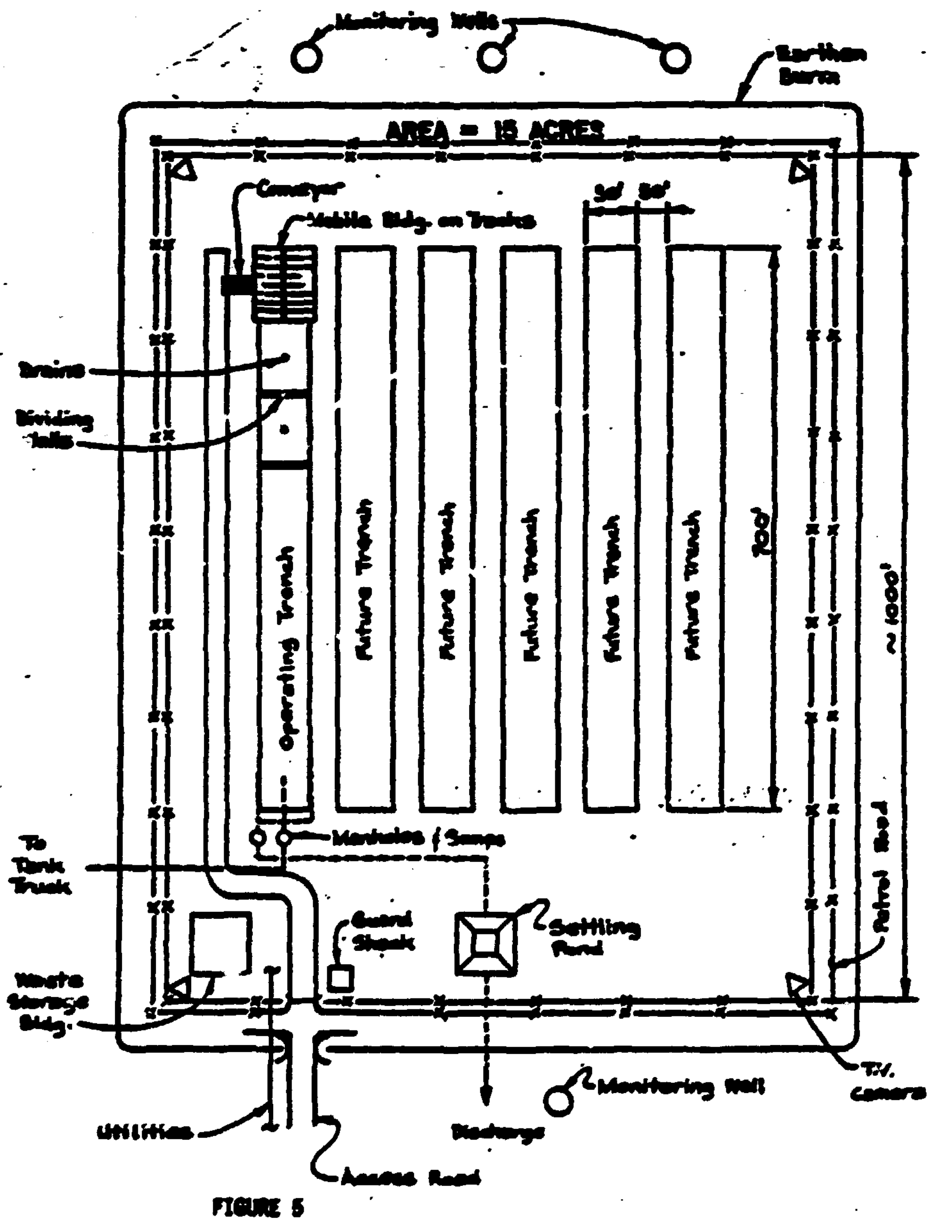


FIGURE 5

CONCRETE TRENCHES FOR METAL SCRAP STORAGE - SITE PLAN

ORT./R.M.S.

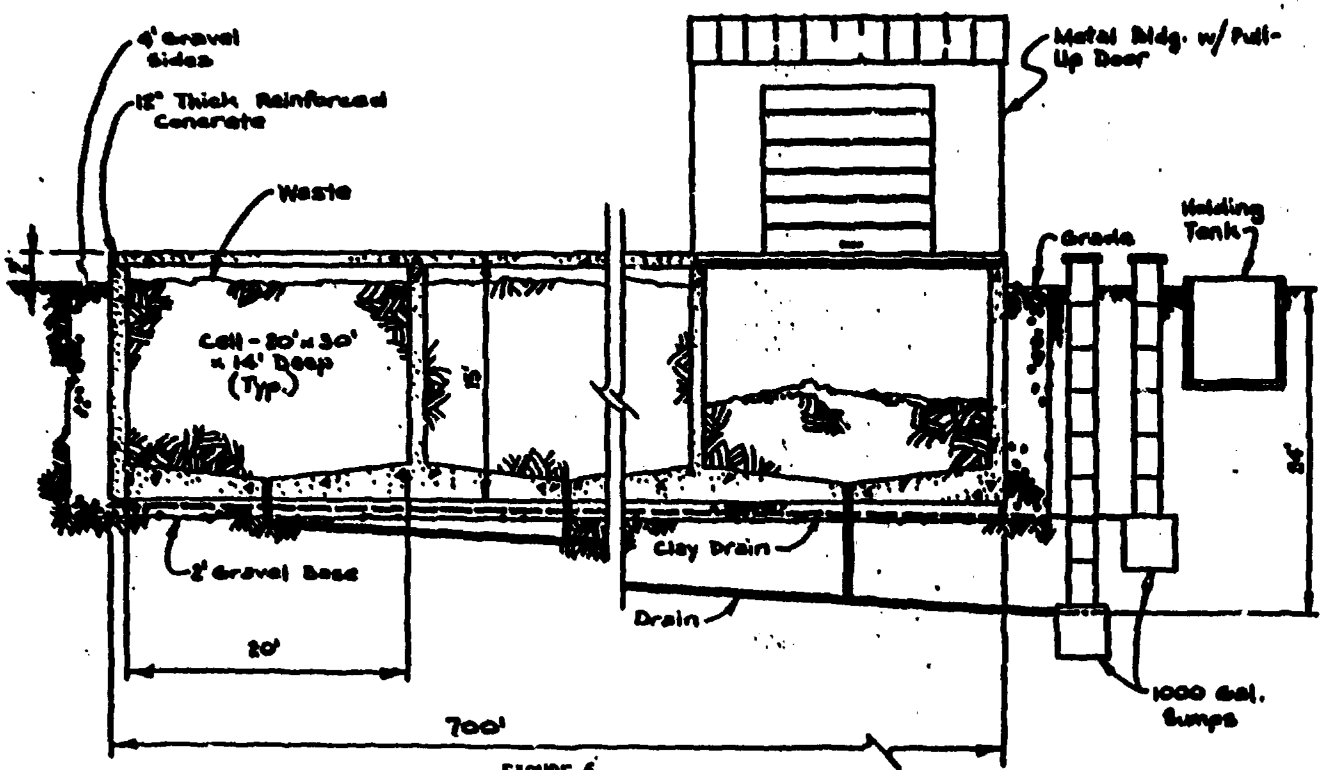


FIGURE 6

CONCRETE TRENCHES FOR METAL SCRAP STORAGE

LONGITUDINAL SECTION

W.T.T./R.M.S.

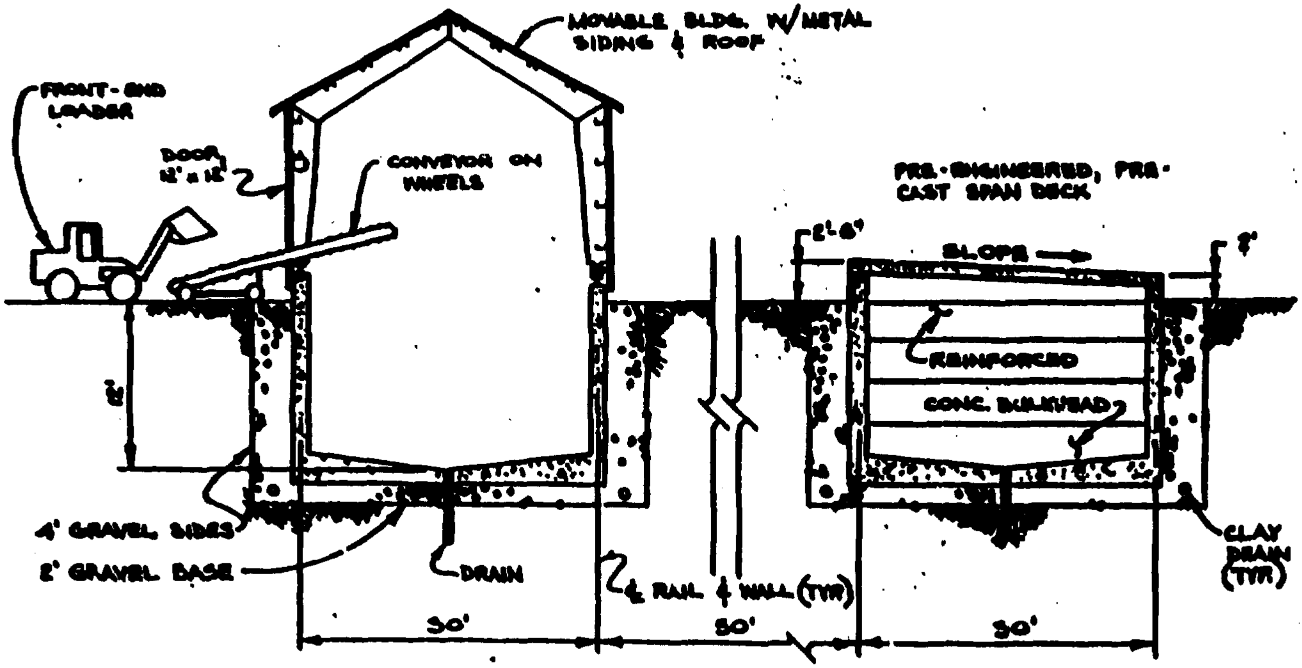


FIGURE 7

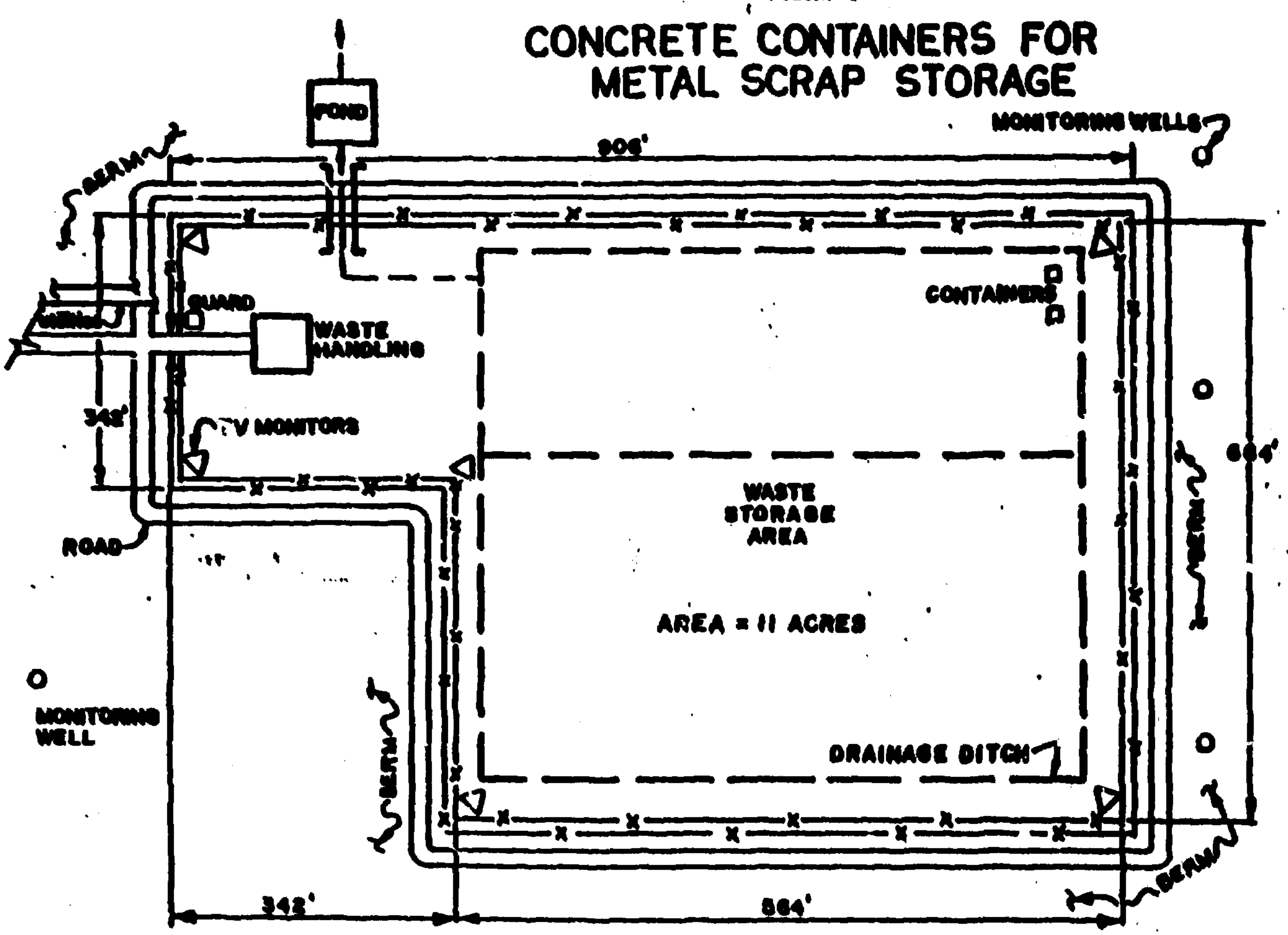
CONCRETE TRENCHES FOR METAL SCRAP STORAGE

CROSS SECTION

W.T.T./E.R.S.

FIGURE 8

CONCRETE CONTAINERS FOR METAL SCRAP STORAGE



SITE PLAN

Table 4. Design Consideration for Storage of Contaminated/Waste in Cubes

1. A waste handling building will be included.

2. A surface water diversion structure will be provided.

3. Monitoring wells will be included.

4. A large forklift to handle empty and full cubes will be provided.

4. OPERATIONAL REQUIREMENTS

Operational requirements for each option are summarized in this section. The operational plans for each option share the following assumed criteria: the facility will operate 250 days/yr for eight hours/day; and waste packaging or pretreatment operations are not considered in this evaluation. It is realized that any pretreatment and/or packaging processes could impact real estate and building volume allowances.

Operation of the Unlined Shallow Land Burial Facility

Operation of the unlined shallow land burial facility will be similar to operation of a sanitary landfill. The waste will be transported to the disposal site and placed into the trench or into the temporary waste storage building. Excavation of the trench will preceed the placement of waste by only a few days to minimize the collection of surface water in the trench. Typically, a D-7 caterpillar tractor will perform most of the excavation while end loaders will handle the waste at the storage facility and serve as backups to the D-7.

Site and equipment maintenance are included in the operation plan. Assumptions concerning the operation of the unlined shallow land burial facilty are presented in Table 5.

Table 5. Assumptions for the Operation of the Unlined Shallow Land Burial Facility

1. Waste will be transported to the disposal site in two dump truck loads per day. (The exact transportation mode will be dependent on security requirements).

2. A dump truck will be required on-site to haul waste from the storage facility to the disposal trench.

3. The storage facility will provide a 5 day storage capacity.

4. The waste will have a daily soil cover placed over it.

5. Equipment will be available on loan from a DOE plant for removal of solids out of the runoff retention pond.

6. Water diverted around the facility will not be collected and treated since it is not a point source.

7. Any precipitation falling into an open trench will be pumped out and into a tank truck for transport to an off-site liquid treatment facility (not costed in this study).

Operation of the Lined Shallow Land Burial Facility

The trench will be divided into five sections each separated by clay berms. Rainfall collected in the working section of the trench can be contained separately between the section berms. As filling operations progress runoff from the working section will be pumped to a holding tank. When a section is filled to capacity a cap composed of clay, fill earth, and topsoil layers will be constructed. Leachate collected in filled and capped sections will be pumped to a holding tank. Runoff collected in nonworking sections will be pumped to the surface water collection system.

Operation of the Building Storage Option

Waste will be picked up in a form suitable for hauling to the waste storage facility. The waste will be stored on the building's concrete floor and later transported to a waste pile or placed onto a skip hoist with a front end loader. The skip hoist will place the waste to a predetermined maximum height of 30 ft. The front end loader will also be required to position the skip hoist for properly mounding the waste.

Equipment maintenance and building repair were included in operating costs. Expansion of the facility will be accomplished by lengthening the building at intervals to lengths suitable for handling a predetermined quantity of waste.

The operation of this facility is the least weather dependent of all storage operations.

Operation of the Concrete Trench Storage Facility

Waste will be transported to the trench site and unloaded adjacent to the operating section of the trench. No provisions are made for storage of waste due to adverse weather. A front end loader will pick up the waste and place it onto a conveyor that will spread the material evenly over the area of the working section. After approximately 30 days of operation the trench section will be full at which time a crane will position the building, which was located over the working section of the trench, over the next empty section. The crane will then place span deck caps over the full section.

It is assumed that a crane will be available for 1 day out of every 35 days to handle the span deck and building, and that a tank truck will be available to transport leachate and runoff.

A new trench will be constructed adjacent to the old trench as more storage space is needed.

Storage in Concrete Cubes

The last storage option was estimated to be the most labor intensive. The waste will be received on-site and stored in the waste management building. In the building the waste will be placed into prefabricated concrete cubes with the use of a front end loader. The cubes will be capped with a prefabricated concrete cap and sealed with grout. A forklift, designed to handle the cubes, will load two full cubes onto a trailer and then pull the trailer out to the storage area. After positioning the trailer, the forklift will disconnect and unload the cubes stacking them two high. About two cubes per day will be required to store the waste generated.

5. COST ESTIMATES

Bills of Materials (B/M's), which were prepared and estimated for each option by Engineering, contain not only all construction requirements needed for the development of capital costs but also lists equipment needed for daily operation of the facility.

Operational schedules were developed concurrently with the B/M's so that complete operational costs could be included in the estimates. Table 6 presents ROM cost estimates for each option. This table represents preliminary ROM estimates for comparison purposes, and should be recognized as figures corresponding to the preliminary design studies. Several assumptions required to estimate costs are listed in Table 7.

Table 6 shows the breakdown of the total cost figures. Capital costs represent all costs that would occur in the initial phase of facility construction. Operating costs include all charges associated with the daily operation of each facility, e.g. truck operation, security guards. Future capital or expense cost includes costs for expansion of the initial facility to accommodate future waste and the purchase of any equipment which would need replacement.

Table 6. ROM Costs for Solid Waste Management

Options	Total Initial Capital[1]	Future Capital Expense[1,2]	Total[1]	Costs/ft^3
SLB (3×10^6 ft^3) Unlined Trench	2.0	0.7	8.6	$2.86
SLB (3×10^6 ft^3) Lined Trench	3.0	5.2	13.5	$4.50
Storage (1.7×10^6 ft^3) Metal Building	1.0	1.1	5.8	$3.87
Storage (1.7×10^6 ft^3) Concrete Trench	1.5	3.1	8.1	$4.80
Storage (1.7×10^6 ft^3)	2.7	6.8	13.5	$7.90

[1] Numbers represent millions in 1979 dollars.

[2] Capital/Expense figures are for total expansion costs associated with each option.

Table 7. Assumptions for Cost Development

1. All facility costs include estimates for security requirements.

2. All costs include 20% for engineering and 30% for contingency and are in 1979 dollars.

3. The costs are ball park estimates to be used for comparison.

4. The estimates are based on steady state waste generation.

5. The cost figures cannot be extrapolated on a straight line basis to obtain dollars per cubic foot for various production rates. The estimates for the two disposal options represent two extremes. A combination of the two disposal methods would not result in a cost exceeding the estimate for hazardous waste disposal.

Cost Summary

As expected the disposal option utilizing shallow land burial of low-level nonhazardous waste in an unlined disposal trench is tne less costly of the two disposal options. The principal difference in capital cost is due to the clay liner and leachate collection system as required under RCRA for hazardous waste management facilities. Although unlined shallow land burial trenches are lower in capital cost, they are higher in operating cost. The higher operation cost resulted from a greater amount of earth work required for day to day trench excavation and fill. These costs were incurred as capital costs in the lined trench option.

The cost differential for the three storage options was primarily the capital cost incurred initially and during the phased expansion.

It is of interest to note that the fee charged at commercial radioactive waste disposal operations is in the range estimated in this paper.

No estimates have been made for any potential "perpetual care" requirements.