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PRELIMINARY ENGINEERING EVALUATION OF SELECTED REMEDIAL ACTION ALTERNATIVES FOR THE ALBANY RESEARCH CENTER, ALBANY, OREGON

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SPECIAL NOTE E-24730

This Preliminary Engineering Evaluation of Selected Remedial Action Alternatives (EEA) was originally prepared in early 1984. In the EEA, three remedial action alternatives are discussed: (1) On-Site Above-Grade Disposal; (2) On-Site Below-Grade Disposal; and (3) Transport to Hanford, Washington for disposal at the existing Department of Energy (DOE) facility.

In evaluating these alternatives, Bechtel National, Inc. (BNI) used estimates of volumes of contaminated material derived from the results of two radiological surveys conducted by Argonne National Laboratory (ANL) (Refs. 1 and 2). The ANL surveys had been conducted to determine if the Albany Research Center (ARC) was radioactively contaminated to the extent that it would qualify for designation by DOE as a Formerly Utilized Sites Remedial Action Program (FUSRAP) site. The ANL surveys indicated that areas were contaminated if the areas exceeded local background radiation levels. As designation, or "walk over" surveys, the ANL investigations were not intended to provide precise estimates of the volumes of contaminated materials.

Because of the uncertainty regarding the volume of contaminated material, BNI evaluated the three alternatives listed above utilizing a range of 10,000-23,000 m^3 (13,000-30,000 yd^3) of contaminated material, with the volume of contaminated material most likely to be 13,500 m^3 (17,000 yd^3). However, based on the results of an in-depth radiological survey conducted in the spring of 1984 by BNI*, the volume of radioactively contaminated material is now more accurately estimated to be 2300 m^3 (3000 yd^3).

To improve waste volume estimating and other remedial action planning, a civil survey was included as part of the BNI

*The results of the BNI survey are reported in Radiological Survey of the Albany Research Center, DOE/OR/20722-29, Bechtel National, Inc., Oak Ridge, TN, January 1985.

radiological survey. To more accurately define the boundaries and depths of contamination, radiological measurements were tied to the grid developed from the civil survey of the site. Volume estimates also were based on the current (March 1984) proposed FUSRAP radiological guidelines. The waste volume estimates for the ARC buildings did not change significantly when recalculated using the data from the BNI survey.

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The cost estimates for the three remedial action alternatives were subject to numerous uncertainties. Due to these uncertainties and a compressed schedule for preparation of the EEA, the cost estimates were performed as "comparative costs" for the alternatives. That is, some elements common to all alternatives were not costed. Because of the uncertainty in the waste volume estimates, the comparative costs were displayed in Figure 5-1 as linear functions of the waste volume range of 10,000-23,000 m^3 (13,000-30,000 yd^3).

However, an extrapolation from 10,000 m^3 (13,000 yd^3) downward to 2300 m^3 (3000 yd^3) cannot be done accurately because the costs of each alternative involved substantial fixed costs for engineering design and review, National Environmental Policy Act (NEPA) assessment, construction mobilization, and minimum site work for each alternative. In addition, the two on-site alternatives would entail "perpetual care" in the form of continuing environmental monitoring, custodial care, and maintenance. It should be noted, however, that the Transport to Hanford alternative would have the lowest fixed cost of the three alternatives.

Therefore, although it is not possible to use Figure 5-1 to estimate the comparative remedial action costs for the three alternatives for disposing of a waste volume of 2300 m^3 (3000 yd^3), the relative ranking of the three alternatives would remain the same for volumes from 21,500 m^3 (28,000 yd^3) to 2300 m^3 (3000 yd^3) or less.

Furthermore, when compared to the on-site disposal alternatives, the Transport to Hanford alternative becomes more attractive as waste

volume decreases. The other advantages of the Transport to Hanford alternative that were noted in the EEA (future unrestricted use of the site, probable greater state, local, and public support) are essentially unaffected by the smaller volume of contaminated material.

In summary, for the reduced volume estimate, the Transport to Hanford alternative remains the most cost effective, involves the least risk, has the shortest schedule, and will most likely meet with greater public acceptance.

ABSTRACT

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This report was prepared for the U.S. Department of Energy (DOE) by Bechtel National, Inc., to facilitate DOE decisions regarding actions to be taken to remedy radiological conditions at the U.S. Bureau of Mines' Albany Research Center (ARC), Albany, Oregon.

This report compares three alternatives for the final disposal of low-level radioactive (natural uranium and thorium) waste at the ARC. These alternatives are: On-Site Above-Grade Disposal; On-Site Below-Grade Disposal; and Transport to Hanford, Washington. For the most-likely quantity of about 13,500 m^3 (17,000 yd^3) of waste, removal and transport to Hanford, Washington should clearly result in the lowest cost and should have the shortest schedule. The cross-over volume where on-site disposal becomes more economical is estimated to be 21,500 m^3 (28,000 yd^3). Expected radiological health effects, minimal in all cases, are approximately the same for each alternative.

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1.0 INTRODUCTION AND SUMMARY

This report compares three methods for the final disposal of low-level radioactive wastes at the Albany Research Center (ARC) in Albany, Oregon, as a part of the Formerly Utilized Sites Remedial Action Program (FUSRAP). These disposal alternatives are: On-Site Above-Grade Disposal; On-Site Below-Grade Disposal; and Transport to Hanford, Washington for Disposal. Because the extent of radioactive contamination is uncertain, the alternatives were costed on the basis of two estimates of the volumes of waste, 10,000 m^3 (13,000 yd^3) and 23,000 m^3 (30,000 yd^3). The most likely volume of contaminated material is estimated to be 13,500 m^3 (17,000 yd^3), based on the Argonne National Laboratory surveys (Refs. 1 and 2). Beyond the fixed costs for each alternative, costs were considered to increase linearly with waste volume. The two volumes selected for cost estimates were selected to bracket the actual volume (yet to be determined), and allow for a cost comparison of the alternatives based on the actual waste volume. This is discussed in Section 5.0. If the actual waste volume is greater than 23,000 m^3 (30,000 yd^3), the costs can be extrapolated upward for volumes of at least 38,000 m^3 (50,000 yd^3).

Permanent on-site disposal of the low-level uranium- and thorium-contaminated soil and building material would require construction of engineered earthen structures designed to ensure containment of the radioactive material for 200 years, with a goal of 1,000 years. The two on-site disposal alternatives (below-grade and above-grade) are not interim storage options. Either alternative would result in a portion of the ARC site becoming a permanent DOE radioactive waste disposal facility. Interim storage of wastes at the ARC site was not considered because the cost for an interim storage facility plus eventual transport to a final disposal site clearly exceeds the cost for immediate transfer of the waste to the DOE's Hanford Reservation radioactive waste disposal facility near Richland, Washington, some 565 km (350 mi) distant.

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The third alternative, Transport to Hanford, would require excavating above-criteria contaminated soil and hauling these wastes to the disposal facility.

Comparison of the three alternatives indicates the Transport to Hanford alternative costs less and has a shorter schedule than either on-site disposal alternative for volumes up to at least 21,500 m^3 (28,000 yd^3).

2.0 SITE DESCRIPTION

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2.1 LOCATION

The ARC site is located in Albany, Oregon, about 37 km (23 miles) south of Salem, Oregon. Figure 2-1 depicts Albany with respect to Richland, Washington (Ref. 3). Figure 2-2 shows a plan view of the ARC.

The ARC property covers an almost-rectangular area of approximately 14.4 ha (36 acre). It is bounded on the north by Queen Avenue, on the east by Liberty Street, on the south by a tennis club, and on the west by Broadway Street. To the north is a moderate-income housing area. The South Albany School Complex and adjacent private residences are located to the east beyond Liberty Street. The school complex consists of an elementary, middle, and high school. Beyond the tennis club to the south lies an established residential area. The area to the west, beyond Broadway Street, is mostly farm and pasture land, with some residences; however, some of this area is zoned for residential development. Figure 2-3 is an aerial photograph of the site and its immediate environs.

The ARC site comprises three main areas: the ARC proper, which consists of a number of buildings in the northernmost 11.7 ha (29 acre) of the site; an 0.8-ha (2-acre) BioMass Research Facility, which (inactive) occupies the center of the site; and a 5.7-ha (14-acre) grass-and-weed covered area known as the "Back Forty," which occupies the southernmost end of the site. Portions of the Back Forty and the area now occupied by the BioMass Facility were contaminated with wastes of uranium and thorium and their associated daughters (Refs. 1 and 2).

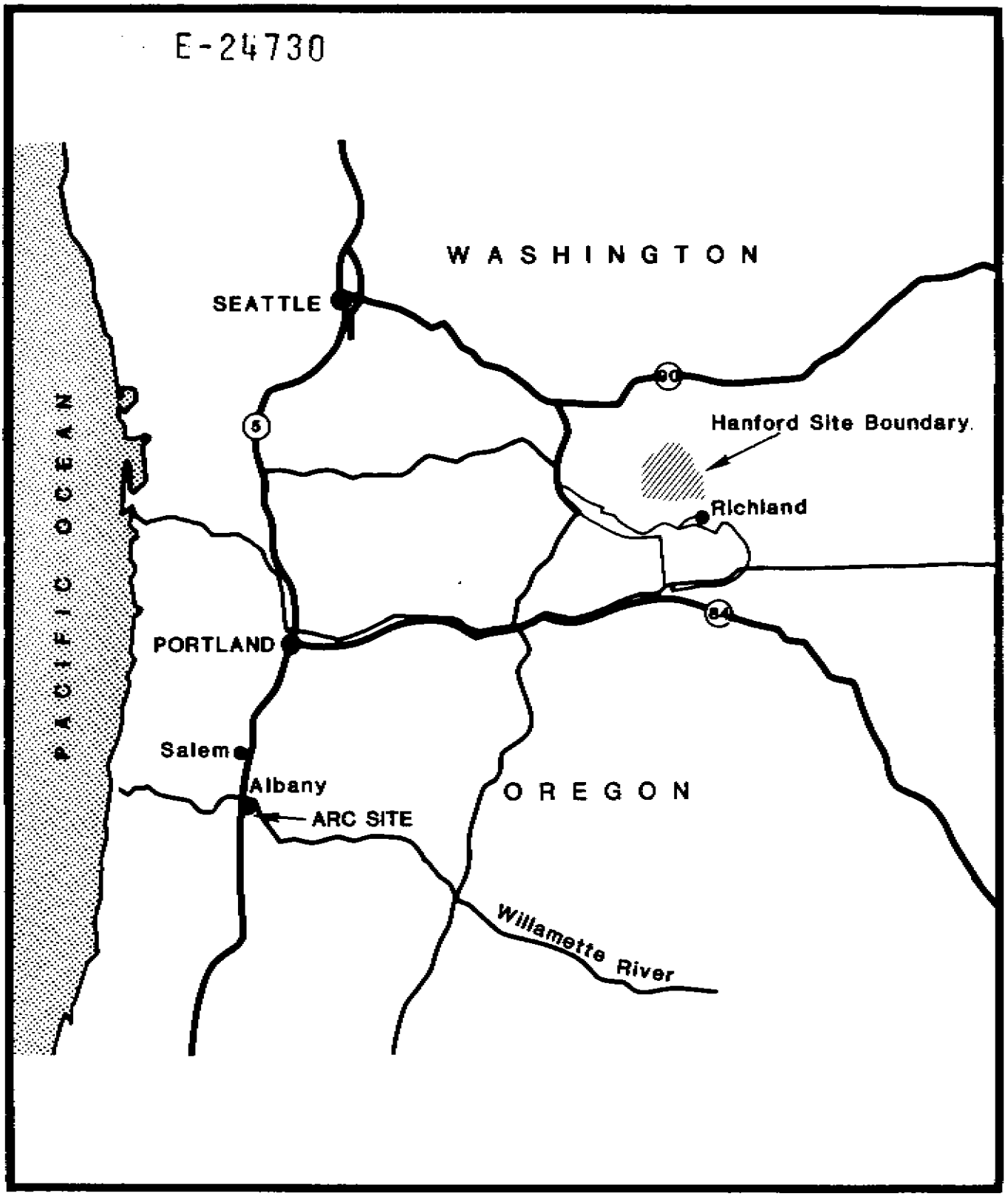

FIGURE 2-1 LOCATION OF ALBANY, OREGON IN RELATION TO RICHLAND, WASHINGTON

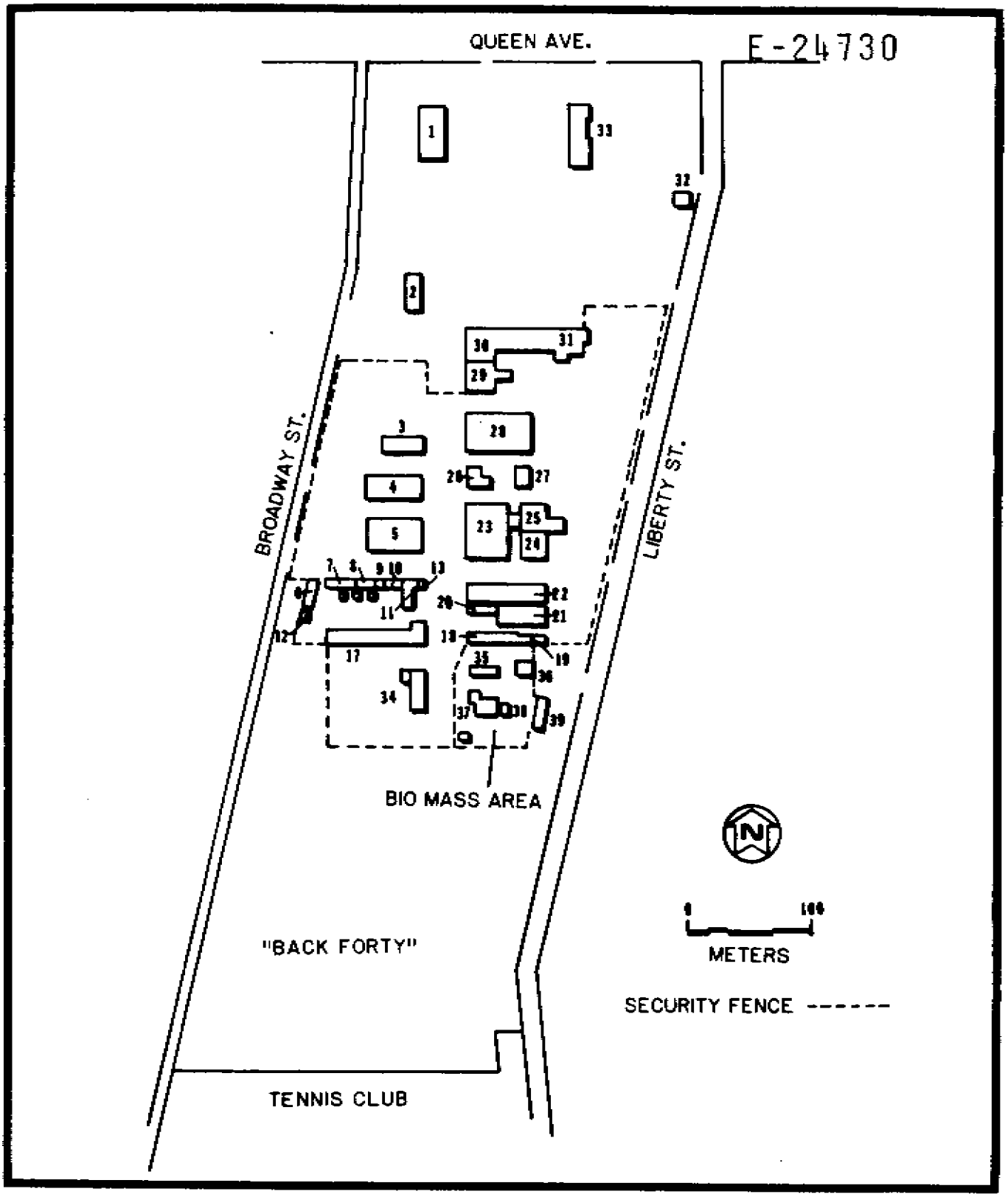

FIGURE 2-2 ALBANY RESEARCH CENTER (ARC) SITE

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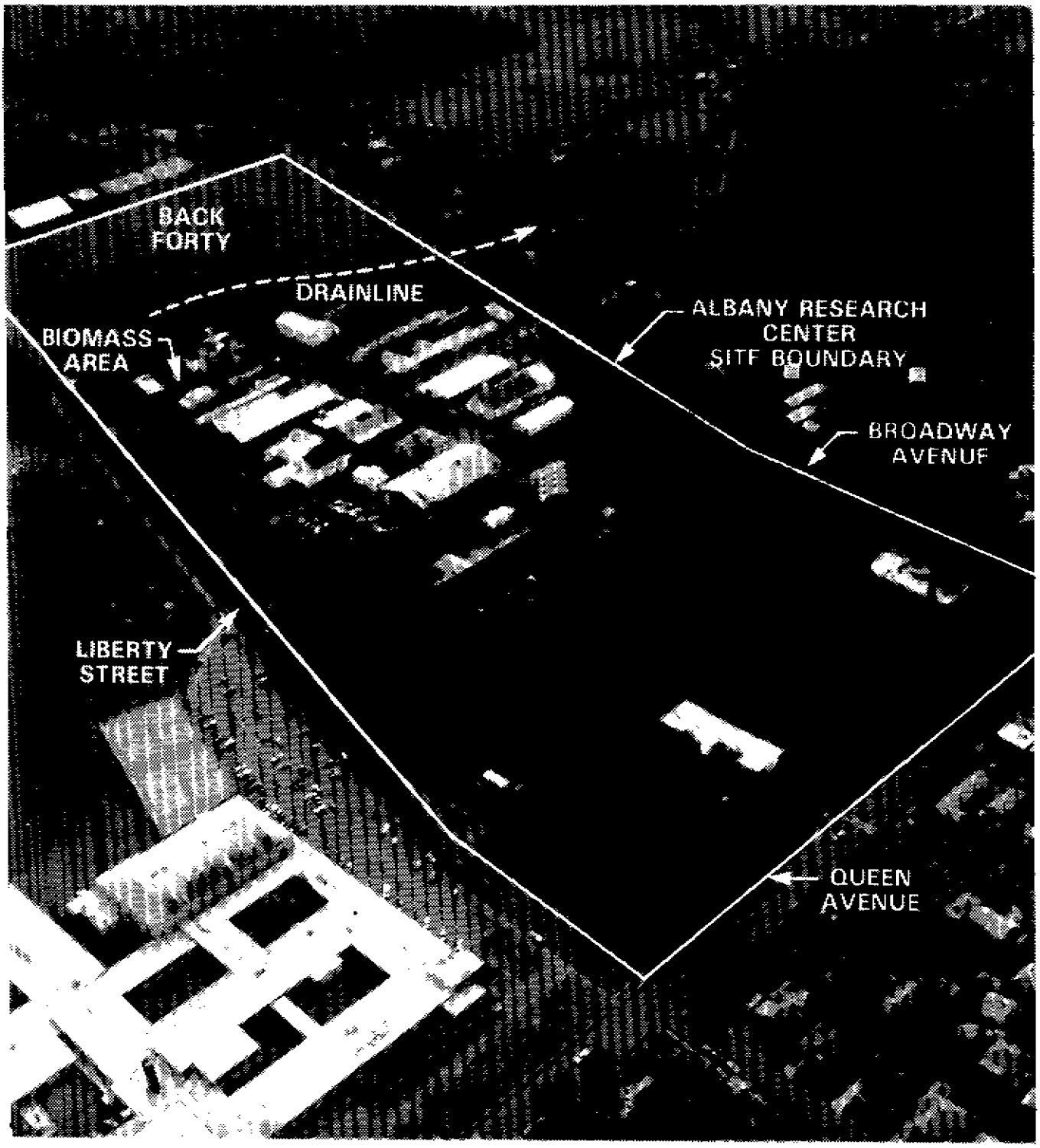

FIGURE 2-3 AERIAL PHOTOGRAPH OF THE ARC SITE
(LOOKING SOUTHWEST)

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2.2 HISTORY

The ARC is operated by the U. S. Bureau of Mines. Research on alloys of uranium and thorium started in 1955, involving metallurgical operations that included the melting, machining, welding, and alloying of thorium. Operations were suspended in 1978.

During the era of Manhattan Engineering District (MED) and U. S. Atomic Energy Commission (AEC) contracts, process buildings and surroundings were decontaminated at various times to the guidelines provided by the AEC. The decontamination guidelines provided at those times were not as specific as the guidelines in effect in 1978 when the work at the ARC was terminated, and the records relating to the decontamination effort were not adequate to determine if the buildings and surrounding areas met the 1978 DOE radiological guidelines. As a result, a radiological assessment of ARC was initiated by Argonne National Laboratory (ANL), Argonne, Illinois, in 1978 (Refs. 1 and 2). The results of this assessment are reported in Subsection 2.4.

2.3 SITE GEOLOGY AND HYDROLOGY

The geology of the Back Forty area at the ARC is characterized by soils overlying unconsolidated sediments and bedrock. Soils consist of various types of silt loam ranging from 0.3 to 1.5 m (1 to 5 ft) in depth. The soils have low permeability and are poorly drained.

Records of two wells located near the site show that a clay unit, approximately 4.5 to 7.5 m (15 to 25 ft) thick, is present below the soil horizon. Below the clay unit, gravel layers interspersed with materials that range from fine sand to clay are about 15 m (50 ft) to at least 55 m (180 ft) thick. The maximum thickness of the gravel unit is not known because the well terminates within the gravel unit (Ref. 4).

Three 4.5-m- (15-ft-) deep boreholes drilled at the corners of the Back Forty area in July 1983 also encountered clay overlying sand

and gravel (Ref. 5). The clay encountered at the site may represent the clays of the Willamette Silts, and the alluvial deposits below the clay may belong to the lower part of the older alluvium. The alluvial deposits overlie the sandstone of the Spencer Formation (Ref. 6).

Groundwater in the Albany area occurs under perched, confined, and unconfined conditions (Refs. 6 and 7). Groundwater contour maps of the Albany area indicate groundwater movement is in a northwesterly direction towards the Willamette River (Ref. 7). The three boreholes drilled at the site encountered water at a depth of 3 to 4.3 m (10 to 14 ft) below the present ground surface (Ref. 5). As a result of confining pressure caused by the clay unit, the water level rose to 1 to 2 m (3.0 to 6.5 ft) below grade level in one day. These water level measurements suggest that the clay unit at the site may be only 3 to 4.3 m (10 to 14 ft) thick. However, sufficient data are not available to confirm this. Static water level measurements suggest that groundwater in the Back Forty area may be flowing in a southwesterly direction, perhaps to the Calapooia River, which differs from the regional northwesterly flow direction.

The site-specific geohydrological investigations were done primarily by ANL (Ref. 5). Additional geologic and geophysical investigations will be required if a decision for final disposal other than on-site cannot be made based on this study. Selection of the On-Site Below-Grade alternative would also necessitate an additional geohydrologic investigation.

2.4 RADIOLOGICAL CONDITIONS

In several periods from June 1978 through September 1982, the Occupational Health and Safety Division of ANL performed a radiological assessment of the ARC site (Refs. 1 and 2). The findings are summarized in the following subsections.

2.4.1 Buildings

The radiological survey of the interior of the buildings revealed that 10 buildings have surface contamination in 44 separate locations (Ref. 2). Together, these locations cover an estimated 13 m^2 (140 ft^2). The maximum contact radiation reading associated with these contaminated locations was 1 mR/h. All measurements within the buildings for radon and daughters were below the 0.02 working level (WL) EPA standard (Ref. 8). The decontamination of the buildings is not included in this evaluation since it is a task common to all alternatives.

2.4.2 Grounds Contamination

Exterior surface contamination was found at 26 locations totaling 31 m^2 (334 $feet^2$) on unpaved areas and at 33 locations totaling 12 m^2 (129 $feet^2$) on paved areas.

The vertical extent of contamination was generally confined to the first foot of soil. The deepest contamination exceeding DOE guidelines was at a depth of 1 m (3 ft). The contamination consisted mainly of natural thorium, with lesser amounts of normal uranium.

The septic system behind Buildings 12 and 17 was sampled. The sludge taken from the septic tank had thorium-232 levels of 215 pCi/g and uranium levels of 10,400 pCi/g. The water in the tank had elevated uranium levels. For these reasons, the leach field also is presumed to be radioactively contaminated.

2.4.3 BioMass Facility

The BioMass Facility consists of five buildings on 0.8 ha (2 acres) of the ARC site. The buildings are not contaminated and are being demolished for other reasons by the Bureau of Mines. In September

1980, ANL conducted subsurface radiological investigations at the BioMass Facility and the Back Forty. A detailed radiological survey of structures, equipment, and materials at the BioMass Facility was completed by ANL two years later (Ref. 1).

The ANL subsurface investigations consisted of taking and analyzing two "environmental" soil samples 10 cm in diameter and 30 cm deep (4 in. x 12 in.) and eight borehole samples drilled to 3-m (10-ft) depths. This investigation revealed contamination consistent with the use of the area as a waste dump. Two soil corings revealed elevated levels of thorium-232, radium-226, and uranium-238 at the 0.3 m (1 ft) depth. An auxiliary sample taken from a ditch at the 0.3 m (1 ft) depth also revealed elevated levels of uranium-238 and radium-226. Analysis of the soil borings indicated that the contamination is subsurface, occurring mostly in the first 1.2 m (4 ft), with the primary contaminants being natural thorium and normal uranium.

Gamma spectral analysis of a water sample taken from an American Petroleum Institute (API) Oil Separator revealed the presence of a contaminant in the suspended solids. The level of activity reported is insignificant as a health hazard but could be indicative of contamination in the BioMass Facility sewer and drain lines (Ref. 1).

2.4.4 Back Forty Area

The Back Forty is a vacant field approximately 5.7 ha (14 acres) in size. During 1979-1980, ANL performed a surface and subsurface radiological survey of the area (Ref. 1). The subsurface investigations consisted of taking and analyzing seven "environmental" soil samples 10 cm in diameter and 0.3 m deep (4 x 12 in.), and eighteen borehole samples drilled to 3-m (10-ft) depths. As a result of the survey, 0.3 ha (0.8 acre) of the area was identified as being radioactively contaminated.

A water sample taken from a borehole which exhibited the highest level of contamination in the Back Forty did not show abnormal

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(significantly above background for the Albany area) levels of radioactivity. However, this should not be considered to be indicative of chemical stability of the contamination. Since the water table in the area seems to overlap the contamination, at least during some times of the year, the possibility of subsurface lateral migration cannot be ruled out.

2.5 RADIOLOGICAL SURVEY PLANS

During the period from February to April 1984, Bechtel National, Inc. (BNI), will perform additional site radiological characterization work to: (1) accurately determine the extent of activities necessary to decontaminate the site to current DOE guidelines; and (2) further refine the estimate of the volume of radioactive waste to result from decontamination activities.

2.6 CHEMICAL CONDITIONS

Present documentation does not indicate either the presence or absence of hazardous chemicals in the radioactively contaminated areas. This evaluation assumes that no hazardous chemicals are mixed with the radioactively contaminated material. During the radiological survey, samples will be taken to affirm (or deny) the validity of this assumption. Any commingled (radioactive mixed) waste encountered during remedial action would be disposed of in accordance with applicable requirements. Should the treatment of commingled waste be required, the cost impact could be significant, depending on the quantity of material and type of chemicals involved. Treatment cost was assumed to be common to each alternative, and excluded from the cost comparison.

E-24730 3.0 REMEDIAL ACTION

3.1 REMEDIAL ACTION GUIDELINES

The radiological guidelines determined by DOE to be applicable to cleanup, storage and/or disposal of radioactive materials under FUSRAP are presented in Appendix A.

3.2 REMEDIAL ACTION ALTERNATIVES

The alternatives identified by DOE for consideration in this report are:

- On-Site Above-Grade Disposal
- On-Site Below-Grade Disposal
- Transport to Hanford, Washington

All three alternatives would require virtually the same support facilities and operational controls. These requirements will not be discussed in detail.

All three alternatives would require the excavation of contaminated soil and the removal of contaminated materials from facilities at the site. These radioactively contaminated wastes would be consolidated and placed in either an above-grade or a below-grade engineered permanent disposal facility on the ARC site, or transported to the Hanford Reservation near Richland, Washington.

The volumes of contaminated material used for this evaluation were based on ANL data (Refs. 1 and 2). ANL estimated the volume of contaminated soil by two methods. One approach used the maximum measured depth of contaminated soil to compute volume, which resulted in an estimated volume of about 23,700 m^3 (31,000 yd^3). This volume is considered to be an upper limit. Another ANL approach estimated volume based on average depths of

contamination. This method resulted in an estimated volume of about 13,500 m^3 (17,000 yd^3). At present, this is considered to be the most likely estimate of the volume of contaminated material at the ARC site. In addition, ANL defined "contaminated material" as "any material with radioactive concentrations above background." Hence the most likely volume may include material below the present DOE criteria for remedial action.

For this report, two volumes were selected as the bases for estimating costs and otherwise evaluating the alternatives from a cost sensitivity perspective. These volumes, 10,000 m^3 (13,000 yd^3) and 23,000 m^3 (30,000 yd^3) were chosen to provide reasonable lower and conservative upper margins by which the most likely volume, 13,500 m^3 (17,000 yd^3) may vary. The upper range of variance is greater because experience at other sites has shown that actual volumes of contamination are more likely to be higher than the estimated volume. The volumes used by BNI to estimate remedial action alternative costs were selected as reasonable upper and lower bounds for the cost estimates, based on limited BNI site investigations subsequent to the ANL surveys. If actual waste volume is greater than 23,000 m^3 (30,000 yd^3), the cost estimates can be extrapolated linearly up to a waste volume of at least 38,000 m^3 (50,000 yd^3). The 10,000 m^3 (13,000 yd^3) is considered to be a minimum value. Extrapolation of cost for lower volume is not straightforward because of the influence of significant fixed cost. Hence, the lower value of 10,000 m^3 (13,000 yd^3) was selected to provide a good lower cost limit.

3.2.1 On-Site Above-Grade Disposal

The Back Forty area (excluding the contaminated area) is considered to be the least disturbed portion of the ARC site and has been chosen as the best place to locate the disposal facility. This area, measuring 240 x 300 m (800 x 1000 ft), forms a slightly irregular parallelogram providing sufficient area for a waste disposal facility with a 30-m (100-ft) buffer zone.

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The basic features of the On-Site Above-Grade Disposal facility would include a low-permeability (10^{-7} cm/sec) bottom liner with a low-permeability multi-layer sidewall and top liner.

Figure 3-1 shows plan and sectional views of the above-grade disposal facility for the maximum waste volume case of 23,000 m^3 (30,000 yd^3). This facility is 190 x 190 m (630 x 630 ft); the waste would occupy an area 150 x 150 m (500 x 500 ft) within the facility. This design is generic and has been accepted by the DOE for other sites. It has not been tailored for the ARC site. The layered cap consists of 46 cm (18 in.) of topsoil, underlain by 15 cm (6 in.) of sand and gravel transition, 1 m (3 ft) of riprap, another 15 cm (6 in.) of sand and gravel transition, and 1.5 m (5 ft) of compacted clay. The minimum slope to provide surface drainage is 5 percent. The maximum slope at the sides of the containment is 20 percent. The combined thickness of the layered cap would be 3.2 m (10.5 ft). This thickness would provide excess protection from gamma radiation, radon emanation, and beta-gamma activity from radon daughters from the waste. The thickness is dictated primarily by the clay required to prevent saturation of the waste from surface infiltration, the materials required for inadvertent intruder/biointrusion barriers, and topsoil for a vegetative cover. Because only low amounts of radium-226 are present, radon gas (radon-222) would not be a problem during the design life of the disposal facility. Emanation of radon gases in the uranium and thorium decay chains through the entire cap is unlikely due to the short half-life of radon-222 (3.8 days) and radon-220 (55 seconds) (Ref. 9).

3.2.2 On-Site Below-Grade Disposal

The On-Site Below-Grade Disposal alternative is similar to the above-grade disposal alternative, except the waste disposal location at the site would be excavated to a depth of 1.4 m (4.5 ft) over an area of approximately 120 x 150 m (400 x 500 ft), assuming a 23,000 m^3 (30,000 yd^3) volume of waste. The areal extent of the

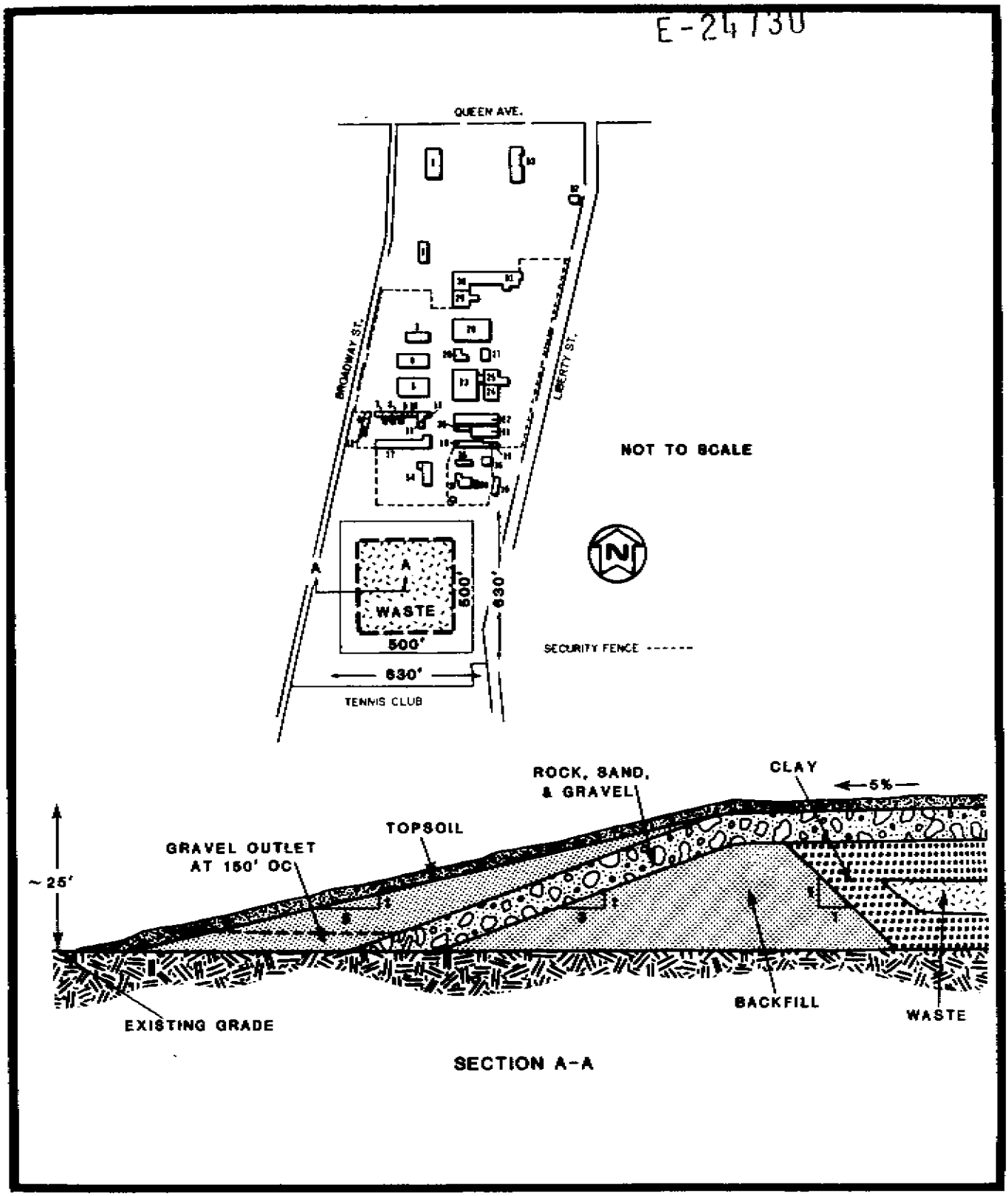

FIGURE 3-1 ABOVE-GRADE WASTE DISPOSAL FACILITY

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cap would be 150 x 180 m (500 x 600 ft), primarily due to cap thickness and slope considerations. The existing ground would be excavated, temporarily stockpiled on-site, and used for backfill over the buried waste to provide the necessary slope for cap surface drainage. The walls would consist of the existing clay and would be extended above ground with additional clay to form a continuum with the clay layer of the engineered cap/drainage cover. A cap similar to that described for the above-grade alternative would be placed over the compacted backfill. Figure 3-2 illustrates the basic design features for this alternative.

The dimensions given above for the below-grade facility would be optimized in final design after the existing clay depth and quality were determined by geological investigations. If the water table precluded excavating the existing ground to the full depth of 1.4 m (4.5 ft), the above-grade capacity could be utilized for waste disposal rather than backfill. This would present a disposal configuration partially below-grade and partially above-grade.

It is emphasized that this alternative assumes that the existing site subsoil consists of a clay suitable for waste containment, and that engineered clay bottom and sidewalls are not required. Should future geotechnical evaluation show that this is not the case, the cost of this option would rise substantially. The cost increase would result from the cost of the imported clay and from the additional excavation and earthwork required for constructing the 1.4 m (4.5 ft) thick clay bottom and side walls.

The drainage cover design would be essentially the same as described in On-site Above Grade, except the amount of cover material required would be less. Due to slope and cover depth considerations, the area covered by a below-grade structure also would be somewhat less than for an above-grade structure.

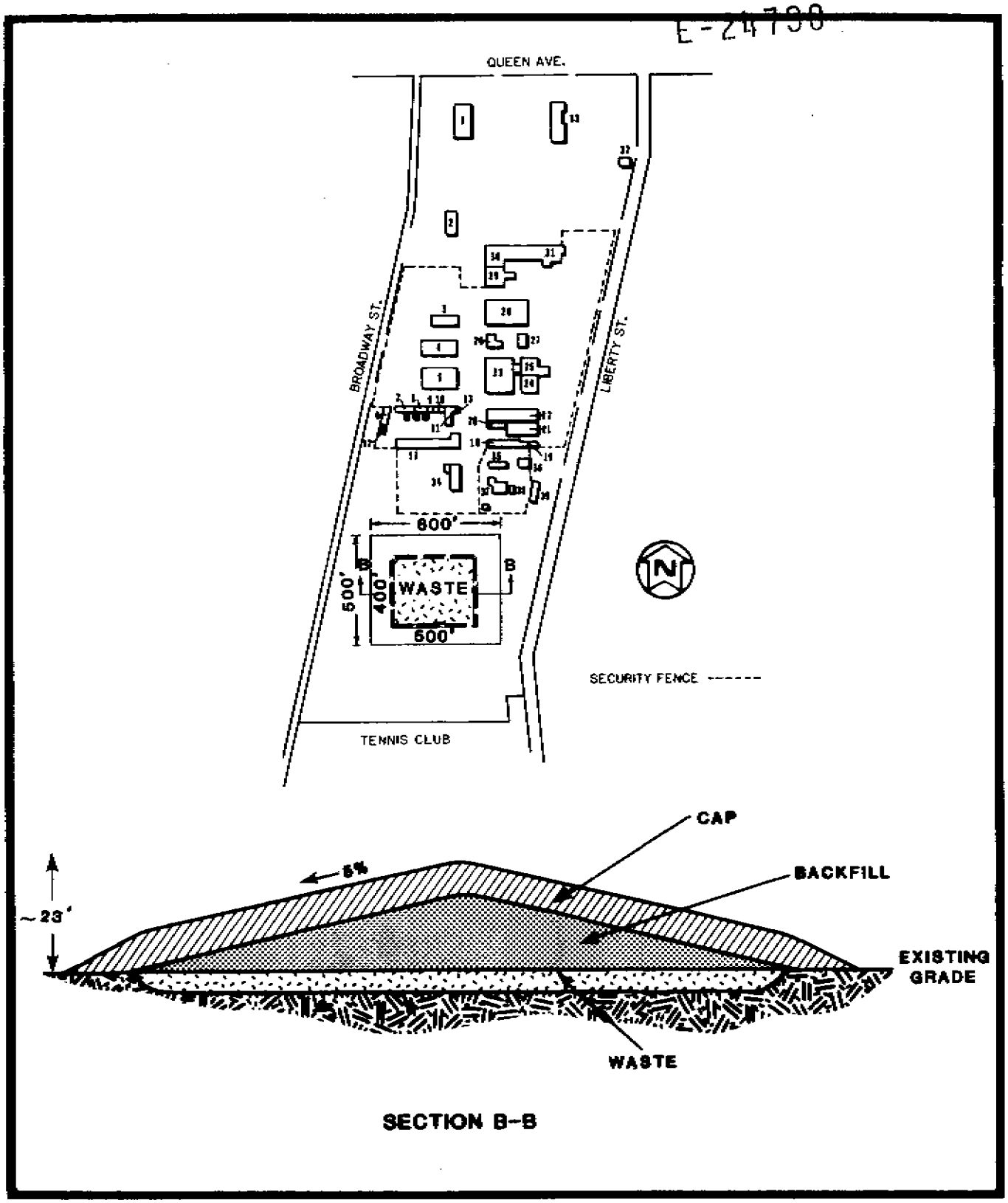

FIGURE 3-2 BELOW-GRADE WASTE DISPOSAL FACILITY

3.2.3 Transport to Hanford

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This alternative would result in the removal of radioactive material which exceeds current DOE guidelines and would allow the ARC site to be released for unconditional use from a radiological standpoint. Contaminated materials would be removed to the extent necessary to comply with DOE radiological guidelines (Appendix A). All of the collected wastes would be shipped to the Hanford Reservation near Richland, Washington for permanent disposal at the DOE waste disposal facility.

After the ARC site had been decontaminated to below the current DOE radiological criteria, the site would be restored to conditions suitable for future use of the buildings and grounds. It is assumed that after decontamination the buildings would be restored as necessary to original conditions. The excavated areas would be backfilled as necessary, graded and reseeded.

4.0 EVALUATION OF ALTERNATIVES

4.1 BASIS

Each alternative has been evaluated on the basis of four general factors: (1) advantages/disadvantages; (2) radiological and safety hazards; (3) schedule; and, (4) cost. The evaluation does not include the decontamination of the existing buildings and the radiological survey, common to all alternatives. Hence, the cost presented for each alternative is not the total cost for the cleanup of the entire ARC site. The basis of the estimate (qualifications, assumptions, inclusions, exclusions, etc.) are contained in Appendix B.

4.2 ON-SITE ABOVE-GRADE DISPOSAL

4.2.1 Advantages/Disadvantages

The above-grade disposal facility's advantage is that it can be used even where there are high groundwater levels. There are several disadvantages, including: the susceptibility to erosion; the required long-term maintenance; the probable adverse public reaction toward a permanent radioactive waste disposal site located near a school and residential area; and the restriction on future use of the property.

4.2.2 Radiological and Safety Hazards

The excavation and storage of the contaminated material would not constitute a health hazard to either the general public or to the workers. The haul distances would be very short and entirely on the ARC site, so no transport over public roads would be required.

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4.2.3 Schedule

The schedule for the On-Site Above-Grade Disposal alternative can be broken into pre-construction and construction phases. For either of the estimated volumes, the National Environmental Policy Act (NEPA) process for permanent on-site disposal would require about 28 months (Ref. 10). This would be the critical task and would dominate the first phase of the schedule. The construction phase, based on 9 months per year, would require about 18 months for the 10,000 m^3 (13,000 yd^3) volume and 24 months for the 23,000 m^3 (30,000 yd^3) volume. If the construction period were less than 9 months per year, the schedule would lengthen and overall project cost would increase. Surveillance and maintenance are considered to be required for a minimum of 200 years.

4.2.4 Cost

Table 4-1 reflects the order of magnitude cost estimate for the On-Site Above-Grade Disposal alternative.

Preparation of an Environmental Impact Statement (EIS) spanning 28 months was assumed and was estimated at $500,000 for either disposal volume. This figure includes ANL preparation cost and BNI support cost.

The surveillance and maintenance cost is based on $755,000 for the first 5 years and $35,000 per year for the following 195 years. The surveillance and monitoring cost for the first five years would include active air and groundwater monitoring programs that would establish baseline data and insure satisfactory facility performance. It would also include the cost of possible minor repairs to the cap. After the initial five year period, surveillance and maintenance costs would be for routine caretaker operations and periodic data analysis. The $35,000 per year annual cost results in a present value cost of $1,163,000 based on an assumed real interest rate of 3 percent.

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TABLE 4-1

ON-SITE ABOVE-GRADE DISPOSAL COST[a]

Item	Activity	Cost ($1,000) 10,000 m^3 (13,000 yd^3)	23,000 m^3 (30,000 yd^3)
1.0	Radiological Characterization, Engineering, NEPA Process (EIS), Radiological and Construction Management	$2,480	$ 2,840
2.0	Site Preparation[b] (Water treatment, decontamination facilities, utilities, etc.)	85	85
3.0	Excavation and Placement of Waste (containment structure, dewatering, backfilling, restoration, etc.)	2,700	4,190
4.0	Transportation and Disposal of Waste	--	--
5.0	Surveillance and Maintenance (security fence, mowing, radiological monitoring, maintenance, etc.)	1,885	1,885
	SUBTOTAL	$7,150	$ 9,000
	Escalation	930	1,530
	Contingency (15%)	1,210	1,580
	TOTAL	$9,290	$12,110

[a]Not total cost for cleanup of entire site.

[b]Excluding possible property acquisition cost of $168,000 (est.)

The cost of the land may also be a factor. Federal Property Management Regulation 101-47.203-7(f) implies that the fair market value of the land acquired by one government agency from another must be paid unless a waiver or exemption is granted. Based on an estimated value of $12,000 per acre, the 14 acres needed for the disposal site could cost $168,000. The $12,000 per acre cost was assumed to be fair market value for the property. This value was selected based on informal discussions with a realtor and land appraiser and actual sale prices for land adjoining the site. The land for the tennis club located at the south end of the site sold for $12,000 per acre.

4.3 ON-SITE BELOW-GRADE DISPOSAL

4.3.1 Advantages/Disadvantages

The uncertainty in the clay layer induces significant technical risk for this alternative. The cost estimate assumes the existing clay base is an acceptable liner; however, additional subsurface investigation would be required for confirmation. Additionally, the water table varies seasonally and there are indications it is occasionally near the surface. These factors would require extensive dewatering for excavation of the containment structure and could mean that periodically the water table would be higher than the bottom of the disposal pit, a highly undesirable condition for waste containment.

4.3.2 Radiological and Safety Hazards

The same comments apply for below-grade disposal as were discussed for above-grade (Subsection 4.2.2).

4.3.3 Schedule

The same NEPA process requirements which would exist for above-grade disposal (28 months) would exist for this alternative and would be

the critical pre-construction task. The construction period for below-grade disposal would be longer than above-grade for both selected volumes, because the pit would require excavation prior to relocation of the contaminated materials. The below-grade approach would require 33 months for the 10,000 m^3 (13,000 yd^3) and 39 months for the 23,000 m^3 (30,000 yd^3) volume. Adverse weather could significantly increase the construction time, resulting in additional costs due to escalation. If the construction period were less than 9 months per year, the schedule would lengthen and overall project costs would increase.

4.3.4 Cost

Table 4-2 reflects the order-of-magnitude cost estimate for the below-grade disposal alternative.

A significant cost is derived from the additional construction year required to complete this option. Dewatering for the pit would also be a major cost since the groundwater is near the surface most of the year.

The cost comments for above-grade disposal (Section 4.2.4) concerning NEPA, surveillance and maintenance, and land acquisition also apply to the below-grade alternative.

4.4 TRANSPORT TO HANFORD

4.4.1 Advantages/Disadvantages

There are several advantages for decontaminating the site and transporting the waste to Hanford. There would be no requirement for an on-site permanent disposal facility, so no long term maintenance would be required. The land could be released for unconditional use such as a park/recreational area. There would not

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TABLE 4-2

ON-SITE BELOW-GRADE DISPOSAL COST[a]

Item	Activity	Cost ($1,000) 10,000 m^3 (13,000 yd^3)	Cost ($1,000) 23,000 m^3 (30,000 yd^3)
1.0	Radiological Characterization, Geological Investigation, Engineering, NEPA Process (EIS), Radiological and Construction Management	$ 3,410	$ 3,790
2.0	Site Preparation[b] (Water treatment, decontamination facilities, utilities, etc.)	210	210
3.0	Excavation and Placement of Waste (containment structure, dewatering, backfilling, restoration, etc.)	2,300	3,530
4.0	Transport and Disposal of Waste	--	--
5.0	Surveillance and Maintenance (security fence, mowing, radiological monitoring, maintenance, etc.)	1,885	1,885
	SUBTOTAL	$ 7,805	$ 9,415
	Escalation	1,325	1,975
	Contingency (15%)	1,370	1,710
	TOTAL	$10,500	$13,100

[a]Not total cost for cleanup of entire site.

[b]Excluding possible property acquisition cost of $168,000 (est.)

be as much adverse public reaction to this option and some indication has been made to the public that the material would be moved to the Hanford Reservation.

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4.4.2 Radiological and Safety Hazards

There is no radiological danger to the general public or workers from the contaminated material. However, the transport of 10,000 to 23,000 m^3 (13,000 to 30,000 yd^3) of contaminated soil does increase the risk to the general public, since at least 350,000 truckmiles will be required to transport the waste to the disposal site. The radiological hazard to the public for the transport option is minimal for the 350,000 truckmiles, but is greater than if no movement over public roads is made.

Truck transport of the bulk waste would be done in covered tractor trailer dump trucks with gasketed tailgates. The engineered containment (i.e. sealed tailgates and covered trailers) of the contaminated materials coupled with procedural controls such as frequent inspection of the trucks during transport, will insure that no minor leakage of material occurs. Any major release (i.e. accident or mechanical failure) will be promptly cleaned up. These steps preclude the requirement for extensive radiological monitoring along the travel route to Hanford. Weight restrictions would limit the volume of waste transported in 15 m^3 (20 yd^3) trucks to approximately 10 m^3 (13 yd^3).

Occupationally, the worst case exposure would be to the truck driver, at less than 1.0 mrem per trip. A driver would have to make 500 trips per year to reach a dose rate of 500 mrem per year.

The highest risk would be highway safety. Assuming a 1130 km (700 mi) round trip and the 10,000 m^3 (13,000 yd^3) estimated volume, about 1,000 trips would be required, for a total of 700,000 round trip road miles. (The trucks would contain no waste on return trips.) The National Highway accident rate would indicate

1.2 accidents and the probability of 0.03 fatalities. The 23,000 m^3 (30,000 yd^3) case would be about 2.3 times these values or 2.8 accidents, with the probability of 0.08 fatalities. The accident rate is based on yearly activities which include both good and bad weather conditions.

4.4.3 Schedule

For the transport alternative, the NEPA process would probably require only an ADM/EA, a 4 to 6 month effort. The preconstruction phase would be limited to radiological definition of the site, engineering and procurement activities, requiring a total of about 12 months. The construction phase would require 18 months for the 10,000 m^3 (13,000 yd^3) volume and 24 months for the 23,000 m^3 (30,000 yd^3) volume. The impact of a construction period shorter than 9 months per year due to inclement weather could be minimized by stockpiling the material in good weather and continuing transport throughout the year.

4.4.4 Cost

Table 4-3 reflects the order-of-magnitude cost estimate for the Transport to Hanford alternative.

The ADM/EA can be expected to require only a limited effort by ANL, and only $50,000 is estimated. The principal costs are derived from the disposal fee and transportation cost. No radiological monitoring along the route would be required (see Subsection 4.4.2).

A cost of $4.10 per ft^3 was used for the disposal fee at the DOE facility in Hanford, Washington. Weight restrictions would limit the volume of waste transported in 15 m^3 (20 yd^3) trucks to approximately 10 m^3 (13 yd^3). The transportation cost was based on leasing sufficient quantities of trucks with drivers by the hour, which is less costly than contracting by the ton-mile. Purchase of

TABLE 4-3

TRANSPORT TO HANFORD COST[a] F-24730

Item	Activity	Cost ($1,000) 10,000 m^3 (13,000 yd^3)	23,000 m^3 (30,000 yd^3)
1.0	Radiological Characterization, Engineering, NEPA Process (EA/ADM), Radiological and Construction Management	$1,680	$ 2,015
2.0	Site Preparation (Water treatment, decontamination facilities, utilities, etc.)	85	85
3.0	Excavation of Waste (dewatering, backfilling, restoration, etc.)	850	1,300
4.0	Transport and Disposal of Waste	2,585	5,960
5.0	Surveillance and Maintenance	200	200
	SUBTOTAL	$5,400	$ 9,560
	Escalation	540	1,240
	Contingency (15%)	890	1,620
	TOTAL	6,830	$12,420

[a]Not total cost for cleanup of entire site.

trucks and trailers was not considered in this cost estimate. The distance from the ARC to the Hanford disposal site was estimated at 565 km (350 miles). No long-term surveillance would be required. However, costs are included to reflect environmental monitoring required during construction. Cost of land is not a factor since the waste is being removed from the site for disposal.

Table 5-1 compares in summary form the three alternatives. For the 10,000 m^3 (13,000 yd^3) volume of waste, the Transport to Hanford alternative is the least costly, is low risk, has the shortest construction schedule, and would likely have greater public acceptance. For 23,000 m^3 (30,000 yd^3) volume, the Transport to Hanford alternative costs slightly more than the the On-Site Above-Grade alternative, with a shorter construction schedule. The On-Site Below-Grade alternative would be most expensive for the entire range of volumes considered.

Figure 5-1 depicts the range of the order-of-magnitude cost estimates versus waste volume quantities for the three alternatives. The ranges are illustrated as linear, however, this is an approximation that was made to simplify analysis and presentation of the three alternatives. Based on Figure 5-1, the Transport to Hanford alternative appears to be the most cost effective for waste volumes up to 21,500 m^3 (28,000 yd^3).

Schedule is also a strong factor favoring the Transport to Hanford alternative. Hauling activities would not be adversely affected by rainy weather because the contaminated material could be stockpiled during dry seasons and loaded and transported during dry periods in the rainy season. For the on-site disposal alternatives, rain would be a serious problem that could hamper construction of the containment structure. Additionally, for the below-grade alternative, an extensive dewatering system would be required to permit construction of the containment structure and placement of wastes.

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TABLE 5-1

COMPARISON OF ALTERNATIVES

Item	On-Site Above-Grade	On-Site Below-Grade	Transfer to Hanford	Remarks
Advantages/Disadvantages				
Risk	Low	High	Low	Uncertainty in Geology/Water Table.
NEPA	EIS	EIS	ADM/EA	
Public Opinion	Negative	Negative	Positive	
Site Use	Restricted	Restricted	Unrestricted	
Radiological Hazard				
Occupational	None	None	Very Low	Driver exposure. More than on-site but still negligible.
Public	None	None	Negligible	
Safety				
Highway Accidents				
10,000 m^3	None	None	1.2	Probability of less than 0.1 fatalities.
23,000 m^3	None	None	2.8	
Schedule				
10,000 m^3	46 mos.	61 mos.	30 mos.	Schedule based on a 9-mo./year construction period.
23,000 m^3	52 mos.	67 mos.	36 mos.	
Cost (x $1000)				
10,000 m^3 Volume	$ 9,290	$10,500	$ 6,830	Not total cost for cleanup. Fair market price could be $168,000.
23,000 m^3 Volume	$12,110	$13,100	$12,420	
Land Acquisition	Required	Required	N/A	

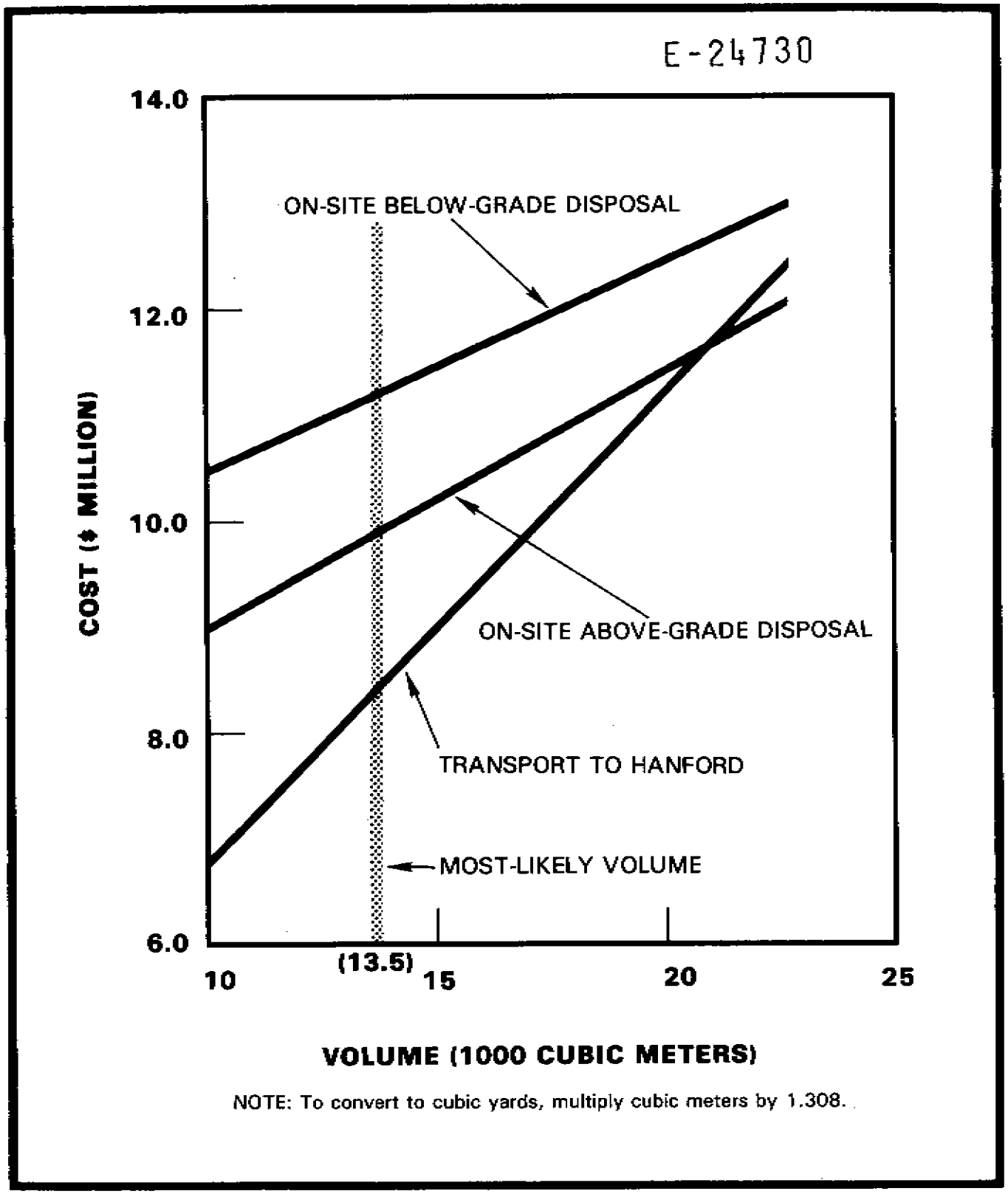

FIGURE 5-1 COMPARATIVE COST VS WASTE VOLUME FOR THE ARC SITE

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APPENDIX A E-24730

RADIOLOGICAL GUIDELINES FOR THE FINAL DISPOSITION OF THE ARC SITE

Table A-1 summarizes the current radiological guidelines for the ARC site. This summary is from the "Design Criteria for Formerly Utilized Sites Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP) Project (Draft)," prepared by the U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN March 1984.

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TABLE A-1

RADIOLOGICAL GUIDELINES FOR THE FINAL DISPOSITION OF THE ARC SITE

Subject	Guidelines	Source
Control of Wastes		
Longevity of waste containment area	Up to 1000 years to the extent reasonably achievable, but at least 200 years.	40 CFR 192.02[a]
Radon emissions from waste containment area	20 pCi/m^2-s or 0.5 pCi/l in air outside of the waste containment area	DOE Design Criteria[a] (Appendix C, Rev. 1)
Water Protection		
Surface water discharge (uncontrolled areas)	U-238 - 600 pCi/l Ra-226 - 30 pCi/l Ra-228 - 30 pCi/l Th-230 - 2000 pCi/l Th-232 - 2000 pCi/l	DOE Order 5480.1A (Chapter XI) (Converted from uC/ml)
In community water systems	Ra-226 and Ra-228 - 5 pCi/l	40 CFR 141.15[a]
Soil Decontamination		
Ra-226 Ra-228 Th-230 Th-232	5 pCi/g in the 15 cm surface layer[b] 15 pCi/g in any 15 cm layer beneath the surface layer	40 CFR 192.12[a] DOE Design Criteria[a,c]
Uranium	150 pCi/g (total uranium)	
Building Decontamination		
Indoor radon decay products	0.03 working level (WL) in any habitable area within the structure; to the extent practicable, achieve 0.02 WL	40 CFR 192.12[b]
Facilities/Equipment Surface Decontamination	0.2 mR/h (average) 1.0 mR/h (maximum)	NRC Guidelines[d]
Transport of Wastes		
Exposure rates	Not to exceed 10 mR/h at a distance of 2 m (6 ft) from the vehicle side and 2 mR/h at any normally occupied position.	49 CFR 173
Transport containers	For design and licensing	DOE Order 5480.1A Chapter III DOE Order 1540.1

TABLE A-1

(Continued)

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Subject	Guidelines	Source
Waste Disposal Site		
Maintenance and surveillance[e]	Includes maintenance, surveillance, and environmental monitoring	DOE Order 5480.1A Chapter XI[f]

[a]U.S. Department of Energy. Design Criteria for Formerly Utilized Site Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP) Project (Draft), 14501-00-DC-01-07. Oak Ridge Operations Office, Oak Ridge, TN, March, 1984.

[b]Above background level.

[c]Keller, E. L. Letter to R. L. Rudolph, Bechtel National, Inc., Oak Ridge, TN. Subject: Criteria for cleanup of sites contaminated with thorium and decay products. U.S. Dept. of Energy, Oak Ridge Operations, Oak Ridge, TN, July 10, 1984.

[d]U. S. Nuclear Regulatory Commission 1982 Guidelines for Decontamination of Facilities and equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material. Division of Fuel Cycle and Material Safety, Washington, DC., 1982.

[e]Assumed to continue for the design life of the waste containment area.

[f]Although not specifically addressed, the need for maintenance and surveillance is implied.

APPENDIX B

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BASIS OF COST ESTIMATE

GENERAL QUALIFICATIONS AND ASSUMPTIONS

The estimates were developed based on the following qualifications and assumptions. Changes to the qualifications will result in changes in the estimate.

- Sufficient qualified labor is available to support construction needs and schedule requirements.
- In general, a basic 40-hour week will be worked, with no scheduled shift-work in the construction schedule.
- Construction activities were based on 14 effective work days per month, 9 months per year. Work generally will be conducted continuously from mid-March through mid-December.
- Access is available to work areas.
- All required utilities are available at the facility.
- Field contractor's profit and indirect costs are estimated at 15 percent of the total cost.
- Suitable materials for the final cover and off-site borrow for site restoration are available within a 40-km (25-mi) radius of the ARC site.
- The cost estimate for each alternative was based on volumes of waste extrapolated from available data and is subject to change pending receipt of more current and complete information.
- Costs are for BNI, its subcontractors and ANL.

NCLUSIONS

- Site preparation and facilities to support construction, i.e., access roads, decontamination pads, and retention ponds (as required)
- Field contractor's indirects (mobilization, special equipment and repairs, management expenses, and special allowances)
- Purchase and operating cost of water treatment equipment (as required)

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- o Lease and operating cost of transport vehicles
- o Waste disposal cost at Hanford
- o Storage pads (where required)
- o Administrative support
- o Technical support
- o Site restoration.

EXCLUSIONS

- o Taxes (local, state, and federal)
- o Purchase of earthmoving equipment and transport vehicles
- o Effects of possible governmental funding restraints
- o Decontamination of existing buildings
- o Radiological survey
- o Vicinity property decontamination
- o Relocation/Rework of existing on-site electrical, overhead transmission lines
- o Treatment of commingled (chemical and radioactive) waste (if present)

ESTIMATE DEVELOPMENT BASIS

GENERAL

Costs in this estimate are based on first quarter FY84 pricing with escalation to the construction midpoints added as a bottom line adjustment. The estimate reflects the costs for completing the work within the time frame of the construction schedule. The contractor's field costs — major equipment, bulk materials, labor, and indirect costs — are based upon estimates, vendor quotations, and labor agreements in effect at the estimate base date of first quarter FY84.

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- Major Equipment Rental

  All major equipment rental cost is based on local quotations and national publications.

- Bulk Materials

  Bulk material costs are based upon informal vendor quotations, suppliers' price data, and historical cost data. The quantities were determined by takeoffs.

- Direct Labor

  The manual labor hours were developed by utilizing unit man-hour or crewing concepts. The work week is based on 40 hours per week for most operations.

- Contractor's Indirects
  The estimate of the contractor's indirects was developed based on the total package being awarded to a prime contractor who will be responsible for all work at any one site. Development of the costs for the contractor's home office support, field supervision, temporary buildings and utilities, construction equipment, support labor, overhead, and profit cover all work associated with this estimate.

- Common Indirects and Construction Management

  No allowance is made in this estimate for any common indirect facilities or functions that may be supplied or required by DOE.

- Escalation

  The escalation amount is an average that was computed based on the midpoint of the design and construction schedules. The escalation was applied at a rate of 5.5 percent for FY84 and 7 percent for FY85 and subsequent years per DOE guidance.

- Contingency

  Contingency of 15% was used since the cost estimates were not developed for budget purposes but for comparison of different methods/techniques based on selected waste volumes, and the cost estimates were developed to a larger degree of detail than that normally used for order of magnitude (ROM) estimates.

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NE-24

Preliminary Engineering Evaluation - Albany Research Center, Albany, OR, (April 1985)

Robert Atkin
Oak Ridge Operations Office

The resolution to our comments on the subject report are satisfactory, as is the special note in the front of the report. The report may be issued.

If there are any questions, please call me on FTS 233-5439.

/s/ Gale Turi

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