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SCOPING INVESTIGATION OF SHORT-TERM STORAGE COSTS FOR AFRIMET RESIDUES - NFSS AND FMPC SEPTEMBER 29, 1980 (USED AS A REFERENCE IN THE OU4 RI REPORT)

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SCOPING INVESTIGATION OF

SHORT-TERM AND LONG-TERM STORAGE COSTS FOR

AFRIMET RESIDUES — NFSS AND FMPC

FEED MATERIALS PRODUCTION CENTER

NATIONAL LEAD COMPANY OF OHIO

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SCOPING INVESTIGATION OF SHORT-TERM AND LONG-TERM STORAGE COSTS FOR AFRIMET RESIDUES - NFSS AND FMPC

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September 29, 1980

I. INTRODUCTION

Large quantities of Afrimet-owned radioactive residues are stored at the DOE Niagara Falls Storage Site, NFSS. Additional quantities of Afrimet-owned residues (K-65) are located at the Feed Materials Production Center, FMPC, near Fernald, Ohio. The current contract between Afrimet Metals Company and DOE for the storage of the Afrimet residues will terminate in 1983. In preparation for contractural discussions with Afrimet, the DOE has requested National Lead Company of Ohio (NLO) to investigate and scope the costs associated with the most effective means for short-term and long-term storage of the Afrimet residues at both the NFSS and the FMPC.

The Niagara Falls Storage Site has been managed for the AEC, ERDA, and now DOE by NLO for a number of years. A history and description of the NFSS, along with the characterization of the site and stored residues are contained in recent NLO reports[1,4]. Similarly, a study of alternate methods for disposal of radioactive residues now stored at NFSS[3] and also recommendations for actions to be taken after removal of the Afrimet residues[2] was completed by NLO in ~~1977.~~ 1977

The FMPC is a functional DOE site and has been operated by NLO since its construction in the early 1950's. Afrimet K-65 residues are currently stored in two large silos at Fernald.

Three primary objectives exist for the disposition of the Afrimet residues at NFSS:

1. The K-65 residues are to be removed from Building 434 at NFSS and the building dismantled.

2. Short-term storage (20 years) alternatives are to be examined for all Afrimet residues (K-65, L-30, L-50, and F-32). These storage options will primarily consider surface or near-surface locations for the residues. Shipment off-site of Afrimet residues will be disregarded as a short-term alternative.
3. Long-term disposal options will be examined for all Afrimet residues (K-65, L-30, L-50, and F-32). Options considered are to include (1) sub-surface entombment on-site and (2) removal of residues from the NFSS site after the 20-year interim storage.

The Afrimet-owned K-65 at FMPC will be examined for short-term remedial actions, and also, possible entombment after the FMPC is no longer a functional plant. Shipment off-site to a permanent disposal site will be costed.

Due to the short time available to prepare this study of costs for custodial care and disposition of Afrimet radioactive residues, the methods proposed for short-term storage are based on existing technology and techniques, thus can be implemented in a reasonable time frame. The long-term storage, where entombment of residues at NFSS and FMPC are proposed, will be costed but will require further study and supportive geological and radionuclide migration data.

II. EXECUTIVE SUMMARY

The characteristic and quantities of Afrimet-owned radioactive residues stored at NFSS and FMPC are summarized in Table II.1. A map of the NFSS showing the location of the stored residues is included as Figure II.1.

II.1. Short-Term Storage of Afrimet Residues - NFSS

The recommended method for the storage of Afrimet residues at NFSS for the short-term (20 years or less) is illustrated in Figure II.2. The general concept is to transfer all of the Afrimet residues to a common repository - which is Building 411. This entails (1) the removal of about 110,000 ft^3 of K-65 material from Building 434 (165 ft silo), (2) removal of about 58,000 ft^3 of L-50 residues from Buildings 413 and 414, and (3) sealing of about 3950 ft^3 of F-32 type residues in the Recarbonation Basin. Prior to the residues being placed in Building 411, about 100,000 ft^3 of water would be removed from Building 411 and transferred to Building 409 for evaporation. In preparation of Building 411, remedial actions will be implemented to insure the physical integrity of the building and the isolation of the structure from effects of ground water. Radon abatement will be implemented via concrete and/or bentonite capping of the residues. The R-10 residues and spoils pile will be relocated to an engineered storage pad. This will permit proper monitoring of the 411 building and isolates the R-10 radionuclides from environmental migration.

The total estimated cost for short-term storage of Afrimet residues is $7,511,000 (1980 dollars). This cost includes $2,524,000 for the relocation of the R-10 residues and spoils pile onto an engineered storage pad. Also associated with this program are the administration and support costs of $2,140,000. Details of these costs are discussed in Section III.

II.2. Long-Term Storage of Afrimet Residues - NFSS

This study considered the costs associated with (1) entombment of the Afrimet residues at a near-surface location at NFSS and (2) the packaging, transportation and perpetual care of the materials off-site, e.g., Nevada.

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TABLE II.1 INVENTORY AND CHARACTERISTICS OF AFRIMET RESIDUES[g,i]

	L-30	L-50	K-65 (NFSS)	K-65 (FMPC)	F-32
Dry Weight (tons)	8,227[a,b]	1,878[a,b]	1,757[a,b]	9,690[h]	138[a,b]
Estimated Volume (ft^3)	215,000	58,000	110,000	195,000	3,950-12,000
Density (lb/ft^3)	56.2[b]	78.0-79.2[b]	73.6[b]	--	--
Uranium (%)	0.18[d]	0.12-0.13[b]	0.05[b]	(0.06)[c]	0.40[f]
Weight Uranium (tons)	17.2[a]; 14.8[b]	1.8[a]; (2.4)[b]	4.65[a]; 0.9[b]	(5.8)[d]	1.2[a]; 0.6[d]
mg Radium/ton	6.5[d]	6.4 -7.6[d]	163.4[d]	181.6[d]	--
Total Radium (Ci)	53.8[b]	13.3[b]	287.2[b]	1,760[b]	--
Composition (ppm)					
Au	<0.2[e]	<0.2[e]	<0.2[e]	<40-60[c]	--
Ag	<0.3[e]	<0.2[e]	<0.5[e]	<20[c]	--
P	<0.5[e]	<1.0[e]	<0.5[e]	ND[c]	--
Pd	<0.5[e]	<0.5[e]	20[e]	--	--
Cu	2000[f]; 200-300[e]	2400[f]; 500[e]	200[e]	400-600[c]	1000[f]
Co	6200[f]; 1000-2000[e]	5900[f]; 1000[e]	100[e]	1500-2000[c]	400[f]
Ni	20,000[f]; 3000[e]	19,100[f]; 5000[e]	100[e]	2000-3000[c]	1800[f]
Pb	--	7600[f]	95,000[f]	48,000-52,000[c]	33,000[f]

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Inventory and Characteristics of Afrimet Residues (cont'd)

Composition (ppm)	L-30	L-50	K-65 (NFSS)	K-65 (FMPC)	F-32
La	100-200[e]	100-300[e]	500[e]	400-2000[c]	--
Ce	100-200[e]	50-300[e]	500[e]	2000-5000[c]	--
Pr	10-20[e]	10-100[e]	100[e]	60-120[c]	--
Nd	20-50[e]	20-200[e]	300[e]	250-500[c]	--
Sm	3-20[e]	5-20[e]	50[e]	30-70[c]	--
Eu	2-5[e]	5-20[e]	20[e]	ND[c]	--
Gd	3-10[e]	10-30[e]	20[e]	30-50[c]	--
Tb	0.5-2[e]	1-2[e]	5[e]	ND[c]	--
Dy	5-10[e]	3-5[e]	30[e]	20-40[c]	--
Ho	0.3-0.5[e]	0.2-0.5[e]	2[e]	<15[c]	--
Er	0.3-1[e]	0.3-2[e]	3[e]	ND[c]	--
Yb	0.5[e]	≤0.5[e]	1[e]	1-10[c]	--
Y	5-10[e]	5-10[e]	5[e]	10-80[c]	--
Sc	30-50[e]	30[e]	50[e]	6-30[c]	--
Nb	3-10[e]	3-5[e]	5[e]	ND[c]	--

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Table II.1 Inventory and Characteristics of Afrimet Residues (cont'd) -3-

a. B. M. Robinson. Memo to File, Lake Ontario Ordnance Works Residues. June 28, 1965.

b. F. W. Neblett and J. B. Patton. Letter to J. H. Cavendish, Report on Trip to DOE-Niagara Falls Site, August 8, 1978. August 17, 1978.

c. NLO analysis of FMPC K-65 samples. September 1970, File A-3.5.6.

d. Based on the dry weight of the residues and the % U.

e. B. Ausmus, et al. A Comprehensive Radiological Survey of the DOE-Niagara Falls Storage Site (draft), BMI-2045, March 1980.

f. J. Dasher, et al, (Chemical Construction Corporation). Final Report - Waste Processing, NYO-1047, Issued October 22, 1953.

g. Numbers in parentheses are average values.

h. J. H. Cavendish, et al, (NLO). Scoping Investigation of Alternative Methods for Disposal of Radioactive Residues Stored at the DOE-Niagara Falls Site. September 1980.

i. Over the last three decades numerous analyses of the residues have varying results - reflecting the heterogeneity of the residues and possibly differences in analytical procedures. The numbers in this table are those numbers which seem most reasonable. The double entries reflect the difference between old records and current analyses.

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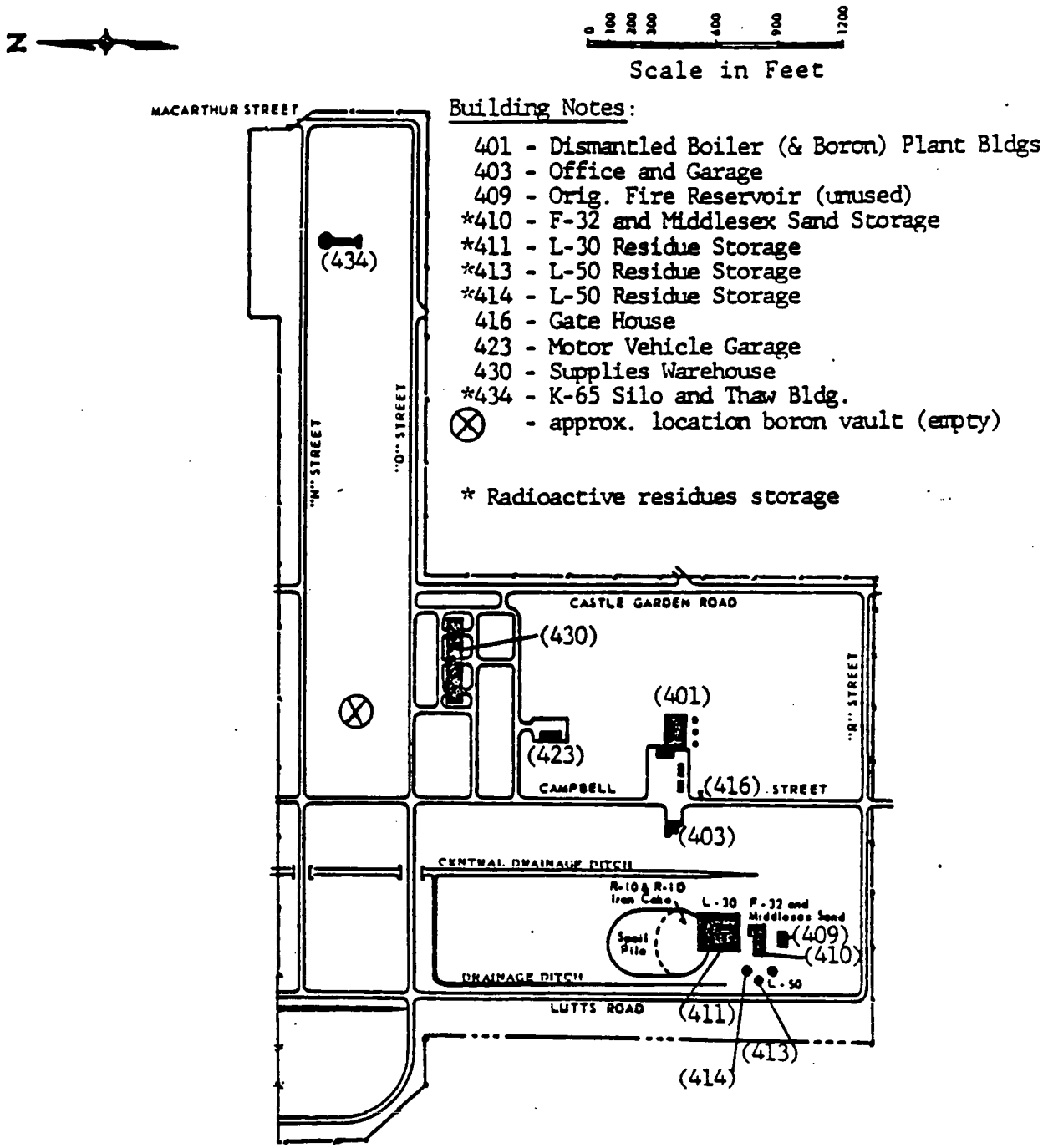

NIAGARA FALLS STORAGE SITE

Radioactive Waste Storage Locations. (Present building number designations in parentheses).

FIGURE II.1

RESIDUE STORAGE

AFRIMET RESIDUES - NIAGARA FALLS STORAGE SITE

FOR SHORT-TERM STORAGE (LESS THAN 20 YEARS)

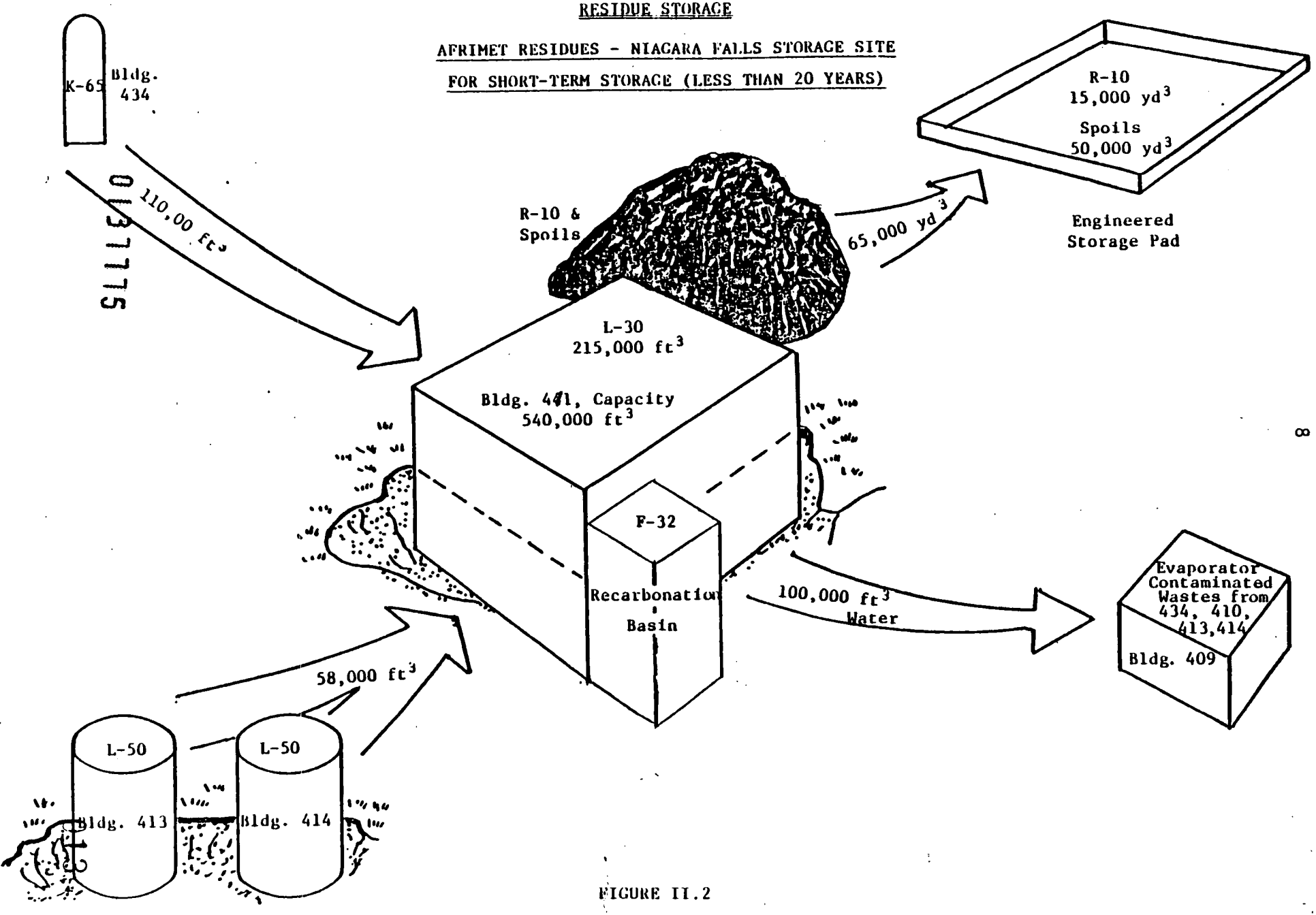

FIGURE II.2

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Figure II.3 graphically shows the extension of the short-term storage to long-term storage of the radioactive materials from Building 411 to a demonstrated and proven entombment location at NFSS. This illustration shows the dry residues encased in a concrete vault. The Bentonite lining serves the two-fold purpose of radon abatement and the isolation of the residues in this vault from groundwater.

All operations proposed for short-term and long-term storage of the Afrimet residues will undergo an environmental assessment.

The total estimated costs for the long-term storage of the Afrimet residues at NFSS is $7,215,000. The administrative and support costs included in this number are estimated at $4,390,000. The average annual radiological monitoring and maintenance is estimated at $6,000. Removal of the residues, contaminated rubble off-site and perpetual care is estimated to cost $18,259,000.

II.3. Short-Term Storage of Afrimet Residues - FMPC

There are approximately 195,000 ft^3 of Afrimet K-65 residues in storage at FMPC. The current storage silos are providing adequate control and are in good physical condition. However, if private homes were built adjacent to the FMPC and the ALAP (As Low As Practicable) concept is applicable, the dose levels at the Fernald property will need to be reduced. This dose reduction is achievable by the installation of a concrete and/or clay cap to the K-65 material in the existing silo structures. An asphaltic seal may be required on any cracks in the concrete.

The cost to improve the shielding, if required, in the existing K-65 silos at Fernald is estimated at $250,000. Maintenance and surveillance costs are estimated at $40,000 annually.

II.4. Long-Term Storage of Afrimet Residues - FMPC

The FMPC is an operating plant, thus only maintenance and surveillance is of current concern for the Afrimet K-65 material. At some later date, long-term storage of these residues will indeed need action.

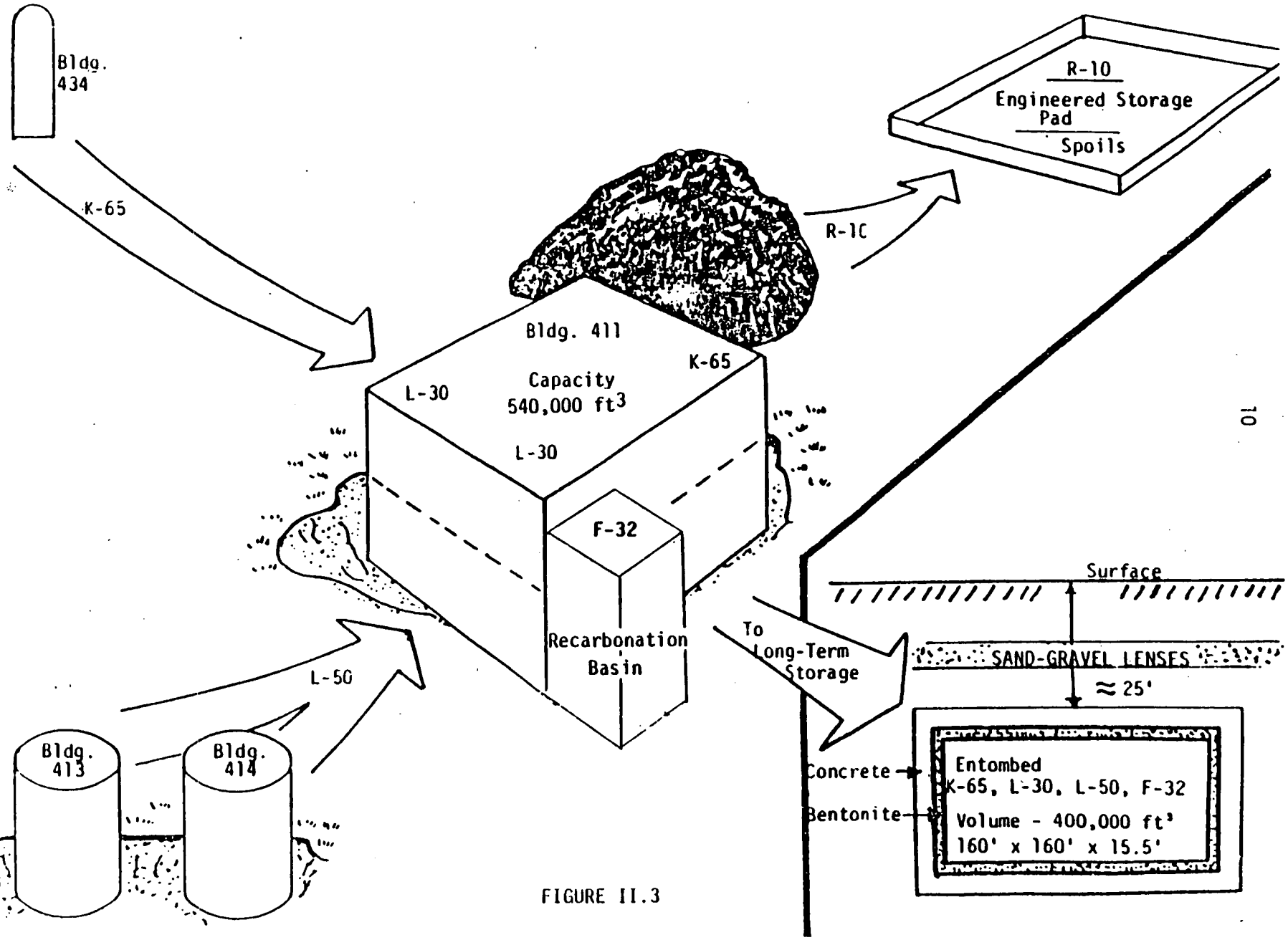

FIGURE II.3

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The proposed method for long-term storage is entombment in a subsurface vault at FMPC. Bentonite clay will provide the absorbing media for the radon and decay daughters of radon. The exterior of the buried vault is to be concrete. As stated above in Item II.2, development and demonstration studies will need to be done to confirm the final engineering design. The storage of the K-65 raffinates at the FMPC is graphically displayed in Figure II.4. Also costed is the packaging, transport, and disposal at an off-site "perpetual care" location.

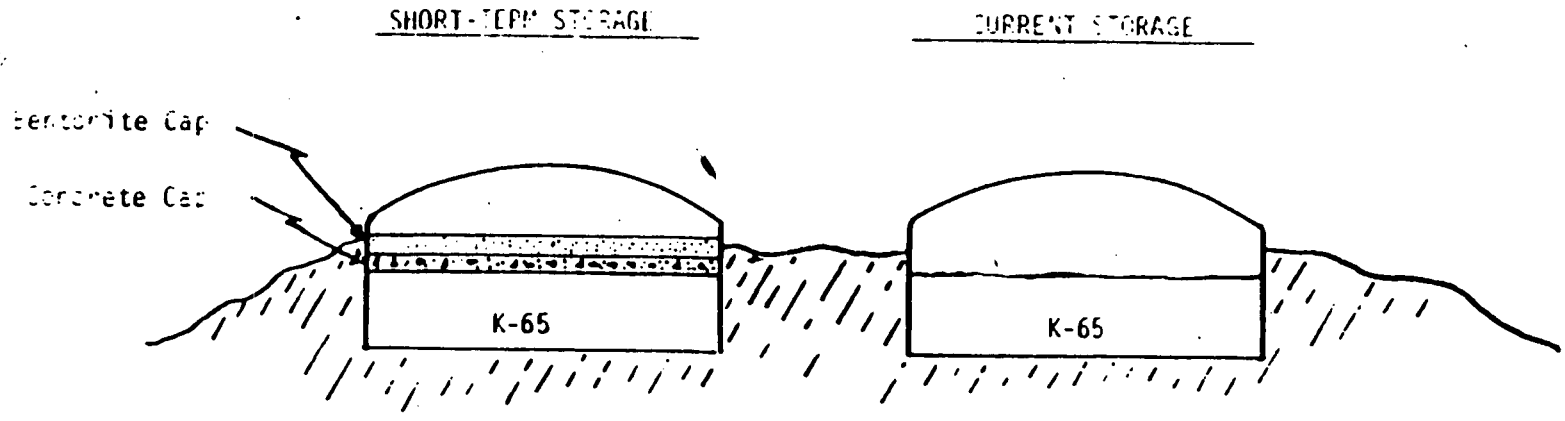
The cost for the entombing of the K-65 material and building rubble at FMPC is estimated at $3,493,000. Annual radiological monitoring and maintenance is estimated at $5,000. Removal of the Afrimet residues and building rubble to an away-from-FMPC location is estimated to be $7,115,000.

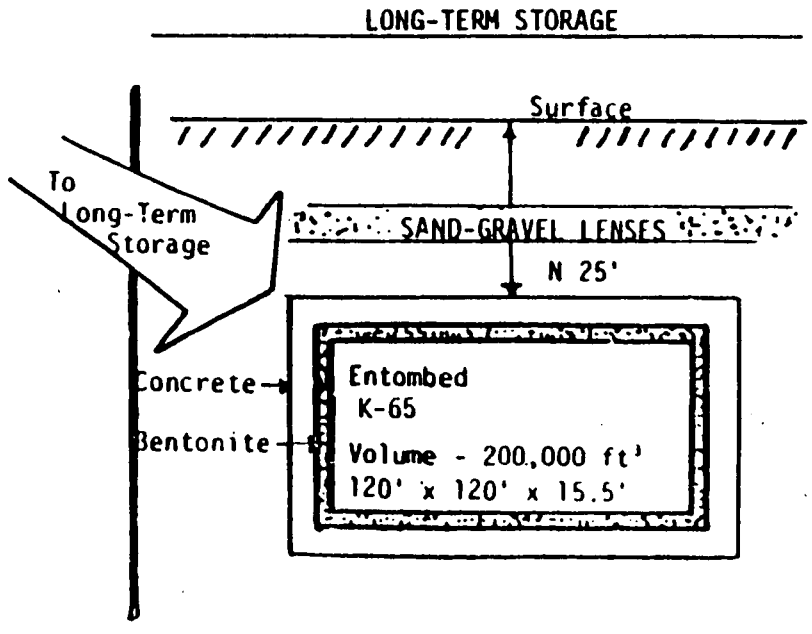
In brief summary, at the NFSS it is proposed to consolidate all Afrimet residues into one upgraded storage facility - Building 411, for short-term storage. This requires the relocation of R-10 tailings and spoil pile to an engineered storage pad. Those structures which housed Afrimet residues before consolidation, i.e., Buildings 434, 413, and 414, will have their radioactivity level reduced. Building 434 will be dismantled and placed into Building 413 or 414 for retention. This method minimizes handling of materials. Contaminated liquids will be processed via an evaporator in Building 409. The evaporator discharge will be filtered to meet all environmental considerations.

For storage in excess of 20 years, it is proposed that the NFSS residues be entombed in a bentonite/concrete subsurface vault, after the confirmation of the engineering design. Rubble from dismantling Buildings 411, 434, 413, and 414 will be buried on-site as LSA material.

For the operational FMPC site, short-term storage of radioactive K-65 must consider reducing off-site exposure by remedial action, such as a concrete and/or bentonite cap on the existing storage silos.

STORAGE - AFRIMET K-65 RESIDUES AT FMPC- FERNALD, OHIO





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Long-term storage is to be considered after FMPC is no longer a functional DOE site. Proposed is the entombment in subsurface enclosures, encapsulated in bentonite and concrete. The two silos would be dismantled after the surface contamination is reduced and buried on-site as LSA material or transported off-site for disposal. Again, off-site storage of the K-65 is costed.

III. SHORT-TERM STORAGE AT NFSS

Consideration of various options (see Appendix A) for short-term storage facility at NFSS for the on-site Afrimet residues resulted in the decision to modify Building 411 to serve as that facility. The primary reason for selecting Building 411 for short-term storage was that the building already contains more than half of the estimated total of all of the Afrimet residues stored at NFSS. Other reasons for selecting Building 411 were that the building (1) is centrally located, (2) has the capacity to provide storage for the Afrimet residues from Buildings 434, 413, and 414, and (3) can be upgraded to provide improved storage conditions. One drawback is the need to remove the R-10 and spoils pile to an engineered storage pile away from Building 411. This is required to establish reliable radiological monitoring of the consolidated Afrimet residues stored in Building 411.

III.1 Administration and Support

For the implementation of short-term storage of residues at NFSS, the following items are essential for the successful isolation of the residues and contaiminated materials.

- Program Management
  - Project Manual Plan--1 man-year @$80,000/man-year — $ 80,000
- EIS--Safety Analysis
  - Environmental Impact Statement--6 man-years @ $80,000/man-years — $480,000
  - Preliminary Safety Analysis--6 man-years @ $80,000/man-year — $480,000
  - Final Safety Analysis--6 man-years @ $80,000/man-year — $480,000

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• Health Physics--3-3/4 man-years @ $80,000/man-years	$300,000
• Personnel Monitoring	
• Bioassay	
• Environmental Monitoring	
• Field Supervision--4 man-years @ $80,000/man-year	$320,000
TOTAL	$2,140,000

Total estimated costs for administration and support to implement short-term storage at NFSS is $2,140,000.

III.2 Preparation of Short-Term Storage Facility (STSF)

Approximately 215,000 cubic feet of L-30 residues, out of an estimated 387,000 cubic feet of Afrimet residues, are currently stored in building 411. Most of the L-30 is in the west bay and is covered by approximately 100,000 cubic feet of water. The remaining L-30 is somewhat dispersed throughout the east bay of the building. Approximately 4,000 cubic feet of F-32 residue is currently stored in the Recarbonation Basin. The Recarbonation Basin is attached to Building 411 and is considered to be an integral part of Building 411.

III.2.1 Interior Improvements. The water presently covering L-30 residue in the west bay will be removed and evaporated in a facility located at Building 409. Pipes leading to the recarbonation pit and to Building 410 will be sealed. Building 411 will be partitioned to allow segregation of the various residues. The existing center wall provides a convenient divider. L-30 residue in the east bay will be concentrated in the west half of the building. It is estimated that the depth of L-30 residues, when transferred to the west bay, will be about 12 feet. A second north-south wall centered in the east bay, extends from the south wall to within approximately 25 feet of the north wall. The first 120 feet of the west half of the east bay will provide space for the L-50 residues from Buildings 413 and 414. The depth would be about 11 feet.

The remaining 80 feet of this bay, plus 180 feet of the east half of the east bay, will provide space for the K-65 residues which are to be transferred from Building 434. The depth will be about 10 feet. The L-50 residues will be piled to a depth of about 11 feet. The F-32 residue currently stored in the Recarbonation Basin will remain in place and this annex will become an integral part of building 411.

Figure III.1 illustrates a proposed division of the available space in Building 411 for each of the residues.

The cost of interior improvements to Building 411 are estimated to cost $1,118,000.

III.2.2 Exterior Improvements. Improvements will be made to the building to insure that the residues will be suitably contained. The existing earthen embankment will be excavated around the entire building so that a monitoring system can be installed at the footer level to confirm containment of the Afrimet residues. The excavation would then be backfilled with a bentonite dam to prevent subsurface migration of any contaminants and exclusion of surface water from contact with the concrete containment. The dam would extend to the top of the walls and after the installation of a new reinforced concrete roof, the bentonite will be continued on over the roof as a seal for radon emission. The bentonite thickness would be adequate to reduce the radon emissions to acceptable levels. The embankment would be restored and a layer of topsoil would be placed over the top of the bentonite cover to permit seeding for ground cover. Details of storage facility improvements are shown in Figure III.2.

The cost of exterior improvements to Building 411 is estimated to be $682,000.

III.2.3 Relocation of R-10 Residues and Spoils. Prior to the work required to prepare Building 411 for short-term storage, it will be necessary to excavate and remove an adjacent storage pile of R-10 residues and the spoils from the 1972 cleanup. In addition to the above ground materials, it will be necessary to excavate an estimated 6 to 8 feet of soil contaminated through leaching action. The R-10's, spoils, and contaminated earth will be stored on an engineered storage pad. It will be

SHORT-TERM STORAGE, BUILDING 411
DEPTH 19 FEET

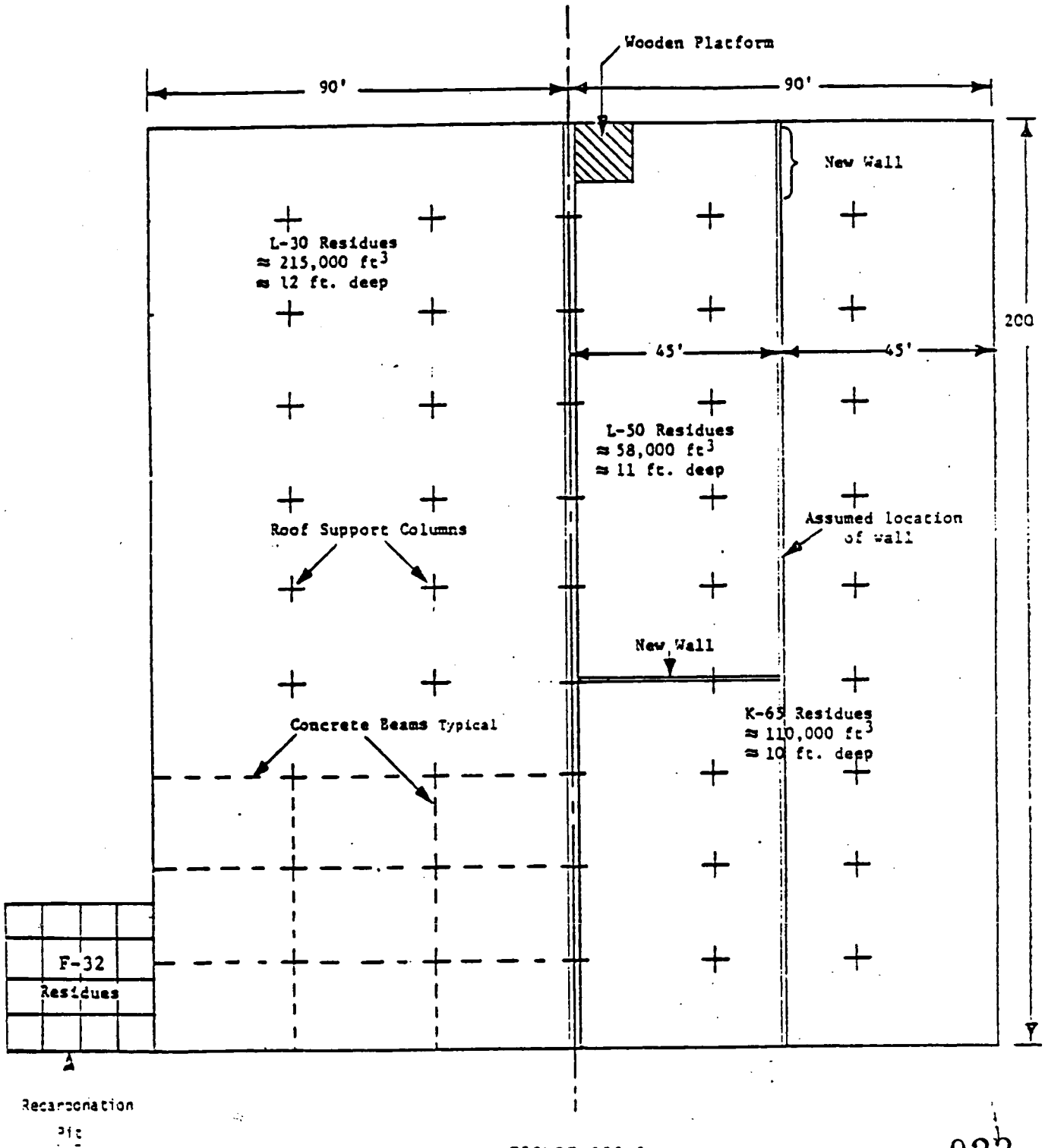


FIGURE III.1

SHORT-TERM STORAGE - BUILDING 411

EXISTING STRUCTURE

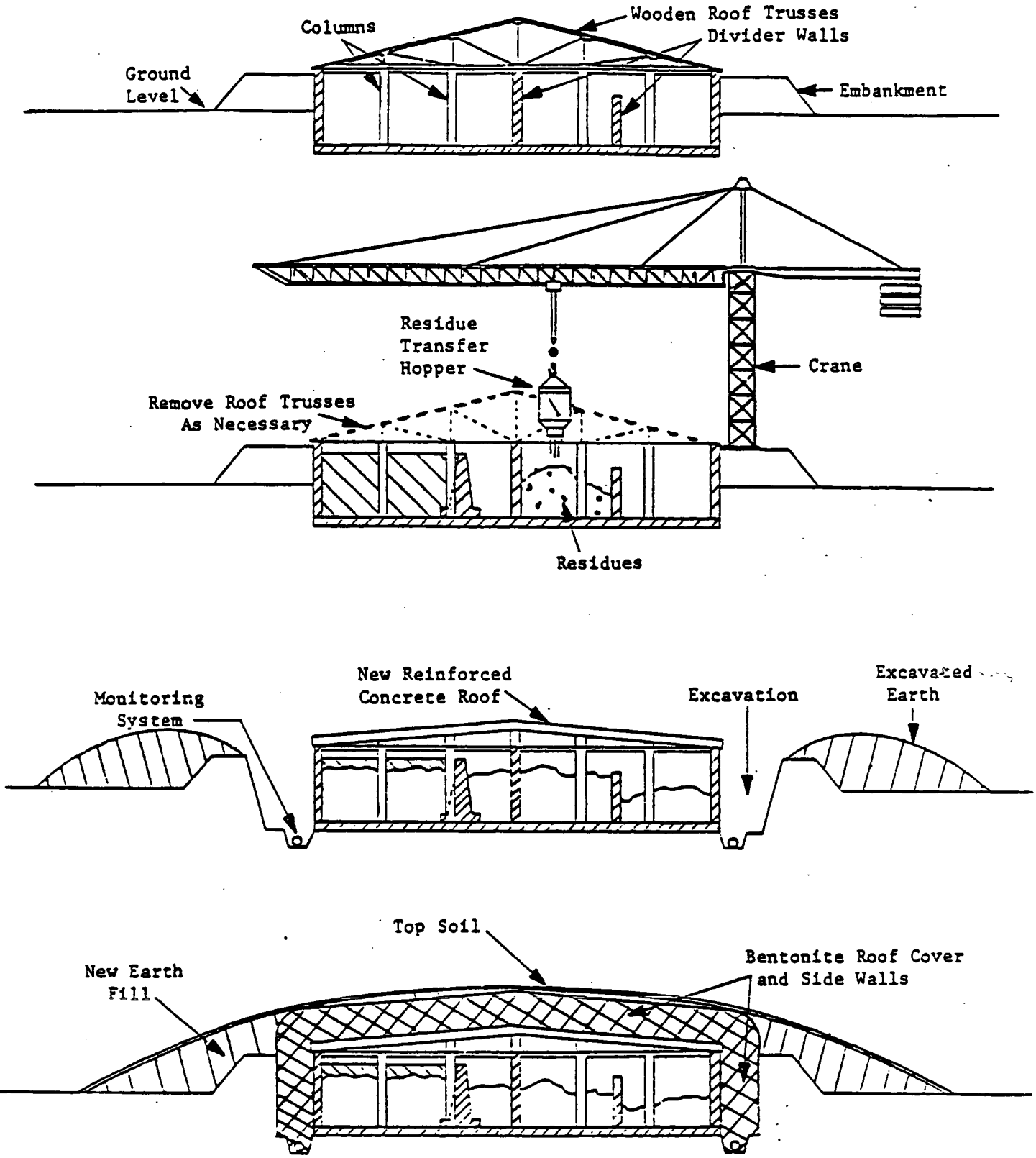


FIGURE III.2

necessary to backfill the excavation with clean soil to restore the site to grade level.

The cost to relocate R-10 residues and contaminated earth and to backfill the excavation is estimated to cost $2,524,000.

III.2.4 Building 410 Cleanup. Various Afrimet-owned residues have been spilled and have leached into parts of Building 410. The bulk spilled material contained therein will be collected with a vacuum system and placed in the Short-Term Storage Facility. A major decontamination effort is not contemplated.

The cost of removing the Afrimet-related residue in Building 410 is estimated to cost $25,000.

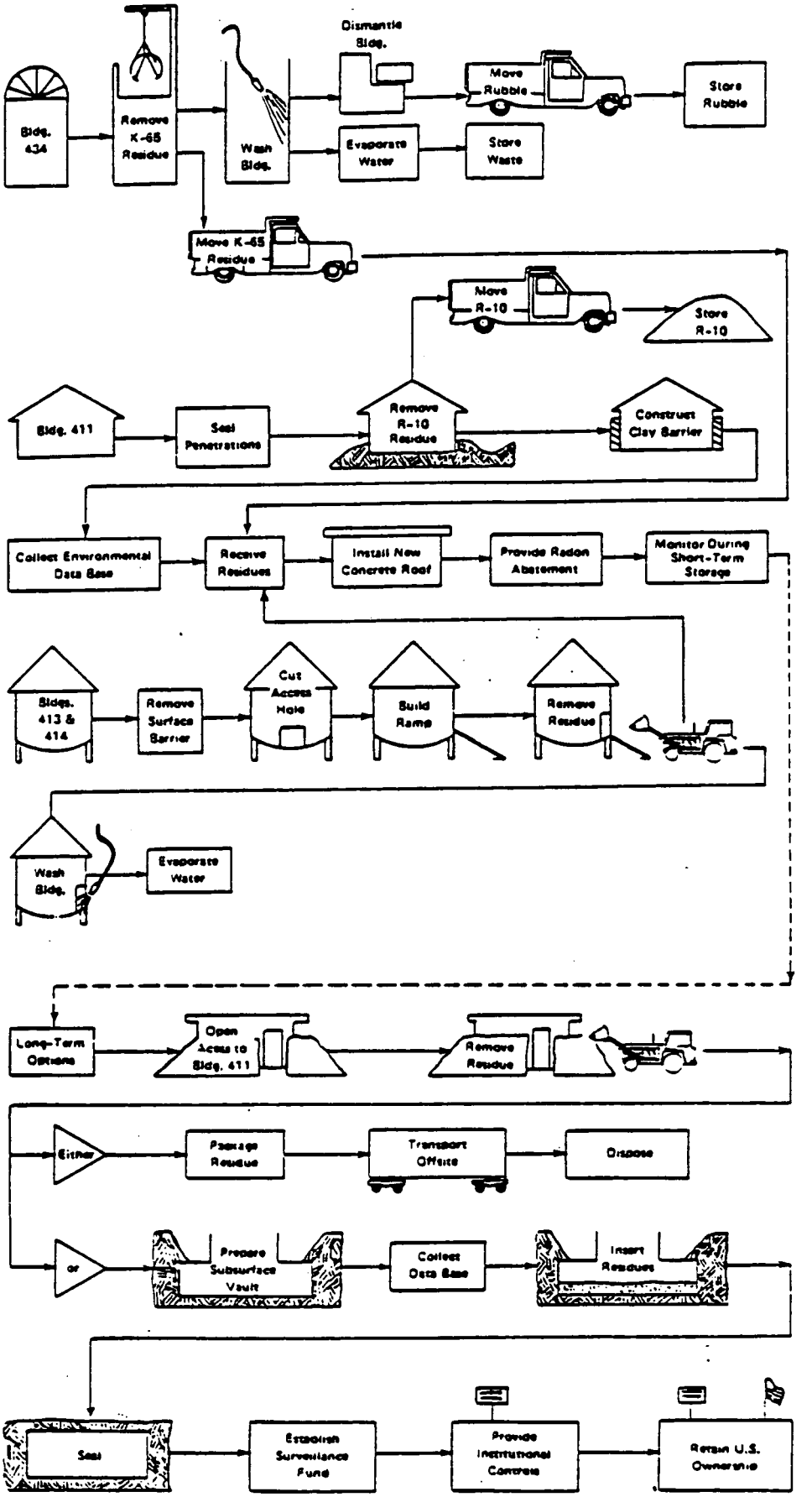
III.3 K-65 Removal and Transport to Short-Term Storage Facility (STSF)

A modified concrete water tower, designated Building 434, presently contains approximately 110,000 cubic feet of Afrimet K-65 residue. Access to the residue will be gained by dismantling the top 50 feet of the tower. This work will require erection of scaffolding, use of a large crane and clamshell, and extensive manual labor.

The K-65 residue will be removed with the clamshell bucket and loaded into hoppers mounted on tandem trucks. Loaded hoppers will be temporarily sealed as required, then transported to the short-term storage facility. Another crane, stationed at the short term storage facility, will pick the loaded hopper off the truck and the material will be deposited into the appropriate compartment of the storage facility. (See Figure III.3.)

Residue removal and demolition operations at Building 434 will require the prior construction of an impermeable, curbed pad and sump to contain spilled residue and water. High pressure water will be required to wash residue off the insides of the tower and to aid in dust suppression. Water and residue collected in the sump will be periodically collected and taken to the evaporation facility.

It is anticipated that residue removal and demolition will be done concurrently. However, costs for each operation are shown separately for



PROPOSED DISPOSITION OF AFRIMET RESIDUES – NFSS

FIGURE III.3

clarity. The cost to remove K-65 residue from Building 434 and place the material in the Short-Term Storage Facility is estiamted to be $145,000.

III.4 L-50 Removal and Transport to Short-Term Storage Facility

Two concrete water treatment tanks, designated Building 413 and Building 414, presently contain approximately 58,000 cubic feet of L-50 residues. Access to the residue will be gained by removal of the existing wood roof structures. The roof debris must be considered contaminated and will be returned to Building 413 after the L-50 material is removed to the STSF.

Relocation of the L-50 residue will be accomplished in a manner similar to that anticipated for the K-65 residue. Removal will be done by clamshell bucket and/or front end loader. Transport and placement into the Short-Term Storage Facility will be done as previously described for K-65.

Residue removal from building 413 and 414 will require the prior construction of an impermeable, curbed pad and sump to contain spilled residue and water. High perssure water will be required to wash residue off the tank walls and to aid in dust suppression. Water and residues collected in the sump will be periodically collected and taken to the evaporation facility.

The cost to remove the L-50 residue from Buildings 413 and 414 and place it in the Short-Term Storage Facility is estimated to be $94,000.

III.5 F-32 Disposition

The recarbonation pit, which is a concrete tank attached to the southwest corner of Building 411 currently holds approximately 4000 cubic feet of Afrimet F-32 residue. The residue is covered with rainwater which will be removed and evaporated. The residue will be sealed in the recarbonation pit as a part of the Short-Term Storage Facility.

The costs to remove the water and seal the F-32 residues are in-

III.6 Disposition of Afrimet Utilized Residue Storage Buildings

Buildings 413 and 414, previously containing L-50 residues, will be washed to reduce the level of contamination. Contaminated water will be evaporated. The buildings will be utilized to store the rubble of Building 434 and several pads and sumps utilized for residue transfer.

Building 434 will be dismantled in three phases, concurrent with removal of the K-65 residue. Dismantling will be accomplished by sawing the structure into blocks which will be removed by crane. Rubble will be washed, if required, then loaded onto trucks and transported to Building 413 for storage.

The temporary pads and sumps at Buildings 434, 413, and 414 will be washed, then dismantled and stored in 413 and 414. New concrete roofs will be constructed over 413 and 414 buildings to provide reliable storage for the short-term storage period. Due to the reduced level of contamination associated with these buildings and the rubble therein, surveillance requirements will be minimal.

The cost to prepare Buildings 413 and 414, dismantle and store Building 434 and all pads and sumps, and to re-roof Buildings 413 and 414 is estimated to be $283,000.

III.7 Short-Term Surveillance

It will be necessary to monitor and maintain the short-term storage facility throughout the period of use. Monitoring will consist of groundwater sampling and radon monitoring. Maintenance of ground cover and earth berms will also be required.

The cost to monitor and maintain the STSF is estimated to be $25,000 per year.

III.8 Cost Summary--Short-Term Storage at NFSS

The cost to plan and implement the short term storage option described herein is summarized below:

Administration and Support	$2,140,000
Preparation of STSF	$4,349,000
Relocation of all Residues	$ 239,000
Disposition of Storage Buildings	$ 283,000
Short-Term Surveillance	$ 500,000
TOTAL	$7,511,000

IV. LONG-TERM ENTOMBMENT OF AFRIMET RESIDUES AT NFSS

It may be possible to provide safe long-term entombment of Afrimet residues at NFSS. For the purposes of this study, it is assumed that applicable regulations will permit such on-site entombment and that New York State, the public and DOE agree to such on-site entombment.

The basic concept of long-term on-site entombment of Afrimet residues at NFSS involves (1) the construction of a subsurface entombment vault of bentonite and concrete, (2) the transfer of the Afrimet residues from the Short-Term-Storage Facility to the subsurface vault, and (3) the dismantling of the Short-Term Storage Facilities. The following section describes each of these operations and estimates their cost.

IV.1. Administration, Development and Support

Afrimet residues are a somewhat unique waste disposal problem. While Afrimet residues are similar in nature to uranium mill tailings, the Afrimet residues were derived from exceptionally high-grade Congo pitchblende instead of low-grade uranium ores. Therefore, the radionuclide concentrations of uranium daughter products in Afrimet residues are necessarily higher than in conventional uranium mill tailings. Because of this, the entombment of Afrimet residues at NFSS will require careful development.

The special nature of the Afrimet residues will require that a modest research program be initiated to determine such things as: detailed chemical analysis of the residues; investigation as to the presence of complexing agents; transport fate and effect of residue radionuclides; sub-surface groundwater flow rates; radon abatement requirements; groundwater chemistry and its effect on the residues and the environment. This research and environmental data base study will have the following components:

• Laboratory Studies, 3 man-years at $80,000/man-year	$ 240,000
• Field Studies, 5 man-years at $80,000/man-year	400,000
• Confirmation of Design, 5 man-years at $80,000/man-year	400,000
• Analytical, hydrology	100,000
• Field Equipment	200,000
• EIS-Safety Analyses, 18 man-years at $80,000/man-year	1,440,000
• Program Management Plan, 1 man-year at $80,000/man-year	80,000
• Engineering Design (Title II) for Entombment Facility, 4 man-years at $80,000/man-year	320,000
• Radiological Construction Support - 3.75 man-years at $80,000/man-year	300,000
• Field Supervision-Project - 11 man-years at $80,000/man-year	880,000
Total	$4,360,000

IV.2. Subsurface Entombment Facility Construction

Although the exact design of a subsurface entombment facility for the Afrimet residues is not available, a conceptual design of such a facility has been generated and is shown in Figure IV.1. The entombment facility will consist of about 4-ft. thick bentonite sidewalls and floor and a bentonite cap sufficient in thickness to reduce Radon levels to acceptable criteria. The sidewalls will be supported by 2-ft. thick concrete walls.

In order to provide for adequate radon abatement, the floor of the entombment facility will be located at a depth of approximately 40 ft. on bedrock. Thus, for a cavity with internal dimensions of 160 ft. x 160 ft. x 16 ft., enough space remains for the bentonite cap and more than 14 ft. of soil.

Bentonite prevents water from flowing through the residues and acts to effectively eliminate the transport of radionuclides from the residues out of entombment vault. Bentonite is also pliable and self-sealing and will provide for viable containment of the residues.

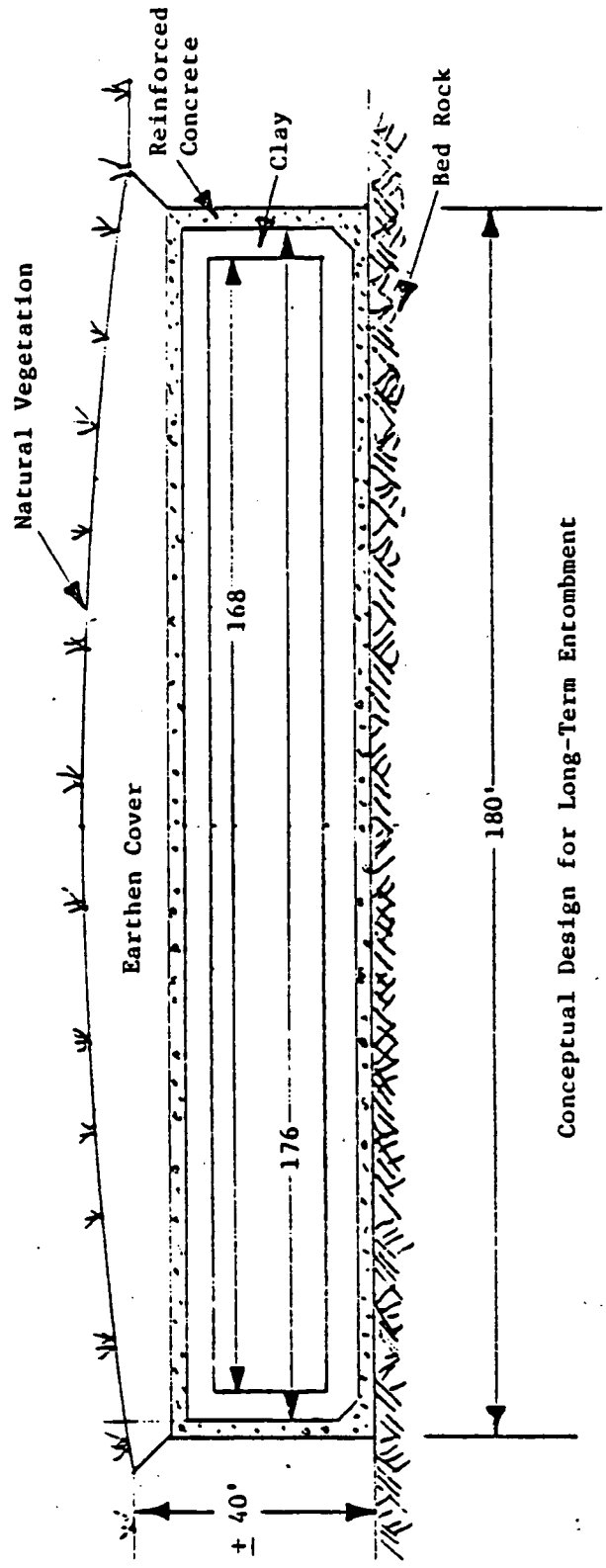


FIGURE IV-1.

Conceptual Design for Long-Term Entombment

The estimated cost to construct an entombment facility for Afrimet residues at the NFSS is $1,618,000.

IV.3. Residue Removal and Transport to Entombment

Residues must be removed from the Short-Term Storage Facility (Building 411) and transported to the long-term entombment vault. Costs associated with this operation are rightly charged to long-term entombment.

The most straightforward method of removing the residues from the Short-Term Storage Facility is to remove sufficient banked soil from the sides of the building, cut openings in the wall, and use a wheel loader to dig out the residues. Residue transport is assumed to be 1/2 mile or less by truck.

Costs to remove residues from the STSF and transport to the entombment vault is $197,000.

IV.4. Disposition of Afrimet Utilized Storage Buildings

Once the residues are removed from the Short-Term Storage Facility and placed in the entombment vault, the STSF and Buildings 413 and 414 must be dismantled. Because of the radioactivity remaining on building surfaces, these Afrimet-utilized buildings will need to be cleaned to reduce contamination. Liquids used in cleaning will be evaporated.

After the level of contamination is reduced, these buildings will be dismantled by sawing the concrete into pieces. Uncontaminated portions (roofs) will be buried on-site. Contaminated rubble will be buried adjacent to the entombment in a bentonite clay lined pit.

The cost to dispose of all Afrimet utilized storage buildings on-site is estimated to be $710,000.

IV.5. Long-Term Surveillance and Maintenance

A long-term surveillance program will be established to verify the integrity of the entombment vault. Radon emanation and groundwater leaching measurements will be required periodically. Also, maintenance of the grounds (mowing) would be desirable.

Estimated costs would be $15,000/year for the first 5 years and perhaps $2,000/year thereafter for perpetual care and institutional control. Total cost for a 50-year period would be $300,000.

IV.6. Cost Summary - Long-Term Entombment at NFSS

The cost to plan and implement the long-term entombment option described herein is summarized below:

Administration and Support	$4,360,000
Construction of Entombment Facility	1,618,000
Transfer of Residues from STSF to Entombment	197,000
Disposition of Storage Buildings	710,000
Long-Term Surveillance	300,000
	$7,185,000

V. DISPOSITION OF AFRIMET RESIDUES AT FMPC

There are currently 195,000 ft^3 of Afrimet-owned K-65 residue stored in two sealed concrete tanks at the FMPC. This storage facility is monitored and maintained regularly, and, to date, is secure. Annual monitoring and maintenance cost is estimated to be $40,000. There are no immediate plans to modify the storage tanks; however, future circumstances may require additional shielding and/or radon abatement to meet short-term storage requirements. In the event of deactivation of the FMPC it will be necessary to place the K-65 residues into long-term storage, either on-site or off-site.

V.1 Administration, Development and Support - FMPC

As discussed in Section IV.1, the Afrimet residues present a unique storage problem for long-term storage. The residue storage method proposed for NFSS is also suggested for Fernald, that is, entombment of the K-65 material in a sub-surface vault constructed of concrete and bentonite (see Figure II.4).

The development of the entombment concept for Afrimet residues for NFSS will provide many generic facts on design parameters, materials of construction, installation techniques and environmental monitoring effort requirements. However, suitability of the entombment approach must be evaluated for Fernald. Thus, the following cost items are essential for the implementation of the entombment of K-65 at the FMPC.

• Development Activities and Environmental Data Base - 3 man-years at $80,000/man-yr.	$ 240,000
• Analytical, field testing, hydrology	100,000
• EIS - Safety Analysis 8 man-years at $80,000/man-yr.	640,000
• Engineering Design (Title II) for Entombment Facility - 2 man-years at $80,000/man-yr.	160,000
• Radiological and Field Support	
• Management Plan - 1 man-yr. at $80,000	80,000
• Radiological - 3 man-yr. at $80,000	240,000
• Field Engineering - 2 man-yr. at $80,000	160,000
• Field Management - 3 man-yr. at $80,000	240,000
	$1,860,000

V.2 Short-Term Storage - FMPC

It is probable that additional shielding and radon abatement will be required at some time within the twenty-year short-term storage period.

The minimum measure anticipated would be the installation of asphaltic emulsion coatings over the existing concrete to reduce radon leakage from cracks in the silos. Radiation attenuation and additional radon suppression would require placement of a bentonite clay and concrete seal on the K-65 residues. This work would be accomplished by pumping the clay and concrete into the tanks through openings in the existing concrete domes.

Additional measures to preclude the potential for sub-surface migration of radionuclides may be required at some time within the twenty-year short-term storage period. This work would consist of removing the existing earth berms, surrounding the tanks with a bentonite clay barrier, then replacing the earth berms.

To improve the radiation shielding and reduce radon emission to the environment from the two FMPC silos, the cost is estimated at $250,000. Surveillance and maintenance expenses are estimated at $40,000 annually.

V.3 Long-Term Disposition at FMPC

In the event of deactivation at the FMPC, it will be necessary to place the K-65 residue and the contaminated storage tank rubble into an entombment facility. A concrete structure similar to that described for the NFSS (Art. IV) would be built at an appropriate location on the FMPC site. The tops of the existing storage tanks will be removed and placed in the entombment. The K-65 residues will be removed and transported to the entombment in a manner similar to that described for NFSS (Art. III). The remaining walls and base slabs of the storage tanks essentially LSA materials will be dismantled and placed in the entombment.

The estimated cost of placing the Afrimet-owned K-65 residue and K-65 storage tank rubble into an engineered entombment facility is $1,633,000.

V.4 Cost Summary - FMPC K-65 Residue

Current storage of K-65 residues at FMPC is accomplished at an annual cost of less than $40,000 for radiological control and maintenance. At some time within the twenty year short-term storage period it may be necessary to install additional radiation shielding and radon suppression media, costing about $250,000.

Total cost for long-term disposition of K-65 residues by entombment, disposition of storage silos and support and development costs is estimated to be $3,493,000.

VI. OFF-SITE DISPOSITION OF AFRIMET RESIDUES

Environmental conditions at NFSS and/or FMPC or DOE policy may preclude the long-term entombment of Afrimet-owned residues of these sites. In that event, it will eventually be necessary to move the residues to a long-term storage facility such as NTS or Hanford. For purposes of this study, it is assumed that the residues will be in the previously described short-term storage facilities at the time an off-site transfer is implemented.

Transfer of residues to an off-site storage facility will require unloading of the Short-Term Storage Facility, packaging and shipping of the residues and payment of a one-time fee for perpetual care at the receiving facility. It is probable that off-site disposition of Afrimet-owned residues would be implemented only in the event of decontamination and decommissioning of NFSS or FMPC. Therefore, it is likely that all contaminated building rubble would also have to be transferred off-site. Costs for packaging, shipping, and perpetual care of contaminated rubble will also be reported.

VI.1. Off-Site Disposition - NFSS

There will be approximately 387,000 ft^3 of residue and 184,000 ft^3 of contaminated rubble that will require packaging, shipping, and perpetual care at an off-site long-term storage facility. For this study, DOT-approved 55-gallon drums will be assumed for shipment of residues.

VI.1.1. Administration and Support--NFSS. Administration and support costs for this option would be similar to the entombment option, with the EIS and development costs. Total costs are estimated to be $1,340,000.

VI.1.2. Residue Packaging--NFSS. Access to the residues stored in the STSF at NFSS would be gained by removing the earth berm and bentonite barrier from part of one side of the structure and cutting ~20 ft. wide openings in the exposed wall. Specially outfitted front end loaders will be used to transfer the residues to the packaging station.

The packaging station will be set up near the STSF on an impermeable curbed pad inside an air supported structure. The packaging station will receive the residue and load them to 55-gallon drums. Filled drums will be labeled and logged, then palletized and loaded onto trucks for shipment.

The cost to retrieve Afrimet residues from the STSF, package them and load the containers onto trucks is estimated to be $2,531,000.

VI.1.3. Residue Shipping--NFSS. Shipping of packaged Afrimet residues and building rubble will need to be conducted in accordance with applicable regulations, which for this study, are assumed to be only the DOT regulations. Shipping from NFSS can be done by rail or truck, and the most efficient mode must be selected at the time.

Recent data for truck shipment were used for this costing study. The estimate cost for shipping the packaged residues is $2,696,000.

VI.1.4. Residue Perpetual Care--NFSS. It is difficult to predict the one-time fee that may be charged for perpetual care at a long-term storage facility. The current fee charged by facilities such as Nuclear Engineering at Beatty, Nevada, or Hanford, Washington, is approximately $10 per cubic foot of container volume. The 55,300 drums required for packaging all residues represents a container volume of 406,500 ft^3.

The cost for perpetual care of Afrimet-owned residues currently stored at NFSS is estimated to be $4,065,000.

VI.1.5. Disposition of Afrimet-Related Structures--NFSS. All buildings and structures used for the storage and handling of Afrimet owned residues will have to be dismantled. Uncontaminated rubble can be stored on-site. Contaminated rubble will require packaging in LSA containers for shipment off-site.

The cost to dismantle, package, transport, and dispose of all Afrimet-related storage structures located at NFSS is $7,627,000.

VI.2. Off-Site Disposition--FMPC

There will be approximately 195,000 ft^3 of K-65 residue and 40,000 ft^3 of contaminated building rubble that will require packaging, shipping, and perpetual care at an off-site long-term storage facility.

VI.2.1. Administration and Support--FMPC. Administration and support required to implement this option are estimated to cost $980,000.

VI.2.2. Residue Packaging--FMPC. Access to residues stored in the concrete tanks at FMPC would be gained by removal of the concrete and clay covers on the residues. The residue would be removed by a clamshell and transported to a packaging station. The packaging operation would be similar to that described for the NFSS.

The cost to retrieve Afrimet residues from the short-term storage tanks, package them, and loading the containers on to trucks is estimated to be $1,463,000.

VI.2.3. Shipping--FMPC. Shipping of the residues from Fernald would be as described for Afrimet residues at NFSS. Cost is estimated to be $1,359,000.

VI.2.4. Perpetual Care--FMPC. The factors considered for perpetual care of Afrimet residues currently at NFSS apply to the K-65 residue at FMPC also. The cost for perpetual care of Afrimet K-65 residue currently stored at FMPC is estimated to be $2,043,000.

VI.2.5. Disposition of Afrimet-Related Rubble--FMPC. Following removal of the K-65 residue from the Short-Term Storage Tanks, the earth berms will be removed. The structures will be washed and dismantled as previously described. The rubble will be loaded into LSA containers and shipped off-site. Contaminated portions of the packaging pad will be packaged and shipped off-site also.

The cost to dispose of all Afrimet-related storage structures located at the FMPC is estimated to be $ 2,250,000.

TABLE VII. SUMMARY OF COSTS

	Estimated Costs - ($)	
	On-Site	Off-Site Total
NFSS - Short Term	7,511,000	
NFSS - Long Term	7,215,000	18,259,000
FMPC - Short Term	250,000	
FMPC - Long Term	3,493,000	8,095,000

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2. A. F. Pennak and R. G. Lenyk. Niagara Falls Waste Management Plan, NLCO-1101, Rev. 4, July 31, 1977.

3. J. H. Cavendish, et al, National Lead Company of Ohio. Scoping Investigations of Alternate Methods for Disposal of Radioactive Residues Stored at the DOE-Niagara Falls Site, September 1978.

4. National Lead Company of Ohio. Informational Report on the U.S. Department of Energy - Niagara Falls Site (draft), NLCO-003EV (Special). July 1979.

APPENDIX A

SELECTED COST DATA

APPENDIX A

SELECTED COST DATA

III.2.1 Interior Improvements - STSF @ NFSS

Seal pipes, etc.	$ 15,000
Consolidate residues	10,000
Evaporation facility	940,000
Evaporator operation	153,000
	$1,118,000

III.2.2 Exterior Improvements - STSF @ NFSS

Demolish existing roof	$ 47,000
Bentonite clay dam	108,000
Concrete roof	504,000
Topsoil and seeding	23,000
	$ 682,000

III.2.3 Relocation of R-10 Residues & Spoils - STSF @ NFSS

Engineered storage pad	$ 371,000
Excavation and transport	883,000
Backfill excavation	395,000
Cover R-10 and spoils	875,000
	$2,524,000

III.3 K-65 Removal and Transport to STSF - NFSS

Pad and sump	$ 22,000
Unload and transport residue	79,000
Load residue into STSF	44,000
	$ 145,000

III.4 L-50 Removal and Transport to STSF - NFSS

Pad and sump	$ 25,000
Unload and transport residue	46,500
Load residue into STSF	22,500
	$ 94,000

III.6 Disposition of Afrimet Utilized Residue Storage Buildings - NFSS

Dismantle pads and sumps	$ 19,000
Dismantle Building 434	153,000
Haul rubble	12,000
Load rubble into Bldg. 413 & 414	59,000
Concrete roofs on Bldg. 413 & 414	40,000
	$ 283,000

IV.2 Sub-surface Entombment Facility Construction - NFSS

Excavation	$ 785,000
Concrete structure	531,000
Bentonite, in place	265,000
Backfill	37,000
	$1,618,000

IV.3 Residue Removal and Transport to Entombment - NFSS

Unload STST	$ 108,000
Transport residue	40,000
Load into entombment	49,000
	$ 197,000

IV.4 Disposition of Afrimet Utilized Storage Buildings - NFSS

Dismantle Building 411	$ 409,000
Dismantle Bldg. 413 & 414	97,000
Haul rubble	71,000
Bury rubble	133,000
	$ 710,000

Selected Unit Costs for Off-site Disposition of Afrimet Residues and Building Rubble - NFSS and FMPC

Drums	$ 30.00/each
Drum filling and handling	$ 15.00 each
Shipping (82 drums/truck or 1 LSA container/truck)	$4000.00/truckload
LSA container for rubble	$1700.00 each
Perpetual care (one-time fee)	$ 10.00/cubic foo

APPENDIX B

OPTIONS CONSIDERED

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APPENDIX B

OPTIONS CONSIDERED

The purpose of this appendix is to briefly describe the many options considered for both the short-term and long-term disposition of Afrimet residues at NFSS. Similar options are applicable to FMPC. The options selected for this study are indicated by an asterisk (*).

A.1 Options for K-65 Residue Removal from Building 434.

A.1.1 Clamshell* - Use crane and clamshell bucket to remove residues from tower. Dump contents in container which can be raised to the top of the building by a construction elevator. Use forklift to place filled containers on truck for transport to Building 411.

A.1.2 Rotating Scraper Blades - Insert specially designed unit housing scraper blades into top of Building 434. Scrape and loosen material, then vacuum overside. Collect at bottom of building and transport to Building 411 similar to A.1.1.

A.1.3 High Pressure Water - Use high pressure spray nozzle to breakup and slurry material from top of Building 434, then pump overside. Filter solids at bottom of 434 and recycle water. Load wet filter cake on trucks and haul to 411.

A.1.4 Work from Underneath Silo - Tunnel under silo. Drill up from bottom. Drill down from top until holes meet. Scrape or slurry material into hole. Use conveyor belt to load material on trucks and transport to 411.

A.1.5 Lift Building 434 and Lower Horizontally - Riggers International claims to be able to lift Building 434 and its contents (6000 tons) and lower into a horizontal position. Since 434 is constructed of fairly thick concrete, it can serve as an adequate short-term storage facility for K-65 residues.

A.1.6 Lift Building 434 and Lower Vertically - Riggers International also claims to be able to lower Building 434 into a previously constructed hole (50 ft. - 60 ft. deep). After the Building is lowered, the top 40-50 ft. of 434 can be removed leaving only 50 ft. above ground. Again, 434 will serve as short-term storage of K-65 residues.

A.1.7 Cut 434 into 3 Pieces - Dravo Corp. suggests removing the top 50 ft. of 434 and lowering it intact to a pad on the ground. Residues can then be dug out of 434 and placed in the removed portion of the building. The unloaded portion of the building can then be removed and lowered intact to a second pad. Additional residues can be loaded into the second portion of the building. The net result is that three 50 ft. buildings would contain K-65 residues instead of one 160 ft. high building.

A.2 Options for Building 434 Dismantling

A.2.1 Saw and Remove Piecewise* - Decontaminate tower using sprays. Collect solution for eventual evaporation. Use concrete cutting saws and cranes to dismantle 434. Use truck to haul pieces to storage.

A.2.2 Explosive - Decontaminate 434 thoroughly using sprays. Collect water for eventual evaporation. Selectively dynamite 434 into a trench.

A.2.3 Crane and Ball - Decontaminate Building as above. Collect water for evaporation. Use crane and ball to demolish 434.

A.3 Short-Term Storage Options for Afrimet Residues

A.3.1 Utilize Building 411 for Short-Term Storage* - Building 411 has the capacity to contain all Afrimet residues currently located at NFSS. Remove water from 411 and evaporate. Construct partitions in 411 to segregate various residues. Seal building

penetrations. Install bentonite dike around building. Remove current spills and R-10 pile in order to provide adequate monitoring. Load residues into building. Install new concrete roof. Mound dirt around building sides.

A.3.2 Utilize Building 409 - It may be possible to utilize Bldg. 409 to contain K-65 residues. In general, building preparation and sealing would be similar to those listed for 411. In this option 411 must also be used.

A.3.3 Utilize Building 430 - Building 430 could be used for short-term storage of Afrimet residues if they are packaged. Reinforce 430 floor. Install new sides and roof. Load in residues in containers. The problem that exists for this option is that if one container fails and has to be replaced, it will be difficult to locate and difficult to retrieve. Virtually the entire storage array could be disrupted for such retrieval.

A.3.4 Construct New Facility - A new facility could be constructed for short-term storage. However, it would probably be quite similar to Building 411 and would not offer any significant advantages over 411. Furthermore, residues currently in 411 would have to be moved to the new facility.

A.4 Onsite Transport of Residue

A.4.1 Truck* - Dump trucks of flatbed trailers with appropriate covers to prevent the spread of contamination appear adequate.

A.4.2 Railcar - Railcars could possibly be used but new track would have to be installed. Railcar transport onsite appears unnecessary.

A.4.3 Conveyor Belts - Generally only feasible for short distances. Covers must be added to prevent spillage.

A.4.4 Pipeline - Residues could be transported on-site by pipeline if slurried. In general, contamination and volume considerations make this unattractive.

A.4.5 Tank Trucks - The onsite transport of residues as a slurry in tank truck offers little merit.

A.5 Onsite Packaging Options for Short-Term Storage of Afrimet Residues

A.5.1 55 Gallon Drums - Approximately 55,000 required @ $30/drum. See A.3.3 for problems.

A.5.2 M-3 Containers - Approximately 3500 required at $500/container. (See A.3.3 for problems).

A.5.3 Railcars - Approximately 200 cars required at $10,000/car (used) or $40,000/car (new). Considerable track must be laid.

A.5.4 Containers Larger Than M-3 - Develop container. License container. See A.3.3 for problems.

A.6 Building 411 Residue Removal Options

A.6.1 Remove Sidewall and Use Wheelloader* - Remove soil piled up around building to provide openings to sidewall. Cut doors in sidewall. Use wheelloader to remove residues.

A.6.2 Remove Bottom Corner - Dig under 411 corner. Arrange trough and conveyor under corner of building. Drill hole in corner. Use equipment to push residues to hole. Conveyor transport to trucks.

A.7 Long-Term Disposition Options for Afrimet Residues

A.7.1 Subsurface Entombment Vault* - Excavate and construct an engineered vault of concrete and bentonite on bedrock (40 deep) Bentonite prevents water entrance. Load in residues. Seal with bentonite and cover with soil.

A.7.2 Offsite Disposition - Package residues in 55-gallon drums and ship offsite. Costs will exceed onsite entombment by a significant margin.