

**U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING**

**SUBJECT: REPOSITORY ADVANCED CONCEPTUAL
DESIGN (ACD): SUBSURFACE**

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**DENVER, COLORADO
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Outline

- **FY93 repository design objectives and tasks**
- **Status of Advanced Conceptual Design (ACD) tasks related to thermal-loading studies including**
 - **Waste-package handling**
 - **Subsurface layouts**
 - **Ventilation concepts**

FY93 Repository Subsurface Advanced Conceptual Design (ACD) Objectives

- **Support system studies in the areas of thermal loading and emplacement mode**
- **Support repository/ESF interface development**
- **Support Multi-Purpose Canister (MPC) design study**
- **Support site characterization activities**
- **Perform other ACD tasks to preserve the ACD schedule, to the extent possible**

Repository ACD Tasks for FY93

- **Management and integration (M&I)**
- **Requirements and basis for design**
- **Subsurface waste-package handling equipment concepts**
- **Shafts and ramps concepts**
- **Subsurface excavation system**
- **Underground service system**
- **Operations/maintenance**

Repository Subsurface Design Activities Supporting System Studies

- **Provide subsurface layouts concepts for**
 - **A range of thermal loading**
 - **Three emplacement modes**
 - **A range of waste-package design concepts**
- **Operability issues including**
 - **Safety**
 - **Transportation equipment**
 - **Retrievability**
- **Preliminary comparative cost estimate**

Subsurface Waste-Package Handling Equipment Concepts

Thermal loading and MPC studies are considering a large range of waste packages, emplacement modes, and areal power densities

To support these studies concepts are being developed for

- **Transportation, emplacement, and retrieval equipment for waste packages**
 - **Containing 2 to 21 (PWR) (SNF) assemblies**
 - **Weighing from 13 to 164 tonnes (29,000 lbs to 360,000 lbs)**
- **Emplacement in vertical borehole, horizontal borehole, and in-drift**

Concepts for Transportation in Repository

Evaluating in repository transport equipment including

- **Wheeled**
- **Tracked**
- **Rails**
- **Monorail**

Criteria for Evaluation of Transportation Equipment Concepts

The criteria for evaluation of concepts include

- **Gradient of drifts/ramps**
- **Drift size requirement**
- **Waste-package size and weight**
- **Operating environment (radiation, temperature)**
- **Emission requirement**
- **Ease of automation**
- **Power source**
- **Compatibility with emplacement mode**
- **Requirement for relocation**
- **Retrievability requirements**

Concepts for Transportation in Repository

Description	Rail	Rubber tired
Power source	diesel, electric, battery	diesel, electric
Typical operating grade limit	<ul style="list-style-type: none"> • standard rail 4 % • cog rail 30 % • adhesion rail 10 % 	15 %
Operating environment	up to 50°C	up to 50°C

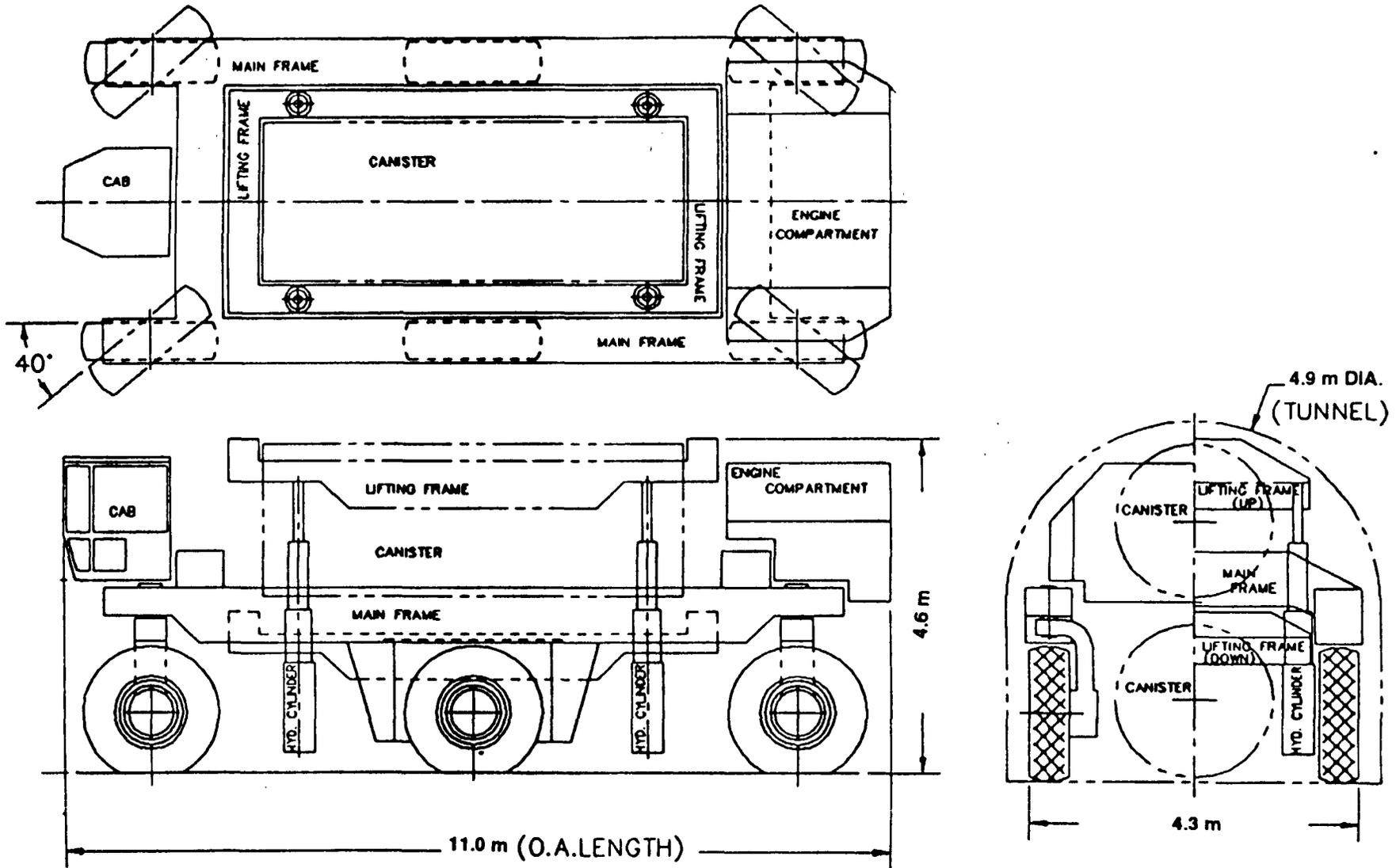
Concepts for Transportation in Repository

(Continued)

Description	Drift Size* Rail	Drift Size* Rubber-Tired
In-drift emplacement	4.5 m (14 ft)	6 m (20 ft)
Vertical/horizontal emplacement	7 m (23 ft)	7 m (23 ft)

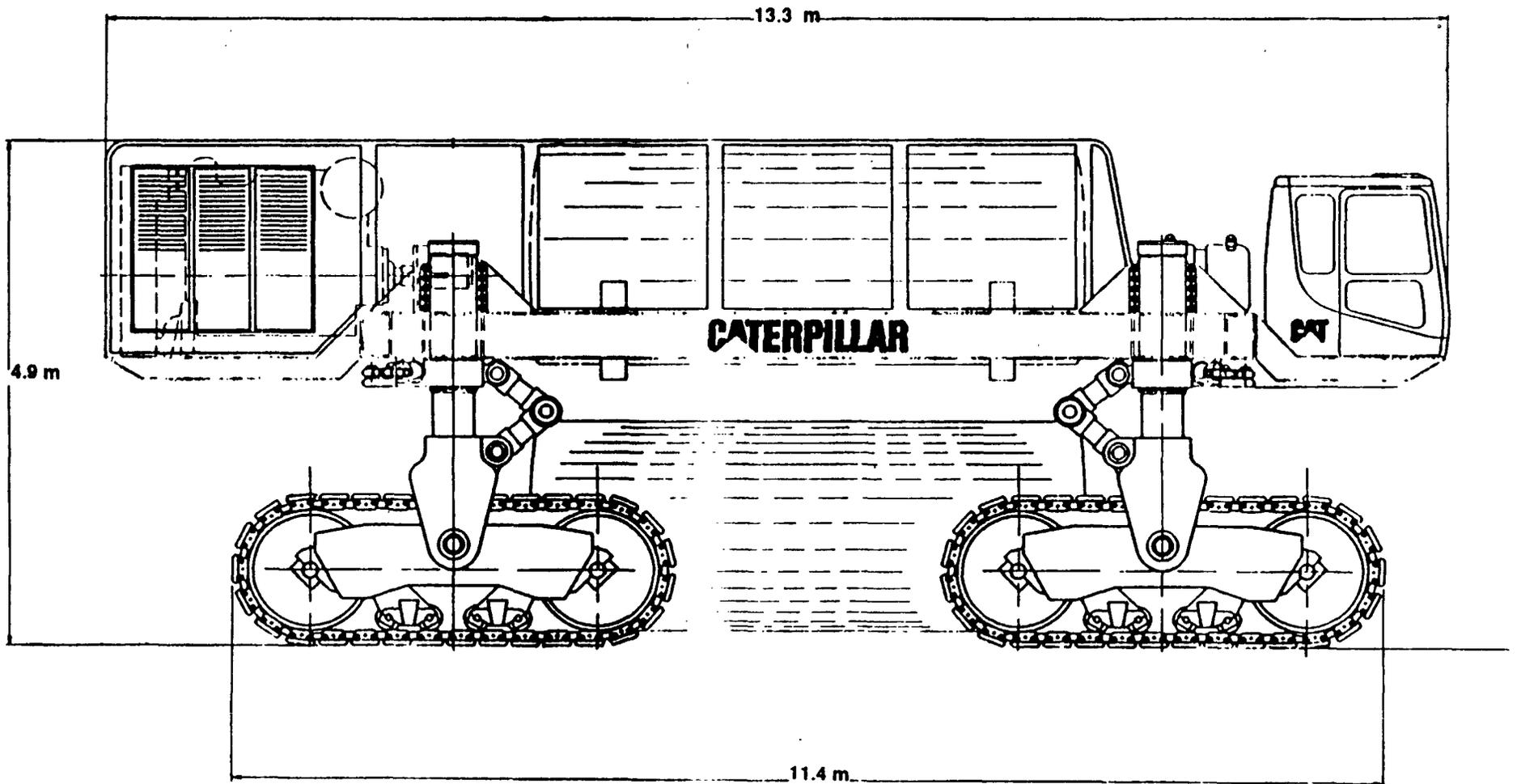
* Approximate

Rubber Tired Transporter



Preliminary Drawing
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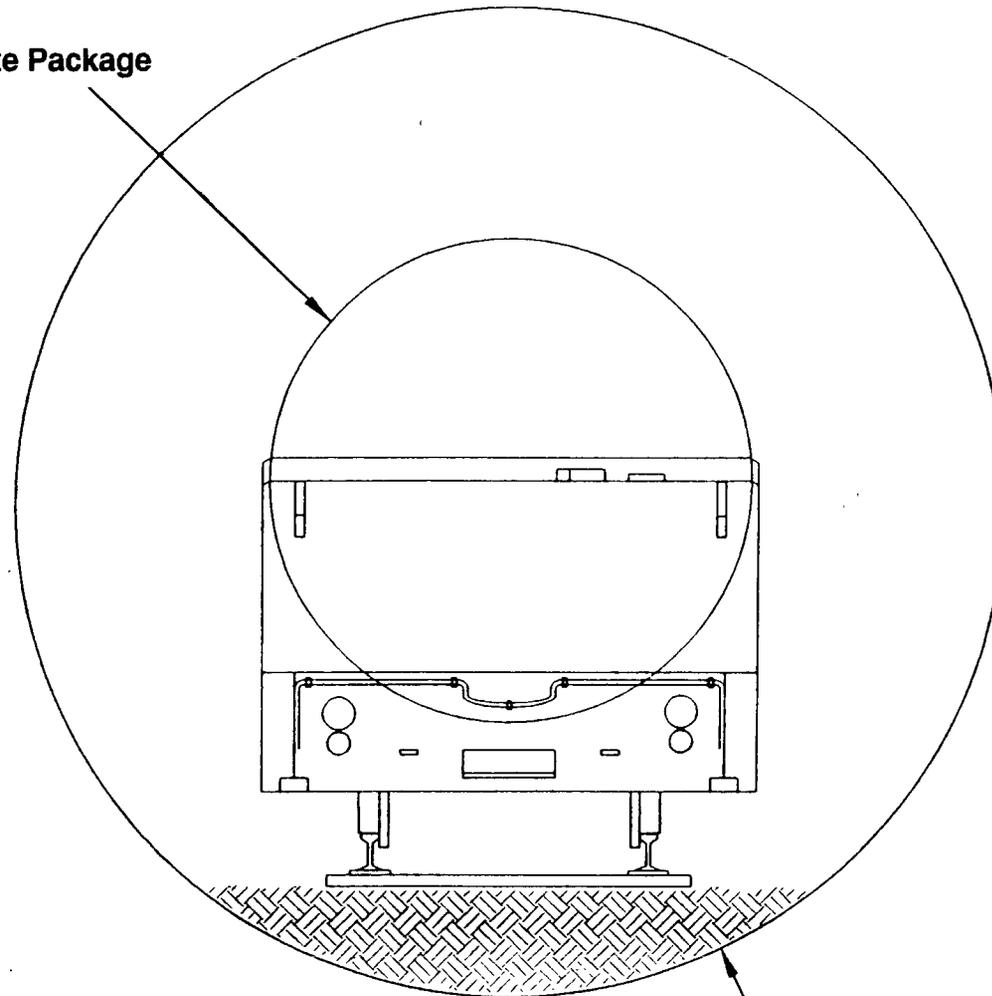
Tracked Waste Transporter



Preliminary Drawing
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Rail Waste Transporter

2.1 m Diameter Waste Package

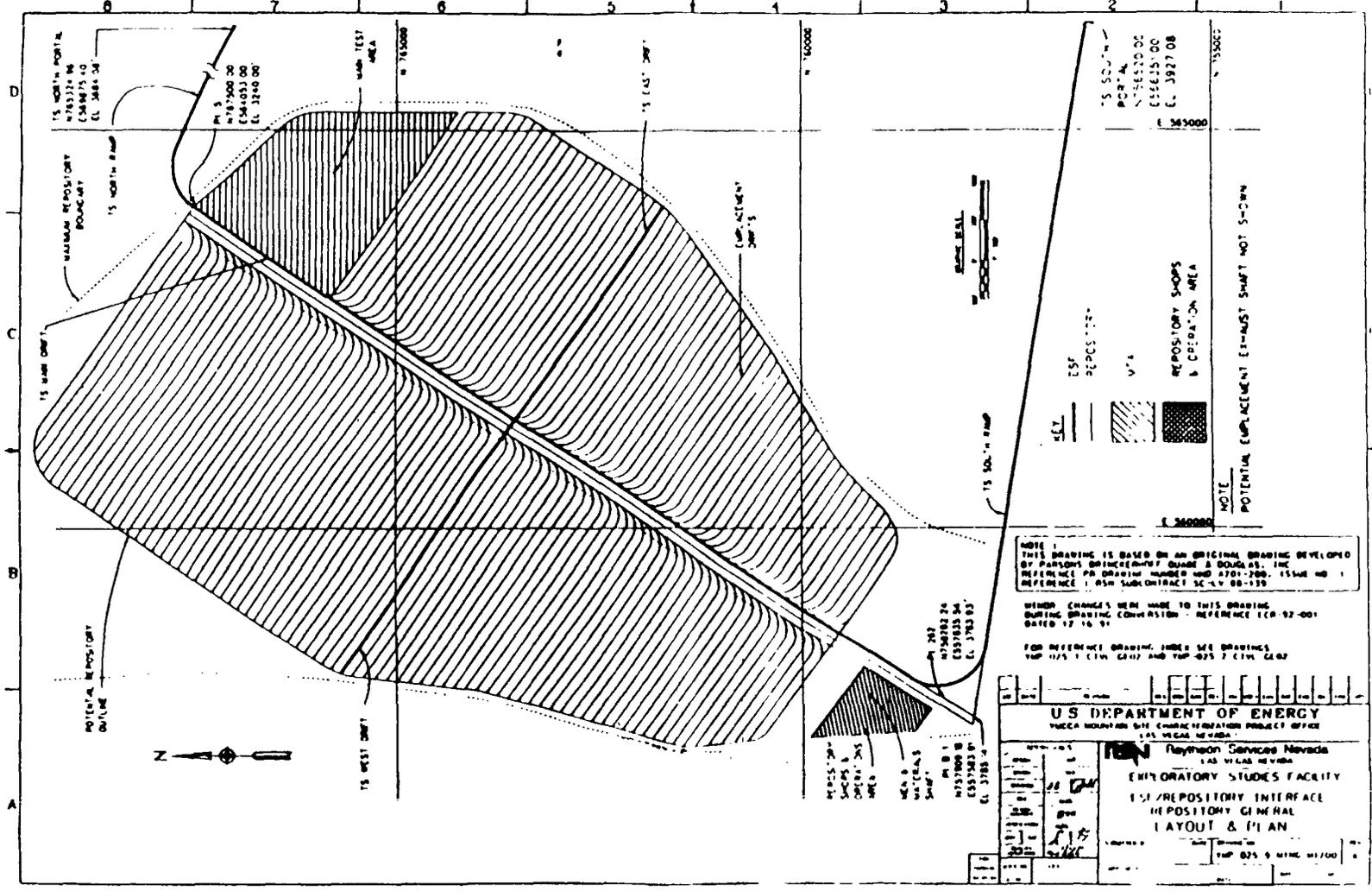


4.3 m Diameter Tunnel

Preliminary Drawing
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Subsurface Layout Concepts

- **Preparing layouts and costs for thermal-loading studies using**
 - **A range of waste-package sizes (2 -21 PWR)**
 - **Three emplacement modes**
 - **Range of areal power densities (20 to 114 kW/acre)**
- **Preparing ESF/interface concepts**



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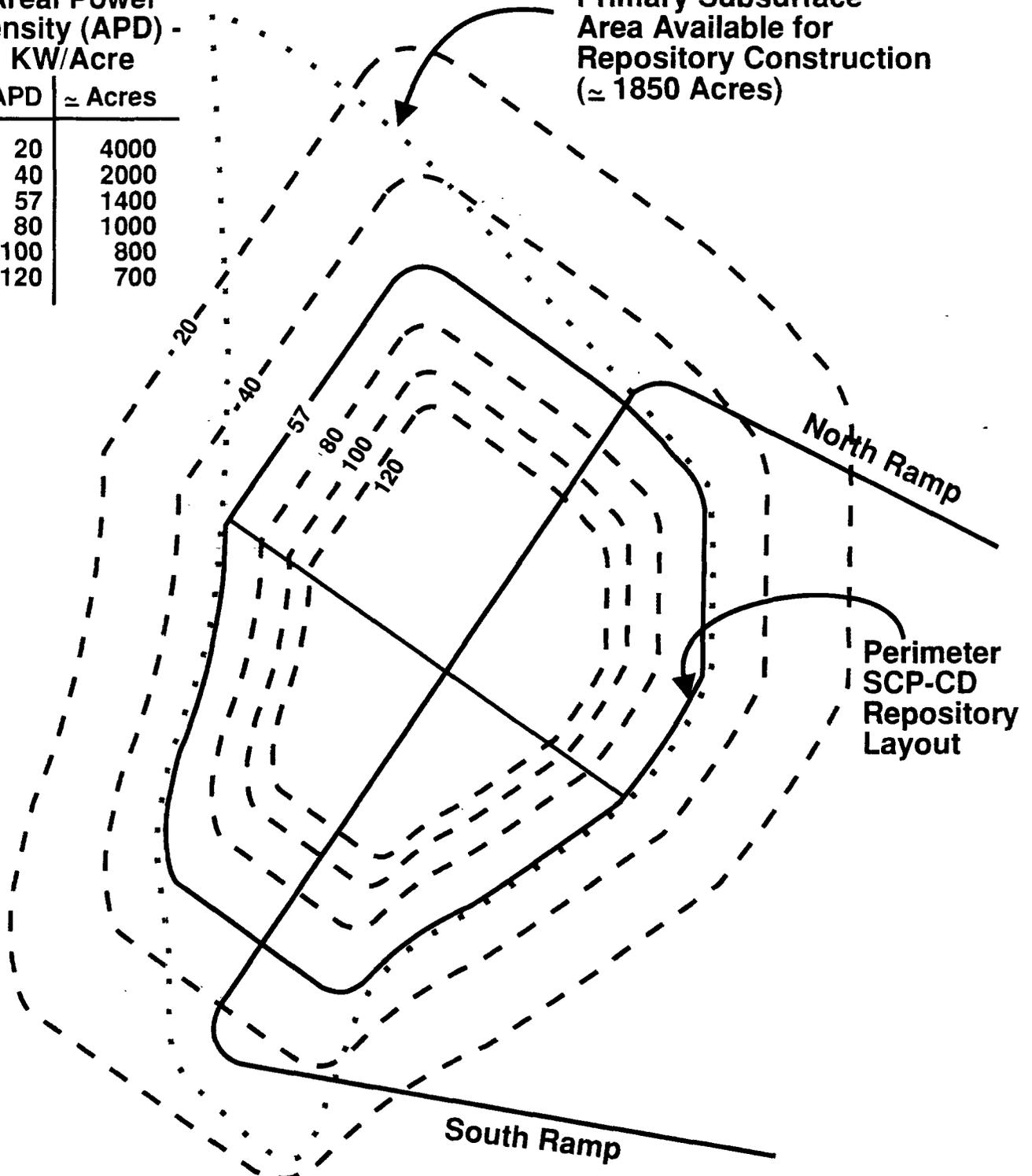
Area Requirements at Various Areal Power Densities

(SCP-CD Fuel Age and Burn-up)

Areal Power Density (APD) - KW/Acre

APD	≈ Acres
20	4000
40	2000
57	1400
80	1000
100	800
120	700

Primary Subsurface Area Available for Repository Construction (≈ 1850 Acres)



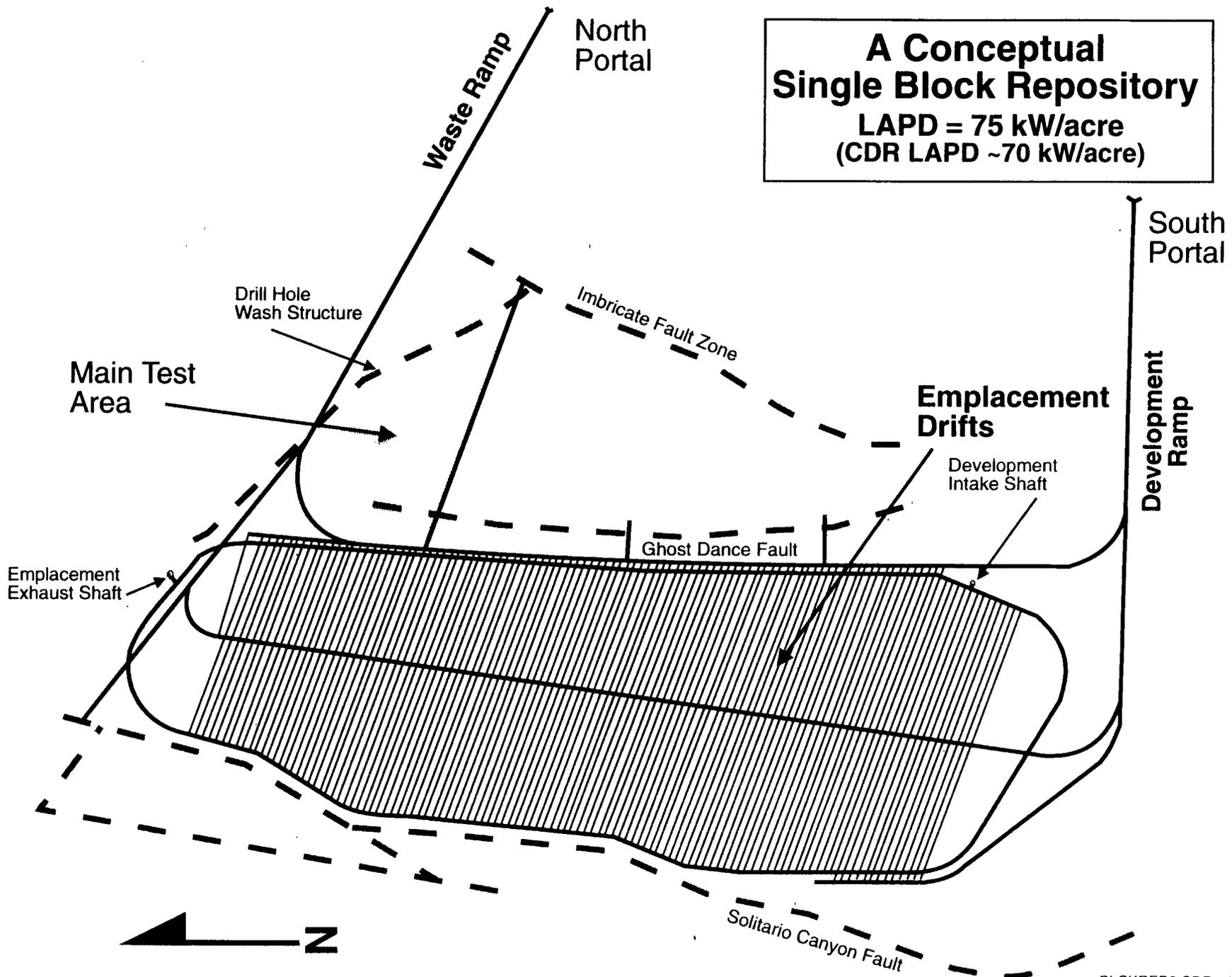
Subsurface Layout Concepts

(Continued)

A repository concept to interface with the current ESF design

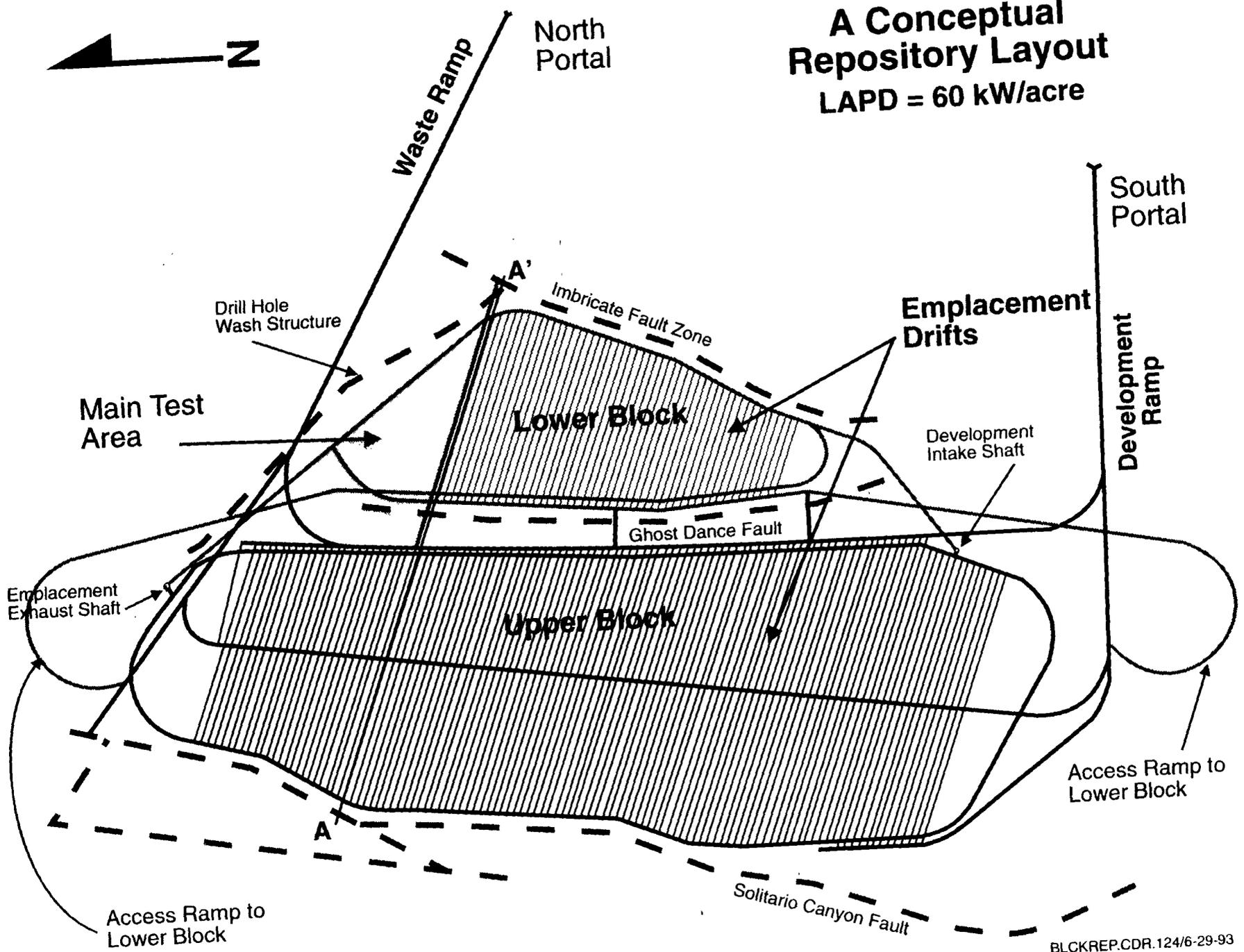
- **Step-block concepts with no development in Ghost Dance fault**
- **TBM excavation**
- **Integrated rail transportation**
- **Virtually flat emplacement drifts and gradients of less than 3 percent elsewhere**
- **In-drift emplacement using approximately 4 m diameter emplacement drifts**

**A Conceptual
Single Block Repository**
LAPD = 75 kW/acre
(CDR LAPD ~70 kW/acre)

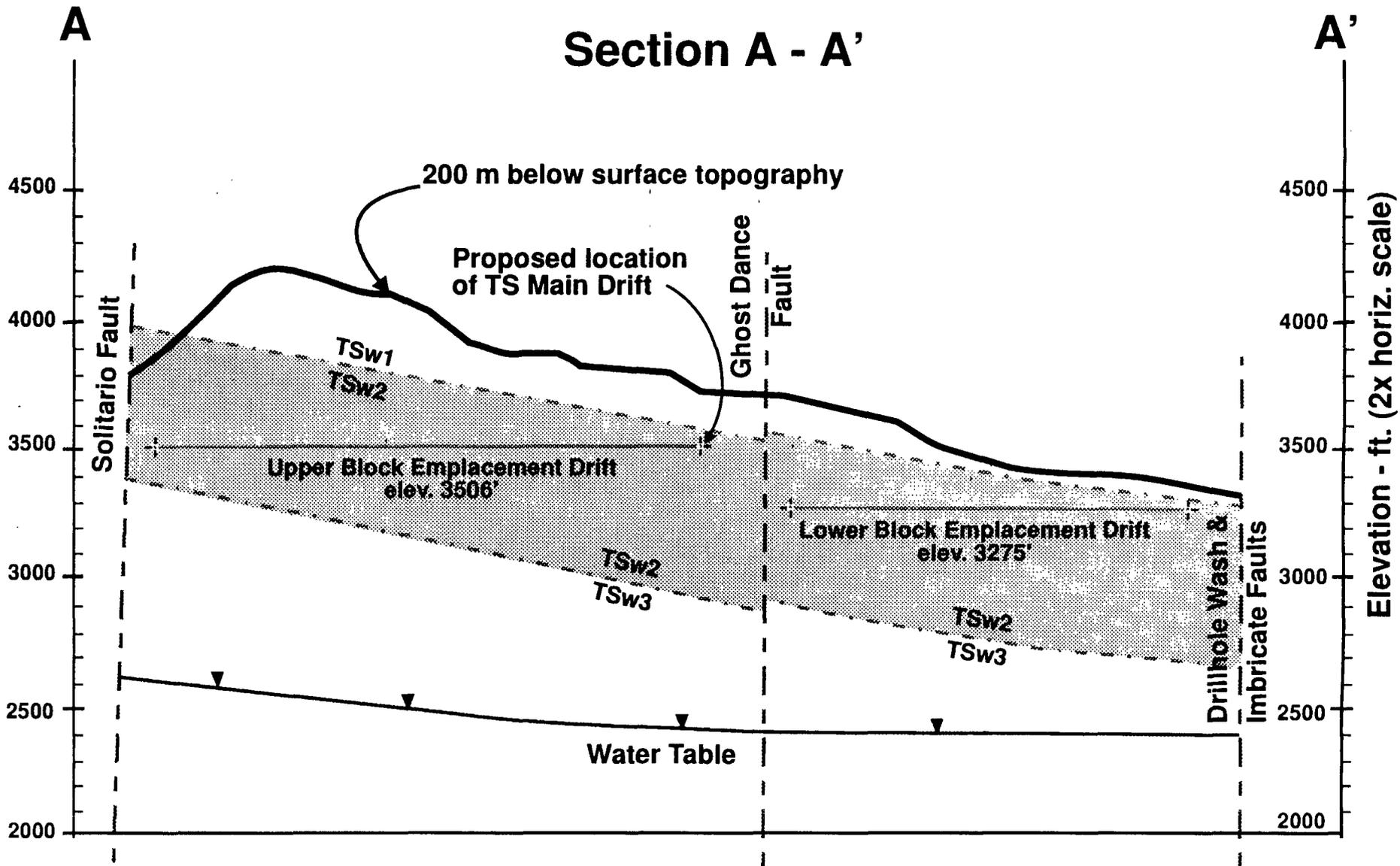


A Conceptual Repository Layout

LAPD = 60 kW/acre



Section A - A'



Note: Plane of section cuts through lowest emplacement drift in step-block layout.

Ventilation Studies

- **Evaluating drift lengths from feasibility of temperature control during emplacement or retrieval**
- **Evaluating ventilation requirements for continuous cooling or cooling as required**
- **Evaluating concepts for removal of heat from waste packages during pre-closure period**
- **Evaluating shaft/ramps size, number, location for various ventilation concepts**

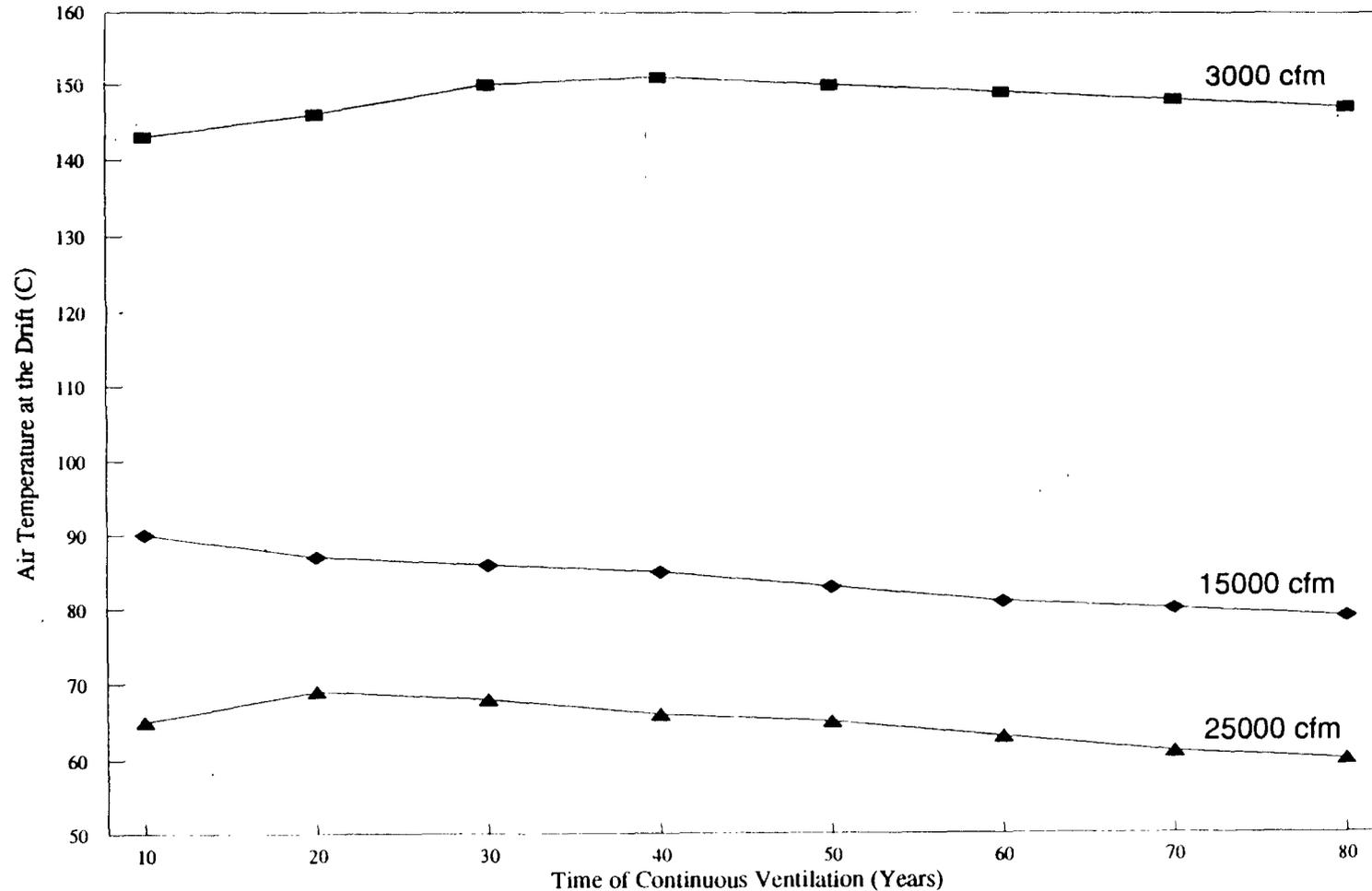
Ventilation Studies

(Continued)

- **Effects of allowing ventilation air to flow continuously through the emplacement drifts**
 - **Studies suggest that it is feasible to control air temperature by continuous ventilation. May require large number of additional shafts and higher power cost to handle the additional air**
 - **Ventilation air-flow is capable of removing a significant amount of heat output from emplaced waste packages**

- **Effects of forced cooling of previously closed drifts for retrieval or maintenance**
 - **Studies suggest that cooling of emplacement drifts within a period of months is feasible using a relatively large amount of air**

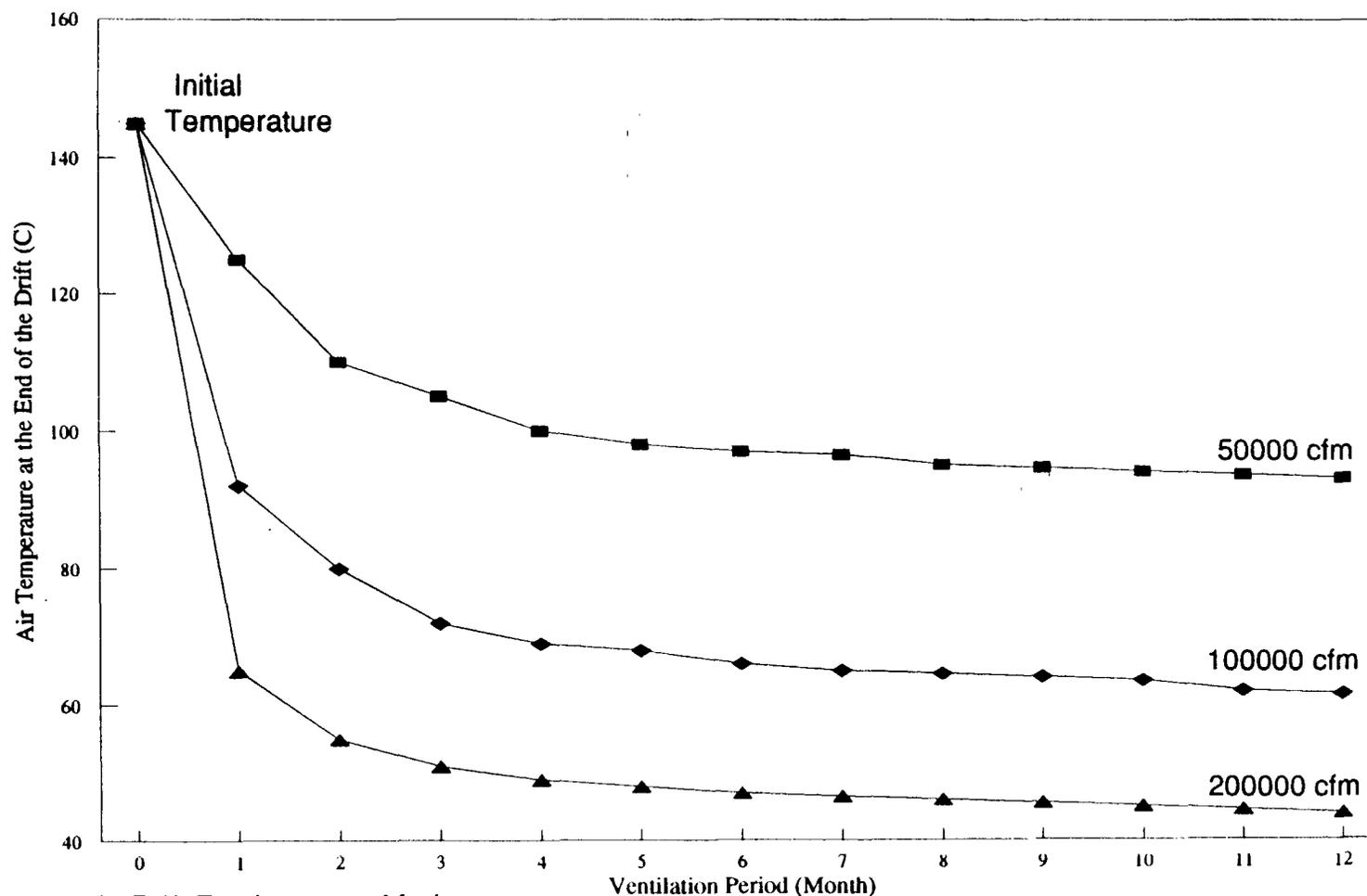
Effect of Continuous Ventilation in an Emplacement Drift



In-Drift Emplacement Mode
Areal Power Density 114 kW/Acre
Length of the Drift 900 m
Intake Air Temperature 26.5 C

Source: Danko, G., 1992

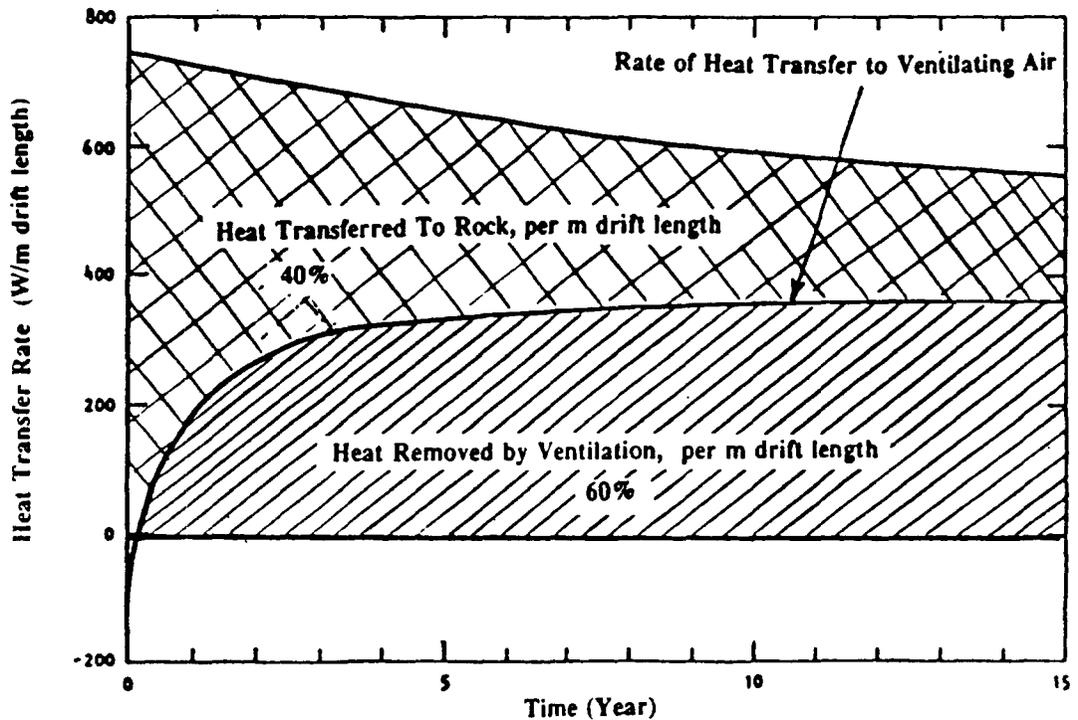
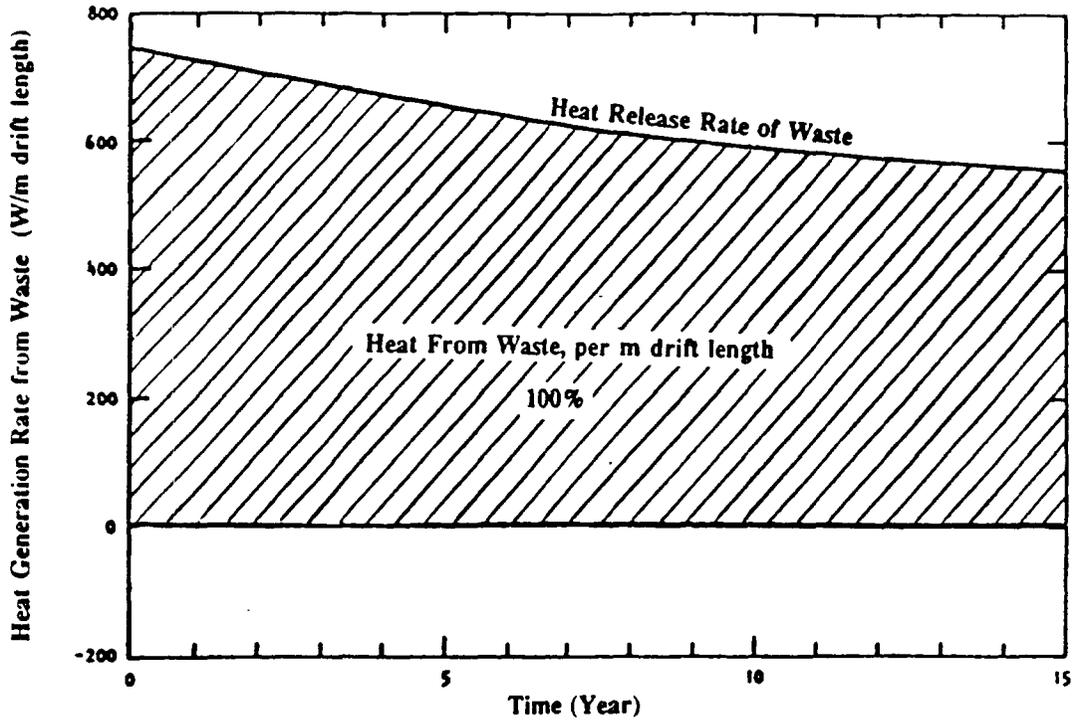
Cooling by Ventilation of a Previously Sealed Drift



In-Drift Emplacement Mode
Drift Length 900 m, Sealing Period 50 Years
Areal Power Density 114 kW/Acre
Intake Air Temperature 26.5 C

Source: Danko, G., 1992

Heat Removal by Ventilation (For Vertical Emplacement)



Source St. John, C., 1985
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Summary

- **FY93 repository ACD tasks include support of system studies including thermal loading**
- **The repository ACD is considering a range of thermal loading, waste package design, and emplacement mode concepts**
- **In support of the system studies, preliminary concepts are being developed for**
 - **Repository layouts**
 - **Transportation system**
 - **Ventilation schemes**
 - **Shafts/ramps design concepts**
 - **Material handling system**
 - **Emplacement and retrieval system**
- **Concepts for ESF/repository interface are being developed in conjunction with the Title II design of ESF**