Summary Descriptions of Enhanced Design Alternatives (EDAs)

Presentation to:
Nuclear Waste Technical Review Board (NWTRB)

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Yucca Mountain Project

Basic Elements of EDAs
Common Features

- Drip shield
- Carbon steel ground support
- Drift diameter (5.5 m)
- Pre-closure ventilation
- 70,000 MTHM waste emplacement
- Steel invert with granular ballast

Basic Elements of EDAs
Variable Features

- Thermal goals
- Backfill
- Waste package materials
- Thermal blending
- Drift spacing
- Waste package spacing
- Location within characterized area

EDA Constraints

- **Maintain CSNF cladding <350°C**
- **Personnel access for off-normal events**
- **Allow repository closure 50 years or later after start of waste emplacement**

EDA I

- **Goals specific to EDA I**
  - **Maintain drift wall <96ºC**

- **Design Elements**
  - **AML~45 MTHM/acre**
  - **Area required~1400 acres**
  - **Point loading @ 3 m WP spacing**
  - **Drift spacing=43 m**
  - **Emp. drift length=132 km**
  - **12 PWR size WP**
  - **20% thermal blending, WP heat output max. 6.7 kW**
  - **WP material–2 cm Alloy 22 over 5 cm SS**
  - **Total WPs=15,903**

EDA II

- **Goals specific to EDA II**
  - **Maintain drift wall <200ºC**
  - **Center of pillars (between drifts)<96ºC**

- **Design elements**
  - **AML~60 MTHM/acre**
  - **Area required~1,050 acres**
  - **Line loading @ 10 cm WP spacing**
  - **Emp. drift spacing=81 m**
  - **Emp. drift length=54 km**
  - **21 PWR size WP**
  - **20% thermal blending-, WP heat output max. 11.8 kW**
  - **WP Material–2 cm Alloy 22 over 5 cm SS**
  - **Total WPs=10,039**
  - **Backfill @ Closure**

EDA III (a&b)

- **Goals specific to EDA III**
  - **Maintain drift wall <200°C**
  - **WP surface <80°C before RH>90%**

- **Design elements**
  - **AML~85 MTHM/acre**
  - **Area required~740 acres**
  - **Line loading@ 10 cm WP Spacing**
  - **Emp. drift spacing=56 m**
  - **Emp. drift length=55 km**
  - **21 PWR size WP**
  - **Limited thermal blending, WP heat output max. 18.0 kW**
  - **WP material–(a)2 cm Alloy 22 over 5 cm SS (b) 2 cm Alloy 22 over 1.5 cm Ti-7 over 4 cm SS**
  - **Total WPs=10,213**

EDA IV

- **Goals specific to EDA IV**
  - **Maintain drift wall <200°C**
  - **Keep drifts hot and dry thousands of years**
  - **Limit g dose @ WP surface <200 mr/hr**
- **Design elements**

- **AML~85 MTHM/acre**
- **Area required~740 acres**
- **Line loading @ 10 cm WP spacing**
- **Emp. drift spacing=56 m**
- **Emp. drift length=60 km**
- **21 PWR size WP**
- **Limited thermal blending, WP heat output max. 18.0 kW**
- **WP material–30 cm CS**
- **Total WPs=10,213**
- **Backfill @ closure**

EDA V

- **Goals specific to EDA IV**
  - **Maintain drift wall <225ºC**
  - **Keep drifts hot & dry thousands of years**

- **Design elements**
  - **AML~150 MTHM/acre**
  - **Area required~420 acres**
  - **Line loading @ 10 cm WP Spacing**
  - **Emp. drift spacing=32 m**
  - **Emp. drift length=54 km**
  - **21 PWR size WP**
  - **20% thermal blending, WP heat output max. 11.8 kW**
  - **WP material–2 cm Alloy 22 over 5 cm SS**
  - **Total WPs=10,039**

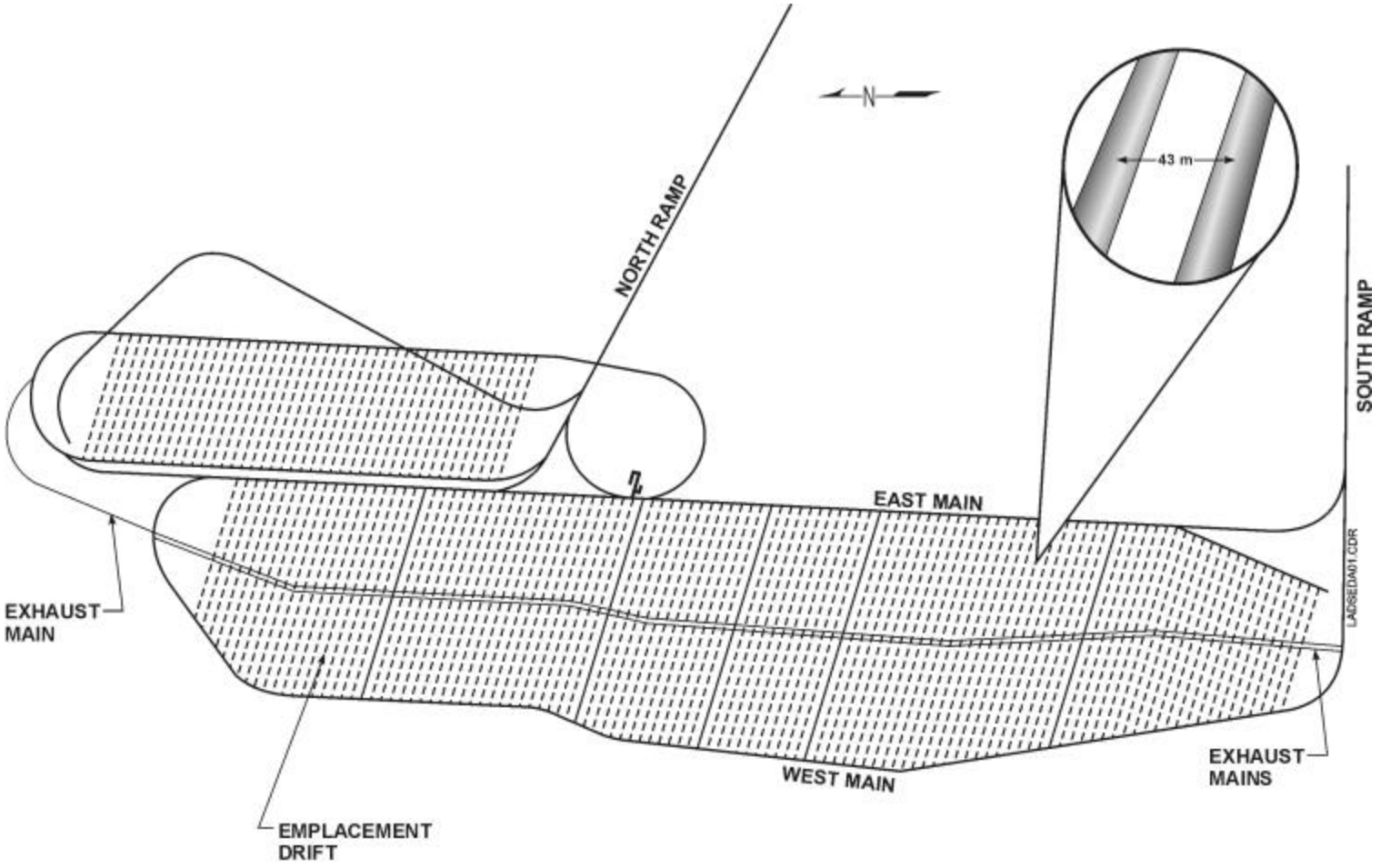
EDA Summary

- **Five viable EDAs were developed**
- **All meet performance screening criterion with considerable margin**
- **All have defense in depth**
- **All EDAs can be closed as early as 50 years from start of emplacement**

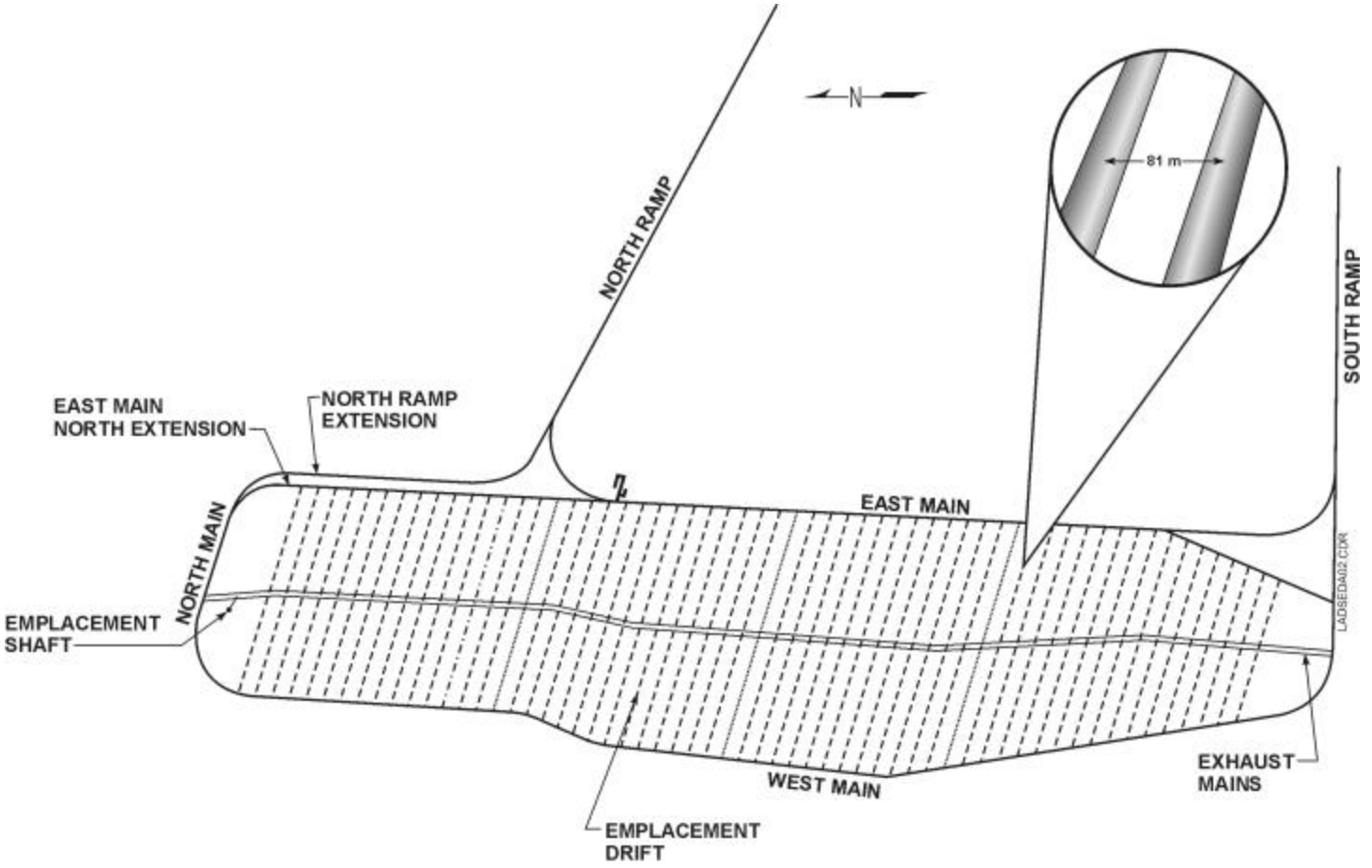
License Application Design Selection Enhanced Design Alternatives Design Values

DESIGN ELEMENT	EDA I	EDA II	EDA III	EDA IV	EDA V
Thermal Goals • Cladding	350°C	350°C	350°C	350°C	350°C
• Waste package surface			Cools to 80°C before relative humidity reaches 90%		
• Drift wall	96°C	200°C	200°C	200°C	225°C
• Drift environment				Keep drifts dry for thousands of years	Keep drifts dry for several thousand years
• Pillar temperatures		Keep centers of pillars below boiling (96°C)			
• Other goals				Limit gamma dose at waste package surface to 200 mrem/hr	
Areal Mass Loading (MTHM/acre)	45	60	85	85	150
Area (acres) for 70,000 MTHM	1,400	1,050	740	740	420
Line/Point Load	Point	Line	Line	Line	Line
Waste Package Size (PWR)	12	21	21	21	21
Drift Diameter (m)	5.5	5.5	5.5	5.5	5.5
Drift Spacing (m)	43	81	56	56	32
Preclosure Ventilation	50 years @ 2 to10 m^3/s	50 years @ 2 to 10 m^3/s	50 years @ 2 to10 m^3/s	50 years @ 2 to10 m^3/s	50 years @ 2 to 10 m^3/s
Waste package heat output at emplacement Maximum Average (PWR waste package) (CRWMS M&O 1999bb)	20% blending used to reduce maximum 6.7 kW 5.6 kW	20% blending used to reduce maximum 11.8 kW 9.8 kW	Limited blending 18.0 kW 9.5 kW for PWR	Limited blending 18.0 kW 9.5 kW	20% blending used to reduce maximum 11.8 kW 9.8 kW
Waste Package Material	2-cm Alloy-22 over 5-cm stainless steel	2-cm Alloy-22 over 5-cm stainless steel	a) 2-cm Alloy-22 over 5-cm stainless steel b) 2-cm Alloy-22 over 1.5-cm Ti-7 over 4-cm stainless steel	30-cm carbon steel	2-cm Alloy-22 over 5-cm stainless steel
Fillers	No	No	No	Integral filler	No
Backfill	No	Yes	No	Yes	No
Drip Shield	Yes	Yes	Yes	Yes	Yes
Total Waste Packages	15,903	10,039	10,213	10,213	10,039

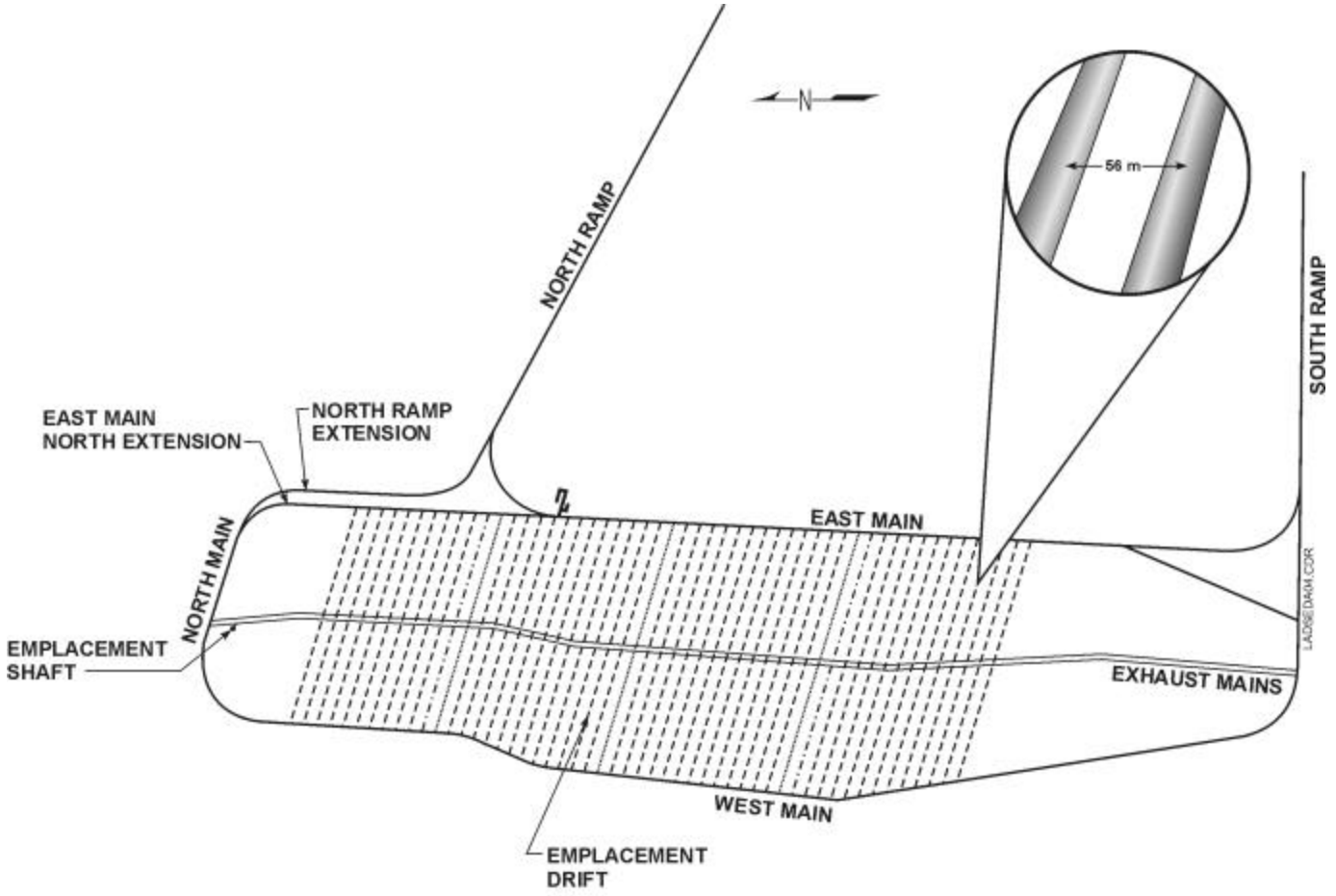
EDA I Site Layout



EDA II Site Layout



EDA III and IV Site Layout



EDA V Site Layout