

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

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

**SUBJECT: SUBSURFACE REMOTE OPERATIONS**

**PRESENTER: ALDEN M. SEGREST**

**PRESENTER'S TITLE  
AND ORGANIZATION: MANAGER, MGDS DEVELOPMENT  
MANAGEMENT AND OPERATING CONTRACTOR  
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**TELEPHONE NUMBER: (702) 794-1924**

**ARLINGTON, VIRGINIA  
OCTOBER 9-10, 1996**

# Remote Operations Issue

**The issue is the application of remote handling technology to subsurface repository operations, which is characterized by**

- **High radiation environment**
- **Elevated temperatures**
- **Confined operating area**
- **Access limitations for maintenance/repair**

# **Why is the Remote Operations Issue an Important one to Repository Subsurface Design?**

- **Emplacement drifts will compose 90% of the subsurface area**
- **Under normal conditions, emplacement drifts are off-limits to personnel due to high heat (up to 200 °C) and high radiation**
  - **Therefore, all operations within emplacement drifts during and after waste emplacement must be operated remotely**
- **Repository design concept relies on the successful implementation of remote systems**

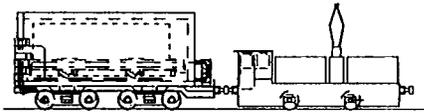
# Impacts of the Remote Operations Issue on Design

- **Loaded disposal container**
  - Transport from waste handling building at the surface to emplacement drift entrance
  - Transfer at emplacement drift entrance
  - Emplacement/retrieval operation
- **Operation of rail switches and emplacement drift access control doors**
- **Performance confirmation tasks**
- **Recovery from off-normal conditions**

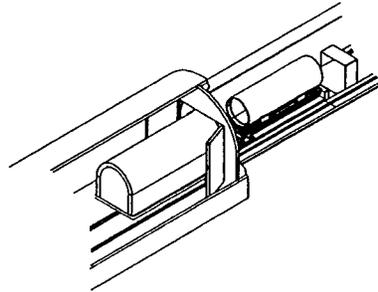
# Subsurface Remote Operations For Disposal Container Handling

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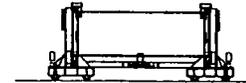
Underground Haulage



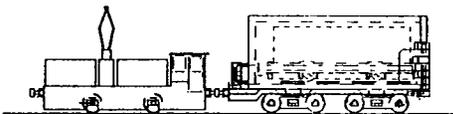
Transfer at Emplacement



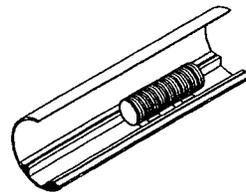
Emplacement

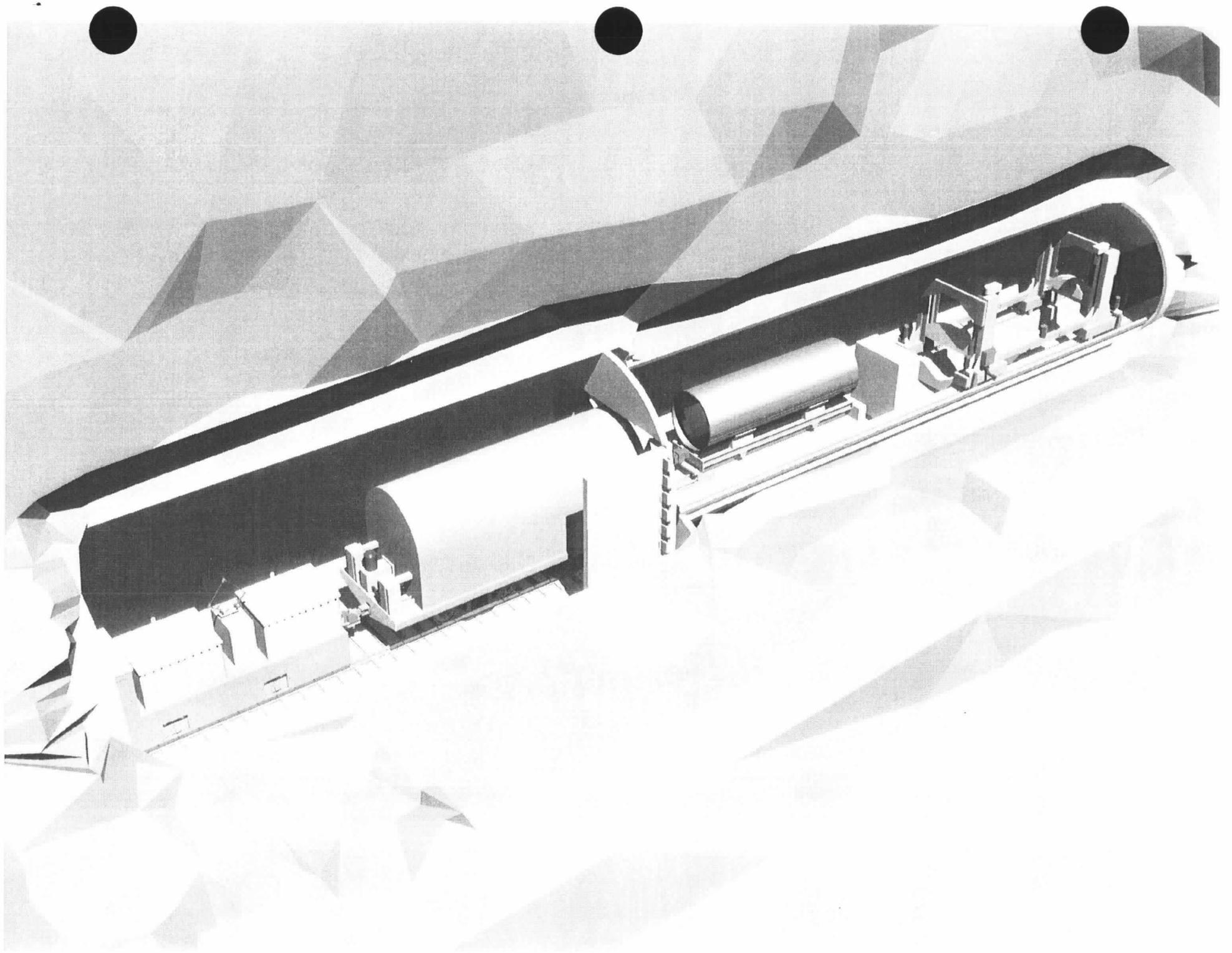


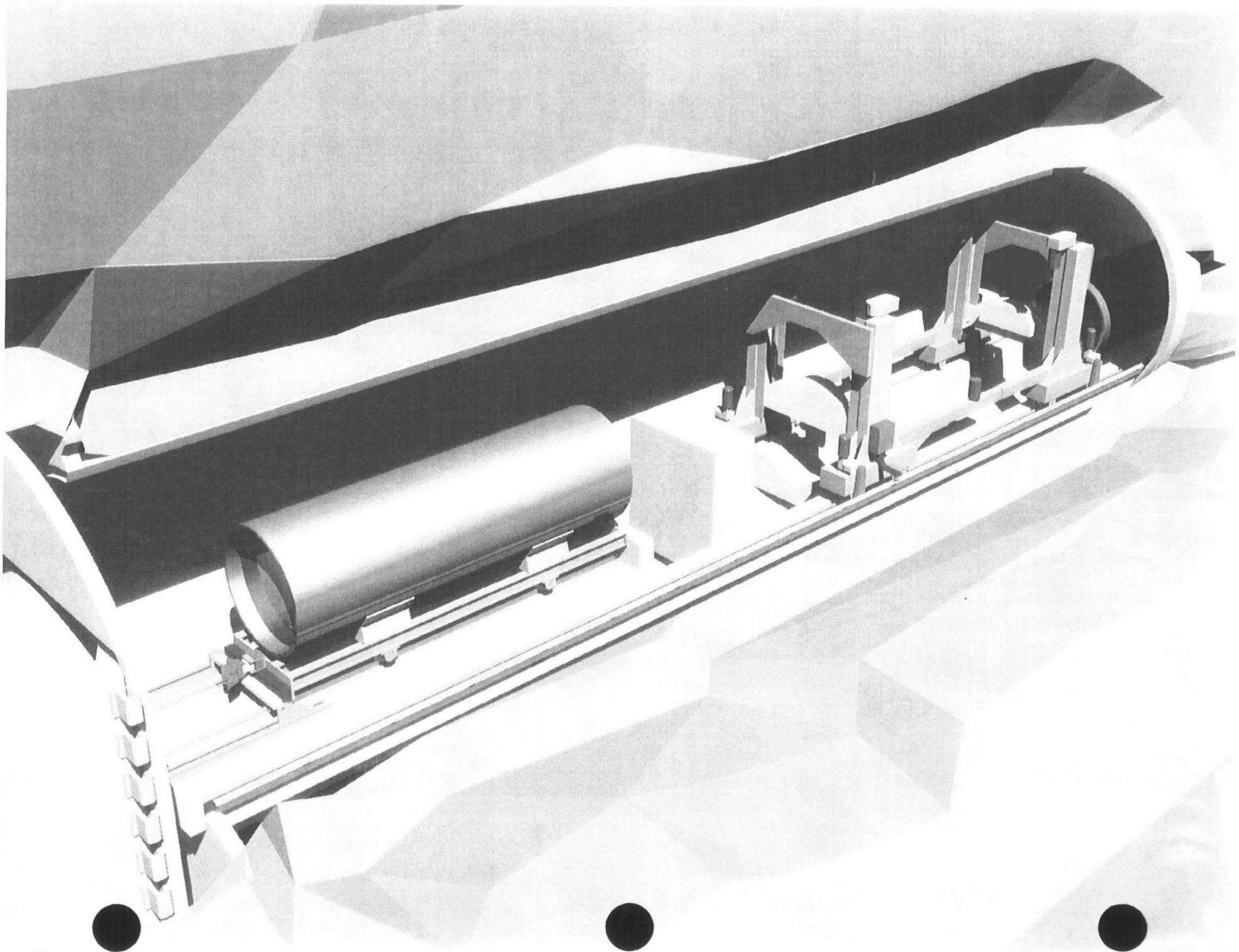
Retrieval

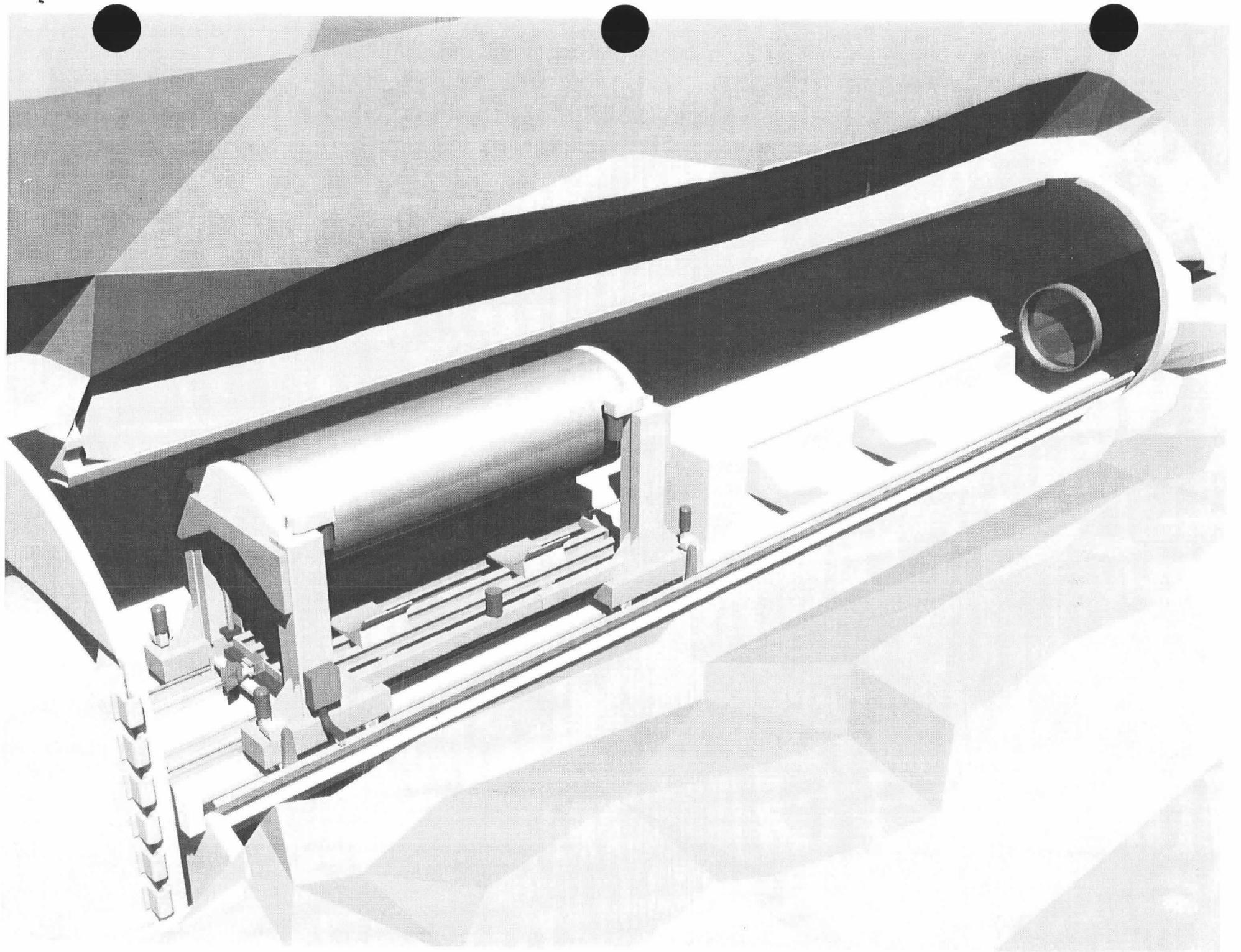


Monitoring and  
Performance Confirmation









# Recent Activities to Resolve the Issue

**Extensive review of available technologies performed during FY96: research sources include**

- **Mining industry: automated mining applications**
- **Railroad industry: automated locomotive and rail systems**
- **Nuclear industry: automation and robotics for high radiation environment**
- **Industrial application: automation, robot manipulators, controls**

# **Recent Activities to Resolve the Issue**

(continued)

- **Nuclear waste programs: Yucca Mountain Project, Waste Isolation Pilot Plant (WIPP)**
- **DOE research: intelligent mobile vehicles, advanced remote systems**
- **NASA research: telerobotics, operator interfaces, communications**
- **University research: sensors, computers, robotics, controls**

# **Recent Activities to Resolve the Remote Operations Issue**

**Work has been focused on the following areas**

- **Mobile remote communication technologies**
- **Power source technology for mobile remote machines**
- **Remote systems for hazardous environment**
- **Electronics, sensors, and equipment designed for use in elevated thermal and radiation environments**

# **Results of Recent Remote Systems Design Effort**

**The evaluation of technologies are performed with licensing consideration of safety, redundancy, and back-up systems for critical items**

## **Evaluation criteria**

- **Personnel safety**
- **Functionality**
- **Reliability, maintainability**
- **Proven technology**
- **Passive/active components**

# Results of Recent Remote Systems Design Effort

## Evaluation criteria *(continued)*

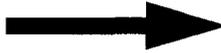
- **Customization required**
- **Survivability**
- **Installation complexity**
- **Installed, operational, and management costs**

# Results of Recent Remote Systems Design Effort

(continued)

## Available mobile communications technologies evaluated

- Leaky feeder coaxial cable
- Direct Radio Control
- Laser/optical
- Microwave
- Slotted microwave guide
- Infrared
- Cable reel
- Festoon
- Conductor bar



## Leading candidates for further evaluation

- Direct Radio Control
- Leaky feeder
- Slotted microwave

# Results of Recent Remote Systems Design Effort

(continued)

## Available mobile vehicle power technologies evaluated

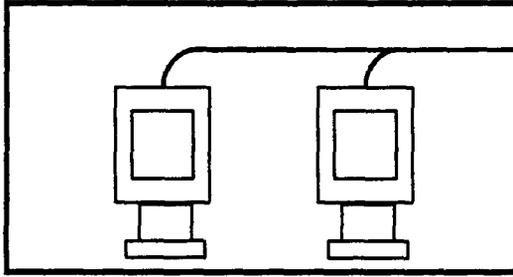
- Electrical third rail
- Trolley wire
- Motorized cable reel
- Battery
- Conductor bar
- Festoon



## Leading candidates for further evaluation

- Conductor bar
- Battery

**OPERATOR CONTROL STATION**



**NORTH PORTAL**

**TRANSPORT LOCOMOTIVE AND WP TRANSPORTER**

**NORTH RAMP**

**EXHAUST MAIN**

**SHIELD DOOR**

**EMPLACEMENT DRIFT**

**GANTRY WITH WASTE PACKAGE**

**TRANSPORT LOCOMOTIVE & GANTRY CARRIER**

**LEGEND**

- FIBEROPTIC BACKBONE
- - - RADIO FREQUENCY (RF) EQUIPMENT
- △ VIDEO EQUIPMENT
- ∨ RADIO LINK
- PLC EQUIPMENT

# Results of Recent Remote Systems Design Effort

(continued)

**Preliminary conclusions from work performed to date are that for emplacement and retrieval operations (where temperature is  $< 50^{\circ}\text{C}$ )**

- **Adequate technology exists for**
  - **Control, communication, command, and power**
  - **Locomotion/mobility, actuators, and sensors**
- **Key design areas are**
  - **Underground mobile communications**
  - **Mobile power**
  - **Systems integration**

# **Results of Recent Remote Systems Design Effort**

(continued)

**Preliminary conclusions are that for elevated temperature (up to 200°C) environment expected during performance confirmation period poses significant design challenges**

- **Promising technologies for elevated temperature applications are**
  - **New heat-tolerant electronics**
  - **Active and passive cooling systems**
  - **Advance heat insulation and heat rejection techniques**

# Recent Activities to Resolve the Issue

(continued)

## For recovery from off-normal conditions

- **Equipment failures such as derailment, stuck isolation doors, loss of power, communication, and other system failures are being considered in development of remote systems**
  - **Subsystems critical to remote systems operation will have built-in redundancy and back-up systems to ensure safety and reliability**
  - **Provisions will be made for inoperable remote vehicles to be removed from inaccessible areas**

# **Planned Activities to Resolve this Issue**

**FY97 activity in the remote operations area will focus on**

- **Selection of preliminary remote handling concepts for**
  - **Subsurface waste package handling equipment and related communications and power supply**
  - **Mobile remote power, communication, and control systems for elevated thermal environment**

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**NUCLEAR WASTE TECHNICAL REVIEW BOARD  
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**SUBJECT: DRIFT STABILITY AND MAINTENANCE**

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# Overview

- **Description of the drift stability issue and long-term maintenance**
- **Impacts of the drift stability issue on repository design**
- **Recent activities to resolve the issue**

# **Drift Stability and Maintenance**

**Drift stability and maintenance is an issue because**

- **Construction material for ground support must be compatible with post-closure performance**
- **The ground support method used must be compatible with**
  - **Performance confirmation requirements**
  - **Construction method**
- **Drifts must be safely useable for a long operational life including a potential retrieval period**
- **Emplaced waste packages producing heat and radiation will make access difficult for drift maintenance**

# **Impacts of the Drift Stability and Maintenance Issue on Design**

**This issue affects the following aspects of repository design:**

- **Ground support system**
- **Repository layout**
- **Retrievability**

# **Impacts of the Issue on the Design of Ground Support System**

- **Post-closure performance of repository affects the selection of ground support material, such as concrete or steel**
- **Requirement for data collection, such as mapping in emplacement drifts during construction, affects the method of support, such as cast-in-place or pre-cast concrete**
- **Long operational life, high temperature, radiation, and the need to minimize maintenance of ground support affect the selection of a support system**



# **Impacts of the Issue on the Design of Repository Layout**

- **The orientation and location of the repository is affected by drift stability consideration. The repository is oriented so as to minimize adverse influence of faults and dominant fracture system**
- **The size and shape of the drifts are affected by long-term stability considerations**
- **The lengths of the emplacement drifts are influenced by considerations of ease-of-access and maintenance**

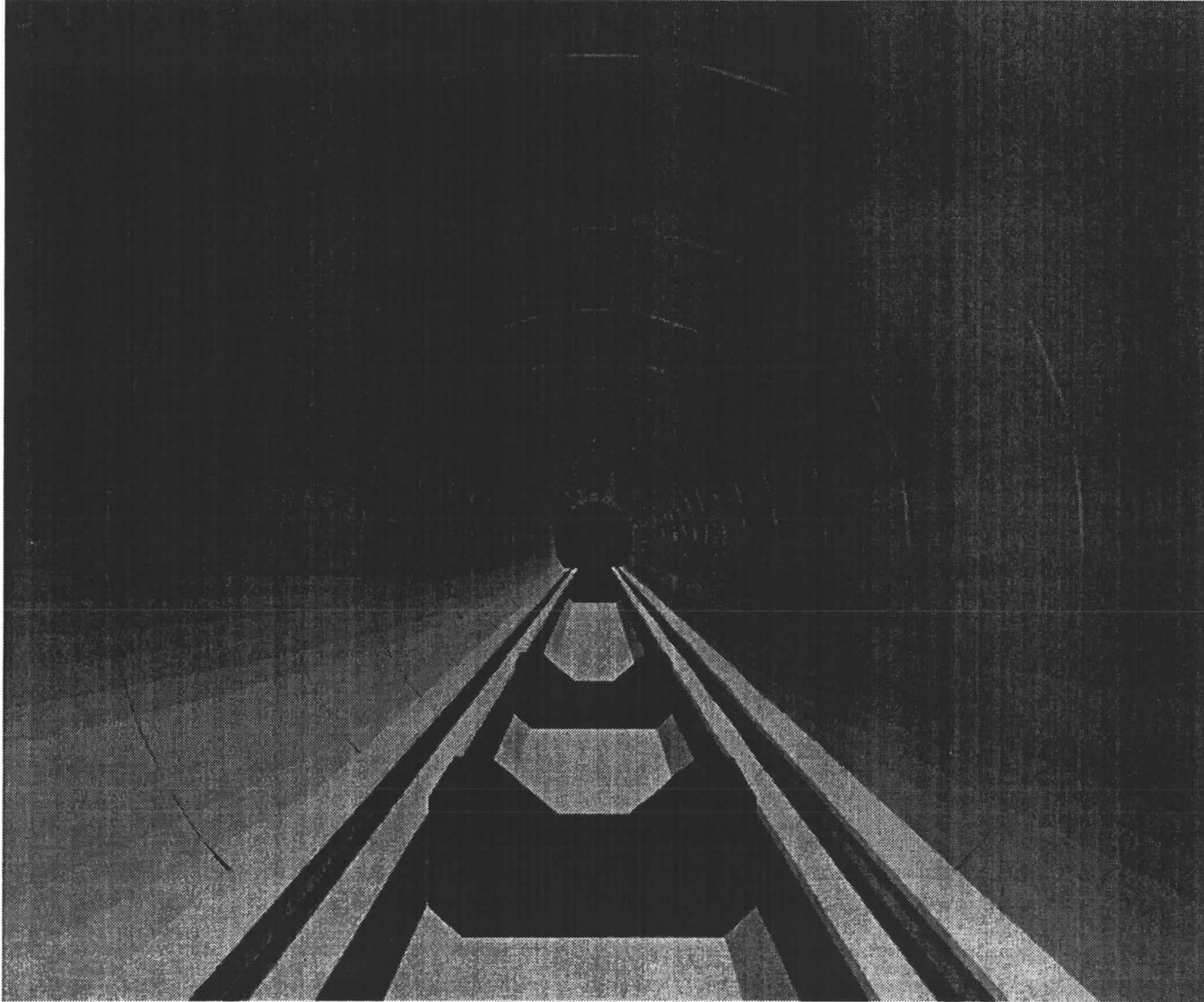
# **Impacts of the Issue on Design of Retrieval**

- **The ease and viability of retrieval depends on the design of a reliable ground support system**
- **The expected off-normal conditions to be dealt with during retrieval will depend on the system of ground support**

# Recent Activities to Resolve the Issue

- **Using the Repository Board of Consultants to guide the evaluation of most likely candidate support system(s)**
  - **Providing a single and robust ground support design suitable for all expected rock conditions**
  - **Seeking economy in efficiency of construction of support system by making the system most compatible with the expected tunnel boring machine excavation system**
  - **Using the best available information from the excavation of the Exploratory Studies Facilities**

# Ground Support System Concept

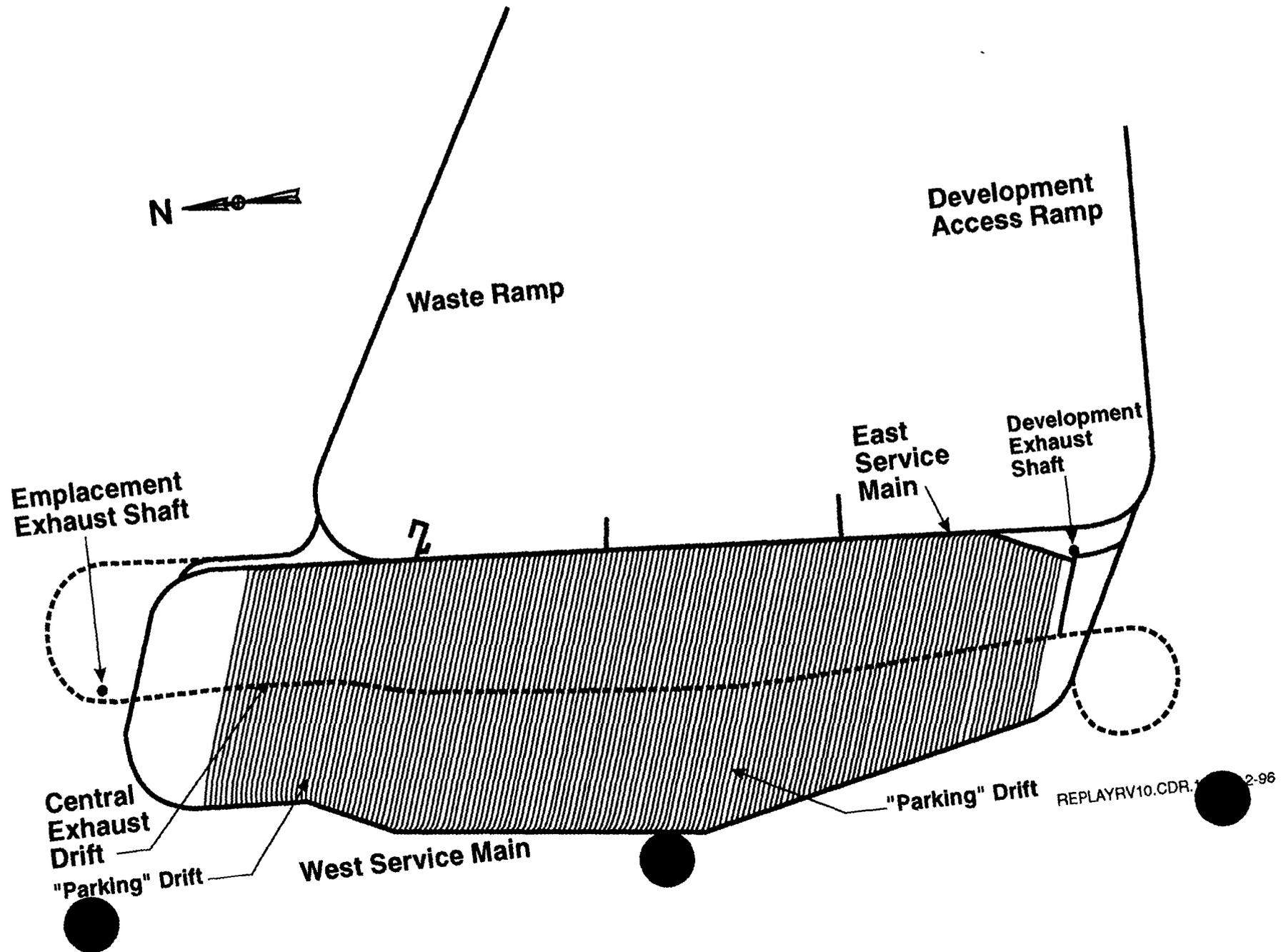


# **Recent Activities to Resolve the Issue**

(Continued)

- **Reduced the length of emplacement drifts to a range of 350 to 600 m for ease-of-access and maintenance. Emplacement drifts accessible from the east and west sides of the block**
- **Developed gantry system to move waste packages out of emplacement drifts for maintenance, when required**
- **Provided empty drifts at intervals to “park” waste packages to allow access to emplacement drifts to be maintained**

# Current Repository Layout



# **Recent Activities to Resolve the Issue**

(Continued)

- **Working to resolve the issue of construction material usage (cementitious material) within M&O and with consultants**
  - **Preliminary recommendation regarding usage of cementitious material is expected by first quarter and decision for Viability Assessment is expected by the second quarter of FY97**
- **Addressing performance confirmation issues (e.g. drift wall mapping) with licensing and site groups**