CRWMS/M&O

# Design Analysis Cover Sheet

*Complete only applicable items.*

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| 2. DESIGN ANALYSIS TITLE | | | |
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| Repository Layout Supporting Design Feature #13- Waste Package Self Shielding | | | |
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11. REMARKS

| 2. DESIGN ANALYSIS TITLE |
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## 1. PURPOSE

The objective of this analysis is to develop a repository layout, for Feature # 13, that will accommodate self-shielding waste packages (WP) with an areal mass loading of 25 metric tons of uranium per acre (MTU/acre). The scope of this analysis includes determination of the number of emplacement drifts, amount of emplacement drift excavation required, and a preliminary layout for illustrative purposes.

## 2. QUALITY ASSURANCE

This design analysis has been evaluated (Reference 5.1) in accordance with QAP-2-0, *Conduct of Activities,* and has been determined to be subject to the requirements of the *Quality Assurance Requirements and Description* (QARD) (Reference 5.2). The *Classification of Permanent Items,* QAP-2-3, evaluation entitled *Classification of the Preliminary MGDS Repository Design* has identified the emplacement drifts as important to waste isolation (QA-2) (Reference 5.3, Attachment V, page 3). Due to the preliminary and conceptual nature of the analysis, unverified and unqualified criteria and engineering data are identified and designated as to be verified (TBV) or to be determined (TBD). This document was prepared in accordance with QAP-3-9, *Design Analysis,* and is subject to QA controls.

## 3. METHOD

The repository layout developed in this analysis is based on emplacing 63,000 metric tons of uranium (MTU) (Reference 5.4) with an areal mass loading (AML) of 25 MTU/acre. Available emplacement area is identified in *Identification of Potential Repository Expansion Areas* (Reference 5.5). From Reference 5.5, the following emplacement blocks are incorporated into the repository layout:

- Upper Repository Block
- Lower Block
- Drill Hole Wash Block
- Boomerang Point Block
- Abandoned Wash Block

Due to the preliminary nature of the layout developed in this analysis, a very simplistic method is used to analyze the total emplacement drift length (average block area / average block length).

## 4. DESIGN INPUTS

Conceptual and preliminary data is marked to be verified (TBV) but it is not required to be tracked per NLP-3-15 section 2 since this document is not to be used for procurement, construction, or fabrication.

### 4.1 DESIGN PARAMETERS

#### 4.1.1 Available Emplacement Blocks (TBV)

Emplacement blocks suitable for waste isolation are illustrated in Figure 1 (Reference 5.5, page 7). Table 1 contains the area of each emplacement block used in the repository layout (Reference 5.5, page 10) and approximate emplacement block lengths which were measured from North to South from Reference 5.5, page 7. The additional area in the Jet Ridge block was not needed. This parameter is used in section 7.2 and 7.3.

**Table 1. Emplacement Block Description**

| Emplacement Block | Area (acres) | Approximate Length (meters) |
|---|---|---|
| Upper* | 854 | 3,000 |
| Lower | 760 | 3,400 |
| Drill Hole Wash | 270 | 1,200 |
| Abandoned Wash | 203 | 1,400 |
| Boomerang Point | 1,040 | 4,200 |

* Reference 5.6, Attachment I, page 2 (includes contingency area).

#### 4.1.2 Average MTU per PWR Assembly (TBV)

The average MTU per Assembly is 0.432 MTU/Assembly (Reference 5.7, page 68). This parameter is used in section 7.1.

#### 4.1.3 Repository Capacity (TBV)

It is assumed that the repository will accommodate 63,000 MTU of commercial spent nuclear fuel and 7,000 MTU of high-level waste (HLW) and Department of Energy spent nuclear fuel (DOE SNF) (Reference 5.4, page 3-13). The HLW and DOE SNF WPs are assumed to have little heat output and may be placed between commercial spent nuclear fuel. This parameter is used in section 7.1.

#### 4.1.4 Emplacement Drift Spacing (TBV)

Emplacement drift spacing is assumed to be 28 m. This is the same spacing that is used in the Viability Assessment (VA) design (Reference 5.6, page 11). This parameter is used in section 7.1.

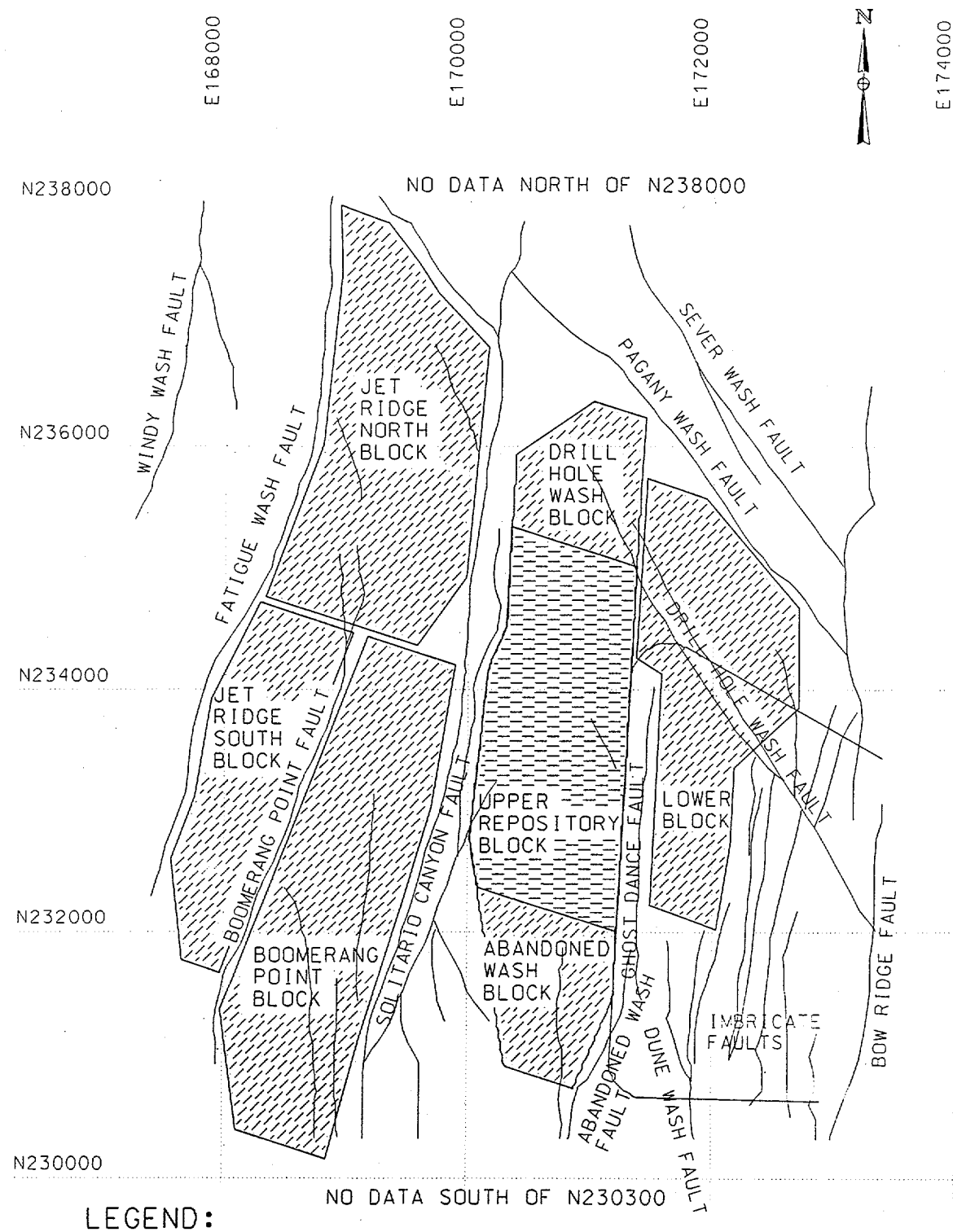


FIGURE 1
POTENTIAL REPOSITORY EXPANSION AREAS

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## 4.2 DESIGN CRITERIA

This analysis addresses design criteria in the following subsections. Layouts developed in this analysis are preliminary and have not been evaluated against all criteria pertaining to nuclear waste isolation; criteria not evaluated in this analysis includes but is not limited to maximum rock temperatures, WP handling equipment, maximum WP temperature, and preferred drift orientation.

### 4.2.1 Ventilation

Proposed repository layouts shall accommodate ventilation requirements for all modes of repository construction/development and emplacement operations. The repository shall maintain separate ventilation systems for excavation and emplacement operations (Reference 5.8, Vol. I, page 12). This is used in sections 7.2 and 7.3.

### 4.2.2 Performance Confirmation

"The system shall provide drifts for periodic human access to the thermally altered zone for Performance Confirmation monitoring and testing using instrumentation and equipment" (Reference 5.8, Vol. I, page 9). This is used in sections 7.2 and 7.3.

## 4.3 DESIGN ASSUMPTIONS

### 4.3.1 Areal Mass Loading (TBV)

The areal mass loading (AML) is assumed to be 25 MTU/acre. Compared to the VA design, which uses an 85 MTU/acre (Reference 5.6, page 11), this is a low thermal load. This assumption is used in section 7.1.

### 4.3.2 Waste Packages (TBV)

This analysis assumes that all waste is placed in 5 PWR WPs. The 5 PWR WP is used as a proxy for other commercial fuel WPs and has a very similar mass loading. Each WP contains 5 assemblies. This assumption is used in section 7.1.

### 4.3.3 Emplacement Drift Turnouts (TBV)

Emplacement drift turnouts are assumed to be 31 m. This value is based on the average turnout distance in the VA (Reference 5.6, Attachment I, page 2). This assumption is used in section 7.2.

### 4.3.4 Standoff Distances (TBV)

A standoff distance of 15 m measured from the emplacement drift turnouts to the first WP in an emplacement drift is used to allow for adequate equipment operating space. Fault standoff distance is 15 m per side. This assumption is used in section 7.2.

### 4.3.5 Empty Emplacement Drifts (TBV)

Twenty-five emplacement drifts will be left empty during emplacement operations. These empty drifts will serve as cross-block drifts for ventilation, monitoring, emergency egress, and/or performance confirmation. This number is based on five empty drifts per emplacement block. This assumption is used in section 7.2.

## 4.4 CODES AND STANDARDS

Not used.

# 5. REFERENCES

5.1 CRWMS M&O 1997. QAP 2-0 Activity Evaluation: *Develop Technical Documents.* Las Vegas, Nevada: CRWMS M&O. MOL.19971215.0080.

5.2 DOE 1998. *Quality Assurance Requirements and Description.* DOE/RW-0333P, Rev 08. Washington D.C.: U.S. Department of Energy. MOL.19980601.0022.

5.3 CRWMS M&O 1998. *Classification of the Preliminary MGDS Repository Design.* B00000000-01717-0200-00134 Rev. 01. Las Vegas, Nevada: CRWMS M&O. MOL.19981103.0546.

5.4 CRWMS M&O 1998. *Controlled Design Assumptions Document.* B00000000-01717-4600-00032 REV 5. Las Vegas, Nevada: CRWMS M&O. MOL.19980804.0481.

5.5 CRWMS M&O 1999. *Identification of Potential Repository Expansion Areas.* BCA000000-01717-0210-00002 Rev. 00. Las Vegas, Nevada: CRWMS M&O. MOL.19990126.0231.

5.6 CRWMS M&O 1997. *Repository Subsurface Layout Configuration Analysis.* BCA000000-01717-0200-00008 REV 00. Las Vegas, Nevada: CRWMS M&O. MOL.19971201.0879.

5.7 CRWMS M&O 1998. *Preliminary Design Basis for WP Thermal Analysis.* BBAA00000-01717-0200-00019 Rev. 00. Las Vegas, Nevada: CRWMS M&O. MOL.19980203.0529.

5.8 CRWMS M&O 1998. *Subsurface Facility System Description Document.* BCA000000-01717-1705-00014 REV 00. Las Vegas, Nevada: CRWMS M&O. MOL.19980826.0161.

# 6. USE OF COMPUTER SOFTWARE

No computer software was used.

# 7. DESIGN ANALYSIS

## 7.1 REQUIRED EMPLACEMENT DRIFT LENGTH

The following calculation table shows the calculation for the required usable emplacement drift length.

| Column | Description | Formula | Result | |
|---|---|---|---|---|
| A | Average MTU / WP Assembly | | 0.432 | MTU / Assembly (4.1.2) |
| B | Assemblies per WP | | 5 | Assemblies / WP (4.3.2) |
| C | MTU per WP | A x B | 2.16 | MTU / WP |
| D | Drift Spacing | | 28 | m (4.1.4) |
| E | AML | | 25 | MTU / acre (4.3.1) |
| F | Area per WP (acres) | C / E | 0.0864 | acres |
| G | Conversion Factor | | 4047 | sq m / acre |
| H | Area per WP (metric) | F x G | 350 | sq m |
| I | Meters per WP | H / D | 12.5 | m / WP |
| J | Total Commercial Uranium | | 63,000 | MTU (4.1.3) |
| K | Minimum Usable Drift Length | J / C x I | 364,583 | m |

## 7.2 NUMBER OF EMPLACEMENT DRIFTS

The following calculation table shows the calculation for the approximate number of emplacement drifts and emplacement drift excavation required. Calculations are based on an average emplacement drift length. The 25 empty emplacement drifts are to satisfy

| Block | Available Area (acres) | Approximate Length (m) | Approximate Avg. Width (m) | Area x Avg. Width (acre-meter) |
|---|---|---|---|---|
| Column | A | B | C | D |
| Formula | (sec 4.1.1) | (sec 4.1.1) | A x 4047 / B | A x C |
| Upper | 854 | 3,000 | 1,152 | 983,808 |
| Lower | 760 | 3,400 | 905 | 687,800 |
| Boomerang | 1,040 | 4,200 | 1,002 | 1,042,080 |
| Drill Hole | 270 | 1,200 | 911 | 245,970 |
| Abandoned | 203 | 1,400 | 587 | 119,161 |
| SUM | 3,127 | | | 3,078,819 |

Average Block Width [ sum(D) / sum(A)] = 985 m

| Row | Description | Formula | Result | |
|---|---|---|---|---|
| A | Average Block Width | | 985 | m (from above) |
| B | Turnout Distance | | 31 | m (4.3.3) |
| C | Standoff Distance | | 15 | m (4.3.4) |
| D | Average Usable Drift Length | A - 2 x (B + C) | 893 | m |
| E | Minimum Emplacement Length | | 364,583 | m (7.1) |
| F | Number of Emplacement Drifts | E / D | 409 | drifts |
| G | Number of Empty Drifts | | 25 | empty drifts (4.3.5) |
| H | Total Number of Drifts | | 434 | drifts |

ventilation (section 4.2.1) and performance confirmation (section 4.2.2) requirements.

With 434 emplacement drifts, there are 117 intersections between emplacement drifts and faults (see Figure 1). This requires the layout to have 4 additional drifts to accommodate the fault standoff distance of 15-m (section 4.3.4). With the 4 additional drifts, the total amount of emplacement drift excavation is 431,430 m.

### 7.3 LAYOUT DEVELOPMENT

Figure 2 shows the layout that will accommodate self-shielding waste packages at an AML of 25 MTU/acre, which has 438 drifts. Each emplacement block contains an exhaust main (section 4.2.1), ventilation shafts (section 4.2.1), and performance confirmation drifts (section 4.2.2). This layout is contained within five emplacement block areas (section 4.1.1).

## 8. CONCLUSIONS

The layout developed in this analysis is preliminary; all results are TBV. This design contains 438 emplacement drifts that require approximately 431,430 m of excavation. The following emplacement blocks were incorporated into the design:

- Upper Repository Block
- Lower Block
- Drill Hole Wash Block
- Abandoned Wash Block
- Boomerang Point Block

## 9. ATTACHMENTS

No attachments.

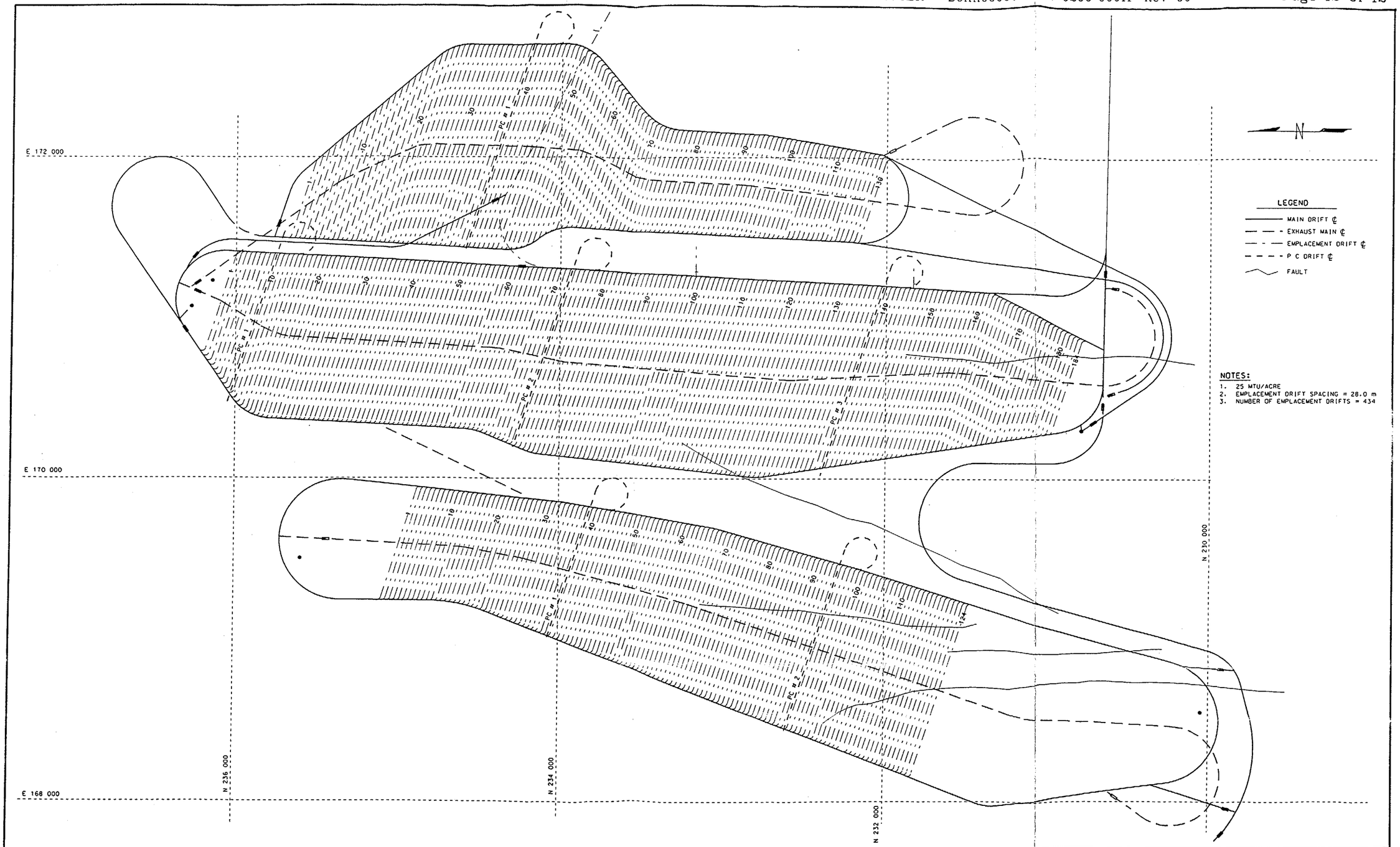


FIGURE 2
REPOSITORY LAYOUT