CRWMS/M&O

Calculation Cover Sheet

Complete only applicable items.

1. QA: L

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8. Checker	Mike Gross	M B Gross	6/11/99
9. Lead Design Engineer	Vinod Vallikat	Vinod V.V.	6/11/99

10. Remarks

Editorial changes have been made including:
- Font and alignment of figure captions changed
- Content section expanded to include 3 heading levels
- "NV" changed to "Nevada" in reference citations
- Period added after first level heading ~~citation~~ numbers NE 6/23/99 NE 6/23/99
- Changed "MGDS" to "MGR" on title page NE 6/29/99 V.V. 6/29/99 V.V. 6/23/99

Revision History

11. Revision No.	12. Date Approved	13. Description of Revision
00	6/11/99	Initial Issue

Title: Total System Performance Assessment – License Application Design Selection (LADS) Phase 1 Analysis of Surface Modification Consisting of Addition of Alluvium (Feature 23a)

Document Identifier: B00000000-01717-0210-00053 REV 00

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Date: 11 June, 1999

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1. Purpose

The objective of this report is to document the analysis that was conducted to evaluate the effect of a potential change to the TSPA-VA base case design that could improve long-term repository performance. The design feature evaluated in this report is a modification of the topographic surface of Yucca Mountain. The modification consists of covering the land surface immediately above the repository foot-print with a thick layer of unconsolidated material utilizing rip-rap and plants to mitigate erosion. This surface modification is designated as Feature 23a or simply abbreviated as F23a. The fundamental aim of F23a is to reduce the net infiltration into the unsaturated zone by enhancing the potential for evapotranspiratiration at the surface; such a change would, in turn, reduce the seepage flux and the rate of radionuclide releases from the repository.

Field and modeling studies of water movement in the unsaturated zone have indicated that shallow infiltration at the surface is almost negligible in locations where the bedrock is covered by a sufficiently thick soil layer. In addition to providing storage for meteoric water, a thick soil layer would slow the downward movement of soil moisture to such an extent that evaporation and transpiration could easily transfer most of the soil-water back to the atmosphere.

Generic requirements for the effectiveness of this design feature are two-fold. First, the soil layer above the repository foot-print must be thick enough to provide sufficient storage of meteoric water (from episodic precipitation events) and accommodate plant roots. Second, the added soil layer must be engineered so as to mitigate thinning by erosional processes and have sufficient thickness to accommodate the roots of common desert plants. Under these two conditions, it is reasonable to expect that modification would be effective for a significant time period and the net infiltration and deep percolation flux would be reduced by orders of magnitude lower than the present levels.

Conceptually, the topographic surface above the repository foot-print would be re-contoured to make it more suitable for placement of unconsolidated materials (e.g., alluvium). Figure 1 shows the region of the surface modification in relation to the location of the repository foot-print. The surface contours in this region after modification are shown in the plot presented in Figure 2. Basically, the surface modification would be accomplished by applying cuts to the ridges slopes on the east flank of Yucca Mountain to produce a relatively uniform slope of about 10%. The alluvium would be covered with rock fragments (to imitate the desert pavement) to reduce erosion.

This report documents the modeling assumptions and performance analysis conducted to estimate the long-term performance for Feature 23a. The performance measure for this evaluation is dose-rate. Results are presented that compare the dose-rate time histories for the new design feature to those of the TSPA-VA base case calculation (CRWMS M&O 1998a).

2. Method

Total system performance assessment calculations require coupling and/or information transfer between models that represent the major components of the repository. These models, their coupling, and input parameter values used in the TSPA-VA base case are described in *Total System Performance Assessment – Viability Assessment Base Case* (CRWMS M&O, 1998a). The overall computational system remains unchanged for the design feature assessments presented in this report. However, the implementation of specific components of the base case model is changed to account for the effects of this design feature. The specific changes to the base case model are described in the following sections of this document.

3. Assumptions

The principal modeling assumptions made for the evaluation of F23a are discussed in this section. :

- A 2.5 m thick layer of alluvium is placed in the topographic region shown in Figure 2.
  This thickness should be sufficient to provide storage of meteoric water and accommodate plant roots. Used in Section 5.1.
- The rip-rap and plant media are effective in preventing layer thinning by erosional processes.
  Little data are available to predict the lifetime of the rip-rap. For this LADS Phase I scoping calculation, the assumption is made that the rip-rap will last for 10,000 years. Used in Section 5.1.
- The thermal-hydraulic conditions (i.e., temperature, relative humidity, and reflux patterns) in the vicinity of the waste package are not significantly different from the base case.
  This is a simplifying assumption used for this LADS Phase I calculation. Used in Section 5.1.
- The UZ flow fields are similar to the base case but flux magnitudes are scaled (i.e., reduced).
  This is a simplifying assumption for this Phase I LADS calculation. Used in Section 5.1.
- Seepage fluxes into the drift can be scaled in accordance to the reduced infiltration rates.
  This is a simplifying assumption for this Phase I LADS calculation. Used in Section 5.2.
- The presence of the alluvium decreases the liquid velocity through the UZ from 21 to 0.5 mm/yr (factor of 42) for the long term average climate (CRWMS M&O, 1999b, Section 6.2, p. 14 of 22. 0.5 mm/yr value from 50-yr simulation result) and from 8.5 to 0.1 mm/yr (factor of 85) for the current dry climate (CRWMS M&O, 1999b, Section 6.1, p. 14 of 22)

The "period of effectiveness" for this design feature should be varied parametrically because of the uncertainty in estimating how long the rip-rap and plants would protect the soil layer from erosion. However, the period of effectiveness was assumed to be 10,000 years because of the limitations of the current version of the RIP code. This value for period of effectiveness was arbitrarily chosen; however, it appears that there would be very limited performance benefit derived from F23a if it is only effective for hundreds or a few thousands of years. This is expected because waste package corrosion failures do not begin to occur (for the base case) until about 4,000 yrs and only the source term produced by juvenile failures would be reduced as a result of implementing F23a.

4. Use of Computer Software

4.1 Software Approved for QA Work

The software used for modeling different components of the repository system in the TSPA-VA total system model are listed in this section. The FEHM software has not been verified at the time of the calculations and the results from these calculations should be considered TBV (to be verified). The software used for the analyses presented in this document include the same software used for the TSPA-VA base case calculation (CRWMS M&O 1998a). No new software was used for the design feature analyses.

WAPDEG is used to produce waste package degradation inputs to the total system model. This program is mentioned in the calculation section of this document but is not described in detail. Separate documentation has been produced to describe the use of this software for Feature 23a (CRWMS M&O, 1999a).

4.1.1 RIP Version 5.19.01, CSCI: 30055

Installed on a dual processor Intel Pentium II-based IBM compatible personal computer with 512 Mb RAM, under the Windows NT 4.0 Operating system.

Since RIP is used as the integrating shell for combining the different components of the repository system, all the input/output files required for running the TSPA-VA base case model are listed in DTN: MO9807MWDRIP00.000 and are discussed in CRWMS M&O, 1998a. Files that were changed or added for individual analyses are listed in Attachment I in directories that correspond to the particular simulation. These files are provided in DTN: MO9904MWDRIP53.000.

a) The RIP computer code (Golder Associates, 1998) is an appropriate tool to perform the following functions that are part of the Total System Performance Assessment: (1) Simulate the release of radionuclides from the engineered barrier system, including the effects of radioactive decay, package failure, dissolution of radionuclides and transport through the engineered barrier system. (2) Simulate the impact of radionuclides on the biosphere, including the determination of

exposure to identified populations.
b) This software has been validated for all of the components used within this calculation. (*Software Qualification Report, Repository Integration Program*, Version 5.19.01, DI: 30047-2003, Rev. 2, CRWMS M&O, 1998b)
c) This software was obtained from Software Configuration Management (SCM) in accordance with the appropriate procedures.

4.1.2 FEHM Version 2.0.0 , CSCI: N/A (TBV 564)

FEHM Version 2.0.0 was compiled as a dynamic link library (DLL) with Digital Visual Fortran 5.0 and is used as an external subroutine (fehmn.dll) to RIP 5.19.01. This DLL was installed on a dual processor Intel Pentium II-based IBM compatible personal computer with 512 Mb RAM, under the Windows NT 4.0 operating system. Files from the TSPA-VA base case are provided in DTN MO9807MWDRIP00.000 and are described in CRWMS M&O, 1998a. Any files that were changed are listed in Attachment I and are provided in DTN MO9904MWDRIP53.000.

a) The FEHM computer code is an appropriate tool to perform mass transport simulations in the saturated and unsaturated zones below the potential Yucca Mountain repository. (Zyvoloski et al., 1997)
b) This software has not been validated over the range it was used.
c) This software was not obtained from Software Configuration Management in accordance with the appropriate proceedure.

4.2 Software Routines

4.2.1 SZ_Convolute, Version 1.0 , CSCI: 30038

SZ_Convolute was compiled as a dynamic link library using Digital Visual Fortran 5.0 and is used as an external subroutine (szconv.dll) to RIP. This DLL was installed on a dual processor Intel Pentium II-based IBM compatible personal computer with 512 Mb RAM, under the Windows NT 4.0 operating system.

The program is written in the FORTRAN programming language and uses a convolution integral technique to combine concentration breakthrough curves based on unit releases with transient radionuclide mass flux at the water table to determine radionuclide concentrations at a specified downstream boundary for which the concentration breakthrough curves were derived. The underlying assumptions in using convolution are: (1) the transport processes and flow fields from the unsaturated zone model and the saturated zone model are independent of one another, (2) the transport processes in the saturated zone model are linear, and (3) steady-state flow is valid for the saturated zone. More information on the formulation and inputs can be found in *Software Routine Report for SZ_Convolute* (CRWMS M&O, 1998c).

4.2.2 TRANSP Version 1.0, CSCI: 30065

External Functions for the Dissolution Rate and Diffusion Coefficient Calculations within RIP (TRANSP) (CRWMS M&O, 1998d), contains three DLLs (dynamically linked libraries).

SFDiss, GLDiss, and EDCoef were compiled as dynamic link libraries using Visual C++ 4.0 to be used as external subroutines (sfdis.dll, gldiss.dll, and edc.dll) to RIP. These DLL's were installed on a dual processor Intel Pentium II-based IBM compatible personal computer under the Windows NT 4.0 operating system.

SFDiss is a subroutine written in C programming language to calculate the commercial spent fuel dissolution rate based on the equation developed from experimental data. More details on the formulas used and inputs for this subroutine can be found in Software Routine Report, *External Functions for Dissolution Rate and Diffusion Coefficient Calculations within RIP for TSPA-VA* (CRWMS M&O, 1998d).

GLDiss is a subroutine written in C programming language to calculate the glass dissolution rate based on the equation developed from experimental data. More details on the formulas used and inputs for this subroutine can be found in Software Routine Report, *External Functions for Dissolution Rate and Diffusion Coefficient Calculations within RIP for TSPA-VA* (CRWMS M&O, 1998d).

EDCoef is a subroutine written in C programming language to calculate the effective diffusion coefficient in an unsaturated porous medium based on the equation developed from experimental data. More details on the formulas used and inputs for this subroutine can be found in Software Routine Report, *External Functions for Dissolution Rate and Diffusion Coefficient Calculations within RIP for TSPA-VA* (CRWMS M&O, 1998d).

5. Calculation

The TSPA-VA base case model and parameters were used with only minor changes to the RIP input files to account for the effects of Feature 23a. The base case model and parameters are presented in the *Total System Performance Assessment-Viability Assessment Base Case Revision 01* (CRWMS M&O, 1998a). Components of the base case calculation that were not changed for the design feature analyses are not discussed in this document.

The base case model remains unchanged for the assessment of Feature 23a except for the following primary conceptual model changes:

The presence of the alluvium at the surface decreases flux through the UZ to the degree that there is no dripping on packages for the lifetime of the modification.

The liquid velocity through the UZ is decreased by a factor of 50 during the lifetime of the modification.

5.1 Liquid Velocity through UZ

The presence of the alluvium at the surface decreases the velocity of liquid through the UZ by a factor of 42 (0.5 vs. 2.1 mm/yr) for the long-term average climate and a factor of 85 (0.1 vs. 8.5 mm/yr) for the current dry climate (see assumptions section). To implement the change in velocity within the total system model, the porosity values for the UZ fracture and matrix were increased by a factor of 50 for the 10,000-year simulation. This is appropriate for scaling velocities since velocity is inversely proportional to porosity. Porosity values are constant with time, therefore the scaling factor is constant with time. A factor of 50 was chosen because it is between the LTA and DRY factors but is closer to the lower LTA factor, which is conservative. Porosity values were increased by a factor of 50 in the FEHM input files "fmQb.rock" and "fmQb.dpdp" (see attachment I for file listing).

No velocity change was made for the 1,000,000-year simulation because porosity remains constant in the FEHM input files. The velocity factor must be returned to 1 at the end of the modification's lifetime; however, the porosity change could not be easily implemented in the total system model and the effect of the change would be negligible for the 1,000,000-year time frame. Hence, there is no velocity change for the 1,000,000-year total system simulation. The velocity scaling factors are based on NQ data.

5.2 Seepage Flux

The 42 and 85-factor decrease in percolation flux for LTA and DRY climates respectively produces percolation flux values that are less than 2.2 mm/yr for all regions and both climates. There is no seepage flux (or seepage fraction) when the percolation flux is below 2.2 mm/yr (CRWMS 1998e, Table 2-56), therefore no dripping onto packages occurs during the lifetime of the surface modification. To implement this change, a switch was added to the RIP model. The parameter ZRB takes a value of zero during the lifetime of the surface modification (time < 10,000 years) and a value of 1 at the end of the lifetime (time >=10000 years). The seepage flux values are multiplied by the switch so that there is no seepage flux during the lifetime of the modification. Parameters QDRIP1 to QDRIP6 are related to the new parameters ZDRIP1 to ZDRIP6 and ZRB by: QDRIPi= ZDRIPi * ZRB for i=1,2 …6.

5.3 Dose from Plutonium Colloids

In the base case, the dose from plutonium colloids was not accurately tracked for early times (before 10,000 years). This never affected results since doses from the plutonium colloids were several orders of magnitude less than total doses. For the 10,000-year simulation with a factor of 50 decrease in UZ velocity, however, the plutonium colloids become the only contributor to dose. Not only do the colloids not sorb to the materials in the UZ, there is no matrix diffusion for the colloids. In the base case calculation, dose for plutonium colloids was combined with the dose for the dissolved plutonium. For the 10,000-year Feature 23a simulation, the colloid doses are tracked separately. The following changes were made to track plutonium colloid doses separately. Note: no change was made for the plutonium colloids in the 1,000,000-year simulation since the velocity in the UZ was not scaled (see section 5.1). The plutonium colloid modeling is based on NQ data.

Parameter	Description	New Value
MDFPF	Modified dose factor for Pu-239 colloids	(FACPF/FPFSUM)*DFPU1
MDFPG	Modified dose factor for Pu-242 colloids	(FACPG/FPGSUM)*DFPU2
MDFPU1	Modified dose factor for Pu-239	(FACPU1/FP1SUM)*DFPU1
MDFPU2	Modified dose factor for Pu-242	(FACPU2/FP2SUM)*DFPU2

5.4 Waste Package Degradation

As described in section 5.2, the decrease in percolation flux as a result of the surface modification prevents any packages from being dripped on during the lifetime of the surface modification. The change in dripping history causes a change in waste package degradation. WAPDEG v3.09 was used to create failure curves for "dripping" packages (DTN: MO9812MWDASM60.000). For the base case, dripping starts shortly after the initial thermal pulse. For feature 23a, these same packages will not see drips before 10,000 years (the assumed lifetime of the surface modifications). Table 20 (*.t20) was replaced with the new WAPDEG results. (DTN: MO9812MWDASM60.000). The WAPDEG results are based on NQ data.

5.5 Summary of change to RIP

- Porosity values for matrix and fracture increased by a factor of 50 to decrease velocity (10,000-year case only)

- ZRB added as switch to turn off dripping flux during lifetime of surface modification
- Dose tracked separately for plutonium colloids (10,000-year case only) including the modification of MDFPF, MDFPG, MDFPU1 and MDFPU2
- Table *.t20 replaced with new WAPDEG results

6. Results

Since unqualified inputs were used in the development of the results presented in this section, they should be considered TBV. This document will not directly support any construction, fabrication, or procurement activity, and therefore, the inputs and outputs are not required to be procedurally controlled as TBV. However, any use of the data from this analysis for inputs into documents supporting construction, fabrication, or procurement is required to be controlled as TBV in accordance with appropriate procedures.

The following table summarizes several post-closure performance measures. These performance measures are useful for providing objective measures of the performance-related benefit of a LADS feature in comparison to the base case. The suggested postclosure performance measures are as follows:

- The peak dose rate and its time of occurrence during the first 10,000 years after closure. This is a reasonable criterion because 10,000 years is the likely regulatory period.

- The peak dose rate and its time of occurrence during 1,000,000 years. Periods up to 1,000,000 years may be considered during licensing. Note that the peak dose rate often occurs during the first or second superpluvial (SP) period, around 300,000 or 700,000 years.

- A figure of merit (FOM) based on the weighted dose rate over the time period of interest. The FOM is defined as:

$$FOM = \frac{1}{\ln[1x10^6] - \ln[1x10^3]} * \int_0^T \frac{r}{t} dt,$$

where

- r is the dose rate (mrem/year),
- t is the time (years), and
- T is the period of interest (years).

Note that this FOM has the units of mrem/year and that the time variable is inside the integral sign, which has the effect of weighting early-time doses more than late-time doses. Results for the simple FOM calculation are found in "doc4 _fom.xls" in DTN MO9904MWDRIP53.000

Feature	**Description**	**FOM**	**10,000-year duration Peak Rate (mrem/yr)**	**10,000-year duration Time (years)**	**1,000,000-year duration Peak Rate (mrem/yr)**	**1,000,000-year duration Time (years)**
Base case		25.02	0.04218	10000	300.9	317000
Feature 23a	Alluvium surface modification	25.24	<1e-10	10000	338.0	317000

For the 10,000-year case, only plutonium colloids contribute to dose. All of the dissolved radionuclides are retarded by matrix diffusion and/or sorption. No graphical results are provided for the 10,000-year case since the dose rates are so low (i.e., << 1 mrem/yr) for Feature 23a in this time frame.

Figure 3 shows the comparison between the base case and Feature 23a dose rates for the 1,000,000-year case. The base case and Feature 23a are very similar for the 1,000,000-year case, with only a slight delay in the dose rate curve for Feature 23a. The Figure of Merit (FOM) and peak dose rate are also similar for the two cases.

7. References

CRWMS M&O 1998a. *Total System Performance Assessment – Viability Assessment Base Case.* B00000000-01717-0210-00011 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981202.0279.

CRWMS M&O 1998b. *Software Qualification Report, Repository Integration Program (RIP), Version 5.19.01.* Software Configuration Identifier (CSCI): 30055 V.5.19.01. DI: 30047-2003 REV 2. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980916.0337.

CRWMS M&O 1998c. *Software Routine Report for SZ_Convolute.* Version 1.0 DI: 30038-2999 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981103.0084.

CRWMS M&O 1998d. *Software Routine Report, External Functions for Dissolution Rate and Diffusion Coefficient Calculations within RIP for TSPA-VA.* Version 1.0 DI: 30065-2999 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981120.0103.

CRWMS M&O 1998e. *Total System Performance Assessment – Viability Assessment Technical Basis Document, Chapter 2 Unsaturated Zone Hydrology Model.* B00000000-01717-4301-00002 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981008.0002.

CRWMS M&O 1999a. *Design Input Transmittal for WAPDEG AND RIP results for D23a (Addition of Alluvium).* Input Tracking No. SSR-PA-99032.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990211.0764.

CRWMS M&O 1999b. *Design Input Transmittal for Document Prepared Under NLP-3-27 (Engineering Calculations) Describing Analyses of the Effects from Two Scenarios: a) Cutting the Mountain Down to Reduce the Slope, Filling in Solitario Canyon, and Covering the Cut and Fill Area with 2.5 Meters of Unconsolidated Material; and b) Removal of All Thin Alluvium up to 0.5 Meters Thick from the Surface....* Input Tracking No. SSR-NEP-99031.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990323.0253.

Golder Associates 1998. *RIP Integrated Probabilistic Simulator for Environmental Systems: Theory Manual and User's Guide.* Redmond, Washington: Golder Associates Inc. TIC: 238560.

Zyvoloski, G.A.; Robinson, B.A.; Dash, Z.V.; and Trease, L.L. 1997. *Summary of the Models and Methods for the FEHM Application - A Finite-Element Heat- and Mass- Transfer Code.* LA-13307-MS. Los Alamos, New Mexico: Los Alamos National Laboratory. TIC: 235587.

8. Attachments

I. Directory of Input/Output files (4 pages)

II. Figures (4 pages)

Attachment I

Directory of Input/Output files

For details and explanation of directories and files, see readme.txt file in

DTN: MO9904MWDRIP53.000

```
 Directory of G:\

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02/22/99  10:18a        <DIR>          ..
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12/16/98  09:56a        <DIR>          f23be6
12/16/98  09:56a        <DIR>          f23ce4
04/06/99  08:46p                 7,599 readme.txt
               6 File(s)       348,977 bytes

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12/01/98  11:49a                28,297 DOSE.DAT
10/27/92  05:00a                 5,527 EGAVGA.BGI
11/30/98  05:10p               501,057 F23BE6.BAK
12/01/98  11:46a                88,731 f23be6.BPF
12/01/98  11:46a                12,019 f23be6.bsr
12/01/98  08:49a               580,477 f23be6.BTF
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04/05/98  01:44a                11,964 f23be6.t03
04/05/98  01:44a                12,266 f23be6.t04
04/05/98  01:59a                 7,220 f23be6.t05
04/05/98  01:44a                11,715 f23be6.t06
03/28/98  08:25a                 6,070 f23be6.t07
03/27/98  10:33a                 6,002 f23be6.t08
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11/30/98  05:09p                186 sz_convolute2.dat
              51 File(s)     27,806,266 bytes

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12/16/98  09:56a        <DIR>          ..
09/30/98  12:40p                787 baserun1.dat
12/07/98  02:05p              3,097 DOSE.DAT
10/27/92  05:00a              5,527 EGAVGA.BGI
12/02/98  04:28p            501,057 F23CE4.BAK
12/02/98  04:37p             88,731 f23ce4.BPF
12/02/98  04:37p             12,019 f23ce4.bsr
12/02/98  04:30p            578,677 f23ce4.BTF
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12/02/98  04:29p            501,057 F23CE4.RP
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04/05/98  01:44a             11,964 f23ce4.t03
04/05/98  01:44a             12,266 f23ce4.t04
04/05/98  01:59a              7,220 f23ce4.t05
04/05/98  01:44a             11,715 f23ce4.t06
03/28/98  08:25a              6,070 f23ce4.t07
03/27/98  10:33a              6,002 f23ce4.t08
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03/27/98  09:27a              6,070 f23ce4.t16
03/27/98  09:27a              6,002 f23ce4.t17
03/27/98  09:28a              6,002 f23ce4.t18
03/27/98  09:34a              6,002 f23ce4.t19
11/30/98  03:19p              6,228 f23ce4.t20
03/27/98  09:35a              6,002 f23ce4.t21
03/27/98  09:36a              6,070 f23ce4.t22
03/27/98  09:41a              6,070 f23ce4.t23
03/27/98  09:41a              6,070 f23ce4.t24
03/27/98  10:41a              6,002 f23ce4.t25
03/27/98  10:41a              6,070 f23ce4.t26
03/27/98  10:41a                698 f23ce4.t27
03/27/98  10:41a              6,002 f23ce4.t28
03/27/98  10:42a              6,002 f23ce4.t29
03/27/98  10:42a              6,070 f23ce4.t30
03/27/98  10:42a              6,070 f23ce4.t31
03/27/98  10:43a              6,070 f23ce4.t32
03/27/98  10:43a              6,070 f23ce4.t33
03/30/98  03:38p              2,874 f23ce4.t34
03/30/98  03:37p              2,466 f23ce4.t35
03/30/98  03:30p              1,990 f23ce4.t36
04/01/98  07:57a              1,865 f23ce4.t37
```

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12/02/98  04:10p              1,206 fmQb.dpdp
12/02/98  04:07p              4,639 fmQb.rock
09/30/98  12:40p            160,935 ptrk.expval
09/30/98  12:40p                185 sz_convolute2.dat
                 53 File(s)      4,748,632 bytes
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Attachment II

Figures

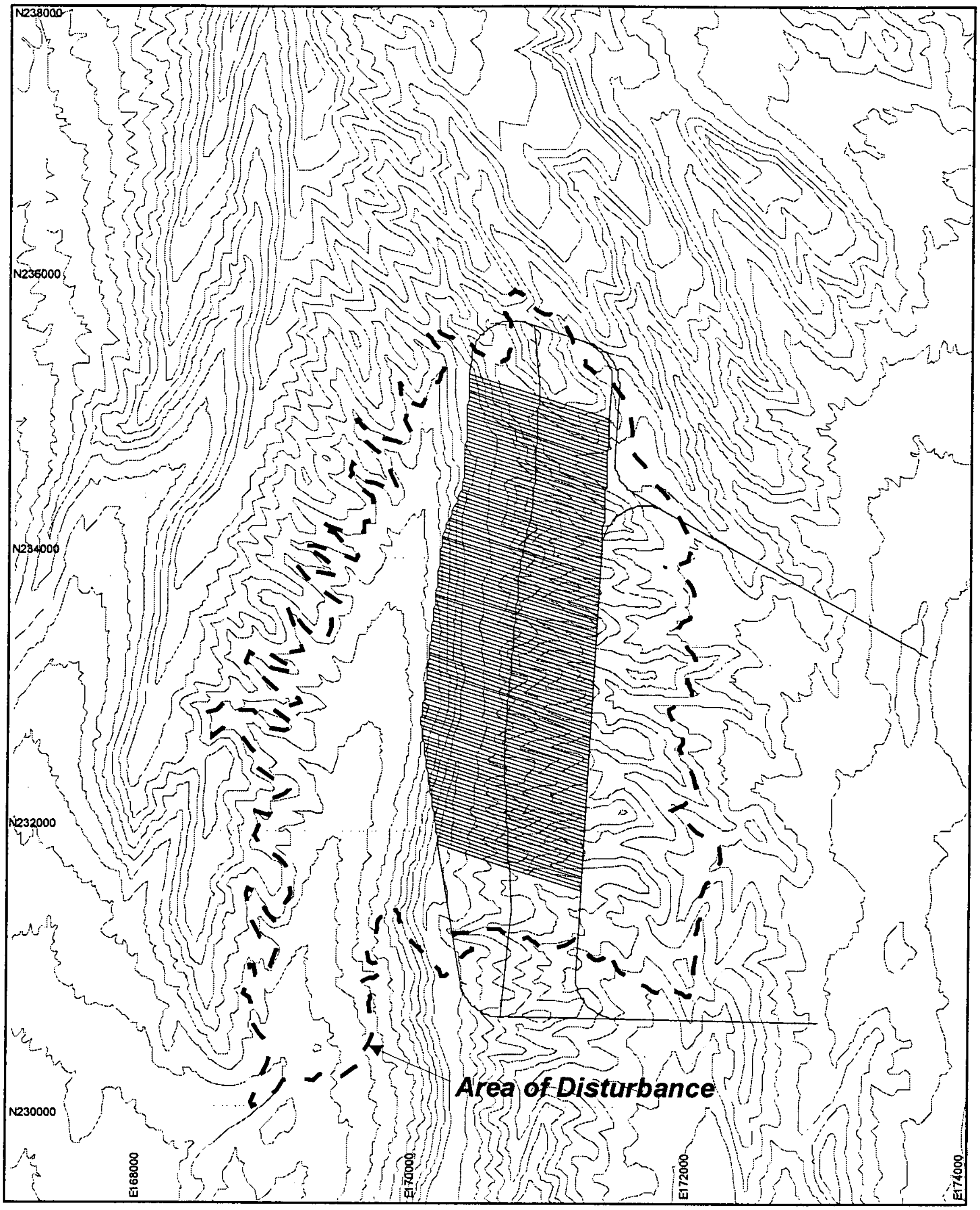

Figure 1. Repository Site Showing VA Reference Design With Topographic Contours And The Planned Area of Disturbance For Feature 23a (Addition Of Alluvium).

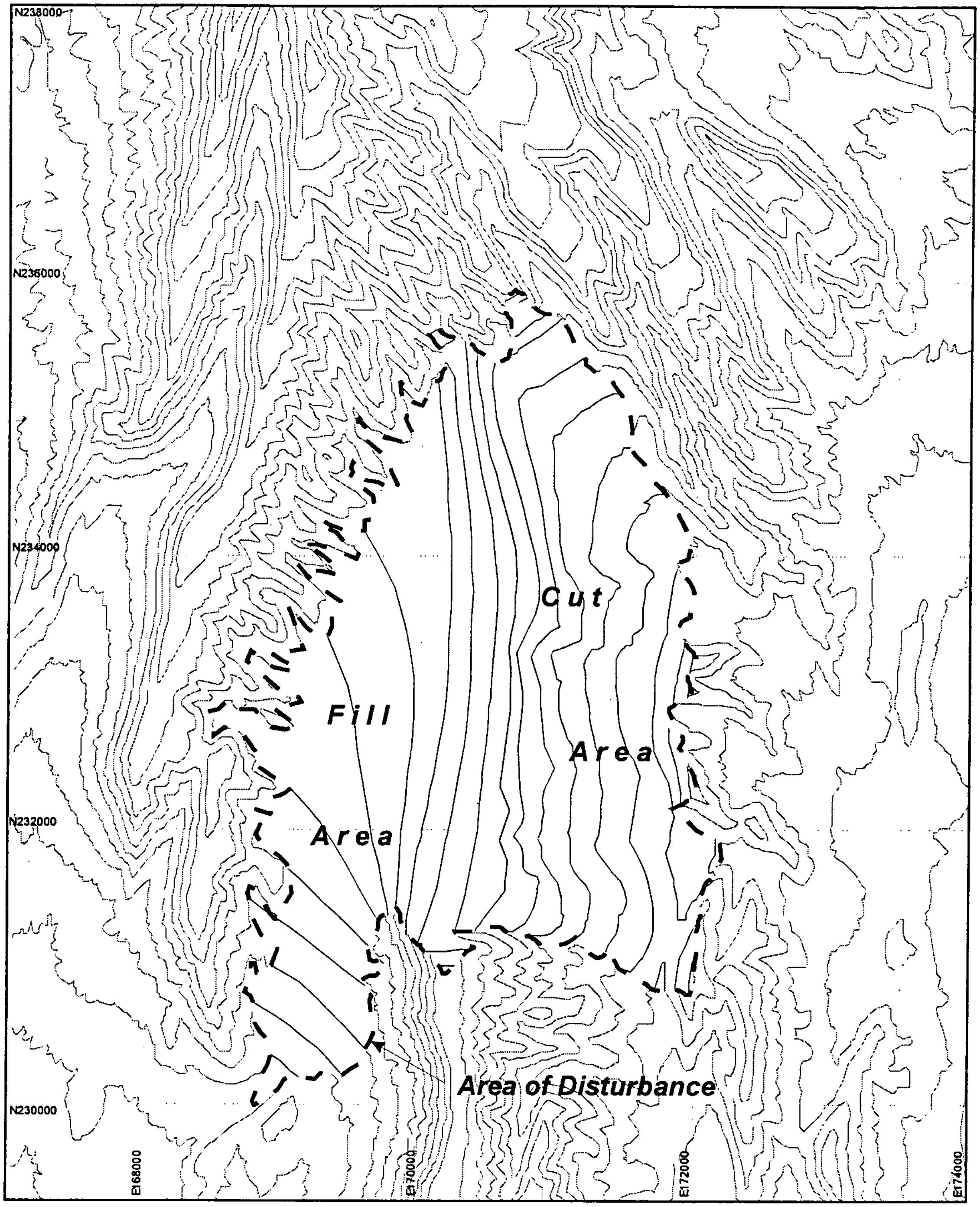

Figure 2. Final Surface Contours For Feature 23a (Addition Of Alluvium).

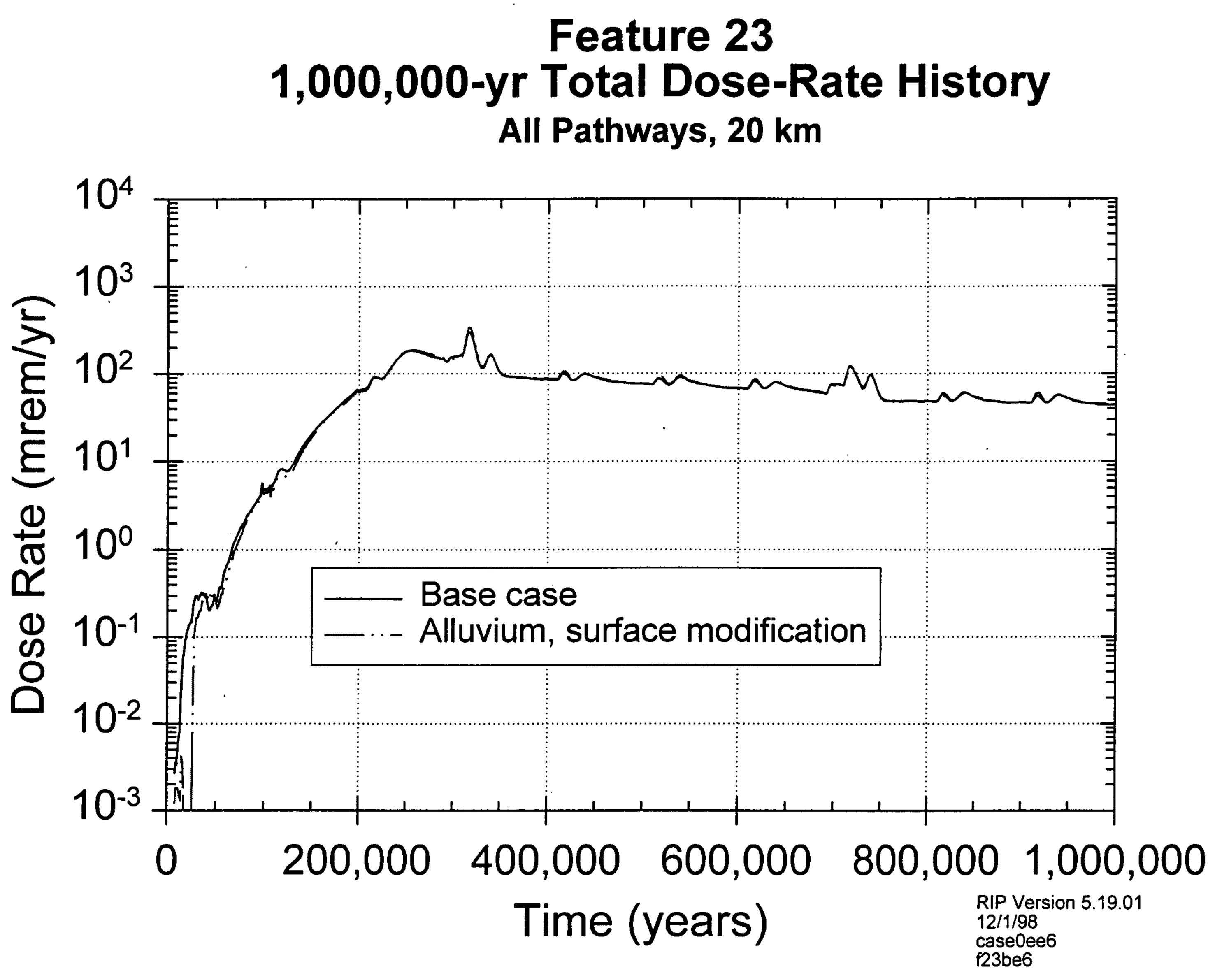

Figure 3 Dose Rate Results From Base Case And Feature 23a For 1,000,000-Year Simulation.