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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
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DISCLAIMER

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1. PURPOSE

The purpose of this analysis is to provide insight into the unsaturated-zone (UZ) subsystem performance through particle tracking analyses of the base-case flow fields. The particle tracking analyses will not be used directly in total-system performance-assessment (TSPA) calculations per se. The objective of this activity is to evaluate the transport of radionuclides through the unsaturated zone and to determine how different system parameters such as matrix diffusion, sorption, water-table rise, and perched water influence the transport to the water table. Plots will be generated to determine normalized cumulative breakthrough curves for selected radionuclides. The scope of this work is limited to the particle tracking analyses of "base-case" flow fields that are to be used by the code FEHM (Finite Element Heat and Mass; Zyvoloski 1997) for particle tracking simulations in *Total System Performance Assessment—Site Recommendation Report* (TSPA-SR).

Constraints and limitations of this work include the preliminary status of the input data used in the analysis (see Section 4). Once these source data are qualified, the results of this analysis can be considered qualified. Until then, the information developed from this analysis must be considered unqualified. Detailed planning of this analysis can be found in the *Development Plan*, "Analysis of Base-Case Particle Tracking Results of the Base-Case Flow Fields (ID:U0160)" (CRWMS M&O 1999a).

2. QUALITY ASSURANCE

The Quality Assurance (QA) program applies to the development of this analysis and model report (AMR). The Performance Assessment Operations (PAO) responsible manager has evaluated this activity in accordance with QAP-2-0, *Conduct of Activities*. The QAP-2-0 activity evaluation (CRWMS M&O 1999b) determined that the development of this AMR is subject to the *Quality Assurance Requirements and Description* (DOE 1998) requirements.

3. COMPUTER SOFTWARE AND MODEL USAGE

Several software codes and a software routine are used in this analysis and are summarized in Table 1. The use of these acquired software and routines comply with AP-SI.1Q Rev. 2, ICN 1 (*Software Management*).

FEHM v. 2.0 is qualified software and is used to perform the majority of the particle-tracking analyses in this analysis. It uses a semi-analytical semi-infinite-fracture-spacing matrix-diffusion model. FEHM v. 2.1 is being developed by Los Alamos National Laboratory and is currently unqualified. It uses a finite-fracture-spacing matrix-diffusion model. DCPT v. 1.0 is developed and used at Lawrence Berkeley National Laboratory and is currently being used as unqualified software as well (per Section 5.12 of SP-SI.1Q Rev. 2, ICN 1. PROCESS1 is a software routine that extracts information from FEHM output files to produce files of mass flow and cumulative breakthrough at the water table as a function of time. This routine is used per Section 5.1 of AP-SI.1Q Rev. 2, ICN 1. The results of this software routine have been visually inspected, and the routine has been determined to be operating correctly for its intended use and expected range of inputs (see results in subdirectory 'process1_test' in DTN: SN9912T0581699.003).

Additional "off-the-shelf" industry-standard software was used to create the plots and graphics in this report. These software include KaleidaGraph v. 3.09 and Transform v. 3.3, which were used on a Dell OptiPlex GXa PC with Pentium II processor running Windows NT 4.00.1381.

Table 1. Software and Routines Used in This Analysis

Software	Tracking Number	Computer Platform	Comments
FEHM v. 2.0	10031-2.00-00	UNIX Sun OS 5.7	Qualified code obtained from Software Configuration Management System (SCMS).
FEHM v. 2.1	10086-2.10-00	UNIX Sun OS 5.7	Unqualified code acquired per Section 5.12 of AP-SI.1Q Rev 2, ICN 1. TBV-3980.
DCPT v. 1.0	10078-1.0-00	PC Windows 98	Unqualified code being developed and used by Lawrence Berkeley National Laboratories (LBNL) under TBV-3156. Acquired for this analysis per Section 5.12 of AP-SI.1Q Rev 2, ICN 1.
PROCESS1 v. 1.0 (Software Routine)	Accession Number: MOL.19990915.0360	UNIX Sun OS 5.7	Results of this software routine have been visually inspected as part of this analysis to ensure that it is producing correct results for its intended use (see subdirectory 'process1_test' in DTN: SN9912T0581699.003. The code listing and additional verification have been documented in CRWMS M&O (1999c).

4. INPUTS

4.1 DATA AND PARAMETERS

Table 2 summarizes the input data used in this analysis. It lists the Data Tracking Numbers (DTNs), qualification status (Q-Status), and specific information taken from each data set.

Table 2. Input Data

Title	Data Tracking Number (DTN)	Q-Status	Comments
FRACTURE PROPERTIES FOR THE UZ MODEL GRIDS AND UNCALIBRATED FRACTURE AND MATRIX PROPERTIES FOR THE UZ MODEL LAYERS FOR AMR U0090, "ANALYSIS OF HYDROLOGIC PROPERTIES DATA."	LB990501233129.001	Qualified TBV-3168 Submitted: 8/25/1999	Matrix and fracture porosities, fracture frequencies.
3-D UZ MODEL GRIDS FOR CALCULATION OF FLOW FIELDS FOR PA FOR AMR U0000, "DEVELOPMENT OF NUMERICAL GRIDS F OR UZ FLOW AND TRANSPORT MODELING."	LB990701233129.001	Not Qualified TBV-3167 Submitted: 9/24/1999	Dual-permeability mesh files containing the ELEME and CONNE cards for determination of fracture volume, fracture/matrix connection area, and aperture parameter
TSPA GRID FLOW SIMULATIONS FOR AMR U0050,"UZ FLOW MODELS AND SUBMODELS."	LB990801233129.003	Not Qualified TBV-3662 Submitted: 11/29/1999	Present-day, mean infiltration TOUGH2 input file for perched model #1 that contains ROCKS card for hydrologic parameters (e.g., γ parameter)
CALIBRATED FAULT PROPERTIES FOR THE UZ FLOW AND TRANSPORT MODEL FOR AMR U0035, "CALIBRATED PROPERTIES MODEL."	LB991091233129.004	Not Qualified TBV-3979 Submitted: 10/22/1999	Excel spreadsheet of calibrated fault properties–γ parameter and residual fracture liquid saturation
CALIBRATED BASECASE INFILTRATION 1-D PARAMETER SET FOR THE UZ FLOW AND TRANSPORT MODEL, FY99	LB997141233129.001	Qualified TBV-3095 Submitted: 7/21/1999	Calibrated 1-D hydrologic properties for mean infiltration cases (no faults)
HEAT DECAY DATA AND REPOSITORY FOOTPRINT FOR THERMAL-HYDROLOGIC AND CONDUCTION-ONLY MODELS FOR TSPA-SR (TOTAL SYSTEM PERFORMANCE ASSESSMENT-SITE RECOMMENDATION)	SN9907T0872799.001	Not Qualified TBV-3599 Submitted: 7/27/1999	Repository outline used to define repository nodes
POST-PROCESSED FLOW FIELDS FOR RIP: DEVELOPED DATA FROM AMR U0125 (ABSTRACT FLOW FIELDS FOR RIP)	SN9910T0581699.002	Not Qualified TBV-3946 Submitted: 10/15/1999	Files for FEHM particle tracking

4.2 CRITERIA

No additional criteria govern the particle-tracking activities in this analysis beyond the scope and objectives presented in the Development Plan (CRWMS M&O 1999a). Standard requirements are specified in AP-3.10Q (*Analyses and Models*) regarding the documentation, review, and records. Although no specific criteria have been identified in project requirements documents (e.g., System Description Documents) as applicable to this activity, this analysis supports requirements for performance assessment as required by the interim guidance from the Department of Energy pending issuance of new regulations by the Nuclear Regulatory Commission (Dyer 1999). Relevant requirements for performance assessment from Section 114 of that document are: "Any performance assessment used to demonstrate compliance with Sec. 113(b) shall: (a) Include data related to the geology, hydrology, and geochemistry ... used to define parameters and conceptual models used in the assessment. (b) Account for uncertainties and variabilities in parameter values and provide the technical basis for parameter ranges, probability distributions, or bounding values used in the performance assessment. (c) Consider alternative conceptual models of features and processes that are consistent with available data and current scientific understanding, and evaluate the effects that alternative conceptual models have on the performance of the geologic repository. ... (g) Provide the technical basis for models used in the performance assessment such as comparisons made with outputs of detailed process-level models ... ."

4.3 CODES AND STANDARDS

No specific, formally established codes or standards have been identified as applying to this analysis activity.

5. ASSUMPTIONS

1. We assume deterministic transport property values for two radionuclides in this analysis. The actual values are not so important as having distinct differences in the radionuclide properties (e.g., sorbing vs. non-sorbing). The purpose of this analysis is to gain insight into the transport of radionuclides through the UZ, not to make actual predictions. Therefore, the use of assumed, deterministic values is sufficient. This assumption is applicable to Section 6.1.1 and Section 6.2.2 through Section 6.2.6.

2. The input files (DTN: SN9910T0581699.002) are assumed to consist of flow fields that represent the unsaturated flow system at Yucca Mountain. The basis for this assumption is provided by the rigorous development of the upstream process-models that produce the flow fields through calibration and validation against actual site properties and processes. This assumption is applicable to all of Section 6.2.

3. The number of particles used in both FEHM and DCPT is assumed to be adequate to represent the probabilistic distributions of particle movement. In FEHM, we use nearly 100,000 particles over the repository region. Runs with more particles do not show any differences. The DCPT does not rely on probabilistic movement of particles as much as FEHM, so the number of particles released in the repository can be less (2750 particles are used). This assumption is applicable to all of Section 6.2.

6. ANALYSIS

Several specific objectives are desired to gain insight into the behavior of radionuclide transport in the base-case UZ flow simulations using particle tracking analyses:

1. Identify the spatial distribution of particles that reach the water table so that proper source regions can be defined for saturated-zone flow and transport studies.

2. Compare the two perched water models that were used in the base-case flow simulations. Based on the results of breakthrough curves at the water table, the most conservative model will be chosen for use in TSPA-SR.

3. Compare two matrix diffusion models implemented in FEHM.

4. Evaluate the effects of water-table rise on travel times through the UZ.

5. Compare the results of two particle tracking methods using FEHM and DCPT.

6. Determine the range of travel times that are produced by the different infiltration rates (lower, mean, and upper) for each of the three climates.

This section describes the approach and parameter development for the particle tracking analyses, along with a discussion of the results. For the first five objectives, only the mean infiltration simulations are analyzed for each of the three climate scenarios (present-day, monsoon, glacial-transition) to obtain a representative distribution of particle-tracking results. For the sixth objective, the upper and lower infiltration simulations are also analyzed.

6.1 APPROACH

As described in Section 3, two software codes are used to perform the particle tracking analyses. The method implemented by FEHM for UZ transport is called the Residence Time Transfer Function (RTTF) particle-tracking technique. It employs an efficient particle-tracking algorithm that eliminates the need to interpolate velocity vectors at all particle positions. Instead, the mean residence time and the probabilities of travel to adjacent cells are computed for each cell. The fluid mass and inter-cell mass flows rates are provided in the fluid flow solution, so the method can be implemented without regard to the nature of the numerical grid (e.g., structured versus unstructured grids). The position of the particle is not resolved below the sub-element scale.

The DCPT implements a random-walk particle-tracking methodology using a Lagrangian perspective that tracks the particle positions in a continuous space. The velocity, dispersion coefficients, and other transport parameters are provided as tables of values on a discrete grid. Within each cell, the properties are uniform, but each cell has two sets of parameters corresponding to either the fracture or matrix material. Transfer between the fracture and the matrix is governed by the particle-transfer probability that should be consistent with the mass flow between the fracture and matrix for each cell.

The particle tracking code that will be used in TSPA-SR is FEHM, but the results of DCPT are included to provide insight into alternative particle tracking methods and to form a basis for future decisions regarding the use of different particle tracking methods in TSPA calculations.

6.1.1 Development of FEHM Particle Tracking Analyses

Most of the input files that are required for the FEHM particle tracking analyses are provided in a data set that was submitted to the TDMS as part of an upstream analysis (DTN: SN9910T0581699.002). The remaining input files that are required include the FEHM 'ptrk' and 'dpdp' macros that are developed as part of this analysis (see Attachment I). The 'ptrk' file contains values for transport properties such as sorption (K_d) and diffusion coefficients, and it assigns the properties to individual nodes or zones. Two radionuclides are used in this analysis, and their assumed properties are summarized in Table 3.

Table 3. Summary of Transport Properties Used in This Analysis

Radionuclide Simulated	Diffusion Coefficient (m^2/s)	Vitric K_d (cc/g)	Zeolitic K_d (cc/g)	K_d in all other units (cc/g)	Fracture Dispersivity (m)
Technetium (Tc)	3.2×10^{-11}	0	0	0	20
Neptunium (Np)	1.6×10^{-10}	1.0	4.0	1.0	20

A previous set of 'dpdp' macros were submitted as part of the upstream data set (DTN: SN9910T0581699.002), which are sufficient for the FEHM v. 2.0 simulations. However, the use of FEHM v. 2.1 requires an additional parameter that was not included in the previous 'dpdp' files. In FEHM v. 2.1, the fracture half spacing (half the inverse of the fracture frequency) is required for all fractures that experience matrix diffusion. This value is used to calculate matrix diffusion assuming a finite fracture spacing (as opposed to an infinite fracture spacing used in FEHM v. 2.0). The fracture half-spacing values are entered following the listing of the fracture bulk porosities in the 'dpdp' macro (see Attachment I).

Other required FEHM files for the particle-tracking analyses were also taken from DTN: SN9910T0581699.002. The output files and other developed data files from this analysis have been submitted to the TDMS under DTN: SN9912T0581699.003 and DTN: SN0001T0581699.004.

6.1.2 Development of DCPT Particle Tracking Analyses

Two simulations are performed using the DCPT code for comparison to the FEHM particle-tracking results. The two radionuclides in Table 3 are simulated for the mean infiltration, glacial-transition-climate flow field. Ten particles are released at each of the 275 repository fracture nodes using the same transport properties listed in Table 3. Details of the input and output files for the DCPT simulations are presented in Attachment II.

6.2 RESULTS

The results of the particle tracking analyses are presented in six sections. The first presents the spatial distribution of the particles that arrive at the water table for different climate scenarios.

The second presents a comparison between the two perched water models that were used in the base-case flow fields and the results of the cumulative breakthrough curves at the water table. The third section presents a comparison between two matrix diffusion models used in FEHM, and the fourth section describes the effects of water-table rise on travel times. The fifth section presents a comparison between two particle tracking methods (FEHM and DCPT), and the sixth section present an analysis of the radionuclide transport using different infiltration simulations. A summary of these runs and the features considered are given in Table 4.

Table 4. Summary of Features Analyzed in Each Section of This Report

		Section					
Model Feature		**6.2.1**	**6.2.2**	**6.2.3**	**6.2.4**	**6.2.5**	**6.2.6**
Perched-Water Model #1		X	X	X	X	X	X
Perched-Water Model #2		X	X				
Present-Day Climate	Low Infiltration						X
	Mean Infiltration	X	X	X			X
	Upper Infiltration						X
Monsoon Climate	Low Infiltration						X
	Mean Infiltration	X	X				X
	Upper Infiltration						X
Glacial-Transition Climate	Low Infiltration						X
	Mean Infiltration	X	X	X	X	X	X
	Upper Infiltration						X
FEHM v. 2.0		X	X	X			X
FEHM v. 2.1				X	X	X	
DCPT v. 2.0						X	
Water Table Elevation ~ 730 m		X	X	X	X	X	X
Water-Table Rise (Elevation = 850 m)		X			X		
Advective Transport Only		X					
Technetium Transport			X			X	X
Neptunium Transport			X	X	X	X	X

6.2.1 Particle Breakthrough Locations at the Water Table Using FEHM

In this section, non-diffusing and non-sorbing particles are used in FEHM v. 2.0 to identify particle breakthrough locations at the water table (these plots can be used to determine appropriate source regions for the saturated-zone modeling studies). The advection-only particles are used to ensure that all particles leave the system within the simulated time, and the particle locations are not affected by matrix diffusion in the FEHM simulations. A total of 99,825 particles[1] are released as a pulse among 275 fracture nodes that fall within the specified repository outline (DTN: SN9907T0872799.001). The simulation lasts for one million years, and the location and number of particles that exit the bottom boundary (i.e., water table) of the domain are recorded. The simulations are performed using the mean infiltration flow field for each of the three climates (present-day, monsoon, and glacial-transition). Figure 1, Figure 2, and Figure 3 show the breakthrough concentration of particles at the water table for each of the three climates and for the two perched water models used in the UZ flow simulations. In addition, Figure 4 shows the breakthrough concentration for the glacial-transition climate with an assumed water table elevation of 850 m, which is approximately 120 m higher than the original water table elevation used in the original flow fields. The input file required for the assumed water table rise ('*wt850.ini') was taken from DTN: SN9910T0581699.002, and it reflects a potentially higher water table due to wetter future climates.

All four plots show that the particles become diverted and concentrated along faults beneath the northern portion of the repository. The diversion occurs due to a low permeability zone implemented by LBNL to obtain perched water above the basal vitrophyre. Perched water model #2 shows more diversion and concentration along the faults, primarily in the southern portions of the repository (see Section 6.2.2 for more details). For both perched-water model #1 and #2, the diversion is augmented in the future climate simulations in which the infiltration and percolation is greater. As the infiltration and percolation increase, the relative amount of flow through the fracture continuum increases in the welded units, and particles are less likely to travel downward through the low-permeability "perched-water elements." Instead, the particles are carried along advective pathways that are diverted above the low-permeability perched-water elements to faults, which act as relatively high-permeability conduits to the water table.

[1] A total of 100,000 particles is specified in the 'ptrk' macro, but FEHM chooses the largest number of particles (less than the specified number of particles) that can be equally divided among the specified number of nodes.

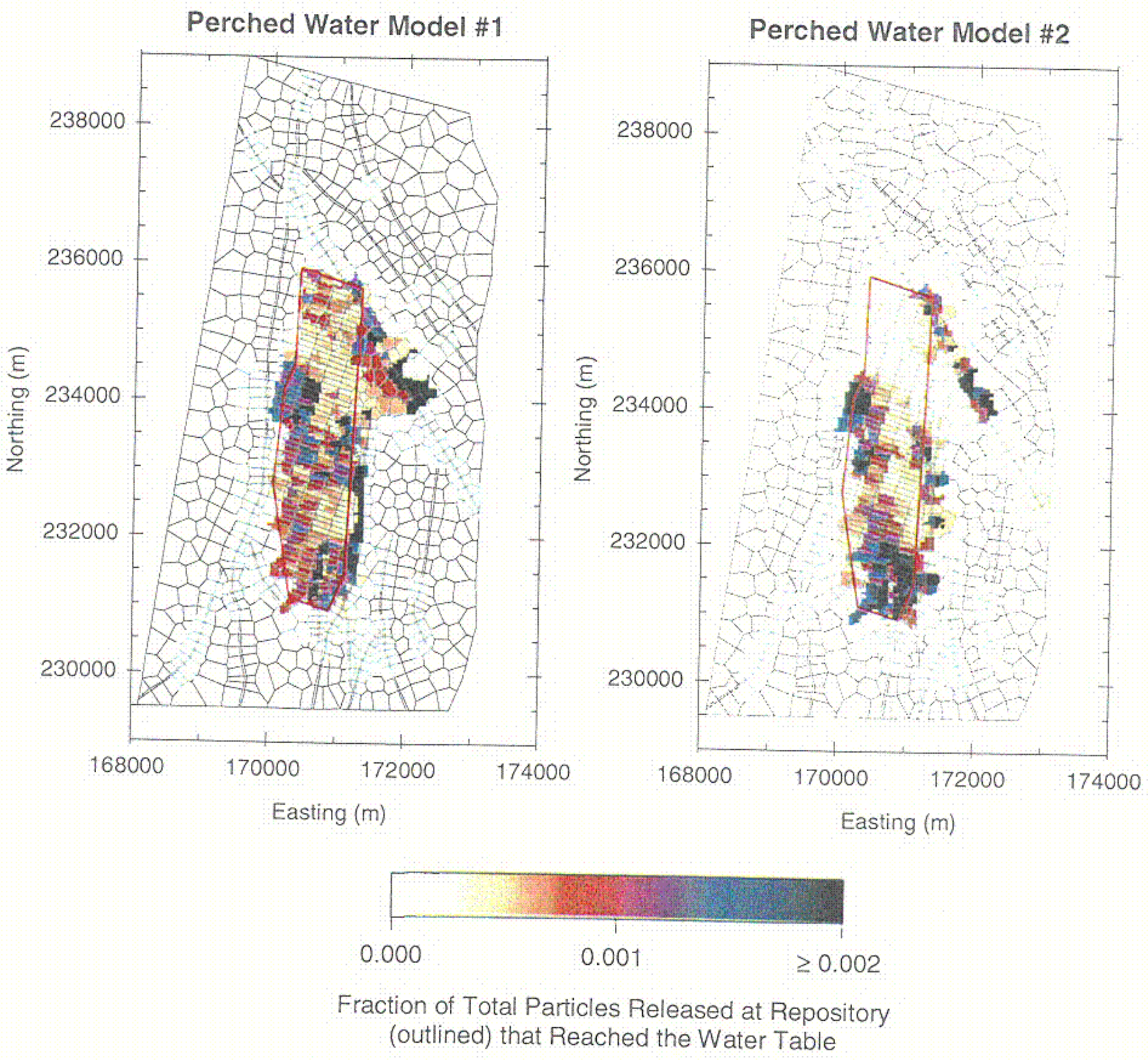

Figure 1. Locations of Particle Breakthrough at the Water Table for the Mean Infiltration, Present-Day Climate Using Two Perched Water Models ('pchm1' and 'pchm2')

C1

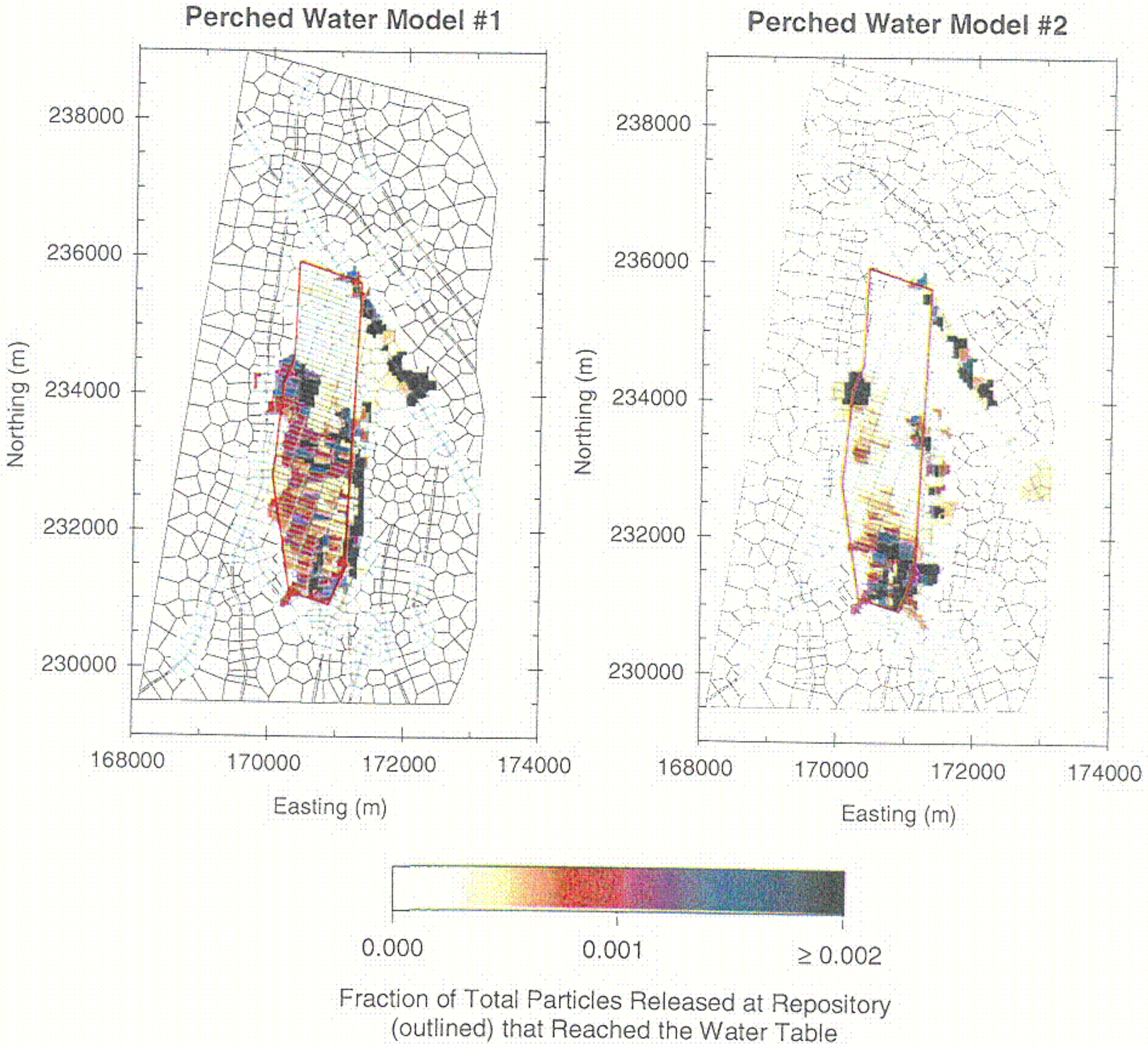

Figure 2. Locations of Particle Breakthrough at the Water Table for the Mean Infiltration, Monsoon Climate Using Two Perched Water Models ('monm1' and 'monm2')

C2

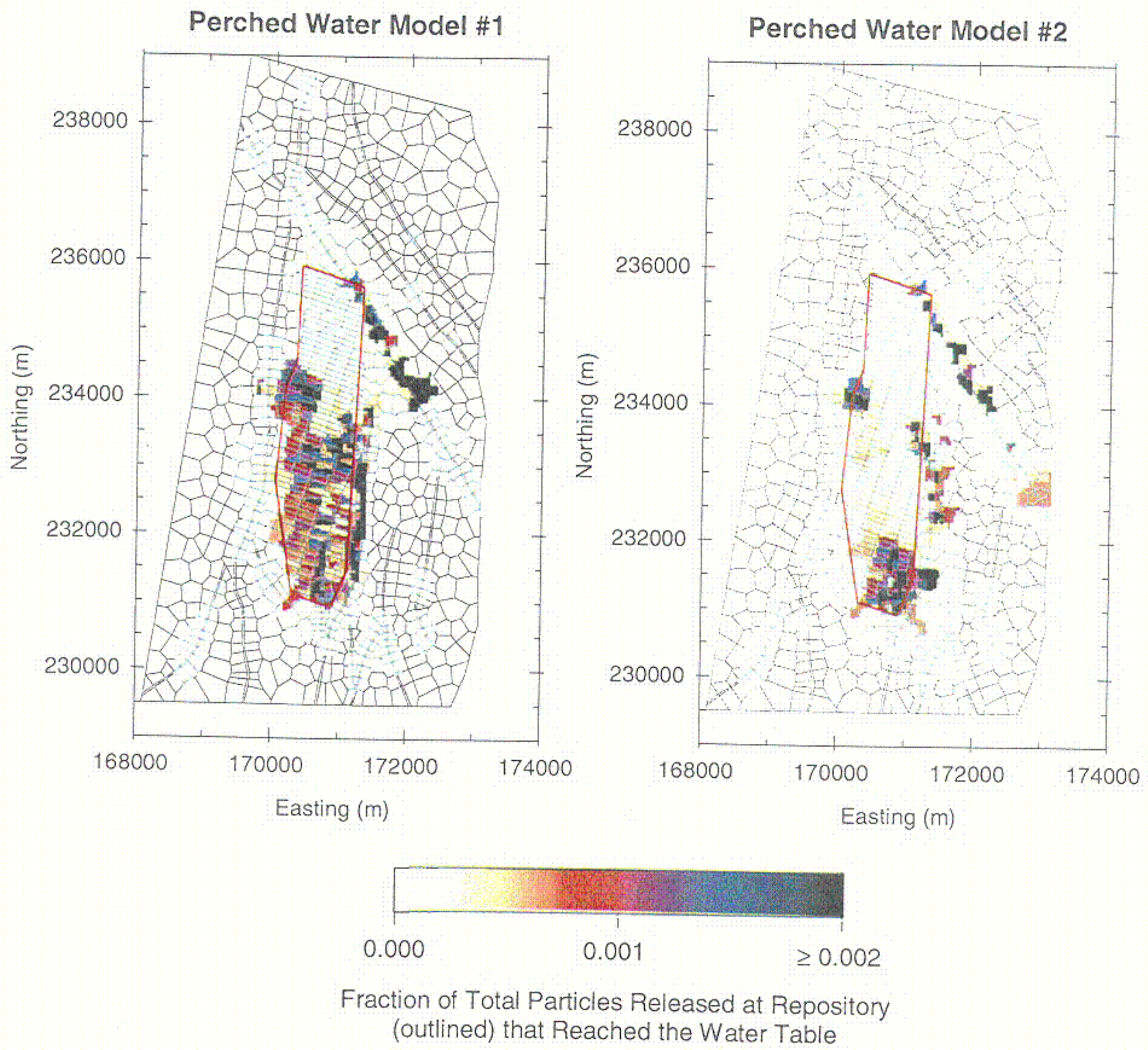

Figure 3. Locations of Particle Breakthrough at the Water Table for the Mean Infiltration, Glacial-Transition Climate Using Two Perched Water Models ('glam1' and 'glam2')

C3.

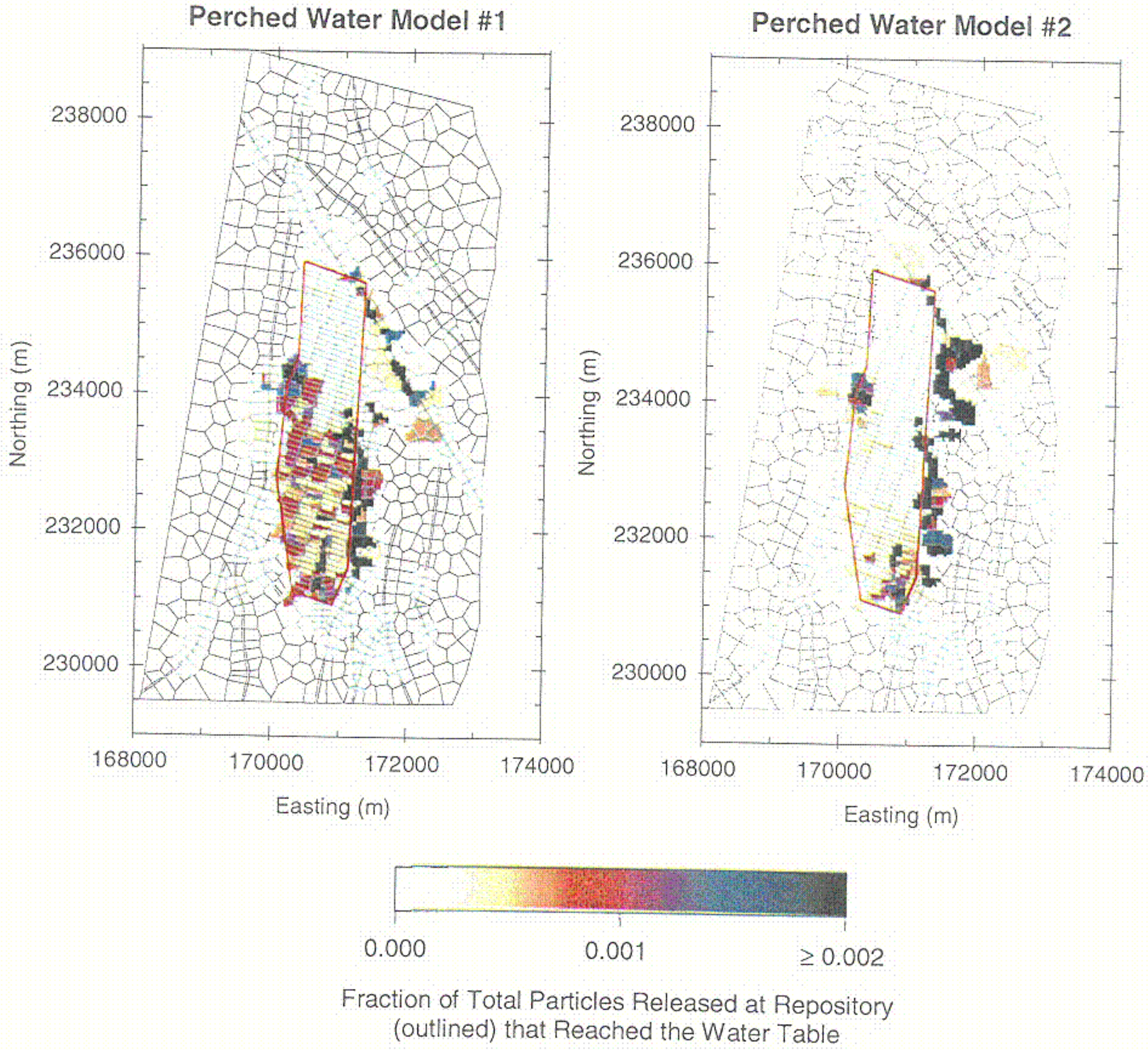

Figure 4. Locations of Particle Breakthrough at the Water Table for the Mean Infiltration, Glacial-Transition Climate Using Two Perched Water Models ('glam1' and 'glam2') and an Elevated Water Table at 850 m

6.2.2 Particle Tracking Comparison Between Two Perched Water Models Using FEHM

Two alternative perched water models were used in the base-case UZ flow simulations. In the first model, additional materials were created to simulate "perched-water elements." These material names begin with 'pc' and were assigned to elements in the vicinity of the perched water. These materials consist of low permeability, matrix-like properties, even for the fractures that promote perched water. The locations of these elements for perched-water model #1 are shown in Figure 5. The UNIX command 'grep' was used to extract all elements (and associated coordinates) whose material names begin with the character string 'pc.'

C4

The second perched-water model contained a similar modification in the region of perched water. All zeolitic fracture elements (denoted with a "z" in the last character of the material name) were converted to the corresponding matrix material, which has a much lower permeability. The locations of the modified Calico Hills elements (whose material names begin with "ch") are also shown in Figure 5. These plots reveal that both perched-water models create a low-permeability barrier over much of the domain except in the faulted regions. Perched-water model #1 exhibits fewer regions of low-permeability alterations in the southern portion of the repository. However, both perched water models are expected to yield a significant amount of lateral diversion to the faults. The following particle tracking simulations are intended to reveal which model yields the most conservative results for use in TSPA-SR.

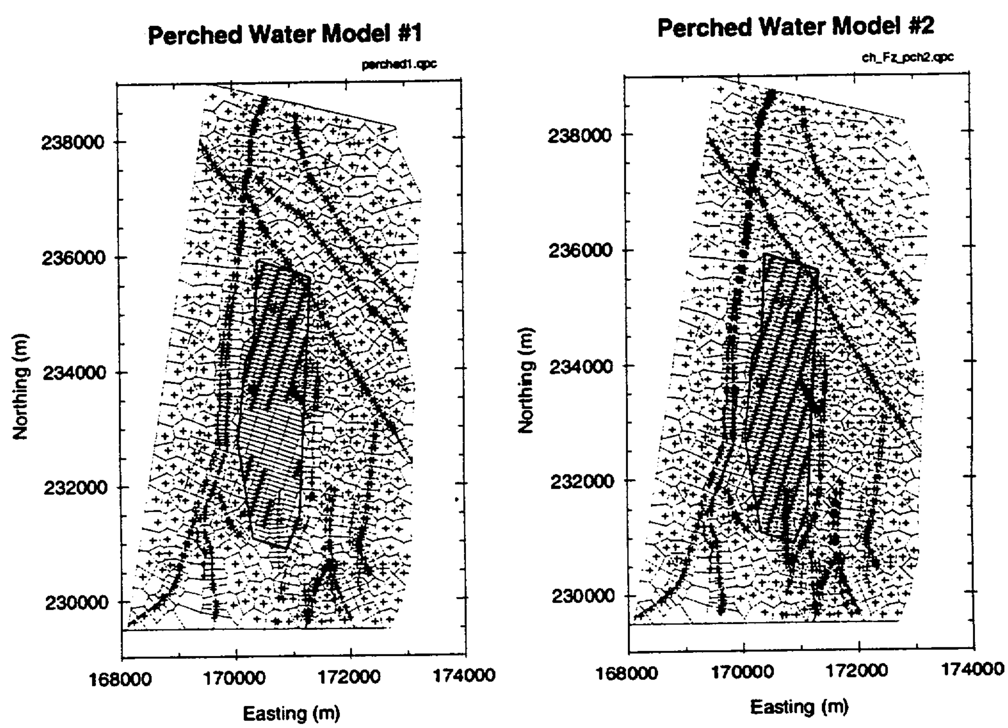

Figure 5. Location of Elements (Denoted by '+' Symbol) That Were Modified to Have Low Permeability for Perched Water

FEHM v. 2.0 is used to simulate Tc and Np transport using both perched water models. Figure 6, Figure 7, and Figure 8 show a comparison of the cumulative normalized breakthrough curve for 99,825 particles released instantaneously and uniformly in the repository fracture nodes for the present-day, monsoon, and glacial-transition climates, respectively. The plots reveal that the results of the two perched water models are similar, although perched water model #1 yields slightly more conservative results, especially for early breakthrough times (via fracture transport). This may be a consequence of the shorter travel paths in the southern portion of the repository, where more particles experience vertical flow rather than lateral diversion as in perched water model #2. As a result, particles may be experiencing less opportunity for matrix diffusion and subsequent matrix sorption in those vertical pathways. It is uncertain how much flow below the southern portion of the repository is dominated by matrix flow in the Calico Hills units, but it appears that at least some of the flow is via fractures. For conservatism, it is recommended that perched water model #1 be used in TSPA-SR calculations.

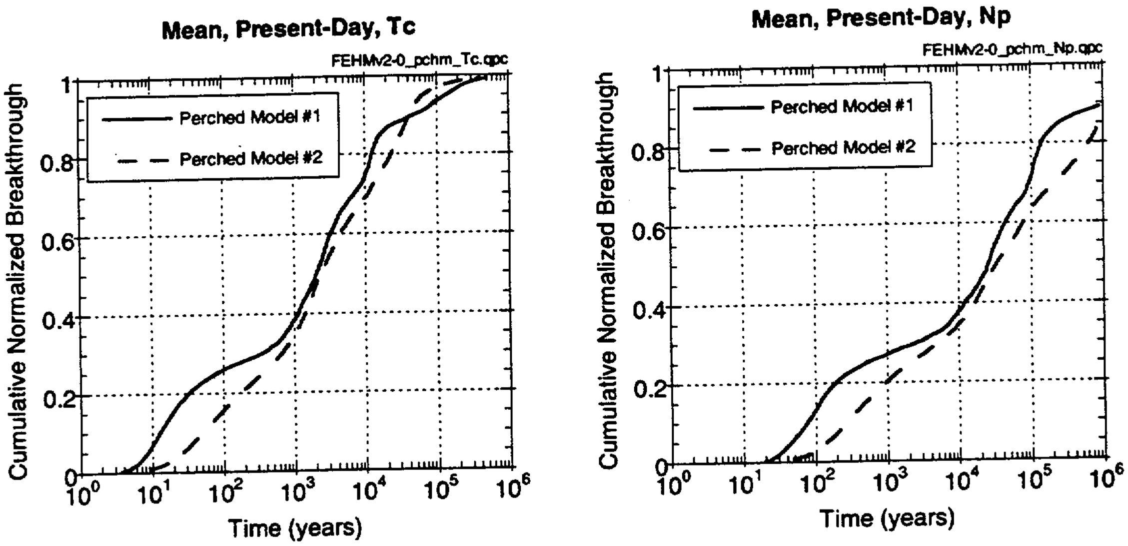

Figure 6. Comparison of Cumulative Normalized Breakthrough Curves at the Water Table Using Perched Water Model #1 and #2 with Tc (left) and Np (right) for Mean-Infiltration, Present-Day Climate

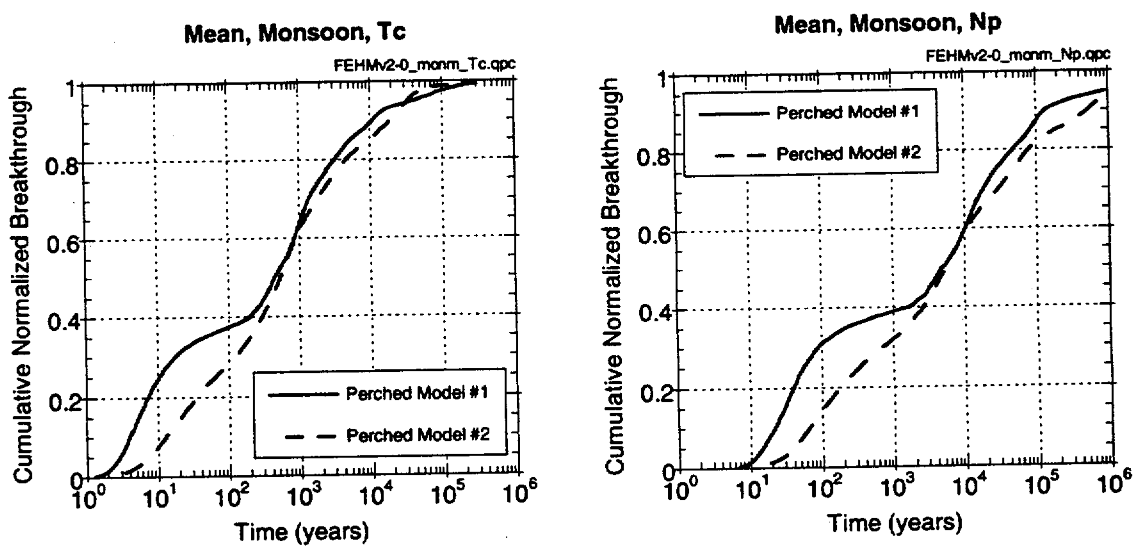

Figure 7. Comparison of Cumulative Normalized Breakthrough Curves at the Water Table Using Perched Water Model #1 and #2 with Tc (left) and Np (right) for Mean-Infiltration, Monsoon Climate

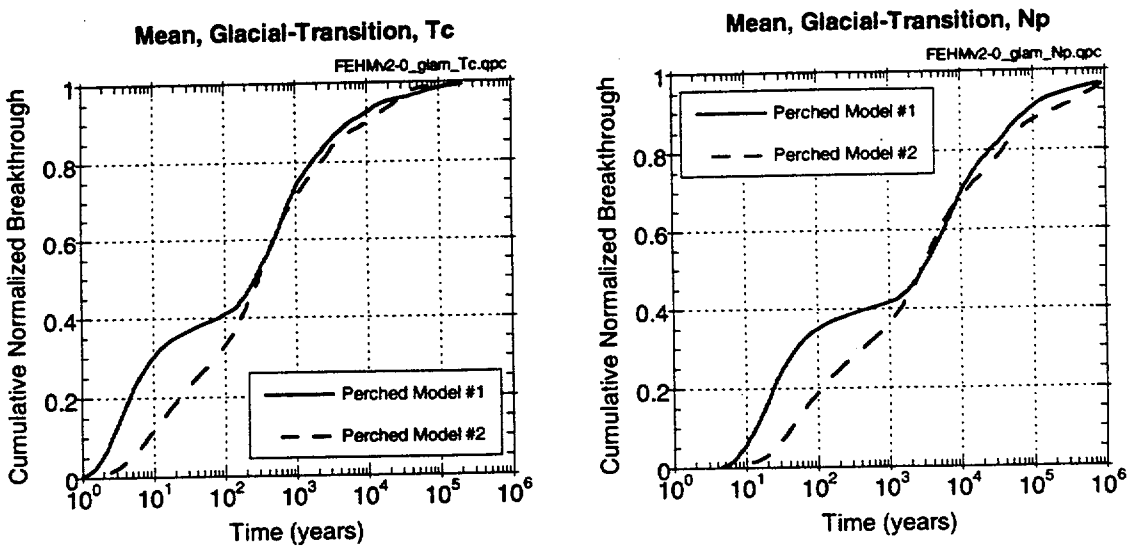

Figure 8. Comparison of Cumulative Normalized Breakthrough Curves at the Water Table Using Perched Water Model #1 and #2 with Tc (left) and Np (right) for Mean-Infiltration, Glacial-Transition Climate

As expected, Figure 6, Figure 7, and Figure 8 show that the travel time between the repository and the water table decreases for the monsoon and glacial-transition climates, which have successively higher infiltration rates. Also, a somewhat bimodal breakthrough is observed in each curve as a result of the dual-continuum model domain that consists of high-permeability fractures and low-permeability matrix. The bimodal shape is more evident in the results of perched-water model #1 than in the results of perched-water model #2. The initial breakthrough is due to transport through fractures, which apparently accounts for approximately 30% of the particles during the present-day simulation and approximately 40% of the particles during the monsoon and glacial-transition climates (as shown in Figure 6, Figure 7, and Figure 8). Because more particles are diverted above the perched water in perched-water model #2, the early travel times via fractures are delayed due to longer travel paths and greater opportunity for diffusion into the matrix, thereby smoothing the initial "hump" in the breakthrough curve.

It should be noted that these results assume no water-table rise for future climates. Water-table rise can be incorporated into the particle-tracking simulations by using modified '*wt850.ini' files provided in DTN: SN9910T0581699.002.

6.2.3 Particle Tracking Comparison Between Two Matrix Diffusion Models Using FEHM

The matrix-diffusion model in FEHM v. 2.0 assumes that the matrix is a semi-infinite domain. The diffusive flux of radionuclides from the fractures into the matrix is maximized as a result of the imposed larger concentration gradients between the fracture and matrix elements. FEHM v. 2.1 implements a finite-fracture-spacing matrix-diffusion model that accounts for the geometric spacing of fractures as well as the increased distance between actively flowing fractures (Liu et al. 1998; Eq. 17).

Figure 9 shows the cumulative normalized breakthrough curves at the water table using both versions of FEHM with Np and perched water model #1 for the present-day and glacial-transition climates. The plots show that the results are nearly identical between the two matrix-diffusion models. The finite-fracture-spacing model in FEHM v. 2.1 yields slightly more conservative results, and it is a more consistent representation of the conceptual flow model. Therefore, the finite-fracture-spacing model in FEHM v. 2.1 is recommended for use in TSPA-SR. The comparisons using Tc are similar, but the differences between FEHM v. 2.0 and FEHM v. 2.1 are even less.

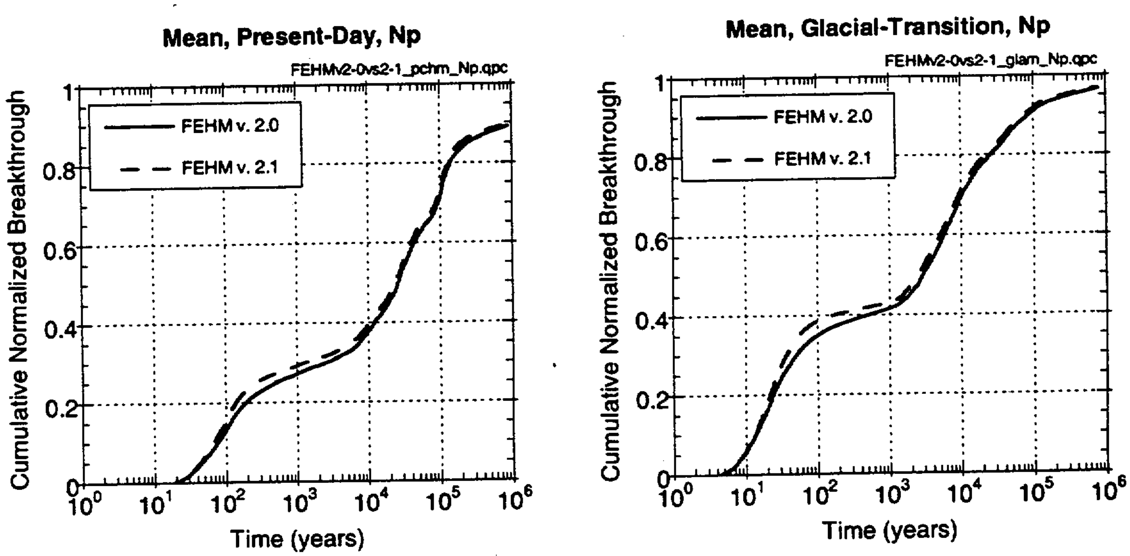

Figure 9. Comparison of Cumulative Normalized Breakthrough Curves at the Water Table Using FEHM v. 2.0 and FEHM v. 2.1 with Np for Mean-Infiltration, Present-Day (left) and Glacial-Transition (right) Climates

6.2.4 Effect of Water-Table Rise on Particle Travel Times

Figure 10 shows the breakthrough curves for Np using the mean infiltration, glacial-transition climate scenario with perched-water model #1. Both the original water-table elevation (~730 m) and an increased water-table elevation[2] (~850 m) are simulated. As shown in Figure 3 and Figure 4, the locations of particle breakthrough at the water table are similar for the different water-table elevations, which indicates that the majority of particle paths between ~730 m and ~850 m are primarily vertical.

The higher water-table elevation decreases the median travel time by nearly a thousand years. At ten thousand years, it increases the cumulative breakthrough of particles from ~70% to ~80%.

[2] The file 'fm_glam1_wt850.ini' in DTN: SN9910T0581699.002 was used for this run.

These differences are not expected to be significant in TSPA calculations. Similar differences are observed for simulations using Tc and other climates as well.

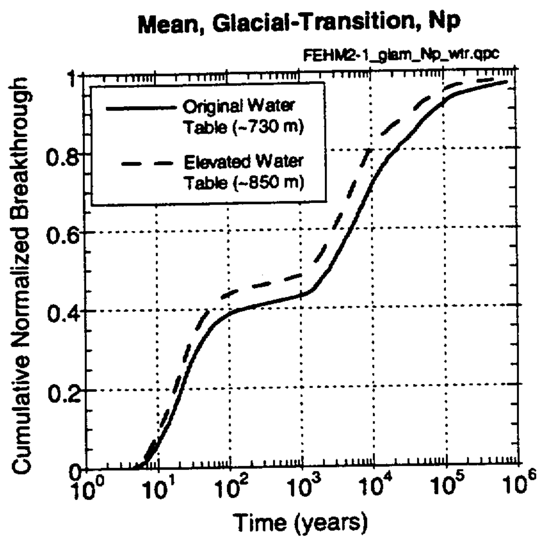

Figure 10. Comparison of Cumulative Normalized Breakthrough Curves at the Water Table Using FEHM v. 2.1 with Np for Mean-Infiltration, Glacial-Transition (right) Climate with Two Water-Table Elevations

6.2.5 Particle Tracking Comparison Between FEHM and DCPT

This section evaluates two different methods of particle tracking. As introduced earlier, FEHM uses the RTTF method that determines a residence time for each particle in each grid cell. This residence time can incorporate advection, matrix diffusion, and sorption processes. The DCPT code uses a Lagrangian approach that interpolates the velocity field onto a continuous space in which particles can travel. A primary difference between these two methods that may impact subsystem performance is the treatment of matrix diffusion (i.e., the diffusion of particles from fracture cells to matrix cells). Because FEHM implements a residence time function for each cell, any particle that experiences matrix diffusion is retained for a sampled amount of time. The sampled time is taken from a semi-analytical solution yielding breakthrough times for advection through a fracture with matrix diffusion and sorption in a dual-porosity system. However, the "diffusing" particles do not physically enter the matrix cell. They only experience an additional residence time in the fracture cell due to the matrix diffusion and sorption. In contrast, DCPT allows the particles to physically transport into the matrix cells by diffusion. Once in the matrix, the particles may experience sorption or transport to an adjacent matrix, which could increase the overall travel time. The DCPT is more consistent with the dual-permeability conceptual model used for the flow fields, but the concept of dual-permeability matrix diffusion vs. dual-porosity matrix diffusion (as implemented in FEHM) needs to be investigated further to determine which is more representative of transport through actual fractured-rock systems.

Figure 11 shows a comparison of results between FEHM v. 2.1 and DCPT. The breakthrough curves for Tc reveal that FEHM 2.1 yields faster transport times with a median travel time that is several hundred years less than the median travel time for DCPT. The differences are even more remarkable for Np. The median travel time for Np using DCPT is several tens of thousands of years greater than the median travel time calculated in FEHM v. 2.1. At ten thousand years, the percentage of particles that have reached the water table is approximately 25% in DCPT, but over 70% in FEHM 2.1. We postulate that the cause for the significant discrepancy is a result of the different treatment of matrix diffusion in the two codes. With the dual-porosity matrix-diffusion concept used in FEHM, particles that experience matrix diffusion are not subject to subsequent transport within the matrix. In FEHM, particles must advect into the matrix to experience transport within the matrix. Thus, a potentially large percentage of particles that physically diffuse into the matrix in DCPT (i.e., a dual-permeability matrix-diffusion concept) may be experiencing significantly longer travel times via subsequent matrix sorption and slow advection through the matrix. It should be noted that these postulations are also supported by additional simulations that show very similar results between advection-only simulations using the dual-porosity and dual-permeability matrix-diffusion concepts with Tc and Np transport. Thus, the only aspect that appears to cause significant differences in the breakthrough curves is the simulated process of matrix diffusion.

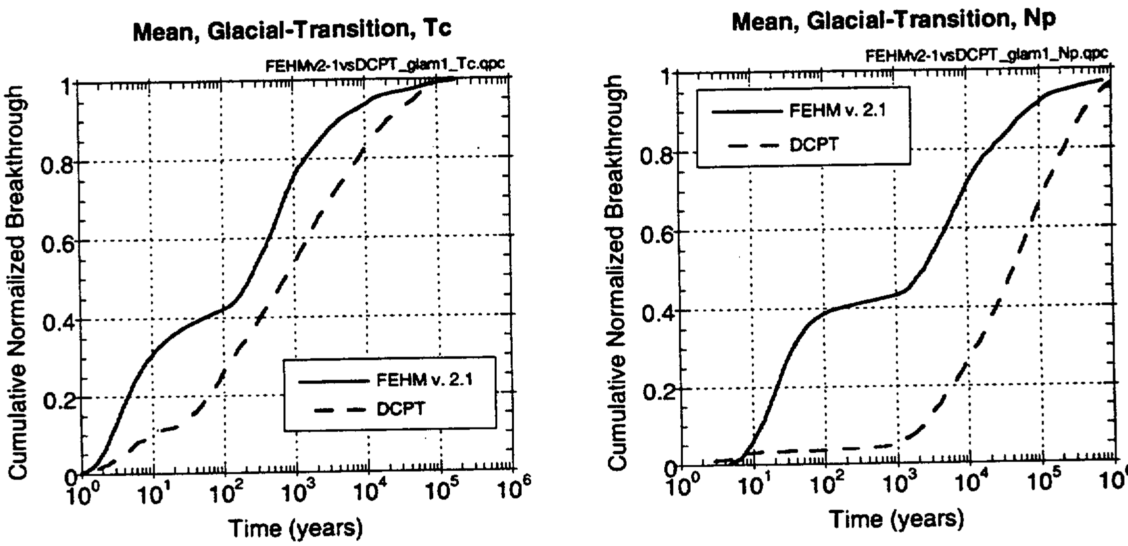

Figure 11. Comparison of Cumulative Normalized Breakthrough Curves at the Water Table Using FEHM v. 2.1 and DCPT with Tc (left) and Np (right) for Mean-Infiltration, Glacial-Transition Climate

6.2.6 Analysis of Different Infiltration Rates on Radionuclide Breakthrough Curves

In this last analysis, breakthrough curves are produced for Np and Tc for the mean, upper, and lower infiltration simulations for each climate. FEHM v. 2.0 is used instead of v. 2.1 because v. 2.0 is qualified, and Section 6.2.3 has shown that the results between FEHM v. 2.0 and v. 2.1 are similar. The purpose is to gain insight into the range of possible results based on the different discrete infiltration simulations. The future climates (monsoon and glacial-transition) do not use elevated water tables from current conditions for the current analysis; however, simulations in TSPA-SR will likely incorporate water-table rise in the particle-tracking simulations using future climates.

Figure 12 shows the breakthrough curves for Np and Tc using the present-day climate and three infiltration simulations. The lower infiltration yields extremely long travel times, especially for the weakly sorbing Np. The median travel time for Tc approaches a million years, and less than 40% of the Np particles reach the water table in one million years. As expected, the higher infiltration rates yield shorter breakthrough times relative to lower infiltration rates.

Figure 13 and Figure 14 show similar plots for the monsoon and glacial-transition climates, respectively. The results for the monsoon climate show less spread between the upper- and lower-infiltration breakthrough curves than the other two climates. The range of median travel times for Tc is close to a million years in the present-day climate and several thousand years in the glacial-transition climate, but it is only approximately a thousand years for the monsoon climate. The range of median travel times for Np is at least a million years in the present-day climate and approximately 40,000 years in the glacial-transition climate, but it is only approximately 10,000 years for the monsoon climate. Note that the results of the lower-infiltration simulations for the monsoon climate show faster breakthrough times than the lower-infiltration simulations for the glacial-transition climate. This result is likely due to the lower precipitation that was used in the analog for the lower-infiltration simulation in the glacial-transition climate.

It should be emphasized that these results do not reflect the actual breakthrough times that will be simulated in TSPA-SR. The duration of each climate period will be less than a million years, and the future climates will likely experience a water-table rise. The purpose of this analysis is to explore the possible range of results that may occur for each of the simulated flow fields.

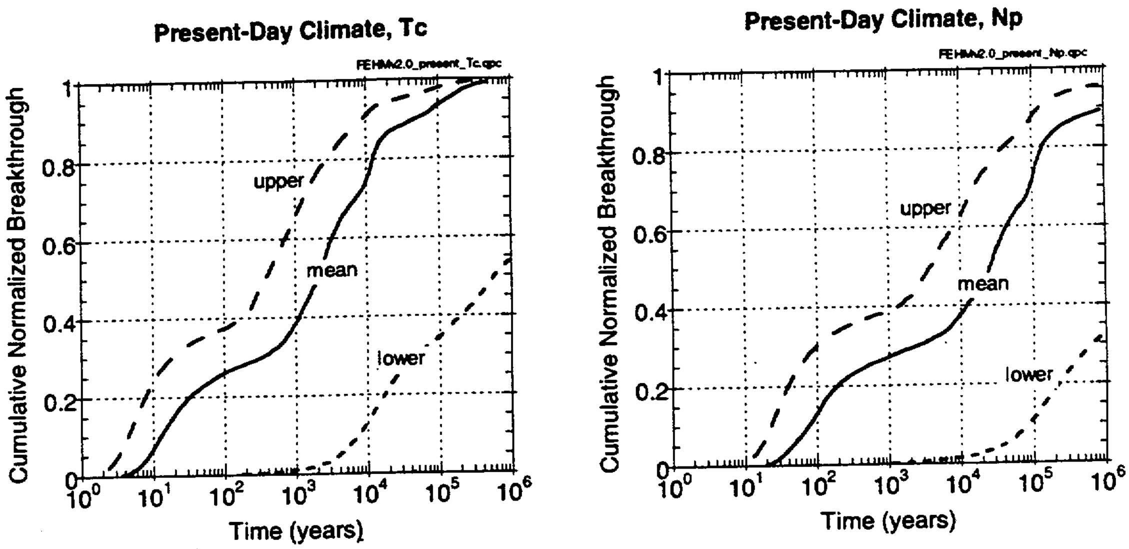

Figure 12. Effect of Infiltration (mean, upper, and lower) on Cumulative Normalized Breakthrough Curves at the Water Table Using FEHM v. 2.0 with Tc (left) and Np (right) for Present-Day Climate

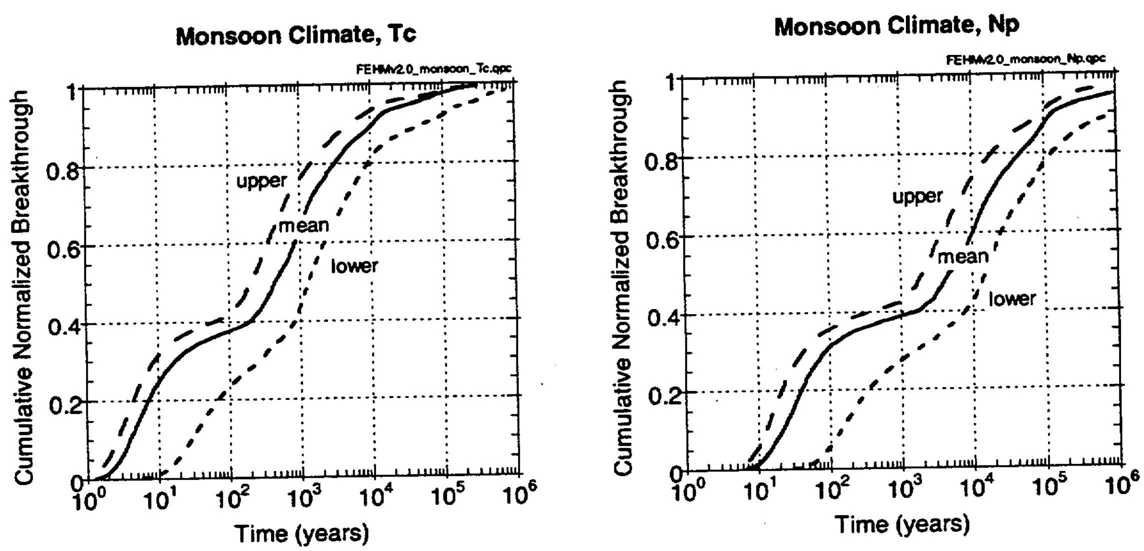

Figure 13. Effect of Infiltration (mean, upper, and lower) on Cumulative Normalized Breakthrough Curves at the Water Table Using FEHM v. 2.0 with Tc (left) and Np (right) for Monsoon Climate

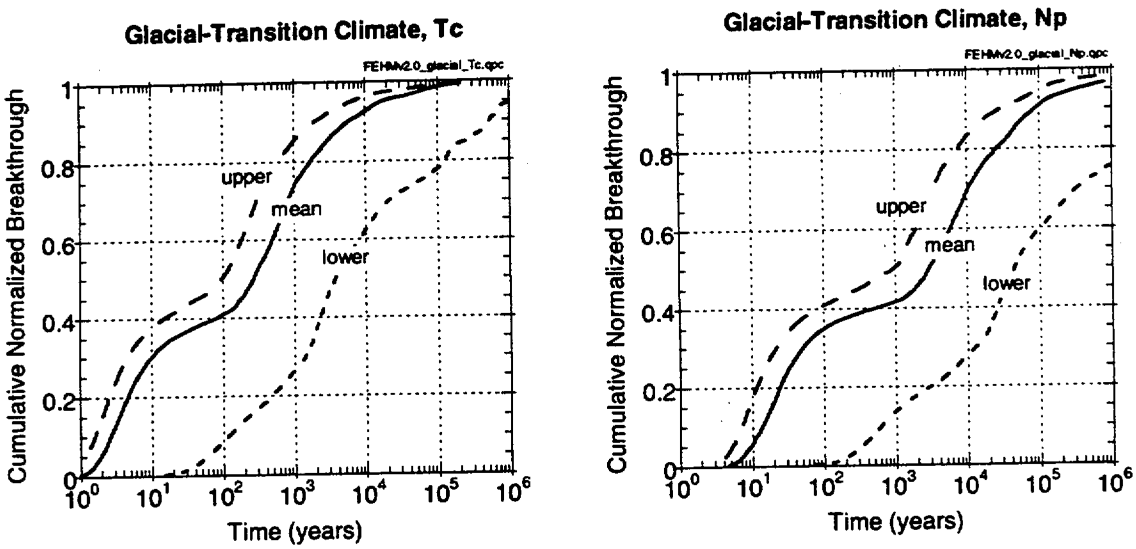

Figure 14. Effect of Infiltration (mean, upper, and lower) on Cumulative Normalized Breakthrough Curves at the Water Table Using FEHM v. 2.0 with Tc (left) and Np (right) for Glacial-Transition Climate

7. CONCLUSIONS

Particle-tracking analyses have been performed on UZ base-case flow fields to gain insight into the UZ subsystem transport behavior for TSPA-SR. Results show that particle breakthrough locations at the water table are concentrated along faults in the northern part of the repository due to lateral diversion over "perched-water elements." Perched-water model #1 shows less lateral diversion in the southern portion of the repository. Comparisons between the two perched-water models show that breakthrough curves are very similar, although perched-water model #1 yields slightly more conservative results. Comparisons between two matrix-diffusion models in FEHM show that the finite-fracture-spacing matrix-diffusion model (FEHM v. 2.1) yields slightly lower residence times and slightly faster breakthrough curves relative to the infinite-fracture-spacing matrix-diffusion model (FEHM v. 2.0). An evaluation of the effects of water-table rise on particle travel times show that impact of water-table rise is not significant to TSPA calculations. Comparisons between FEHM and DCPT reveal significant differences in the breakthrough curves, which are postulated to be caused by the different matrix-diffusion conceptual models used in each (dual porosity vs. dual permeability). Finally, analyses of the three different infiltration simulations (mean, upper, and lower) reveal that a significant range of breakthrough times exists for each of the three climates. The monsoon climate has the least amount of range, while the present-day climate yields the greatest range.

As a result of these analyses, it is recommended that TSPA-SR calculations use the perched-water model #1 results with the finite-fracture-spacing model in FEHM v. 2.1. It is also recommended that the dual-permeability matrix-diffusion concept in DCPT be considered for future TSPA calculations. However, for initial (conservative) calculations, FEHM v. 2.1 should be used.

All files associated with this analysis have been submitted to the TDMS (DTN: SN9912T0581699.003 and DTN: SN0001T0581699.004) and are considered "preliminary" pending qualification of upstream source data. Consequently, any use of data from this analysis is required to be controlled as "To Be Verified (TBV)" in accordance with appropriate procedures until this analysis becomes fully qualified. However, no consequential impacts are expected from the preliminary nature of both the source data and the developed data in this report.

This document and its conclusions may be affected by technical product input information that requires confirmation. Any changes to the document or its conclusions that may occur as a result of completing the confirmation activities will be reflected in subsequent revisions. The status of the input information quality may be confirmed by review of the Document Input Reference System database.

8. REFERENCES

8.1 DOCUMENTS CITED

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Pruess, K. 1991. *TOUGH2 - A General-Purpose Numerical Simulator for Multiphase Fluid and Heat Flow.* LBL-29400. Berkeley, California: Lawrence Berkeley National Laboratory. ACC: NNA 19940202.0088.

QAP-2-0, Rev. 5, ICN 0. *Conduct of Activities.* Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980826.0209.

Zyvoloski, G.A.; Robinson, B.A.; Dash, Z.V.; and Trease, L.L. 1997. *User's Manual for the FEHM Application - A Finite-Element Heat-and-Mass-Transfer Code.* LA-13306-M. Los Alamos, New Mexico: Los Alamos National Laboratory. TIC: 235999.

8.2 SOFTWARE

(See Table 1 for more details on software and routines)

Software Code: FEHM V.2.0, STN: 10031-2.00-00. Qualified.

Software Code: FEHM V.2.1, STN: 10086-2.10-00. TBV-3980

Software Code: DCPT V.1.0, STN: 10078-1.0-00. TBV-3156.

Software Routine: PROCESS1 V.1.0. ACC: MOL.19990915.0360.

8.3 SOURCE DATA

LB990501233129.001. Fracture Properties for the UZ Model Grids and Uncalibrated Fracture and Matrix Properties for the UZ Model Layers for AMR U0090, "Analysis Of Hydrologic Properties Data." Submittal date: 08/25/1999. (TBV-3168)

LB990701233129.001. 3-D UZ Model Grids for Calculation of Flow Fields for PA for AMR U0000, "Development of Numerical Grids For UZ Flow and Transport Modeling." Submittal date: 09/24/1999. (TBV-3167)

LB990801233129.003. TSPA Grid Flow Simulations for AMR U0050, "UZ Flow Models and Submodels." Submittal date: 11/29/1999. (TBV-3662)

LB991091233129.004. Calibrated Fault Properties for the UZ Flow and Transport Model for AMR U0035, "Calibrated Properties Model. " Submittal date: 10/22/1999. (TBV-3979)

LB997141233129.001. Calibrated Basecase Infiltration 1-D Parameter Set for the UZ Flow and Transport Model, FY99. Submittal date: 07/21/1999. (TBV-3095)

SN9907T0872799.001. Heat Decay Data and Repository Footprint for Thermal-Hydrologic and Conduction-Only Models for TSPA-SR (Total System Performance Assessment-Site Recommendation). Submittal date: 07/27/1999. (TBV-3599)

SN9910T0581699.002. Post-Processed Flow Fields for RIP: Developed Data from AMR U0125 (Abstract Flow Fields for Rip). Submittal date: 10/15/1999. (TBV-3946)

9. ATTACHMENTS

Attachment	Title
I	Input and Output Files for FEHM
II	Input and Output Files for DCPT
III	Directory of Files Submitted to Technical Data Management System

ATTACHMENT I

Input and Output Files for FEHM

The input files that were developed for FEHM in this analysis include the 'ptrk' and 'dpdp' macros. These files complement the FEHM files that were post-processed as part of an upstream data set (DTN: SN9910T0581699.002). Additional information on input files for FEHM can be found in Zyvoloski et al. (1997). The output files that were developed as part of this analysis have been submitted to the TDMS (DTN: SN9912T0581699.003 and DTN: SN0001T0581699.004).

I.1 DEVELOPMENT OF 'ptrk' INPUT FILES

The 'ptrk' file contains transport properties and other information relevant to the particle tracking simulation in FEHM. A total of nine 'ptrk' files were created manually as part of this analysis. Different 'ptrk' files were required for two radionuclides (Np and Tc), two perched water models, two versions of FEHM, and an advection-only simulation. The different transport properties for Np and Tc are summarized in Table 3 and are reflected in the 'ptrk' macros for the respective simulations. The two perched water models that are used in the base-case flow simulations contain different rock material types that are also reflected in the 'ptrk' file. The latest version of FEHM (v. 2.1) requires additional parameter values in the 'ptrk' file that were not needed in FEHM v. 2.0, so additional 'ptrk' macros are required. Finally, a 'ptrk' macro was developed for the advection-only runs that were used to identify particle breakthrough locations at the water table. All the files can be found in the data developed from this analysis and submitted to the TDMS (DTN: SN9912T0581699.003 and DTN: SN0001T0581699.004). Samples of the 'ptrk' files are provide below (note that some of the lines are wrapped):

I.1.1 'ptrk' File for Np Simulation Using Perched Water Model #1 and FEHM v. 2.0 ('pch1_Np.ptrk')

The following 'ptrk' file was used in developing all transport simulations (including low, mean, and upper infiltration scenarios in present-day, monsoon, and glacial-transition climates) using Np (see Figure 6 through Figure 9 and Figure 12 through Figure 14):

```
ptrk                      /* Tracer simulation withdiffusion, dispersion, AND sorption
100000 204853          /* 100,000 particles, random # seed 204853 */
0 1.e20 0. 1.e20       /* time for starting, ending trans. simulation,and time for ending,
starting flow simultaion */
1 0 2 -1               /* print out particle information and store it in *.fin */
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.10E-01  1.00E-04  #  1  tswM4    13
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.31E-01  1.00E-04  #  2  tswM5    14
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.12E-01  1.00E-04  #  3  tswM6    15
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  9.40E-02  1.00E-04  #  4  tswM7    16
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.70E-02  1.00E-04  #  5
tswM8,pcM38,pcF38  17,38,86  17
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.73E-01  1.00E-04  #  6
tswM9,pcM39,pcF39  18,39,87  18
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.73E-01  1.00E-04  #  7  ch1Mv    19
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.45E-01  1.00E-04  #  8
ch2Mv,ch3Mv,ch4Mv,ch5Mv  20,21,22,23  20
```

```
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.31E-01  1.00E-04  #  9
ch3Mz,ch4Mz,ch5Mz  26,27,28     26
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.66E-01  1.00E-04  #  10
ch6Mz,pcM6z,pcF6z  29,43,91     29
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.25E-01  1.00E-04  #  11  pp4Mz       30
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.03E-01  1.00E-04  #  12  pp3Md       31
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.63E-01  1.00E-04  #  13  pp2Md       32
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.80E-01  1.00E-04  #  14  pp1Mz       33
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.15E-01  1.00E-04  #  15  bf3Md,tr3Md
34,36   34
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.59E-01  1.00E-04  #  16  bf2Mz,tr2Mz
35,37   35
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.88E-01  1.00E-04  #  17  pcM1z,pcF1z
40,88   40
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.31E-01  1.00E-04  #  18
pcM2z,pcM5z,pcF2z,pcF5z 41,42,89,90  41
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.25E-01  1.00E-04  #  19  pcM4p,pcF4p
44,92        44
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  8.60E-02  1.00E-04  #  20  tcwMf       45
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  4.46E-01  1.00E-04  #  21  ptnMf       46
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.27E-01  1.00E-04  #  22  tswMf       47
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.59E-01  1.00E-04  #  23  chnMf       48
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.10E-01  7.14E-04  #  24  tswF4       61
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.31E-01  1.13E-03  #  25  tswF5       62
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.12E-01  1.25E-03  #  26  tswF6       63
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  9.40E-02  1.25E-03  #  27  tswF7       64
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.70E-02  9.23E-04  #  28  tswF8       65
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.73E-01  1.53E-03  #  29  tswF9       66
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.73E-01  2.30E-03  #  30  ch1Fv       67
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.45E-01  2.07E-03  #  31
ch2Fv,ch3Fv,ch4Fz,ch5Fz  68,69,70,71  68
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.31E-01  1.00E-03  #  32
ch3Fz,ch4Fz,ch5Fz  74,75,76  74
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.66E-01  1.55E-03  #  33  ch6Fz     77
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.25E-01  1.00E-03  #  34  pp4Fz     78
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.03E-01  1.80E-03  #  35  pp3Fd     79
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.63E-01  1.80E-03  #  36  pp2Fd     80
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.80E-01  1.00E-03  #  37  pp1Fz     81
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.15E-01  1.80E-03  #  38  bf3Fd,tr3Fd
82,84   82
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.59E-01  1.00E-03  #  39  bf2Fz,tr2Fz
83,85   83
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  8.60E-02  3.38E-03  #  40  tcwFf     93
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  4.46E-01  1.23E-02  #  41  ptnFf     94
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.27E-01  4.19E-03  #  42  tswFf     95
4  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.59E-01  3.40E-03  #  43  chnFf     96

  1  0  0  1
-13  0  0  1
-14  0  0  2
-15  0  0  3
-16  0  0  4
-17  0  0  5
-18  0  0  6
-19  0  0  7
-20  0  0  8
-21  0  0  8
-22  0  0  8
-23  0  0  8
-26  0  0  9
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-30  0  0  11
-31  0  0  12
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-33  0  0  14
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-35  0  0  16
-36  0  0  15
-37  0  0  16
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-38  0  0   5
-39  0  0   6
-40  0  0  17
-41  0  0  18
-42  0  0  18
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-45  0  0  20
-46  0  0  21
-47  0  0  22
-48  0  0  23
-61  0  0  24
-62  0  0  25
-63  0  0  26
-64  0  0  27
-65  0  0  28
-66  0  0  29
-67  0  0  30
-68  0  0  31
-69  0  0  31
-70  0  0  31
-71  0  0  31
-74  0  0  32
-75  0  0  32
-76  0  0  32
-77  0  0  33
-78  0  0  34
-79  0  0  35
-80  0  0  36
-81  0  0  37
-82  0  0  38
-83  0  0  39
-84  0  0  38
-85  0  0  39
-86  0  0   5
-87  0  0   6
-88  0  0  17
-89  0  0  18
-90  0  0  18
-91  0  0  10
-92  0  0  19
-93  0  0  40
-94  0  0  41
-95  0  0  42
-96  0  0  43

-500 0 0 -1. 0. 1.E-5     /* release particles at zone 500  */
```

The first line in this file indicates the name of the FEHM macro ('ptrk'). The second line contains the number of particles and a seed value. The third line contains information regarding the starting and ending times for the flow and transport simulations (because this is just a particle-tracking simulation, the end time for the flow simulation is zero). The fourth line contains information regarding the print out. The following sequence of rows before the blank line contains the transport models that are associated with each material in the model. The first number in each row specifies the transport mode, where "1" denotes advection only and "4" denotes advection, matrix diffusion, and dispersion. The second number is the K_d value (cc/g), and the third through fifth numbers are the dispersivities (m) in the x, y, and z directions. The sixth number is the diffusion coefficient (m^2/sec), and the seventh number specifies whether or not fracture sorption occurs ("1" indicates no fracture sorption). The eighth number is the matrix porosity (DTNs: LB990501233129.001), and the ninth number is the aperture parameter (not used for matrix materials). The aperture parameter for each fracture material is calculated as the ratio of the fracture volume to the fracture/matrix connection area. This ratio is only dependent on the material type, and it is calculated using the ELEME and CONNE cards in the TOUGH2 (Pruess 1991) mesh files (DTN: LB990701233129.001). An element is chosen that corresponds to a given material, and the ratio is calculated from the values in the ELEME and CONNE cards for that particular element. The use of this aperture parameter in the FEHM transport equation is consistent with the reduced fracture/matrix connection area implemented by the active-fracture model (Liu et al. 1998; Section 2.4).

The '#' symbol denotes the end of the data each line, and additional comments are provided following the symbol (i.e., transport model number, material name(s) corresponding to the transport model, and FEHM zones that correspond to the material(s)). Note that several materials (i.e., zones) share the same transport model in some instances. This was done to consolidate transport models of materials that shared the same hydrologic properties. In addition, if special materials (e.g., perched water materials beginning with 'pc') were not identified in the hydrologic property spreadsheets (DTN: LB990501233129.001), the materials were matched to proxy materials that consisted of the same hydrologic properties.

Following the blank line that concludes the list of transport models, each zone (denoted by a negative number) is assigned a transport model number. Finally, below the model assignments, the particles are specified to be released from zone 500 as a pulse. Zone 500 contains the nodes that fall within the repository outline that is described in DTN: SN9907T0872799.001. It should be noted that the nodes in zone 500 are assigned to transport model #1 per the global assignment '1 0 0 1'. Rigorously, each node in this zone should be assigned transport models that correspond to its material type. For example, the fracture nodes belonging to zone 500 should be assigned fracture transport properties corresponding to the material of each node. The use of model #1 for all repository nodes assigns matrix transport parameters (corresponding to tswM4) to the source nodes. This has no effect on Tc, but because sorption occurs for Np, the early breakthrough is slightly delayed (as demonstrated by runs not included in this analysis). It is recommended that for the actual TSPA calculations, the 'ptrk' macro should contain explicit nodal assignments for the source zones (and the SZ zones) to corresponding transport models.

It should also be noted that for perched water model #1, the perched water fracture elements (elements belonging to materials whose first three characters are 'pcF') are assigned to corresponding matrix materials because their properties are similar to those of the matrix. This was done intentionally in the development of the flow model to "perch" water at desired locations.

I.1.2 'ptrk' File for Np Simulation Using Perched Water Model #1 and FEHM v. 2.1 ('afm_pch1_Np.ptrk')

The following 'ptrk' file was used for the mean infiltration scenario with perched-water model #1 and Np as the radionuclide (see Figure 9 through Figure 11):

```
ptrk                    /* Tracer simulation withdiffusion, dispersion, AND sorption
100000 204853          /* 100,000 particles, random # seed 204853 */
0 1.e20 0. 1.e20       /* time for starting, ending trans. simulation,and time for ending,
starting flow simultaion */
1 0 2 -1               /* print out particle information and store it in *.fin */
afm
```

```
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.10E-01  1.00E-04  0.00  0.00  #  1
tswM4      13
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.31E-01  1.00E-04  0.00  0.00  #  2
tswM5      14
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.12E-01  1.00E-04  0.00  0.00  #  3
tswM6      15
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  9.40E-02  1.00E-04  0.00  0.00  #  4
tswM7      16
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.70E-02  1.00E-04  0.00  0.00  #  5
tswM8,pcM38,pcF38  17,38,86  17
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.73E-01  1.00E-04  0.00  0.00  #  6
tswM9,pcM39,pcF39  18,39,87  18
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.73E-01  1.00E-04  0.00  0.00  #  7
ch1Mv      19
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.45E-01  1.00E-04  0.00  0.00  #  8
ch2Mv,ch3Mv,ch4Mv,ch5Mv  20,21,22,23  20
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.31E-01  1.00E-04  0.00  0.00  #  9
ch3Mz,ch4Mz,ch5Mz  26,27,28    26
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.66E-01  1.00E-04  0.00  0.00  #  10
ch6Mz,pcM6z,pcF6z  29,43,91    29
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.25E-01  1.00E-04  0.00  0.00  #  11
pp4Mz      30
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.03E-01  1.00E-04  0.00  0.00  #  12
pp3Md      31
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.63E-01  1.00E-04  0.00  0.00  #  13
pp2Md      32
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.80E-01  1.00E-04  0.00  0.00  #  14
pp1Mz      33
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.15E-01  1.00E-04  0.00  0.00  #  15
bf3Md,tr3Md  34,36  34
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.59E-01  1.00E-04  0.00  0.00  #  16
bf2Mz,tr2Mz  35,37  35
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.88E-01  1.00E-04  0.00  0.00  #  17
pcM1z,pcF1z  40,88  40
1  4.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.31E-01  1.00E-04  0.00  0.00  #  18
pcM2z,pcM5z,pcF2z,pcF5z 41,42,89,90  41
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  3.25E-01  1.00E-04  0.00  0.00  #  19
pcM4p,pcF4p  44,92       44
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  8.60E-02  1.00E-04  0.00  0.00  #  20
tcwMf      45
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  4.46E-01  1.00E-04  0.00  0.00  #  21
ptnMf      46
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  1.27E-01  1.00E-04  0.00  0.00  #  22
tswMf      47
1  1.00E+00  0.00E+00  0.00E+00  0.00E+00  1.60E-10  1  2.59E-01  1.00E-04  0.00  0.00  #  23
chnMf      48
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.10E-01  7.14E-04  0.01  0.41  #  24
tswF4      61
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.31E-01  1.13E-03  0.01  0.41  #  25
tswF5      62
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.12E-01  1.25E-03  0.01  0.41  #  26
tswF6      63
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  9.40E-02  1.25E-03  0.01  0.41  #  27
tswF7      64
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.70E-02  9.23E-04  0.01  0.41  #  28
tswF8      65
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.73E-01  1.53E-03  0.01  0.41  #  29
tswF9      66
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.73E-01  2.30E-03  0.01  0.13  #  30
ch1Fv      67
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.45E-01  2.07E-03  0.01  0.13  #  31
ch2Fv,ch3Fv,ch4Fz,ch5Fz  68,69,70,71  68
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.31E-01  1.00E-03  0.01  0.10  #  32
ch3Fz,ch4Fz,ch5Fz  74,75,76  74
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.66E-01  1.55E-03  0.01  0.10  #  33
ch6Fz      77
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.25E-01  1.00E-03  0.01  0.10  #  34
pp4Fz      78
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  3.03E-01  1.80E-03  0.01  0.46  #  35
pp3Fd      79
```

```
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.63E-01  1.80E-03  0.01  0.46  #  36
pp2Fd     80
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.80E-01  1.00E-03  0.01  0.10  #  37
pp1Fz     81
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.15E-01  1.80E-03  0.01  0.46  #  38
bf3Fd,tr3Fd    82,84  82
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.59E-01  1.00E-03  0.01  0.10  #  39
bf2Fz,tr2Fz    83,85  83
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  8.60E-02  3.38E-03  0.01  0.30  #  40
tcwFf     93
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  4.46E-01  1.23E-02  0.01  0.09  #  41
ptnFf     94
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  1.27E-01  4.19E-03  0.01  0.50  #  42
tswFf     95
6  0.00E+00  2.00E+01  2.00E+01  2.00E+01  1.60E-10  1  2.59E-01  3.40E-03  0.01  0.30  #  43
chnFf     96

   1  0  0  1
 -13  0  0  1
 -14  0  0  2
 -15  0  0  3
 -16  0  0  4
 -17  0  0  5
 -18  0  0  6
 -19  0  0  7
 -20  0  0  8
 -21  0  0  8
 -22  0  0  8
 -23  0  0  8
 -26  0  0  9
 -27  0  0  9
 -28  0  0  9
 -29  0  0  10
 -30  0  0  11
 -31  0  0  12
 -32  0  0  13
 -33  0  0  14
 -34  0  0  15
 -35  0  0  16
 -36  0  0  15
 -37  0  0  16
 -38  0  0   5
 -39  0  0   6
 -40  0  0  17
 -41  0  0  18
 -42  0  0  18
 -43  0  0  10
 -44  0  0  19
 -45  0  0  20
 -46  0  0  21
 -47  0  0  22
 -48  0  0  23
 -61  0  0  24
 -62  0  0  25
 -63  0  0  26
 -64  0  0  27
 -65  0  0  28
 -66  0  0  29
 -67  0  0  30
 -68  0  0  31
 -69  0  0  31
 -70  0  0  31
 -71  0  0  31
 -74  0  0  32
 -75  0  0  32
 -76  0  0  32
 -77  0  0  33
 -78  0  0  34
 -79  0  0  35
 -80  0  0  36
 -81  0  0  37
```

```
 -82  0  0  38
 -83  0  0  39
 -84  0  0  38
 -85  0  0  39
 -86  0  0   5
 -87  0  0   6
 -88  0  0  17
 -89  0  0  18
 -90  0  0  18
 -91  0  0  10
 -92  0  0  19
 -93  0  0  40
 -94  0  0  41
 -95  0  0  42
 -96  0  0  43

-500 0 0 -1. 0. 1.E-5     /* release particles at zone 500  */
```

In the 'ptrk' file for FEHM v. 2.1, a new option allows the use of finite fracture spacing for matrix diffusion modeling. This is invoked in the first field in the rows of transport models. If the value is '6', then finite fracture spacing will be invoked for matrix diffusion, along with advection and dispersion. The keyword 'afm' above the list of transport models indicates that two additional fields are added at the end of each row for the transport models (before the '#' symbol) to invoke the active-fracture model. The active-fracture model in FEHM v. 2.1 increases the geometric fracture spacing specified in the 'dpdp' macro by dividing it by the effective fracture liquid saturation raised to the power of γ, where γ is a fitting parameter in the active-fracture model that specifies the fraction of fractures that have flowing liquid (Liu et al. 1998; Section 2.1). Note that the γ parameter is different for the low, mean, and upper infiltration scenarios.

The first additional field in the 'ptrk' file for the active-fracture model in FEHM v. 2.1 is the residual fracture liquid saturation (not used for matrix materials). These values are taken from DTN: LB997141233129.001 for non-fault materials and from the ROCKS card of 'pa_pchm1.dat' (DTN: LB990801233129.003) for the fault materials (tcwFf, ptnFf, tswFf, and chnFf). The second additional field is the active-fracture-model γ parameter, which is taken from the same DTNs. It should be noted that the calibrated fault material properties can also be found in an Excel spreadsheet in DTN: LB991091233129.004, but the values are reported with fewer significant digits than in the TOUGH2 ROCKS card.

It should be noted that for perched water model #2, the perched water fracture elements (elements belonging to materials whose first three characters are 'pcF') are assigned to corresponding matrix materials because their properties are similar to those of the matrix. In addition, all fracture elements belonging to zeolitic rock (materials denoted with 'z' in the last character) are also assigned matrix properties. This was done intentionally in the development of the flow model to "perch" water at desired locations.

I.1.3 'ptrk' File for Advection-Only Simulation ('fm_tracer.ptrk')

The following 'ptrk' file is used for the advection-only runs shown in Figure 1 through Figure 5. No diffusion, dispersion, or sorption is considered in these runs.

```
ptrk                        /* Tracer simulation with no diffusion, dispersion, or sorption
100000 204853              /* 100,000 particles, random # seed 204853 */
0 1.e20 0. 1.e20           /* time for starting, ending trans. simulation,and time for ending,
starting flow simultaion */
1 0 2 -1                   /* print out particle information and store it in *.fin */
1  0.000E+00  0.000E+00  0.000E+00  0.000E+00 0.000E+00  1.0  1.0 1.0

1 0 0 1

-500 0 0 -1. 0. 1.E-5     /* release particles at zone 500  */
```

In this file, the line containing '1 0 0 1' denotes that all nodes are assigned transport model #1, which consists of advection only.

I.2 DEVELOPMENT OF 'dpdp' INPUT FILES FOR FEHM V. 2.1

Two 'dpdp' files are developed manually as part of this analysis for use with FEHM v. 2.1. The 'dpdp' files are independent of the radionuclide being used; however, different 'dpdp' files must be created for the different perched water models because of the different materials used in each.

The following 'dpdp' file is for perched-water model #1. It is invariant among the different infiltration, climate, and radionuclide transport (e.g., Tc vs. Np) scenarios:

'afm_pch1.dpdp'

```
dpdp
1
     -49       0       0      0.2800E-01
     -50       0       0      0.2000E-01
     -51       0       0      0.1500E-01
     -52       0       0      0.1100E-01
     -53       0       0      0.1200E-01
     -54       0       0      0.2500E-02
     -55       0       0      0.1200E-01
     -56       0       0      0.6200E-02
     -57       0       0      0.3600E-02
     -58       0       0      0.5500E-02
     -59       0       0      0.9500E-02
     -60       0       0      0.6600E-02
     -61       0       0      0.1000E-01
     -62       0       0      0.1100E-01
     -63       0       0      0.1500E-01
     -64       0       0      0.1500E-01
     -65       0       0      0.1200E-01
     -66       0       0      0.4600E-02
     -67       0       0      0.6900E-03
     -68       0       0      0.8900E-03
     -69       0       0      0.8900E-03
     -70       0       0      0.8900E-03
     -71       0       0      0.8900E-03
     -72       0       0      0.1700E-03
     -73       0       0      0.4300E-03
     -74       0       0      0.4300E-03
     -75       0       0      0.4300E-03
     -76       0       0      0.4300E-03
     -77       0       0      0.1700E-03
     -78       0       0      0.4300E-03
     -79       0       0      0.1100E-02
     -80       0       0      0.1100E-02
     -81       0       0      0.4300E-03
     -82       0       0      0.1100E-02
     -83       0       0      0.4300E-03
     -84       0       0      0.1100E-02
     -85       0       0      0.4300E-03
```

```
    -86        0         0       0.3700E-01
    -87        0         0       0.1730E+00
    -88        0         0       0.2880E+00
    -89        0         0       0.3310E+00
    -90        0         0       0.3310E+00
    -91        0         0       0.2660E+00
    -92        0         0       0.3250E+00
    -93        0         0       0.4400E-01
    -94        0         0       0.1600E-01
    -95        0         0       0.3600E-01
    -96        0         0       0.1600E-02

    -49        0         0       0.543
    -50        0         0       0.262
    -51        0         0       0.179
    -52        0         0       0.746
    -53        0         0       1.087
    -54        0         0       0.877
    -55        0         0       1.087
    -56        0         0       0.962
    -57        0         0       0.515
    -58        0         0       0.230
    -59        0         0       0.446
    -60        0         0       0.617
    -61        0         0       0.116
    -62        0         0       0.158
    -63        0         0       0.124
    -64        0         0       0.124
    -65        0         0       0.115
    -66        0         0       0.521
    -67        0         0       5.000
    -68        0         0       3.571
    -69        0         0       3.571
    -70        0         0       3.571
    -71        0         0       3.571
    -72        0         0       12.50
    -73        0         0       3.571
    -74        0         0       3.571
    -75        0         0       3.571
    -76        0         0       3.571
    -77        0         0       12.50
    -78        0         0       3.571
    -79        0         0       2.500
    -80        0         0       2.500
    -81        0         0       3.571
    -82        0         0       2.500
    -83        0         0       3.571
    -84        0         0       2.500
    -85        0         0       3.571
    -86        0         0       99.00
    -87        0         0       99.00
    -88        0         0       99.00
    -89        0         0       99.00
    -90        0         0       99.00
    -91        0         0       99.00
    -92        0         0       99.00
    -93        0         0       0.263
    -94        0         0       0.926
    -95        0         0       0.294
    -96        0         0       3.846

stop
```

The following 'dpdp' file is for perched-water model #2. It is invariant among the different infiltration, climate, and radionuclide transport (e.g., Tc vs. Np) scenarios:

'afm_pch2.dpdp'

```
dpdp
1
     -44       0       0     0.2800E-01
     -45       0       0     0.2000E-01
     -46       0       0     0.1500E-01
     -47       0       0     0.1100E-01
     -48       0       0     0.1200E-01
     -49       0       0     0.2500E-02
     -50       0       0     0.1200E-01
     -51       0       0     0.6200E-02
     -52       0       0     0.3600E-02
     -53       0       0     0.5500E-02
     -54       0       0     0.9500E-02
     -55       0       0     0.6600E-02
     -56       0       0     0.1000E-01
     -57       0       0     0.1100E-01
     -58       0       0     0.1500E-01
     -59       0       0     0.1500E-01
     -60       0       0     0.1200E-01
     -61       0       0     0.4600E-02
     -62       0       0     0.6900E-03
     -63       0       0     0.8900E-03
     -64       0       0     0.8900E-03
     -65       0       0     0.8900E-03
     -66       0       0     0.8900E-03
     -67       0       0     0.1700E-03
     -68       0       0     0.4300E-03
     -69       0       0     0.4300E-03
     -70       0       0     0.4300E-03
     -71       0       0     0.4300E-03
     -72       0       0     0.1700E-03
     -73       0       0     0.4300E-03
     -74       0       0     0.1100E-02
     -75       0       0     0.1100E-02
     -76       0       0     0.4300E-03
     -77       0       0     0.1100E-02
     -78       0       0     0.4300E-03
     -79       0       0     0.1100E-02
     -80       0       0     0.4300E-03
     -81       0       0     0.3700E-01
     -82       0       0     0.1730E+00
     -83       0       0     0.4400E-01
     -84       0       0     0.1600E-01
     -85       0       0     0.3600E-01
     -86       0       0     0.1600E-02

     -44       0       0     0.543
     -45       0       0     0.262
     -46       0       0     0.179
     -47       0       0     0.746
     -48       0       0     1.087
     -49       0       0     0.877
     -50       0       0     1.087
     -51       0       0     0.962
     -52       0       0     0.515
     -53       0       0     0.230
     -54       0       0     0.446
     -55       0       0     0.617
     -56       0       0     0.116
     -57       0       0     0.158
     -58       0       0     0.124
     -59       0       0     0.124
     -60       0       0     0.115
     -61       0       0     0.521
     -62       0       0     5.00
     -63       0       0     3.571
     -64       0       0     3.571
     -65       0       0     3.571
```

```
   -66       0       0    3.571
   -67       0       0    12.50
   -68       0       0    3.571
   -69       0       0    3.571
   -70       0       0    3.571
   -71       0       0    3.571
   -72       0       0    12.50
   -73       0       0    3.571
   -74       0       0    2.500
   -75       0       0    2.500
   -76       0       0    3.571
   -77       0       0    2.500
   -78       0       0    3.571
   -79       0       0    2.500
   -80       0       0    3.571
   -81       0       0    99.00
   -82       0       0    99.00
   -83       0       0    0.263
   -84       0       0    0.926
   -85       0       0    0.294
   -86       0       0    3.846

stop
```

In these two 'dpdp' files, the zones corresponding to fracture nodes belonging to each material are listed along with the corresponding bulk fracture porosity for each material. Following the blank line, the same zones are listed again with the fracture half spacing (half the inverse of the fracture frequency). The fracture frequencies corresponding to each material are taken from DTN: LB990501233129.001.

I.3 OUTPUT FILES FROM FEHM

The output files from FEHM are described in detail in Zyvoloski et al. (1997). The output file containing the primary particle information is the '*.fin' file. This file is post-processed using the PROCESS1 software routine to provide text columns of time (years), mass flow at the water table (mol/year), and cumulative mass arriving at the water table (mol) in a '*.output' file. A sample of the first and last few lines of the output file that is plotted for Np transport during the present-day mean climate using perched-water model #1 and FEHM v. 2.0 (fm_pchm1_Np_tracer.output) is as follows (see Figure 6, Figure 9, and Figure 12):

```
 .
17.9199867 4.56405629e-04 1.00175303e-05
22.9815865 1.30574964e-03 4.48785396e-03
25.8188248 1.76180829e-03 8.96568969e-03
28.2247219 2.03770655e-03 1.34435259e-02
30.4081726 1.96700683e-03 1.79213621e-02
32.6451530 1.91854325e-03 2.23991983e-02
34.8349533 2.26716511e-03 2.68770345e-02
36.8910751 2.06031092e-03 3.13548706e-02
39.0363503 2.20884848e-03 3.58327068e-02
 .
 .
 .
233123.938 2.53230098e-07 0.846321046
252470.359 1.94349909e-07 0.850798905
279136.250 1.59731911e-07 0.855276763
312549.594 1.10904871e-07 0.859754562
355794.250 9.30835000e-08 0.864232421
402439.094 9.89259021e-08 0.868710220
```

```
460795.031 6.44197300e-08 0.873188078
539226.625 4.96984818e-08 0.877665937
645865.563 3.99412841e-08 0.882143736
762204.688 3.54991840e-08 0.886621594
901695.188 3.04012993e-08 0.891099453
```

ATTACHMENT II

Input and Output Files for DCPT

The two DCPT simulations reported in this analysis were performed at LBNL. All input and output files developed for the DCPT simulations have been submitted to the TDMS (DTN: SN9912T0581699.003 and DTN: SN0001T0581699.004).

II.1 Format of input files

II.1.1 Control File ('*.in')

Row	Data	Format
1	Title (first five characters must to be MULTI)	String
2	Maximum simulation time, Number of species	Real, Real
3	Filename of the TEC file (matrix)	String in " "
4	Filename of the TEC file (fracture)	String in " "
5	Filename of the mesh file	String in " "
6	Filename of the initial particle distribution	String in " "
7	Filename of the final status of particles	String in " "
8	Filename of the numbers of particles in each cell	String in " "
9	Filename of the rock properties	String in " "
10	Filename of the flow rates of each connection	String in " "
11	Filename of the connection configurations	String in " "
12	Filename of the rock index for each cell	String in " "
13	Filename of the particle properties	String in " "
14	Flag indicating whether or not the dispersion process is considered	Logical (.true. or .false.)
15	Flag indicating whether or not the mass exchange between the fracture and the matrix is considered	Logical (.true. or .false.)
16	Flag indicating whether or not the sorption process is considered	Logical (.true. or .false.)
17	Flag indicating whether or not the colloid facilitate process is considered	Logical (.true. or .false.)
18	Any two real number (not used)	Real, separated by a comma
19	Any two real number (not used)	Real, separated by a comma
20	Any two real number (not used)	Real, separated by a comma
21	Any two real number (not used)	Real, separated by a comma
22	Dispersivity on the interface between the fracture and the matrix	Real

The following 'PAGlam1.in' file was used in this analysis:

```
MULTIInput for Particle tracking for PA
8.E+15,2                      Tmax, Maximun time allowed
"glam1_m.tec"            tec file of matrix
"glam1_f.tec"            tec file of fracture
"PA99mesh.txt"             mesh file
"PA99PTini.txt"           Initial distribution
"PA99_out.txt"           Output file (final status)
"PA99_Dist.txt"            OutPut File (final distribution,per cell)
"PARock99pch1.roc"                Rock properties
"glam1.flow"                Flow per connection
"PA99mesh.con"             connection configuration
"PARock99pch1.idx"                  Rock index per cell
"PtP_PA.dat"                      Particle properties, only if MULTI
.true.                          HasDispersion
```

```
.true.                    HasF/M interaction
.true.                    Has Adsorption
.false.                   Colloid facilitated
 0.0,20.D0               MDispL,FDispL,used only if single
 0.0,20.D-4              MDispT,FDispT,used only if single
 1.6d-10,1.6D-13         MD0,FD0, used only if Single
 0.0,0.0                 adsorption coeeficient (M, F), no longer used
 0.0                     Dispersivity F/M
```

II.1.2 TEC File (matrix)

The first three rows will be skipped in reading by DCPT V1.0. Each following row contains information of a cell (matrix part) in the format of "a1,a1,a3,8x,3(f10.3,1x),15(e14.6)". The variables are Name, x, y, z, P, SL, PCap, Vx, Vy, Vz, Fx, Fy, Fz, Ff-m, Af-m, S, phi, Vn, and Tau. Among these variables, only those listed in the following table are used by DCPT:

Variable	Format
Name (the first character must be "M")	String with length of 5
X	F10.3 plus a space
Y	F10.3 plus a space
Z	F10.3 plus a space
SL (liquid saturation)	E14.6
Vx (x-component of pore velocity)	E14.6
Vy (y-component of pore velocity)	E14.6
Vz (z-component of pore velocity)	E14.6
Ff-m (liquid flow rate from fracture to matrix)	E14.6
Af-m (area of the fracture/matrix interface)	E14.6
S (characteristic distance of the fracture-matrix system)	E14.6
Phi (porosity)	E14.6
Vn (bulk volume)	E14.6
Tau (tortuosity)	E14.6

The following are the first few lines of the 'glam1_m.tec' file used in this analysis (note that the lines are wrapped):

```
#Time = 0.50000E+05
Variables= x y z P SL Pcap VMx VMy VMz FMx FMy FMz Ff-m Af-m Df-m phi, Vn, Tau
Zone F=FEPOINT I=  97976 J=
Maa 1          169398.601 236623.643   1626.096  -0.274552E+05  0.296434E+00 -0.119455E+06 -
0.304523E-12 -0.459076E-10 -0.284225E-10 -0.110923E-13 -0.441135E-08 -0.230340E-08  0.108237E-08
0.373100E+06  0.181200E+00  0.253000E+00  0.226700E+06  0.000000E+00
Mba 1          169398.601 236623.643   1606.466   0.885896E+05  0.995114E+00 -0.341044E+04
0.782747E-12 -0.955420E-12 -0.329724E-10  0.495234E-13 -0.748698E-10 -0.279181E-08 -0.739807E-11
0.421700E+08  0.877200E-01  0.820000E-01  0.317900E+07  0.000000E+00
Mca 1          169398.601 236623.643   1569.837   0.815142E+05  0.979608E+00 -0.104858E+05
0.338314E-12 -0.125995E-11 -0.113493E-10  0.210138E-13 -0.103417E-09 -0.104300E-08  0.475876E-16
0.421700E+08  0.877200E-01  0.820000E-01  0.317900E+07  0.000000E+00
Mda 1          169398.601 236623.643   1547.726  -0.131684E+06  0.841775E+00 -0.223684E+06
0.174454E-08 -0.926233E-08 -0.999475E-09  0.875208E-08 -0.301101E-05 -0.317376E-06  0.906935E-07
0.672400E+06  0.248800E+00  0.387000E+00  0.665000E+06  0.000000E+00
Mea 1          169398.601 236623.643   1535.453  -0.143485E+05  0.371663E+00 -0.106349E+06
0.542594E-10 -0.230890E-09 -0.264556E-08  0.748595E-10 -0.366298E-07 -0.645448E-06  0.145385E-08
0.210300E+07  0.362300E+00  0.439000E+00  0.148400E+07  0.000000E+00
```

II.1.3 TEC File (fracture)

The first three rows will be skipped in reading by DCPT V1.0. Each following row contains information of a cell (fracture part) in the format of "a1,a1,a3,8x,3(f10.3,1x),15(e14.6)". The variables are Name, x, y, z, P, SL, PCap, Vx, Vy, Vz, Fx, Fy, Fz, Ff-m, Xf-m, S, phi, Vn, Tau, and Rf-m. Among these variables, only those listed in the following table are used by DCPT:

Variable	Format
Name (the first character must be "F")	String with length of 5
X	F10.3 plus a space
Y	F10.3 plus a space
Z	F10.3 plus a space
SL (liquid saturation)	E14.6
Vx (x-component of pore velocity)	E14.6
Vy (y-component of pore velocity)	E14.6
Vz (z-component of pore velocity)	E14.6
Ff-m (liquid flow rate from fracture to matrix)	E14.6
Rf-m (reduction factor to the area of the fracture/matrix interface)	E14.6
Phi (porosity)	E14.6
Vn (bulk volume)	E14.6
Tau (tortuosity)	E14.6

The following are the first few lines of the 'glam1_f.tec' file used in this analysis (note that the lines are wrapped):

```
#Time = 0.50000E+05
Variables= x y z P SL Pcap VFx VFy VFz FFx FFy FFz Ff-m R_fm phi, Vn, Tau, fac_f-m
Zone F=FEPOINT I=  97976 J=
Faa 1        169399.101 236623.643    1626.096    0.907526E+05  0.461184E-01 -0.124741E+04 -
0.252185E-08 -0.652050E-07 -0.276415E-06 -0.868405E-11 -0.865655E-07 -0.394131E-06  0.108237E-08
0.000000E+00  0.100000E+01  0.653000E+04  0.000000E+00  0.134407E-01
Fba 1        169399.101 236623.643    1606.466    0.885835E+05  0.208725E-01 -0.341654E+04
0.686986E-07 -0.141458E-06 -0.106320E-05  0.225816E-10 -0.575322E-07 -0.747258E-06 -0.739807E-11
0.000000E+00  0.100000E+01  0.648800E+05  0.000000E+00  0.100000E+01
Fca 1        169399.101 236623.643    1569.837    0.885805E+05  0.208513E-01 -0.341950E+04
0.468053E-07 -0.227466E-06 -0.156625E-05  0.155098E-10 -0.962187E-07 -0.741507E-06  0.475876E-16
0.000000E+00  0.100000E+01  0.648800E+05  0.000000E+00  0.280972E-02
Fda 1        169399.101 236623.643    1547.726    0.872078E+05  0.518675E-01 -0.479225E+04
0.145444E-08 -0.115248E-07 -0.815115E-06  0.133884E-10 -0.723707E-08 -0.409033E-06  0.906935E-07
0.000000E+00  0.100000E+01  0.739600E+04  0.000000E+00  0.317617E-01
Fea 1        169399.101 236623.643    1535.453    0.742664E+05  0.286816E-01 -0.177336E+05
0.184833E-08 -0.120751E-07 -0.909572E-07  0.548611E-11 -0.416802E-08 -0.484053E-07  0.145385E-08
0.000000E+00  0.100000E+01  0.180200E+05  0.000000E+00  0.131741E-01
```

II.1.4 Mesh File

This file contains three sections of information: cells, columns, and segments.

Section 1: The first row is the number of cells (integer). Each cell occupies two rows. The first row of two is the cell ID (integer). The second row contains ColumnID (integer), Cell Type (one character n ""), x (real), y (real), z_top (real), z_bottom (real), and Cell size (real), separated by a comma. The first few lines of this section are given from 'PA99mesh.txt' (some lines are wrapped):

```
50312
1
1,"t",169398.600586,236623.64349375,1627.412604,1627.412604,-1,88565.5673840102
2
1,"1",169398.600586,236623.64349375,1627.412604,1624.78,297.59967638425,233158.066957426
3
1,"1",169398.600586,236623.64349375,1624.78,1588.15132496834,297.59967638425,3244039.38670367
4
```

```
1,"1",169398.600586,236623.64349375,1588.15132496834,1551.52264993668,297.59967638425,3244039.386
70367
5
1,"1",169398.600586,236623.64349375,1551.52264993668,1543.93,297.59967638425,672447.349589882
6
1,"1",169398.600586,236623.64349375,1543.93,1526.97549184,297.59967638425,1501585.63490723
7
1,"1",169398.600586,236623.64349375,1526.97549184,1512.99259184,297.59967638425,1238403.47217388
8
1,"1",169398.600586,236623.64349375,1512.99259184,1480.03953994,297.59967638425,2918505.73855824
9
1,"1",169398.600586,236623.64349375,1480.03953994,1449.73455489361,297.59967638425,2683978.195197
18
10
1,"1",169398.600586,236623.64349375,1449.73455489361,1419.42956984723,297.59967638425,2683978.195
19718
```

Section 2: The first row is the number of columns (integer). Each column occupies two rows. The first row of two contains the column ID (integer) and the number of its neighboring columns (integer). The second row contains all neighboring column IDs (integers), the top cell ID (integer) and the bottom cell ID (integer) of this column, x (real), and y (real), separated by a comma. The following are the first few lines for this section from 'PA99mesh.txt':

```
1324
1,4
1,2,3,4,1,37,169398.600586,236623.64349375
2,6
5,6,7,8,9,10,38,69,172705.4375,230904.03125
3,5
11,12,13,14,15,70,101,168909.65625,233244.625
4,7
16,17,18,19,20,21,22,102,125,171465.90625,237975.359375
5,5
23,24,25,26,27,126,150,172320.4519045,237217.732620313
```

Section 3: The first row is the total number of the segments (integer). Each segment occupies two rows. The first row of two contains the segment ID (integer). The second row contains two neighboring cell IDs (integers) and x-y coordinates (real) of two ends of the segment. The first few lines of this section in 'PA99mesh.txt' are given below:

```
3120
1
1,-1,169251.917,236795.473,169201.033,236473.209
2
1,114,169201.033,236473.209,169428.63,236411.341
3
1,102,169428.63,236411.341,169501.1745,236823.139
4
1,31,169501.1745,236823.139,169251.917,236795.473
5
2,133,172943.786,230984.566,172730.132,231087.475
6
2,94,172730.132,231087.475,172487.977,231043.0255
7
2,130,172487.977,231043.0255,172606.485,230777.016
8
2,199,172606.485,230777.016,172683.106,230740.154
9
2,200,172683.106,230740.154,172829.738,230784.794
```

II.1.5 Initial Particle Distribution File

This file provides information of particles to be simulated. The first row of data is the total number (integer) of the particle groups. Then each row of data describes one group of particles, including the number of the particles in the group (integer), the ID (integer) of the cell that hosts the particles initially, the ratio (real) of the particles that reside in the fracture continuum to the total, and the initial time (the time of the particles entering the domain, real). The first few lines in 'PA99PTini.txt' are show as follows:

```
275
10,33156,1,0,1
10,33201,1,0,1
10,33248,1,0,1
10,33293,1,0,1
10,33338,1,0,1
10,33386,1,0,1
10,33432,1,0,1
10,33477,1,0,1
10,33524,1,0,1
10,33571,1,0,1
10,33618,1,0,1
10,33666,1,0,1
```

II.1.6 Flow Rates Per Connection

This file is a section of the TOUGH2 output file. It lists all flow rates per 3-D connections in the order that is consistent with that in the connection configuration file. Note that for one connection there are one flow rate via fracture and another via matrix, listed consecutively. Only the data positioned between column 32 and 46 are used with a format of "E15.6". The first 7 rows are skipped in reading by DCPT and then three rows are skipped every 60 rows because of the format used by TOUGH2. The first several lines of 'glam1.flow' are provided below:

```
ELEM1   ELEM2   INDEX      FLO(LIQ)          VEL          (FLO_X3)       (FLO_CUM)
ELEM1   ELEM2   INDEX      FLO(LIQ)          VEL          (FLO_X3)       (FLO_CUM)
ELEM1   ELEM2   INDEX      FLO(LIQ)          VEL          (FLO_X3)       (FLO_CUM)
ELEM1   ELEM2   INDEX      FLO(LIQ)          VEL          (FLO_X3)       (FLO_CUM)
ELEM1   ELEM2   INDEX      FLO(LIQ)          VEL          (FLO_X3)       (FLO_CUM)
                             (KG/S)          (M/S)         (KG/S)          (KG)

Fea 1   Fda 1          1  0.58478473E-02  0.66213512E-10  0.12887739E-82  0.65751762E-59
Mea 1   Mda 1          2  0.56111148E-01  0.63533598E-09  0.41186939E-81  0.61779188E-58
Fda 1   Fca 1          3  0.66833278E-01  0.75673566E-09  0.13441705E-81  0.75176827E-58
Mda 1   Mca 1          4  0.94107756E-04  0.10655547E-11  0.49970583E-83  0.27767769E-59
Fca 1   Fba 1          5  0.66793638E-01  0.75628682E-09  0.18997935E-82  0.13352748E-58
Mca 1   Mba 1          6  0.93860283E-04  0.10627531E-11 -0.19151343E-84 -0.97866416E-61
Fba 1   Faa 1          7  0.67594592E-01  0.76535428E-09  0.31452586E-87  0.19337232E-63
```

II.1.7 Connection Configuration File

The first row of data in this file is the total number of the 3-D connections between the cells. Each of following rows contains two neighboring cells' IDs (integers) and the area of the connection (the interface). The listing order of the connections must be consistent with that used in the file of the flow rates per connections. The first few lines from 'PA99mesh.con' are provided below:

```
CONNE
```

```
174553
6,5,88565.5673840102,-1
5,4,88565.5673840102,-1
4,3,88565.5673840102,-1
3,2,88565.5673840102,-1
7,6,88565.5673840102,-1
8,7,88565.5673840102,-1
9,8,88565.5673840102,-1
10,9,88565.5673840102,-1
11,10,88565.5673840102,-1
12,11,88565.5673840102,-1
13,12,88565.5673840102,-1
14,13,88565.5673840102,-1
15,14,88565.5673840102,-1
16,15,88565.5673840102,-1
17,16,88565.5673840102,-1
18,17,88565.5673840102,-1
19,18,88565.5673840102,-1
```

II.1.8 Rock Property File

The first row of data is the number of species, Ns (integer). Then the data are listed by rocks. Each rock card consists of Ns+1 rows of data. The first row contains RockID (integer), RockName (5 characters), RockDensity (real), Poresize (real), PoreIndex (real), Concentration of colloid (real), and Fraction of Filtered colloid (real), respectively. Each row of the following data in the rock card corresponds to one particle. The data are longitude dispersivity (real), transverse dispersivity (real), Kd (real), Kd to colloid (real), and dispersivity for fracture/matrix interface (real), respectively. The first few lines from 'PARock99pch1.roc' are shown below:

```
3
   1 tcwM1      0.25500E+04      0.50000E-07      0.10000E+01      0.69000E-02      0.30000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
   2 tcwM2      0.25100E+04      0.50000E-07      0.10000E+01      0.69000E-02      0.30000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
   3 tcwM3      0.24700E+04      0.50000E-07      0.10000E+01      0.69000E-02      0.30000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
```

II.1.9 List of Rock Index for Cells

Columns in this file correspond to CellID, RockIndex for matrix continuum, and RockIndex for fracture continuum, respectively. The first few lines from 'PARock99pch1.idx' are shown below:

```
     2          1          49
     3          2          50
     4          2          50
     5          4          52
     6          5          53
     7          6          54
     8          7          55
     9          8          56
    10          8          56
    11          9          57
    12         10          58
```

II.1.10 Particle Property File

The first row of data is a description of variables and ignored by DCPT. After that, columns are corresponding to ParticleName, ParticleID, DaughterParticleID (if 0—no daughter products), ParticleSize, DecayRate, Molecular diffusion coefficient, and ParticleType, respectively. The file 'PtP_PA.dat' is given below:

```
Name ID Daughter Size   Rdecay      Dm         pType units m and s
Np   1    0          0   0.       1.60e-10    "N"
Tc   2    0          0   0.       3.20e-11    "N"
Pu   3    0          0   9.1087e-13 1.597e-10    "N"
```

II.2 Format of output data files

II.2.1 Final Status of Particles

This file lists the status of all particles by either the maximum simulation time or when the particle exiting the domain. Each row of data describes an individual particle. The status of a particle is described with following variables (A2,5E15.5,F10.4,2I10,E15.8,A2,2I10):

Variable	Format	Explanation
B_S	Character	"b" – exit through bottom boundary; "t" – exit through top boundary; "I" – still inside the domain
Tstart	Real	The time of the particle entering the domain
Tend	Real	The time of the particle leaving the domain or the maximum simulation time
X	Real	x-coordinate of the particle
Y	Real	y-coordinate of the particle
Z	Real	z-coordinate of the particle
F_M	Real	0 – in fracture; 1 – in matrix
Cell_start	Integer	The ID of the cell where the particle entered the domain
Cell_end	Integer	The ID of the cell where the particle resides at Tend
Mass	Real	Mass of the particle
Ptype	Character	C--Colloid, F--Filtered colloid, N--Normal, A--Adhere to Colloid
ID	Integer	ID of the particle
Parent	Integer	ID of the parent particle if this particle is a daughter product

The first few lines of 'PA99_out.txt' are shown below (lines are wrapped):

```
b     0.00000E+00     0.51455E+12     0.17044E+06     0.23110E+06     0.73000E+03     0.0000     33156
33185 0.10000000E+01 N          1          1
 b     0.00000E+00     0.36016E+11     0.17044E+06     0.23111E+06     0.73000E+03     1.0000     33156
33185 0.10000000E+01 N          2          2
 b     0.00000E+00     0.45073E+13     0.17075E+06     0.23115E+06     0.73000E+03     0.0000     33156
43511 0.10000000E+01 N          1          1
 b     0.00000E+00     0.46788E+12     0.17044E+06     0.23110E+06     0.73000E+03     0.0000     33156
33185 0.10000000E+01 N          2          2
 b     0.00000E+00     0.75795E+12     0.17071E+06     0.23118E+06     0.73000E+03     1.0000     33156
43687 0.10000000E+01 N          1          1
 b     0.00000E+00     0.99603E+11     0.17063E+06     0.23118E+06     0.73000E+03     1.0000     33156
43687 0.10000000E+01 N          2          2
 b     0.00000E+00     0.10799E+14     0.17044E+06     0.23111E+06     0.73000E+03     1.0000     33156
33185 0.10000000E+01 N          1          1
```

II.2.2 Final Distribution of Particles Per Cell

This file lists (x, y, z) coordinates of every cells in the grid and the number of particles in those cells. Each row of data in this file describes an individual cell with following variables (3E15.5,I8):

Variable	Format	Explanation
X	Real	x-coordinate of the cell
Y	Real	y-coordinate of the cell
Z	Real	z-coordinate of the cell
Np	Integer	Number of particles in the cell at Tend

The first few lines from 'PA99_Dist.txt' are given below:

```
0.17202E+06    0.23443E+06    0.73000E+03       6
0.17141E+06    0.23584E+06    0.73000E+03      10
0.17140E+06    0.23455E+06    0.73000E+03       2
0.17132E+06    0.23505E+06    0.73000E+03       2
0.17175E+06    0.23418E+06    0.73000E+03     185
0.17124E+06    0.23275E+06    0.73092E+03      52
0.17119E+06    0.23174E+06    0.73000E+03     126
0.17139E+06    0.23532E+06    0.73000E+03       1
0.17178E+06    0.23444E+06    0.73000E+03      20
0.17183E+06    0.23448E+06    0.73000E+03       3
0.17211E+06    0.23394E+06    0.73000E+03       1
0.17216E+06    0.23397E+06    0.73000E+03       7
0.17108E+06    0.23101E+06    0.73000E+03       1
```

ATTACHMENT III

Directory of Files Submitted to Technical Data Management System

DTN: SN9912T0581699.003

```
a AMR_U0160/ 0K
a AMR_U0160/fehm-v2.00/ 0K
a AMR_U0160/fehm-v2.00/glam1/ 0K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/ 0K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fehmn.err 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.chk 774K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.con 13406K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.dat 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.files 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.fin 5742K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.his 2K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.out 8K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1.trc 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1_tracer.output 8K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_glam1_wtp.dat 36K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/fm_tracer.ptrk 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/process.dat 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Adv/README 2K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/ 0K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1.chk 774K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1.con 13406K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1.dat 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1.files 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1.his 2K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1.out 8K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1.trc 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1_Np.fin 5811K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/fm_glam1_Np_tracer.output 8K
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a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/pch1_Np.ptrk 6K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/process.dat 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Np/README 3K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/ 0K
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a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/fm_glam1.chk 774K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/fm_glam1.con 13406K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/fm_glam1.dat 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/fm_glam1.files 1K
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a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/fm_glam1_Np.fin 5811K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/fm_glam1_Np_tracer.output 8K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/fm_glam1_Np_wtp.dat 30K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/pch1.rock 4K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/pch1_Np.ptrk 6K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/process.dat 1K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_Tc/README 3K
a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_wt850_Adv/ 0K
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a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_wt850_Adv/fm_glam1.chk 774K
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```

```
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a AMR_U0160/fehm-v2.00/glam1/fehm-v2.00_glam1_wt850_Adv/fm_tracer.ptrk 1K
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a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Adv/fm_glam2.chk 773K
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a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Np/fm_glam2.con 13406K
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a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Np/README 3K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/ 0K
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a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2.chk 773K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2.con 13406K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2.dat 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2.files 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2.his 2K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2.out 8K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2.trc 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2_Tc.fin 5825K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/fm_glam2_Tc_wtp.dat 33K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/pch2_Tc.ptrk 6K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/process.dat 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_Tc/README 2K
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a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.chk 773K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.con 13406K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.dat 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.files 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.fin 5706K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.his 2K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.out 8K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2.trc 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2_tracer_wt850.output 8K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_glam2_wt850_wtp.dat 29K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/fm_tracer.ptrk 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/process.dat 1K
a AMR_U0160/fehm-v2.00/glam2/fehm-v2.00_glam2_wt850_Adv/README 2K
a AMR_U0160/fehm-v2.00/monm1/ 0K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/ 0K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fehmn.err 1K
```

```
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.chk 774K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.con 13406K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.dat 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.files 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.fin 5749K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.his 2K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.out 8K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1.trc 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1_tracer.output 8K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_monm1_wtp.dat 36K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/fm_tracer.ptrk 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/process.dat 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Adv/README 2K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/ 0K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1.chk 774K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1.con 13406K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1.dat 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1.files 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1.his 2K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1.out 8K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1.trc 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1_Np.fin 5842K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1_Np_tracer.output 8K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/fm_monm1_Np_wtp.dat 30K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/pch1.rock 4K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/pch1_Np.ptrk 6K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/process.dat 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Np/README 3K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/ 0K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1.chk 774K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1.con 13406K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1.dat 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1.files 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1.his 2K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1.out 8K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1.trc 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1_Tc.fin 5778K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/fm_monm1_Tc_wtp.dat 36K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/pch1_Tc.ptrk 6K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/process.dat 1K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/README 2K
a AMR_U0160/fehm-v2.00/monm1/fehm-v2.00_monm1_Tc/test 1K
a AMR_U0160/fehm-v2.00/monm2/ 0K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/ 0K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fehmn.err 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.chk 773K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.con 13406K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.dat 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.files 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.fin 5762K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.his 2K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.out 8K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2.trc 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2_tracer.output 8K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_monm2_wtp.dat 33K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/fm_tracer.ptrk 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/process.dat 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Adv/README 2K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/ 0K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2.chk 773K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2.con 13406K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2.dat 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2.files 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2.his 2K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2.out 8K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2.trc 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2_Np.fin 5896K
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a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2_Np_tracer.output 8K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/fm_monm2_Np_wtp.dat 30K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/pch2.rock 3K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/pch2_Np.ptrk 6K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/process.dat 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Np/README 3K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/ 0K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2.chk 773K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2.con 13406K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2.dat 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2.files 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2.his 2K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2.out 8K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2.trc 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2_Tc.fin 5840K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/fm_monm2_Tc_wtp.dat 33K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/pch2_Tc.ptrk 6K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/process.dat 1K
a AMR_U0160/fehm-v2.00/monm2/fehm-v2.00_monm2_Tc/README 2K
a AMR_U0160/fehm-v2.00/pchm1/ 0K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/ 0K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fehmn.err 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.chk 774K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.con 13406K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.dat 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.files 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.fin 5795K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.his 2K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.out 8K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.stor 0K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1.trc 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1_tracer.output 8K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_pchm1_wtp.dat 36K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/fm_tracer.ptrk 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/process.dat 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/README 2K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Adv/screenout 36K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/ 0K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1.chk 774K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1.con 13406K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1.dat 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1.files 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1.his 2K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1.out 8K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1.trc 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1_Np.fin 5891K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1_Np_tracer.output 8K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/fm_pchm1_Np_wtp.dat 29K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/pch1.rock 4K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/pch1_Np.ptrk 6K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/process.dat 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Np/README 3K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/ 0K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1.chk 774K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1.con 13406K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1.dat 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1.files 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1.his 2K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1.out 8K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1.trc 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1_Tc.fin 5832K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/fm_pchm1_Tc_wtp.dat 37K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/pch1.rock 4K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/pch1_Tc.ptrk 6K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/process.dat 1K
a AMR_U0160/fehm-v2.00/pchm1/fehm-v2.00_pchm1_Tc/README 2K
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a AMR_U0160/fehm-v2.00/pchm2/ 0K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/ 0K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fehmn.err 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.chk 773K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.con 13406K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.dat 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.files 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.fin 5788K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.his 2K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.out 8K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2.trc 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2_tracer.output 8K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_pchm2_wtp.dat 33K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/fm_tracer.ptrk 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/process.dat 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Adv/README 2K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/ 0K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2.chk 773K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2.con 13406K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2.dat 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2.files 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2.his 2K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2.out 8K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2.trc 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2_Np.fin 5899K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2_Np_tracer.output 8K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/fm_pchm2_Np_wtp.dat 28K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/pch2.rock 3K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/pch2_Np.ptrk 6K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/process.dat 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Np/README 3K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/ 0K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2.chk 773K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2.con 13406K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2.dat 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2.files 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2.his 2K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2.out 8K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2.trc 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2_Tc.fin 5889K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/fm_pchm2_Tc_wtp.dat 34K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/pch2_Tc.ptrk 6K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/process.dat 1K
a AMR_U0160/fehm-v2.00/pchm2/fehm-v2.00_pchm2_Tc/README 2K
a AMR_U0160/src_fehm/ 0K
a AMR_U0160/src_fehm/README 1K
a AMR_U0160/src_fehm/process1_test/ 0K
a AMR_U0160/src_fehm/process1_test/README 2K
a AMR_U0160/src_fehm/process1_test/fehmn.err 1K
a AMR_U0160/src_fehm/process1_test/fmTc_diff_test.output 1K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.check 1K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.chk 19K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.con 8K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.dat 1K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.dpdp 3K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.files 1K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.fin 6K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.grid 2K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.his 2K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.ini 5K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.out 8K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.ptrk 5K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.rock 9K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.stor 7K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.trc 1K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.zone 5K
a AMR_U0160/src_fehm/process1_test/fmsd9_e9.zone2 5K
a AMR_U0160/src_fehm/process1_test/process.dat 1K
```

```
a AMR_U0160/src_fehm/process1_test/process1.doc 41K
a AMR_U0160/src_fehm/process1_test/process1_test.txt 1K
a AMR_U0160/src_fehm/process1_test/screen.out 1K
a AMR_U0160/src_fehm/process1_fuj 569K
a AMR_U0160/src_fehm/xfehm_v2.00 3769K
a AMR_U0160/src_fehm/xfehm_v2.10 7146K
a AMR_U0160/README 2K
a AMR_U0160/fehm-v2.10/ 0K
a AMR_U0160/fehm-v2.10/glam1/ 0K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/ 0K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/afm_pch1.dpdp 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/afm_pch1_Np.ptrk 7K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fehm2.1_glam1_Np_850.fin 5783K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fehm2.1_glam1_Np_850.output 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fehm2.1_glam1_Np_850_wtp.dat 34K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fm_glam1.chk 774K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fm_glam1.con 13406K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fm_glam1.dat 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fm_glam1.files 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fm_glam1.his 2K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fm_glam1.out 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/fm_glam1.trc 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/pch1.rock 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/process.dat 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/README 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/README_wtrise 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Np/runwtrise 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/ 0K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/afm_pch1.dpdp 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/afm_pch1_Tc.ptrk 7K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fehm2.1_glam1_Tc_850.fin 5744K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fehm2.1_glam1_Tc_850.output 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fehm2.1_glam1_Tc_850_wtp.dat 39K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fm_glam1.chk 774K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fm_glam1.con 13406K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fm_glam1.dat 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fm_glam1.files 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fm_glam1.his 2K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fm_glam1.out 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/fm_glam1.trc 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/process.dat 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/README 3K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_850_Tc/README_wtrise 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/ 0K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1.chk 774K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1.con 13406K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1.dat 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1.files 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1.his 2K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1.out 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1.trc 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1_Np.fin 5811K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1_Np_tracer.output 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fm_glam1_Np_wtp.dat 30K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/pch1.rock 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/pch1_Np.ptrk 6K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/process.dat 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/README 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/afm_pch1.dpdp 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/afm_pch1_Np.ptrk 7K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fehm2.1_glam1_Np.fin 5798K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fehm2.1_glam1_Np_tracer.output 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Np/fehm2.1_glam1_Np_wtp.dat 30K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/ 0K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1.chk 774K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1.con 13406K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1.dat 1K
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a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1.files 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1.his 2K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1.out 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1.trc 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1_Tc.fin 5765K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fm_glam1_Tc_wtp.dat 36K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/pch1_Tc.ptrk 6K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/process.dat 1K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/README 3K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/afm_pch1.dpdp 4K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/afm_pch1_Tc.ptrk 7K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fehm2.1_glam1_Tc.fin 5761K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fehm2.1_glam1_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.10/glam1/fehm-v2.10_glam1_Tc/fehm2.1_glam1_Tc_wtp.dat 36K
a AMR_U0160/fehm-v2.10/glam2/ 0K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/ 0K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/afm_pch2.dpdp 4K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/afm_pch2_Np.ptrk 6K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fehm2.1_glam2_Np.fin 5881K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fehm2.1_glam2_Np_tracer.output 8K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fehm2.1_glam2_Np_wtp.dat 30K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fm_glam2.chk 773K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fm_glam2.con 13406K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fm_glam2.dat 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fm_glam2.files 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fm_glam2.his 2K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fm_glam2.out 8K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/fm_glam2.trc 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/pch2.rock 3K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/process.dat 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Np/README 4K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/ 0K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/afm_pch2.dpdp 4K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/afm_pch2_Tc.ptrk 6K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fehm2.1_glam2_Tc.fin 5820K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fehm2.1_glam2_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fehm2.1_glam2_Tc_wtp.dat 33K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fm_glam2.chk 773K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fm_glam2.con 13406K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fm_glam2.dat 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fm_glam2.files 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fm_glam2.his 2K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fm_glam2.out 8K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/fm_glam2.trc 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/process.dat 1K
a AMR_U0160/fehm-v2.10/glam2/fehm-v2.10_glam2_Tc/README 3K
a AMR_U0160/fehm-v2.10/monml/ 0K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/ 0K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/afm_pch1.dpdp 4K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/afm_pch1_Np.ptrk 7K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fehm2.1_monml_Np.fin 5834K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fehm2.1_monml_Np_tracer.output 8K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fehm2.1_monml_Np_wtp.dat 30K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fehmn.err 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fm_monml.chk 774K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fm_monml.con 13406K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fm_monml.dat 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fm_monml.files 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fm_monml.his 2K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fm_monml.out 8K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/fm_monml.trc 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/pch1.rock 4K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/process.dat 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Np/README 3K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/ 0K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/afm_pch1.dpdp 4K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/afm_pch1_Tc.ptrk 7K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fehm2.1_monml_Tc.fin 5775K
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a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fehm2.1_monml_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fehm2.1_monml_Tc_wtp.dat 36K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fm_monml.chk 774K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fm_monml.con 13406K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fm_monml.dat 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fm_monml.files 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fm_monml.his 2K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fm_monml.out 8K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/fm_monml.trc 1K
a AMR_U0160/fehm-v2.10/monml/fehm-v2.10_monml_Tc/process.dat 1K
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a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/ 0K
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a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/afm_pch2_Tc.ptrk 6K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fehm2.1_monm2_Tc.fin 5837K
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a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fehmn.err 1K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fm_monm2.chk 773K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fm_monm2.con 13406K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fm_monm2.dat 1K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fm_monm2.files 1K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fm_monm2.his 2K
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a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Tc/fm_monm2.trc 1K
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a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Np/afm_pch2.dpdp 4K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Np/afm_pch2_Np.ptrk 6K
a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Np/fehm2.1_monm2_Np.fin 5896K
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a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Np/fm_monm2.con 13406K
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a AMR_U0160/fehm-v2.10/monm2/fehm-v2.10_monm2_Np/fm_monm2.files 1K
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a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Np/afm_pch1_Np.ptrk 7K
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a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Np/fm_pchml.con 13406K
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a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Np/pch1.rock 4K
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a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Tc/afm_pch1.dpdp 4K
a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Tc/afm_pch1_Tc.ptrk 7K
a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Tc/fehm2.1_pchml_Tc.fin 5830K
a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Tc/fehm2.1_pchml_Tc_tracer.output 8K
a AMR_U0160/fehm-v2.10/pchml/fehm-v2.10_pchml_Tc/fehm2.1_pchml_Tc_wtp.dat 37K
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a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/fm_pchm1.con 13406K
a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/fm_pchm1.dat 1K
a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/fm_pchm1.files 1K
a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/fm_pchm1.his 2K
a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/fm_pchm1.out 8K
a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/fm_pchm1.trc 1K
a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/process.dat 1K
a AMR_U0160/fehm-v2.10/pchm1/fehm-v2.10_pchm1_Tc/README 3K
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a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Np/ 0K
a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Np/afm_pch2.dpdp 4K
a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Np/afm_pch2_Np.ptrk 6K
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a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Np/fm_pchm2.con 13406K
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a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Tc/afm_pch2_Tc.ptrk 6K
a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Tc/fehm2.1_pchm2_Tc.fin 5889K
a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Tc/fehm2.1_pchm2_Tc_tracer.output 8K
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a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Tc/fm_pchm2.con 13406K
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a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Tc/fm_pchm2.trc 1K
a AMR_U0160/fehm-v2.10/pchm2/fehm-v2.10_pchm2_Tc/process.dat 1K
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a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/afm_pch2.dpdp 4K
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a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/diff2.0vs2.1_wtp.dat 0K
a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/fehm2.1_test_pchm2.fin 5788K
a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/fehm2.1_test_pchm2.output 8K
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a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/fm_pchm2.chk 773K
a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/fm_pchm2.con 13406K
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a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/fm_pchm2.trc 1K
a AMR_U0160/fehm-v2.10/pchm2/fehm2.0vs2.1_compare/process.dat 1K
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a AMR_U0160/DCPT-v1.0/PA99Mu_out.dat.gz 6K
a AMR_U0160/DCPT-v1.0/PA99PTini.txt.gz 1K
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a AMR_U0160/DCPT-v1.0/PA99mesh.txt.gz 1276K
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a AMR_U0160/DCPT-v1.0/PtP_PA.dat.gz 1K
a AMR_U0160/DCPT-v1.0/glam1.flow.gz 11032K
a AMR_U0160/DCPT-v1.0/DCPT_QA_Attachment A1.doc 85K
a AMR_U0160/DCPT-v1.0/glam1_f.tec.gz 3202K
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DTN: SN0001T0581699.004

(These files contain FEHM v. 2.0 particle tracking results for the lower and upper infiltration cases using perched-water model #1)

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a glal1/fehm-v2.00_glal1_Np/fm_glal1.files 1K
a glal1/fehm-v2.00_glal1_Np/fm_glal1.out 8K
a glal1/fehm-v2.00_glal1_Np/fm_glal1.his 2K
a glal1/fehm-v2.00_glal1_Np/fm_glal1.trc 1K
a glal1/fehm-v2.00_glal1_Np/fm_glal1.con 13406K
a glal1/fehm-v2.00_glal1_Np/fm_glal1.chk 774K
a glal1/fehm-v2.00_glal1_Np/fm_glal1_Np.fin 5886K
a glal1/fehm-v2.00_glal1_Np/fm_glal1_Np_wtp.dat 22K
a glal1/fehm-v2.00_glal1_Np/fm_glal1_Np.output 8K
a glal1/fehm-v2.00_glal1_Np/pch1.rock 4K
a glal1/fehm-v2.00_glal1_Np/pch1_Np.ptrk 6K
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a glal1/fehm-v2.00_glal1_Tc/pch1.rock 4K
a glal1/fehm-v2.00_glal1_Tc/pch1_Tc.ptrk 6K
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a glal1/fehm-v2.00_glal1_Tc/fm_glal1.chk 774K
a glal1/fehm-v2.00_glal1_Tc/fm_glal1_Tc.fin 5898K
a glal1/fehm-v2.00_glal1_Tc/fm_glal1_Tc_wtp.dat 37K
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a glau1/fehm-v2.00_glau1_Tc/fm_glau1.out 8K
a glau1/fehm-v2.00_glau1_Tc/fm_glau1.his 2K
a glau1/fehm-v2.00_glau1_Tc/fm_glau1.trc 1K
a glau1/fehm-v2.00_glau1_Tc/fm_glau1.con 13406K
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a glau1/fehm-v2.00_glau1_Tc/pch1.rock 4K
a glau1/fehm-v2.00_glau1_Tc/process.dat 1K
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a glau1/fehm-v2.00_glau1_Tc/pch1_Tc.ptrk 6K
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a glau1/fehm-v2.00_glau1_Np/fm_glau1.dat 1K
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a glaul/fehm-v2.00_glaul_Np/fm_glaul.chk 774K
a glaul/fehm-v2.00_glaul_Np/fm_glaul_Np.fin 5774K
a glaul/fehm-v2.00_glaul_Np/fm_glaul_Np_wtp.dat 27K
a glaul/fehm-v2.00_glaul_Np/fm_glaul_Np.output 8K
a glaul/fehm-v2.00_glaul_Np/pch1.rock 4K
a glaul/fehm-v2.00_glaul_Np/pch1_Np.ptrk 6K
a glaul/fehm-v2.00_glaul_Np/process.dat 1K
a glaul/fehm-v2.00_glaul_Np/README 2K
a glaul/fehm-v2.00_glaul_Np/fm_glaul.con.gz 758K
a monl1/ 0K
a monl1/fehm-v2.00_monl1_Np/ 0K
a monl1/fehm-v2.00_monl1_Np/README 2K
a monl1/fehm-v2.00_monl1_Np/fm_monl1.files 1K
a monl1/fehm-v2.00_monl1_Np/fehmn.err 1K
a monl1/fehm-v2.00_monl1_Np/pch1.rock 4K
a monl1/fehm-v2.00_monl1_Np/pch1_Np.ptrk 6K
a monl1/fehm-v2.00_monl1_Np/process.dat 1K
a monl1/fehm-v2.00_monl1_Np/fm_monl1.dat 1K
a monl1/fehm-v2.00_monl1_Np/fm_monl1.out 8K
a monl1/fehm-v2.00_monl1_Np/fm_monl1.his 2K
a monl1/fehm-v2.00_monl1_Np/fm_monl1.trc 1K
a monl1/fehm-v2.00_monl1_Np/fm_monl1.con 13406K
a monl1/fehm-v2.00_monl1_Np/fm_monl1.chk 774K
a monl1/fehm-v2.00_monl1_Np/fm_monl1_Np.fin 5898K
a monl1/fehm-v2.00_monl1_Np/fm_monl1_Np_wtp.dat 24K
a monl1/fehm-v2.00_monl1_Np/fm_monl1_Np.output 8K
a monl1/fehm-v2.00_monl1_Tc/ 0K
a monl1/fehm-v2.00_monl1_Tc/README 2K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1.files 1K
a monl1/fehm-v2.00_monl1_Tc/fehmn.err 1K
a monl1/fehm-v2.00_monl1_Tc/pch1.rock 4K
a monl1/fehm-v2.00_monl1_Tc/pch1_Tc.ptrk 6K
a monl1/fehm-v2.00_monl1_Tc/process.dat 1K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1.dat 1K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1.out 8K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1.his 2K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1.trc 1K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1.con 13406K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1.chk 774K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1_Tc.fin 5863K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1_Tc_wtp.dat 37K
a monl1/fehm-v2.00_monl1_Tc/fm_monl1_Tc.output 8K
a monul/ 0K
a monul/fehm-v2.00_monul_Np/ 0K
a monul/fehm-v2.00_monul_Np/README 2K
a monul/fehm-v2.00_monul_Np/fm_monul.files 1K
a monul/fehm-v2.00_monul_Np/fehmn.err 1K
a monul/fehm-v2.00_monul_Np/pch1.rock 4K
a monul/fehm-v2.00_monul_Np/pch1_Np.ptrk 6K
a monul/fehm-v2.00_monul_Np/process.dat 1K
a monul/fehm-v2.00_monul_Np/fm_monul.dat 1K
a monul/fehm-v2.00_monul_Np/fm_monul.out 8K
a monul/fehm-v2.00_monul_Np/fm_monul.his 2K
a monul/fehm-v2.00_monul_Np/fm_monul.trc 1K
a monul/fehm-v2.00_monul_Np/fm_monul.con 13406K
a monul/fehm-v2.00_monul_Np/fm_monul.chk 774K
a monul/fehm-v2.00_monul_Np/fm_monul_Np.fin 5803K
a monul/fehm-v2.00_monul_Np/fm_monul_Np_wtp.dat 26K
a monul/fehm-v2.00_monul_Np/fm_monul_Np.output 8K
a monul/fehm-v2.00_monul_Tc/ 0K
a monul/fehm-v2.00_monul_Tc/README 2K
a monul/fehm-v2.00_monul_Tc/fm_monul.files 1K
a monul/fehm-v2.00_monul_Tc/fehmn.err 1K
a monul/fehm-v2.00_monul_Tc/pch1.rock 4K
a monul/fehm-v2.00_monul_Tc/pch1_Tc.ptrk 6K
a monul/fehm-v2.00_monul_Tc/process.dat 1K
a monul/fehm-v2.00_monul_Tc/fm_monul.dat 1K
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a monul/fehm-v2.00_monul_Tc/fm_monul.out 8K
a monul/fehm-v2.00_monul_Tc/fm_monul.his 2K
a monul/fehm-v2.00_monul_Tc/fm_monul.trc 1K
a monul/fehm-v2.00_monul_Tc/fm_monul.con 13406K
a monul/fehm-v2.00_monul_Tc/fm_monul.chk 774K
a monul/fehm-v2.00_monul_Tc/fm_monul_Tc.fin 5761K
a monul/fehm-v2.00_monul_Tc/fm_monul_Tc_wtp.dat 33K
a monul/fehm-v2.00_monul_Tc/fm_monul_Tc.output 8K
a pchl1/ 0K
a pchl1/fehm-v2.00_pchl1_Np/ 0K
a pchl1/fehm-v2.00_pchl1_Np/README 2K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1.files 1K
a pchl1/fehm-v2.00_pchl1_Np/fehmn.err 1K
a pchl1/fehm-v2.00_pchl1_Np/pchl.rock 4K
a pchl1/fehm-v2.00_pchl1_Np/pchl_Np.ptrk 6K
a pchl1/fehm-v2.00_pchl1_Np/process.dat 1K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1.dat 1K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1.out 8K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1.his 2K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1.trc 1K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1.con 13406K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1.chk 774K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1_Np.fin 5849K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1_Np_wtp.dat 15K
a pchl1/fehm-v2.00_pchl1_Np/fm_pchl1_Np.output 9K
a pchl1/fehm-v2.00_pchl1_Tc/ 0K
a pchl1/fehm-v2.00_pchl1_Tc/README 2K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1.files 1K
a pchl1/fehm-v2.00_pchl1_Tc/fehmn.err 1K
a pchl1/fehm-v2.00_pchl1_Tc/pchl.rock 4K
a pchl1/fehm-v2.00_pchl1_Tc/pchl_Tc.ptrk 6K
a pchl1/fehm-v2.00_pchl1_Tc/process.dat 1K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1.dat 1K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1.out 8K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1.his 2K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1.trc 1K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1.con 13406K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1.chk 774K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1_Tc.fin 5869K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1_Tc_wtp.dat 26K
a pchl1/fehm-v2.00_pchl1_Tc/fm_pchl1_Tc.output 8K
a pchul/ 0K
a pchul/fehm-v2.00_pchul_Np/ 0K
a pchul/fehm-v2.00_pchul_Np/README 2K
a pchul/fehm-v2.00_pchul_Np/fm_pchul.files 1K
a pchul/fehm-v2.00_pchul_Np/fehmn.err 1K
a pchul/fehm-v2.00_pchul_Np/pchl.rock 4K
a pchul/fehm-v2.00_pchul_Np/pchl_Np.ptrk 6K
a pchul/fehm-v2.00_pchul_Np/process.dat 1K
a pchul/fehm-v2.00_pchul_Np/fm_pchul.dat 1K
a pchul/fehm-v2.00_pchul_Np/fm_pchul.out 8K
a pchul/fehm-v2.00_pchul_Np/fm_pchul.his 2K
a pchul/fehm-v2.00_pchul_Np/fm_pchul.trc 1K
a pchul/fehm-v2.00_pchul_Np/fm_pchul.con 13406K
a pchul/fehm-v2.00_pchul_Np/fm_pchul.chk 774K
a pchul/fehm-v2.00_pchul_Np/fm_pchul_Np.fin 5841K
a pchul/fehm-v2.00_pchul_Np/fm_pchul_Np_wtp.dat 26K
a pchul/fehm-v2.00_pchul_Np/fm_pchul_Np.output 8K
a pchul/fehm_v2.00_pchul_Tc/ 0K
a pchul/fehm_v2.00_pchul_Tc/README 2K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul.dat 1K
a pchul/fehm_v2.00_pchul_Tc/fehmn.err 1K
a pchul/fehm_v2.00_pchul_Tc/pchl.rock 4K
a pchul/fehm_v2.00_pchul_Tc/pchl_Tc.ptrk 6K
a pchul/fehm_v2.00_pchul_Tc/process.dat 1K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul.files 1K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul.out 8K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul.his 2K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul.trc 1K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul.con 13406K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul.chk 774K
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a pchul/fehm_v2.00_pchul_Tc/fm_pchul_Tc.fin 5779K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul_Tc_wtp.dat 35K
a pchul/fehm_v2.00_pchul_Tc/fm_pchul_Tc.output 8K
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