OCRWM — SCIENTIFIC ANALYSIS COVER SHEET

1. QA: QA

DOC.20031030.0003

2. Scientific Analyses Title

Analysis of Infiltration Uncertainty

3. DI (including Revision Number)

ANL-NBS-HS-000027 REV01

4. Total Attachments	5. Attachment Numbers - Number of pages in each
6	I-22, II-4, III-36, IV-6, V-12, VI-18

	Printed Name	Signature	Date
6. Originator	R. McCurley	SIGNATURE ON FILE	10/27/2003
7. Checker	B.A. Faybishenko	SIGNATURE ON FILE	10/27/2003
8. QER	K. Gilkerson	SIGNATURE ON FILE	10/27/2003
9. Responsible Manager/Lead	J.S.Y. Wang/ J.E. Houseworth	SIGNATURE ON FILE	10/27/2003
10. Responsible Manager	P. Dixon	SIGNATURE ON FILE	10/27/03

11. Remarks

Block 6. Additional Originator is D. Levitt.

Technical Error Report (TER) Log Numbers

TER-02-013*, TER-02-093, TER-02-095*

*Note that these TERs were assessed against ANL-NBS-HS-000032 REV 00 ICN 02 (USGS 2001 [160355]) and are not applicable to this report.

Revision History

12. Revision/ICN No.	13. Description of Revision/Change
REV 00	Initial Issue
REV 01	Entire scientific analysis documentation was revised. Changes were too extensive to use side bars (per Step 5.6c)1) of AP-SIII.9Q/Rev. 1/ICN 1).

INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

INTENTIONALLY LEFT BLANK

LIST OF TABLES

Note: Additional Tables are found in Attachments I, III, IV, V, and VI

INTENTIONALLY LEFT BLANK

ACRONYMS

AMR	Analysis and Model Report
BSC	Bechtel SAIC Company, LLC
CDB	Computational Database
CFR	Code of Federal Regulations
CRWMS	Civilian Radioactive Waste Management Systems
DEM	Digital Evaluation Model
DIRS	Document Input Reference System
DTN	Data Tracking Number
ET	Evapotranspiration
FEPs	Features, Events, and Processes
GCD	Greater Confinement Disposal (boreholes)
IED	Interface Exchange Design
LA	License Application
LHS	Latin Hypercube Sampling
M&O	Management and Operating Contractor
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
OCRWM	Office of Civilian Radioactive Waste Management
PA	Performance Assessment
PDF	Probability Density Function
PT	Priestly-Taylor
Q	Qualified
QA	Quality Assurance
RWMS	Radioactive Waste Management Site
SC	Safety Category
SCM	Software Configuration Management
SNL	Sandia National Laboratories
SUR	Software User's Request

ACRONYMS (Continued)

TDMS	Technical Data Management System
TER	Technical Error Report
TSPA	Total System Performance Assessment
TRU	transuranic (waste)
TWP	Technical Work Plan
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
UZ	unsaturated zone
VMS	Virtual Memory System (DEC operating system)
WIPP	Waste Isolation Pilot Plant
WP	Waste Package
YMP	Yucca Mountain Project
YMRP	*Yucca Mountain Review Plan, Final Report*

1. PURPOSE

1.1 PURPOSE OF THE SCIENTIFIC ANALYSIS

The primary objectives of this uncertainty analysis are: (1) to develop and justify a set of uncertain parameters along with associated distributions; and (2) to use the developed uncertain parameter distributions and the results from selected analog site calculations done in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) to obtain the net infiltration weighting factors for the glacial transition climate. These weighting factors are applied to unsaturated zone (UZ) flow fields in Total System Performance Assessment (TSPA), as outlined in the *Total System Performance Assessment-License Application Methods and Approach* (BSC 2002 [160146], Section 3.1) as a method for the treatment of uncertainty.

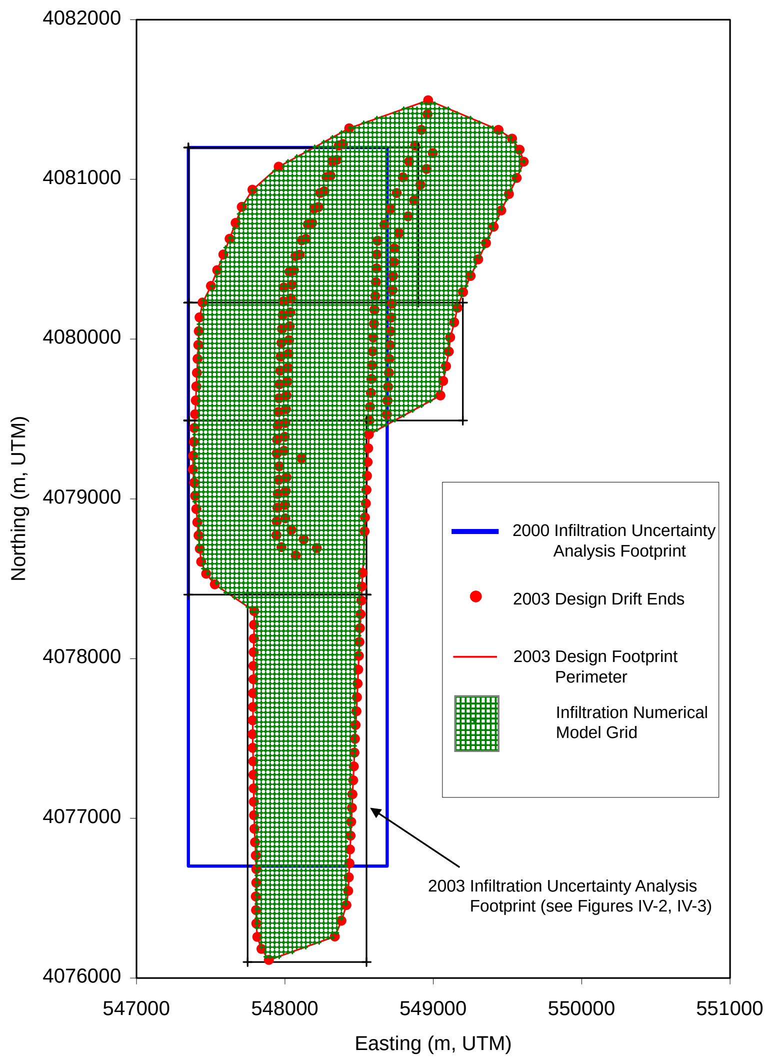
This report is a scientific analysis because no new and mathematical physical models are developed herein, and it is based on the use of the models developed in or for *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]). Any use of the term *model* refers to those developed in the infiltration numerical model report.

TSPA License Application (LA) has included three distinct climate regimes in the comprehensive repository performance analysis for Yucca Mountain: present-day, monsoon, and glacial transition. Each climate regime was characterized using three infiltration-rate maps, including a lower- and upper-bound and a mean value (equal to the average of the two boundary values). For each of these maps, which were obtained based on analog site climate data, a spatially averaged value was also calculated by the USGS. For a more detailed discussion of these infiltration-rate maps, see *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]). For this Scientific Analysis Report, spatially averaged values were calculated for the lower-bound, mean, and upper-bound climate analogs only for the glacial transition climate regime, within the simulated multi-rectangular region approximating the repository footprint, shown in Figure 1-1. (For brevity, these maps will be referred to as the analog maps, and the corresponding averaged net infiltration values as the analog values.)

Infiltration is treated as a probabilistic process in this scientific analysis. Probabilistic considerations are needed to account for the variability and uncertainty of parameters (BSC 2002 [158794], Section 4.1):

> *Variability*, also referred to as aleatoric uncertainty, arises due to natural randomness or heterogeneity. This type of uncertainty cannot be reduced through further testing and data collection; it can only be better characterized. Thus, this first type of uncertainty is also referred to as irreducible uncertainty. It is typically accounted for using geostatistical approaches, e.g., using appropriate probability distribution functions.
>
> *Uncertainty*, also referred to as epistemic uncertainty, arises from the lack of knowledge about parameters because the data are limited or there are alternative interpretations of the available data. This type of uncertainty can be reduced because the state of knowledge can be improved by further testing or data collection. As a consequence, this type of uncertainty is also referred to as reducible uncertainty.

In this Scientific Analysis Report, we consider both *aleatoric* and *epistemic* uncertainty. This analysis incorporates the uncertainty inherent in probabilistic parameters (Rechard 1996 [125981], p. 4-3) by assigning a range of values and a distribution type to select infiltration model input parameters, using known site characterization data, expert judgment, and analog site data records. The parameters analyzed in this report account for the majority of uncertainty in the output infiltration rates. This report incorporates both epistemic and aleatoric uncertainties, and the resulting uncertainty should be considered as combined epistemic/aleatoric uncertainty. A detailed description of uncertainty input data and the justification for using the corresponding uncertain distributions is found in Section 6.



NOTE: Outline of multi-rectangular area (relative to actual engineering design repository footprint) used in uncertainty analysis of infiltration (see caption with arrow beneath legend). UTM coordinates supplied by 800-IED-EBS0-00402-000-00B (BSC 2003 [161727]). The original coordinates, in Nevada state plane coordinates (central zone) with meters as units are converted to UTM coordinates using EARTHVISION V5.1 (Dynamic Graphics 2000 [152614]), see Attachment VI. The repository perimeter schematic is from 800-IED-EBS0-00401-000-00C (BSC 2003 [162289]). The schematic is for illustrative purposes only. The Numerical Model Grid depicted here is a portion of the numerical grid used by the USGS for the infiltration calculations zone in ANL-NBS-HS-000032 REV00 ICN02 (USGS 2001 [160355]).

Figure 1-1. Modeled Region and Repository Footprint

Four non-overlapping contiguous rectangular regions were used as an approximation of the loaded region's geometry (Attachment IV). Note that the repository footprint changed in 2003 and is now different from that used in the last version of *Analysis of Infiltration Uncertainty* (CRWMS M&O 2000 [143244]) and in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]).

1.2 LIMITATIONS

The uncertainty analysis performed here is limited to include the propagation of a subset of input parameters characterized, stochastically, as a probability function, through a numerical model used for predicting the net infiltration.

1.3 TWP REQUIREMENTS

This Scientific Analysis Report has been prepared in accordance with AP-SIII.9Q, *Scientific Analyses* and in accordance with the *Technical Work Plan for: Performance Assessment Unsaturated Zone* (BSC 2002 [160819]), with specific regard to Section 1.10.8, Paragraph 3. According to the technical work plan (TWP), the report includes development and justification of uncertainty parameters for the model developed in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) and evaluates the uncertainty in infiltration-rate maps.

Only the Technical Error Report, TER-02-093, as directed in the *Technical Work Plan for: Performance Assessment Unsaturated Zone* (BSC 2002 [160819], Section 1.10.8, paragraph 3) is addressed in this report (Section 6.1.2.1, Table 6-3). The two Technical Error Reports, TER-02-013 and TER-02-095 will not be discussed in this report but in the planned revision of *Simulation of Net Infiltration and Potential Future Climates* (USGS 2001 [160355]).

INTENTIONALLY LEFT BLANK

2. QUALITY ASSURANCE

Development of this analysis report and the supporting analyses have been determined to be subject to the OCRWM quality assurance program (BSC 2002 [160819], Section 8.2, Work Package (WP) AUZM06). Approved quality assurance procedures identified in the technical work plan (BSC 2002 [160819], Section 4) have been used to conduct and document the activities described in this analysis report. The technical work plan also identifies the methods used to control the electronic management of data (BSC 2002 [160819], Section 8.4, WP AUZM06) during the analysis and documentation activities.

This Scientific Analysis Report provides weighting factors for net infiltration through surficial soils and fractured rock of the unsaturated zone, which are a natural barrier and are classified in the *Q-List* (BSC 2003 [165179]) as SC (Safety Category) because they are important to waste isolation, as defined in AP-2.22Q *Classification Analyses and Maintenance of the Q-List*. The results of this report are important to the demonstration of compliance with the postclosure performance objectives prescribed in 10 CFR 63.113 [156605]. The report contributes to the analysis data used to support performance assessment; the conclusions do not directly impact engineered features important to safety, as defined in AP-2.22Q.

INTENTIONALLY LEFT BLANK

3. USE OF SOFTWARE

The following two subsections describe the software used in this analysis. All of the controlled software items used are in FORTRAN and compiled with the FORTRAN 77 compiler, with the exception of INFIL VA_2.a1 (SNL 2001 [147608]), which was compiled with the FORTRAN 90 compiler and GSLIB HISTPLT V. 2.01, which is compiled with Lahey FORTRAN. All FORTRAN software was used on Platform COMPAQ Alpha and Operating System Open VMS AXP V7.3 at Sandia National Laboratories (SNL) with the exception of GSLIB HISTPLT V.2.01, which is run on a PC using a Windows 2000 operating system.

3.1 SOFTWARE CODES

The analyses includes the use of two Level A computer codes as noted in Table 3-1 and as described below:

- INFIL VA_2.a1 (SNL 2001 [147608], compiled under FORTRAN90), a modified version (specifically to run on the platform described above in the introduction to Section 3) of INFIL V2.0 (USGS 2001 [139422]), performs modeling of net infiltration rate, using climatic and hydrological data. INFIL V. 2.0 will be discussed throughout the document, but is for reference only.

- Latin Hypercube Sampling (LHS V2.50) (SNL 2000 [147277]), which is a form of the stratified Monte Carlo technique, used in this report to perform a sampling of uncertain input parameters.

These two software codes are qualified and baselined for use in the Yucca Mountain Project License Application (LA) Performance Assessment (PA) according to AP-SI.1Q, *Software Management*. Software User Requests (SURs) were submitted to the Software Configuration Management (SCM) to acquire the LHS V2.50 (SNL 2000 [147277]) and INFIL VA_2.a1 (SNL 2001 [147608]) for the calculations performed in this analysis. These software codes are appropriate for the intended use and have been used strictly in the range of validation performed.

Several FORTRAN software items (each consisting of multiple subroutines) were utilized for this analysis, which can be characterized as either a preprocessor or postprocessor. Software used in this analysis is listed in Table 3-1. Included are five codes acquired from Waste Isolation Pilot Project (WIPP) and three developed codes. Two of the developed software items include a preprocessor, PREINFIL V1.20 (SNL 2003 [163674]), and postprocessor, POSTINFIL V2.50 (SNL 2003 [163676]) for the code INFIL VA_2.a1 (SNL 2001 [147608]). In addition, the software PRELHS V2.02 (SNL 2003 [163673]) was developed as a preprocessor for LHS V2.50 (SNL 2000 [147277]) (this version was originally developed, though never qualified for use, in WIPP PA). These software were developed and used on the platform COMPAQ Alpha running Open VMS AXP V7.3 (owned by the WIPP program) at SNL. This platform was approved for use in YMP LA. These software were qualified as either acquired or developed (as appropriate), Level B codes, under AP-SI.1Q, *Software Management* and AP-SI.3Q, *Software Independent Verification and Validation*.

The three software items CAMCON_LIB V2.19 (SNL 2003 [164055]), CAMDAT_LIB V1.24 (SNL 2003 [164056]), and CAMSUPES_LIB V2.21 (SNL 2003 [164057]) are software libraries that have modules used by the software items described below.

Much of the software described below will read and write to a binary file referred to as a "Computational Database". The computational database (CDB) file serves throughout the analysis as a dynamically changing reservoir of information from which the final steps of the uncertainty analysis can be accomplished. The CDB file also maintains a set of information records that includes a complete history of what and when codes have written information to it. This CDB file is used solely for the computational advantages of storing and maintaining information in a binary form. (See Attachment I, *Listing of Sample Input for Software*, for examples of input control files and further elucidation of the interaction of these codes.)

The software item PRELHS V2.02 (SNL 2003 [163673]) reads a file that contains the uncertain distribution parameters (developed for this Scientific Analysis Report) and automatically creates the input file for LHS V2.50 (SNL 2000 [147277]), the sampling engine. POSTLHS V4.07 (SNL 2003 [163675]) uses the output from LHS V2.50 (SNL 2000 [147277]) to a new CDB file of sampled input parameters.

Another software item used in this analysis is GROPECDB V2.12. This software item is used for display of binary information only (information found in CDB files) and is exempt from qualification according to Section 2.1.2 of AP-SI.1Q. A copy is maintained in SCM. It is not included in Table 3-1.

The software item PREINFIL V1.20 (SNL 2003 [163674]) was developed to automate the process of producing numerous realizations of input control files for INFIL VA_2.a1 (SNL 2001 [147608]), each containing a unique set of values for the sampled parameters. This enabled rapid and accurate transfer of information, in an automated environment, between LHS V2.50 (SNL 2000 [147277]) whose output is processed by POSTLHS V4.07 (SNL 2003 [163675]) and the input control file used by INFIL VA_2.a1 (SNL 2001 [147608]). In addition, PREINFIL V1.20 (SNL 2003 [163674]) transfers the designated filenames for both the pointwise and summary output infiltration rate files (as will be produced by INFIL VA_2.a1 (SNL 2001 [147608])) into the same input control file.

The software item POSTINFIL V2.50 (SNL 2003 [163676]) was developed to automate the transfer of selected output, including the spatially averaged infiltration rate and the number of cells within the approximated repository footprint for each watershed simulated, to intermediate CDB files (see Section 4.1.5 describing watersheds). It processes the pointwise infiltration rate file output from INFIL VA_2.a1 (SNL 2001 [147608]) and calculates the spatial average net infiltration rates for only those cells found within the multi-rectangular region for a specified watershed. It then writes that information to an output CDB file for each realization. The output CDB file also contains all the sampled parameter values for that realization. Initially, the input CDB file for POSTINFIL V2.50 (SNL 2003 [163676]) is produced by POSTLHS V4.07 (SNL 2003 [163675]) (for each realization). POSTINFIL V2.50 (SNL 2003 [163676]) will then use, as input, the CDB file produced from the previously calculated watershed. The output CDB will then contain, in addition to the infiltration results for the presently specified watershed, the infiltration results from all the previously analyzed watersheds as well. Thus, POSTINFIL

V2.50 (SNL 2003 [163676]) processes the net infiltration output until the net infiltration output (the spatial averages, etc.) from all the watersheds are contained in a single CDB file, for each realization.

The software item EARTHVISION V5.1 (Dynamic Graphics 2000 [152614]) was used with regards to original coordinates, in Nevada state plane coordinates (central zone) with meters as units, which were converted to UTM coordinates (see Figure 1-1 and Attachment VI).

Table 3-1. Qualified Software Used in the Uncertainty Analysis of Net Infiltration Rates in This Scientific Analysis Report

Software Name and Version	Software Tracking Number (STN)	DIRS Reference Number
CAMCON_LIB* V2.19	10992-2.19-00	164055
CAMDAT_LIB* V1.24	10991-1.24-00	164056
CAMSUPES_LIB* V2.21	10990-2.21.00	164057
PRELHS V2.02	10981-2.02-00	163673
POSTLHS* V4.07	10989-4.07-00	163675
PREINFIL V1.20	10982-1.20-00	163674
POSTINFIL V2.50	10983-2.50-00	163676
ALGEBRACDB* V2.35	10985-2.35-00	164058
LHS V2.50	10205-2.50-00	147277
INFIL VA_2.a1	10253-A_2.a1-00	147608
GSLIB HISTPLT V2.01	10802-2.01-00	158223
EARTHVISION V5.1	10174-5.1-00	152614

NOTE: Each of the software listed above utilize an input user control file (see Attachment I). The Users Manual or the Software Management Reports, as appropriate, are listed in the reference section.

The documentation for the WIPP QA-approved codes (designated with an (*) in Table 3-1) to satisfy AP-SI.1Q, can be found in SCM.

Once the calculated infiltration rate and watershed dimension information (number of cells within simulated region) for all of the watersheds included in the analysis has been stored in the CDB files (whose number is the realization number), a software item called ALGEBRACDB V2.35 (SNL 2003 [164058]) computes the spatial average over the entire simulated domain (i.e., the multi-rectangular region that includes the repository footprint). A software item called GSLIB HISTPLT V2.01 (SNL 2002 [158223] uses a tabulation of the average infiltration results (or their logarithm, base 10) for 100 realizations to create a histogram plot for the resulting infiltration-rate distribution as a (discrete) histogram (Probability Density Function [PDF]) (see Figure 6-2a and Figure 6-3a).

Standard Microsoft Excel (Office 2002 V10.3506.3501 SP-1) and visual display graphics programs (Adobe Illustrator V8.0) were also used. These commercial, off-the-shelf software are not subject to software quality assurance requirements and are exempt from qualification under AP-SI.1Q. They are used to process the infiltration maps generated in the report (USGS 2001 [160355]; DTN: GS000308311221.005 [147613]) for the lower-bound, mean, and upper-bound values of the glacial transition climate to obtain the average net infiltration of the simulated region and the actual repository footprint areas. The details of the area approximation can be found in Attachment IV. All information needed to reproduce the work using the software is included in Attachments I–III (see also Sections 6.1.3 and 6.2).

A wiring diagram showing the sequence of code interactions and their inputs and outputs for the uncertainty analysis is shown in Attachment II. The use of these software and input descriptions is also described in the corresponding Users Manuals (Level A software) or Software Management Reports (Level B software). In Attachment I, *Listing of Sample Input Software*, listings can be found for examples of the input files indicated in Attachment II.)

Microsoft Excel 2000 V9.0.5121 SP-1 (also commercial off-the-shelf software) was used to perform a sensitivity analysis (Section 6.4.1, Table 6-8) to evaluate the sensitivity of output net infiltration results to the uncertain input parameters.

4. INPUTS

4.1 DATA AND PARAMETERS

The following seven subsections contain a general description of the inputs and technical information that can be characterized as having a fixed value (i.e., not stochastic). The stochastic input (characterized by uncertainty distributions) is discussed briefly below in Section 4.1.1 and fully in Section 6. A summary of the Data Tracking Numbers (DTNs) used as input to this analysis is provided in Table 4-1. There is also one Interface Exchange Document (IED) item, 800-IED-EBS0-00-402-000-00B (BSC 2003 [161727]), used as direct input (discussed in Section 4.1.2).

Additionally, a sample listing of the control input for each software item can be found in Attachment I. A chart that shows what input and output files are owned by each of the software items used is included in Attachment I.

Table 4-1. Summary of Input DTNs and IED

DTN / IED	Description
GS000308311221.004 [146853]	The geospatial data characteristic of the watersheds used in this analysis
GS000308311221.005 [147613]	The infiltration rate maps calculated by the USGS for the lower-, mean, and upper-bounds for present-day, monsoon, and glacial transition climates
GS000308311221.010 [147602]	Glacial transition climate data consisting primarily of precipitation records
GS000308311221.011 [147615]	Template Input User Control File for INFIL VA_2.a1 (SNL 2001 [147608])
800-IED-EBS0-00402-000-00B (BSC 2003 [161727])	Coordinates of drift endpoints in repository design for License Application

4.1.1 Types of Uncertain Input Parameters

As discussed in Section 6, this uncertainty analysis requires (upper and lower bounds) the ranges of uncertain parameters, parameter distribution types, and the correlation values (including values of zero) between parameters for selected model input parameters considered potentially significant to evaluate the net infiltration of uncertainty. The source input used to identity the mean values of potential uncertain input parameters for present-day, monsoon, and glacial transition climates, is provided within *Template Files for Uncertainty Analyses* (DTN: GS000308311221.011 [147615]). Parameters selected for development of uncertainty distributions include effective bedrock porosity, bedrock root zone thickness, soil depth, precipitation, potential evapotranspiration, bulk-bedrock saturated hydraulic conductivity, soil saturated hydraulic conductivity, two parameters associated with bare soil evaporation, and effective surface-water flow area. Two additional parameters related to sublimation and melting of snow cover are included for the glacial transition climate.

The mean values for these 12 uncertain parameters are provided within *Template Files for Uncertainty Analyses* (DTN: GS000308311221.011 [147615]). The data sources, expert judgment, and rationale utilized for the determination of the parameter ranges, distribution types, and correlation values among these sets of 10 (for present-day and monsoon climates) and 12 (for glacial transition climate) uncertain parameters are provided in Section 6.

4.1.2 Repository Footprint

The repository footprint coordinates are assigned according to the UTM (Universal Transverse Mercator) coordinates from 800-IED-EBS0-00402-000-00B (BSC 2003 [161727]; see Figure 1-1). A set of four contiguous rectangles are used to approximate the repository footprint for the purposes of assessing the infiltration uncertainties, as discussed in Section 1 and Attachment IV.

4.1.3 Template Input Control File for INFIL VA_2.a1

A template input control file for the software code INFIL VA_2.a1 (SNL 2001 [147608]) is used by PREINFIL V1.20 (SNL 2003 [163674]) for each realization. An example of the template input user control file is found in Attachment I (Table I-7). This file was examined and found to be identical to the data in the Technical Data Management System (TDMS) *Template Files for Uncertainty Analysis,* Infil2a1.ctl, which is a control file *for INFIL Version A_2.a1*. This file is input to *PREINFIL* (DTN: GS000308311221.011 [147615]). It is this template input user control file that is modified by PREINFIL V1.20 (SNL 2003 [163674]) by substituting the actual sampled values for the uncertain parameters for each realization to become the input control file used by INFIL VA_2.a1 (SNL 2001 [147608]). The distributions and ranges of the uncertain parameters for the glacial transition climate are given in Table 6-3. (The actual sampled values for these parameters for the 100 realizations can be found in Attachment III, *Output File from LHS Sampled Values of Input Parameters for All 100 Realizations*.)

4.1.4 Climate Data

Climate data consisting primarily of precipitation and temperature records of the Tule Lake site were provided by USGS (DTN: GS000308311221.010 [147602]), representing the mean glacial transition climate regime. The data file and pathname on the COMPAQ Alpha representing the glacial climate regime and its DTN are given in Table 4-2.

Table 4-2. Climate Data for Uncertainty Analysis

Climate Analog	Data File Pathname on COMPAQ Alpha	Status	Data Tracking Number
Glacial Transition	U1:[RDMCCUR.YMP_2003_QACALCS.INFIL]TUKELAKE.INP	Q	GS000308311221.010 [147602]

4.1.5 Watershed Data

There are 11 watersheds provided by the USGS that are required to calculate net infiltration over the region of the repository footprint. These watersheds and the symbolic names of their subdivisions are listed in Table 4-3. The original watersheds used in the infiltration report were subdivided for the uncertainty analysis done here; see Section 6.1.3 for further discussion. The geodetic data found in these files include the coordinates of cells used for calculations of the net infiltration. A more detailed description of the geodetic data can be found in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Attachment IV).

Table 4-3. Watersheds Used in Glacial Transition Climate Uncertainty Analysis

Name of Watershed	Symbolic Identifier	Data File Pathname on COMPAQ Alpha	Status	Data Tracking Number (DTN)
Wren Wash	ww1	U1:[RDMCCUR.YMP_2003_QACALCS.INFIL. WW1]WW1.W20	Q	GS000308311221.004 [146853]
Split Wash	sw1	U1:[RDMCCUR.YMP_2003_QACALCS.INFIL. SW1]SW1.W20	Q	GS000308311221.004 [146853]
Coyote Wash	cw1	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.CW1]CW1.W20	Q	GS000308311221.004 [146853]
WT2 Wash	wt2	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.WT2]WT2.W20	Q	GS000308311221.004 [146853]
Drillhole Wash	dh3	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.DH3]DH2.W20	Q	GS000308311221.004 [146853]
Drillhole Wash	dh4	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.DH4]DH2.W.20	Q	GS000308311221.004 [146853]
Solitario Canyon Watersheds	us1	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.US1]US1.W20	Q	GS000308311221.004 [146853]
	se7	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.SE7]SE7.W20	Q	GS000308311221.004 [146853]
	se8	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.SE8]SE8.W20	Q	GS000308311221.004 [146853]
	se9	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.SE9]SE9.W20	Q	GS000308311221.004 [146853]
	se10	U1:[RDMCCUR.YMP_2003_QACALCS. INFIL.SE10]SE10.W20	Q	GS000308311221.004 [146853]

4.1.6 Infiltration Rate Maps for Glacial Transition Climates

This uncertainty analysis requires the spatially averaged mean net infiltration rates calculated over the footprint of the repository (see the multi-rectangular domain defined by the 4 boxes in Figure IV-2) for the lower-bound, mean, and upper-bound glacial transition climates (DTN: GS000308311221.005 [147613]). These calculated means are used in conjunction with the output net infiltration uncertainty distribution calculated in this report to determine the weighting factors. These calculations are discussed in Section 6.3.

4.1.7 Control Input for Level B Software

Each software item used in this analysis, tabulated in Section 3, has associated input and output files. Because of the linkage of two major codes (LHS and INFIL) used here, each of these minor software have output files that serve as input files to the code subsequently used in the analysis. Attachment II, *Flow Diagram for Uncertainty Analysis*, shows the linkage of this software, and Attachment I contains listings of the input control files that serve to link and automate the entire process. The input files and their use for the corresponding software are described in their respective Software Management Reports or Users Manuals (for LHS V2.50 and INFIL VA_2.a1) (see Table 3-1). These inputs are control parameters, such as naming conventions, computational storage directives; they have no basis in physical reality and, thus, no additional documentation is required.

4.2 CRITERIA

The YMP *Project Requirements Document* (Canori and Leitner 2003 [161770]) identifies the high-level requirements for the Project. The requirements that pertain to this analysis report, and their links to 10 CFR 63 [156605], are shown in Table 4-4. The *Yucca Mountain Review Plan, Final Report* (YMRP; NRC 2003 [163274]) lists acceptance criteria pertaining to these requirements. Criteria applicable to this analysis report are listed in Table 4-4 and described below.

Table 4-4. Project Requirements and YMRP Acceptance Criteria Applicable to This Analysis Report

Requirement Number[a]	Title [a]	10 CFR 63 [156605] Link	YMRP Acceptance Criteria
PRD -002/T-016	Requirements for Multiple Barriers	10 CFR 63.115(a)–(c) and 10 CFR 63.113 (a)	2.2.1.1.3, criteria 1 to 3 [b]
PRD -002/T-015	Requirements for Performance Assessment	10 CFR 63.114(a)–(c) and (e)–(g)	2.2.1.3.6.3, criteria 2 and 3 [c]

NOTES: [a] from Canori and Leitner (2003 [161770], Section 3)
[b] from NRC (2003 [163274], Section 2.2.1.1.3)
[c] from NRC (2003 [163274], Section 2.2.1.3.6.3)

The criteria from Section 2.2.1.1.3 *Acceptance Criteria*, [for Section 2.2.1.1 *System Description and Demonstration of Multiple Barriers*], which are based on meeting the requirements of 10 CFR 63.113 [156605] (a) and 63.115 [156605] (a)–(c), are:

- Acceptance Criterion 1, *Identification of Barriers Is Adequate*:

  Barriers relied on to achieve compliance with 10 CFR 63.113 [156605] (b), as demonstrated in the Total System Performance Assessment (TSPA), are adequately identified and are clearly linked to their capability. The barriers identified include at least one from the engineered system and one from the natural system (this report only concerns the natural system).

  This report concerns the barrier capability of the surficial soils and topography, which are identified in BSC (2002 [160146], Section 8.3.1) as the first natural barrier. The function of this barrier is to limit infiltration to the unsaturated zone. This barrier is treated explicitly in the model report *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]).

- Acceptance Criterion 2, *Description of Barrier Capability to Isolate Waste Is Acceptable*:

  The capability of the identified barriers to prevent or substantially delay the movement of water or radioactive materials is adequately identified and described.

This report summarizes the capability of the surficial soils and topography to limit infiltration in Section 6.6 (see Table 6-10).

The uncertainty associated with barrier capabilities is adequately described.

The principal purpose of this report is to assign weighting factors to the mean and upper and lower bounds of infiltration over the repository footprint, thus capturing the uncertainty in the barrier's capability to limit infiltration. These results are presented in Subsections 6.3.1–6.3.2.

- Acceptance Criterion 3, *Technical Basis for Barrier Capability Is Adequately Presented*:

  The technical bases are consistent with the technical basis for the Performance Assessment (PA). The technical basis for assertions of barrier capability is commensurate with the importance of each barrier's capability and the associated uncertainties.

  The barrier's capability to limit infiltration is presented as infiltration maps for various scenarios of infiltration over the footprint of the UZ site scale model in the AMR *Simulation of Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]). The present Analysis Report provides weighting factors for the use of these scenarios in TSPA. The technical basis for these factors is presented in Section 6.

The criteria from Section 2.2.1.3.6.3 *Acceptance Criteria* [for 2.2.1.3.6 *Flow Paths in the Unsaturated Zone*], which are based on meeting the requirements of 10 CFR 63.114 [156605] (a)–(c) and (e)–(g), relating to flow paths in the saturated zone model abstraction, are:

- Acceptance Criterion 2, *Data Are Sufficient for Model Justification*:

  Hydrological values used in the safety case are adequately justified. Adequate descriptions of how data were used, interpreted, and appropriately synthesized into the parameters are provided.

  Sensitivity or uncertainty analyses are performed to assess data sufficiency, and determine the possible need for additional data.

  Accepted and well-documented procedures are used to construct numerical models.

  Reasonably complete process-level conceptual and mathematical models are used in the analyses. In particular, mathematical models are provided that are consistent with conceptual models and site characteristics.

  Data and technical information used in this report are presented in Subsections 4.1.1–4.1.7. Data analysis and demonstration of data and technical information sufficiency are documented in Subsections 6.1.2.2-6.1.2.4.

- Acceptance Criterion 3, *Data Uncertainty Is Characterized and Propagated Through the Model Abstraction*:

Models use parameter values, assumed ranges, probability distributions, and/or bounding assumptions that are technically defensible, and reasonably account for uncertainties and variabilities. Uncertainties in the characteristics of the natural system are considered.

The uncertainty in the characteristics of the natural system is captured by the mean, upper, and lower-bound infiltration maps (USGS 2001 [160355]), and by the uncertainty captured by distributions of input parameter values (e.g., precipitation, permeability, evapotranspiration multipliers) presented in Sections 6.1.2, and probability distributions and weighting factors, derived in the present Analysis Report, in Section 6.3.

All acceptance criteria described above in Section 2.2.1.3.6.3, Acceptance Criteria 2, applicable to this report are discussed in Section 6.1.2. Additionally, Acceptance Criterion 3, *Data Uncertainty Is Characterized and Propagated Through the Model Abstraction,* is further discussed in Sections 6.3 and Section 6.4.

4.3 CODES AND STANDARDS

Not applicable. No other standards or code requirements than those referenced in Section 4.2 apply to this analysis.

5. ASSUMPTIONS

Table 5.1 presents the single assumption used in this report.

Table 5-1. Assumptions

Assumption Description	Section Where Basis Is Described	Section Used in
The Latin Hypercube Sampling assumes distribution endpoints represent the range from 1.0 to 99.0 percentile	5.1	6.1

5.1 ASSUMPTIONS USED FOR LHS SAMPLING

For lognormal and normal distributions, Latin Hypercube Sampling (LHS) assumes that the low and high values in the range are at the 1.0 and 99.0 percentile. The basis for this assumption is that the 1.0 and 99.0 percentile values of a distribution contain nearly the entire range of the actual distribution. These values reasonably bound the distribution for this analysis, and thus no further confirmation of this assumption is required.

This assumption is used both in the determination of the ranges defined in the distributions for uncertain input parameters and in the sampling process, as described in Section 6.1.

5.2 DISCUSSION OF ASSUMPTIONS MADE IN ANL-NBS-HS-000032

All of the assumptions made in the model report *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Sections 5.1–5.4) are implicitly incorporated in this scientific analysis report as well; since, clearly, this analysis depends directly and to a great extent on the inputs and results produced by the infiltration numerical model, INFIL VA_2.a1 (SNL 2001 [147608]). Thus, the accuracy and precision of the present analysis is limited by the accuracy and precision of the numerical model (USGS 2001 [160355], Subsections 5.2.1, 5.2.2). It is not within the scope of this report as defined in TWP (BSC 2002 [160819], Section 1.10.8) to attempt to evaluate the consequence of any conceptual model or the calibration of the infiltration model, as described in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6).

For a detailed description of the net infiltration conceptual model approximated using INFIL V2.0 (USGS 2001 [139422]), refer to Section 6.1 and Figure 6-2 in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6).

INTENTIONALLY LEFT BLANK

6. RESULTS OF UNCERTAIN INPUT SELECTION AND UNCERTAINTY ANALYSIS

This Scientific Analysis Report provides an uncertainty analysis for the glacial transition climate only, since the climate model used in TSPA for the 10,000-year performance (and 20,000-year simulation) period is predominantly a glacial transition climate (CRWMS M&O 2000 [148384]). Thus, the input-parameter-distribution development is directed solely toward the uncertainty appropriate for the glacial transition climate. Note also that this Scientific Analysis Report provides an uncertainty analysis based on a collection (size = 100) of single representative (spatial mean) infiltration rates. This rate is obtained by spatially averaging the rates in a group of grid cells that range over the simulated rectangular regions that encompass the loaded footprint of the repository (see Figure 1-1). (The information contained in the infiltration rate map has been folded into this single averaged rate.) Details on how this averaged rate was calculated are found in Section 6.1.3.

The key scientific notebooks used in this study are:

- Guertal 2001 [164070], SN-USGS-SCI-108-V1 and
- Guertal 2001 [164071], SN-USGS-SCI-108-V2.

6.1 LHS METHODOLGY

6.1.1 Selection and Discussion of LHS Technique

The analysis used a modified Monte Carlo technique, a form of stratified sampling, Latin Hypercube Sampling (LHS), developed by McKay et al. (1979 [127905]) and Iman and Shortencarier (1984 [100905]). LHS is a form of stratified sampling, whereby the interval for a sampled variable is divided into k intervals of equal probability. Then exactly one sample is selected, for a given set of m variables, from each of the k intervals; thus, there will be k m-tuples (m dimensional vector) in all (total $k \times m$ samples taken).

LHS technique provides the most effective approach to an analysis of uncertainty propagation, through a model, for the following reasons:

(1) A sampling-based approach provides a full coverage of the range of each uncertain input parameter

(2) Modification of the model (e.g. infiltration model) is not required

(3) Direct estimates of output distribution functions are provided

(4) Analyses are conceptually simple and easy to implement

(5) Though not fully developed here, a variety of sensitivity analyses procedures are potentially available.

LHS is preferred due to the efficient manner in which it stratifies across the range of each sampled parameter. LHS not only incorporates many of the desirable features of random and stratified sampling but produces more stable analysis outcomes than random sampling (*Latin Hypercube Sampling and the Propagation of Uncertainty in the Analysis of Complex Systems*, Helton and Davis 2002 [163475], p. 13).

The main advantage of using LHS is that greater confidence in the resulting output distribution, $f(\chi_1, \chi_2, ..., \chi_k)$ for uncertain parameters $\chi_1, \chi_2, ..., \chi_k$, can be obtained with far fewer samples than with Monte Carlo random sampling.

Uncertainty analysis generally involves the estimation of the mean, variance, and distribution function for the considered dependent variable, $y_i = f(\chi_1, \chi_2, ..., \chi_k)_i$ for a set of realizations of independent variables $\chi_1, \chi_2, \dots \chi_k$. Here, y_i would be the net infiltration, averaged over the simulated region, and the χ_j's are the sampled parameters (from Table 6-3). McKay et al. (1979 [127905], Section 2.1) have shown that Var $(T_S) \leq$ Var(T_R), where T_S and T_R represent unbiased estimators of the expected value (or mean for statistical and random sampling, respectively) for a function, $g(y_i)$, where $y_i = y_i(\chi_1, \chi_2, \dots \chi_k)$ is the i^{th} realization of the dependent variable using stratified and random sampling techniques; and where Var represents the variance of the estimated mean value (of the estimator) under repeated estimations. Here, the function g may be a moment of the distribution. Furthermore, if the dependent variable is monotonic with respect to each of the input variables, and g is monotonic in y (which is true for the 1st, 2nd and 3rd moments), McKay et al. (1979 [127905]) have shown that Var $(T_L) \leq$ Var(T_R), where T_L and T_R are estimates for LHS and random sampling, respectively (Helton and Davis 2002 [163475], p. 15, Eq. 3.5 and Theorem 3.1).

Specifically, if "G(y), is the "estimator for the quantile on the distribution function associated with y," as described in Helton and Davis (2002 [163475], p. 16, Eq. 3.22), then Var $[G_s(y)] \leq$ Var$[G_r(y)]$, where G_s and G_r are estimators for stratified and random sampling techniques. And if the monotonic condition stated in the previous paragraph holds, Var $[G_l(y)] \leq$ Var$[G_r(y)]$, G_l is the estimator for LHS. In the example considered in McKay et al. (1979 [127905]), Var $[(G_l(y)] \ll$ Var $[G_s(y)] \leq$ Var $[G_r(y)]$, where G_r, G_s, and G_l are the estimators for random, stratified, and LHS, respectively (in the citation given here, "G" has replaced "T" as in the preceding paragraph). Thus, LHS is at least as good an estimator of the various moments of a distribution and percentiles of the distribution of dependent variables, but can be much better.

Also, as shown in the report *Sampling Based Methods for Uncertainty and Sensitivity Analysis* (Helton and Davis 2000 [156572], Section 5.4, Figure 5.6), LHS produces distribution functions that are more stable than those produced by random sampling.

To avoid spurious pairwise correlation using the restricted pairing technique (Helton et al. 1998 [100951], Section 6.2) between uncorrelated input parameters, it is desirable to have a sufficiently large number of realizations somewhat greater than the number of uncertain parameters used in the analysis (for stability in the restricted pairing technique and for regression procedures, a minimum of 25% greater according to *Sensitivity Analysis Techniques; Self-Teaching Curriculum*, Iman and Conover 1981 [165064]). If sufficient computational resources are available and time permits, a sample size of 2 to 3 times the number of sampled parameters will give best results (Iman and Conover 1981 [165064]). Generally, if more than this number is done, results may be slightly better but no worse. In this analysis, we chose to sample 12 parameters (Table 6-3), and 100 realizations (samples) were used. No spurious correlations are observed in the LHS output used in this analysis. The number of 100 realizations was chosen (1) to satisfy the criteria above and (2) to facilitate (simplify) the calculation of weighting factors from a frequency distribution.

A more detailed discussion of the LHS methodology is beyond the scope of this Scientific Analysis Report, though additional discussion can be found in numerous documents, some of which are cited in this report.

The decision to use LHS, in addition to the advantages enumerated above, was based on the following criteria:

(1) Desirability of complete coverage of the probability space, particularly the upper and lower percentiles

(2) Reasonable sample size from a computational standpoint

(3) Availability of usable software

(4) Previous use in the Waste Isolation Pilot Project and the Yucca Mountain Project Performance Assessments.

Other methods considered were Monte Carlo, random, Latin Hypercube, stratified, and pseudo-Monte Carlo (e.g., Helton) sampling (Saliby and Pacheco 2002 [163930]). Random sampling was dismissed immediately, because of the large sample size, relative to alternative sampling methods, required to cover the probability space. Of the alternative methods, LHS has a superior pedigree in terms of previous use in performance assessment (Helton et al. 1998 [100951], Section 6.1; Helton and Davis 2002 [163475], Section 3.3). Additionally, this method had already been implemented in software (LHS V2.50; SNL 2000 [147277]) that was readily available. Another known advantage of this method, using the LHS software, is that, as referred to above, pairwise correlations between (uncertain) input parameters, unless otherwise specified, are forced to be very small. In addition, if non-zero correlation is specified, LHS forces the resulting correlation to be very nearly equal to that specified (Iman and Shortencarier 1984 [100905], Section 2; Helton and Davis 2002 [163475], Section 5.1). Finally, as indicated in item 4) in the list above, the LHS method had wide and extensive use in performance assessment uncertainty analysis.

As discussed above, LHS has been shown to be superior to a random Monte Carlo technique in its estimation of a distribution function as given by the variance for estimators. Moreover, for a given sample size, LHS is more stable than a random Monte Carlo technique (Helton and Davis 2002 [163475], p. 13).

6.1.2 Uncertain Parameters

6.1.2.1 General Considerations and Descriptions of Uncertain Parameters

This uncertainty analysis uses the mean and ranges of uncertain parameters (upper and lower bounds), parameter distribution types (normal, lognormal, or uniform), and correlation values (all parameters have values of zero) between parameters for selected model input parameters considered potentially significant to evaluate the net infiltration uncertainties. The names and types of the 12 uncertain parameters that were selected for sampling with respect to the glacial transition climate scenario are shown in Table 6-1.

The distribution ranges and types of ten selected uncertain parameters for the present-day and monsoon climate scenarios are shown in Table 6-2, and the distribution ranges and types of 12 selected uncertain parameters for the glacial transition climate scenario are shown in Table 6-3. For the purposes of this uncertainty analysis, the routine PRELHS V2.02 (SNL 2003 [163673]) uses the parameter ranges and distribution types listed in Table 6-3 as inputs to produce an input file to LHS for the glacial transition climate scenario. The file containing the sampled parameter values per realization (for 100 realizations) resulting from LHS operating on these distributions is found in Attachment III, *Output File from LHS Sampled Values of Input Parameters for all 100 Realizations*. Multipliers of physical parameters, which could be considered independent of spatial location, were characterized stochastically, for this analysis. As discussed below, parameters that could only be treated as spatially varying were not considered.

All of the irreducible uncertainties inherent to infiltration phenomena and reducible uncertainties such as those caused by measurement error. that may produce uncertainty in the results reported in the model report *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]), are implicitly incorporated in this scientific analysis report. This analysis depends directly and to a great extent on the inputs and results produced by the infiltration numerical model, INFIL V A_2.a1 (SNL 2001 [147608]) (numerically equivalent to INFIL V. 2.0 (USGS 2001 [139422])). Thus, the accuracy and precision of the present analysis is limited by the accuracy and precision of the INFIL V2.0 numerical model (USGS 2001 [160355], Section 5.2.1).

The relevant parameters from the infiltration numerical model are treated as uncertainty distributions so that the relative weights can be determined and assigned for the different infiltration fields from the infiltration model. This analysis considers implicitly spatial heterogeneity uncertainty in physical descriptors that apply to specific locations (e.g., permeability of specific rock types or precipitation at a specific location) through the infiltration numerical modeling. It does consider scale-dependent uncertainty explicitly, with the uncertainty distributions developed specifically for the region encompassed by the repository footprint. The reader is referred to the infiltration numerical modeling report for additional discussion of the uncertainties considered therein (USGS 2001 [160355], Section 7.2).

Additionally, because of the dominant duration of the glacial transition climate regime, an analysis decision was made to restrict the uncertainty analyses to this climate regime for estimation of the weighting factors. The glacial transition climate will dominate the majority of the simulated period (USGS 2001 [160355]), beginning at ~2,000 years and lasting beyond the performance time period of 10,000 years and the 20,000-year TSPA calculation period. Also, since the monsoon climate is expected to last a relatively short period of time (900 to 1,400 years) (*Future Climate Analysis*, USGS 2001 [158378], p. 66) compared to the glacial transition climate, there is no change in the uncertain parameter distribution going from present-day to monsoon climates. The present-day and monsoon climate uncertain parameter distributions are presented here as supporting reference information.

Table 6-1. Description of Uncertain Input Parameters for Glacial Transition Climate

Parameter Identifier	Parameter
BRPERM	Bedrock bulk saturated hydraulic conductivity (multiplier)
BRPOROS	Bedrock effective root-zone porosity
BRZDEPTH	Bedrock root-zone thickness
ETCOEFFA	First coefficient in expression for evapotranspiration
ETCOEFFB	Second coefficient in expression for evapotranspiration
FLAREA	Surface flow runoff area
POTETMUL	Daily evapotranspiration (multiplier)
PRECIPM	Daily precipitation (multiplier)
SNOPAR1	Snow-melt parameter
SOILDEPM	Soil zone thickness (multiplier)
SOILPERM	Soil saturated hydraulic conductivity (multiplier)
SUBPAR1	First term (“A1”) in snow loss (sublimation) equation for temperature regime below freezing (i.e. $T_k \leq 0.0°C$)

NOTES: All 12 are used in the analyses for the infiltration rate uncertainty for the glacial transition climate.
For a more detailed description of input used in the two INFIL (V2.0, USGS 2001 [139422]) or VA_2.a1, SNL 2001 [147608]) codes, refer to Section 6.4 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]).

Table 6-2. Uncertain Input Parameter Distributions for Present-Day and Monsoon Climates

Parameter Identifier	Mean	Low Range	High Range	Distribution Type	Units
BRPERM	1.00	0.10	10.0	LOGNORMAL	NONE
BRPOROS	0.009	0.002	0.024	NORMAL	NONE
BRZDEPTH	1.00	0.00	2.00	NORMAL	METERS
ETCOEFFA	-10.0	-0.10	-19.9	NORMAL	NONE
ETCOEFFB	1.04	0.54	1.54	NORMAL	NONE
FLAREA	0.50	0.01	0.99	NORMAL	NONE
POTETMUL	1.00	0.60	1.40	NORMAL	NONE
PRECIPM	1.00	0.60	1.40	NORMAL	NONE
SOILDEPM	1.00	0.10	1.90	NORMAL	NONE
SOILPERM	1.00	0.10	10.0	LOGNORMAL	NONE

Output-DTN: SN0309T0503100.009

NOTE: Parameter identifiers are defined in Table 6-1.

Table 6-3. Uncertain Input Parameter Distributions for Glacial-Transition Climate

Parameter Identifier	Mean	Low Range	High Range	Distribution Type	Units
BRPERM	1.00	0.10	10.0	LOGNORMAL	NONE
BRPOROS	0.009	0.002	0.024	NORMAL	NONE
BRZDEPTH	1.50	0.00	3.00	NORMAL	METERS
ETCOEFFA	-10.0	-0.10	-19.9	NORMAL	NONE
ETCOEFFB	1.04	0.54	1.54	NORMAL	NONE
FLAREA	0.25	0.01	0.49	NORMAL	NONE
POTETMUL	1.00	0.60	1.40	NORMAL	NONE
PRECIPM	1.00	0.60	1.40	NORMAL	NONE
SNOPAR1	1.78	0.78	2.78	UNIFORM	NONE
SOILDEPM	1.00	0.10	1.90	NORMAL	NONE
SOILPERM	1.00	0.10	10.0	LOGNORMAL	NONE
SUBPAR1	0.10	0.00	0.20	UNIFORM	NONE

Output-DTN: SN0309T0503100.009

NOTES: Parameter identifiers are defined in Table 6-1.

For lognormal and normal distributions, LHS assumes that the low and high values in the range are at the 1.0 and 99.0 percentile (Section 5.1).

For parameter ETCOEFFA, LHS samples over a positive range of values, the negative sign is re-introduced by PREINFIL for the code INFIL V2.0 (USGS 2001 [139422]).

For some parameters, such as effective bedrock porosity (BRPOROS), the input parameter distribution was defined using actual values. In other cases, the input parameter distribution was defined using a multiplier, which was then applied to calculate the parameter value distribution across all grid cells of the infiltration model. For input distributions defined using multipliers, the actual physical property values, which depended on the value of the multiplier, varied from cell to cell. Distribution types for all parameters were selected to be one of three types: normal, lognormal, or uniform. Selection of an appropriate distribution type was usually based on results from prior studies (e.g., lognormal distribution for hydraulic conductivity; see *Analysis of Hydrologic Properties Data* (BSC 2003 [161773], Section 6.2.1, p. 50)) or based on the distribution type of the actual dataset (e.g. fracture porosity and precipitation DTN: SN0309T0503100.011.

Upper and lower bounds for the parameters were determined using absolute bounds defined by the physical limits of the parameter (i.e. BRPOROS, BRZDEPTH, SOILDEPM, PRECIPM, POTETMUL, BRPERM, SOILPERM, FLAREA, ETCOEFFB, SNOPAR1, and SUBPAR1 could not be negative, ETCOEFFA could not be positive, and BRPOROS and FLAREA could not be greater than 1).

Two correlations between parameters were considered: one between the soil-depth parameter SOILDEPM and the bedrock-rooting-depth parameter BRZDEPTH; and one between the precipitation-rate multiplier PRECIPM and the potential-evapotranspiration multiplier POTETMUL. SOILDEPM and BRZDEPTH are inversely correlated, by definition, through Equation 17 in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], pp. 50–51) for deterministic model simulations. The inclusion of a negative correlation between SOILDEPM and BRZDEPTH was considered but ultimately not used in order to capture the uncertainty of soil depth and bedrock rooting depth, independently of each other. A correlation between PRECIPM and POTETMUL was not used in this analysis because daily potential evapotranspiration is affected by more than daily precipitation alone (e.g., sun angle).

For this Scientific Analysis Report, zero pairwise correlation has been used between the sampled input parameters. That is, these parameters are uncorrelated and vary independently of one another. The software LHS V2.50 (SNL 2000 [147277]) imposes a very small (i.e. $|r| << 1.0$) correlation, r, to all pairs of parameters that do not have a correlation specified. Those parameters that were not correlated, were physically unrelated, or there was insufficient physical justification indicating that these parameters were significantly correlated.

6.1.2.2 Parameter Distributions Developed for the Present-Day and Monsoon Climate Scenarios

Effective Bedrock Porosity: A mean value of 0.009 was assigned to BRPOROS, with a lower-bound value of 0.002 and an upper-bound value of 0.024 considered to be representative of the maximum effective fracture porosity. The BRPOROS range is the same for both present-day (and monsoon), and glacial transition climate scenarios. A normal distribution was assigned to BRPOROS, based on the distribution of the first 12 bedrock porosities reported in *Analysis of Hydrologic Properties Data* (BSC 2003 [161773], Table 7), and using the *W* test of Shapiro and Wilk (Gilbert 1987 [163705], pp. 158-160; Output-DTN: SN0309T0503100.011), the hypothesis that the distribution is normal is accepted. This range of values is narrower than the input used for model simulations presented in the previous version of *Analysis of Infiltration Uncertainty* (CRWMS M&O 2000 [143244]). This new range uses actual bedrock fracture porosity values for all exposed rock units as shown in the Cross Drift As-Built Geologic Cross Section in *Geology of the ECRB Cross Drift–Exploratory Studies Facility, Yucca Mountain Project, Yucca Mountain, Nevada* (Includes Drawings OA-46-345 and OA-46-346) (Mongano et al. 1999 [149850]) and uses the first 12 fracture porosity values in *Analysis of Hydrologic Properties Data* (BSC 2003 [161773], Table 7). Although the area of this Geologic Cross Section is larger than the repository footprint, this range is considered to be a more realistic range of bedrock effective porosities than was previously used.

Soil Thickness: The multiplier SOILDEPM was used to uniformly scale estimates of soil depth across all model grid cells. A deviation of ± 0.9 (± 90%) was used to define the lower- and upper-bound estimates of 0.1 and 1.9 for SOILDEPM. This distribution was considered appropriate to adequately capture the large uncertainty in the estimate of soil depth across the model domain.

In addition to consistency with data used in the INFIL (V2.0 (USGS 2001 [139422]) and VA_2.a1 (SNL 2001 [147608])) model, the input distribution of soil depths was considered to be consistent with soil-thickness data from *State Soil Geographic (STATSGO) Data Base, Data Use*

Information (USDA 1994 [154246]) in the vicinity of Yucca Mountain. A normal distribution was assigned to SOILDEPM.

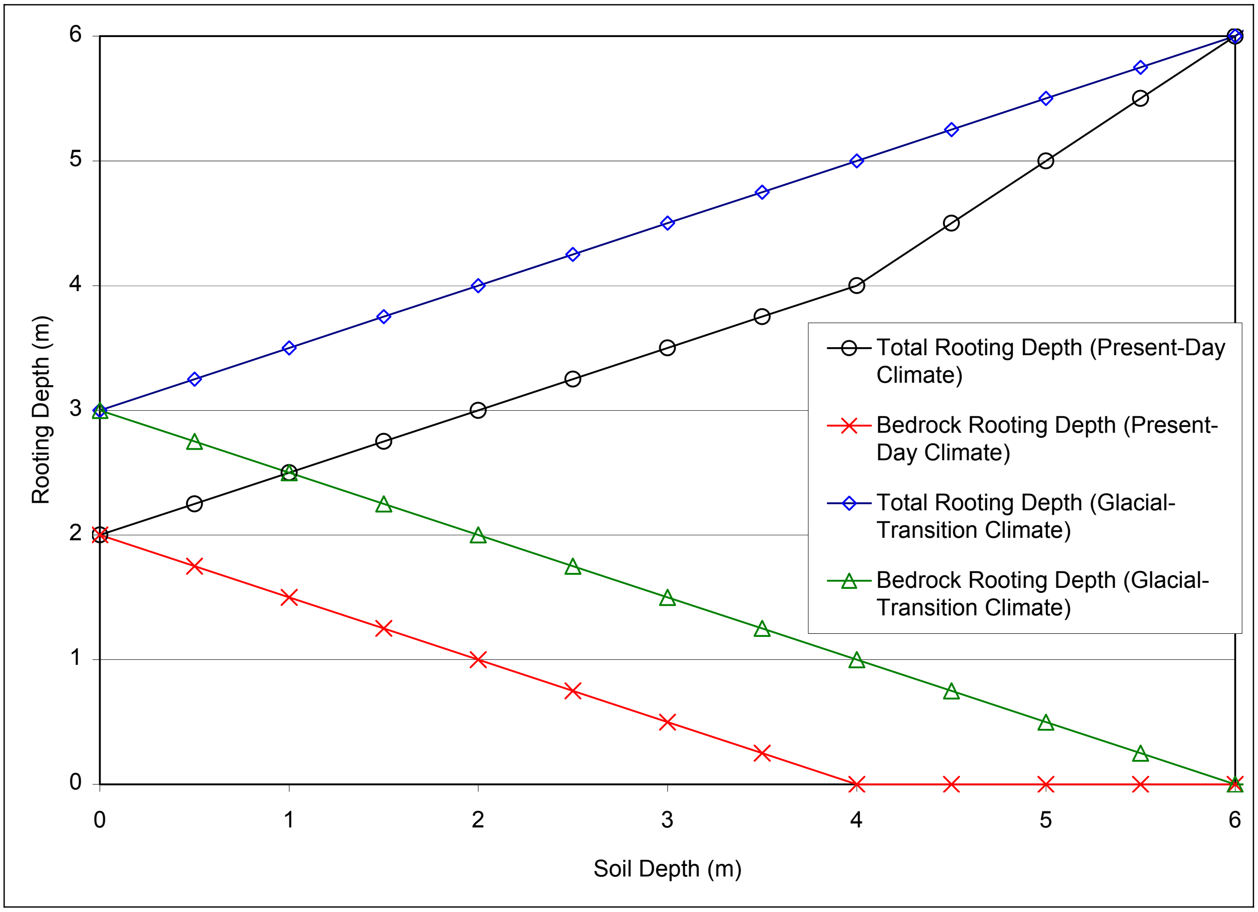
Bedrock Root-zone Thickness: BRZDEPTH is expected to vary with climate, with lower values for drier climates and higher values for wetter climates, as discussed in Wirth et al. (1999 [162961]). For the present-day climate scenario, BRZDEPTH was assigned a mean value of 1 m, varying between 0 and 2 m. The thickness of the root zone in bedrock is calculated using Equation 17 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6.7.2) with the soil-depth-class map (DTN: GS000308311221.004 [146853]) using the INFIL V2.0 (USGS 2001 [139422]) model. Refer to Figure 6-1 for a graphical representation of the relationship between soil depth and rooting depth for present-day and glacial transition climates, as defined by Equation 17 in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], pp. 50-51). For model grid cells, the root zone thickness in bedrock decreases as the thickness of soil increases. In addition, the root density in bedrock is only a small fraction of the root density in soil, which decreases as a function of depth below the surface (USGS 2001 [160355], Section 6.8.3, p. 56).

This range for BRZDEPTH is narrower than the input used for model simulations presented in the previous version of *Analysis of Infiltration Uncertainty* (CRWMS M&O 2000 [143244]). This new range is considered to be a more realistic range of bedrock rooting depth than was previously used because it is based entirely on the use of Equation 17 in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6.7.2).

A normal distribution was assigned to BRZDEPTH. For this uncertainty analysis, the sampled values of the parameters SOILDEPM and BRZDEPTH were sampled independently of each other (no correlation) to capture the large uncertainty in bedrock rooting depth. The ranges used in this uncertainty analysis are likely to be larger (with shallower values of bedrock rooting depth) than would be found over the repository footprint.

Literature regarding plant-rooting depths near Yucca Mountain generally reports rooting depths for vegetation in deep alluvial soils and not on mountainside slopes typical of Yucca Mountain. Rooting depths for shrubs typically range from 0 to 50 cm (Wallace et al. 1980 [162955]), and occasionally to depths of several meters (Rundel and Nobel 1991 [128001]). Wirth et al. (1999 [162961]) compiled ranges of maximum rooting depths for various vegetation types under current and future (glacial-transition) climates for a study related to the waste disposal of transuranic (TRU) waste in Greater Confinement Disposal (GCD) boreholes at the Nevada Test Site (NTS) (Cochran et al. 2001 [163189]). The regulatory compliance period for the TRU waste at GCD is 10,000 years, the same as for high-level waste at Yucca Mountain. Wirth et al. (1999 [162961]) report a range of maximum rooting depths of 0.35 to 17.4 m for shrubs under current and future climates, and a range of maximum rooting depths of 0.2 to 30 m for trees under a future climate. In the "Evaluation of the Occurrence of Termite Species and Potential Termite Burrowing Depths in the Area of the Nevada Test Site: Present Data and for the Next 10,000 Years" (refer to McCurley 2003 [162947]), it states that under a future cooler, wetter climate at the NTS, areas inhabited by shrubs may become inhabited by Pinon-Juniper communities currently found at the upper elevations of the NTS. Juniper has a deep rooting depth, ranging from 6 to 60 m. This review of rooting depths is included to satisfy the comment made during the *Model Validation Status Review* (BSC 2001 [156257]) and documented in TER-

02-013 that rooting depths used in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) were too deep.



NOTE: This figure is based on Equation 17 in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]).

Figure 6-1. Relationship between Soil Depth and Rooting Depth

Precipitation and Potential Evapotranspiration: The PRECIPM and POTETMUL distribution ranges were left unchanged (± 0.4 about the mean). As described in Section 6.1.2.1, the multiplier range of ± 0.4 was consistent with the ranges of mean annual precipitation between the upper and lower climate bounds for modern, monsoon, and glacial transition climates used in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Table 6-19).

The distribution of precipitation using the PRECIPM parameter was consistent with the observed variability in estimated average annual precipitation for the Yucca Mountain area (French 1983 [125313]; Hevesi et al. 1992 [116809]), and it was consistent with the ranges of mean annual precipitation between the upper and lower climate bounds. For example, the mean annual precipitation during the mean present-day climate is 197 mm, which is 41% lower than the mean annual precipitation for the upper-bound present-day climate (278 mm) (USGS 2001 [160355], Table 6-10).

The range of multipliers between the lower and upper bounds of potential evapotranspiration for present-day (and monsoon) climates is expected to be the same as the range between the lower and upper bounds of precipitation for each climate.

Bedrock and Soil Permeability: A lognormal distribution was assigned to conductivity multiplier parameters BRPERM and SOILPERM, based on the predicted distributions of conductivity reported in previous studies (e.g., Freeze and Cherry 1979 [101173], pp. 30–31), and based on the distribution of the first 12 fracture permeabilities reported in Table 7, and the discussion on page 50 of *Analysis of Hydrologic Properties Data* (BSC 2003 [161773]). For BRPERM, the upper- and lower-bound values were set to be ± 1.0 orders of magnitude (± a multiplier of 10) around the mean value (where the mean value is defined by BRPERM = 1). Therefore, the total range for BRPERM is 2 orders of magnitude. This range is consistent with the expected range of hydraulic conductivities reported by Freeze and Cherry (1979 [101173], p. 31), who report that permeability in most geological formations have a standard deviation in the range of 0.5 to 1.5 (log K), and show total heterogeneous variations of 1–2 orders of magnitude. This range in standard deviation of permeability reported in Freeze and Cherry (1979 [101173], p. 31) is consistent with the average standard deviation of 0.57 for the exposed units (top 12 layers) of fracture permeability data reported in *Analysis of Hydrologic Properties Data* (BSC 2003 [161773], Table 7). This range for BRPERM is narrower than the input used for model simulations presented in the previous version of *Analysis of Infiltration Uncertainty* (CRWMS M&O 2000 [143244]). This new range is considered to be a less conservative, but more realistic range of effective bedrock permeability than was previously used.

The range of ± 1.0 (log K) is also consistent with the range of flux rates calculated for matrix and open and filled fractures and reported in Flint et al. (1996 [100147], Table 2), if the calculated flux for matrix and unfilled 250 μm wide fractures are not included. If the range in calculated flux for all other combinations of matrix and filled and unfilled fractures of varying widths are considered, the average range in calculated flux for all exposed rock units is less than 2 orders of magnitude (Flint et al. 1996 [100147], Table 2).

A range of two orders of magnitude (± 1.0 (log K)) was also assigned to SOILPERM. This distribution for SOILPERM is considered to be representative of both field-scale variability within mapped soil types and uncertainty in estimated values provided in Flint et al. (1996 [100147], Table 4), which reports that soil saturated hydraulic conductivity ranges from 5.6×10^{-6} to 3.8×10^{-5} m/s. Although the distribution for SOILDEPM is wider than this range in soil conductivities, the wider distribution was considered appropriate because the soils at Yucca Mountain generally have a high percentage of coarse material (grain sizes > 2 mm) with very high permeability, but they can also contain layers cemented with calcium carbonate (Flint et al. 1996 [100147], p. 39) having a very low permeability.

Evapotranspiration (ET) Coefficients A & B: Normal distributions for the parameters ETCOEFFA and ETCOEFFB are used in the modified Priestley-Taylor equation (Priestley and Taylor 1972 [125321]; Flint and Childs 1991 [124946]) for the estimation of bare-soil evaporation. The mean values for both parameters (-10.00 for ETCOEFFA and 1.04 for

ETCOEFFB) are consistent with values reported in Flint and Childs (1991 [124946]). However, note that the bare-soil coefficients alpha and beta in Flint and Childs (1991 [124946]) are renamed ETCOEFFB and ETCOEFFA, respectively, in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) and in this uncertainty analysis. The large ranges of ± 9.9 for ETCOEFFA and ± 0.5 for ETCOEFFB were used to represent the large uncertainty in ET estimates, which are largely caused by the large variability in percent vegetation cover. For example, as vegetation cover increases, bare-soil evaporation decreases and plant transpiration increases. Since percent vegetative cover is assigned a constant value for a given climate scenario, a large range in ETCOEFFA and ETCOEFFB can capture the uncertainty in percent vegetation cover (and ET).

The applicability of the modified Priestley-Taylor (PT) ET equation as described in Flint and Childs (1991 [124946]) has also been demonstrated in a 1996 study conducted at Area 5 of the Nevada Test Site. A Letter Report, "Modeling Evapotranspiration from Arid Environments: Literature Review and Preliminary Model Results" (Levitt et al. 1996 [163191]) compared a variety of ET models, including the same PT model used in the INFIL (V2.0 (USGS 2001 [139422]) or VA_2.a1 (SNL 2001 [147608])) models, with ET data provided by two weighing lysimeters (one with bare soil, one with native vegetation) located near the Area 5 Radioactive Waste Management Site (RWMS) at the NTS. (Refer to Levitt et al. (1996 [163183]) for details of these weighing lysimeters at the NTS.) The modified PT equation, with the alpha parameter calibrated to volumetric water content measured in the weighing lysimeters at a depth of 10 cm, yielded daily estimates of ET that were very close to those measured in the weighing lysimeters. These results indicate that the modified PT equation is appropriate and accurate for estimating ET at Yucca Mountain.

<u>Surface Flow Runoff Area:</u> A normal distribution was assigned to the FLAREA parameter, which defines the fraction of each grid cell in the infiltration model affected by overland flow and channel flow during the routing of runoff. For the present-day climate, overland flow processes are considered to be the primary component of surface water flow, with a mean value of 0.5 assigned to FLAREA. The mean value of 0.5 was also defined as part of the model calibration process to match stream-flow records. The INFIL model was calibrated by adjusting root zone density weighing parameters and FLAREA in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6.8), so while the mean value of 0.5 may not have a strong physical basis, its use is nonetheless justified. A wide distribution of ± 0.49 was assigned to FLAREA, with a lower bound of 0.01 and an upper bound of 0.99, representing a high degree of variability and uncertainty in this parameter (only values between 0 and 1 are valid for FLAREA). The FLAREA parameter is expected to exhibit a high degree of both spatial and temporal variability.

6.1.2.3 Parameter Distributions Developed for the Glacial Transition Climate Scenario

Based on a combination of the results from the present-day climate LHS computations and the predictions concerning future climate conditions, adjustments were made to the BRZDEPTH and FLAREA input distributions for the glacial transition climate scenario. The distributions for BRZDEPTH and FLAREA were adjusted based on estimated changes in root zone and channel characteristics for the glacial transition climate scenario relative to the present-day climate scenario. The 12 uncertain parameters used for the glacial transition climate scenario included a snow-melt parameter (SNOPAR1) and a sublimation parameter (SUBPAR1), which were added in order to utilize the snow module in the infiltration model (USGS 2001 [160355]).

Effective Bedrock Porosity: For the glacial-transition-climate parameter distribution, the BRPOROS distribution was left unchanged, based on the approximation that effective fracture porosity would remain constant for all climates.

Soil Thickness: The SOILDEPM mean, range, and distribution type were left unchanged. There may be some changes in soil development as a result of the advent of the glacial transition climate, but there is insufficient justification to change the multiplier for soil depth.

Bedrock Root-Zone Thickness: The mean value for BRZDEPTH was increased from 1 to 1.5 m, and the distribution range was changed from ± 1 m to ± 1.5 m. The increase in BRZDEPTH was selected because the root zone thickness in fractured bedrock should increase as precipitation increases. A range of 0 to 3 m is consistent with the expected range of bedrock rooting depth for the glacial transition climate, using Equation 17 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6.7.2). Refer to Figure 6-1 for a graphical representation of the relationship between soil depth and rooting depth during present-day and glacial transition climates, which is based exclusively on Equation 17 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6.7.2).

Precipitation and Potential Evapotranspiration: The PRECIPM and POTETMUL distribution ranges were left unchanged (± 0.4 about the mean). As described in Section 6.1.2.2, the multiplier range of ± 0.4 was consistent with the ranges of mean annual precipitation between the upper and lower climate bounds for modern, monsoon, and glacial transition climates. For example, the mean annual precipitation during the mean glacial transition climate is 323 mm, which is 39% higher than the minimum annual precipitation for the lower-bound glacial transition climate (198 mm) and 41% lower than the maximum annual precipitation for the upper-bound glacial transition climate (455 mm) (USGS 2001 [160355], Table 6-19). The range between the lower and upper bounds of potential evapotranspiration for the glacial transition climate is expected to be consistent with the range between the lower and upper bounds of precipitation.

However, the precipitation dataset used for the glacial transition climate for this analysis of infiltration uncertainty (GS000308311221.010 [147602] and Output-DTN: SN0309T0503100.011 is not the same as that used in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]). The mean annual precipitation from the Tule Lake dataset Output-DTN: SN0309T0503100.011 is 278 mm, calculated from daily data in DTN: GS000308311221.010 [147602], while that used in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) is 323 mm. If the two extreme highest and lowest annual precipitation totals from the 49-year Tule Lake dataset Output-DTN: SN0309T0503100.011 are not used, then the mean annual precipitation rate of 278 mm/yr is 39% higher than the minimum annual precipitation rate (169 mm/yr) and 42% lower than the maximum annual precipitation rate (394 mm). Therefore, the use of a multiplier of ± 0.4 about the mean is approximately the same between the approaches used in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) and in this report.

Bedrock and Soil Permeability: The bedrock and soil permeability multipliers (BRPERM and SOILPERM) were left unchanged. Although some fracture filling might be expected at some elevations during the glacial transition climate, with a resulting reduction in bedrock permeability, there are insufficient data to justify changing in the mean or range of BRPERM. In fact, while higher precipitation during the glacial transition climate could cause some fractures to become filled, other fractures may get flushed open by the increased precipitation. Soil permeability might also be expected to change during the glacial-transition climate because of the development of clay horizons, but there are insufficient data to justify changing the range of this parameter.

ET Coefficients A & B: For the two parameters controlling bare-soil evaporation, the means, ranges, and distribution types were left unchanged. The ranges for these parameters for the modern, monsoon, and glacial transition climates are extremely wide in order to capture the large uncertainty in ET and percentage vegetative cover.

Surface Flow Runoff Area: The range of the FLAREA input distribution was narrowed from ± 0.49 about the mean to ± 0.24 about the mean, and the mean was reduced from 0.5 to 0.25. The new distribution was defined by a lower-bound value of 0.01 (same as for present-day climate) and an upper-bound value 0.49 (about one-half that used for present-day climate). The reasoning used for developing the new distribution was that a greater proportion of total surface water flow for the wetter glacial transition climate would occur as channelized stream flow, as opposed to widespread overland flow. A supporting assumption was also made that drainage networks would be better established for a wetter climate, and surface features would include better-defined rill features on sideslopes and in headwater areas of drainages, which in turn would serve to better concentrate overland flow. The reduction in FLAREA from the present/monsoon climate to the glacial transition climate is conservative for TSPA infiltration calculations, because the change will have the effect of increasing infiltration. Furthermore, the infiltration model is relatively insensitive to the value of the uncertain parameter FLAREA. Refer to Section 6.4.1 for the results of a sensitivity analysis conducted for this study.

Snow-melt and Sublimation: For the glacial transition climate, the parameters SNOPAR1 and SUBPAR1 were added to the input parameter set to utilize the snow module of the infiltration model. A uniform distribution was used for both parameters, with SNOPAR1 defining the snowmelt rate and SUBPAR1 defining the sublimation rate (SNOPAR1 is equivalent to “A” in Equation 7, and SUBPAR1 is equivalent to “A1” in Equation 6 of USGS 2001 [160355], p. 38). A uniform distribution was selected for both parameters because of a lack of data defining input distributions. The mean value of 1.78 for SNOPAR1 was based on the temperature-index expression for light, open forest during April (Sierra Nevada, California) obtained from Maidment (1993 [125317], Table 7.3.7). The upper-bound value of 2.78 and the lower-bound value of 0.78 were defined using an assumed distribution range of ± 1.0 for SNOPAR1, based on a qualitative assessment of various temperature-index expressions provided in Maidment (1993 [125317], Table 7.3.7). Parameter values in Maidment (1993 [125317]) range from minimum values of 0.58 (Boreal forest, midseason) and 0.9 (Southern Manitoba) to maximum values of 4.58 (Montana Rockies, May), 3.3 (Western Cascades, May), and 5.7 (Southern Ontario). In the literature, there is no equivalent for a temperature-index expression to estimate changes in the snowpack caused by sublimation and advective processes (saltation and turbulent diffusion). Existing studies indicate a high dependency on wind direction and speed, in addition to air temperature, relative humidity, and elevation (Maidment 1993 [125317], pp. 7.5–7.10 and Figure 7.2.4). To include the sublimation component of the snowpack water balance in the infiltration model (USGS 2001 [160355]), a model was developed using an assumed energy-index expression, where the energy for sublimation/advection is defined using the adjusted PT potential evapotranspiration rate (USGS 2001 [160355], p. 38). This hypothetical sublimation/advection model assumes that no snow accumulates due to advection (snow drifts).

Given a conceptual understanding that sublimation (including saltation and turbulent diffusion) of snow is a component of the snowpack water balance, the parameter was assigned a range such that it would be small compared to the snow-melt parameter. To be conservative, the mean percentage of snowpack loss resulting from sublimation/advection was assumed to be considerably less than the maximum values of 41 to 34 % indicated by field studies (Maidment 1993 [125317], p. 7.8). Therefore, a value of 0.10 with a range of ± 0.10 was assigned to the SUBPAR1 parameter.

6.1.2.4 Tiva Canyon Tuff Permeability Data

This section compares the different estimates of bulk-bedrock saturated hydraulic conductivities (or permeabilities) for the upper lithophysal unit of Tiva Canyon Tuff to further justify the range of ± 1.0 (log K) for BRPERM used in this uncertainty analysis. The sources for these varying estimates are: (1) the bulk bedrock hydraulic conductivity for the upper lithophysal unit of Tiva Canyon Tuff used in the INFIL model (SNL 2001 [147608]) which was taken from Table IV-3 in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], pp. IV-11 to IV-15); (2) the infiltration rate data reported for the Alcove 1 experiments; and (3) air-permeability data reported by LeCain (1998 [100052]).

The saturated hydraulic conductivity (K) value for the upper lithophysal unit (Tpcpul) reported in Table IV-3 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) is 1.13 mm/day. This corresponds to an intrinsic permeability (k) of 1.33×10^{-15} m^2. The hydraulic conductivities used in the INFIL model (SNL 2001 [147608]) and reported in Table IV-3 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) are equal to the calculated value of bulk bedrock saturated hydraulic conductivity for 250-µm-aperature fractures filled with in-fill materials, as described in Flint et al. (1996 [100147]).

The results of the Alcove 1 infiltration experiments, conducted in the upper lithophysal zone of the Tiva Canyon Tuff, can be used to estimate the maximum rock permeability. In the Alcove 1 experiments, an irrigation system was designed such that water infiltrated into the bedrock directly above Alcove 1 at rates less than the fracture saturated hydraulic conductivity. The range of flux was from 0 to 30 mm/d (3.54×10^{-14} m^2 [assuming a hydraulic gradient equal to a unit-gradient condition]) from February 19, 1999, to December 15, 1999 (Flint et al. 2000 [162880]). The flux range of 18 mm/d (2.12×10^{-14} m^2) to 25 mm/d (2.95×10^{-14} m^2) was maintained from September 21, 1999, to October 15, 1999, before a test with tracer application began. In both the Phase I test (from March 8, 1998, to December 4, 1998, see DTN: GS990108312242.006 [162979]) and the Phase II tests (from January 29, 1999 to June 20, 2000, see DTN: GS000808312242.006 [162980]), water application was controlled such that no surface runoff occurred.

However, there are insufficient data at this time to relate the highly variable water application flux rates during the Alcove 1 experiments to the bulk-bedrock-saturated hydraulic conductivity of the Tpcpul unit. Furthermore, it is possible that the Tpcpul units above Alcove 1 are not subject to the same structural stresses as the Tpcpul units above the repository footprint, because of proximity to the edge of Yucca Mountain, and are therefore more open fractures. However, current data are insufficient to support this supposition.

Therefore, the multiplier BRPERM has a range that does not quite encompass the permeability determined from the Alcove 1 infiltration experiments, but the additional uncertainty that would be introduced if BRPERM was widened for one exposed rock unit (Tpcpul) to encompass the Alcove 1 flux rates is not warranted at this time.

In addition to the infiltration tests, LeCain (1998 [100052]) conducted air permeability tests in the Tpcpul unit in horizontal boreholes in Alcove 1. LeCain (1998 [100052]) reports a natural log mean of 2.772 (16.0×10^{-12} m^2) for air permeabilities for boreholes RBT#1, RBT#2, and RBT#3 in the Tpcpul unit. This permeability estimate is approximately four orders of magnitude larger than the value reported in Table IV-3 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]).

Permeabilities for fractures without filling are greater than those for filled fractures with the same aperture (Flint et al. 1996 [100147], Table 2). This is why the permeability values measured by air injection in Alcove 1 (along underground boreholes drilled from the alcove, and situated below surface covers) are much higher than the values tabulated in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Table IV-3). For fractured tuff locations such as Alcove 1, large differences may exist between the bedrock conductivity values representing filled fractures, as applied in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]), and measured values from boreholes intersecting open fractures. The filled fractures may control the infiltration through the bedrock near the ground surface, while the open fractures may control the flow paths for air movement and liquid flow deep below the ground surface in response to high-rate injection, such as that conducted during the Alcove 1 infiltration tests.

Additional justification for the use of a range of ± 1.0 (log K) for BRPERM can be found in permeability data reported by LeCain (1998 [100052]) and LeCain (1997 [100153]). These air-permeability data rarely demonstrate a range larger than 2 orders of magnitude for a given rock unit, even though the reported air permeabilities are much larger than those reported in Table IV-3 of *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) for the Tpcpul unit.

For locations and general descriptions of the tests conducted at Alcove 1, refer to LeCain (1998 [100052]). For data package and tracer data, refer to Scientific Notebooks by Guertal (2001 [164070] and [164071]). For details on modeling the Alcove 1 infiltration experiments, refer to Liu et al. (2003 [162470]).

6.1.3 LHS Methodology Applied to Glacial Transition Analysis

The long run times (central processing unit time) experienced in performing scoping calculations (~4.5 hours per realization for the larger watersheds, along with a need to use a significantly long climate record for this future climate) led to reducing the size of watershed regions done for the scoping calculations into multiple smaller watersheds that could be run in parallel. The watershed regions approximate the footprint boundary. The USGS (DTN: GS000308311221.004 [146853]) provided new watershed input files that significantly reduced the areas of the largest watershed region, by subdividing this region into smaller regions used in this report. Thus, for the glacial transition analysis, a total of 11 watersheds were used. (The repository footprint boundary for Site Recommendation included 17 watersheds, six of which are no longer included within the revised footprint boundary for License Application.)

For the simulated domain, an analysis decision was made to use a multi-rectangular (for these calculations, 4 rectangles were used) region that approximates the entire loaded footprint region. Figures 1-1 and IV-2 (Attachment IV) shows this area outlined relative to the repository footprint. The averaged net infiltration in this region is approximately the same as that within the actual footprint, as discussed below.

The spatially averaged infiltration rate for each watershed is a spatial mean infiltration rate calculated as the average pointwise infiltration rates in the set of all nodal locations within the boundary of the designated rectangular subregion approximating the repository footprint. An areal (spatially averaged) mean infiltration rate over the repository footprint was calculated using Equation 6-1, using the definition of a weighted average for a discrete sum,

$$\vartheta_{rf} = \sum_{k=1}^{11}\left(\alpha_k \phi_k\right) / \sum_{k=1}^{11} \alpha_k \quad \text{(Eq. 6-1)}$$

where

ϑ_{rf} = Mean (spatially averaged) net infiltration rate over the entire repository footprint.

α_k = The coefficients represented by the area of active cells within each watershed; since the area of each cell is the same (900 m^2), this coefficient may also represent the number of active cells in watershed k (an active cell is a cell within the simulated multi-rectangular region).

ϕ_k = The spatially averaged net infiltration rate for each watershed, k.

(The sum runs from 1 to 11, since there are 11 watersheds.)

Thus, ϑ_{rf} is calculated as a single number for each of the realizations done for this uncertainty analysis, and the calculated uncertainty distribution is a distribution for $\vartheta_{rf.}$

Attachment IV (Figure IV-2) shows the drawing of the four rectangles approximating the repository footprint with and without the contingency area (see also Figure 1-1). In the same attachment, Items 4 and 5 show the coordinates of these four rectangles with and without the contingency area. Figure IV-3 total area of all watersheds used in this analysis. Even though the watershed region does not cover the northeast portion of the exact footprint, Table IV-1 in

Attachment IV shows that the ensemble behavior of the net infiltration rate represented by the spatially averaged infiltration maps over those regions have a relatively very small difference. For example (see Table 6-4 below), for the exact footprint (excluding the contingency area), the relative differences are (if I_E and I_A represent the exact and approximated average net infiltrations):

$$(|\, I_E - I_A\,|)/I_E = \frac{0.01}{1.92} \approx 0.005\,,\ \frac{0.07}{18.57} \approx 0.004\,,\ \frac{0.11}{35.23} \approx 0.003$$

corresponding to the lower-bound, mean, and upper bound analog maps, respectively. This is very small relative to other sources of "error" in the derived net infiltration distributions. Thus, it is justifiable to use this four-rectangle area to estimate the ensemble behavior of the net infiltration in response to the parameter uncertainty input to the model.

Table 6-4 shows the values of the spatially averaged net infiltrations for the four-rectangle region and the area bounded within the exact footprint, without the contingency area, for the nine realizations of net infiltration from present-day and monsoon climates, in addition to the glacial transition climate.

Table 6-4. Comparisons between the Four-Rectangle Approximation and Exact Footprint for the Nine Different Net Infiltration Analog Climate Realizations

Climate Regime	Climate Analog	Average Net Infiltration for 4-Rectangle Approximation to Repository Footprint [mm/yr]	Average Net Infiltration for Exact Footprint of Repository [mm/yr]	% Relative Difference (nearest tenth of 1%)
Present-day	Lower	0.24	0.25	3.7
	Mean	4.21	4.20	0.2
	Upper	10.79	10.80	0.1
Monsoon	Lower	4.21	4.20	0.2
	Mean	11.95	11.86	0.8
	Upper	19.69	19.53	0.8
Glacial-Transition	Lower	1.93	1.92	0.5
	Mean	18.64	18.57	0.4
	Upper	35.34	35.23	0.3

Output-DTN: SN0309T0503100.010

The comparisons between the spatially averaged net infiltration for the four-rectangle approximation and the exact footprint shown in Table 6-4 demonstrate that the four -rectangle approximation adequately captures the ensemble behavior of infiltration, as represented by the spatial average used to measure net infiltration in this analysis. (This is especially true for the 3 glacial transition analog realization comparisons.) All of the relative differences, except for the lower modern (which is very small net infiltration), are less than 1%; most are significantly less than 1%.

6.2 RESULTS OF GLACIAL-TRANSITION-CLIMATE UNCERTAINTY ANALYSIS

The USGS provided the modeling results (DTN: GS000308311221.005 [147613]) containing infiltration-rate maps produced from calculations corresponding to the lower-bound, mean, and upper-bound analog simulations as developed in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355], Section 6.11.3). For this analysis, these modeling results (containing infiltration-rate map data) were used to calculate a representative (analog) net infiltration rate, averaged over either of the two simulated repository footprint regions, corresponding to a region where (1) a contingency area was included, or (2) the contingency area was excluded. Both of these calculations are done using Microsoft Excel 2002 V1.0.3506.3501 SP-1. The results of this calculation are included in Attachment IV. Thus, three infiltration rates, corresponding to the lower-bound, mean, and upper-bound analog simulations, were calculated for the simulated multi-rectangular region. These rates are, here, called “analog values” (Table 6-7).

Results are presented below for the uncertainty analysis (1) including the contingency and (2) excluding the contingency area for the simulated region of the repository footprint.

6.2.1 Uncertainty Analysis Results Including Contingency Area

A frequency histogram of net infiltration rates also displays the locations of the analog values in Figure 6-2a. Figure 6-2b displays the same data as a cumulative distribution plot. These figures are meant to display the data found in Table 6-5 (Column 2). The distribution displayed in Figures 6-2a and b for the uncertain net infiltration rates has a mean of 24.1 [mm/yr] and a standard deviation of 17.5 [mm/yr] (see Note of Table 6-5).

Table 6-5. Resulting Net Infiltration Rates for 100 Realizations, Including Contingency Area

Run Number	Net Infiltration Rate (mm/yr)
1.	3.06E+01
2.	1.90E+01
3.	1.24E+01
4.	2.42E+01
5.	2.20E+01
6.	1.38E+00
7.	1.03E+01
8.	3.69E+01
9.	5.31E+01
10.	2.95E+01
11.	7.01E+01
12.	1.54E+01
13.	1.49E+01
14.	1.82E+01
15.	1.80E+01
16.	4.01E+01
17.	3.09E+01
18.	8.14E+00
19.	5.03E+01
20.	2.09E+01
21.	9.58E+00
22.	6.70E+01
23.	8.56E+00
24.	1.13E+01
25.	9.10E+01
26.	8.10E+00

Run Number	Net Infiltration Rate (mm/yr)
27.	4.66E+01
28.	3.94E+01
29.	5.70E+01
30.	2.42E+01
31.	2.04E+01
32.	4.66E+01
33.	3.51E+01
34.	4.34E+01
35.	2.11E+01
36.	3.84E+01
37.	5.27E+00
38.	2.98E+01
39.	3.35E+01
40.	2.21E+01
41.	6.47E+00
42.	1.38E+01
43.	3.74E+01
44.	2.45E+01
45.	6.46E+00
46.	4.91E+01
47.	2.87E+01
48.	7.57E+00
49.	2.87E+01
50.	8.61E+00

Table 6-5. Resulting Net Infiltration Rates for 100 Realizations, Including Contingency Area (Continued)

Run Number	Net Infiltration Rate (mm/yr)
51.	4.33E+01
52.	3.52E+00
53.	1.49E+01
54.	1.09E+01
55.	1.17E+01
56.	4.73E+01
57.	1.24E+01
58.	4.80E+01
59.	6.34E+00
60.	2.24E+01
61.	6.31E+00
62.	2.07E+00
63.	1.06E+01
64.	1.83E+00
65.	2.65E+01
66.	1.45E+01
67.	1.89E+01
68.	9.8E+00
69.	6.71E+00
70.	3.50E+01
71.	9.33E+00
72.	9.19E+00
73.	2.01E+01
74.	1.09E+01
75.	4.38E+01
76.	1.21E+00
77.	2.88E+01
78.	1.71E+01
79.	5.67E+01
80.	5.35E+01
81.	7.84E+00
82.	7.56E+00

Run Number	Net Infiltration Rate (mm/yr)
83.	3.57E+01
84.	2.22E+01
85.	2.68E+01
86.	1.55E+01
87.	2.65E+00
88.	1.29E+01
89.	5.34E+00
90.	1.18E+01
91.	4.35E+01
92.	1.82E+01
93.	2.84E+01
94.	1.40E+01
95.	2.40E+01
96.	1.70E+01
97.	1.01E+01
98.	1.691E+01
99.	5.26E+01
100.	2.51E+01

Output DTN: SN0308T0503100.008

NOTE: Mean =24.1
St Dev=17.5

(GSLIB HISTPLT V2.01 calculates the standard deviation using $\sqrt{N}$ (where N is the sample size) which is incorrect; rather $\sqrt{N-1}$ should be used. Thus the value of the standard deviation of 17.5 was obtained by multiplying the value from GSLIB HISTPLT V2.01 (SNL 2002 [158223]) by $\sqrt{\frac{N}{N-1}}$.)

6.2.2 Uncertainty Analysis Results Excluding Contingency Area

A frequency histogram of net infiltration rates also displays the locations of the analog values in Figure 6-3a. Figure 6-3b displays the same data as a cumulative distribution plot. These figures are meant to display the data found in Table 6-6 (Column 2). The distribution displayed in Figures 6-3a and b for the uncertain net infiltration rates has a mean of 24.4 [mm/yr] and a standard deviation of 17.7 [mm/yr] (see Note of Table 6-6).

Table 6-6. Resulting Net Infiltration Rates for 100 Realizations, Excluding Contingency Area

Run Number	Net Infiltration Rate (mm/yr)
1.	3.08E+01
2.	1.93E+01
3.	1.27E+01
4.	2.43E+01
5.	2.21E+01
6.	1.43E+00
7.	1.04E+01
8.	3.83E+01
9.	5.33E+01
10.	2.96E+01
11.	7.14E+01
12.	1.55E+01
13.	1.50E+01
14.	1.82E+01
15.	1.82E+01
16.	4.05E+01
17.	3.11E+01
18.	8.35E+00
19.	5.03E+01
20.	2.11E+01
21.	9.67E+00
22.	6.83E+01
23.	8.65E+00
24.	1.15E+01
25.	9.17E+01
26.	8.28E+00
27.	4.76E+01
28.	4.03E+01
29.	5.78E+01
30.	2.43E+01
31.	2.08E+01

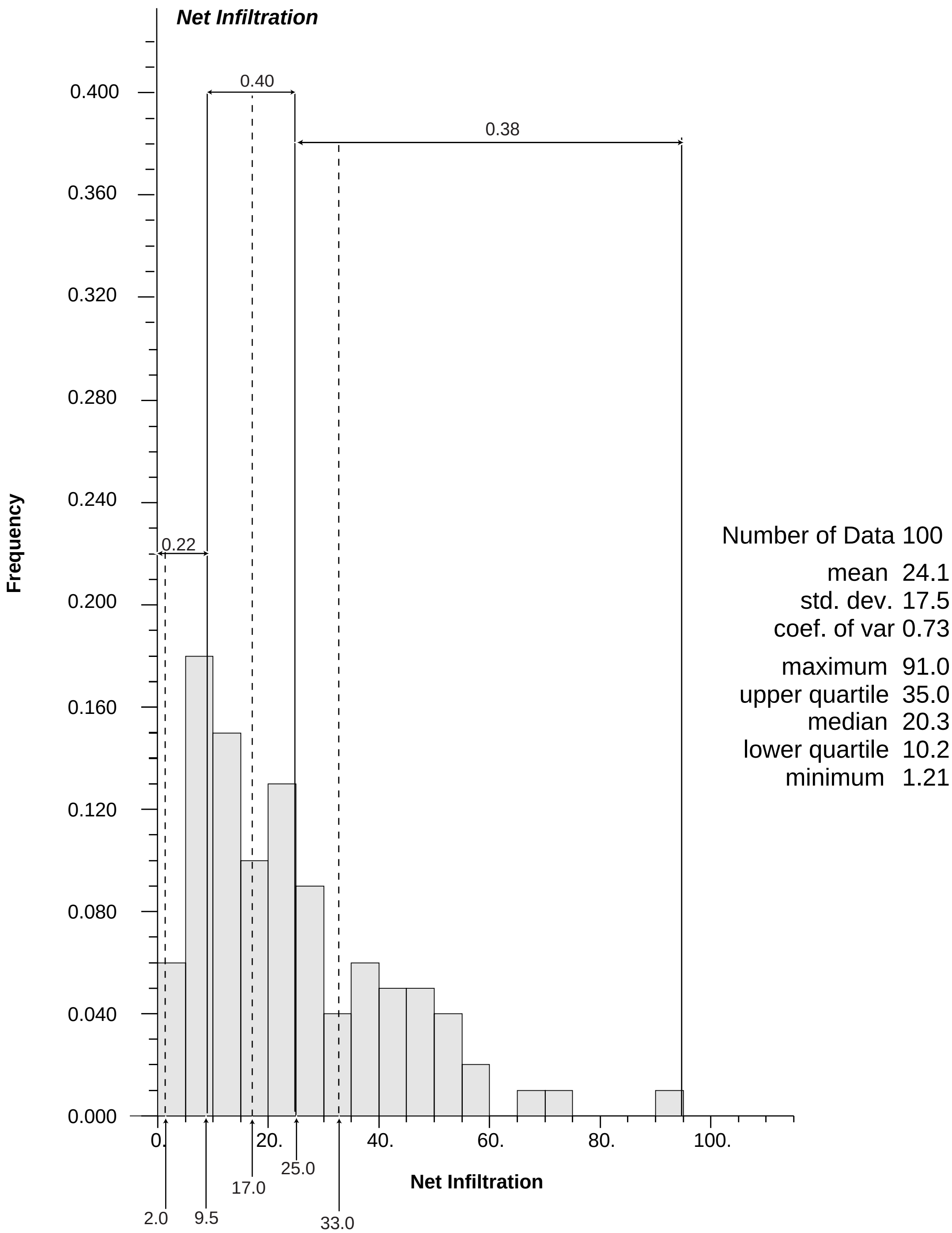
Run Number	Net Infiltration Rate (mm/yr)
32.	4.73E+01
33.	3.58E+01
34.	4.37E+01
35.	2.12E+01
36.	3.86E+01
37.	5.42E+00
38.	2.98E+01
39.	3.40E+01
40.	2.22E+01
41.	6.60E+00
42.	1.41E+01
43.	3.76E+01
44.	2.51E+01
45.	6.55E+00
46.	4.99E+01
47.	2.93E+01
48.	7.72E+00
49.	2.90E+01
50.	8.70E+00
51.	4.36E+01
52.	3.58E+00
53.	1.51E+01
54.	1.10E+01
55.	1.18E+01
56.	4.75E+01
57.	1.25E+01
58.	4.88E+01
59.	6.46E+00
60.	2.26E+01
61.	6.48E+00
62.	2.12E+00

Table 6-6. Resulting Net Infiltration Rates for 100 Realizations, Excluding Contingency Area (Continued)

Run Number	Net Infiltration Rate (mm/yr)
63.	1.07E+01
64.	1.88E+00
65.	2.72E+01
66.	1.46E+01
67.	1.91E+01
68.	1.01E+01
69.	6.80E+00
70.	3.60E+01
71.	9.59E+00
72.	9.30E+00
73.	2.04E+01
74.	2.38E+01
75.	4.46E+01
76.	1.25E+00
77.	2.90E+01
78.	1.72E+01
79.	5.80E+01
80.	5.41E+01
81.	7.94E+00
82.	7.74E+00
83.	3.57E+01
84.	2.29E+01
85.	2.69E+01
86.	1.55E+01
87.	2.71E+00
88.	1.30E+01
89.	5.44E+00
90.	1.19E+01
91.	4.61E+01
92.	1.83E+01
93.	2.94E+01
94.	1.41E+01
95.	2.41E+01
96.	1.72E+01
97.	1.02E+01
98.	1.70E+01
99.	5.40E+01
100.	2.52E+01

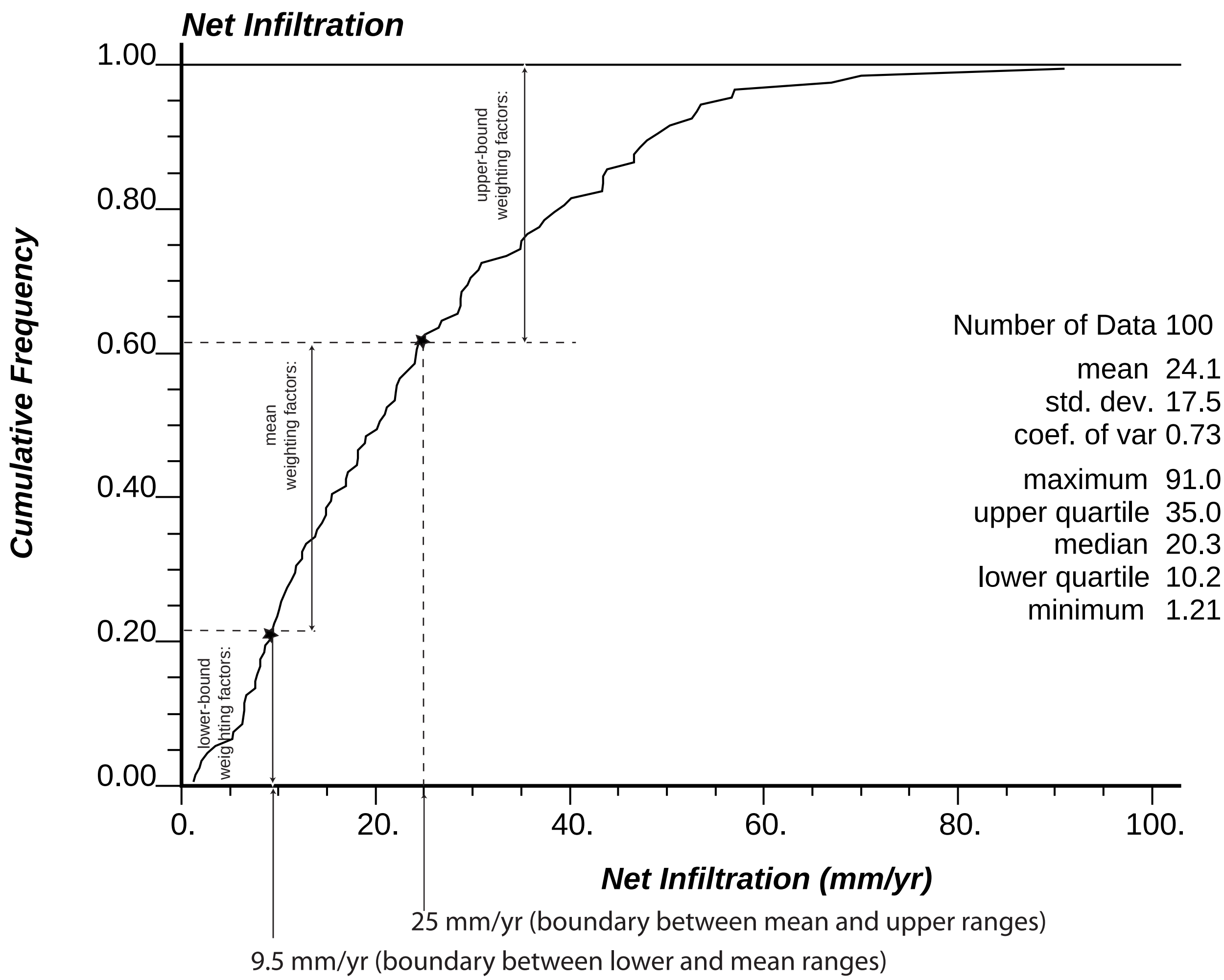
Output-DTN: SN0308T0503100.008

NOTE: Mean =24.4 St Dev=17.7



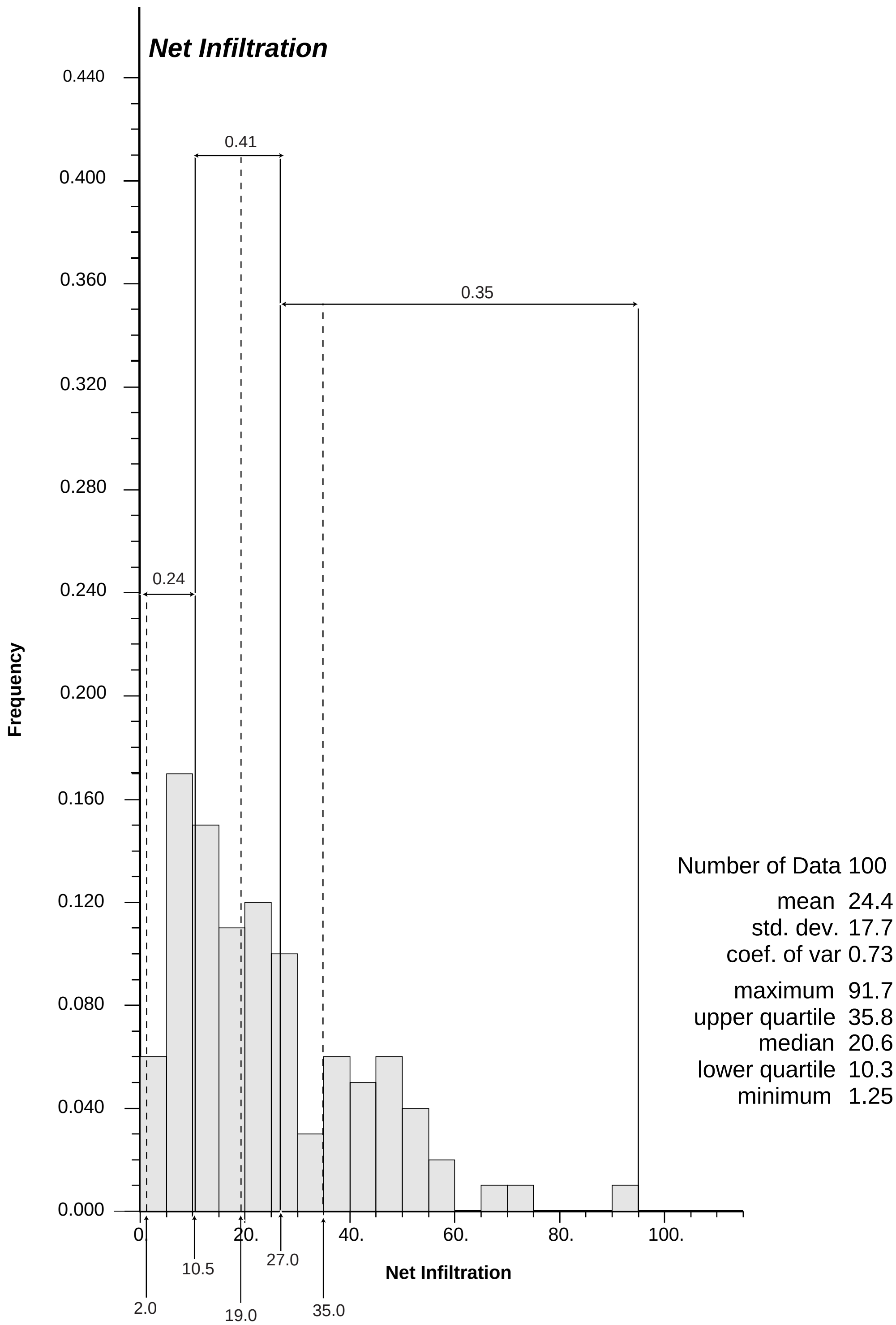
NOTE: The lower-bound, mean, and upper-bound analog weighting factors are equal to the sums of the bin frequency values belonging to the net infiltration rate ranges for the corresponding analog. Bin size facilitates the visual evaluation of weighting factors. This plot represents data presented in Table 6-5 (column 2) only.

Figure 6-2a. Histogram, Including Contingency Area, of Average Annual Net Infiltration and Weighting Factors for Glacial Transition Climate



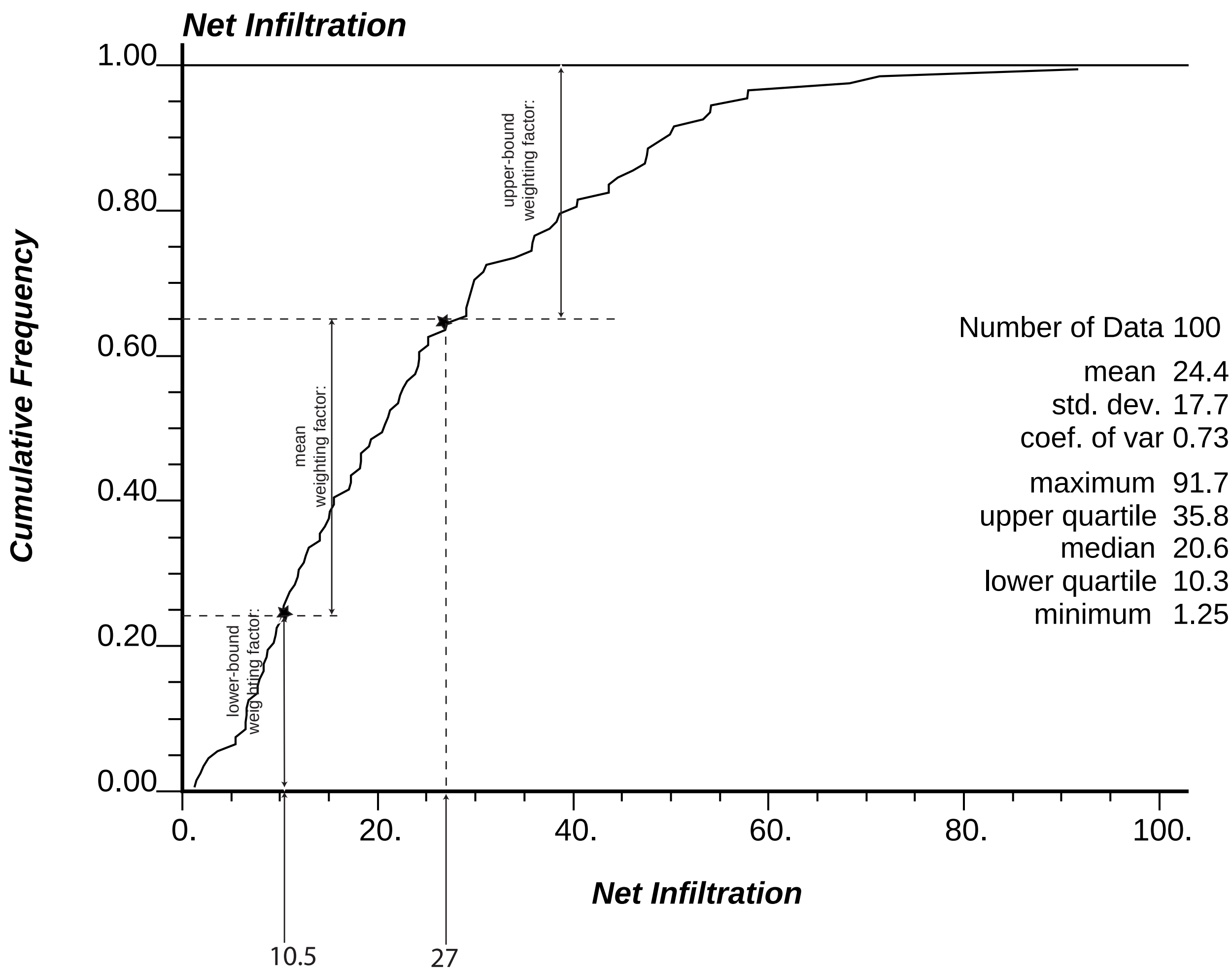
NOTE: Locations of * show the boundaries between net infiltration corresponding to lower-bound, mean, and upper-bound climates.

Figure 6-2b. Cumulative Distribution Plot, Including Contingency Area, of Average Annual Infiltration and Weighting Factors for Glacial Transition Climate



NOTE: The lower-bound, mean, and upper-bound analog weighting factors are equal to the sums of the bin frequency values belonging to the net infiltration rate ranges for the corresponding analog. This plot represents data presented in Table 6-6 (column 2) only.

Figure 6-3a. Histogram, Excluding Contingency Area, of Average Annual Infiltration and Weighting Factors for Glacial Transition Climate



NOTE: Locations of * show the boundaries between net infiltration corresponding to lower-bound, mean, and upper-bound climates.

Figure 6-3b. Cumulative Distribution Plot, Excluding Contingency Area, of Average Annual Infiltration and Weighting Factors for Glacial Transition Climate

6.3 CALCULATION OF NET INFILTRATION WEIGHTING FACTORS FOR TSPA

The final desired product from this uncertainty analysis was to obtain weighting factors, w_1, w_2, w_3, for the lower-bound, mean, and upper-bound analog climate infiltration rate maps (USGS 2001 [160355], Section 6.11.3).

Subsections 6.3.1 and 6.3.2 discuss the calculation of the weighting factors for model domains footprints including and excluding the contingency area, respectively.

6.3.1 Calculation Including the Contingency Area

Figure 6-2a is a histogram of the frequency distribution of the 100 realizations in each of the 19 bins within the lower and upper ranges of the distribution. This figure also displays the values of R_1, R_2, and R_3, the lower-bound, mean, and upper-bound analog climate net infiltration rates, respectively, spatially averaged over the simulated multi-rectangular region representing the repository footprint (including the contingency area). Additionally, σ and $\overline{R}$, the standard deviation and mean of the uncertainty distribution, respectively, are displayed for informative purposes; this information is not used to determine the weighting factors. The values R_1, R_2, and R_3 are rounded to the nearest millimeter per year. Figure 6-2b represents the same data as a cumulative distribution plot.

Based on the skewness of the distribution of the net infiltration displayed in Figure 6-2a and the relative positioning of the climate analog values calculated (Attachment IV), a decision was made to use a simple graphical partitioning of the distribution into three parts assigned to the lower-bound, mean, and upper-bound climates. This method is more transparent than the approach used in the previous revision, REV 00, of the document (CRWMS M&O 2000 [143244]). Then the net infiltration weighting factors for the lower-bound, mean, and upper-bound glacial climates are determined as the cumulative probability of the occurrence of net infiltration rate within a range of 0–9.5 mm/yr (lower analog value is 2 mm/yr), 9.5–25 mm/yr (mean analog value is 17 mm/yr), and 25–95 mm/yr (upper analog value is 33 mm/yr), respectively. Thus, the weighting factor is linked to the range of the infiltration rates for each climate scenario.

In average net infiltration space, $R_1 \cong 2.0$, $R_2 \cong 17.0$, and $R_3 \cong 33.0$ in units of millimeter per year (Table 6-7). In addition, $\sigma \cong 17.5$ and $\overline{R} \cong 24.1$ (Table 6-5) in units of millimeter per year correspond to the standard deviation and the mean of the uncertainty distribution. To calculate the weighting factors, the ranges of the net infiltration corresponding to the lower-bound, mean, and upper-bound climate analogs were determined by the following ad hoc procedure. First, the lower-mean and mean-upper boundaries are defined using the midpoints between the low and mean and between the mean and upper-bound analogs, which are 9.5 mm/yr and 25.0 mm/yr, respectively. Then, the other two boundaries are assigned as 0.0 and 95.0 which bracket the end points of the distribution. The analog values are represented by dashed lines in Figure 6-2a, with the bin boundaries indicated by solid vertical lines). The final step in calculating the weighting factors is to merely add the heights (representing the fraction of realizations) of the bins located within the boundaries (solid lines) defining the lower-bound, mean, and upper-bound climate analogs. If a bin falls partially within two different climate analogs, then the bin is apportioned according to the fraction of that bin on each side of the corresponding boundary. For the lower-bound climate, the average net infiltration ranges between 0.0 and 9.5, for the mean, between 9.5 and 25.0; and for the upper-bound, between 25.0 and 95; (units are mm/year). There are two complete bins (moving from left to right) within the low climate analog boundaries. The mean climate analog contains a fraction (1/10) of the second bin and the next three complete bins. All of the remaining bins, of course, fall completely within the high climate analog (there are 12 of them), counting the included empty bins.

Alternatively, the weighting factors can be estimated from the cumulative distribution plot (Figure 6-2b). The values estimated are consistent with the values determined as described in the previous paragraph.

When the contributions (frequencies) of all the bins (and fractions of bins) belonging to each analog are summed, the values of w_i are then 0.22, 0.40, and 0.38 for the weighting factors corresponding to the lower-bound, mean, and upper-bound climate infiltration maps, respectively (Output-DTN: SN0308T0503100.008). The height of the dashed lines are the values of the corresponding weighting factors in Figure 6-2a.

6.3.2 Calculation Excluding the Contingency Area

Figure 6-3a is a histogram of the distribution showing the fraction of the 100 realizations in each of the 19 bins within the lower and upper ranges of the distribution. This figure also displays the values of R_1, R_2, and R_3, the lower-bound, mean, and upper-bound analog climate infiltration rate maps spatially averaged over the simulated multi-rectangular region, representing the repository footprint excluding the contingency area. Additionally, σ and $\overline{R}$, the standard deviation and mean of the uncertainty distribution, respectively, are displayed for informative purposes and not used to determine the weighting factors. Figure 6-3b represents the same data as a cumulative distribution plot.

In average net infiltration space, $R_1 \cong 2.0$, $R_2 \cong 19.0$, and $R_3 \cong 35.0$ in units of millimeter per year (Table 6-7). In addition, $\sigma \cong 17.7$ and $\overline{R} \cong 24.4$ (Table 6-6) in units of millimeter per year correspond to the standard deviation and the mean of the uncertainty distribution.

The widths of the segments corresponding to the lower-bound, middle, and upper-bound climate infiltration maps were determined by the following ad hoc procedure. First, the midpoints were placed between the lower and mean and between the mean and upper analogs (in averaged net infiltration space, i.e., 10.5 mm/yr and 27.0 mm/yr, respectively) and then as the two corresponding segment boundaries. In addition, the other two boundaries are 0.0 and 95.0. The analog values are represented by dashed lines in Figure 6-3a, with the bin boundaries indicated by solid vertical lines. The heights of the solid lines are the values of the corresponding weighting factors. The final step in calculating the weighting factors is to merely add the heights (representing the fraction of realizations) of the bins located within the boundaries defining the lower-bound, mean, and upper-bound climate analogs. If a bin falls partially within two different climate analogs, then the bin is apportioned according to the fraction of that bin on each side of the corresponding boundary. For the lower-bound climate, the boundaries fall between average net infiltrations between 0.0 and 10.5; for the mean, between 10.5 and 27.0, and the upper-bound, between 27.0 and 95 (units are mm/year). There are two complete bins (moving from left to right) within the lower climate analog boundaries, plus a fraction (1/10) of the next bin. The mean climate analog contains 9/10 of this same bin plus the next two complete bins and 2/5 of the next. Thus 3/5 of that same bin is within the upper-bound climate analog boundaries. All of the remaining bins, of course, fall completely within the high climate analog (there are 13 of them).

Alternatively, the weighting factors can be visually estimated from the cumulative distribution plot (Figure 6-3b). Here, the weighting factors are estimated from the locations of the (*) symbol on the vertical axis. The values estimated are consistent with the values determined as described in the previous paragraph.

When the contributions (frequencies) of all the bins (and fractions of bins) belonging to each analog are summed, the values of w_i are then 0.24, 0.41, and 0.35 for the weighting factors corresponding to the lower-bound, mean, and upper-bound climate infiltration maps, respectively

(Output-DTN: SN0308T0503100.008). The heights of the dashed lines are the values of the corresponding weighting factors.

Table 6-7 summarizes the results for the analog-map representative values and the weighting factors corresponding to the lower-bound, mean, and upper-bound climates for the glacial transition climate regime.

Table 6-7. Summary of Analog Infiltration Results and Weighting Factors Calculated in This Analysis

Glacial-transition Climate	Analog Value Include Contingency Area [a, b] Output-DTN: SN0309T0503100.010	Weighting Factor [c] Include Contingency Area [a, b] Output-DTN: SN0308T0503100.008	Analog Value Exclude Contingency Area [a, b] Output-DTN: SN0309T0503100.010	Weighting Factor [c] Exclude Contingency Area [a,b] Output-DTN SN0308T0503100.008
Lower-bound	2.0 [mm/yr]	0.22	2.0 [mm/yr]	0.24
Mean	17.0 [mm/yr]	0.40	19.0 [mm/yr]	0.41
Upper-bound	33.0 [mm/yr]	0.38	35.0 [mm/yr]	0.35

NOTES: [a] Analog values are calculated using the infiltration rate maps calculated by the USGS for the lower-bound, mean, and upper-bound glacial transition climates (DTN: GS000308311221.005 [147613]) averaged over the simulated multi-rectangular region including and excluding the contingency area (Figure 1-1).

The calculated analog values for the approximate multi-rectangular regions including and excluding the contingency area are, respectively, 1.78, 17.35, and 32.93 mm/yr and 1.93, 18.64, and 35.34 for the lower-bound, mean, and upper-bound glacial transition climates (Attachment IV). The values in the table (Columns 2 and 4) and used to calculate the weighting factors have been rounded to the nearest mm/yr. The minor differences between the calculated means for the exact and simulated footprint (see Attachment IV) are consistent with expected differences, because of the differences in the two areas. The rectangular area is larger than the potential repository area (see Figure 1-1) and includes locations with relatively higher estimates of net infiltration, which causes a slight increase in the means calculated for the rectangular area relative to the mean calculated for the potential repository area.

[b] Weighting factors are calculated as discussed in Section 6.3.1, 6.3.2

6.4 SUMMARY OF UNCERTAINTY ANALYSIS

An uncertainty analysis was performed using the LHS technique. The calculation consisted of a set of 100 realizations (see Attachment III) of the selected set of 12 uncertain input parameters (Table 6-3). Column 2 in Tables 6-5 and 6-6 represent the resulting net infiltrations averaged over the simulated repository footprint, including and excluding the contingency area. The net infiltration map realizations result from the propagation of the resulting input sample space through the infiltration model, INFIL VA_2.a1 (SNL 2001 [147608]). Each of the rate maps (for every realization) is spatially averaged over the simulated repository footprint (Attachment IV) to obtain a single distribution. Each distribution is displayed as a frequency histogram (Figures 6-2a and 6-3a) for the net infiltrations. Likewise, the three net infiltration rate maps for the lower-bound, mean, and upper-bound climates (DTN: GS000308311221.005 [147613] are spatially averaged over the repository footprint in this analysis, as discussed in Attachment IV. These spatially averaged maps for the analog climates are referred to, here, as analog values.

In Figures 6-2a and 6-3a, the graphical locations of the analog values are represented by three values along the horizontal axis for the calculations including and excluding the contingency areas, respectively. The appropriate distribution is partitioned according to the method described in Section 6.3.1 or in 6.3.2. The resulting ranges of average net infiltration belonging to the lower-bound, mean, and upper-bound climates are defined by this partition. Thus, the weighting factors corresponding to these sets of ranges are determined by the frequency of net infiltration maps whose spatial average over the footprint fall within that range.

An inspection of Figures 6-2 and 6-3 reveals that the value of the somewhat relatively large weight for the upper-bound analog value is reflected in the fact that the distribution is skewed toward values to the right of the mean, though there is a high density of values within the midrange of the distribution. Note that the upper quartile boundary is almost exactly the same as the upper-bound analog value. Approximately 25% of the infiltration map realizations have larger amounts of net infiltration than that corresponding to the upper-bound analog map. This may reflect the effects of lognormally distributed input such as bedrock permeability, which has a strong effect on infiltration, as discussed in Flint et al. (2001 [164506]).

One standard deviation to the right of the mean of the distribution is between 41 and 42 mm/yr, and two standard deviations to the right is between 59 and 60 mm/yr; the latter includes all but the three greatest values of net infiltration (for either footprint option). Thus, 97% of the distribution is within 2σ of the mean, μ (i.e., 97% is within μ +/- 2σ). Thus, the upper-bound weighting factor is essentially determined within 2σ of μ.

6.4.1 Discussion of Sensitivity Results

A sensitivity analysis using Microsoft Excel 2000 (V.9.0.5121 SR-1, using the CORREL function), shows that the most significant parameter for net infiltration is precipitation (Table 6-8, Column 5), followed by soil depth (Table 6-8, Column 4), potential evapotranspiration (Table 6-8, Column 6), and bedrock permeability (Table 6-8, Column 7). Table 6-8 (from Excel) shows all twelve sampled input parameters with the calculated correlation coefficients, based on the equation:

$$\rho_{x,y} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu_x)(y_i - \mu_y)}{\sigma_x \sigma_y} \qquad \text{(Eq. 6-2)}$$

where μ is the mean and *n* is the number of samples. The nominator is the covariance, and σ is the standard deviation.

Table 6-8. Correlation Coefficients between Uncertain Input Parameters and Output Net Infiltrations (excluding the contingency area), from Microsoft Excel 2000

Parameter index in LHS	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)
Parameter ID	BRPOROS	BRZDepth	soildepm	precipm	potermul	brperm
Correlation Coefficient	-0.091	-0.050	-0.493	0.638	-0.341	0.236

Parameter index in LHS	X(7)	X(8)	X(9)	X(10)	X(11)	X(12)
Parameter ID	soilperm	etcoeffa	etcoeffb	flarea	subpar1	snowpar2
Correlation Coefficient	0.009	-0.098	-0.185	-0.029	0.022	0.047

Output DTN: SN0309T0503100.011

NOTE: If the parameter BRPERM, which has a lognormal distribution, is log-transformed, the resulting parameter has a correlation of 0.305
SOILPERM also has a lognormal distribution but does not have a significant correlation coefficient

6.4.2 Deterministic Mean Net Infiltration Result Using Tule Lake

An additional deterministic (not statistical) calculation was performed to evaluate the aggregate (spatial) net infiltration (within the simulated region excluding the contingency area) applying the mean values from the uncertain parameter distributions to the climate input represented in the Tule Lake input file, "Tulelake.inp" (used in the uncertainty analysis). In other words, all of the sampled parameters have the mean value assigned (for multipliers, this value is 1.0). See Attachment V for documentation of the input used in this calculation.

The resulting net infiltration is 17.8 mm/yr. This value is 0.8 mm/yr, or about 4% smaller than the value obtained from the USGS (DTN: GS000308311221.005 [147613]) for the simulated region in this analysis. However, the mean precipitation in Tulelake.inp is 278 mm/yr, less than the mean value from the infiltration report for the potential repository region (USGS 2001 [160355], Table 6-19) of 323 mm/year. In addition, the mean daily temperature in Tulelake.inp is about 8° Celsius, and the mean temperatures used in the lower-bound and upper-bound glacial transition climates were both approximately 9°-10° Celsius, respectively (USGS 2001 [160355], Table 6-6). The difference in average annual precipitation will reduce the net infiltration for Tule Lake relative to the mean calculated in the infiltration report for a similar region. The temperature difference is quite small, though a warmer average air temperature may imply a little more evapotranspiration; the effect on net infiltration is not nearly as significant as the effect caused by the average annual precipitation differences, as shown in the sensitivity analysis. Though precipitation is the most important parameter affecting infiltration, average annual precipitation is not necessarily a good indicator of infiltration. This is because (1) heavy precipitation events at Yucca Mountain are episodic (USGS 2001 [160355], Sections 6.3.4) and (2) below a threshold precipitation amount, at most negligible infiltration will occur due to competing processes removing soil water content (e.g., evapotranspiration, runoff). Furthermore, the 2001 infiltration numerical model footprint boundary (where the data in USGS 2001 [160355], Tables 6-6 and 6-19, are applicable) includes an area on the southwest side with relatively large infiltrations (USGS 2001 [160355], Figure 6-36) that is no longer within the current design LA footprint (nor the specific region simulated in this analysis, Figure IV-2). Thus, it is difficult to conclude whether Tule Lake is underpredicting or overpredicting net infiltration as a mean glacial-transition-climate analog relative to the lower-bound or upper-bound climate analogs used in the infiltration report.

6.5 FEPS DISCUSSION

Table 6-9 summarizes the features, events, and processes (FEPs) that were taken from the LA FEP List (DTN: MO0307SEPFEPS4.000 [164527]). The LA FEP List is a revision of the previous project FEP list (Freeze et al. 2001 [154365]) used to develop the list of included FEPs in the *Technical Work Plan for: Performance Assessment Unsaturated Zone* (BSC 2002 [160819], Table 2-6). The selected FEPs are those taken from the LA FEP List that are associated with the subject matter of this report, regardless of the anticipated status for exclusion or inclusion in TSPA-LA as represented in BSC (2002 [160819]). The results of this analysis are part of the basis for the treatment of FEPs as discussed in the *Total System Performance Assessment-License Application Methods and Approach* (BSC 2002 [160146], Section 3.2.2).

The cross-reference for each FEP to the relevant subsection (or subsections) of this report is also given below.

Below in Table 6-9 are summary descriptions and documentation of the inclusion of the applicable FEPs as incorporated in this analysis.

Table 6-9. Table of FEPs

LA FEP Number	FEP Name	YMP Description	Section Discussed	Treatment of FEP in This Report Including Disposition
1.2.02.01.0A	Fractures	Groundwater flow in the Yucca Mountain region and transport of any released radionuclides may take place along fractures. The rate of flow and the extent of transport in fractures are influenced by characteristics such as orientation, aperture, asperity, fracture length, connectivity, and the nature of any linings or infills.	6.1.2	The disposition of the FEP1.2.02.01.0A is handled by incorporation of the fracture parameters bedrock permeability (BRPERM) and the bedrock porosity) (BRPOROS) that are included implicitly in the determination of the weighting factors. The uncertainties for these parameters are described in Table 6-2 and 6-3. These uncertainties are propagated through the infiltration numerical model and so are implicitly included in the output (weighting factors) that is passed to TSPA-LA (Output-DTN: SN0308T0503100.008).
1.3.01.00.0A	Climate change	Climate change may affect the long-term performance of the repository. This includes the effects of long-term change in global climate (e.g., glacial/interglacial cycles) and shorter-term change in regional and local climate. Climate is typically characterized by temporal variations in precipitation and temperature.	*6.1, 6.2, 6.3	Climate change is incorporated in this report through the use of the analog climate (lower-bound, mean, and upper-bound) infiltration rate maps (see Table 6-7, DTN: GS000308311221.005 [147613]) developed by the USGS in the report *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]) by using the climate analog data as direct input. It is incorporated implicitly by inclusion of the spatial average analog net infiltration rate maps in the calculation of the weighting factors which are passed to TSPA-LA (Output-DTN: SN0308T0503100.008).
2.2.03.02.0A	Rock properties of host rock and other units	Physical properties such as porosity and permeability of the relevant rock units, soils, and alluvium are necessary for the Performance Assessment. Possible heterogeneities in these properties should be considered. Questions concerning events and processes that may cause these physical properties to change over time are considered in other FEPs	6.1.2.1, 6.1.2.2, 6.1.2.3	This FEP disposition is through inclusion of the fracture parameters bedrock permeability (BRPERM) and bedrock porosity (BRPOROS). The uncertainties for these parameters are described in Tables 6-2 and 6-3. These uncertainties are propagated through the infiltration numerical model and so are implicitly included in the output (weighting factors) that is passed to TSPA-LA (Output-DTN: SN0308T0503100.008). Heterogeneities in these properties are included in the input used in the analysis reported in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]).
2.2.07.01.0A	Locally saturated flow at bedrock/ alluvium contact	The YMP description is "In washes in arid areas, infiltration can descend to the alluvium/bedrock interface and then proceed down the wash at that interface as a saturated flow system distant from the surface and distinct from the local water table."	6.1.2	Flow through the alluvium/bedrock interface is incorporated into the uncertainty analysis using the uncertain parameters such as soil depth (SOILDEPM), the soil permeability (SOILPERM), and the effective bedrock permeability (BRPERM). It is incorporated implicitly by inclusion of uncertainty in the soil depth, the soil permeability, and the effective bedrock permeability in the calculation of the weighting factors which are passed to TSPA-LA (Output-DTN: SN0308T0503100.008).

Table 6-9. Table of FEPs (Continued)

LA FEP Number	FEP Name	YMP Description	Section Discussed	Treatment of FEP inThis Report Including Disposition
2.2.07.08.0A	Fracture flow in the UZ	Fractures or other analogous channels act as conduits for fluids to move into the subsurface to interact with the repository and as conduits for fluids to leave the vicinity of the repository and be conducted to the SZ. Water may flow through only a portion of the fracture network, including flow through a restricted portion of a given fracture plane.	6.1.2.1, 6.1.2.2, 6.1.2.3	This FEP is implicitly included in the determination of the weighing factors fed to TSPA-LA (Output-DTN: SN0308T0503100.008). This FEP is incorporated in the uncertain parameters describing the bedrock permeability multiplier (BRPERM) and bedrock porosity (BRPOROS).
2.3.01.00.0A	Topography and morphology	The YMP description is "This FEP is related to the topography and surface morphology of the disposal region. Topographical features include outcrops and hills, water-filled depressions, wetlands, recharge areas, and discharge areas. Topography, precipitation, and surficial permeability distribution in the system will determine the flow boundary conditions, i.e. location and amount of recharge and discharge in the system."	6.1.2	Topographical features, precipitation, and surficial permeability distribution are incorporated into the INFIL (V2.0 (USGS 2001 [139422]) or VA_2.a1 (SNL 2001 [147608])) model while precipitation and surficial permeability distribution are also incorporated into the uncertainty analysis. Topographical features are captured in the INFIL (V2.0 (USGS 2001 [139422]) or VA_2.a1 (SNL 2001 [147608])) model using data from the Digital Elevation Model (DEM). Precipitation and the surficial permeability distribution are captured in the uncertainty analysis using the precipitation multiplier (PRECIPM), the soil permeability multiplier (SOILPERM), and the effective bedrock permeability multiplier (BRPERM). It is incorporated implicitly by inclusion of uncertainty in the precipitation multiplier, soil permeability multiplier, and effective bedrock permeability multiplier in the calculation of the weighting factors which are passed to TSPA-LA (Output-DTN: SN0308T0503100.008).
2.3.11.01.0A	Precipitation	Precipitation is an important control on the amount of recharge. It transports solutes with it as it flows downward through the subsurface or escapes as runoff. The amount of precipitation depends on climate	6.1.2	Precipitation is incorporated in this analysis through the precipitation-rate multiplier (Table 6-3 and Section 6.1.2). The precipitation-rate multiplier operates on the precipitation rate, as prescribed in the input file TULELAKE.INP, which contains the precipitation record for the selected "mean glacial-transition-climate" analog site, within the infiltration model software, INFIL VA_2.a1 (SNL 2001 [147608]) (and also INFIL V2.0; USGS 2001 [139422]).
2.3.11.02.0A	Surface runoff and flooding	The YMP description is "Surface runoff and evapotranspiration are components in the water balance, together with precipitation and infiltration. They can also be important vehicles for the dispersion of contaminants. Surface runoff produces erosion, and can feed washes, arroyos, and impoundments, where flooding may lead to increased recharge."	6.1.2	Evapotranspiration is incorporated in this analysis through the two evapotranspiration coefficient-rate multipliers (Table 6-3 and Section 6.1.2.). The evapotranspiration rate multiplier operates on the evapotranspiration rate, as calculated within the infiltration model software, INFIL VA_2.a1 (SNL 2001 [147608]) (and also INFIL V2.0; USGS 2001 [139422]). Surface runoff is also incorporated through the inclusion of a parameter that defines the fraction of each grid cell in the infiltration model that is affected by overland flow and channel flow during the routing of runoff (FLAREA). It is incorporated implicitly by inclusion of uncertainty in the fraction of each grid cell in the infiltration model that is affected by overland flow and channel flow during the routing of runoff (FLAREA) in the calculation of the weighting factors which are passed to TSPA-LA (Output-DTN: SN0308T0503100.008).

Table 6-9. Table of FEPs (Continued)

LA FEP Number	FEP Name	YMP Description	Section Discussed	Treatment of FEP in This Report Including Disposition
2.3.11.03.0A	Infiltration and recharge	Infiltration into the subsurface provides a boundary condition for groundwater flow. The amount and location of the infiltration influences the hydraulic gradient and the height of the water table. Different sources of recharge water could change the chemistry of groundwater passing through the repository. Mixing of these waters with other groundwaters could result in precipitation, dissolution, and altered chemical gradients.	1.1, 6.1.2.1	Infiltration uncertainty as it applies to the determination of weighting factors fed to TSPA-LA (Output-DTN: SN0308T0503100.008) is a main focus of this report. The way it is handled is summarized in Subsections 1.1 paragraph 3. "TSPA License Application (LA) has included three distinct climate regimes in the comprehensive repository performance analysis for Yucca Mountain: present-day, monsoon, and glacial transition. Each climate regime was characterized using three infiltration-rate maps, including a lower- and upper-bound and a "mean" value (equal to the average of the two boundary values). For each of these maps, which were obtained based on analog site climate data, a spatially averaged value was also calculated by the USGS. For a more detailed discussion of these infiltration-rate maps, see *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]). For this Scientific Analysis Report, spatially averaged values were calculated for the lower-bound, mean, and upper-bound climate analogs only for the glacial transition climate regime, within the simulated multi-rectangular region approximating the repository footprint, shown in Figure 1-1. (For brevity, these maps will be referred to as the analog maps, and the corresponding averaged net infiltration values as the analog values.) " and 6.1.2.1, paragraph 1: "This uncertainty analysis uses the mean and ranges of uncertain parameters (upper and lower bounds), parameter distribution types (normal, lognormal, or uniform), and correlation values (all parameters have values of zero) between parameters for selected model input parameters considered potentially significant to evaluate the net infiltration uncertainties. The names and types of the 12 uncertain parameters that were selected for sampling for the glacial transition climate scenario are shown in Table 6-1." The net infiltration maps (DTN: GS000308311221.005 [147613]) which define a boundary condition for groundwater flow in the unsaturated zone are generated in the report *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]).

6.6 DISCUSSION OF BARRIER CAPABILITY

The surficial soils and underlying few meters of bedrock itself are natural barriers to downward water infiltration. The surficial soils function as a barrier by diverting runoff (because some water is arriving as precipitation and runon) and by storing the remainder of water so that some of it is removed by ET. Substantial amount of surface water thus diverted or evaporated cannot present a source of net infiltration (USGS 2001 [160355], p. 23). Based on the mean analog values of the precipitation and net infiltration for the lower-bound, mean, and upper-bound glacial climate (USGS 2001 [160355], Table 6-19), Table 6-10 lists the estimated percentage of net infiltration over precipitation. This table indicates that only 1.1%, 6.1%, and 8.5% of precipitation may become net infiltration for the lower-, mean- and upper-bound glacial transition climate, respectively.

Table 6-10. Percentage of Net Analog Infiltration over Precipitation for Glacial Transition Climates over the Repository Footprint (data from USGS 2001 [160355], Table 6-19)

Glacial Transition Climate States	Precipitation (mm/year)	Net Infiltration (mm/year)	Net Infiltration %
Lower-bound	205.5	2.2	1.1
Mean	323.1	19.8	6.1
Upper-bound	440.6	37.3	8.5

This report directly addresses the uncertainty associated with the infiltration model for this barrier. This is accomplished quantitatively in Section 6; further qualitative discussion of uncertainty in the infiltration model follows in the infiltration report (USGS 2001 [160355], Section 7.2). Furthermore, the weighting factors developed in this report for the glacial transition climate for the entire compliance period strengthens the performance assessment done in TSPA-LA by adding conservatism to the infiltration calculation as it is incorporated into the performance assessment model for TSPA-LA.

INTENTIONALLY LEFT BLANK

7. CONCLUSIONS

7.1 SUMMARY

A set of uncertain input parameters (Table 6-3), based on probability density function characterizing climatic conditions and soil/rock properties, was developed and used to perform a probabilistic analysis of the net infiltration uncertainty for the glacial transition climate regime (Output-DTN: SN0309T0503100.009). The Output-DTN: SN0309T0503100.011 was a statistical tool developed to technically support the distributions ascribed to the "set of uncertain input parameters" (see Section 6.1.2.1.) The uncertainty analysis was performed using 100 realizations of the set of uncertain input parameters to generate corresponding net infiltration maps, using the computer code INFIL VA_2.a1 (SNL 2000 [147608]). For each realization, a single representative net infiltration rate is obtained by calculating the spatially averaged net infiltration rate over a multi-rectangular region (see Figure 1-1), approximating the footprint of the repository. The uncertainty analysis was provided for two possible repository footprints, one that included a potential contingency disposal area, and one that did not. The time duration for this glacial transition climate regime covered most of the 10,000-year performance period (from 2,000-10,000 years) considered for TSPA-LA.

For each of the two possible repository footprints, we determined a frequency histogram of the net infiltration rate resulting from the set of 100 realizations. The averaged net infiltration rates provided by the USGS (DTN: GS000308311221.005 [147613]) were then used (as direct input) to determine the average net infiltration over the simulated repository footprint. The output technical product of the computation (Output-DTN: SN0309T0503100.010) discussed in Attachment IV (see also Table 6-7) were then used to partition each of the histograms (with and without the contingency area) into three parts, corresponding to the lower-bound, mean, and upper-bound glacial-transition-climate net infiltration rates. In this way, the uncertainty distributions were used to determine weighting factors for the range of the net infiltration rates, characterizing each of these climates (Output-DTN: SN0308T0503100.008). The results are based on input that is qualified, and are displayed in Table 7-1.

Table 7-1. Weighting Factors of the Net Infiltration Rates to be Used by TSPA for the Glacial Transition Lower-Bound, Mean, and Upper-Bound Analog Infiltration-Rate Maps

Symbol	Area Including Contingency Output-DTN: SN0308T0503100.008		Area Excluding Contingency Output-DTN: SN0308T0503100.008		Climate
	Weighting Factor	Net Infiltration Rate, mm/yr.	Weighting Factor	Net Infiltration Rate, mm/yr.	
w_1	0.22	0–9.5	0.24	0–10.5	Lower-bound
w_2	0.40	9.5–25	0.41	10.5–27.0	Mean
w_3	0.38	25–95	0.35	27.0–95	Upper-bound

7.2 LIMITATIONS AND UNCERTAINTIES

This uncertainty analysis should be evaluated with the following considerations:

- Input parameters used for the uncertainty analysis of the net infiltration for the glacial transition climate present a combination of the aleotoric parameters (spatially variable) and epistemic (based on the degree of current knowledge of changes of climatic conditions and soil/rock properties).

- It is possible that the lognormal probability distribution of the permeability (with high permeability values typical for saturated fractures) significantly influences the net infiltration uncertainty distribution and overestimates the net-infiltration weighting factors for the upper-bound glacial transition state.

7.2.1 Statistical Limitations and Uncertainties

Limitations on the number of potential samples are driven by the number and size of watersheds used in the analysis. The limitations in the input distributions and their ranges are propagated through the analysis to the output net infiltration-rate distributions. In addition, all of the irreducible uncertainties inherent to infiltration phenomena and reducible uncertainties, such as those caused by measurement error, that may produce uncertainty in the results reported in *Simulation of Net Infiltration for Modern and Potential Future Climates* (USGS 2001 [160355]), are implicitly incorporated in this scientific analysis report. Clearly this analysis depends directly and to a great extent on the inputs and results produced by the infiltration numerical model, INFIL V A_2.a1 (SNL 2000 [147608]) (numerically equivalent to INFIL V2.0 (USGS 2001 [139422]). Thus, the accuracy and precision of the present analysis is limited by the accuracy and precision of the infiltration numerical model (USGS 2001 [160355]).

7.3 GENERAL IMPACT OF UNRESOLVED TECHNICAL INFORMATION

This document may be affected by technical product input information that requires confirmation. The status of the input information quality may be confirmed by review of the Document Input Reference System (DIRS) database.

8. INPUTS AND REFERENCES

The following is a list of the references cited in this document. Column 1 represents the unique six digit numerical identifier (the Document Input Reference System [DIRS] number), which is placed in the text following the reference callout (e.g., BSC 2002 [160819]). The purpose of these numbers is to assist the reader in locating a specific reference. Within the reference list, multiple sources by the same author (e.g., BSC 2002) are sorted alphabetically by title.

8.1 CITED DOCUMENTS

156257 BSC (Bechtel SAIC Company) 2001. *Model Validation Status Review*. TDR-WIS-MD-000005 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20011211.0095.

158794 BSC (Bechtel SAIC Company) 2002. *Guidelines for Developing and Documenting Alternative Conceptual Models, Model Abstractions, and Parameter Uncertainty in the Total System Performance Assessment for the License Application*. TDR-WIS-PA-000008 REV 00, ICN 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20020904.0002.

159527 BSC (Bechtel SAIC Company) 2002. *Repository Design, Repository/PA IED Subsurface Facilities Plan Sht. 1 of 5, Sht. 2 of 5, Sht. 3 of 5, Sht. 4 of 5, and Sht. 5 of 5*. DWG-MGR-MD-000003 REV A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20020601.0194.

160819 BSC (Bechtel SAIC Company) 2002. *Technical Work Plan for: Performance Assessment Unsaturated Zone*. TWP-NBS-HS-000003 REV 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20030102.0108.

160146 BSC (Bechtel SAIC Company) 2002. *Total System Performance Assessment-License Application Methods and Approach*. TDR-WIS-PA-000006 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20020923.0175.

161773 BSC (Bechtel SAIC Company) 2003. *Analysis of Hydrologic Properties Data*. MDL-NBS-HS-000014 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20030404.0004.

165179 BSC (Bechtel SAIC Company) 2003. *Q-List*. TDR-MGR-RL-000005 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20030930.0002.

162289 BSC (Bechtel SAIC Company) 2003. *Repository Design, Repository/PA IED Subsurface Facilities*. 800-IED-EBS0-00401-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20030303.0002.

161727 BSC (Bechtel SAIC Company) 2003. *Repository Design, Repository/PA IED Subsurface Facilities*. 800-IED-EBS0-00402-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20030109.0146.

161770 Canori, G.F. and Leitner, M.M. 2003. *Project Requirements Document*. TER-MGR-MD-000001 REV 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20030404.0003.

163189 Cochran, J.R.; Beyeler, W.E.; Brosseau, D.A.; Brush, L.H.; Brown, T.J.; Crowe, B.M.; Conrad, S.H.; Davis, P.A.; Ehrhorn, T.; Feeney, T.; Fogleman, B.; Gallegos, D.P.; Haaker, R.; Kalinina, E.; Price, L.L.; Thomas, D.P.; and Wirth, S. 2001. *Compliance Assessment Document for the Transuranic Wastes in the Greater Confinement Disposal Boreholes at the Nevada Test Site, Volume 2: Performance Assessment, Version 2.0*. SAND2001-2977. Albuquerque, New Mexico: Sandia National Laboratories. TIC: 254267.

143244 CRWMS M&O (Civilian Radioactive Waste Management and Operating Contractor) 2000. *Analysis of Infiltration Uncertainty*. ANL-NBS-HS-000027 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000525.0377.

148384 CRWMS M&O 2000. *Total System Performance Assessment (TSPA) Model for Site Recommendation.* MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

124946 Flint, A.L. and Childs, S.W. 1991. "Use of the Priestley-Taylor Evaporation Equation for Soil Water Limited Conditions in a Small Forest Clearcut." *Agricultural and Forest Meteorology, 56*, (3-4), 247-260. Amsterdam, The Netherlands: Elsevier. TIC: 241865.

162880 Flint, A.L.; Flint, L.E.; Hevesi, J.A.; D'Agnese, F.A.; and Faunt, C.C. 2000. "Estimation of Regional Recharge and Travel Time Through the Unsaturated Zone in Arid Climates." *Dynamics of Fluids in Fractured Rock, [Papers Selected from a Symposium held at Ernest Orlando Lawrence Berkeley National Laboratory on February 10-12, 1999]*. Faybishenko, B.; Witherspoon, A.; and Benson, S.M.; eds. Geophysical Monograph 122. Pages 115-128. [Washington, D.C.]: American Geophysical Union. TIC: 254272.

164506 Flint, A.L.; Flint, L.E.; Kwicklis, E.M.; Bodvarsson, G.S.; and Fabryka-Martin, J.M. 2001. "Hydrology of Yucca Mountain, Nevada." *Reviews of Geophysics, 39,* (4), 447-470. Washington, D.C.: American Geophysical Union. TIC: 254964.

100147 Flint, A.L.; Hevesi, J.A.; and Flint, L.E. 1996. *Conceptual and Numerical Model of Infiltration for the Yucca Mountain Area, Nevada*. Milestone 3GUI623M. Denver, Colorado: U.S. Geological Survey. ACC: MOL.19970409.0087.

154365 Freeze, G.A.; Brodsky, N.S.; and Swift, P.N. 2001. *The Development of Information Catalogued in REV00 of the YMP FEP Database*. TDR-WIS-MD-000003 REV 00 ICN 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010301.0237.

101173 Freeze, R.A. and Cherry, J.A. 1979. *Groundwater*. Englewood Cliffs, New Jersey: Prentice-Hall. TIC: 217571.

125313 French, R.H. 1983. "Precipitation in Southern Nevada." *Journal of Hydraulic Engineering, 109*, (7), 1023-1036. New York, New York: American Society of Civil Engineers. TIC: 238300.

163705 Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. New York, New York: John Wiley & Sons. TIC: 252619.

164070 Guertal, W. 2001. Seepage into Alcove 1. Scientific Notebook SN-USGS-SCI-108-V1. ACC: MOL.20011219.0325.

164071 Guertal, W. 2001. Seepage into Alcove 1. Scientific Notebook SN-USGS-SCI-108-V2. ACC: MOL.20011219.0326.

156572 Helton, J.C. and Davis, F.J. 2000. *Sampling-Based Methods for Uncertainty and Sensitivity Analysis.* SAND99-2240. Albuquerque, New Mexico: Sandia National Laboratories. TIC: 251256.

163475 Helton, J.C. and Davis, F.J. 2002. *Latin Hypercube Sampling and the Propagation of Uncertainty in Analyses of Complex Systems*. SAND2001-0417. Albuquerque, New Mexico: Sandia National Laboratories. TIC: 254367.

100951 Helton, J.C.; Bean, J.E.; Berglund, J.W.; Davis, F.J.; Economy, K.; Garner, J.W.; Johnson, J.D.; MacKinnon, R.J.; Miller, J.; O'Brien, D.G.; Ramsey, J.L.; Schreiber, J.D.; Shinta, A.; Smith, L.N.; Stoelzel, D.M.; Stockman, C.; and Vaughn, P. 1998. *Uncertainty and Sensitivity Analysis Results Obtained in the 1996 Performance Assessment for the Waste Isolation Pilot Plant*. SAND98-0365. Albuquerque, New Mexico: Sandia National Laboratories. TIC: 238277.

127858 Helton, J.C.; Garner, J.W.; McCurley, R.D.; and Rudeen, D.K. 1991. *Sensitivity Analysis Techniques and Results for Performance Assessment at the Waste Isolation Pilot Plant*. SAND90-7103. Albuquerque, New Mexico: Sandia National Laboratories. ACC: NNA.19930104.0089.

116809 Hevesi, J.A.; Flint, A.L.; and Istok, J.D. 1992. "Precipitation Estimation in Mountainous Terrain Using Multivariate Geostatistics. Part II: Isohyetal Maps." *Journal of Applied Meteorology, 31*, (7), 677-688. Boston, Massachusetts: American Meteorological Society. TIC: 225248.

165064 Iman, R.L. and Conover, W.J. 1982. *Sensitivity Analysis Techniques: Self-Teaching Curriculum.* NUREG/CR-2350. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: HQS.19880517.2724.

100905 Iman, R.L. and Shortencarier, M.J. 1984. *A FORTRAN 77 Program and User's Guide for the Generation of Latin Hypercube and Random Samples for Use with Computer Models*. NUREG/CR-3624. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 224592.

100153 LeCain, G.D. 1997. *Air-Injection Testing in Vertical Boreholes in Welded and Nonwelded Tuff, Yucca Mountain, Nevada.* Water-Resources Investigations Report 96-4262. Denver, Colorado: U.S. Geological Survey. ACC: MOL.19980310.0148.

100052 LeCain, G.D. 1998. *Results from Air-Injection and Tracer Testing in the Upper Tiva Canyon, Bow Ridge Fault, and Upper Paintbrush Contact Alcoves of the Exploratory Studies Facility, August 1994 through July 1996, Yucca Mountain, Nevada*. Water-Resources Investigations Report 98-4058. Denver, Colorado: U.S. Geological Survey. ACC: MOL.19980625.0344.

163183 Levitt, D.G.; Lohrstorfer, C.F.; Sully, M.J.; and Ginanni, J.M. 1996. "An Arid Zone Lysimeter Facility for Performance Assessment and Closure Investigations at the Nevada Test Site." *HLW, LLW, Mixed Wastes and Environmental Restoration — Working Towards a Cleaner Environment, WM '96, Proceedings, February 25-29, 1996, Tucson, Arizona*. Tucson, Arizona: Laser Options. TIC: 254421.

163191 Levitt, D.G.; Sully, M.J.; and Lohrstorfer, C.F. 1996. *Modeling Evapotranspiration from Arid Environments: Literature Review and Preliminary Model Results*. Las Vegas, Nevada: Bechtel Nevada. TIC: 254273.

162470 Liu, H-H.; Haukwa, C.B.; Ahlers, C.F.; Bodvarsson, G.S.; Flint, A.L.; and Guertal, W.B. 2003. "Modeling Flow and Transport in Unsaturated Fractured Rock: An Evaluation of the Continuum Approach." *Journal of Contaminant Hydrology, 62-63*, 173-188. New York, New York: Elsevier. TIC: 254205.

125317 Maidment, D.R., ed. 1993. *Handbook of Hydrology*. New York, New York: McGraw-Hill. TIC: 236568.

162947 McCurley, R. 2003. " 'Evaluation of the Occurrence of Termite Species and Potential Termite Burrowing Depths in the Area of the Nevada Test Site: Present Data and for the Next 10,000 Years' by Myles, T.G. and Hooten, M.M." Memorandum from R. McCurley (SNL) to Records Processing Center (RPC), October 22, 2003, with attachment. ACC: MOL.20031023.0116.

127905 McKay, M.D.; Beckman, R.J.; and Conover, W.J. 1979. "A Comparison of Three Methods for Selecting Values of Input Variables in the Analysis of Output from a Computer Code." *Technometrics, 21*, (2), 239-245. Alexandria, Virginia: American Statistical Association. TIC: 221741.

149850 Mongano, G.S.; Singleton, W.L.; Moyer, T.C.; Beason, S.C.; Eatman, G.L.W.; Albin, A.L.; and Lung, R.C. 1999. *Geology of the ECRB Cross Drift - Exploratory Studies Facility, Yucca Mountain Project, Yucca Mountain, Nevada.* [Deliverable SPG42GM3]. Denver, Colorado: U.S. Geological Survey. ACC: MOL.20000324.0614.

163274 NRC (U.S. Nuclear Regulatory Commission) 2003. *Yucca Mountain Review Plan, Final Report*. NUREG-1804, Rev. 2. Washington, D.C.: U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards. TIC: 254568.

125321 Priestley, C.H.B. and Taylor, R.J. 1972. "On the Assessment of Surface Heat Flux and Evaporation Using Large-Scale Parameters." *Monthly Weather Review, 100*, (2), 81-92. Washington, D.C.: U.S. Department of Commerce. TIC: 235941.

125981 Rechard, R.P. 1996. *An Introduction to the Mechanics of Performance Assessment Using Examples of Calculations Done for the Waste Isolation Pilot Plant Between 1990 and 1992*. SAND93-1378 Revised. Albuquerque, New Mexico: Sandia National Laboratories. TIC: 245715.

128001 Rundel, P.W. and Nobel, P.S. 1991. "Structure and Function in Desert Root Systems." *Plant Root Growth, An Ecological Perspective, Special Publication Number 10,* 349-378. London, England: Blackwell Scientific Publications. TIC: 242299.

163930 Saliby, E. and Pacheco, F. 2002. "An Emperical Evaluation of Sampling Methods in Risk Analysis Simulation: Quasi-Monte Carlo, Descriptive Sampling, and Latin Hypercube Sampling." *Proceedings of the 2002 Winter Simulation Conference, [San Diego, California, December 8-11, 2002]*. Yücesan, E.; Chen, C.-H.; Snowdon, J.L.; and Charnes, J.M.; eds. 1606-1610. [New York, New York: Institute of Electrical and Electronics Engineers]. TIC: 254434.

154246 USDA (U.S. Department of Agriculture) 1994. *State Soil Geographic (STATSGO) Data Base, Data Use Information*. Miscellaneous Publication Number 1492. Washington, D.C.: U.S. Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center. TIC: 249639.

158378 USGS (U.S. Geological Survey) 2001. *Future Climate Analysis.* ANL-NBS-GS-000008 REV 00 ICN 01. Denver, Colorado: U.S. Geological Survey. ACC: MOL.20011107.0004.

160355 USGS (U.S. Geological Survey) 2001. *Simulation of Net Infiltration for Modern and Potential Future Climates*. ANL-NBS-HS-000032 REV 00 ICN 02. Denver, Colorado: U.S. Geological Survey. ACC: MOL.20011119.0334.

162955 Wallace, A.; Romney, E.M.; and Cha, J.W. 1980. "Depth Distribution of Roots of Some Perennial Plants in the Nevada Test Site Area of the Northern Mojave Desert." *Great Basin Naturalist Memoirs, 4*, 201-207. [Provo, Utah]: Brigham Young University. TIC: 254271.

162961 Wirth, S.; Brown, T.; and Beyeler, W. 1999. *Native Plant Uptake Model for Radioactive Waste Disposal Areas at the Nevada Test Site*. SAND98-1789. Albuquerque, New Mexico: Sandia National Laboratories. TIC: 254423.

Software Cited

152614 Dynamic Graphics. 1998. *Software Code: EARTHVISION*. 5.1. Silicon Graphics Indigo R4000. 10174-5.1-00.

147277 SNL (Sandia National Laboratories) 2000. *Software Code: LHS*. V2.50. DEC Alpha/Open VMS.AXP V7.2. 10205-2.50-00.

147608 SNL (Sandia National Laboratories) 2001. *Software Code: INFIL*. VA_2.a1. DEC Alpha, OpenVMS V7.2-1. 10253-A_2.a1-00.

158223 SNL (Sandia National Laboratories) 2002. *Software Code: GSLIB HISTPLT*. V2.01. 10802-2.01-00.

164058 SNL (Sandia National Laboratories) 2003. *Software Code: ALGEBRACDB*. V2.35. Compaq ALPHA/OpenVMS 7.3-1. 10985-2.35-00.

164055 SNL (Sandia National Laboratories) 2003. *Software Code: CAMCON_LIB*. V2.19. Compaq ALPHA/OpenVMS 7.3-1. 10992-2.19-00.

164056 SNL (Sandia National Laboratories) 2003. *Software Code: CAMDAT_LIB*. V1.24. Compaq ALPHA/OpenVMS 7.3-1. 10991-1.24-00.

164057 SNL (Sandia National Laboratories) 2003. *Software Code: CAMSUPES_ LIB*. V2.21. Compaq ALPHA/OpenVMS 7.3-1. 10990-2.21-00.

163676 SNL (Sandia National Laboratories) 2003. *Software Code: POSTINFIL*. V2.50. Compaq ALPHA/OpenVMS 7.3-1. 10983-2.50-00.

163675 SNL (Sandia National Laboratories) 2003. *Software Code: POSTLHS*. V4.07. Compaq ALPHA/OpenVMS 7.3-1. 10989-4.07-00.

163674 SNL (Sandia National Laboratories) 2003. *Software Code: PREINFIL*. V1.20. Compaq ALPHA/OpenVMS 7.3-1. 10982-1.20-00.

163673 SNL (Sandia National Laboratories) 2003. *Software Code: PRELHS*. V2.02. Compaq ALPHA/OpenVMS 7.3-1. 10981-2.02-00.

139422 USGS (U.S. Geological Survey) 2001. *Software Code: INFIL*. V2.0. PC. 10307-2.0-00.

8.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

156605 10 CFR 63. Energy: Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada. Readily available.

AP-2.22Q, Rev. 1, ICN 0. *Classification Analyses and Maintenance of Q-List*. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20030807.0002.

AP-SI.1Q, Rev. 5, ICN 2. *Software Management*. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20030902.0003.

AP-SI.3Q, Rev. 1, ICN 1. *Software Independent Verification and Validation*. Washington, D.C.: U.S Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.200300902.0002.

AP-SIII.9Q, Rev. 1, ICN 1. *Scientific Analyses*. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: DOC.20030929.0005.

8.3 SOURCE DATA, LISTED BY DATA TRACKING NUMBER

146853 GS000308311221.004. Geospatial Input Data for Infil V2.0 FY99. Submittal date: 03/01/2000.

147613 GS000308311221.005. Net Infiltration Modeling Results for 3 Climate Scenarios for FY99. Submittal date: 03/01/2000.

147602 GS000308311221.010. Developed Daily Climate Data from Tule Lake, California Used for Infiltration Uncertainty Analysis. Submittal date: 03/07/2000.

147615 GS000308311221.011. Template Files for Uncertainty Analyses. Submittal date: 03/13/2000.

162980 GS000808312242.006. Pulse Flow Meter Data for the Alcove 1 Infiltration Experiment from 02/19/99 to 06/20/00. Submittal date: 09/07/2000.

162979 GS990108312242.006. Pulse Flow Meter Data for the Alcove 1 Infiltration Experiment from 03/08/98 to 12/04/98. Submittal date: 01/29/1999.

164527 MO0307SEPFEPS4.000. LA FEP List. Submittal date: 07/31/2003.

8.4 OUTPUT DATA, LISTED BY DATA TRACKING NUMBER

SN0308T0503100.008. Revised Frequency Distributions For Net Infiltrations And Weighting Factors Applied To Lower, Mean, And Upper Climates. Submittal date: 08/28/2003.

SN0309T0503100.009. Updated Input Parameter Distributions Used For Infiltration Uncertainty Analysis. Submittal date: 09/15/2003.

SN0309T0503100.010. Updated Annual Average Net Infiltration Using Five Approximations Of The Repository Footprint. Submittal date: 09/15/2003.

SN0309T0503100.011. Statistical Tests For Normalcy And Conversion Of Daily Precipitation Data Into Annual Precipitation Data. Submittal date: 09/15/2003.

INTENTIONALLY LEFT BLANK

ATTACHMENT I

LISTING OF SAMPLE INPUT FOR SOFTWARE

Example input files are included for the following software in order of use in analysis. They appear in this attachment in the order below. Table I-1 contains a cross-reference chart describing the linkage of input files and output files for these software.

PRELHS V2.02 (SNL 2003 [163673])
LHS V2.50 (SNL 2000 [147277])
POSTLHS V4.07 (SNL 2003 [163675])
PREINFIL V1.20 (SNL 2003 [163674])
INFIL V. A_2.a1 (SNL 2000 [147608])
POSTINFIL V2.50 (SNL 2003 [163676])
ALGEBRACDB V2.35 (SNL 2003 [164058])
GSLIB HISTPLT V2.02 (SNL 2002 [158223])

Table I-1. Parameter Naming Convention Correspondence Between Tables I-2a and I-6 or I-7

Parameter Name	
I-2a	**I-6 and I-7**
BRPOROS	RKPOR
BRZDEPTH	RDEPTH4
SOILDEPM	SDFACT
PRECIPM	PPTFACT
POTETMUL	ETFACT
BRPERM	IMBFACT
SOILPERM	SKSFACT
ETCOEFFA	BARSOIL1
ETCOEFFB	BARSOIL2
SUBPARI	SUBPARI
SNOPARI	SNOPARI

NOTE: Parameter names may occur in upper or lower case, and are equivalent.

Table I-2a. Input User Control File for PRELHS software item

```
!  DESCRIPTION:
!  PRELHS Variable Sampling Input File for Glacial Transition Climate
!
!========= No Comments Allowed between *ECHO and *ENDECHO ==============
*ECHOLHS
TITLE BEGIN LHS, Aug 22, 2003 SAMPLING FOR FOOTPRINT SET WATERSHEDS
NOBS                100
RANDOM SEED         0733050198
OUTPUT CORR HIST DATA PLOT
*ENDECHO
!
!==== PROPERTIES TO BE RETRIEVED FROM YMP DATABASE, '.SDB' ====
*RETRIEVE
!
   MATERIALS,  FOOTPRNT
   PROPERTIES, BRPOROS, BRZDEPTH, SOILDEPM, PRECIPM, POTETMUL, BRPERM, &
               SOILPERM, ETCOEFFA, ETCOEFFB, FLAREA, SUBPAR1, SNOPAR1
!
!=========================================================================
!
*END
```

NOTE: Statements following ! are comments and not read as input

Table I-2b. ASCII Datafile Containing Uncertain Parameter Distributions Used to Set Up Input Files for LHS

PARAMETERS.SDB;7 22-AUG-2003 16:18:24.92

```
*HEADERLINES=1
*ENTRY=IDMTRL,IDPRAM
ID         2:5       I4        'ID'
IDMTRL     7:14      A8        'MATERIAL ID'
IDPRAM    16:23      A8        'PARAMETER ID'
MEAN      24:35      1PE12.4     'MEAN'
MEDIAN    36:47      1PE12.4     'MEDIAN'
LOWRNG    48:59      1PE12.4     'MINIMUM'
HIRNGE    60:71      1PE12.4     'MAXIMUM'
VRYFRC    72:83      1PE12.4     'COEFFICIENT OF VARIATION'
SCALE     84:95      1PE12.4     'PROBABILITY'
DISTYP    97:108     A12       'DISTRIBUTION'
UNITS    110:121     A12       'UNITS'
IDWELL   123:130     A8        'DUMMY WELL ID'
IDSCAL   123:130     A8        'DUMMY SCALE ID'
*NMGEOL=PARAMETERS.SDB
*NSDBVR=1
*ENDDSCR
         BRPOROS, BRZDEPTH, SOILDEPM, PRECIPM, POTETMUL, BRPERM,
         SOILPERM, ETCOEFFA, ETCOEFFB, FLAREA, SNOPAR1, SUBPAR1
 ID   IDMTRL   IDPRAM  MEAN        MEDIAN      LOWRNG      HIRNGE      VRYFRC      SCALE        DISTYP       UNITS
 1001 FOOTPRNT BRPOROS   9.0000E-03  9.0000E-03  2.0000E-03  2.4000E-02  0.0000E+00  0.0000E+00 NORMAL       NONE
 1002 FOOTPRNT BRZDEPTH  1.5000E+00  1.5000E+00  0.0000E+00  3.0000E+00  0.0000E+00  0.0000E+00 NORMAL       m
 1003 FOOTPRNT SOILDEPM  1.0000E+00  1.0000E+00  1.0000E-01  1.9000E+00  0.0000E+00  0.0000E+00 NORMAL       NONE
 1004 FOOTPRNT PRECIPM   1.0000E+00  1.0000E+00  6.0000E-01  1.4000E+00  0.0000E+00  0.0000E+00 NORMAL       NONE
 1005 FOOTPRNT POTETMUL  1.0000E+00  1.0000E+00  6.0000E-01  1.4000E+00  0.0000E+00  0.0000E+00 NORMAL       NONE
 1006 FOOTPRNT BRPERM    1.0000E+00  1.0000E+00  1.0000E-01  1.0000E+01  0.0000E+00  0.0000E+00 LOGNORMAL    NONE
 1007 FOOTPRNT SOILPERM  1.0000E+00  1.0000E+00  1.0000E-01  1.0000E+01  0.0000E+00  0.0000E+00 LOGNORMAL    NONE
 1008 FOOTPRNT ETCOEFFA  1.0000E+01  1.0000E+01  1.0000E-01  1.9900E+01  0.0000E+00  0.0000E+00 NORMAL       NONE
 1009 FOOTPRNT ETCOEFFB  1.0400E+00  1.0400E+00  5.4000E-01  1.5400E+00  0.0000E+00  0.0000E+00 NORMAL       NONE
 1010 FOOTPRNT FLAREA    2.5000E-01  2.5000E-01  1.0000E-02  4.9000E-01  0.0000E+00  0.0000E+00 NORMAL       NONE
 1011 FOOTPRNT SNOPAR1   1.7800E+00  1.7800E+00  7.8000E-01  2.7800E+00  0.0000E+00  0.0000E+00 UNIFORM      NONE
 1012 FOOTPRNT SUBPAR1   1.0000E-01  1.0000E-01  0.0000E+00  2.0000E-01        0.0000E+00  0.0000E+00 UNIFORM      NONE
```

NOTE: See Table I-1 for parameter naming convention correspondence to Table I-6 or I-7.
The negative sign was assigned to ETCOEFFA in the code INFIL

Table I-3. Input file for LHS that is automatically produced by PRELHS software item.

```
NOBS                  100
RANDOM SEED           0733050198
NORMAL                    FOOTPRNT  BRPOROS
    2.00000E-03    2.40000E-02
NORMAL                    FOOTPRNT  BRZDEPTH
    0.00000E+00    3.00000E+00
NORMAL                    FOOTPRNT  SOILDEPM
    1.00000E-01    1.90000E+00
NORMAL                    FOOTPRNT  PRECIPM
    6.00000E-01    1.40000E+00
NORMAL                    FOOTPRNT  POTETMUL
    6.00000E-01    1.40000E+00
LOGNORMAL                 FOOTPRNT  BRPERM
    1.00000E-01    1.00000E+01
LOGNORMAL                 FOOTPRNT  SOILPERM
    1.00000E-01    1.00000E+01
NORMAL                    FOOTPRNT  ETCOEFFA
    1.00000E-01    1.99000E+01
NORMAL                    FOOTPRNT  ETCOEFFB
    5.40000E-01    1.54000E+00
NORMAL                    FOOTPRNT  FLAREA
    1.00000E-02    4.90000E-01
UNIFORM                   FOOTPRNT  SUBPAR1
    0.00000E+00    2.00000E-01
UNIFORM                   FOOTPRNT  SNOPAR1
    7.80000E-01    2.78000E+00
OUTPUT CORR HIST DATA PLOT
```

NOTES: See Attachment II for output from LHS.
Parameter names may occur in upper or lower case, and are equivalent.
ETCOEFFA is listed as a positive value, and the sign is changed.

Table I-4. Sample Input User Control File for POSTLHS Software item which Post-processes the LHS Output

```
!=======================================================================
!  TITLE:    POSTLHS input file == POSTLHS.INP
!  ANALYST:  R. McCurley--  08/22/2003 SNL/GRAM 505-998-0045
!=======================================================================
!
!  DESCRIPTION:  YMP INFIL FOOTPRINT WATERSHEDS ANALYSIS, Glacial
!                Transition
!
!=======================================================================
*ATTRIBUTE_STORE
   MATERIALS  = FOOTPRNT , &
!   ATTRIBUTE_NAMES =
   PROPERTY_NAMES = BRPOROS, BRZDEPTH, SOILDEPM, PRECIPM, POTETMUL, BRPERM, &
                    SOILPERM, ETCOEFFA, ETCOEFFB, FLAREA, SUBPAR1, SNOPAR1
!
!=======================================================================
*END
```

NOTE: Documented directory location, name, and date of file. Internal comments may not reflect correct information regarding this.
Statements following ! are comments and not read as input

Table I-5. Sample Input User Control File for PREINFIL Software item

```
PREINFIL user input file
!Analyst--Ron McCurley GRAM
! Date Aug 22, 2003
!Begin input
*FILES
 NAMES: MAIN=INFILMN_US1_R###.OUT, ECHO=INFILECHO_R###.OUT, &
        SUMMARY=INFILSM_US1_R###.OUT
*REPLACE
   REGION: FOOTPRNT
       PROPERTIES: PPTFACT=PRECIPM,ETFACT=POTETMUL,RDEPTH3=BRZDEPTH, &
       SKSFACT=SOILPERM, FLAREA=SAME, &
       SDFACT=SOILDEPM, RKPOR=BRPOROS, IMBFACT=BRPERM, BARSOIL1=ETCOEFFA, &
       BARSOIL2=ETCOEFFB, SNOPAR1=SAME, SUBPAR1=SAME
                                     *END
```

NOTE: Statements following ! are comments and not read as input

Table I-6. Template Input User Control File for INFIL Version A_2a.1 Input to PREINFIL

Source DTN: GS000308311221.011 [147615]

```
1   0.00000001                    IROUT(1 = coupled, 0 = uncoupled, -1 = flow routing off, -2 = infil off), IFRTOL
2   2     1.78                                   ISNOW, ISNWMOD, SNOPAR1
3   0.1   0.3                     ISUBLIM, SUBPAR1, SUBPAR2
0   1.                            IPPTTEST (1 for testing), PPTTEST = constant
0   .0                            IETTEST (1 for testing), ETTEST = constant
30.0                        CELSIZE (node spacing (meters): using for flow volume calculations)
544721.0  4072203.0               xcfs,ycfs: coords for discharge cell
1950  1    1996    366   1   5    yr1 = start year, dnn1 = start day, yr2 = end year, dn2 = end day
1     1    1    1                 multipliers ( pptfact, etfact, imbfact, sksfact)
1.0   0    0.4                    SDFACT (soil depth multiplier), IVEGC (set to 1 for map data), FVEGC (use if IVEGC = 0)
1.0   0.8   0.8    0.2            ROOTF1,ROOTF2,ROOTF3,ROOTF4
1.0   1.0   0.5    0.1            MAXWGT1, MAXWGT2, MAXWGT3, MAXWGT4
0.3   2.0   3.0    2.0            RDEPTH1,RDEPTH2,RDEPTH3,RDEPTH4,RDEPTHF
0.02  1.0  .25                    RKPOR, RKMMFACT, FLAREA
1   1    0                        INFMOD, ETMOD, RUNMOD
 -10.0  1.04                       BARSOIL1, BARSOIL2:  bare soil et parameters
3   17.3  11.74                   IAIRTEMP = 1 for new air temp model, ATEMP1 = avg. air temp, ATEMP2 = air temp seasonal
deviation
2                HSTEP: time step for PET model (hours)
5  181  3        PPTYUC (=5 diminished elev. correlation, =2 for 4JA , =1 for simple elevation transfer), AAPREPX, IPPTDAT
Tulelake.inp                      input file name:  daily precip
     0      1    0.5      1     1              dpthflag, irtz, delvwcf, moistcr, fracmod
     0      1.75                  IVWCFLG,   vwcfact
us1.w20                           input file name:  map parameters (*.inp)-1
us1-gm1.2a1                                       dayall: average daily mass balance terms
1    1                                     ndaymap, imap
70   1995
us1-gm1.2a2
us1-gm1.2a3                                       output file name:  daily mass balance
us1-gm1.2a4                                       output file name:  total daily fluxes
1      1                                         dbgflag, dbgflag2
us1-gm1.2a5                                       output file name:  annual mass balance terms
0                                                IDEBUG:  debugging option parameter
us1-gm1.2a6                                       new debug file
us1-gm1                                          map output:  annual totals or mult-year averages
--------------- Parameters for dynamic root-zone function -------------------------------------
--      depth  rtza   rtzb   rtzc  rtzd  bsoil    delvwc
--      m
     1    0.5     15      3     3     2     0.30      0.50
     2    1.5     15      4     2     2     0.20      0.50
```

Table I-6. Template Input User Control File for INFIL Version A_2a.1 Input to PREINFIL (Continued)

```
     3    4.5     10    1.5     1     2     0.10      0.50
     4    6.0     10    1.5     1     2     0.05      0.25
--
-------------- Soil Properties (Brooks & Corey/van Genuchten combined) ------------------------------------------
--     fdcp   etresidpor    beta  alpah ksat     PE        B     n     vg-alpha sorp     SOILP   potis
--                                      Kg s /m^3J/Kg                  1/(J/Kg) ???             J/Kg
    10
     1  0.242  0.054  0.366  -3.5  1.26  5.6E-04 -1.19E+00  4.72  1.24  5.2E-01    0.390    0.05 -1.0E+02
     2  0.173  0.023  0.315  -3.5  1.26  1.2E-03 -9.41E-01  3.70  1.31  6.2E-01    0.500    0.05 -1.0E+02
     3  0.163  0.017  0.325  -3.5  1.26  1.3E-03 -8.60E-01  3.36  1.36  6.6E-01    0.510    0.05 -1.0E+02
     4  0.073  0.002  0.281  -3.5  1.26  3.8E-03 -6.22E-01  2.18  1.62  8.7E-01    0.700    0.05 -1.0E+02
     5  0.200  0.035  0.330  -3.5  1.26  6.7E-04 -1.07E+00  4.14  1.78  5.6E-01    0.400    0.05 -1.0E+02
     6  0.150  0.011  0.339  -3.5  1.26  2.7E-03 -7.55E-01  3.06  1.40  7.4E-01    0.700    0.05 -1.0E+02
     7  0.234  0.046  0.370  -3.5  1.26  5.6E-04 -1.10E+00  4.43  1.26  5.5E-01    0.390    0.05 -1.0E+02
     8  0.234  0.046  0.370  -3.5  1.26  5.6E-04 -1.10E+00  4.43  1.26  5.5E-01    0.390    0.05 -1.0E+02
     9  0.189  0.028  0.322  -3.5  1.26  5.7E-04 -1.08E+00  3.88  1.30  5.5E-01    0.370    0.05 -1.0E+02
    10  0.189  0.028  0.322  -3.5  1.26  5.7E-05 -1.08E+00  3.88  1.00  5.5E-01    0.037    0.05 -1.0E+02
--
--------------Rockl Properties (Brooks & Corey/van Genuchten combined)------------------------------------------
--     rkcp   etresidpor    beta  alpha ksat     PE        B     n     vg-alpha fracks   imbibe  potir
--                                      Kg s /m^3J/Kg                  1/(J/Kg) Kg s /m^3mm/dy   J/Kg
     129
       1     0.35    0.065    0.366     -1.5     1.26   0.0011    -0.93      3.6     1.25     0.52  0.00056       500      -100
       2    0.043    0.005    0.048     -1.5     1.26  1.6E-07    -88.1     6.43     1.25      890  3.7E-07      0.41      -100
       3    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052     46.66      -100
       4    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.09      -100
       5    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052     46.66      -100
       6    0.043    0.005    0.048     -1.5     1.26  1.6E-07    -88.1     6.43     1.25      890  3.7E-07      0.41      -100
       7    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052     46.66      -100
       8    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.09      -100
       9    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052     46.66      -100
      10    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.09      -100
      11    0.105     0.02     0.11     -1.5     1.26  4.0E-09       -6     3.92     1.47       64  2.4E-07      0.06      -100
      12    0.388    0.039    0.393     -1.5     1.26 0.000053     -242     4.57     1.38     2400 0.000053      2.74      -100
      13     0.43    0.044    0.435     -1.5     1.26   0.0004    -1790     6.81     1.23    18000   0.0004     13.83      -100
      14    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.09      -100
      15    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052     46.66      -100
      16    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.09      -100
      17    0.043    0.005    0.048     -1.5     1.26  1.6E-07    -88.1     6.43     1.25      890  3.7E-07      0.35      -100
      18    0.248     0.01    0.253     -1.5     1.26  3.8E-06    -82.3     2.71     1.84      830  3.9E-06      3.34      -100
      19    0.159     0.01    0.164     -1.5     1.26  1.2E-06     -140     3.61     1.53     1400  1.3E-06      1.13      -100
      20    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.06      -100
      21    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.06      -100
      22    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.06      -100
      23    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.06      -100
      24    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07      0.06      -100
```

Table I-6. Template Input User Control File for INFIL Version A_2a.1 Input to PREINFIL (Continued)

25	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
26	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
27	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
28	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
29	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
30	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
31	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
32	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
33	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
34	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
35	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
36	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
37	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
38	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
39	0.494	0.05	0.499	-1.5	1.26	0.000088	-4000	3.78	1.49	40000	0.000088	75.62	-100
40	0.494	0.05	0.499	-1.5	1.26	0.000088	-341	4.19	1.43	3400	0.000088	75.62	-100
41	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
42	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
43	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
44	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-26.9	5.6	1.29	270	2.1E-07	0.09	-100
45	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
99	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.25	-100
46	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
47	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
48	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
49	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
50	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
51	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
52	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
53	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
54	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
55	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
56	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
57	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
58	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
59	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
60	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
61	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
62	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
63	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
64	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
65	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
66	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
67	0.031	0.018	0.036	-1.5	1.26	5.0E-09	-0.6	3.39	1.58	10	2.4E-07	0.17	-100
68	0.168	0.021	0.173	-1.5	1.26	7.3E-08	-125	5.36	1.31	1300	1.3E-07	0.07	-100
69	0.327	0.066	0.332	-1.5	1.26	4.5E-09	-39	5.66	1.29	390	6.6E-08	0.02	-100

Table I-6. Template Input User Control File for INFIL Version A_2a.1 Input to PREINFIL (Continued)

70	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
71	0.327	0.066	0.332	-1.5	1.26	4.5E-09	-39	5.66	1.29	390	6.6E-08	0.01	-100
72	0.317	0.023	0.322	-1.5	1.26	3.8E-08	-181	4.01	1.46	1800	9.9E-08	1.65	-100
73	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
74	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
75	0.281	0.051	0.286	-1.5	1.26	1.7E-08	-17.5	4.01	1.45	180	7.8E-08	0.02	-100
76	0.112	0.011	0.117	-1.5	1.26	4.1E-08	-3.2	3.07	1.68	36	1.0E-07	0.09	-100
77	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.25	-100
201	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
202	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.06	-100
203	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
204	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	120	1.4E-07	500	-100
205	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
206	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
207	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
208	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
209	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
210	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
211	0.112	0.011	0.117	-1.5	1.26	4.1E-08	-3.2	3.07	1.68	36	1.0E-07	0.09	-100
212	0	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
213	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
214	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
301	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	0.52	0.00056	500	-100
302	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	0.52	0.00056	500	-100
303	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
304	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
305	0.388	0.039	0.393	-1.5	1.26	0.000053	-242	4.57	1.38	2400	0.000053	2.74	-100
306	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
307	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
308	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
309	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
310	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
311	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
312	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
313	0.248	0.01	0.253	-1.5	1.26	3.8E-06	-82.3	2.71	1.84	830	3.9E-06	3.34	-100
314	0.248	0.01	0.253	-1.5	1.26	3.8E-06	-82.3	2.71	1.84	830	3.9E-06	3.34	-100
315	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
316	0.159	0.01	0.164	-1.5	1.26	1.2E-06	-140	3.61	1.53	1400	1.3E-06	1.13	-100
317	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
318	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
319	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
320	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
321	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
322	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
323	0.388	0.039	0.393	-1.5	1.26	0.000053	-242	4.57	1.38	2400	0.000053	2.74	-100
324	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100

Table I-6. Template Input User Control File for INFIL Version A_2a.1 Input to PREINFIL (Continued)

325	0.494	0.05	0.499	-1.5	1.26	0.000088	-4000	3.78	1.49	40000	0.000088	75.62	-100
326	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
327	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
328	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
329	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
330	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
331	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
332	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
333	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
334	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
335	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
336	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
345	0.097	0.01	0.102	-1.5	1.26	1.3E-07	-154.6	5.02	1.56	1560	2.9E-07	0.24	-100

NOTES: Line 9 data on simulation time in years is shadowed because even though Tule Lake data is provided beginning in 1931, the code is only using the data from 1950 onward through 1996

Line 14 comment on right side should not include RDEPTH3 (no such data item is read by INFIL V A_2.a1). Thus, RDEPTH4 is 3rd (not 4th) actual entry on this line.

Line 19 data on air temperature is shadowed because the code is reading air temperature data directly from a file; it does not use the value of 17.3.

Table I-7. Sample Input User Control File for INFIL Version A_2a.1 Produced by PREINFIL

INFIL_US1_R001.INP;4

22-AUG-2003 16:52:14.26

```
INFIL2a1.ctl: T1 test Wash, Tule Lake, us1-2a1-gm1-k2-w20 (11/18/1999)
1   0.00000001                                IROUT(1 = coupled, 0 = uncoupled, -1 = flow routing off, -2 = infil off),
IFRTOL
   2   2 2.16E+00                             ISNOW   ISNWMOD SNOPAR1
  3 1.57E-01 3.00E-01                         ISUBLIM SUBPAR1 SUBPAR2
0   1.                                        IPPTTEST (1 for testing), PPTTEST = constant
0   .0                                        IETTEST (1 for testing), ETTEST = constant
30.0                                           CELSIZE (node spacing (meters): using for flow volume calculations)
544721.0  4072203.0                           xcfs,ycfs: coords for discharge cell
1950  1    1996    366   1   5                yr1 = start year, dnn1 = start day, yr2 = end year, dn2 = end day
1.12E+00 9.01E-01 3.70E+00 1.85E+00           MULTIPLI(       PPTFACT ETFACT  IMBFACT SKSFACT)
1.23E+00   0  4.00E-01                        SDFACT  (SOIL   DEPTH
1.0   0.8   0.8    0.2                        ROOTF1,ROOTF2,ROOTF3,ROOTF4
1.0   1.0   0.5    0.1                        MAXWGT1, MAXWGT2, MAXWGT3, MAXWGT4
  0.30  2.00  2.06  2.00                        RDEPTH1 RDEPTH2 RDEPTH3 RDEPTH4
1.82E-02  1.00E+00  3.04E-01                      RKPOR    RKMMFACT FLAREA
1   1    0                                    INFMOD, ETMOD, RUNMOD
 -11.210   1.102                              BARSOIL1 BARSOIL2
3   17.3  11.74                               IAIRTEMP = 1 for new air temp model, ATEMP1 = avg. air temp, ATEMP2 = air temp
seaso
2                                             HSTEP: time step for PET model (hours)
5  181  3                                     PPTYUC (=5 diminished elev. correlation, =2 for 4JA , =1 for simple elevation
transf
Tulelake.inp                                  input file name:  daily precip
     0      1    0.5      1     1             dpthflag, irtz, delvwcf, moistcr, fracmod
     0      1.75                               IVWCFLG,   vwcfact
us1.w20                                       input file name:  map parameters (*.inp)
-1
us1-gm1.2a1                                     dayall: average daily mass balance terms
1    1                                   ndaymap, imap
70   1995
us1-gm1.2a2
INFILSM_US1_R001.OUT
INFILMN_US1_R001.OUT
1      1                                       dbgflag, dbgflag2
us1-gm1.2a5                                     output file name:  annual mass balance terms
0                                              IDEBUG:  debugging option parameter
INFILECHO_R001.OUT
us1-gm1                                        map output:  annual totals or mult-year averages
--
-------------- Parameters for dynamic root-zone function --------------------------------------
```

Table I-7. Sample Input User Control File for INFIL Version A_2a.1 Produced by PREINFIL (Continued)

```
--     depth  rtza   rtzb   rtzc  rtzd  bsoil    delvwc
--     m
     4
     1    0.5     15      3     3     2     0.30      0.50
     2    1.5     15      4     2     2     0.20      0.50
3    4.5     10    1.5     1     2     0.10      0.50
     4    6.0     10    1.5     1     2     0.05      0.25
--
--------------- Soil Properties (Brooks & Corey/van Genuchten combined) -------------------------------------------
--     fdcp   etresidpor    beta  alpah ksat     PE        B     n     vg-alpha sorp     SOILP   potis
--                                      Kg s /m^3J/Kg                  1/(J/Kg) ???              J/Kg
    10
     1  0.242  0.054  0.366  -3.5  1.26  5.6E-04 -1.19E+00  4.72  1.24  5.2E-01    0.390    0.05 -1.0E+02
     2  0.173  0.023  0.315  -3.5  1.26  1.2E-03 -9.41E-01  3.70  1.31  6.2E-01    0.500    0.05 -1.0E+02
     3  0.163  0.017  0.325  -3.5  1.26  1.3E-03 -8.60E-01  3.36  1.36  6.6E-01    0.510    0.05 -1.0E+02
     4  0.073  0.002  0.281  -3.5  1.26  3.8E-03 -6.22E-01  2.18  1.62  8.7E-01    0.700    0.05 -1.0E+02
     5  0.200  0.035  0.330  -3.5  1.26  6.7E-04 -1.07E+00  4.14  1.78  5.6E-01    0.400    0.05 -1.0E+02
     6  0.150  0.011  0.339  -3.5  1.26  2.7E-03 -7.55E-01  3.06  1.40  7.4E-01    0.700    0.05 -1.0E+02
     7  0.234  0.046  0.370  -3.5  1.26  5.6E-04 -1.10E+00  4.43  1.26  5.5E-01    0.390    0.05 -1.0E+02
     8  0.234  0.046  0.370  -3.5  1.26  5.6E-04 -1.10E+00  4.43  1.26  5.5E-01    0.390    0.05 -1.0E+02
     9  0.189  0.028  0.322  -3.5  1.26  5.7E-04 -1.08E+00  3.88  1.30  5.5E-01    0.370    0.05 -1.0E+02
    10  0.189  0.028  0.322  -3.5  1.26  5.7E-05 -1.08E+00  3.88  1.00  5.5E-01    0.037    0.05 -1.0E+02
--
--------------Rockl Properties (Brooks & Corey/van Genuchten combined)-------------------------------------------
--     rkcp   etresidpor    beta  alpha ksat     PE        B     n     vg-alpha fracks   imbibe  potir
--                                      Kg s /m^3J/Kg                  1/(J/Kg) Kg s /m^3mm/dy   J/Kg
     129
       1     0.35    0.065    0.366     -1.5     1.26   0.0011    -0.93      3.6     1.25     0.52  0.00056      500      -100
       2    0.043    0.005    0.048     -1.5     1.26  1.6E-07    -88.1     6.43     1.25      890  3.7E-07     0.41      -100
       3    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052    46.66      -100
       4    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07     0.09      -100
       5    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052    46.66      -100
       6    0.043    0.005    0.048     -1.5     1.26  1.6E-07    -88.1     6.43     1.25      890  3.7E-07     0.41      -100
       7    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052    46.66      -100
       8    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07     0.09      -100
       9    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052    46.66      -100
      10    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07     0.09      -100
      11    0.105     0.02     0.11     -1.5     1.26  4.0E-09       -6     3.92     1.47       64  2.4E-07     0.06      -100
      12    0.388    0.039    0.393     -1.5     1.26 0.000053     -242     4.57     1.38     2400 0.000053     2.74      -100
      13     0.43    0.044    0.435     -1.5     1.26   0.0004    -1790     6.81     1.23    18000   0.0004    13.83      -100
      14    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07     0.09      -100
      15    0.401     0.07    0.406     -1.5     1.26 0.000052    -4150     6.78     1.23    42000 0.000052    46.66      -100
      16    0.077    0.011    0.082     -1.5     1.26  5.4E-09      -12     3.04     1.69      120  1.4E-07     0.09      -100
      17    0.043    0.005    0.048     -1.5     1.26  1.6E-07    -88.1     6.43     1.25      890  3.7E-07     0.35      -100
      18    0.248     0.01    0.253     -1.5     1.26  3.8E-06    -82.3     2.71     1.84      830  3.9E-06     3.34      -100
      19    0.159     0.01    0.164     -1.5     1.26  1.2E-06     -140     3.61     1.53     1400  1.3E-06     1.13      -100
```

Table I-7. Sample Input User Control File for INFIL Version A_2a.1 Produced by PREINFIL (Continued)

20	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
21	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
22	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
23	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
24	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
25	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
26	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
27	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
28	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
29	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
30	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
31	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
32	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
33	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
34	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
35	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
36	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
37	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
38	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
39	0.494	0.05	0.499	-1.5	1.26	0.000088	-4000	3.78	1.49	40000	0.000088	75.62	-100
40	0.494	0.05	0.499	-1.5	1.26	0.000088	-341	4.19	1.43	3400	0.000088	75.62	-100
41	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
42	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
43	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
44	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-26.9	5.6	1.29	270	2.1E-07	0.09	-100
45	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
99	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.25	-100
46	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
47	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
48	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
49	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
50	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
51	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
52	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
53	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
54	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
55	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
56	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
57	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
58	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
59	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
60	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
61	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
62	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
63	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
64	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100

Table I-7. Sample Input User Control File for INFIL Version A_2a.1 Produced by PREINFIL (Continued)

65	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
66	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
67	0.031	0.018	0.036	-1.5	1.26	5.0E-09	-0.6	3.39	1.58	10	2.4E-07	0.17	-100
68	0.168	0.021	0.173	-1.5	1.26	7.3E-08	-125	5.36	1.31	1300	1.3E-07	0.07	-100
69	0.327	0.066	0.332	-1.5	1.26	4.5E-09	-39	5.66	1.29	390	6.6E-08	0.02	-100
70	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
71	0.327	0.066	0.332	-1.5	1.26	4.5E-09	-39	5.66	1.29	390	6.6E-08	0.01	-100
72	0.317	0.023	0.322	-1.5	1.26	3.8E-08	-181	4.01	1.46	1800	9.9E-08	1.65	-100
73	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
74	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
75	0.281	0.051	0.286	-1.5	1.26	1.7E-08	-17.5	4.01	1.45	180	7.8E-08	0.02	-100
76	0.112	0.011	0.117	-1.5	1.26	4.1E-08	-3.2	3.07	1.68	36	1.0E-07	0.09	-100
77	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.25	-100
201	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
202	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.06	-100
203	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
204	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	120	1.4E-07	500	-100
205	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
206	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
207	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
208	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
209	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
210	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
211	0.112	0.011	0.117	-1.5	1.26	4.1E-08	-3.2	3.07	1.68	36	1.0E-07	0.09	-100
212	0	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
213	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
214	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
301	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	0.52	0.00056	500	-100
302	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	0.52	0.00056	500	-100
303	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
304	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
305	0.388	0.039	0.393	-1.5	1.26	0.000053	-242	4.57	1.38	2400	0.000053	2.74	-100
306	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
307	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
308	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
309	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
310	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
311	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
312	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
313	0.248	0.01	0.253	-1.5	1.26	3.8E-06	-82.3	2.71	1.84	830	3.9E-06	3.34	-100
314	0.248	0.01	0.253	-1.5	1.26	3.8E-06	-82.3	2.71	1.84	830	3.9E-06	3.34	-100
315	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
316	0.159	0.01	0.164	-1.5	1.26	1.2E-06	-140	3.61	1.53	1400	1.3E-06	1.13	-100
317	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
318	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
319	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100

Table I-7. Sample Input User Control File for INFIL Version A_2a.1 Produced by PREINFIL (Continued)

320	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
321	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
322	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
323	0.388	0.039	0.393	-1.5	1.26	0.000053	-242	4.57	1.38	2400	0.000053	2.74	-100
324	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
325	0.494	0.05	0.499	-1.5	1.26	0.000088	-4000	3.78	1.49	40000	0.000088	75.62	-100
326	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
327	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
328	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
329	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
330	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
331	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
332	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
333	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
334	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
335	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
336	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
345	0.097	0.01	0.102	-1.5	1.26	1.3E-07	-154.6	5.02	1.56	1560	2.9E-07	0.24	-100

NOTES: Line 9 data on simulation time in years is shadowed because even though Tule Lake data is provided beginning in 1931, the code is only using the data from 1950 onward through 1996

Line 14 comment on right side should not include RDEPTH3 (no such data item is read by INFIL V A_2.a1). Thus, RDEPTH4 is 3rd (not 4th) actual entry on this line.

Line 19 data on air temperature is shadowed because the code is reading air temperature data directly from a file; it does not use the value of 17.3.

Table I-8. Sample Input User Control File for POSTINFIL Software item

POSTINF_US1.INP;7   26-AUG-2003 09:35:10.46

```
!POSTINFIL input control file for watershed US1
!Store mean infiltration and no. of active cells for watershed US1
*STORE, &
 ARRAY=GLOBAL, STEP=1, COPY=0, &
 NAMES: MEAN_INFIL=INF_US1,NUMBER_CELLS=NCELLUS1,MEAN_RUNOFF=RUN_US1
*coord, &
 number=5, &
 number=4, &
 rect: x1=547750., x2=548550., y1=4077000., y2=4078400., &
 rect: x1=547350., x2=548550., y1=4078400., y2=4079490., &
 rect: x1=547350., x2=549200., y1=4079490., y2=4080228., &
 rect: x1=547350., x2=548900., y1=4080228., y2=4081200.
*END
```

NOTE: Statements following ! are comments and not read as input

Table I-9. Input File for ALGEBRACDB for Obtaining Weighted Average over Repository Footprint, Glacial Transition Climate

ALG_MEAN.INP;16 18-FEB-2003 13:22:58.40

```
!========================================================================
!$ compute the weighted mean infiltration rate
!$ sum over cells from all watersheds in repository footprint
 TEMPSUM1 = NCELLSE7+NCELLSE8+NCELLSE9+NCELSE10
 TEMPSUM2 = NCELLWT2+NCELLDH4+NCELLDH3+NCELLCW1+NCELLSW1
 SUMCELLS= MAKEGLOB(TEMPSUM1+TEMPSUM2+NCELLWW1+NCELLUS1)
!$
 TMPMEAN1 =  NCELLWT2*INF_WT2 + NCELLDH4*INF_DH4 + NCELLDH3*INF_DH3
 TMPMEAN2 =  NCELLCW1*INF_CW1 + NCELLSW1*INF_SW1 + NCELLWW1*INF_WW1
 TMPMEAN3 =  NCELLSE7*INF_SE7 + NCELLSE8*INF_SE8 + NCELLSE9*INF_SE9
 TMPMEAN4 =  NCELSE10*INF_SE10 + NCELLUS1*INF_US1
 INFMEAN = MAKEGLOB(TMPMEAN1 + TMPMEAN2 + TMPMEAN3 + TMPMEAN4)/SUMCELLS
 EXIT
```

NOTES: This input file did not change for the new distribution set
Statements following ! are comments and not read as input

Table I-10. Input “MEAN_NOCONT.PAR” File for HISTPLT Contains User Control Input

```
START OF PARAMETERS:
MEAN_nocont.DAT                     -file with data
2   0                         -   columns for variable and weight
0.0     100.00                  -   trimming limits
MEAN_nocont.ps                      -file for PostScript output
0.00     100.00                -attribute minimum and maximum
-1.0                          -frequency maximum (<0 for automatic)
20                             -number of classes
0                             -0=arithmetic, 1=log scaling
0                             -0=frequency,  1=cumulative histogram
-1                             -   number of cum. quantiles (<0 for all)
4                             -number of decimal places (<0 for auto.)
Net Infiltration              -title
1.5                           -positioning of stats (L to R: -1 to 1)
-1.1e21                       -reference value for box plot
```

NOTE: Output variable.
Statements following ! are comments and not read as input

Table I-11. Input "MEAN_NOCONT.DAT" File for HISTPLT Contains Spatially Averaged Net Infiltration Rates for 100 Realizations

```
Net Infiltration

Net Infiltration
 1.000000E+00  3.079317E+01
 2.000000E+00  1.928659E+01
 3.000000E+00  1.267163E+01
 4.000000E+00  2.425489E+01
 5.000000E+00  2.211648E+01
 6.000000E+00  1.429575E+00
 7.000000E+00  1.039542E+01
 8.000000E+00  3.829909E+01
 9.000000E+00  5.330711E+01
 1.000000E+01  2.964881E+01
 1.100000E+01  7.136793E+01
 1.200000E+01  1.548387E+01
 1.300000E+01  1.499520E+01
 1.400000E+01  1.822721E+01
 1.500000E+01  1.821940E+01
 1.600000E+01  4.047265E+01
 1.700000E+01  3.112090E+01
 1.800000E+01  8.348252E+00
 1.900000E+01  5.027693E+01
 2.000000E+01  2.109658E+01
 2.100000E+01  9.674167E+00
 2.200000E+01  6.829691E+01
 2.300000E+01  8.645650E+00
 2.400000E+01  1.150310E+01
 2.500000E+01  9.168285E+01
 2.600000E+01  8.281649E+00
 2.700000E+01  4.760906E+01
 2.800000E+01  4.033131E+01
 2.900000E+01  5.777871E+01
 3.000000E+01  2.425288E+01
 3.100000E+01  2.078906E+01
 3.200000E+01  4.733222E+01
 3.300000E+01  3.582712E+01
 3.400000E+01  4.367863E+01
 3.500000E+01  2.121077E+01
 3.600000E+01  3.859789E+01
 3.700000E+01  5.417884E+00
 3.800000E+01  2.984533E+01
 3.900000E+01  3.400833E+01
 4.000000E+01  2.224382E+01
 4.100000E+01  6.601534E+00
 4.200000E+01  1.408699E+01
 4.300000E+01  3.758164E+01
 4.400000E+01  2.515456E+01
 4.500000E+01  6.553335E+00
 4.600000E+01  4.988036E+01
 4.700000E+01  2.926154E+01
 4.800000E+01  7.720592E+00
 4.900000E+01  2.903201E+01
 5.000000E+01  8.698252E+00
 5.100000E+01  4.361856E+01
 5.200000E+01  3.584125E+00
 5.300000E+01  1.508128E+01
 5.400000E+01  1.097829E+01
 5.500000E+01  1.179343E+01
 5.600000E+01  4.752187E+01
 5.700000E+01  1.247029E+01
 5.800000E+01  4.880799E+01
 5.900000E+01  6.457878E+00
 6.000000E+01  2.261053E+01
 6.100000E+01  6.475675E+00
 6.200000E+01  2.123507E+00
 6.300000E+01  1.071773E+01
 6.400000E+01  1.877090E+00
 6.500000E+01  2.715320E+01
 6.600000E+01  1.460489E+01
 6.700000E+01  1.908889E+01
 6.800000E+01  1.010454E+01
 6.900000E+01  6.796621E+00
 7.000000E+01  3.600076E+01
 7.100000E+01  9.594579E+00
 7.200000E+01  9.303779E+00
 7.300000E+01  2.044018E+01
 7.400000E+01  2.377228E+01
 7.500000E+01  4.456317E+01
 7.600000E+01  1.247509E+00
 7.700000E+01  2.903187E+01
 7.800000E+01  1.724594E+01
 7.900000E+01  5.792326E+01
 8.000000E+01  5.413282E+01
 8.100000E+01  7.941258E+00
 8.200000E+01  7.742651E+00
 8.300000E+01  3.569651E+01
 8.400000E+01  2.294829E+01
 8.500000E+01  2.693925E+01
 8.600000E+01  1.551060E+01
 8.700000E+01  2.706384E+00
 8.800000E+01  1.295347E+01
 8.900000E+01  5.440431E+00
 9.000000E+01  1.187560E+01
 9.100000E+01  4.610298E+01
 9.200000E+01  1.826513E+01
 9.300000E+01  2.942361E+01
 9.400000E+01  1.406856E+01
 9.500000E+01  2.413916E+01
 9.600000E+01  1.721134E+01
 9.700000E+01  1.021559E+01
 9.800000E+01  1.702860E+01
 9.900000E+01  5.404278E+01
 1.000000E+02  2.515358E+01
```

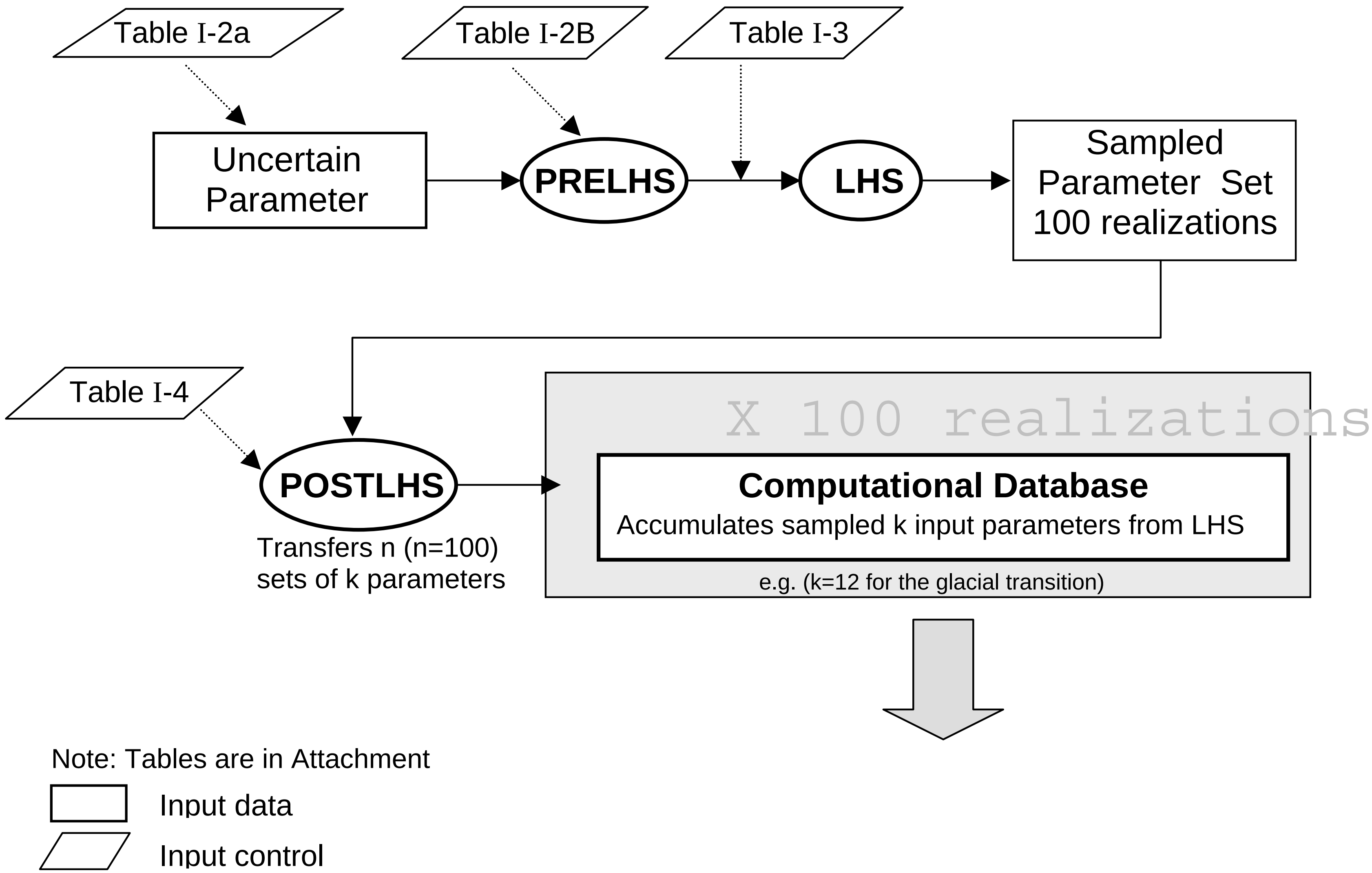
INTETIONALLY LEFT BLANK

ATTACHMENT II

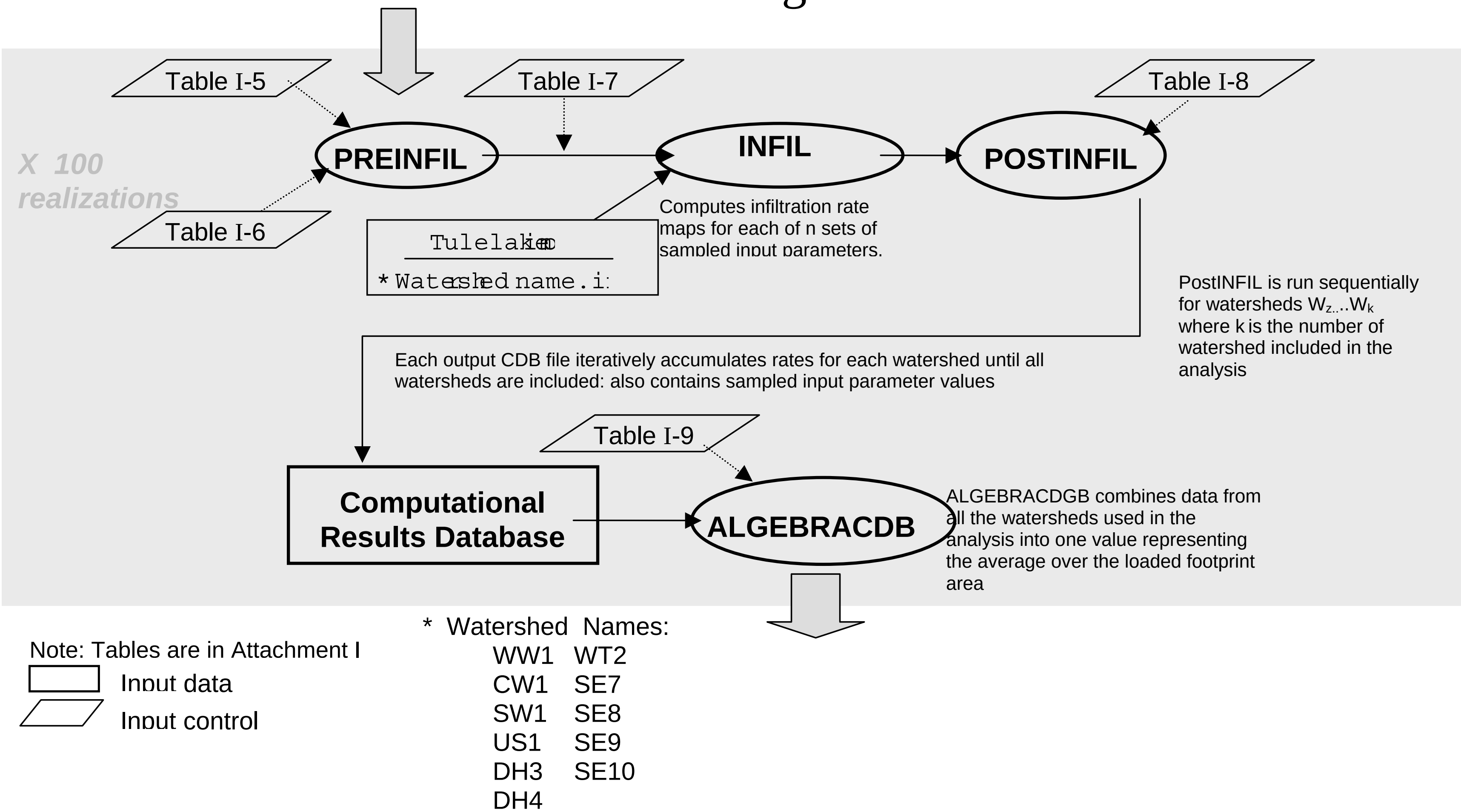
FLOW DIAGRAM OF UNCERTAINTY ANALYSIS FOR ONE REALIZATION

This attachment contains a diagram showing the flow of information as the uncertainty analysis proceeds towards the final product of each realization. The whole process is repeated 100 times, resulting in an uncertainty distribution for the infiltration-rate maps as spatially averaged over the modeled rectangular region.

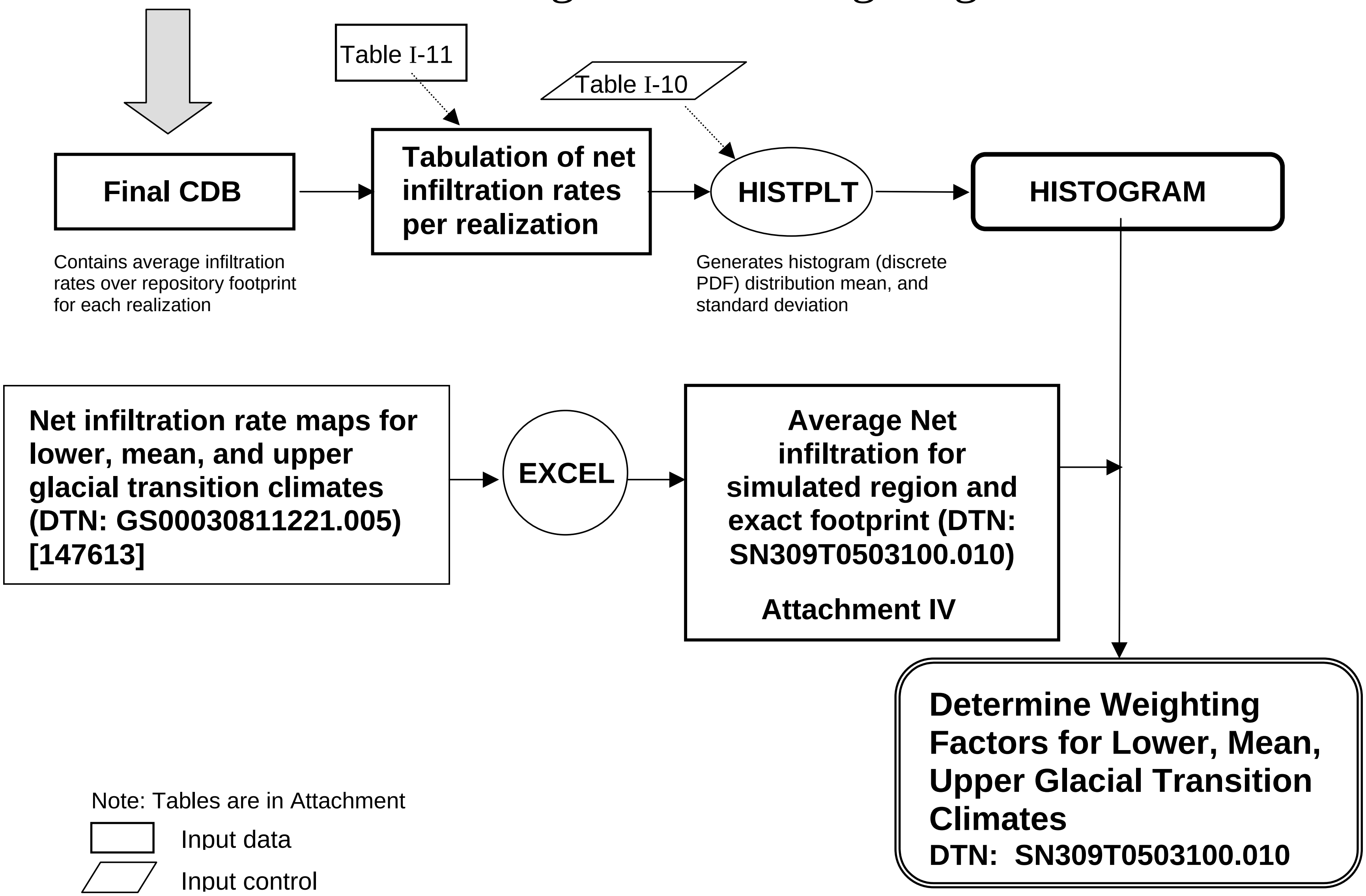
Generate LHS



Computer Net Infiltration Map and Average Net Infiltration for Simulated Region



Generate Histograms and Weighting Factors



ATTACHMENT III

OUTPUT FILE FROM LHS SAMPLED VALUES OF INPUT PARAMETERS FOR ALL 100 REALIZATIONS

This attachment contains sampled values for the twelve uncertain input parameters listed in Table 6-3 (as obtained from LHS) using 100 realizations.

(LHS first echos the input; random seed, number of realizations, sampled parameter names, distribution types and ranges. Then the actual sampled values for the 12 uncertain parameters for each of the 100 realizations begins following the heading. "LATIN HYPERCUBE SAMPLE INPUT VECTORS" on page III-3, where the sampled values for the first 10 parameters are listed first, horizontally, then for all 100 realizations, and then the sampled values for the remaining last two parameters are listed, again for 100 realizations. The realization number increases vertically downward. Below this table is another table showing the ranks for each parameter versus realization. And below this, finally, are displayed graphical representations of the resulting Latin Hypercube distribution for each parameter.)

Table III-1. LHS Output File Containing Sampled Values for 12 Uncertain Parameters

```
1

   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1              08/22/03 16:27:48

   RANDOM SEED =   733050198

   NUMBER OF VARIABLES =  12

   NUMBER OF OBSERVATIONS =  100
0  THE SAMPLE INPUT VECTORS WILL BE PRINTED ALONG WITH THEIR CORRESPONDING RANKS
0  HISTOGRAMS OF THE ACTUAL SAMPLE WILL BE PLOTTED FOR EACH INPUT VARIABLE
0  THE CORRELATION MATRICES (RAW DATA AND RANK CORRELATIONS) WILL BE PRINTED
0  A PLOT FILE OF SAMPLED VALUES AND CUMULATIVE PROBABILITIES WILL BE CREATED
1

   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1              08/22/03 16:27:48

   VARIABLE  DISTRIBUTION         RANGE           LABEL
0      1     NORMAL           2.0000E-03 TO   2.4000E-02  FOOTPRNT  BRPOROS
0      2     NORMAL           0.0000E+00 TO    3.000      FOOTPRNT  BRZDEPTH
0      3     NORMAL           0.1000     TO    1.900      FOOTPRNT  SOILDEPM
0      4     NORMAL           0.6000     TO    1.400      FOOTPRNT  PRECIPM
0      5     NORMAL           0.6000     TO    1.400      FOOTPRNT  POTETMUL
0      6     LOGNORMAL           0.1000     TO    10.00      FOOTPRNT  BRPERM
```

0 7 LOGNORMAL 0.1000 TO 10.00 FOOTPRNT SOILPERM

0 8 NORMAL 0.1000 TO 19.90 FOOTPRNT ETCOEFFA

0 9 NORMAL 0.5400 TO 1.540 FOOTPRNT ETCOEFFB

0 10 NORMAL 1.0000E-02 TO 0.4900 FOOTPRNT FLAREA

0 11 UNIFORM 0.0000E+00 TO 0.2000 FOOTPRNT SUBPAR1

0 12 UNIFORM 0.7800 TO 2.780 FOOTPRNT SNOPAR1

1TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0LATIN HYPERCUBE SAMPLE INPUT VECTORS

	RUN NO.	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)	X(8)	X(9)	X(10)
0	1	1.823E-02	2.060E+00	1.230E+00	1.115E+00	9.015E-01	3.698E+00	1.851E+00	1.121E+01	1.102E+00	3.044E-01
0	2	1.284E-02	3.000E+00	7.175E-01	8.211E-01	7.525E-01	6.332E-01	2.890E+00	1.366E+01	1.158E+00	1.557E-01
0	3	1.694E-02	2.801E+00	9.871E-01	9.971E-01	1.077E+00	3.644E-01	1.035E+00	9.421E+00	8.562E-01	3.208E-01
0	4	7.808E-03	1.536E+00	6.747E-01	9.582E-01	1.375E+00	4.567E+00	1.450E+00	1.356E+01	1.165E+00	4.268E-01
0	5	1.674E-02	1.322E+00	1.217E+00	1.024E+00	9.981E-01	4.088E+00	1.226E+00	5.313E+00	1.177E+00	2.193E-01
0	6	1.361E-02	1.576E+00	1.450E+00	6.208E-01	8.708E-01	8.936E-01	1.896E+00	1.088E+01	7.500E-01	1.340E-01
0	7	1.736E-02	1.515E+00	1.091E+00	9.348E-01	9.136E-01	5.330E-01	5.526E-01	9.808E+00	1.354E+00	3.492E-01
0	8	1.560E-02	1.168E+00	3.948E-01	1.194E+00	1.020E+00	2.993E-01	1.021E+00	8.538E+00	1.193E+00	1.893E-01
0	9	1.172E-02	1.054E+00	6.379E-01	1.144E+00	1.104E+00	2.529E+00	8.038E-01	5.179E+00	5.400E-01	8.259E-02
0	10	1.134E-02	1.295E+00	1.292E+00	1.073E+00	8.152E-01	1.661E+00	2.610E-01	1.499E+00	1.467E+00	2.785E-01
0	11	9.853E-03	2.268E+00	8.968E-01	1.252E+00	7.342E-01	1.007E+00	3.259E-01	7.534E+00	6.023E-01	1.303E-01
0	12	7.563E-03	1.210E+00	1.204E+00	8.813E-01	1.123E+00	5.763E+00	8.696E-01	9.352E+00	1.150E+00	2.856E-01
0	13	1.356E-02	1.774E+00	1.392E+00	1.170E+00	1.135E+00	1.063E+00	8.321E-01	1.695E+01	1.403E+00	4.811E-01
0	14	8.031E-03	1.810E+00	8.060E-01	8.351E-01	1.099E+00	3.049E+00	1.179E+00	2.771E+00	1.325E+00	2.183E-01
0	15	4.424E-03	2.021E+00	8.375E-01	8.849E-01	9.188E-01	6.677E-01	5.081E-01	1.140E+01	1.062E+00	2.707E-01
0	16	1.031E-02	2.840E+00	8.235E-01	1.177E+00	1.049E+00	2.067E+00	2.220E+00	7.330E+00	1.265E+00	2.907E-01

0	17	2.054E-02	2.156E+00	9.597E-01	1.102E+00	1.006E+00	2.753E+00	2.087E-01	7.963E+00	9.041E-01	4.194E-01
0	18	1.631E-02	2.013E+00	1.332E+00	6.838E-01	9.656E-01	7.951E+00	3.044E+00	3.420E+00	6.412E-01	3.573E-01
0	19	6.506E-03	2.298E+00	5.468E-01	9.258E-01	9.488E-01	1.000E+01	4.167E-01	1.214E+01	9.933E-01	1.944E-01
0	20	2.117E-02	1.421E+00	1.725E+00	1.153E+00	9.650E-01	2.613E+00	2.796E-01	1.894E+01	6.666E-01	1.836E-01
0	21	2.019E-02	1.088E+00	9.112E-01	9.036E-01	1.206E+00	6.143E-01	9.508E-01	1.210E+01	1.026E+00	2.750E-01
0	22	1.213E-02	1.490E+00	5.120E-01	1.225E+00	8.440E-01	1.246E+00	1.693E+00	9.031E+00	1.120E+00	2.346E-01
0	23	2.272E-02	1.837E+00	1.121E+00	9.242E-01	1.038E+00	1.453E+00	2.416E+00	1.104E+01	1.312E+00	1.000E-02
0	24	1.375E-02	1.729E+00	1.037E+00	9.756E-01	1.072E+00	3.132E-01	1.000E+01	1.990E+01	8.043E-01	2.331E-01
0	25	1.161E-02	5.303E-01	7.009E-01	1.357E+00	8.334E-01	3.322E+00	6.063E-01	1.654E+01	7.821E-01	1.279E-01
0	26	1.420E-02	1.847E+00	1.054E+00	8.575E-01	8.780E-01	2.607E-01	4.570E+00	7.680E+00	9.812E-01	2.615E-01
0	27	8.134E-03	2.217E+00	4.487E-01	9.433E-01	6.727E-01	7.443E-01	1.289E+00	1.182E+01	1.143E+00	2.931E-01
0	28	9.155E-03	1.303E+00	2.265E-01	9.059E-01	1.024E+00	1.092E+00	2.647E+00	1.572E+01	1.049E+00	3.741E-01
0	29	1.248E-02	6.803E-01	4.792E-01	9.912E-01	7.209E-01	1.492E+00	6.805E-01	9.528E+00	7.139E-01	4.411E-01
0	30	1.573E-02	5.906E-01	1.065E+00	1.038E+00	1.082E+00	2.001E+00	1.814E+00	1.017E+01	1.052E+00	3.320E-01
0	31	1.439E-02	2.471E+00	1.980E-01	7.330E-01	1.058E+00	8.465E-01	9.613E-01	9.783E+00	8.274E-01	1.745E-01
0	32	1.616E-02	2.069E+00	1.202E+00	1.325E+00	9.705E-01	1.180E+00	1.464E+00	4.730E+00	9.189E-01	3.029E-01
0	33	1.644E-02	1.553E+00	5.347E-01	1.070E+00	1.028E+00	5.539E-01	8.893E-01	3.989E+00	8.921E-01	3.356E-01
0	34	4.801E-03	1.232E+00	1.415E+00	1.282E+00	9.279E-01	2.182E+00	6.225E-01	6.821E+00	9.121E-01	7.665E-02
0	35	6.676E-03	1.882E+00	7.410E-01	8.227E-01	9.762E-01	2.906E+00	6.115E+00	1.410E+01	9.748E-01	3.830E-01
0	36	1.386E-02	1.364E+00	1.045E+00	1.034E+00	8.252E-01	5.499E+00	3.224E+00	1.508E+01	1.022E+00	1.685E-01
0	37	1.913E-02	1.918E+00	6.722E-01	7.822E-01	8.854E-01	1.540E-01	7.950E-01	1.281E+01	1.220E+00	2.143E-01
0	38	1.540E-02	7.329E-01	6.579E-01	1.013E+00	1.283E+00	2.438E+00	1.396E+00	5.802E+00	9.466E-01	2.052E-01
0	39	1.504E-02	1.340E+00	6.069E-01	1.130E+00	1.153E+00	6.613E-01	3.595E-01	6.003E+00	7.724E-01	2.544E-01
0	40	1.274E-02	2.253E+00	1.344E+00	1.118E+00	1.042E+00	2.273E+00	1.197E+00	1.530E+01	9.624E-01	3.420E-01
0	41	9.393E-03	1.403E-01	1.900E+00	8.661E-01	1.014E+00	1.318E+00	7.292E-01	1.598E+01	8.986E-01	1.622E-01
0	42	1.757E-02	1.198E+00	7.616E-01	1.020E+00	1.120E+00	3.357E-01	1.505E+00	1.143E+01	1.185E+00	2.517E-01

0	43	1.778E-02	1.460E+00	1.027E+00	9.552E-01	6.915E-01	6.622E+00	5.691E-01	1.235E+01	1.106E+00	2.251E-01
0	44	1.891E-02	1.760E+00	1.179E+00	1.262E+00	1.033E+00	3.778E-01	1.994E+00	1.774E+01	1.006E+00	3.529E-01
0	45	2.184E-02	1.709E+00	1.488E+00	1.004E+00	1.112E+00	7.848E-01	3.056E-01	7.237E+00	1.298E+00	1.457E-01
0	46	7.393E-03	-2.384E-07	7.962E-01	1.008E+00	6.082E-01	8.729E-01	9.021E+00	6.139E+00	1.093E+00	2.392E-01
0	47	1.226E-02	9.947E-01	9.202E-01	1.108E+00	8.830E-01	5.887E-01	2.328E+00	1.472E+01	1.032E+00	1.002E-01
0	48	8.774E-03	1.067E+00	1.435E+00	1.054E+00	1.066E+00	2.735E-01	6.694E+00	8.199E+00	1.179E+00	4.109E-02
0	49	1.657E-02	1.235E+00	3.032E-01	8.403E-01	1.011E+00	1.537E+00	3.422E-01	1.051E+01	8.205E-01	3.896E-01
0	50	1.289E-02	7.498E-01	7.653E-01	7.585E-01	8.964E-01	3.969E-01	4.910E-01	8.801E+00	1.365E+00	1.515E-01
0	51	2.000E-03	1.121E+00	4.129E-01	1.084E+00	1.212E+00	1.695E+00	1.201E-01	1.255E+01	9.522E-01	2.721E-01
0	52	1.113E-02	1.407E+00	1.365E+00	8.053E-01	1.143E+00	7.692E-01	6.369E-01	1.187E+01	1.016E+00	3.688E-01
0	53	1.018E-02	1.674E+00	8.769E-01	1.080E+00	1.323E+00	6.935E-01	1.560E+00	8.603E+00	1.490E+00	2.558E-01
0	54	1.846E-02	9.085E-01	8.451E-01	7.558E-01	7.670E-01	1.128E+00	9.251E-01	7.508E+00	1.385E+00	2.886E-01
0	55	1.946E-02	9.208E-01	1.128E+00	9.101E-01	9.056E-01	7.050E-01	7.726E-01	1.032E+01	1.224E+00	2.088E-01
0	56	1.868E-02	1.589E+00	1.275E+00	1.125E+00	8.406E-01	4.988E+00	5.553E+00	2.205E+00	9.879E-01	3.480E-01
0	57	1.201E-02	8.746E-01	1.167E+00	9.619E-01	1.110E+00	9.152E-01	3.862E-01	9.227E+00	1.131E+00	1.902E-01
0	58	1.795E-02	2.523E+00	5.941E-01	1.051E+00	9.838E-01	8.043E-01	2.702E+00	8.509E-01	1.281E+00	2.213E-01
0	59	3.468E-03	6.100E-01	1.610E+00	9.517E-01	9.823E-01	2.890E-01	3.504E+00	6.865E+00	1.088E+00	3.006E-01
0	60	1.458E-02	2.177E+00	3.243E-01	8.438E-01	1.244E+00	1.927E+00	7.183E-01	1.160E+01	8.598E-01	1.142E-01
0	61	1.260E-02	6.677E-01	1.752E+00	1.099E+00	9.216E-01	1.309E-01	1.605E+00	1.082E+01	9.649E-01	2.669E-01
0	62	1.321E-02	8.442E-01	1.316E+00	6.000E-01	9.348E-01	1.369E+00	1.000E-01	5.681E+00	9.996E-01	2.806E-01
0	63	6.252E-03	2.102E+00	1.070E+00	8.120E-01	7.936E-01	5.129E-01	4.722E-01	1.455E+01	1.125E+00	3.984E-01
0	64	5.682E-03	2.412E+00	1.248E+00	6.596E-01	1.349E+00	1.195E+00	1.660E+00	5.477E+00	1.167E+00	6.914E-02
0	65	9.701E-03	9.489E-01	7.140E-01	1.216E+00	1.267E+00	4.108E-01	1.154E+00	1.426E+01	1.099E+00	2.014E-01
0	66	1.474E-02	1.954E+00	1.007E+00	9.833E-01	1.163E+00	2.146E+00	6.478E-01	9.644E+00	1.329E+00	3.125E-01
0	67	1.058E-02	1.784E+00	1.644E+00	9.149E-01	6.000E-01	1.576E+00	1.333E+00	1.307E+01	8.758E-01	3.251E-01
0	68	8.447E-03	1.870E+00	1.509E+00	1.160E+00	1.070E+00	2.248E-01	2.046E+00	1.317E+01	1.060E+00	4.458E-01

0	69	9.306E-03	1.030E+00	1.252E+00	7.244E-01	7.780E-01	1.266E+00	2.176E-01	1.405E+01	1.140E+00	9.449E-02
0	70	5.598E-03	1.523E+00	4.971E-01	1.043E+00	9.298E-01	3.472E-01	8.560E-01	6.474E+00	9.714E-01	3.080E-01
0	71	2.783E-03	1.625E+00	1.144E+00	1.146E+00	1.147E+00	1.712E-01	1.401E-01	1.023E+01	1.233E+00	2.603E-01
0	72	1.973E-02	1.734E+00	1.459E+00	9.393E-01	1.089E+00	1.610E+00	1.766E+00	4.148E+00	7.620E-01	2.440E-01
0	73	2.251E-02	1.661E+00	5.729E-01	8.919E-01	8.610E-01	6.009E-01	6.956E-01	1.295E+01	1.078E+00	1.793E-01
0	74	1.457E-02	2.401E+00	1.300E+00	1.195E+00	9.398E-01	4.335E-01	1.055E+00	6.672E+00	1.010E+00	3.810E-01
0	75	1.069E-02	1.441E+00	6.246E-01	1.064E+00	8.032E-01	9.749E-01	4.674E+00	1.166E+01	1.114E+00	1.393E-01
0	76	1.344E-02	1.642E+00	1.566E+00	7.045E-01	1.055E+00	7.304E-01	5.377E-01	1.338E+01	1.043E+00	2.828E-01
0	77	1.309E-02	2.674E+00	1.520E+00	1.400E+00	1.266E+00	1.414E+00	1.283E+00	1.109E+01	9.288E-01	1.545E-01
0	78	1.597E-02	1.278E+00	1.114E+00	1.088E+00	9.907E-01	9.450E-01	9.999E-01	8.901E+00	1.540E+00	1.066E-01
0	79	1.191E-02	7.920E-01	7.853E-01	1.315E+00	9.447E-01	8.237E-01	2.091E+00	3.165E+00	1.081E+00	2.027E-01
0	80	1.145E-02	1.902E+00	9.287E-01	1.234E+00	8.629E-01	1.735E+00	1.105E+00	1.236E+01	9.382E-01	1.967E-01
0	81	1.729E-02	1.614E+00	8.539E-01	8.981E-01	1.400E+00	5.194E-01	5.193E-01	1.056E+01	8.511E-01	3.135E-01
0	82	1.118E-02	1.393E+00	1.108E+00	9.919E-01	1.167E+00	1.883E-01	3.572E-01	7.093E+00	7.362E-01	2.267E-01
0	83	1.713E-02	8.070E-01	9.913E-01	1.208E+00	1.130E+00	3.382E+00	1.625E-01	1.486E+01	1.256E+00	1.205E-01
0	84	1.039E-02	2.561E+00	1.014E+00	1.092E+00	8.092E-01	2.093E-01	1.089E+00	6.331E+00	1.037E+00	1.641E-01
0	85	1.399E-02	1.483E+00	8.857E-01	1.183E+00	1.180E+00	1.831E+00	2.510E+00	1.740E+01	1.418E+00	2.969E-01
0	86	1.511E-02	9.743E-01	9.619E-01	8.553E-01	8.915E-01	2.332E+00	4.326E-01	1.072E+01	1.213E+00	3.386E-01
0	87	2.400E-02	3.183E-01	9.348E-01	7.756E-01	1.230E+00	1.000E-01	1.371E+00	1.267E+01	9.410E-01	1.839E-01
0	88	9.524E-03	1.964E+00	1.190E+00	9.654E-01	1.195E+00	3.939E+00	4.592E-01	1.555E+01	1.252E+00	2.421E-01
0	89	8.916E-03	1.980E+00	1.576E+00	8.757E-01	9.562E-01	5.685E-01	4.499E-01	1.002E+01	9.270E-01	2.452E-01
0	90	1.000E-02	1.161E+00	1.153E+00	9.305E-01	1.233E+00	9.926E-01	3.194E+00	7.832E+00	8.151E-01	2.635E-01
0	91	1.578E-02	1.022E+00	1.000E-01	1.044E+00	1.094E+00	4.579E-01	3.903E-01	4.329E+00	7.918E-01	3.263E-01
0	92	1.229E-02	1.915E-01	1.263E+00	9.818E-01	1.189E+00	1.349E+00	4.099E+00	9.083E+00	8.358E-01	4.900E-01
0	93	1.495E-02	2.136E+00	9.796E-01	1.138E+00	7.849E-01	2.420E-01	2.419E-01	1.810E+01	6.957E-01	2.498E-01
0	94	7.027E-03	1.696E+00	1.088E+00	9.710E-01	1.047E+00	1.033E+00	7.562E-01	9.910E+00	1.287E+00	2.111E-01

0	95	1.330E-02	1.383E+00	8.685E-01	1.014E+00	9.574E-01	1.883E+00	5.894E-01	1.383E+01	1.199E+00	1.704E-01
0	96	1.096E-02	2.342E+00	1.839E+00	1.060E+00	1.002E+00	4.879E-01	1.863E-01	1.000E-01	8.723E-01	2.310E-01
0	97	1.082E-02	1.266E+00	9.462E-01	7.967E-01	8.518E-01	4.733E-01	2.268E+00	8.052E+00	8.878E-01	3.641E-01
0	98	8.661E-03	1.139E+00	8.125E-01	8.728E-01	1.175E+00	1.137E+00	3.860E+00	8.292E+00	5.755E-01	3.582E-02
0	99	1.524E-02	4.409E-01	7.356E-01	1.290E+00	7.100E-01	4.349E-01	2.921E-01	8.436E+00	1.241E+00	4.031E-01
0	100	1.413E-02	4.268E-01	1.372E+00	1.028E+00	9.944E-01	3.196E+00	3.608E+00	4.833E+00	1.072E+00	3.177E-01

1TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0LATIN HYPERCUBE SAMPLE INPUT VECTORS

	RUN NO.	X(11)	X(12)
0	1	1.571E-01	2.158E+00
0	2	7.899E-02	1.084E+00
0	3	4.278E-02	1.073E+00
0	4	1.945E-01	1.778E+00
0	5	2.968E-04	8.480E-01
0	6	1.137E-01	2.000E+00
0	7	4.974E-02	1.687E+00
0	8	1.170E-01	1.806E+00
0	9	1.689E-01	1.169E+00
0	10	1.595E-01	1.047E+00
0	11	1.192E-01	2.216E+00
0	12	1.819E-01	2.654E+00
0	13	1.973E-01	1.849E+00
0	14	6.094E-02	1.668E+00
0	15	2.240E-02	1.587E+00
0	16	1.261E-01	2.285E+00

0	17	1.061E-01	8.812E-01
0	18	3.334E-02	2.513E+00
0	19	1.374E-01	1.399E+00
0	20	1.318E-01	2.001E+00
0	21	8.391E-02	1.916E+00
0	22	5.225E-03	1.629E+00
0	23	1.150E-01	1.945E+00
0	24	7.343E-02	1.821E+00
0	25	1.624E-01	2.581E+00
0	26	5.193E-02	1.747E+00
0	27	8.031E-02	2.772E+00
0	28	7.456E-02	1.787E+00
0	29	1.762E-02	9.068E-01
0	30	7.349E-03	9.300E-01
0	31	1.549E-01	8.084E-01
0	32	1.339E-01	2.498E+00
0	33	1.357E-01	2.758E+00
0	34	4.017E-02	1.710E+00
0	35	8.800E-02	2.732E+00
0	36	1.443E-01	2.047E+00
0	37	1.741E-01	2.604E+00
0	38	8.808E-02	2.339E+00
0	39	9.344E-02	1.139E+00
0	40	4.684E-02	1.110E+00
0	41	1.391E-02	2.166E+00
0	42	1.611E-01	1.872E+00

0	43	1.720E-01	8.214E-01
0	44	1.468E-02	2.232E+00
0	45	9.658E-02	2.523E+00
0	46	1.760E-01	1.498E+00
0	47	1.105E-01	1.577E+00
0	48	1.425E-01	1.005E+00
0	49	1.491E-01	1.333E+00
0	50	6.248E-02	2.022E+00
0	51	2.432E-02	2.469E+00
0	52	1.255E-01	9.749E-01
0	53	9.936E-02	1.306E+00
0	54	1.405E-01	1.272E+00
0	55	8.284E-03	2.407E+00
0	56	5.477E-02	2.197E+00
0	57	3.717E-02	1.231E+00
0	58	1.097E-01	2.430E+00
0	59	8.425E-02	1.030E+00
0	60	1.711E-01	2.663E+00
0	61	1.856E-01	2.709E+00
0	62	1.027E-01	2.255E+00
0	63	1.175E-02	2.094E+00
0	64	5.221E-02	1.509E+00
0	65	3.294E-03	2.108E+00
0	66	6.838E-02	2.632E+00
0	67	3.874E-02	1.723E+00
0	68	3.449E-02	1.430E+00

0	69	2.707E-02	2.273E+00
0	70	9.583E-02	1.477E+00
0	71	7.627E-02	1.368E+00
0	72	4.562E-02	1.199E+00
0	73	5.641E-02	9.557E-01
0	74	1.641E-01	1.211E+00
0	75	3.159E-02	2.301E+00
0	76	1.517E-01	2.399E+00
0	77	1.051E-01	1.257E+00
0	78	1.531E-01	1.538E+00
0	79	1.675E-01	1.407E+00
0	80	1.985E-02	1.459E+00
0	81	7.060E-02	1.617E+00
0	82	6.630E-02	2.065E+00
0	83	2.975E-02	1.152E+00
0	84	5.834E-02	2.578E+00
0	85	1.010E-01	1.293E+00
0	86	1.391E-01	1.921E+00
0	87	1.292E-01	1.644E+00
0	88	1.214E-01	9.884E-01
0	89	1.992E-01	1.971E+00
0	90	1.928E-01	2.556E+00
0	91	2.063E-02	2.458E+00
0	92	6.468E-02	2.350E+00
0	93	1.906E-01	1.356E+00
0	94	1.783E-01	1.548E+00

0	95	1.475E-01	2.690E+00
0	96	9.158E-02	2.367E+00
0	97	1.869E-01	7.898E-01
0	98	1.898E-01	8.639E-01
0	99	1.828E-01	1.880E+00
0	100	1.222E-01	2.122E+00

1TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0RANKS OF LATIN HYPERCUBE SAMPLE INPUT VECTORS

	RUN NO.	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)	X(8)	X(9)	X(10)
0	1	87.	81.	73.	75.	29.	91.	74.	62.	62.	71.
0	2	49.	100.	24.	15.	8.	33.	86.	81.	71.	19.
0	3	80.	98.	49.	50.	68.	16.	52.	45.	20.	76.
0	4	14.	53.	21.	41.	99.	94.	65.	80.	72.	96.
0	5	79.	40.	72.	56.	50.	93.	59.	14.	74.	39.
0	6	56.	55.	88.	2.	23.	46.	75.	59.	9.	14.
0	7	83.	51.	60.	36.	31.	27.	28.	49.	93.	84.
0	8	71.	31.	6.	87.	55.	12.	51.	37.	77.	28.
0	9	40.	25.	18.	80.	73.	83.	42.	13.	1.	6.
0	10	37.	38.	78.	67.	15.	70.	9.	3.	98.	61.
0	11	26.	89.	40.	93.	7.	51.	13.	29.	3.	13.
0	12	13.	33.	71.	25.	77.	97.	45.	44.	70.	64.
0	13	55.	67.	85.	84.	79.	53.	43.	95.	96.	99.
0	14	15.	69.	31.	17.	72.	87.	57.	5.	91.	38.
0	15	4.	80.	34.	26.	32.	35.	25.	63.	55.	58.
0	16	29.	99.	33.	85.	62.	77.	79.	27.	86.	66.

0	17	95.	85.	46.	73.	52.	85.	6.	32.	27.	95.
0	18	76.	79.	81.	4.	43.	99.	87.	7.	4.	86.
0	19	9.	90.	13.	34.	39.	100.	19.	70.	42.	30.
0	20	96.	46.	97.	82.	42.	84.	10.	99.	5.	26.
0	21	94.	27.	41.	29.	89.	32.	48.	69.	48.	60.
0	22	43.	50.	11.	91.	19.	59.	71.	41.	65.	45.
0	23	99.	70.	63.	33.	59.	65.	82.	60.	90.	1.
0	24	57.	64.	54.	45.	67.	13.	100.	100.	14.	44.
0	25	39.	7.	22.	99.	17.	89.	31.	94.	12.	12.
0	26	61.	71.	56.	21.	24.	9.	94.	30.	40.	55.
0	27	16.	87.	8.	38.	3.	39.	61.	67.	69.	67.
0	28	21.	39.	3.	30.	56.	54.	84.	92.	52.	89.
0	29	46.	11.	9.	48.	6.	66.	35.	46.	7.	97.
0	30	72.	8.	57.	59.	69.	76.	73.	52.	53.	79.
0	31	62.	94.	2.	7.	64.	44.	49.	48.	17.	24.
0	32	75.	82.	70.	98.	44.	57.	66.	11.	29.	70.
0	33	77.	54.	12.	66.	57.	28.	46.	8.	25.	80.
0	34	5.	34.	86.	95.	34.	79.	32.	23.	28.	5.
0	35	10.	73.	26.	16.	45.	86.	97.	84.	39.	91.
0	36	58.	42.	55.	58.	16.	96.	89.	89.	47.	22.
0	37	91.	75.	20.	11.	26.	3.	41.	75.	80.	37.
0	38	70.	12.	19.	53.	96.	82.	64.	17.	34.	34.
0	39	67.	41.	16.	78.	82.	34.	16.	18.	11.	52.
0	40	48.	88.	82.	76.	60.	80.	58.	90.	36.	82.
0	41	23.	2.	100.	22.	54.	61.	38.	93.	26.	20.
0	42	84.	32.	27.	55.	76.	14.	67.	64.	76.	51.

0	43	85.	48.	53.	40.	4.	98.	29.	71.	63.	41.
0	44	90.	66.	68.	94.	58.	17.	76.	97.	44.	85.
0	45	97.	63.	90.	51.	75.	41.	12.	26.	89.	16.
0	46	12.	1.	30.	52.	2.	45.	99.	19.	60.	46.
0	47	44.	22.	42.	74.	25.	30.	81.	87.	49.	8.
0	48	19.	26.	87.	63.	65.	10.	98.	34.	75.	3.
0	49	78.	35.	4.	18.	53.	67.	14.	55.	16.	92.
0	50	50.	13.	28.	9.	28.	18.	24.	39.	94.	17.
0	51	1.	28.	7.	69.	90.	71.	2.	73.	35.	59.
0	52	35.	45.	83.	13.	80.	40.	33.	68.	46.	88.
0	53	28.	61.	38.	68.	97.	36.	68.	38.	99.	53.
0	54	88.	18.	35.	8.	9.	55.	47.	28.	95.	65.
0	55	92.	19.	64.	31.	30.	37.	40.	54.	81.	35.
0	56	89.	56.	77.	77.	18.	95.	96.	4.	41.	83.
0	57	42.	17.	67.	42.	74.	47.	17.	43.	67.	29.
0	58	86.	95.	15.	62.	47.	42.	85.	2.	87.	40.
0	59	3.	9.	95.	39.	46.	11.	90.	24.	59.	69.
0	60	64.	86.	5.	19.	93.	75.	37.	65.	21.	10.
0	61	47.	10.	98.	72.	33.	2.	69.	58.	37.	57.
0	62	52.	16.	80.	1.	36.	63.	1.	16.	43.	62.
0	63	8.	83.	58.	14.	12.	25.	23.	86.	66.	93.
0	64	7.	93.	74.	3.	98.	58.	70.	15.	73.	4.
0	65	25.	20.	23.	90.	95.	19.	56.	85.	61.	32.
0	66	65.	76.	51.	47.	83.	78.	34.	47.	92.	73.
0	67	31.	68.	96.	32.	1.	68.	62.	77.	23.	77.
0	68	17.	72.	91.	83.	66.	7.	77.	78.	54.	98.

0	69	22.	24.	75.	6.	10.	60.	7.	83.	68.	7.
0	70	6.	52.	10.	60.	35.	15.	44.	21.	38.	72.
0	71	2.	58.	65.	81.	81.	4.	3.	53.	82.	54.
0	72	93.	65.	89.	37.	70.	69.	72.	9.	10.	48.
0	73	98.	60.	14.	27.	21.	31.	36.	76.	57.	25.
0	74	63.	92.	79.	88.	37.	20.	53.	22.	45.	90.
0	75	32.	47.	17.	65.	13.	49.	95.	66.	64.	15.
0	76	54.	59.	93.	5.	63.	38.	27.	79.	51.	63.
0	77	51.	97.	92.	100.	94.	64.	60.	61.	31.	18.
0	78	74.	37.	62.	70.	48.	48.	50.	40.	100.	9.
0	79	41.	14.	29.	97.	38.	43.	78.	6.	58.	33.
0	80	38.	74.	43.	92.	22.	72.	55.	72.	32.	31.
0	81	82.	57.	36.	28.	100.	26.	26.	56.	19.	74.
0	82	36.	44.	61.	49.	84.	5.	15.	25.	8.	42.
0	83	81.	15.	50.	89.	78.	90.	4.	88.	85.	11.
0	84	30.	96.	52.	71.	14.	6.	54.	20.	50.	21.
0	85	59.	49.	39.	86.	86.	73.	83.	96.	97.	68.
0	86	68.	21.	47.	20.	27.	81.	20.	57.	79.	81.
0	87	100.	4.	44.	10.	91.	1.	63.	74.	33.	27.
0	88	24.	77.	69.	43.	88.	92.	22.	91.	84.	47.
0	89	20.	78.	94.	24.	40.	29.	21.	51.	30.	49.
0	90	27.	30.	66.	35.	92.	50.	88.	31.	15.	56.
0	91	73.	23.	1.	61.	71.	22.	18.	10.	13.	78.
0	92	45.	3.	76.	46.	87.	62.	93.	42.	18.	100.
0	93	66.	84.	48.	79.	11.	8.	8.	98.	6.	50.
0	94	11.	62.	59.	44.	61.	52.	39.	50.	88.	36.

0	95	53.	43.	37.	54.	41.	74.	30.	82.	78.	23.
0	96	34.	91.	99.	64.	51.	24.	5.	1.	22.	43.
0	97	33.	36.	45.	12.	20.	23.	80.	33.	24.	87.
0	98	18.	29.	32.	23.	85.	56.	92.	35.	2.	2.
0	99	69.	6.	25.	96.	5.	21.	11.	36.	83.	94.
0	100	60.	5.	84.	57.	49.	88.	91.	12.	56.	75.

1TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0RANKS OF LATIN HYPERCUBE SAMPLE INPUT VECTORS

	RUN NO.	X(11)	X(12)
0	1	79.	69.
0	2	40.	16.
0	3	22.	15.
0	4	98.	50.
0	5	1.	4.
0	6	57.	61.
0	7	25.	46.
0	8	59.	52.
0	9	85.	20.
0	10	80.	14.
0	11	60.	72.
0	12	91.	94.
0	13	99.	54.
0	14	31.	45.
0	15	12.	41.
0	16	64.	76.

0	17	54.	6.
0	18	17.	87.
0	19	69.	31.
0	20	66.	62.
0	21	42.	57.
0	22	3.	43.
0	23	58.	59.
0	24	37.	53.
0	25	82.	91.
0	26	26.	49.
0	27	41.	100.
0	28	38.	51.
0	29	9.	7.
0	30	4.	8.
0	31	78.	2.
0	32	67.	86.
0	33	68.	99.
0	34	21.	47.
0	35	44.	98.
0	36	73.	64.
0	37	88.	92.
0	38	45.	78.
0	39	47.	18.
0	40	24.	17.
0	41	7.	70.
0	42	81.	55.

0	43	87.	3.
0	44	8.	73.
0	45	49.	88.
0	46	89.	36.
0	47	56.	40.
0	48	72.	12.
0	49	75.	28.
0	50	32.	63.
0	51	13.	85.
0	52	63.	10.
0	53	50.	27.
0	54	71.	25.
0	55	5.	82.
0	56	28.	71.
0	57	19.	23.
0	58	55.	83.
0	59	43.	13.
0	60	86.	95.
0	61	93.	97.
0	62	52.	74.
0	63	6.	66.
0	64	27.	37.
0	65	2.	67.
0	66	35.	93.
0	67	20.	48.
0	68	18.	33.

0	69	14.	75.
0	70	48.	35.
0	71	39.	30.
0	72	23.	21.
0	73	29.	9.
0	74	83.	22.
0	75	16.	77.
0	76	76.	81.
0	77	53.	24.
0	78	77.	38.
0	79	84.	32.
0	80	10.	34.
0	81	36.	42.
0	82	34.	65.
0	83	15.	19.
0	84	30.	90.
0	85	51.	26.
0	86	70.	58.
0	87	65.	44.
0	88	61.	11.
0	89	100.	60.
0	90	97.	89.
0	91	11.	84.
0	92	33.	79.
0	93	96.	29.
0	94	90.	39.

```
0   95       74.       96.
0   96       46.       80.
0   97       94.        1.
0   98       95.        5.
0   99       92.       56.
0  100       62.       68.
1   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1            08/22/03 16:27:48
0  HISTOGRAM FOR VARIABLE NO.  1     NORMAL        DISTRIBUTION

    MIDPOINT        FREQ.

   0.1650000E-02       1    X
   0.2750000E-02       1    X
   0.3850000E-02       1    X
   0.4950000E-02       2    XX
   0.6050000E-02       4    XXXX
   0.7149999E-02       4    XXXX
   0.8249999E-02       6    XXXXXX
   0.9349999E-02       7    XXXXXXX
   0.1045000E-01       8    XXXXXXXX
   0.1155000E-01       8    XXXXXXXX
   0.1265000E-01       9    XXXXXXXXX
   0.1375000E-01      10    XXXXXXXXXX
   0.1485000E-01       8    XXXXXXXX
   0.1595000E-01       8    XXXXXXXX
   0.1705000E-01       7    XXXXXXX
```

0.1815000E-01	5	XXXXX
0.1925000E-01	4	XXXX
0.2035000E-01	2	XX
0.2145000E-01	2	XX
0.2255000E-01	2	XX
0.2365000E-01	1	X

0 100

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE
0.1999998E-02	0.2400000E-01	0.2200000E-01	0.1299409E-01	0.1299157E-01	0.2160614E-04

1 TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0 HISTOGRAM FOR VARIABLE NO. 2 NORMAL DISTRIBUTION

MIDPOINT	FREQ.	
-0.7500000E-01	1	X
0.7500000E-01	1	X
0.2250000	1	X
0.3750000	3	XXX
0.5250000	2	XX
0.6750001	5	XXXXX
0.8250001	4	XXXX
0.9750001	7	XXXXXXX

```
   1.125000        8   XXXXXXXX
   1.275000        9   XXXXXXXXX
   1.425000        9   XXXXXXXXX
   1.575000        9   XXXXXXXXX
   1.725000        9   XXXXXXXXX
   1.875000        7   XXXXXXX
   2.025000        7   XXXXXXX
   2.175000        5   XXXXX
   2.325000        4   XXXX
   2.475000        4   XXXX
   2.625000        2   XX
   2.775001        2   XX
   2.925001        1   X
0              100


    MIN        MAX        RANGE        MEAN        MEDIAN      VARIANCE

 -0.2384186E-06  3.000000    3.000000    1.499640    1.502515    0.3986081

1   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1            08/22/03 16:27:48
0  HISTOGRAM FOR VARIABLE NO.  3    NORMAL        DISTRIBUTION

    MIDPOINT       FREQ.

  0.1349999         1    X
```

0.2249999	2	XX
0.3149998	2	XX
0.4049998	3	XXX
0.4949997	4	XXXX
0.5849997	5	XXXXX
0.6749997	7	XXXXXXX
0.7649996	7	XXXXXXX
0.8549996	9	XXXXXXXXX
0.9449996	9	XXXXXXXXX
1.034999	9	XXXXXXXXX
1.124999	9	XXXXXXXXX
1.214999	8	XXXXXXXX
1.304999	7	XXXXXXX
1.394999	5	XXXXX
1.484999	5	XXXXX
1.574999	3	XXX
1.664999	1	X
1.754999	2	XX
1.844999	1	X
1.934999	1	X

0 100

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE
0.9999979E-01	1.900000	1.800000	1.000563	0.9991257	0.1434197

```
1   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1             08/22/03 16:27:48
0  HISTOGRAM FOR VARIABLE NO.  4     NORMAL        DISTRIBUTION

    MIDPOINT        FREQ.

   0.6199999          2    XX
   0.6599999          1    X
   0.6999999          2    XX
   0.7399999          4    XXXX
   0.7800000          3    XXX
   0.8200000          5    XXXXX
   0.8600000          7    XXXXXXX
   0.9000000          8    XXXXXXXX
   0.9400001          9    XXXXXXXXX
   0.9800001          9    XXXXXXXXX
    1.020000          9    XXXXXXXXX
    1.060000          8    XXXXXXXX
    1.100000          9    XXXXXXXXX
    1.140000          7    XXXXXXX
    1.180000          5    XXXXX
    1.220000          4    XXXX
    1.260000          2    XX
    1.300000          3    XXX
    1.340000          2    XX
    1.380000          0
```

1.420000	1	X

0 100

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE
0.6000000	1.400000	0.8000001	0.9998415	1.000569	0.2853096E-01

1 TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0 HISTOGRAM FOR VARIABLE NO. 5 NORMAL DISTRIBUTION

MIDPOINT	FREQ.	
0.6199999	2	XX
0.6599999	1	X
0.6999999	2	XX
0.7399999	3	XXX
0.7800000	4	XXXX
0.8200000	5	XXXXX
0.8600000	7	XXXXXXX
0.9000000	8	XXXXXXXX
0.9400001	9	XXXXXXXXX
0.9800001	9	XXXXXXXXX
1.020000	9	XXXXXXXXX
1.060000	9	XXXXXXXXX
1.100000	7	XXXXXXX

```
   1.140000      7  XXXXXXX
   1.180000      6  XXXXXX
   1.220000      4  XXXX
   1.260000      3  XXX
   1.300000      1  X
   1.340000      2  XX
   1.380000      1  X
   1.420000      1  X
0              100
```

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE
0.6000000	1.400000	0.8000001	1.000062	0.9998701	0.2863144E-01

```
1   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1            08/22/03 16:27:48
0  HISTOGRAM FOR VARIABLE NO.  6     LOGNORMAL       DISTRIBUTION

     MIDPOINT        FREQ.

   0.2499999      24   XXXXXXXXXXXXXXXXXXXXXXXX
   0.7499998      26   XXXXXXXXXXXXXXXXXXXXXXXXXX
    1.250000      16   XXXXXXXXXXXXXXXX
    1.750000       9   XXXXXXXXX
    2.249999       7   XXXXXXX
    2.749999       4   XXXX
```

```
     3.249999          4   XXXX
     3.749999          2   XX
     4.249999          1   X
     4.749999          2   XX
     5.249999          1   X
     5.749999          1   X
     6.249999          0
     6.749999          1   X
     7.249999          0
     7.749999          1   X
     8.249998          0
     8.749998          0
     9.249998          0
     9.749998          0
     10.25000          1   X
0                   100


      MIN        MAX        RANGE        MEAN        MEDIAN      VARIANCE

   0.9999995E-01   10.00000     9.900004     1.578308     0.9997468     2.868173

1   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1            08/22/03 16:27:48
0  HISTOGRAM FOR VARIABLE NO.  7     LOGNORMAL      DISTRIBUTION

     MIDPOINT        FREQ.
```

0.2499999	24	XXXXXXXXXXXXXXXXXXXXXXXX
0.7499998	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
1.250000	16	XXXXXXXXXXXXXXXX
1.750000	10	XXXXXXXXXX
2.249999	6	XXXXXX
2.749999	4	XXXX
3.249999	3	XXX
3.749999	3	XXX
4.249999	1	X
4.749999	2	XX
5.249999	0	
5.749999	1	X
6.249999	1	X
6.749999	1	X
7.249999	0	
7.749999	0	
8.249998	0	
8.749998	0	
9.249998	1	X
9.749998	0	
10.25000	1	X

0 100

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE

0.9999995E-01	10.00000	9.900004	1.586937	1.010666	3.028481

1 TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0 HISTOGRAM FOR VARIABLE NO. 8 NORMAL DISTRIBUTION

MIDPOINT	FREQ.	
0.4949997	2	XX
1.484999	1	X
2.474998	2	XX
3.464998	2	XX
4.454997	5	XXXXX
5.444996	5	XXXXX
6.434996	7	XXXXXXX
7.424995	7	XXXXXXX
8.414994	9	XXXXXXXXX
9.404994	9	XXXXXXXXX
10.39499	10	XXXXXXXXXX
11.38499	9	XXXXXXXXX
12.37499	7	XXXXXXX
13.36499	7	XXXXXXX
14.35499	5	XXXXX
15.34499	5	XXXXX
16.33499	2	XX
17.32499	3	XXX

18.31499	1	X
19.30499	1	X
20.29499	1	X

0 100

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE
0.9999847E-01	19.90000	19.80000	9.992899	9.966703	17.41113

1 TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0 HISTOGRAM FOR VARIABLE NO. 9 NORMAL DISTRIBUTION

MIDPOINT	FREQ.	
0.5249998	1	X
0.5749998	1	X
0.6249998	2	XX
0.6749998	2	XX
0.7249998	2	XX
0.7749999	5	XXXXX
0.8249999	5	XXXXX
0.8749999	8	XXXXXXXX
0.9249999	8	XXXXXXXX
0.9749999	9	XXXXXXXXX
1.025000	9	XXXXXXXXX

```
    1.075000          9   XXXXXXXXX
    1.125000          8   XXXXXXXX
    1.175000          9   XXXXXXXXX
    1.225000          5   XXXXX
    1.275000          6   XXXXXX
    1.325000          3   XXX
    1.375000          3   XXX
    1.424999          2   XX
    1.474999          2   XX
    1.524999          1   X
0                 100
```

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE
0.5399998	1.540000	1.000000	1.039693	1.040313	0.4451736E-01

1   TITLE SDB Name = PARAMETERS.SDB , Ver = 1   08/22/03 16:27:48

0 HISTOGRAM FOR VARIABLE NO. 10   NORMAL   DISTRIBUTION

```
    MIDPOINT         FREQ.

  0.1200000E-01        1    X
  0.3600001E-01        2    XX
  0.6000002E-01        1    X
  0.8400002E-01        3    XXX
```

```
  0.1080000          3    XXX
  0.1320000          5    XXXXX
  0.1560000          6    XXXXXX
  0.1800000          8    XXXXXXXX
  0.2040000          8    XXXXXXXX
  0.2280000          9    XXXXXXXXX
  0.2520001         10     XXXXXXXXXX
  0.2760001          8    XXXXXXXX
  0.3000001          8    XXXXXXXX
  0.3240001          8    XXXXXXXX
  0.3480001          6    XXXXXX
  0.3720002          5    XXXXX
  0.3960002          3    XXX
  0.4200002          2    XX
  0.4440002          2    XX
  0.4680002          0
  0.4920003          2    XX
0                 100


    MIN          MAX          RANGE          MEAN          MEDIAN        VARIANCE

  0.9999931E-02  0.4900001      0.4800001      0.2500286      0.2507621      0.1025054E-01

1   TITLE SDB Name = PARAMETERS.SDB  , Ver = 1              08/22/03 16:27:48
0  HISTOGRAM FOR VARIABLE NO. 11     UNIFORM        DISTRIBUTION
```

MIDPOINT	FREQ.	
0.4949997E-02	5	XXXXX
0.1484999E-01	4	XXXX
0.2474998E-01	5	XXXXX
0.3464998E-01	6	XXXXXX
0.4454997E-01	4	XXXX
0.5444996E-01	6	XXXXXX
0.6434996E-01	5	XXXXX
0.7424995E-01	5	XXXXX
0.8414995E-01	5	XXXXX
0.9404995E-01	4	XXXX
0.1039499	5	XXXXX
0.1138499	5	XXXXX
0.1237499	5	XXXXX
0.1336499	5	XXXXX
0.1435499	5	XXXXX
0.1534499	5	XXXXX
0.1633499	5	XXXXX
0.1732499	5	XXXXX
0.1831499	5	XXXXX
0.1930499	5	XXXXX
0.2029499	1	X

0 100

MIN	MAX	RANGE	MEAN	MEDIAN	VARIANCE
0.2967655E-03	0.1992379	0.1989412	0.9998050E-01	0.1001890	0.3331727E-02

1 TITLE SDB Name = PARAMETERS.SDB , Ver = 1 08/22/03 16:27:48

0 HISTOGRAM FOR VARIABLE NO. 12 UNIFORM DISTRIBUTION

MIDPOINT	FREQ.	
0.7424996	1	X
0.8414995	5	XXXXX
0.9404994	5	XXXXX
1.039499	5	XXXXX
1.138499	4	XXXX
1.237499	5	XXXXX
1.336499	5	XXXXX
1.435499	5	XXXXX
1.534499	5	XXXXX
1.633499	5	XXXXX
1.732499	5	XXXXX
1.831499	6	XXXXXX
1.930499	4	XXXX
2.029499	5	XXXXX
2.128499	5	XXXXX
2.227499	5	XXXXX

```
    2.326499           5    XXXXX
    2.425499           5    XXXXX
    2.524499           4    XXXX
    2.623499           6    XXXXXX
    2.722499           5    XXXXX
0                   100


      MIN          MAX          RANGE          MEAN          MEDIAN        VARIANCE


   0.7897703      2.771902      1.982131      1.780235      1.782253      0.3336386


1TITLE SDB Name = PARAMETERS.SDB  , Ver = 1              08/22/03 16:27:48
0CORRELATIONS AMONG INPUT VARIABLES CREATED BY THE LATIN HYPERCUBE SAMPLE FOR RAW DATA                           PAGE
1
0    1  1.0000
0    2 -0.0121  1.0000
0    3 -0.0050 -0.0121  1.0000
0    4  0.0042  0.0105 -0.0103  1.0000
0    5 -0.0007  0.0074 -0.0030 -0.0016  1.0000
0    6 -0.0101  0.0555  0.0140 -0.0395 -0.0271  1.0000
0    7 -0.0993 -0.1102  0.0319 -0.0290 -0.0889  0.0015  1.0000
0    8  0.0002 -0.0006  0.0086  0.0084  0.0029  0.0054  0.0018  1.0000
0    9  0.0065 -0.0072  0.0075  0.0022  0.0071 -0.0458 -0.0680  0.0153  1.0000
0   10  0.0035  0.0043 -0.0063  0.0062 -0.0101  0.0294 -0.0139  0.0108  0.0018  1.0000
0   11  0.0468 -0.0164 -0.0226  0.0110 -0.0057  0.0771  0.0207 -0.0168  0.0142 -0.0431  1.0000
```

0   12 0.0099 -0.0099 0.0160 -0.0309 -0.0194 0.0053 0.0172 -0.0093 -0.0153 0.0117 0.0086 1.0000

0   1   2   3   4   5   6   7   8   9   10   11   12

0VARIABLES

0THE VARIANCE INFLATION FACTOR FOR THIS MATRIX IS 1.04

1TITLE SDB Name = PARAMETERS.SDB , Ver = 1   08/22/03 16:27:48

0CORRELATIONS AMONG INPUT VARIABLES CREATED BY THE LATIN HYPERCUBE SAMPLE FOR RANK DATA   PAGE

1

0   1 1.0000

0   2 -0.0177 1.0000

0   3 -0.0097 0.0432 1.0000

0   4 0.0330 0.0041 -0.0076 1.0000

0   5 -0.0011 -0.0263 0.0272 0.0109 1.0000

0   6 0.0056 -0.0069 0.0359 0.0131 0.0276 1.0000

0   7 -0.0394 0.0051 0.0212 -0.0045 0.0126 0.0008 1.0000

0   8 -0.0325 0.0420 -0.0150 -0.0459 -0.0076 0.0227 -0.0610 1.0000

0   9 -0.0032 -0.0268 -0.0115 0.0025 -0.0192 0.0083 0.0021 0.0513 1.0000

0   10 0.0442 0.0529 0.0334 -0.0153 0.0084 -0.0095 0.0338 -0.0228 -0.0400 1.0000

0   11 0.0246 -0.0147 -0.0378 -0.0008 -0.0045 0.0242 0.0031 -0.0322 0.0200 -0.0386 1.0000

0   12 0.0117 0.0168 0.0022 -0.0239 -0.0349 0.0010 0.0088 0.0132 -0.0117 0.0038 0.0082 1.0000

0   1   2   3   4   5   6   7   8   9   10   11   12

0VARIABLES

0THE VARIANCE INFLATION FACTOR FOR THIS MATRIX IS 1.01

Note: The correlations in LHS are controlled using a method proposed by Iman and Conover: A discussion of this method can be found in *Sensitivity Analysis Techniques and Results for Performance Assessment at the Waste Isolation Pilot Plant* (Helton et al. 1991 [127858]).

INTENTIONALLY LEFT BLANK

ATTACHMENT IV

Annual Average Net Infiltration Using Various Approximations of the Repository Footprint (Output-DTN: SN0309T0503100.010)

This attachment contains descriptions of the calculations of the average net infiltration for the exact and simulated approximations to the repository footprint. These calculations require that the infiltration maps correspond to the lower, mean, and upper analog glacial transition climates in DTN: GS000308311221.005 [147613].

Average annual net infiltration was calculated for various approximations of the repository footprint for lower, mean, and upper glacial transition climates. Modeling results for the three glacial transition climates for an area that overlaps the repository footprint was downloaded from the TDMS (DTN: GS000308311221.005 [147613]; Net Infiltration Modeling Results for 3 Climate Scenarios FY99; Submittal date: 03/01/2000). The coordinates of the repository drifts were taken from two documents (BSC 2003 [162289] and BSC 2003 [161727]). All coordinates were converted to northing and easting (meters, UTM).

Five methods were used to represent the repository footprint:

1) Exact Footprint: the outer drift end-point coordinates were used to represent the exact repository footprint and lines were drawn between the outer drift end-point coordinate values. All grid locations that were located outside of the footprint defined by the outer drift coordinates were deleted. This footprint is shown in Figure IV-1. The data files with these data (northing, easting, average annual net infiltration rate (mm/yr) are titled exact_glacialL, exact_glacialM, and exact_glacialU for lower, mean, and upper glacial transition climates, respectively.

2) Exact Footprint w/o contingency area: Same as 1), but without the "contingency area" defined in BSC 2003 [162289] and [161727]. This footprint is shown in Figure IV-1. The data files with these data (northing, easting, average annual net infiltration rate (mm/yr) are titled exact_noCA_glacialL, exact_noCA_glacialM, and exact_noCA_glacialU for lower, mean, and upper glacial transition climates, respectively.

3) Single Rectangle: one rectangular box was used to represent the repository footprint. All grid locations that were located outside of the footprint defined by the rectangle were deleted. This footprint is shown in Figure 1-1 and Figure IV-1. The data files with these data (northing, easting, average annual net infiltration rate (mm/yr) are titled 1box_glacialL, 1box_glacialM, and 1box_glacialU for lower, mean, and upper glacial transition climates, respectively. The coordinates for this box were taken from *Analysis of Infiltration Uncertainty* (CRWMS M&O 2000 [143244]) and they are as follows:

Easting	Northing
547350	4081200
548690	4081200
548690	4076700
547350	4076700

4) Four Rectangles: four rectangular boxes were used to represent the repository footprint, including the contingency area. All grid locations that were located outside of the footprint defined by the four rectangles were deleted. This footprint is shown in Figure IV-2. The data files with these data (northing, easting, average annual net infiltration rate (mm/yr) are titled 4boxes_glacialL, 4boxes_glacialM, and 4boxes_glacialU for lower, mean, and upper glacial transition climates, respectively.

This is the method that was used to do the uncertainty calculations in this Scientific Analysis Report. The coordinates for these boxes are as follows:

Box 1 Easting	Box 1 Northing	Box 2 Easting	Box 2 Northing	Box 3 Easting	Box 3 Northing	Box 4 Easting	Box 4 Northing
547350	4081200	547350	4080228	547350	4079490	547750	4078400
548900	4081200	549200	4080228	548550	4079490	548550	4078400
548900	4080228	549200	4079490	548550	4078400	548550	4076100
547350	4080228	547350	4079490	547350	4078400	547750	4076100

5) Four Rectangles w/o Contingency Area: Same as 4), but without the "contingency area" defined in BSC 2003 [162289] and [161727]. This footprint is shown in Figure IV-2. The data files with these data (northing, easting, average annual net infiltration rate (mm/yr) are titled 4boxes_noCA_glacialL, 4boxes_noCA_glacialM, and 4boxes_noCA_glacialU for lower, mean, and upper glacial transition climates, respectively. The coordinates for these boxes are as follows (these rectangular regions and how they compare with the exact footprint are illustrated in Figure IV-2):

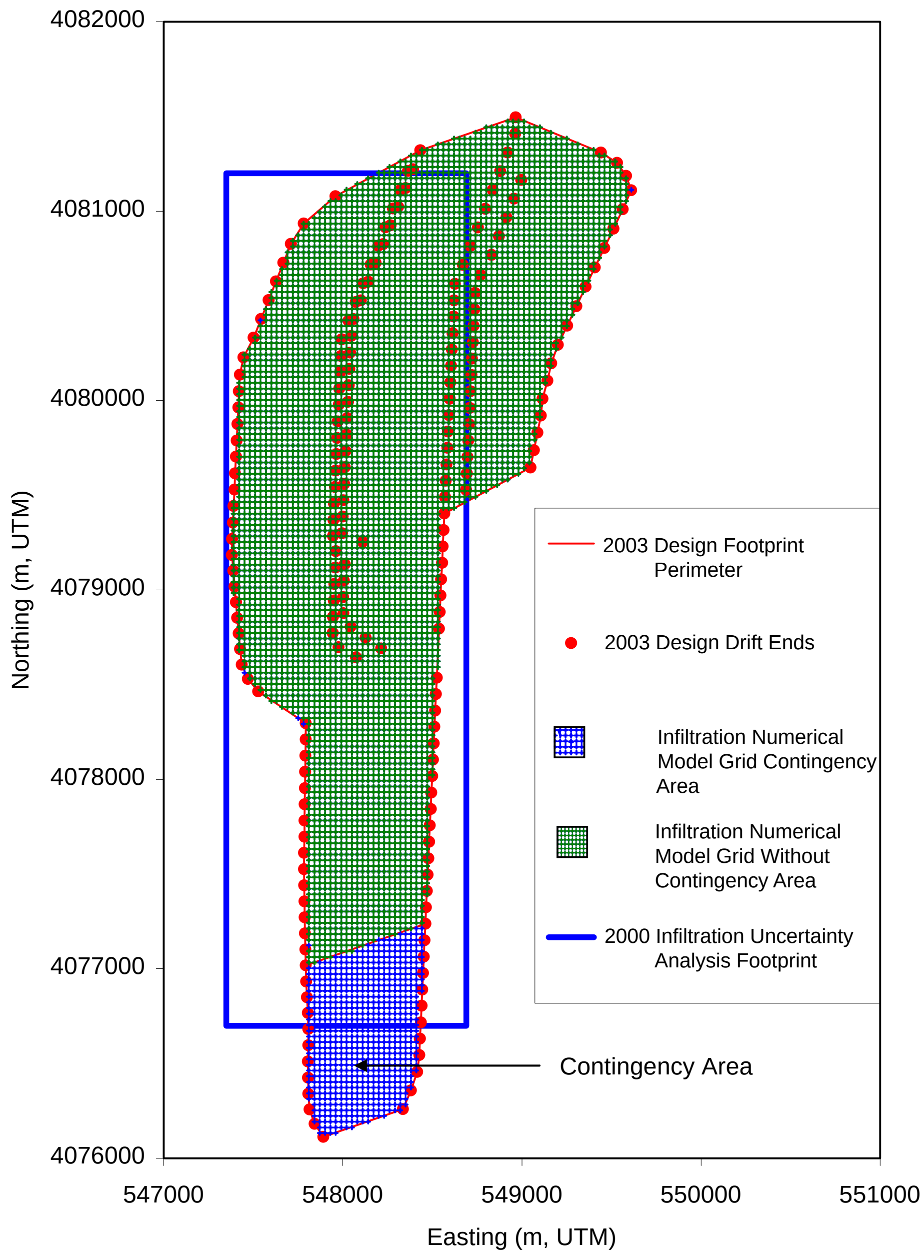
Box 1 Easting	Box 1 Northing	Box 2 Easting	Box 2 Northing	Box 3 Easting	Box 3 Northing	Box 4 Easting	Box 4 Northing
547350	4081200	547350	4080228	547350	4079490	547750	4078400
548900	4081200	549200	4080228	548550	4079490	548550	4078400
548900	4080228	549200	4079490	548550	4078400	548550	4077000
547350	4080228	547350	4079490	547350	4078400	547750	4077000

The average annual net infiltration values (in mm/yr) using these four approximations of the repository footprint for the Lower, Mean, and Upper Glacial Transition Climates are as follows, based on the infiltration maps provide in DTN: GS000308311221.005 [147613]:

Table IV-1 Comparisons of the Spatial Averages for Net Infiltration over the Four-Rectangle Region and the Exact Footprint

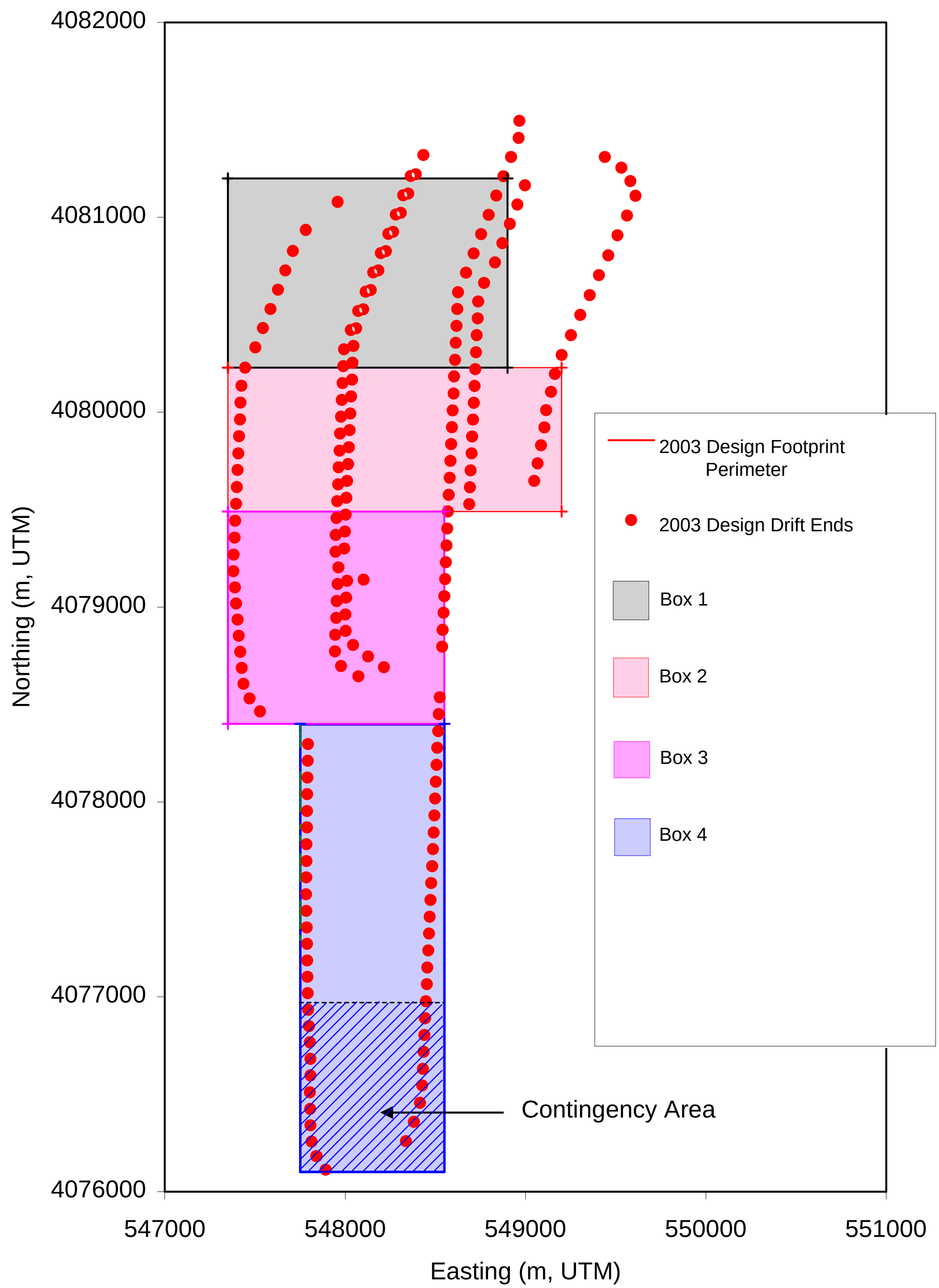
Repository Footprint Approximation Method	Glacial Transition Climate Lower (mm/year)	Glacial Transition Climate Mean (mm/year)	Glacial Transition Climate Upper (mm/year)
Exact Footprint	1.81	17.63	33.44
Exact Footprint w/o Contingency Area	1.92	18.57	35.23
Single Rectangle	2.54	21.02	39.51
4 Rectangles	1.78	17.35	32.93
4 Rectangles w/o Contingency Area	1.93	18.64	35.34

It is important to note that the actual simulated domain used in the realizations developed in the uncertainty analysis do not fully cover the actual repository footprint. The simulated domain, as actually covered by the watersheds, omits a small area within the approximation of the repository footprint using 4 rectangles. A comparison of the model domain, and the actual repository footprint, and the approximations of the repository footprint using rectangles is shown in Figure IV-3.



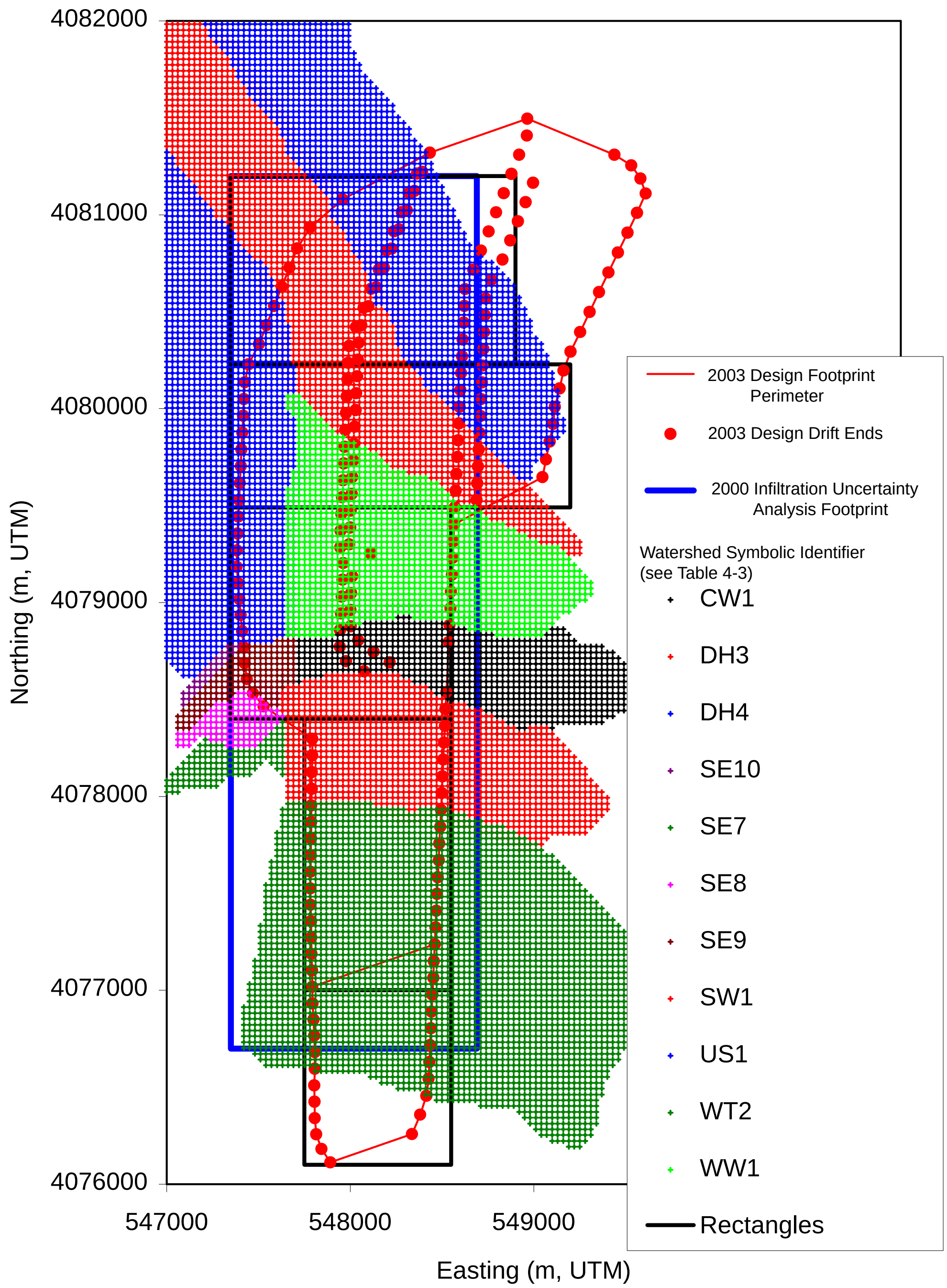
NOTE: Refer to BSC 2003 [162289] for Design Footprint Perimeter and BSC 2003 [161727] for Design Drift Ends. The Numerical Model Grid depicted here is a portion of the numerical grid used by the USGS for the infiltration calculations zone in ANL-NBS-HS-000032 REV00 ICN02 (USGS 2001 [160355]). Refer to CRWMS M&O 2000 [143244]) for 2000 Infiltration Uncertainty Analysis Footprint.

Figure IV-1. Exact Repository Footprint With Drift End Points, With and Without Contingency Area, and the Approximated Footprint Using One Rectangle



NOTE: Refer to BSC 2003 [162289] for Design Footprint Perimeter and BSC 2003 [161727] for Design Drift Ends.

Figure IV-2. Exact Repository Footprint With Drift End Points and Approximated Footprint Using Four Rectangles, With and Without Contingency Area.



NOTE: The area used in the uncertainty calculations done in this report is within the watershed area as bounded by the four boxes.
Refer to BSC 2003 [162289] for Design Footprint Perimeter and BSC 2003 [161727] for Design Drift Ends.
Refer to CRWMS M&O 2000 [143244] for Infiltration Uncertainty Analysis Footprint.
The Numerical Model Grid depicted here is a portion of the numerical grid used by the USGS for the infiltration calculations zone in ANL-NBS-HS-000032 REV00 ICN02 (USGS 2001 [160355]).

Figure IV-3. Map of Watersheds with Respect to the Exact Repository Footprint With Drift End Points and Approximated Footprint Using Four Rectangles, With Contingency Area.

ATTACHMENT V

Annual Average Net Infiltration Deterministic Calculation Using Tule Lake Climate Data

Table V-1. Input Control File for INFIL V. A_2.a1 – There are eleven of these, one for each watershed

(The code INFIL V. A_2.a1 must be run eleven separate times, once for each of the watersheds)

```
INFIL2a1.ctl: T1 test Wash, Tule Lake, us1-2a1-gm1-k2-w20 (11/18/1999)
1   0.00000001                 IROUT(1 = coupled, 0 = uncoupled, -1 = flow routing off, -2 = infil off),
IFRTOL
2   2   1.78                                              ISNOW, ISNWMOD, SNOPAR1
3   0.1   0.3                  ISUBLIM, SUBPAR1, SUBPAR2
0   1.                     IPPTTEST (1 for testing), PPTTEST = constant
0   .0                     IETTEST (1 for testing), ETTEST = constant
30.0                                    CELSIZE (node spacing (meters): using for flow volume calculations)
544721.0  4072203.0              xcfs,ycfs: coords for discharge cell
1950  1  1996  366   1   5         yr1 = start year, dnn1 = start day, yr2 = end year, dn2 = end day
1   1  1  1                    multipliers ( pptfact, etfact, imbfact, sksfact)
1.0   0  0.4                     SDFACT (soil depth multiplier), IVEGC (set to 1 for map data), FVEGC (use if
IVEGC = 0)
1.0   0.8   0.8  0.2                 ROOTF1,ROOTF2,ROOTF3,ROOTF4
1.0   1.0   0.5  0.1                 MAXWGT1, MAXWGT2, MAXWGT3, MAXWGT4
0.3   2.0   3.0  2.0                  RDEPTH1,RDEPTH2,RDEPTH3,RDEPTH4,RDEPTHF
0.02  1.0  .25                 RKPOR, RKMMFACT, FLAREA
1   1  0                   INFMOD, ETMOD, RUNMOD
 -10.0  1.04                            BARSOIL1, BARSOIL2:  bare soil et parameters
3   17.3  11.74                IAIRTEMP = 1 for new air temp model, ATEMP1 = avg. air temp, ATEMP2 = air temp
seasonal deviation
2                        HSTEP: time step for PET model (hours)
5  181  3                        PPTYUC (=5 diminished elev. correlation, =2 for 4JA , =1 for simple elevation
transfer), AAPREPX, IPPTDAT
Tulelake.inp                     input file name:  daily precip
   0    1  0.5    1   1          dpthflag, irtz, delvwcf, moistcr, fracmod
   0    1.75                  IVWCFLG,   vwcfact
us1.w20                    input file name:  map parameters (*.inp)
-1
us1-gm1.2a1                    dayall: average daily mass balance terms
1  1                     ndaymap, imap
70   1995
us1-gm1.2a2
us1-gm1.2a3                    output file name:  daily mass balance
us1-gm1.2a4                    output file name:  total daily fluxes
1    1                    dbgflag, dbgflag2
us1-gm1.2a5                    output file name:  annual mass balance terms
0                        IDEBUG:  debugging option parameter
us1-gm1.2a6                    new debug file
us1-gm1                       map output:  annual totals or mult-year averages
--
--------------- Parameters for dynamic root-zone function -------------------------------------
--   depth  rtza   rtzb   rtzc  rtzd  bsoil  delvwc
--   m
   4
   1  0.5   15    3   3   2   0.30    0.50
   2  1.5   15    4   2   2   0.20    0.50
   3  4.5   10  1.5   1   2   0.10    0.50
   4  6.0   10  1.5   1   2   0.05    0.25
--
--------------- Soil Properties (Brooks & Corey/van Genuchten combined) --------------------------------------
----
--   fdcp   etresidpor  beta  alpah ksat   PE    B   n   vg-alpha sorp   SOILP   potis
--                    Kg s /m^3J/Kg         1/(J/Kg) ???        J/Kg
  10
   1  0.242  0.054  0.366  -3.5  1.26  5.6E-04 -1.19E+00  4.72  1.24  5.2E-01  0.390  0.05 -1.0E+02
   2  0.173  0.023  0.315  -3.5  1.26  1.2E-03 -9.41E-01  3.70  1.31  6.2E-01  0.500  0.05 -1.0E+02
   3  0.163  0.017  0.325  -3.5  1.26  1.3E-03 -8.60E-01  3.36  1.36  6.6E-01  0.510  0.05 -1.0E+02
   4  0.073  0.002  0.281  -3.5  1.26  3.8E-03 -6.22E-01  2.18  1.62  8.7E-01  0.700  0.05 -1.0E+02
   5  0.200  0.035  0.330  -3.5  1.26  6.7E-04 -1.07E+00  4.14  1.78  5.6E-01  0.400  0.05 -1.0E+02
   6  0.150  0.011  0.339  -3.5  1.26  2.7E-03 -7.55E-01  3.06  1.40  7.4E-01  0.700  0.05 -1.0E+02
   7  0.234  0.046  0.370  -3.5  1.26  5.6E-04 -1.10E+00  4.43  1.26  5.5E-01  0.390  0.05 -1.0E+02
   8  0.234  0.046  0.370  -3.5  1.26  5.6E-04 -1.10E+00  4.43  1.26  5.5E-01  0.390  0.05 -1.0E+02
   9  0.189  0.028  0.322  -3.5  1.26  5.7E-04 -1.08E+00  3.88  1.30  5.5E-01  0.370  0.05 -1.0E+02
  10  0.189  0.028  0.322  -3.5  1.26  5.7E-05 -1.08E+00  3.88  1.00  5.5E-01  0.037  0.05 -1.0E+02
--
---------------Rockl Properties (Brooks & Corey/van Genuchten combined)----------------------------------------
----
--   rkcp   etresidpor  beta  alpha ksat   PE    B   n   vg-alpha fracks   imbibe  potir
--                    Kg s /m^3J/Kg         1/(J/Kg) Kg s /m^3mm/dy   J/Kg
   129
```

1	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	0.52	0.00056	500	-100
2	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
3	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
4	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
5	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
6	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
7	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
8	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
9	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
10	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
11	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.06	-100
12	0.388	0.039	0.393	-1.5	1.26	0.000053	-242	4.57	1.38	2400	0.000053	2.74	-100
13	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
14	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
15	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
16	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
17	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
18	0.248	0.01	0.253	-1.5	1.26	3.8E-06	-82.3	2.71	1.84	830	3.9E-06	3.34	-100
19	0.159	0.01	0.164	-1.5	1.26	1.2E-06	-140	3.61	1.53	1400	1.3E-06	1.13	-100
20	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
21	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
22	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
23	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
24	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
25	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
26	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
27	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
28	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
29	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
30	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
31	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
32	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
33	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
34	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
35	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
36	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
37	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
38	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
39	0.494	0.05	0.499	-1.5	1.26	0.000088	-4000	3.78	1.49	40000	0.000088	75.62	-100
40	0.494	0.05	0.499	-1.5	1.26	0.000088	-341	4.19	1.43	3400	0.000088	75.62	-100
41	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
42	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
43	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
44	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-26.9	5.6	1.29	270	2.1E-07	0.09	-100
45	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
99	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.25	-100
46	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
47	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
48	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
49	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
50	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
51	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
52	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
53	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
54	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
55	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
56	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
57	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
58	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
59	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
60	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
61	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
62	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
63	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
64	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
65	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.07	-100
66	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
67	0.031	0.018	0.036	-1.5	1.26	5.0E-09	-0.6	3.39	1.58	10	2.4E-07	0.17	-100
68	0.168	0.021	0.173	-1.5	1.26	7.3E-08	-125	5.36	1.31	1300	1.3E-07	0.07	-100
69	0.327	0.066	0.332	-1.5	1.26	4.5E-09	-39	5.66	1.29	390	6.6E-08	0.02	-100
70	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
71	0.327	0.066	0.332	-1.5	1.26	4.5E-09	-39	5.66	1.29	390	6.6E-08	0.01	-100
72	0.317	0.023	0.322	-1.5	1.26	3.8E-08	-181	4.01	1.46	1800	9.9E-08	1.65	-100
73	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
74	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
75	0.281	0.051	0.286	-1.5	1.26	1.7E-08	-17.5	4.01	1.45	180	7.8E-08	0.02	-100
76	0.112	0.011	0.117	-1.5	1.26	4.1E-08	-3.2	3.07	1.68	36	1.0E-07	0.09	-100
77	0.043	0.002	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.25	-100
201	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
202	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.06	-100

203	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
204	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	120	1.4E-07	500	-100
205	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
206	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.41	-100
207	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
208	0.089	0.03	0.094	-1.5	1.26	7.5E-09	-1.8	2.31	2.14	22	2.5E-07	0.14	-100
209	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
210	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.09	-100
211	0.112	0.011	0.117	-1.5	1.26	4.1E-08	-3.2	3.07	1.68	36	1.0E-07	0.09	-100
212	0	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
213	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
214	0.232	0.024	0.237	-1.5	1.26	3.8E-07	-6.8	3.31	1.6	72	4.4E-07	0.05	-100
301	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	0.52	0.00056	500	-100
302	0.35	0.065	0.366	-1.5	1.26	0.0011	-0.93	3.6	1.25	0.52	0.00056	500	-100
303	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
304	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
305	0.388	0.039	0.393	-1.5	1.26	0.000053	-242	4.57	1.38	2400	0.000053	2.74	-100
306	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
307	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
308	0.401	0.07	0.406	-1.5	1.26	0.000052	-4150	6.78	1.23	42000	0.000052	46.66	-100
309	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
310	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
311	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
312	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
313	0.248	0.01	0.253	-1.5	1.26	3.8E-06	-82.3	2.71	1.84	830	3.9E-06	3.34	-100
314	0.248	0.01	0.253	-1.5	1.26	3.8E-06	-82.3	2.71	1.84	830	3.9E-06	3.34	-100
315	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
316	0.159	0.01	0.164	-1.5	1.26	1.2E-06	-140	3.61	1.53	1400	1.3E-06	1.13	-100
317	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
318	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
319	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
320	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
321	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
322	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
323	0.388	0.039	0.393	-1.5	1.26	0.000053	-242	4.57	1.38	2400	0.000053	2.74	-100
324	0.43	0.044	0.435	-1.5	1.26	0.0004	-1790	6.81	1.23	18000	0.0004	13.83	-100
325	0.494	0.05	0.499	-1.5	1.26	0.000088	-4000	3.78	1.49	40000	0.000088	75.62	-100
326	0.077	0.011	0.082	-1.5	1.26	5.4E-09	-12	3.04	1.69	120	1.4E-07	0.06	-100
327	0.485	0.05	0.49	-1.5	1.26	0.00042	-5260	5.86	1.28	53000	0.00042	276.49	-100
328	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
329	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
330	0.043	0.005	0.048	-1.5	1.26	1.6E-07	-88.1	6.43	1.25	890	3.7E-07	0.35	-100
331	0.151	0.007	0.156	-1.5	1.26	1.7E-07	-377	2.11	2.4	3800	2.8E-07	0.20	-100
332	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
333	0.149	0.01	0.154	-1.5	1.26	2.0E-08	-65.3	5.09	1.33	660	1.2E-07	0.05	-100
334	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
335	0.105	0.02	0.11	-1.5	1.26	4.0E-09	-6	3.92	1.47	64	2.4E-07	0.09	-100
336	0.125	0.01	0.13	-1.5	1.26	2.3E-08	-26.9	5.6	1.29	270	2.2E-07	0.09	-100
345	0.097	0.01	0.102	-1.5	1.26	1.3E-07	-154.6	5.02	1.56	1560	2.9E-07	0.24	-100

Additional input files for INFIL V. A_2.a1 include the Tule Lake climate input file “Tulelake.inp”, DTN: GS000308311221.010 [147602], (see Table 4-2) and the Watershed Data Files DTN: GS000308311221.004 [146853] (see Table 4-3).

Table V-2. Output File from Running INFIL V. A_2.a1 Using the Input Control File in Table V-1.

```
   easting   northing    precip     rain  snow-fall   snow-cover  snow-melt  sublimation   evapotrans  run-
infil   del-soil  net-infil     runoff       run-on  mass-balance    max-balance  mass-balance #2
  547661.0  4078143.0   304.01522  226.52299   77.49223   1302.59009   67.38841    9.26259  263.32949
0.00000    1.85583   28.08674    0.63935   0.000000     -0.1278977E-12   -0.6755707E-13   -0.2842171E-13
  547661.0  4078203.0   303.91343  226.44715   77.46628   1296.97849   67.32266    9.30349  265.68519
0.00000    1.83213   25.77829    0.47420   0.000000    0.5684342E-13   -0.4952982E-13   -0.1421085E-13
  547661.0  4078173.0   303.91343  226.44715   77.46628   1298.30510   67.39638    9.22950  263.30361
0.00000    1.85562   28.02994    0.65435   0.000000     -0.2842171E-13   -0.5961898E-13   -0.1421085E-13
  547661.0  4078383.0   303.81181  226.37144   77.44038   1295.49959   67.49510    9.10541  260.61200
0.00000    1.88052   30.59610    0.77792   0.000000     -0.2700062E-12   -0.4179990E-13   0.000000
  547661.0  4078233.0   303.81181  226.37144   77.44038   1290.86705   67.23996    9.36153  264.14734
0.00000    1.83217   26.98083    0.65106   0.000000    0.1421085E-13   -0.5717649E-13   0.000000
  547661.0  4078413.0   303.71027  226.29577   77.41449   1295.14841   67.73032    8.84433  254.51339
0.00000    1.94099   36.53665    1.03507   0.000000    0.5968559E-12   -0.5095924E-13  0.5400125E-12
  547661.0  4078353.0   303.71027  226.29577   77.41449   1286.54120   67.25837    9.31810  264.17665
0.00000    1.83088   26.89263    0.65399   0.000000    0.2984279E-12   -0.5329071E-13  0.5400125E-12
  547661.0  4078443.0   303.60869  226.22009   77.38860   1295.14021   67.98307    8.56564  247.64603
0.00000    2.00652   43.22886    1.32174   0.000000     -0.6963319E-12   -0.4385381E-13   -0.5968559E-12
  547661.0  4078323.0   303.60869  226.22009   77.38860   1296.90595   68.08033    8.46804  259.79965
0.00000    1.94562   31.83990    0.71524   0.000000     -0.7531753E-12   -0.4507505E-13   -0.5968559E-12
  547661.0  4078263.0   303.60869  226.22009   77.38860   1308.88058   68.76929    7.77661  254.80001
0.00000    2.04700   37.36647    0.77590   0.000000     -0.5968559E-12   -0.5126455E-13   -0.5968559E-12
  547661.0  4078293.0   303.50728  226.14453   77.36275   1299.10130   68.45735    8.06467  254.12461
0.00000    2.01867   37.57736    0.88123   0.000000     -0.3694822E-12   -0.6222800E-13  0.7105427E-12
  547631.0  4078443.0   303.40591  226.06900   77.33692   1296.05981   68.54581    7.95097  253.73436
0.00000    2.02774   37.94976    0.90295   0.000000    0.8526513E-13   -0.5989653E-13   -0.7247536E-12
  547631.0  4078413.0   303.30454  225.99346   77.31108   1286.77768   68.27101    8.20185  248.89155
0.03603    2.02918   42.16399    1.21578   1.285716     -0.6252776E-12   -0.3996803E-13   -0.6110668E-12
  547631.0  4078383.0   303.10215  225.84266   77.25949   1272.59840   67.98576    8.43853  238.78276
0.03720    2.12742   51.37157    1.58387  0.9978709    0.2415845E-12   -0.6417089E-13  0.5542233E-12
  547631.0  4078173.0   303.10215  225.84266   77.25949   1283.22938   68.59022    7.83180  249.65341
0.00000    2.52061    1.60791   40.65094  0.6393480     -0.5258016E-12   -0.4493628E-13  0.5542233E-12
  547631.0  4078203.0   303.00095  225.76726   77.23369   1281.15187   68.72581    7.67081  249.02796
0.00000    2.53581    1.62676   41.30253  0.6543543     -0.1136868E-11   -0.4418688E-13  0.6963319E-12
  547631.0  4078353.0   302.69799  225.54152   77.15647   1254.89323   67.91946    8.40555  253.56744
0.00000    2.41831    1.46271   36.01251  0.7779184     -0.1350031E-11   -0.4528322E-13   -0.6110668E-12
  547631.0  4078233.0   302.69799  225.54152   77.15647   1272.35931   68.96159    7.35958  240.52070
0.00000    2.53827    1.88877   49.55537  0.4742009     -0.1506351E-11   -0.4463097E-13   -0.6110668E-12
  547631.0  4078323.0   302.49637  225.39129   77.10508   1250.62803   68.14121    8.13327  248.93372
0.00000    2.43656    1.54081   40.62141  0.6539860     -0.1136868E-11   -0.5073719E-13  0.6252776E-12
  547631.0  4078293.0   302.39559  225.31620   77.07939   1251.50617   68.43539    7.81316  243.61107
0.00000    2.45811    1.70765   45.97476  0.7152425     -0.1293188E-11   -0.4796163E-13   -0.6110668E-12
  547631.0  4078263.0   302.39559  225.31620   77.07939   1257.27475   68.78234    7.46493  241.57169
0.00000    2.51306    1.83615   48.17763   2.308194     -0.1350031E-11   -0.5195844E-13   -0.6110668E-12
  547601.0  4078413.0   302.09378  228.15092   73.94286   1197.68037   65.10841    8.00732  218.39352
0.00000    2.35480   56.29036   16.22066  0.9029453     -0.3979039E-12   -0.4524159E-13  0.1421085E-13
  547601.0  4078383.0   301.69228  227.84769   73.84459   1177.33383   64.85753    8.16436  216.33954
0.04794    2.30995   55.99055   18.11313   2.453554    0.2700062E-12   -0.2742251E-13  0.5400125E-12
  547601.0  4078203.0   301.29186  227.54528   73.74658   1178.97197   65.90673    7.01628  198.89746
7.27257    2.40478   68.30218   31.12016   34.01772     -0.3552714E-12   -0.2775558E-13  0.2842171E-13
  547601.0  4078353.0   301.19182  227.46973   73.72209   1157.02969   64.81397    8.08988  214.82332
0.04816    2.29794   55.99795   19.21265   2.533579     -0.2415845E-12   -0.2747802E-13   0.000000
  547601.0  4078233.0   300.99215  227.31893   73.67322   1171.17582   66.15160    6.69986  201.92721
8.05949    2.44520   69.14303   28.01459   33.89739    0.2842171E-12   -0.3422262E-13  0.5400125E-12
  547601.0  4078323.0   300.79269  227.16829   73.62440   1148.33517   65.20082    7.60694  208.97186
7.05361    2.33692   62.51371   25.60023   29.73682     -0.4405365E-12   -0.3463896E-13  0.1421085E-13
  547601.0  4078293.0   300.69307  227.09305   73.60001   1151.39492   65.61996    7.16273  205.96548
7.71420    2.39848   65.26076   26.80250   33.56119    0.1989520E-12   -0.3547163E-13  0.5684342E-12
  547601.0  4078263.0   300.69307  227.09305   73.60001   1157.36736   65.99001    6.79133  204.17557
14.97620    2.43934   69.46083   31.98352   132.2292    0.2842171E-13   -0.3375078E-13  0.5684342E-12
  547571.0  4078383.0   300.09661  226.65811   73.43850   1117.23648   64.88753    7.74144  213.03772
0.28550    2.32147   57.26082   19.21113   16.83811     -0.1421085E-13   -0.3014256E-13   -0.6821210E-12
  547571.0  4078353.0   299.60132  226.28403   73.31729   1095.21651   64.65458    7.85845  234.60796
0.16919    2.31869    1.79709   52.38405   20.39750    0.2273737E-12   -0.3341771E-13  0.5684342E-12
  547571.0  4078233.0   299.30492  226.06016   73.24476   1110.06979   66.21660    6.21936  220.06267
0.28357    2.50450    2.30708   67.68608   64.85431     -0.4405365E-12   -0.3042011E-13  0.6110668E-12
  547571.0  4078323.0   299.00908  230.05910   68.94999   1019.09805   61.03672    7.11250  227.54007
0.35213    2.35972    1.88406   59.66410   21.39410    0.2984279E-12   -0.3150258E-13  0.4689582E-12
  547571.0  4078263.0   299.00908  230.05910   68.94999   1039.02055   62.15475    5.98878  220.13927
0.43519    2.52948    2.26708   67.71322   61.47679    0.2273737E-12   -0.2614575E-13  0.4689582E-12
  547571.0  4078293.0   298.91054  229.98328   68.92726   1029.13985   61.78799    6.33485  222.89630
0.55572    2.45748    2.17272   64.80049   279.3578     -0.2415845E-12   -0.3286260E-13   -0.2842171E-13
  547541.0  4078353.0   298.22298  229.45427   68.76871  985.60676   60.58789    7.38812  236.00902    0.38463
2.31838    1.67431   50.42508   35.66462    0.7105427E-14   -0.2842171E-13   0.000000
```

```
  547541.0  4078233.0   297.73369  229.07780   68.65589  988.08956   61.86935    5.99263  226.37074    0.00000
2.50120    2.02563   60.04959   0.000000    -0.8455459E-12   -0.2620126E-13   -0.4831691E-12
  547541.0  4078323.0   297.44093  228.85255   68.58838  962.57934   60.85551    6.94615  233.28777    0.54871
2.33965    1.74486   52.88448   72.23284    -0.2415845E-12   -0.2686740E-13  0.6536993E-12
  547541.0  4078263.0   297.44093  228.85255   68.58838  983.19100   62.13073    5.66421  224.61615    1.44794
2.54261    2.16628   63.10619   131.0924    -0.2557954E-12   -0.3397282E-13  0.6536993E-12
  547541.0  4078293.0   297.14869  228.62770   68.52099  968.79853   61.77603    5.95548  227.68468    2.13700
2.48395    1.98718   60.38493   552.2694    -0.2771117E-12   -0.3375078E-13   -0.1421085E-13
  547511.0  4078233.0   296.17874  231.95658   64.22216  865.96092   57.62956    5.81301  231.04734    0.00000
2.46578    1.80303   54.26999   0.000000    -0.6323830E-12   -0.2486900E-13   -0.4547474E-12
  547511.0  4078323.0   296.08211  231.88091   64.20121  851.41238   56.86526    6.56082  237.05130    0.83670
2.33849    1.61085   48.58223   85.25299   0.2842171E-13   -0.2625677E-13   -0.5968559E-12
  547511.0  4078263.0   295.88894  231.72962   64.15932  861.57599   57.94713    5.43329  233.27565    1.84810
2.53424    1.83757   53.87739   58.20149    -0.8810730E-12   -0.3375078E-13  0.5826450E-12
  547511.0  4078293.0   295.59974  231.50313   64.09661  848.65413   57.63937    5.68100  241.86816   11.39561
2.48060    1.60254   54.58681   920.5747   0.4050094E-12   -0.3455569E-13  0.5258016E-12
  547481.0  4078233.0   294.63967  230.79086   63.84881  813.71195   57.38828    5.69464  240.41318    0.00000
2.46709    1.52960   43.76928   0.000000    -0.6963319E-12   -0.3458345E-13   -0.4618528E-12
  547481.0  4078263.0   294.54402  230.71594   63.82808  812.01784   57.46933    5.59325  245.08497    0.00000
2.50396    1.47243   39.12391   0.000000    -0.9805490E-12   -0.4618528E-13  0.4831691E-12
  547481.0  4078203.0   294.54402  230.71594   63.82808  808.08339   57.19420    5.86970  241.86920    3.36078
2.44161    1.48717   45.47293   50.90921    -0.2700062E-12   -0.3264056E-13  0.4831691E-12
  547481.0  4078293.0   294.35284  230.56619   63.78665  803.57943   57.28033    5.74330  254.18000   20.13646
2.48767    1.38818   49.92713   1200.939    -0.1101341E-11   -0.4829470E-13  0.4831691E-12
  547451.0  4078263.0   293.30606  233.97305   59.33301  711.04844   53.08411    5.49539  249.64053  112.12236
2.20962  128.65977   18.66960   1138.744    -0.1492140E-12   -0.5548340E-13  0.4476419E-12
  547451.0  4078233.0   293.21119  233.89737   59.31382  709.43224   53.13608    5.42478  226.44144   26.50132
2.33136   79.97799    4.78398   12.62259    -0.9947598E-13   -0.2930989E-13   -0.1421085E-13
  547451.0  4078203.0   293.21119  233.89737   59.31382  711.09966   53.23634    5.32374  223.84020   29.19801
2.33386   84.51074    5.64692   14.57126    -0.3197442E-12   -0.5018208E-13   -0.1421085E-13
  547451.0  4078173.0   293.11649  233.82183   59.29466  709.56055   53.30214    5.23930  220.26350   93.99172
2.71104  158.14113    0.00000   2.390424    -0.7460699E-12   -0.2131628E-13   -0.4263256E-12
  547421.0  4078263.0   292.45505  233.29419   59.16086  689.60422   52.89555    5.51982  235.87326    0.00000
2.77793   47.53854    0.00000   0.000000    -0.2131628E-13   -0.3341771E-13   -0.5329071E-12
  547421.0  4078233.0   292.26657  233.26781   58.99876  685.50200   52.81401    5.44088  236.64726  411.56640
2.79267  458.20829    0.00000   745.8471   0.4263256E-12  0.4263256E-13   -0.5258016E-12
  547421.0  4078203.0   292.17246  233.19270   58.97977  684.14384   52.89479    5.34169  227.52415   17.33079
2.84753   73.04659    0.00000  0.7578769E-01  0.3410605E-12   -0.3563816E-13   -0.5400125E-12
  547421.0  4078143.0   292.17246  233.19270   58.97977  688.85104   53.26038    4.97391  228.30248    0.00000
2.85734   55.29325    0.00000   0.000000    -0.1136868E-12   -0.3852474E-13   -0.5400125E-12
  547421.0  4078173.0   292.07836  233.11758   58.96077  686.21073   53.21037    5.00599  225.70350   20.85492
2.87251   78.60686    0.00000   1.753688    -0.4973799E-13   -0.3863576E-13   -0.5258016E-12
  547391.0  4078263.0   291.89045  232.96761   58.92284  676.13964   52.64910    5.53312  240.89646    0.00000
2.73467   41.98558    0.00000   0.000000    -0.5684342E-13   -0.3724798E-13   -0.3552714E-13
  547391.0  4078233.0   291.60897  232.74295   58.86602  668.72725   52.53438    5.59409  241.47814    0.00000
2.71872   41.08047    0.00000   0.000000    -0.3765876E-12   -0.4085621E-13  0.4831691E-12
  547391.0  4078203.0   291.42159  232.59340   58.82819  666.38907   52.70701    5.38495  240.58999  271.19568
2.75090  313.15521    0.00000   474.6515    -0.7531753E-12   -0.3907985E-13   -0.3623768E-12
  547391.0  4078143.0   291.42159  232.59340   58.82819  673.29345   53.28392    4.80485  234.57852    0.00000
2.81197   48.48683    0.00000   0.000000    -0.7105427E-12  0.3785861E-13   -0.3623768E-12
  547391.0  4078173.0   291.32796  232.51867   58.80929  667.21099   52.94643    5.12612  236.36971    1.82948
2.79085   48.13400    0.00000   0.000000    -0.3410605E-12   -0.4263256E-13  0.4689582E-12
  547361.0  4078263.0   291.23446  232.44404   58.79042  662.64054   52.67547    5.37990  238.00238    0.00000
2.76708   44.35005    0.00000   0.000000    -0.6394885E-13  0.3730349E-13  0.4831691E-12
  547361.0  4078233.0   291.04757  232.29488   58.75269  656.69771   52.47649    5.54354  239.13671    0.00000
2.74069   42.89397    0.00000   0.000000   0.3979039E-12   -0.4007905E-13  0.4689582E-12
  547361.0  4078143.0   290.86100  232.14597   58.71503  659.44135   53.07206    4.90913  237.31756    0.00000
2.80044   45.10004    0.00000   0.000000    -0.2771117E-12   -0.3580469E-13  0.4334311E-12
  547361.0  4078203.0   290.76771  232.07152   58.69620  650.31990   52.43488    5.53138  239.30021    0.00000
2.73670   42.46949    0.00000   0.000000   0.1421085E-13   -0.4263256E-13   -0.2131628E-13
  547361.0  4078173.0   290.58150  231.92290   58.65861  651.02111   52.85349    5.07493  281.44196   34.04408
2.18728   15.02118   20.17005   440.6074    -0.1733724E-11   -0.8124057E-13   -0.4263256E-13
  547331.0  4078293.0   290.39547  236.19060   54.20487  590.55524   48.49333    4.98330  267.09210    0.00000
2.13711   10.83433    4.62039   0.000000    -0.2344791E-12   -0.6605827E-13   -0.2131628E-13
  547331.0  4078263.0   290.39547  236.19060   54.20487  590.03109   48.43626    5.04056  268.65885    0.00000
2.10576   10.17154    3.69072   0.000000    -0.5968559E-12   -0.6472600E-13   -0.2131628E-13
  547331.0  4078233.0   290.39547  236.19060   54.20487  587.58147   48.21756    5.26050  269.81289    0.00000
2.04289    9.22123    3.33114   0.000000    -0.5826450E-12   -0.7052692E-13   -0.2131628E-13
  547331.0  4078203.0   290.11687  235.96400   54.15287  580.51892   48.08476    5.34429  272.99840    0.00000
2.08997    3.91551    5.04488   0.000000    -0.1705303E-12   -0.5401235E-13  0.4902745E-12
  547331.0  4078143.0   290.11687  235.96400   54.15287  588.46215   48.78634    4.63866  270.15769    0.00000
2.28983    5.15477    7.14803   0.000000    -0.4334311E-12   -0.6300516E-13  0.4902745E-12
  547331.0  4078173.0   289.83882  235.73786   54.10097  579.55174   48.51123    4.86599  278.87324   24.22296
2.22920    5.54772   21.82189   436.5545    -0.2557954E-12   -0.5757894E-13  0.4689582E-12
  547301.0  4078293.0   289.65375  235.58733   54.06642  575.06014   48.46460    4.88029  273.62265    0.00000
2.19169    4.02464    4.21295   0.000000    -0.7247536E-12   -0.7799317E-13  0.4760636E-12
  547301.0  4078263.0   289.65375  235.58733   54.06642  574.90634   48.44237    4.90256  272.26990    0.42063
2.17222    4.33387    5.67434   4.199760    -0.4192202E-12   -0.6145084E-13  0.4760636E-12
  547301.0  4078233.0   289.56134  235.51216   54.04917  570.67889   48.21615    5.11367  272.31463    0.24604
2.10868    4.06910    5.48196   3.444672    -0.4263256E-13   -0.7494005E-13   -0.2131628E-13
```

```
  547301.0  4078203.0   289.37660  235.36191   54.01469  565.75496   48.08717    5.21039  285.63145    3.33114
1.14877    0.00000    0.00000   0.000000    0.6465939E-12   -0.8837375E-13  0.4192202E-12
  547301.0  4078143.0   289.37660  235.36191   54.01469  574.30822   48.87140    4.42151  268.36761    0.00000
2.29980    5.31917    8.24672   0.000000    0.7318590E-12   -0.5401235E-13  0.4192202E-12
  547271.0  4078293.0   289.00792  235.06205   53.94587  561.80337   48.38747    4.84298  286.18381    0.00000
-2.73429    0.00000    0.00000   0.000000    -0.5968559E-12   -0.9414691E-13  0.4689582E-12
  547271.0  4078263.0   289.00792  235.06205   53.94587  561.11085   48.32600    4.90486  286.94059    4.21295
0.66041    0.00000    0.00000   0.000000    -0.1918465E-12  0.9148238E-13  0.4689582E-12
  547301.0  4078173.0   289.00792  235.06205   53.94587  563.72159   48.55004    4.67922  384.00588  117.70951
4.75378    0.93313   11.62881   352.8598    -0.1968203E-11   -0.1563194E-12  0.4689582E-12
  547271.0  4078233.0   288.82391  234.91239   53.91153  556.41188   48.22601    4.97283  290.87662    9.87410
2.12496    0.01091    0.00000   0.000000    0.7318590E-12   -0.9170442E-13  0.3481659E-12
  547271.0  4078113.0   288.82391  234.91239   53.91153  558.37896   48.39838    4.79913  274.05615    0.00000
2.14631    0.64099    6.46733   0.000000    0.2415845E-12   -0.8593126E-13  0.3481659E-12
  547271.0  4078143.0   288.64020  234.76297   53.87723  559.50823   48.82118    4.34105  271.87891    0.00000
2.27917    0.73244    8.69363   0.000000    -0.2060574E-12   -0.6394885E-13   -0.4760636E-12
  547271.0  4078203.0   288.54836  237.84650   50.70186  538.84523   45.00519    4.98672  289.95800    8.92663
1.81487    0.00545    0.00000   0.000000    0.9237056E-13  0.1092459E-12   -0.4476419E-12
  547241.0  4078263.0   288.36500  237.69536   50.66964  537.04960   45.17546    4.78497  285.86985    0.00000
-2.99902    0.00000    0.00000   0.000000    0.4973799E-13  0.9370282E-13  0.3552714E-13
  547271.0  4078173.0   288.27336  237.61982   50.65354  537.79545   45.40273    4.54076  443.15108  181.35579
18.60780    0.70814    1.91132   191.3795    -0.3154810E-11   -0.5577760E-12   -0.3055334E-12
  547241.0  4078233.0   288.18182  237.54436   50.63745  532.16988   45.03849    4.89212  285.62542    0.00000
-3.04256    0.00000    0.00000   0.000000    -0.1918465E-12  0.9992007E-13  0.4263256E-12
  547241.0  4078203.0   287.99887  237.39357   50.60531  528.23453   44.98377    4.91651  285.44853    0.00000
-3.07119    0.00000    0.00000   0.000000    -0.1989520E-12   -0.8659740E-13   -0.1421085E-13
  547241.0  4078143.0   287.99887  237.39357   50.60531  533.93761   45.52211    4.37469  283.95968    0.00000
-1.04400    0.00000    0.00000   0.000000    -0.3552714E-12  0.8859580E-13   -0.1421085E-13
  547241.0  4078113.0   287.99887  237.39357   50.60531  531.36957   45.27564    4.62266  283.67937    0.00000
-1.01016    0.00000    0.00000   0.000000    0.1421085E-13   -0.8093526E-13   -0.1421085E-13
  547241.0  4078083.0   287.90752  237.31827   50.58926  529.63041   45.26934    4.61367  278.26756    1.83015
2.16031    0.30315    3.68674   4.637182    -0.1065814E-12   -0.6306067E-13  0.4476419E-12
  547211.0  4078233.0   287.72493  237.16776   50.55717  523.85465   45.05218    4.80182  287.42872    0.00000
-5.20878    0.00000    0.00000   0.000000    -0.1065814E-12  0.1416645E-12  0.7105427E-14
  547241.0  4078173.0   287.72493  237.16776   50.55717  526.20058   45.26342    4.58903  358.80069   88.82951
12.44932    0.01069    0.00000   113.1549    -0.4760636E-12  0.4263256E-12  0.7105427E-14
  547211.0  4078203.0   287.54264  237.01750   50.52514  519.36613   44.95027    4.87386  287.20982    0.00000
-5.24205    0.00000    0.00000   0.000000    0.3623768E-12   -0.1216804E-12  0.3410605E-12
  547211.0  4078113.0   287.45151  236.94238   50.50913  520.85343   45.25184    4.55518  283.55528    0.00000
-1.36105    0.00000    0.00000   0.000000    -0.1634248E-12  0.1014744E-12  0.7105427E-14
  547211.0  4078173.0   287.36051  236.86737   50.49314  517.73864   45.10980    4.68280  287.17238    0.00000
-5.19520    0.00000    0.00000   0.000000    -0.5400125E-12   -0.1402212E-12  0.4689582E-12
  547211.0  4078143.0   287.36051  236.86737   50.49314  519.53457   45.28034    4.51122  318.24359   35.50188
-0.59399    0.00000    0.00000   77.65306    -0.4618528E-12  0.1623146E-12  0.4689582E-12
  547211.0  4078083.0   287.36051  236.86737   50.49314  520.10201   45.32660    4.46445  291.61606    8.32392
-1.09817    0.00000    0.00000   0.000000    -0.4263256E-12   -0.1119105E-12  0.4689582E-12
  547181.0  4078203.0   287.17862  236.71744   50.46118  512.61907   44.94296    4.82024  286.89580    0.00000
-5.23540    0.00000    0.00000   0.000000    -0.9947598E-13  0.1174616E-12  0.7105427E-14
  547181.0  4078083.0   287.08779  236.64258   50.44522  515.06154   45.32854    4.41700  282.00887    0.00000
-0.03775    0.00000    0.00000   0.000000    -0.2557954E-12   -0.6838974E-13  0.4405365E-12
  547181.0  4078173.0   286.99697  236.56771   50.42926  509.74480   44.99224    4.74031  286.77671    0.00000
-5.21676    0.00000    0.00000   0.000000    -0.7958079E-12   -0.1370015E-12   -0.3126388E-12
  547181.0  4078143.0   286.90627  236.49294   50.41332  508.95336   45.07778    4.63908  281.68459    0.00000
-0.11387    0.00000    0.00000   0.000000    -0.4973799E-12   -0.8171241E-13   -0.2913225E-12
  547181.0  4078113.0   286.90627  236.49294   50.41332  511.03419   45.26326    4.45231  305.88045   22.52498
-1.59926    0.00000    0.00000   55.12808    -0.9805490E-12   -0.1365574E-12   -0.2913225E-12
  547151.0  4078083.0   286.81562  236.41822   50.39739  509.37680   45.27593    4.42451  281.73098    0.00000
-0.03682    0.00000    0.00000   0.000000    0.4476419E-12   -0.7682743E-13  0.2984279E-12
  547151.0  4078173.0   286.72497  236.34350   50.38146  504.62216   44.99457    4.69253  286.55572    0.00000
-5.21765    0.00000    0.00000   0.000000    0.7105427E-13   -0.1614264E-12   -0.4263256E-12
  547151.0  4078143.0   286.63444  236.28371   50.35073  503.32060   45.03272    4.62412  286.51688    0.00000
-5.20045    0.00000    0.00000   0.000000    -0.2131628E-13  0.1463274E-12   -0.4547474E-12
  547151.0  4078113.0   286.63444  236.28371   50.35073  505.30583   45.21839    4.43730  296.17146   12.43776
-2.23161    0.00000    0.00000   42.69032    0.2842171E-13   -0.1167955E-12   -0.4547474E-12
  547121.0  4078083.0   286.45349  236.13454   50.31895  501.94016   45.23076    4.39468  281.42263    0.00000
-0.05733    0.00000    0.00000   0.000000    -0.2060574E-12  0.7560619E-13  0.4973799E-12
  547121.0  4078143.0   286.36313  236.06006   50.30307  498.08130   45.03356    4.57807  286.29948    0.00000
-5.20587    0.00000    0.00000   0.000000    -0.3197442E-12  0.1341149E-12  0.4760636E-12
  547121.0  4078113.0   286.36313  236.06006   50.30307  499.71763   45.18538    4.42531  296.28384   16.94194
1.90353    0.00000    0.00000   25.74838    -0.3552714E-12  0.1247891E-12  0.4760636E-12
  547091.0  4078113.0   286.00222  235.76255   50.23968  492.19747   45.11570    4.43522  296.00266   16.94230
1.81789    0.00000    0.00000   8.806088    -0.7815970E-13   -0.1274536E-12   -0.4405365E-12
  547061.0  4078083.0   285.73214  238.55795   47.17420  458.78044   42.14184    4.40862  287.99758    7.26811
-0.02968    0.00000    0.00000   1.537975    -0.7105427E-14   -0.9947598E-13  0.3836931E-12
  547031.0  4078053.0   285.55236  238.40785   47.14451  454.61754   42.09297    4.43211  282.14555    1.53797
-0.10676    0.00000    0.00000   0.000000    -0.6821210E-12  0.8404388E-13   -0.2700062E-12
```

Table V-3. Input File Used by POSTINFIL to Postprocess results from INFIL V. A_2.a1 (There are eleven of these input files corresponding to each watershed)

```
!=======================================================================
!POSTINFIL V. 2.50 input user control file
!For use in calculations for YMP LA
!Date: September, 2003
!  ANALYST:  Ron McCurley, GRAM, Inc.
!
!  DESCRIPTION:
!   POSTINFIL Input File for SE7 watershed, glacial transition climate
!
!=======================================================================
!Store mean infiltration and no. of active cells for watershed SE7
*STORE, &
 ARRAY=GLOBAL, STEP=1, COPY=0, &
 NAMES: MEAN_INFIL=INF_SE7,NUMBER_CELLS=NCELLSE7,MEAN_RUNOFF=RUN_SE7
*coord, &
 number=4, &
 rect: x1=547750., x2=548550., y1=4077000., y2=4078400., &
 rect: x1=547350., x2=548550., y1=4078400., y2=4079490., &
 rect: x1=547350., x2=549200., y1=4079490., y2=4080228., &
 rect: x1=547350., x2=548900., y1=4080228., y2=4081200.
*END
```

Table V-4. Input File for ALGEBRACDB

```
!=======================================================================
!  ALGEBRACDB input file
!  ANALYST:  Ron McCurley, GRAM
!  Date:  September, 2003
!  DESCRIPTION:
!  ALGEBRACDB Input File for obtaining weighted average over repository
!  footprint, glacial transition climate
!
!=======================================================================
!$ compute the weighted mean infiltration rate
!$ sum over cells from all watersheds in repository footprint
 TEMPSUM1 = NCELLSE7+NCELLSE8+NCELLSE9+NCELSE10
 TEMPSUM2 = NCELLWT2+NCELLDH4+NCELLDH3+NCELLCW1+NCELLSW1
 SUMCELLS= MAKEGLOB(TEMPSUM1+TEMPSUM2+NCELLWW1+NCELLUS1)
!$
 TMPMEAN1 =  NCELLWT2*INF_WT2 + NCELLDH4*INF_DH4 + NCELLDH3*INF_DH3
 TMPMEAN2 =  NCELLCW1*INF_CW1 + NCELLSW1*INF_SW1 + NCELLWW1*INF_WW1
 TMPMEAN3 =  NCELLSE7*INF_SE7 + NCELLSE8*INF_SE8 + NCELLSE9*INF_SE9
 TMPMEAN4 =  NCELSE10*INF_SE10 + NCELLUS1*INF_US1
 INFMEAN = MAKEGLOB(TMPMEAN1 + TMPMEAN2 + TMPMEAN3 + TMPMEAN4)/SUMCELLS
 EXIT
```

Table V-5. Input File for GROPECDB

```
!Input file for GROPECDB
PRINT GVARS
EXIT
```

Table V-6. Listing of Output from GROPECDB showing the value of the average net infiltration (INFMEAN)

```
                    GROPECDB_PA96

  GGGGG  RRRRRR   OOOOO  PPPPPP  EEEEEEE  CCCCC  DDDDDD  BBBBBB      PPPPPP
 GG   GG RR   RR OO   OO PP   PP EE     CC   CC DD   DD BB   BB     PP   PP
 GG    RR   RR OO   OO PP   PP EE     CC     DD   DD BB   BB     PP   PP
 GG    RRRRRR  OO   OO PPPPPP  EEEEE   CC     DD   DD BBBBBB      PPPPPP
 GG  GGG RRRRR   OO   OO PP     EE     CC     DD   DD BB   BB     PP
 GG   GG RR  RR  OO   OO PP     EE     CC    CC DD   DD BB   BB     PP
  GGGGG  RR   RR  OOOOO  PP     EEEEEEE  CCCCC  DDDDDD  BBBBBB  _______ PP

              GROPECDB_PA96 Version 2.12
               PROD PA96 Built 06/27/96
               Sponsored by Amy Gilkey

               Run on 09/08/03 at 12:49:31
             Run on ALPHA AXP CCR OpenVMS V7.3-1

 Database:  U1:[RDMCCUR.YMP_2003_QACALCS.POSTPROCESS.MEAN_TULELAKE]MEAN_R001.CDB;1
 Written on:  08/28/03 11:00:26

 CAMDAT Version:   1    (EXODUS Version:   1)

 GLOBAL TIME STEP VARIABLES

  Step     Time     NCELLSE7    INF_SE7     RUN_SE7     NCELLSE8
              INF_SE8     RUN_SE8     NCELLSE9    INF_SE9
              RUN_SE9     NCELSE10    INF_SE10    RUN_SE10
              NCELLWW1    INF_WW1     RUN_WW1     NCELLCW1
              INF_CW1     RUN_CW1     NCELLSW1    INF_SW1
              RUN_SW1     NCELLDH3    INF_DH3     RUN_DH3
              NCELLDH4    INF_DH4     RUN_DH4     NCELLWT2
              INF_WT2     RUN_WT2     NCELLUS1    INF_US1
              RUN_US1     TEMPSUM1    TEMPSUM2    SUMCELLS
              TMPMEAN1    TMPMEAN2    TMPMEAN3    TMPMEAN4
              INFMEAN
    1   0.00000E+00   5.00000E+00   4.32339E+01   0.00000E+00   4.80000E+01
             4.82621E+01   0.00000E+00   8.50000E+01   4.89723E+01
             0.00000E+00   8.00000E+00   3.88690E+01   0.00000E+00
             7.81000E+02   2.03001E+01   0.00000E+00   3.39000E+02
             2.37957E+01   0.00000E+00   5.92000E+02   1.94368E+01
             0.00000E+00   1.25300E+03   1.62281E+01   0.00000E+00
             9.11000E+02   1.07267E+01   0.00000E+00   8.43000E+02
             1.67334E+01   0.00000E+00   0.00000E+00   0.00000E+00
             0.00000E+00   1.46000E+02   3.93800E+03   4.86500E+03
             4.42121E+04   3.54277E+04   6.69539E+03   3.10952E+02
             1.78101E+01
```

INTENTIONALLY LEFT BLANK

ATTACHMENT VI

Conversion of Nevada State Coordinates in 800-IED-EBS0-00402-000-00B (BSC 2003 [161727]) to UTM Coordinates Presented in Figure 1-1 and in Attachment IV

README.DOC

Included in this attachment is a description of the conversion of coordinates (Nevada State) as found in “end point coor042002.xls” to the UTM coordinates in “end_points_utm.dat”

The Excel spreadsheet “end point coor042002.xls” is the initial electronic source for the final electronic file “end_points_utm.dat”. The initial coordinates are in Nevada state plane coordinates (central zone) with meters as units. The northing, easting, and elevation columns of the Excel spreadsheet were rounded to integers using the Excel format options. These rounded numbers were visually/manually compared with the values found in *Repository/PA IED Subsurface Facilities Plan Sht 2 and 3 of 5* (BSC 2003 [159527]) and found to be identical. The Excel spreadsheet was exported to an ASCII file and converted into an EarthVision dat file using a text editor. The EARTHVISION V5.1 (Dynamic Graphics 2000 [152614]) coordinate conversion utility was used to convert from the initial coordinates to UTM (Zone 11- the numbering of the zone on the planet where the proposed repository is located). The resulting file is an ASCII file which contains the end point coordinates in UTM coordinates.

Note that the final file information is in a different order than the original. Northing in the spreadsheet corresponds to “y”, the fourth column in end_points_utm.dat, Easting corresponds to “x” the third column in end_points_utm.dat, and Elevation corresponds to “z”, the fifth column in end_points_utm.dat.

Note that the second end point coordinate pair found in the spreadsheet which includes the note “not shown” is not included in any of the the subsequent files. This drift is not currently planned to be used for emplacement.

The following files are included:

(1)	readme.doc	This file.
(2)	end point coor042202.xls	Initial electronic source for this data.
(3)	end_points_utm.dat	ASCII EarthVision file resulting from coordinate transformation which contains UTM drift end coordinates.

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial

PRELIMINARY DRAFT OF END POINT COORDINATES

Primary Block	Northing(m)	Easting(m)	Elevation(m)	Zone	Drift	Panel	Side
1a	236323.863	171665.62	1037.65	2	1	West	East
	236150.798	171132.977	1037.65	2	1	West	West
1b	236141.527	171104.445	1037.65	3	1		East
not Shown	236062.484	170861.174	1037.65	3	1		West
2a	236237.412	171661.674	1038.822	2	2	West	East
	236052.003	171091.041	1038.822	2	2	West	West
2b	236042.732	171062.509	1038.822	3	2		East
	235910.955	170656.939	1038.822	3	2		West
3	236138.618	171619.739	1039.993	2	3	West	East
	235953.208	171049.105	1039.993	2	3	West	West
	235943.937	171020.573	1039.993	3	3		East
	235768.238	170479.825	1039.993	3	3		West
4	236039.823	171577.803	1041.164	2	4	West	East
	235854.413	171007.169	1041.164	2	4	West	West
	235845.142	170978.637	1041.164	3	4		East
	235659.733	170408.003	1041.164	3	4		West
5a	236137.403	172140.248	1042.336	2	1	East	East
	235992.979	171695.756	1042.336	2	1	East	West
5b	235941.028	171535.867	1042.336	2	5	West	East
	235755.618	170965.233	1042.336	2	5	West	West
5c	235746.348	170936.701	1042.336	3	5		East
	235560.938	170366.067	1042.336	3	5		West
6	235462.143	170324.131	1043.507	3	6		West
	235647.553	170894.765	1043.507	3	6		East
	235656.823	170923.297	1043.507	2	6	West	West
	235842.233	171493.931	1043.507	2	6	West	East
	235894.184	171653.82	1043.507	2	2	East	West
	236081.661	172230.815	1043.507	2	2	East	East
7	236012.902	172281.32	1044.678	2	3	East	East
	235795.39	171611.884	1044.678	2	3	East	West
	235743.438	171451.995	1044.678	2	7	West	East
	235558.029	170881.361	1044.678	2	7	West	West
	235548.758	170852.83	1044.678	3	7		East
	235363.348	170282.196	1044.678	3	7		West
8	235264.554	170240.26	1045.85	3	8		West
	235449.963	170810.894	1045.85	3	8		East
	235459.234	170839.425	1045.85	2	8	West	West
	235644.644	171410.059	1045.85	2	8	west	East

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

PRELIMINARY DRAFT OF END POINT COORDINATES							
Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block
	235696.595	171569.949	1045.85	2	4	East	West
	235936.845	172309.363	1045.85	2	4	East	East
9	235835.884	172260.76	1047.021	2	5	East	East
	235597.8	171528.013	1047.021	2	5	East	West
	235545.849	171368.123	1047.021	2	9	West	East
	235360.439	170797.489	1047.021	2	9	West	West
	235351.169	170768.958	1047.021	3	9		East
	235165.759	170198.324	1047.021	3	9		West
10	235061.884	170140.754	1048.192	3	10		West
	235252.842	170728.461	1048.192	3	10		East
	235262.112	170756.993	1048.192	2	10	West	West
	235446.003	171322.951	1048.192	2	10	West	East
	235492.689	171466.637	1048.192	2	6	East	West
	235733.817	172208.754	1048.192	2	6	East	East
11	235631.751	172156.749	1049.363	2	7	East	East
	235397.389	171435.455	1049.363	2	7	East	West
	235359.359	171318.411	1049.363	2	11	West	East
	235172.007	170741.8	1049.363	2	11	West	West
	235155.124	170689.838	1049.363	3	11		East
	234969.843	170119.603	1049.363	3	11		West
12	234883.199	170115.062	1050.535	3	12		West
	235068.48	170685.297	1050.535	3	12		East
	235085.363	170737.259	1050.535	2	12	West	West
	235272.715	171313.87	1050.535	2	12	West	East
	235310.745	171430.914	1050.535	2	8	East	West
	235529.684	172104.743	1050.535	2	8	East	East
13	235427.618	172052.738	1051.706	2	9	East	East
	235224.101	171426.373	1051.706	2	9	East	West
	235186.071	171309.329	1051.706	2	13	West	East
	234998.719	170732.718	1051.706	2	13	West	West
	234981.835	170680.756	1051.706	3	13		East
	234796.554	170110.521	1051.706	3	13		West
14	234709.91	170105.98	1052.877	3	14		West
	234895.191	170676.215	1052.877	3	14		East
	234912.075	170728.177	1052.877	2	14	West	West
	235099.427	171304.788	1052.877	2	14	West	East
	235137.456	171421.832	1052.877	2	10	East	West
	235325.552	172000.733	1052.877	2	10	East	East
15	235223.485	171948.727	1054.049	2	11	East	East
	235050.812	171417.292	1054.049	2	11	East	West

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

PRELIMINARY DRAFT OF END POINT COORDINATES							
Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block
	235012.782	171300.247	1054.049	2	15	West	East
	234825.43	170723.637	1054.049	2	15	West	West
	234808.547	170671.674	1054.049	3	15		East
	234623.266	170101.44	1054.049	3	15		West
16	234536.621	170096.899	1055.22	3	16		West
	234721.902	170667.133	1055.22	3	16		East
	234738.786	170719.096	1055.22	2	16	West	West
	234926.138	171295.706	1055.22	2	16	West	East
	234964.168	171412.751	1055.22	2	12	East	West
	235121.419	171896.722	1055.22	2	12	East	East
17	235023.895	171858.695	1056.391	2	13	East	East
	234877.524	171408.21	1056.391	2	13	East	West
	234839.494	171291.166	1056.391	2	17	West	East
	234652.142	170714.555	1056.391	2	17	West	West
	234635.258	170662.593	1056.391	3	17		East
	234449.977	170092.358	1056.391	3	17		West
18	234363.333	170087.817	1057.563	3	18		West
	234548.614	170658.052	1057.563	3	18		East
	234565.497	170710.014	1057.563	2	18	West	West
	234752.849	171286.625	1057.563	2	18	West	East
	234790.879	171403.669	1057.563	2	14	East	West
	234931.743	171837.205	1057.563	2	14	East	East
19	234837.896	171810.496	1058.734	2	15	East	East
	234704.235	171399.128	1058.734	2	15	East	West
	234666.205	171282.084	1058.734	2	19	West	East
	234478.853	170705.473	1058.734	2	19	West	West
	234461.969	170653.511	1058.734	3	19		East
	234276.688	170083.276	1058.734	3	19		West
20	234190.044	170078.735	1059.905	3	20		West
	234375.325	170648.97	1059.905	3	20		East
	234392.209	170700.932	1059.905	2	20	West	West
	234579.561	171277.543	1059.905	2	20	West	East
	234617.59	171394.587	1059.905	2	16	East	West
	234749.206	171799.66	1059.905	2	16	East	East
21	234657.945	171780.91	1061.077	2	17	East	East
	234530.946	171390.046	1061.077	2	17	East	West
	234492.916	171273.002	1061.077	2	21	West	East
	234305.564	170696.391	1061.077	2	21	West	West

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

PRELIMINARY DRAFT OF END POINT COORDINATES							
Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block
	234288.681	170644.429	1061.077	3	21		East
	234103.4	170074.195	1061.077	3	21		West
22	234017.679	170072.497	1062.248	3	22		West
	234202.036	170639.888	1062.248	3	22		East
	234218.92	170691.851	1062.248	2	22	West	West
	234406.272	171268.461	1062.248	2	22	West	East
	234444.302	171385.506	1062.248	2	18	East	West
	234566.457	171761.463	1062.248	2	18	East	East
23a	234474.97	171742.017	1063.419	2	19	East	East
	234357.657	171380.965	1063.419	2	19	East	West
23b	234319.628	171263.921	1063.419	2	23	West	East
	234132.276	170687.31	1063.419	2	23	West	West
23c	234116.274	170638.061	1063.419	3	23		East
	233934.865	170079.743	1063.419	3	23		West
24a	233852.05	170086.988	1064.59	3	24		West
	234036.36	170654.237	1064.59	3	24		East
24b	234085.101	170804.246	1064.59	1	1		West
	234232.983	171259.38	1064.59	1	1		East
25	234146.339	171254.839	1065.762	1	2		East
	233967.124	170703.269	1065.762	1	2		West
	233949.716	170649.696	1065.762	3	25		East
	233769.235	170094.233	1065.762	3	25		West
26	233686.42	170101.479	1066.933	3	26		West
	233863.071	170645.156	1066.933	3	26		East
	233879.956	170697.118	1066.933	1	3		West
	234059.696	171250.298	1066.933	1	3		East
27	233973.052	171245.757	1068.105	1	4		East
	233793.312	170692.577	1068.105	1	4		West
	233776.427	170640.615	1068.105	3	27		East
	233603.605	170108.724	1068.105	3	27		West
28	233520.79	170115.969	1069.276	3	28		West
	233689.782	170636.074	1069.276	3	28		East
	233708.625	170694.06	1069.276	1	5		West
	233886.408	171241.216	1069.276	1	5		East
29	233799.763	171236.676	1070.447	1	6		East
	233636.504	170734.215	1070.447	1	6		West
	233604.032	170634.286	1070.447	3	29		East
	233438.937	170126.175	1070.447	3	29		West

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

PRELIMINARY DRAFT OF END POINT COORDINATES							
Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block
30	233364.351	170158.746	1071.618	3	30		West
	233529.465	170666.915	1071.618	3	30		East
	233713.121	171232.135	1071.618	1	7		East
	233578.451	170817.667	1071.618	1	7		West
31a	233475.813	170763.914	1072.79	3	31		East
	233298.212	170217.316	1072.79	3	31		West
31b	233626.476	171227.594	1072.79	1	8		East
	233521.685	170905.079	1072.79	1	8		West
32	233366.538	171213.971	1076.304	5	1		East
	233128.777	170482.22	1076.304	5	1		West
33	233043.122	170480.724	1077.476	5	2		West
	233279.893	171209.43	1077.476	5	2		East
34	233193.249	171204.89	1078.647	5	3		East
	232957.467	170479.229	1078.647	5	3		West
35	232871.813	170477.734	1079.818	5	4		West
	233106.604	171200.349	1079.818	5	4		East
36	233019.96	171195.808	1080.99	5	5		East
	232786.158	170476.239	1080.99	5	5		West
37	232700.503	170474.744	1082.161	5	6		West
	232933.315	171191.267	1082.161	5	6		East
38	232846.671	171186.726	1083.332	5	7		East
	232614.848	170473.249	1083.332	5	7		West
39	232529.193	170471.754	1084.504	5	8		West
	232760.026	171182.185	1084.504	5	8		East
40	232673.382	171177.645	1085.675	5	9		East
	232443.538	170470.259	1085.675	5	9		West
41	232357.824	170468.583	1086.847	5	10		West
	232586.737	171173.104	1086.847	5	10		East
42	232500.093	171168.563	1088.018	5	11		East
	232273.136	170470.061	1088.018	5	11		West
43	232188.447	170471.539	1089.189	5	12		West
	232413.448	171164.022	1089.189	5	12		East

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

PRELIMINARY DRAFT OF END POINT COORDINATES							
Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block	Primary Block
44	232326.804	171159.481	1090.361	5	13		East
	232103.758	170473.017	1090.361	5	13		West
45	232019.069	170474.496	1091.532	5	14		West
	232240.159	171154.94	1091.532	5	14		East
46	232153.515	171150.399	1092.703	5	15		East
	231934.38	170475.974	1092.703	5	15		West
47	231849.692	170477.452	1093.875	5	16		West
	232066.87	171145.859	1093.875	5	16		East
48	231980.225	171141.318	1095.046	5	17		East
	231765.003	170478.93	1095.046	5	17		West
49	231681.102	170482.833	1096.218	5	18		West
	231893.581	171136.777	1096.218	5	18		East
50	231806.936	171132.236	1097.389	5	19		East
	231597.515	170487.704	1097.389	5	19		West
51	231513.079	170489.959	1098.56	5	20		West
	231720.292	171127.695	1098.56	5	20		East
52	231633.647	171123.154	1099.732	5	21		East
	231427.892	170489.905	1099.732	5	21		West
53	231341.922	170487.44	1100.903	5	22		West
	231547.003	171118.614	1100.903	5	22		East
54	231460.358	171114.073	1102.074	5	23		East
	231256.87	170487.8	1102.074	5	23		West
55	231172.181	170489.278	1103.246	5	24		West
	231373.714	171109.532	1103.246	5	24		East
56	231284.914	171098.358	1104.417	5	25		East
	231089.313	170496.36	1104.417	5	25		West
57	231013.008	170523.641	1105.589	5	26		West
	231188.179	171062.762	1105.589	5	26		East
58	231088.605	171018.429	1106.76	5	27		East
	230943.765	170572.657	1106.76	5	27		West

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

Lower Block	Northing	Easting	Elevation	Zone	Drift	Panel	Side
1	235253.906	172084.841	1001.937	4	1	East	West
	235425.731	172613.666	1001.937	4	1	East	East
2	235345.392	172628.528	1001.287	4	2	East	East
	235145.081	172012.034	1001.287	4	2	East	West
3	235046.287	171970.098	1000.636	4	3	East	West
	235232.338	172542.704	1000.636	4	3	East	East
4	234947.493	171928.163	999.985	4	4	East	West
	235132.357	172497.117	999.985	4	4	East	East
5	235029.969	172444.122	999.335	4	5	East	East
	234850.11	171890.57	999.335	4	5	East	West
6	234761.42	171879.734	998.684	4	6	East	West
	234938.631	172425.131	998.684	4	6	East	East
7	234855.024	172429.939	998.033	4	7	East	East
	234675.573	171877.645	998.033	4	7	East	West
8	234587.983	171870.193	997.382	4	8	East	West
	234771.724	172435.687	997.382	4	8	East	East
9	234678.932	172412.225	996.732	4	9	East	East
	234491.821	171836.357	996.732	4	9	East	West
10a	234401.076	171819.196	996.081	4	10	East	West
	234594.395	172414.169	996.081	4	10	East	East
10b	234245.198	171339.453	996.081	4	1	West	West
	234391.806	171790.664	996.081	4	1	West	East
				4			
11	234515.912	172434.746	995.43	4	11	East	East
	234323.604	171842.882	995.43	4	11	East	West
	234158.555	171334.912	995.43	4	2	West	West
	234314.333	171814.35	995.43	4	2	West	East
12	234071.911	171330.371	994.78	4	3	West	West
	234236.861	171838.036	994.78	4	3	West	East
	234246.131	171866.567	994.78	4	12	East	West
	234440.189	172463.814	994.78	4	12	East	East
13	234364.465	172492.882	994.129	4	13	East	East
	234168.659	171890.253	994.129	4	13	East	West
	234159.388	171861.721	994.129	4	4	West	East
	233985.267	171325.83	994.129	4	4	West	West

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

Lower Block	Northing	Easting	Elevation	Zone	Drift	Panel	Side
14	233898.623	171321.29	993.478	4	5	West	West
	234081.286	171883.467	993.478	4	5	West	East
	234090.664	171912.33	993.478	4	14	East	West
	234288.741	172521.949	993.478	4	14	East	East
15	233811.979	171316.749	992.827	4	6	West	West
	233997.389	171887.383	992.827	4	6	West	East
	234006.66	171915.914	992.827	4	15	East	West
	234213.017	172551.017	992.827	4	15	East	East
16	234137.294	172580.085	992.177	4	16	East	East
	233920.016	171911.374	992.177	4	16	East	West
	233910.746	171882.842	992.177	4	7	West	East
	233725.335	171312.208	992.177	4	7	West	West
17	233638.692	171307.667	991.526	4	8	West	West
	233824.102	171878.301	991.526	4	8	West	East
	233833.372	171906.833	991.526	4	17	East	West
	234061.57	172609.153	991.526	4	17	East	East
18	233985.874	172638.307	990.875	4	18	East	East
	233746.728	171902.292	990.875	4	18	East	West
	233737.458	171873.76	990.875	4	9	West	East
	233552.048	171303.126	990.875	4	9	West	West
19	233465.404	171298.585	990.224	4	10	West	West
	233650.814	171869.219	990.224	4	10	West	East
	233660.085	171897.751	990.224	4	19	East	West
	233906.404	172655.844	990.224	4	19	East	East
20	233818.569	172647.636	989.574	4	20	East	East
	233573.441	171893.21	989.574	4	20	East	West
	233564.17	171864.679	989.574	4	11	West	East
	233378.76	171294.045	989.574	4	11	West	West
21	233292.116	171289.504	988.923	4	12	West	West
	233477.526	171860.138	988.923	4	12	West	East
	233486.797	171888.669	988.923	4	21	East	West
	233722.167	172613.065	988.923	4	21	East	East
22	233625.576	172577.908	988.272	4	22	East	East
	233400.153	171884.129	988.272	4	22	East	West
	233390.883	171855.597	988.272	4	13	West	East
	233205.472	171284.963	988.272	4	13	West	West
23	233118.829	171280.422	987.622	4	14	West	West
	233304.239	171851.056	987.622	4	14	West	East
	233313.509	171879.588	987.622	4	23	East	West
	233528.984	172542.752	987.622	4	23	East	East

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

Lower Block	Northing	Easting	Elevation	Zone	Drift	Panel	Side
24	233432.393	172507.595	986.971	4	24	East	East
	233226.865	171875.047	986.971	4	24	East	West
	233217.595	171846.515	986.971	4	15	West	East
	233032.185	171275.881	986.971	4	15	West	West
25	232945.541	171271.341	986.32	4	16	West	West
	233130.951	171841.975	986.32	4	16	West	East
	233140.222	171870.506	986.32	4	25	East	West
	233335.801	172472.439	986.32	4	25	East	East
26	233239.21	172437.283	985.669	4	26	East	East
	233053.578	171865.965	985.669	4	26	East	West
	233044.307	171837.434	985.669	4	17	West	East
	232858.897	171266.8	985.669	4	17	West	West
27	232772.253	171262.259	985.019	4	18	West	West
	232957.663	171832.893	985.019	4	18	West	East
	232966.934	171861.425	985.019	4	27	East	West
	233148.327	172419.696	985.019	4	27	East	East
28	233061.683	172415.155	984.368	4	28	East	East
	232880.29	171856.884	984.368	4	28	East	West
	232871.02	171828.352	984.368	4	19	West	East
	232685.609	171257.718	984.368	4	19	West	West
29	232598.966	171253.177	983.717	4	20	West	West
	232784.376	171823.811	983.717	4	20	West	East
	232793.646	171852.343	983.717	4	29	East	West
	232975.04	172410.614	983.717	4	29	East	East
30	232888.396	172406.074	983.067	4	30	East	East
	232707.002	171847.802	983.067	4	30	East	West
	232697.732	171819.27	983.067	4	21	West	East
	232512.322	171248.637	983.067	4	21	West	West
31	232425.678	171244.096	982.416	4	22	West	West
	232611.088	171814.73	982.416	4	22	West	East
	232620.359	171843.261	982.416	4	31	East	West
	232801.752	172401.533	982.416	4	31	East	East
32	232715.108	172396.992	981.765	4	32	East	East
	232533.715	171838.721	981.765	4	32	East	West
	232524.444	171810.189	981.765	4	23	West	East
	232339.034	171239.555	981.765	4	23	West	West
33	232252.39	171235.014	981.114	4	24	West	West
	232437.8	171805.648	981.114	4	24	West	East
	232447.071	171834.18	981.114	4	33	East	West
	232628.464	172392.451	981.114	4	33	East	East

Table VI-1. Electronic Source for this Data (from 800-IED-EBS0-00402-000-00B, BSC 2003 [161727]) end point coor042202.xlsInitial (Continued)

Lower Block	Northing	Easting	Elevation	Zone	Drift	Panel	Side
34	232541.82	172387.91	980.464	4	34	East	East
	232360.427	171829.639	980.464	4	34	East	West
	232351.157	171801.107	980.464	4	25	West	East
	232165.746	171230.473	980.464	4	25	West	West
35	232079.102	171225.932	979.813	4	26	West	West
	232264.513	171796.566	979.813	4	26	West	East
	232273.783	171825.098	979.813	4	35	East	West
	232455.177	172383.37	979.813	4	35	East	East
36a	232368.533	172378.829	979.162	4	36	East	East
	232187.139	171820.557	979.162	4	36	East	West
36b	232177.869	171792.026	979.162	4	27	West	East
	232060.697	171431.409	979.162	4	27	West	West
37	232100.496	171816.016	978.511	4	37	East	West
	232281.889	172374.288	978.511	4	37	East	East
38	232195.245	172369.747	977.861	4	38	East	East
	232044.967	171907.24	977.861	4	38	East	West

Table VI-2. end_points_utm.dat Edited ASCII EarthVision file resulting from coordinate transformation which contains UTM drift end coordinates (in meters).(x, y, z referred to in readme.doc correspond to the 3rd, 4th, and 5th column respectively)

```
# Type: scattered data
# Version: 5
# Description: end point coordinates mol.20020601.0194; these are rounded to
nearest meter from excel spreadsheet.
# Format: free
# Field: 1 Block
# Field: 2 Number
# Field: 3 x
# Field: 4 y
# Field: 5 z meters
# Field: 6 Zone
# Field: 7 Drift
# Field: 8 Panel
# Field: 9 Side
# Field: 10 Lineid non-numeric
# Projection: Universal Transverse Mercator
# Zone: 11
# Units: meters
# Ellipsoid: Clarke 1866
# End:
P     1a    548966.0766 4081494.984 1038  2     1     West  East  1
P     ""    548433.8373 4081320.173 1038  2     1     West  West  1
P     2a    548962.3884 4081407.996 1039  2     2     West  East  2
P     ""    548392.192  4081221.054 1039  2     2     West  West  2
P     2b    548364.2318 4081211.959 1039  3     2     ""    East  3
P     ""    547958.8063 4081078.578 1039  3     2     ""    West  3
P     3     548920.7351 4081309.876 1040  2     3     West  East  4
P     ""    548350.5458 4081121.935 1040  2     3     West  West  4
P     ""    548322.5852 4081112.841 1040  3     3     ""    East  5
P     ""    547782.3585 4080935.001 1040  3     3     ""    West  5
P     4     548879.0954 4081210.757 1041  2     4     West  East  6
P     ""    548308.9074 4081022.817 1041  2     4     West  West  6
P     ""    548280.9465 4081013.722 1041  3     4     ""    East  7
P     ""    547710.754  4080826.781 1041  3     4     ""    West  7
P     5a    549440.5964 4081309.692 1042  2     1     East  East  8
P     ""    548997.2225 4081164.182 1042  2     1     East  West  8
P     5b    548837.4547 4081111.639 1042  2     5     West  East  9
P     ""    548267.2625 4080924.698 1042  2     5     West  West  9
P     5c    548239.3068 4080914.603 1042  3     5     ""    East  10
P     ""    547669.1068 4080727.662 1042  3     5     ""    West  10
P     6     547627.4675 4080628.543 1044  3     6     ""    West  11
P     ""    548197.6605 4080816.484 1044  3     6     ""    East  11
P     ""    548225.6132 4080825.579 1044  2     6     West  West  12
P     ""    548795.813  4081012.52  1044  2     6     West  East  12
P     ""    548955.5829 4081065.063 1044  2     2     East  West  13
P     ""    549531.7677 4081255.025 1044  2     2     East  East  13
P     7     549581.9894 4081186.219 1045  2     3     East  East  14
P     ""    548913.9424 4080965.945 1045  2     3     East  West  14
P     ""    548754.1704 4080913.401 1045  2     7     West  East  15
P     ""    548183.9719 4080726.461 1045  2     7     West  West  15
P     ""    548156.0099 4080717.365 1045  3     7     ""    East  16
P     ""    547585.8272 4080529.425 1045  3     7     ""    West  16
```

P	8	547544.1803	4080431.306	1046	3	8	""	West	17
P	""	548114.3672	4080618.246	1046	3	8	""	East	17
P	""	548142.3297	4080627.341	1046	2	8	West	West	18
P	""	548712.521	4080815.282	1046	2	8	west	East	18
P	""	548872.2951	4080867.825	1046	2	4	East	West	19
P	""	549610.2478	4081110.338	1046	2	4	East	East	19
P	9	549562.6196	4081009.198	1047	2	5	East	East	20
P	""	548830.6525	4080768.707	1047	2	5	East	West	20
P	""	548670.8764	4080716.163	1047	2	9	West	East	21
P	""	548100.6864	4080528.223	1047	2	9	West	West	21
P	""	548072.7325	4080519.127	1047	3	9	""	East	22
P	""	547502.5381	4080332.187	1047	3	9	""	West	22
P	10	547445.9126	4080228.017	1048	3	10	""	West	23
P	""	548032.0805	4080421.013	1048	3	10	""	East	23
P	""	548061.0419	4080430.111	1048	2	10	West	West	24
P	""	548626.2417	4080616.034	1048	2	10	West	East	24
P	""	548770.0322	4080663.524	1048	2	6	East	West	25
P	""	549510.9854	4080907.046	1048	2	6	East	East	25
P	11	549459.3589	4080804.892	1049	2	7	East	East	26
P	""	548738.3796	4080567.439	1049	2	7	East	West	26
P	""	548621.5424	4080529.041	1049	2	11	West	East	27
P	""	548046.3619	4080340.084	1049	2	11	West	West	27
P	""	547994.4313	4080322.907	1049	3	11	""	East	28
P	""	547425.2381	4080135.971	1049	3	11	""	West	28
P	12	547420.544	4080048.978	1051	3	12	""	West	29
P	""	547989.7431	4080235.914	1051	3	12	""	East	29
P	""	548041.6653	4080253.091	1051	2	12	West	West	30
P	""	548617.8444	4080443.052	1051	2	12	West	East	30
P	""	548734.6828	4080481.45	1051	2	8	East	West	31
P	""	549407.7311	4080702.74	1051	2	8	East	East	31
P	13	549356.102	4080600.587	1052	2	9	East	East	32
P	""	548729.9845	4080394.457	1052	2	9	East	West	32
P	""	548613.1537	4080356.059	1052	2	13	West	East	33
P	""	548037.9702	4080167.101	1052	2	13	West	West	33
P	""	547986.0386	4080149.924	1052	3	13	""	East	34
P	""	547416.8514	4079962.987	1052	3	13	""	West	34
P	14	547412.1481	4079875.995	1053	3	14	""	West	35
P	""	547981.3501	4080062.932	1053	3	14	""	East	35
P	""	548033.2734	4080080.109	1053	2	14	West	West	36
P	""	548609.4612	4080269.07	1053	2	14	West	East	36
P	""	548726.2932	4080307.467	1053	2	10	East	West	37
P	""	549304.4717	4080498.434	1053	2	10	East	East	37
P	15	549252.8459	4080395.282	1054	2	11	East	East	38
P	""	548721.5889	4080221.474	1054	2	11	East	West	38
P	""	548604.7557	4080183.076	1054	2	15	West	East	39
P	""	548029.5749	4079993.119	1054	2	15	West	West	39
P	""	547977.6454	4079976.942	1054	3	15	""	East	40
P	""	547407.4536	4079789.002	1054	3	15	""	West	40
P	16	547403.7607	4079703.012	1055	3	16	""	West	41
P	""	547972.9478	4079889.949	1055	3	16	""	East	41
P	""	548024.8811	4079907.126	1055	2	16	West	West	42
P	""	548601.0631	4080096.087	1055	2	16	West	East	42
P	""	548717.8975	4080134.484	1055	2	12	East	West	43
P	""	549201.2131	4080293.129	1055	2	12	East	East	43
P	17	549163.562	4080196.023	1056	2	13	East	East	44
P	""	548713.2019	4080048.491	1056	2	13	East	West	44
P	""	548596.372	4080009.094	1056	2	17	West	East	45

P	""	548021.1824	4079820.137	1056	2	17	West	West	45
P	""	547969.2574	4079802.96	1056	3	17	""	East	46
P	""	547399.0661	4079616.019	1056	3	17	""	West	46
P	18	547395.3696	4079529.03	1058	3	18	""	West	47
P	""	547964.554	4079716.966	1058	3	18	""	East	47
P	""	548016.4851	4079733.143	1058	2	18	West	West	48
P	""	548592.6734	4079923.104	1058	2	18	West	East	48
P	""	548709.5013	4079961.501	1058	2	14	East	West	49
P	""	549141.8897	4080103.972	1058	2	14	East	East	49
P	19	549115.228	4080009.904	1059	2	15	East	East	50
P	""	548704.8112	4079874.509	1059	2	15	East	West	50
P	""	548587.9732	4079836.111	1059	2	19	West	East	51
P	""	548011.7911	4079647.15	1059	2	19	West	West	51
P	""	547960.8634	4079629.977	1059	3	19	""	East	52
P	""	547390.6691	4079443.037	1059	3	19	""	West	52
P	20	547386.9725	4079356.047	1060	3	20	""	West	53
P	""	547956.1655	4079542.985	1060	3	20	""	East	53
P	""	548008.092	4079560.16	1060	2	20	West	West	54
P	""	548584.2744	4079750.122	1060	2	20	West	East	54
P	""	548701.1136	4079788.519	1060	2	16	East	West	55
P	""	549105.5352	4079920.895	1060	2	16	East	East	55
P	21	549086.8598	4079829.855	1061	2	17	East	East	56
P	""	548696.4144	4079701.526	1061	2	17	East	West	56
P	""	548579.5829	4079663.128	1061	2	21	West	East	57
P	""	548003.3977	4079474.167	1061	2	21	West	West	57
P	""	547951.4706	4079456.991	1061	3	21	""	East	58
P	""	547382.2774	4079269.054	1061	3	21	""	West	58
P	22	547380.5751	4079184.071	1062	3	22	""	West	59
P	""	547947.7708	4079370.002	1062	3	22	""	East	59
P	""	547999.6984	4079387.178	1062	2	22	West	West	60
P	""	548574.8823	4079576.135	1062	2	22	West	East	60
P	""	548692.7224	4079614.536	1062	2	18	East	West	61
P	""	549067.1913	4079737.81	1062	2	18	East	East	61
P	23a	549048.515	4079646.769	1063	2	19	East	East	62
P	""	548688.0172	4079528.543	1063	2	19	East	West	62
P	23b	548571.1832	4079490.145	1063	2	23	West	East	63
P	""	547995.0096	4079300.185	1063	2	23	West	West	63
P	23c	547946.071	4079284.019	1063	3	23	""	East	64
P	""	547388.8638	4079101.123	1063	3	23	""	West	64
P	24a	547396.1542	4079018.17	1065	3	24	""	West	65
P	""	547962.3534	4079204.097	1065	3	24	""	East	65
P	24b	548112.1327	4079253.606	1065	1	1	""	West	66
P	""	548566.4914	4079403.152	1065	1	1	""	East	66
P	25	548562.7978	4079316.163	1066	1	2	""	East	67
P	""	548011.5754	4079135.288	1066	1	2	""	West	67
P	""	547958.6479	4079118.108	1066	3	25	""	East	68
P	""	547403.4358	4078935.219	1066	3	25	""	West	68
P	26	547410.7264	4078852.266	1067	3	26	""	West	69
P	""	547953.9584	4079031.114	1067	3	26	""	East	69
P	""	548005.8791	4079048.291	1067	1	3	""	West	70
P	""	548558.1	4079230.17	1067	1	3	""	East	70
P	27	548554.4062	4079143.181	1068	1	4	""	East	71
P	""	548002.1885	4078961.302	1068	1	4	""	West	71
P	""	547950.2583	4078944.124	1068	3	27	""	East	72
P	""	547419.0101	4078770.317	1068	3	27	""	West	72
P	28	547426.301	4078687.365	1069	3	28	""	West	73
P	""	547945.563	4078858.132	1069	3	28	""	East	73

P	""	548003.4821	4078877.329	1069	1	5	""	West	74
P	""	548549.705	4079056.188	1069	1	5	""	East	74
P	29	548546.0053	4078970.197	1070	1	6	""	East	75
P	""	548043.7193	4078805.488	1070	1	6	""	West	75
P	""	547943.8629	4078772.149	1070	3	29	""	East	76
P	""	547436.5818	4078605.423	1070	3	29	""	West	76
P	30	547469.8338	4078530.56	1072	3	30	""	West	77
P	""	547977.1187	4078697.285	1072	3	30	""	East	77
P	""	548541.3128	4078883.204	1072	1	7	""	East	78
P	""	548127.9054	4078746.799	1072	1	7	""	West	78
P	31a	548074.2697	4078644.638	1073	3	31	""	East	79
P	""	547528.0432	4078464.781	1073	3	31	""	West	79
P	31b	548537.6186	4078796.215	1073	1	8	""	East	80
P	""	548215.0712	4078691.118	1073	1	8	""	West	80
P	32	548524.5272	4078537.239	1076	5	1	""	East	81
P	""	547793.5579	4078296.753	1076	5	1	""	West	81
P	33	547792.8635	4078210.774	1077	5	2	""	West	82
P	""	548519.8341	4078450.246	1077	5	2	""	East	82
P	34	548516.1394	4078363.257	1079	5	3	""	East	83
P	""	547791.1616	4078124.79	1079	5	3	""	West	83
P	35	547790.4616	4078039.811	1080	5	4	""	West	84
P	""	548511.4404	4078277.264	1080	5	4	""	East	84
P	36	548507.7456	4078190.274	1081	5	5	""	East	85
P	""	547788.7596	4077953.829	1081	5	5	""	West	85
P	37	547788.0595	4077868.849	1082	5	6	""	West	86
P	""	548503.0431	4078103.281	1082	5	6	""	East	86
P	38	548499.3513	4078017.292	1083	5	7	""	East	87
P	""	547786.3574	4077782.867	1083	5	7	""	West	87
P	39	547785.6539	4077696.887	1085	5	8	""	West	88
P	""	548494.6486	4077930.298	1085	5	8	""	East	88
P	40	548490.9534	4077843.309	1086	5	9	""	East	89
P	""	547783.955	4077611.904	1086	5	9	""	West	89
P	41	547783.2514	4077525.925	1087	5	10	""	West	90
P	""	548486.2537	4077757.316	1087	5	10	""	East	90
P	42	548482.5582	4077670.326	1088	5	11	""	East	91
P	""	547784.5484	4077440.953	1088	5	11	""	West	91
P	43	547786.8439	4077355.983	1089	5	12	""	West	92
P	""	548477.8641	4077583.334	1089	5	12	""	East	92
P	44	548473.173	4077497.341	1090	5	13	""	East	93
P	""	547788.1353	4077272.01	1090	5	13	""	West	93
P	45	547789.4322	4077187.038	1092	5	14	""	West	94
P	""	548469.4772	4077410.351	1092	5	14	""	East	94
P	46	548464.777	4077324.358	1093	5	15	""	East	95
P	""	547791.7278	4077102.068	1093	5	15	""	West	95
P	47	547793.0281	4077018.096	1094	5	16	""	West	96
P	""	548461.0811	4077237.368	1094	5	16	""	East	96
P	48	548456.3863	4077150.375	1095	5	17	""	East	97
P	""	547795.3238	4076933.127	1095	5	17	""	West	97
P	49	547799.6113	4076849.164	1096	5	18	""	West	98
P	""	548452.6845	4077064.385	1096	5	18	""	East	98
P	50	548447.9895	4076977.393	1097	5	19	""	East	99
P	""	547804.9008	4076766.206	1097	5	19	""	West	99
P	51	547807.1966	4076681.236	1099	5	20	""	West	100
P	""	548444.2932	4076890.403	1099	5	20	""	East	100
P	52	548439.5923	4076804.41	1100	5	21	""	East	101
P	""	547807.495	4076596.26	1100	5	21	""	West	101
P	53	547804.7939	4076510.274	1101	5	22	""	West	102

P	""	548435.8958	4076717.42	1101	5	22	""	East	102
P	54	548431.2093	4076630.428	1102	5	23	""	East	103
P	""	547806.091	4076425.301	1102	5	23	""	West	103
P	55	547807.388	4076340.329	1103	5	24	""	West	104
P	""	548427.5068	4076544.437	1103	5	24	""	East	104
P	56	548415.8225	4076455.421	1104	5	25	""	East	105
P	""	547814.6754	4076257.377	1104	5	25	""	West	105
P	57	547842.9334	4076181.496	1106	5	26	""	West	106
P	""	548381.1676	4076358.326	1106	5	26	""	East	106
P	58	548336.5267	4076259.197	1107	5	27	""	East	107
P	""	547892.1536	4076112.686	1107	5	27	""	West	107

INTENTIONALLY LEFT BLANK