ATTACHMENT VII

INCLUSION OF UPDATED BEDROCK GEOLOGY USING GEOMAP7 V1.0

TOTAL PAGES: 28

Inclusion Of Updated Bedrock Geology Using GEOMAP7 V1.0

1. Name of routine/macro with version/OS/hardware environment and user information:

Name of software routine: GEOMAP7 V1.0
OS and hardware environment: Windows NT 4.0, Pentium Pro PC
Computer Identification: SM321276 with a USGS specific host-name P720dcasr
Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. Name of commercial software with version/OS/hardware used to develop routine/macro:

The source code for GEOMAP7 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. General Description of routine/macro:

GEOMAP7 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (GEOMAP7.FOR), compiled executable file (GEOMAP7.EXE), routine control file (GEOMAP7.CTL), input and output files, validation test files, and a copy of this attachment, are located under the directory GEOMAP7 on a CD-ROM labeled GEOINPUT-1. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing applications such as Microsoft Word. The executable file can be used to run GEOMAP7 V1.0 on any PC with an INTEL processor (with adequate RAM).

All parameters calculated by GEOMAP7 V1.0 that are included in the developed output file GEOMAP7.INP are used for the development of the geospatial parameter input file for INFIL V2.0. The file GEOMAP7.INP is used directly as input to the routine SOILMAP6 V1.0 (see Attachment IX).

4. Test plan for the software routine GEOMAP7 V1.0:

- **Explain whether this is a routine or macro and describe what it does:**

GEOMAP7 V1.0 is the second routine in a sequence of developed FORTRAN77 routines that are used in the development of the geospatial parameter input files for INFIL V2.0. The primary function performed by the routine is the inclusion of the updated bedrock geology map for the central block area (source data obtained from Day and others, 1998, (GS971208314221.003) into the original geospatial parameter input file (30MSITE.INP) used as input for INFIL V1.0, the 1996 version of the net infiltration model (Flint and others, 1996). The modified bedrock geology is defined by the rock-type identification

number included in the output file GEOMAP7.INP. The updated bedrock geology map is provided as an ASCII text, column-formatted input file named NEWGEOL.DAT. Using standard ARCINFO applications, NEWGEOL.DAT is developed by rasterizing[1] the available source data[2] onto the grid geometry defined by 30MSITE.INP and exporting the rasterized data as a column-formatted, xyz ASCII text file. To incorporate the updated bedrock geology, GEOMAP7 scans the input grid defined by the easting and northing coordinate locations in 30MSITE.INP (columns 2 and 3), matches the grid cells with the corresponding locations of NEWGEOL.DAT, and substitutes the existing rock-type identification number in column 11 of 30MSITE.INP with the updated rock-type identification number in NEWGEOL.DAT. To identify the new rock-type identification numbers as separate from the original rock-type identification numbers used in 30MSITE.INP, which are based on the geologic maps developed by Scott and Bonk (1984) (MO0003COV00095.000) and Sawyer et al. (1995) (GS000300001221.010), GEOMAP7 adds 300 to the initial integer values provided by NEWGEOL.DAT.

A second function performed by the routine is a back-substitution of the original Scott and Bonk (1984) rock-type identification number (column 11 in 30MSITE.INP) wherever there are locations with soil thickness less than 6 meters as identified by the soil depth class number (column 10 in 30MSITE.INP), and which are associated with an updated rock-type identification number that corresponds to alluvium. The back-substitution is accomplished by excluding the updated rock-type numbers during the scanning of the input grid and is performed only if the original rock-type defined in 30MSITE.INP is associated with a consolidated rock-type.

The input and output files used by GEOMAP7 are defined in the routine control file GEOMAP7.CTL that is itself an input file for the routine. The input files defined in GEOMAP7.CTL consist of 30MSITE.INP, NEWGEOL.DAT, and the output file GEOMAP7.INP. Two additional lines following the filenames are a lower and upper bound easting coordinate (5th line in file, two input values) and a lower and upper bound northing coordinate (6th line in file, two input values). These parameters are used only to limit the search area scanned by GEOMAP7 to a rectangular area centered over and fully containing all grid cells in NEWGEOL.DAT associated with rock-type identification numbers from Day and others (1998). The purpose of this function is only to decrease routine run-time, and is not associated with functions used in the development of the output file.

[1] Rasterization refers to a standard ARCINFO operation of transferring spatial data defined by points, vector lines, and polygons onto the grid-cell areas of a "raster" grid matrix defined by a fixed square cell dimension, the location coordinates of the lower left grid cell included in the matrix, and the number of rows and columns defining the matrix.

[2] The source data consists of an ARCINFO vector-based map coverage (*.e00 file and associated metadata)

- **Listing of FORTRAN77 Source code:**

A listing of the FORTRAN77 source code for the routine GEOMAP7 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

A validation test of the functions performed by the routine was conducted by a visual comparison between the input files (30MSITE.INP and NEWGEOL.DAT) and the output file (GEOMAP7.INP). The test plan for the primary function performed by GEOMAP7 consists of a visual verification that the rock-type identification numbers defining the updated geology (and provided as input by NEWGEOL.DAT) are associated with the correct grid cell locations defined by the new geospatial parameter input file (GEOMAP7.INP). The test plan involves a visual verification that a value of 300 has been added to the updated rock-type identification numbers. The test plan for the additional function performed by GEOMAP7 (exclusion of the updated rock-type based on a comparison against the soil depth map and the updated geology) consists of a visual verification that the rock-type identification numbers defining the original geology (column 11 in 30MSITE.INP) are associated with the correct grid cell locations based on a comparison against both the soil depth map and the updated geology map. The comparison of input and output grid cell values was facilitated using the raster-based grid and map-imaging utilities available in the acquired software program TRANSFORM. The raster-based grid and map-imaging utilities allow for an analysis of the entire raster grid and also a detailed evaluation of grid cell values for specified grid locations. The criteria applied during this phase of the routine test plan was an indication by the map images generated in TRANSFORM that: 1) a value of 300 had been correctly added to the updated geology, 2) that modifications to the rock-type parameter had been performed to the correct grid cell locations, and 3) that the bedrock geology defined by Day and others (1998) had been correctly represented by the modified rock-type parameter.

Additional routine validation tests were performed by extracting and comparing identical subsets (in terms of grid cell locations) from the raster images created in TRANSFORM and by importing identical subsets (based on grid cell locations) of the input file 30MSITE.INP and the output file GEOMAP7.INP into an EXCEL worksheet file. This method of testing provided an additional check that the functions performed by GEOMAP7 were operating correctly. The EXCEL worksheet file (GEOMAP7.XLS) was used to perform an inspection of the entire set of geospatial parameters for a selected subset of grid locations. The criteria applied in this method of validation consisted of verifying within the spreadsheet that the intended modification of the geospatial input file had been correctly performed, and that no unintended modifications had occurred during program execution, either to the parameters being modified (in this case, the rock-type identification number) or to any of the other parameters not requiring modification during this stage of the development of the geospatial parameter input files for INFIL V2.0.

- **Specify the range of input values to be used and why the range is valid:**

Two column-formatted ASCII-text files, NEWGEOL.DAT and 30MSITE.INP, are used as input by GEOMAP7 V1.0. Both files consist of a series of rows (one row per grid cell location), two columns defining grid cell locations (NAD27 UTM, zone 11 coordinates, in meters), and additional columns containing the geospatial input parameters associated with each grid cell. The two input files are specified in the routine control file, GEOMAP7.CTL, which is the third input file needed for the execution of GEOMAP7 V1.0. The range of input values specified in the listing below is valid because these values were obtained from ARCINFO using the source data as input and the functions performed by the routine BLOCKR7 V1.0 (see Attachment VI for description of source data used for 30MSITE.INP). The input parameters are identical to the geospatial input parameters used for INFIL V1.0 (Flint and others, 1996).

1. **NEWGEOL.DAT:** Column-formatted ASCII text file consisting of 4 columns and 57,038 rows. This file is exported from ARCINFO using the Day and others (1998) (DTN: GS971208314221.003) geology map and the merged digital elevation model (DTN: GS000308311221.006) as input. The first column defines the grid cell location number, the next two columns define the UTM easting and northing coordinates (in meters) for each grid cell location, and the fourth column defines the updated rock-type identification number from Day and others (1998) consisting of values ranging from 1 to 45, and a no-data flag of -99.

2. **30MSITE.INP:** Column-formatted ASCII text file consisting of 48 columns and 253,597 rows. This file is developed as the output from BLOCKR7. The rock-type identification numbers are located in column 11 and consist of integer values ranging from 1 to 214. The rock-type identification numbers were used as input for INFIL V1.0 (Flint and others, 1996) and are based on the Scott and Bonk (1984) (DTN: MO0003COV00095.000) and the Sawyer et al. (1995) (DTN: GS000300001221.010) geology maps. A more complete description of the parameters included in this file, along with input and output ranges, is provided in Attachment VI.

5. Test Results.

- **Output from test:**

The output for the test case is the main output file GEOMAP7.INP generated by GEOMAP7 V1.0. Additional files developed as part of the testing procedure include four TRANSFORM map image files (NEWGEOL.HDF, 30MGEOL.HDF, 30MDPTH.HDF, and GEOMAP7.HDF) that are used to inspect the modified parameters between the input and output files and an EXCEL worksheet (GEOMAP7.XLS) used to perform additional inspections of parameter modifications for a selected subset of grid cell locations.

- **Description of how the testing shows that the results are correct for the specified input:**

The map images developed using TRANSFORM (Figures VII-1 through VII-3) indicate by visual inspection that the integer values defining the updated bedrock geology from Day and others (1998) have been correctly incorporated into the output file GEOMAP7.INP that is created by GEOMAP7. For example, it is verified by visual inspection that the original rock-type identification parameters (Figure VII-2), which range from 1 to 214, have been correctly modified to include the updated rock-types (Figure VII-1), which consist of integer values ranging from 1 to 45, because the rock-type identification numbers of the output file show the correct composite spatial positioning of the three separate geologic maps and the new rock-type identification numbers range from 301 to 345 (Figure VII-3). Visual inspection of the map images indicates that the integer values represented by Figure VII-1 have been correctly overlain onto the original rock-type integer values shown in Figure VII-2 and increased by a value of 300 to produce the final set of rock-type identification numbers represented by Figure VII-3. The test criteria of the correct placement of updated rock-type identification numbers and the correct separation of the updated integer values from the original rock-type identification numbers by adding 300 to the integer values provided by NEWGEOL.DAT is satisfied based on the visual comparison of the map images.

Verification that the correct back-substitution of the original rock-type identification numbers for Scott and Bonk (1984) geology for locations where a soil depth of less than 6 meters (soil depth classes less than 4) coincided with mapped alluvium from Day and others (1998) is provided by a comparison of Figures VII-4 (indicating the original rock-type identification numbers defined using Scott and Bonk (1984)) and VII-5 (indicating the new rock-type identification numbers defined using Day and others (1998) with Figure VII-4 (the new rock-type identification numbers) and Figure VII-6 (the soil depth class map). The locations where the Scott and Bonk (1984) rock-types were retained coincide with the locations of upper washes and lower sideslopes where mapping bedrock geology is less certain because of increasing soil thickness, and this is the intended result.

Additional validation that the test criteria are satisfied for the two functions performed by GEOMAP7 is provided by Tables VII-1 through VII-6. Tables VII-1 through VII-4 were created by selecting in TRANSFORM a subset of the raster matrix grid defined by 30MSITE.INP from the map images of the Day and others (1998) geology map (NEWGEOL.HDF) for Table VII-1, the soil depth class map (30MDPTH.HDF) for Table VII-2, the original rock-type identification numbers in 30MSITE.INP (30MGEOL.HDF) for Table VII-3, and the new rock-types identification numbers created by GEOMAP7 (GEOMAP7.HDF) for Table VII-4. A comparison of the four tables indicates that the new rock-type numbers were correctly substituted and increased by 300 (validation of test criteria for the first function) and that the original consolidated rock-type number 20 from Scott and Bonk (1984) was retained for three grid locations were the updated rock-types of 301 and 302 indicated unconsolidated rock-types for a location having only 0 to 0.5 meters of soil cover (which is inconsistent). For satisfying the test criteria that no modifications were made to parameters other than rock-type, identical sections of the files 30MSITE.INP and GEOMAP7.INP were extracted into an EXCEL worksheet (GEOMAP7.XLS). Table VII-5 shows the input parameters obtained

from 30MSITE.INP (with the exception of the 36 blocking ridge parameters) and Table VII-6 shows that the only parameter modified in the output file GEOMAP7 is the rock-type identification.

- **List limitations or assumptions to this test case and code in general:**

The limitations of the developed test case are based on the practical limitations of verifying modified parameter values for all 253,597 grid cells included in the output file used for the developed test case. Validation of the entire output file used in the test case was performed as a visual evaluation of a map image produced in TRANSFORM. Only a subset of the entire output file could be used for more detailed validation tests that were performed in an EXCEL worksheet.

- **Electronic files identified by name and location:**

Electronic files are located on CD-ROM labeled GEOINPUT-1, under the directory GEOMAP7, included as an attachment to the AMR. The following electronic files are provided:

GEOMAP7.CTL:	Input file consisting of the input and output file names for GEOMAP7 V1.0, along with 4 UTM coordinate parameters that are used to define a rectangular area centered over and containing the updated central block bedrock geology map from Day and others (1998).
GEOMAP7.FOR:	FORTRAN source code listing for the routine GEOMAP7 V1.0. A printout of the source code is included as part of this attachment.
GEOMAP7.EXE:	Executable file for the routine GEOMAP7 V1.0, compiled for INTEL processors.
NEWGEOL.DAT:	Input file consisting of a column-formatted, ASCII text file with 4 columns and 57,038 rows. This file was developed in ARCINFO by a rasterization of the Day and others (1998) map coverage, (DTN: GS971208314221.003) which is an ARCINFO vector-based file (*.e00 file), onto the raster-grid defined by the merged digital elevation model (DTN: GS000308311221.006). The rasterized map was exported from ARCINFO as a column-formatted, ASCII text file. A partial print-out of the first part of this file is included as part of this attachment.
30MSITE.INP:	Input file consisting of a column-formatted, ASCII text file with 48 columns and 253,597 rows. Each row corresponds to a grid cell location for the geospatial parameter base grid (the UTM location coordinates are defined by columns 2 and 3). This file is developed as output from BLOCKR7 V1.0 (see Attachment VI of this AMR for more details). A partial print-out of the first part of this file is included as part of this attachment.

GEOMAP7.INP: Output file consisting of a column-formatted, ASCII text file with 48 columns and 253,597 rows. Each row corresponds to a grid cell location for the geospatial parameter base grid (the UTM location coordinates are defined by columns 2 and 3). Column 11 of this file includes the updated rock-type identification numbers as a result of the functions performed by the routine GEOMAP7 V1.0. A partial print-out of the first part of this file is included as part of this attachment.

GEOMAP7.XLS: EXCEL worksheet used to perform the software routine validation test, provided only as supporting information for the validation test. This file is not a part of the routine application.

GEOMAP7.HDF: TRANSFORM raster-based map image of the updated rock-type identification numbers (created using column 11 in GEOMAP7.INP) used to perform the software routine validation test, provided only as supporting information for the validation test. This file is not a part of the routine application.

30MGEOL.HDF: TRANSFORM raster-based map image of the original rock-type identification numbers (created using column 11 in 30MSITE.INP) used to perform the software routine validation test, provided only as supporting information for the validation test. This file is not a part of the routine application.

NEWGEOL.HDF: TRANSFORM raster-based map image of the rasterized central block bedrock geology map from Day and others (1998) (created using column 4 in NEWGEOL.DAT) used to perform the software routine validation test, provided only as supporting information for the validation test. This file is not a part of the routine application.

30MDPTH.HDF: TRANSFORM raster-based map image of the soil depth class number (created using column 10 in 30MSITE.INP) used to perform the software routine validation test, provided only as supporting information for the validation test. This file is not a part of the routine application.

6. **Supporting Information. (Include background information, such as revision to a previous routine or macro, or explanation of the steps performed to run the software. Include listings of all electronic files and codes used).**

- **Procedure for running routine:**

To run the routine GEOMAP7 V1.0, an executable version of the code, the input files NEWGEOL.DAT and 30MSITE.INP, and the routine control file GEOMAP7.CTL must be placed in the same directory. The routine is executed by typing GEOMAP7 in a DOS window, or by double clicking on the file GEOMAP7.EXE in the Microsoft Windows

operating system. The input and output file names and the parameters used for the blocking ridge calculations must be in the correct sequential order as specified in the routine control file GEOMAP7.CTL (see example listing in this section)

- **Example listing of routine control file GEOMAP7.CTL**

```
geomap7.ctl  Routine GEOMAP7 to incorporate new bedrock geology map (Day and
others, 1998)
newgeol.dat
30msite.inp
geomap7.inp
545357   551200
4075111  4083269
```

- **Example listing of 30MSITE.INP. This is the main input file used by GEOMAP7 V1.0 (only the first 20 lines of the file are listed)**

```
      1  544661.  4087833. 36.9373 116.4985  21 238  1739  5  1 201  4  0  0
0  0  0  0  0  2 25 25 25 24 23 21 19 16 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      2  544691.  4087833. 36.9373 116.4981  25 259  1750  5  1 201  4  0  0
0  0  0  0  0  3 29 28 27 26 25 22 19 17 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      3  544721.  4087833. 36.9373 116.4978  26 269  1767  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 24 20 18 17 10 10  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      4  544751.  4087833. 36.9373 116.4975  24 277  1781  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 25 22 18 16  9  9  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      5  544781.  4087833. 36.9373 116.4971  25 284  1794  5  1 201  4  0  0
0  0  0  0  0  2 26 26 27 26 25 23 21 17 11 11  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      6  544811.  4087833. 36.9373 116.4968  28 286  1807  5  1 201  4  0  0
0  0  0  0  0  3 29 28 24 25 24 23 20 17 14 14  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      7  544841.  4087833. 36.9373 116.4965  28 284  1824  5  1 201  4  0  0
0  0  0  0  0  2 25 23 15 16 15 17 15 13 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      8  544871.  4087833. 36.9373 116.4961  24 277  1838  5  1 201  4  0  0
0  0  0  0  0  2 23 20  2  5  6  6  6  5  8  9  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      9  544901.  4087833. 36.9373 116.4958  16 241  1851  5  1 201  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     10  544931.  4087833. 36.9373 116.4955  13 169  1854  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     11  544961.  4087833. 36.9373 116.4951  21 127  1846  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  2  1  0  1  1  1  2  1 14 12
0  0  0  0  0  0  0  0
     12  544991.  4087833. 36.9373 116.4948  20 128  1836  5  1 202  4  0  0
0  0  0  0  0  0  8  7  1  1  0  0  0  0  0  0  2  4  4  4  4  7  9  9 18 15
0  0  0  0  0  0  0  0
     13  545021.  4087833. 36.9373 116.4944  16 166  1829  5  1 202  4  0  0
0  0  0  0  0  1 14 13  8  3  1  0  0  0  0  0  2  5  6  6  6  7  8 11 15 13
0  0  0  0  0  0  0  0
     14  545051.  4087833. 36.9373 116.4941  19 220  1833  5  1 202  4  0  0
0  0  0  0  0  2 18 16  8  6  2  1  0  0  0  0  0  3  4  4  3  3  3  3  9  7
0  0  0  0  0  0  0  0
```

```
     15  545081.  4087833. 36.9373 116.4938  22 232  1843  5  1 201  4  0  0
0  0  0  0  0  1 16 14  3  2  0  0  0  0  0  0  0  0  1  2  1  1  1  1  4  3
0  0  0  0  0  0  0  0
     16  545111.  4087833. 36.9373 116.4934  20 224  1852  5  1 201  4  0  0
0  0  0  0  0  1 11  9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     17  545141.  4087833. 36.9373 116.4931  20 204  1858  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     18  545171.  4087833. 36.9373 116.4928  21 188  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     19  545201.  4087833. 36.9373 116.4924  23 178  1862  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     20  545231.  4087833. 36.9373 116.4921  23 162  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0
0  0  0  0  0  0  0  0
```

- **Example listing of NEWGEOL.DAT. This is the ASCII text file exported from ARCINFO and developed as a rasterization of the vector-based bedrock geology map from Day and others (1998). The first column is the grid cell location number, columns 2 and 3 are the NAD27 UTM zone 11 coordinates (in meters), and column 4 is the integer code associated with the Day and others (1998) (DTN: GS971208314221.003) central block geology map (values range from 1 to 45, with a no-data flag of –99).**

```
56812    549971.   4082283.     2
56813    550001.   4082283.     1
56814    550031.   4082283.     1
56815    550061.   4082283.     1
56816    550091.   4082283.     1
56817    550121.   4082283.     1
56818    550151.   4082283.     1
56819    550181.   4082283.     1
56820    550211.   4082283.     1
56821    550241.   4082283.     1
56822    550991.   4082283.     2
56823    551021.   4082283.     2
56824    551051.   4082283.   -99
56825    551081.   4082283.   -99
56826    551111.   4082283.   -99
56827    551141.   4082283.   -99
56828    551171.   4082283.   -99
56955    545381.   4082253.   -99
56956    545411.   4082253.   -99
56957    545441.   4082253.   -99
56958    545471.   4082253.   -99
56959    545501.   4082253.   -99
56960    545531.   4082253.   -99
56961    545561.   4082253.   -99
56962    545591.   4082253.   -99
56963    545621.   4082253.   -99
56964    545651.   4082253.   -99
56965    545681.   4082253.   -99
56966    545711.   4082253.   -99
56967    545741.   4082253.   -99
56968    545771.   4082253.   -99
56969    545801.   4082253.   -99
56970    545831.   4082253.   -99
56971    545861.   4082253.   -99
56972    545891.   4082253.   -99
56973    545921.   4082253.   -99
```

56974	545951.	4082253.	-99
56975	545981.	4082253.	-99
56976	546011.	4082253.	-99
56977	546041.	4082253.	-99
56978	546071.	4082253.	-99
56979	546101.	4082253.	-99
56980	546131.	4082253.	-99
56981	546161.	4082253.	-99
56982	546191.	4082253.	-99
56983	546221.	4082253.	-99
56984	546251.	4082253.	-99
56985	546281.	4082253.	-99
56986	546311.	4082253.	-99
56987	546341.	4082253.	-99
56988	546371.	4082253.	-99
56989	546401.	4082253.	-99
56990	546431.	4082253.	12
56991	546461.	4082253.	12
56992	546491.	4082253.	12
56993	546521.	4082253.	12
56994	546551.	4082253.	12
56995	546581.	4082253.	13
56996	546611.	4082253.	13
56997	546641.	4082253.	14
56998	546671.	4082253.	19
56999	546701.	4082253.	19
57000	546731.	4082253.	20
57001	546761.	4082253.	21
57002	546791.	4082253.	21
57003	546821.	4082253.	24
57004	546851.	4082253.	23
57005	546881.	4082253.	22
57006	546911.	4082253.	21
57007	546941.	4082253.	21
57008	546971.	4082253.	21
57009	547001.	4082253.	20
57010	547031.	4082253.	20
57011	547061.	4082253.	19
57012	547091.	4082253.	20
57013	547121.	4082253.	20
57014	547151.	4082253.	20
57015	547181.	4082253.	2
57016	547211.	4082253.	2
57017	547241.	4082253.	20
57018	547271.	4082253.	19
57019	547301.	4082253.	20
57020	547331.	4082253.	21
57021	547361.	4082253.	21
57022	547391.	4082253.	23
57023	547421.	4082253.	24
57024	547451.	4082253.	24
57025	547481.	4082253.	1
57026	547511.	4082253.	1
57027	547541.	4082253.	1
57028	547571.	4082253.	24
57029	547601.	4082253.	22
57030	547631.	4082253.	21
57031	547661.	4082253.	19
57032	547691.	4082253.	14
57033	547721.	4082253.	12
57034	547751.	4082253.	12
57035	547781.	4082253.	12
57036	547811.	4082253.	12
57037	547841.	4082253.	12
57038	547871.	4082253.	12

```
57039    547901.   4082253.    12
57040    547931.   4082253.    12
57041    547961.   4082253.    13
57042    547991.   4082253.    13
57043    548021.   4082253.    12
57044    548051.   4082253.    12
57045    548081.   4082253.    12
57046    548111.   4082253.    12
57047    548141.   4082253.    12
```

- **Example listing of GEOMAP7.INP (only the first 20 lines are included in the printout). This is the output file generated by GEOMAP7 V1.0 and supplied as input to the routine GEOMOD4 V1.0 (See Attachment VIII).**

```
      1  544661.  4087833. 36.9373 116.4985  21 238  1739  5  1 201  4  0  0
0  0  0  0  0  2 25 25 25 24 23 21 19 16 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      2  544691.  4087833. 36.9373 116.4981  25 259  1750  5  1 201  4  0  0
0  0  0  0  0  3 29 28 27 26 25 22 19 17 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      3  544721.  4087833. 36.9373 116.4978  26 269  1767  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 24 20 18 17 10 10  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      4  544751.  4087833. 36.9373 116.4975  24 277  1781  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 25 22 18 16  9  9  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      5  544781.  4087833. 36.9373 116.4971  25 284  1794  5  1 201  4  0  0
0  0  0  0  0  2 26 26 27 26 25 23 21 17 11 11  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      6  544811.  4087833. 36.9373 116.4968  28 286  1807  5  1 201  4  0  0
0  0  0  0  0  3 29 28 24 25 24 23 20 17 14 14  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      7  544841.  4087833. 36.9373 116.4965  28 284  1824  5  1 201  4  0  0
0  0  0  0  0  2 25 23 15 16 15 17 15 13 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      8  544871.  4087833. 36.9373 116.4961  24 277  1838  5  1 201  4  0  0
0  0  0  0  0  2 23 20  2  5  6  6  6  5  8  9  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      9  544901.  4087833. 36.9373 116.4958  16 241  1851  5  1 201  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     10  544931.  4087833. 36.9373 116.4955  13 169  1854  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     11  544961.  4087833. 36.9373 116.4951  21 127  1846  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  2  1  0  1  1  1  2  1 14 12
0  0  0  0  0  0  0  0
     12  544991.  4087833. 36.9373 116.4948  20 128  1836  5  1 202  4  0  0
0  0  0  0  0  0  8  7  1  1  0  0  0  0  0  0  2  4  4  4  4  7  9  9 18 15
0  0  0  0  0  0  0  0
     13  545021.  4087833. 36.9373 116.4944  16 166  1829  5  1 202  4  0  0
0  0  0  0  0  1 14 13  8  3  1  0  0  0  0  0  2  5  6  6  6  7  8 11 15 13
0  0  0  0  0  0  0  0
     14  545051.  4087833. 36.9373 116.4941  19 220  1833  5  1 202  4  0  0
0  0  0  0  0  2 18 16  8  6  2  1  0  0  0  0  0  3  4  4  3  3  3  3  9  7
0  0  0  0  0  0  0  0
     15  545081.  4087833. 36.9373 116.4938  22 232  1843  5  1 201  4  0  0
0  0  0  0  0  1 16 14  3  2  0  0  0  0  0  0  0  0  1  2  1  1  1  1  4  3
0  0  0  0  0  0  0  0
     16  545111.  4087833. 36.9373 116.4934  20 224  1852  5  1 201  4  0  0
0  0  0  0  0  1 11  9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
```

```
      17  545141.  4087833. 36.9373 116.4931  20 204  1858  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      18  545171.  4087833. 36.9373 116.4928  21 188  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      19  545201.  4087833. 36.9373 116.4924  23 178  1862  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      20  545231.  4087833. 36.9373 116.4921  23 162  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0
0  0  0  0  0  0  0  0
```

- **Figures used as part of the routine test plan:**

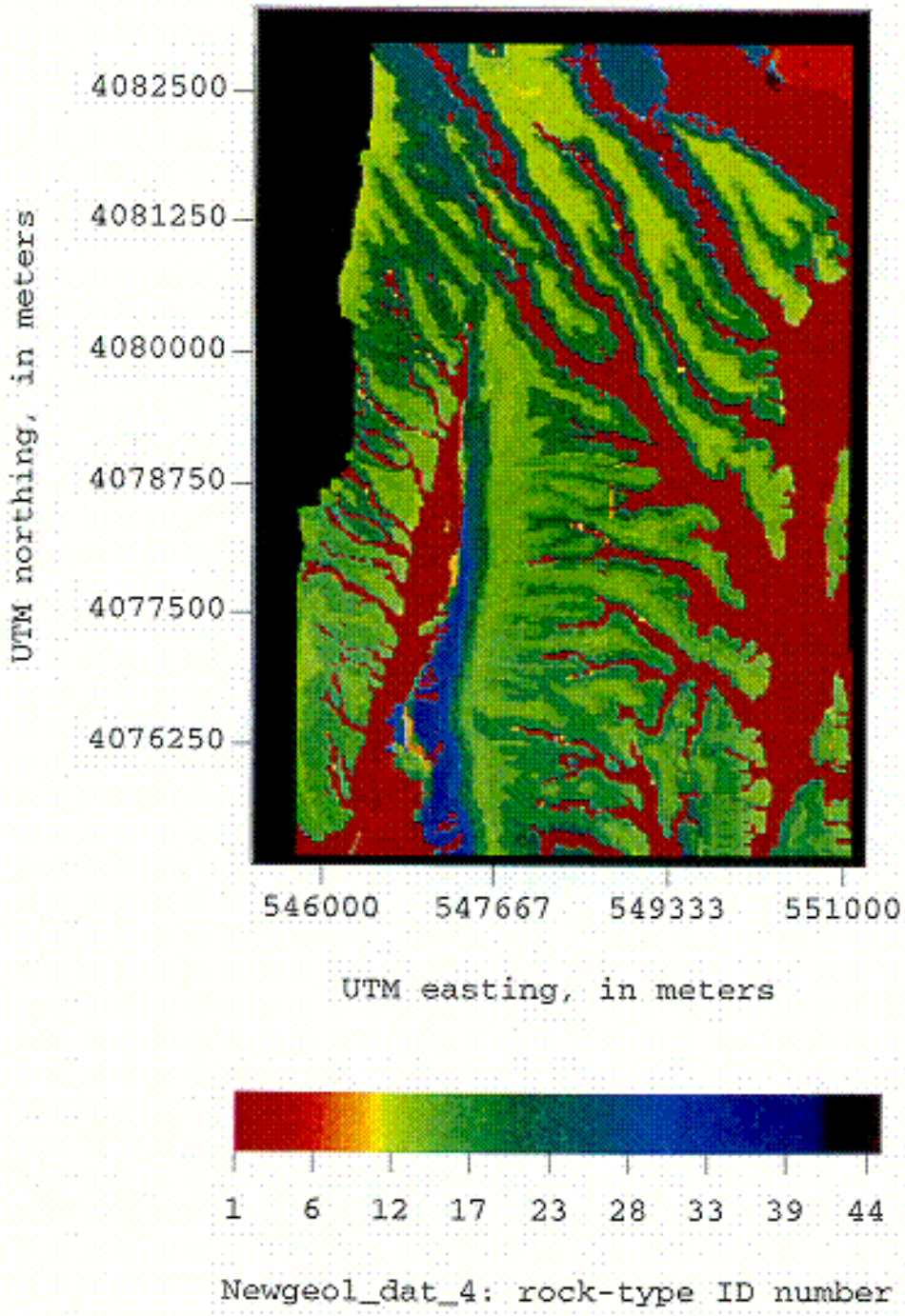

Figure VII-1. TRANSFORM map image of the rasterized central block geology map form Day and others (1998) (DTN: GS971208314221.003). The image (file NEWGEOL.HDF) was developed using column 4 of the file NEWGEOL.DAT provided as input for GEOMAP7 V1.0. Black indicates grid locations with no data (identified by values of –99)

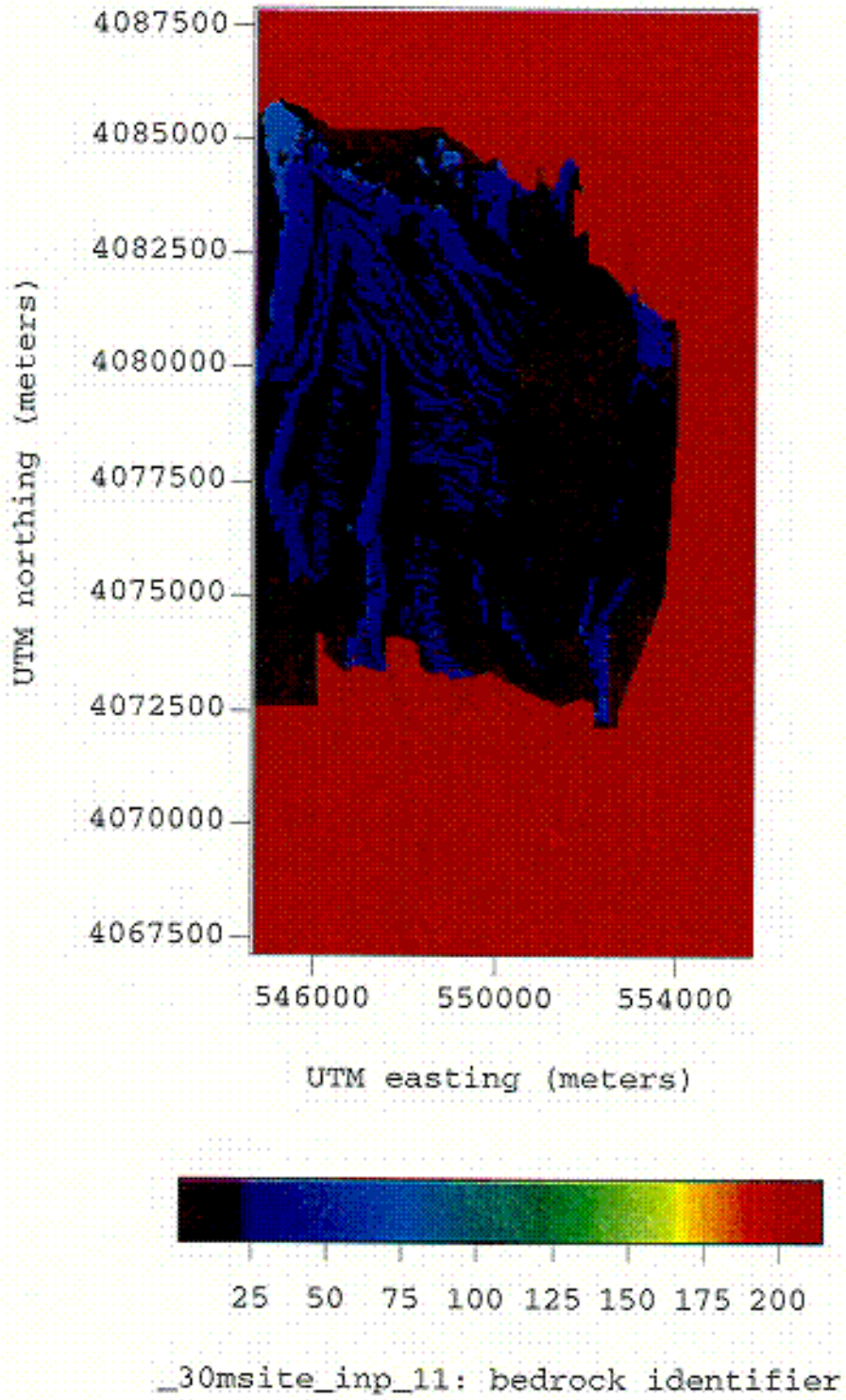

Figure VII-2. TRANSFORM map image of the rock-type identification numbers representing the original bedrock geology input for INFIL V1.0 (Flint and others, 1996). The map image (file 30MSITE.HDF) was developed using column 11 of the file 30MSITE.INP that was provided as input to GEOMAP7 V1.0.

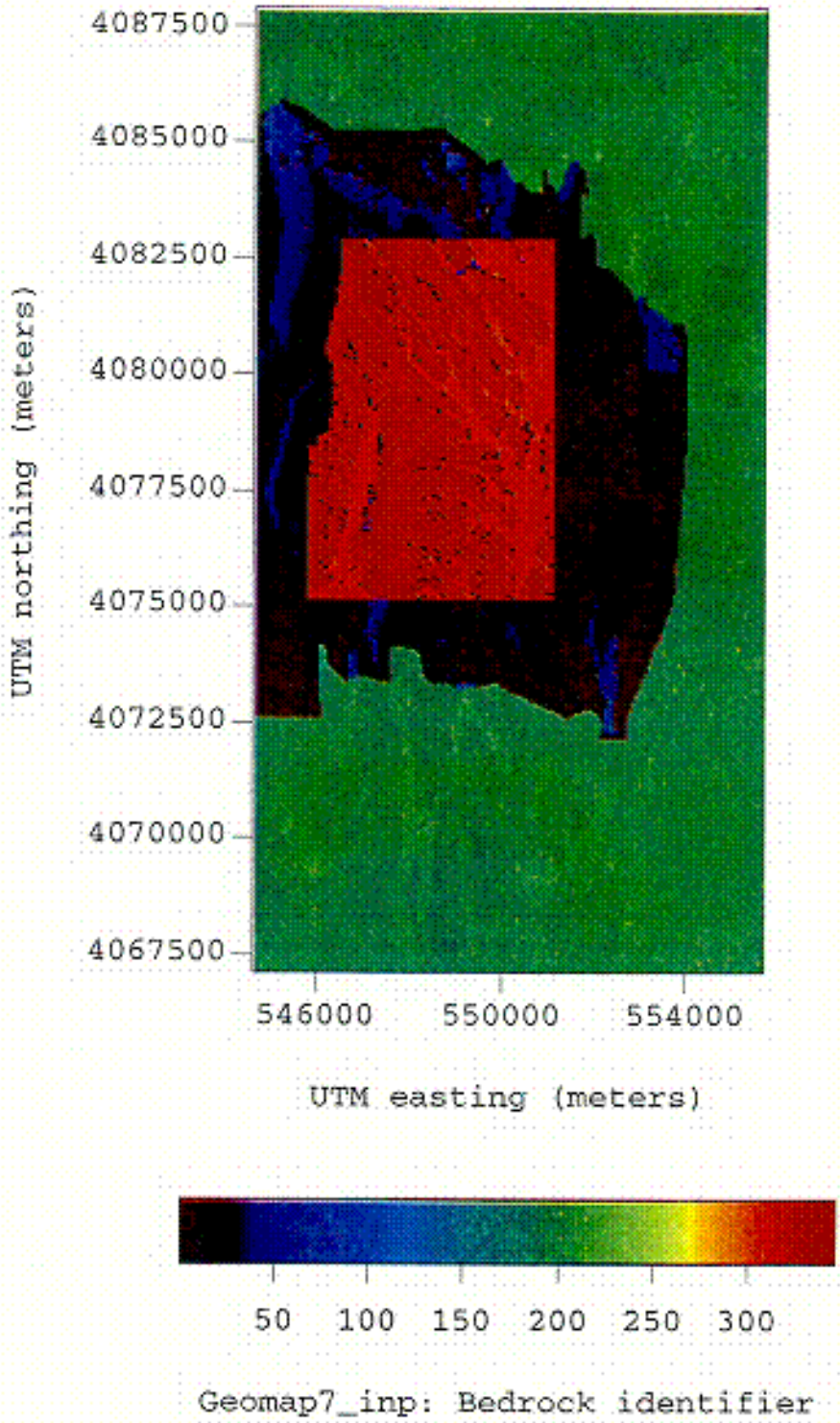

Figure VII-3. TRANSFORM map image of the updated rock-type identification numbers created by GEOMAP7. The map image (GEOMAP7.HDF) was developed using column 11 of the file GEOMAP7.INP generated as output from GEOMAP7 V1.0.

C3

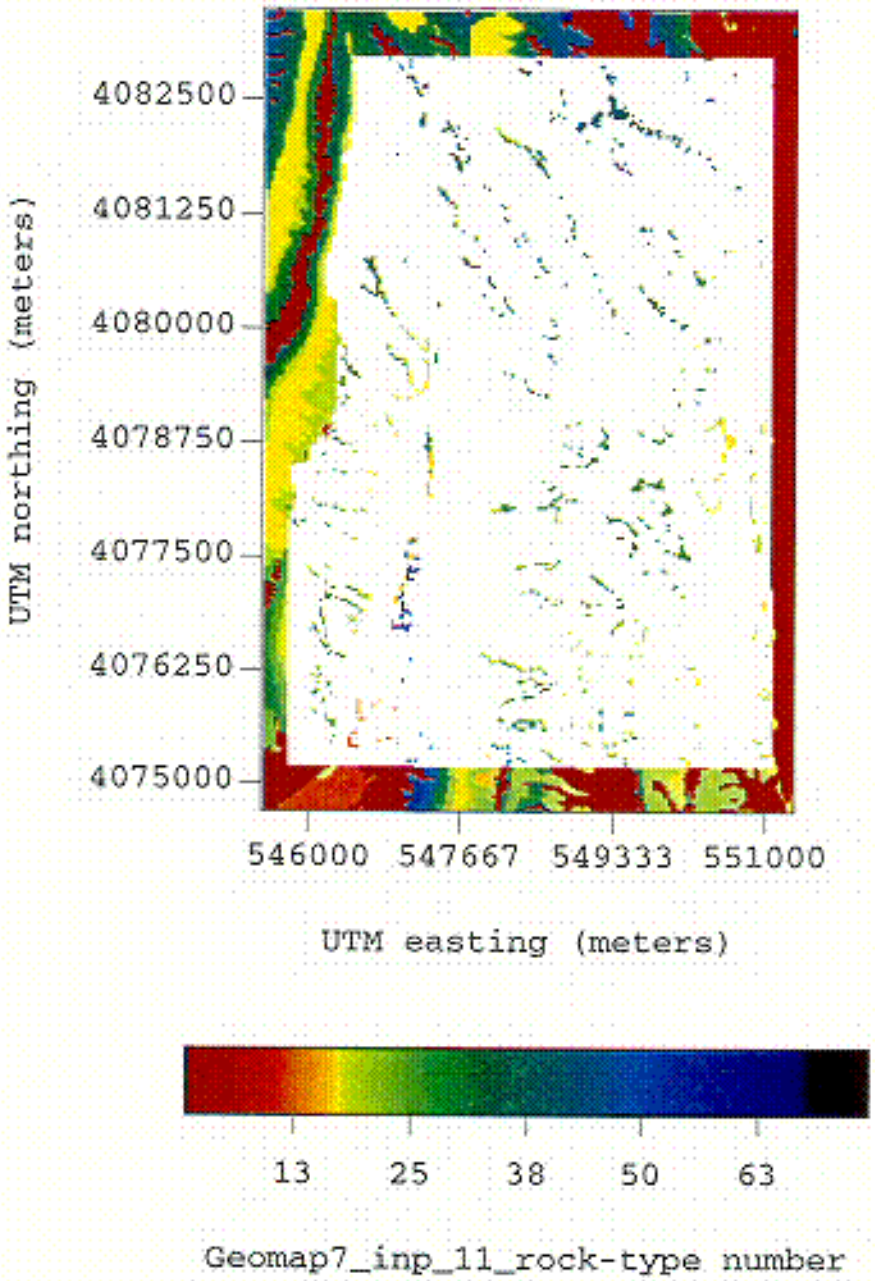

Figure VII-4. TRANSFORM map image of the updated rock-type identification numbers created by GEOMAP7. The map image (file GEOMAP7b.hdf) was developed using column 11 from file GEOMAP7.INP and is used to indicate grid cells where the original rock-type numbers from the Scott and Bonk (1984) geology map were left in place.

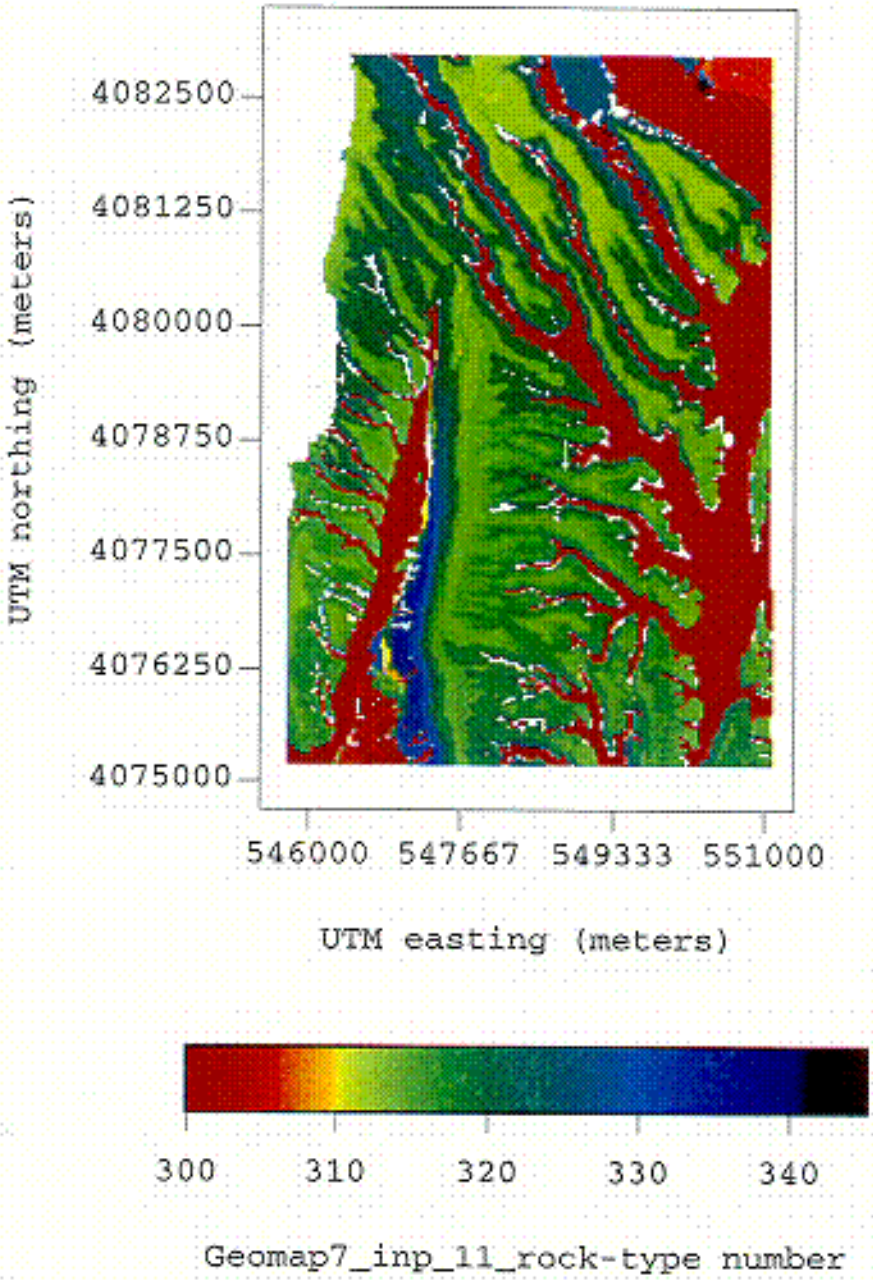

Figure VII-5. TRANSFORM map image of the updated rock-type identification numbers created by GEOMAP7. The map image (file GEOMAP7c.hdf) was developed using column 11 from file GEOMAP7.INP and is used to indicate grid cells where the updated rock-type numbers from the Day and others (1998) geology map were exchanged for the original rock-type numbers of the input file 30MSITE.INP.

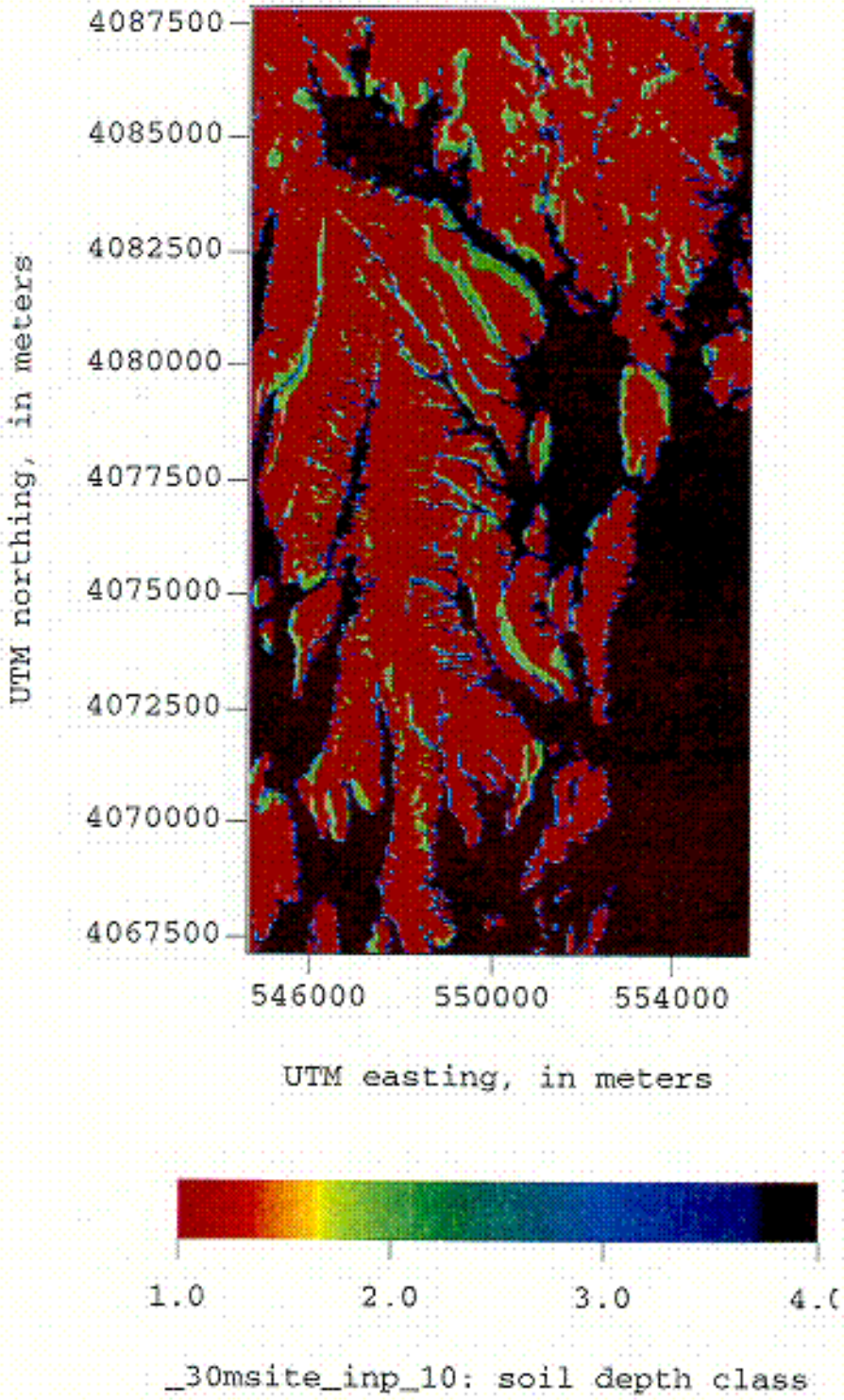

Figure VII-6. TRANSFORM map image (file 30MDEPTH.HDF) of soil depth class (integer values from 1 to 4) for the area of the Yucca Mountain model domain, generated using column 10 of the file 30MSITE.INP and used as input for GEOMAP7.

- **Tables used as part of the routine test plan:**

Table VII-1. Subset of raster grid matrix from the file NEWGEOL.DAT that is provided as input to GEOMAP7 V1.0. The rock-type identification numbers correspond to the geologic codes provided by Day and others (1998) for the central block geology of Yucca Mountain. Rock-type values of 1 and 2 in NEWGEOL.DAT indicate unconsolidated rocks (alluvium and colluvium).

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)		
	547991	548021	548051
4076523	18	16	16
4076493	18	18	18
4076463	18	18	18
4076433	18	18	18
4076403	2	1	1
4076373	2	2	2

Table VII-2. Subset of raster grid matrix for soil depth class from the file 30MSITE.INP (identical to the grid cell locations used in Table VII-1) that is provided as input to GEOMAP7 V1.0. Soil depth class values are provided in column 10 of 30MSITE.INP, and were used as input for INFIL V1.0 (Flint and others, 1996). The soil depth class values of 1 indicate thin upland soils ranging from 0 to 0.5 meters in thickness for all grid cell locations in the selected subset.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)		
	547991	548021	548051
4076523	1	1	1
4076493	1	1	1
4076463	1	1	1
4076433	1	1	1
4076403	1	1	1
4076373	1	1	1

Table VII-3. Subset of raster grid matrix from 30MSITE.INP (identical to the grid cell locations used in Table VII-1) showing rock-type identification numbers used in the geospatial parameter input file for INFIL V1.0 (Flint and others, 1996) and provided as input to GEOMAP7. The rock-type identifier codes correspond to the rasterized bedrock geology map of Scott and Bonk (1984).

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)		
	547991	548021	548051
4076523	20	20	20
4076493	20	20	20
4076463	20	20	20
4076433	20	20	20
4076403	1	1	1
4076373	20	20	20

Table VII-4. Subset of raster grid matrix from GEOMAP7.INP (identical to the grid cell locations used in Tables VII-1 and VII-2) showing new rock-type identification numbers (values of 300 and greater) created by GEOMAP7 using updated bedrock geology map from Day and others (1998). Rock-type identification numbers less than 300 indicate locations where the original rock-type used for INFIL V1.0 (Flint and others, 1996) was substituted back because the updated rock-type indicated alluvium or colluvium for locations having less than 6 meters of soil cover, as identified by the soil depth class map.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)		
	547991	548021	548051
4076523	318	316	316
4076493	318	318	318
4076463	318	318	318
4076433	318	318	318
4076403	302	301	301
4076373	20	20	20

Table VII-5. Extracted section of input file 30MSITE.INP analyzed in the EXCEL spreadsheet GEOMAP7.XLS as part of the test plan for the routine GEOMAP7. The table shows the input file format for the first 11 columns in terms of the separate input parameter sets organized by columns and also in terms of the set of different geospatial input parameters associated with specific grid cell locations and organized by rows.

Grid cell sequence number	Universal Transverse Mercator Easting (meters)	Universal Transverse Mercator Northing (meters)	Latitude (decimal degrees)	Longitude (decimal degrees)	Slope (deg)	Aspect (deg)	Elevation (meters)	Soil Type Code (ID#)	Soil Depth class	Scott and Bonk (1984) Rock type Map ID
112500	550571	4078653	36.8543	116.4327	5	91	1159	2	4	1
112501	550601	4078653	36.8543	116.4324	4	91	1157	2	4	1
112502	550631	4078653	36.8543	116.4321	3	92	1155	2	4	1
112503	550661	4078653	36.8543	116.4317	3	97	1153	2	4	1
112504	550691	4078653	36.8543	116.4314	3	104	1152	2	4	1
112505	550721	4078653	36.8543	116.4311	2	100	1151	2	4	1
112506	550751	4078653	36.8543	116.4307	2	166	1150	2	3	1
112507	550781	4078653	36.8543	116.4304	6	303	1151	9	2	1
112508	550811	4078653	36.8543	116.43	9	309	1155	9	2	12
112509	550841	4078653	36.8543	116.4297	10	318	1159	5	1	1
112510	550871	4078653	36.8543	116.4294	10	327	1163	5	1	19
112511	550901	4078653	36.8543	116.429	9	224	1165	5	1	19
112512	550931	4078653	36.8543	116.4287	9	49	1163	5	1	17
112513	550961	4078653	36.8542	116.4284	14	88	1158	5	1	17
112514	550991	4078653	36.8542	116.428	17	100	1149	5	1	17
112515	551021	4078653	36.8542	116.4277	14	104	1140	5	1	1
112516	551051	4078653	36.8542	116.4274	10	101	1134	5	1	1
112517	551081	4078653	36.8542	116.427	8	99	1130	9	2	1
112518	551111	4078653	36.8542	116.4267	6	104	1126	9	2	1
112519	551141	4078653	36.8542	116.4263	4	115	1123	9	2	1
112520	551171	4078653	36.8542	116.426	3	124	1122	9	2	1

Table VII-6. Extracted section of the output file GEOMAP7.INP created by GEOMAP7 V1.0 and analyzed in the EXCEL spreadsheet GEOMAP7.XLS as part of the routine test plan. The grid cell locations are identical to those indicated in Table VII-5. The table indicates that only the rock type map ID number has been modified (values of 300 and greater), and that the original Scott and Bonk (1984) map type ID number has been preserved for grid cell locations were a soil depth class of 3 or less coincided with an unconsolidated rock-type from Day and others (1998).

Grid cell sequence number	Universal Transverse Mercator Easting (meters)	Universal Transverse Mercator Northing (meters)	Latitude (decimal degrees)	Longitude (decimal degrees)	Slope (deg)	Aspect (deg)	Elevation (meters)	Soil Type Code (ID#)	Soil Depth class	Updated Rock type Map ID # using Day and others (1998) geology
112500	550571	4078653	36.8543	116.4327	5	91	1159	2	4	301
112501	550601	4078653	36.8543	116.4324	4	91	1157	2	4	301
112502	550631	4078653	36.8543	116.4321	3	92	1155	2	4	301
112503	550661	4078653	36.8543	116.4317	3	97	1153	2	4	301
112504	550691	4078653	36.8543	116.4314	3	104	1152	2	4	301
112505	550721	4078653	36.8543	116.4311	2	100	1151	2	4	301
112506	550751	4078653	36.8543	116.4307	2	166	1150	2	3	301
112507	550781	4078653	36.8543	116.4304	6	303	1151	9	2	301
112508	550811	4078653	36.8543	116.43	9	309	1155	9	2	12
112509	550841	4078653	36.8543	116.4297	10	318	1159	5	1	302
112510	550871	4078653	36.8543	116.4294	10	327	1163	5	1	315
112511	550901	4078653	36.8543	116.429	9	224	1165	5	1	315
112512	550931	4078653	36.8543	116.4287	9	49	1163	5	1	314
112513	550961	4078653	36.8542	116.4284	14	88	1158	5	1	313
112514	550991	4078653	36.8542	116.428	17	100	1149	5	1	313
112515	551021	4078653	36.8542	116.4277	14	104	1140	5	1	314
112516	551051	4078653	36.8542	116.4274	10	101	1134	5	1	1
112517	551081	4078653	36.8542	116.427	8	99	1130	9	2	1
112518	551111	4078653	36.8542	116.4267	6	104	1126	9	2	1
112519	551141	4078653	36.8542	116.4263	4	115	1123	9	2	1
112520	551171	4078653	36.8542	116.426	3	124	1122	9	2	1

- **Listing of source code for routine GEOMAP7 V1.0:**

```
      program geomap7
c     version 1.0
c
c     Routine to include the updated bedrock geology
c     for the central block area (from Day and others, 1998)
c     into the geospatial parameter input file for INFIL version 2.0.
c
c     This is the second routine in a sequence of pre-processing
c     routines used to develop the geospatial input files used
c     for the net infiltration modeling program, INFIL version 2.0.
c
c     GEOMAP7 performs two functions:
c     The first function is a modification of the rock-tpye
c     identification number (column 11 of the input file 30MSITE.INP).
c     The modification is performed by adding a value of 300 to
c     the values of the 4th column in the input file NEWGEOL.DAT,
c     which correspond to the central block area bedrock geology
c     map from Day and others (1998). The modification is performed
c     by exchanging (substituting) the old rock-type numbers provided
c     by the Sawyer et al. (1995) and the Scott and Bonk (1984)
c     geology maps with the new rock-type numbers for grid cell
c     locations within the area of the central block geology map.
c
c     The first function also performs a back-substitution of the
c     rock-type numbers
c     to the original rock-type numbers within the area of the
c     central block map. The back-substitution is performed to
c     utilize the Scott and Bonk (1984) geology map for
c     providing estimates of rock-type numbers for grid cells with
c     intermediate soil thickness (between 0.5 and 6 meters).
c
c     The second function consists of a modification of
c     the original soil depth class parameters to identify areas where
c     thin soil overlies mapped alluvium and colluvium.
c     This provides the option to correct (increase) soil depth for these
c     grid locations, which would otherwise have a strong potential of
c     being high flux locations.
c
c
c     The input and output files are column-formatted
c     ASCII text files consisting of 253,597 rows (for
c      253,597 grid cell locations) and 48 columns where
c     each column corresponds to a specific geospatial
c     parameter according to the following order:
c
c     column 1:     LOCID (grid location number)
c     column 2:     X2 (UTM easting coordinate, in meters)
c     column 3:     Y2 (UTM northing coordinate, in meters)
c     column 4:     LAT (latitude for X coordinate, in decimal degrees)
c     column 5:     LON (longitude for Y coordinate, in decimal degrees)
c     column 6:     SL (ground surface slope, in degrees)
c     column 7:     ASP (ground surface aspect, in degrees)
c     column 8:     ELEV (ground surface elevation, in meters)
c     column 9:     SOILTYPE (soil type identification number)
c     column 10:    DEPTHCLASS (soil depth class identification number)
c     column 11:    ROCKTYPE (rock type identification number)
c     column 12:    TOPOID (topographic position identification number)
c     column 13:    RIDGE(1) (1st blocking ridge angle)
c     "             "
c     "             "
c     column 48     RIDGE(36) (last blocking ridge angle)
c
```

```
c
c  This routine was written by
c  Joe Hevesi, U.S. Geological Survey, WRD
c  Placer Hall, 6000 J Street
c  Sacramento, CA,
c
c-----------------------------------------------------------------------72
c
   integer n,geo1,rocktype,soiltype,depthclass,topoid
   integer sl,asp,elev
   integer iopt,x1,y1
   integer geo(300000)
   real x3(300000),y3(300000)
   real lat,lon,x2,y2
   integer minx,maxx,miny,maxy
   integer ridge(40)

   character*20 geoin,inpfile,newgeo
   character*80 header
   character*10,legend

5  format(A)
   open(unit=7,file='geomap7.ctl')
   read(7,5) header
   read(7,5) geoin
   read(7,5) inpfile
   read(7,5) newgeo
   read(7,*) minx,maxx
   read(7,*) miny,maxy
c
   open(unit=8,file=geoin)
   open(unit=9,file=inpfile)
   open(unit=10,file=newgeo)
c
c
c---- read in new geology map
c  -----------------------
   n = 1
150 read(8,*,end=160) nx,x3(n),y3(n),geo(n)
     n = n + 1
     goto 150
160 n = n -1
   write(*,*) n
   pause
c
c---- read in original INFIL version 1.0 input file
c  ---------------------------------------------
200 read(9,*,END=900) locid,x2,y2,lat,lon,
     1    sl,asp,elev,SOILTYPE,depthclass,ROCKTYPE,
     2    topoid,(ridge(j), j=1,36)
c
c
c-------- x2,y2 restrict number of times newgeol file
c    needs to be sampled
     if(x2.ge.minx.and.x2.le.maxx.and.y2.ge.miny.and.y2.le.maxy)
   1 then
c
          do i = 1,n
c
c---------------- scan grids for matching cell locations
                 if(x3(i).eq.x2.and.y3(i).eq.y2) then
c
c
c----------------      Use Scott & Bonk geology if present, rather
c                then Day et al alluvium/colluvium.
```

```
c                 If soil depth class map indicates that this
c                 is an upland location, change soil depth class
c                 to 2. If soil depth class map indicates thick
c                 soils (value of 4), change to 3
                  if((geo(i).eq.1.or.geo(i).eq.2).and.
   1                     ((rocktype.ne.0).and.
     2                          (rocktype.ne.1).and.
     3                          (rocktype.ne.204))) then
                         if(depthclass.eq.1) depthclass = 2
                         if(depthclass.eq.4) depthclass = 3
                         goto 300
                  endif
c
                  if(geo(i).gt.0) rocktype = geo(i) + 300
c
c
300          continue
             endif
             enddo
     endif
c
c
     write(10,205) locid,x2,y2,lat,lon,sl,asp,elev,
   1 soiltype,depthclass,rocktype,topoid,(ridge(j), j=1,36)
205  format(i7,f9.0,f10.0,f8.4,f9.4,i4,i4,i6,i3,i3,i4,i3,
   1                     36i3)
     write(*,*) locid
     goto 200
c
900 continue
    close(10)
    stop
    end
```

ATTACHMENT VIII

ADJUSTMENT OF THE SOIL DEPTH CLASS MAP USING GEOMOD4 V1.0

TOTAL PAGES: 20

Adjustment of the Soil Depth Class Map using GEOMOD4 V1.0

1. Name of routine/macro with version/OS/hardware environment and user information:

Name of software routine: GEOMOD4 V1.0
OS and hardware environment: Windows NT 4.0, Pentium Pro PC
Computer Identification: SM321276 with a USGS specific host-name P720dcasr
Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. Name of commercial software with version/OS/hardware used to develop routine/macro:

The source code for GEOMOD4 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. General Description of routine/macro:

GEOMOD4 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (GEOMOD4.FOR), compiled executable file (GEOMOD4.EXE), routine control file (GEOMOD4.CTL), input and output files, validation test files, and a copy of this attachment, are located under the directory GEOMOD4 on a CD-ROM labeled GEOINPUT-1. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing applications such as Microsoft Word. The executable file can be used to run GEOMOD4 V1.0 on any PC with an INTEL processor (with adequate RAM).

The parameters calculated by GEOMOD4 that are included in the developed output file, GEOMOD4.INP, are used for the development of the geospatial parameter input file for INFIL V2.0. The file GEOMOD4.INP is used directly as input to the routine SOILMAP6 V1.0

4. Test plan for the software routine GEOMOD4 V1.0:

- **Explain whether this is a routine or macro and describe what it does:**

GEOMOD4 V1.0, is the third routine applied in a sequence of FORTRAN 77 routines that are used in the development of the geospatial parameter input file for INFIL V2.0. GEOMOD4 V1.0 uses the input file GEOMAP7.INP (the output file created by GEOMAP7 V1.0) to perform a partial modification of the original soil depth class parameters used as input to INFIL V1.0 (Flint and others, 1996). In addition, GEOMOD4 V1.0 performs an adjustment of the rock-type identification numbers based on the modified soil depth class parameters.

The modifications to the soil depth class parameters performed by GEOMOD4 V1.0 are required to maintain consistency with the updated bedrock geology obtained from Day and others (1998) and incorporated into the geospatial parameter input file using GEOMAP7. Two separate modifications to the soil depth class parameters are performed by GEOMOD4. To perform the first modification, the routine systematically scans the entire input grid and identifies all grid cells with unconsolidated rock-types that are adjacent to grid cells with consolidated rock-types (areas with consolidated rock-types are indicative of upland areas with thin soils). The grid cells defining the modified boundary are assigned a new soil depth class number of 5. Soil depth class 5 is used to represent a transitional soil thickness zone between thick soils defined by mapped areas of unconsolidated materials (alluvium and colluvium) and thin soils defined by mapped areas of consolidated bedrock. The original transitional soil depth class 3 was developed in ARCINFO v6.1.2 using a 30-meter buffer zone along the boundary defined by the alluvium-bedrock or colluvium-bedrock contacts. The buffer zone is thus used to define a 30-meter transitional area of intermediate soil depths between locations with thick soils identified by soil depth class 4 and locations with thin soils identified by soil depth classes 1 and 2. Soil depth class 5 is equivalent to soil depth class 3 obtained form the input file, in terms of defining an intermediate range of potential soil thickness.

The second soil depth class modification is performed by identifying grid cells having soil depth class 4 (soil thickness of 6 meters and greater) and also a consolidated rock-type number. This combination indicates the possibility of an inconsistency between the soil depth class map and the updated rock-type. The soil depth class is changed to 6 for the purpose of identifying these locations as a part of the intermediate soil thickness zone. Depth class 6 is equivalent to depth classes 5 and 3 in terms of the procedure used for estimating soil thickness in the routine SOILMAP6 (see Attachment IX). The purpose of using three different soil depth class numbers (3, 5, and 6) for representing an equivalent intermediate soil depth classes is to identify the method used to estimate the depth class. This information is used as part of the test plan.

The second function performed by GEOMOD4 V1.0 is a modification of rock-type parameters for grid cells having an intermediate or thin soil depth class number. This modification is required to prevent the inconsistency of having locations with thin or intermediate soil thickness assigned an unconsolidated rock-type. The routine identifies grid cells having this inconsistency and a consolidated rock-type is estimated by scanning the eight adjacent grid cell locations and identifying the most prevalent consolidated rock-type map number (or the first consolidated rock-type encountered, if there is no prevalent consolidated rock-type). If all adjacent grid cells are associated with unconsolidated rock-types, the inconsistency is corrected by changing the soil depth class to 4 (for thick soils) and the existing unconsolidated rock-type number is not modified.

- **Listing of FORTRAN77 Source code:**

A listing of the FORTRAN77 source code for the routine GEOMAP7 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

A validation test of the functions performed by the routine was conducted by a visual comparison between the input files (GEOMAP7.INP) and the output file (GEOMOD4.INP). The test criteria for the functions performed by GEOMOD4 consists of visual verification that the soil depth class parameters have been correctly modified and that the rock-type identification numbers for grid cells assigned to soil depth class 5 have been correctly estimated based on adjacent grid cells. The test plan consists of a 3-step testing procedure using a combination of a visual inspection of map images and a visual inspection of parameter values in the input and output ASCII test files. The comparison of input and output grid cell values and the generation of map images was facilitated using the raster-based grid and map-imaging applications available in the acquired software program TRANSFORM. The raster-based grid and map-imaging utilities allow for an analysis of the entire raster grid and also a detailed evaluation of grid cell values for specified grid locations.

Additional validation tests were also performed by extracting and comparing identical subsets (in terms of grid cell locations) from the raster images created in TRANSFORM and by visually inspecting identical subsets (based on grid cell locations) of the input file GEOMAP7.INP and the output file GEOMOD4.INP. This method of testing allowed for quantitative manual checking of the specific operations performed by GEOMOD4 based on the values of the input and output parameters. The criteria applied in this method of validation consisted of a visual verification that the intended modifications of the geospatial input file had been correctly performed. A final test that the routine had functioned correctly was performed by a comparison of the input and output files to verify that no unintended modifications had occurred during program execution.

- **Specify the range of input values to be used and why the range is valid:**

GEOMAP7.INP is the main input file used by GEOMOD4 V1.0. The file is specified in the file GEOMOD4.CTL, which is the routine control file for GEOMOD4 and is required for program execution. GEOMAP7.INP is a column-formatted ASCII file consisting of 253,597 rows and 48 columns (see Attachment VII). Two parameters provided by GEOMAP7.INP are used by GEOMOD4: the soil depth class number (column 10) and the rock-type number (column 11). The input values for soil depth class are integers from 1 to 4 and the input values for rock-type are integers from 1 to 345. This input range is valid because the values were obtained from ARCINFO using the source data as input (see Attachment VI for description of source data used for 30MSITE.INP) and a sequence of applied software routines described in Attachments VI through VII of this AMR.

5. Test Results.

- **Output from test:**

The output for the test case is the main output file GEOMOD4.INP generated by GEOMOD4 V1.0. The output file is used to generate raster-format map image files in TRANSFORM which are used only as a part of the validation test plan (the map image files are not required as part of the pre-processing procedure for developing the input used by INFIL V2.0).

- **Description of how the testing shows that the results are correct for the specified input:**

The map images (Figures VIII-1 and VIII-2) developed using TRANSFORM indicate by visual inspection that the integer values defining the updated soil depth class parameter have been correctly modified and incorporated into the output file GEOMOD4.INP that is created by GEOMOD4. Figure VIII-1 indicates the original soil depth class parameters consisting of integer values of 1 to 4 provided by column 10 of the input file GEOMAP7.INP. Figure VIII-2 indicates the modified soil depth class parameters consisting of integer values of 1 to 6 obtained from the output file GEOMOD4.INP. Visual comparison of the two figures indicates that the intended modification of the soil depth class parameters has been correctly performed.

Tables VIII-1 through VIII-4 indicate the subset of grid cell locations (a rectangular area in the upper part of Solitario Canyon) and corresponding input and output parameter values that were used to visually check that the functions performed by the routine had been executed correctly (the intended modifications to the parameters had occurred). Table VIII-1 indicates the integer values of 1 to 4 for soil depth class obtained from column 10 of the input file, and Table VIII-2 indicates integer values of 17 to 325 for rock-type obtained from column 11 of the input file. Inspection of Tables VIII-3 and VIII-4 indicates that the correct modifications were performed to the soil depth class and the rock-type parameters based on the combination of the input soil depth class and rock-type values. For example, the grid cell located at 547241 easting and 4079703 northing has an input soil depth class of 3 and a rock-type of 301. Rock-type values of 301 and 302 indicate unconsolidated material based on the Day and others (1998) updated geology for the central block area, and thus there is an inconsistency between the intermediate soil depth class and the rock-type for this grid cell. Table VIII-3 indicates that GEOMOD4 has correctly changed the soil depth class to 5, and Table VIII-4 indicates that GEOMOD4 has correctly estimated the underlying rock-type to be 19 based on the value for the adjacent grid cell. This comparison between the input and output verifies that the first soil depth class modification and the rock-type estimation function are being properly executed by the routine.

For the grid cell located at 547391 easting and 4079253 northing, the input soil depth class is 4 representing locations with thick soils of 6 meters and greater and the input rock-type is 321 which is consolidated bedrock and thus indicates an upland location that should be associated with thin to intermediate soil thickness. Table VIII-3 indicates that GEOMOD4 has correctly identified the inconsistency and has modified the soil depth class to 6 which is equivalent to depth class 3 and 5 in terms of estimating soil thickness. Table VIII-4 indicates

that no modifications were made to the rock-type for this location. This comparison between the input and output verifies that the second soil depth class modification is being properly executed by the routine.

Comparison of the input and output files indicates that no unintended modifications occurred during program execution (see printouts for input and output files under section 6). Both the input and output files consist of 253,597 rows and 48 columns, and the order and format of the rows and columns has not been modified. With the exception of the intended modifications made to the soil depth and rock-type parameters, the input and output files were found to be equivalent.

- **List limitations or assumptions to this test case and code in general:**

The limitations of the developed test case are based on the practical limitations of verifying modified parameter values for all 253, 597 grid cells included in the output file used for the developed test case. Validation of the entire output file used in the test case was performed as a visual evaluation of raster-based map images produced in TRANSFORM. Only a representative subset of the entire output file could be used for a more detailed and quantitative testing of the specific functions performed by the routine.

- **Electronic files identified by name and location:**

Electronic files are located on CD-ROM labeled GEOINPUT-1, under the directory GEOMOD4, included as an attachment to the AMR. The following electronic files are provided:

GEOMOD4.CTL:	Input file consisting of the input and output file names for GEOMOD4.
GEOMOD4.FOR:	FORTRAN source code listing for the routine GEOMOD4 V1.0. A printout of the source code is included as part of this attachment.
GEOMOD4.EXE:	Executable file for the routine GEOMOD4 V1.0, compiled for INTEL processors.
GEOMAP7.INP:	Input file consisting of a column-formatted, ASCII text file with 253,597 rows and 48 column. This file was developed as the output file from GEOMAP7 version (see Attachment VII). A partial print-out of the first part of this file is included as part of this attachment.

GEOMOD4.INP: Output file consisting of a column-formatted, ASCII text file with 48 columns and 253,597 rows. Each row corresponds to a grid cell location for the geospatial parameter base grid (the UTM location coordinates are defined by columns 2 and 3). Columns 10 (soil depth class) and 11 (rock-type number) of this file contain the parameters modified by GEOMOD4 V1.0. A partial printout of the first part of this file is included as part of this attachment.

GEOMAP7B.HDF: TRANSFORM raster-based map image (Figure VIII-1) of the soil depth class parameters obtained from column 10 of the input file GEOMAP7.INP. The file is used to perform the software routine validation test and is provided as supporting information. This file is not a part of the routine application.

GEOMOD4A.HDF: TRANSFORM raster-based map image (Figure VIII-2) of the modified soil depth class parameters obtained from column 10 of the output file GEOMOD4.INP. The file is used to perform the software routine validation test and is provided as supporting information. This file is not a part of the routine application.

6. Supporting Information. (Include background information, such as revision to a previous routine or macro, or explanation of the steps performed to run the software. Include listings of all electronic files and codes used).

- **Procedure for running routine:**

To run the routine GEOMOD4 V1.0, the executable file (GEOMOD4.EXE), the routine control file (GEOMOD4.CTL), and the input file specified in the routine control file (GEOMAP7.INP) must be placed in the same directory. The routine is executed by typing GEOMOD4 in a DOS window or by double clicking on the file GEOMOD4.EXE in the Microsoft Windows operating system, or by typing in the path and filename in the RUN window of the Windows NT or Windows 98 start menu. The input and output file names must be in the correct sequential order as specified in the routine control file (see example listing below).

- **Example listing of routine control file GEOMOD4.CTL**

```
geomod4.ctl        (header line)
geomap7.inp        (input file from routine GEOMAP7 version 1.0)
geomod4.inp        (output file generated by GEOMOD4.ctl)
```

- **Example listing of GEOMAP7.INP. This is the output file generated by GEOMAP7 V1.0 and supplied as input to the routine GEOMOD4 V1.0 (only the first 20 lines of the file are listed).**

```
      1  544661.  4087833. 36.9373 116.4985  21 238  1739  5  1 201  4  0  0
0  0  0  0  0  2 25 25 25 24 23 21 19 16 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
```

```
      2  544691.  4087833. 36.9373 116.4981  25 259  1750  5  1 201  4  0  0
0  0  0  0  0  3 29 28 27 26 25 22 19 17 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      3  544721.  4087833. 36.9373 116.4978  26 269  1767  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 24 20 18 17 10 10  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      4  544751.  4087833. 36.9373 116.4975  24 277  1781  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 25 22 18 16  9  9  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      5  544781.  4087833. 36.9373 116.4971  25 284  1794  5  1 201  4  0  0
0  0  0  0  0  2 26 26 27 26 25 23 21 17 11 11  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      6  544811.  4087833. 36.9373 116.4968  28 286  1807  5  1 201  4  0  0
0  0  0  0  0  3 29 28 24 25 24 23 20 17 14 14  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      7  544841.  4087833. 36.9373 116.4965  28 284  1824  5  1 201  4  0  0
0  0  0  0  0  2 25 23 15 16 15 17 15 13 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      8  544871.  4087833. 36.9373 116.4961  24 277  1838  5  1 201  4  0  0
0  0  0  0  0  2 23 20  2  5  6  6  6  5  8  9  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      9  544901.  4087833. 36.9373 116.4958  16 241  1851  5  1 201  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     10  544931.  4087833. 36.9373 116.4955  13 169  1854  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     11  544961.  4087833. 36.9373 116.4951  21 127  1846  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  2  1  0  1  1  1  2  1 14 12
0  0  0  0  0  0  0  0
     12  544991.  4087833. 36.9373 116.4948  20 128  1836  5  1 202  4  0  0
0  0  0  0  0  0  8  7  1  1  0  0  0  0  0  0  2  4  4  4  4  7  9  9 18 15
0  0  0  0  0  0  0  0
     13  545021.  4087833. 36.9373 116.4944  16 166  1829  5  1 202  4  0  0
0  0  0  0  0  1 14 13  8  3  1  0  0  0  0  0  2  5  6  6  6  7  8 11 15 13
0  0  0  0  0  0  0  0
     14  545051.  4087833. 36.9373 116.4941  19 220  1833  5  1 202  4  0  0
0  0  0  0  0  2 18 16  8  6  2  1  0  0  0  0  0  3  4  4  3  3  3  3  9  7
0  0  0  0  0  0  0  0
     15  545081.  4087833. 36.9373 116.4938  22 232  1843  5  1 201  4  0  0
0  0  0  0  0  1 16 14  3  2  0  0  0  0  0  0  0  0  1  2  1  1  1  1  4  3
0  0  0  0  0  0  0  0
     16  545111.  4087833. 36.9373 116.4934  20 224  1852  5  1 201  4  0  0
0  0  0  0  0  1 11  9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     17  545141.  4087833. 36.9373 116.4931  20 204  1858  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     18  545171.  4087833. 36.9373 116.4928  21 188  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     19  545201.  4087833. 36.9373 116.4924  23 178  1862  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     20  545231.  4087833. 36.9373 116.4921  23 162  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0
0  0  0  0  0  0  0  0
```

- **Example listing of GEOMOD4.INP. This is the output file generated by GEOMOD4 V1.0 and supplied as input to the routine SOILMAP6 V1.0 (only the first 20 lines of the file are listed).**

```
1  544661.  4087833. 36.9373 116.4985  21 238  1739  5  1 201  4  0  0  0  0
0  0  0  2 25 25 25 24 23 21 19 16 11 11  1  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0
     2  544691.  4087833. 36.9373 116.4981  25 259  1750  5  1 201  4  0  0
0  0  0  0  0  3 29 28 27 26 25 22 19 17 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     3  544721.  4087833. 36.9373 116.4978  26 269  1767  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 24 20 18 17 10 10  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     4  544751.  4087833. 36.9373 116.4975  24 277  1781  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 25 22 18 16  9  9  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     5  544781.  4087833. 36.9373 116.4971  25 284  1794  5  1 201  4  0  0
0  0  0  0  0  2 26 26 27 26 25 23 21 17 11 11  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     6  544811.  4087833. 36.9373 116.4968  28 286  1807  5  1 201  4  0  0
0  0  0  0  0  3 29 28 24 25 24 23 20 17 14 14  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     7  544841.  4087833. 36.9373 116.4965  28 284  1824  5  1 201  4  0  0
0  0  0  0  0  2 25 23 15 16 15 17 15 13 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     8  544871.  4087833. 36.9373 116.4961  24 277  1838  5  1 201  4  0  0
0  0  0  0  0  2 23 20  2  5  6  6  6  5  8  9  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
     9  544901.  4087833. 36.9373 116.4958  16 241  1851  5  1 201  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
    10  544931.  4087833. 36.9373 116.4955  13 169  1854  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
    11  544961.  4087833. 36.9373 116.4951  21 127  1846  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  2  1  0  1  1  1  2  1 14 12
0  0  0  0  0  0  0  0
    12  544991.  4087833. 36.9373 116.4948  20 128  1836  5  1 202  4  0  0
0  0  0  0  0  0  8  7  1  1  0  0  0  0  0  0  2  4  4  4  4  7  9  9 18 15
0  0  0  0  0  0  0  0
    13  545021.  4087833. 36.9373 116.4944  16 166  1829  5  1 202  4  0  0
0  0  0  0  0  1 14 13  8  3  1  0  0  0  0  0  2  5  6  6  6  7  8 11 15 13
0  0  0  0  0  0  0  0
    14  545051.  4087833. 36.9373 116.4941  19 220  1833  5  1 202  4  0  0
0  0  0  0  0  2 18 16  8  6  2  1  0  0  0  0  0  3  4  4  3  3  3  3  9  7
0  0  0  0  0  0  0  0
    15  545081.  4087833. 36.9373 116.4938  22 232  1843  5  1 201  4  0  0
0  0  0  0  0  1 16 14  3  2  0  0  0  0  0  0  0  0  1  2  1  1  1  1  4  3
0  0  0  0  0  0  0  0
    16  545111.  4087833. 36.9373 116.4934  20 224  1852  5  1 201  4  0  0
0  0  0  0  0  1 11  9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
    17  545141.  4087833. 36.9373 116.4931  20 204  1858  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
    18  545171.  4087833. 36.9373 116.4928  21 188  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
    19  545201.  4087833. 36.9373 116.4924  23 178  1862  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
```

```
     20  545231.  4087833. 36.9373 116.4921  23 162  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0
0  0  0  0  0  0  0  0
```

- Figures used as part of the routine test plan:

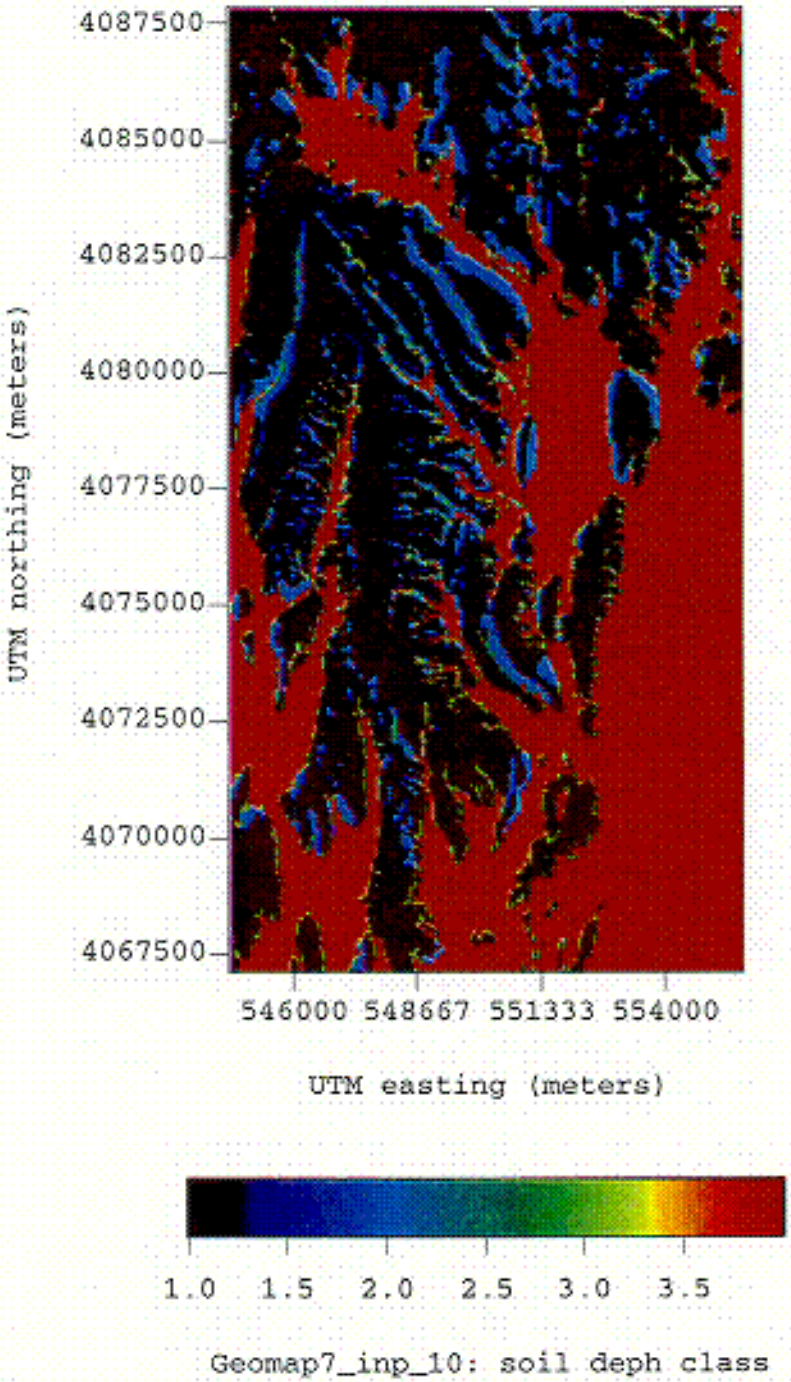

Figure VIII-1. TRANSFORM map image (file GEOMAP7B.HDF) of soil depth class obtained from column 10 of the input file GEOMAP7.INP.

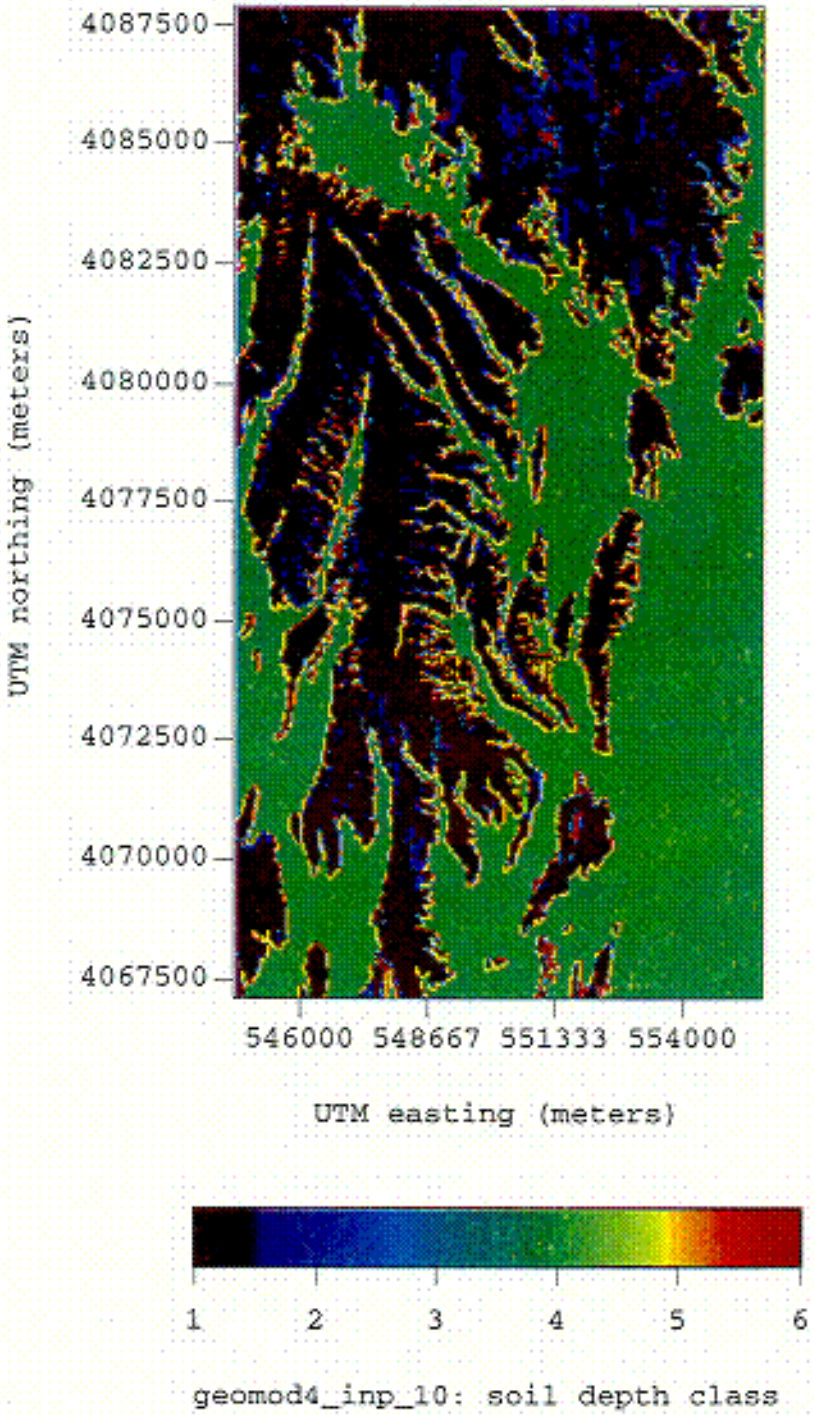

Figure VIII-2. TRANSFORM map image (file GEOMOD4A.HDF) of modified soil depth class parameters obtained from column 10 of the output file GEOMOD4.INP generated by GEOMOD4 V1.0 showing integer values ranging from 1 to 6.

- Tables used as part of the routine test plan:

Table VIII-1. Soil depth classes obtained from column 10 of the input file GEOMAP7.INP, showing integer values ranging from 1 to 4 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	1	3	4	4	3	2	1	1
4079673	2	1	3	4	3	2	1	1
4079643	1	2	3	3	3	2	1	1
4079613	1	1	2	3	3	1	1	1
4079583	1	1	2	3	3	1	1	1
4079553	1	1	2	3	3	1	1	1
4079523	1	1	3	4	3	1	1	1
4079493	1	1	3	3	1	1	1	1
4079463	1	1	3	3	1	1	1	1
4079433	1	3	4	3	1	1	1	1
4079403	1	3	4	3	1	1	1	1
4079373	3	3	4	3	1	1	1	1
4079343	3	4	4	3	1	1	3	3
4079313	4	4	4	4	3	3	3	3
4079283	4	4	4	4	4	4	3	1
4079253	4	4	4	4	4	4	4	3
4079223	4	4	4	4	4	3	3	3
4079193	4	4	4	4	3	1	1	1
4079163	4	4	4	4	3	1	1	1
4079133	4	4	3	3	1	1	1	1
4079103	4	4	3	1	1	1	1	1
4079073	4	4	3	3	1	1	1	1
4079043	4	4	3	3	1	1	1	1
4079013	4	3	1	1	1	1	1	1
4078983	4	3	1	1	1	1	1	1
4078953	3	3	1	1	1	1	1	1
4078923	3	1	2	1	1	1	1	1
4078893	3	1	1	1	1	1	1	1
4078863	3	3	2	1	1	1	1	1
4078833	3	1	2	1	1	1	1	1
4078803	3	1	2	2	1	1	1	1
4078773	3	3	2	2	1	1	1	1
4078743	3	1	2	1	1	1	1	1

Table VIII-2. Rock-type numbers obtained from column 11 of the input file GEOMAP7.INP, showing integer values ranging from 1 to 345 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	301	301	301	301	301	31	320	319
4079673	19	301	301	301	301	31	320	319
4079643	314	19	301	301	301	31	320	319
4079613	314	314	18	301	301	321	320	320
4079583	314	314	17	301	301	321	320	320
4079553	314	314	17	301	313	321	321	320
4079523	314	314	17	301	313	321	320	320
4079493	314	314	17	301	313	321	320	320
4079463	314	314	301	313	313	321	320	320
4079433	314	17	301	313	320	321	320	320
4079403	314	17	301	313	320	321	320	320
4079373	17	17	301	313	320	321	320	320
4079343	17	301	301	313	320	321	321	320
4079313	301	301	301	313	320	321	321	320
4079283	301	301	301	313	320	321	321	320
4079253	301	301	301	313	320	321	321	324
4079223	301	301	301	313	320	321	321	324
4079193	301	301	301	313	320	321	321	324
4079163	301	301	301	313	319	321	321	324
4079133	301	301	301	313	314	319	321	324
4079103	301	301	301	313	314	319	319	324
4079073	301	301	313	313	314	319	319	324
4079043	301	301	313	313	314	319	319	324
4079013	301	301	313	313	314	319	319	325
4078983	301	301	313	313	314	314	319	325
4078953	301	301	313	314	314	313	323	325
4078923	301	301	16	314	313	311	323	325
4078893	301	302	313	314	314	313	325	325
4078863	301	302	30	314	314	314	325	324
4078833	301	302	30	314	314	314	325	324
4078803	301	302	30	28	315	315	325	324
4078773	302	302	30	28	315	319	325	324
4078743	302	302	30	314	314	319	325	324

Table VIII-3. Soil depth classes obtained from column 10 of the output file GEOMOD4.INP, showing integer values ranging from 1 to 6 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	5	5	4	4	5	2	1	1
4079673	2	5	5	4	5	2	1	1
4079643	1	2	5	5	5	2	1	1
4079613	1	1	2	5	5	1	1	1
4079583	1	1	2	5	5	1	1	1
4079553	1	1	2	5	3	1	1	1
4079523	1	1	3	5	3	1	1	1
4079493	1	1	3	5	1	1	1	1
4079463	1	1	5	3	1	1	1	1
4079433	1	3	5	3	1	1	1	1
4079403	1	3	5	3	1	1	1	1
4079373	3	3	5	3	1	1	1	1
4079343	3	5	5	3	1	1	3	3
4079313	5	5	5	6	3	3	3	3
4079283	5	4	5	6	6	6	3	1
4079253	4	4	5	6	6	6	6	3
4079223	4	4	5	6	6	3	3	3
4079193	4	4	5	6	3	1	1	1
4079163	4	4	5	6	3	1	1	1
4079133	4	4	5	3	1	1	1	1
4079103	4	5	5	1	1	1	1	1
4079073	4	5	3	3	1	1	1	1
4079043	4	5	3	3	1	1	1	1
4079013	4	5	1	1	1	1	1	1
4078983	4	5	1	1	1	1	1	1
4078953	4	5	1	1	1	1	1	1
4078923	4	5	2	1	1	1	1	1
4078893	4	5	1	1	1	1	1	1
4078863	4	5	2	1	1	1	1	1
4078833	4	5	2	1	1	1	1	1
4078803	4	5	2	2	1	1	1	1
4078773	4	5	2	2	1	1	1	1
4078743	5	5	2	1	1	1	1	1

Table VIII-4. Rock-type numbers obtained from column 11 of the output file GEOMOD4.INP, showing integer values ranging from 1 to 345 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	319	19	301	301	30	31	320	319
4079673	19	19	19	301	31	31	320	319
4079643	314	19	19	18	31	31	320	319
4079613	314	314	18	18	31	321	320	320
4079583	314	314	17	18	321	321	320	320
4079553	314	314	17	17	313	321	321	320
4079523	314	314	17	17	313	321	320	320
4079493	314	314	17	17	313	321	320	320
4079463	314	314	314	313	313	321	320	320
4079433	314	17	314	313	320	321	320	320
4079403	314	17	17	313	320	321	320	320
4079373	17	17	17	313	320	321	320	320
4079343	17	17	17	313	320	321	321	320
4079313	314	17	313	313	320	321	321	320
4079283	17	301	313	313	320	321	321	320
4079253	301	301	313	313	320	321	321	324
4079223	301	301	313	313	320	321	321	324
4079193	301	301	313	313	320	321	321	324
4079163	301	301	313	313	319	321	321	324
4079133	301	301	313	313	314	319	321	324
4079103	301	313	313	313	314	319	319	324
4079073	301	313	313	313	314	319	319	324
4079043	301	313	313	313	314	319	319	324
4079013	301	313	313	313	314	319	319	325
4078983	301	313	313	313	314	314	319	325
4078953	301	313	313	314	314	313	323	325
4078923	301	313	16	314	313	311	323	325
4078893	301	16	313	314	314	313	325	325
4078863	301	313	30	314	314	314	325	324
4078833	301	30	30	314	314	314	325	324
4078803	301	30	30	28	315	315	325	324
4078773	302	30	30	28	315	319	325	324
4078743	30	30	30	314	314	319	325	324

- **Listing of source code for routine GEOMOD4 V1.0:**

```
      program geomod4
c version 1.0
c
c subroutine to modify soil depth buffer zone based on
c the updated geology (output from geomap7)
c
c This is the third routine in a sequence of pre-processing
c routines used to develop the geospatial input files used
c for the net infiltration modeling program, INFIL version 2.0.
c
c GEOMOD4 performs two functions:
c The first function is a modification of the soil depth
c class parameters (column 10 of the input file GEOMAP7.INP).
c The modification of soil depth class is performed to
c create a consistency between soil thickness and the
c updated geology map from Day and others (1998),
c and consists of two steps:
c The first step is an adjustment of the intermediate soil depth
c class representing the transitional zone between the thin soils
c of rugged upland areas and the thick soils of basin-fill areas.
c The second step is a flagging of grid cells with thick soils and
c a consolidated rock-type number.
c
c The second function is a modification of the rock-type number
c for all grid cells within the updated intermediate soil
c depth class having an unconsolidated rock-type. The function
c consists of estimating the rock-type based on a scanning of
c of the adjacent grid cells and selecting the most prevalent
c rock-type (or the first rock-type if there is
c no prevalent rock-type).
c
c The input and output files are column-formatted
c ASCII text files consisting of 253,597 rows (for
c  253,597 grid cell locations) and 48 columns where
c each column corresponds to a specific geospatial
c parameter according to the following order:
c
c column 1:   LOCID (grid location number)
c column 2:   X (UTM easting coordinate, in meters)
c column 3:   Y (UTM northing coordinate, in meters)
c column 4:   LAT (latitude for X coordinate, in decimal degrees)
c column 5:   LONG (longitude for Y coordinate, in decimal degrees)
c column 6:   SLOPE (ground surface slope, in degrees)
c column 7:   ASPECT (ground surface aspect, in degrees)
c column 8:   ELEV (ground surface elevation, in meters)
c column 9:   SOILTYPE (soil type identification number)
c column 10:  DEPTHCLASS (soil depth class identification number)
c column 11:  ROCK (rock type identification number)
c column 12:  TOPOID (topographic position identification number)
c column 13:  RIDGE(1) (1st blocking ridge angle)
c "                  "
c "                  "
c column 48   RIDGE(36) (last blocking ridge angle)
c
c
c This routine was written by
c Joe Hevesi, U.S. Geological Survey, WRD
c Placer Hall, 6000 J Street
c Sacramento, CA,
c
```

```
c-----------------------------------------------------------------------72
c
  integer n,geo1,rocktype,rown,coln,geo2
  integer soiltype(-1:300000),depthclass(-1:300000),
  1                 topoid(-1:300000),locid(-1:300000)
c
  integer row(-1:300000),col(-1:300000)
  integer slope(-1:300000),aspect(-1:300000),elev(-1:300000)
  integer ridge(-1:300000,36)
  integer iopt
  integer geo(-1:1000,-1:1000),newgeo(-1:300000)
  integer ntemp(30),geotemp(30)
c
  double precision x(-1:300000),y(-1:300000)
  real lat(-1:300000),long(-1:300000)
  real x1,y1,x2,y2,yold
  integer minrow,maxrow,mincol,maxcol
c

  character*20 inpfile,geonew
  character*80 header
  character*10,legend

5 format(A)
  open(unit=7,file='geomod4.ctl')
  read(7,5) header
  read(7,5) inpfile
  read(7,5) geonew
c
  open(unit=8,file=inpfile)
  open(unit=9,file=geonew)
c
c
  maxrow = -9999
  maxcol = -9999
  minrow = 9999
  mincol = 9999
c
  n = 1
      coln = 0
      rown = 0
  yold = 0.
c
100    read(8,*,END=150) locid(n),x(n),y(n),lat(n),long(n),
     1    slope(n),aspect(n),elev(n),soiltype(n),depthclass(n),
     2 rocktype,topoid(n),(ridge(n,j), j=1,36)
c
         if(y(n).ne.yold) then
            rown = rown + 1
            coln = 1
        write(*,*) n,row(n),col(n)
        endif
      if(maxrow.lt.rown) maxrow = rown
      if(minrow.gt.rown) minrow = rown
      if(maxcol.lt.coln) maxcol = coln
      if(mincol.gt.coln) mincol = coln

        col(n) = coln
        row(n) = rown
        coln = coln + 1
        yold = y(n)
      geo(row(n),col(n)) = rocktype
        n = n + 1
```

```
c
      goto 100
150   n = n - 1
      write(*,*) n, row(n), col(n)
  pause
c
  do 300 i = 1,n
c
       geo1 = geo(row(i),col(i))
       newgeo(i) = geo1
c
c------- if cell is in alluvium/colluvium, then check
c      geology of surrounding cells

       if((geo1.eq.0).or.
  2    (geo1.eq.1).or.
  3    (geo1.eq.204).or.
     4 (geo1.eq.301).or.
     5 (geo1.eq.302)) then

             do ii = 1,8
                    ntemp(ii) = 0
                    geotemp(ii) = -1
             enddo
c
             ntemp2 = 0
             geotemp2 = -99
             nn = 0
c
c---------- tag all bedrock geology within 1st layer
c            of cells surrounding primary cell (geotemp)
c            keep track of which geo type has the most
c            cells (ntemp)
c
             do 500 ir = -1,1
                    do 500 ic = -1,1
                           if(ir.eq.0.and.ic.eq.0) goto 500
                           row2 = row(i) + ir
                           col2 = col(i) + ic
                           geo2 = geo(row2,col2)

                           if((geo2.ne.0).and.
  1                        (geo2.ne.1).and.
  2                        (geo2.ne.204).and.
  3                        (geo2.ne.301).and.
  4                        (geo2.ne.302)) then
                                  nn = nn + 1
                                  geotemp(nn) = geo2
                                  ntemp(nn) = ntemp(nn) + 1
                           endif
500                 continue
             do ii = 1,8
                    if(ntemp(ii).gt.ntemp2) then
                           ntemp2 = ntemp(ii)
                           geotemp2 = geotemp(ii)
                    endif
             enddo

             if(geotemp2.ne.-99) then
                    newgeo(i) = geotemp2
                    depthclass(i) = 5
                    write(*,*) i, newgeo(i)
```

```
                endif
        endif
c
        if((depthclass(i).eq.4).and.
  1             ((newgeo(i).ne.0).and.
  2             (newgeo(i).ne.1).and.
  3             (newgeo(i).ne.204).and.
  4             (newgeo(i).ne.301).and.
  5             (newgeo(i).ne.302))) then
                      depthclass(i) = 6
        endif
c
        if((newgeo(i).eq.0).or.
  1             (newgeo(i).eq.1).or.
  2             (newgeo(i).eq.204).or.
  3             (newgeo(i).eq.301).or.
  4             (newgeo(i).eq.302)) then
                      depthclass(i) = 4
        endif
c
        write(9,205) locid(i),x(i),y(i),lat(i),long(i),
  1     slope(i),aspect(i),elev(i),soiltype(i),depthclass(i),
  2     newgeo(i),topoid(i),(ridge(i,j), j=1,36)
205             format(i7,f9.0,f10.0,f8.4,f9.4,i4,i4,i6,i3,i3,i4,i3,
  1                           36i3)
c
300     continue
c
  close(9)
  stop
  end
```

ATTACHMENT IX

ESTIMATION OF SOIL DEPTH USING SOILMAP6 V1.0

TOTAL PAGES: 25

Estimation of Soil Depth using SOILMAP6 V1.0

1. Name of routine/macro with version/OS/hardware environment and user information:

Name of software routine: SOILMAP6 V1.0,
OS and hardware environment: Windows NT 4.0, Pentium Pro PC
Computer Identification: SM321276 with a USGS specific host-name P720dcasr
Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. Name of commercial software with version/OS/hardware used to develop routine/macro:

The source code for SOILMAP6 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. General Description of routine/macro:

SOILMAP6 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (SOILMAP6.FOR), compiled executable file (SOILMAP6.EXE), routine control file (SOILMAP6.CTL), input and output files, validation test files, and a copy of this attachment, are located under the directory SOILMAP6 on a CD-ROM labeled GEOINPUT-1. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing or spreadsheet applications such as Microsoft WORD and EXCEL. The executable file can be used to run SOILMAP6 V1.0 on any PC with an INTEL processor (with adequate RAM).

All input parameters used by SOILMAP6 V1.0 and the parameters calculated by SOILMAP6 that are included in the developed output file, SOILMAP6.INP, are used for the development of the geospatial parameter input file for INFIL V2.0. The file SOILMAP6 is used directly as input to the routine SORTGRD1 V1.0

4. Test plan for the software routine SOILMAP6 V1.0:

- **Explain whether this is a routine or macro and describe what it does:**

SOILMAP6 V1.0 is the fourth routine applied in a sequence of FORTRAN 77 routines that are used in the development of the geospatial parameter input file for INFIL V2.0. Modifications to the geospatial parameter input file performed by SOILMAP6 involve an application of empirical, linear scaling functions to estimate an absolute soil thickness (in meters) for each grid cell location using the up-dated soil depth class and ground surface

slope parameters obtained from the file 30msite.inp[1]. The linear scaling functions are based on an assumed correlation between calculated ground surface slope and soil thickness within each depth class. The assumed correlation is qualitatively supported by subjective field observations indicating a general decrease in soil thickness with an increase in ground surface slope.

The soil thickness function for depth class 1 is based on an assumption that soils tend to be relatively thin at summit and ridge-crest locations and are the thinnest for steep side slope locations. Thicker soils are assumed to occur at the relatively gently sloping shoulder areas that define the transition between summit or ridge-crest areas and steep sideslope areas. Thicker soils are also assumed to occur for more gently sloping foot-slope locations. Using these assumptions, the linear scaling function used to estimate soil depth for model grid cells assigned a soil-depth class number of 1 (designated for rugged upland areas with thin soils) is defined by:

$$D = 0.03 * S + 0.1, \qquad S \leq 10$$
$$D = 0.013 * (10 - S) + 0.4, \qquad 10 < S < 40$$
$$D = 0.01, \qquad S \geq 40$$

where D = soil depth (in meters), and S = slope (degrees). The soil thickness function for depth class 2, which is defined on the basis of mapped zones of greater soil thickness within upland areas generally associated with soil depth class 1, assumes a simpler correlation between slope and soil thickness. For grid locations associated with soil depth class 2, absolute soil thickness is estimated using:

$$D = 2 - (0.05 * S), \qquad S < 32$$
$$D = 0.4, \qquad S \geq 32$$

A single soil thickness function is used for depth classes 3, 5, and 6. The function is also based on the assumption of a simple linear correlation between slope and soil thickness. For grid locations associated with soil depth classes 3, 5, and 6, absolute soil thickness is estimated by:

$$D = 6 - (0.16 * S), \qquad S \leq 25$$
$$D = 2.0 \qquad S > 25$$

For depth class 4, soil depth is set to a uniform depth of 6 meters.

Prior to calculating the soil depth estimates, SOILMAP6 V1.0 uses the input file GEOMOD4.INP (the output file created by GEOMOD4 V1.0) to perform a final adjustment of the original soil depth class parameters. The modifications to the soil depth class parameters performed by SOILMAP6 are based on a comparison between the updated soil depth classes and the updated rock-type parameters. The comparison provides a final consistency check to ensure that no grid cell locations have a combination of a soil depth class indicating thin soils

[1] Ground surface slope is calculated using ARCINFO which provides a standardized approximation of the true ground surface slope using the raster-based grid format of the digital elevation model used as source data and a five-point calculation of the average slope.

(associated with rugged upland areas) and a rock-type indicating unconsolidated material (associated with basin-fill areas).

- **Listing of FORTRAN77 Source code:**

  A listing of the FORTRAN77 source code for the routine SOILMAP6 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

  A validation test of the functions performed by the routine was conducted by a visual comparison between the input file GEOMOD4.INP and the output file SOILMAP6.INP. The visual analysis was facilitated by raster-based map images created using the acquired software program TRANSFORM. The raster-based grid and map-imaging utilities allow for an analysis of the entire raster grid and also a detailed evaluation of grid cell values for specified grid locations.

  The test criteria for the functions performed by SOILMAP6 consist of visual verification that the soil depth class parameters have been correctly modified and that the calculations of soil depth estimates have been correctly performed. The test plan consists of a 3-step testing procedure. The first step requires a visual inspection of the TRANSFORM map images. The second step requires a check of the calculations performed by the routine using a comparison of manual calculations against a selected subset of the input and output files. The third step requires a check of the input and output files to ensure that the output file format is correct and that no modifications other than those intended by the routine application have occurred.

  The second step of the test plan was facilitated by extracting identical subsets (in terms of grid cell locations) of the input and output files using the raster-based files created by TRANSFORM. The subsets are in the format of ASCII text matrices and are used to check the estimated soil thickness values in the output file against a manual calculation. The criteria applied in the third step of the test plan consists of visually inspecting the input and output files and verifying that the intended modification of the geospatial input file had been correctly performed, and that no unintended modifications had occurred during program execution.

  SOILMAP6 V1.0 performs an internal testing of the modified soil depth class parameters by flagging the soil depth class parameter for a given grid cell location with a negative sign if an inconsistency is still identified after the final modification of the soil depth class parameters. If no negative values occur in the output file then the internal validation test performed by the routine is satisfied.

- **Specify the range of input values to be used and why the range is valid:**

  GEOMOD4.INP is the main input file used by SOILMAP6 V1.0. The file is specified in the file SOILMAP6.CTL, which is the routine control file for SOILMAP6 and is required for

program execution. GEOMOD4.INP is a column-formatted ASCII file consisting of 253,597 rows and 48 columns (see Attachment VIII). Three parameters provided by GEOMOD4.INP are used by SOILMAP6: the soil depth class number (column 10), the rock-type number (column 11), and the ground surface slope (column 6). The input values for soil depth class are integers from 1 to 6, the input values for rock-type are integers from 1 to 345, and the input values for slope are integers from 0 to 47. This input range is valid because the values were obtained from ARCINFO using the source data as input (see Attachment VII for description of source data used for 30MSITE.INP) and a sequence of applied software routines described in Attachments VII through VIII of this AMR.

5. Test Results.

- **Output from test:**

The output for the test case is the main output file SOILMAP6.INP generated by SOILMAP6 V1.0. The output file is used to generate raster-format map image files in TRANSFORM which are used only as a part of the validation test plan (the map image files are not required as part of the pre-processing procedure for developing the input used by INFIL V2.0).

- **Description of how the testing shows that the results are correct for the specified input:**

The map images developed using TRANSFORM (Figures IX-1 through IX-5) indicate by visual inspection that the routine SOILMAP6 V1.0 is functioning correctly for all grid cell locations within the modeling domain. Comparison of Figures IX-1 and IX-2 indicates that the re-defined soil depth classes are consistent with calculated ground surface slope. Figure IX-2 indicates the finalized soil depth class parameters consisting of integer values of 1 to 6. The figure indicates that no modifications were performed by SOILMAP6 to the soil depth class parameters. Negative soil depth class numbers do not occur in the output from SOILMAP6 and therefore inconsistencies in the soil depth class parameters were not found in the output file created by GEOMOD4. Comparison of Figures IX-2 and IX-3 indicates that the soil depth classes were correctly applied by the routine in the calculation of soil thickness estimates on the scale of the modeling domain. Thick soils of 6 meters and greater match the area of soil depth class 4, and thin soils of 0.5 meters and less match the area of depth class 1. Figure IX-4 indicates that the calculation of soil thickness estimates for soil depth class 1 was performed correctly and provides reasonable estimates of soil thickness for upland areas. Locations with minimum soil thickness estimates (< 0.1 meters) coincide with locations having high slope values (> 30 degrees). Locations with relatively high soil thickness estimates (> 0.35 meters) for depth class 1 coincide with low and intermediate slope values (< 20 degrees). Figure IX-5 indicates the expected result for soil thickness estimates in the intermediate depth classes (2, 3, 5, and 6). The soil thickness estimates range from approximately 0.5 to < 6.0 meters and occur for locations representing the transition between thin upland soils and thick basin-fill soils and areas mapped as having intermediate soil thickness within upland areas.

Tables IX-1 and IX-2 indicate the values of input parameters obtained from GEOMOD4.INP (Table IX-1 shows the soil depth class number and Table IX-2 shows the rock-type number)

for a subset of grid cells located in upper Solitario Canyon that are extracted from the input file. The input data is used by SOILMAP6 to perform a final consistency check of the modified soil depth class parameters relative to the updated rock-type parameters. Table IX-3 indicates that the finalized soil depth class parameters included in the output file SOILMAP6.INP are identical to the soil depth class parameters in the input file GEOMDO4.INP (no modifications were performed by the routine). Table IX-4 indicates the values of calculated ground surface slope obtained from the input file that are used in calculating soil thickness estimates. Table IX-5 shows the values of soil thickness estimates obtained from the output file. A manual check of the soil thickness estimates indicates that the routine is functioning correctly. For example, for the grid cell located at 547421 easting and 4079643 northing, a manual check of the equation used for soil depth class 1 and a slope value of 22 indicates a value of 0.24 meters for estimated soil thickness, and this agrees with the value obtained from the output file. For the grid cell located at 547211 easting and 4079673 northing, a manual check of the equation used for soil depth class 2 and a slope value of 15 indicates a value of 1.25 meters for estimated soil thickness, which agrees with the output.

Visual inspection of the input and output files (see partial listing of files GEOMOD4.INP and SOILMAP6.INP provided under supporting information) indicates that the soil thickness estimates were correctly included as column 11 in the output file and that no unintended modifications of the input parameters and input file format occurred. The output file has the correct number of lines (253,597), the correct number of columns (49), and the position of the columns and rows is correct.

- **List limitations or assumptions to this test case and code in general:**

The limitations of the developed test case are based on the practical limitations of verifying modified parameter values for all 253, 597 grid cells included in the output file used for the developed test case. Validation of the entire output file used in the test case was performed as a visual evaluation of raster-based map images produced in TRANSFORM. Only a subset of the entire output file could be used for more detailed validation tests that included a manual check of the equations used by the routine.

- **Electronic files identified by name and location:**

Electronic files are located on CD-ROM labeled GEOINPUT-1, under the directory SOILMAP6, included as an attachment to the AMR. The following electronic files are provided:

SOILMAP6.CTL:	Input file consisting of the input and output file names for SOILMAP6 V1.0.
SOILMAP6.FOR:	FORTRAN source code listing for the routine SOILMAP6 V1.0. A printout of the source code is included as part of this attachment.

SOILMAP6.EXE:	Executable file for the routine SOILMAP6 V1.0, compiled for INTEL processors.
GEOMOD4.INP:	Input file consisting of a column-formatted, ASCII text file with 253,597 rows and 48 column. This file was developed as the output file from GEOMOD4 version (see Attachment VIII). A partial printout of the first part of this file is included as part of this attachment.
SOILMAP6.INP:	Output file consisting of a column-formatted, ASCII text file with 49 columns and 253,597 rows. Estimates of soil depth, in meters, are added as a new column between columns 10 and 11 (rock-type number) of the input file column order. Each row corresponds to a grid cell location for the geospatial parameter base grid (the UTM location coordinates are defined by columns 2 and 3). Columns 10 (soil depth class) and 11 (estimated soil depth in meters) of this file contain the parameters modified by SOILMAP6 V1.0. A partial printout of the first part of this file is included as part of this attachment.
30MSLOPE.HDF:	TRANSFORM raster-based map image (Figure IX-1) of calculated ground surface slope obtained from column 6 of the input file GEOMOD4.INP. The file is used to perform the software routine validation test and is provided as supporting information. This file is not a part of the routine application
SOILM6DC.HDF:	TRANSFORM raster-based map image (Figure IX-2) of the soil depth class parameters obtained from column 10 of the output file SOILMAP6.INP. The file is used to perform the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
SOILMP61.HDF:	TRANSFORM raster-based map image (Figure IX-3) of the soil thickness estimates obtained from column 11 of the output file SOILMAP6.INP. The file is used to perform the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
SOILMP62.HDF:	TRANSFORM raster-based map image (Figure IX-4) of the soil thickness estimates obtained from column 11 of the output file SOILMAP6.INP. The file is used to perform the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
SOILMP63.HDF:	TRANSFORM raster-based map image (Figure IX-5) of the soil thickness estimates obtained from column 11 of the output file SOILMAP6.INP. The file is used to perform the software routine validation test and is provided as supporting information. This file is not a part of the routine application.

6. Supporting Information. (Include background information, such as revision to a previous routine or macro, or explanation of the steps performed to run the software. Include listings of all electronic files and codes used).

- **Procedure for running routine:**

To run the routine SOILMAP6 V1.0, the executable file (SOILMAP6.EXE), the routine control file (SOILMAP6.CTL), and the input file specified in the routine control file (SOILMAP6.INP) must be placed in the same directory. The routine is executed by typing SOILMAP6 in a DOS window, by double clicking on the file SOILMAP6.EXE in the Microsoft Windows operating system, or by typing in the path and filename in the RUN window of the Windows NT or Windows 98 start menu. The input and output file names must be in the correct sequential order as specified in the routine control file (see example listing below).

- **Example listing of routine control file SOILMAP6.CTL**

```
soilmap6.ctl            (header line)
geomod4.inp             (input file name)
soilmap6.inp            (main output file name)
soilmap6.out            (auxiliary output file used for routine testing)
```

- **Example listing of the input file GEOMOD4.INP (only the first 20 lines of the file are listed). The input parameters used by SOILMAP6 V1.0 are slope (column 6), soil depth class (column 10), and rock-type (column 11).**

```
      1  544661.  4087833. 36.9373 116.4985  21 238  1739  5  1 201  4  0  0
0  0  0  0  0  2 25 25 25 24 23 21 19 16 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      2  544691.  4087833. 36.9373 116.4981  25 259  1750  5  1 201  4  0  0
0  0  0  0  0  3 29 28 27 26 25 22 19 17 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      3  544721.  4087833. 36.9373 116.4978  26 269  1767  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 24 20 18 17 10 10  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      4  544751.  4087833. 36.9373 116.4975  24 277  1781  5  1 201  4  0  0
0  0  0  0  0  2 25 25 26 26 25 22 18 16  9  9  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      5  544781.  4087833. 36.9373 116.4971  25 284  1794  5  1 201  4  0  0
0  0  0  0  0  2 26 26 27 26 25 23 21 17 11 11  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      6  544811.  4087833. 36.9373 116.4968  28 286  1807  5  1 201  4  0  0
0  0  0  0  0  3 29 28 24 25 24 23 20 17 14 14  2  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      7  544841.  4087833. 36.9373 116.4965  28 284  1824  5  1 201  4  0  0
0  0  0  0  0  2 25 23 15 16 15 17 15 13 11 11  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      8  544871.  4087833. 36.9373 116.4961  24 277  1838  5  1 201  4  0  0
0  0  0  0  0  2 23 20  2  5  6  6  6  5  8  9  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      9  544901.  4087833. 36.9373 116.4958  16 241  1851  5  1 201  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
```

```
      10  544931.  4087833. 36.9373 116.4955  13 169  1854  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      11  544961.  4087833. 36.9373 116.4951  21 127  1846  5  1 202  4  0  0
0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  2  1  0  1  1  1  2  1 14 12
0  0  0  0  0  0  0  0
      12  544991.  4087833. 36.9373 116.4948  20 128  1836  5  1 202  4  0  0
0  0  0  0  0  0  8  7  1  1  0  0  0  0  0  2  4  4  4  4  7  9  9 18 15
0  0  0  0  0  0  0  0
      13  545021.  4087833. 36.9373 116.4944  16 166  1829  5  1 202  4  0  0
0  0  0  0  0  1 14 13  8  3  1  0  0  0  0  2  5  6  6  6  7  8 11 15 13
0  0  0  0  0  0  0  0
      14  545051.  4087833. 36.9373 116.4941  19 220  1833  5  1 202  4  0  0
0  0  0  0  0  2 18 16  8  6  2  1  0  0  0  0  3  4  4  3  3  3  3  9  7
0  0  0  0  0  0  0  0
      15  545081.  4087833. 36.9373 116.4938  22 232  1843  5  1 201  4  0  0
0  0  0  0  0  1 16 14  3  2  0  0  0  0  0  0  0  1  2  1  1  1  1  4  3
0  0  0  0  0  0  0  0
      16  545111.  4087833. 36.9373 116.4934  20 224  1852  5  1 201  4  0  0
0  0  0  0  0  1 11  9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      17  545141.  4087833. 36.9373 116.4931  20 204  1858  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      18  545171.  4087833. 36.9373 116.4928  21 188  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      19  545201.  4087833. 36.9373 116.4924  23 178  1862  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0
      20  545231.  4087833. 36.9373 116.4921  23 162  1861  5  1 201  4  0  0
0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0
0  0  0  0  0  0  0  0
```

- **Example listing of the output file SOILMAP6.INP (only the first 20 lines of the file are listed). The modified output consists of the addition of a new column consisting of the estimated soil thickness, in meters (column 11).**

```
       1 544661. 4087833. 36.9373 116.4985  21 238  1739  5  1  0.26 201  4
0  0  0  0  0  0  0  2 25 25 25 24 23 21 19 16 11 11  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
       2 544691. 4087833. 36.9373 116.4981  25 259  1750  5  1  0.20 201  4
0  0  0  0  0  0  0  3 29 28 27 26 25 22 19 17 11 11  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
       3 544721. 4087833. 36.9373 116.4978  26 269  1767  5  1  0.19 201  4
0  0  0  0  0  0  0  2 25 25 26 26 24 20 18 17 10 10  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
       4 544751. 4087833. 36.9373 116.4975  24 277  1781  5  1  0.22 201  4
0  0  0  0  0  0  0  2 25 25 26 26 25 22 18 16  9  9  2  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
       5 544781. 4087833. 36.9373 116.4971  25 284  1794  5  1  0.20 201  4
0  0  0  0  0  0  0  2 26 26 27 26 25 23 21 17 11 11  2  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
       6 544811. 4087833. 36.9373 116.4968  28 286  1807  5  1  0.17 201  4
0  0  0  0  0  0  0  3 29 28 24 25 24 23 20 17 14 14  2  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
       7 544841. 4087833. 36.9373 116.4965  28 284  1824  5  1  0.17 201  4
0  0  0  0  0  0  0  2 25 23 15 16 15 17 15 13 11 11  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
```

```
       8 544871. 4087833. 36.9373 116.4961  24 277  1838  5  1  0.22 201  4
0  0  0  0  0  0  0  2 23 20  2  5  6  6  6  5  8  9  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
       9 544901. 4087833. 36.9373 116.4958  16 241  1851  5  1  0.32 201  4
0  0  0  0  0  0  0  0  5  4  0  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      10 544931. 4087833. 36.9373 116.4955  13 169  1854  5  1  0.36 202  4
0  0  0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      11 544961. 4087833. 36.9373 116.4951  21 127  1846  5  1  0.26 202  4
0  0  0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  2  1  0  1  1  1  2  1
14 12  0  0  0  0  0  0  0  0
      12 544991. 4087833. 36.9373 116.4948  20 128  1836  5  1  0.27 202  4
0  0  0  0  0  0  0  0  8  7  1  1  0  0  0  0  0  0  2  4  4  4  4  7  9  9
18 15  0  0  0  0  0  0  0  0
      13 545021. 4087833. 36.9373 116.4944  16 166  1829  5  1  0.32 202  4
0  0  0  0  0  0  0  1 14 13  8  3  1  0  0  0  0  0  2  5  6  6  6  7  8 11
15 13  0  0  0  0  0  0  0  0
      14 545051. 4087833. 36.9373 116.4941  19 220  1833  5  1  0.28 202  4
0  0  0  0  0  0  0  2 18 16  8  6  2  1  0  0  0  0  0  3  4  4  3  3  3  3
9  7  0  0  0  0  0  0  0  0
      15 545081. 4087833. 36.9373 116.4938  22 232  1843  5  1  0.24 201  4
0  0  0  0  0  0  0  1 16 14  3  2  0  0  0  0  0  0  0  0  1  2  1  1  1  1
4  3  0  0  0  0  0  0  0  0
      16 545111. 4087833. 36.9373 116.4934  20 224  1852  5  1  0.27 201  4
0  0  0  0  0  0  0  1 11  9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      17 545141. 4087833. 36.9373 116.4931  20 204  1858  5  1  0.27 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      18 545171. 4087833. 36.9373 116.4928  21 188  1861  5  1  0.26 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      19 545201. 4087833. 36.9373 116.4924  23 178  1862  5  1  0.23 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      20 545231. 4087833. 36.9373 116.4921  23 162  1861  5  1  0.23 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
1  0  0  0  0  0  0  0  0  0
```

- **Figures used as part of the routine test plan:**

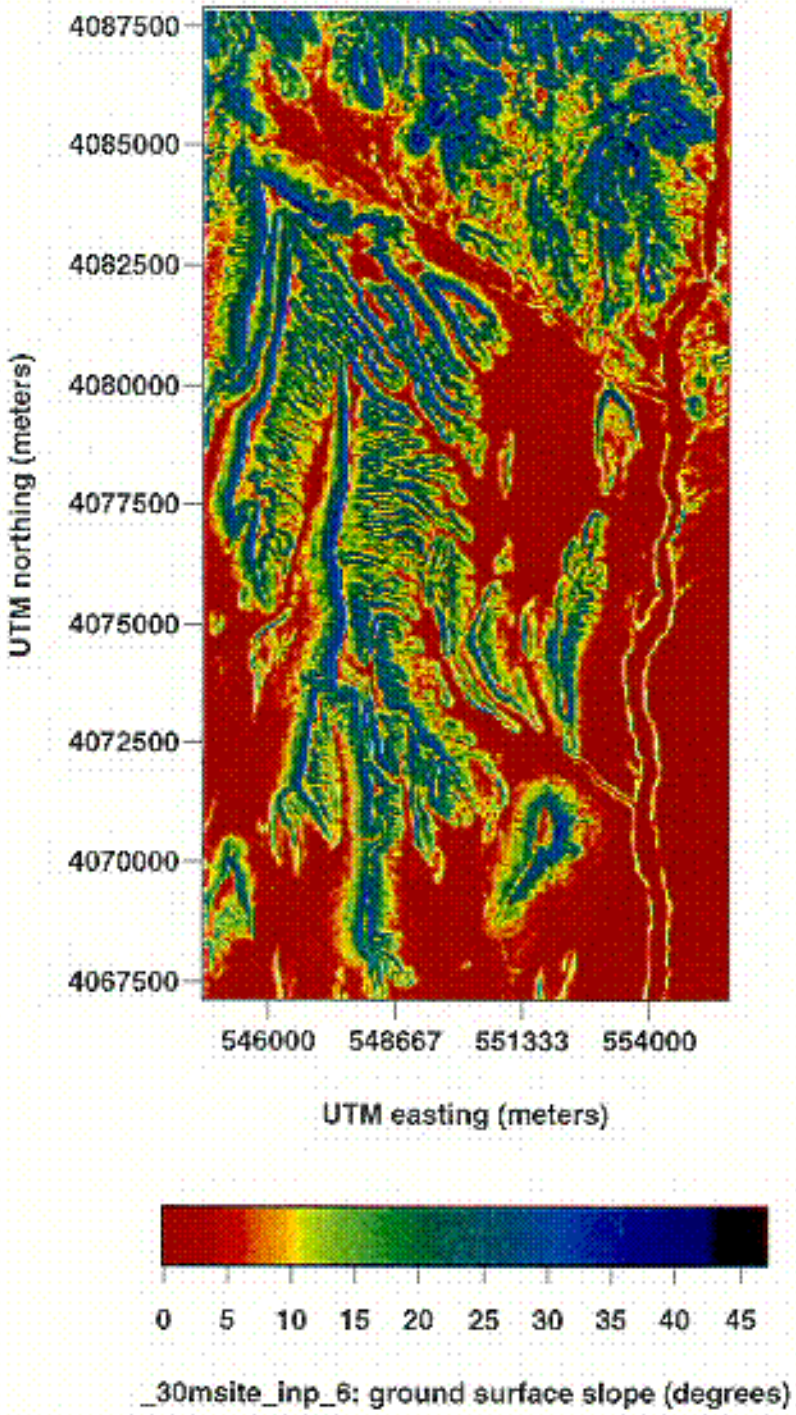

Figure IX-1. TRANSFORM map image (file 30MSLOPE.HDF) created using the input parameter ground surface slope from column 6 of the input file GEOMOD4.INP.

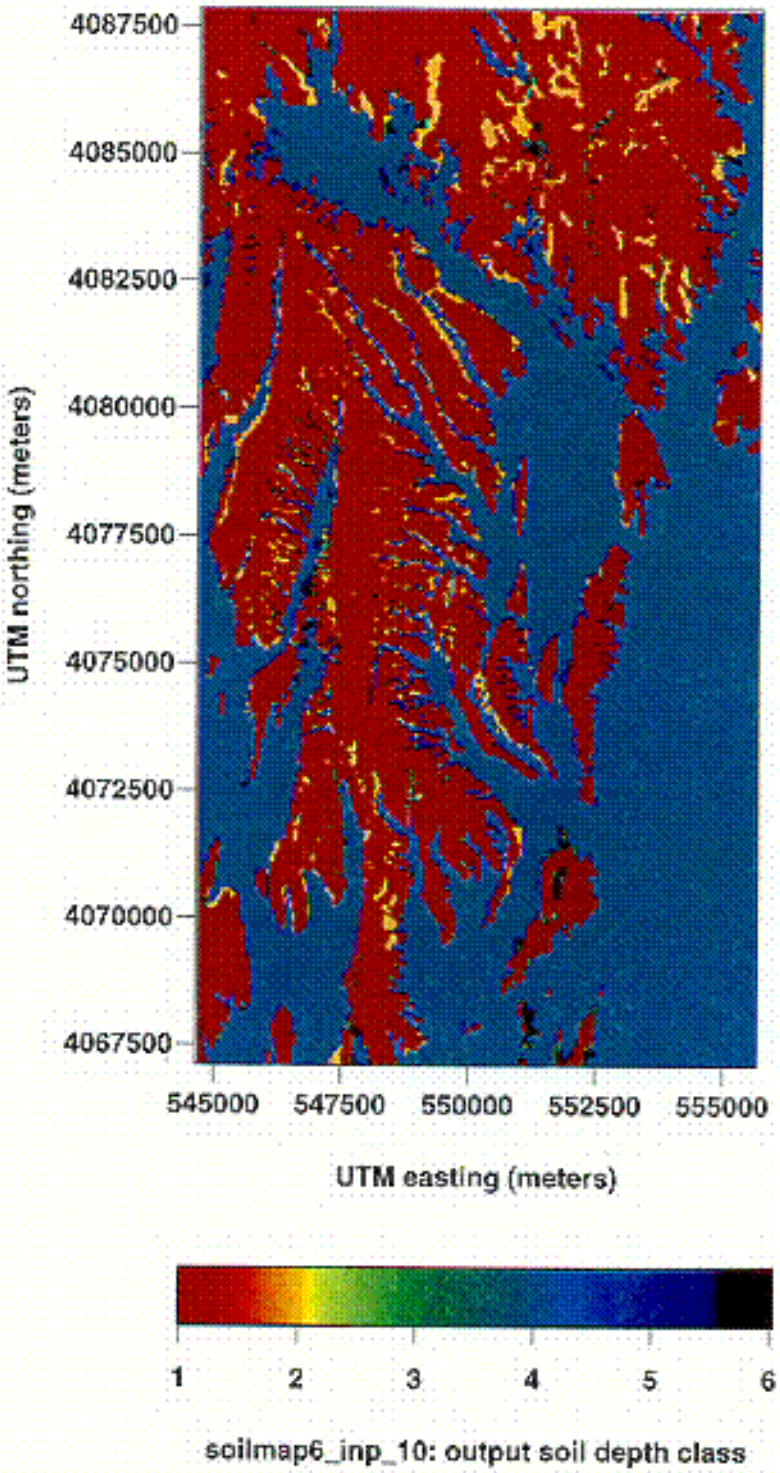

Figure IX-2. TRANSFORM map image (file SOILM6DC.HDF) of the finalized soil depth class obtained from column 10 of the output file SOILMAP6.INP, showing integer values ranging from 1 to 6.

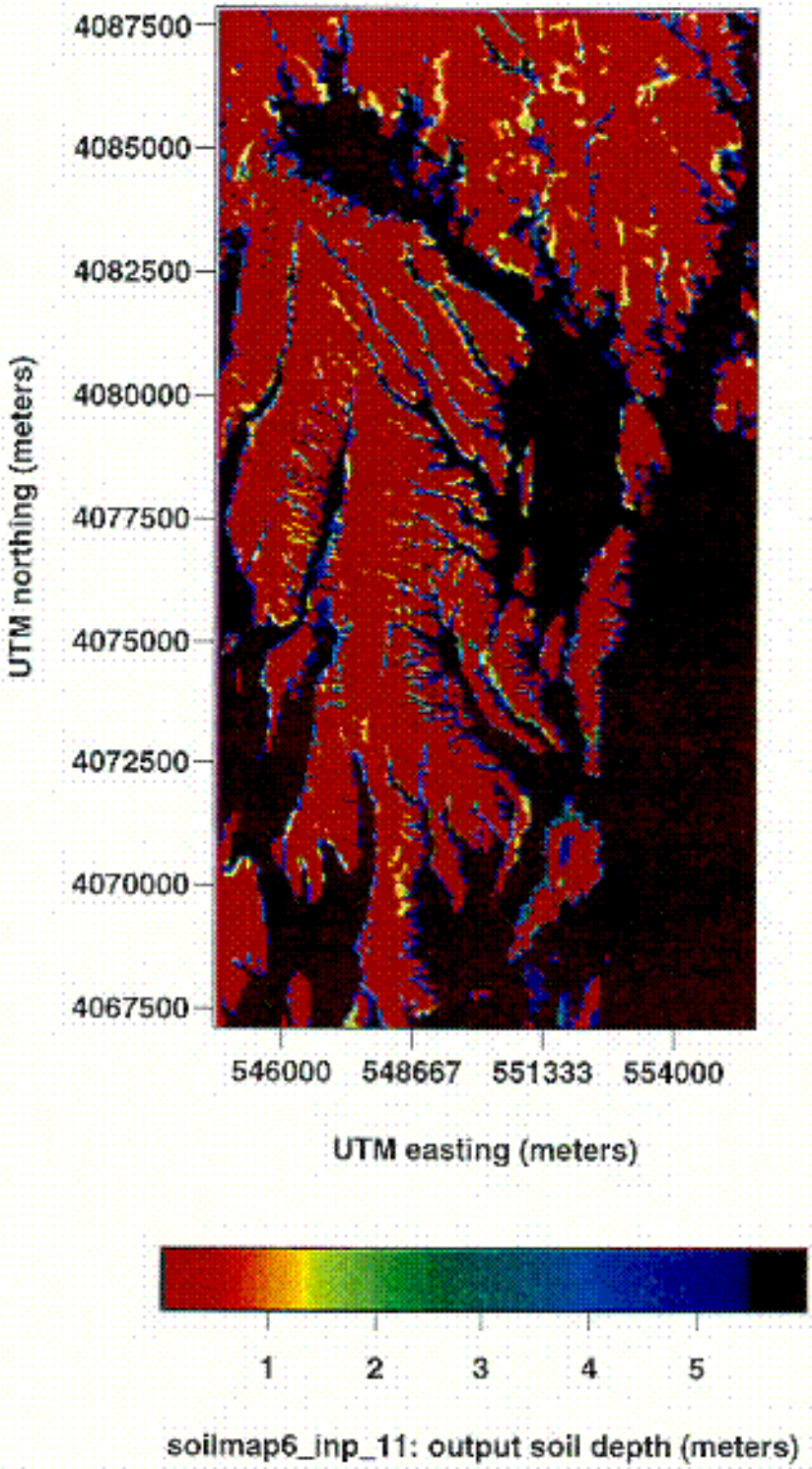

Figure IX-3. TRANSFORM map image (file SOILMP61.HDF) created using the estimated soil thickness from column 11 of the output file SOILMAP6.INP, showing the full range of estimated soil thickness of 0.01 to 6 meters (a soil thickness of 6 meters represents locations where actual soil thickness is 6 meters and greater).

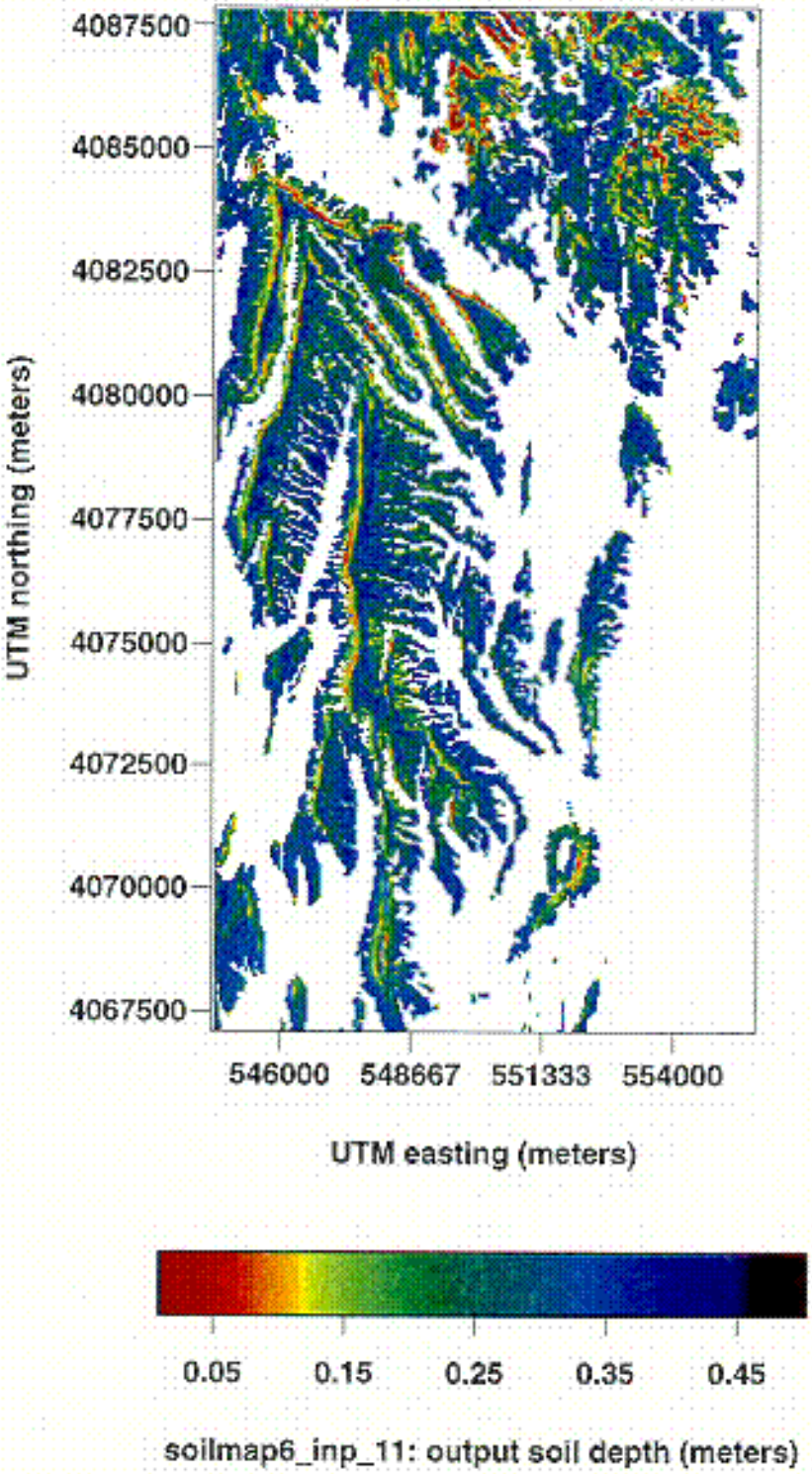

Figure IX-4. TRANSFORM map image (file SOILMP62.HDF) created using the estimated soil thickness from column 11 of the output file SOILMAP6.INP, showing estimated soil thickness for locations with thin soils.

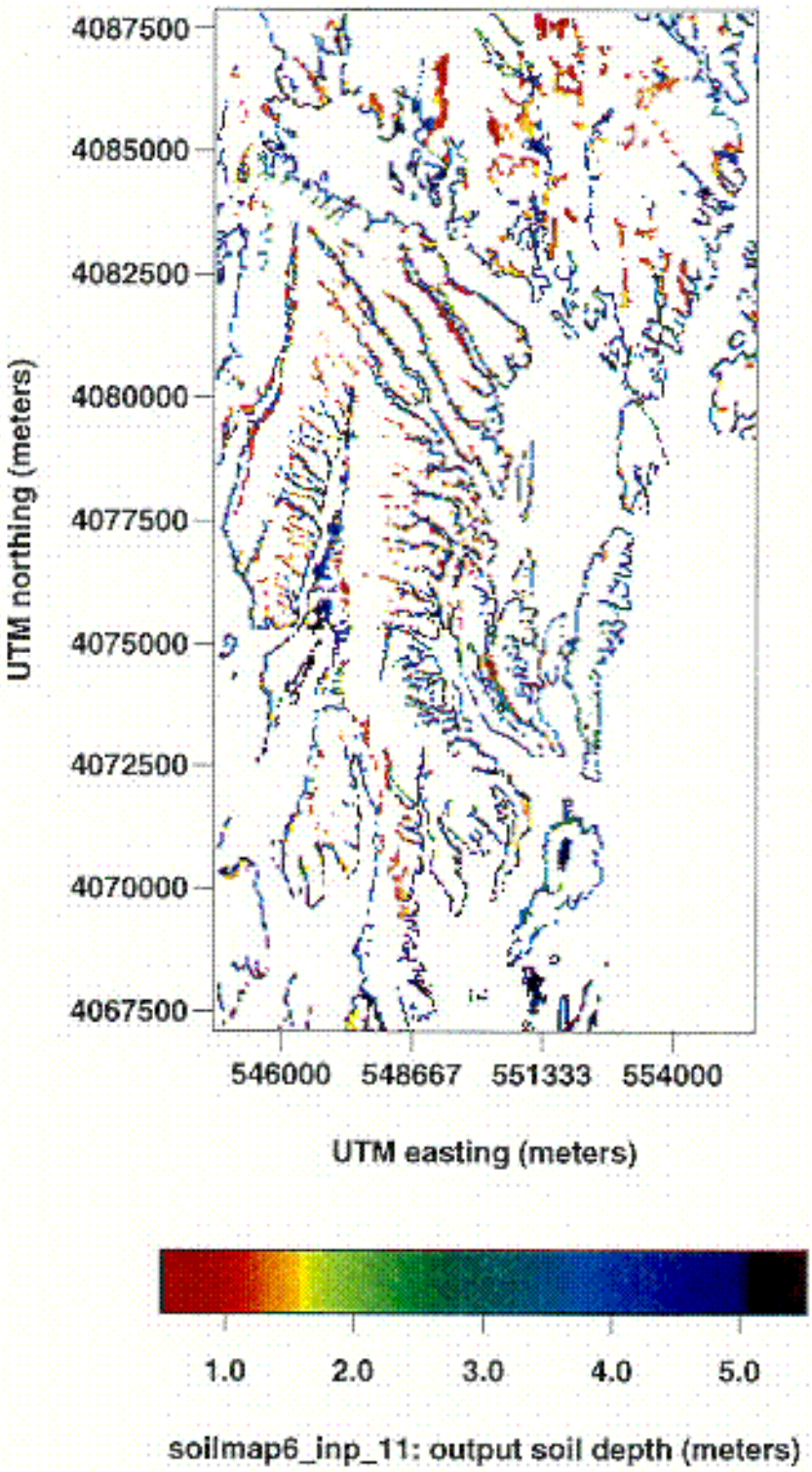

Figure IX-5. TRANSFORM map image (file SOILMP63.HDF) created using the estimated soil thickness from column 11 of the output file SOILMAP6.INP, showing estimated soil thickness for locations with intermediate soil thickness.

C13

- **Tables used as part of the routine test plan:**

Table IX-1. Soil depth classes obtained from column 10 of the input file GEOMOD4.INP, showing integer values ranging from 1 to 6 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	5	5	4	4	5	2	1	1
4079673	2	5	5	4	5	2	1	1
4079643	1	2	5	5	5	2	1	1
4079613	1	1	2	5	5	1	1	1
4079583	1	1	2	5	5	1	1	1
4079553	1	1	2	5	3	1	1	1
4079523	1	1	3	5	3	1	1	1
4079493	1	1	3	5	1	1	1	1
4079463	1	1	5	3	1	1	1	1
4079433	1	3	5	3	1	1	1	1
4079403	1	3	5	3	1	1	1	1
4079373	3	3	5	3	1	1	1	1
4079343	3	5	5	3	1	1	3	3
4079313	5	5	5	6	3	3	3	3
4079283	5	4	5	6	6	6	3	1
4079253	4	4	5	6	6	6	6	3
4079223	4	4	5	6	6	3	3	3
4079193	4	4	5	6	3	1	1	1
4079163	4	4	5	6	3	1	1	1
4079133	4	4	5	3	1	1	1	1
4079103	4	5	5	1	1	1	1	1
4079073	4	5	3	3	1	1	1	1
4079043	4	5	3	3	1	1	1	1
4079013	4	5	1	1	1	1	1	1
4078983	4	5	1	1	1	1	1	1
4078953	4	5	1	1	1	1	1	1
4078923	4	5	2	1	1	1	1	1
4078893	4	5	1	1	1	1	1	1
4078863	4	5	2	1	1	1	1	1
4078833	4	5	2	1	1	1	1	1
4078803	4	5	2	2	1	1	1	1
4078773	4	5	2	2	1	1	1	1
4078743	5	5	2	1	1	1	1	1

Table IX-2. Rock-type numbers obtained from column 11 of the input file GEOMOD4.INP, showing integer values ranging from 16 to 325 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	319	19	301	301	30	31	320	319
4079673	19	19	19	301	31	31	320	319
4079643	314	19	19	18	31	31	320	319
4079613	314	314	18	18	31	321	320	320
4079583	314	314	17	18	321	321	320	320
4079553	314	314	17	17	313	321	321	320
4079523	314	314	17	17	313	321	320	320
4079493	314	314	17	17	313	321	320	320
4079463	314	314	314	313	313	321	320	320
4079433	314	17	314	313	320	321	320	320
4079403	314	17	17	313	320	321	320	320
4079373	17	17	17	313	320	321	320	320
4079343	17	17	17	313	320	321	321	320
4079313	314	17	313	313	320	321	321	320
4079283	17	301	313	313	320	321	321	320
4079253	301	301	313	313	320	321	321	324
4079223	301	301	313	313	320	321	321	324
4079193	301	301	313	313	320	321	321	324
4079163	301	301	313	313	319	321	321	324
4079133	301	301	313	313	314	319	321	324
4079103	301	313	313	313	314	319	319	324
4079073	301	313	313	313	314	319	319	324
4079043	301	313	313	313	314	319	319	324
4079013	301	313	313	313	314	319	319	325
4078983	301	313	313	313	314	314	319	325
4078953	301	313	313	314	314	313	323	325
4078923	301	313	16	314	313	311	323	325
4078893	301	16	313	314	314	313	325	325
4078863	301	313	30	314	314	314	325	324
4078833	301	30	30	314	314	314	325	324
4078803	301	30	30	28	315	315	325	324
4078773	302	30	30	28	315	319	325	324
4078743	30	30	30	314	314	319	325	324

Table IX-3. Finalized soil depth classes generated by SOILMAP6 and included in column 10 of the output file SOILMAP6.INP, showing values ranging from 1 to 6 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	5	5	4	4	5	2	1	1
4079673	2	5	5	4	5	2	1	1
4079643	1	2	5	5	5	2	1	1
4079613	1	1	2	5	5	1	1	1
4079583	1	1	2	5	5	1	1	1
4079553	1	1	2	5	3	1	1	1
4079523	1	1	3	5	3	1	1	1
4079493	1	1	3	5	1	1	1	1
4079463	1	1	5	3	1	1	1	1
4079433	1	3	5	3	1	1	1	1
4079403	1	3	5	3	1	1	1	1
4079373	3	3	5	3	1	1	1	1
4079343	3	5	5	3	1	1	3	3
4079313	5	5	5	6	3	3	3	3
4079283	5	4	5	6	6	6	3	1
4079253	4	4	5	6	6	6	6	3
4079223	4	4	5	6	6	3	3	3
4079193	4	4	5	6	3	1	1	1
4079163	4	4	5	6	3	1	1	1
4079133	4	4	5	3	1	1	1	1
4079103	4	5	5	1	1	1	1	1
4079073	4	5	3	3	1	1	1	1
4079043	4	5	3	3	1	1	1	1
4079013	4	5	1	1	1	1	1	1
4078983	4	5	1	1	1	1	1	1
4078953	4	5	1	1	1	1	1	1
4078923	4	5	2	1	1	1	1	1
4078893	4	5	1	1	1	1	1	1
4078863	4	5	2	1	1	1	1	1
4078833	4	5	2	1	1	1	1	1
4078803	4	5	2	2	1	1	1	1
4078773	4	5	2	2	1	1	1	1
4078743	5	5	2	1	1	1	1	1

Table IX-4. Calculated ground surface slope obtained from column 6 of the input file GEOMOD4.INP, showing values ranging from 1 to 345 for a subset of grid cells located in upper Solitario Canyon.

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	10	4	4	4	6	12	17	20
4079673	15	7	3	5	6	13	19	21
4079643	16	10	5	5	7	13	19	22
4079613	14	11	7	4	5	13	18	22
4079583	14	11	7	4	4	12	17	21
4079553	14	11	7	4	5	11	16	19
4079523	14	9	5	4	6	13	17	19
4079493	13	8	4	4	7	14	17	19
4079463	11	6	3	3	8	14	17	19
4079433	9	5	3	4	9	14	16	18
4079403	7	3	2	4	10	14	15	17
4079373	6	3	3	5	10	14	15	17
4079343	5	3	4	6	9	13	15	18
4079313	4	3	4	7	9	12	15	19
4079283	3	3	5	7	10	13	16	19
4079253	3	3	5	7	10	14	16	18
4079223	3	3	5	7	10	14	17	18
4079193	3	3	5	8	10	13	16	18
4079163	2	3	5	8	11	13	15	17
4079133	2	3	5	9	12	13	14	17
4079103	3	4	6	10	12	13	14	17
4079073	3	4	8	10	12	13	14	16
4079043	3	5	9	11	12	13	14	15
4079013	3	6	10	12	12	13	14	16
4078983	4	7	10	12	12	12	14	16
4078953	4	8	12	12	12	14	15	16
4078923	5	10	13	12	13	14	14	16
4078893	5	10	13	13	13	13	14	17
4078863	5	10	13	14	14	13	14	18
4078833	6	11	13	14	14	13	14	18
4078803	7	11	13	14	14	13	14	18
4078773	8	11	13	13	13	13	14	18
4078743	8	12	14	12	12	13	14	18

Table IX-5. Soil thickness estimates obtained from column 11 of the output file SOILMAP6.INP. For the indicated subset of grid cells located in upper Solitario Canyon, the table shows estimated soil thickness ranging from 0.24 meters for grid cells in soil depth class 1 with a slope of 22 degrees to 6 meters and greater for grid cells in soil depth class 4.

UTM northing Grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547211	547241	547271	547301	547331	547361	547391	547421
4079703	4.4	5.36	6	6	5.04	1.4	0.31	0.27
4079673	1.25	4.88	5.52	6	5.04	1.35	0.28	0.26
4079643	0.32	1.5	5.2	5.2	4.88	1.35	0.28	0.24
4079613	0.35	0.39	1.65	5.36	5.2	0.36	0.3	0.24
4079583	0.35	0.39	1.65	5.36	5.36	0.37	0.31	0.26
4079553	0.35	0.39	1.65	5.36	5.2	0.39	0.32	0.28
4079523	0.35	0.37	5.2	5.36	5.04	0.36	0.31	0.28
4079493	0.36	0.34	5.36	5.36	0.31	0.35	0.31	0.28
4079463	0.39	0.28	5.52	5.52	0.34	0.35	0.31	0.28
4079433	0.37	5.2	5.52	5.36	0.37	0.35	0.32	0.3
4079403	0.31	5.52	5.68	5.36	0.4	0.35	0.34	0.31
4079373	5.04	5.52	5.52	5.2	0.4	0.35	0.34	0.31
4079343	5.2	5.52	5.36	5.04	0.37	0.36	3.6	3.12
4079313	5.36	5.52	5.36	4.88	4.56	4.08	3.6	2.96
4079283	5.52	6	5.2	4.88	4.4	3.92	3.44	0.28
4079253	6	6	5.2	4.88	4.4	3.76	3.44	3.12
4079223	6	6	5.2	4.88	4.4	3.76	3.28	3.12
4079193	6	6	5.2	4.72	4.4	0.36	0.32	0.3
4079163	6	6	5.2	4.72	4.24	0.36	0.34	0.31
4079133	6	6	5.2	4.56	0.37	0.36	0.35	0.31
4079103	6	5.36	5.04	0.4	0.37	0.36	0.35	0.31
4079073	6	5.36	4.72	4.4	0.37	0.36	0.35	0.32
4079043	6	5.2	4.56	4.24	0.37	0.36	0.35	0.34
4079013	6	5.04	0.4	0.37	0.37	0.36	0.35	0.32
4078983	6	4.88	0.4	0.37	0.37	0.37	0.35	0.32
4078953	6	4.72	0.37	0.37	0.37	0.35	0.34	0.32
4078923	6	4.4	1.35	0.37	0.36	0.35	0.35	0.32
4078893	6	4.4	0.36	0.36	0.36	0.36	0.35	0.31
4078863	6	4.4	1.35	0.35	0.35	0.36	0.35	0.3
4078833	6	4.24	1.35	0.35	0.35	0.36	0.35	0.3
4078803	6	4.24	1.35	1.3	0.35	0.36	0.35	0.3
4078773	6	4.24	1.35	1.35	0.36	0.36	0.35	0.3
4078743	4.72	4.08	1.3	0.37	0.37	0.36	0.35	0.3

- **Listing of source code for routine SOILMAP6 V1.0:**

```
      program soilmap6
c     version 1.0
c
c     Routine to estimate soil thickness (in meters)
c     using an empirical linear function based on
c     the updated soil depth class parameter and the
c     the calculated ground surface slope obtained from
c     from the input file GEOMOD4.INP.
c
c     This is the fourth routine in a sequence of pre-processing
c     routines used to develop the geospatial input files used
c     for the net infiltration modeling program, INFIL version 2.0.
c
c     SOILMAP6 performs two functions:
c     The first function is a final adjustment of the soil depth
c     class parameters defined by GEOMOD4 based on a check for
c     the occurrence of inconsistencies between the updated soil
c     depth class parameters and the updated rock-type parameters.
c     A final set of depth class parameters is created to flag
c     specific combinations of soil depth class and rock-types,
c     and the modified depth class parameters are included in the
c     output file SOILMAP6.INP.
c
c     The second function consists of an estimation of
c     soil thickness (in meters) based on the finalized depth class
c     parameters and the calculated ground surface slope. The estimates
c     are obtained using a simple empirical linear function
c     specific to each depth class.
c
c     The input and output files are column-formatted
c     ASCII text files consisting of 253,597 rows (for
c      253,597 grid cell locations). The input file consists
c     of 48 columns where each column corresponds to a specific geospatial
c     parameter according to the following order:
c
c     column 1:   LOCID (grid location number)
c     column 2:   X2 (UTM easting coordinate, in meters)
c     column 3:   Y2 (UTM northing coordinate, in meters)
c     column 4:   LAT (latitude for X coordinate, in decimal degrees)
c     column 5:   LON (longitude for Y coordinate, in decimal degress)
c     column 6:   SL (ground surface slope, in degress)
c     column 7:   ASP (ground surface aspect, in degrees)
c     column 8:   ELEV (ground surface elevation, in meters)
c     column 9:   SOILTYPE (soil type identification number)
c     column 10:  DEPTHCLASS (soil depth class identification number)
c     column 11:  ROCKTYPE (rock type identification number)
c     column 12:  TOPOID (topographic position identification number)
c     column 13:  RIDGE(1) (1st blocking ridge angle)
c     "                  "
c     "                  "
c     column 48   RIDGE(36) (last blocking ridge angle)
c
c
c     The output file consists of an additional column following
c     the depth class parameter (column 10) and consists of the estimated
c     soil thickness, in meters.
c
c     This routine was written by
c     Joe Hevesi, U.S. Geological Survey, WRD
c     Placer Hall, 6000 J Street
```

```
c     Sacramento, CA,
c
c-----------------------------------------------------------------------72
c
      integer n,geol,rocktype,soiltype,depthclass,topoid
      integer sl,asp,elev
      integer iopt
      double precision x1,x2,y1,y2
      real lat,lon,depth
      integer ridge(40)

      character*20 inpfile,newsoil,outfile
      character*80 header
      character*10,legend

5     format(A)
      open(unit=7,file='soilmap6.ctl')
      read(7,5) header
      read(7,5) inpfile
      read(7,5) newsoil
      read(7,5) outfile
c
      open(unit=9,file=inpfile)
      open(unit=10,file=newsoil)
      open(unit=11,file=outfile)
c
c
      n2 = 1
200   read(9,*,END=900) locid,x2,y2,lat,lon,
      1     sl,asp,elev,SOILTYPE,depthclass,ROCKTYPE,
      2     topoid,(ridge(j), j=1,36)
c
      depth = -.99
c
c---- depthclass 1 = shallow upland sopils
      if(depthclass.eq.1) then
c
c----- if shallow soil overlies alluvium or colluvium,
c      change to depthclass 6 and flag using -
c
       if((rocktype.eq.0).or.
      2          (rocktype.eq.1).or.
      3          (rocktype.eq.204).or.
      4          (rocktype.eq.301).or.
      5          (rocktype.eq.302)) then
c
           depthclass = -1
           depth = 6
c
           write(11,215) x2,y2,soiltype,rocktype,depthclass,
      1                  sl,depth
215        format(1x,f10.1,f11.1,3i5,1x,i5,f8.4)
c
       else
c
c----- use new slope model for upland soil (depthclass 1)
c
           if(sl.le.10) depth = 0.03*sl+0.1
           if(sl.gt.10) depth = 0.013*(10-sl)+0.4
           if(sl.gt.40) depth = 0.01
           write(11,215) x2,y2,soiltype,rocktype,depthclass,
      1                  sl,depth
c
```

```
      endif
c
c---- depthclass 2 = colluvium (footslopes)
     else if(depthclass.eq.2) then
c
      if((rocktype.eq.0).or.
     2           (rocktype.eq.1).or.
     3           (rocktype.eq.204).or.
     4           (rocktype.eq.301).or.
     5           (rocktype.eq.302)) then
c
          depthclass = -2
          depth = 6
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      else
          depth = 0.4
          if(sl.le.32) depth = 2-(.05*sl)
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
      endif
c
c---- depthclass 3 = initial buffer zone
     else if(depthclass.eq.3) then
c
      if((rocktype.eq.0).or.
     2           (rocktype.eq.1).or.
     3           (rocktype.eq.204).or.
     4           (rocktype.eq.301).or.
     5           (rocktype.eq.302)) then
c
          depthclass = -3
          depth = 6
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      else
          depth = 2.0
          if(sl.le.25) depth = 6-(0.16*sl)
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      endif
c
c
c---- depthclass 5 = 2nd buffer zone
     else if(depthclass.eq.5) then
c
      if((rocktype.eq.0).or.
     2           (rocktype.eq.1).or.
     3           (rocktype.eq.204).or.
     4           (rocktype.eq.301).or.
     5           (rocktype.eq.302)) then
c
          depthclass = -5
          depth = 6
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      else
          depth = 2.0
          if(sl.le.25) depth = 6-(0.16*sl)
```

```
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      endif
c
c
c---- depthclass 6 = bedrock geology within buffer zone
     else if(depthclass.eq.6) then
c
      if((rocktype.eq.0).or.
     2           (rocktype.eq.1).or.
     3           (rocktype.eq.204).or.
     4           (rocktype.eq.301).or.
     5           (rocktype.eq.302)) then
c
          depthclass = -6
          depth = 6
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      else
          depth = 2.0
          if(sl.le.25) depth = 6-(0.16*sl)
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      endif
c
c
c---- depthclass 4 = deep alluvium
     else if(depthclass.eq.4) then

      if((rocktype.ne.0).and.
     1    (rocktype.ne.1).and.
     2    (rocktype.ne.204).and.
     3    (rocktype.ne.301).and.
     4    (rocktype.ne.302)) then
          depthclass = -4
          depth = 2.0
          if(sl.le.25) depth = 6-(0.16*sl)
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      else
          depth = 6
          write(11,215) x2,y2,soiltype,rocktype,depthclass,
     1                  sl,depth
c
      endif
c
     endif
c
c
      write(10,205) locid,x2,y2,lat,lon,sl,asp,elev,
     1    soiltype,depthclass,depth,rocktype,topoid,
     2   (ridge(j), j=1,36)
205   format(i7,f8.0,f9.0,f8.4,f9.4,i4,i4,i6,i3,i3,f6.2,i4,i3,
     1                        36i3)
c
     if(n2.eq.1000) then
      write(*,*) locid
      n2 = 0
     endif
```

```
c
      n2 = n2 + 1
      goto 200
c
900   continue
      close(10)
      close(11)
      stop
      end
```

ATTACHMENT X

DEVELOPMENT OF FLOW ROUTING PARAMETERS USING SORTGRD1 V1.0

TOTAL PAGES: 19

Development of Flow Routing Parameters using SORTGRD1 V1.0

1. Name of routine/macro with version/OS/hardware environment and user information:

Name of software routine: SORTGRD1 V1.0
OS and hardware environment: Windows NT 4.0, Pentium Pro PC
Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129
Computer Identification: SM321276 with a USGS specific hostname P720dcasr

2. Name of commercial software with version/OS/hardware used to develop routine/macro:

The source code for SORTGRD1 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. General Description of routine/macro:

SORTGRD1 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (SORTGRD1.FOR), compiled executable file (SORTGRD1.EXE), routine control file (SORTGRD1.CTL), input and output files, validation test files, and a copy of this attachment, are located under the directory SORTGRD1 on a CD-ROM labeled GEOINPUT-2. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing or spreadsheet applications such as Microsoft WORD and EXCEL. The executable file can be used to run SORTGRD1 V1.0 on any PC with an INTEL processor (with adequate RAM).

All input parameters used by SORTGRD1 V1.0 and the parameters calculated by SORTGRD1 that are included in the developed output file, 30MGRD01.SR1, are used for the development of the geospatial parameter input file for INFIL V2.0. The file 30MGRD01.SR1 is used directly as input to the routines CHNNET16 V1.0 and VEGCOV01 V1.0.

4. Test plan for the software routine SORTGRD1 V1.0:

- **Explain whether this is a routine or macro and describe what it does:**

SORTGRD1 V1.0 is the fifth routine applied in a sequence of FORTRAN 77 routines that are used in the development of the geospatial parameter input file for INFIL V2.0. The routine's primary function is an application of a basic bubble-sort algorithm to perform an ascending sort (highest values at the top of the list, lowest values at the bottom) of the ground surface elevation values included in the developed geospatial parameter input file SOILMAP6.INP (which is the output file from SOILMAP6 V1.0). The pre-processing

application performed by SORTGRD1 V1.0 is the initial phase of the pre-processing applications required to develop surface water flow routing parameters and to extract watershed modeling domains from the geospatial parameter base grid. The output file created by SORTGRD1 V1.0 is 30MGRD01.SR1, which is supplied directly as input to the routines CHNNET16 V1.0 and VEGCOV01 V1.0.

The sorting function performed by SORTGRD1 V1.0 moves the entire row of the input file SOILMAP6.INP during the sorting process. Thus, the sorting performs a shuffling of the input deck, one row at a time, until the row or grid cell sequence of the entire input deck has been re-organized based on the ascending order of elevation values. Because the entire line is moved as a unit during the re-ordering, the raster-based grid geometry defined by the UTM coordinates for each grid cell is maintained for all geospatial parameters, with the exception of the grid cell number. SORTGRD1 modifies the grid cell number according to the results of the sorting. The new grid cell number is the new row sequence number (the grid cell number for the top row is 1 and the grid cell number for the bottom row is 253,597).

A second function performed by SORTGRD1 is the addition of the raster-grid row and column indices to the output file. These are created by SORTGRD1 using the UTM grid cell easting and northing coordinates obtained from the input file SOILMAP6.INP. The row and column indices are used by CHNNET16 V1.0 and by INFIL V2.0 to increase the efficiency of the flow routing algorithm.

A third function performed by SORTGRD1 V1.0 is the re-positioning of the column sequence and the addition of two columns to the output file that identify the column position for the vegetation parameters using a place holder value of –99.

- **Listing of FORTRAN77 Source code:**

A listing of the FORTRAN77 source code for the routine SORTGRD1 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

To test that the first function performed by the routine is working properly, a selection of the input and output from the routine is printed out and visually inspected. The selection of the input printout is in Table X-1; and the output printout is in Table X-2. The test involves determining whether the sequence of rows in the output file is sorted correctly according to a descending sequence of elevations. To satisfy the test criteria, the highest elevation value from the input file must be in the first row of the output file and the lowest elevation value from the input file must be in the last row of the output file.

To test the second function of generating row and column grid cell indices, map images of the row and column indices included in the output file (columns 6 and 7) are created in TRANSFORM and visually inspected. To satisfy the test criteria, the map image of the row index must show a north-south linear increase of row indices from 1 to 691, and the map

image of the column index must show a west-east linear increase of column indices from 1 to 367.

To test the third function performed by the SORTGRD1 V1.0, the format and column ordering of the output files is visually inspected. To satisfy the test criteria, the output file must consist of 253,597 rows and 53 columns. The modified grid cell number must be in column 1, the new row and column indices must be in columns 6 and 7, and the slope and aspect parameters must be re-positioned to columns 9 and 10. The –99 place holder values for the vegetation parameters must be in columns 16 and 17.

- **Specify the range of input values to be used and why the range is valid:**

SOILMAP6.INP is the input file used by SORTGRD1 V1.0. The file is specified in the file SORTGRD1.CTL, which is the routine control file for SORTGRD1 and is required for program execution. SOILMAP6.INP is a column-formatted ASCII file consisting of 253,597 rows and 49 columns (see Attachment IX). The parameters provided by SOILMAP6.INP and used or modified by SORTGRD1 are elevation (values are in meters, from 918 to 1969), UTM easting coordinate (from 544,661 to 555,641 meters), UTM northing coordinate values (4,067,133 to 4,087,833 meters), and the grid cell number (integers from 1 to 253,597).

5. **Test Results.**
   - **Output from test:**

The output for the test case is the main output file 30MGRD01.SR1 generated by SORTGRD1. The output file is used to generate raster-format map image files in TRANSFORM which are used only as a part of the validation test plan (the map image files are not required as part of the pre-processing procedure for developing the input used by INFIL V2.0).

- **Description of how the testing shows that the results are correct for the specified input:**

A comparison of the input and output files shows the unsorted row-sequence of elevation values in the input file (Table X-1) and the sorted (descending order) row-sequence of elevation values in the output file (Table X-2). The printout of the first 20 lines of the output file shows the first line of the file has the highest elevation and the last line of the file has the lowest elevation (see file printouts for SOILMAP6.INP and 30MGRD01.SR1 provided under section 6 as supporting information). These results indicate that the test criteria for the first function are satisfied.

The TRANSFORM map image of the row index (Figure X-1) obtained from the output file indicates the correct north-to-south linearly increasing row sequence of 1 to 691. The TRANSFORM map image of the column index (Figure X-2) obtained from the output file indicates the correct west-to-east linearly increasing column sequence of 1 to 367.). These results indicate that the test criteria for the second function are satisfied.

Visual inspection of the input and output files (see printouts in section 6) indicates that the row and column indices were correctly included as columns 6 and 7 in the output file, the –99 place holder values for the vegetation parameters were correctly added as columns 16 and 17, and the slope and aspect parameters were correctly re-positioned to columns 9 and 10. Only the intended modifications of the input parameters and input file format is observed. The output file has the correct number of lines (253,597), the correct number of columns (53), and the sequencing of columns and rows is correct. These results indicate that the test criteria for the third function are satisfied.

- **List limitations or assumptions to this test case and code in general:**

The limitations of the developed test case are based on the practical limitations of verifying modified parameter values for all 253, 597 grid cells included in the output file used for the developed test case. Validation of the entire output file used in the test case was performed as a visual evaluation of raster-based map images produced in TRANSFORM. Only a subset of the entire output file could be used for more detailed validation tests that included a manual check of the equations used by the routine.

- **Electronic files identified by name and location:**

Electronic files are located on CD-ROM labeled GEOINPUT-2, under the directory SORTGRD1, included as an attachment to the AMR. The following electronic files are provided:

SORTGRD1.CTL:	Input file consisting of the input and output file names for SORTGRD1 V1.0.
SORTGRD1.FOR:	FORTRAN source code listing for the routine SORTGRD1 V1.0. A printout of the source code is included as part of this attachment.
SORTGRD1.EXE:	Executable file for the routine SORTGRD1 V1.0, compiled for INTEL processors.
SOILMAP6.INP:	Input file consisting of a column-formatted, ASCII text file with 253,597 rows and 49 columns. This file was developed as the output file from SOILMAP6 V1.0 (see Attachment IX). A partial printout of the first part of this file is included as part of this attachment.

30MGRD01.SR1: Output file consisting of a column-formatted, ASCII text file with 253,597 rows and 53 columns. Each row corresponds to a grid cell location for the geospatial parameter base grid (the UTM location coordinates are defined by columns 2 and 3). Columns 6 and 7 are the row and column grid cell indices added by SORTGRD1 and used as input for CHNNET16 V1.0 (see Attachment XI). Columns 9 and 10 are place holder values added by SORTGRD1 for two vegetation parameters (all values are –99). A partial printout of the first part of this file is included as part of this attachment.

SRT-ROW.HDF: TRANSFORM map image of the row index (**Figure X-1**). This file is used only as supporting information for the test plan.

SRT-COL.HDF: TRANSFORM map image of the column index (Figure **X**-2). This file is used only as supporting information for the test plan.

6. **Supporting Information. (Include background information, such as revision to a previous routine or macro, or explanation of the steps performed to run the software. Include listings of all electronic files and codes used).**

- **Procedure for running routine:**

To run the routine SORTGRD1 V1.0, the executable file (SORTGRD1.EXE), the routine control file (SORTGRD1.CTL), and the input file (SOILMAP6.INP) specified in the routine control file must be placed in the same directory. The routine is executed by typing SORTGRD1 in a DOS window, by double clicking on the file SORTGRD1.EXE in the Microsoft Windows operating system, or by typing in the path and filename in the RUN window of the Windows NT or Windows 98 start menu. The input and output file names must be in the correct sequential order as specified in the routine control file (see example listing below).

- **Example listing of routine control file SORTGRD1.CTL**

```
Sortgrd1.ctl            (header line)
Soilmap6.inp            (input file from routine SOILMAP6 version1.0)
30mgrd01.srl     (output file sorted from high elevation to low, generated
by sortgrd1.ctl)
```

- **Example listing of the input file SOILMAP6.INP (only the first 20 lines of the file are listed).**

```
      1 544661. 4087833. 36.9373 116.4985  21 238  1739  5  1  0.26 201  4
0  0  0  0  0  0  0  2 25 25 25 24 23 21 19 16 11 11  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      2 544691. 4087833. 36.9373 116.4981  25 259  1750  5  1  0.20 201  4
0  0  0  0  0  0  0  3 29 28 27 26 25 22 19 17 11 11  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      3 544721. 4087833. 36.9373 116.4978  26 269  1767  5  1  0.19 201  4
0  0  0  0  0  0  0  2 25 25 26 26 24 20 18 17 10 10  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
```

```
      4 544751. 4087833. 36.9373 116.4975  24 277  1781  5  1  0.22 201  4
0  0  0  0  0  0  0  2 25 25 26 26 25 22 18 16  9  9  2  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      5 544781. 4087833. 36.9373 116.4971  25 284  1794  5  1  0.20 201  4
0  0  0  0  0  0  0  2 26 26 27 26 25 23 21 17 11 11  2  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      6 544811. 4087833. 36.9373 116.4968  28 286  1807  5  1  0.17 201  4
0  0  0  0  0  0  0  3 29 28 24 25 24 23 20 17 14 14  2  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      7 544841. 4087833. 36.9373 116.4965  28 284  1824  5  1  0.17 201  4
0  0  0  0  0  0  0  2 25 23 15 16 15 17 15 13 11 11  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      8 544871. 4087833. 36.9373 116.4961  24 277  1838  5  1  0.22 201  4
0  0  0  0  0  0  0  2 23 20  2  5  6  6  6  5  8  9  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
      9 544901. 4087833. 36.9373 116.4958  16 241  1851  5  1  0.32 201  4
0  0  0  0  0  0  0  0  5  4  0  0  0  0  0  0  1  2  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0.  0
     10 544931. 4087833. 36.9373 116.4955  13 169  1854  5  1  0.36 202  4
0  0  0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
     11 544961. 4087833. 36.9373 116.4951  21 127  1846  5  1  0.26 202  4
0  0  0  0  0  0  0  0  5  4  0  0  0  0  0  0  0  0  2  1  0  1  1  1  2  1
14 12  0  0  0  0  0  0  0  0
     12 544991. 4087833. 36.9373 116.4948  20 128  1836  5  1  0.27 202  4
0  0  0  0  0  0  0  0  8  7  1  1  0  0  0  0  0  0  2  4  4  4  4  7  9  9
18 15  0  0  0  0  0  0  0  0
     13 545021. 4087833. 36.9373 116.4944  16 166  1829  5  1  0.32 202  4
0  0  0  0  0  0  0  1 14 13  8  3  1  0  0  0  0  0  2  5  6  6  6  7  8 11
15 13  0  0  0  0  0  0  0  0
     14 545051. 4087833. 36.9373 116.4941  19 220  1833  5  1  0.28 202  4
0  0  0  0  0  0  0  2 18 16  8  6  2  1  0  0  0  0  0  3  4  4  3  3  3  3
9  7  0  0  0  0  0  0  0  0
     15 545081. 4087833. 36.9373 116.4938  22 232  1843  5  1  0.24 201  4
0  0  0  0  0  0  0  1 16 14  3  2  0  0  0  0  0  0  0  0  1  2  1  1  1  1
4  3  0  0  0  0  0  0  0  0
     16 545111. 4087833. 36.9373 116.4934  20 224  1852  5  1  0.27 201  4
0  0  0  0  0  0  0  1 11  9  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
     17 545141. 4087833. 36.9373 116.4931  20 204  1858  5  1  0.27 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
     18 545171. 4087833. 36.9373 116.4928  21 188  1861  5  1  0.26 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
     19 545201. 4087833. 36.9373 116.4924  23 178  1862  5  1  0.23 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
     20 545231. 4087833. 36.9373 116.4921  23 162  1861  5  1  0.23 201  4
0  0  0  0  0  0  0  0  6  5  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
1  0  0  0  0  0  0  0  0  0
```

- **Example listing of the output file 30MGRD01.SR1 (only the first 20 lines of the file are listed). The row and column grid cell indices have been added as column 6 and 7, the slope and aspect columns have been shifted to columns 9 and 10, and place holders (values of -99) for two vegetation parameters have been added as columns 16 and 17.**

```
        1   546191.  4087833.  36.9372 116.4813    1   52  1969.  25 206   5
1   0.20 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        2   546221.  4087833.  36.9372 116.4810    1   53  1969.  28 147   5
1   0.17 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        3   546191.  4087803.  36.9370 116.4813    2   52  1959.  23 199   5
1   0.23 201   4 -99 -99  1  0  0  7  7  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 16 18
        4   546161.  4087833.  36.9372 116.4816    1   51  1955.  30 241   5
1   0.14 201   4 -99 -99  0  0  0  0  0  0  0  2 25 22  0  0  2  2  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        5   546221.  4087803.  36.9370 116.4810    2   53  1955.  28 140   5
1   0.17 201   4 -99 -99  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  7  6  0  0  8  7  0  0 22 25
        6   546191.  4087773.  36.9367 116.4813    3   52  1951.  20 188   5
1   0.27 201   4 -99 -99  1 11  4  2  2  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0 14 16
        7   546251.  4087833.  36.9372 116.4806    1   54  1950.  36 125   5
1   0.06 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  3  3  2  5  3 32 28  0  0  0  0  0  0  0  0
        8   546161.  4087803.  36.9370 116.4816    2   51  1949.  27 241   5
1   0.18 201   4 -99 -99  1  0  0 13 13  5 12  2 18 15  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
        9   549311.  4087833.  36.9371 116.4463    1  156  1944.  23 180   5
1   0.23 206   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       10   546221.  4087773.  36.9367 116.4810    3   53  1944.  28 134   5
1   0.17 201   4 -99 -99  2  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1 13 11  0  2  8  8 13  4 19 22
       11   546161.  4087773.  36.9367 116.4816    3   51  1943.  24 237   5
1   0.22 201   4 -99 -99  1 16  6 11 12  5  7  1 14 12  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
       12   546191.  4087743.  36.9364 116.4813    4   52  1942.  20 175   5
1   0.27 201   4 -99 -99 15 11  5  2  1  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  6 15 16
       13   546131.  4087833.  36.9372 116.4820    1   50  1939.  33 247   5
1   0.10 201   4 -99 -99  0  0  0  0  0  0  0  3 28 25 10 11  6  6  2  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       14   549281.  4087833.  36.9371 116.4466    1  155  1939.  26 221   5
1   0.19 206   4 -99 -99  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       15   549341.  4087833.  36.9371 116.4459    1  157  1939.  26 155   5
1   0.19 206   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0  0
       16   546251.  4087803.  36.9370 116.4806    2   54  1938.  35 124   5
1   0.08 201   4 -99 -99  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  4  4  3  8  5 29 26 12 15 16 15  0  0 18 21
       17   546161.  4087743.  36.9364 116.4816    4   51  1937.  23 229   5
1   0.23 201   4 -99 -99 17 18 16 17  9  1  3  1  9  7  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
       18   546131.  4087803.  36.9370 116.4820    2   50  1933.  33 252   5
1   0.10 201   4 -99 -99  1  0  0 15 14  9 26 20 28 25  7  9  5  5  2  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
```

```
        19   546281.  4087833.  36.9372 116.4803    1   55  1932.  34 130   5
1   0.09 201    4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  4  8 12 17 16 31 27  0  0  0  0  0  0  0  0
        20.  549371.  4087833.  36.9371 116.4456    1  158  1932.  27 153   5
1   0.18 206    4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1 13 11  0  0  0  0  0  0  0  0
```

- **Example listing of the output file 30MGRD01.SR1 (only the last 20 lines of the file are listed). The row and column grid cell indices have been added as column 6 and 7, the slope and aspect columns have been shifted to columns 9 and 10, and place holders (values of -99) for two vegetation parameters have been added as columns 16 and 17.**

```
   253578   554141.  4067223.  36.7510 116.3935  688  317   918.   0  -1   3
4   6.00 204    2 -99 -99  1  1  1  2  2  2  3  3  3  3  4  3  1  0  0  0  0
0  0  0  0  0  0  0  0  0  2  2  2  2  3  4  2  2  1  1
   253579   554141.  4067343.  36.7521 116.3935  684  317   918.   0  -1   3
4   6.00 204    2 -99 -99  1  2  2  2  3  3  3  3  3  3  3  3  3  2  0  0  0
0  0  0  0  0  0  0  2  2  3  3  2  2  3  4  2  2  1  1
   253580   553931.  4067253.  36.7513 116.3959  687  310   918.   0  48   3
4   6.00 204    2 -99 -99  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0
0  0  0  0  2  4  5  6  6  8  8  8  8  7  5  5  4  2  2
   253581   553901.  4067163.  36.7505 116.3962  690  309   918.   1  59   3
4   6.00 204    2 -99 -99  1  1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0
1  0  0  0  0  0  1  5  7  8  8  8  7  7  6  6  4  2  2
   253582   554261.  4067463.  36.7532 116.3921  680  321   918.   3 267   3
4   6.00 204    2 -99 -99  2  4  5  6  7  7  7  7  8  7  6  6  6  5  4  4  2
2  0  0  0  0  0  1  1  1  2  2  2  2  3  4  2  2  1  1
   253583   554141.  4067283.  36.7516 116.3935  686  317   918.   0  -1   3
4   6.00 204    2 -99 -99  1  1  1  2  2  2  2  3  3  3  3  3  3  1  0  0  0
0  0  0  0  0  0  0  1  2  2  2  2  2  3  4  2  2  1  1
   253584   554171.  4067283.  36.7516 116.3932  686  318   918.   0 103   3
4   6.00 204    2 -99 -99  1  1  2  2  3  3  3  3  4  3  3  3  3  2  1  0  0
0  0  0  0  0  0  0  0  2  2  2  2  2  3  4  2  2  1  1
   253585   554201.  4067283.  36.7516 116.3928  686  319   918.   1 287   3
4   6.00 204    2 -99 -99  1  2  3  3  3  3  4  4  5  4  4  4  4  3  3  1  0
0  0  0  0  0  0  0  0  1  2  2  2  2  3  4  2  2  1  1
   253586   554021.  4067193.  36.7508 116.3949  689  313   918.   0  -1   4
4   6.00 204    1 -99 -99  1  1  1  1  2  1  1  2  2  1  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1  4  3  3  4  4  4  3  2  1  1
   253587   554231.  4067283.  36.7516 116.3925  686  320   918.   3 287   4
4   6.00 204    1 -99 -99  1  2  3  3  4  5  6  7  7  7  6  6  6  5  5  4  1
1  0  0  0  0  0  0  0  1  2  2  2  2  3  4  2  2  1  1
   253588   554171.  4067343.  36.7521 116.3932  684  318   918.   0  -1   3
4   6.00 204    2 -99 -99  1  2  2  2  3  3  3  3  4  3  3  3  3  3  2  0  0
0  0  0  0  0  0  0  1  2  2  2  2  3  4  2  2  1  1
   253589   554111.  4067463.  36.7532 116.3938  680  316   918.   0  93   4
4   6.00 204    1 -99 -99  1  1  2  2  2  3  3  3  3  2  2  2  2  1  1  0  0
0  0  0  0  0  1  2  2  3  3  3  4  3  3  4  2  2  1  1
   253590   553961.  4067343.  36.7521 116.3955  684  311   918.   0  -1   3
4   6.00 204    2 -99 -99  1  1  1  1  1  2  2  1  1  1  1  1  0  0  0  0  0
0  0  0  1  3  4  5  6  6  7  7  6  6  6  5  4  4  2  2
   253591   554111.  4067373.  36.7524 116.3938  683  316   918.   0  -1   4
4   6.00 204    1 -99 -99  1  1  2  2  2  3  2  2  3  2  2  2  2  1  0  0  0
0  0  0  0  0  0  1  2  3  3  3  3  3  3  4  2  2  1  1
   253592   554051.  4067463.  36.7532 116.3945  680  314   918.   0  16   3
4   6.00 204    2 -99 -99  1  1  2  2  2  2  2  2  2  2  2  2  2  0  0  0  0
0  0  0  0  1  2  2  3  3  5  5  5  5  5  5  4  2  1  1
   253593   554081.  4067313.  36.7518 116.3942  685  315   918.   0  -1   4
4   6.00 204    1 -99 -99  1  1  1  1  2  2  2  2  2  2  2  2  2  0  0  0  0
0  0  0  0  0  0  2  2  3  3  3  3  3  3  4  2  2  1  1
```

```
   253594   553931.  4067403.  36.7527 116.3958  682  310   918.   6  65   3
4   6.00 204   2 -99 -99  1  1  1  1  1  1  2  1  1  1  1  1  0  0  0  0  0
0  0  3  4  6  7  8  9  9 12 11 10 11 10 10  8  6  4  4
   253595   553961.  4067403.  36.7527 116.3955  682  311   918.   0  -1   3
4   6.00 204   2 -99 -99  1  1  1  1  1  2  2  1  1  1  1  1  0  0  0  0  0
0  0  0  1  3  5  5  6  7  8  8  8  8  7  5  5  5  2  2
   253596   554261.  4067433.  36.7529 116.3921  681  321   918.   3 278   3
4   6.00 204   2 -99 -99  2  3  4  5  6  6  7  7  7  7  7  6  6  5  5  4  2
2  0  0  0  0  0  1  1  1  2  2  2  2  3  4  2  2  1  1
   253597   553931.  4067433.  36.7529 116.3958  681  310   918.   8  67   3
4   6.00 204   2 -99 -99  1  1  1  1  1  1  2  1  1  1  1  1  0  0  0  0  0
0  0  3  4  6  8  8  9 10 18 17 10 11 10 10  8  8  5  5
```

- **Example listing of a randomly selected row from the input file SOILMAP6.INP, used to compare against corresponding row of the output file 30MGRD01.SR1. The row number in the input file is 24404.**

```
24404 550091. 4085853. 36.9192 116.4376  26 113  1649  5  1  0.19 206  4  8
4  3  2  1  0  0  0  0  0  0  0  0  0  0  0  4  5 12 14 17 19 21 23 24 25 29
29 32 31 31 29 27 24 17 17
```

- **Example listing of the row in the output file 30MGRD01.SR1 corresponding to row 24404 of the input file, showing the modified grid cell number indicating the new row sequence number (10994) created by the elevation sort. With the exception of the modified grid cell number, the addition of the row and column indices (columns 6 and 7), the re-positioning of the slope and aspect parameters to columns 9 and 10, and the addition of the two place holder columns for the vegetation parameters (columns 16 and 17), no other modifications were performed.**

```
10994   550091.  4085853.  36.9192 116.4376   67  182  1649.  26 113   5  1
0.19 206   4 -99 -99  8  4  3  2  1  0  0  0  0  0  0  0  0  0  0  0  4  5
12 14 17 19 21 23 24 25 29 29 32 31 31 29 27 24 17 17
```

- **Figures used as part of the routine test plan:**

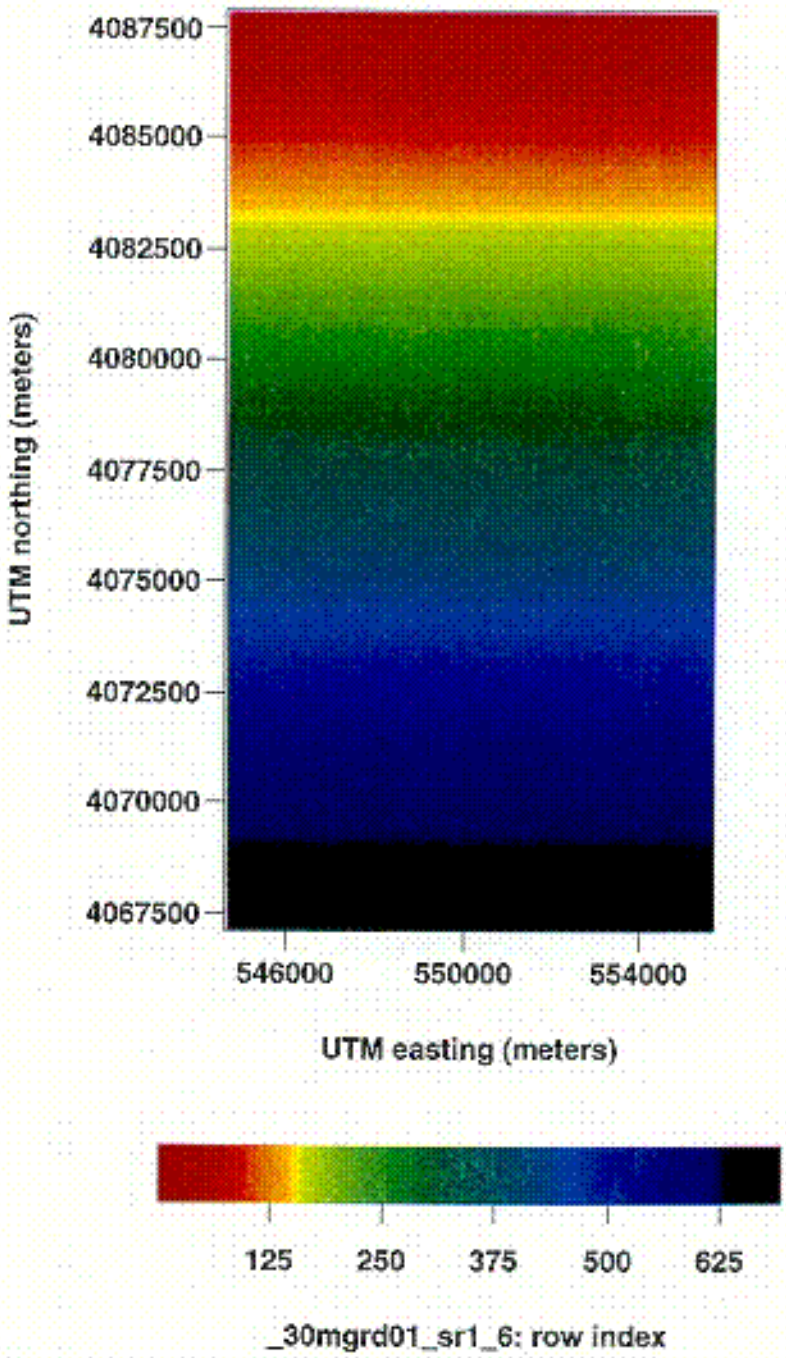

Figure X-1. TRANSFORM map image (file SRT-ROW.HDF) of the grid cell row index parameter calculated by SORTGRD1 V1.0.

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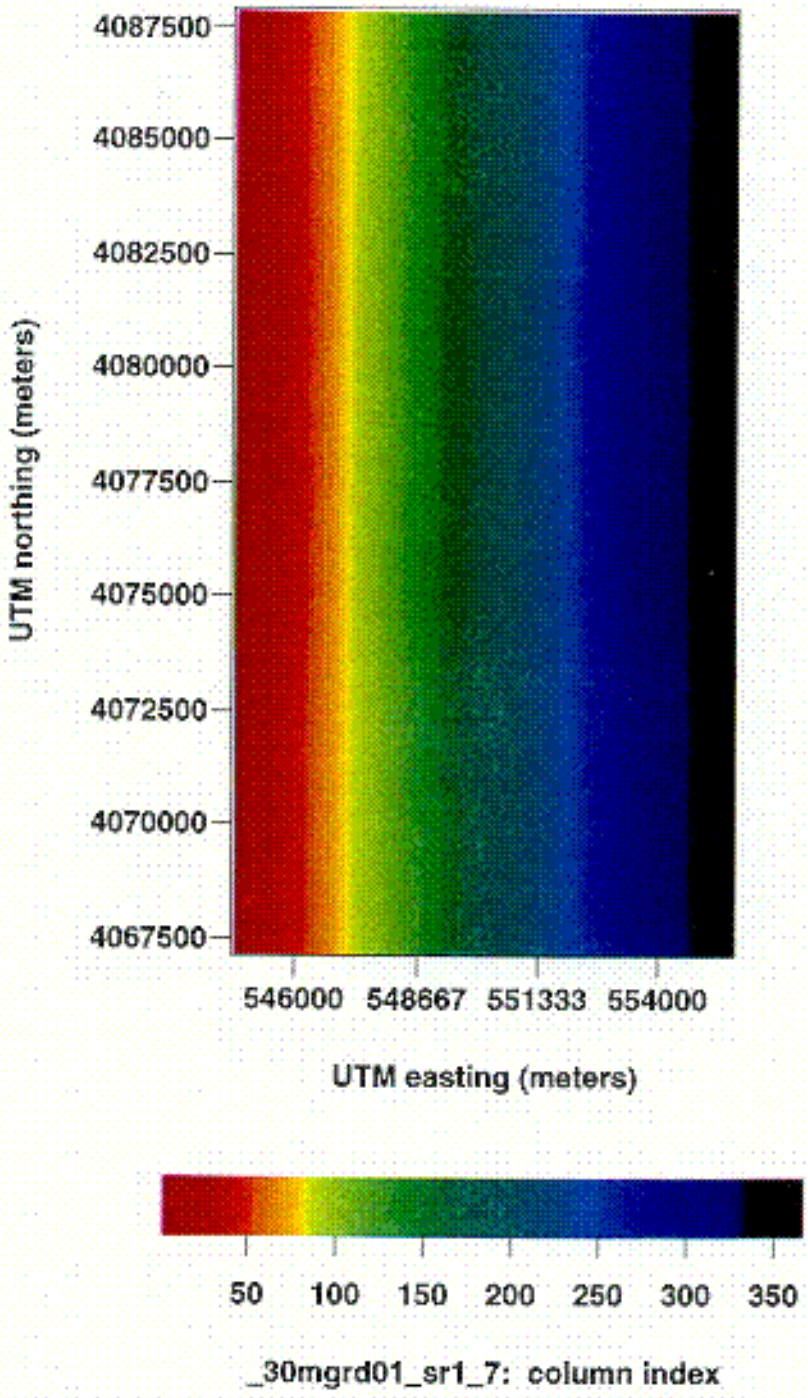

Figure X-2. TRANSFORM map image (file SRT-COL.HDF) of the grid cell column index parameter calculated by SORTGRD1 V1.0.

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- Tables used as part of the routine test plan:

Table X-1. Selection of input for SORTGRD1 indicating unsorted elevations and grid cell coordinates obtained from the file SOILMAP6.INP. Also shown are the grid cell row and column indices of the raster-based grid defined by the grid cell coordinates.

Grid Cell Identifier	UTM northing	UTM easting	Latitude	Longitude	Grid cell row index	Grid cell column index	Elevation
1	544661	4087833	36.9373	116.4985	1	1	1739
2	544691	4087833	36.9373	116.4981	1	2	1750
3	544721	4087833	36.9373	116.4978	1	3	1767
4	544751	4087833	36.9373	116.4975	1	4	1781
5	544781	4087833	36.9373	116.4971	1	5	1794
6	544811	4087833	36.9373	116.4968	1	6	1807
7	544841	4087833	36.9373	116.4965	1	7	1824
8	544871	4087833	36.9373	116.4961	1	8	1838
9	544901	4087833	36.9373	116.4958	1	9	1851
10	544931	4087833	36.9373	116.4955	1	10	1854
11	544961	4087833	36.9373	116.4951	1	11	1846
12	544991	4087833	36.9373	116.4948	1	12	1836
13	545021	4087833	36.9373	116.4944	1	13	1829
14	545051	4087833	36.9373	116.4941	1	14	1833
15	545081	4087833	36.9373	116.4938	1	15	1843
16	545111	4087833	36.9373	116.4934	1	16	1852
17	545141	4087833	36.9373	116.4931	1	17	1858
18	545171	4087833	36.9373	116.4928	1	18	1861
19	545201	4087833	36.9373	116.4924	1	19	1862
20	545231	4087833	36.9373	116.4921	1	20	1861
21	545261	4087833	36.9373	116.4917	1	21	1854
22	545291	4087833	36.9373	116.4914	1	22	1846
23	545321	4087833	36.9373	116.4911	1	23	1841
24	545351	4087833	36.9373	116.4907	1	24	1836
25	545381	4087833	36.9373	116.4904	1	25	1821
26	545411	4087833	36.9373	116.4901	1	26	1805
27	545441	4087833	36.9373	116.4897	1	27	1791
28	545471	4087833	36.9373	116.4894	1	28	1777
29	545501	4087833	36.9373	116.4891	1	29	1765
30	545531	4087833	36.9373	116.4887	1	30	1763
31	545561	4087833	36.9373	116.4884	1	31	1766
32	545591	4087833	36.9373	116.488	1	32	1772
33	545621	4087833	36.9373	116.4877	1	33	1781
34	545651	4087833	36.9373	116.4874	1	34	1789

Grid Cell Identifier	UTM northing	UTM easting	Latitude	Longitude	Grid cell row index	Grid cell column index	Elevation
35	545681	4087833	36.9373	116.487	1	35	1799
36	545711	4087833	36.9373	116.4867	1	36	1805
37	545741	4087833	36.9373	116.4864	1	37	1807
38	545771	4087833	36.9373	116.486	1	38	1814
39	545801	4087833	36.9373	116.4857	1	39	1825
40	545831	4087833	36.9373	116.4853	1	40	1840
41	545861	4087833	36.9373	116.485	1	41	1854
42	545891	4087833	36.9373	116.4847	1	42	1863
43	545921	4087833	36.9372	116.4843	1	43	1868
44	545951	4087833	36.9372	116.484	1	44	1868
45	545981	4087833	36.9372	116.4837	1	45	1867
46	546011	4087833	36.9372	116.4833	1	46	1871
47	546041	4087833	36.9372	116.483	1	47	1881
48	546071	4087833	36.9372	116.4827	1	48	1898
49	546101	4087833	36.9372	116.4823	1	49	1920
50	546131	4087833	36.9372	116.482	1	50	1939
51	546161	4087833	36.9372	116.4816	1	51	1955
52	546191	4087833	36.9372	116.4813	1	52	1969
53	546221	4087833	36.9372	116.481	1	53	1969
54	546251	4087833	36.9372	116.4806	1	54	1950
55	546281	4087833	36.9372	116.4803	1	55	1932
56	546311	4087833	36.9372	116.48	1	56	1919
57	546341	4087833	36.9372	116.4796	1	57	1910
58	546371	4087833	36.9372	116.4793	1	58	1900
59	546401	4087833	36.9372	116.4789	1	59	1889
60	546431	4087833	36.9372	116.4786	1	60	1878
61	546461	4087833	36.9372	116.4783	1	61	1869
62	546491	4087833	36.9372	116.4779	1	62	1857
63	546521	4087833	36.9372	116.4776	1	63	1841
64	546551	4087833	36.9372	116.4773	1	64	1821
65	546581	4087833	36.9372	116.4769	1	65	1803

Table X-2. Selection from the output file 30MGRD01.SR1, indicating elevation values are arranged in descending order. Also indicated are the modified grid cell identifier numbers and the grid cell indices that are included in the output file.

Grid Cell Identifier	UTM northing	UTM easting	Latitude	Longitude	Grid cell row index	Grid cell column index	Elevation
1	546191	4087833	36.9372	116.4813	1	52	1969
2	546221	4087833	36.9372	116.481	1	53	1969
3	546191	4087803	36.937	116.4813	2	52	1959
4	546161	4087833	36.9372	116.4816	1	51	1955
5	546221	4087803	36.937	116.481	2	53	1955
6	546191	4087773	36.9367	116.4813	3	52	1951
7	546251	4087833	36.9372	116.4806	1	54	1950
8	546161	4087803	36.937	116.4816	2	51	1949
9	549311	4087833	36.9371	116.4463	1	156	1944
10	546221	4087773	36.9367	116.481	3	53	1944
11	546161	4087773	36.9367	116.4816	3	51	1943
12	546191	4087743	36.9364	116.4813	4	52	1942
13	546131	4087833	36.9372	116.482	1	50	1939
14	549281	4087833	36.9371	116.4466	1	155	1939
15	549341	4087833	36.9371	116.4459	1	157	1939
16	546251	4087803	36.937	116.4806	2	54	1938
17	546161	4087743	36.9364	116.4816	4	51	1937
18	546131	4087803	36.937	116.482	2	50	1933
19	546281	4087833	36.9372	116.4803	1	55	1932
20	549371	4087833	36.9371	116.4456	1	158	1932
21	546221	4087743	36.9364	116.481	4	53	1932
22	546191	4087713	36.9362	116.4813	5	52	1932
23	549311	4087803	36.9368	116.4463	2	156	1931
24	546161	4087713	36.9362	116.4817	5	51	1930
25	549281	4087803	36.9368	116.4466	2	155	1929
26	546251	4087773	36.9367	116.4806	3	54	1928
27	546131	4087773	36.9367	116.482	3	50	1927
28	549401	4087833	36.9371	116.4453	1	159	1926
29	549251	4087833	36.9371	116.4469	1	154	1924
30	549341	4087803	36.9368	116.4459	2	157	1924
31	549431	4087833	36.9371	116.4449	1	160	1922
32	546131	4087743	36.9364	116.482	4	50	1922
33	546221	4087713	36.9362	116.481	5	53	1922
34	546161	4087683	36.9359	116.4817	6	51	1922
35	546281	4087803	36.937	116.4803	2	55	1921
36	546101	4087833	36.9372	116.4823	1	49	1920

Grid Cell Identifier	UTM northing	UTM easting	Latitude	Longitude	Grid cell row index	Grid cell column index	Elevation
37	546191	4087683	36.9359	116.4813	6	52	1920
38	546311	4087833	36.9372	116.48	1	56	1919
39	549281	4087773	36.9365	116.4466	3	155	1918
40	549251	4087803	36.9368	116.4469	2	154	1917
41	546131	4087713	36.9362	116.482	5	50	1917
42	549371	4087803	36.9368	116.4456	2	158	1916
43	546251	4087743	36.9364	116.4806	4	54	1916
44	549311	4087773	36.9365	116.4463	3	156	1913
45	546131	4087683	36.9359	116.482	6	50	1912
46	549461	4087833	36.9371	116.4446	1	161	1911
47	546101	4087803	36.937	116.4823	2	49	1911
48	549251	4087773	36.9365	116.4469	3	154	1911
49	546161	4087653	36.9356	116.4817	7	51	1911
50	546341	4087833	36.9372	116.4796	1	57	1910
51	549401	4087803	36.9368	116.4453	2	159	1910
52	546281	4087773	36.9367	116.4803	3	55	1910
53	546221	4087683	36.9359	116.481	6	53	1908
54	546191	4087653	36.9356	116.4813	7	52	1908
55	549431	4087803	36.9368	116.4449	2	160	1907
56	546311	4087803	36.937	116.48	2	56	1905
57	546101	4087773	36.9367	116.4823	3	49	1905
58	546251	4087713	36.9362	116.4806	5	54	1905
59	549221	4087833	36.9371	116.4473	1	153	1904
60	549341	4087773	36.9365	116.4459	3	157	1904
61	549281	4087743	36.9363	116.4466	4	155	1903
62	546131	4087653	36.9356	116.482	7	50	1903
63	549461	4087803	36.9368	116.4446	2	161	1902
64	546101	4087743	36.9364	116.4823	4	49	1901
65	549251	4087743	36.9363	116.447	4	154	1901

- **Listing of source code for routine SORTGRD1 V1.0:**

```
PROGRAM sortgrd1
c     version 1.0
c
      INTEGER LOCID(1190000)
      INTEGER LOCID2
  integer slp(1190000),asp(1190000)
      integer row(1190000),col(1190000)
      integer row2,col2,rown,coln
      integer SOILID(1190000),DEPTHID(1190000),ROCKID(1190000),
  1         TOPOID(1190000)
      integer SOILID2,DEPTHID2,ROCKID2,TOPOID2
  integer block(1190000,36)
      integer BLOCK2(36)
  integer vegt(1190000),vegc(1190000)

  integer slp2,asp2
c
      real X(1190000),Y(1190000)
  real el(1190000),depth(1190000)
  real LAT(1190000),LON(1190000)
  real depth2,x2,y2,yold
      REAL LAT2,LON2,Emax
  real pie,rd,space,hypot,rmax
  real s11,s12,s21,s22,s31,s32,s41,s42,s51,s52,s61,s62,
  1     s71,s72,s81,s82
  real s1,r1,s2,r2,s3,r3,s4,r4,s5,r5,s6,r6,s7,r7,s8,r8
c
c
      CHARACTER*20 INFILE,OUTFILE,outfil2
      CHARACTER*80 HEADER
c
c
15    FORMAT(A)
      OPEN(UNIT=7,FILE='sortgrd1.CTL')
      READ(7,15) HEADER
      READ(7,15) INFILE
      READ(7,15) OUTFILE
  read(7,15) outfil2
C
      OPEN(UNIT=8,FILE=INFILE)
      OPEN(UNIT=9,FILE=OUTFILE)
  open(unit=10,file=outfil2)
C
      EMAX = -9999999.
c
c ---------- initialize 2d elevation array
c
      N = 1
      coln = 0
      rown = 0
  yold = 0.
 100  READ(8,*,END=150) LOCID(n),X(n),Y(n),LAT(n),LON(n),
     1                  SLP(n),ASP(n),EL(n),soilid(n),
     2                  depthid(n),depth(n),ROCKID(n),
     3                  TOPOID(n),(BLOCK(n,I), I=1,36)
C
         if(y(n).ne.yold) then
            rown = rown + 1
            coln = 1
         write(*,*) n,rown
         endif
```

```
         col(n) = coln
         row(n) = rown
         coln = coln + 1
         yold = y(n)
         n = n + 1
c
      goto 100
150   n = n - 1
      write(*,*) n, row(n), col(n)
  pause
c
C
c ------------- do bubble sort for elevation -------------
c
      do 600 i = 1,n
  write(*,*) i
      do 610 j = i,n
      if(el(j).gt.emax) then
         emax      = el(j)
         locid2    = locid(j)
         row2      = row(j)
         col2      = col(j)
         x2        = x(j)
         y2        = y(j)
         lat2      = lat(j)
         lon2      = lon(j)
         slope2    = slp(j)
         asp2      = asp(j)
         soilid2   = soilid(j)
         depthid2  = depthid(j)
       depth2    = depth(j)
         rockid2   = rockid(j)
         topoid2   = topoid(j)
         do k = 1,36
         block2(k) = block(j,k)
         enddo
         jid       = j
      endif
610   continue
c
      el(jid)   = el(i)
      locid(jid) = locid(i)
      row(jid)   = row(i)
      col(jid)   = col(i)
      x(jid)     = x(i)
      y(jid)     = y(i)
      lat(jid)   = lat(i)
      lon(jid)    = lon(i)
      slp(jid)            = slp(i)
      asp(jid)   = asp(i)
      soilid(jid) = soilid(i)
      depthid(jid) = depthid(i)
  depth(jid)    = depth(i)
      rockid(jid) = rockid(i)
      topoid(jid) = topoid(i)
      do k = 1,36
         block(jid,k) = block(i,k)
      enddo
c
c
      el(i)   = emax
      locid(i) = locid2
      row(i) = row2
```

```
      col(i) = col2
      x(i) = x2
      y(i) = y2
      lat(i) = lat2
      lon(i) = lon2
      slp(i) = slope2
      asp(i) = asp2
      soilid(i) = soilid2
      depthid(i) = depthid2
  depth(i) = depth2
      rockid(i) = rockid2
      topoid(i) = topoid2
      do k = 1,36
         block(i,k) = block2(k)
      enddo
      emax = -99999
600   continue
c
c
      do 700 i = 1,n
c
c---- create place holders for veg parameters
c
       vegt(i) = -99
       vegc(i) = -99
c
c
       WRITE(9,711) i,x(i),y(i),LAT(i),LON(i),
  1    row(i),col(i),el(i),slp(i),asp(i),soilid(i),
     2   depthid(i),depth(i),rockid(i),topoid(i),
     3 vegt(i),vegc(i),(BLOCK(i,j), j=1,36)
c
 711          FORMAT(1X,i8,2f10.0,2f9.4,2i5,F7.0,3i4,i3,f7.2,4i4,
  1           36i3)

c
700   continue
c
c
      CLOSE(9)
  close(10)
      END
```

ATTACHMENT XI

CALCULATION OF FLOW ROUTING PARAMETERS USING CHNNET16 V1.0

TOTAL PAGES: 23

Calculation of Flow Routing Parameters using CHNNET16 V1.0

1. Name of routine/macro with version/OS/hardware environment and user information:

Name of software routine: CHNNET16 V1.0,
OS and hardware environment: Windows NT 4.0, Pentium Pro PC
Computer Identification: SM321276 with a USGS specific host-name P720dcasr
Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. Name of commercial software with version/OS/hardware used to develop routine/macro:

The source code for CHNNET16 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. General Description of routine/macro:

CHNNET16 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (CHNNET16.FOR), compiled executable file (CHNNET16.EXE), routine control file (CHNNET16.CTL), input and output files, validation test files, and a copy of this attachment, are located under the directory CHNNET16 on a CD-ROM labeled GEOINPUT-2. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing or spreadsheet applications such as Microsoft WORD and EXCEL. The executable file can be used to run CHNNET16 V1.0 on any PC with an INTEL processor (with adequate RAM).

The output developed by CHNNET16 V1.0 is required for the development of the geospatial parameter input file for INFIL V2.0. The output file created by CHNNET16 is used directly as input to the routine WATSHD20 V1.0.

4. Test plan for the software routine CHNNET16 V1.0:

- **Explain whether this is a routine or macro and describe what it does:**

CHNNET16 V1.0 is the eighth routine applied in a sequence of FORTRAN 77 routines that are used in the development of the geospatial parameter input files for INFIL V2.0. The first function performed by CHNNET16 is the calculation of the second flow routing parameter using input from 30MGRD01.SR1 which is the elevation-sorted output file from SORTGRD1 V1.0 (see Attachment X). The flow routing calculation is based on a standard D-8 routing scheme in which the eight grid cells surrounding a given grid cell location are scanned and flow is routed to the lowest elevation cell. The first flow routing parameter is the current grid cell identification number provided as input from 30MGRD01.SR1. This

parameter is generated by SORTGRD1 and indicates the sequence of sorted elevation values. The second flow routing parameter is generated by CHNNET16 using the grid cell elevations obtained from 30MGRD01.SR1 and is the grid cell identification number for the downstream grid cell that surface water flow is being routed to. In most cases the downstream cell is one of eight adjacent cells surrounding a given grid cell. In cases where all adjacent grid cells have elevations higher than the current grid cell, the next surrounding layer of grid cells is scanned. This process is repeated until a grid cell is located with an elevation less than the current grid cell, or 20 layers have been scanned (which ever occurs first). If 20 layers have been scanned and a routing cell is not located, the current grid cell is designated as a sink (closed basin).

A second function performed by CHNNET16 V1.0 is the calculation of the flow accumulation term (the number of upstream cells for each grid cell location). The calculation is performed by routing a uniformly distributed precipitation input of one unit (in this case, 1.0 millimeters) using the two flow routing parameters. The flow accumulation term is used to identify grid cell locations needed as input for extracting watershed modeling domains using the routine WATSHD20 (see Attachment XIV). In addition, the flow accumulation term is used as part of the routine test plan for evaluating if CHNNET16 V1.0 is functioning correctly.

The second flow routing parameter (downstream grid cell number) and the flow accumulation term are included in the output file 30MGRD01.C16 generated by CHNNET16 (this file is provided as input to WATSHD20). Additional parameters included in the output file are the easting and northing grid cell coordinates, the row and column grid cell indices, and the first flow routing parameter (the grid cell number). These additional parameters are obtained from the input file 30MGRD01.SR1. Additional columns in the output file 30MGRD01.C16 are optional parameters generated by CHNNET16 V1.0 that are not used in the development of the geospatial parameter input files for INFIL V2.0.

- **Listing of FORTRAN77 Source code:**

A listing of the FORTRAN77 source code for the routine CHNNET16 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

A validation test of the functions performed by the routine was conducted by a visual evaluation of the calculated flow accumulation term included in the output file generated by the routine. The flow accumulation term is calculated based on the result of routing a uniform precipitation input of 1 mm. The flow accumulation term is thus equal to the number of upstream grid cells for a given grid cell location. Map images of the flow accumulation term are created in TRANSFORM and ARCVIEW to provide visual representations of the channel network defined by the calculated flow routing parameters. Using applications in ARCVIEW the map image of the channel network is superimposed with a contour or shaded relief image of the topography to provide a method of testing that the routine has functioned correctly. The test criterion is that the channel network defined by CHNNET16 must agree

with the expected channel network defined by the topography (within the limitations of the standard D8 routing algorithm). For example, all grid cells having a flow accumulation term of 0 (no upstream cells) indicate flow divides and must occur for ridgetop and summit locations or for high points within the more flat lying basin fill areas. In contrast, all grid cells having approximately 10 or more upstream cells define stream channel locations and must occur along mid to lower sideslopes and the bottom of washes as opposed to ridgetop and summit locations. Major stream channels consisting of approximately 1,000 or more upstream cells must occur in the mid- to downstream-sections of the larger washes and drainages in upland areas or far downslope in gently sloping basin-fill areas with poorly defined drainages.

The flow accumulation term must systematically increase with decreasing elevation in the downstream direction (up-hill flow cannot occur), and must exactly equal the sum of all contributing upstream grid cells. Major channels cannot cross drainage divides formed by ridges. All flow routing must be convergent and cannot terminate unless a major sink is reached. A grid cell can be routed to by up to 7 adjacent cells (or even more for locations defined as a sinks), but all cells can only rout to one cell (divergent flow is not allowed).

A visual check that the flow routing and the flow accumulation terms are being calculated correctly is also conducted using TRANSFORM to create raster-based map images and extracting input and output parameter values for a subset of grid cells identified in the TRANSFORM file. The input and output parameter values for the subset of grid cells are visually inspected to determine that the functions performed by CHNNET16 have operated correctly and have provided the intended result.

An additional test performed as part of the routine validation is an inspection of the output file containing the flow routing parameters. The criteria of the test is that the output file must be in the proper format with the correct number and sequencing of 10 columns and 253,597 rows. The UTM coordinates and the grid cell number of the output file 30MGRD01.C16 must match the UTM coordinates and the grid cell number of the corresponding line in the input file 30MGRD01.SR1.

- **Specify the range of input values to be used and why the range is valid:**

The input range is completely determined by the parameters in the file 30MGRD01.SR1 because this is the only source of input provided to the routine. The file is specified in the file CHNNET16.CTL, which is the routine control file for CHNNET16 and is required for the execution of the routine. 30MGRD01.SR1 is a column-formatted ASCII file consisting of 253,597 rows and 53 columns (see Attachments X and XI). For the parameters used by the routine, the input ranges are specified by the following:

SORTGRD01.SR1 is the main input file used by CHNNET16 V1.0. Four parameters provided by the input file SORTGRD01.SR1 are used by functions in CHNNET16 V1.0: the grid cell number (column 1), the grid cell row index (column 6), the grid cell column index (column 7), and the grid cell elevation. The input values for the grid cell number are integers from 1 to 253,597. The input values for grid cell row index are integers from 1 to 691. The input values for grid cell column index are integers from 1 to 367. The input values for grid

cell elevation are real numbers from 918 to 1,969 (the elevation values are to the nearest meter). This input range is valid because the values were obtained from ARCINFO using the source data as input (see Attachment VI for description of source data used for 30MSITE.INP) and a sequence of applied software routines described in Attachments VI through X of this AMR.

5. Test Results.

- **Output from test:**

The output for the test case is the main output file 30MGRD01.C16 generated by CHNNET16 V1.0. The output file is used to generate raster-format map image files in TRANSFORM and ARCVIEW which are used only as a part of the validation test plan (the map image files are not required as part of the pre-processing procedure for developing the input used by INFIL V2.0).

- **Description of how the testing shows that the results are correct for the specified input:**

The ARCVIEW map images of the flow accumulation term (Figures XI-1 to XI-3) obtained from column 8 of the output file 30MGRD01.C16 indicate that the flow routing parameters are being calculated correctly by the routine CHNNET16 V1.0. The overlay of the flow accumulation term with a shaded relief image of the topography indicates that the stream channel network defined by the flow routing parameters is correctly positioned relative to topography. Figure XI-1 indicates the major stream channels (channels having more than 10,000 upstream grid cells) defined by the flow accumulation term on the scale of the net infiltration model. The locations of the major channels defined by the flow accumulation term are generally consistent with the known locations of the main channels for Yucca Wash, Drill Hole Wash, Dune Wash, and Solitario Canyon. Deviations of the channel network defined by the flow accumulation term relative to the known locations of channels are within the expected level of accuracy based on the limitations of the digital elevation grid and the D8 routing directions in representing the true locations of channels.

Figure XI-2 indicates the major stream channels (channels having more than 1,000 upstream grid cells) defined by the flow accumulation term for the area of the UZ ground water flow model. The stream channel network defined by the flow accumulation term is consistent with the known locations of channels such as Pagany Wash, Wren Wash, Coyote Wash, WT-2 Wash, and Abandoned Wash. Figure XI-3 indicates a more detailed view of the flow accumulation term over the area of the potential repository and the ESF. The overlay of the flow accumulation term with the shaded relief map image and the elevation contours shows the correct locations of surface water flow divides and the stream channel network relative to topography (divides are along ridgetops and streams are in valley bottoms). In addition, Figure XI-3 shows that the flow accumulation term increases with decreasing elevation, and this indicates that the flow routing parameters have been correctly calculated by the routine.

Tables XI-1 through XI-4 indicate the input and output parameter values for the subset of grid cells extracted from the input and output files using TRANSFORM. Table XI-1 indicates the grid cell elevation and Table XI-2 indicates the grid cell number obtained from

the input file 30MGRD01.SR1. Inspection of the elevation values and the corresponding grid cell numbers indicates that surface water flow should be routed downstream to grid cell 73,045 from grid cells 72,096, 72,424, and 71,468 (located in right half of the top row of each table). Inspection of Table XI-3 indicates that the routine has functioned properly because all three cells indicate routing to cell 73,045. The flow accumulation term (Table XI-4) indicates an accumulated flow term of 1,389 for grid cell 73,045. The accumulated flow term in Table XI-4 is checked by adding the number of cells routing to 73,045 to the flow being routed from those grid cells: (3) + (2 + 1,382 + 2). The manual calculation shows that the expected flow routed to 73,045 is 1,389 and this agrees with the value in Table XI-4. This method of manual checking was repeated using the input and output parameters shown in the tables and the output results were found to be in agreement with the expected results, indicating that the functions of CHNNET16 V1.0 were executing correctly and performing the intended operations.

Visual inspection of the input and output files (see example printouts below) indicated that the format of the output file is correct and consists of the intended 253,597 rows and 10 columns, with the columns and rows occurring in the correct sequence. The UTM coordinates, grid cell number, and the row and column indices for each line of the output file matches the UTM coordinates, grid cell number, and row and column indices of the corresponding line of the input file, indicating that no unintended modifications were performed by the routine.

- **List limitations or assumptions to this test case and code in general:**

The limitations of the developed test case are based on the practical limitations of verifying calculated parameter values for all 253, 597 grid cells included in the output file used for the developed test case. Validation of the entire output file used in the test case was performed as a visual evaluation of raster-based map images produced in TRANSFORM and ARCVIEW. Only a subset of the entire output file could be used for more detailed validation tests that were performed in an EXCEL worksheet.

- **Electronic files identified by name and location:**

Electronic files are located on CD-ROM labeled GEOINPUT-2, under the directory CHNNET16, included as an attachment to the AMR. The following electronic files are provided:

CHNNET16.CTL:	Input file consisting of the input and output file names for CHNNET16 V1.0.
CHNNET16.FOR:	FORTRAN source code listing for the routine CHNNET16 V1.0. A printout of the source code is included as part of this attachment.
CHNNET16.EXE:	Executable file for the routine CHNNET16 V1.0, compiled for INTEL processors.

30MGRD01.SR1: Input file consisting of a column-formatted, ASCII text file with 253,597 rows and 53 columns. This file was developed as the output file from SORTGRD1 V1.0 (see Attachment IX). A partial printout of the first part of this file is included as part of this attachment.

30MGRD01.C16: Output file consisting of a column-formatted, ASCII text file with 10 columns and 253,597 rows. The first two columns are the easting and northing coordinates, columns 3 and 4 are the row and column indices. The flow routing parameters consist of the grid cell number (column 5), the boundary cell parameter (column 6), the downstream cell number (column 7), and the flow accumulation term (column 9).

CHN16-A.APR: ARCVIEW project file (including all files in associated directories) used to create the raster-based map image of flow accumulation for the area of the net infiltration model (Figure XI-1). The files are used to perform the software routine validation test and are provided as supporting information only.

CHN16-B.APR: ARCVIEW project file (including all files in associated directories) used to create the raster-based map image of flow accumulation for the area of the UZ ground water flow model (Figure XI-2). The files are used to perform the software routine validation test and are provided as supporting information only.

CHN16-C.APR: ARCVIEW project file (including all files in associated directories) used to create the raster-based map image of flow accumulation for the potential repository area (Figure XI-3). The files are used to perform the software routine validation test and are provided as supporting information only.

CHN-ELEV.HDF: TRANSFORM raster-based map image of grid cell elevation obtained from column 8 of the input file 30MGRD01.SR1. The file is used to create Table XI-1 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.

CHN-R1.HDF: TRANSFORM raster-based map image of the first flow routing parameter obtained from column 1 of the input file 30MGRD01.SR1. The file is used to create Table XI-2 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.

CHN-R2.HDF: TRANSFORM raster-based map image of the second flow routing parameter obtained from column 7 of the output file 30MGRD01.C16. The file is used to create Table XI-3 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.

CHN-C16.HDF: TRANSFORM raster-based map image of the flow accumulation term (number of upstream grid cells) obtained from column 8 of the output file 30MGRD01.C16. The file is used to create Table XI-4 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.

6. Supporting Information. (Include background information, such as revision to a previous routine or macro, or explanation of the steps performed to run the software. Include listings of all electronic files and codes used).

- **Procedure for running routine:**

To run the routine CHNNET16 V1.0, the executable file (CHNNET16.EXE), the routine control file (CHNNET16.CTL), and the input file specified in the routine control file (CHNNET16.INP) must be placed in the same directory. The routine is executed by typing CHNNET16 in a DOS window, by double clicking on the file CHNNET16.EXE in the Microsoft Windows operating system, or by typing in the path and filename in the RUN window of the Windows NT or Windows 98 start menu. The input and output file names must be in the correct sequential order as specified in the routine control file (see example listing below).

- **Example listing of routine control file CHNNET16.CTL**

```
chnnet16 test file (7/9/98)    (header line)
30mgrd01.sr1                         (input file from SORTGRD01 version 1.0)
30mgrd01.c16                   (main output file from CHNNET16 version 1.0)
30mgrd01.h16                   (auxiliary output file)
30mgrd01.g16                   (auxiliary output file)
0 2                      (input/output format options, set to 0, 2)
```

- **Example listing of the input file 30MGRD01.SR1. The file contains 253,597 lines and 53 columns (only the first 20 lines of the file are listed). The input parameters used by CHNNET16 V1.0 are grid cell number (column 1), grid cell row index (column 6), grid cell column index (column 7), and grid cell elevation (column 8).**

```
1   546191.  4087833.  36.9372 116.4813    1   52  1969.  25 206   5  1
0.20 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        2   546221.  4087833.  36.9372 116.4810    1   53  1969.  28 147   5
1   0.17 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        3   546191.  4087803.  36.9370 116.4813    2   52  1959.  23 199   5
1   0.23 201   4 -99 -99  1  0  0  7  7  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 16 18
        4   546161.  4087833.  36.9372 116.4816    1   51  1955.  30 241   5
1   0.14 201   4 -99 -99  0  0  0  0  0  0  0  2 25 22  0  0  2  2  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        5   546221.  4087803.  36.9370 116.4810    2   53  1955.  28 140   5
1   0.17 201   4 -99 -99  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  7  6  0  0  8  7  0  0 22 25
        6   546191.  4087773.  36.9367 116.4813    3   52  1951.  20 188   5
1   0.27 201   4 -99 -99  1 11  4  2  2  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0 14 16
```

```
        7   546251.  4087833.  36.9372 116.4806    1   54  1950.  36 125   5
1   0.06 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  3  3  2  5  3 32 28  0  0  0  0  0  0  0  0
        8   546161.  4087803.  36.9370 116.4816    2   51  1949.  27 241   5
1   0.18 201   4 -99 -99  1  0  0 13 13  5 12  2 18 15  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
        9   549311.  4087833.  36.9371 116.4463    1  156  1944.  23 180   5
1   0.23 206   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       10   546221.  4087773.  36.9367 116.4810    3   53  1944.  28 134   5
1   0.17 201   4 -99 -99  2  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1 13 11  0  2  8  8 13  4 19 22
       11   546161.  4087773.  36.9367 116.4816    3   51  1943.  24 237   5
1   0.22 201   4 -99 -99  1 16  6 11 12  5  7  1 14 12  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
       12   546191.  4087743.  36.9364 116.4813    4   52  1942.  20 175   5
1   0.27 201   4 -99 -99 15 11  5  2  1  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  6 15 16
       13   546131.  4087833.  36.9372 116.4820    1   50  1939.  33 247   5
1   0.10 201   4 -99 -99  0  0  0  0  0  0  0  3 28 25 10 11  6  6  2  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       14   549281.  4087833.  36.9371 116.4466    1  155  1939.  26 221   5
1   0.19 206   4 -99 -99  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       15   549341.  4087833.  36.9371 116.4459    1  157  1939.  26 155   5
1   0.19 206   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0  0
       16   546251.  4087803.  36.9370 116.4806    2   54  1938.  35 124   5
1   0.08 201   4 -99 -99  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  4  4  3  8  5 29 26 12 15 16 15  0  0 18 21
       17   546161.  4087743.  36.9364 116.4816    4   51  1937.  23 229   5
1   0.23 201   4 -99 -99 17 18 16 17  9  1  3  1  9  7  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
       18   546131.  4087803.  36.9370 116.4820    2   50  1933.  33 252   5
1   0.10 201   4 -99 -99  1  0  0 15 14  9 26 20 28 25  7  9  5  5  2  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
       19   546281.  4087833.  36.9372 116.4803    1   55  1932.  34 130   5
1   0.09 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  4  8 12 17 16 31 27  0  0  0  0  0  0  0  0
       20   549371.  4087833.  36.9371 116.4456    1  158  1932.  27 153   5
1   0.18 206   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1 13 11  0  0  0  0  0  0  0  0
```

- **Example listing of the output file 30MGRD01.C16. The file contains 253, 597 lines and 10 columns (only the first 20 lines of the file are listed). The UTM easting and northing coordinates (columns 1 and 2), the grid cell row and column indices (columns 3 and 4), and the grid cell number (column 5) are identical to the values in the input file. The grid cell number is the first flow routing parameter. Column 6 is the watershed boundary parameter created by CHNNET16, where –3 indicates grid cells on the perimeter of the grid and 0 indicates grid cells on watershed divides (these are grid cells with no upstream cells). Column 7 is the second flow routing parameter and indicates the grid cell number of the downstream cell. Column 9 is the flow accumulation term (number of upstream cells) used to map the stream channel network defined by the 2 flow routing parameters.**

546191.0	4087833.0	1	52	1	-3	0	0	0.00000	-1.0
546221.0	4087833.0	1	53	2	-3	0	0	0.00000	-1.0
546191.0	4087803.0	2	52	3	0	11	0	0.00000	-1.0
546161.0	4087833.0	1	51	4	-3	0	0	0.00000	-1.0
546221.0	4087803.0	2	53	5	0	26	0	0.00000	-1.0
546191.0	4087773.0	3	52	6	0	21	0	0.00000	-1.0
546251.0	4087833.0	1	54	7	-3	0	0	0.00000	-1.0
546161.0	4087803.0	2	51	8	0	27	0	0.00000	-1.0
549311.0	4087833.0	1	156	9	-3	0	0	0.00000	-1.0
546221.0	4087773.0	3	53	10	0	43	0	0.00000	-1.0
546161.0	4087773.0	3	51	11	11	32	0	1.00000	-1.0
546191.0	4087743.0	4	52	12	0	33	0	0.00000	-1.0
546131.0	4087833.0	1	50	13	-3	0	0	0.00000	-1.0
549281.0	4087833.0	1	155	14	-3	0	0	0.00000	-1.0
549341.0	4087833.0	1	157	15	-3	0	0	0.00000	-1.0
546251.0	4087803.0	2	54	16	0	52	0	0.00000	-1.0
546161.0	4087743.0	4	51	17	0	41	0	0.00000	-1.0
546131.0	4087803.0	2	50	18	0	57	0	0.00000	-1.0
546281.0	4087833.0	1	55	19	-3	0	0	0.00000	-1.0
549371.0	4087833.0	1	158	20	-3	0	0	0.00000	-1.0

- **Figures used as part of the routine test plan:**

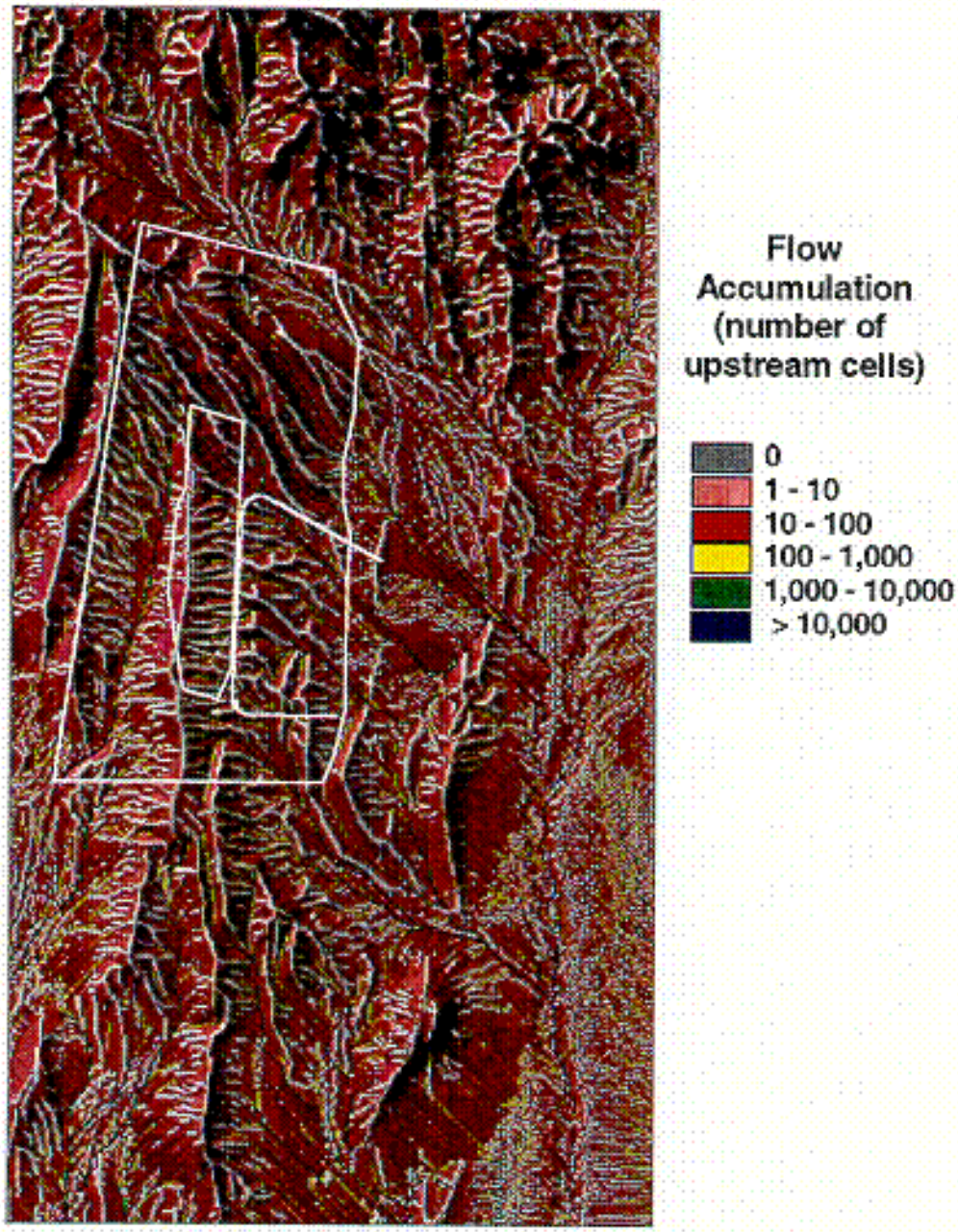

Figure XI-1. ARCVIEW map image (project CHN16-A.APR) of the flow accumulation term calculated by CHNNET16 V1.0, indicating the stream channel network for the area of the net infiltration model.

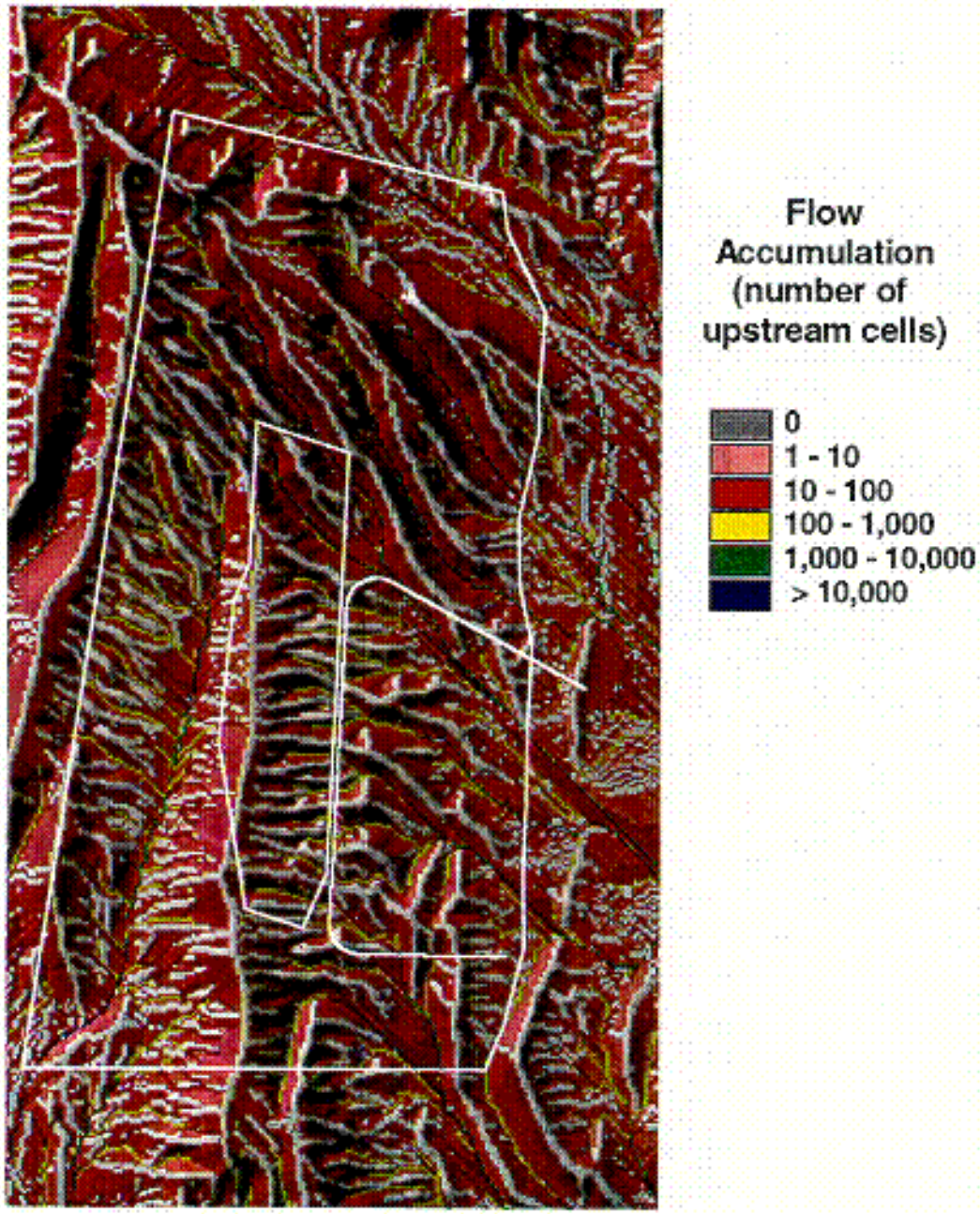

Figure XI-2. ARCVIEW map image (project file CHN16-B.APR) of the flow accumulation term calculated by CHNNET16 V1.0, indicating the stream channel network for the UZ model area.

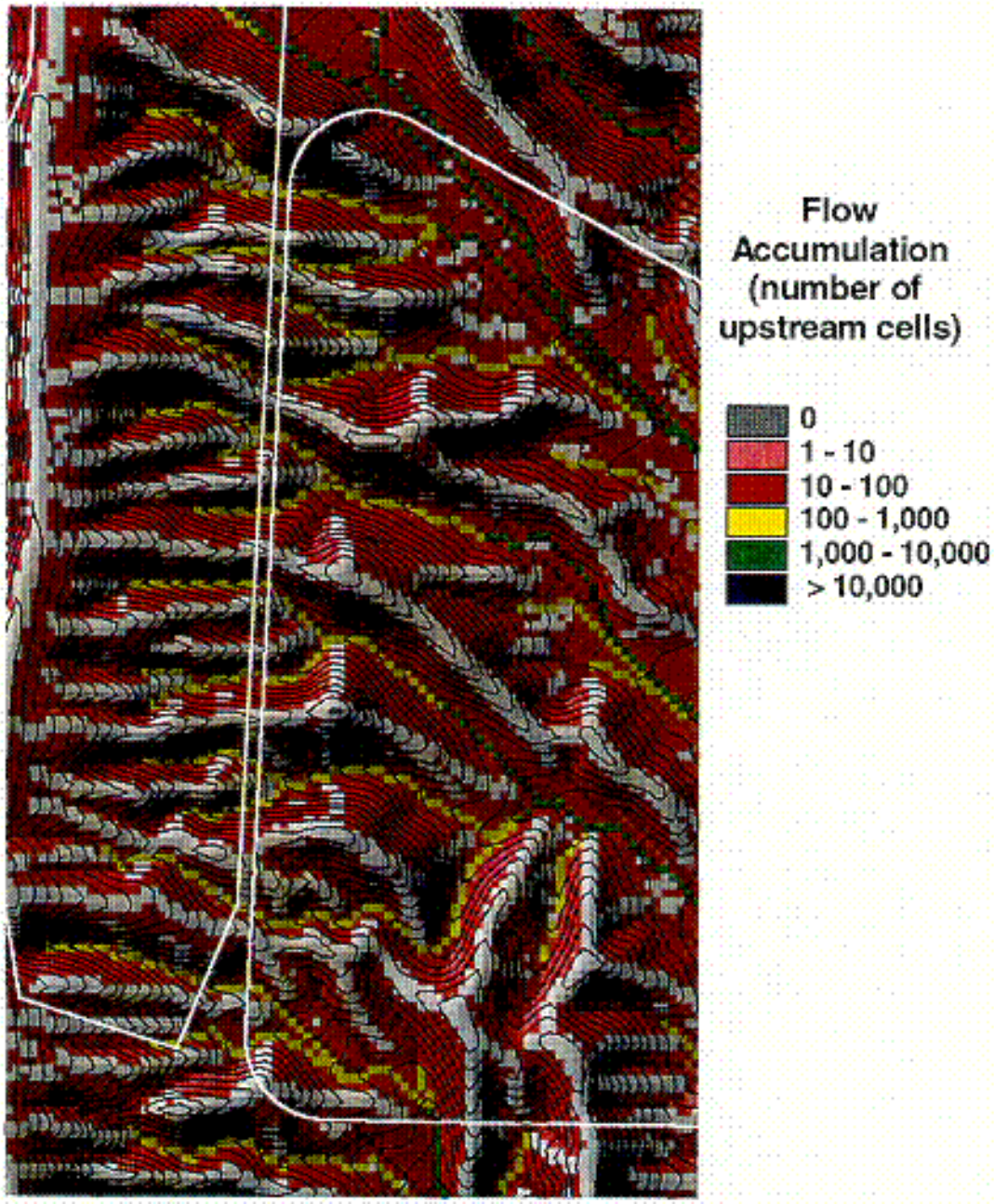

Figure XI-3. ARCVIEW map image (project file CHN16-C.APR) of the flow accumulation term calculated by CHNNET16 V1.0, indicating the stream channel network for drainages crossing the ESF (elevation contour interval is 10 meters).

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- **Tables used as part of the routine test plan:**

Table XI-1. Grid cell elevation (in meters) obtained from column 8 of the input file 30MGRD01.SR1, showing elevation values for a subset of grid cells located in upper Solitario Canyon (subset was extracted from the TRANSFORM file CHN-ELEV.HDF).

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547181	547211	547241	547271	547301	547331	547361	547391
4079703	1364	1356	1354	1354	1353	1352	1355	1364
4079673	1369	1358	1352	1352	1351	1350	1354	1364
4079643	1371	1362	1354	1350	1349	1348	1353	1362
4079613	1370	1362	1355	1350	1346	1346	1350	1359
4079583	1367	1360	1354	1349	1347	1345	1350	1357
4079553	1363	1357	1351	1347	1345	1345	1348	1356
4079523	1360	1353	1347	1345	1343	1343	1349	1357
4079493	1356	1349	1344	1343	1342	1343	1350	1359
4079463	1352	1345	1341	1341	1341	1343	1349	1358
4079433	1348	1342	1340	1340	1340	1343	1349	1357
4079403	1344	1340	1338	1338	1339	1343	1350	1358
4079373	1341	1338	1337	1337	1339	1343	1351	1358
4079343	1338	1336	1336	1336	1339	1342	1348	1355
4079313	1335	1334	1334	1335	1338	1342	1347	1354
4079283	1334	1332	1333	1334	1337	1341	1348	1355
4079253	1332	1331	1331	1333	1336	1340	1347	1356
4079223	1330	1330	1330	1331	1335	1339	1345	1353
4079193	1329	1328	1329	1330	1334	1338	1344	1352
4079163	1328	1327	1327	1329	1333	1338	1344	1351
4079133	1327	1326	1327	1328	1331	1338	1344	1352
4079103	1326	1325	1326	1328	1332	1338	1345	1352
4079073	1324	1324	1324	1327	1332	1337	1344	1352
4079043	1323	1322	1323	1326	1332	1338	1345	1352
4079013	1321	1321	1322	1327	1333	1340	1346	1353
4078983	1320	1320	1322	1326	1332	1338	1344	1351
4078953	1318	1318	1321	1327	1333	1339	1345	1352
4078923	1316	1317	1320	1328	1335	1342	1349	1356
4078893	1315	1316	1320	1327	1334	1341	1348	1355
4078863	1314	1316	1320	1327	1334	1341	1348	1355
4078833	1314	1316	1321	1328	1336	1343	1350	1357
4078803	1314	1316	1321	1328	1335	1342	1349	1356
4078773	1312	1315	1320	1327	1334	1342	1349	1356
4078743	1311	1315	1320	1329	1336	1342	1349	1355

Table XI-2. Grid cell number (first flow routing parameter) obtained from column 1 of the input file 30MGRD01.SR1, showing grid cell ordering based on elevation (higher elevation cells have lower grid cell numbers) for a subset of grid cells located in upper Solitario Canyon (subset was extracted from the TRANSFORM file CHN-R1.HDF).

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547181	547211	547241	547271	547301	547331	547361	547391
4079703	68664	71180	71778	71779	72096	72424	71468	68665
4079673	67144	70598	72425	72426	72728	73045	71783	68669
4079643	66541	69291	71784	73047	73329	73644	72098	69292
4079613	66855	69293	71477	73049	74293	74294	73050	70284
4079583	67775	69937	71788	73333	73985	74578	73055	70876
4079553	68996	70880	72733	73987	74580	74581	73649	71188
4079523	69941	72107	73988	74584	75219	75220	73337	70882
4079493	71194	73343	74894	75223	75496	75224	73062	70291
4079463	72445	74588	75842	75843	75844	75228	73345	70617
4079433	73657	75500	76185	76186	76187	75231	73347	70887
4079403	74901	76190	76807	76808	76506	75233	73068	70621
4079373	75853	76809	77106	77107	76508	75238	72743	70622
4079343	76812	77434	77435	77436	76511	75510	73665	71493
4079313	77732	78063	78064	77733	76816	75512	73999	71803
4079283	78065	78701	78391	78066	77114	75863	73670	71497
4079253	78703	79040	79041	78397	77444	76200	74003	71201
4079223	79378	79379	79380	79043	77740	76517	74604	72130
4079193	79689	79981	79690	79384	78075	76819	74912	72460
4079163	79983	80299	80300	79693	78402	76822	74913	72751
4079133	80301	80647	80302	79986	79052	76826	74916	72462
4079103	80649	80974	80650	79988	78714	76830	74607	72466
4079073	81303	81304	81305	80307	78715	77123	74921	72469
4079043	81593	81884	81594	80658	78719	76834	74610	72471
4079013	82191	82192	81893	80308	78410	76210	74335	72145
4078983	82516	82517	81896	80662	78721	76839	74929	72767
4078953	83177	83178	82199	80311	78413	76532	74614	72476
4078923	83810	83501	82521	80000	77757	75534	73370	71217
4078893	84144	83813	82522	80318	78096	75879	73694	71514
4078863	84453	83818	82525	80322	78098	75880	73695	71517
4078833	84455	83822	82207	80005	77456	75266	73086	70916
4078803	84457	83828	82209	80008	77760	75537	73377	71223
4078773	85087	84157	82529	80328	78099	75538	73381	71224
4078743	85418	84161	82534	79713	77461	75540	73383	71524

Table XI-3. Downstream grid cell number (second flow routing parameter) obtained from column 7 of the output file 30MGRD01.C16, identifying the grid cell to which flow is being routed to (grid cells are identified by grid cell numbers indicated in Table XI-2) for a subset of grid cells located in upper Solitario Canyon (subset was extracted from the TRANSFORM file CHN-R2.HDF).

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547181	547211	547241	547271	547301	547331	547361	547391
4079703	71180	72425	72426	72728	73045	73045	73045	71783
4079673	71180	72425	73047	73329	73644	73644	73644	72098
4079643	70598	72425	73049	74293	74294	74294	74294	73050
4079613	69937	71788	73333	74293	74578	74578	74578	73055
4079583	70880	72733	73987	74580	74581	74581	74581	73649
4079553	72107	73988	74584	75219	75220	75220	75220	73649
4079523	73343	74894	75223	75496	75496	75496	75224	73649
4079493	74588	75842	75843	75844	75844	75844	75228	73345
4079463	75500	76185	76186	76187	76187	76187	75231	73347
4079433	76190	76807	76808	76808	76808	76506	75233	73347
4079403	76809	77106	77107	77107	77107	76508	75238	73347
4079373	77434	77435	77436	77436	77436	76511	75510	73665
4079343	78063	78064	78064	78064	77733	76816	75512	73999
4079313	78701	78701	78701	78391	78066	77114	75863	73999
4079283	79040	79041	79041	79041	78397	77444	76200	74003
4079253	79379	79380	79380	79380	79043	77740	76517	74604
4079223	79981	79981	79981	79690	79384	78075	76819	74912
4079193	80299	80300	80300	80300	79693	78402	76822	74913
4079163	80647	80647	80647	80302	79986	79052	76826	74916
4079133	80974	80974	80974	80650	79988	79052	76830	74916
4079103	81304	81305	81305	81305	80307	79052	77123	74921
4079073	81884	81884	81884	81594	80658	78719	77123	74921
4079043	82192	82192	82192	81893	80658	78719	77123	74921
4079013	82517	82517	82517	81896	80662	78721	76839	74929
4078983	83178	83178	83178	82199	80662	78721	76839	74929
4078953	83810	83810	83501	82521	80662	78721	76839	74929
4078923	84144	84144	83813	82522	80318	78413	76532	74614
4078893	84453	84453	83818	82525	80322	78098	75880	73695
4078863	84775	84455	83822	82525	80322	78098	75880	73695
4078833	85085	84457	83828	82525	80322	78098	75880	73695
4078803	85415	85087	84157	82529	80328	78099	75538	73381
4078773	85750	85418	84161	82534	80328	78099	75540	73383
4078743	86052	85423	84463	82536	80328	78104	76550	74346

Table XI-4. Flow accumulation term (number of upstream grid cells) obtained from column 9 of the output file 30MGRD01.C16. This parameter is used to identify the stream channel network for a subset of grid cells located in upper Solitario Canyon (subset was extracted from the TRANSFORM file CHN-C16.HDF).

UTM northing grid coordinates (meters)	UTM easting grid coordinates (meters)							
	547181	547211	547241	547271	547301	547331	547361	547391
4079703	1	7	22	693	2	1382	2	0
4079673	1	1	11	23	694	1389	1	0
4079643	0	0	0	12	24	2087	1	1
4079613	0	0	0	1	15	2115	2	2
4079583	2	1	1	1	0	2135	3	3
4079553	1	3	2	2	2	2141	57	50
4079523	1	2	4	3	3	2203	0	1
4079493	1	2	3	5	2212	1	0	0
4079463	1	2	3	4	2221	1	1	0
4079433	1	2	3	4	2229	2	11	8
4079403	1	2	3	2239	3	12	0	0
4079373	1	2	3	2248	13	1	0	0
4079343	1	2	3	2267	2	1	1	2
4079313	1	2	2275	3	2	2	36	32
4079283	2	2281	4	3	3	37	0	0
4079253	571	3	2291	4	38	1	1	0
4079223	27	572	2301	39	2	2	1	2
4079193	1	2903	40	3	3	2	3	3
4079163	4	2	2949	4	3	4	4	41
4079133	19	2958	5	4	56	5	43	0
4079103	22	2985	5	57	0	44	0	0
4079073	385	23	3050	1	0	68	65	2
4079043	5	3461	2	72	70	0	0	60
4079013	5	3471	73	0	0	0	0	0
4078983	6	3552	1	46	42	38	34	30
4078953	7	3562	47	0	1	1	1	1
4078923	3578	48	1	0	0	0	0	0
4078893	3636	2	1	1	0	0	0	0
4078863	3649	2	24	20	17	14	11	8
4078833	3	25	0	0	0	0	0	0
4078803	26	1	0	0	0	0	0	0
4078773	2	1	1	6	3	1	1	2
4078743	2	2	7	0	0	2	3	2

- **Listing of source code for routine CHNNET16 V1.0:**

```
PROGRAM chnnet16
c     version 1.0
c
c     Routine to calculate the flow routing parameters used as input
c     to INFIL version 2.0 for the surface water flow module and
c     also as input to the routine WATSHD20 for extracting watershed
c     model domains from the geospatial parameter base-grid
c     defined by 30MSITE.INP.
c
c     CHNNET16 is used to calculate the flow routing parameters
c     and the flow accumulation term (# of upstream cells) using
c     digital elevation data (in standard raster grid format)
c     This routine requires the output from SORTGRD1 as input.
c
c     CHNNET16 was written by Joe Hevesi
c     U.S. Geological Survey
c     Placer Hall, 6000 J Street
c     Sacramento, CA 95819-6129
c
c-----------------------------------------------------------------------
      real ssl,selev,maxsl,minsl,maxelev,minelev
      integer nloc,ncell,n2,rown,coln,maxrow,maxcol,nold
      integer edge,minrow,mincol
      integer row1,col1,row2,col2
      integer iopt,iopt2
      real lat,lon
      real totout2
c
      double precision x(1190000),y(1190000)
      integer slp,asp,loc
      real soild
      integer rblock(36)
c
      integer row(1190000),col(1190000),
      1       soilt,geol,topo
c
      integer iout(0:1204,0:985),iwat(0:1204,0:985)
      integer locid(0:1204,0:985)
      real elev(0:1204,0:985),flowout(0:1204,0:985),
     1   flowin(0:1204,0:985),totout(0:1204,0:985),
     2 run(0:1204,0:985),totin(0:1204,0:985),
     4 pond(0:1204,0:985)
      real elhole,elmin
      integer irun,nrun
      integer hole(0:1204,0:985)
c
      character*80 header
      character*20 infile,chnfile,holefile,gisfile
c
c
15    format(A)
      open(unit=7,file='chnnet16.ctl')
      read(7,15) header
      read(7,15) infile
      read(7,15) chnfile
      read(7,15) holefile
      read(7,15) gisfile
      read(7,*) iopt,iopt2
c
      open(unit=8,file=infile)
      open(unit=9,file=chnfile)
      open(unit=10,file=holefile)
```

```
      if(iopt.eq.1) open(unit=11,file=gisfile)
c
      write(10,15) header
c
      NLOC    = 1
      SSL     = 0.
      SELEV   = 0.
      MAXSL   = -99999.
      minsl   =  99999.
      MAXELEV = -99999.
      MINELEV =  99999.
C
c
      n = 1
      nn = 0
      nmax = 1000
      maxrow  = -999
      maxcol  = -999
      minrow  = 9999
      mincol  = 9999
      ncell   = 0
      n2      = 0
      elold   = 999999
      nold    = 0
c
c---- read output from sorting subroutine (SORTGRD1 or GRDSORT7)
c
100   if(iopt2.eq.1) then
c
c------- regional model input from grdsort7
       read(8,*,END=130) loc,x(n),y(n),lat,lon,row(n),col(n),
     4             el,slp,asp,soilt,
     5             soild,geol,topo,vegt,vegc,
     6             (rblock(j),j=1,36)
c
      else
c
c------- site model input from sortgrd1
       read(8,*,END=130) loc,x(n),y(n),lat,lon,row(n),col(n),
     4             el,slp,asp,soilt,dclass
     5             soild,geol,topo,vegt,vegc,
     6             (rblock(j),j=1,36)
      endif

      locid(row(n),col(n)) = loc
      elev(row(n),col(n)) = el
c
c---- option for generating grid files for mapping
c
      if(iopt.eq.1) then
         write(11,101) x(n),y(n),elev(row(n),col(n)),
      1            soilt,soild,geol,topo,vegt,vegc
101      format(1x,2f11.1,f7.0,i4,f7.2,4i40)
      endif
c
c
      if(elev(row(n),col(n)).gt.elold) then
         write(*,106) n,elev(row(n),col(n)),elold
106      format(1x,'error in sequence: n = ',i8,'elev = ',f8.2,
     1           'previous = ',f8.2)
         stop
      endif
      elold = elev(row(n),col(n))
c
```

```
      if(row(n).gt.maxrow) maxrow = row(n)
      if(col(n).gt.maxcol) maxcol = col(n)
      if(row(n).lt.minrow) minrow = row(n)
      if(col(n).lt.mincol) mincol = col(n)
      if(nold.eq.1000) then
       write(*,107) n,minrow,maxrow,mincol,maxcol,elold
107    format(1x,i8,4i5,f8.0)
       nold = 0
      endif
C
       if(el.eq.-9999.) goto 120
             ncell = ncell + 1
             if(lon.lt.0) lon = -lon
             SSL   = SSL + slp
             SELEV = SELEV + ELEV(row(n),col(n))
             IF (MAXSL.LE.slp) MAXSL = slp
             if(minsl.ge.slp) minsl = slp
             IF (MAXELEV.LE.ELEV(row(n),col(n)))
      1                    MAXELEV = ELEV(row(n),col(n))
             IF (MINELEV.GE.ELEV(row(n),col(n)))
     1              MINELEV = ELEV(row(n),col(n))


120   n = n + 1
      GOTO 100
c
c
 130  n = n-1
      rown = maxrow
      coln = maxcol
      NLOC    = n
      AVGSL   = SSL/ncell
      AVGELEV = SELEV/ncell
C
         WRITE(*,135) NLOC,ncell,AVGELEV,MAXELEV,MINELEV,AVGSL,
      1                           maxsl,MINSL
         WRITE(10,135) NLOC,ncell,AVGELEV,MAXELEV,MINELEV,AVGSL,
      1                           maxsl,MINSL
c
 135     FORMAT(/1X,'Total number of grid cells   = ',I8,
      1                    /1x,'Total number of valid cells  = ',i8,
     2          /1X,'AVERAGE ELEVATION OF SAMPLE  = ',F8.1,
     3          /1X,'MAXIMUM ELEVATION OF SAMPLE  = ',F8.1,
     4          /1X,'MINIMUM ELEVATION OF SAMPLE  = ',F8.1,
     5          /1X,'AVERAGE SLOPE OF SAMPLE      = ',F8.1,
     6          /1X,'MAXIMUM SLOPE OF SAMPLE      = ',F8.1,
      7                 /1x,'MINIMUM SLOPE OF SAMPLE      = ',F8.1,//)
c
C
      if(iopt.eq.1) close(11)
      pause
c
c---- initialize grid
c
      do 70 i = minrow-1,maxrow+1
      do 70 j = mincol-1,maxcol+1
       flowout(i,j) = 1.
         flowin(i,j)  = 0.
         totout(i,j)  = 0.
         totin(i,j)   = 0.
       iwat(i,j)     = 0
       iout(i,j)      = 0
       pond(i,j)     = -1.
       run(i,j)      = 0.
```

```
      hole(i,j)      = 0
      if((i.lt.minrow.or.i.gt.maxrow).or.
     1       (j.lt.mincol).or.(j.gt.maxcol)) then
             elev(i,j) = -9999.
      endif
      if(elev(i,j).eq.-9999.) iwat(i,j) = -3
70    continue
c
      iter = 0.
      totout2 = 0.
400   nrun = 0
      iter = iter + 1
      edge = 1
      totflow = 0.
      niwat = 1
c
      do 250 i = 1,nloc
             row1 = row(i)
             col1 = col(i)
c
c
c ------------- bypass edges of model domain
c
             if(iwat(row1,col1).eq.-3) goto 250
c
             if(row1.le.minrow.or.row1.ge.maxrow) then
                    iwat(row1,col1) = -3
                    goto 250
             endif
             if(col1.le.mincol.or.col1.ge.maxcol) then
                    iwat(row1,col1) = -3
                    goto 250
             endif
c
             elmin = elev(row1,col1)
             iout(row1,col1) = 0
             if(iter.gt.1) then
c
                    flowout(row1,col1) = flowin(row1,col1)
                    totout(row1,col1)  = totout(row1,col1) +
     1                                   flowout(row1,col1)
                    flowin(row1,col1)  = 0.
c
             endif
c
c
c ---------------- start flow routing -------------------
c
             elhole = 9999999.
             do 230 ir = -1,1
             do 230 ic = -1,1
c
                    if(ir.eq.0.and.ic.eq.0) goto 230

                    if(elhole.gt.elev(row1+ir,col1+ic))
     1                     elhole = elev(row1+ir,col1+ic)


                    if((elev(row1+ir,col1+ic).le.elmin).and.
     1                     (locid(row1,col1).lt.locid(row1+ir,col1+ic)))then
                           if(iout(row1+ir,col1+ic).eq.locid(row1,col1))
     1                            goto 230
                                  row2 = row1+ir
                                  col2 = col1+ic
```

```
                                    elmin = elev(row2,col2)
                                    iout(row1,col1) = locid(row2,col2)
                        endif

230           continue

              if(iout(row1,col1).ne.0) then
                        flowin(row2,col2) = flowout(row1,col1)
     1                                    + flowin(row2,col2)
                        run(row2,col2) = flowin(row2,col2)
                        if(iwat(row2,col2).eq.0)
     1                                    iwat(row2,col2) = locid(row2,col2)
C
              else
c
c -------------- 20th order hole effect correction
c
                        pond(row1,col1) = elhole - elmin
                        ih = 1
245                     ih = ih + 1
                        if(ih.gt.20) goto 285

                        hole(row1,col1) = ih
                        write(*,247) iter,ih,x(i),y(i),elev(row1,col1),
     1                        iout(row1,col1),pond(row1,col1)
c
                        write(10,247) iter,ih,x(i),y(i),elev(row1,col1),
     2            iout(row1,col1),pond(row1,col1)
247                     format(2i4,3f11.1,i5,f12.2)
c
c
                        do 260 ir = -ih,ih
                        do 260 ic = -ih,ih
                              if(((ir.le.ih-1).and.(ir.ge.-(ih-1)))
     1                        .and.((ic.le.ih-1).and.(ic.ge.-(ih-1)))) goto 260


                              if(elhole.gt.elev(row1+ir,col1+ic))
     1                              elhole = elev(row1+ir,col1+ic)


                              if(elev(row1+ir,col1+ic).le.elmin) then
                                    if((iout(row1+ir,col1+ic).ne.locid(row1,col1))
     1                                    .and.(locid(row1+ir,col1+ic).gt.
     2                              locid(row1,col1))) then
                                          row2 = row1+ir
                                          col2 = col1+ic
                                          elmin = elev(row2,col2)
                                          iout(row1,col1) = locid(row2,col2)
                                    endif
                              endif
260                     continue
c
                        if(iout(row1,col1).eq.0) goto 245
c
                        flowin(row2,col2) =
     1                  flowout(row1,col1) + flowin(row2,col2)
                        run(row2,col2) = flowin(row2,col2)
                        if(iwat(row2,col2).eq.0)
     1                              iwat(row2,col2) = locid(row2,col2)
c
              endif
c
c ---------------------------------------------------
```

```
c
285           continue
              totflow = totflow + flowout(row1,col1)
c
              if(flowout(row1,col1).gt.0.) then
                    irun = 1
              else
                    irun = 0
              endif
              nrun = nrun + irun
c
250     continue
c
c
c------ calculate total outflow
c
        totout2 = 0.
        do 550 i = 1,nloc
              if(iwat(row(i),col(i)).ne.-3) goto 550
              flowout(row(i),col(i)) =
      1             flowout(row(i),col(i)) + flowin(row(i),col(i))
              flowin(row(i),col(i)) = 0.
              totout2 = totout2 + flowout(row(i),col(i))
550     continue
c
c------------- hole effect bypass
c
        if(iter.gt.30) goto 500
c
c ----------- continue iteration if exces ppt still exists
c             up to maximum iteration of 30
c
        if(nrun.gt.0) then
              WRITE(10,*) ITER,NRUN,TOTOUT2
              goto 400
        endif
500    continue
c
      do i = 1,nloc
       write(9,705) x(i),y(i),row(i),col(i),locid(row(i),col(i)),
      1       iwat(row(i),col(i)),iout(row(i),col(i)),
      2       hole(row(i),col(i)),totout(row(i),col(i)),
      3       pond(row(i),col(i))
705    format(1x,2f11.1,1x,2i4,3i8,i5,g14.6,f7.1)
c
      enddo
      close(8)
      close(9)
      stop
      end
c==========================================
```

ATTACHMENT XII

DEVELOPMENT OF GEOSPATIAL INPUT PARAMETERS USING VEGCOV01 V1.0

TOTAL PAGES: 9

Development of Geospatial Input Parameters using VEGCOV01 V1.0

1. Name of routine/macro with version/OS/hardware environment and user information:

Name of software routine: VEGCOV01 V1.0,
OS and hardware environment: Windows NT 4.0, Pentium Pro PC
Computer Identification: SM321276 with a USGS specific host-name P720dcasr
Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. Name of commercial software with version/OS/hardware used to develop routine/macro:

The source code for VEGCOV01 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. General Description of routine/macro:

VEGCOV01 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (VEGCOV01.FOR), compiled executable file (VEGCOV01.EXE), routine control file (VEGCOV01.CTL), input and output files used for routine validation, supplemental files created as part of validation testing, and a copy of this attachment, are located under the directory VEGCOV01 on a CD-ROM labeled GEOINPUT-2. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing applications such as Microsoft Word. The executable file can be used to run VEGCOV01 V1.0 on any PC with an INTEL processor (with adequate RAM).

4. Test plan for the software routine VEGCOV01 V1.0:

- **Explain whether this is a routine or macro and describe what it does:**

The software routine, VEGCOV01 V1.0, is used in the development of the geospatial parameter input files for INFIL 2.0. The routine changes the saturated hydraulic conductivity of the Yucca Mountain Tuff of the Paintbrush Group (rock type 324). The different saturated hydraulic conductivity is assigned if the exposed Yucca Mountain Tuff is north of 4082606.93 m (rock type 309 is assigned) or south of 4079955.91 m north (rock type 308 is assigned) on Yucca Mountain.

The functions of VEGCOV01 V1.0 are executed using a single routine control file named VEGCOV01.CTL. The file defines the input and output file names.

- **Listing of Control File (VEGCOV01.CTL)**

```
vegcov01.ctl                    (header line)
30mgrd01.sr1                    (primary input file)
vegtyp01.xyz                    (auxiliary input file)
30mgrd04.sr1                    (output file)
0   0                           (control options set to 0, 0)
```

- **Example listing of input file 30MGRD01.SR1 (only the first 20 lines of the file are shown):**

```
        1   546191.  4087833.  36.9372 116.4813    1   52  1969.  25 206   5
1   0.20 201    4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        2   546221.  4087833.  36.9372 116.4810    1   53  1969.  28 147   5
1   0.17 201    4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        3   546191.  4087803.  36.9370 116.4813    2   52  1959.  23 199   5
1   0.23 201    4 -99 -99  1  0  0  7  7  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 16 18
        4   546161.  4087833.  36.9372 116.4816    1   51  1955.  30 241   5
1   0.14 201    4 -99 -99  0  0  0  0  0  0  0  2 25 22  0  0  2  2  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        5   546221.  4087803.  36.9370 116.4810    2   53  1955.  28 140   5
1   0.17 201    4 -99 -99  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  7  6  0  0  8  7  0  0 22 25
        6   546191.  4087773.  36.9367 116.4813    3   52  1951.  20 188   5
1   0.27 201    4 -99 -99  1 11  4  2  2  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0 14 16
        7   546251.  4087833.  36.9372 116.4806    1   54  1950.  36 125   5
1   0.06 201    4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  3  3  2  5  3 32 28  0  0  0  0  0  0  0  0
        8   546161.  4087803.  36.9370 116.4816    2   51  1949.  27 241   5
1   0.18 201    4 -99 -99  1  0  0 13 13  5 12  2 18 15  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
        9   549311.  4087833.  36.9371 116.4463    1  156  1944.  23 180   5
1   0.23 206    4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       10   546221.  4087773.  36.9367 116.4810    3   53  1944.  28 134   5
1   0.17 201    4 -99 -99  2  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1 13 11  0  2  8  8 13  4 19 22
       11   546161.  4087773.  36.9367 116.4816    3   51  1943.  24 237   5
1   0.22 201    4 -99 -99  1 16  6 11 12  5  7  1 14 12  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
       12   546191.  4087743.  36.9364 116.4813    4   52  1942.  20 175   5
1   0.27 201    4 -99 -99 15 11  5  2  1  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  6 15 16
       13   546131.  4087833.  36.9372 116.4820    1   50  1939.  33 247   5
1   0.10 201    4 -99 -99  0  0  0  0  0  0  0  3 28 25 10 11  6  6  2  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       14   549281.  4087833.  36.9371 116.4466    1  155  1939.  26 221   5
1   0.19 206    4 -99 -99  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
       15   549341.  4087833.  36.9371 116.4459    1  157  1939.  26 155   5
1   0.19 206    4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0  0
       16   546251.  4087803.  36.9370 116.4806    2   54  1938.  35 124   5
1   0.08 201    4 -99 -99  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  4  4  3  8  5 29 26 12 15 16 15  0  0 18 21
```

```
      17   546161.  4087743.  36.9364 116.4816    4   51  1937.  23 229   5
1   0.23 201   4 -99 -99 17 18 16 17  9  1  3  1  9  7  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
      18   546131.  4087803.  36.9370 116.4820    2   50  1933.  33 252   5
1   0.10 201   4 -99 -99  1  0  0 15 14  9 26 20 28 25  7  9  5  5  2  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
      19   546281.  4087833.  36.9372 116.4803    1   55  1932.  34 130   5
1   0.09 201   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  4  8 12 17 16 31 27  0  0  0  0  0  0  0  0
      20   549371.  4087833.  36.9371 116.4456    1  158  1932.  27 153   5
1   0.18 206   4 -99 -99  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  1 13 11  0  0  0  0  0  0  0  0
```

- **Example listing of output file 30MGRD04.SR1 (only the first 20 lines of the file are shown):**

```
               1   546191.  4087833.  36.9372 116.4813    1   52  1969.  25 206   5
1   0.20 201   4   4  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
               2   546221.  4087833.  36.9372 116.4810    1   53  1969.  28 147   5
1   0.17 201   4   4  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
               3   546191.  4087803.  36.9370 116.4813    2   52  1959.  23 199   5
1   0.23 201   4   4  30  1  0  0  7  7  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 16 18
               4   546161.  4087833.  36.9372 116.4816    1   51  1955.  30 241   5
1   0.14 201   4   4  30  0  0  0  0  0  0  0  2 25 22  0  0  2  2  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
               5   546221.  4087803.  36.9370 116.4810    2   53  1955.  28 140   5
1   0.17 201   4   4  30  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  7  6  0  0  8  7  0  0 22 25
               6   546191.  4087773.  36.9367 116.4813    3   52  1951.  20 188   5
1   0.27 201   4   4  30  1 11  4  2  2  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  2  0 14 16
               7   546251.  4087833.  36.9372 116.4806    1   54  1950.  36 125   5
1   0.06 201   4   4  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  3  3  2  5  3 32 28  0  0  0  0  0  0  0  0
               8   546161.  4087803.  36.9370 116.4816    2   51  1949.  27 241   5
1   0.18 201   4   4  30  1  0  0 13 13  5 12  2 18 15  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
               9   549311.  4087833.  36.9371 116.4463    1  156  1944.  23 180   5
1   0.23 206   4  10  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
              10   546221.  4087773.  36.9367 116.4810    3   53  1944.  28 134   5
1   0.17 201   4   4  30  2  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  1 13 11  0  2  8  8 13  4 19 22
              11   546161.  4087773.  36.9367 116.4816    3   51  1943.  24 237   5
1   0.22 201   4   4  30  1 16  6 11 12  5  7  1 14 12  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
              12   546191.  4087743.  36.9364 116.4813    4   52  1942.  20 175   5
1   0.27 201   4   4  30 15 11  5  2  1  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  3  6 15 16
              13   546131.  4087833.  36.9372 116.4820    1   50  1939.  33 247   5
1   0.10 201   4   4  30  0  0  0  0  0  0  0  3 28 25 10 11  6  6  2  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
              14   549281.  4087833.  36.9371 116.4466    1  155  1939.  26 221   5
1   0.19 206   4  10  30  0  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
              15   549341.  4087833.  36.9371 116.4459    1  157  1939.  26 155   5
1   0.19 206   4  10  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0  0
```

```
                 16   546251.  4087803.  36.9370 116.4806    2   54  1938.  35 124   5
1   0.08 201   4   4  30  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  4  4  3  8  5 29 26 12 15 16 15  0  0 18 21
                 17   546161.  4087743.  36.9364 116.4816    4   51  1937.  23 229   5
1   0.23 201   4   4  30 17 18 16 17  9  1  3  1  9  7  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
                 18   546131.  4087803.  36.9370 116.4820    2   50  1933.  33 252   5
1   0.10 201   4   4  30  1  0  0 15 14  9 26 20 28 25  7  9  5  5  2  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
                 19   546281.  4087833.  36.9372 116.4803    1   55  1932.  34 130   5
1   0.09 201   4   4  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  4  8 12 17 16 31 27  0  0  0  0  0  0  0  0
                 20   549371.  4087833.  36.9371 116.4456    1  158  1932.  27 153   5
1   0.18 206   4  10  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  1 13 11  0  0  0  0  0  0  0  0
```

- **Listing of FORTRAN77 Source code:**

A listing of the FORTRAN77 source code for the routine VEGCOV01 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

To evaluate the accuracy of the functions performed by the routine, it is necessary to perform a visual inspection of the input file 30MGRD01.SR1 for rock type 324 and verify that the rock type was changed in file 30MGRD04.SR1 to 309 if the grid block location is north of northing 4082606.93 m and changed to rock type 308 if the grid block location is south of 4079955.91 m. Extractions of the input file and output file will be imported into EXCEL and it will be determined visually that the criteria are met.

- **Specify the range of input values to be used and why the range is valid:**

The input values used are those grid block locations for which the original map unit rock type is 324.

5. Test Results

- **Output from test (explain difference between input range used and possible input):**

The acceptance criteria for the testing of VEGCOV01 is that the rock type 324 is changed in the output file to 309 if the grid block location is north of northing 4082606.93 m and changed to rock type 308 if the grid block location is south of 4079955.91 m.

- **Description of how the testing shows that the results are correct for the specified input:**

If the testing results in output that conforms to the above criteria then the results are correct acceptable.

- **List limitations or assumptions to this test case and code in general:**

The test case is limited to geospatial input rock type 324.

- **Electronic files identified by name and location:**

The following electronic files including VEGCOV01 V1.0 and selected input and output files are provided:

VEGCOV01.CTL:	Control file used for specifying input and output files. A printout of the control file is included as part of this attachment.
VEGCOV01.FOR:	FORTRAN source code listing for the routine VEGCOV01. A printout of the source code is included as part of this attachment.
VEGCOV01.EXE:	Executable file for the routine VEGCOV01, compiled for INTEL processors.
Input file for test case:	30MGRD01.SR1
Output file for test case:	30MGRD04.SR1

6. Results from test case

The data in the input file and output file for VEGCOV01 was extracted to shown an example for rock type 324 in Table XII-1. The top 12 rows illustrate the input file with rock type ID 324 for a series of grid block locations, all of which are north of northing 4082606.93, and all of which indicate that the 324 was replaced with rock type 309 in the output file. The center series of 12 rows indicate that no change was made to rock type 324 between northings 4082606.93 and 4079955.91. The bottom four rows indicate that rock type 324 that occurred in grid blocks located south of 4079955.91 are replaced with rock type 308. These results confirm that the routine performs as required and meets the acceptance criteria.

Table XII-1. Comparison of extracted data from 30MGRD01.SR1, the input file to VEGCOV01 and 30MGRD04.SR1, the output file from VEGCOV01.

30MGRD01.SR1		Input file		30MGRD04.SR1		Output file	
Grid Block ID	Easting	Northing	Rock Type ID	Grid Block ID	Easting	Northing	Rock Type ID
43261	548381	4082973	324	43261	548381	4082973	309
16087	547271	4082973	324	16087	547271	4082973	309
17672	547241	4082973	324	17672	547241	4082973	309
18807	547151	4082973	324	18807	547151	4082973	309
17415	547121	4082973	324	17415	547121	4082973	309
16755	547091	4082973	324	16755	547091	4082973	309
17414	547061	4082973	324	17414	547061	4082973	309
18534	547031	4082973	324	18534	547031	4082973	309
15438	546731	4082973	324	15438	546731	4082973	309
14420	546701	4082973	324	14420	546701	4082973	309
13723	546671	4082973	324	13723	546671	4082973	309
13053	546641	4082973	324	13053	546641	4082973	309
12309	546611	4082973	324	12309	546611	4082973	309
46561	548441	4082583	324	46561	548441	4082583	324
24597	547361	4082583	324	24597	547361	4082583	324
25276	547331	4082583	324	25276	547331	4082583	324
26423	547301	4082583	324	26423	547301	4082583	324
23915	547121	4082583	324	23915	547121	4082583	324
22019	547091	4082583	324	22019	547091	4082583	324
14798	546941	4082583	324	14798	546941	4082583	324
14434	546911	4082583	324	14434	546911	4082583	324
14081	546881	4082583	324	14081	546881	4082583	324
13502	546851	4082583	324	13502	546851	4082583	324
12949	546821	4082583	324	12949	546821	4082583	324
12194	546791	4082583	324	12194	546791	4082583	324
49421	548471	4082553	324	49421	548471	4082553	324
61457	547421	4077843	324	61457	547421	4077843	308
61467	547391	4077633	324	61467	547391	4077633	308
61469	547361	4077543	324	61469	547361	4077543	308
59675	547361	4077513	324	59675	547361	4077513	308

7. Listing of source code for VEGCOV01 V1.0

```
      program vegcov01
c
c     Program to fix problem in defining hydro properties
c     for Day et al TPY unit 24 (Yucca Mt Tuff).  New properties
c     assigned according to northing position.  This model,
c     which applies only to TPY, was developed by Lorrie Flint
c     on 7/17/98
c
c     This program also provides estimates of plant cover based
c     on soil thickness for upland areasslope (steeper slopes assumed to have less
      plants),
c     aspect (north facing slopes assumed to have more plants),
c     and geology (colluvium/alluvium assumed to have more plants)
c
      integer rocktype,soiltype,depthclass,topoid,imod,irock
      integer vegt,vegc,slp,asp,row,col
      real slope,aspect,elev
      real x,y,depth
      real x2(300000),y2(300000),vegtyp(300000)
      real lat,lon
      real ridge(40)
      integer block(40)
c
      character*20 sortfile,outfile,vegtype
      character*80 header
c
5     format(A)
      open(unit=7,file='vegcov01.ctl')
      read(7,5) header
      read(7,5) sortfile
      read(7,5) vegtype
      read(7,5) outfile
      read(7,*) imod, irock
c
      open(unit=8,file=sortfile)
      open(unit=9,file=outfile)
      open(unit=10,file=vegtype)
c
      n = 1
50    read(10,*,end=100) x2(n),y2(n),vegtyp(n)
      n=n+1
      goto 50
100   n = n-1
      pause
c
      n2 = 0
200        read(8,*,end=900) locid,x,y,lat,lon,
      1    row,col,elev,slp,asp,soiltype,depthclass,
     2  depth,rocktype,topoid,
     3  vegt,vegc,(block(j), j=1,36)
c
c
c----- simple veg cover model: cover = 30%
c
           if(imod.eq.0) then
                 vegc = 30
           else
                 if(depth.le.0.4)
      1                vegc = int((0.5*depth + 0.05)*100)
                 if(depth.gt.0.4.and.depth.le.2.4)
```

```
     1                 vegc = int((0.05*depth + 0.23)*100)
                 if(depth.gt.2.4)
     1                 vegc = 35
                 vegc = int(((elev-1200)/1000)*vegc + vegc)

            endif
c
c
c
c----- TPY correction by Lorrie Flint
c
            if(irock.eq.1) then
            if(rocktype.eq.324) then
                 if(y.ge.4082606.93) then
                      rocktype = 309
                 else if (y.lt.4079955.91) then
                      rocktype = 308
                 endif
            endif
            endif
c
c----- use regional vegtypes for Yucca Mountain
c
            if(imod.eq.2) then
            do i = 1,n
                 if((x.lt.x2(i)+10.and.x.gt.x2(i)-10).and.
     1           (y.lt.y2(i)+10.and.y.gt.y2(i)-10)) then
                      vegt = vegtyp(i)
                 endif
            enddo
            endif
c
c
            WRITE(9,711) locid,x,y,lat,lon,
     1      row,col,elev,slp,asp,soiltype,depthclass,
     2   depth,rocktype,topoid,
     3   vegt,vegc,(block(j), j=1,36)
c
 711        FORMAT(1X,i8,2f10.0,2f9.4,2i5,F7.0,3i4,i3,f7.2,4i4,
     1           36i3)
c
            if(n2.eq.1000) then
                 write(*,*) locid, n2
                 n2 = 0
            endif
        n2 = n2 + 1
        goto 200
c
c
c
900     continue
        close(9)
        stop
        end
```

ATTACHMENT XIII

EXTRACTION OF WATERSHED MODELING DOMAINS USING WATSHD20 V1.0

TOTAL PAGES: 28

Extraction of Watershed Modeling Domains using WATSHD20 V1.0

1. Name of routine/macro with version/OS/hardware environment and user information:

Name of software routine: WATSHD20 V1.0,
OS and hardware environment: Windows NT 4.0, Pentium Pro PC
Computer Identification: SM321276 with a USGS specific host-name P720dcasr
Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. Name of commercial software with version/OS/hardware used to develop routine/macro:

The source code for WATSHD20 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. General Description of routine/macro:

WATSHD20 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (WATSHD20.FOR), compiled executable file (WATSHD20.EXE), routine control file (WATSHD20.CTL), input and output files, validation test files, and a copy of this attachment, are located under the directory WATSHD20 on a CD-ROM labeled GEOINPUT-2. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing or spreadsheet applications such as Microsoft WORD and EXCEL. The executable file can be used to run WATSHD20 V1.0 on any PC with an INTEL processor (with adequate RAM).

The output developed by WATSHD20 V1.0 is required for the development of the geospatial parameter input file for INFIL V2.0. The output files created by WATSHD20 are used directly as input to the program INFIL V2.0.

4. Test plan for the software routine WATSHD20 V1.0:

- **Explain whether this is a routine or macro and describe what it does:**

WATSHD20 V1.0 is the final routine applied in a sequence of FORTRAN 77 routines that are used in the development of the geospatial parameter input files for INFIL V2.0. The first function performed by WATSHD20 is the extraction of a watershed model domain based on the surface water flow routing parameters obtained from the input file 30MGRD01.C16 and the specified easting and northing coordinates of the grid cell for which the upstream area is being extracted. The grid cell coordinates are supplied as input in the routine control file and are selected based on the flow accumulation term included in the file 30MGRD01.C16.

A second function performed by WATSHD20 V1.0 is the transfer of the flow routing terms from the input file (30MGRD01.SR1) to the output file defining the watershed being modeled. This includes the second flow routing term (the downstream grid cell number) and the flow accumulation term calculated by CHNNET16. WATSHD20 modifies the second flow routing term, which is the downstream grid cell number, by identifying the perimeter grid cells surrounding the active cells for the extracted watershed model area and assigning these cells a downstream grid cell number of –3. If the grid cells have already been assigned a value of –3 in column 6 of 30MGRD01.C16 (these are the edges of the base-grid), the –3 value is carried over by WATSHD20 as the downstream cell number. The –3 values are used for identifying the perimeter grid cells, which are on the outer side of the surface water flow divide defining the active cells in the watershed model domain. The perimeter cells can rout to other perimeter cells, but cannot rout to the active watershed cells.

- **Listing of FORTRAN77 Source code:**

A listing of the FORTRAN77 source code for the routine WATSHD20 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

A validation test of the functions performed by the routine was conducted by a visual evaluation of the extracted watershed area with the topography defined by the elevation values. Using applications in ARCVIEW the map image of the extracted watershed area and the flow accumulation term is superimposed with a contour or shaded relief image of the topography to provide a method of testing that the routine has functioned correctly. The test criteria used in the visual evaluation consists of verifying that the extracted active model grid cells included in the output file created by WATSHD20 define an area that is completely bounded by surface water flow divides, with the exception of the grid cell defining the watershed outflow location. The grid cells defining the watershed perimeter must all have values of –3 for the downstream grid cell parameter, and the watershed perimeter cells must completely enclose the active model cells. The grid cell defining the watershed outflow location is specified in the routine control file, and the total number of active cells in the watershed model domain must equal 1 plus the number of cells upstream from the cell defining the watershed outflow location. The total number of lines or cells included in the output file must be equal to the number of active cells plus the number of perimeters cells.

Additional test criteria are similar to those applied in the testplan for CHNNET16 V1.0. The flow accumulation term is used to visualize the surface water routing network within the extracted watershed area, which in turn provides a method of testing the calculated flow routing parameters. The fow accumulation term must agree with the expected channel network defined by the topography (within the limitations of the standard D8 routing algorithm). Major stream channels consisting of hundreds or thousands of upstream cells must occur along the bottom of washes and not along ridgetops. The flow accumulation term must systematically increase in the downstream direction (up-hill flow cannot occur). The flow accumulation term must systematically increase with a decrease in elevation, but cannot

become greater than the sum of all contributing upstream grid cells. All flow routing must be convergent and cannot terminate unless a major sink is reached. All cells can only rout to one cell (divergent flow is not allowed).

An additional test performed as part of the routine validation is an inspection of the output file containing the flow routing parameters. The criteria of the test is that the output file must be in the proper format with the correct number and sequencing of 55 columns. The number of rows is equal to the total number of grid cells used to define the watershed model domain, including both the active model cells and the inactive perimeter cells that are used to define the watershed boundary.

- **Specify the range of input values to be used and why the range is valid:**

The input range is completely determined by the parameters in the files 30MGRD04.SR1 and 30MGRD01.C16 because this is the only source of input provided to the routine. The files are specified in the file WATSHD20.CTL, which is the routine control file for WATSHD20 and is required for the execution of the routine. 30MGRD04.SR1 is a column-formatted ASCII file consisting of 253,597 rows and 53 columns (see Attachment XII). 30MGRD01.C16 is a column formatted ASCII file consisting of 253, 597 rows and 10 columns. For the parameters used by the routine, the input ranges are specified by the following:

30MGRD01.C16 is the main input file used by WATSHD20 V1.0. Parameters in the first 9 columns provided by 30MGRD01.C16 are used as input by functions in WATSHD20 V1.0:

1. Grid cell easting coordinate (column 1)
2. Grid cell northing coordinate (column 2)
3. Grid cell row index (column 3, integers from 1 to 691)
4. Grid cell column index (column 4, integers from 1 to 367)
5. Grid cell number (column 5, integers from 1 to 253,597)
6. Perimeter grid cell identifier (column 6, integers from –3 to 253,597)
7. The downstream grid cell number (column 7, integers from 1 to 253,597)
8. Index for identifying grid cells in depressions (column 8, integers from 0 to 20)
9. The flow accumulation term (column 9, integers from 0 to 155,471)

The input range provided by the input file 30MGRD01.C16 is valid because the values were obtained from ARCINFO using the source data as input (see Attachment VI for description of source data used for 30MSITE.INP) and a sequence of applied software routines described in Attachments VI through XII of this AMR.

All Parameters provided as input from the file 30MGRD04.SR1 are transferred to the output file. WATSHD20 does not modify any of the 53 input columns provided by 30MGRD04.SR1.

5. Test Results.

- **Output from test:**

The output for the test case is the main output file WT2.W20 generated by WATSHD20 V1.0. The output file is used to generate raster-format map image files in TRANSFORM and ARCVIEW which are used only as a part of the validation test plan.

- **Description of how the testing shows that the results are correct for the specified input:**

The ARCVIEW map image (Figure XIII-1) of the main output file used for the test plan (file WT2.W20) shows that the correct watershed area has been extracted from the input file (30MGRD04.SR1) based on the comparison of the 3,142 extracted cells with the topography. For example, the map image shows that the area has been correctly defined by the surface water flow divides (the ridgetop locations) and that there is only one outflow point for the watershed, which is defined by the easting and northing coordinates specified in the control file. There is no inflow of water to the area defined by the extracted file, and with the exception of the one grid cell defining the watershed outflow location, there is no other outflow from the watershed area. This visual comparison of the test watershed area with the topography satisfies the test criteria and indicates that the routine has function correctly.

The TRANSFORM map image (Figure XIII-2) of elevation for the grid cells included in the output file shows that the elevations of all grid cells upstream of the outflow cell specified in the control file have higher elevations than the outflow cell. The only exception to this are the inactive perimeter cells downstream of the specified outflow cell. The TRANSFORM map image (Figure XIII-3) of the 2nd flow routing parameter (the downstream cell number) indicates that the 282 perimeter cells have been correctly identified by WATSHD20. The perimeter cells completely enclose the active model cells, and with the exception of the one grid cell downstream from the outflow cell identified in the control file, all perimeter cells are along surface water flow divides.
These results indicate that the test criteria for WATSHD20 have been met and the routine is functioning correctly.

The TRANSFORM map image (Figure XIII-4) of the flow accumulation term indicates that the number of upstream cells for the identified outflow cell (2,859) matches the total number of active grid cells extracted by WATSHD20, minus 1 for the outflow cell which is itself an active model cell. These results were verified in the EXCEL worksheet file WT2-W20.XLS included as part of the supporting information. The worksheet was also used to verify that the total number of grid cells in WT2.W20 equals the 2,860 active cells plus the 282 perimeter cells.

The TRANSFORM map images Figures 5 and 6 of the flow accumulation term indicates that surface water flow is being routed correctly within the watershed. All flow is convergent and is routed towards the watershed outflow location. Major stream channels consisting of hundreds or thousands of upstream cells occur along the bottom of washes and not along ridgetops. The flow accumulation term systematically increase in the downstream direction

(up-hill flow doe not occur). The flow accumulation term systematically increase with a decrease in elevation, but cannot does not become greater than the sum of all contributing upstream grid cells.
These results indicate that the test criteria for WATSHD20 have been met and the routine is functioning correctly.

Visual comparison of the input and output files indicates the correct format and ordering of columns for the output file (see example printouts included under supporting information). The output file has 55 columns, the first flow routing parameter is in column 1, and the 2nd flow routing parameter and the flow accumulation term have been correctly added as columns 8 and 9.

Inspection of the last 20 lines of the output file WT2.W20 (see printout provided under supporting information) indicates that the fifth to last line (hi-lighted in red) is the watershed outflow cell identified in the control file with the coordinates 549,671 easting, 4,076,913 northing. The grid cell has 2,859 upstream cells (indicated in column 9) and routs surface water to cell number 121,694 (indicated in column 8), which is the grid cell identified by the last line of the file. Values of –3 in column 8 identify perimeter cells that are used only to define the boundary of the watershed. The seventh to last line (hi-lighted in blue) is the one grid cell upstream of the watershed outflow cell, and has 2,858 upstream cells. These results indicate that WATSHD20 correctly performed the intended modifications to the 2nd flow routing term and that the watershed outflow location is correctly defined. No unintended modifications occurred to input parameters obtained from 30MGRD04.SR1, and thus all test criteria are satisfied.

- **List limitations or assumptions to this test case and code in general:**

The limitations of the developed test case are based on the practical limitations of verifying calculated parameter values for all 253, 597 grid cells included in the output file used for the developed test case. Validation of the entire output file used in the test case was performed as a visual evaluation of raster-based map images produced in TRANSFORM and ARCVIEW.

- **Electronic files identified by name and location:**

Electronic files are located on CD-ROM labeled GEOINPUT-2, under the directory WATSHD20, included as an attachment to the AMR. The following electronic files are provided:

WATSHD20.CTL:	Input file consisting of the input and output file names for WATSHD20 V1.0.
WATSHD20.FOR:	FORTRAN source code listing for the routine WATSHD20 V1.0. A printout of the source code is included as part of this attachment.
WATSHD20.EXE:	Executable file for the routine WATSHD20 V1.0, compiled for INTEL processors.

30MGRD04.SR1:	Input file consisting of a column-formatted, ASCII text file with 253,597 rows and 53 columns. This file was developed as the output file from VEGCOV01 V1.0 (see Attachment VII). A partial printout of the first part of this file is included as part of this attachment.
30MGRD01.C16:	Input file consisting of a column-formatted, ASCII text file with 10 columns and 253,597 rows. This file contains all flow routing parameters developed by SORTGRD1 and CHNNET16 that are used by WATSHD20 to extract watershed model domains.
WT2-W20.APR:	ARCVIEW project file (including all files in associated directories) used to create the raster-based map image (Figure XIII-1) of the extracted watershed area using the output from the test case (the test file WT2.W20).
WT2-ELEV.HDF:	TRANSFORM map image of elevation for the grid cells in the test file WT2.W20, used to visually evaluate the extracted watershed area. The file is used to create Figure XIII-2 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
WT2-8.HDF:	TRANSFORM map image of the 2nd flow routing parameter (downstream cell number) obtained from the output file WT2.W20. The file is used to create Figure XIII-3 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
WT2-9.HDF:	TRANSFORM map image of the flow accumulation term obtained from WT2.W20. The file is used to create Figure XIII-4 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
WT2-9B.HDF:	TRANSFORM map image of the flow accumulation term obtained from WT2.W20. The file is used to create Figure XIII-5 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
WT2-9C.HDF:	TRANSFORM map image of the flow accumulation term obtained from WT2.W20. The file is used to create Figure XIII-6 for the software routine validation test and is provided as supporting information. This file is not a part of the routine application.
WT2-W20.XLS:	EXCEL worksheet used to check the number of upstream cells defined by the flow accumulation term for the watershed outflow cell against the total number of active cells extracted. The worksheet is also used to check that the total number of lines in the output file is equal to the number of active cells plus the number of perimeter cells. This file is not a part of the routine application.

6. Supporting Information. (Include background information, such as revision to a previous routine or macro, or explanation of the steps performed to run the software. Include listings of all electronic files and codes used).

- **Procedure for running routine:**

To run the routine WATSHD20 V1.0, the executable file (WATSHD20.EXE), the routine control file (WATSHD20.CTL), and the input file specified in the routine control file (WATSHD20.INP) must be placed in the same directory. The routine is executed by typing WATSHD20 in a DOS window, by double clicking on the file WATSHD20.EXE in the Microsoft Windows operating system, or by typing in the path and filename in the RUN window of the Windows NT or Windows 98 start menu. The input and output file names must be in the correct sequential order as specified in the routine control file (see example listing below).

- **Example listing of routine control file WATSHD20.CTL**

```
watshd20: WT-2 Wash, 2859 active cells, new model parameters (7/26/98)
30mgrd04.sr1            (input file from VEGCOV01)
30mgrd01.c16            (input file from CHNNET16)
wt2.w20                 (main output file)
wt2.o20                 (auxiliary output file)
wt2.h20                 (auxiliary output file)
wt2.b20                 (auxiliary output file)
wt2.d20                 (auxiliary output file)
549671.0 4076913.0      (specified watershed discharge point)
0  1
```

- **Example listing of the input file 30MGRD04.SR1. The file contains 253,597 lines and 53 columns (only the first 20 lines of the file are listed).**

```
         1   546191.  4087833.  36.9372 116.4813    1   52  1969.  25 206   5  1   0.20
 201   4 -99  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0
         2   546221.  4087833.  36.9372 116.4810    1   53  1969.  28 147   5  1   0.17
 201   4 -99  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0
         3   546191.  4087803.  36.9370 116.4813    2   52  1959.  23 199   5  1   0.23
 201   4 -99  30  1  0  0  7  7  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0 16 18
         4   546161.  4087833.  36.9372 116.4816    1   51  1955.  30 241   5  1   0.14
 201   4 -99  30  0  0  0  0  0  0  0  2 25 22  0  0  2  2  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0
         5   546221.  4087803.  36.9370 116.4810    2   53  1955.  28 140   5  1   0.17
 201   4 -99  30  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  7  6  0  0  8  7  0  0 22 25
         6   546191.  4087773.  36.9367 116.4813    3   52  1951.  20 188   5  1   0.27
 201   4 -99  30  1 11  4  2  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  2  0 14 16
         7   546251.  4087833.  36.9372 116.4806    1   54  1950.  36 125   5
1   0.06 201   4 -99  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  3  3  2  5  3 32 28  0  0  0  0  0  0  0  0
         8   546161.  4087803.  36.9370 116.4816    2   51  1949.  27 241   5
1   0.18 201   4 -99  30  1  0  0 13 13  5 12  2 18 15  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
         9   549311.  4087833.  36.9371 116.4463    1  156  1944.  23 180   5
1   0.23 206   4 -99  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

```
        10   546221.  4087773.  36.9367 116.4810    3   53  1944.  28 134   5
1   0.17 201   4 -99  30  2  3  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  1 13 11  0  2  8  8 13  4 19 22
        11   546161.  4087773.  36.9367 116.4816    3   51  1943.  24 237   5
1   0.22 201   4 -99  30  1 16  6 11 12  5  7  1 14 12  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
        12   546191.  4087743.  36.9364 116.4813    4   52  1942.  20 175   5
1   0.27 201   4 -99  30 15 11  5  2  1  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  3  6 15 16
        13   546131.  4087833.  36.9372 116.4820    1   50  1939.  33 247   5
1   0.10 201   4 -99  30  0  0  0  0  0  0  0  3 28 25 10 11  6  6  2  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        14   549281.  4087833.  36.9371 116.4466    1  155  1939.  26 221   5
1   0.19 206   4 -99  30  0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
        15   549341.  4087833.  36.9371 116.4459    1  157  1939.  26 155   5
1   0.19 206   4 -99  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  1  9  7  0  0  0  0  0  0  0  0
        16   546251.  4087803.  36.9370 116.4806    2   54  1938.  35 124   5
1   0.08 201   4 -99  30  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  4  4  3  8  5 29 26 12 15 16 15  0  0 18 21
        17   546161.  4087743.  36.9364 116.4816    4   51  1937.  23 229   5
1   0.23 201   4 -99  30 17 18 16 17  9  1  3  1  9  7  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
        18   546131.  4087803.  36.9370 116.4820    2   50  1933.  33 252   5
1   0.10 201   4 -99  30  1  0  0 15 14  9 26 20 28 25  7  9  5  5  2  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  9 11
        19   546281.  4087833.  36.9372 116.4803    1   55  1932.  34 130   5
1   0.09 201   4 -99  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  4  8 12 17 16 31 27  0  0  0  0  0  0  0  0
        20   549371.  4087833.  36.9371 116.4456    1  158  1932.  27 153   5
1   0.18 206   4 -99  30  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  1 13 11  0  0  0  0  0  0  0  0
```

- **Example listing of the input file 30MGRD01.C16 (see Attachment XII for a more detailed explaination. The file contains 253, 597 lines and 10 columns (only the first 20 lines of the file are listed).**

```
546191.0  4087833.0   1  52     1    -3     0   0  0.00000    -1.0
546221.0  4087833.0   1  53     2    -3     0   0  0.00000    -1.0
546191.0  4087803.0   2  52     3     0    11   0  0.00000    -1.0
546161.0  4087833.0   1  51     4    -3     0   0  0.00000    -1.0
546221.0  4087803.0   2  53     5     0    26   0  0.00000    -1.0
546191.0  4087773.0   3  52     6     0    21   0  0.00000    -1.0
546251.0  4087833.0   1  54     7    -3     0   0  0.00000    -1.0
546161.0  4087803.0   2  51     8     0    27   0  0.00000    -1.0
549311.0  4087833.0   1 156     9    -3     0   0  0.00000    -1.0
546221.0  4087773.0   3  53    10     0    43   0  0.00000    -1.0
546161.0  4087773.0   3  51    11    11    32   0  1.00000    -1.0
546191.0  4087743.0   4  52    12     0    33   0  0.00000    -1.0
546131.0  4087833.0   1  50    13    -3     0   0  0.00000    -1.0
549281.0  4087833.0   1 155    14    -3     0   0  0.00000    -1.0
549341.0  4087833.0   1 157    15    -3     0   0  0.00000    -1.0
546251.0  4087803.0   2  54    16     0    52   0  0.00000    -1.0
546161.0  4087743.0   4  51    17     0    41   0  0.00000    -1.0
546131.0  4087803.0   2  50    18     0    57   0  0.00000    -1.0
546281.0  4087833.0   1  55    19    -3     0   0  0.00000    -1.0
549371.0  4087833.0   1 158    20    -3     0   0  0.00000    -1.0
```

- **Example listing of the output file WT2.W20 created for the test case (only the first 20 lines of the file are shown). This file defines a watershed model domain and is supplied directly to INFIL V2.0 as the geospatial parameter input file. Column 8 is the modified second flow routing parameter obtained from 30MGRD01.C16. Column 9 is the flow accumulation term obtained from 30MGRD01.C16.**

```
    31864   547421.0  4076823.0  36.8379 116.4682  368   93      -3      0.
1506.  10 211   5   1   0.50 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    31865   547421.0  4076793.0  36.8377 116.4682  369   93      -3      0.
1506.   8 206   5   1   0.46 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    31866   547421.0  4076763.0  36.8374 116.4682  370   93      -3      0.
1506.   7 205  10   1   0.44 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1
    31867   547421.0  4076733.0  36.8371 116.4682  371   93      -3      0.
1506.   6 205  10   1   0.42 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1
    32048   547481.0  4077063.0  36.8401 116.4675  360   95      -3      0.
1505.  10 220   5   1   0.50 314   4   3  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32049   547451.0  4076913.0  36.8387 116.4678  365   94      -3      0.
1505.  10 222   5   1   0.50 314   4   5  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32239   547481.0  4077033.0  36.8398 116.4675  361   95      -3      0.
1504.   7 209   5   1   0.44 314   5   3  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32240   547421.0  4076853.0  36.8382 116.4682  367   93      -3      0.
1504.  12 219   5   1   0.47 314   4   5  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  2  3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32241   547421.0  4076703.0  36.8368 116.4682  372   93      -3      0.
1504.   4 191  10   1   0.38 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2  3
    32435   547511.0  4077153.0  36.8409 116.4672  357   96      -3      0.
1503.   8 221   5   1   0.46 314   5   3  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32436   547511.0  4077123.0  36.8406 116.4672  358   96   33791      0.
1503.   6 228   5   1   0.42 314   6   3  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32437   547481.0  4077003.0  36.8396 116.4675  362   95   33411      0.
1503.   5 208  10   1   0.40 314   6   3  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32438   547481.0  4076973.0  36.8393 116.4675  363   95   33412      0.
1503.   4 231   5   1   0.38 314   6   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32439   547451.0  4076943.0  36.8390 116.4678  364   94      -3      0.
1503.  11 225   5   1   0.48 314   4   5  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  2  3  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
    32440   547481.0  4076943.0  36.8390 116.4675  364   95   34392      0.
1503.   6 116   5   1   0.42 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  1  1  1
    32441   547451.0  4076883.0  36.8385 116.4678  366   94   33606      0.
1503.   6 227  10   1   0.42 314   6   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  1  2  3
    32442   547451.0  4076853.0  36.8382 116.4678  367   94   33607      0.
1503.   6  90  10   1   0.42 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  1  0  2  2  0  0  0  1  0  0  0  0  0  0  1  1  1
    32443   547451.0  4076763.0  36.8374 116.4679  370   94   33415      0.
1503.   6  82  10   1   0.42 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  2  2  0  0  0  5  4  0  0  1  1  1  1  1  1
```

```
    32444   547451.0  4076733.0  36.8371 116.4679  371   94   33216      0.
1503.   5  99  10   1   0.40 314   5   5  30  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  5  4  0  0  1  1  1  1  1  1
    32620   547511.0  4077243.0  36.8417 116.4671  354   96      -3      0.
1502.  10 209   5   1   0.50 314   5   3  30  1  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  1  1  1
```

- **Example listing of the output file WT2.W20 created for the test case (only the last 20 lines of the file are shown). The fifth to last line (hi-lighted in red) is the watershed outflow cell identified in the control file with the coordinates 549,671 easting, 4,076,913 northing. The grid cell has 2,859 upstream cells (indicated in column 9) and routs surface water to cell number 121,694 (indicated in column 8), which is the grid cell identified by the last line of the file. Values of –3 in column 8 identify perimeter cells that are used only to define the boundary of the watershed. The seventh to last line (hi-lighted in blue) is the one grid cell upstream of the watershed outflow cell, and has 2,858 upstream cells.**

```
   117562   549581.0  4077003.0  36.8394 116.4439  362  165  119071     12.
1212.   5 138   3   4   6.00 301   2   3  30  8  8  8  9  9  8  7  5  2  1
0  0  0  1  3  4  5  5  8  9  8  6  6  8 10 10  7  7  8  7  6  8  9  9 10 11
   117565   549551.0  4076973.0  36.8392 116.4443  363  164  118290   2773.
1212.   4  96   3   4   6.00 301   2   4  30  7  7  6  7  7  6  5  3  2  1
0  0  0  3  4  5  8  9 11 11  9  7  7  9 11 10  8  8  9  8  6  7  8  8  9  9
   117902   549581.0  4076943.0  36.8389 116.4440  364  165  119071      1.
1211.   7  50   3   4   6.00 301   2   4  30  7  7  7  7  6  5  4  2  2  1
0  0  1  3  5  6  7  8 11 12 13 11  9  8 10 10  9  8  8  8  6  6  7  8  8  8
   117903   549611.0  4076913.0  36.8386 116.4436  365  166  119826      3.
1211.   9  60   3   4   6.00 301   2   4  30  7  7  6  6  5  4  3  2  1  0
0  0  1  5  6  7  5  5  6  9 11 13 13 13 12  9  9  8  7  7  6  6  7  7  7  7
   118288   549611.0  4077003.0  36.8394 116.4436  362  166      -3      6.
1210.   5 143   3   4   6.00 301   2   3  30  9  9 10 10 10  9  8  5  3  2
0  0  0  0  2  5  5  5  6  9  9  6  6  8 10  9  7  7  8  7  6  8  9 10 11 11
   118290   549581.0  4076973.0  36.8392 116.4440  363  165  119071   2834.
1210.   4  97   3   4   6.00 301   2   4  30  7  7  8  8  8  7  6  4  2  1
0  0  0  2  5  6  6  6  9 11 10  8  7  8 10 10  8  8  9  7  6  7  8  9  9  9
   118675   549641.0  4077003.0  36.8394 116.4433  362  167      -3      5.
1209.   5 151   3   4   6.00 301   2   3  30 10 11 11 11 11  9  8  6  3  2
0  0  0  0  1  4  5  5  5  7  9  8  7  7  9  9  7  7  8  6  6  8 10 10 10 10
   118680   549611.0  4076943.0  36.8389 116.4436  364  166  119826      2.
1209.   6  66   3   4   6.00 301   2   4  30  8  8  8  8  7  5  4  3  2  1
0  0  0  3  5  6  5  5  7  9 11 12 10  9  9 10  8  8  8  7  6  7  8  8  8  8
   119071   549611.0  4076973.0  36.8392 116.4436  363  166  119826   2850.
1208.   4 109  10   4   6.00 301   2   4  30  8  8  9 10  9  7  6  4  3  2
0  0  0  2  4  5  5  5  7  9 10  9  8  8  9 10  7  7  9  7  6  7  8  9  9  9
   119074   549641.0  4076913.0  36.8386 116.4433  365  167      -3      0.
1208.   6  72   3   4   6.00 301   2   4  30  7  8  7  7  6  4  3  2  1  0
0  0  1  4  6  7  6  6  5  7  9 11 12 12 11 10  9  8  7  7  6  6  7  8  7  7
   119076   549641.0  4076883.0  36.8384 116.4433  366  167      -3      1.
1208.   7  83   3   4   6.00 301   2   4  30  7  8  6  6  5  4  3  2  1  0
0  2  4  6  8  9  6  6  5  7  9 11 13 13 14 13 11 10  7  8  6  6  7  7  6  6
   119446   549641.0  4076973.0  36.8392 116.4433  363  167      -3      7.
1207.   4 127   3   4   6.00 301   2   4  30  9 10 11 11 10  8  6  4  3  2
0  0  0  1  3  5  5  5  5  8  9 10  9  8  9  9  7  7  8  7  6  8  9  9  9  9
   119822   549671.0  4076973.0  36.8392 116.4429  363  168      -3      6.
1206.   4 135   3   4   6.00 301   2   4  30 11 12 11 11 10  8  7  5  4  3
0  0  0  0  2  4  5  6  5  6  8  9  8  7  9  9  7  7  8  6  6  8  9  9  9 10
   119826   549641.0  4076943.0  36.8389 116.4433  364  167  120209   2858.
1206.   4  82   3   4   6.00 301   2   4  30  8  9 10 10  8  6  5  4  3  2
0  0  0  3  5  7  6  6  6  8 10 11 11  9  9  9  8  8  8  7  6  7  8  9  8  8
```

```
   120205   549671.0  4076943.0  36.8389 116.4429  364  168      -3      8.
1205.   3 102   3   4   6.00 301   2   4  30 10 11 12 10  9  7  5  4  3  2
0  0  0  1  3  5  6  6  5  6  8 10 10  9  9  9  8  8  8  7  6  7  8  9  9  9
   120209   549671.0  4076913.0  36.8386 116.4429  365  168  121694   2859.
1205.   5  91   3   4   6.00 301   2   4  30  8  9  9  8  7  5  4  3  2  1
0  0  1  4  6  7  7  7  5  6  8 10 12 11 10  9  9  8  7  7  6  7  7  8  8  8
   120211   549671.0  4076883.0  36.8384 116.4429  366  168      -3      1.
1205.   6  77   3   4   6.00 301   2   4  30  8  9  7  6  5  4  3  2  1  0
0  2  4  8  9  9  8  8  5  6  8 10 12 13 12 11 10  9  7  7  6  6  7  7  7  7
   120918   549701.0  4076943.0  36.8389 116.4426  364  169      -3      7.
1203.   4 116   3   4   6.00 301   2   4  30 12 13 12 10  9  7  6  5  4  3
0  0  0  0  2  4  7  8  5  5  7  9 10  9  9  8  8  8  8  7  6  8  9  9  9 10
   121311   549701.0  4076913.0  36.8386 116.4426  365  169      -3      9.
1202.   4 111  10   4   6.00 301   2   4  30  9 10 10  9  8  6  6  5  3  2
0  0  0  3  5  7  9 10  5  5  7  9 11 11 10  9  9  8  7  7  6  7  8  8  8  9
   121694   549701.0  4076883.0  36.8383 116.4426  366  169      -3   2886.
1201.   5  47   3   5   5.25 321   2   4  30  8  9  8  8  6  4  5  4  2  1
0  2  5  8 10 12 12 12  8  7  7  9 11 12 12 11 10  9  7  7  6  7  7  7  7  8
```

- **Example listing of the output file WT2.B20 created for the test case (only the first 26 lines are shown). This file indicates the easting and northing coordinates of the 282 perimeter cells defining the watershed boundary (all grid cells having a value of –3 in column 8 of the file WT2.W20) and is used only to provide supporting information for the routine test plan.**

```
547421.0   4076823.0    -3
547421.0   4076793.0    -3
547421.0   4076763.0    -3
547421.0   4076733.0    -3
547481.0   4077063.0    -3
547451.0   4076913.0    -3
547481.0   4077033.0    -3
547421.0   4076853.0    -3
547421.0   4076703.0    -3
547511.0   4077153.0    -3
547451.0   4076943.0    -3
547511.0   4077243.0    -3
547481.0   4077093.0    -3
547451.0   4076703.0    -3
547511.0   4077213.0    -3
547511.0   4077183.0    -3
547451.0   4076973.0    -3
547481.0   4076703.0    -3
547511.0   4077273.0    -3
547481.0   4077123.0    -3
547451.0   4077003.0    -3
547421.0   4076883.0    -3
547451.0   4077033.0    -3
547511.0   4077303.0    -3
547481.0   4076673.0    -3
547541.0   4077363.0    -3
```

- **Figures used as part of the routine test plan:**

Figure XIII-1. ARCVIEW map image (project file WT2-W20.APR) of the test watershed WT2.W20 extracted from the geospatial parameter base-grid (30MGRD04.SR1). The 3,142 extracted watershed grid cells (including both the 2,860 active model cells and the 282 inactive perimeter cells) with less than 10 upstream cells are shaded purple. The stream channel network defined by the flow accumulation term is red for locations with 10 to 100 upstream cells, yellow for 100 to 1,000 cells, and blue for more than 1,000 cells.

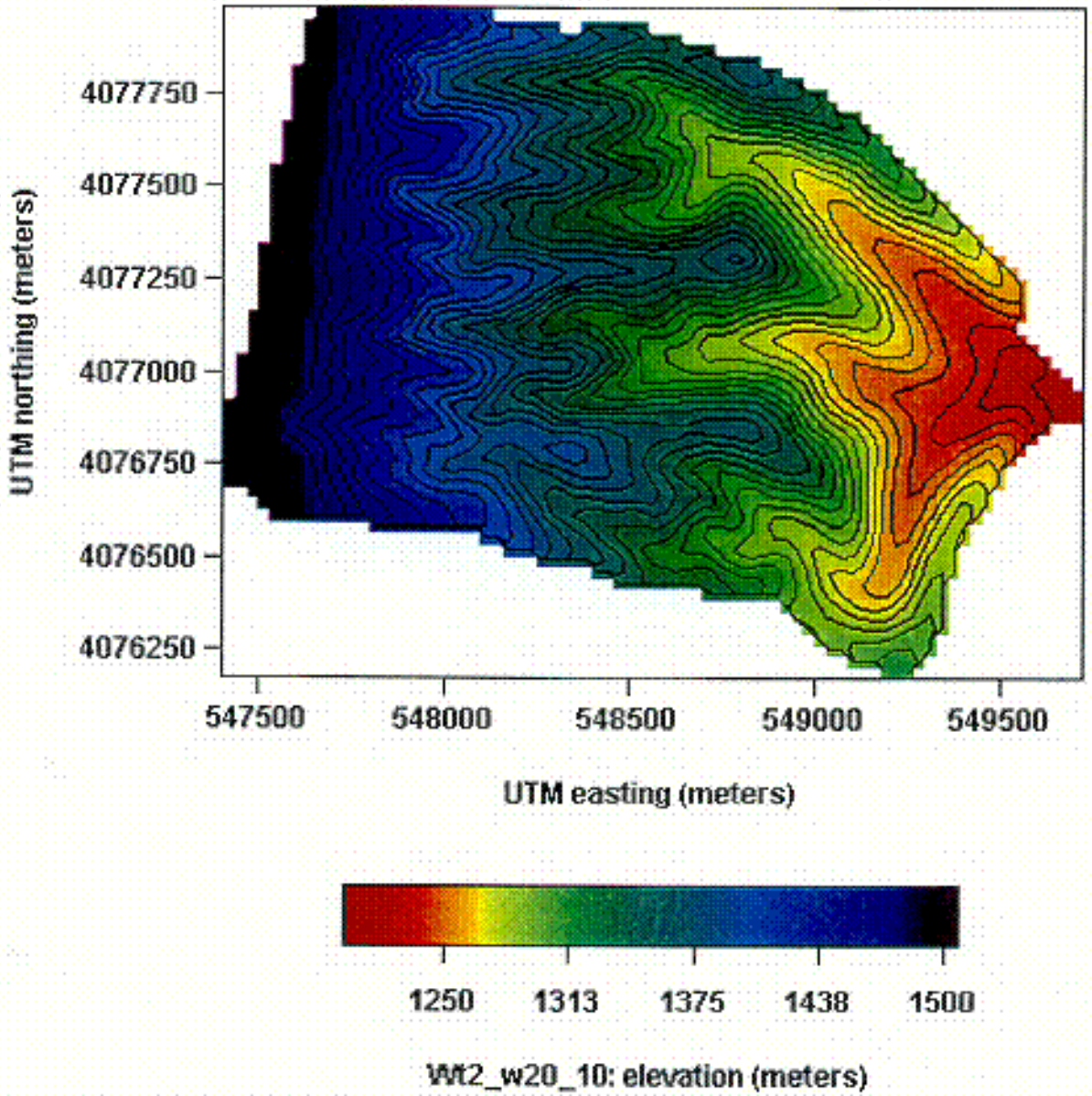

Figure XIII-2. TRANSFORM map image (file WT2-ELEV.HDF) of elevation obtained from column 10 of the test watershed (file WT2.W20). The elevation values of the 3,142 grid cells included in the watershed model domain are used to verify that the correct watershed area has been extracted by WATSHD20 V1.0.

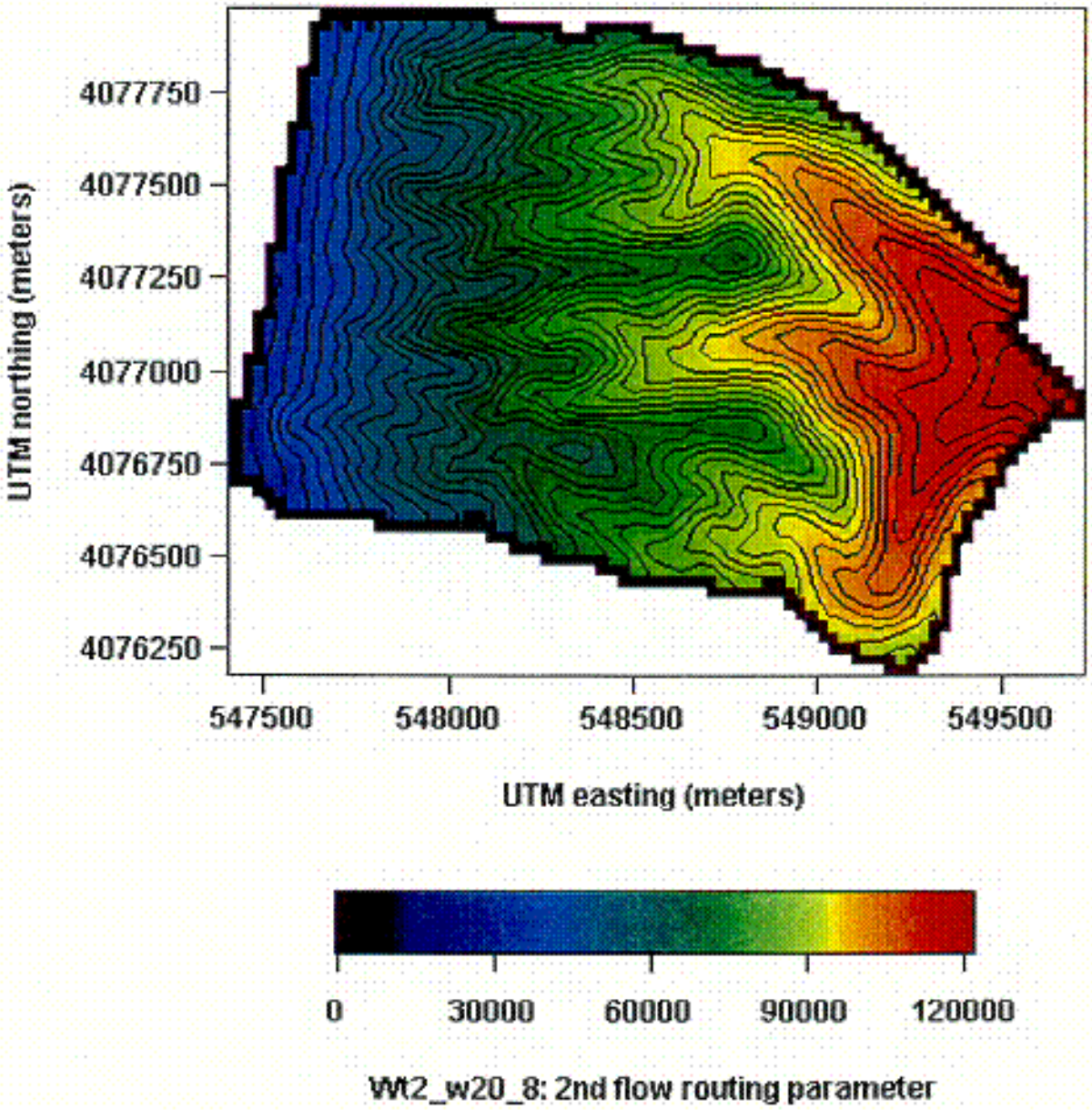

Figure XIII-3. TRANSFORM map image (file WT2-8.HDF) of the downstream cell number obtained from column 8 of the test watershed (file WT2.W20). The 282 perimeter grid cells are correctly identified by a downstream cell number of –3. The downstream cell number for the 2,860 active model cells increases in the downstream direction.

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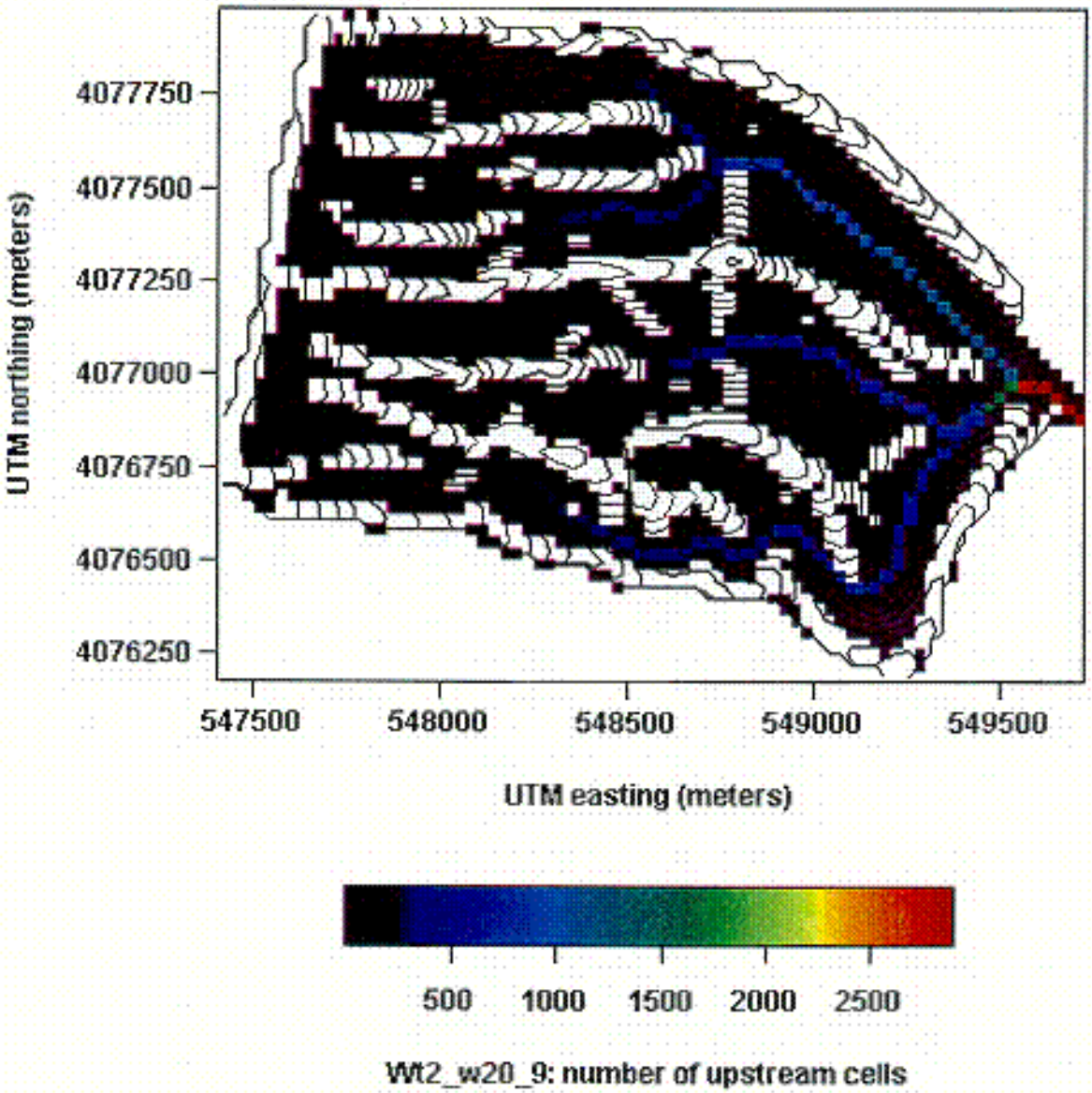


Figure XIII-4. TRANSFORM map image (file WT2-9.HDF) of the flow accumulation term obtained from column 9 of the test watershed (file WT2.W20). The grid cell defining the outflow location from the watershed has 2,859 upstream cells, and the total number of active cells in the watershed model domain is 2,860. Only those cells that are routed to from upstream cells are indicated by color in the map image. The non-colored grid cell locations correctly indicate the surface water flow divides.

C22

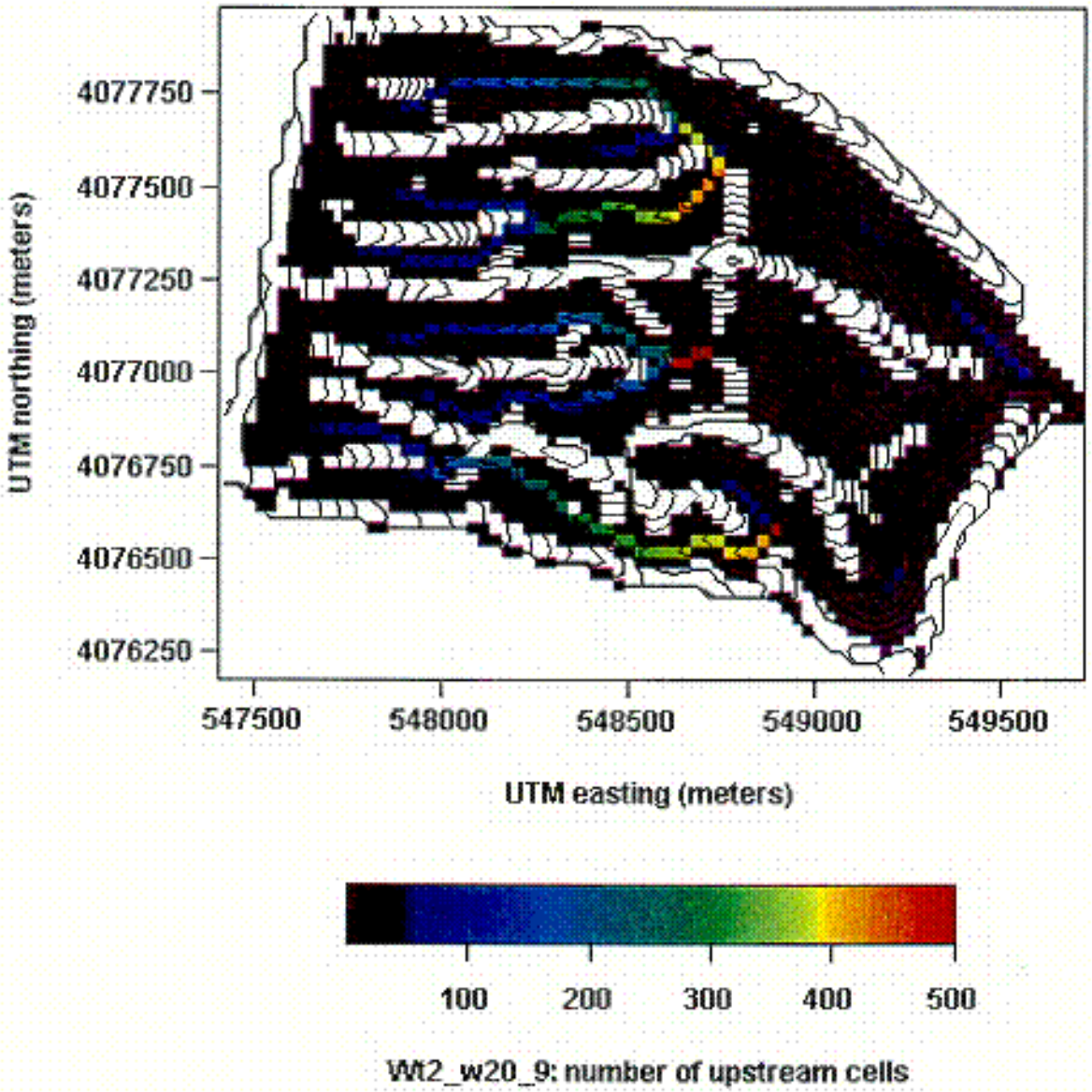


Figure XIII-5. TRANSFORM map image (file WT2-9B.HDF) of the flow accumulation term obtained from column 9 of the test watershed (file WT2.W20). All grid cells with 500 or more upstream cells are black.

C23

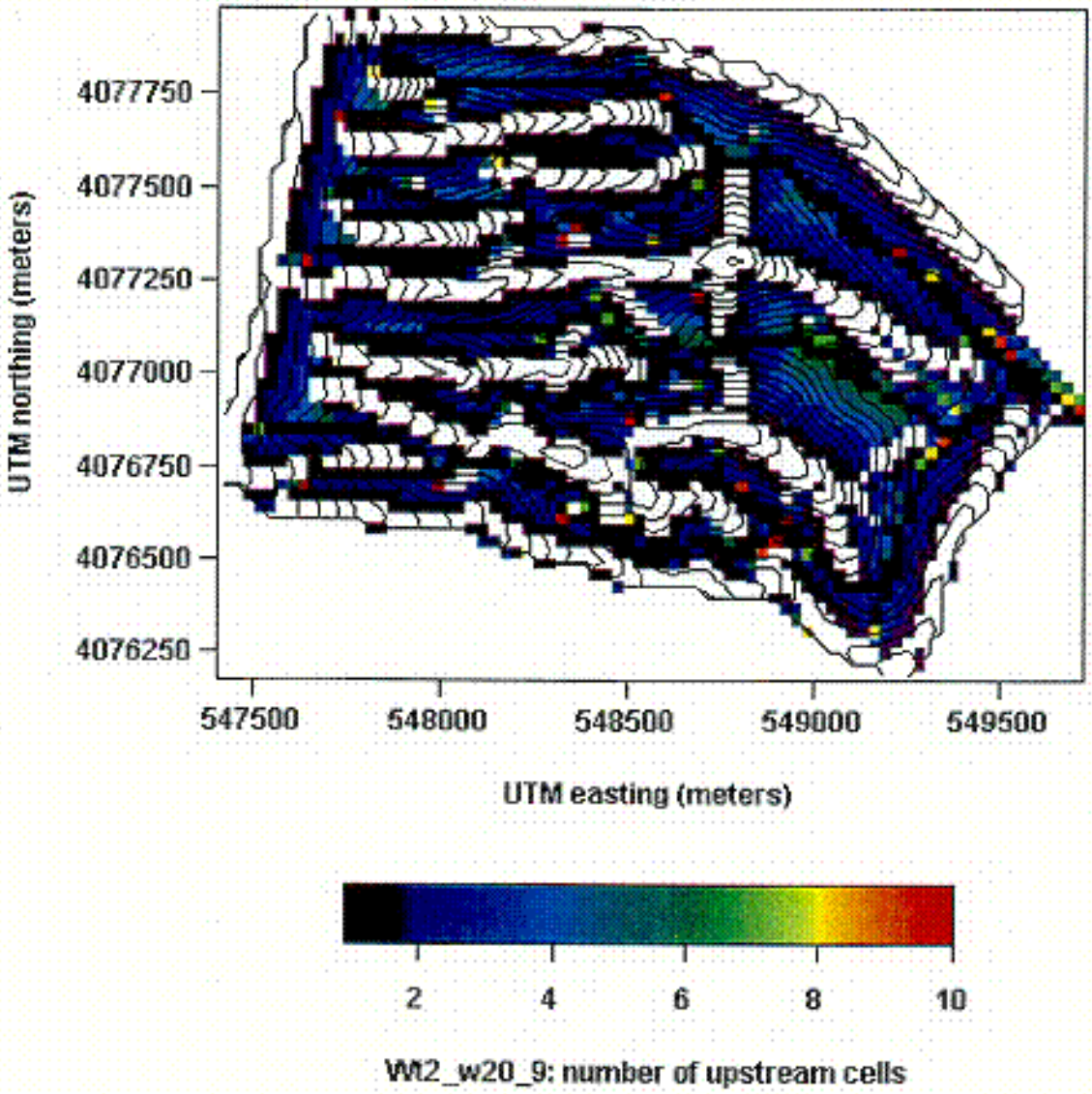


Figure XIII-6. TRANSFORM map image (file WT2-9C.HDF) of the flow accumulation term obtained from column 9 of the test watershed (file WT2.W20). All grid cells with 10 or more upstream cells are black. The map image indicates that surface water on sideslopes is being correctly routed as overland flow downslope towards channel locations.

C24

- **Listing of source code for routine WATSHD20 V1.0:**

```
PROGRAM WATSHD20
c version 1.0
c
c program to extract watershed-defined grids from
c     elevation sorted rectangular input grid
c obtained as output from SORTGRD1 and using
c surface flow routing results obtained from CHNNET16
c
c The routing method is a simple D8 convergent flow routing method
c and accounts for routing difficulties due to surface
c depressions.
c
c written by Joe Hevesi, U.S. Geological Survey
c
c-----------------------------------------------------------------------
      integer locid(0:1204,0:985)
  real el(0:1204,0:985)
  real rblock(36)
      integer row(1190000),col(1190000),irow(1190000),icol(1190000)
      integer rown,coln,nbot,iter,iter2,depthid
  integer r0,c0,r1,c1,r2,c2,r3,c3,ro,co
  integer soilt,geol,topo,vegt,vegc,slp,asp,dclass
  integer block(36)
      double precision x(0:1204,0:985),y(0:1204,0:985)
  double precision xx,yy,xbot,ybot
  real soild,lat,lon
      real emax
  real yold
  real maxelev,minelev,maxsl
  real maxx,minx,maxy,miny
  integer minrow,maxrow,mincol,maxcol
c
c----- watshed parameters
c
  real xpoint,ypoint,elbot,elmin
  real elcell
  double precision xc,yc
  integer rowc,colc,locidc,iwatc,ioutc
  real totoutc
  integer iwat(0:1204,0:985),iout(0:1204,0:985)
  integer hole(0:1204,0:985)
  integer nwat
  integer ichan,idepth
c
      character*20 infile,outfile,outfil2,holefile,boundary,
  1                  bugfile,chnfile
      character*80 header
c
c
15    format(A)
      open(unit=7,file='watshd20.ctl')
      read(7,15) header
      read(7,15) infile
  read(7,15) chnfile
      read(7,15) outfile
  read(7,15) outfil2
  read(7,15) holefile
  read(7,15) boundary
  read(7,15) bugfile
  read(7,*)  xpoint,ypoint
```

```
c
c---- added ichan option: ichan = 1 to bypass soiltype modification
c (use for generating watershed domains of original model)
c
  read(7,*) ichan, idepth
c
c
c unit 9 = main output file
c
      open(unit=8,file=infile)
      open(unit=9,file=outfile)
  open(unit=10,file=outfil2)
  open(unit=11,file=holefile)
  open(unit=12,file=boundary)
  open(unit=13,file=bugfile)
  open(unit=14,file=chnfile)
C
c
c---- initialize statistics
c -----------------------
c
  nloc    = 1
  ssl     = 0.
  selev   = 0.
  maxsl   = -99999.
  maxelev = -99999.
  minelev =  99999.
  maxx    = -99999.
  minx    =  9999999.
  maxy    = -99999.
  miny    =  9999999.
      emax    = -9999999.
C
      illopx = 0
  lnumber = 0
  inumber = 0
  maxrow  = -999
  maxcol  = -999
  minrow = 9999
  mincol = 9999

c---- read in sorted grid input
c created using sortgrd1
c ---------------------------
c
      N = 1
      coln = 0
      rown = 0
  yold = 0.
      n2    = 0
  nn2   = 0
      elold = 999999
c
  n = 1
50     read(8,*,END=70) loc,xx,yy,lat,lon,ro,co,elev,
     1              slp,asp,soilt,dclass,soild,geol,topo,
     2                vegt,vegc,(rblock(j), j=1,36)
c
c
       row(n) = ro
       col(n) = co
       x(row(n),col(n)) = xx
       y(row(n),col(n)) = yy
```

```
      el(row(n),col(n)) = elev
      locid(row(n),col(n)) = n
      n2 = n2+1
      nn2 = nn2 + 1
c
c
c ------- check to see if input is sorted by elevation
c
      if(el(row(n),col(n)).gt.elold) then
            write(*,56) n,el(row(n),col(n)),elold
56                format(1x,'error in sequence: n = ',i8,'elev = ',f8.2,
     1          'previous = ',f8.2)
            stop
      endif
      elold = el(row(n),col(n))
c
c ------- initialize routing parameters
c
      iwat(row(n),col(n)) = -2
      iout(row(n),col(n)) = 0

c
      if(row(n).gt.maxrow) maxrow = row(n)
      if(col(n).gt.maxcol) maxcol = col(n)
      if(row(n).lt.minrow) minrow = row(n)
      if(col(n).lt.mincol) mincol = col(n)
c
c ------- output to screen
c
      if(nn2.eq.1000) then
            write(*,77) n,minrow,maxrow,mincol,maxcol,
 1                              el(row(n),col(n))
77                format(1x,i8,4i5,f8.0)
            nn2 = 0
      endif
C
      ssl   = ssl + slp
      selev = selev + el(row(n),col(n))
      IF (MAXSL.LE.slp) MAXSL = slp
      IF (MAXELEV.LE.EL(row(n),col(n)))
     1 MAXELEV = EL(row(n),col(n))
      IF (MINELEV.GE.EL(row(n),col(n)))
     1 MINELEV = EL(row(n),col(n))

      if(maxx.lt.x(row(n),col(n))) maxx = x(row(n),col(n))
      if(maxy.lt.y(row(n),col(n))) maxy = y(row(n),col(n))
      if(minx.gt.x(row(n),col(n))) minx = x(row(n),col(n))
      if(miny.gt.y(row(n),col(n))) miny = y(row(n),col(n))
c
       n = n + 1
c
 GOTO 50
c
c---- done reading input, now output grid statistics
c and rewind input file
c
70    rewind(8)
c
c
 n = n - 1
 rown = maxrow-minrow-2
     coln = maxcol-mincol-2
     ncell = rown*coln
```

```
      nloc     = n
  avgsl    = ssl/nloc
      avgelev = selev/nloc
C
  WRITE(*,75) NLOC,AVGELEV,MAXELEV,MINELEV,AVGSL,MAXSL,NCELL,
  1            coln,rown
  WRITE(13,75) NLOC,AVGELEV,MAXELEV,MINELEV,AVGSL,MAXSL,NCELL,
  1            coln,rown
c
75     FORMAT(/1X,'TOTAL NUMBER OF LOCATIONS     = ',I8,
     1          /1X,'Average elevation of sample  = ',F8.1,
     2          /1X,'Maximum elevation of sample  = ',F8.1,
     3          /1X,'Minimum elevation of sample  = ',F8.1,
     4          /1X,'Average slope of sample      = ',F8.1,
     5          /1X,'Maximum slope of sample      = ',F8.1,
     6          /1X,'Number of active locations   = ',I8,
     7         /1x,'number of active columns     = ',i8,
     8          /1x,'number of active rows        = ',i8)
c
  write(*,76) minx,maxx,miny,maxy
  write(13,76) minx,maxx,miny,maxy
76     format(1x,'minimum easting                = ',f11.1,
     1       /1x,'maximum easting                = ',f11.1,
     2    /1x,'minimum northing              = ',f11.1,
     3       /1x,'maximum northing               = ',f11.1,//)
C
C
c---- read in channel network parameters obtained
c using chnnet16
c ---------------------------------------------
c
  nc=1
100    read(14,*,end=105) xc,yc,rowc,colc,locidc,
  1    iwatc,ioutc,holec,totoutc,pondc
c
  if((locidc.eq.locid(row(nc),col(nc))).and.
  1    (rowc.eq.row(nc)).and.(colc.eq.col(nc))) then
c
       iout(row(nc),col(nc)) = ioutc
       hole(row(nc),col(nc)) = holec
c
  endif
  nc = nc + 1
  goto 100
c
c --- initialize grid borders
c
c
105    rewind(14)
c
  do i = mincol-1,maxcol+1
       el(minrow-1,i) = -99999.
       el(maxrow+1,i) = -99999.
  enddo
c
  do i = minrow-1,maxrow+1
       el(i,mincol-1) = -99999.
       el(i,maxcol+1) = -99999.
  enddo
c
c---- find specified starting point
c ------------------------------
c
```

```
      do i = 1,nloc
           if((xpoint.ge.x(row(i),col(i))-15.).and.
     1     (xpoint.lt.x(row(i),col(i))+15.).and.
     2     (ypoint.ge.y(row(i),col(i))-15.).and.
        3     (ypoint.lt.y(row(i),col(i))+15.)) then
                xbot  = x(row(i),col(i))
            ybot  = y(row(i),col(i))
                elbot = el(row(i),col(i))
                nbot = i
           endif
      enddo
c
      nw = 0
c
      write(*,300) xbot,
     1     ybot,elbot,
     2     locid(row(nbot),col(nbot)),
        3 iout(row(nbot),col(nbot)),
     4     iwat(row(nbot),col(nbot))
c
      write(13,300) xbot,
     1     ybot,elbot,
     2     locid(row(nbot),col(nbot)),
        3 iout(row(nbot),col(nbot)),
     4     iwat(row(nbot),col(nbot))
c
c
c---- start uphill search from 1st point
c -----------------------------------
c
      elmin = elbot
      nwat = 0
      r0 = row(nbot)
      c0 = col(nbot)
      iwat(r0,c0) = 0
c
c ------ 1st loop for cells surrounding starting cell
c
      do 200 ir = -1,1
      do 200 ic = -1,1
           if(ir.eq.0.and.ic.eq.0)    goto 200
c
           r1 = r0+ir
           c1 = c0+ic
           if((r1.ge.maxrow.or.r1.le.0)
     1           .or.(c1.ge.maxcol.or.c1.le.0))    goto 200
           if(locid(r1,c1).gt.locid(r0,c0))        goto 200
                if(el(r1,c1).eq.-99999)                                    goto 200
           if(iout(r1,c1).eq.locid(r0,c0)) then
                nw = nw + 1
                irow(nw) = r1
                icol(nw) = c1
                iwat(r1,c1) = nw
c
                write(*,300) x(irow(nw),icol(nw)),
     1          y(irow(nw),icol(nw)),el(irow(nw),icol(nw)),
     2          locid(irow(nw),icol(nw)),iout(irow(nw),icol(nw)),
     3          iwat(irow(nw),icol(nw))
c
                write(13,300) x(irow(nw),icol(nw)),
     1          y(irow(nw),icol(nw)),el(irow(nw),icol(nw)),
     2          locid(irow(nw),icol(nw)),iout(irow(nw),icol(nw)),
     3          iwat(irow(nw),icol(nw))
```

```
c
c
 300                format(1x,2f11.1,f8.1,3i6)
c
      endif
c
c
200   continue
c
c
c---- start main loop
c -------------------------------
C
 iter2 = 1
 iter = 0
 nw1 = 1
600   nw2 = nw
 iter = iter + 1
 write(13,*) iter2,iter,nw1,nw2,nw
 write(*,*) iter2,iter,nw1,nw2,nw
 do 400 i = nw1,nw2
      r0 = irow(i)
      c0 = icol(i)
      elcell = el(r0,c0)
c
c ------ 1st loop for cells surrounding starting cells
c
      do 450 ir = -1,1
      do 450 ic = -1,1
             if(ir.eq.0.and.ic.eq.0) goto 450
c
             r1 = r0+ir
             c1 = c0+ic
             if(el(r1,c1).eq.-99999) goto 450
             if(iwat(r1,c1).gt.-2) goto 450
             if(el(r1,c1).lt.elcell) goto 450
             if(iout(r1,c1).eq.locid(r0,c0)) then
                    nw = nw + 1
                    irow(nw) = r1
                    icol(nw) = c1
                    iwat(r1,c1) = nw
c
             endif
c
             write(11,247) i,iter,x(r1,c1),y(r1,c1),
 1                         el(r1,c1),iout(r1,c1)
247                 format(2i8,3f11.1,i8)
c
c
450          continue
400   continue
c
c---- if cells exist in temporary array, then do next iteration
c
 if(nw.gt.nw2) then
      nw1 = nw2 + 1
      goto 600
 endif
c
c
c---- define watershed boundary cells
c niwat = number of boundary cells
c ---------------------------------
```

```
c
  niwat = 0
  do i = 1,nloc
       if (iwat(row(i),col(i)).gt.-2) then
       do 700 ir = -1,1
       do 700 ic = -1,1
              r1 = row(i)+ir
              c1 = col(i)+ic
              if(ir.eq.0.and.ic.eq.0) goto 700
              if(iwat(r1,c1).eq.-2) then
                           iwat(r1,c1) = -3
                           niwat = niwat + 1
              endif

700           continue
       endif
  enddo
  write(*,*) niwat
  write(13,*) niwat
c
c==================================
c
c
c---- check beyond boundary for holes
c loop through all cells to find boundary cells
c ------------------------------------------------
c
  nhole = 0
  iter2 = iter + 1
  do 1500 i = 1,nloc
       r1 = row(i)
       c1 = col(i)
       if(iwat(r1,c1).ne.-3) goto 1500
c
c
c------- explore 19 layers beyond perimeter cell to find hole
c      cells outside of watershed identified by iwat < 0
c      if hole found (hole > 0) then see if hole routs to
c      watershed
c
c
       do 1000 j = 1,19
c
              do 1050 ir2 = -j,j
              do 1050 ic2 = -j,j
                     if(((ir2.le.j-1).and.(ir2.ge.-(j-1)))
     1               .and.((ic2.le.j-1).and.(ic2.ge.-(j-1)))) goto 1050

                     r2 = r1+ir2
                     c2 = c1+ic2
                     if(r2.lt.minrow.or.r2.gt.maxrow) goto 1050
                     if(c2.lt.mincol.or.c2.gt.maxcol) goto 1050
                     if(iwat(r2,c2).ge.0) goto 1050
                     if(hole(r2,c2).gt.0) then
c
c---------------- if hole found explore 20 layers to see if
c                            hole routs to watershed
c
                            do 1100 j2 = 1,20
                                   do 1110 ir3 = -j2,j2
                                   do 1110 ic3 = -j2,j2
                                          if(((ir3.le.j2-1).and.(ir3.ge.-(j2-
       1))).and.
```

```
     1                                    ((ic3.le.j2-1).and.(ic3.ge.-(j2-1))))
     2                                          goto 1110
                                                r3 = r2+ir3
                                                c3 = c2+ic3
                                                if(r3.lt.minrow.or.r3.gt.maxrow)
       goto 1110
                                                if(c3.lt.mincol.or.c3.gt.maxcol)
       goto 1110
                                                if(iwat(r3,c3).lt.0) goto 1110


              if(locid(r3,c3).eq.iout(r2,c2)) then
                                                                nhole = nhole + 1
                                                                nw = nw + 1
                                                                irow(nw) = r2
                                                                icol(nw) = c2
                                                                iwat(r2,c2) = nw

                                  write(*,2065) nw,x(r2,c2),y(r2,c2),
  1                               el(r2,c2),x(r3,c3),y(r3,c3)
                                  write(13,2065) nw,x(r2,c2),y(r2,c2),
  1                               el(r2,c2),x(r3,c3),y(r3,c3)
 2065                                   format(1x,i8,2f11.1,f7.1,2f11.1)

 c
                                                                  endif
 1110                                   continue
 1100                             continue
                     endif
 1050                continue
 1000          continue
 1500   continue
        if(nw.gt.nw2) then
        nw1 = nw2 + 1
        goto 600
   endif
 c
 c
 c==================================
 c
 c return from perimeter test
 c
 c---- generate output file
 c re-read unit 9 (unit 9 = main output file)
 c
 c
 c
 c---- dummy vegetation type and cover parameters (vegt, vegc)
 c added as place holders
 c
   vegt = -99
   vegc = -99
 c
 c
 c----- added depthclass parameter (dclass)
 c
   i2 = 0
   do i = 1,nloc
        read(8,*) loc,xx,yy,lat,lon,ro,co,elev,slp,asp,
   1              soilt,dclass,soild,geol,topo,vegt,vegc,
      2              (block(j), j=1,36)
 c
        read(14,*) xc,yc,rowc,colc,locidc,
```

```
  1     iwatc,ioutc,holec,totoutc,pondc
c
c---- error trap: check files to be safe
c
      if((xc.ne.xx).and.(yc.ne.yy)) stop
c
c
      if(iwat(row(i),col(i)).ne.-2) then
            if(row(i).eq.minrow.or.row(i).eq.maxrow)
  1         iwat(row(i),col(i)) = -3
            if(col(i).eq.mincol.or.col(i).eq.maxcol)
  1         iwat(row(i),col(i)) = -3
            if(iwat(row(i),col(i)).eq.-3) iout(row(i),col(i)) = -3
            i2 = i2 + 1
c
c------- mod to specify channel soil-type for numeric channels
c
            if(ichan.eq.1) then
                  if(totoutc.gt.50) soilt = 4
            endif
c
c------- if idepth = 0 then use default soil depths
c     (2nd to last soil depth model)
c
c------- if idepth = 1 use new soil depth model
c     (last soil depth model)
            if(idepth.eq.1) then
                  if(dclass.eq.1) then
                        soild = 0.01
                        if(slp.le.10) soild = (slp*0.02)+0.3
                        if(slp.gt.10.and.slp.le.39)
  1                           soild = (10-slp)*0.017+0.5
c
                  else if(dclass.eq.2) then
                        soild = 0.5
                        if(slp.le.25) soild = 3-(0.1*slp)
c
                  else if(dclass.eq.3.or.dclass.eq.5.or.dclass.eq.6)
  1               then
                        soild = 3.
                        if(slp.le.20) soild = (6-0.15*slp)
                  endif
c
c
c-------- if idepth = 2 use 1st soil depth model
c
            else if(idepth.eq.2) then
                  if(dclass.eq.1) then
                        soild = 0.5 - slp*0.01
                  else if(dclass.eq.2) then
                        if(slp.le.20) then
                              soild = 3.0 - slp*0.125
                        else
                              soild = 0.5
                        endif
                  else if(dclass.eq.3.or.dclass.eq.5.or.
  1               dclass.eq.6) then
                        if(slp.le.20) then
                              soild = 6.0 - slp*0.15
                        else
                              soild = 3.0
                        endif
                  endif
```

```
c
c---------- simple soil depth option
c
              else if(idepth.eq.3) then
                     if(dclass.eq.1) soild = 0.35
                     if(dclass.eq.2) soild = 1.5
                     if(dclass.eq.3) soild = 4.0
                     if(dclass.eq.4) soild = 6.0
c
c---------- original soil depth model
c
              else if(idepth.eq.4) then
                     if(dclass.eq.1) soild = 0.5
                     if(dclass.eq.2) soild = 1.5
                     if(dclass.eq.3) soild = 4.5
                     if(dclass.eq.4) soild = 6.0
              endif
c
              write(9,715) i,xx,yy,lat,lon,ro,co,
  1           iout(row(i),col(i)),totoutc,elev,slp,asp,
     2        soilt,dclass,soild,geol,topo,vegt,vegc,
     3        (block(j), j=1,36)
c
715                  format(1x,i8,2f11.1,2f9.4,2i5,i8,f8.0,f7.0,
  1                         4i4,f7.2,4i4,36i3)

              write(10,730) x(row(i),col(i)),
  1           y(row(i),col(i)),el(row(i),col(i)),
  2           locid(row(i),col(i)),iout(row(i),col(i)),
  3           iwat(row(i),col(i)),hole(row(i),col(i)),totoutc
c
730                  format(1x,2f11.1,f8.1,4i7,f9.0)
c
c
c---------- output boundary cells
c
              if(iwat(row(i),col(i)).eq.-3) then
                     write(12,725) x(row(i),col(i)),y(row(i),col(i)),
  1                                iwat(row(i),col(i))
725                       format(1x,f12.1,f12.1,i6)
              endif
c
       endif
  enddo
  stop
c
      CLOSE(9)
  close(10)
  close(11)
  close(12)
  close(13)
      END
```

ATTACHMENT XIV

POST-PROCESSING OF MODEL RESULTS USING MAPADD20 V1.0

TOTAL PAGES: 16

Post-processing of model results using MAPADD20 V1.0

1. **Name of routine/macro with version/OS/hardware environment and user information:**

   Name of software routine: MAPADD20 V1.0,
   OS and hardware environment: Windows NT 4.0, Pentium Pro PC
   Computer Identification: SM321276 with a USGS specific host-name P720dcasr
   Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
   User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. **Name of commercial software with version/OS/hardware used to develop routine/macro:**

   The source code for MAPADD20 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. **General Description of routine/macro:**

   MAPADD20 V1.0 is a FORTRAN77 routine developed in accordance with AP-SI.1Q, specifically for the analysis/model activity documented in this AMR. The routine source code (MAPADD20.FOR), compiled executable file (MAPADD20.EXE), routine control file (MAPADD20.CTL), input and output files used for routine validation, supplemental files created as part of validation testing, and a copy of this attachment, are located under the directory MAPADD20 on a CD-ROM labeled POSTINF-1. The routine source code, control file, and the input and output files are ASCII text files that can be read using any standard ASCII text editor and can be imported into standard word processing applications such as Microsoft Word. The executable file can be used to run MAPADD20 V1.0 on any PC with an INTEL processor (with adequate RAM).

4. **Test plan for the software routine MAPADD20 V1.0:**
   - **Explain whether this is a routine or macro and describe what it does:**

   MAPADD20 is a post processing routine that uses output from INFIL V2.0 computer software to perform three tasks in the process of developing net-infiltration estimates for nine separate climate scenarios: (1) the routine averages results in files from individual simulations into a single result, (2) the routine adds together simulation files for several watersheds into single files, and (3) the routine compares selected files to determine the minimum net infiltration value among the files for a given grid block and produces a new file with the minimum net infiltration values for all grid blocks in the original files.

   The specific rationale for these tasks is described in detail in the main document (Section 6.9). Briefly, task (1) is used to determine the average result of simulations run for several analog sites that represent a given climate scenario, task (2) is used to combine results from individual watersheds into the entire composite watershed model domain,

and task (3) is done to define the minimum net-infiltration estimates for the lower bound modern climate scenario by sampling the 1980-95 simulation, the 4JA 100-year stochastic simulation, and the driest (in terms of net infiltration) 10-year period within the 4JA 100-year simulation, which is 1980-1990.

- **Listing of FORTRAN77 Source code:**

A listing of the FORTRAN77 source code for the routine MAPADD20 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

To evaluate the accuracy of the functions performed by the routine, there are 3 test cases used to evaluate the accuracy of MAPADD20 in performing its expected calculations. Task (1) will use MAPADD20 to calculate an arithmetic mean of values of simulated net infiltration from two files. This will be verified for the values by calculating the final mean as (File1+File2)/2. Task (2) will be verified visually using maps of the individual watersheds and the final composite watershed model domain to evaluate if they occupy the same space. Task (3) will be evaluated by calculating a minimum with MAPADD20 using three input files of values and producing an output file. The input files and the output file will be imported into EXCEL and it will be determined for a selection of the data if the output value for a given grid block is the minimum value of the three input values for the grid block.

- **Specify the range of input values to be used and why the range is valid:**

For task (1) the routine needs to be able to compute an arithmetic mean and any range of data chosen from the simulated infiltration test for the evaluation is valid. For task (2) all of the ten watersheds are used to visually ascertain if the final composite watershed model domain is produced using MAPADD20. For task (3) the routine needs to be able to calculate a minimum value from a selection of values and any range of data chosen from simulated infiltration values is acceptable.

5. **Test Results**
   - **Output from test (explain difference between input range used and possible input):**

The acceptance criteria for the testing of MAPADD20 is that the output must provide for task (1), an accurate arithmetic mean to zero decimal places, for task (2) that a visual determination that the files of the 10 individual watersheds occupy the same space as the final composite file when illustrated graphically, and for task (3), that for a selection of values MAPADD20 accurately selects the minimum value.

- **Description of how the testing shows that the results are correct for the specified input:**

If the testing results in output that conforms to the above criteria then the results are correct for the specified input.

- **List limitations or assumptions to this test case and code in general:**

Limitations to the developed test cases (1) and (3) consist of the selection only of a small number of values that are assumed to be representative of the entire data sets. Limitations to test case (2) are based on the ability of the evaluator to discern that two maps occupy the same space.

- **Electronic files identified by name and location:**

The following electronic files including MAPADD20 V1.0 and selected input and output files are provided:

MAPADD20.FOR:	FORTRAN source code listing for the routine MAPADD20. A printout of the source code is included as part of this attachment.
MAPADD20.EXE:	Executable file for the routine MAPADD20, compiled for INTEL processors.
Test Case for task (1):	Input files SC2-MU1.504 and SC2-MU2.504 and output file OUTPUT.TXT. Selections of these files are illustrated in Table XIV-1 for the verification.
Test Case for task (3):	Input files YM1-X.4E4, 4JA1-X.4E4 and 4JA1-90.4E4 and output file MODERN1.OUT. Net infiltration values for selected grid block locations from these files are illustrated in Table XIV-5 for the verification.

6. Test Case for Task (1): calculation of arithmetic mean

Extraction of input files are illustrated below in Table XIV-1 and Table XIV-2. Table XIV-3 is an extraction of the same grid blocks for the corresponding output file from MAPADD20 that calculates an arithmetic mean of the two input files. Table XIV-4 is a calculation of the arithmetic mean of values in Tables XIV-1 and XIV-2 performed as (Value1+Value2)/2. The values in Table XIV-3 and Table XIV-4 for corresponding grid block locations match, indicating that the routine MAPADD20 correctly performs the specified function.

Table XIV-1. Extraction of input file SC2-MU1.504

easting	northing	precip	rain	snow-fall	snow-cover	snow-melt	sublim-ation	evapo-trans	run-infil	del-soil	net-infil	runoff
545621	4075233	390.64838	390.31409	0.33429	0.91931	0.31581	0.01848	392.27072	0	-1.64082	0	0
545621	4075203	390.52993	390.19574	0.33419	0.91685	0.31467	0.01952	392.24604	0	-1.73563	0	0
545591	4075233	390.41155	390.26021	0.15134	0.38352	0.14303	0.00831	392.0268	0	-1.62357	0	0
545591	4075203	390.29324	390.14195	0.15129	0.3828	0.14261	0.00868	391.98121	0	-1.69664	0	0
545621	4075173	390.17502	390.02377	0.15125	0.38223	0.14229	0.00896	391.91474	0	-1.74868	0	0
545561	4075203	390.05687	389.90567	0.1512	0.3828	0.14266	0.00854	391.72013	0	-1.6718	0	0
545591	4075173	390.05687	389.90567	0.1512	0.38237	0.1424	0.0088	391.76968	0	-1.72161	0	0
545561	4075173	389.93879	389.78764	0.15115	0.3825	0.14251	0.00864	391.62292	0	-1.69276	0	0
545621	4075143	389.93879	389.78764	0.15115	0.38197	0.14218	0.00897	391.68411	0	-1.75429	0	0
545531	4075173	389.8208	389.66969	0.15111	0.38226	0.14239	0.00872	391.5222	0	-1.71012	0	0
545561	4075143	389.8208	389.66969	0.15111	0.38186	0.14214	0.00896	391.56645	0	-1.75461	0	0
545591	4075143	389.8208	389.66969	0.15111	0.38185	0.14214	0.00897	384.62755	0	0.55348	0	4.6308
545501	4075173	389.70288	389.55181	0.15106	0.3821	0.14232	0.00874	391.4104	0	-1.71626	0	0
545531	4075143	389.70288	389.55181	0.15106	0.38181	0.14214	0.00892	391.44264	0	-1.74869	0	0
545501	4075143	389.46726	389.31629	0.15097	0.38176	0.14217	0.0088	391.18893	0	-1.73047	0	0
545591	4075113	389.46726	389.31629	0.15097	0.38172	0.14214	0.00883	391.19263	0	-1.7342	0	0
545471	4075173	389.34957	389.19864	0.15093	0.38186	0.14226	0.00867	391.04835	0	-1.70745	0	0
545501	4075113	389.34957	389.19864	0.15093	0.38173	0.14218	0.00875	391.06159	0	-1.72077	0	0
545531	4075113	389.34957	389.19864	0.15093	0.38158	0.14208	0.00884	391.07804	0	-1.73731	0	0
545561	4075113	389.34957	389.19864	0.15093	0.38157	0.14208	0.00884	384.5676	0.7188	0.57015	0	4.9218
545471	4075143	389.23195	389.08107	0.15088	0.38179	0.14224	0.00864	390.92549	0	-1.70218	0	0
545561	4075083	389.23195	389.08107	0.15088	0.38172	0.1422	0.00868	390.9323	0	-1.70903	0	0
545471	4075113	389.11441	388.96358	0.15083	0.38165	0.14218	0.00865	390.81158	0	-1.70582	0	0
545501	4075083	389.11441	388.96358	0.15083	0.38159	0.14215	0.00869	383.91684	0	0.59475	0	4.5941
545531	4075083	389.11441	388.96358	0.15083	0.38155	0.14212	0.00871	398.52077	8.17741	-1.23766	0	0

Table XIV-2. Extraction of input file SC2-MU2.504

easting	northing	precip	rain	snow-fall	snow-cover	snow-melt	Sublim-ation	Evapo-trans	run-infil	del-soil	net-infil	runoff
545621	4075233	394.33749	386.76666	7.57083	21.29757	7.2249	0.34593	392.16129	0	-1.64526	0	3.47552
545621	4075203	394.21793	386.6494	7.56853	21.2211	7.20413	0.36441	392.14155	0	-1.73799	0	3.44997
545591	4075233	394.09847	388.10767	5.9908	15.10834	5.68791	0.30289	391.95811	0	-1.63227	0	3.46974
545591	4075203	393.97896	387.98997	5.98899	15.06655	5.67397	0.31502	392.84929	0.96379	-1.67158	0	3.45002
545621	4075173	393.85967	387.8725	5.98717	15.03006	5.66302	0.32416	391.85825	0	-1.75537	0	3.43264
545561	4075203	393.74034	387.75498	5.98536	15.03408	5.67505	0.31031	392.59228	0.96067	-1.64765	0	3.44606
545591	4075173	393.74034	387.75498	5.98536	15.01869	5.66631	0.31905	392.63596	0.95307	-1.69674	0	3.43515
545561	4075173	393.62118	387.63763	5.98355	15.00758	5.66975	0.3138	392.49194	0.95274	-1.66866	0	3.43684
545621	4075143	393.62118	387.63763	5.98355	14.9884	5.65887	0.32468	391.63636	0	-1.7618	0	3.42194
545531	4075173	393.50211	387.52038	5.98174	14.98262	5.66532	0.31642	392.39373	0.95036	-1.6861	0	3.42843
545561	4075143	393.50211	387.52038	5.98174	14.9684	5.65726	0.32448	391.52263	0	-1.76234	0	3.41735
545591	4075143	393.50211	387.52038	5.98174	14.96808	5.65708	0.32466	370.07629	0.13904	-0.73597	0	23.9761
545501	4075173	393.383	387.40307	5.97993	14.96111	5.66286	0.31707	391.3702	0	-1.72564	0	3.42137
545531	4075143	393.383	387.40307	5.97993	14.9505	5.65684	0.32309	392.31421	0.94631	-1.72366	0	3.41568
545501	4075143	393.14523	387.16891	5.97631	14.91675	5.65716	0.31915	392.06503	0.94254	-1.70684	0	3.41042
545591	4075113	393.14523	387.16891	5.97631	14.91516	5.65627	0.32005	392.06398	0.93692	-1.71102	0	3.40913
545471	4075173	393.02637	387.05186	5.97451	14.90407	5.65973	0.31478	391.01993	0	-1.71812	0	3.40978
545501	4075113	393.02637	387.05186	5.97451	14.89954	5.65717	0.31734	391.03369	0	-1.73127	0	3.40661
545531	4075113	393.02637	387.05186	5.97451	14.89406	5.65406	0.32045	391.05083	0	-1.74753	0	3.40262

easting	northing	precip	rain	snow-fall	snow-cover	snow-melt	Sublim-ation	Evapo-trans	run-infil	del-soil	net-infil	runoff
545561	4075113	393.02637	387.05186	5.97451	14.89393	5.65399	0.32052	370.29435	1.34731	-0.72987	0	24.4886
545471	4075143	392.90765	386.93495	5.9727	14.88554	5.65896	0.31375	391.80519	0.93871	-1.67989	0	3.40731
545561	4075083	392.90765	386.93495	5.9727	14.88304	5.65754	0.31516	391.80516	0.93097	-1.68709	0	3.40539
545471	4075113	392.78906	386.81816	5.9709	14.86451	5.65676	0.31414	391.69097	0.93409	-1.68386	0	3.4019
545501	4075083	392.78906	386.81816	5.9709	14.8623	5.65552	0.31538	369.33118	0	-0.7198	0	23.8623
545531	4075083	392.78906	386.81816	5.9709	14.86084	5.65469	0.31621	409.5185	20.2297	-1.11013	0	4.29423

Table XIV-3. Extraction of output file, OUTPUT.TXT

easting	northing	precip	rain	snow-fall	snow-cover	snow-melt	Sublim-ation	Evapo-trans	run-infil	del-soil	net-infil	runoff
545621	4075233	392.49293	388.54038	3.95256	11.10844	3.77035	0.18221	392.216	0	-1.64304	0	1.73776
545621	4075203	392.37393	388.42257	3.95136	11.06898	3.7594	0.19196	392.1938	0	-1.73681	0	1.72498
545591	4075233	392.25501	389.18394	3.07107	7.74593	2.91547	0.1556	391.99245	0	-1.62792	0	1.73487
545591	4075203	392.1361	389.06596	3.07014	7.72467	2.90829	0.16185	392.41525	0.4819	-1.68411	0	1.72501
545621	4075173	392.01734	388.94813	3.06921	7.70615	2.90266	0.16656	391.88649	0	-1.75203	0	1.71632
545561	4075203	391.8986	388.83033	3.06828	7.70844	2.90885	0.15942	392.1562	0.48034	-1.65972	0	1.72303
545591	4075173	391.8986	388.83033	3.06828	7.70053	2.90436	0.16392	392.20282	0.47653	-1.70918	0	1.71758
545561	4075173	391.77999	388.71263	3.06735	7.69504	2.90613	0.16122	392.05743	0.47637	-1.68071	0	1.71842
545621	4075143	391.77999	388.71263	3.06735	7.68519	2.90053	0.16683	391.66024	0	-1.75805	0	1.71097
545531	4075173	391.66146	388.59503	3.06643	7.68244	2.90386	0.16257	391.95797	0.47518	-1.69811	0	1.71422
545561	4075143	391.66146	388.59503	3.06643	7.67513	2.8997	0.16672	391.54454	0	-1.75848	0	1.70867
545591	4075143	391.66146	388.59503	3.06643	7.67497	2.89961	0.16681	377.35192	0.06952	-0.09125	0	14.3034
545501	4075173	391.54294	388.47744	3.0655	7.6716	2.90259	0.16291	391.3903	0	-1.72095	0	1.71069
545531	4075143	391.54294	388.47744	3.0655	7.66615	2.89949	0.166	391.87842	0.47315	-1.73618	0	1.70784
545501	4075143	391.30624	388.2426	3.06364	7.64926	2.89967	0.16397	391.62698	0.47127	-1.71866	0	1.70521
545591	4075113	391.30624	388.2426	3.06364	7.64844	2.89921	0.16444	391.62831	0.46846	-1.72261	0	1.70457
545471	4075173	391.18797	388.12525	3.06272	7.64297	2.90099	0.16173	391.03414	0	-1.71279	0	1.70489
545501	4075113	391.18797	388.12525	3.06272	7.64063	2.89967	0.16304	391.04764	0	-1.72602	0	1.70331
545531	4075113	391.18797	388.12525	3.06272	7.63782	2.89807	0.16465	391.06444	0	-1.74242	0	1.70131
545561	4075113	391.18797	388.12525	3.06272	7.63775	2.89804	0.16468	377.43097	1.03306	-0.07986	0	14.7052
545471	4075143	391.0698	388.00801	3.06179	7.63367	2.9006	0.16119	391.36534	0.46936	-1.69104	0	1.70365
545561	4075083	391.0698	388.00801	3.06179	7.63238	2.89987	0.16192	391.36873	0.46548	-1.69806	0	1.7027
545471	4075113	390.95173	387.89087	3.06087	7.62308	2.89947	0.16139	391.25127	0.46704	-1.69484	0	1.70095
545501	4075083	390.95173	387.89087	3.06087	7.62194	2.89884	0.16203	376.62401	0	-0.06253	0	14.2282
545531	4075083	390.95173	387.89087	3.06087	7.6212	2.89841	0.16246	404.01963	14.2035	-1.17389	0	2.14711

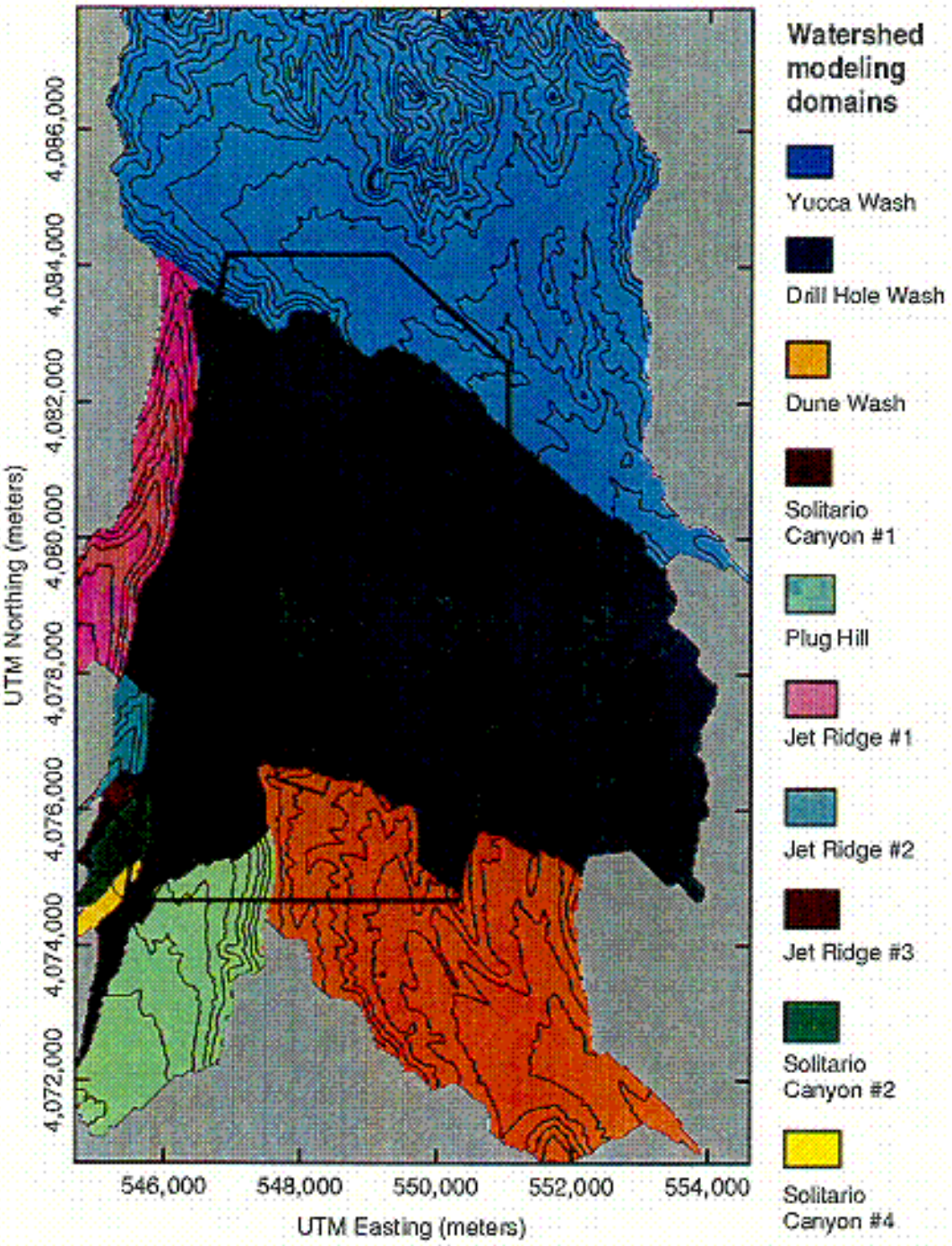
Table XIV-4. Extraction of calculated arithmetic means for comparison with values from Table XIV-3.

easting	northing	precip	rain	snow-fall	snow-cover	snow-melt	Sublim-ation	Evapo-trans	run-infil	del-soil	net-infil	runoff
545621	4075233	392.49294	388.54038	3.95256	11.10844	3.770355	0.182205	392.21601	0	-1.64304	0	1.73776
545621	4075203	392.37393	388.42257	3.95136	11.06897	3.7594	0.191965	392.1938	0	-1.73681	0	1.72498
545591	4075233	392.25501	389.18394	3.07107	7.74593	2.91547	0.1556	391.99246	0	-1.62792	0	1.73487
545591	4075203	392.1361	389.06596	3.07014	7.724675	2.90829	0.16185	392.41525	0.48189	-1.68411	0	1.72501
545621	4075173	392.01735	388.94814	3.06921	7.706145	2.902655	0.16656	391.8865	0	-1.75202	0	1.71632
545561	4075203	391.89861	388.83033	3.06828	7.70844	2.908855	0.159425	392.15621	0.48033	-1.65972	0	1.72303
545591	4075173	391.89861	388.83033	3.06828	7.70053	2.904355	0.163925	392.20282	0.47653	-1.70917	0	1.71757
545561	4075173	391.77999	388.71264	3.06735	7.69504	2.90613	0.16122	392.05743	0.47637	-1.68071	0	1.71842
545621	4075143	391.77999	388.71264	3.06735	7.685185	2.900525	0.166825	391.66024	0	-1.75804	0	1.71097
545531	4075173	391.66146	388.59504	3.066425	7.68244	2.903855	0.16257	391.95797	0.47518	-1.69811	0	1.71421

easting	northing	precip	rain	snow-fall	snow-cover	snow-melt	Sublim-ation	Evapo-trans	run-infil	del-soil	net-infil	runoff
545561	4075143	391.66146	388.59504	3.066425	7.67513	2.8997	0.16672	391.54454	0	-1.75847	0	1.70867
545591	4075143	391.66146	388.59504	3.066425	7.674965	2.89961	0.166815	377.35192	0.06952	-0.09124	0	14.3034
545501	4075173	391.54294	388.47744	3.065495	7.671605	2.90259	0.162905	391.3903	0	-1.72095	0	1.71068
545531	4075143	391.54294	388.47744	3.065495	7.666155	2.89949	0.166005	391.87843	0.47315	-1.73617	0	1.70784
545501	4075143	391.30625	388.2426	3.06364	7.649255	2.899665	0.163975	391.62698	0.47127	-1.71865	0	1.70521
545591	4075113	391.30625	388.2426	3.06364	7.64844	2.899205	0.16444	391.62831	0.46846	-1.72261	0	1.70456
545471	4075173	391.18797	388.12525	3.06272	7.642965	2.900995	0.161725	391.03414	0	-1.71278	0	1.70489
545501	4075113	391.18797	388.12525	3.06272	7.640635	2.899675	0.163045	391.04764	0	-1.72602	0	1.70330
545531	4075113	391.18797	388.12525	3.06272	7.63782	2.89807	0.164645	391.06444	0	-1.74242	0	1.70131
545561	4075113	391.18797	388.12525	3.06272	7.63775	2.898035	0.16468	377.43098	1.03305	-0.07986	0	14.7052
545471	4075143	391.0698	388.00801	3.06179	7.633665	2.9006	0.161195	391.36534	0.46935	-1.69103	0	1.70365
545561	4075083	391.0698	388.00801	3.06179	7.63238	2.89987	0.16192	391.36873	0.46548	-1.69806	0	1.70269
545471	4075113	390.95174	387.89087	3.060865	7.62308	2.89947	0.161395	391.25128	0.46704	-1.69484	0	1.70095
545501	4075083	390.95174	387.89087	3.060865	7.621945	2.898835	0.162035	376.62401	0	-0.06252	0	14.2282
545531	4075083	390.95174	387.89087	3.060865	7.621195	2.898405	0.16246	404.01964	14.2035	-1.17389	0	2.14711

7. Test Case for Task (2)

Figure XIV-1 illustrates the boundaries for the 10 watersheds used as input to MAPADD20. Figure XIV-2 illustrates the final boundary of the composite model domain as produced by MAPADD20, indicating a successful verification of routine function for this task.



elevation contour interval = 50 meters

Figure XIV-1. Location of 10 individual watershed model domains used as input to MAPADD20.

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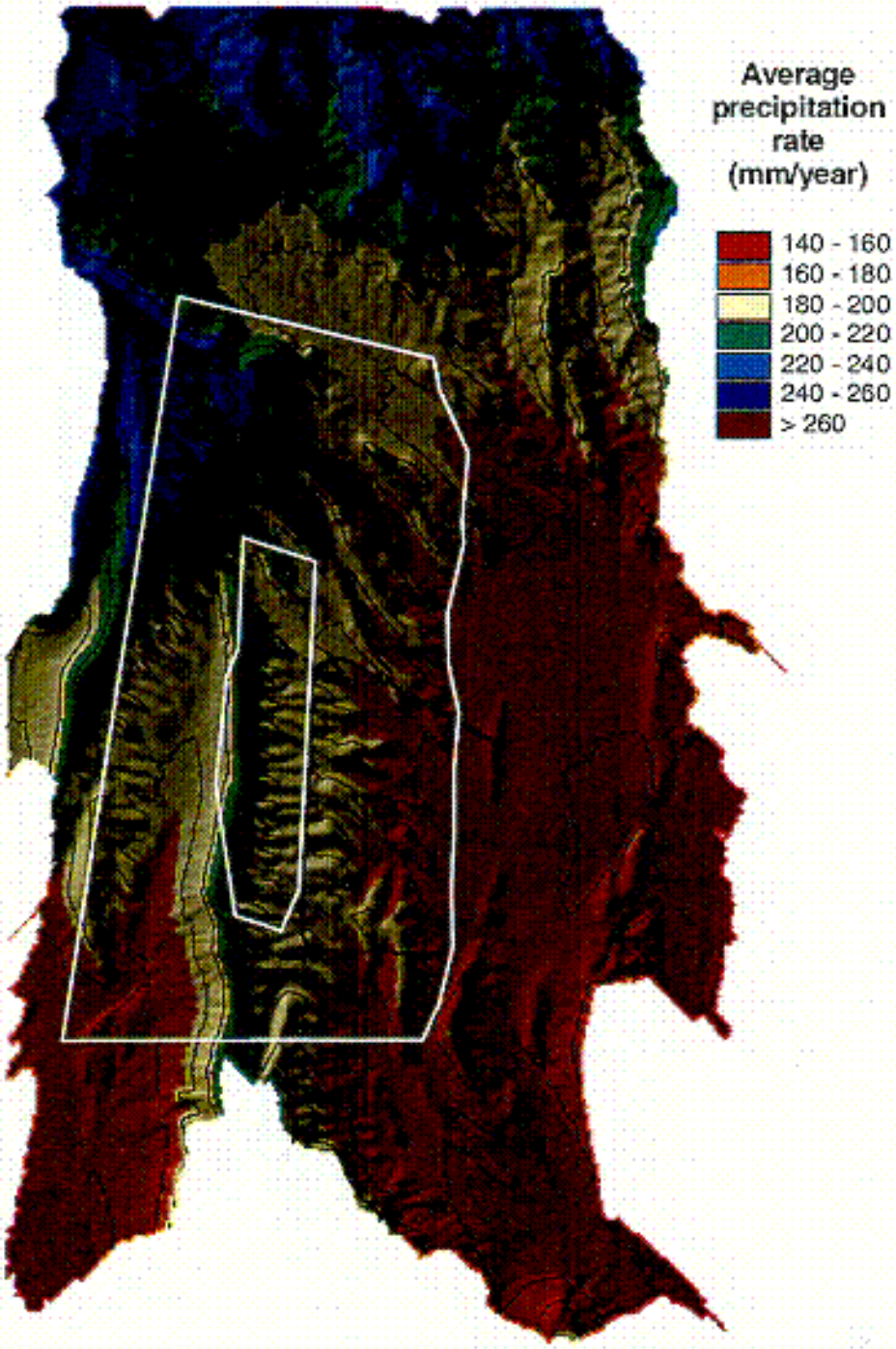

Figure XIV-2. Composite model domain obtained as output from the addition of all 10 watersheds in MAPADD20 and used for, in this example, representation of precipitation rate for the site.

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8. Test Case for Task (3)

This test case uses files as input to MAPADD20 that are output files from INFIL simulating infiltration. The net infiltration column, along with the easting and northing grid block location for each file were extracted from the files that were used as input to MAPADD20. The minimum infiltration value was chosen for the three input files for each grid block location. This value is then compared to the net-infil column extracted from the output file from MAPADD20 for the same grid block locations. The values match exactly, indicating a successful routine function for this task.

Table XIV-5. Input files for MAPADD20 and output files and calculated minimum net infiltration for a selection of grid blocks.

Input file 4ja1-90.4e4			Input file 4ja1-x.4e4			Input file ym1-x.4e4			Minimum	Output file Modern1.out		
easting	northing	net-infil	easting	northing	net-infil	easting	northing	net-infil	net- Infil	easting	northing	net-infil
546521	4083693	0.32	546521	4083693	4.07978	546521	4083693	6.18809	0.32	546521	4083693	0.32
546491	4083693	0.02	546491	4083693	3.24408	546491	4083693	5.51655	0.02	546491	4083693	0.02
546461	4083693	0	546461	4083693	3.10509	546461	4083693	5.48266	0	546461	4083693	0
546551	4083663	0	546551	4083663	3.04639	546551	4083663	5.44498	0	546551	4083663	0
546521	4083663	0.07	546521	4083663	3.37394	546521	4083663	5.41782	0.07	546521	4083663	0.07
546581	4083663	0	546581	4083663	2.88503	546581	4083663	5.38286	0	546581	4083663	0
546491	4083663	0.27	546491	4083663	3.79583	546491	4083663	5.93402	0.27	546491	4083663	0.27
546461	4083663	0.31	546461	4083663	3.89956	546461	4083663	6.16089	0.31	546461	4083663	0.31
546641	4083633	0	546641	4083633	3.07656	546641	4083633	5.43437	0	546641	4083633	0
546551	4083633	0.9	546551	4083633	4.1375	546551	4083633	6.51973	0.9	546551	4083633	0.9
546581	4083633	0.49	546581	4083633	4.0147	546581	4083633	6.50978	0.49	546581	4083633	0.49
546611	4083633	0.31	546611	4083633	3.84763	546611	4083633	6.11523	0.31	546611	4083633	0.31
546431	4083663	0.22	546431	4083663	3.68611	546431	4083663	5.76996	0.22	546431	4083663	0.22
546521	4083633	1.74	546521	4083633	4.54947	546521	4083633	6.68346	1.74	546521	4083633	1.74
546671	4083603	0.48	546671	4083603	3.95898	546671	4083603	6.47334	0.48	546671	4083603	0.48
546491	4083633	2.39	546491	4083633	4.86752	546491	4083633	6.84224	2.39	546491	4083633	2.39
546641	4083603	2.37	546641	4083603	4.85292	546641	4083603	6.83729	2.37	546641	4083603	2.37
546401	4083633	0.64	546401	4083633	8.49658	546401	4083633	16.19353	0.64	546401	4083633	0.64
546431	4083633	0.06	546431	4083633	0.33627	546431	4083633	0.60473	0.06	546431	4083633	0.06
546461	4083633	2.31	546461	4083633	4.79992	546461	4083633	6.77004	2.31	546461	4083633	2.31
546701	4083573	0.85	546701	4083573	3.95518	546701	4083573	6.31528	0.85	546701	4083573	0.85
546611	4083603	4.87	546611	4083603	5.71362	546611	4083603	6.78471	4.87	546611	4083603	4.87
546581	4083603	6.3	546581	4083603	6.1654	546581	4083603	6.78572	6.1654	546581	4083603	6.1654

9. Listing of source code for MAPADD20 V1.0

```
      program mapadd20
c     version 1.0
c
c     post-processing subroutine for INFIL v2.0 results
c
      real fn,pdone
      integer nfile,nmap,imod2
      integer inmod(20,0:10)
      double precision easting(200000,0:5),northing(200000,0:5),
     1       aappt(200000,0:5),aarain(200000,0:5),aasnow(200000,0:5),
     2       aasncv(200000,0:5),aamelt(200000,0:5),aasubl(200000,0:5),
     3       aatet(200000,0:5),aainfr(200000,0:5),aadsw(200000,0:5),
     4       aainf(200000,0:5),aaoff(200000,0:5),aarun(200000,0:5),
     5       massb(200000,0:5),maxbal(200000,0:5),massb2(200000,0:5)
```

```
c
c
      double precision gaappt,gaarain,gaasnow,gaasncv,gaamelt,gaasubl,
     1        gaatet,gaainfr,gaadsw,gaainf,gaaoff,gaarun,gmassb,
     2        gmaxbal,gmassb2
c
      double precision maxppt,maxrain,maxsnow,maxsncv,maxmelt,maxsubl,
     1        maxtet,maxinfr,maxdsw,maxinf,maxoff,maxrun,maxmassb,
     2        mxmaxbal,mxmassb2
c
      double precision minppt,minrain,minsnow,minsncv,minmelt,minsubl,
     1        mintet,mininfr,mindsw,mininf,minoff,minrun,minmassb,
     2        mnmaxbal,mnmassb2
c
      double precision maxerr,minerr
c
      character*20 infile(20,0:10)
      character*20 outfile,outfile2,sumfile,errfile
      character*20 modinfo(22)
      character*20 modstamp(200000)
      character*256 header,header2

5     format(A)
      open(unit=7,file='mapadd20.ctl')
      read(7,5) header
      read(7,5) outfile
      read(7,5) outfile2
      read(7,5) sumfile
      read(7,5) errfile
      read(7,*) imod2
      read(7,*) nfile,nmap,maxerr
      do 50 i = 1,nfile
              read(7,5) modinfo(i)
              do 50 j = 1,nmap
                      read(7,15) inmod(i,j),infile(i,j)
15                    format(i2,2x,a20)
c
50    continue
      open(unit=12,file=outfile)
      open(unit=13,file=outfile2)
      open(unit=14,file=sumfile)
      open(unit=15,file=errfile)
c
      write(14,5) header
      write(14,35) outfile,sumfile
35    format(1x,'main output file:       ',a20,
     1                /1x,'summary outputfile:     ',a20,
     2                /1x,'input files:'//)
c
      do 55 i = 1,nfile
              write(14,5) modinfo(i)
              do 55 j = 1,nmap
                      write(14,65) inmod(i,j),infile(i,j)
65                    format(1x,i2,2x,a20)
c
55    continue
      write(14,56)
56    format(/)
c
c
      minerr = -maxerr
c
      gaappt  = 0.
      gaarain = 0.
      gaasnow = 0.
      gaasncv = 0.
c
      ndata = 0
      nstart = 1
      do 400 i = 1,nfile
c
              do 350 j = 1,nmap
                      n2 = 1
```

```
                    n = nstart
                    open(unit=8,file=infile(i,j))
                    if((n2.eq.1).and.(inmod(i,j).eq.1)) read(8,5) header2
c
                    if(inmod(i,j).eq.1) then
100                 read(8,*,end=300)
     1
easting(n,j),northing(n,j),aappt(n,j),aarain(n,j),
     1                          aasnow(n,j),aasncv(n,j),aamelt(n,j),aasubl(n,j),
      2                         aatet(n,j),aainfr(n,j),aadsw(n,j),aainf(n,j),
      3                         aaoff(n,j),aarun(n,j),massb(n,j),maxbal(n,j),
     4                          massb2(n,j)
c
                        if(j.eq.1) modstamp(n) = modinfo(i)
                        n2 = n2 + 1
                        n = n + 1
                        goto 100
c
300                 nlast = n-1
                    n2 = n2 - 1
                    close(8)
c
c                   use inmod = 0 for infils4e input average annual format
                    else if(inmod(i,j).eq.0) then
110                 read(8,*,end=310)
     1                          easting(n,j),northing(n,j),aappt(n,j),
     2                          aatet(n,j),aainfr(n,j),aadsw(n,j),aainf(n,j),
      3                         aaoff(n,j),aarun(n,j),massb(n,j),maxbal(n,j)
c
c                       error trap
                        if((easting(n,j).ne.easting(n,1).or.
     1                  northing(n,j).ne.northing(n,1))) stop
c
                        if(j.eq.1) modstamp(n) = modinfo(i)
                        n2 = n2 + 1
                        n = n + 1
                        goto 110
c
310                 nlast = n-1
                    n2 = n2 - 1
                    close(8)
c
c                   use inmod = 3 for infils4e input annual format (4ja1-90)
                    else if(inmod(i,j).eq.2) then
c
c
120                 read(8,*,end=320)
     1                          easting(n,j),northing(n,j),aappt(n,j),
     2                          aatet(n,j),aadsw(n,j),aainf(n,j),aainfr(n,j),
      3                         aaoff(n,j),aarun(n,j)
c
                        if(aappt(n,j).eq.0.) goto 120
                                massb(n,j) = -9999.0
                        maxbal(n,j) = -9999.0
c
c                       error trap
                        if((easting(n,j).ne.easting(n,1).or.
     1                  northing(n,j).ne.northing(n,1))) stop
c
                        if(j.eq.1) modstamp(n) = modinfo(i)
                        n2 = n2 + 1
                        aainf(n,0) = 99999999.
                        n = n + 1
                        goto 120
c
320                 nlast = n-1
                    n2 = n2 - 1
                    close(8)
c
                    endif
                    write(*,*) i,j,nstart,n2,nlast
                    write(14,*) i,j,nstart,n2,nlast
c
```

```
350         continue
                    nstart = nlast+1
c
400 continue
c
    write(14,401)
401 format(/)
c
    ndata = nlast
    do 600 i = 1,ndata
            do 600 j = 1,nmap
c
c                   do simple averaging
                    if(imod2.ne.2) then
                    aappt(i,0) = aappt(i,0) + aappt(i,j)
                    aarain(i,0) = aarain(i,0) + aarain(i,j)
                    aasnow(i,0) = aasnow(i,0) + aasnow(i,j)
                    aasncv(i,0) = aasncv(i,0) + aasncv(i,j)
                    aamelt(i,0) = aamelt(i,0) + aamelt(i,j)
                    aasubl(i,0) = aasubl(i,0) + aasubl(i,j)
                    aatet(i,0) = aatet(i,0) + aatet(i,j)
                    aainfr(i,0) = aainfr(i,0) + aainfr(i,j)
                    aadsw(i,0) = aadsw(i,0) + aadsw(i,j)
                    aainf(i,0) = aainf(i,0) + aainf(i,j)
                    aaoff(i,0) = aaoff(i,0) + aaoff(i,j)
                    aarun(i,0) = aarun(i,0) + aarun(i,j)
                    massb(i,0) = massb(i,0) + massb(i,j)
                    maxbal(i,0) = maxbal(i,0) + maxbal(i,j)
                    massb2(i,0) = massb2(i,0) + massb2(i,j)
c
c                   mod mapadd02 (5/30/99) to catch mass balance error
                    if(massb(i,j).gt.maxerr)
    1               write(15,605) easting(i,j),northing(i,j),massb(i,j),j
c
                    if(massb(i,j).lt.minerr)
    1               write(15,605) easting(i,j),northing(i,j),massb(i,j),j
c
605                 format(2f11.1,1x,g16.6,1x,i2)
c
c
c                   lower bound modern day climate
                    else if(imod2.eq.2) then
                    if(aainf(i,0).gt.aainf(i,j)) then
                            aainf(i,0) = aainf(i,j)
                            aappt(i,0) = aappt(i,j)
                            aarain(i,0) = -9999.0
                            aasnow(i,0) = -9999.0
                            aasncv(i,0) = -9999.0
                            aamelt(i,0) = -9999.0
                            aasubl(i,0) = -9999.0
                            aatet(i,0) = aatet(i,j)
                            aainfr(i,0) = aainfr(i,j)
                            aadsw(i,0) = aadsw(i,j)
                            aaoff(i,0) = aaoff(i,j)
                            aarun(i,0) = aarun(i,j)
                            massb(i,0) = -9999.0
                            maxbal(i,0) = -9999.0
                            massb2(i,0) = -9999.0
                    endif
            endif
c
600 continue
c
c
c   write header line
    write(12,4915)
4915        format(5x,'easting',3x,'northing',1x,7x,'precip',9x,'rain',
    1                   4x,'snow-fall',3x,'snow-cover',4x,'snow-melt',
    2                   2x,'sublimation',
    2                   3x,'evapotrans',4x,'run-infil',5x,'del-soil',
    3                   4x,'net-infil',7x,'runoff',11x,'run-on',
     4                  5x,'mass-balance',6x,'max-balance',
     5                  2x,'mass-balance #2',3x,'model ID')
```

```
c
      write(13,4925)
4925        format(5x,'easting',3x,'northing',1x,7x,'precip',9x,'rain',
     1                    4x,'snow-fall',3x,'snow-cover',4x,'snow-melt',
     2                    2x,'sublimation',
     2                    3x,'evapotrans',4x,'run-infil',5x,'del-soil',
     3                    4x,'net-infil',7x,'runoff',11x,'run-on',
      4                   5x,'mass-balance',6x,'max-balance',
      5                   2x,'mass-balance #2')
c
c
c     initialize statistical parameters
      maxppt = 1E-30
      maxrain = 1E-30
      maxsnow = 1E-30
      maxsncv = 1E-30
      maxmelt = 1E-30
      maxsubl = 1E-30
      maxtet  = 1E-30
      maxinfr = 1E-30
      maxdsw = 1E-30
      maxinf = 1E-30
      maxoff = 1E-30
      maxrun = 1E-30
      maxmassb = 1E-30
      mxmaxbal = 1E-30
      mxmassb2 = 1E-30
c
      minppt = 1e+30
      minrain = 1e+30
      minsnow = 1e+30
      minsncv = 1e+30
      minmelt = 1e+30
      minsubl = 1e+30
      mintet = 1e+30
      mininfr = 1e+30
      mindsw = 1e+30
      mininf = 1e+30
      minoff = 1e+30
      minrun = 1e+30
      minmassb = 1e+30
      mnmaxbal = 1e+30
      mnmassb2 = 1e+30
c
c
c     begin final processing
      write(*,*)
      n3 = 0
      fn = 0
      do 700 i = 1,ndata
              fn = fn + 1.
              n3 = n3 + 1
              pdone = (fn/ndata)*100.
              if(n3.eq.1000) then
                      write(*,*) i,pdone
                      n3 = 0
              endif
c
              if(imod2.ne.2) then
              aappt(i,0) = aappt(i,0)/nmap
              aarain(i,0) = aarain(i,0)/nmap
              aasnow(i,0) = aasnow(i,0)/nmap
              aasncv(i,0) = aasncv(i,0)/nmap
              aamelt(i,0) = aamelt(i,0)/nmap
              aasubl(i,0) = aasubl(i,0)/nmap
              aatet(i,0) = aatet(i,0)/nmap
              aainfr(i,0) = aainfr(i,0)/nmap
              aadsw(i,0) = aadsw(i,0)/nmap
              aainf(i,0) = aainf(i,0)/nmap
              aaoff(i,0) = aaoff(i,0)/nmap
              aarun(i,0) = aarun(i,0)/nmap
              massb(i,0) = massb(i,0)/nmap
              maxbal(i,0) = maxbal(i,0)/nmap
```

```
            massb2(i,0) = massb2(i,0)/nmap
c
            if(imod2.eq.0) then
                    aarain(i,0) = -9999.0
                    aasnow(i,0) = -9999.0
                    aasncv(i,0) = -9999.0
                    aamelt(i,0) = -9999.0
                    aasubl(i,0) = -9999.0
                    massb2(i,0) = -9999.0
            endif
            endif
c
c
            if(aappt(i,0).gt.maxppt) maxppt = aappt(i,0)
            if(aarain(i,0).gt.maxrain) maxrain = aarain(i,0)
            if(aasnow(i,0).gt.maxsnow) maxsnow = aasnow(i,0)
            if(aasncv(i,0).gt.maxsncv) maxsncv = aasncv(i,0)
            if(aamelt(i,0).gt.maxmelt) maxmelt = aamelt(i,0)
            if(aasubl(i,0).gt.maxsubl) maxsubl = aasubl(i,0)
            if(aatet(i,0).gt.maxtet) maxtet = aatet(i,0)
            if(aainfr(i,0).gt.maxinfr) maxinfr = aainfr(i,0)
            if(aadsw(i,0).gt.maxdsw) maxdsw = aadsw(i,0)
            if(aainf(i,0).gt.maxinf) maxinf = aainf(i,0)
            if(aaoff(i,0).gt.maxoff) maxoff = aaoff(i,0)
            if(aarun(i,0).gt.maxrun) maxrun = aarun(i,0)
            if(massb(i,0).gt.maxmassb) maxmassb = massb(i,0)
            if(maxbal(i,0).gt.mxmaxbal) mxmaxbal = maxbal(i,0)
            if(massb2(i,0).gt.mxmassb2) mxmassb2 = massb2(i,0)
c
c
            if(aappt(i,0).lt.minppt) minppt = aappt(i,0)
            if(aarain(i,0).lt.minrain) minrain = aarain(i,0)
            if(aasnow(i,0).lt.minsnow) minsnow = aasnow(i,0)
            if(aasncv(i,0).lt.minsncv) minsncv = aasncv(i,0)
            if(aamelt(i,0).lt.minmelt) minmelt = aamelt(i,0)
            if(aasubl(i,0).lt.minsubl) minsubl = aasubl(i,0)
            if(aatet(i,0).lt.mintet) mintet = aatet(i,0)
            if(aainfr(i,0).lt.mininfr) mininfr = aainfr(i,0)
            if(aadsw(i,0).lt.mindsw) mindsw = aadsw(i,0)
            if(aainf(i,0).lt.mininf) mininf = aainf(i,0)
            if(aaoff(i,0).lt.minoff) minoff = aaoff(i,0)
            if(aarun(i,0).lt.minrun) minrun = aarun(i,0)
            if(massb(i,0).lt.minmassb) minmassb = massb(i,0)
            if(maxbal(i,0).lt.mnmaxbal) mnmaxbal = maxbal(i,0)
            if(massb2(i,0).lt.mnmassb2) mnmassb2 = massb2(i,0)
c
c
            gaappt = gaappt + aappt(i,0)
            gaarain = gaarain + aarain(i,0)
            gaasnow = gaasnow + aasnow(i,0)
            gaasncv = gaasncv + aasncv(i,0)
            gaamelt = gaamelt + aamelt(i,0)
            gaasubl = gaasubl + aasubl(i,0)
            gaatet = gaatet + aatet(i,0)
            gaainfr = gaainfr + aainfr(i,0)
            gaadsw = gaadsw + aadsw(i,0)
            gaainf = gaainf + aainf(i,0)
            gaaoff = gaaoff + aaoff(i,0)
            gaarun = gaarun + aarun(i,0)
            gmassb = gmassb + massb(i,0)
            gmaxbal = gmaxbal + maxbal(i,0)
            gmassb2 = gmassb2 + massb2(i,0)
c
C
                    write(12,4905) easting(i,1),northing(i,1),
     1                      aappt(i,0),aarain(i,0),aasnow(i,0),aasncv(i,0),
     2                      aamelt(i,0),aasubl(i,0),aatet(i,0),aainfr(i,0),
     3                      aadsw(i,0),aainf(i,0),aaoff(i,0),aarun(i,0),
     4                      massb(i,0),maxbal(i,0),massb2(i,0),modstamp(i)
c
4905                format(1x,2f11.1,1x,11f13.5,4(1x,g16.7),3x,a22)
c
                    write(13,4935) easting(i,1),northing(i,1),
```

```
     1                    aappt(i,0),aarain(i,0),aasnow(i,0),aasncv(i,0),
     2                    aamelt(i,0),aasubl(i,0),aatet(i,0),aainfr(i,0),
     3                    aadsw(i,0),aainf(i,0),aaoff(i,0),aarun(i,0),
     4                    massb(i,0),maxbal(i,0),massb2(i,0)
c
4935              format(1x,2f11.1,1x,11f13.5,4(1x,g16.7))
c
700 continue
c
     gaappt = gaappt/ndata
     gaarain = gaarain/ndata
     gaasnow = gaasnow/ndata
     gaasncv = gaasncv/ndata
     gaamelt = gaamelt/ndata
     gaasubl = gaasubl/ndata
     gaatet = gaatet/ndata
     gaainfr = gaainfr/ndata
     gaadsw = gaadsw/ndata
     gaainf = gaainf/ndata
     gaaoff = gaaoff/ndata
     gaarun = gaarun/ndata
     gmassb = gmassb/ndata
     gmaxbal = gmaxbal/ndata
     gmassb2 = gmassb2/ndata
c
c
     write(14,7005) ndata,gaappt,maxppt,minppt,gaarain,maxrain,
     1       minrain,gaasnow,maxsnow,minsnow,gaasncv,maxsncv,minsncv,
      2      gaamelt,maxmelt,minmelt,gaasubl,maxsubl,minsubl,gaatet,
      3      maxtet,mintet,gaainfr,maxinfr,mininfr,gaadsw,maxdsw,
      4      mindsw,gaainf,maxinf,mininf,gaaoff,maxoff,minoff,gaarun,
      5      maxrun,minrun,gmassb,maxmassb,minmassb,gmaxbal,mxmaxbal,
      6      mnmaxbal,gmassb2,mxmassb2,mnmassb2
c
     write(*,7005) ndata,gaappt,maxppt,minppt,gaarain,maxrain,
     1       minrain,gaasnow,maxsnow,minsnow,gaasncv,maxsncv,minsncv,
      2      gaamelt,maxmelt,minmelt,gaasubl,maxsubl,minsubl,gaatet,
      3      maxtet,mintet,gaainfr,maxinfr,mininfr,gaadsw,maxdsw,
      4      mindsw,gaainf,maxinf,mininf,gaaoff,maxoff,minoff,gaarun,
      5      maxrun,minrun,gmassb,maxmassb,minmassb,gmaxbal,mxmaxbal,
      6      mnmaxbal,gmassb2,mxmassb2,mnmassb2
c
c
7005        format(//1x,'Total number of cells:  ',i12/,
c
     1/1x,'Parameter                          ','Average     ',5x,
      2'Maximum     ',5x,'Minimum',/
c
     1/1x,'Precipitation (mm/yr):        ',f14.6,3x,f14.6,3x,f14.6,
     2/1x,'Rain (mm/yr):                 ',f14.6,3x,f14.6,3x,f14.6,
     3/1x,'Snow-fall (mm/yr):            ',f14.6,3x,f14.6,3x,f14.6,
     4/1x,'Snow cover (mm/yr):           ',f14.6,3x,f14.6,3x,f14.6,
      5/1x,'Snow-melt (mm/yr):            ',f14.6,3x,f14.6,3x,f14.6,
      6/1x,'Sublimation (mm/yr):          ',f14.6,3x,f14.6,3x,f14.6,
      7/1x,'Evapotranspiration (mm/yr):   ',f14.6,3x,f14.6,3x,f14.6,
      8/1x,'Run-on infiltration (mm/yr):  ',f14.6,3x,f14.6,3x,f14.6,
      9/1x,'Stored water change (mm/yr):  ',f14.6,3x,f14.6,3x,f14.6,
      1/1x,'Net infiltration (mm/yr):     ',f14.6,3x,f14.6,3x,f14.6,
      2/1x,'Run-off (mm/yr):              ',f14.6,3x,f14.6,3x,f14.6,
     3/1x,'Run-on (mm/yr):               ',f14.6,3x,f14.6,3x,f14.6,
     4/1x,'Mass balance error (mm/yr):   ',g14.6,3x,g14.6,3x,g14.6,
     5/1x,'Max daily error (mm/dy):      ',g14.6,3x,g14.6,3x,g14.6,
     6/1x,'Mass balance 2 (mm/yr):       ',g14.6,3x,g14.6,3x,g14.6)
c
c
     close(12)
     close(13)
     close(14)
     close(15)
     stop
     end
```

ATTACHMENT XV

POST-PROCESSING OF MODEL RESULTS USING MAPSUM01 V1.0

TOTAL PAGES: 14

Post-processing of model results using MAPSUM01 V1.0

1. **Name of routine/macro with version/OS/hardware environment and user information:**
   Name of software routine: MAPSUM01 V1.0,
   OS and hardware environment: Windows NT 4.0, Pentium Pro PC
   Computer Identification: SM321276 with a USGS specific host-name P720dcasr
   Software Users: Joseph Hevesi (916-278-3274), Alan Flint (916-278-3221)
   User Location: U.S. Geological Survey, Room 5000E, Placer Hall, 6000 J Street, Sacramento, CA 95819-6129

2. **Name of commercial software with version/OS/hardware used to develop routine/macro:**

   The source code for MAPSUM01 V1.0 was developed using the standard FORTRAN77 programming language. The source code was written, debugged, and compiled (for PC platforms using INTEL processors) using DIGITAL Visual Fortran with Microsoft Developer Studio, V. 5.0.

3. **Test Plan.**
   - **Explain whether this is a routine or macro and describe what it does:**

   The software routine, MAPSUM01 V1.0, is a FORTRAN77 routine developed in accordance with AP-SI.1Q , Section 5.1.12, specifically for the analysis/model activity documented in this AMR. The documentation provided in this attachment is used to satisfy software quality assurance requirements for software routines as defined under AP-SI.1Q.

   MAPSUM01 V1.0 is a FORTRAN routine developed to calculate simple summary statistics for results obtained from the post-processing routine MAPADD20 V1.0 (which is a post-processing routine for results obtained using INFIL V2.0). The summary statistics are calculated for the subset of grid cells located within areas defined by SURFER V6.04 output files. The results from these calculations are included in tables in the AMR report that are used to compare the results obtained for the various different climate scenarios.

   The SURFER V6.04 output files consist of masked raster-based grid files with the masked areas defined by vector-based irregular boundary lines that are imported into the SURFER V6.04 grid utility application using the standard boundary line file format (*.bln format) under the GRID/BLANK menu option. The masked grid is created by importing the geospatial input parameter base grid into SURFER V6.04 and creating a new master grid based on ground surface elevation. In all cases, the developed SURFER V6.04 master grid file is used only to define the grid cell coordinates for the masking process and is equivalent to the base grid used to define the geospatial parameter input files (see Attachments VII through XIV). To complete the masking process, the base grid is combined with the imported boundary line and all grid.cells located outside of the closed boundary are flagged with the standard default null value used by SURFER V6.04 (1.70141E+038). The masked grid is exported as an xyz column formatted ASCII text file (the values of the non-masked z-values are irrelevant). Using the masked grid as a template for identifying the grid cells located

within the area defined by the boundary line file specified in SURFER V6.04, MAPSUM01 V1.0 calculates a set of 1st-order summary statistics for all the water balance terms (precipitation, evapotranspiration, change in root-zone water content, runoff, runon, net infiltration). The grid cell coordinates and the water balance terms are obtained from the input file created by the post-processing of the INFIL V2.0 results using the routine MAPADD20 V1.0. The water balance terms have units of millimeters/year.

For the application of MAPSUM01 used in this AMR, summary statistics were calculated for two different sub-areas defined by boundary line files imported into SURFER V6.04: the Site-Scale Unsaturated Zone Flow and Transport model area and the potential repository area.

The functions of MAPSUM01 V1.0 are executed using a single routine control file named MAPSUM01.CTL. The file defines the input and output file names, and specifies a distance tolerance parameter, in units of meters. The distance tolerance parameter (set to 10.0 meters in all applications of MAPSUM01 used in this AMR) is needed to compensate for differences in the precision of raster grid coordinates used by SURFER V6.04 relative to the precision of the input grid defined by the geospatial input parameter base grid discussed in section 6.5 of this AMR. The two input files listed consist of the masked SURFER grid (either uzmod2.dat or repos8.dat) saved using the ASCII xyz column formatted option and the final output file created by MAPADD20 consisting of the developed net infiltration estimates for one of the nine climate scenarios (for example, glacialu.dat or modernl.dat)

The routine source code, compiled executable file, example input and output files, and example validation test files are located under the directory MAPSUM01 on the CD-ROM labeled POSTINF-1.

- **Source code: (including equations or algorithms from software setup (LabView, Excel, etc.):**

A listing of the FORTRAN77 source code for the routine MAPSUM01 V1.0 along with examples of the input and output files used in the test plan are included at the end of this attachment.

- **Description of test(s) to be performed:**

To evaluate the accuracy of the routine calculations and output, a test calculation was performed. The test involves determining whether the summary statistics calculated using the routine are correct. A test was completed using an input file (Glacialm.dat) and a boundary file (REPOS8.BLN). For the first part of the test, the auxiliary output file created by MAPSUM01, GM-REP8.MAP, was imported into the EXCEL worksheet MAPSUM01.XLS and the summary statistics (average, maximum, and minimum values) were calculated using functions in EXCEL (AVERAGE, MAX, MIN). The calculated results were compared against the results listed in the output file GM-REP8.SUM. For the second part of the test, SURFER V6.04 was used to create a masked grid output file called Netinfilb.dat. The file was creating using the same technique described in section 2 above. GLACIALM.DAT was combined with the imported boundary line (REPOS8.BLN) and all

grid cells located outside of the closed boundary were flagged with the standard default null value used by SURFER V6.04. The masked grid was exported as an xyz column formatted ASCII text file (NETINFILB.DAT). The data included in the exported file (NETINFILB.DAT) includes northing, easting, and net infiltration. NETINFILB.DAT was imported into MAPSUM01.XLS and summary statistics for net infiltration were calculated using EXCEL commands (AVERAGE, MAX, MIN). In both test cases, if the values calculated in MAPSUM01.XLS were found to be within the acceptance criteria defined as + or – 0.01, then the routine correctly calculated the summary statistics.

- **Specify the range of input values to be used and why the range is valid:**

The range of input values to be used is equivalent to the range of output values calculated by INFIL V2.0. There are no criteria for the range of input values.

4. **Test Results.**
   - **Output from test:**

The output from the test is located in attached file MAPSUM01.XLS. This file is too large to be included in the attachment as a printed table.

- **Description of how the testing shows that the results are correct for the specified input:**

The sequence of calculations performed using MAPSUM01 are very basic and were easily compared to calculations performed by EXCEL. Summary statistics were calculated in the EXCEL worksheet MAPSUM01.XLS using the auxiliary output file GM-REP8.MAP. The calculated statistics exactly matched the output in the summary file GM-REP8.SUM (Table XV-1). The summary statistics (average, maximum, and minimum values) for net infiltration were also calculated in MAPSUM01.XLS using a manually extracted subset of the grid cells located within the boundary defined by REPOS8.BLN. The calculated statistics were found to be within were checked against the output values in GM-REP8.SUM and were found to be within the acceptance criteria defined as + or – 0.01 (Table XV-2).

- **List limitations or assumptions to this test case and code in general:**

Limitations are only those inherent in the input files, and in the ability of the reviewer to determine if the summary statistics calculated using EXCEL are within the acceptance criteria.

- **Electronic files identified by name and location (include disc if necessary):**

Electronic files are located on CD-ROM labeled POSTINF-1, under the directory MAPSUM01, included as an attachment to the AMR. The following electronic files are provided:

REPOS8.BLN –	boundary line file for the potential repository area
REPOS8.DAT-	Masking file creating by SURFER V6.04
GLACIALM.DAT -	input file used to create Netinfilb.dat
GM-REP8.SUM –	MAPSUM01 output file with summary statistics.
GM-REP8.MAP –	subset of results extracted from the input file GLACIALM.DAT using the SURFER V6.04 masking file REPOS8DAT. This file is created as an auxiliary output file and is used as part of the test plan.
NETINFILB.DAT -	the masked file used to test summary statistic calculations
MAPSUM01.XLS –	the EXCEL file used to calculate summary statistics

5. **Supporting Information. Include background information, such as revision to a previous routine or macro, or explanation of the steps performed to run the software. Include listings of all electronic files and codes used.**

- **Procedure for running routine:**

To run the routine MAPSUM01 V1.0, the executable file (MAPSUM01.EXE), the routine control file (MAPSUM01.CTL), and the input files specified in the routine control file (REPOS8.DAT and GLACIALM.DAT) must be placed in the same directory. The routine is executed by typing MAPSUM01 in a DOS window or by double clicking on the file MAPSUM01.EXE in the Microsoft Windows operating system, or by typing in the path and filename in the RUN window of the Windows NT or Windows 98 start menu. The input and output file names must be in the correct sequential order as specified in the routine control file (see example listing below).

- **Example listing of routine control file MAPSUM01.CTL**

```
mapsum01.ctl: 1999 potential repository 8 model area mean glacial transition
climate results (gm-5os)  9/1/99          (header line)
repos8.dat                                (masked SURFER grid)
10.0                                      (distance tolerance, in meters)
glacialm.dat                              (output from MAPADD20)
gm-rep8.sum                               (main output file)
gm-rep8.map                               (secondary output file used for
                                          validation)
```

- **Example listing of input file GLACIALM.DAT developed as output from MAPADD20 V1.0 (see Attachment XIV). Only the first 10 lines of the file are listed.**

```
    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
    546521.0  4083693.0     368.26735    237.21505    131.05230   6014.18170
111.78057     18.73772    295.42480      0.00000      1.64116      8.36099
43.56865     0.000000      -0.1900702E-12   -0.5748180E-13    0.4144834E-12
    546491.0  4083693.0     368.13263    237.12826    131.00436   5982.74314
111.45309     19.02130    299.99299      0.00000      1.61317      7.53981
39.43538     0.000000      -0.1474375E-12   -0.4412211E-13   -0.4950116E-12
    546461.0  4083693.0     367.86326    236.95475    130.90850   5940.35044
111.21879     19.16479    300.29268      0.00000      1.60110      7.40576
38.87402     0.000000      -0.8467299E-13   -0.3442154E-13   -0.1243450E-12
    546551.0  4083663.0     367.72877    236.86812    130.86064   5919.97186
111.12073     19.21742    300.43058      0.00000      1.59464      7.34809
38.61555     0.000000      -0.3262575E-12   -0.3953319E-13   -0.6394882E-13
    546521.0  4083663.0     367.59435    236.78154    130.81281   5891.78511
110.86277     19.43119    297.85613      0.00000      1.57294      7.65572
40.55952     0.000000      -0.4571159E-12   -0.3654484E-13    0.4736952E-14
    546581.0  4083663.0     367.59435    236.78154    130.81281   5916.66076
111.39227     18.89784    301.85962      0.00000      1.61581      7.21073
37.48765     0.000000      -0.4979722E-12   -0.1243450E-13    0.4736952E-14
    546491.0  4083663.0     367.32570    236.60850    130.71721   5842.78144
110.47885     19.72574    293.19867      2.88793      1.57708      8.34757
46.85196     40.68072      -0.2291500E-12   -0.1058413E-13    0.1918465E-12
    546461.0  4083663.0     367.05740    236.43568    130.62173   5804.76115
110.32784     19.78588    290.94198      2.61177      1.58257      8.62725
48.22348     36.82361      -0.3440211E-12   -0.5570544E-13    0.3884299E-12
    546641.0  4083633.0     366.92344    236.34938    130.57405   5821.65830
111.01392     19.04874    299.54145      0.00000      1.58696      7.43119
38.80370     0.000000      -0.4825768E-12   -0.9131585E-14   -0.6335671E-12
    546551.0  4083633.0     366.78944    236.26307    130.52638   5747.27079
109.73212     20.29416    281.71067      0.00000      1.60689      9.76482
52.91281     0.000000      -0.8052816E-13   -0.4344557E-13    0.2250050E-13
```

- **Example listing of input file REPOS8.DAT developed as output from SURFER V6.04. Only the first 10 lines of the file are listed.**

```
544691 4.07079E+006 1.70141E+038
544721 4.07079E+006 1.70141E+038
544751 4.07079E+006 1.70141E+038
544781 4.07079E+006 1.70141E+038
544811 4.07079E+006 1.70141E+038
544841 4.07079E+006 1.70141E+038
544871 4.07079E+006 1.70141E+038
544901 4.07079E+006 1.70141E+038
544931 4.07079E+006 1.70141E+038
544961 4.07079E+006 1.70141E+038
```

- **Example listing of input file GM-REP8.MAP developed as output from SURFER V6.04. Only the first 20 lines of the file are listed.**

```
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
    547511.0  4077123.0     333.84400    268.69023     65.15376   1552.67875
56.88268      8.13961    277.04121      0.00000      1.32346     45.97340
1.23486     0.000000        0.1782278E-12    0.1032971E-13    0.1835568E-13
    547511.0  4077093.0     333.73145    268.77621     64.95524   1550.48055
56.99238      7.83101    275.78499      0.00000      1.35319     47.36268
1.26772     0.000000        0.2152353E-12   -0.9714450E-14   -0.1125026E-13
    547541.0  4077243.0     333.50649    268.59503     64.91146   1545.16400
57.14216      7.63807    276.53962      0.00000      1.35540     46.73842
1.10377     0.000000        0.3102703E-12    0.3141931E-13    0.2048731E-12
    547511.0  4077063.0     333.50649    268.59503     64.91146   1539.99094
56.92711      7.85386    280.47958      0.00000      1.29955     42.97566
0.76734     0.000000        0.2466175E-12   -0.2647420E-13    0.2048731E-12
    547541.0  4077303.0     333.39417    268.50457     64.88959   1548.25314
57.46022      7.29764    271.82076      0.00000      1.45925     51.15653
1.52826     0.000000        0.9473890E-14   -0.2486900E-13   -0.3552714E-14
    547541.0  4077273.0     333.39417    268.50457     64.88959   1545.67277
57.35112      7.40711    273.88094      0.00000      1.39549     49.26052
1.31875     0.000000        0.2486900E-13   -0.2645107E-13   -0.3552714E-14
    547541.0  4077213.0     333.39417    268.50457     64.88959   1536.20367
56.95580      7.80378    278.87171      0.00000      1.31351     44.34935
0.92580     0.000000        0.8348877E-13    0.4296563E-13   -0.3552714E-14
    547541.0  4077183.0     333.28195    268.41420     64.86775   1533.10773
57.01330      7.72482    280.05637      0.00000      1.30797     43.29325
0.76992     0.000000        0.3141191E-12    0.2593296E-13    0.2398082E-12
    547511.0  4077033.0     333.28195    268.41420     64.86775   1530.70202
56.91241      7.82605    280.44832      0.00000      1.29740     42.82034
0.76055     0.000000        0.3028688E-12    0.8345175E-14    0.2398082E-12
    547541.0  4077153.0     333.16967    268.32377     64.84590   1529.67595
57.05420      7.66249    279.78108      0.00000      1.31261     43.51451
0.76977     0.000000       -0.1068775E-12    0.1324866E-13   -0.1948071E-12
```

- **Example listing of output file GM-REP8.SUM developed as output from MAPSUM01 V1.0.**

```
mapsum01.ctl: 1999 UZ model 2 area mean glacial transition climate results (gm-5os)
        9/1/99

input area file:                          repos8.dat
total number of model cells in area:                5231
average elevation of model cells:              1403.507
maximum model elevation:                       1503.000
minimum model elevation:                       1294.000


extracted from file:                    glacialm.dat


 Total number of cells:          5231

 Parameter                      Average        Maximum        Minimum

 Precipitation (mm/yr):          323.06747      333.84400      311.82975
 Rain (mm/yr):                   272.79706      276.16370      266.97534
 Snow-fall (mm/yr):               50.27041       65.15376       37.75747
 Snow cover (mm/yr):             948.27595     1552.67875      496.53430
```

Snow-melt (mm/yr):	44.61409	58.02922	32.53234
Sublimation (mm/yr):	5.60752	8.78785	2.21182
Evapotranspiration (mm/yr):	287.82413	477.84380	219.28758
Run-on infiltration (mm/yr):	11.95439	676.58013	0.00000
Stored water change (mm/yr):	1.82030	16.35798	-0.56969
Net infiltration (mm/yr):	19.78021	590.96199	0.00000
Run-off (mm/yr):	19.94089	92.67664	0.00000
Run-on (mm/yr):	202.82021	11553.51000	0.00000
Mass balance error (mm/yr):	-0.16082E-13	0.79992E-11	-0.49241E-11
Max daily error (mm/dy):	-0.26853E-15	0.49614E-12	-0.39888E-12
Mass balance 2 (mm/yr):	0.14078E-13	0.30553E-12	-0.32389E-12

Table XV-1. Comparison of selected summary statistics calculated in EXCEL using the file GM-REP8.MAP and summary statistics calculated by MAPSUM01.

Parameter (mm/year)	EXCEL worksheet calculation			GN-REP8.SUM output file		
Precipitation	323.06747	333.84400	311.82975	323.06747	333.84400	311.82975
Rain	272.79706	276.16370	266.97534	272.79706	276.16370	266.97534
Snow Fall	50.27041	65.15376	37.75747	50.27041	65.15376	37.75747
Snow Melt	44.61409	58.02922	32.53234	44.61409	58.02922	32.53234
Sublimation	5.60752	8.78785	2.21182	5.60752	8.78785	2.21182
Evapo-Transpiration.	287.82413	477.84380	219.28758	287.82413	477.84380	219.28758
Run-on Infiltration	11.95439	676.58013	0.00000	11.95439	676.58013	0.00000
Stored Water Change	1.82030	16.35798	-0.56969	1.82030	16.35798	-0.56969
Net Infiltration	19.78021	590.96199	0.00000	19.78021	590.96199	0.00000
Run-off	19.94089	92.67664	0.00000	19.94089	92.67664	0.00000
Run-on	202.82021	11553.51000	0.00000	202.82021	11553.51000	0.00000

Table XV-2 Summary statistics for net infiltration

Summary Statistics for net infiltration calculated by EXCEL and located in MAPSUM01.xls	
AVERAGE	19.78
MAX	590.96
MIN	0.00

Summary Statistics for net infiltration calculated by MAPSUM01 and located in output file (GM-REP8.SUM)	
AVERAGE	19.78
MAX	590.96
MIN	0.00

6. Listing of source code for MAPSUM01 V1.0

```
      program mapsum01
c     version 1.0
c
c     program for post-processing of main output from
c     program MAPADD20. MAPADD20 is used to create final output maps
c     for all output components (precip, et, net-infil, etc) generated
c     from INFIL2 MAPSUM01 post processing uses blanked
c     SURFER grids (ASCII xyz format) to define areas over which
c     the summary statistics are calculated.
c
c     SURFER dat file (blanked grid) input variables
      double precision east,north,elev,space
      double precision east1(500000),north1(500000),elev1(500000)
      double precision avgelev,maxelev,minelev
      double precision maxeast,mineast,maxnorth,minnorth
c
c     Input variables for main input file
      double precision easting(500000),northing(500000),
     1  precip(500000),rain(500000),snowfall(500000),snowcov(500000),
     2  snowmelt(500000),subl(500000),evap(500000),runinf(500000),
     3  delsoil(500000),netinf(500000),runoff(500000),
     4  runon(500000),massb(500000),maxmassb(500000),massb2(500000)
c
c     output variables
      double precision avgppt,maxppt,minppt,avgrain,maxrain,
     1  minrain,avgsnfl,maxsnfl,minsnfl,avgsncv,maxsncv,minsncv,
     2  avgmelt,maxmelt,minmelt,avgsub,maxsub,minsub,avgevap,
     3  maxevap,minevap,avgrinf,maxrinf,minrinf,avgdels,maxdels,
     4  mindels,avginf,maxinf,mininf,avgoff,maxoff,minoff,avgon,
     5  maxon,minon,avgmb,maxmb,minmb,avgmaxb,maxmaxb,minmaxb,
     6  avgmb2,maxmb2,minmb2
c
c     general input variables
      character*120 header
      character*20 areafile,infile,outsum,outarea
c
c     begin program: read-in control file
      open(unit=7,file='mapsum01.ctl')
15    format(a)
      read(7,15) header
      read(7,15) areafile
      read(7,*)  space
      read(7,15) infile
      read(7,15) outsum
      read(7,15) outarea
```

```
c
      open(unit=8,file=areafile)
      open(unit=9,file=infile)
      open(unit=20,file=outsum)
      open(unit=21,file=outarea)
c
c     set header line for map output file
c     (this file used as input for TRANSFORM and SURFER)
      write(21,4925)
4925  format(5x,'easting',3x,'northing',1x,7x,'precip',9x,'rain',
      1           4x,'snow-fall',3x,'snow-cover',4x,'snow-melt',
      2           2x,'sublimation',
      2           3x,'evapotrans',4x,'run-infil',5x,'del-soil',
      3           4x,'net-infil',7x,'runoff',11x,'run-on',
      4           5x,'mass-balance',6x,'max-balance',
      5           2x,'mass-balance #2')
c
c
c     initialize statistics for areafile (SURFER blanked area)
      avgelev = 0.
      maxelev = -99999.
      minelev = 9999999999.
      maxeast = -99999.
      mineast = 9999999999.
      maxnorth = -99999.
      minnorth = 9999999999.
c
c     read-in SURFER blanked area file (ASCII *.dat export file)
      n1 = 0
100   read(8,*,end=190) east,north,elev
         if(elev.lt.1.0e10) then
           n1 = n1+1
           east1(n1) = east
           north1(n1) = north
           elev1(n1) = elev
           avgelev = avgelev + elev
           if(maxelev.lt.elev) maxelev = elev
           if(minelev.gt.elev) minelev = elev
           if(maxeast.lt.east) maxeast = east
           if(mineast.gt.east) mineast = east
           if(maxnorth.lt.north) maxnorth = north
           if(minnorth.gt.north) minnorth = north
         endif
         goto 100
c
190   avgelev = avgelev/n1
      write(*,15) header
      write(20,15) header
      write(*,195) areafile,n1,avgelev,maxelev,minelev
      write(20,195) areafile,n1,avgelev,maxelev,minelev
195   format(//,'input area file:                          ',a20,
      1    /,'total number of model cells in area:      ',i12,
      2    /,'average elevation of model cells:         ',f12.3,
      3    /,'maximum model elevation:                  ',f12.3,
      4    /,'minimum model elevation:                  ',f12.3)
c
c
      read(9,15) header
      n = 1
200   read(9,*,end=290) easting(n),northing(n),
      1  precip(n),rain(n),snowfall(n),snowcov(n),
      2  snowmelt(n),subl(n),evap(n),runinf(n),
      3  delsoil(n),netinf(n),runoff(n),
      4  runon(n),massb(n),maxmassb(n),massb2(n)
```

```
         n = n + 1
         goto 200
290   n = n-1
c
c     initialize statistics
      avgppt = 0.
      maxppt = -999999.
      minppt = 9999999.
      avgrain = 0.
      maxrain = -999999.
      minrain = 9999999.
      avgsnfl = 0.
      maxsnfl = -999999.
      minsnfl = 9999999.
      avgsncv = 0.
      maxsncv = -999999.
      minsncv = 9999999.
      avgmelt = 0.
      maxmelt = -999999.
      minmelt = 9999999.
      avgsub = 0.
      maxsub = -999999.
      minsub = 9999999.
      avgevap = 0.
      maxevap = -999999.
      minevap = 9999999.
      avgrinf = 0.
      maxrinf = -999999.
      minrinf = 9999999.
      avgdels = 0.
      maxdels = -999999.
      mindels = 9999999.
      avginf = 0.
      maxinf = -999999.
      mininf = 9999999.
      avgoff = 0.
      maxoff = -999999.
      minoff = 9999999.
      avgon = 0.
      maxon = -999999.
      minon = 9999999.
      avgmb = 0.
      maxmb = -999999.
      minmb = 9999999.
      avgmaxb = 0.
      maxmaxb = -999999.
      minmaxb = 9999999.
      avgmb2 = 0.
      maxmb2 = -999999.
      minmb2 = 9999999.
c
c     extract area statistics
      n2 = 0
      do 500 i = 1,n
         if(((easting(i).lt.maxeast+space).and.
     1   (easting(i).gt.mineast-space)).and.
     2   ((northing(i).lt.maxnorth+space).and.
     3   (northing(i).gt.minnorth-space))) then
         do 520 j = 1,n1
           if(((easting(i).lt.east1(j)+space).and.
     1     (easting(i).gt.east1(j)-space)).and.
     2     ((northing(i).lt.north1(j)+space).and.
     3     (northing(i).gt.north1(j)-space))) then
c
```

```
                    avgppt = avgppt + precip(i)
                    if(precip(i).gt.maxppt) maxppt = precip(i)
                    if(precip(i).lt.minppt) minppt = precip(i)
                    avgrain = avgrain + rain(i)
                    if(rain(i).gt.maxrain) maxrain = rain(i)
                    if(rain(i).lt.minrain) minrain = rain(i)
                    avgsnfl = avgsnfl + snowfall(i)
                    if(snowfall(i).gt.maxsnfl) maxsnfl = snowfall(i)
                    if(snowfall(i).lt.minsnfl) minsnfl = snowfall(i)
                    avgsncv = avgsncv + snowcov(i)
                    if(snowcov(i).gt.maxsncv) maxsncv = snowcov(i)
                    if(snowcov(i).lt.minsncv) minsncv = snowcov(i)
                    avgmelt = avgmelt + snowmelt(i)
                    if(snowmelt(i).gt.maxmelt) maxmelt = snowmelt(i)
                    if(snowmelt(i).lt.minmelt) minmelt = snowmelt(i)
                    avgsub = avgsub + subl(i)
                    if(subl(i).gt.maxsub) maxsub = subl(i)
                    if(subl(i).lt.minsub) minsub = subl(i)
                    avgevap = avgevap + evap(i)
                    if(evap(i).gt.maxevap) maxevap = evap(i)
                    if(evap(i).lt.minevap) minevap = evap(i)
                    avgrinf = avgrinf + runinf(i)
                    if(runinf(i).gt.maxrinf) maxrinf = runinf(i)
                    if(runinf(i).lt.minrinf) minrinf = runinf(i)
                    avgdels = avgdels + delsoil(i)
                    if(delsoil(i).gt.maxdels) maxdels = delsoil(i)
                    if(delsoil(i).lt.mindels) mindels = delsoil(i)
                    avginf = avginf + netinf(i)
                    if(netinf(i).gt.maxinf) maxinf = netinf(i)
                    if(netinf(i).lt.mininf) mininf = netinf(i)
                    avgoff = avgoff + runoff(i)
                    if(runoff(i).gt.maxoff) maxoff = runoff(i)
                    if(runoff(i).lt.minoff) minoff = runoff(i)
                    avgon = avgon + runon(i)
                    if(runon(i).gt.maxon) maxon = runon(i)
                    if(runon(i).lt.minon) minon = runon(i)
                    avgmb = avgmb + massb(i)
                    if(massb(i).gt.maxmb) maxmb = massb(i)
                    if(massb(i).lt.minmb) minmb = massb(i)
                    avgmaxb = avgmaxb + maxmassb(i)
                    if(maxmassb(i).gt.maxmaxb) maxmaxb = maxmassb(i)
                    if(maxmassb(i).lt.minmaxb) minmaxb = maxmassb(i)
                    avgmb2 = avgmb2 + massb2(i)
                    if(massb2(i).gt.maxmb2) maxmb2 = massb2(i)
                    if(massb2(i).lt.minmb2) minmb2 = massb2(i)
c
c                   write output to extracted map data file
                    write(21,595) easting(i),northing(i),precip(i),
     1              rain(i),snowfall(i),snowcov(i),snowmelt(i),subl(i),
     2              evap(i),runinf(i),delsoil(i),netinf(i),runoff(i),
     3              runon(i),massb(i),maxmassb(i),massb2(i)
c
595                 format(1x,2f11.1,1x,11f13.5,4(1x,g16.7))
c
                    n2 = n2 + 1
c
          endif
520     continue
        endif
500  continue
c
c    error trap
     if(n2.ne.n1) stop
c
```

```
      avgppt = avgppt/float(n2)
      avgrain = avgrain/float(n2)
      avgsnfl = avgsnfl/float(n2)
      avgsncv = avgsncv/float(n2)
      avgmelt = avgmelt/float(n2)
      avgsub = avgsub/float(n2)
      avgevap = avgevap/float(n2)
      avgrinf = avgrinf/float(n2)
      avgdels = avgdels/float(n2)
      avginf = avginf/float(n2)
      avgoff = avgoff/float(n2)
      avgon = avgon/float(n2)
      avgmb = avgmb/float(n2)
      avgmaxb = avgmaxb/float(n2)
      avgmb2 = avgmb2/float(n2)
c
c     write summary statistics to summary output file
      write(*,605) infile
      write(20,605) infile
605   format(//,'extracted from file:                    ',a20)
c
      write(*,7005) n2,avgppt,maxppt,minppt,avgrain,maxrain,
     1  minrain,avgsnfl,maxsnfl,minsnfl,avgsncv,maxsncv,minsncv,
     2  avgmelt,maxmelt,minmelt,avgsub,maxsub,minsub,avgevap,
     3  maxevap,minevap,avgrinf,maxrinf,minrinf,avgdels,maxdels,
     4  mindels,avginf,maxinf,mininf,avgoff,maxoff,minoff,avgon,
     5  maxon,minon,avgmb,maxmb,minmb,avgmaxb,maxmaxb,
     6  minmaxb,avgmb2,maxmb2,minmb2
c
      write(20,7005) n2,avgppt,maxppt,minppt,avgrain,maxrain,
     1  minrain,avgsnfl,maxsnfl,minsnfl,avgsncv,maxsncv,minsncv,
     2  avgmelt,maxmelt,minmelt,avgsub,maxsub,minsub,avgevap,
     3  maxevap,minevap,avgrinf,maxrinf,minrinf,avgdels,maxdels,
     4  mindels,avginf,maxinf,mininf,avgoff,maxoff,minoff,avgon,
     5  maxon,minon,avgmb,maxmb,minmb,avgmaxb,maxmaxb,
     6  minmaxb,avgmb2,maxmb2,minmb2
c
7005  format(//1x,'Total number of cells:  ',i12/,
c
     1/1x,'Parameter                        ','Average     ',3x,
     2'Maximum     ',3x,'Minimum',/
c
     1/1x,'Precipitation (mm/yr):        ',f12.5,3x,f12.5,3x,f12.5,
     2/1x,'Rain (mm/yr):                 ',f12.5,3x,f12.5,3x,f12.5,
     3/1x,'Snow-fall (mm/yr):            ',f12.5,3x,f12.5,3x,f12.5,
     4/1x,'Snow cover (mm/yr):           ',f12.5,3x,f12.5,3x,f12.5,
     5/1x,'Snow-melt (mm/yr):            ',f12.5,3x,f12.5,3x,f12.5,
     6/1x,'Sublimation (mm/yr):          ',f12.5,3x,f12.5,3x,f12.5,
     7/1x,'Evapotranspiration (mm/yr):   ',f12.5,3x,f12.5,3x,f12.5,
     8/1x,'Run-on infiltration (mm/yr):  ',f12.5,3x,f12.5,3x,f12.5,
     9/1x,'Stored water change (mm/yr):  ',f12.5,3x,f12.5,3x,f12.5,
     1/1x,'Net infiltration (mm/yr):     ',f12.5,3x,f12.5,3x,f12.5,
     2/1x,'Run-off (mm/yr):              ',f12.5,3x,f12.5,3x,f12.5,
     3/1x,'Run-on (mm/yr):               ',f12.5,3x,f12.5,3x,f12.5,
     4/1x,'Mass balance error (mm/yr):   ',g12.5,3x,g12.5,3x,g12.5,
     5/1x,'Max daily error (mm/dy):      ',g12.5,3x,g12.5,3x,g12.5,
     6/1x,'Mass balance 2 (mm/yr):       ',g12.5,3x,g12.5,3x,g12.5)
c
      close(20)
      close(21)
      stop
      end
```