

ADDENDUM

**USER'S GUIDE FOR THE  
AERMOD TERRAIN PREPROCESSOR  
(AERMAP)  
(EPA-454/B-03-003, October 2004)**

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December 2006

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## **1.0 INTRODUCTION**

This document provides user instructions for revisions to the AERMOD terrain preprocessor program, AERMAP. These revisions were first introduced with version 06341 of AERMAP. The discussion provided here supplements the information contained in the current AERMAP User's Guide (EPA, 2004), and it is assumed that the reader is already familiar with the contents of that document.

### **1.1 OVERVIEW OF AERMAP REVISIONS**

The revised AERMAP program includes several modifications associated with process of converting coordinates to account for differences in the reference datums between receptors (and sources) and Digital Elevation Model (DEM) terrain files. One component of the coordinate conversion process is the conversion of geographic coordinates (Latitude and Longitude) between the two reference datums. The datum shift is performed by the North American Datum (NAD) CONversion program, NADCON version 2.1, distributed by the National Geodetic Survey (NGS), which is incorporated into AERMAP. However, previous versions of AERMAP did not properly account for the shift in Universal Transverse Mercator (UTM) coordinates due to the different ellipsoids used to convert from Lat/Long to UTM coordinates for the different datums, which is typically about 200m in the Northing coordinate for the conversion from North American Datum of 1927 (NAD27) to the North American Datum of 1983 (NAD83). The revised AERMAP program accounts for both the datum shift and the shift due to the projection from geographic to UTM coordinates. The incorporation of the NADCON program in AERMAP was also modified to use an iterative calculation for conversions from NAD83 to NAD27, while the conversions from NAD27 to NAD83 do not require an iterative process.

Other issues related to how the user-specified NAD values were processed have also been addressed, including:

1. The procedure used to assign receptors and sources to specific DEM files;

2. The definition of the extent of the user-specified domain (DOMAINLL or DOMAINXY);
3. Applications that cross UTM zones; and
4. The potential for "gaps" to occur between adjoining DEM files with different datums and how receptors and sources located within those gaps are handled.

Due to the potential for gaps to occur between adjacent DEM files as a result of NAD conversions, users are encouraged to avoid using DEM files with different datums within the same application if possible.

In addition to NAD conversion modifications and other bug fixes (see the AERMAP Model Change Bulletin #1 for more details), the new version of AERMAP includes some enhancements to optimize critical hill height scale calculations, and to provide users with options for generating debug output files to assist with documenting and resolving problems with the AERMAP code or with the setup of the AERMAP input data.

## 2.0 BASIC CONCEPTS AND USER INSTRUCTIONS

This section presents information that supplements, and in some cases clarifies or revises, information provided in the current AERMAP User's Guide (EPA, 2004), including a discussion of some of the basic concepts associated with processing terrain data using AERMAP, and a description of modifications to the user instructions for running AERMAP.

### 2.1 HORIZONTAL DATUMS

Section 2.1.1 of the AERMAP User's Guide (EPA, 2004) provides an overview of the concept of horizontal datums, which refers to the model/method used to identify locations on the earth. The same physical location on the earth will have different geographic coordinates (latitude and longitude) depending on the reference datum. In addition, each datum uses a specific model for the size and shape of the earth, or reference ellipsoid, used to project geographic coordinates to other coordinate systems, such as Universal Transverse Mercator (UTM). For AERMAP, the following lists the reference ellipsoids and associated datums that are commonly encountered with Digital Elevation Model (DEM) data:

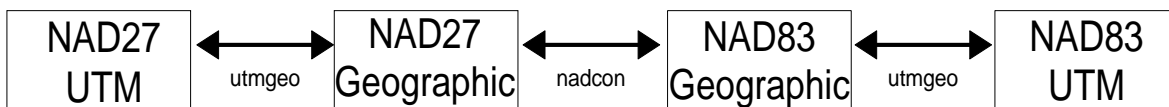
1. Clarke 1866 Ellipsoid:
  - a. NAD27 Datum
  - b. Old Hawaiian Datum
  - c. Puerto Rican Datum
  - d. Guam Datum
2. WGS72 Ellipsoid:
  - a. WGS72 Datum
3. GRS80/WGS84 Ellipsoid:
  - a. NAD83 Datum
  - b. WGS84 Datum

The reference datums for 1-degree DEM data are either WGS72 or WGS84, and 7.5-minute DEM data will be referenced to either the NAD27 or NAD83 datum. While more recent DEM files include the reference datum in the header record (logical record type A) of the data file (USGS, 1998), older files may not include that information. For DEM files without

reference datum information, AERMAP will assume datums of WGS72 for 1-degree data and NAD27 for 7.5-minute data.

While there are some minor differences between the WGS72, WGS84, and NAD83 datums, as discussed in the AERMAP User's Guide, these differences are considered inconsequential for AERMAP applications, and AERMAP treats WGS72, WGS84, and NAD83 datums as equivalent. Therefore, the focus of datum conversion in AERMAP is on the conversion of NAD27 coordinates to NAD83, and vice versa.

Since the AERMAP program is designed to process receptor (and possibly source) locations expressed in terms of Cartesian X- and Y-coordinates, such as UTM or plant coordinates, it is important to emphasize that the conversion of geographic coordinates due to different reference datums is only part of the process. The process of converting UTM coordinates from one datum to another actually involves three steps. The first step is to convert the UTM coordinates from the first datum to geographic coordinates *based on the reference ellipsoid for that datum*. The second step is to convert the geographic coordinates from the first datum to the second datum to account for the datum shift. The final step is to convert the new geographic coordinates back to UTM coordinates *based on the reference ellipsoid for the new datum*. This process of converting coordinates between NAD27 and NAD83 is illustrated in the following diagram:



The diagram also identifies the AERMAP subroutines used to perform each of the steps in the process.

Previous versions of AERMAP only accounted for the middle step, or the datum conversion, and did not account for the effect of different reference ellipsoids between the two datums on the converted UTM coordinates. This typically accounts for an additional shift of about 200m in the Northing coordinate between NAD27 and NAD83, with the NAD83 Northing

coordinate being larger than the NAD27 coordinate. This additional horizontal shift can result in significant discrepancies in calculated receptor elevations and critical hill heights, even in areas with only moderate terrain relief.

In order to successfully apply the AERMAP program for cases involving NAD conversions, the user should first be aware of the reference datum used to define the receptor and source coordinates for that application, and know the reference datum(s) for the DEM file(s) being processed. The user also needs to understand how AERMAP utilizes and interprets the user-specified modeling domain (DOMAINXY or DOMAINLL keywords) and the user-specified anchor point (ANCHORXY keyword). These keywords on the CO pathway are described in detail in Sections 3.2.6 and 3.2.7, respectively, of the AERMAP User's Guide. The basic information is reiterated here, with some additional clarifications. The following sections also document the assumptions incorporated into AERMAP for applications where the DEM file NAD is not identified, and provide suggestions for cases where the user is not certain of the reference datum for receptor and source coordinates being input to AERMAP.

### 2.1.1 Modeling Domain

The DOMAINXY or the DOMAINLL keyword on the CO pathway is used to define the geographic extent of the domain that includes all the receptors and sources specified in a particular AERMAP run, and also defines the region within which the raw terrain data points will be included in calculation of the critical hill height scales. Either of the two keywords may be used to specify the domain extent. The DOMAINXY keyword allows the user to specify the domain in UTM coordinates while the DOMAINLL keyword allows the user to specify it in the World Geodetic System (latitude / longitude). The syntax and type of the keywords are summarized below:

<b>Syntax:</b>	CO DOMAINXY Xdmin Ydmin Zonmin Xdmax Ydmax Zonmax CO DOMAINLL Lonmin Latmin Lonmax Latmax
<b>Type:</b>	Mandatory, Non-repeatable

For the DOMAINXY keyword, Xdmin, Ydmin and Zonmin are the UTM Easting coordinate, UTM Northing coordinate and the UTM zone for the lower left (southwest) corner of the domain; Xdmax, Ydmax and Zonmax are the UTM Easting coordinate, UTM Northing coordinate and the UTM zone for the upper right (northeast) corner of the domain. The UTM coordinates are specified in meters. For the DOMAINLL keyword, Lonmin and Latmin are the longitude and latitude in decimal degrees for the lower right (southeast) corner of the domain; Lonmax and Latmax are the longitude and latitude in decimal degrees for the upper left (northwest) corner of the domain. Note that longitude is entered first, followed by latitude. The current version of AERMAP uses a positive value for west longitude.

There are a few aspects regarding AERMAP's interpretation of the domain that deserve further explanation and clarification. Firstly, while the user can specify the domain using either geographic coordinates (latitude and longitude) or UTM coordinates, the exact shape and extent of the domain will be based on the type of DEM data used. When 1-degree DEM data are processed, AERMAP interprets the domain boundaries along lines of constant latitude and longitude. Conversely, when 7.5-minute DEM data are processed, AERMAP interprets the domain boundaries along lines of constant UTM Northing and Easting coordinates. This means that the same DOMAINXY or DOMAINLL card will define slightly different geographical areas depending upon the type of DEM data being processed. This approach was taken in the initial design of AERMAP to simplify the process of extracting and analyzing the portion of a DEM file that falls within the domain since the domain will parallel the profiles of elevation nodes within the DEM file. The structure of the two types of DEM files is described in more detail in Section 4.2 of the AERMAP User's Guide. To avoid confusion or uncertainty regarding the extent of the domain, users may wish to define the domain in a manner that is consistent with the type of DEM data, i.e., use DOMAINXY with 7.5-minute DEM data and DOMAINLL with 1-degree DEM data, although this is not a requirement.

Users should also be aware that the AERMAP program has been revised to account for NAD shifts in defining the extent of the domain, if needed. In order to accomplish this conversion AERMAP assumes that the domain coordinates are referenced to the datum specified by the user on the ANCHORXY keyword, described in the next section. This revision to

AERMAP may result in AERMAP-generated errors related to the domain extent for some AERMAP applications that ran “successfully” with previous versions.

### 2.1.2 Anchor Point Specification

The ANCHORXY keyword is used to relate the origin of the user-specified coordinate system for the receptor grid to the UTM coordinate system, including specification of the reference datum for the receptor grid. The user has the option of specifying the receptor locations directly in UTM coordinates or in some arbitrary user-specified coordinate system. For any further processing of the terrain data, the AERMAP program needs to determine the location of the receptors in UTM coordinates. This is accomplished using the ANCHORXY keyword by specifying the coordinates of any specific geographic location relative to both the user-specified coordinate system and the UTM coordinate system. The syntax and type of the keyword are summarized below:

<b>Syntax:</b>	CO ANCHORXY Xauser Yauser Xautm Yautm Zautm NADA
<b>Type:</b>	Mandatory, Non-repeatable

where Xauser and Yauser are the coordinates of any geographic location, such as the origin (0,0), in the user coordinate system, and Xautm, Yautm and Zautm are the UTM Easting, Northing and Zone coordinates for the same point. The NADA parameter specifies the horizontal datum that was used to establish the coordinates of the anchor point. NADA values range from 0 to 6, and are described below. If the user specifies the receptor locations in UTM coordinates with the same UTM zone and reference datum as the anchor point, the values of Xauser and Xautm will be identical, and so will those of Yauser and Yautm. All receptor and source locations are referenced to this anchor point.

Table 2-1 provides a list of applicable NADA values and the datum that each NADA value references. These values follow the convention used in the USGS Standards for Digital Elevation Models (USGS, 1998), and the list also follows the convention used in the DEM file headers (logical record type A), except for the use of ‘0’ (zero). Table 2-1 is a revision to Table

4-1 of the current AERMAP User's Guide. Note that the terms 'ellipsoid' and 'spheroid' are often used interchangeably in the literature.

Based on the user-specified datum for the anchor point (NADA) and the datum code read from each DEM file header record, AERMAP will apply the appropriate adjustment to receptor, source and domain coordinates to account for the shifts due to reference datums and reference ellipsoids. The NGS program, NADCON, version 2.1, has been incorporated into AERMAP and is used to calculate the datum shifts. The NADCON program requires additional parameter files containing the grid shift information. These grid shift files have \*.LAS and \*.LOS extensions, and files covering the continental U.S. (CONUS), Hawaii, Puerto Rico/Virgin Islands, Alaska and three Alaskan Island Groups (St. George, St. Paul, and St. Lawrence) are packaged with the AERMAP executable file. When datum shifts are required for a particular AERMAP application, the appropriate grid shift files (\*.LAS and \*.LOS) need to be included in the same folder as the AERMAP input file. AERMAP will issue a fatal error message if the necessary files are not found. Note that only the files needed for the domain of a particular application (such as CONUS.LAS and CONUS.LOS) are required. The grid shift files are not required when a NADA value of '0' is specified on the ANCHORXY card.

NADA	Description
0	<p>No conversion is performed between NAD 27 and NAD 83 for the DEM nodes, receptors, sources, or domain. This option may be used for international applications where NAD shift grid files are not available.</p> <p>While datum conversions are not performed with this option, conversion of UTM to geographic coordinates for receptors, sources and domain within AERMAP will be based on the Clarke 1866 ellipsoid for 7.5-minute DEM files and the GRS80 ellipsoid for 1-degree DEM files.</p>
1	<p>North American Datum of 1927, NAD27, based on Clarke 1866 ellipsoid.</p> <p>AERMAP accounts for shift from NAD27 to NAD83, as needed, for DEM nodes, receptors, sources, and domain.</p>
2	<p>World Geodetic System of 1972 datum, WGS72, based on WGS72* ellipsoid.</p> <p>AERMAP accounts for shift from WGS72 to NAD27, as needed, for DEM nodes, receptors, sources, and domain.</p>
3	<p>World Geodetic System of 1984 datum, WGS84, based on WGS84* ellipsoid.</p> <p>AERMAP accounts for shift from WGS84 to NAD27, as needed, for DEM nodes, receptors, sources, and domain.</p>
4	<p>North American Datum of 1983, NAD83, based on GRS 80* ellipsoid.</p> <p>AERMAP accounts for shift from NAD83 to NAD27, as needed, for DEM nodes, receptors, sources, and domain.</p>
5	<p>Old Hawaii Datum, based on Clarke 1866 ellipsoid, but not NAD 27.</p> <p>AERMAP accounts for shift from the Old Hawaii Datum to NAD83, as needed, for DEM nodes, receptors, sources, and domain.</p>
6	<p>Puerto Rico/Virgin Island Datum, based on Clarke 1866 ellipsoid, but not NAD 27.</p> <p>AERMAP accounts for shift from the Puerto Rico/ Virgin Island Datum to NAD83, as needed, for DEM nodes, receptors, sources, and domain.</p>

TABLE 2-1. DESCRIPTION OF DATUM SWITCHES FOR ANCHOR LOCATION

\* Note: The GRS80 and WGS84 ellipsoids are considered to be the same in AERMAP, although there is actually a very small difference in the flattening which results in the semi-minor axis, b, being different by 0.0001 meters. However, there is no known application of AERMAP for which this difference is significant. While differences between the WGS72 and WGS84 ellipsoids may account for shifts of about 14 meters in mid-latitudes, this shift is still small compared to the typical spacing of about 90 meters between terrain nodes for 1-degree DEM files. As a result, AERMAP treats the WGS72, WGS84 and GRS 80 ellipsoids as equivalent, and no datum shifts are calculated between the NAD83, WGS72 and WGS84 datums.

If the user is not sure regarding the reference datum for the receptors (and sources) to be used in a particular application, then the following suggestions may be helpful. Given the potential significance of NAD shifts on receptor elevation and hill height scale results, the user is first encouraged to make every effort to document the reference datum, perhaps by contacting the original source of the information. When no reliable information is available regarding the datum, then the following assumptions are recommended. If the coordinates are from a previous application that dates back several years (mid-1990's or earlier) or are likely to have been derived from printed USGS 7.5-minute (1:24,000 scale) topographic maps, then the best recommendation is to assume NAD27 as the reference datum. On the other hand, if the coordinates are from a recent application and are likely to have been derived from a global positioning system (GPS) device or a geographic information system (GIS), then the reference datum is more likely to be NAD83. Note that topographic maps available on the web will generally plot coordinates based on the NAD83 datum by default, but may also be able to plot coordinates in the NAD27 datum.

## **2.2 RECEPTOR ELEVATIONS AND HANDLING OF GAPS**

In addition to correcting several issues associated with NAD conversions, the revised AERMAP program also includes modifications to the procedure for calculating receptor elevations and for the handling of receptors that may be located within gaps between adjacent DEM files due to NAD conversions.

### **2.2.1 History of AERMAP Development**

The original version of AERMAP, dating from the early-1990's, did not account for NAD conversions since the early DEM data were based on consistent datums, and the DEM data format at that time did not include a field for the reference datum. Receptor elevations in the original version of AERMAP were also based on a 2-dimensional (bilinear) interpolation of elevations from the four closest terrain nodes surrounding each receptor location. At that time, the only complete DEM dataset for the continental U.S. was 1-degree data, where the node profiles follow latitude and longitude lines parallel to, and including the edges of the DEM file.

While coverage of 7.5-minute DEM data was still limited at the time of the original AERMAP, the issue of receptors that fall along the edges of the 7.5-minute DEM quadrangle beyond the range of the node profiles was addressed by using the two closest nodes and flagging the resulting elevation calculation as an edge receptor. Given the horizontal resolution of 30 meters for 7.5-minute DEM data at that time, this approach for handling edge receptors was considered adequate.

When the AERMAP program was first modified to include a NAD conversion capability to account for variations in reference datums, several changes were made to the structure of the program to address some of the issues that arose, including the possibility of receptors located in gaps between adjacent DEM files. One of the modifications was to use an inverse distance weighted average for the receptor elevation, based on the closest four nodes in each quad (SW, NW, NE, and SE) relative to the receptor, including nodes from adjacent DEM files. With the corrections to the NAD conversion process, the potential magnitude of the gap between DEM files due to reference datums is limited to the datum shift only, and does not include the shift associated with the conversion between UTM and geographic coordinates based on different ellipsoids. The magnitude of the datum shift for NAD27 to NAD83 varies from about 10 meters or less over the Midwest region, to about 30 to 40 meters along much of the Gulf coast region, to about 80 to 100 meters in the Pacific Northwest region.

### 2.2.2 Receptor Elevations and Edge Receptors

The AERMAP program (dated 06341) has been revised to utilize the original 2-dimensional (bilinear) interpolation method for calculating receptor elevations. This is a relatively simple, well-documented method that is appropriate for interpolating between regularly-spaced grid nodes, as in DEM files. The bilinear interpolation has also been specified as the standard method for interpolating elevations from digital terrain data by the Federal Communications Commission (FCC, 1984). Some additional improvements have also been incorporated into AERMAP for handling of edge receptors, located beyond the range of node profiles in 7.5-minute data, to account for proximity to nodes in both the Easting and Northing directions for partial profiles that occur near the edges of the quadrangle. With the introduction

of finer resolution 10-meter 7.5-minute DEM files in recent years, the representativeness of elevations for edge receptors is less of a concern.

### 2.2.3 Gap Receptors Due to NAD Conversions

As discussed above and in Section 2.1 of the current AERMAP User's Guide, coordinate conversions to account for non-uniform datums can result in gaps between adjacent DEM files, ranging in size from a few meters in parts of the Midwest to around 100 meters in parts of the Pacific Northwest. Calculating elevations for receptors located within these gaps is problematic, and the representativeness of these gap calculations may be questionable, especially for areas with larger gap distances. Because of these concerns, users are encouraged to avoid using DEM files with different datums within the same application if possible.

While gaps between DEM files is the main concern, users should also be aware that portions of DEM files may overlap due to datum conversions, mirroring the datum gap, depending on the direction of the NAD conversion (27 to 83 or vice versa) and depending on which side of the DEM file the receptors are located. The effect of this DEM file overlap is that elevations calculated for receptors located within the overlap region may vary slightly depending on the order in which the DEM files are listed in the AERMAP input file, since AERMAP will assign the receptor to the first DEM file that contains those coordinates.

The AERMAP program uses the following method for handling gap receptors:

1. AERMAP loops through each receptor to locate its local DEM file, initially using no distance tolerance on the location of the receptor relative to the edges of the DEM file. For applications that do not involve NAD conversions this loop should uniquely assign each receptor to its local DEM file.
2. AERMAP issues a warning message identifying each gap receptor that is not located within a DEM file based on this initial loop.
3. AERMAP performs a second loop for all gap receptors using a distance tolerance of one-half the datum shift in order to assign the receptor to the closest DEM file.
4. AERMAP issues a fatal error message for any receptor that is not located within a DEM file based on this second loop.

5. If no fatal errors are encountered, AERMAP will continue with calculating elevations for all receptors, including gap receptors. Given the uncertainties regarding appropriate elevations for receptors located within the datum gap, AERMAP handles these receptors as “extended edge” receptors, which means that AERMAP will calculate the receptor elevation using the two closest nodes within the assigned DEM file.

Users are encouraged to check the results for gap receptors relative to topographic maps of the area to ensure the representativeness of the elevations for use in AERMAP.

## **2.3 ADDITIONAL USER OPTIONS**

### **2.3.1 Option for Checking Contents of DEM Files**

The previous version of AERMAP (dated 04300) incorporated a subroutine (DEMCHK) that performs detailed checks on the contents of each DEM file on a character-by-character basis. These checks serve two purposes: 1) to determine the structure of each DEM file by looking for carriage-return (CR) and line-feed (LF) characters and other non-alphanumeric characters for purposes of reading the file correctly; and 2) to document the contents of the DEM file for informational and/or debugging purposes. Based on these checks each DEM file is identified as either: 1) a continuous ASCII record file (with no CR or LF); 2) a UNIX file (with LF but no CR); 3) a standard DOS file (with both CR and LF); or 4) a possible binary file (containing non-alphanumeric characters besides CR and LF). The AERMAP program supports the first three types of files, but a fatal error message is generated if the fourth type of file is encountered. The inclusion of the DEMCHK routine in AERMAP has eliminated the requirement for users to convert DEM files to the standard DOS format using the CRLF.EXE utility program.

The full DEMCHK could be time consuming for applications with a large number of DEM files, and especially for 7.5-minute DEM files with 10 meter horizontal resolution due to the larger file sizes. In order to retain the capabilities of the DEMCHK routine, but to expedite processing where detailed checks of DEM file contents are not warranted, the AERMAP program has been revised to incorporate a more limited DEMCHK as the default operation, with

a user option to request a full DEMCHK on a file-by-file basis. The limited DEMCHK performs the same processing as the full check, but is limited to the first 20480 characters (equivalent to the first 20 records of a DEM file). This limited check should be sufficient to identify the type of DEM file in order to successfully read the data. The complete check can be requested as needed to provide additional documentation if problems are encountered.

The option to request a full DEMCHK for a particular DEM file has been added to the CO DATAFILE keyword. The revised syntax and type of the DATAFILE keyword are:

<b>Syntax:</b>	CO DATAFILE FileName ( <u>CHECK</u> )
<b>Type:</b>	Optional, Repeatable

where the FileName parameter is the DEM filename, and the optional CHECK parameter indicates that the full DEMCHK will be performed for that file. The CHECK parameter is not case-sensitive.

### 2.3.2 Debug Output Files

The revised AERMAP program includes both mandatory and optional, user-specified debug output files. The three mandatory debug files provide general information regarding DEM files and domain setup that may be useful in documenting and resolving problems with the AERMAP code or with the setup of the input data. The filenames for these mandatory debug output files are hardcoded as MAPDETAIL.OUT, MAPPARAMS.OUT, and DOMDETAIL.OUT.

The MAPDETAIL.OUT file contains a summary of information regarding each DEM file based on the results of the DEMCHK routine. The MAPPARAMS.OUT file contains a summary of the parameters for each DEM file, based on the contents of the header record (logical record type A), and also documents the adjacency of the DEM files with a gridded layout showing the relative positions of the DEM files that can be useful in identifying any gaps in coverage for the application area.

The DOMDETAIL.OUT file contains information regarding the extent of the user-specified modeling domain, including which DEM file contains each corner of the domain. This information can be helpful in resolving issues with the domain exceeding the extent of the DEM files.

The optional debug output file options are specified with a new DEBUGOPT keyword that has been added to the CO pathway. Separate debug files are available to document calculations related to the determination of the critical hill height scales, receptor elevations and coordinate conversions, and source elevations and coordinate conversions. Each debug output file has a default filename defined within the AERMAP program, but separate keywords on the OU pathway may be used to specify alternative filenames for these files.

The syntax and type of the DEBUGOPT keyword are:

<b>Syntax:</b>	CO DEBUGOPT HILL and/or RECEPTOR and/or SOURCE or CO DEBUGOPT ALL
<b>Type:</b>	Optional, Non-repeatable

where the HILL, RECEPTOR and SOURCE keywords can be used to request specific types of debug outputs, while the ALL keyword can be used to request all three types of debug outputs. The keywords are not case-sensitive, and the order of keywords for the first option is not critical. Also note that SOURCE debug outputs will only be generated if source locations are included in the AERMAP input file.

The HILL debug option includes a single debug file that documents the calculations of the critical hill height scales. The default filename for the HILL debug output is 'CALCHCDET.OUT'. For each receptor, the HILL debug output file summarizes the search for critical hill heights for each DEM file within the domain. In order to minimize the size of the HILL debug output file, only terrain nodes that factor into the critical hill height calculation are

documented. A sample from a HILL debug output file is provided below in Figure 2-1, with some annotations.

The RECEPTOR and SOURCE debug options each produce three files with the same type of information for receptors or sources, respectively. The discussion here will focus on receptors but also applies to sources. The first file provides details regarding the NAD conversion results for each receptor, with a default filename of ‘RECDETAIL.OUT’. The second file provides results of calculations to locate which DEM file contains each receptor, with a default filename of ‘RECNDDEM.OUT’. The third file contains results of the receptor elevation calculations, with a default filename of ‘RECELV.OUT’. Samples from each of these types of RECEPTOR debug files are provided in Figures 2-2 through 2-4.

The options for user-specified filenames are provided with the DEBUGHIL, DEBUGREC, and DEBUGSRC keywords on the OU pathway. The syntax and type of the DEBUGHIL keyword are:

<b>Syntax:</b>	OU DEBUGHIL HillDebug
<b>Type:</b>	Optional, Non-repeatable

where the HillDebug parameter is the user-specified name for the HILL debug file. The syntax and type of the DEBUGREC and DEBUGSRC keywords are:

<b>Syntax:</b>	OU DEBUGREC RecDebug1 RecDebug2 RecDebug3 OU DEBUGSRC SrcDebug1 SrcDebug2 SrcDebug3
<b>Type:</b>	Optional, Non-repeatable

where the RecDebug1, RecDebug2, and RecDebug3 parameters are the debug filenames for the NAD conversion file, the DEM assignment file, and the receptor elevation file, respectively. The source debug files and naming convention follow the same pattern as the receptor debug files.

```

Entering CALCHC for Receptor:          1
Starting with Local DEM File:         1
Annotations:

Checking DEM File 1 : NORTHWEST DURHAM, NC-240; for Receptor No.: 1

  RECLAT  RECLON  DEM_SELAT  DEM_SELON  DLAT  DLON  ILT  ILN  DIST  MAXELEV  RECELEV
  36.058  78.946    36.000    78.875   0.000  0.000  0  0    0.00  227.40  120.34

REC NADA DEM NADD      Map Name      Latitude  Longitude  Northing  Easting  Zone
  1  1  1  1  NORTHWEST DURHAM, NC-240    36.058    78.946   3992098.48  685017.36  17

  DEM  PROF  NODE      NODE-X      NODE-Y      DIST      ZNODE      RELEV  HEFMAX
  1    135  169  684840.00  3992180.00  195.20   140.00   120.34  140.00
  1    135  170  684840.00  3992190.00  199.58   140.30   120.34  140.30
  1    136  169  684850.00  3992180.00  186.16   140.60   120.34  140.60
  1    136  170  684850.00  3992190.00  190.75   140.80   120.34  140.80
  1    136  171  684850.00  3992200.00  195.75   141.00   120.34  141.00

Checking DEM File 2 : NORTHEAST DURHAM, NC - 2; for Receptor No.: 1

  RECLAT  RECLON  DEM_SELAT  DEM_SELON  DLAT  DLON  ILT  ILN  DIST  MAXELEV  RECELEV
  36.058  78.946    36.000    78.750   0.000  0.125  0  1    6369.29  138.00  120.34

REC NADA DEM NADD      Map Name      Latitude  Longitude  Northing  Easting  Zone
  1  1  2  1  NORTHEAST DURHAM, NC - 2    36.058    78.946   3992098.48  685017.36  17

There were NO potential critical hill heights found in DEM file: NORTHEAST DURHAM, NC - 2

.
.
.

The Critical Hill Height for Receptor: 1 is 141.00 meters.
-----

```

Figure 2-1. Sample from HILL Debug Output File

Processing Receptor Location Data in RECCNV:  
 Determining North American Datum (NAD) shift values in arc-seconds.  
 Total shift (meters) includes both datum shift and projection shift  
 for Lat/Lon to UTM coordinates.

REC#	1	X-,YPT27:	78.94585057	36.05768403
		SHFT SECS	-0.96859971	0.51376142
		SHFT MTRS	19.50169010	216.93349453
		X-,YPT83:	78.94558152	36.05782675
		DATUM SHIFT =	1.10 SECONDS	
		TOTAL SHIFT =	217.81 METERS	
REC#	2	X-,YPT27:	78.94563482	36.05856807
		SHFT SECS	-0.96861997	0.51375221
		SHFT MTRS	19.50137576	216.93574333
		X-,YPT83:	78.94536576	36.05871078
		DATUM SHIFT =	1.10 SECONDS	
		TOTAL SHIFT =	217.81 METERS	

.  
 .  
 .

DOM ZONE/NORTH/EAST#:	17	3993500.000	686500.000
REC ZONE/NORTH/EAST#:	1	3992098.481	685017.365
DOM ZONE/NORTH/EAST#:	17	3990500.000	683500.000
DOM ZONE/NORTH/EAST#:	17	3993500.000	686500.000
REC ZONE/NORTH/EAST#:	2	3992196.962	685034.730
DOM ZONE/NORTH/EAST#:	17	3990500.000	683500.000
DOM ZONE/NORTH/EAST#:	17	3993500.000	686500.000
REC ZONE/NORTH/EAST#:	3	3992295.442	685052.094
DOM ZONE/NORTH/EAST#:	17	3990500.000	683500.000

.  
 .  
 .

Figure 2-2. Sample from the RECEPTOR Debug File for NAD Conversions

```

LOOKING AT DEMs FOR REC:      1
REC#:      1  RLAT/LON:      36.05768403      78.94585057
              SHIFTL/L:      0.51376142      -0.96859971
              UTM(E/N):      685017.365      3992098.481
              SHIFTX/Y:      19.50169010      216.93349453      REC NAD:  1

DEM No.:    1 DEM Name: NORTHWEST DURHAM, NC-24000      DEM NAD:  1
DEM Max. LAT/LON(D.D):    36.12500      79.00000
Rec LAT/LON(D.D):    36.05768      78.94585
DEM Min. LAT/LON(D.D):    36.00000      78.87500

DEM Max. LAT/LON(Sec):    130050.00000      284400.00000
Rec LAT/LON(Sec):    129807.66252      284205.06207
DEM Min. LAT/LON(Sec):    129600.00000      283950.00000

DEM No.:    1 Contains Rec No.:    1

LOOKING AT DEMs FOR REC:      2
REC#:      2  RLAT/LON:      36.05856807      78.94563482
              SHIFTL/L:      0.51375221      -0.96861997
              UTM(E/N):      685034.730      3992196.962
              SHIFTX/Y:      19.50137576      216.93574333      REC NAD:  1

DEM No.:    1 DEM Name: NORTHWEST DURHAM, NC-24000      DEM NAD:  1
DEM Max. LAT/LON(D.D):    36.12500      79.00000
Rec LAT/LON(D.D):    36.05857      78.94563
DEM Min. LAT/LON(D.D):    36.00000      78.87500

DEM Max. LAT/LON(Sec):    130050.00000      284400.00000
Rec LAT/LON(Sec):    129810.84505      284204.28536
DEM Min. LAT/LON(Sec):    129600.00000      283950.00000

DEM No.:    1 Contains Rec No.:    2

```

Figure 2-3. Sample from the RECEPTOR Debug File for Assigning Local DEM File

```

RECEPTOR ELEVATION CALCS FOR REC#      1
LOCATED IN DEM FILE:      1  NORTHWEST DURHAM, NC-24000

DEM FILE NAD:      1 ; ANCHOR POINT NAD:      4

DEM FILE ZONE:      17 ; RECEPTOR LOCATION (UTMx, UTM y, Zone):      684997.8625      3991881.5518      17
CALLING FIND4 w/IREC,JDEM,IERR:      1      1      0
FIND4:
  DEM REC ERR      XRR      YRR
  1      1      0      684997.8625      3991881.5518

  NORTHWEST DURHAM, NC-24000
  SW Corner      NW Corner      NE Corner      SE Corner
  Easting:      680270.939      679985.884      691236.541      691539.436
  Northing:      3985597.778      3999464.516      3999703.384      3985836.309
  Latitude:      36.000      36.125      36.125      36.000
  Longitude:      79.000      79.000      78.875      78.875
Based on the Find4 Coding of:
  IP= 4----3
  |      |
  IP= 1----2

IP      xbase      nx      xx      X-Receptor      ybase      ny      yy      Y-Receptor
1      683490.00      151      684990.00      684997.86      3990290.00      160      3991880.00      3991881.55
2      683500.00      152      685000.00      684997.86      3990290.00      160      3991880.00      3991881.55
3      683500.00      152      685000.00      684997.86      3990290.00      161      3991890.00      3991881.55
4      683490.00      151      684990.00      684997.86      3990290.00      161      3991890.00      3991881.55

DEM RECNUM:
  IP      JREC      NX      NY
  1      45160      151      160
  2      45460      152      160
  3      45461      152      161
  4      45161      151      161
Based on the DEM Coding of:
  IP= 2----3
  |      |
  IP= 1----4

RECELV
  IP      JREC      DEM      XDM      YDM      ELEV
  1      45160      1      684990.00      3991880.00      133.10
  2      45161      1      684990.00      3991890.00      131.10
  3      45461      1      685000.00      3991890.00      132.10
  4      45460      1      685000.00      3991880.00      133.80

ELEVATION (M) FOR IREC      1 =      133.38
-----

```

Figure 2-4. Sample from the RECEPTOR Debug File for Receptor Elevation Calculations

### **3.0 REFERENCES**

Environmental Protection Agency, 2004: User's Guide for the AERMOD Terrain Preprocessor (AERMAP). EPA-454/B-03-003. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

Federal Communications Commission, 1984: Use of Computer-Generated Terrain Data for Determining Antenna Height Above Average Terrain, Interim Procedure Per General Docket 84-705. Federal Communications Commission, Washington, DC 20554.

U.S. Geological Survey, 1998: Standards for Digital Elevation Models, National Mapping Program Technical Instructions, U.S. Department of the Interior, Reston, Virginia 20192.