Appendix 1
Appendix 2

Guidelines to Install the AGNPS-GRASS Interface Tools

The major objective of the AGNPS-GRASS input interface is to minimize the user interaction in preparing the input data for the AGNPS model and to minimize the number of user supplied/developed GIS database layers. Of the 22 different data required by the model for each cell (appendix 2), the interface will prepare the input data with only 8 (appendix 2) basic GIS data base layers supplied by the use and with minimal user interaction. there are 5 (appendix 2) parameters needed for the whole watershed which will be obtained from the user.

Name of the AGNPS-GRASS Input Interface Program: aggrs_input
Procedures to follow while executing the Input Interface:

a. First start GRASS from a shelltool window by typing grass. the mapset location should be agnps and the mapset should be ansi

b. Execute the aggrs_input program from the shelltool window where GRASS is running. (e.g., type aggrs_input and press enter).
Hit Esc to pass the initial copyright message.

c. A Watershed Input menu will appear on the shelltool window requesting the following data/information from the user:

1. Watershed Description: Enter a description about the watershed. This information is optional and will appear in both input and output or the AGNPS model run. (for example type run1).

2. Rainfall Amount in inches: Enter the total amount of rainfall in inches. (type 2.5)

3. Erosivity Index Value: Enter the erosivity index value for thatnparticular storm/rainfall event (type 30).

4. Antecedent Moisture Condition (1,2, or 3): Enter the SCS Antecedent Moisture Condition to compute the SCS curve numbers for each cell (type 2 for AMC II).

5. Enter the cell size in meters: the length of the side of a cell in meters is entered (type 100). The square of the cell size will be the area of each cell.

6. Enter a file name to save in AGNPS format: Enter a file name with .dat as the extension to save the AGNPS model input file created by the AGNPS-GRASS input-interface tool (type run1.dat). This will be stored in the current working directory.

7. Enter the watershed name: the name or the watershed should be entered there (type ansi). All the input layers should have the same watershed name with the proper extension (as X in appendix 1).

   Please refer to appendix 1 for the valid extensions and valid category labels/values that are allowed for each layer.

After answering hit Esc to continue.

d. Error Messages: If any of the category labels/values for the input layers is not valid, an error message is printed and the program quits. Run support on the layer where the category label is wrong to correct it. the program support helps to modify the supporting files of a map, which include header, category, color, and history. the wrong/misspelled category labels can be corrected by running support on the layer to be corrected and choosing the category option. To run support, type support at the prompt. If there is any problem with the flow direction layer, error messages are printed for those cell numbers that had problems and the nature of those problems (like circularity, sinks or holes, or flow directions pointing at each other). Use Dedit on the aspect map to correct the problems. The Dedit program helps to display and edit the aspect map with arrows on it. which should enable one to correct the flow direction on a cell by cell basis. To run Dedit, type Dedit at the prompt.

e. For each run of this input interface tool, a new temp_cell_num layer is created and stored in the current mapset. In this map, the cells are numbered from top to bottom and left to right. This is a useful layer for editing and interpreting the error messages due to conflicting flow direction for any particular cell. While using the Dedit program to correct the errors, this map allows one to locate the cell number where conflicts occur.

f. Once the input interface completes its run with errors, it saves the data in the AGNPS format. the AGNPS model can be executed with this data. The name of the executable file program to run the AGNPS model is agrun. Type agrun from the shelltool window where GRASS is running. The program will ask for the input file name. Enter the name of the file that was saved by running the AGNPS-GRASS input interface, with the .dat extension (type run1.dat). The model will the results or the run with a .nps (run1.nps) extension. Both input and output ASCII files are need to execute the AGNPS-GRASS output interface tool (the Visualization tool). Once the model completes the execution, type wshd_summary file_name.nps (wshd_summary run1.nps) to get the hard copy of the watershed summary from the laser printer in room 118.

Appendix 1

Layer Name	Valid Extension	Allowed Category Labels/Values
Watershed boundary	X.wshd	Should have category values greater than 0 within the watershed and 0's outside of the watershed boundary.
Elevation	X.elev	Elevation data in meters should be the

		category values for each cell. Also make sure at least 1 row and column of data around the watershed boundary exist to estimate slope and aspect at the boundary of the watershed.
Aspect	X.asp.cell_size	The aspect map should have values between 1-8 as category values and should not have any sinks, circularity or more than one outlet. Cell_size is the number that the user entered for question A in the interface input menu. For example, if the watershed is modeled for a 100m cell size, then the aspect map should be X.asp.100
Soils	X.soils	If any of the soil attribute (K factor, clay, sand or hydrological soil group) maps do not exist, then the program looks for X.soils map to extract information from the Soils-5 data base.(currently this is not working fully).
USLE K factor	X.K	The USLE K factor map should contain the value of the K factor as the category label for each cell. This is obtained from the soil type map.
Hydrological soil group	X.hyg	The category labels allowed are either A,B,C, or D and should appear as category labels for each cell. This is obtained from the soil type map.
Sand	X.sand	The percentage of sand content should be the category label for each cell. This

		is obtained from the soil type map.
Clay	X.clay	The percentage of clay content should be there as a category label for each cell. This is obtained from the soil type map.
Land use	X.luse	The land use map category labels allowed are fallow, row crops, small grain, rotation meadow, close-seeded legumes, pasture, range, meadow, woods, hard surface, farmsteads, roads (dirt), water, or marsh.
Management Practice	X.mgpr	The management practice map category labels allowed are straight row, contoured, or contoured and terraced.
Nutrient	X.nut	The cell value should correspond to the level of fertilizer application, i.e. 1,2,3 or 0. Where 1-low, 2-medium, 3-high and 0-urban, farmsteads, water or marsh. (refer fertilizer level table)
Machinery	X.mach	This map is used to find the fertilizer availability factor for the top 1 cm depth of soil. The category labels allowed are large offset disk, moldboard plow, lister, chisel plow, disk, field cultivator, row cultivator, anhydrous applicator, rod weeder, planter, smooth, or no-till. the urban, water, marsh or farmsteads areas category label can be no till or smooth.

Channel slope	X.chsl	A channel slope length map has to be prepared by the user. Percentage of channel slope should be the value of the category in that cell. If this layer is is missing, the user as the choice to either enter the name of layer which has the channel slope values or can accept the default value of 50% of the overland slope value as the channel slope value (recommended by the AGNPS manual).
USLE C factor	X.C	The USLE C factor map should contain the value of the C factor as the category label for each cell.

*replace X with you watershed name (X will be ansi for the lab)

Fertilization Level

Level of Fertilization	Assumed fertilization(lb/acre) N	P	Input
None	0	0	0
Low	50	20	1
Medium	100	40	2
High	200	80	3

Appendix 2: AGNPS cell input parameters

1. Cell number
2. Number of cell into which it drains
3. SCS curve number
4. Average slope %
5. Slope shape factor
6. Average field slope length
7. Average channel slope
8. Slope length factor
9. Mannings roughness coefficient for channel
10. Soil erodibility factor (K) from USLE
11. Cropping factor (C) from USLE
12. Practice factor (P) from USLE
13. Surface condition constant (based on land use)
14. Aspect (one of 8 directions indicating drainage from cell)
15. Soil texture (sand, silt, clay, peat)
16. Fertilization level (zero, low, medium, high)
17. Incorporation Factor (% fertilizer left in top 1 cm of soil)
18. Point source indicator (indicates existence of a point source input within a cell)
19. Gully source level (estimate of amount, tons, or gully

erosion in a cell)
20. Chemical oxygen demand factor
21. Impoundment factor (indicating presence of an impoundment terrace system within a cell)
22. Channel indicator (indicating existence of a defined channel within a cell)

The 8 basic input GIS layers required for extracting the data by the AGNPS-GRASS input interface tool

1. Soils
2. Elevation
3. Land use
4. Management Practice
5. Fertilizer or nutrient inputs
6. Type of machinery used for land preparation
7. Channel slope
8. Slope length factor

The 5 watershed parameters required to run the AGNPS model

1. Watershed description
2. Rainfall amount in inches
3. Erosivity index for that rainfall event
4. Area of each cell in acres
5. Outlet cell number

Guidelines for AGNPS-GRASS Output Interface (the Visualization Tool)

Current NPS models including AGNPS have very limited graphics capability for visualizing and analyzing the model output. A distributed parameter model should assist in pinpointing the critical area where one needs to pay attention for controlling NPS pollution. Even though AGNPS gives detailed output, users often can not make use of it, due to lack of proper analyzation and visualization tools. Graphical displays of the results have proven to be a more effective and efficient way of interpreting the results and in making decisions than scanning through pages and pages of numerical output in the form of tables. the following sections discuss the visualization tool in detail.

AGNPS Output Parameters

Various output options are available with the AGNPS model. Primary output given for watersheds being analyzed includes watershed area, cell size, storm precipitation, rainfall erosivity (EI), estimates of runoff volume, peak flow rate at the watershed outlet, area-weighted erosion, both upland and channel. Also available is a nutrient analysis, which include N,P and COD mass per unit area for both soluble and sediment adsorbed nutrients, and N,P and COD concentrations in the runoff. Table 1 lists a summary of output parameters that can be obtained for each cell or all cells if desired.

Table 1: AGNPS output parameters at the watershed outlet or any cell

Hydrology output	Runoff volume (inches)
	Peak runoff rate (cubic feet/second)

	Fraction of runoff generated within the cell	
Sediment output	Sediment yield (tons) Sediment concentration (ppm) Sediment particle size distribution Upland erosion (tons/acre) Amount of deposition(%) Sediment generated within the cell (tons) Enrichment ratios by particle size Delivery ratios by particle size	
Chemical output	Nitrogen	Sediment associated mass (pounds/acre) Concentration of soluble material (ppm) Mass of soluble material (pounds/acre)
	Phosphorus	Sediment associated mass (pounds/acre) Concentration of soluble material (ppm) Mass of soluble material (pounds/acre)
	Chemical oxygen demand (COD)	Concentration (ppm) Mass (pounds/acre)

Initially the visualization interface generates 17 maps (Table 2) from the ASCII output files of an AGNPS run. the generated maps can be saved for future evaluation of output. All maps are generated using the reclass principle of the GRASS GIS tool, thereby minimum disk space is required. the map from which all output maps were reclassed 9cell number maps, filename_cell_num, where filename refers to the AGNPS ASCII input/output file without its extension) should not be removed.

Table 2: List of AGNPS output maps created using Visualization tool

Hydrology output	Cell number map Runoff generated map Runoff from upstream map Runoff to downstream map
Sediment output	Erosion map Deposition map Sediment leaving the cell map
Chemical output	Nitrogen associated with Sediment(generated) map Nitrogen associated with Sediment (leaving) map Nitrogen associated with Runoff (generated) map Nitrogen associated with Runoff (leaving) map Phosphorus associated with Sediment (generated) m Phosphorus associated with Sediment (leaving) ma Phosphorus associated with Runoff (generated) ma Phosphorus associated with Runoff (leaving) map

COD associated with Runoff (generated) map
COD associated with Runoff (leaving) map

Name of the AGNPS-GRASS Output Interface Program: vis_tool

Procedures to follow will executing the Output Interface (the Visualization Tool):

a. First start GRASS from a shelltool window by typing grass. the mapset location should be agnps and the mapset should be ans

b. Resize the graphics monitor to fit the full screen of the workstation and use the d.mon program to select the monitor (type d.mon select=monitor_name and press enter). The GRASS shelltool window should be at the right hand side bottom of the screen.

c. Execute the vis_tool program from the shelltool window where GRASS is running (e.g., type vis_tool and press enter). Hit Esc to pass the initial copyright message.

d. A Visualization Tool Input menu will appear on the shelltool window requesting the following data/information from the user:

   1. Enter Watershed Map name: Enter the name of the watershed boundary map containing cell values greater than zero and zero's for cells outside the watershed boundary. (type ansi.wshd)

   2. Enter the cell size in meters: the length of the side of a cell in meters for which the model was run is entered.(type 100)

   3. Enter Aspect Map name: Enter the name of the aspect map for the watershed. It should have been created for the same resolution as the cell size above. (type ansi.asp

   4. Enter the ASCII AGNPS file name without its extension: Enter the ASCII AGNPS file name without its extension since the program takes the default extensio of .dat and .nps for input and output of the model, respectively. these files should be in the current working directory, else give the full path with the file name. (for example type run1)

Then hit the Esc key to continue. Always look for a message at the bottom of the ASCII screen for continuing the execution, if there is no message then hit Enter after answering the question else hit Esc to continue.

In the following section, each output screen of the visualization tool is discussed. the visualization tool splits the screen into various screens to display the output of the model. the number of windows created depends on the type of output displayed. the tool always reserves an ASCII terminal (non graphics) for interacting with the user. the first screen (Figure 1) provides various options including a watershed summary (no graphics) and spatially distributed soil loss, nutrients, runoff and feedlot movement (graphics) output of a watershed.

Figure 1: Initial screen of the Visualization tool
Visualization Tool Main Menu

Output Display Options
1. Watershed Summary including sediment (no graphics)
2. Soil Loss (graphics)
3. Nutrients Movement (graphics)
4. Feedlot Analysis (graphics)
5. Runoff Movement (graphics)
6. Analyze Different Scenarios
7. Save Output Maps
8. Exit to GRASS (to come back type 'return')
9. Quit
Enter the choice (1-9):

Option 1 (Figure 1) displays the watershed summary for soil loss, runoff and nutrient movement at the watershed outlet. This output is displayed in the non-graphics window. the watershed summary can be accessed from any part of the visualization tool, providing an opportunity for decision makers/users to compare the detailed cell output with the watershed outlet output for making decisions.

Options 2-5 (Figure 1) move to the next screen (Figure 2) where the appropriate output option maps are displayed. This screen is divided into numerous windows depending on the output option chosen. the screen is divided in half, having a series of top row windows and bottom row windows with an ASCII terminal. the top row windows display the output maps (Table 2). A scale for each of the output maps is displayed showing the color and the numerical value associated with it. the color of the output maps range from green-yellow-red, with increasing intensity of output. the right hand top corner window displays the watershed map with cell numbers by laying a grid on top of it for reference. Below this cell number map, the aspect map of the watershed with arrows pointing in the flow directions is displayed. In the bottom row, two windows display the output and input statistics for any cell. the left window shows cell inputs. the output window shows a bar chart and key features of the output option statistics for the same cell. the default cell statistics displayed in the bottom row windows are the statistics for the outlet cell of the watershed. the tool provides error checking and also explains what to do at each step.

In the next section, options 6-9 of Figure 1 are discussed.

Analyze Different Scenarios: This option allows the user to visualize and analyze a different simulation for the same resolution of the original run. the user is asked to enter the name of the ASCII AGNPS file name without its extension. the AGNPS run that was started with the visualization tool is called the 'current' and the simulation that was selected using this option is referred as 'selected' thereafter in this documentation. the program checks the resolutions between the 'current and the 'selected' runs and checks for the same file names. then the program creates the 17 output maps (table 2) and displays the 'current' and the 'selected' runs and checks for the same file names. then the program creates the 17 output maps (Table 2) and displays the 'current' and the 'selected' output maps on the screen in the top row windows. the default output is the sediment movement maps. Bottom row windows display the output histograms of the 'current' and the 'selected' simulations. the left bottom row window corresponds to the 'current' input/output window and the right bottom window corresponds to the 'selected' input/output.

Under this option the user has the same options (Figure 2) discussed earlier in this document. In addition to this, the user can alter the output visualization/analyzation to other model outputs such as sediment, nutrients, feedlot or runoff movement. While using options 2 and 3 (Figure 2), the user is asked to select either input or output to view in the bottom row windows. For options 5 and 8 (Figure 2), the user is asked to select either the 'current' or the 'selected' simulation results to view in a window.

This option is one of the strongest features of the visualization tool for analyzing different scenarios simultaneously.

Save Output maps: This option allows the user to save the maps created using the visualization tool. the user can save all or only those outputs of interest, which include sediment, N, P, COD, and runoff. the program asks the user to enter a map name for saving the output maps. the program attaches proper extensions depending on the type of outputs (Appendix 1). Please refer to the appendix 1 for the extensions of different map names. It also contains reserved map names that should not exist in the current mapset. Do not remove the filename_cell_num map, since all output maps created in the visualization tool are reclassed from the created cell number map.

Exit to GRASS (to come back type 'return'): This option allows the user to exit to the GRASS temporarily to perform normal operations under the GRASS GIS tool. To come back to the same menu in the visualization tool, type return and hit enter.
Quit: This option takes the user back to the GRASS prompt and exits from the visualization tool. the output maps created will be removed from the current mapset, but will not affect those maps that are saved using the Save Output Maps option. If you plan to use output maps at some future time, be sure to save them.

Figure 2: Generic options screen of the visualization tool for spatially distributed output

```
1.  Zoom
2.  View a Cell
3.  View an area output
4.  Toggle between flow direction map/viewing area
5.  Show the watershed summary output
6.  Displayed range of output maps
7.  Display user's choice map
8.  draw cumulative and Frequency Distribution State
9.  Restore the initial screen
10.  Exit to GRASS (to come back type 'return')
11.  Quit

Enter the choice (1-11):
```

Each of the options in Figure 2 is discussed below: Its usage and how this assists users or decision makers is described. these options can be used alone or in combination with other options.

1. Zoom: Allows users to zoom in or zoom out of any section of the watershed by choosing one of the displayed windows. Once the zoom operation is performed, the tool automatically adjusts or redisplays all the maps in the top row windows to the same area, enabling users to take a closer look at an area of interest.

This option is particularly helpful on large watersheds. Once the Zoom option is selected, the tool requests for a window to perform zoom operations. the user has to use the left mouse they to click on one of the top row windows and then click on the right mouse key to complete the selection process. then the zoom function asks the user to use the left mouse to click on a place to define the area in the selected window, and then drag the mouse to the desired location and click on the right mouse key to complete the zoom process. Always follow the instructions displayed on the ASCII terminal. Failing to do so can cause the program to stop. Similarly, the unzoom operation can be performed.

2. View a cell: This option allows the user to enter a cell number of interest to display the statistics of that cell's inputs and outputs in the bottom row of windows. the displayed bar chart depends on the type of option chosen in the initial screen (Figure 1). the cell number can be either entered directly using the keyboard in the ASCII terminal or the mouse can be used to point out a cell on the graphics monitor using the left mouse key after choosing one of the top row windows. the window selection process is detailed in the Zoom section. This feature is helpful to visualize characteristics of both inputs and outputs of a critical area.

3. View an are output: This option allows the user to select an are from one of the top row windows and displays the average input and output statistics for that are in the bottom row windows. there also, the user is asked to select a window from the top row windows using the selection procedure explained earlier. then using the left mouse key, the user selects a corner of the desired area and drag the mouse to build a box. Click the right mouse key, the user selects a corner of the desired area and drags the mouse to build a box. Click the right mouse key to complete the process. This information is helpful to study the statistics of the critical area and its neighbors. Using this option, one could estimate average inputs and outputs for a field which should assist in making further decisions.

4. Toggle between flow direction map and viewing window location: This feature is helpful when users use Zoom to view any particular section of the watershed. After a couple of zoom operations, users may loose track of which part of the watershed is displayed. This option toggles between the flow direction map and the whole watershed map showing a box around the current viewing area.

5. Show the watershed summary output: the summary at the outlet of the watershed for all the outputs is displayed in the ASCII (non graphics) terminal. This option is useful to correlate cell outputs with those of watershed outputs to make decisions.

6. Display ranges of output maps: This option allows users to visualize output maps (Table 2) for a specified range between maximum and minimum values of the output (Figure 1) chosen. This helps users locate critical areas easily. For example, users can use this option to display problematic areas that are exceeding the soil tolerance limit (T factor). Options are available to save the displayed maps for later reference, compare various scenarios or overlay one map on another in order to make decisions.

7. Display user's choice map: Users have an option to display

a cell map, overlay a map on another map or display a vector map. the chosen map can be displayed on one of the existing windows or users have an option to create a new window anywhere in the graphics monitor to display the map. Further, the map chosen for display can be one of the AGNPS output maps (Table 2) generated from the AGNPS output files or one of the existing maps in the database. From the users/decision makers point of view, this option is helpful to reach conclusions about management strategies. For example, by overlaying a field boundary or property boundary on an erosion map, fields within critical limits can be located. Combinations of various outputs can be viewed simultaneously on the designed graphic windows. On selection of this option, the user is prompted for the map to be displayed. If the user selects to display the map in one of the existing windows, then the selection of the window operation is performed followed by the selection of the type of display. This could be to display a cell map, overlay a map on another map or display a vector map. Maps are listed for selection. If the user selected the option to create a new window to display a map, then the program requests a location to start the window. Using the left mouse key, drag the mouse to create a box of desired size and click the right mouse key to end the process.

8. Draw Cumulative and Frequency Distribution Statistics: This option allows the user to view the percentage of cumulative and frequency distribution area curves for any of the output maps (Table 2) or selective input variables for either user specified ranges of intervals/classes or for 10 equal ranges of intervals/classe between the maximum and minimum of the selected variable. This option is helpful to see how that particular variable is distributed both cumulatively and the number of occurrences in that interval. It is believed this information in combination with spatial referenced maps could be of very useful in the decision making process. the steepness of the curve shows how that variable is increasing within a corresponding range. By choosing this option, the program requests a window to display the statistical curves. then, the program asks the user to select either an input or output variable for which to draw the curves. the use then has the option of keeping the previously selected X-axis intervals/classes or can select a new range of intervals/classes. the selection of new ranges of intervals can be done in one of two ways. Either the use can select 10 equal intervals between the maximum and minimum of the selected variable or the can enter the ranges between the maximum and minimum values. In either case,t the number of intervals can’t exceed 10.

9. Restore the initial screen: This option restores the original or initial display screen that was initiated when one of the options from Figure 1 was chosen.

10. Exit to GRASS (to come back type ’return’): This option allows the user to exit to the GRASS temporarily to perform normal operations under the GRASS GIS tool. To come back to the same menu in the visualization tool, type return and hit enter.

11. Quit: This option takes the user back to the initial screen (Figure 1). If the user has crated any maps using option 6, the program asks if these are to be saved before quitting.