Nitrogen Loss and Environmental Assessment Package with GIS Capabilities (NLEAP-GIS 4.2): User Guide

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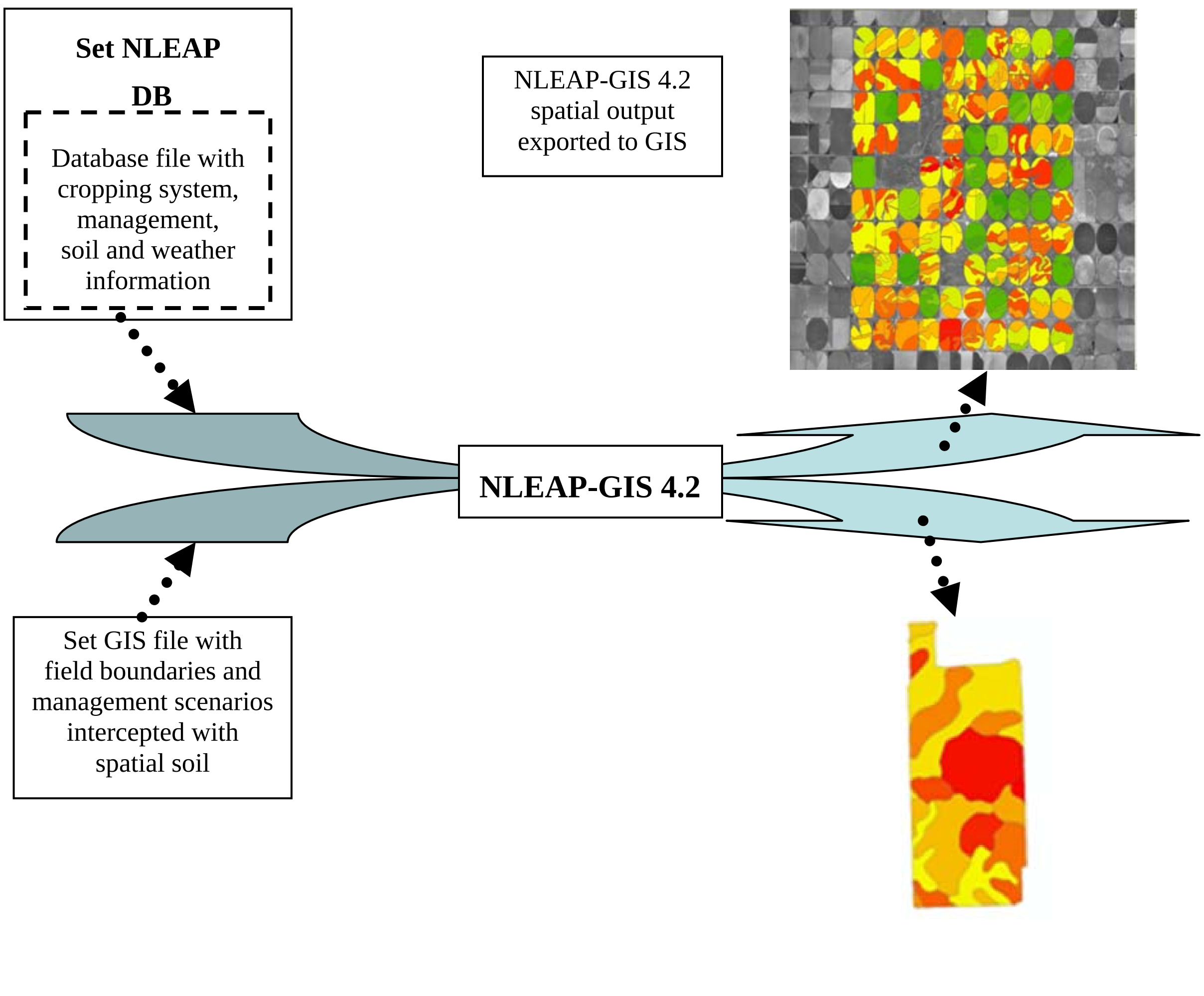

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Contacting the Authors

This guide will help new users become acquainted with the NLEAP-GIS 4.2 program. We look forward to hearing your comments, feedback, questions, and suggestions for improvements of the manual. Comments can be directed to:

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User Agreement

Please carefully read and review the following terms and conditions before using NLEAP-GIS 4.2. The NLEAP-GIS 4.2 is provided free of charge with no expectations or warranties by USDA-ARS-SPNR, 2150 Centre Ave., Suite 100, Fort Collins, CO 80526.

The user assumes all risks and responsibilities for the use and application of NLEAP-GIS 4.2 and interpretation of results. The authors, their affiliated institutions, USDA, ARS, SPNR, other U.S. Government agencies, and Colorado State University will not be liable for any damage, including lost profits, lost savings, lost time, actions by regulatory agencies, or any other direct or indirect incidental or consequential damages occurring from the use of or inability to use NLEAP, its databases, its results, or its documentation for any purpose. There is no guarantee that the NLEAP-GIS 4.2 driver software will be able to function in all computer systems or with all software.

With problems, concerns, questions, or comments please contact:

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1. Introduction

1.1 NLEAP-GIS 4.2 Training

When possible, training will be offered in spring and/or fall sessions at the USDA-ARS Soil Plant Nutrient Research Unit in Fort Collins, Colorado. If the trainer's schedule permits, and if enough interested users are available to attend a training session (a minimum of 10 individuals) a session will be scheduled. Interested individuals who would like to schedule a training session will need to contact Dr. Jorge A. Delgado (jorge.delgado@ars.usda.gov) three months ahead of time so that the session can be set. (Questions about the training can also be directed to the above e-mail address.)

Training sessions will be three days long and will consist of two parts. Part I will be a basic introduction to using NLEAP-GIS 4.2, and Part II will be more advanced and allow attendees to practice using NLEAP-GIS 4.2 either with the example data provided with the software, or if desired, data brought by the trainees. Part I will be a 1.5 days long, followed by Part II, which will also be 1.5 days long.

Any NLEAP-GIS 4.2 training sessions conducted will be offered free of charge (no cost). However, attendees of the training session will need to bring their own laptops (with software) and are responsible for covering all of their costs for their trip to Fort Collins, Colorado. USDA-ARS and USDARS and/or Dr. Jorge A. Delgado reserve the right to cancel any training sessions at any time due to unforeseeable circumstances. Users are responsible for all of their costs of their trip, even if, due to an unforeseeable circumstance, a training session must be canceled and/or rescheduled.

1.1 Capabilities of NLEAP-GIS 4.2

The old DOS version of the Nitrate Leaching and Economic Analysis Package (NLEAP) (Shaffer et al. 1991; Delgado et al. 1998a) has been revised, improved, and renamed the Nitrogen Loss and Environmental Assessment Package with Geographic Information System (GIS) Capabilities (NLEAP-GIS 4.2, Shaffer et al. 2010; Delgado et al. 2010). This new version has been updated and improved to provide users with added functionality for assessment of the effects of management practices on nitrogen losses to the environment across risky landscape and cropping system combinations. This new version is more advanced, with updates to the software that allow for multiple crop rooting depths, simulations of surface residue decay and N_2O emissions, multiple simultaneous simulations, and long-term analyses (Shaffer et al. 2010). Additionally, this version is easier to use with a new graphical user interface and more versatile, allowing quick evaluations of multiple practices employed over long time periods. NLEAP-GIS 4.2 quickly updates database files (DBF) to be used in multiple GIS software packages, facilitating the analysis and evaluation of management systems across single fields, multiple fields, sub-regions and regions (Delgado et al., 2010). This new user interface is also more powerful, allowing rapid connection to internet databases, including current NRCS soil (NASIS and SSURGO) and climate databases.

The NLEAP-GIS 4.2 has several components programmed in different computer languages. The basic NLEAP-GIS 4.2 console was developed in Fortran and C/C++ Shaffer et al. (2010). The NLEAP-GIS 4.2 console contains the algorithms described in Shaffer et al. (2010) to assess nitrogen pools and pathways for nitrogen losses. In order to create a user-friendly NLEAP-GIS 4.2 experience, an interface was developed that runs within a Microsoft Excel®[1] environment[2], driven by Visual Basic® for applications (Delgado et al., 2010). The Excel®-driven menu helps NLEAP-GIS 4.2 quickly communicate with Internet databases, convert these databases to a new format that can be used with NLEAP-GIS 4.2, and communicate with different Geographic Information Systems (examples ArcMap®, MapInfo®,..).

We encourage you to review the literature, especially recent papers, for additional information about the potential uses of NLEAP-GIS 4.2; a list of available literature can be found at the end of this user guide. Some of these papers may be found using web server interfaces with access to electronic publications, while others may be located in library holdings. We recommend that you review some of the most recent related publications, such as the peer-edited book titled *Advances in Nitrogen Management for Water Quality* by Delgado and Follett (2010), especially the chapters from Shaffer et al. (2010) describing the NLEAP-GIS model equations and the new NLEAP-GIS 4.2. Additionally, you may find guidance toward identification of potential applications of this software by reviewing the chapter from Delgado et al (2010) describing the capabilities and the limitations of NLEAP-GIS 4.2. More information about the capabilities and limitations of NLEAP-GIS 4.2 can be found in Shaffer and Delgado (2001, 2002), Delgado and Shaffer (2008) and Delgado et al. (2006, 2008).

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[1] Mention of trade names or commercial products in this report is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

[2] Microsoft, Excel, Access, Visual Basic, and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries. ArcMap is a trademark of ESRI. MapInfo is a registered trademark of MapInfo Corporation, Troy, New York. Other registered trademarks or trademarks mentioned in this user guide are the property of their respective owners.

1.3 Overview of Data Movement in NLEAP

This section of the manual is designed to help you understand the flow of information from database input to NLEAP to database output and all steps in between. The inputs of information necessary to run general NLEAP-GIS 4.2 simulations and NLEAP GIS-linked simulations are described here.

1.3.1 Data Movement for General NLEAP Simulations

As mentioned previously, NLEAP-GIS 4.2[3], is an Excel®-driven interface that is driven by Visual Basic programming, which connects a console programmed in Fortran and C/C++ code with databases, GIS software and the Excel environment. NLEAP-GIS 4.2 has three major tables which are collectively referred to as the NLEAP-GIS 4.2 database (NLEAP DB). These tables are: **1)** the *management scenarios table*, which is a collection of scenario(s) with each scenario populated with the series of events. This table of scenarios with all of the respective events is located in the spreadsheet with the tab named “EVENTS”; **2)** the *soil table*, which is a collection of soil types with each soil populated with the soil profile information. This table of soil types with the respective soil profile (layers) information is located in the spreadsheet with the tab named “SOILAYER”; and **3)** the *weather table*, which is a collection of daily weather at a given location (usually a weather station). This table typically contains years of daily weather and is located in the spreadsheet with the tab named “CLIMLONG”. Users input each of these tables to create the NLEAP DB. More details about each of these tables are given below:

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[3] NLEAP programming for this new, advanced version of NLEAP (NLEAP-GIS 4.2) was developed by Shaffer et al. 2010. The capabilities of the NLEAP-GIS 4.2 driver program were developed by Delgado et al. 2010. NLEAP-GIS 4.2 driver programming connects a console programmed and compiled in Fortran and C/C++ code with databases, GIS software(s), and with programs such as Microsoft Excel® and Visual Basic®. The NLEAP-GIS 4.2 driver program and its user guide are not affiliated with or endorsed by Microsoft, GIS softwares or any other software company or software producer. The user assumes all risks and responsibilities for the use and application of NLEAP GIS 4.2 and interpretation of its results. The authors and their affiliated institutions, USDA, ARS, SPNR, and other U.S. Government agencies, and Colorado State University will not be liable to NLEAP users for any damage, including lost profits, lost savings, lost time, actions by regulatory agencies, or any other direct or indirect incidental or consequential damages occurring from the use of or inability to use NLEAP, its databases, its results, or its documentation for any purpose.

1) The *soil table* (“SOILLAYER”) contains all the soils that are described in a given soil survey for a given county. The SoilLayer table is downloaded from the online NRCS SSURGO databases. These tables can be accessed from NLEAP-GIS 4.2. Once the table is downloaded, it is converted using the Soil Converter Program (SCP) to NLEAP format and exported into the SoilLayer table within the NLEAP database.

2) The *weather table* (“CLIMLONG”) is downloaded from the online NRCS climate databases. Like the soil tables, these tables also can be accessed from NLEAP-GIS 4.2. Once the table is downloaded, it is converted to NLEAP format using the weather converter program (WCP) and imported into the ClimLong table of the NLEAP DB.

3) The *management scenarios table* (“EVENTS”) contains all the events that describe a specific management scenario to be evaluated. For example, a corn soybean rotation will have to include all the management events that occurred during the corn and soybean growing seasons. These events can be entered directly into the model using the Events Creator or can be imported from an Microsoft Excel® spreadsheet or Microsoft Access® database. These management scenarios are exported into the Access-compatible NLEAP DB.

The NLEAP DB outputs each of these three types of tables into separate Microsoft Excel spreadsheets, which can be accessed from the NLEAP program. In other words, the Excel-driven menu interface will have three spreadsheets with the tabs “SOILAYER”, “CLIMLONG” and “EVENTS”.

Using these spreadsheets, you can see the input data, but it is important to note that *the information in the database cannot be changed by altering these spreadsheets.* Changes made within the Excel spreadsheet must be exported to the appropriate NLEAP DB using the tools within NLEAP-GIS 4.2 in order for the changes to persist for future NLEAP simulations.

The NLEAP-GIS 4.2 driver menu connects the Fortran and C/C++ compile console, the NLEAP DB, GIS software and the following files: **1)** the managecodes.IN, which contains the selected scenarios to run; **2)** the managecodes_soil_layer.IN, which contains the soil series to run; and **3)** the CROP.IN (**Figure I**). Once these files and the NLEAP DB have been correctly set, you can run NLEAP-GIS 4.2. NLEAP-GIS 4.2 will then output data that can be viewed in the Excel spreadsheet labeled SOILSYM_Month.

The managecodes.IN and managecodes_soil_layer.IN are located at the "C:\NLEAP\temp" directory and the CROP.IN file is located at the "C:\NLEAP" directory. ***We recommend that you don't work with these files so as to avoid any problems.***

Let's use a concrete example so we can better see how data input and output occur in NLEAP. Say you want to evaluate how two management scenarios impact nitrogen dynamics on five selected soils. The NLEAP-GIS 4.2 scans the Events and SoilLayer tables and presents a query of the unique management scenarios and soil types. You then can use the mouse to quickly select the two management scenarios you would like to test and the five different soil types you want to test. In other words, you will have to select each combination of management scenario and soil type. In this case, each management scenario is saved a total of five times, once for each different soil type. The management scenarios are saved into the management code file (MC Scenarios), while the selected soils will be saved into the management code soil layer file (MC SoilLayer). In our example, 10 different soil and scenario combinations would be created and could be run together for a quick assessment.

You have the option to save the file with unique management scenario codes (**Managecodes.IN**) and the unique management code soil layer file (**Managecodes_soil_layer.IN**). You have the capability of saving these 10 management combinations to quickly run the same simulations again in the future. This is advantageous when testing different management scenarios.

Suppose now that you want to evaluate 20 management scenarios with high N application rates for five different soil textures across a county, and you select clay, clay loam, loam, loamy sand and sandy loam soils. Assume that the scenarios tested had a high application rate of N fertilizer (300 lb N/acre). You can save the 100 run combination for the **Managecodes.IN** and **Managecodes_soil_layer.IN** with a name that you specify, for example 100_Scenario_HN.txt and 100_Soil_HN.txt, respectively.

Additionally, you can edit the Events table through NLEAP-GIS 4.2 by using the Events tab and remembering to export changes back to the NLEAP DB. For example, if the initial high fertilizer rate was tested at 300 lb N per acre, and now you want to test a medium rate of 230 lb N per acre across the same soil series, you could quickly evaluate the 100 combinations at a lower rate by editing the Events file, using the Find and Replace functions in Excel, and changing the 300 lb N/acre rate to 230 lb N/acre. Using the Find and Replace functions can speed the evaluations of several combinations across long temporal evaluations. Similarly, the SoilSym_Month table—essentially the NLEAP output—can be saved for future statistical analysis. The spreadsheets Soilsymonth_300_lb_N_acre.xls and Soilsymonth_230_lb_N_acre.xls can thus be quickly saved for statistical analysis packages.

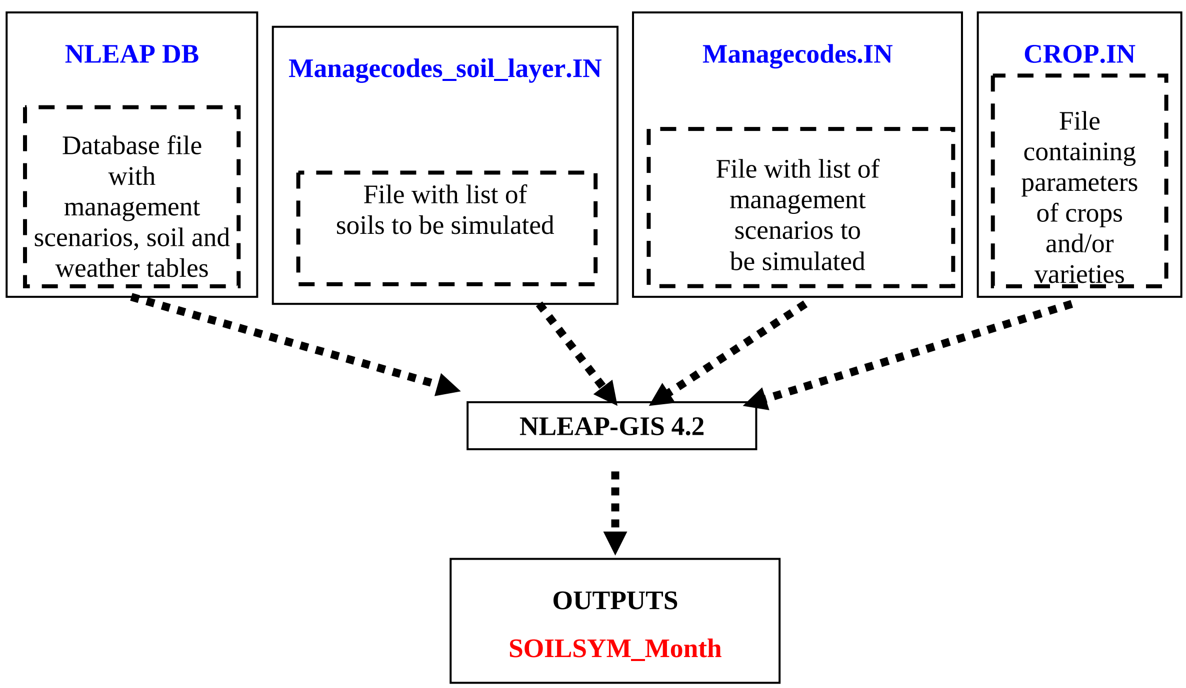

Figure I. The collection of NLEAP-GIS 4.2 files necessary to run an NLEAP simulation.

You can also use other methods for inputting multiple combinations quickly across an area. For instance, you could develop 20 management scenarios with high N fertilizer application rates of 300 lb N/acre, copy the whole data set, and then replace the

N rates with 230 lb N/acre and give different names for each of the 20 management scenarios that reflect medium N fertilizer rates (230 lb N/acre). Then, the Events table will have 20 management scenarios with 300 lb N/acre and 20 scenarios with 230 lb N/acre. The bottom line is that the NLEAP-GIS 4.2 driver is extremely flexible, with the ability to edit or generate data imported to and from Excel or Access and facilitate the management of output data for future statistical analysis. The interaction of databases via a user-friendly interface helps in quickly assessing the effectiveness of management scenarios.

1.3.2 Data Movement for GIS-Linked NLEAP Simulations

Setting up the inputs necessary for a GIS-linked simulation is a similar process to setting up the input for other NLEAP simulations. The collection of NLEAP-GIS 4.2 files necessary to conduct GIS analysis across a landscape is shown in **Figure II**. The main difference is that you must create a GIS database with field boundaries and management scenarios intercepted with the soil type GIS spatial data downloaded from the NRCS GIS database. It is also important to use the same soil GIS data that is in the SoilLayer table in the NLEAP DB. If desired, you can use the same approach to run point simulations (Delgado and Bausch, 2005). We will discuss several examples, limitations, and step-by-step development of GIS databases. ***For more information on the advantages and limitations of NLEAP-GIS approaches, see Delgado and Shaffer (2008)***.

You should keep in mind that the way the GIS databases are constructed is important to maximize the flow and efficiency of the information. If the goal is to conduct GIS analysis across the landscape, **it is recommended that you build the databases by counties**, since the downloaded NRCS GIS SoilLayer table will be organized by county (soil layer). You also need to decide what weather database to use within a county, if there is more than one weather station. This is especially important if there are different climates, different altitudes, and/or different precipitation rates within a county. There is the potential to divide the county into sub-regions and use representative weather stations with the sub-region of the county. NLEAP has been shown to conduct accurate simulations across several counties (Delgado et al., 2001); however Shaffer and Delgado (2001) reported the need to consider site-specific values based on user goals. You have the flexibility to use the same CROP.IN—the file that contains the crop parameters—across several counties, or to use one per county or even create individual CROP.IN files for different counties and sub-regions. The CROP.IN file could also include different crop varieties, and the crop could even be named with a code so that all of the variability across a series of counties is included in just one file. We will present some examples later in this guide.

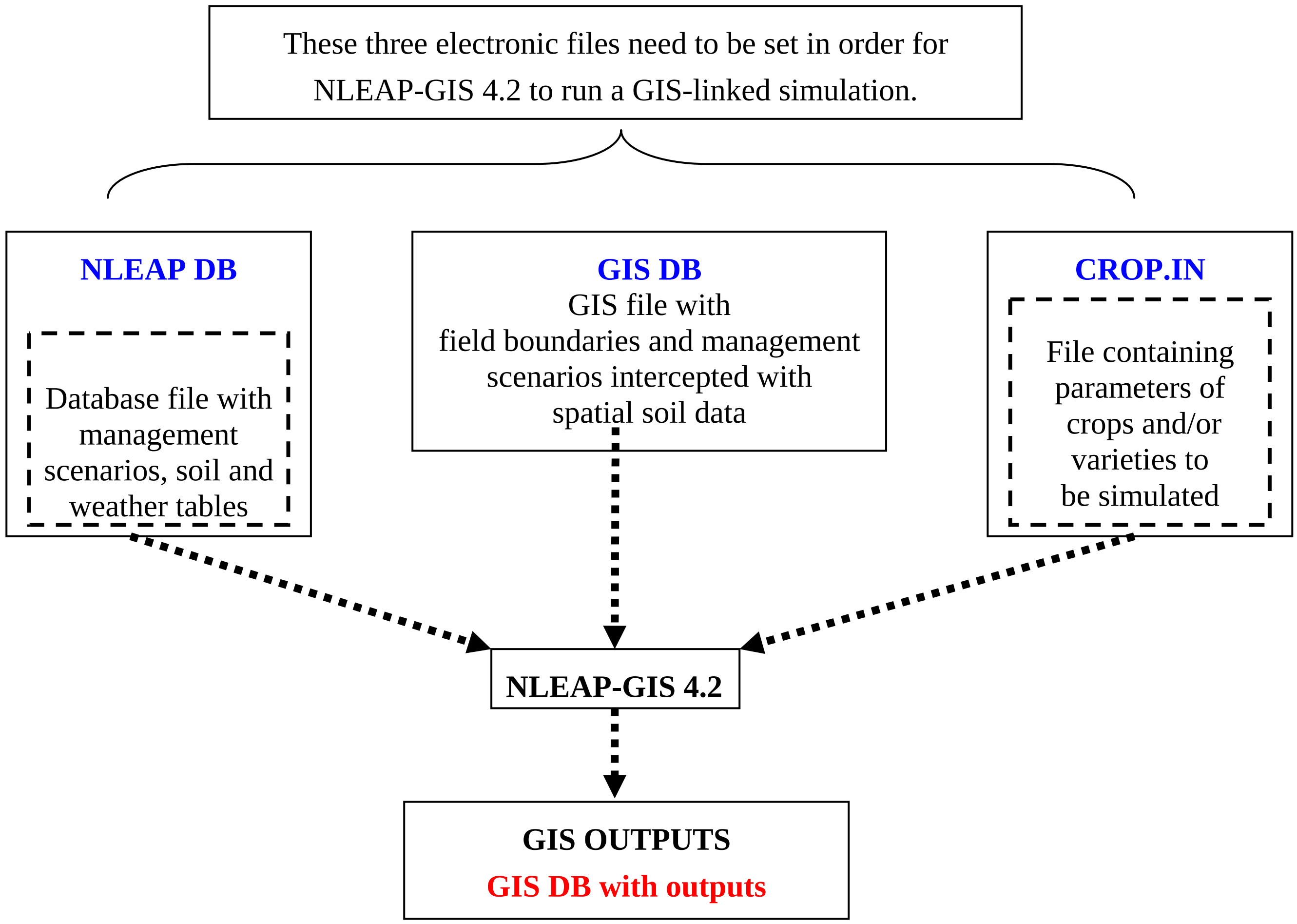

Figure II. The collection of NLEAP-GIS 4.2 files necessary to conduct GIS analysis across the landscape, using the county databases.

As with NLEAP simulations not linked to GIS, these management scenarios are entered into the Events table. The soil type databases are downloaded from the NRCS soil SSURGO GIS databases. Once the databases are downloaded, they are converted to NLEAP format and imported into the SoilLayer table. The weather databases are downloaded from the NRCS climate databases, converted to NLEAP format, and exported to the ClimLong Table.

You will need to create your own Events file describing day of planting, crop, yield, date of harvest, date and amount of fertilizer application, etc. You can create several management scenarios. For example, you can enter all of the management events necessary to describe a corn-corn rotation with high N application rates. All these corn-corn management scenarios can be called “CC-HF.” Similarly, you can enter all the management scenarios for a corn-soybean rotation with high N fertilizer rates and call it “CS-HF.” You could then enter all the management scenarios for a corn-corn rotation that uses a high rate of fertilizer and high rate of manure and call it “CC-HM-HF”.

Let’s assume that for this specific situation, all the management information for the given two years is the same, and the only changes were the use of soybean or application of manure. You can enter the first year management scenario for corn, then copy the whole management Events file, and simply change the dates used to create the CC-HF management. Then, you only need to copy the same first year for corn, and enter the soybean management data, creating CS-HF. For the CC-HM-HF, you can copy both years and just add the manure application event for both years.

By developing a code before starting, you can maximize the benefit of using the Find and Replace functions in Excel. Suppose you wish to reduce the high rates of fertilizer application to medium rates. You only need to copy all the CC-HF, CS-HF, and CC-HM-HF, then use the Find and Replace functions to change the rates of N fertilizer from 300 to 230 lb N/acre. Then, you can change the scenario name (each event line requires the scenario name), from CC-HF, CS-HF, and CC-HM-HF, to CC-MF, CS-MF, and CC-HM-MF, and the three new scenarios are rapidly created.

Just as we can use the Find and Replace functions in Excel to aid us in the development of the Events table, we can also use the Find and Replace functions found with several GIS software packages to quickly create a large GIS data set of different management scenarios to be tested across the landscape. It is important, however, that you first identify the management scenarios to be tested for each farm. Once a large data set has been created for the county or region, individual fields can be selected and evaluated very quickly with point-and-click ease. Additionally, if the farm boundaries are not defined or are not available, you can use the remote sensing images to establish field boundaries. Such an example will also be discussed (Delgado and Bausch, 2005; Berry et al., 2005).

1.4 Summary

This introduction has provided you with a glimpse of how information moves to, within, and from the NLEAP software, and how it is used to generate output datasets which provide insights on the effects of management on N use efficiency, insights which may result in better management decisions. As you have learned, this process begins with the downloading of NRCS soil and weather databases and their conversion to the NLEAP formatted tables named SoilLayer and ClimLong, and their importation into the NLEAP database file (NLEAP DB). You have also learned that you can use the Events Creator to develop a management table containing a large set of management scenarios and insert it directly into the NLEAP DB. The NLEAP-GIS model provides the flexibility to conduct site-specific analysis for any given combinations of weather, soil and management. You can apply these site-specific analyses across spatial and temporal scales. Temporal and spatial analyses can be exported to GIS software and/or to statistical packages to conduct further detailed analyses.

In the sections that follow, you will find specific examples detailing how to use the software, starting with how to set up a basic NLEAP-GIS run. The user guide describes basic data entry, how to generate outputs from simulations, and how to export these outputs to GIS databases and interpret output data. You will also be shown how to create your own databases, how to locate and download databases from specific internet sites, and how to convert these databases into NLEAP tables. To facilitate the learning process, the examples include actual NLEAP examples that show the steps being described as you learn to perform various tasks in the program. We hope that you find this guide helpful as you ultimately progress to running your own complex simulations and analyzing management scenarios of relevance to you.

2. Installing NLEAP-GIS 4.2

2.1 System

This user guide, and the NLEAP-GIS 4.2 software, will be available online for download and will run in a Microsoft Excel® 2010 environment. The user guide and NLEAP-GIS 4.2 driver programming are available at no charge. However, users are responsible for obtaining the Microsoft Excel® 2010 license, the Microsoft Access® 2010 license, and if using GIS capabilities any other licenses they may need. Users are also responsible for the use and interpretation of the model results. See User Agreement on page 3.

Several GIS software programs, such as ArcMap™, MapInfo®, and fGIS, can be used with NLEAP-GIS 4.2. It is up to the user to decide which GIS software to use with NLEAP-GIS 4.2. The instructions provided in the GIS section of this user guide are general, so they can be applied to more than one GIS software program. ***It is expected that the user has basic knowledge of computers, of nitrogen modeling, and of using GIS software.*** The NLEAP-GIS 4.2 driver that runs in Microsoft Excel® 2010 has been tested with ArcMap™ (Version 9.0 and 9.3), MapInfo® (Version 7.0), and fGIS™ (Version Build Date 2005.09.13), and appears to be able export data to .dbf files; however, there is no guarantee that the NLEAP-GIS 4.2 driver software will be able to function in all computer systems or with all software (see disclaimer on Page 3).

To operate NLEAP-GIS 4.2, you will also need the following:

- Windows® operating system, through an account with administrative privileges
- Microsoft Excel® 2010 and Microsoft Access® 2010 installed[1]
- An internet connection (necessary for certain steps)
- GIS software installed (in order to use GIS functionality)

2.2 Installation

Follow the steps below to install NLEAP-GIS. Note that during installation, a number of directories and files will be created in C:\NLEAP. *It is advised that you do not*

[1] Please be sure that you are installing the version of NLEAP-GIS that is compatible with Microsoft Excel® 2010. The user guide assumes you will be working with Microsoft Excel® 2010

tamper with these files. Doing so will prevent the model from functioning properly.

1. Insert the CD into the CD-ROM drive. The installer will automatically appear.
2. Carefully read the User Agreement and, if you agree to the terms, indicate that you agree. Note that if you do not agree to the terms, you will not be able to run NLEAP-GIS.
3. After installation is completed, NLEAP-GIS can be started through the Start menu or by double-clicking on the desktop icon (if created).
4. If NLEAP-GIS becomes corrupted or you no longer want the program installed, a provided uninstaller can be accessed through the Windows Start menu. Double-check that the uninstaller removed all of the files.
5. ***Whenever you exit the NLEAP-GIS 4.2 you will see a message that says, "Do you want to save the changes you made to 'NLEAPGIS10.xlsm'?" You should ALWAYS choose <u>not</u> to save when you see this message, so as to maintain the integrity of the driver and avoid problems with the driver's functionality***.

NOTE 2.2

MACROS AND SECURITY SETTINGS

The first time you start NLEAP-GIS 4.2, you may encounter a message in Microsoft Excel that informs you about your security settings and/or macros settings. If your security settings are already set at a level that allows macros, you may not see the message. It is important that you enable macros in Excel so that NLEAP-GIS 4.2 can function properly. You may also encounter the message in Microsoft Access; macros will need to be enabled in Access as well. ***Go to the directory C:\nleap\user and open the file "BA_model_climdb". When the file opens, be sure that you click on the button inside the yellow-colored security message to enable macros. In the same directory (C:\nleap\user), also open the file "BA_model_userdb". When this file is open, be sure that you click on the button inside the yellow-colored security message to enable macros. If you have problems with accessing any other database in other directories, open the database file and repeat the above procedure.***

2.3 Getting Started with NLEAP-GIS

1. Start NLEAP-GIS by going to the Start menu and clicking NLEAP-GIS in

the Programs menu. NLEAP-GIS 4.2 will open within Excel.

2. A window called the *Driver* will appear inside Excel. The *Driver* window is the interface hub for NLEAP-GIS 4.2 that allows access to all NLEAP-GIS 4.2 functions (**Fig. 1**).

3. To access the *Driver* at any time, navigate to the tab labeled *Driver* at the bottom of the Excel workbook and click the *Show Driver* button near the top of the worksheet and you will see the *Driver* window.

4. To hide the *Driver* window, simply click on the *Hide* button in the top right corner of the window (**Fig. 1**). The buttons in the *Driver* window and other windows will be explained thoroughly in the next sections.

3. Simulating a Simple Example

If you're new to NLEAP-GIS 4.2, this section will familiarize you with the process of running simulations and interpreting NLEAP output data by walking you through a simple case scenario. The example data have already been prepared for you. The process of creating fully functional NLEAP-GIS 4.2 data from scratch will be explained in Section 5 of this manual.

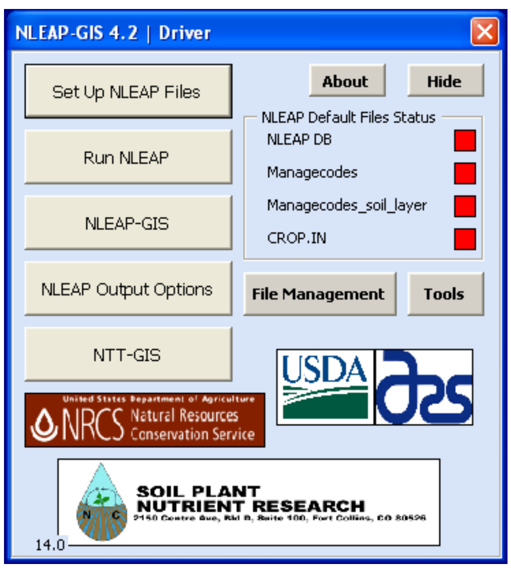

Figure 1

3.1 Setting the NLEAP-GIS 4.2 Database

In order to run NLEAP-GIS 4.2, four separate files must be set up (this process will be explained in more detail in Section 5). Currently, the NLEAP-GIS 4.2 Default Files Status should show four red squares (**Fig. 1**), indicating that NLEAP is not yet ready to run. All four squares must be green to run an NLEAP simulation. Let's begin by setting (in this case, declaring the location of) an NLEAP Database (DB).

1. From the *Driver* window (**Fig. 1**), click on the *Set Up NLEAP Files* button.

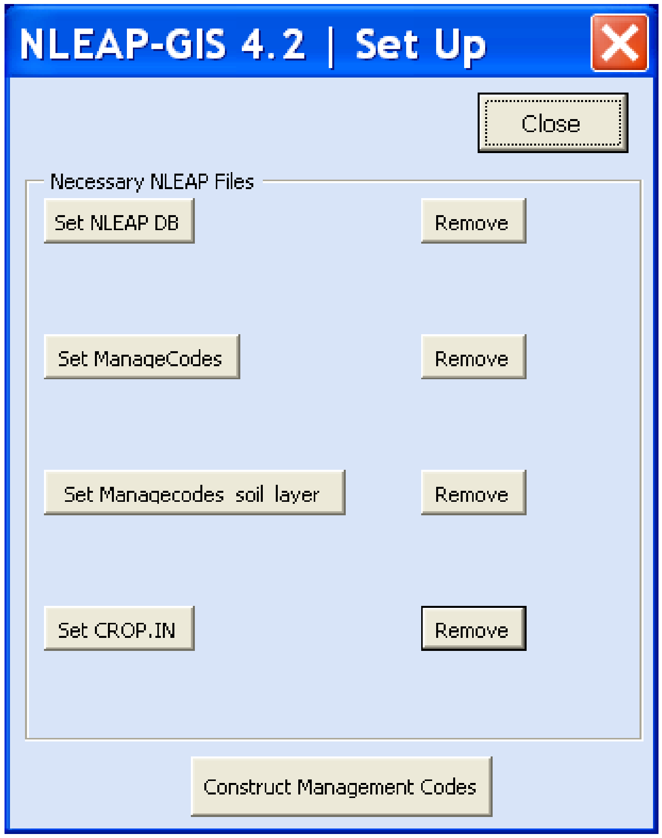

Figure 2

The window named *Set Up* (shown above) will appear (**Fig. 2**). This window allows the user to set the location of the necessary files.

2. To set the NLEAP-GIS 4.2 Database (NLEAP DB), simply click on the *Set NLEAP DB* button, and a Windows Explorer® window will appear. If your Windows Explorer® window does appear, click on the *My Computer* button on the left side of the window, double-click on your C drive (could have any name, but ends with (C:)), and double-click on the "NLEAP" folder.
3. Navigate to "C:\NLEAP\Training_Data\Example_Run_1" by clicking on the "NLEAP", "Training_Data", and "Example_Run_1" subdirectories until you

can select "NLEAP_DB_Example_1.mdb", which is a Microsoft Access file (.mdb).

4. Select the file and click *Open*. You should notice that some changes have been made to your Excel environment.

5. Click *Close* in the *Set Up* window (**Fig. 2**) and return to the *Driver* window (**Fig. 1**).The NLEAP Default Files Status should now show one green square next to *NLEAP DB* and the other three squares should be red (**Fig. 3**).

3.2 Setting CROP.IN

The CROP.IN file contains crop information, including crop type (e.g. barley, wheat, etc.) and variety (e.g. varieties of potatoes: norkotah, nugget, etc.). To set the CROP.IN for NLEAP:

1. Return to the *Set Up* window by clicking the *Set Up NLEAP Files* button in the *Driver* window.

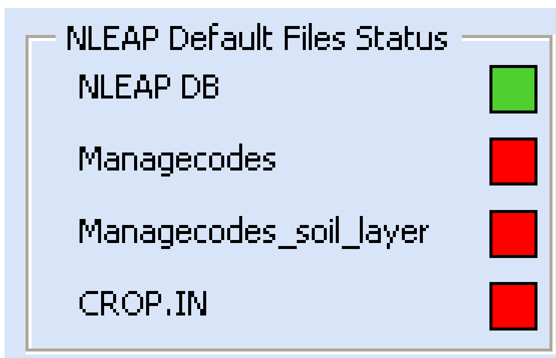

Figure 3

2. Click on the *Set CROP.IN* button (**Fig. 2**).

3. Navigate to "C:\NLEAP\", select "CROP.IN" and click on *Open.*

4. Return to the *Driver* window. The two boxes next to *NLEAP DB* and *CROP.IN* should now be green (**Fig. 4**).

3.3 Constructing Management Codes

The only files missing now are Managecodes (selected management scenarios) and Managecode_soil_layer (selected soil types). Both of these files can be created and set by using the *Construct Management Codes* tool. Management codes explicitly tell NLEAP-GIS 4.2 which scenario (Managecode.IN file) and soil (Managecode_soil_layer.IN file) combinations to simulate.

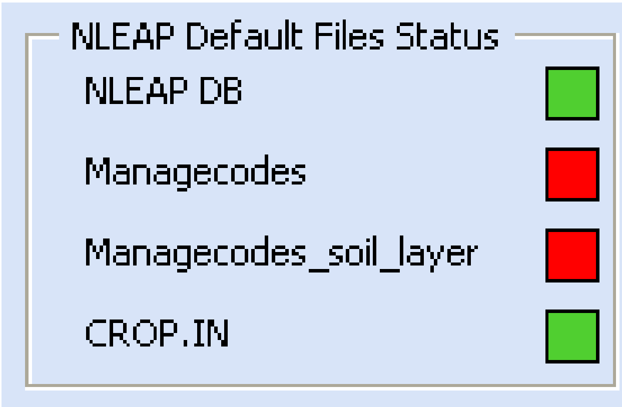

Figure 4

To construct the management codes:

1. First you must access the *Management Codes* window. One way to reach this window is to click on the *Construct Management Codes* button in the bottom center of the *Set Up* window (**Fig. 2**). The other method for reaching this window will be discussed at the end of this section.
2. To create the codes, first enter "F07" into the text box for Field Name, if it is not already entered for you (**Fig. 5**). Multiple field combinations will be left to advanced users for now.

   In our example, two scenarios are available: the Ohio, continuous corn, no-till, manure & fertilizer application ("OH-cc-NT-MF-") and the best management practices for rate, time and method of application ("OH-cc-NT-MF-rtm"). A number of different soils are also available. Each combination of Soil Series (left side) and Scenario (right side) represents an individual NLEAP-GIS 4.2 simulation (**Fig. 5**).
3. Select the soil "Bronson sandy loam, 1 to 6 percent slopes" by clicking on it in the Soil Series box.
4. Then, select the scenario "OH-cc-NT-MF-" by clicking on it in the Scenarios box.
5. Click on the *Add to MC* button and the code should appear in the lower boxes.

6. Repeat this process, selecting the same Field Name (F07) and the same soil ("Bronson sandy loam, 1 to 6 percent slopes") but with the other scenario: "OH-cc-NT-MF-rtm".
7. Now, create two more manage codes by repeating the process with the same Field Name (F07) and each of the scenarios, but this time with "Cohoctah loam" as your soil.
8. If done correctly, the management codes should appear in the two lower boxes of the *Management Codes* window and look identical to what is shown in (**Fig. 6**):
9. Click on the *Save Codes* button at the bottom of the *Management Codes* window. You will be asked whether you would like to set these manage codes as your default files (**Fig. 7**):

   The codes will be created in their respective Excel tabs regardless of your answer, but click on *Yes* to load these management codes into your MC_SoilLayer and MC_Scenario files, which enables NLEAP-GIS to use them for simulations. By clicking *Yes*, the codes will be automatically saved to their respective files: *Managecode_soil_layer.IN* and *Managecode.IN* in "C:\NLEAP\temp".
10. In the *Driver* window, click on the *Hide* button found in the upper right corner. Navigate to the tab named "managecodes_soil_layer" and you will see the codes selected for Soil Series. If you then navigate to the tab named "managecodes", you will see the codes selected for Scenario.

    As you get familiar with NLEAP-GIS 4.2 and make more complex simulations, you will be able to do over 3000 simulations (e.g. 3000 combinations of management x soil in a 12-month weather period) and submit them as one batch. After selecting all of the possible combinations, you would not want to go back to make the same selections again. For these cases of large combinations (or for any other case you desire), you can save the codes for future runs or to conduct sensitive analyses. This will be discussed later as we advance in our capabilities.

11. Upon returning to the *Driver* window, all four NLEAP-GIS 4.2 Default Files Status boxes should now be green, which indicates that NLEAP-GIS 4.2 is ready to run (**Fig. 8**).

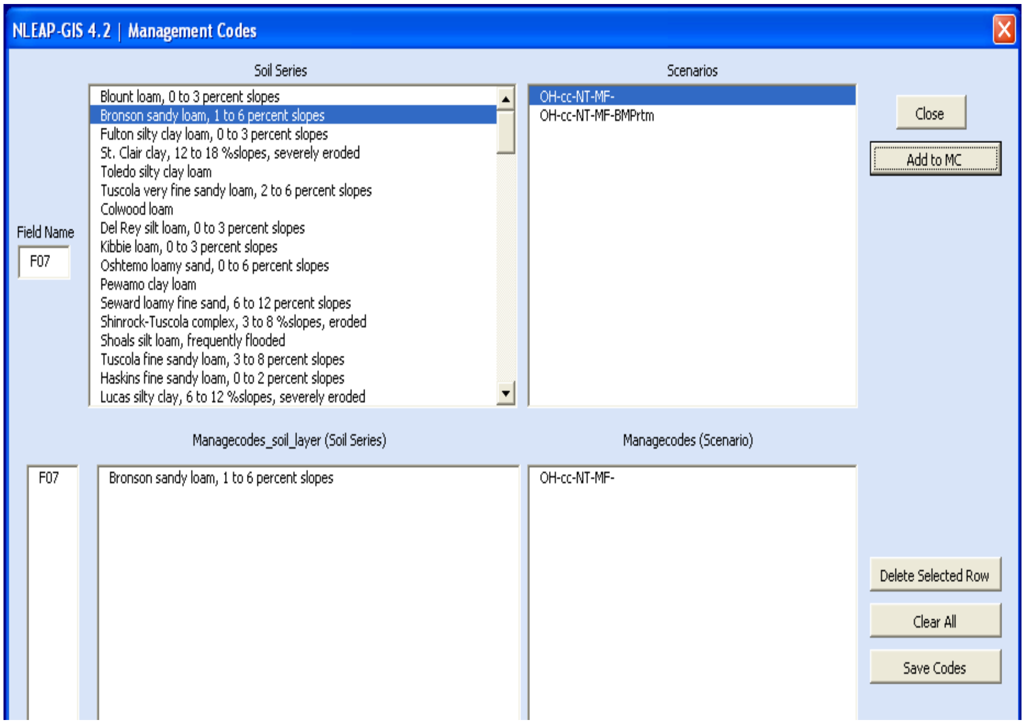

Figure 5

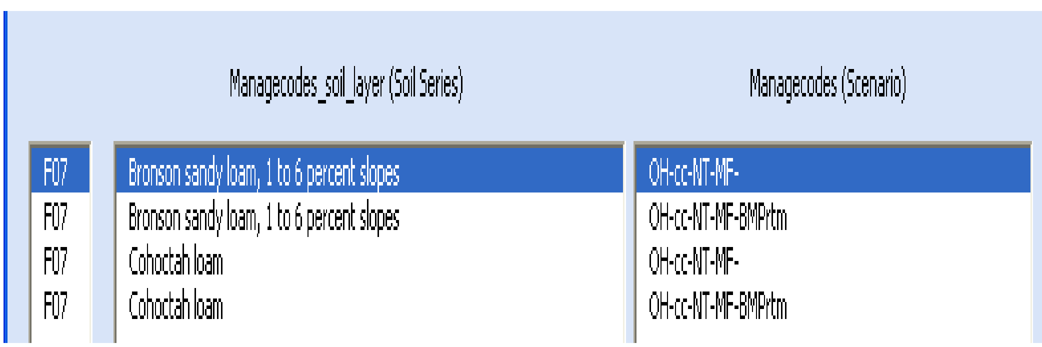

Figure 6

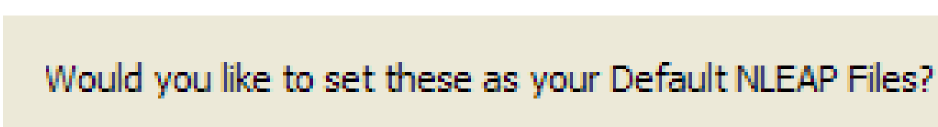

Figure 7

12. Now you can navigate to the tab named "Driver" and click on the button

Show Driver to return to the *Driver* window.

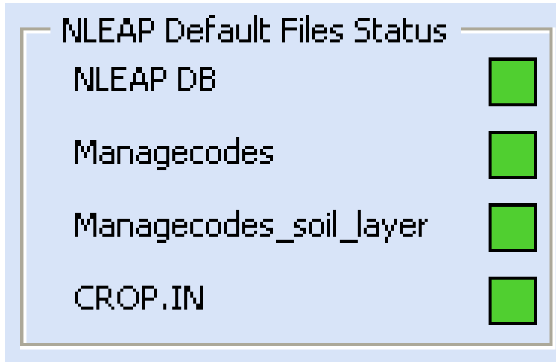

Figure 8

Before moving on, let's learn an alternative method for accessing the *Management Codes* window:

1. Go to the *Driver* and click on the *Tools* button in the bottom right corner of this window (**Fig. 1**).
2. The *Tools* window will appear (**Fig. 9**). You can then click on the *Construct ManageCodes* button on the right side of the window to get to the *Management Codes* window (**Fig. 5**). As you get more familiar with NLEAP-GIS 4.2 you will better understand the need for having the same button twice. Put simply, you could say that the *Construct ManageCodes* button in **Figure 2** is mainly used when you already have the NLEAP DB file set and completed, and the *Construct ManageCodes* button in **Figure 9** is one you may want to use after you finish constructing a new NLEAP DB.

3.4 Running NLEAP

Upon returning to the *Driver* window, all four NLEAP-GIS 4.2 Default Files Status boxes should be green, which indicates that NLEAP-GIS 4.2 is ready to run (**Fig. 8**). To run an NLEAP simulation:

1. Click on the *Run NLEAP* button.
2. You will be warned that unsaved data will be lost, and you will be asked if you want to continue. Click *No* if you have run a previous simulation without saving your data. If all previous simulation data are saved, click *Yes*. For information on how to save simulation data, see Sections 4.3; 4.8; 8.1.3.

3. Select *Yes* when asked whether you want to import water output. By selecting *Yes*, the daily water balance for the requested scenarios will be output to the "waterTable" tab where it will be kept until you choose to save, graph, or conduct a new simulation.
4. A black window, called the "console" will appear as NLEAP conducts the simulation. When this disappears and the *Driver* reappears, the simulation is complete.

   If the simulation runs properly, the NLEAP output can be found in the *SOILSYM_MONTH* tab, and your data is now ready for analysis and for output.

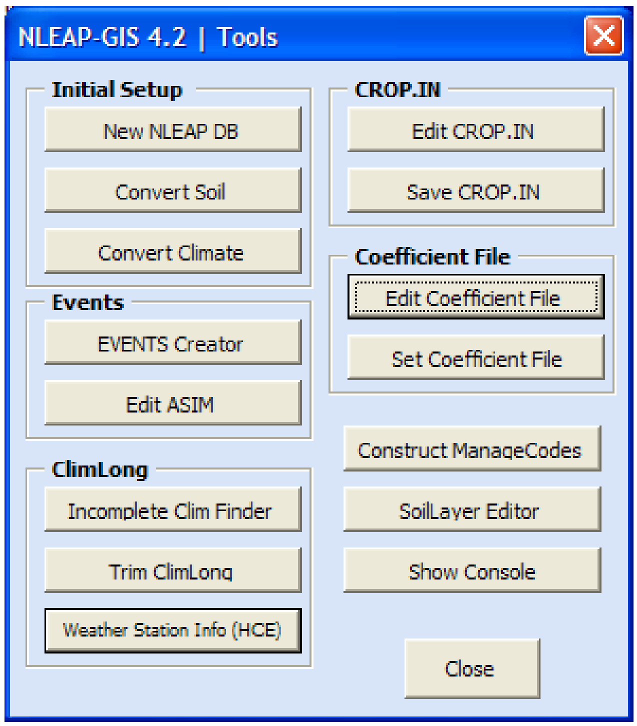

Figure 9

4. Analyzing NLEAP-GIS 4.2 Output

Now that you have input all of the requisite data and run a simulation, you can analyze the output of this information in a variety of ways. This section of the manual describes how you can display these data.

4.1 Nitrogen Options: Convert to Metric/English

To convert your output to Metric or English units:

1. Click on the *NLEAP Output Options* button in the *Driver* window **(Fig. 2**). Then click on the *Nitrogen Output Options* button in the *NLEAP Output Options* window (**Fig. 10a**) to get to the *Nitrogen Options* window (**Fig. 10b**).
2. Click on the *Convert to Metric* button from the *Nitrogen Options* window (**Fig. 10b**). Notice that now the top button reads *Convert to English*. Also notice the SOILSYM_MONTH table that is now showing behind the window, and that we can see the output numbers from NLEAP. See that in M:1 (column M, row 1) it says: In Metric (KGN/HA).

NOTE 3.4

Water Outputs and Nitrogen Outputs

Water Outputs

Not Importing Water Outputs: If you select *No* when asked if you would like to import water output, you will not see the water balance outputs. However, NLEAP will always do a water balance for each N simulation, to the maximum combinations run.

Importing Water Outputs: If you select *Yes* when asked if you would like to import water output, you will need to exercise caution when selecting water outputs. In this version of NLEAP-GIS, the water balance outputs are daily while the nitrogen outputs are monthly. We have not tested what is the maximum possible number of water outputs that can be run, but users could test and determine what is the maximum number of outputs that can be run. For water, we recommend running no more than a maximum of approximately 170 daily annual combinations of management. However, if each combination is run for 24 years, we recommend a maximum of seven combinations. If the simulation is done for 100 years, we recommend one simulation. The user could test the model's capabilities; however, the user will need to be aware that when more water output simulations are run, more time will be required to complete the simulation and write the daily outputs to the file.

Nitrogen Outputs

Importing Nitrogen Outputs: We have not tested the maximum possible number of nitrogen outputs that can be run, but users could test and determine what is the maximum number that can be run. Since the output is monthly, we suggest that up to 5,300 annual combinations can be run. The capability of running thousands of combinations in one exercise is really powerful. For a 24-year simulation, we recommend doing about 225 combinations. The user could test the model's capabilities; however, the user will need to be aware that when more nitrogen output simulations are run, more time will be required to complete the simulation and write the monthly outputs to the file.

3. Please leave the output set to metric for now.

4.2 Nitrogen Options: Create Graphs

One way to analyze NLEAP output is by converting output data into graphs. To create a graph:

1. From the *Nitrogen Options* window, click *Create Graphs* (**Fig. 10b**).
2. You should now be viewing the *NLEAP Graphs* window. You have several options for customizing your nitrogen graph (**Fig. 11a**). We encourage you to

read and work through the following sub-sections as you learn to use each of the features in the *NLEAP Graphs* window. For definitions of the graph values, see Note 4.2.2.

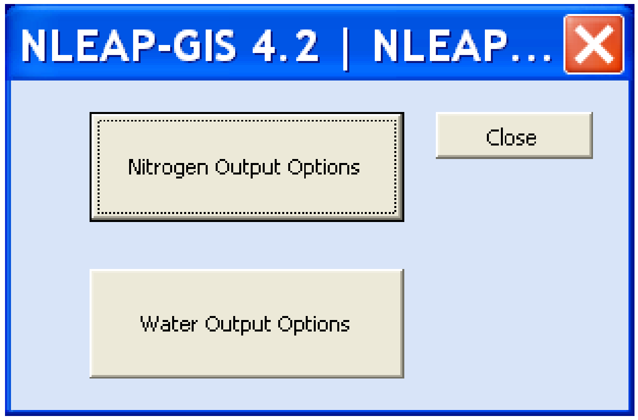

Figure 10a

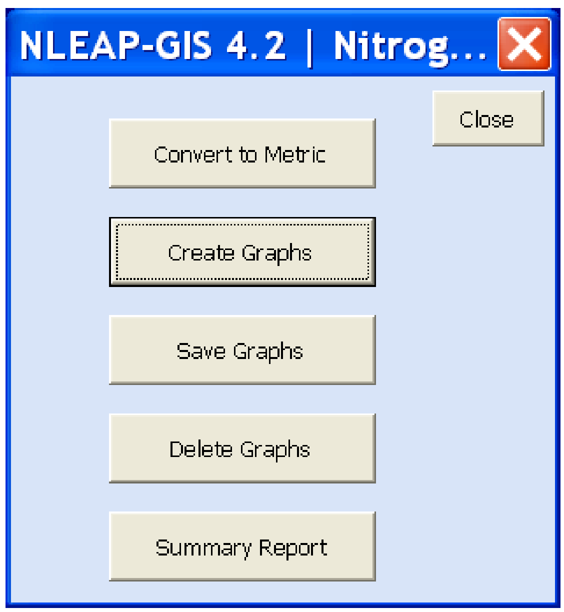

Figure 10b

4.2.1 NLEAP Graphs: Scenario and Soil

Double-click on the Field ("F07") and the scenarios will appear (**Fig. 11b**). By double-clicking on the desired scenario in the *Scenario* box ("OH-cc-NT-MF-rtm"), the soil types simulated for the given scenario will show up in the *Soil* box (BtB is the short soil symbol for "Bronson sandy loam"; Ch is the short soil symbol for "Cohoctah loam") (**Fig. 11b**). The short symbol for the soil names is called a MUSYM code.

Double-clicking on the "BtB" soil for the already selected scenario "OH-cc-NT-

MF-rtm" will add the selected system-soil combination to the graph choices in the far-right box (**Fig. 11b**). Alternatively, once the scenario and soil combination has been selected, you can click on the button *Add to Graph* to select the given combination (**Fig. 11b**).

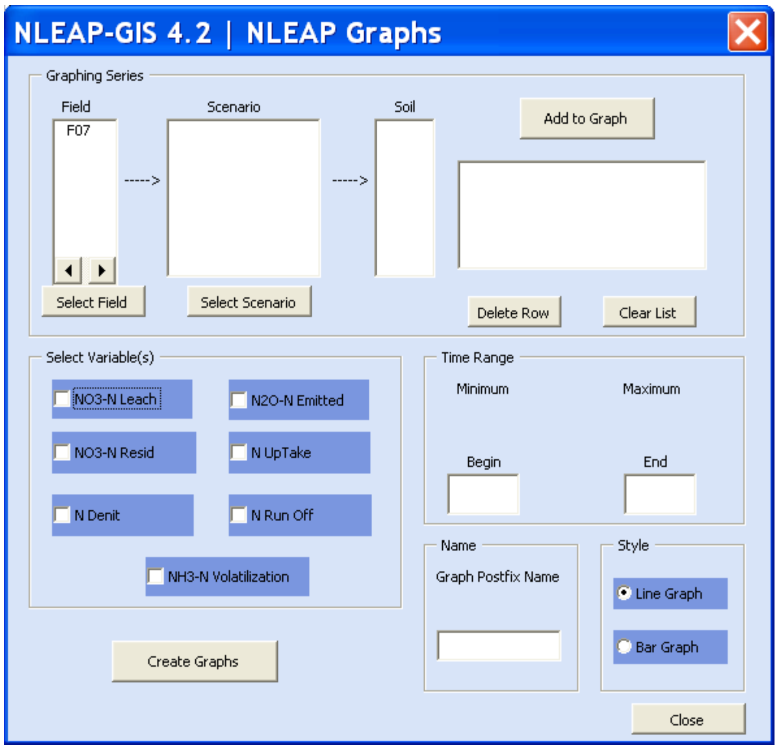

Figure 11a

NOTE 4.2
Field Codes

In the Field box of the *NLEAP Graphs* window there is a field labeled "F07". Recall that we selected "F07" as our field when we constructed management codes in Section 3.3. To avoid confusion, we have used this same code throughout the guide and "F07" is already typed in the Field box. As mentioned before, we will leave the task of entering multiple field combinations to advanced users for the time being.

Each graph data set chosen creates a separate graph line. Repeat for as many lines you want to graph. Before we add a series of selected graph lines, let's practice deleting graph lines. First add another graph line for the "OH-cc-NT-MF-rtm" and "Cohoctah loam" (Ch) scenario-soil combination. Just double-click on "Ch".

If you unintentionally select an incorrect combination, to delete the graph line you can simply highlight the undesired combination and click on the *Delete Row* button. Similarly, the *Clear List* button will delete all of the selected combinations. For this example let's highlight (select) "F07OH-cc-NT-MF-BMPrtmCh". Now click on the *Delete Row* button. Then click on the *Clear List* button. Now that you have practiced how to use the *Delete Row* and *Clear List* buttons, add the graph lines for both scenarios and soil combinations (total of four graph lines). Your window should look like **Figure 11b**.

4.2.2 NLEAP Graphs: Select Variables

You can select the variable(s) (see Note 4.2.2) to graph by clicking on the desired box. The x-axis is the specified time range in months, while the y-axis is the graph value in the chosen units (English or metric). As an example, select the variables *NO3-N Leach*, *N2O-N Emitted*, and *N UpTake*, which will create three graphs (**Fig. 11c**).

4.2.3 NLEAP Graphs: Time Range

You have the option to graph the variable(s) for the whole simulation (1-288 months (**Fig. 11b**) or a given desired range (such as 266-288 months) (**Fig. 11c**). The time range (in months) can be chosen, in case, for example, only the last half of the simulation is to be analyzed. Note that the current Begin and End values are 1 and 288, respectively. The example simulation only spans 24 years, so enter graph Begin and End values (corresponding to months) of 266 and 288, respectively (**Fig. 11c**).

4.2.4 NLEAP Graphs: Name

A graph postfix name helps differentiate each graph from others. The graphs will appear as tabs named using the format variable_postfix. For the example in this walkthrough we are using nitrogen, so a series of tabs for the selected variables will be labeled according to the format VariableName_Example (**Fig. 11c**). You can graph several lines on the same graph (**Fig. 11c**). Graph lines from each data combination will appear on the same graph, unless you choose a different postfix, which would allow you to display different graph lines on separate graphs for later export to other formats. For practice, enter a postfix name of "Example" (**Figs. 11c, 11d**).

4.2.5 NLEAP Graphs: Style

Here you can choose whether to display your data as a line graph or bar graph. For this example, please make sure that the "Line Graph" option has been selected.

NOTE 4.2.2

Terms and Definitions for NLEAP Graph Variables

NO3-N Leach	Total amount of nitrate-N (NO_3-N) leached per unit area per month
NO3-N Resid	Amount of nitrate-N (NO_3-N) residual at the end of each month per unit area
N Denit	Total amount of nitrogen (N_2) denitrified per unit area per month
N2O-N Emitted	Total amount of nitrous oxide (N_2O) emitted per unit area per month
N UpTake	Total amount of nitrogen (N) uptake per unit area per month
N Run Off	Total amount of nitrogen lost in surface runoff per unit area per month
NH3-N Volatilization	Total amount of nitrate-N (NO_3-N) leached per unit area per month

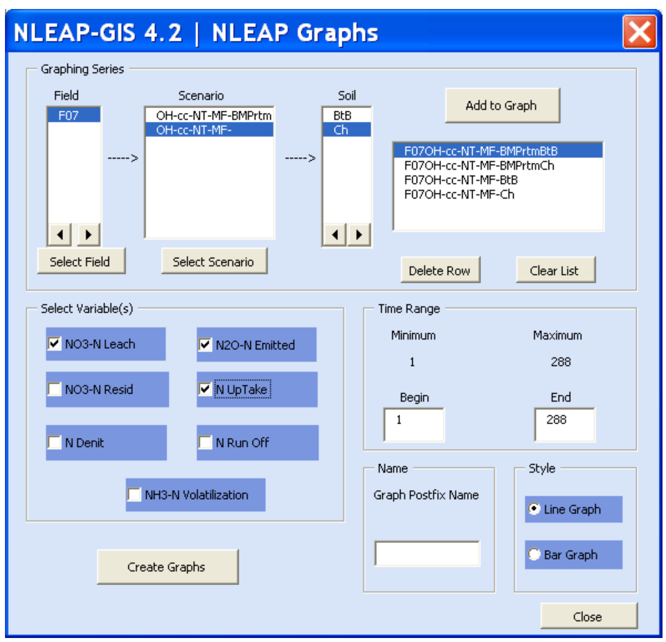

Figure 11b

4.2.6 NLEAP Graphs: Create Graphs

To generate the graph(s) click on the *Create Graphs* button. Click on *Create Graphs* and the graphs will be drawn and placed into new, separate tabs. Navigate to graph by clicking on *Close* button three times until you get back to the *Driver* window, and then click on the *Hide* button. Now you can navigate to the three graphs by just clicking on the tabs which are named after them (Crop N Uptake Example); Soil N2O

Emissions Example; and NO3 Leach Example (**Fig. 11c**).

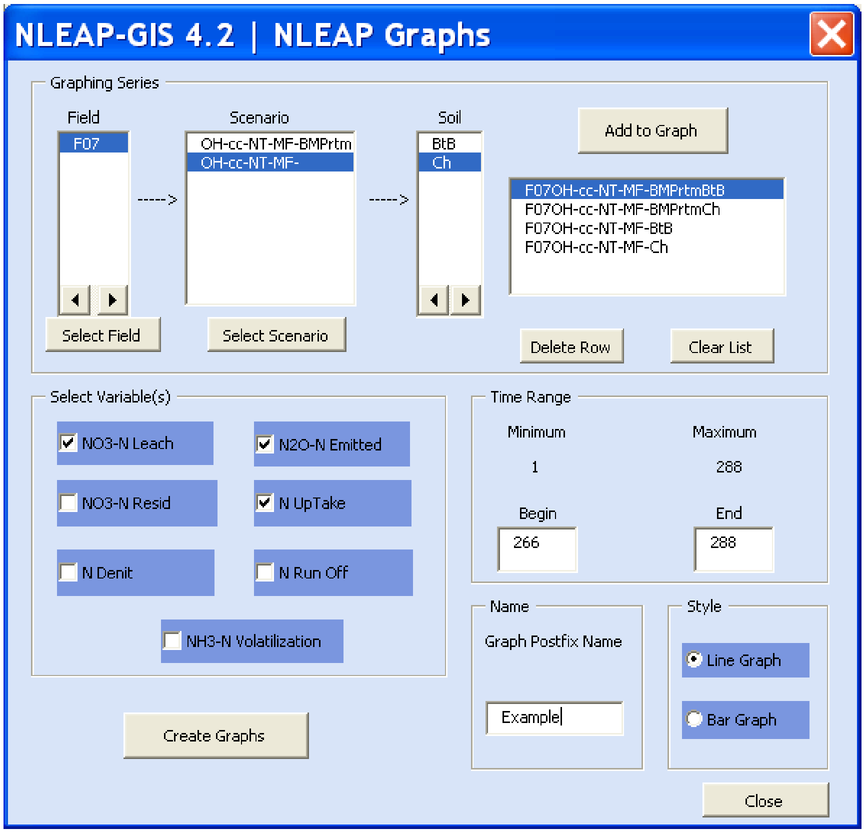

Figure 11c

NOTE 4.2.6

NLEAP Graphs: Helpful Hints

- After you have seen your graph(s), you can use the same postfix you just used to name your old graphs to generate a new set of graphs that will be written over the old graphs. On the other hand, if you would like to see several types of graphs or combination of scenarios simultaneously, the postfix can be changed to generate these different sets (e.g. Example_1; Example_2, Example_3…).
- Once you have completed your graph(s), you can also modify the axis labels by clicking on them and editing the font or the text. You can save the graph or export it as a .jpg file or other format.
- You can also export the water data (water table) and use the basic data to generate graphs with another software program or to do statistical analyses of the simulated outputs.

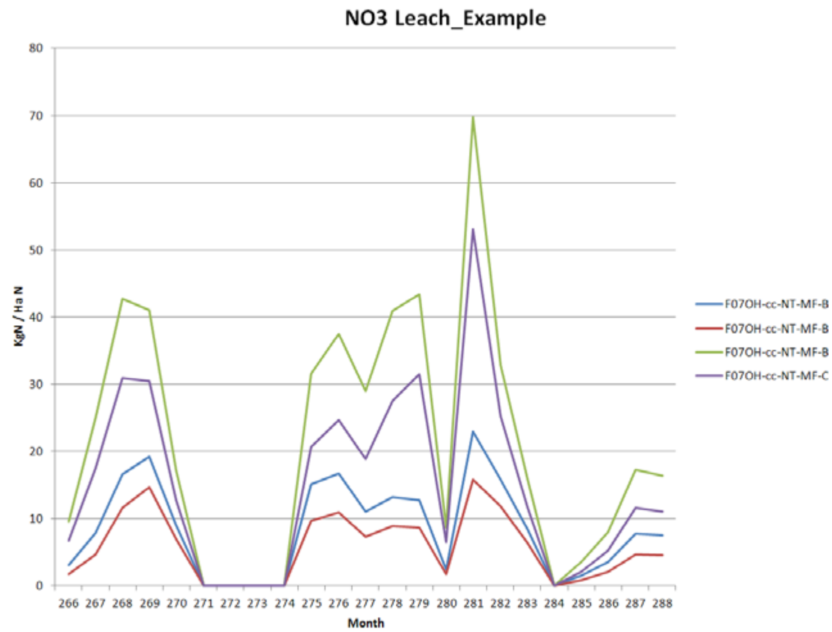

Figure 11d

You can quickly generate another set of graphs just by clicking on the "Driver" tab and navigating back to the *NLEAP Graphs* window. Notice that the variables *NO3 Leach*, *N2O Emitted*, and *N UpTake,* which we selected earlier, are still selected. The previous time range of 266 to 288 is also still entered and the Graph Postfix Name "Example" is still in the box. Let's do the same set of graphs again but change the selected time range to 1 to 288. Just enter "1" as the Begin value and double-click on the previous combinations of Scenario and Soil to get the previous graph lines. Click on *Create Graphs.* Since we are using the same Graph Postfix Name as before, the new graphs will overwrite the old graphs and be found in the same tabs. If we had typed "Example 2" as the Graph Postfix Name, our previous graphs would not have been overwritten. Instead we would have generated three new graphs located in three new tabs. These tabs would have been labeled using the format VariableName_Example2. To see the graphs, go back to the *Driver* window, click *Hide*, and select the tabs for the graphs you want to see (**Fig. 11e**).

4.3 Nitrogen Options: Save Graphs

To save a graph:

1. Go back to the *Nitrogen Options* window.

2. By selecting the *Save Graphs* button in this window, you will be able to select any of the graph names displayed in the *Save Graphs* window. For our example, you can select NO3 Leach_Example to save the individual graph as a bitmap image. Simply select the graph you wish to save and click on *Save Selected Graph* (**Fig. 12**).
3. Provide a name and select a location for the graph image to be saved, click on *Save*, and you now have a graph image file perfect for printing or inserting into slideshows.

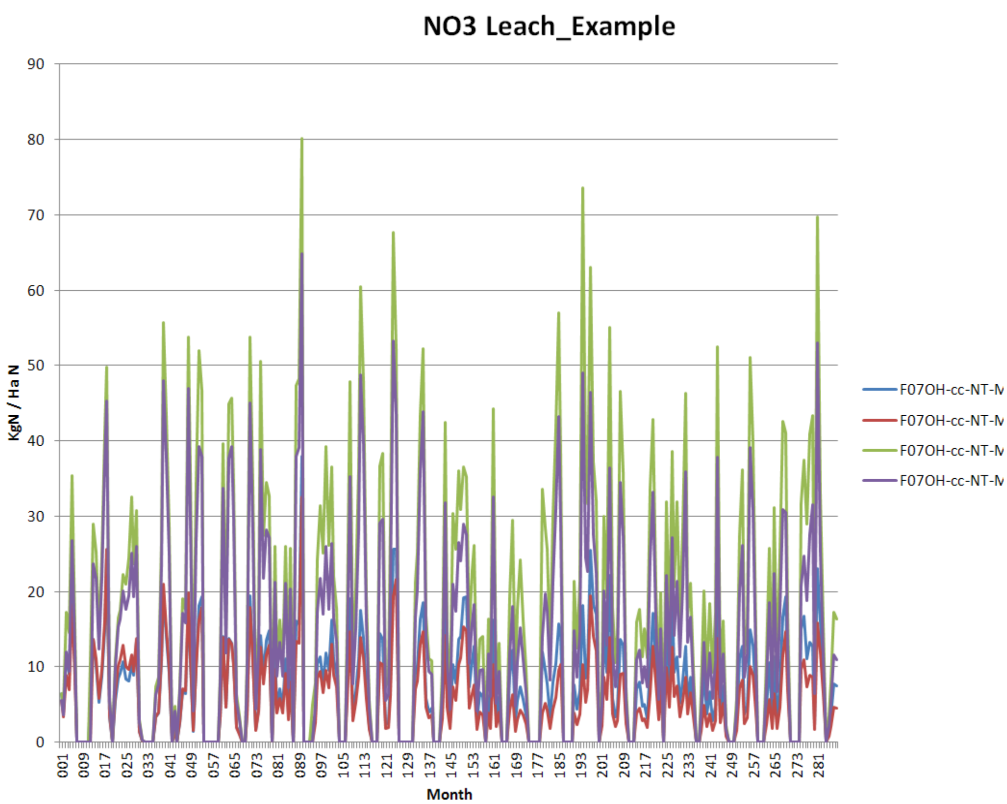

Figure 11e

4.4 Nitrogen Options: Delete Graphs

To delete graphs:

1. Select the *Delete Graphs* button in the *Nitrogen Options* window.
2. Then select the graph that you would like to delete from the *Delete Graph* window. As an example, you may wish to select "Crop_N_Uptake_Example" and "Soil_N2O_Emissions_Example" (**Fig. 12**).

3. After selecting the graph you wish to delete, click on *Delete Selected Graph*. A window will appear asking you to confirm that you would like to delete the selected graphs. Click on *Ok*.

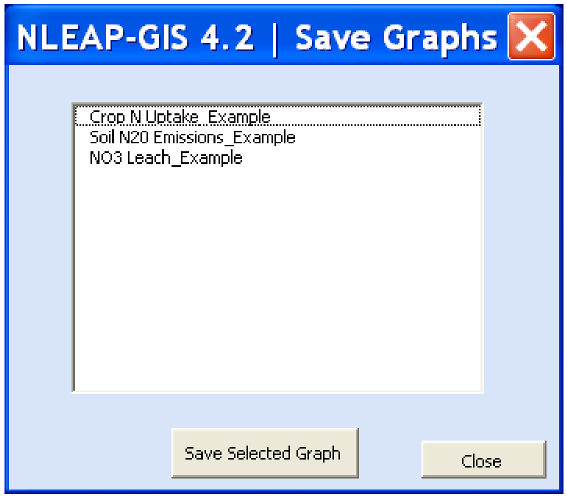

Figure 12

4. Similarly, you can delete any remaining graphs just by clicking on *Delete All*, and all the graphs will be removed (**Fig. 13**).

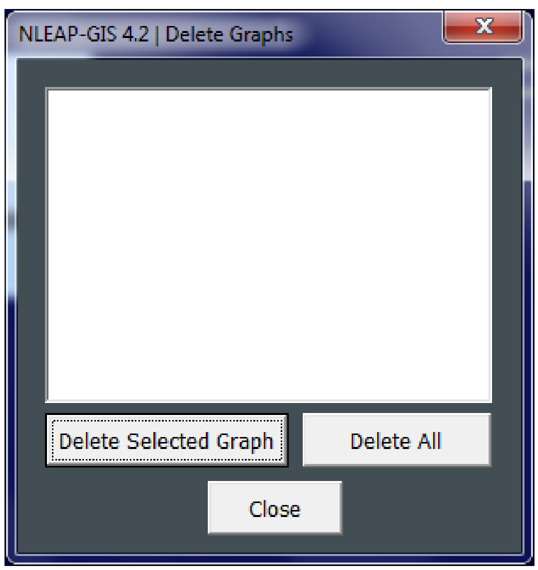

Figure 13

4.5 Nitrogen Options: Summary Report

Another method of output analysis is to view the Summary Report. To view a Summary Report of your simulation (Yearly Average):

1. From the *Nitrogen Options* window, click on the *Summary Report* button (**Fig. 14a**).
2. Since the example simulation spans for 24 years, enter Begin and End values of 1 and 24, respectively. If you have more than six simulations, you can display the data in a sheet, but since this example only has four, the table will suffice.
3. Click on *Calculate* and the yearly averages for several values will be calculated (**Fig. 14b**). These numbers represent the average values for one year, except NO3 Residual, which is the value representative of the last month of the calculation.
4. Let's practice displaying the numbers in an sheet. Just click *In Sheet* and click on the *Calculate* button. If you want to navigate to the "YearlyAvg" tab where the values were just written, just click *Close* for each of the windows until you reach the *Driver* window, click the *Hide* button, and navigate to the Excel tab named "YearlyAvg".

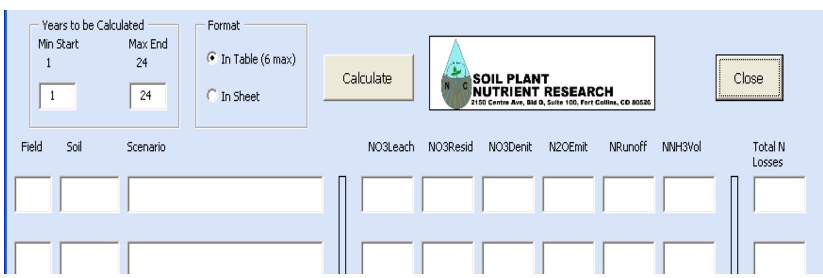

Figure 14a

NOTE 4.5

Terms and Definitions for Summary Report

NO3-N Leach	Mean total amount of nitrate-N (NO_3-N) leached per unit area year
NO3-N Resid	Amount of nitrate-N (NO_3-N) residual at the end of the last year calculated
N Denit	Mean total amount of nitrogen (N_2) denitrified per unit area per year
N2O-N Emitted	Mean total amount of nitrous oxide (N_2O) emitted per unit area per year
N UpTake	Mean total amount of nitrogen (N) uptake per unit area per year
N Run Off	Mean total amount of nitrogen lost in surface runoff per unit area per year
NH3-N Volatilization	Mean total amount of nitrate-N (NO_3-N) leached per unit area per year

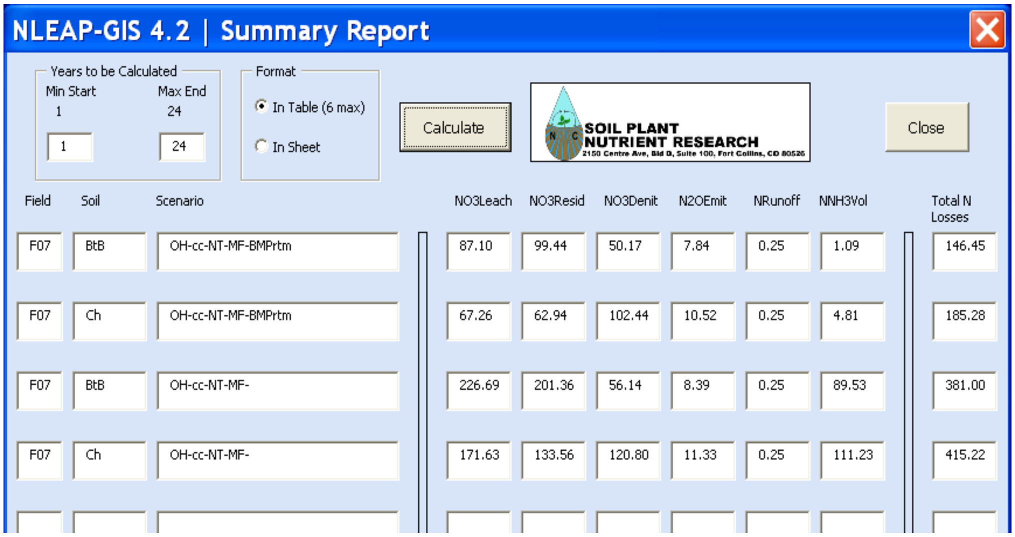

Figure 14b

5. If you want to just see the calculations for the first year, you can return to the *Summary Report* window. Just enter 1 and 1 for Min Start and Max End values, respectively, and click on the *Calculate* button.

4.6 Water Output Options: Create Graphs

To create a graph of water output from your simulation:

1. From the *Driver* window **(Fig. 1**), click on the *NLEAP Output Options* button to reach the window named *NLEAP Output Options*.
2. Select *Water Output Options* to go to the *Water Output Options* window **(Fig. 15**). In this window, you have the option to create a graph from a selected monthly period or to calculate averages and final water balances over a period of time.
3. Then select the *Monthly Graphs* button and the *Water Graphs* window will appear (**Fig. 16a**). The software allows you to graph WC, Sumet, Sumpet, dPre, dIrr, dRO and dDP. For a description of each of these graph values, see Note 4.6.2.
4. Within the *Water Graphs* window, you have some flexibility in deciding what information to include in your graph. To learn how to use each of these features, read Sections 4.6.1 - 4.6.6, which describe each of the components of

the *Water Graphs* window and how to finish creating your water graph. For additional tips on creating Water Graphs, see Note 4.6.6.

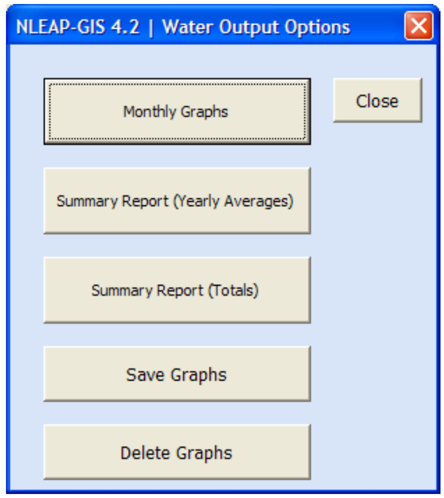

Figure 15

NOTE 4.6
Creating Field Names for Water Output

In this version of NLEAP GIS 4.2, the *Water Graphs* window does not show the field names. So what do you do if you need to be able to identify the field name of a scenario? If you do need to enter field names, you can add the field name as usual in *NLEAP Graphs*, and for the water analysis you can add the field name to the front of the scenario. For example, if the "OH-cc-NT-MF-" scenario was different for fields "F07" and "F08" you could label the scenarios "OH-F07-cc-NT-MF-" and "OH-F08-cc-NT-MF-" to help keep track of things during the water analysis. Our walkthrough examples always assume that we are dealing with one field: "F07".

4.6.1 Water Graphs: Scenario and Soil

By clicking on a scenario under the Scenario box ("OH-cc-NT-MF-"**)**, the soil type simulated for the given scenario will show up in the adjacent Soil box**.** (Recall from Section 3.3 that BtB is the short soil symbol for "Bronson sandy loam" and "Ch" is the short soil symbol for "Cohoctah loam"). Double-click on the selected soil "BtB" for the "OH-cc-NT-MF-" scenario and this will add the selected system-soil combination to the list of graph choices in the far right box. Alternatively, once the scenario and soil combination has been selected, you can click on the button *Add to Graph* to select the given combination**.** Repeat for the "Cohoctah loam" (Ch) and the "OH-cc-NT-MF-" scenario combination.

If you have unintentionally selected an incorrect combination you can simply highlight the undesired combination and click on the *Delete Row* button. Similarly, the *Clear List* button will delete all the selected combinations.

4.6.2 Water Graphs: Select Variables

Select the variable(s) to graph by clicking on the desired box. For our example, you can click on *WC(IN), SUMPET,* and *dPre* (**Fig. 16b**). The note below describes the meaning of each of these values.

4.6.3 Water Graphs: Time Range

You have the option to graph the variable(s) for the whole simulation or for a specified range, such as the last twelve months. Your window should automatically be displaying Begin and End values of 1 and 288, respectively. For our example, be sure to enter the value for the minimum (277) and leave the maximum month unchanged (288) (**Fig. 16b**).

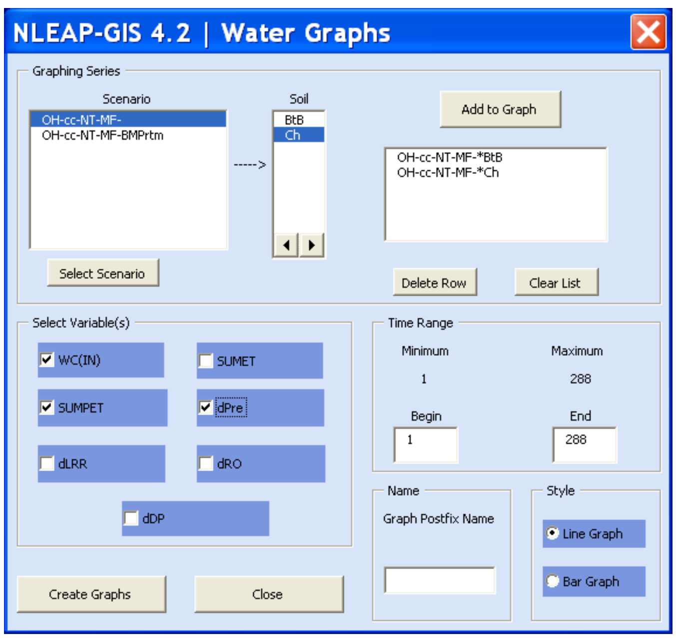

Figure 16a

4.6.4 Water Graphs: Name

The names of graphs in NLEAP use the format variable_postfix, and each graph's corresponding Excel tab is labeled with its name. The Graph Postfix Name we used earlier in this guide is "Example", so enter "Example" as the Graph Postfix Name (**Fig. 16b**). A series of tabs for the selected variables will show up at the bottom of the screen as *VariableName_Example*.

4.6.5 Water Graphs: Style

Here you can choose whether to display your data as a line graph or bar graph. For this example, we are making a line graph, so you'll want to check that "Line Graph" is the style that has been chosen.

4.6.6 Water Graphs: Create Graphs

To generate the graph(s), simply click on the *Create Graphs* button. The same principles that were discussed in Section 4.2.6, NLEAP Graphs: Create Graphs, will apply to the creation of graphs for water variables. You can quickly navigate to the graph shown in **Figure 17** by clicking on the *Close* button twice to get back to the *Driver* window, and then clicking on the *Hide* button. Now you can navigate to the three graphs just by clicking on the tabs with the corresponding name (dPRE_Example; SUMPET_Example ; and WC(IN)_Example).

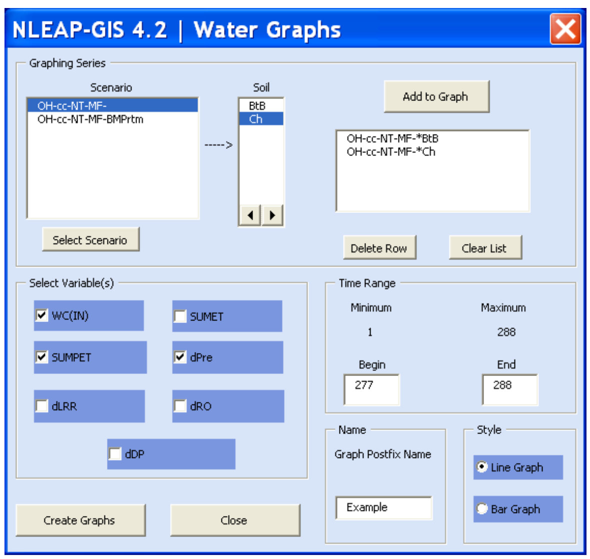

Figure 16b

You can quickly generate another set of graphs by clicking on the tab named "Driver" and navigating back to the *Water Graphs* window. Select the same scenario-soil combination and variables. Also use the same Graph Postfix Name, but now do the graph lines for the whole simulation. Before you click on the *Create Graphs* button, be sure time range is 1 to 288.

Click on *Create Graphs* and the graphs will be drawn again. Since we kept the same Graph Postfix Name, the graphs will overwrite the previous tabs. To see the graphs, go back to *Driver* window and hide the *Driver*. You can see the long-term simulation of dPRE, SUMPET and WC(IN) (**Fig. 18**).

NOTE 4.6.2
Terms and Definitions for Water Graph Variables

WC(in)	Soil water balance at the end of the month for current plant-available water in crop root zone (inches)
Sumet	Monthly Accumulative ET (inches)
Sumpet	Monthly Accumulative potential ET (inches)
dPre	Monthly sum of daily precipitation added (inches)
dIrr	Monthly sum of daily irrigation added (inches)
dRO	Monthly sum of daily surface runoff (inches)
dDP	Monthly sum of daily deep percolation (leaching) (inches)

*****The daily values are available and can be exported to a file for detailed analysis.

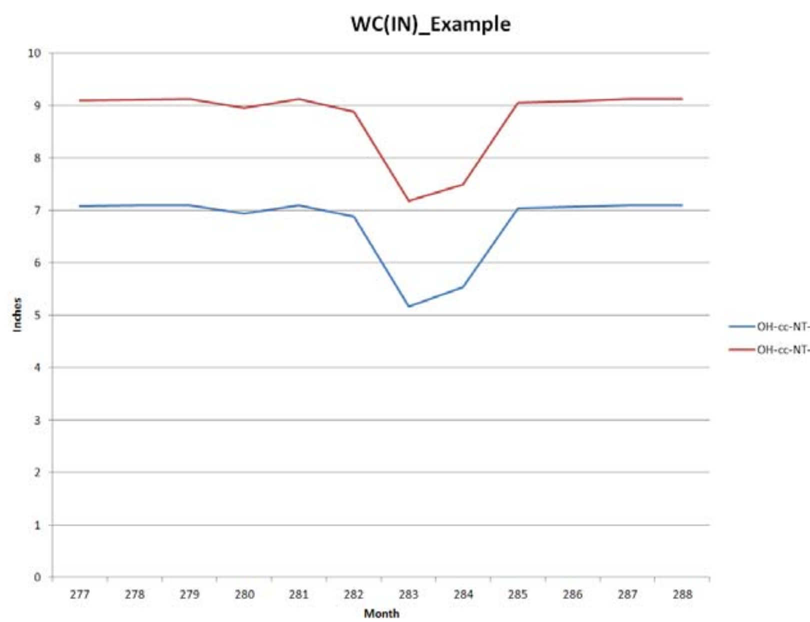

Figure 17

4.7 Water Output Options: Summary Report (Yearly Averages or Totals)

To view a Summary Report of your water output:

1. Go back to the *Driver* and navigate to the *Water Output Options* window.

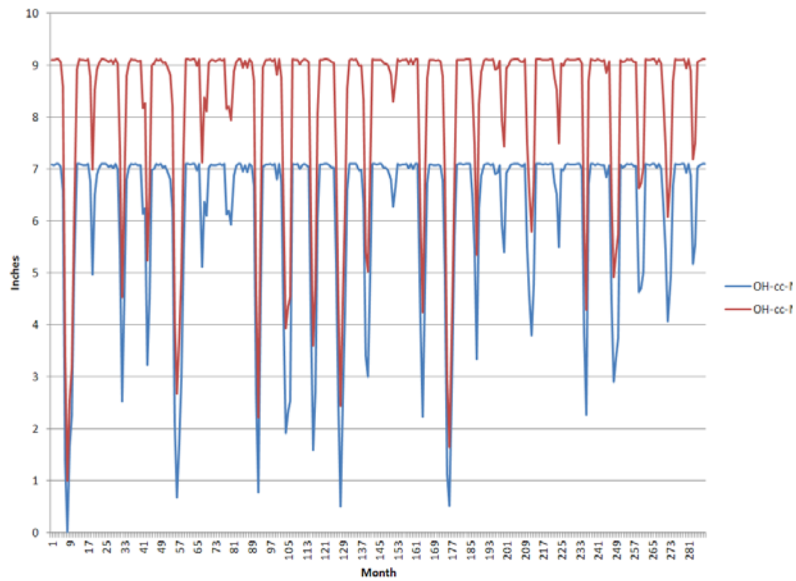

Figure 18

2. To view water balance data select the *Summary Report (Yearly Averages)* button (**Fig. 19**). The summary report will appear with information pertaining to the water outputs of the NLEAP simulation you just ran. For a description of each of these table values, see Note 4.6.2.
3. Note that the *Summary Report (Totals)* feature is currently not functional in this version of NLEAP.

NOTE 4.6.6

Water Graphs: Helpful Hints

- After you have viewed your graphs, you can use the same postfix you just used to name your old graphs to generate a new set of graphs that will be written over the old graphs. On the other hand, if you would like to see several types of graphs or combinations of scenarios simultaneously, the prefix can be changed to generate these different sets (e.g. water_1, water_2, water_3, etc.).
- Once you have completed your graph(s), you can also modify the axis labels by clicking on them and editing the font or the text. You can save the graph or export it as a .jpg file or other format.
- You can export the water data (water table) and use the basic data to generate graphs with another software program or to do statistical analyses of the simulated outputs.

4. Notice that although you selected to do the water graphs only for the combination of "OH-cc-NT-MF-" scenario and the soil types "BtB" and "Ch", since the model simulation was conducted for these two combinations **and** for the "OH-cc-NT-MF-rtm" scenario with the same soil-scenario combinations,

the report will have a summary of all simulated values. In other words, if you simulate four scenario-soil combinations and chose just to graph two, as we did for our example in this guide, the Summary Report will give you a report of all four simulated soil-scenario combinations, not just the two you graphed.

4.8 Water Output Options: Save Graphs/ Delete Graphs

The functions for saving and deleting graphs will be similar to those discussed in Sections 4.3 *Nitrogen Options: Save Graphs* and 4.4 *Nitrogen Options: Delete Graphs*. To review how to save and delete graphs, review the examples in these sections.

5. Creating a Simulation from Scratch

Now that you have successfully run an example simulation, you are ready to create your own simulation. Here you will learn everything you need to know about creating your own databases, downloading climate and soil data, creating events, and constructing manage codes.

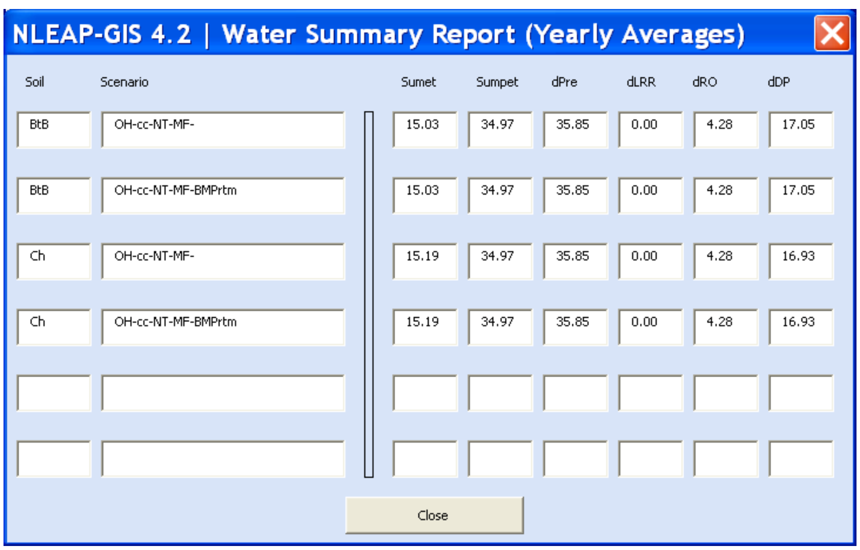

Figure 19

5.1 Understanding the Tables of NLEAP-GIS 4.2 Database

An NLEAP-GIS 4.2 Database consists of three Microsoft Access tables: SoilLayer (table with the soil profile data), ClimLong (table with the weather data), and Events (table with the scenarios – management data).

For a successful NLEAP-GIS 4.2 run, all three of these tables must be created correctly. The SoilLayer table consists of information regarding particular soils in a region. The soil data can be downloaded and converted to NLEAP-GIS 4.2 format. If you will only be working in a certain region, it may only be necessary to download and convert this data one time initially. Like the soil data, ClimLong is downloaded and converted, and this process may only need to be done once. The most time and attention must be devoted to creating a correct Events table, as it contains specific agricultural practice information. The tools available to aid in creating all of these tables are covered in this section.

5.2 Creating a New NLEAP-GIS 4.2 Database

In order to get started, you will need a blank NLEAP-GIS 4.2 Database to fill with data. To create a new NLEAP-GIS 4.2 Database:

1. From the *Driver* window, click on the *Tools* button to get to the *Tools* window. Locate the *New NLEAP DB* button under the heading Initial Setup (**Fig. 9**). This tool creates a blank NLEAP-GIS 4.2 Database with the Events, ClimLong, and SoilLayer tables correctly formatted to the specified location.
2. Click on the *New NLEAP DB* button and navigate to the folder "C:\NLEAP\Training_Data\Example_Run_2". If you desire, you can create your own system of organization and generate a new folder in some other easily accessible location, but this guide will assume you are using the pathway mentioned above.
3. In the folder called "C:\NLEAP\Training_Data\Example_Run_2", name the NLEAP-GIS 4.2 Database "NLEAP_DB_Example_2". Click on *Save*, and a message box will appear asking if you would like to set the file as your default NLEAP DB.
4. Click on *Yes*, as future operations will be easier and you will eventually run NLEAP-GIS 4.2 off this database.
5. Notice how the tab "SOILLAYER" is highlighted but there is no information in the SOILLAYER table. You have created a new NLEAP DB but the tables have not yet been populated.
6. Return to the *Driver* window by clicking on the blue tab labeled "Driver" and clicking on the *Close* button in the *Tools* window. You will notice a green box next to the words "NLEAP DB" under *NLEAP Default Files Status* (**Fig. 20**).

7. If other boxes are green from a previous run, click on the *Set Up NLEAP Files* button and click on the *Remove* button to the right of whichever file(s) has been set (other than the NLEAP DB).
8. This is a good time to also check the Microsoft Access database that we just created. Go to the directory C:\NLEAP\Training_Data\Example_Run_2. Double-click on the recently created file NLEAP_DB_Example2.mdb to open it. You may then see a security message in Microsoft Access. If you have not yet enabled macros in Access, follow the procedures listed in note 2.2. Finally, double-click on SOILLAYER, and you should see that the table has no data.

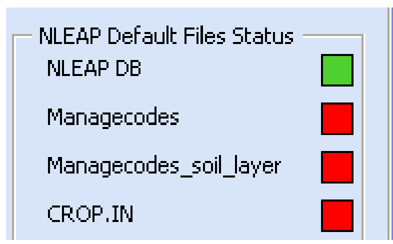

Figure 20

NOTE 5.2b
Unpopulated Databases

It is important to note that although NLEAP-GIS 4.2 has a green box (Fig. 38), it is not yet ready for an NLEAP-GIS 4.2 simulation run. The database currently contains no data, so you'll need to enter data to be sure that the NLEAP-GIS 4.2 DB is completed. A green box simply means that there is a database established, not that the database is populated and ready to use.

In Section 4: Simulating a Simple Example, you used a database that was already populated. Now that you have just learned how to establish a new database here in Section 5, you will soon learn how to fill this new database with data.

5.3 Selecting CROP.IN

Before populating your new NLEAP-GIS 4.2 Database with data you must select the CROP.IN file that contains specific information on all crops available to NLEAP. NLEAP-GIS 4.2 provides a general CROP.IN, which can be tailored to your specific needs. To select a CROP.IN:

1. From the *Set Up* window, click on *Set CROP.IN*, and locate the provided Crop.IN in "C:\NLEAP". Select the "CROP.IN" file and click *Open*.

2. If you would like to use the general information provided in the model, you can move to the following section. If, on the other hand, you would like to edit the CROP.IN, please see Appendix 8.4.

5.4 Downloading and Converting Soil Data

To populate the Soil Layer table in the NLEAP-GIS 4.2 Database, you can download soil information for a specific region from the NRCS Soil Data Mart. The format of the downloaded soil data must be converted in order to be used in NLEAP. The process of extracting and converting this downloaded soil data can be a bit tedious, but will only need to be done once for a given region (usually the local county or soil survey area).

There are two ways to populate the Soil Layer table: you can download soil information for a specific region from the NRCS Soil Data Mart, as will be described in this section, or you can enter the data yourself. You may want to enter or import the soil information from your own research plots if you want to use NLEAP with plot data to test the effects of different treatments. For now, let’s concentrate on how to create a new database by downloading soil information from established websites.

To download and convert soil data:

1. Begin by going to the *Tools* window and clicking *Convert Soil* (found under the Initial Setup heading) to get to the *Convert Soil* window (**Fig. 21**). The *Convert Soil* window contains a link to the website to download soil information and allows access to the soil converter.
2. Click on the *Website to Download Soil and GIS Files* button. This will open your default web browser to the NRCS Soil Data Mart (**Fig. 22**).
3. NLEAP-GIS can be minimized for now, so click on *Close* in the *Convert Soil* window, click on *Close* in the *Tools* window, and then click on *Hide* in the main *Driver*. For this example, you will download data for Defiance County, OH, but the process is the same for any region.
4. Click on *Select State* in the NRCS Soil Data Mart website. Locate Ohio in the list of states and click *Select County* (**Fig. 23**).
5. Locate Defiance County, click on it, then click on *Select Survey Area* (**Fig. 24**).

6. Click on the *Download Data* button (**Fig. 25**) to reach the next screen (**Fig. 26**).

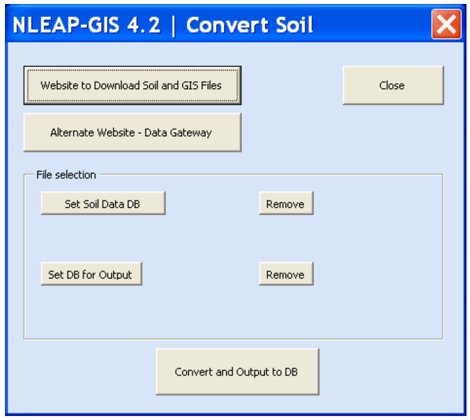

Figure 21

Figure 22

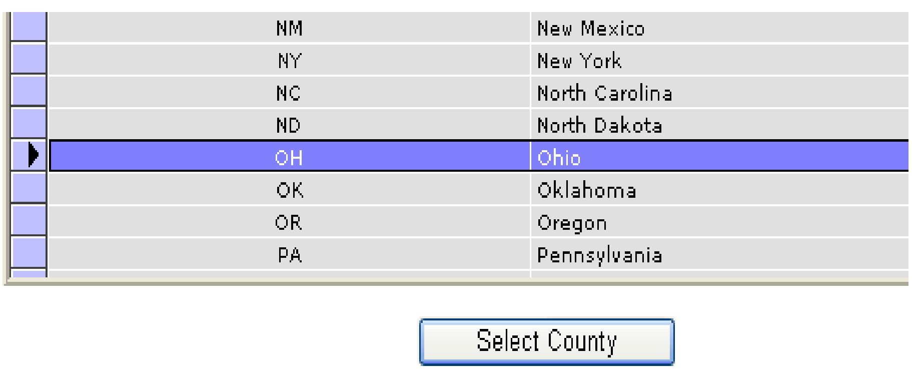

Figure 23

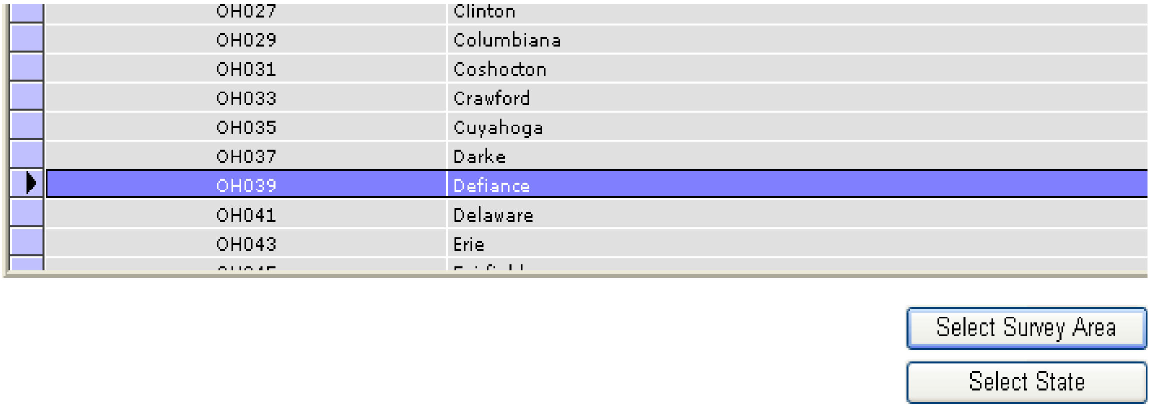

Figure 24

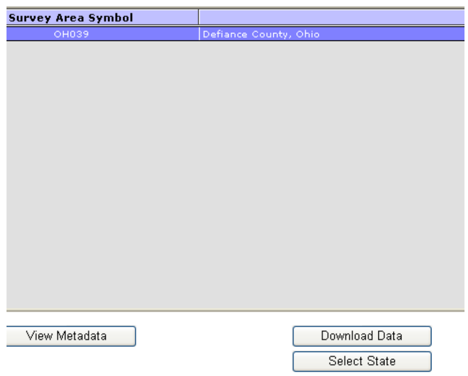

Figure 25

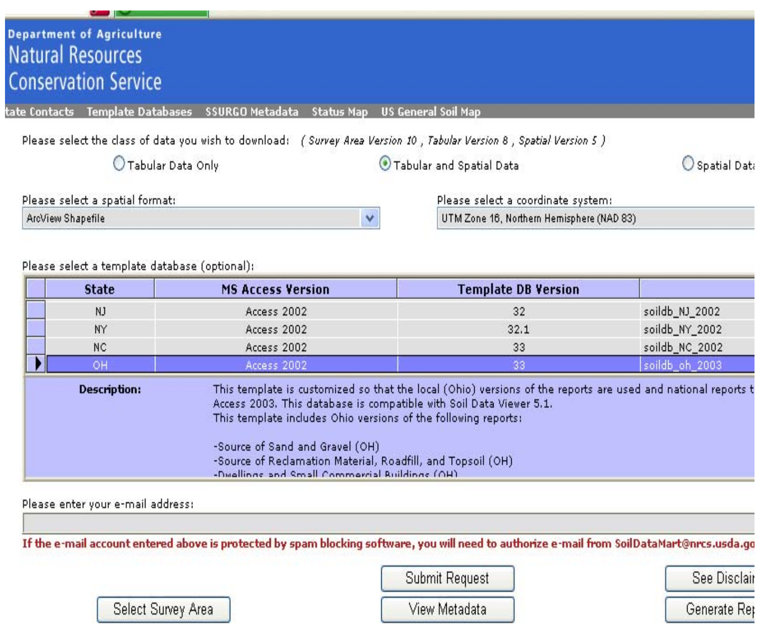

Figure 26

7. Ensure that the Access 2002 version of "soildb_oh_2003" (or the most recent soil db year) and the *Tabular and Spatial Data* radio button at the top of the page are selected. Also be sure that the spatial format selected is *ArcView Shapefile*, and select the coordinate system *UTM Zone 16 Northern Hemisphere (NAD 83)*. Enter your email address and click on *Submit Request*. You will be placed in a queue and will soon receive an e-mail containing a link to download the soil data.
8. Once you have received the e-mail, download the data to the "Example_Run_2" folder, which can be found by navigating to "C:\NLEAP\Training_Data\Example_Run_2". The "Example_Run_2" folder should now contain the file named "soil_oh039.zip".
9. Right-click on that file and then click *Extract All*. Click on *Next* twice, wait for the extraction to complete, and click *Finish*. A new window will appear containing the unzipped folder named "soil_oh039". Open that folder.
10. Open the folder named "tabular".
11. The "tabular" folder should contain a number of text files. We need the address of these text files, so highlight the entire address in the address bar C:\NLEAP|Training_Data\Example_Run_2\soil_oh039\soil_oh039\tabular, right-click and select *Copy*.
12. Return to the parent folder by clicking on the *Up* button.
13. The .zip file named "soildb_oh_2003" must also be unzipped, so right-click on that folder and select *Extract All*.
14. Click on *Next* twice, and then on *Finish*. A window containing an Access database named "soildb_oh_2003" will appear. Double-click on that file and select *Open* when asked if you would like to open it in Access.
15. You may see a security message. If you have not enabled macros in Access, we recommend that you do so. The window *SSURGO Import (Template Version 33)* should appear.
16. Right-click in the white text-box area and click on *Paste*, which will put the address of the tabular data into the text box. The directory to paste is C:\NLEAP|Training_Data\Example_Run_2\soil_oh039\soil_oh039\tabular.

17. Click on *Ok*, and wait for the processing to complete.

18. When a Soil Reports window will appears showing a list of Map Unit Symbol, and Map Unit Name for Soil Survey Area Name “Defiance County: Ohio” (this may take several seconds), Access and the previous folders can be closed, and you can return to the NLEAP-GIS main *Driver* window. Click on the *Tools* button.

19. From the *Tools* window, under Initial Setup, click on the *Convert Soil* button and you will return to the *Convert Soil* window.

20. Click on the *Set Soil Data DB* button and locate the Access file named “soildb_OH_2003”, which should be located in “*C:\NLEAP\Training_Data\Example_Run_2\soil_oh039\soil_oh039\soildb_oh_2003”*. Once you have found it, select the file and click *Open.*

Recall that you have already set up the NLEAP DB file in “*C:\NLEAP\Training_Data\Example_Run_2|NLEAP_DB_Example2.mdb”*.

Then click on the *Set DB for Output* button and select *Yes*, as the output should be set to the recently established NLEAP-GIS 4.2 DB. The window should look like the one presented in **Figure 27**.

21. Click on *Convert and Output to DB* (**Fig. 27**). If you have not previously established the NLEAP DB as your output database, you will be prompted to do so now. A black window will appear and disappear while your soil data is converted and exported to your default NLEAP-GIS 4.2 Database.

22. Return to the *Tools* window.

23. Check the Microsoft Access database that we just created, open the file *C:\NLEAP\Training_Data\Example_Run_2\NLEAP_DB_Example2.mdb.*

Now you will see that the SOILLAYER table is populated with the downloaded data.

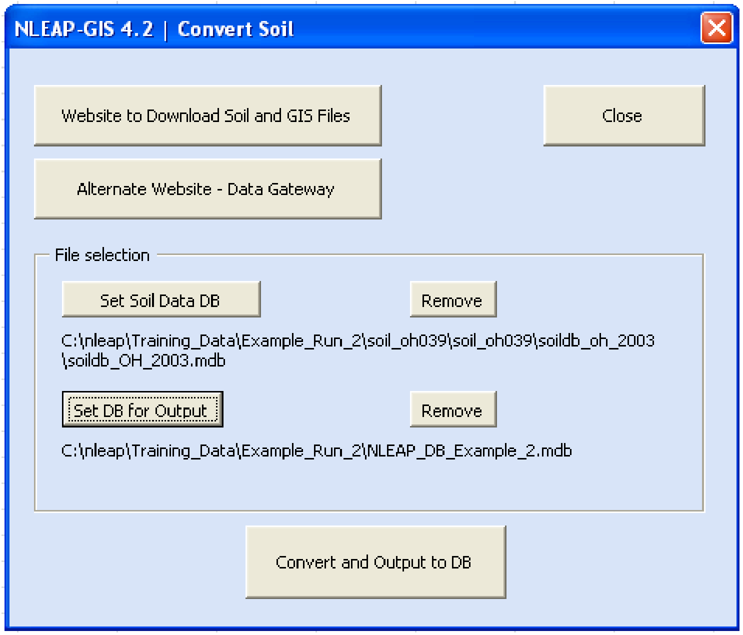

Figure 27

5.5 Downloading and Converting Climate Data

There are a couple of ways you can set the Climate data: it can be downloaded from the NRCS FTP site or the PRIMS site, or it can be imported from local studies. This section will cover how to download and convert data from the FTP site to the ClimLong table in the NLEAP-GIS 4.2 Database.

Before we begin, it would be a good idea to take a look at the CLIMLONG Table of the example database. Open the file named "NLEAP_DB Example_2.mdb", located in "*C:\NLEAP\Training_Data\Example_Run_2\NLEAP_DB_Example_2.mdb*". You will notice that the CLIMLONG table is does not contain any data. We are going to populate the climate data in the following section.

To download and convert climate data:

1. From the *Tools* window, click on *Convert Climate* under Initial Setup. The *Convert Climate* window will appear (**Fig. 28**).
2. In the *Convert Climate* window click on the *FTP for Climate Data Download* button, which will open a virtual folder containing climate data for all states ftp://ftp.wcc.nrcs.usda.gov/support/climate/daily-data/
3. NLEAP-GIS can be minimized for now, so click on *Close* twice and hide the *Driver*.

4. To change FTP appearance, follow the instructions at the top of the FTP page to change the appearance (click on *Page*, then under *Page*, click on *Open FTP Site in Windows Explorer)*. Open the folder labeled "oh" and an executable file named "39.EXE" should appear.

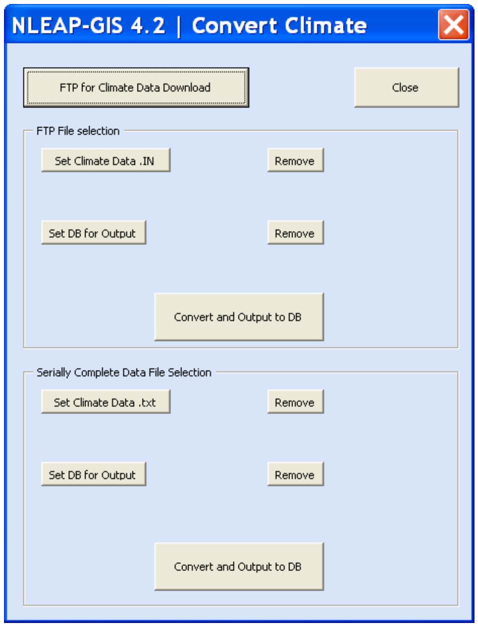

Figure 28

5. Right-click on the file and select *Copy*. The current FTP window can be closed.

6. Return to "C:\NLEAP\Training_Data\Example_Run_2" where the "Example_Run_2" folder was located in (or wherever you initially saved the NLEAP-GIS 4.2 Database), and create a folder within "Example_Run_2" called "Climate". *Paste* the "39.EXE" file by right-clicking in the white space in the "Climate" folder and selecting *Paste* from the available options. The executable file will be downloaded to that folder.

7. Copy the path of your "Climate" folder by copying the full string in the address bar of the window shown below. You will need to paste the path "C:\NLEAP\Training_Data\Example_Run_2\Climate" in the next two steps.

8. Now double-click on "39.EXE" and a new unzip window will appear.

9. Navigate into the box below the words *Unzip to Folder:* and paste the previous path that you have copied "C:\NLEAP\Training_Data\Example_Run_2\Climate" , Click on *Unzip*.

10. A new window will inform you that the files unzipped successfully (93 files). Click *OK* in the new window, and close out of the WinZip Self-Extractor.

11. Your "Climate" folder should now be populated with a group of folders labeled with numbers. Each of those folders contains a numbered text file corresponding to a weather station. The next step is determining the number of the weather station closest to the county we have chosen. In this guide's example, we chose Defiance County (for Ohio), and the number of the weather station nearest to it ends in "2098".

12. Once you have determined your weather station number, the easiest way to locate that specific text file is to conduct a search in that folder. Click the *Search* button at the top of the window. In the left panel of the window, you will see text that asks, *What do you want to search for?* Choose *All Files and Folders*. (It is possible that when you click the *Search* button, the search bar may have already appeared. If so, simply proceed to the next step.) In the box under the text that says *Look in*, you can select the folder "Climate" to narrow the scope of the search.

13. In the search bar, type "2098" and click on *Search.* The text file called "390392098" should be found in the folder named "39039". Return to the *Convert Climate* tool in NLEAP-GIS.

14. Click *Set DB for Output* (**Fig. 29**). A new window with the question, *Would you like to use your set up NLEAP Database?* will appear. Click on *Yes*. The output of the conversion program should populate the ClimLong in our NLEAP-GIS 4.2 Database.

15. Click *Set Climate DATA.IN* and navigate to the directory where the weather data is located: "C:\NLEAP\Training_Data\Example_Run_2\Climate\39039" to select the text file.

16. Check that your *Convert Climate* window looks like **Figure 30.**

17. Click on *Convert and Output to DB* (**Fig. 30**), wait for the processing to complete, and your ClimLong table will be created and exported to the NLEAP-GIS 4.2 Database while updating your current ClimLong tab. You can now see that the weather data is in the CLIMLONG table and the tab is highlighted in white.

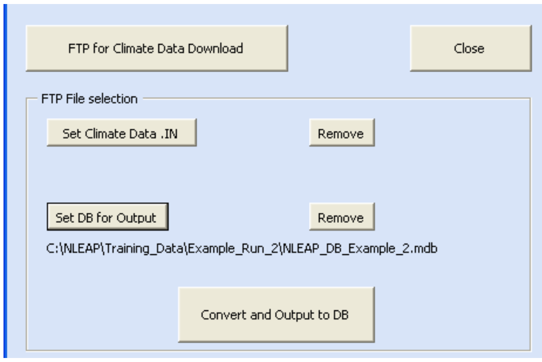

Figure 29

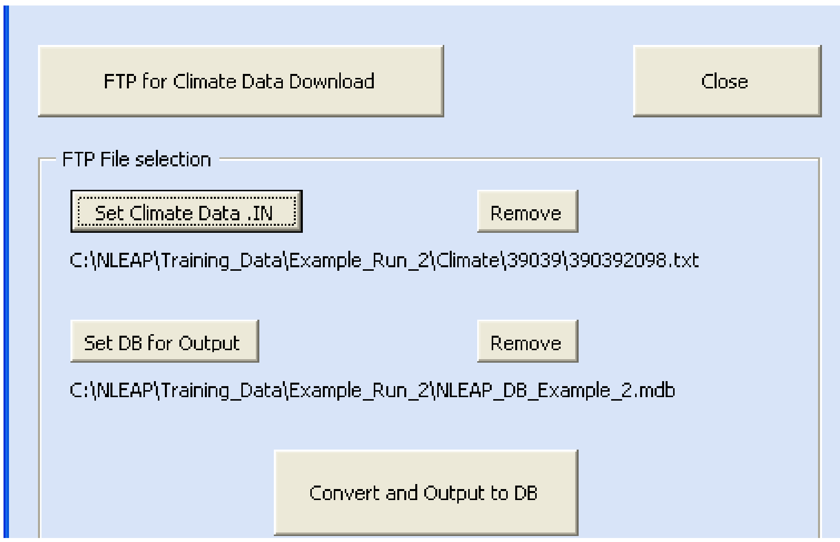

Figure 30

18. Click on the “Driver” tab to return to the *Driver* (**Fig.** 31**).**

19. Return to the *Tools* window**.**

20. Check the database that you have just created. Open Windows Explorer and open the database again using the same instructions from Section 5.2, Step 8 to open the file “NLEAP_DB_Example_2”, which is located in “*C:\NLEAP\Training_Data\Example_Run_2\NLEAP_DB_Example_2.mdb*”. You will see that the CLIMLONG Table is now populated with the downloaded data.

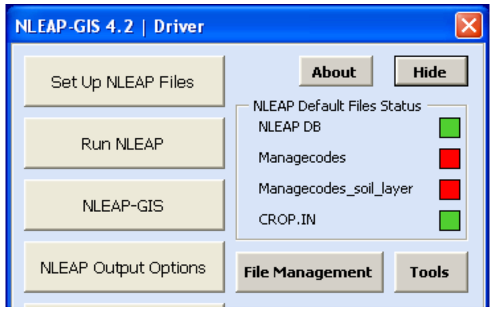

Figure 31

5.6 Selecting Simulation Period for Climate Data

The *Trim ClimLong* tool opens the *Climate Trimmer* window, which trims the climate data to the specified years. ***This is important because NLEAP-GIS 4.2 starts a simulation using the first available climate data.*** So if a simulation is taking place in 1992, the climate data should begin in 1992 as well. Let's practice using the *Trim ClimLong* tool:

1. In the *Tools* window click on the button *Trim ClimLong*. You will get a pop-up message letting you know that your ASIM is not set in the Events table (**Fig. 32)**. This is correct and ASIM has not been created yet, because you have not entered any management scenarios in your Events table. We will explain how to create the Events in the next section, so just click *OK*.
2. For our example, we are going to conduct a simulation for 1992 and 1993, so these are the years that you want to enter in the boxes under *Start Year to Use* and *End Year to Use*, respectively (**Fig. 33).** To select the weather from 1992 to 1993, click on the *Use Specified Range* button (**Fig. 33).**
3. A new window will pop out (**Fig. 34).** To proceed, click on *Ok* and the selected 1992 to 1993 weather will be exported to the NLEAP DB (**Fig. 34).**
4. You will then be asked, *Would you like to export ClimLong?* Click on *Yes* to proceed.
5. One more window will appear. This window will ask, *Would you like to use your default NLEAP DB?* Click on *Yes* to proceed (**Fig. 35)**. By clicking on *Yes*, you are deciding that the already set up NLEAP DB will be used. If you had clicked on *No* instead, then it would have looked for a new NLEAP DB to export that 1992 to 1993 weather data. The process has been completed. Now

you can navigate to the set up NLEAP DB in Microsoft Access, just as you have done before (Section 5.2, step 8), and open the ClimLong table

Figure 32

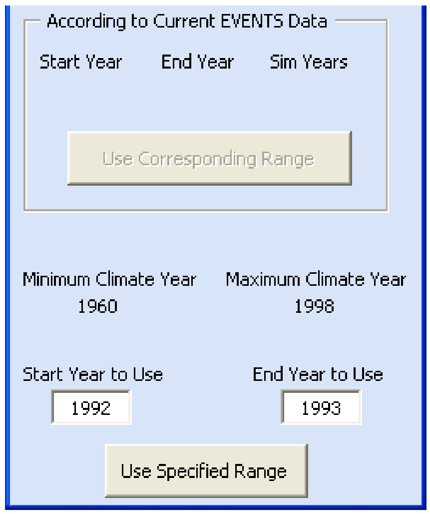

Figure 33

Figure 34

5.7 Creating Events Data

Go back to the *Tools* window and under the Events heading click on the *EVENTS Creator* button (**Fig. 36)**. The *EVENTS Creator* tool opens the *EVENTS Creator* window, which is used to create an Events table. For efficient use of the *EVENTS Creator*, a Crop.IN should be set before using the *EVENTS Creator*.

NOTE 5.6

Exporting ClimLong

Would you like to export ClimLong?

If you answer *Yes*, the 1992 to 1993 weather data will be exported to the ClimLong table in Access. The data will also be kept in the Excel ClimLong table (tab named “CLIMLONG”).

If you answer *No*, the 1992 to 1993 weather data will only be kept in the Excel ClimLong table (tab named “CLIMLONG”), and it will not be exported to Microsoft Access.

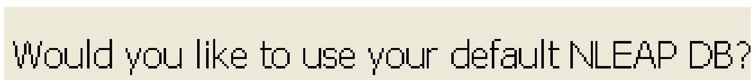

Figure 35

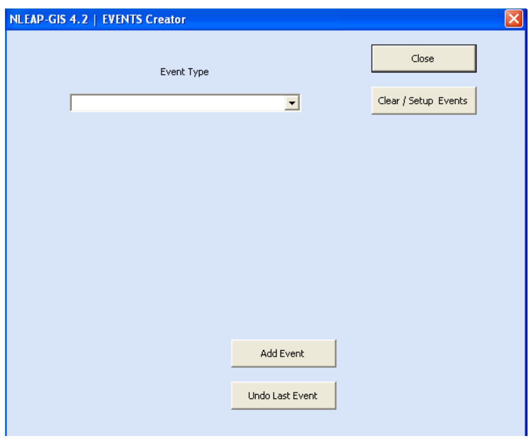

Figure 36

Two of the three tables in the NLEAP-GIS 4.2 Database should now be correctly filled, which leaves you with only the Events table left to create. Each entry in the Events table specifies either an agricultural action for a specific scenario or critical information to the NLEAP-GIS 4.2 simulator. There are twelve types of Events, five of which supply information to the NLEAP-GIS 4.2 simulator, and the remaining seven which represent different agricultural actions. All agricultural events correspond to a specific date and specific scenario. Recall from Section 3.3: Constructing Management Codes that the management codes indicate which soil and scenario combinations are to be included when you run your simulation.

These scenarios are created within the Events table. If an Events table contains data about scenario A and scenario B, both A and B could be simulated together with combinations of soil. Once again, it is advantageous to simulate multiple combinations together because this will allow you to see the behavior of multiple scenarios, and thus make the NLEAP-GIS 4.2 output tools more meaningful to you. Delgado et al. (2008) developed a system where multiple scenarios could be quickly compared to a single scenario. This approach to modeling, where management scenarios are compared to an established baseline, was named the Nitrogen Trading Tool. For more information on the potential uses of the Nitrogen Trading Tool, see Delgado et al (2008).

As an example, utilizing the *EVENTS Creator*, we will create a very simple Events table consisting of just two scenarios for two years. For our exercise we are going to enter the same scenarios that we have used for previous examples: the “OH-cc-NT-MF–” and “OH-cc-NT-MF-rtm” scenarios. These scenarios will be entered for the 1992-1993 period.

5.8 Using EVENTS Creator

1. Before you start working in the *EVENTS Creator* window, go back to the *Set Up* window and be sure that your window looks like **Figure 37**.

2. Navigate to the *Driver* window and to the *Tools* window, select *EVENTS Creator*, and click on the *Clear/Setup Events* button to clear your current Events sheet and set up the correct columns.

3. We will start creating the two-year, Corn-Corn rotation with the two different rates of dairy manure applications: the “OH-cc-NT-MF-rtm” and “OH-cc-NT-MF-” scenarios. We’ll begin by selecting the Event Type. You can locate any type of event by using the dropdown menu of the Event Type box. When beginning an Events table, it’s a good idea to first set your ASIM and STOP events, which are required for every Events table. Select ASIM as your Event Type (**Fig. 38**) and enter the values that are listed in Note 5.8b. After you enter the values, check that your window looks like **Figure 39.** Click on the *Add Event* button.

4. Now let’s add the STOP event. From the *EVENTS Creator*, select the STOP Event Type (**Fig. 40**). Be sure to enter the values in Note 5.8c so the window looks like **Figure 40** and then click on the *Add Event* button. Note that the event has been added to the third row..

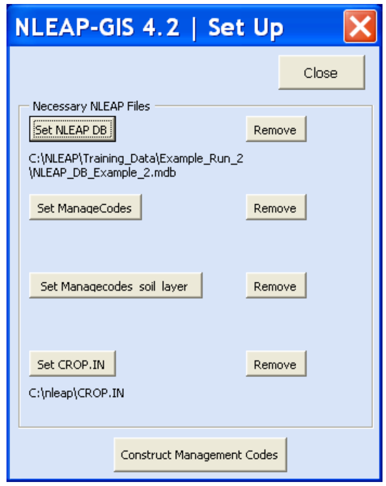

Figure 37

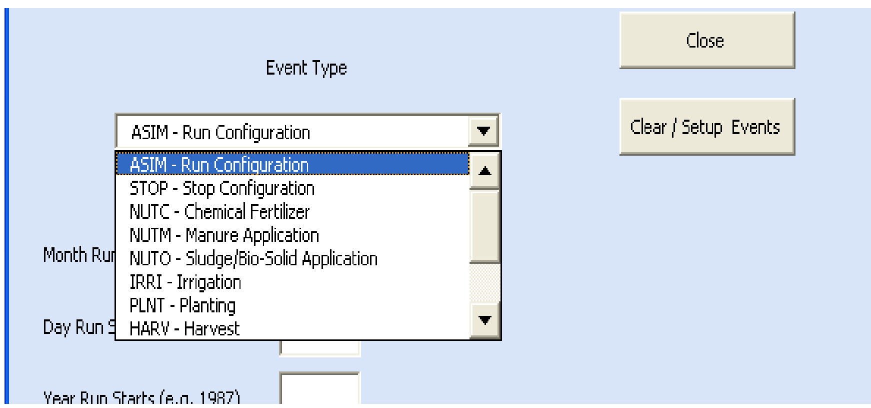

Figure 38

5. Now that we have expressed the time range and soil depth to be simulated, we can move on to actual agricultural events. For this example, we will simulate two manure applications and the planting and harvesting of the corn-corn rotation. On February 25, 1974 apply a NUTM (manure nutrient) Event Type with dairy manure by typing the values listed in Note 5.8f into the appropriate boxes, including the Management Scenario Code. You will not be able to enter the Manure Identifier ("Dairy") and Method of Application ("Liquid Broadcast") manually, but will instead need to select them from their dropdown menus (**Figs. 41a; 41b**).

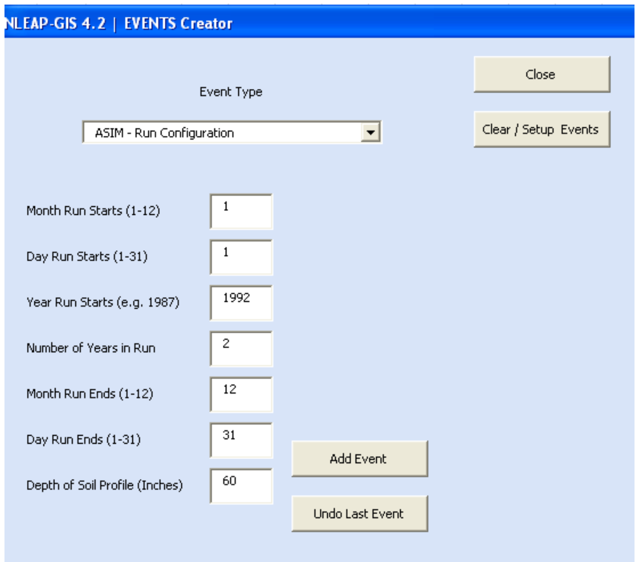

Figure 39

NOTE 5.8b

Values for ASIM Event

Enter the values below into the *EVENTS Creator* for the example ASIM event. The example run starts on January 1st, 1992.

Description	Value to Enter
Month run starts (e.g., 03)	1
Day run starts (e.g., 01)	1
Year run starts (e.g., 2005)	1992
Number of years in run (e.g., 10)	2
Month run ends (e.g., 11)	12
Day run ends (e.g., 30)	31
Depth of soil profile (inches)	60

NOTE 5.8c
Values for STOP Event

Enter the values below into the *EVENTS Creator* for the example STOP event. The example run ends on December 31, 1993.

Description	Value to Enter
Month run ends (e.g., 03)	12
Day run ends (e.g., 01)	31
Year run starts (e.g., 2005)	1993

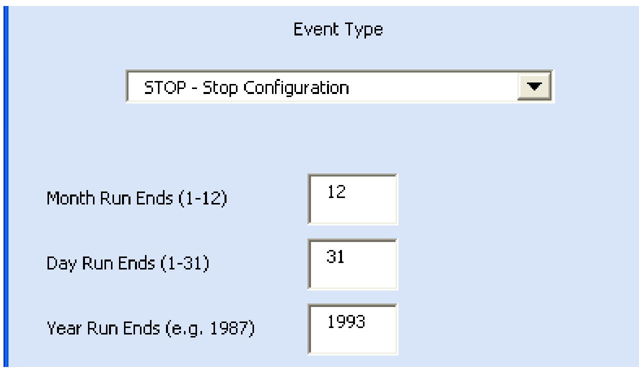

Figure 40

NOTE 5.8d
ASIM and STOP Events

For each Event Type, the *EVENTS Creator* will display a number of text boxes, which unless denoted as optional, must all be filled in with valid information. The ASIM and STOP Event Types report simulation information to the NLEAP-GIS 4.2 model.

Note that without both ASIM and STOP, the NLEAP-GIS 4.2 simulator will not run. It is also important to realize that only one ASIM and STOP are to be present for any Events table, no matter how many different scenarios are present within that table.

NOTE 5.8e
Management Scenario Codes

Whenever you are constructing an Events table, you should enter your events in chronological order (earliest event to latest), as all agricultural Event Types require a date. Since NUTM is our first event in this example, we needed to give a name to the specific scenario we are creating. Since this is a corn–corn rotation with dairy manure, you will enter a scenario name of "OH-cc-NT-MF-rtm" under the heading Management Scenario Code. You should always give meaningful names to your scenarios. There is no standard to the format of the scenario name, although creating a naming convention that makes sense to you is very helpful.

Also notice that the dropdown box for Management Scenario Code will not have any options for you to choose until you have entered your own scenario names.

6. Now click on *Add Event*. You have just entered the third event (**Figs. 41c**).
7. Now let's say that you had clicked on the *Add Event* button twice and so you just added the same event twice. For practice, just click on the *Add Event* button a second time. To correct the double entry, simply click on the *Undo Last Event* button and your table should only have 3 eventtype (ASIM; STOP; NUTM).
8. At this point, you need to complete entering the 1992 events for the "OH-cc-NT-MF-rtm" scenario. To do this, you will have to enter an incorporated solid manure application on March 25th, 1992 (**Figs. 42**). (Additionally, you will have to enter a planting event and a harvesting event for corn and an application of chemical fertilizer. Then, the same information will have to be entered for the corn 1993 growing season. We'll go through each of these steps in more detail below, but for now, let's do the solid manure application.) Enter the values in Note 5.8g. According to the entered values, on March 25th, 1992, corn received a solid broadcast application of manure**.**
9. Once you have added the solid manure application event, select the PLNT-Planting Event Type and enter the values shown in Note 5.8h. These values represent the planting of corn for 1992 for the "OH-cc-NT-MF-rtm" scenario on May 15, 1992. Note that the dropdown menu previously named Method of Application has a new name: Crop Type. Check that the values in your window match **Figure 43** and then click *Add Event*.

NOTE 5.8f

Values for NUTM Event (Incorporated Liquid Broadcast)

Enter the values below into the *EVENTS Creator* for the example NUTM event (Incorporated Liquid Broadcast).

Description	Value to Enter
Month of manure application (e.g., 06)	2
Day of manure application (e.g 15)	25
Year of manure application (e.g., 2005)	1992
Percent NO3-N in manure, dry weight	0.0
Percent NH4-N in manure, dry weight	4.0
Percent water in manure	98
C/N ratio of manure	15
Amount of wet manure applied (t/ac)*	66.5
Percent Organic Matter (OM) in manure	20
Management scenario code	OH-cc-NT-MF-rtm
Manure identifier	Dairy
Method of application	Incorporated Liquid Broadcast

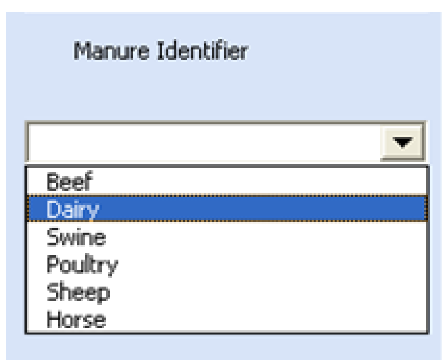

Figure 41a

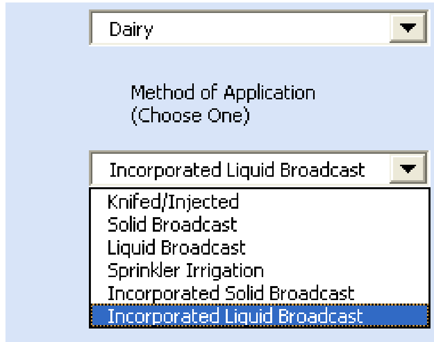

Figure 41b

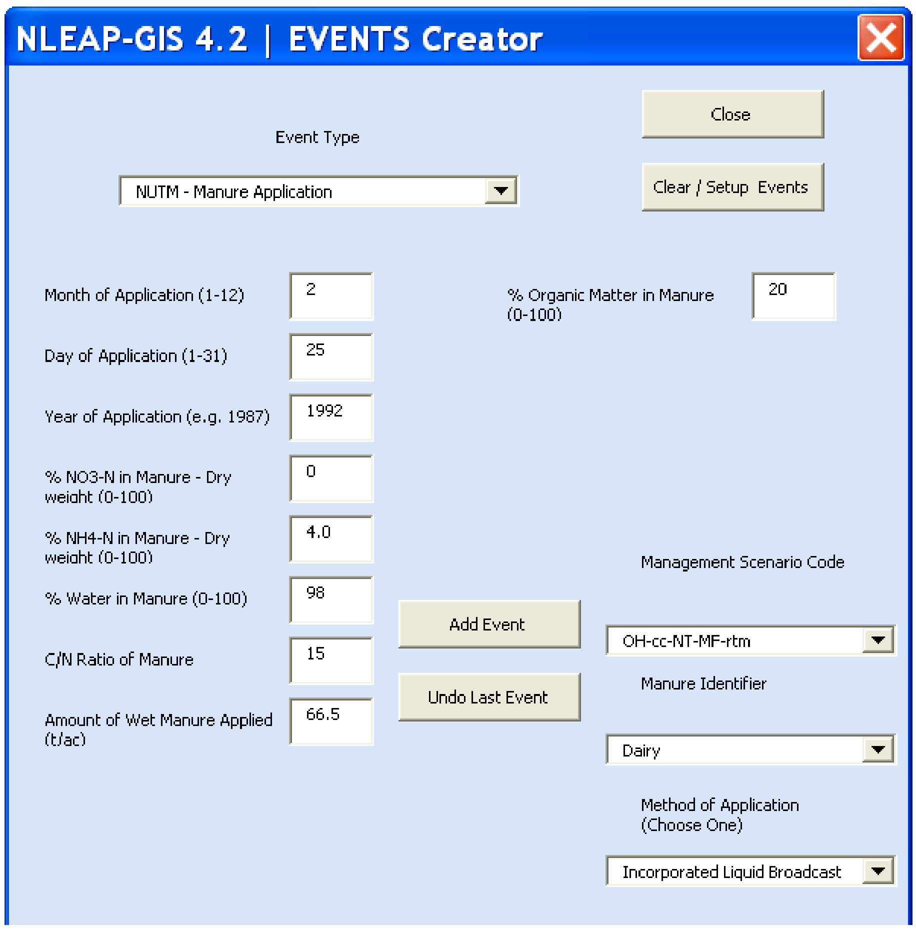

Figure 41c

Now, select the HARV- Harvesting Event Type and enter the values in Note 5.8i to make your window look like **Figure 44**. Recall that this is the harvesting of corn event for 1992 for the "OH-cc-NT-MF-rtm" scenario. Since cutting for Alfalfa does not apply to this crop, enter 0 for those values. This corn crop is harvested on September 15^{th} of that year with the characteristics shown in **Fig. 44**.

NOTE 5.8g

Values for NUTM Event (Incorporated Solid Broadcast)

Enter the values below into the *EVENTS Creator* for the example NUTM event (Incorporated Solid Broadcast).

Description	Value to Enter
Month of manure application (e.g., 06)	3
Day of manure application (e.g., 15)	25
Year of manure application (e.g., 2005)	1992
Percent NO3-N in manure, dry weight basis	0.0
Percent NH4-N in manure, dry weight basis	1.8
Percent water in manure	80
C/N ratio of manure	15
Amount of wet manure applied (t/ac)*	8.8
Percent Organic Matter (OM) in manure (dry weight basis)	25
Management scenario code	OH-cc-NT-MF-rtm
Manure identifier	Dairy
Method of application	Incorporated Solid Broadcast

10. Now that you have entered some Events into the EVENTS table, it's a good time to save the data. In order to save the Events, they should be exported to "NLEAP DB Example_2.mdb" located in "C:\NLEAP\Training_Data\Example_Run_2". Click on the *File Management* button in the *Driver* and under the heading Export, select *Events to Access*. (**Fig 45**). Click *Yes* when asked if you would like to use your default NLEAP database (**Fig. 46**).

11. Select the NUTC- Chemical Fertilizer Event Type and enter the values shown in **Figure 47**.

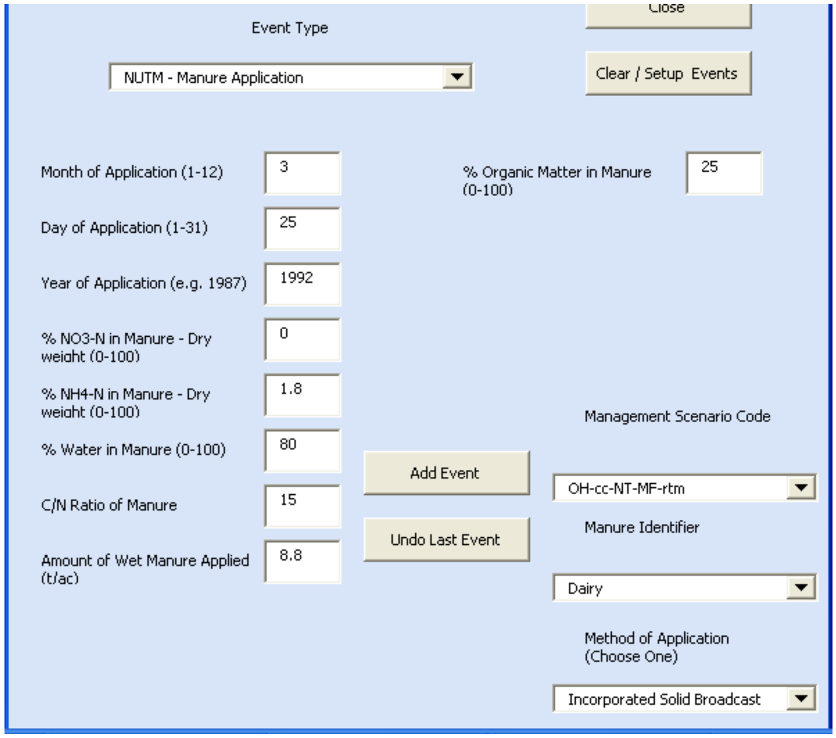

Figure 42

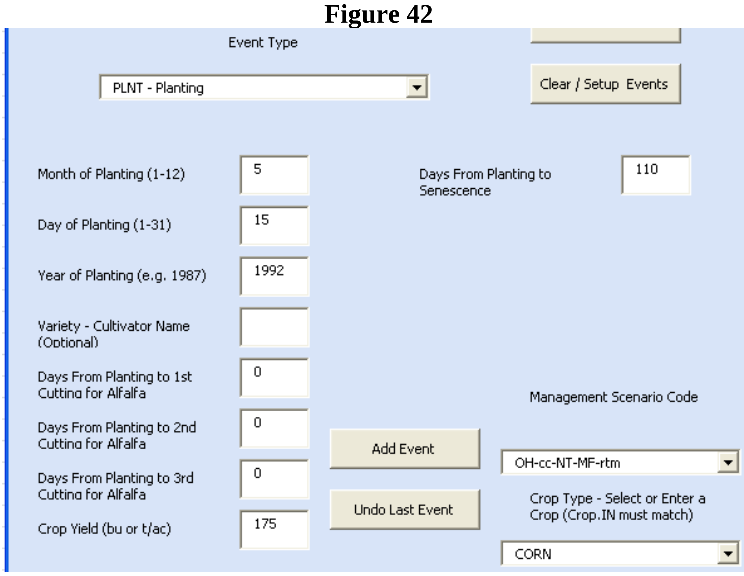

Figure 43

NOTE 5.8h
Values for PLNT Event
Enter the values below into the *EVENTS Creator* for the example PLNT event.

Description	Value to Enter
Month of planting event (e.g., 05)	5
Day of planting event (e.g., 10)	15
Year of planting event (e.g., 2005)	1992
Crop type**	Corn
Variety (cultivar name; optional)	
Days from planting to 1st cutting for alfalfa	0
Days from planting to 2nd cutting for alfalfa	0
Days from planting to 3rd cutting for alfalfa	0
Crop yield (bu or t/ac)	175
Days from planting to senescence (maturity)	110
Management scenario code	OH-cc-NT-MF-rtm

12. You have just completed entering the needed events for the 1992 "OH-cc-NT-MF-rtm" scenario. To complete the 1992-1993 "OH-cc-NT-MF-rtm" scenario, we need to enter the planting, harvesting, and chemical fertilizer events for 1993. To do this, first select the PLNT – Planting Event Type. Enter the values shown in **Figure 48** and click *Add Event.* (You may notice these are the same values we entered for the 1992 planting event for this scenario; we have only changed the year.)

13. Now select HARV - Harvest Event Type and enter the values shown in **Figure 49**. Click *Add Event*. Again, these are the same values we entered for the 1992 harvesting event, but this time we are changing the year.

14. Select the NUTC- Chemical Fertilizer Event Type and enter the values shown in **Figure 50**. Note that for this Event Type, you change not only the year, but you also change the value for Total Bulk Fertilizer Applied (this time it is 150). Click *Add Event*.

NOTE 5.8i

Values for the HARV Event

Enter the values below into the *EVENTS Creator* for the example HARV event.

Description	Value to Enter
Month of harvest event	9
Day of harvest event	15
Year of harvest event	1992
Crop type	Corn
Percent residue standing after harvest	0
Percent reside flat-lying after harvest	100
Percent residue cover on soil surface after harvest	40
Percent stover returned to field	100
Harvest index (HI): ratio of drymatter yield to total drymatter (yield/total)	0.5
Percent water content of yield at harvest	15
Harvest unit weight (lbs per unit of harvest)	56
Management scenario code	OH-cc-NT-MF-rtm

15. Now that you have finished entering the entire 1992-1993 “OH-cc-NT-MF-rtm” scenario, you will need to complete the 1992-1993 “OH-cc-NT-MF-” scenario, incorporating some key differences from the previous scenario: higher manure and fertilizer rates, a Surface Broadcast method of application in the fall, and changing the Management Scenario Code to “OH-cc-NT-MF”. (If this sounds confusing, don’t worry; we’re going to walk you through each of the individual steps right now.)

16. Select NUTM-Manure Application as the Event Type. This will be the first event for the 1992-1993 “OH-cc-NT-MF-” scenario. Enter the values shown in **Figure 51**, then click *Add Event.*

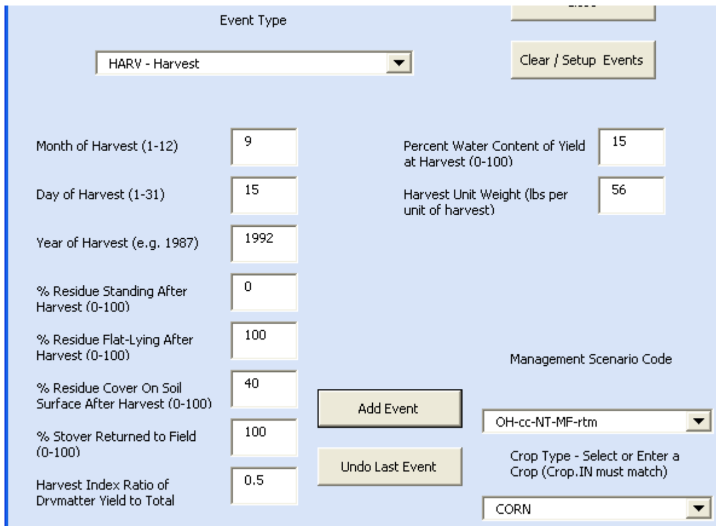

Figure 44

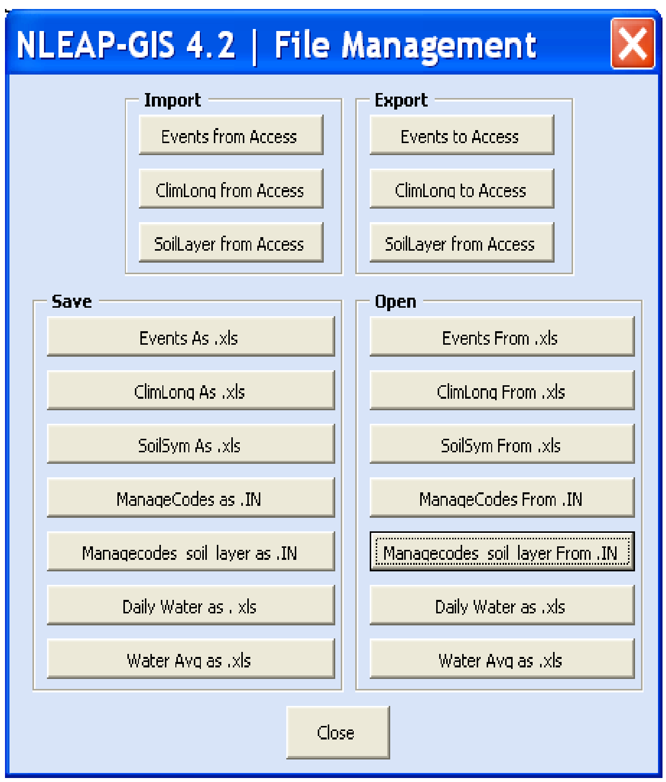

Figure 45

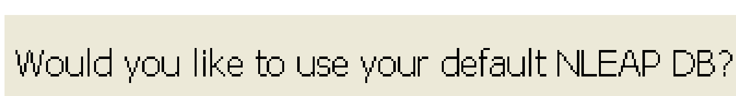

Figure 46

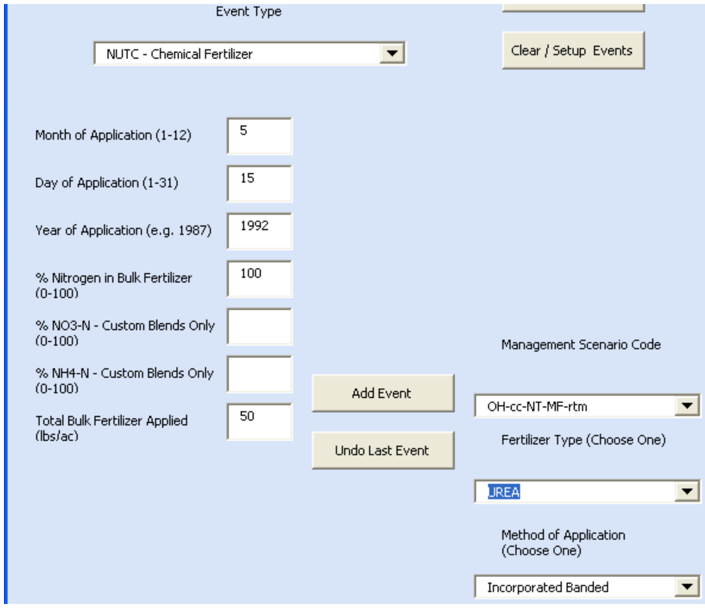

Figure 47

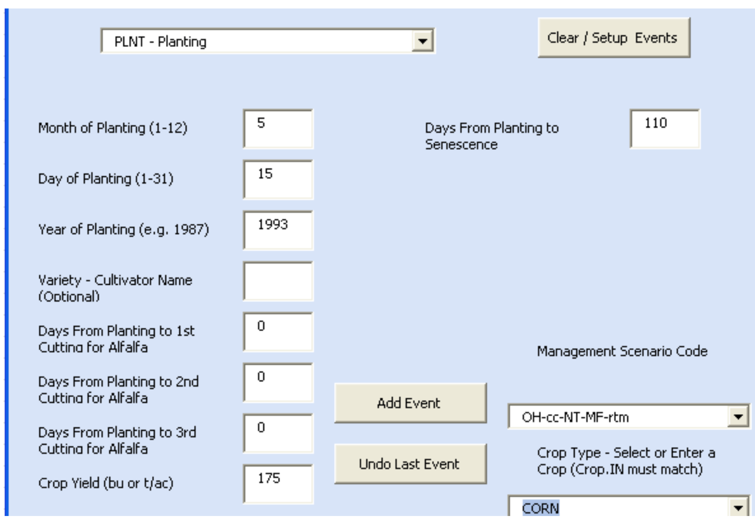

Figure 48

17. Next, enter the values shown in **Figure 52** and click *Add Event*. Notice that you did not change the Event Type (NUTM - Manure Application), but you did change some of the other information, such as the month and day of application.

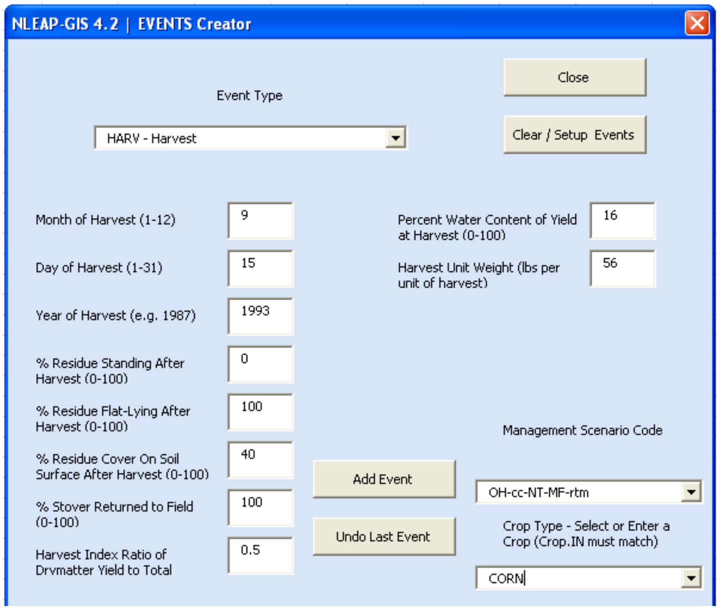

Figure 49

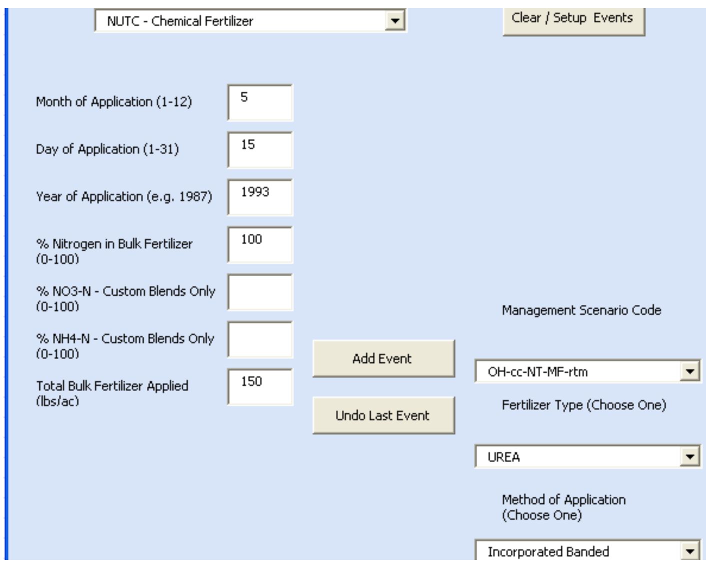

Figure 50

18. Now, select PLNT – Planting as the Event Type and enter the values shown in **Figure 53** and click *Add Event*.
19. While keeping PLNT – Planting selected as the Event Type and all of the other values you just entered the same, change the year to 1993. Check that your window looks like **Figure 54** and click *Add Event*.
20. Select HARV – Harvest as the Event Type. Enter the values shown in **Figure 55** and click *Add Event*.

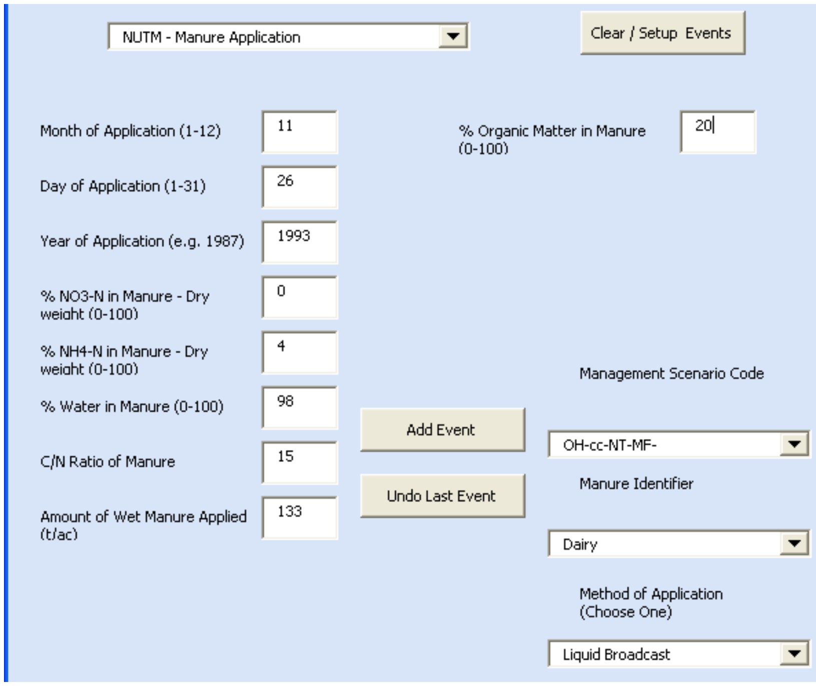

Figure 51

21. While keeping HARV- Harvest selected as the Event Type and all other values you just entered the same, change the year to 1993. Check that your window looks like **Figure 56** and then click *Add Event*.

22. Select the NUTC- Chemical Fertilizer as the Event Type and enter the values shown in **Figure 57**. Click *Add Event*.

23. While keeping NUTC - Chemical Fertilizer as the Event Type and all other values you just enter the same, change the month, day, and year to 11, 20, 1993; change the total bulk fertilizer applied to 100. Check that your window looks like **Figure 58** and click *Add Event*.

24. Now that you have entered the Events for the two management scenarios, save the data. Click on the *File Management* button in the *Driver* and under the heading Export, select *Events to Access*. Click *Yes* when asked if you would like to use your default NLEAP database.

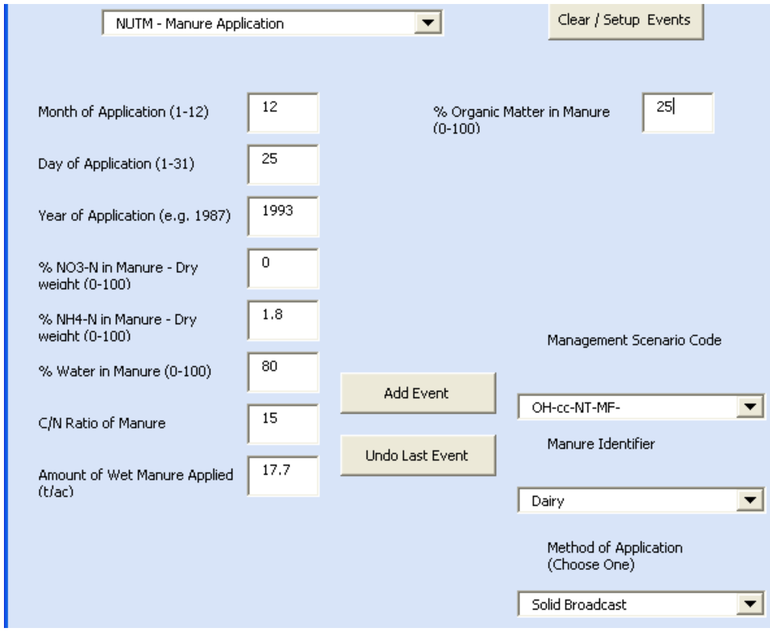

Figure 52

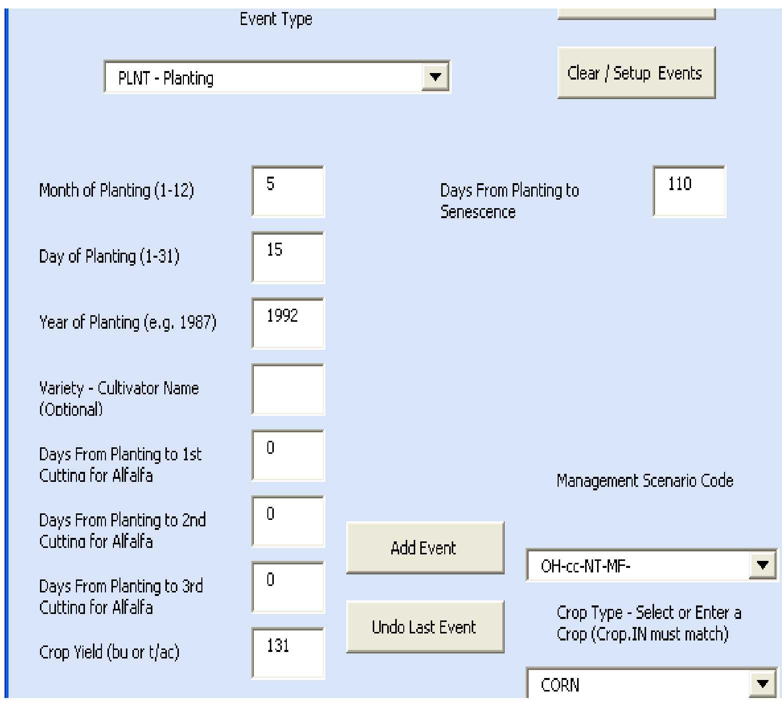

Figure 53

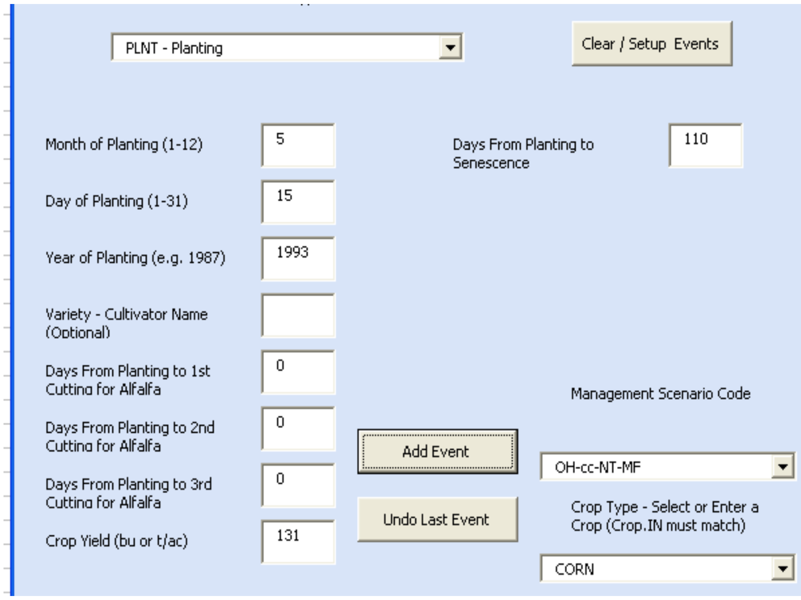

Figure 54

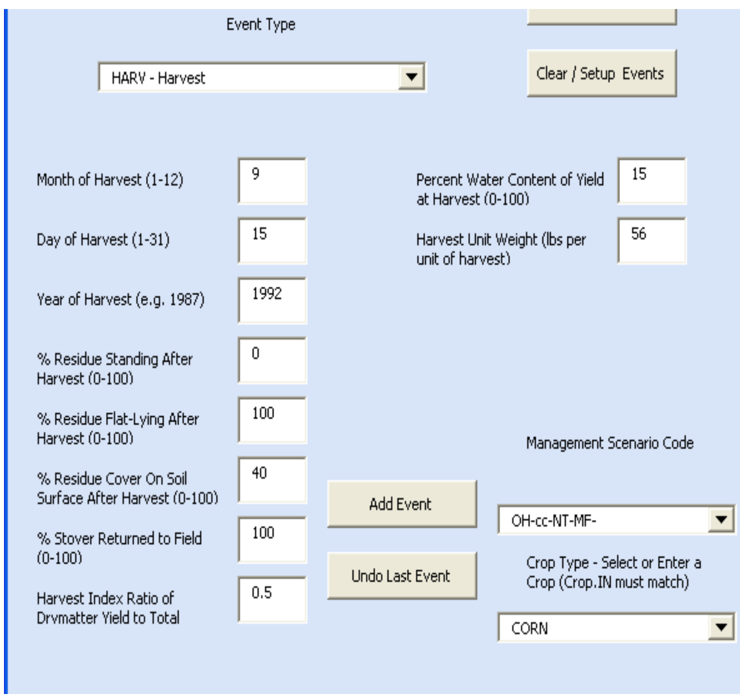

Figure 55

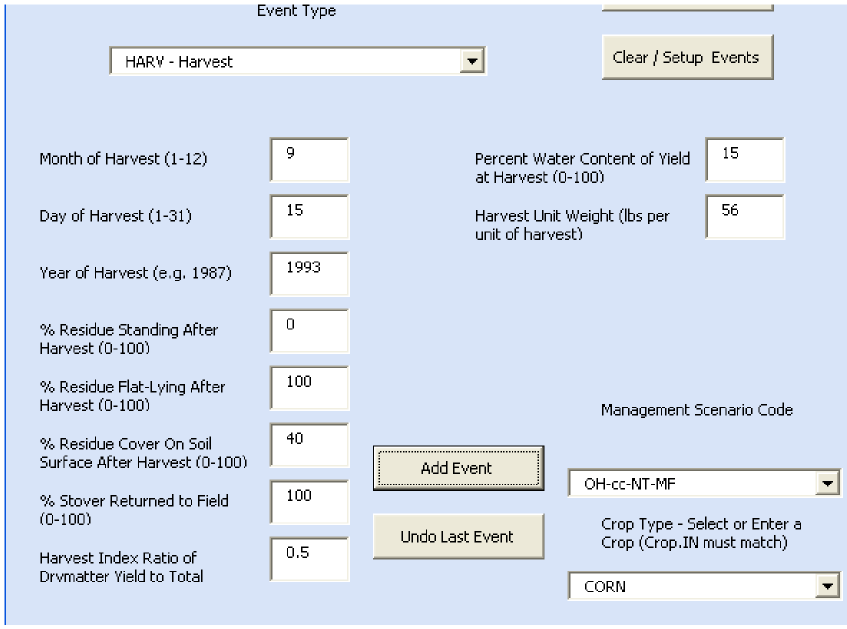

Figure 56

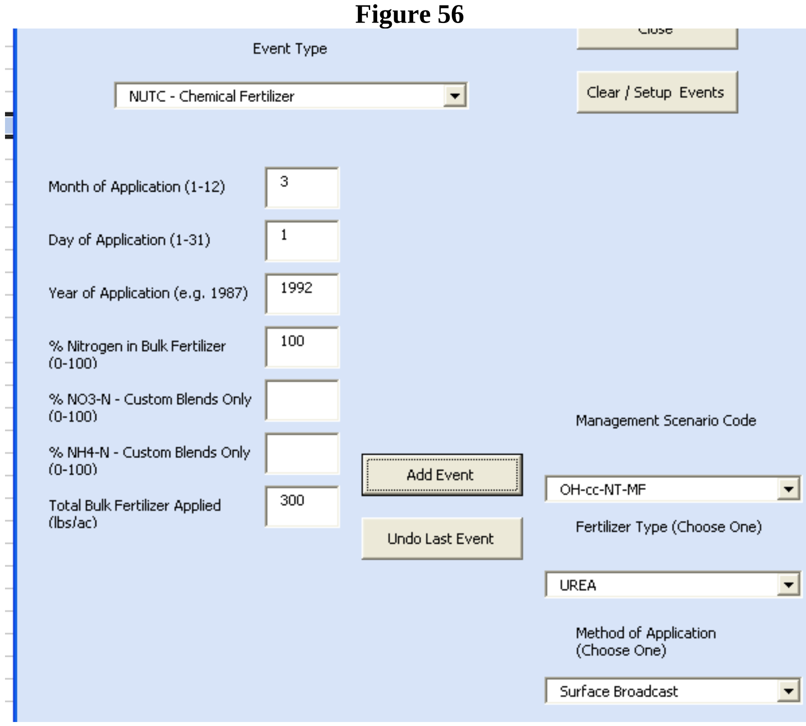

Figure 57

5.9 Constructing Management Codes

At this point, all of the tables of the NLEAP-GIS 4.2 Database are filled and CROP.IN contains valid information about the crops being used in our Events table. All that is left is to once again create a set of Manage Codes to express to NLEAP-GIS 4.2 what combination of scenarios and soils are to be simulated. For this example, we will compare both of our scenarios against the same soil. Create the Management Codes by selecting “Bono silty clay loam” and combine it with both of the scenarios so that you have two management codes (**Figures 59a and 59b**).

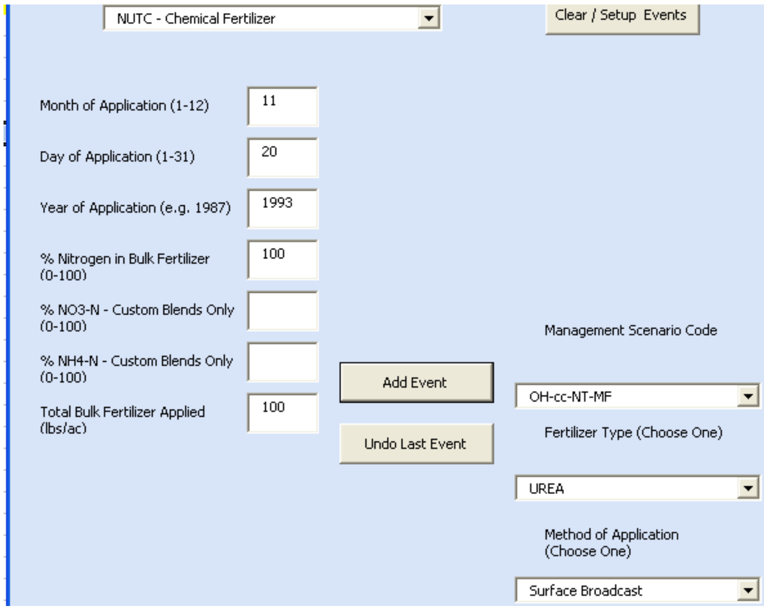

Figure 58

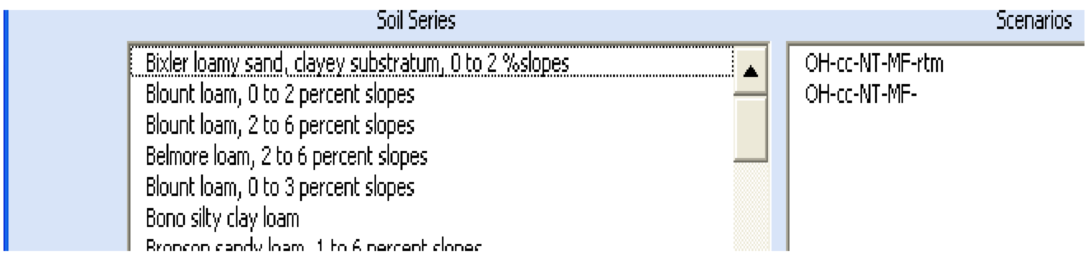

Figure 59a

Save the codes and set them as your Default NLEAP-GIS 4.2 Files, and run NLEAP by clicking on *Run NLEAP* in the *Driver*. A window will appear asking if you would like to overwrite the previous simulation. Click *Yes*. Click *Yes* again when the second window asks if you would like to import water output data. The output of NLEAP-GIS 4.2 is sent to SOILSYM_MONTH, and after a simulation, SOILSYM_MONTH should be inspected to ensure that NLEAP-GIS 4.2 ran correctly. Errors in an NLEAP-GIS 4.2 simulation are usually caused by an incorrect Events table, so you may want to check there if you run into difficulties with your simulation.

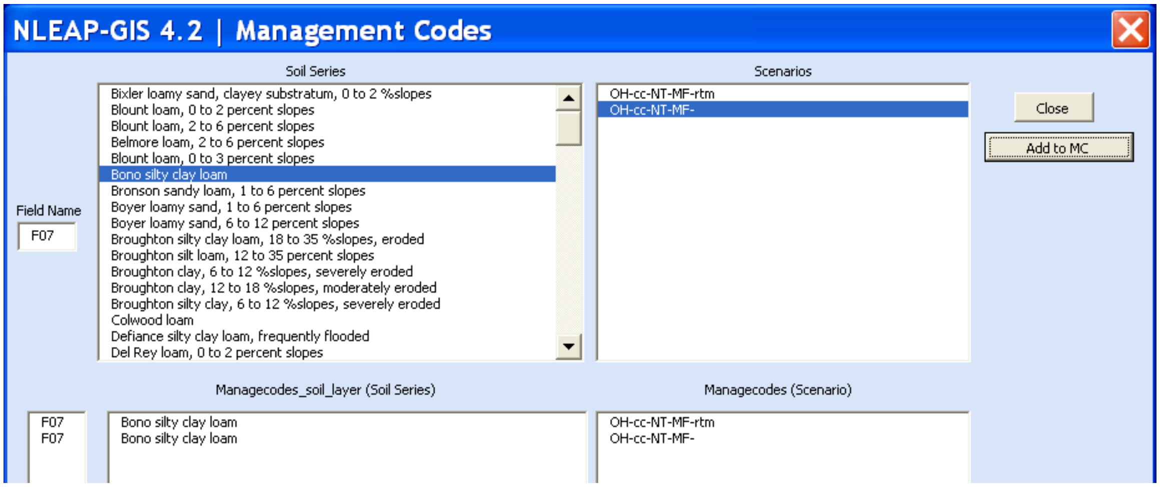

Figure 59b

Now that you have completed your own simulation, you can graph the data. The process for generating graphs is the same as it was when you created graphs for the example simulation in Section 4. If you would like the practice, generate a set of graphs by clicking on the tab named "Driver" and navigating back to the *Nitrogen Graphs* window (make graphs for N uptake, N_2O emissions, residual Soil NO_3-N and NO_3-N leaching by selecting the appropriate variables). You may also want to create a summary report.

6. GIS Capabilities

6.1 Introduction to Using GIS with NLEAP-GIS 4.2

It may be advantageous to return to this section after you have become more familiar and experienced with the NLEAP-GIS environment. If you haven't completely read through the previous sections or started using NLEAP-GIS yet, you can begin by opening NLEAP-GIS 4.2; note the central window that appears. This main window is called the *Driver*. Also note that there is a tab labeled *Driver* highlighted in white at the bottom of the screen, indicating that this is the window currently showing (If you cannot see the *Driver*, click on *Show Driver* button, the *Driver* window will appear.)

6.2 Setting up the GIS Run

All files needed to run the examples presented in this section have been provided for you, and were automatically installed in C:\NLEAP\Training_Data\GIS_manual when you installed NLEAP-GIS 4.2. This exercise will get you familiar with using GIS with NLEAP. Before we begin, *please note that the data used for the example in this guide is purely for instructional purposes and does* ***not*** *represent the actual nitrate leaching for the farms shown.*

The GIS files provided with NLEAP-GIS 4.2 have been provided just to serve as example files. It is assumed in this user guide that the users of NLEAP-GIS 4.2 know how to use GIS and know how to develop GIS files and manage GIS in the software they decide to use. The example files provided were developed using ArcMap™, but if desired, users can import the data from the example files to other GIS programs such as fGIS and MapInfo®, and use these other programs to communicate with NLEAP-GIS (See Section 1.1: Capabilities of NLEAP-GIS 4.2, see disclaimer on page 3, and review recommended references such as Delgado and Shaffer (2008)).

Our first task is to clear all default NLEAP files. When running NLEAP with a GIS program only an NLEAP DB and CROP.IN must be set; NLEAP-GIS will automatically create the correct management codes using the information imported from the GIS files, which contain the spatial information.

Click the *Set Up NLEAP Files* button from the main *Driver* window to access the *Set Up* window. If there are any previously set NLEAP files, click the *Remove* button adjacent to those files. (You can check by ensuring all of the boxes under NLEAP Default Files Status Files are red in the *Driver* window.)

NOTE 6.1

GIS Software

Being familiar with GIS software can be very helpful when using NLEAP-GIS. We recommend that you get additional training in GIS if you are planning to use GIS software to conduct assessments of the effects of best nitrogen management practices on nitrogen losses across the landscape.

1. In the *Set Up* window, click on the *Set NLEAP DB* button to navigate to the directory C:\NLEAP\Training_Data\Example_Run_3_GIS to choose the file "NLEAP_DB_Example_GIS_1.mdb" (**Fig. 60**). The scenarios we wish to simulate on these fields are in our example "NLEAP_DB_Example_GIS_1.mdb" database.

2. Then, click the *Set CROP.IN* button and navigate to the C:\NLEAP directory to select the provided "CROP.IN" file.
3. Your window should look like the one shown in **Figure 60**.
4. Do **not** click on the *Construct Management Codes* button. Please remember that when working with GIS the management codes will be imported from the GIS database. We will explain later in this section how to develop a GIS database with the management codes.

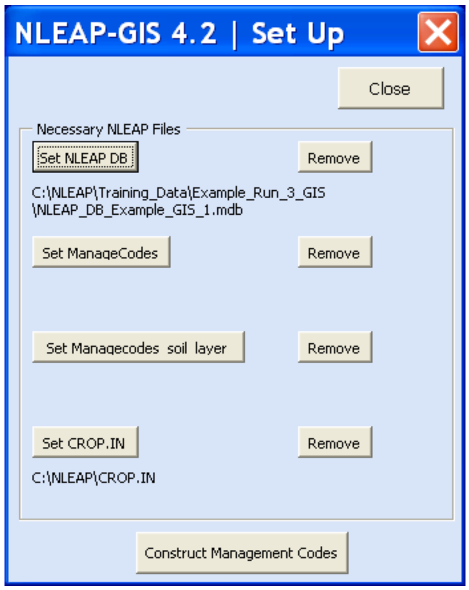

Figure 60

5. Select the *Close* button to return to the main *Driver* window. The NLEAP DB and CROP.IN boxes should be green now (**Fig. 61**).

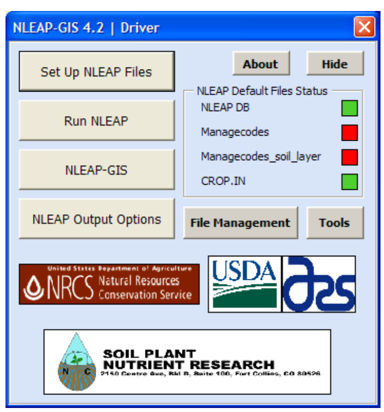

Figure 61

6.3 Running and Exporting NLEAP-GIS Outputs

1. The next step in NLEAP-GIS is to select the GIS file with the spatial

management information and soil information. Open the file “NLEAP_DB_Example_GIS_1.shp” using a GIS software. After locating and selecting the file “NLEAP_DB_Example_GIS_1.shp” in the C:\NLEAP\Training_Data\Example_Run_3_GIS directory, open the file (**Fig. 62**).

Before we go any further, let’s see if this file has any spatial information. In the GIS software you are using, open the attribute table. Since we have not added information to the table, the table should have zeros, but if it does have values, you can modify the data in the table and set all of the values in one of the columns as zeros. Check if the nitrate leaching column (labeled *NO3L*) is filled with (non-zero) values. If so, set all of the values in this column to zero. Later, when we export the NLEAP data to GIS, we will find that the *NO3L* column has populated with values. (If desired, you can clear the values for the columns of other variables as well; when we export the NLEAP data to GIS, you will notice that these columns have been populated with values as well.)

2. Now, if we want to see how the soil types are distributed spatially we could label the polygons by soil type (**Fig. 63**). To *Label Field* select the field *MUSYM*.

3. Now your screen should look like **Figure 63** (Note: The red box in the figure was added to the screenshot to indicate the area that you should zoom for the next step, so the red box shown in **Figure 63** will not be shown on your screen).

4. Now zoom to the six circles identified in the red box (**Fig. 63**). If you zoom to the six circles indicated in **Figure 63**, then your screen should look very close to **Figure 64**. When you zoom to these six circles you will see clearly the soil type variability across these six irrigated center pivots (**Fig. 64).**

5. Now without changing the zoom re-label the figure, but this time the selected six center irrigated pivots should be labeled with the short names used to describe the different management scenarios at these sites and your window should look very close to **Figure 65**.

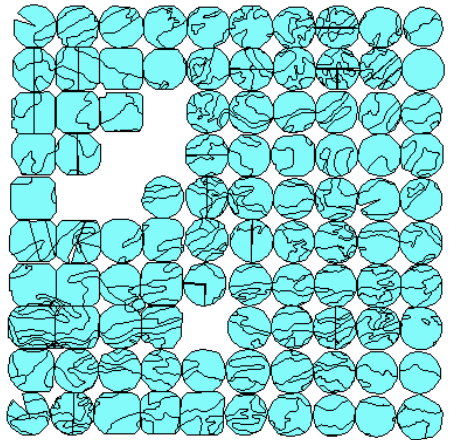

Figure 62

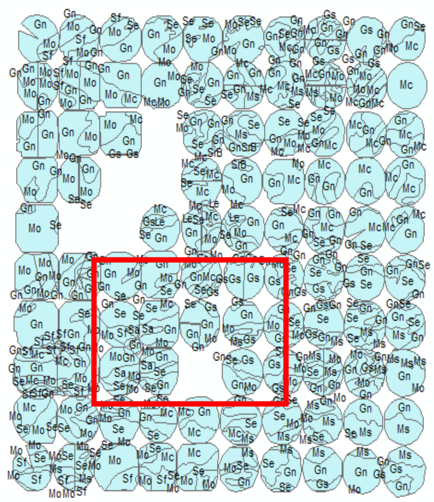

Figure 63

6. Let's return to NLEAP-GIS and locate the file we have just been working on in GIS. After we complete the NLEAP-GIS run, we will immediately check to see if the NLEAP-GIS outputs have been exported to the GIS software, so you'll want to have your software open.

7. Click on the *NLEAP-GIS* button in the *Driver* to access the *GIS* .

8. Note that the *Compute Calculations and Update GIS Data* button in the bottom of the screen is not available. If you click on it nothing will happen. You first must locate the GIS file with the database's information.

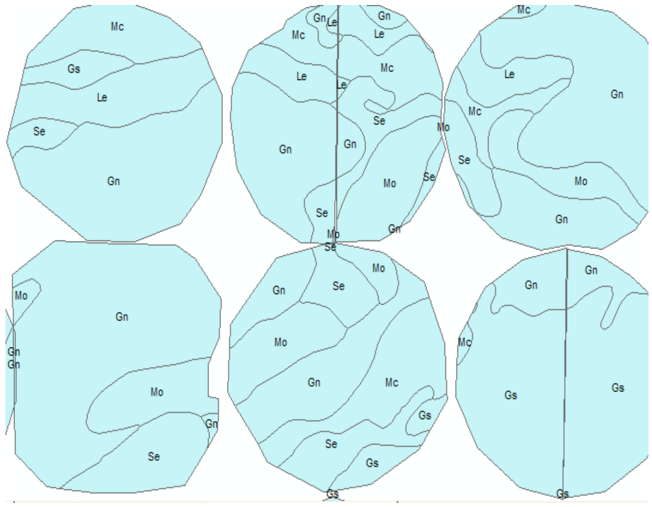

Figure 64

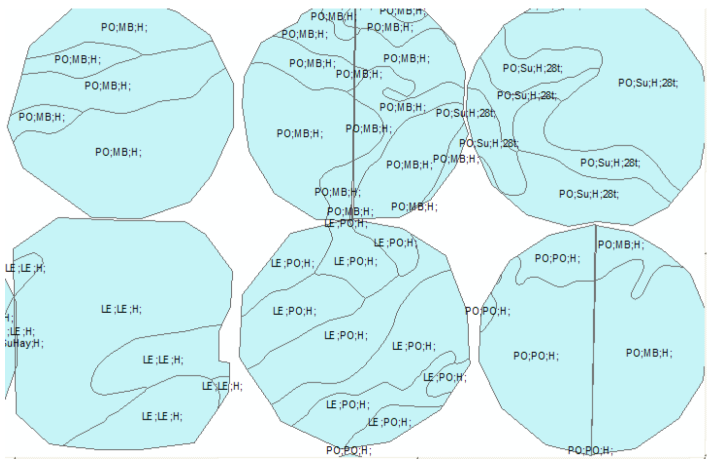

Figure 65

9. Click on the *Set GIS .DBF* button, navigate again to the C:\NLEAP\Training_Data\Example_Run_3_GIS and locate the .DBF file named “NLEAP_DB_Example_GIS_1.dbf” (**Fig. 66**). Click *Open*.
10. In NLEAP-GIS 4.2, click on the *Run NLEAP with GIS Data* button. By clicking on the button you will be submitting the spatial GIS database to be run by the driver. NLEAP-GIS will process all of the spatial combinations of management scenarios and the outputs will be quickly become available for export back to the GIS software.

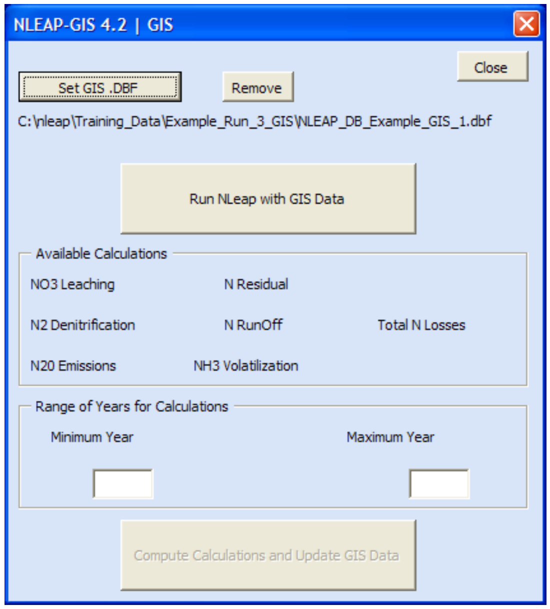

Figure 66

11. The simulation was conducted for 24 years. For this example, let's say that you want to export to the GIS software the average of the last 12 years from 1986 to 1997. You will enter 13 and 24 as the minimum and maximum year, respectively, to calculate the averages that will be exported to the GIS .dbf file. Set the range of years (inclusive) to be included in your calculations, and click on *Compute Calculations and Update GIS Data* (**Fig. 67**).

12. Important Note: Right after you click Compute Calculations and Update GIS Data, and while you see the NLEAP-GIS 4.2 message that says "Processing... Please wait," you may also see a message from Microsoft Access®. If you do, open the message and click on the Open button near the message, "Opening C:\nleap\user \BA_model_userdb.mdb" to complete the export of data to GIS fields

13. After you click *Compute Calculations and Update GIS Data*, if you want to keep a copy of the averages for years 13 to 24, use your GIS software to make a copy (for example, you could save it as something like, "NLEAP_DB_Example_GIS_y_13_24.dbf"). After you have made the copy with your GIS software, you could then go back to NLEAP-GIS 4.2 and export the simulation results for another period (for example, for years 1 to 24) (**Fig. 68**). You can save for as many periods as needed, even one file for each year, but once you move out of the NLEAP-4.2 GIS screen (**Fig. 67**), you will have to run the NLEAP-GIS program again in order to be able to export data to the GIS software you are using.

NOTE 6.3a

Exporting Data to GIS Software

Running the simulation should take NLEAP-GIS around four minutes, but may require more (or less) time depending on the computer you are using. Remember that NLEAP-GIS is doing a simulation across a 90 center irrigated pivots landscape with different soil types, about 100,000 acres that will be simulated for a time period of 24 years. Once processing is completed, green boxes will appear next to those files which have calculations available for export to the GIS software, according to the format of the .DBF file (**Fig. 67**).

At this point, all of the boxes should be green. If you have a red box (or boxes), this indicates that you have incorrectly constructed the GIS database. For example, if a column was not set correctly in the .DBF file, a red box may appear next to that value. This will help you to identify problems in labeling GIS database files. In the next section we will cover how to develop a GIS database with spatial soil and management information.

IMPORTANT: It is important that you immediately export your data to the selected GIS software. If you leave this screen without exporting the data, the data will be lost and you will have to run NLEAP-GIS again.

14. Now that you have exported the data to the GIS database file, go back to the GIS software and check that the data was exported to the GIS database.

15. Now that you have verified that the NLEAP-GIS simulations were exported to the GIS file and the columns are filled up with the simulation values from NLEAP-GIS, you can assess the effect of management on N losses across the landscape. Let's see how this data looks spatially across the landscape in GIS.

a. Using a GIS label the figure with *NO3L* (average nitrate leaching from 1987 to 1997) (**Fig. 69**).

16. Now zoom out so you can assess the variability across the selected region (**Fig. 70**).

17. Sometimes when we look at the spatial simulation, it is difficult to assess where the farms are located if we don't have reference points. When you download the county NRCS spatial databases, you can also download the ortho imagery, which will help you to identify farms, bodies of water, roads, cities, and other landmarks in the region. Using your GIS software Navigate to C:\NLEAP\Training_Data\Example_Run_3_GIS\ ortho_imagery_CO

and select the file named “ortho1-1_co003.sid” (**Fig. 70**).

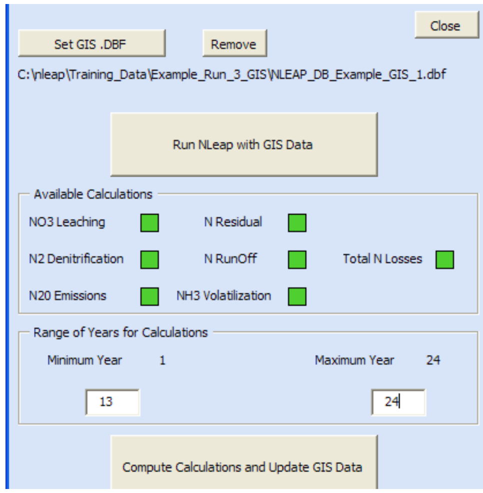

Figure 67

Figure 68

NOTE 6.3b

Maximum Number of Combinations for Simulations

We have not tested for the maximum number of possible combinations that NLEAP-GIS can run. For an annual simulation there should not be any problems doing 5000 + of annual simulations. Users could check the maximum number for their system

18. You can also use your GIS software to quickly generate reports and graphics that can be used to conduct studies, evaluate best management practices, give presentations, or to talk to farmers about what is happening in the area.
19. You could add a *Legend, a North Arrow and/or a Scale Bar*.

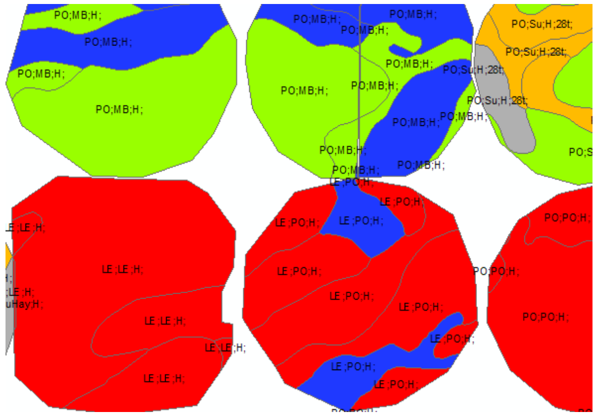

Figure 69

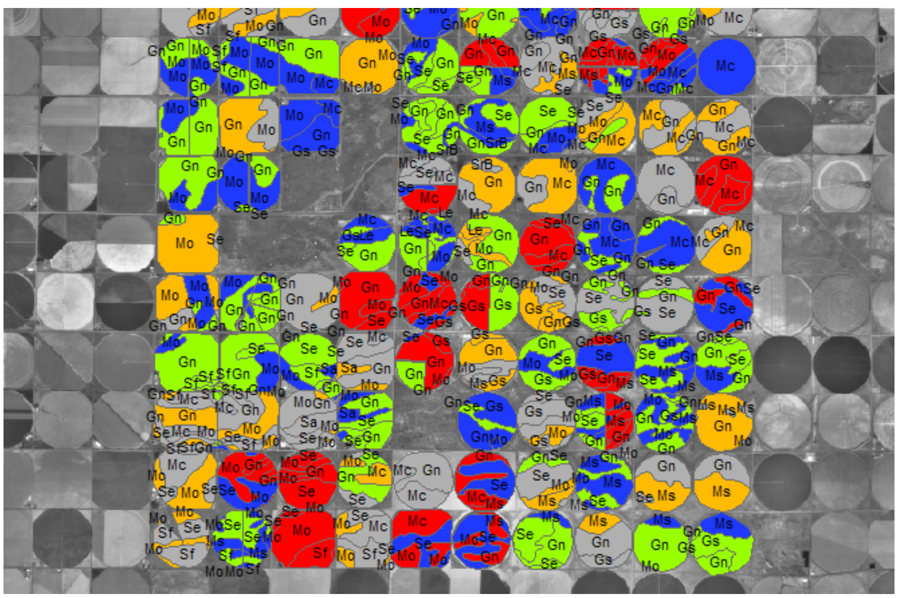

Figure 70

20. Note: You could use your GIS software's *Find and Replace* functions (in your GIS software, it may be called *Find and Replace*, *Search and Replace*, or go by another name) to find H; and replace with L; to quickly generate GIS output scenarios visually in GIS. You will have to use NLEAP-GIS 4.2 to run the low input scenarios and export them to the new GIS file with low (L;) input management scenarios.

NOTE 6.3c
Scenario Abbreviations and Data

If you take a close look at **Figure 69**, you will notice that under the SCENARIO column, the scenarios have been labeled with different abbreviations, such as PO, M, and H. For this specific scenario, PO stands for potato, MB stands for malting barley, and H stands for high N fertilizer inputs.

If an irrigated center pivot, half field, or quarter field is labeled like this, then the crop rotation at the site is a potato-malting barley rotation with high N inputs. Remember that this rotation and scenario was developed for a 24-year period and it can be found in the Events table in the database file Example_GIS_1.db. The GIS database just contains the *spatial* information about the rotation and the type of soil. The information about the soil type, weather, and management across 24 years is held in the Example_GIS_1.db. file. NLEAP-GIS 4.2 connects these two sources of information, runs the simulations, and exports the results back to the GIS software so that you can present the data visually.

6.4 Creating a GIS file from Scratch to Conduct a Tier 2 Assessment of N Management Across the Landscape

To create a new GIS file from scratch to assess the effects of management practices across the landscape, you will need to create a GIS file with database information about the spatial location of your field, different soil types across the field and management scenarios to be evaluated across the fields. For this you will need to create field boundaries or upload established field boundaries from previously developed files. Additionally, you will need to enter the management scenario to be tested across the farm (**Fig. 71**) and add spatial information from the USDA NRCS soil files that are downloaded from the website.

There are several ways you can construct a GIS file to be used by NLEAP-GIS. The approach that we recommended in this guide is to first develop a file that includes the field boundaries so the farm can be located in space. The next step of this approach is to merge the GIS file with field boundaries with the NRCS file containing the spatial soil information at the farm site (**Fig. 71**). You will need to enter the management scenarios to be evaluated across the different fields. Finally, you will need to format the file with the columns needed to receive the outputs from NLEAP-GIS.

These spatial sets of information (field boundary, management scenario and soil type) will be exported to NLEAP-GIS (**Fig. 71**). NLEAP-GIS will use this information to develop the needed scenario management codes and soil management code files to run

NLEAP. Then, these scenario management codes and soil management codes, together with the CROP.IN file and the database containing the weather, event and soil type tables, will be used to conduct the simulations. The output from the simulations will be exported back to the GIS spatial file (**Figs. 71; 72**).

Delgado and Shaffer (2008) discussed the advantages and limitations of NLEAP-GIS. As a Tier 2 tool, the NLEAP-GIS provides advantages that can be used to quickly assess the effects of nitrogen management practice across the landscape (Delgado and Shaffer 2008). ***However, users need to be aware that this Tier 2 model does not transfer mass nitrogen or water inputs or outputs from polygon to polygon; the model just quickly assesses each polygon as a point simulation, keeping track of the spatial location of these polygons across the landscape.***

In cases where runoff can be a major source of variation, users should be aware of this limitation. The model does calculate runoff from each polygon, but again, the N and water mass are not transferred to the adjacent polygons, and neither possible accumulation at the lower areas of the field. A user could potentially divide field areas by sections and conduct simulations across these areas if there is a measurement of the mass transfer that the lower areas are receiving at a given point. The model also can estimate the effects of tile flows at a given polygon; however, tile mass flows are also not passed from polygon to polygon across the landscape. Even with these limitations, the model has been able to simulate and assess nitrogen management across a large number of national and international sites (Delgado and Shaffer 2008).

Remember that when entering the management scenarios spatially across the fields, the user must match these management scenarios with those that already exist in the Events table (e.g. “NLEAP_DB_Example_GIS_1.dbf”). The Events table is the database that has information about the planting, harvesting, irrigation, fertilization and other events. The user must enter exactly the same name for the scenario when entering the GIS label spatially (e.g. “NLEAP_DB_Example_GIS_1.shp”) in a given field to match a given scenario in the database (e.g. “NLEAP_DB_Example_GIS_1.dbf”) (**Figs. 71; 72**). This will allow you to do the NLEAP-GIS simulations to find the needed information about the events at a given site over the long term, for example 24 years (**Figs. 71, 72**).

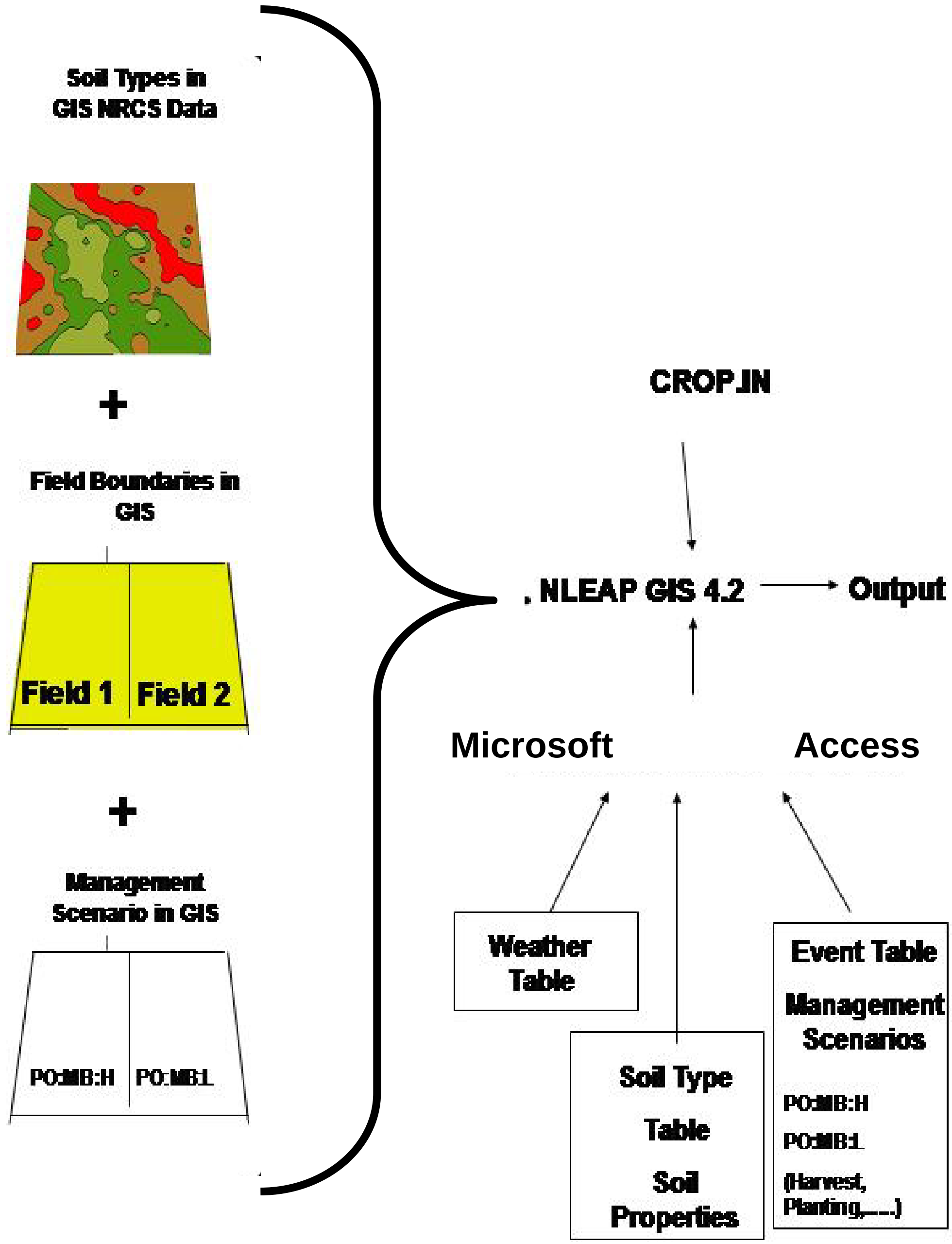

Figure 71

If you have GIS files that have field boundaries available you could use those to merge with the NRCS databases. This will speed up the development of the GIS file with the spatial information.

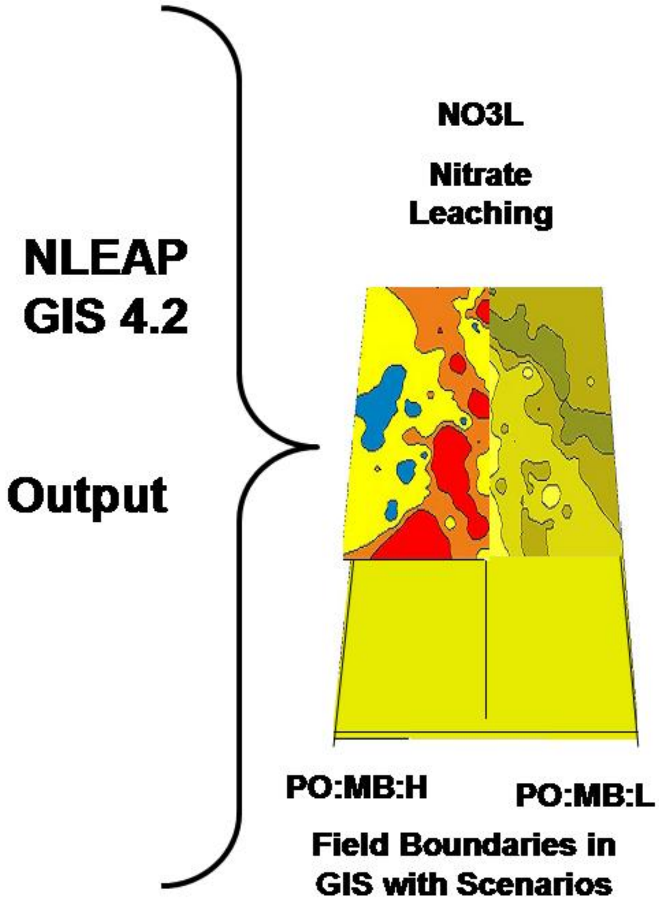

Figure 72

1. Let's begin developing the GIS file from scratch. Use GIS software to locate C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\ortho_imagery. After navigating the directory, select the file named "ortho1-1_1n_s_ar031_2006.sid" and open (**Fig. 73**).
2. When you download the NRCS soil database along with the ortho file that you download, you also download a file about the county. Looking for the *.*shp* file that has the county border named "soilsa_a_ar031.shp". Navigate to C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\soil_ar031\soil_ar031\spatial, select the "soilsa_a_ar031.shp" file, and open (**Fig. 74**). When finished, your main window should look like **Figure 74**.

Figure 73

Figure 74

3. Before we continue working with this NRCS county file and alter it to show the farm boundaries, make a copy to keep the original file intact.

4. To locate the file named *"soilsa_a_ar031.shp"* Navigate to the directory C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\soil_ar031\soil_ar031\spatial. Copy the file to a useful place that you can work, navigate to C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\Boundary and save the new copy with the name *"boundary_soilsa_a_ar031.shp"* on this directory.

5. We want to be able to see the outline of the boundary file and also the image of the ortho file. Take the necessary steps in your software to have your image similar to **Figure 75**.

6. Save *boundary_soilsa_a_ar031.shp* as a layer: Be sure that you are saving the layer in C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\Boundary.

7. From the boundary line you have created, you can see that Craighead County in Arkansas covers a large area. It would be difficult to quickly find a given field in this landscape unless you knew the specific location or you were familiar with the site. To help you create the boundary for some experimental field plots located at Arkansas State University, we added a file that will point you there. Use your software to open "AR_Guide_boundary_.shp.xml" by navigating to C:\nleap\Training_Data\Example_Run_4_GIS\AR\Boundary.

8. Within your GIS software, be sure that the *Fill* and *Outline Color* selected are red, and increase the *outline width* for "AR_Guide_boundary_.shp.xml". With your GIS software, *Zoom to Layer* "AR_Guide_boundary_.shp.xml" and the GIS software will take you to the fields. You can see that now there are markers over four fields that you will have to develop boundaries for. Your map window should now look like **Figure 76**.

9. These fields are located at the University of Arkansas in Jonesboro. We are going to use the fields to conduct a simulation from scratch. With your software make the outline for these fields (**Fig. 77**). Be sure that you select "boundary_soilsa_a_ar031.shp*"* as the target file to edit (**Fig. 77**).

10. Now the next step will be to enter the management scenarios into the "boundary_soilsa_a_ar031.shp" file. Using your GIS software add the field *SCENARIO*, as a TEXT format.

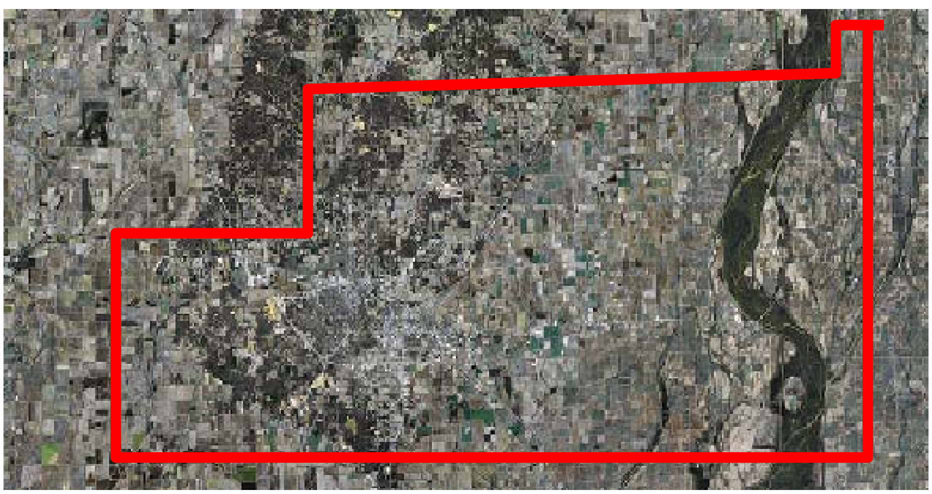

Figure 75

11. Label the polygons that you just created (**Fig. 77**). For this you will enter the first polygon as CSoy;H; the second polygon as CC;H; the third polygon as CSoy;L; and the fourth polygon as CC;L; (**Fig. 78**).

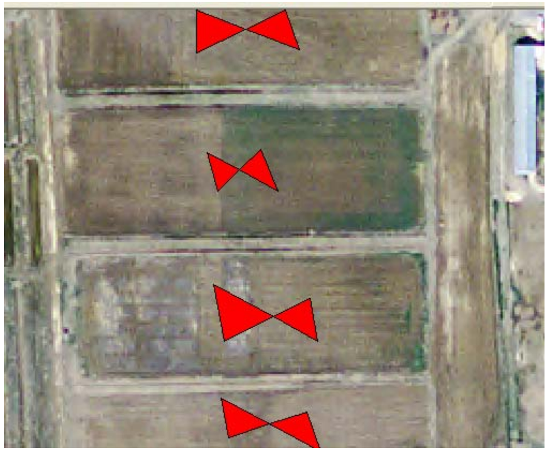

Figure 76

Figure 77

12. Using your GIS software find the first row of the attribute table and delete the row labeled with LKEY =1502. By deleting this line, you are delegating the county line.

13. Right-click on *boundary_soilsa_a_ar031.shp* the data should be clean of not usefull fields. Select the file *boundary_soilsa_a_ar031* Delete AREASYMBOL, SPAIALVER and LKEY.

14. Now that you have constructed the boundary and added the scenarios to the correct field you will need to intercept the file with the NRCS soil spatial information. Using yoru GIS software you need to merge the file *boundary_soilsa_a_ar031.shp* with the soil NRSC file. To open the file "*soilmu_a_ar031.shp"* navigate to the directory C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\soil_ar031\soil_ar031\spatial. Create a new file *soil_field_boundary_intercept* (**Fig. 79**).

Figure 78

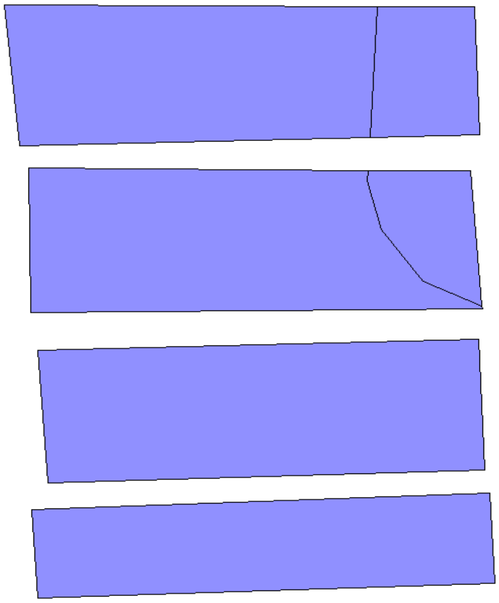

Figure 79

15. Label the polygons by soil type on (**Fig. 80**).

16. Format the new file *soil_field_boundary_intercept* with the right columns that will receive the NLEAP-GIS outputs. To format the file, add the following numeric fields: NO3L, RSN, N2D, N2OE, NRUNO, NH3V and TNL.The abbreviations we are using as the field labels stand for the following:

i. NO3L ➔ Nitrate Leaching

ii. RSN ➔ Residual Soil Nitrate

iii. N2D ➔ Denitrification

iv. N2OE ➔ Nitrous Oxide Emissions

v. NRUNO ➔ Nitrogen Surface Runoff

vi. NH3V ➔ Ammonia Volatilization

vii. TNL ➔ Total Nitrogen Losses

Figure 80

17. Leave the file *soil_field_boundary_intercept* open. We are now going to run the NLEAP-GIS simulation that was created from scratch, and after we complete the NLEAP GIS run, we will return immediately to your GIS software to check the exported NLEAP GIS outputs to the just-created GIS fields. Now, go to the NLEAP-GIS 4.2 *Driver* window.

18. Click the *Set Up NLEAPFiles* button from the main *Driver* window to go to the *Set Up* window.

19. When the new *Set Up* window appears, click on the *Set NLEAP DB* button to navigate to the directory C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\NLEAP_DB to choose the file “Example_GIS__boundary_intercept.mdb”.

20. Then, click the *Set CROP.IN* button and navigate to the C:\NLEAP directory to select the provided CROP.IN (**Fig. 81**).

21. Do **not** click on the *Construct Management Codes* button. Be sure that if any files are selected for the *Construct Management Codes* you click on the *Remove* button. Recall that when working with GIS the management codes will be imported from the GIS database.

22. You just created from scratch a file that has the spatial location of the management scenarios and soil types. This information will be passed on to NLEAP-GIS and the model will do the run. Remember that for our example, we are just running a few simple combinations. Select the *Close* button to return to the main *Driver* window.

23. Click on the *NLEAP-GIS* button and the *GIS* window will show up.

24. Click on the *Set GIS DBF* button and navigate to C:\NLEAP\Training_Data\Example_Run_4_GIS\AR\Boundary to find the file *soil_field_boundary_intercept.dbf* . When selected, click *Open*. and your NLEAP-GIS screen should look like **Figure 82**. Click on the *Run NLEAP with GIS Data* button.

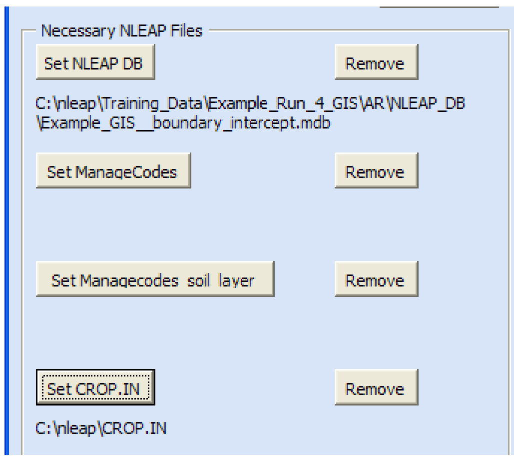

Figure 81

25. After the run is finished your screen should look like **Figure 83.** Once processing is completed, the green boxes appear next to those calculations which are available for export as .DBF files (**Fig. 83**).

26. Export to the GIS software the average of the first 4 years from 1974 to 1978. Enter 1 and 4 for the minimum and maximum year to calculate the averages that will be exported to the GIS .dbf file **(Fig. 83**). Click *Compute Calculations and Update GIS Data* to export the data. You will see a new tab appear in NLEAP called “tempGISdata” (the data in this spreadsheet are the unique combinations that are sent to GIS). You do not need to do anything with this spreadsheet.

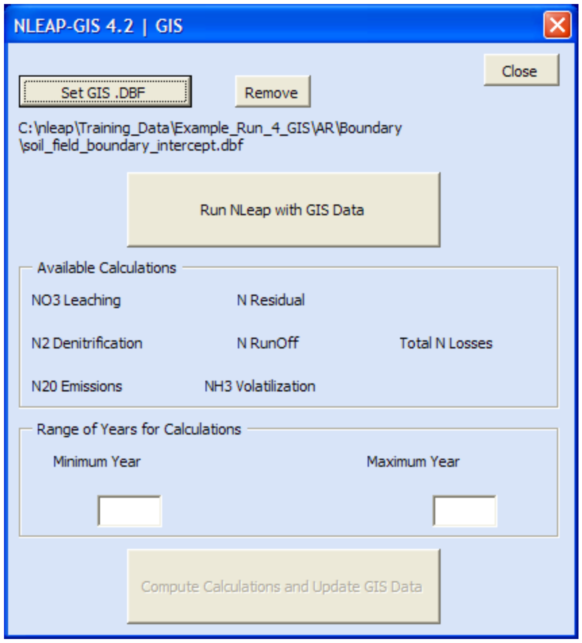

Fig. 82

27. Now go back to the GIS software and check in the attribute table that the data was exported to the GIS database. You have just verified that the NLEAP-GIS simulations were exported to the GIS file that you just created from scratch. To see how this data looks spatially across the landscape in GIS for this file that you just created, for the "soil_field_boundary_intercept" label with *NO3L* (Average Nitrate Leaching from 1987 to 1997) (**Fig. 84**). Use your GIS software to select a set of colors to label as you see fit to label the variable shown spatially *NO3L* (**Fig. 84**). .

7. Summary

7.1 Skills Learned in this Guide

Chapters 1-6 of this guide gave you a basic introduction to the new NLEAP-GIS 4.2 model. If you completed these chapters, you have been familiarized with the basic capabilities of NLEAP and the flow of information (**Chapter 1.0: Introduction**), how to install the program, and what the system requirements are (**Chapter 2.0: Installing NLEAP-GIS 4.2**). You have worked through examples that helped you become acquainted with the software **(Chapter 3.0: Simulating a Simple Example).** With these examples you were able to navigate across the different windows to see some of the capabilities of the software. Additionally, you learned how to visually display the outputs generated by NLEAP **(Chapter 4.0: Analyzing NLEAP-GIS 4.2 Outputs).** This guide also led you through the steps of creating a simulation from scratch, and you learned where to download regional soil data (and how to format the data for use with NLEAP) as well as where to download weather data **(Chapter 5.0: Creating a Simulation from Scratch).**

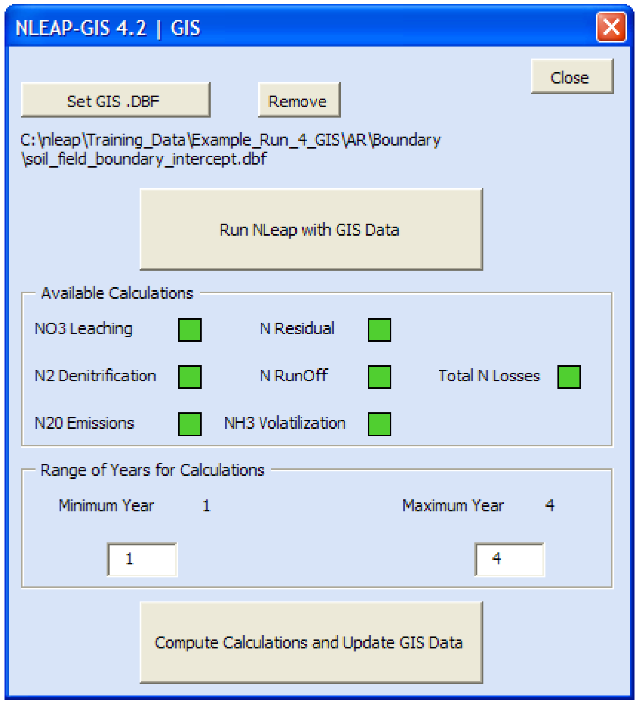

Figure 83

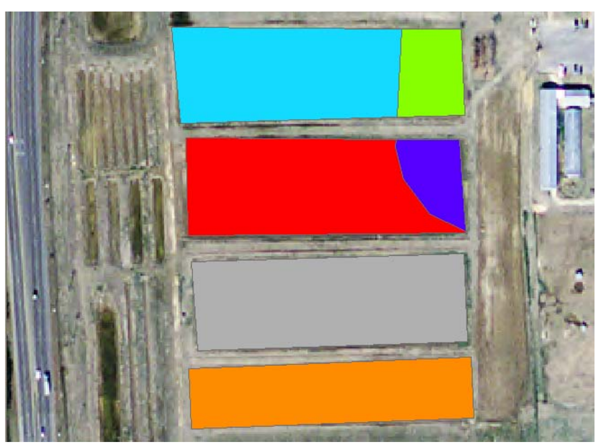

Figure 84

Finally, this user guide walked you through basic GIS applications to identify risky landscape cropping system combinations. You learned that you can quickly use GIS and NLEAP software and you were shown the advantages of using such a quick tool to assess management across large areas. Once these files are set they can quickly be used over and over with new management scenarios. These GIS examples provided you with some basic scenarios to show how you can readily identify those areas with higher potential for reactive losses. You also learned how to develop GIS applications from scratch **(Chapter 6.0: GIS Capabilities).**

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9 Appendixes

9.1 NLEAP-GIS File Management

From the *File Management* window you can access several useful functions, such as importing and exporting data and saving and opening files. In the *Driver* window, click on the *File Management* button to get to the *File Management* window. Here you can save data, create events, and set up a new database (**Fig. 85**).

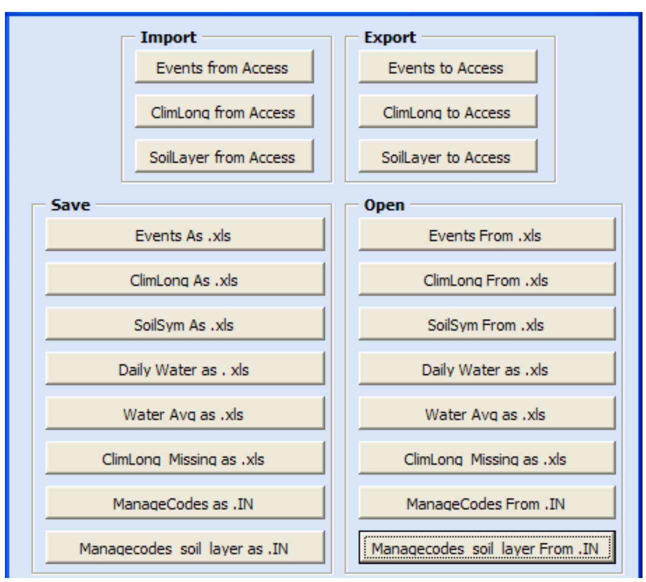


Figure 85

9.1.1 File Management: Import Tools

If you click on any of the *Import* options, you can navigate to select the database file that you want to use to import the events, climate or soil layer information (**Fig. 85**).

The *File Management* tools to import from and export to the database files facilitate editing. You can take advantage to all the functions to quickly generate hundreds of scenarios and to quickly export those scenarios to the database file that can then be used to conduct management analysis and/or GIS analyses across the landscape. Following is a brief description of each of the *Import* tools:

Import Events from Access – This function will import the Events table from the selected database. The data will replace the data present in the current Events.

Import ClimLong from Access – This function will import the ClimLong table from the selected database. The data will replace the data present in the current ClimLong tab.

Import SoilLayer from Access – This function will import the SoilLayer table from the selected database. The data will replace the data present in the current SoilLayer tab.

9.1.2 File Management: Export Tools

If you click on any of the export options, you will be asked, *Would you like to use your default NLEAP DB*?. If you answer *No*, you will have to navigate to find the desired database file. If you answer *Yes*, it will automatically export the information to the selected NLEAP DB. Be sure that if you answer *Yes* you have selected the NLEAP DB; otherwise, you may rewrite information over a file that you don't want to edit. We recommend that you always create a backup of your databases before you start working with NLEAP-GIS.

Following is a brief description of each of the *Export* tools:

Export Events to database – This function will export the current data within the Events tab to the specified database. The exported data will replace the Events table in the database.

Export ClimLong to Access – This function will export the current data within the ClimLong tab to the specified database. The exported data will replace the

ClimLong table in the database.

Export SoilLayer to Access – This function will export the current data within the SoilLayer tab to the specified database. The exported data will replace the SoilLayer table in the database.

9.1.3 File Management: Save Tools

The eight *Save* buttons in the *File Management* window save the data from the tabs to any location. Events, ClimLong, SoilSym, Daily Water, Water Avg and ClimLong Missing are saved as ".xls" Sheets, while ManageCodes and Managecodes soil layer are saved as ".IN" text files. NLEAP-GIS 4.2 Default Files can be selected for the Manage Codes instead of creating Manage Codes through *Construct ManageCodes*. Saving Events, ClimLong, or SoilSym data simply allows that data to be opened for further editing or analysis. *Saving data with these tools does not affect the NLEAP-GIS 4.2 database.*

9.1.4 File Management: Open Tools

The eight *Open* buttons in the *File Management* window simply open any previously saved data into the appropriate tabs for further editing or analysis. *Only files saved correctly through the Save buttons/tools can be opened.*

9.2 NLEAP-GIS Tools: Incomplete Clim Finder

The *Incomplete Clim Finder* tool opens the *Incomplete Climate Finder* window, which analyzes the data in your current ClimLong table. If this tool finds that some of the climate data contain incomplete days or weeks, it will find those dates that are missing in your data and will generate a table or spreadsheet of dates that are missing. ***Any climate date with a maximum temperature equal to zero and a minimum temperature equal to zero is assumed to be missing*** by *Incomplete Clim Finder*. Thus, the tool also assumes that if there are maximum and minimum data reported, the climate is accurate. Users are responsible for double checking and editing the climate data if necessary for missing values. To minimize the amount of data editing, we recommend that you download data from official sites that provide archived edited data.

Official sites that provide archived daily data such as the ftp NRCS site can be used. Some of these official sites will still have missing data, perhaps because the equipment was not working during the missing period or because there were no personnel collecting the data during a given missing period. The *Incomplete Clim Finder* can help you find missing data in large data sets.

9.2.1 Introduction to Incomplete Climate Finder (*Incomplete Clim Finder*)

To conduct an analysis of your incomplete climate, you will need to click on the *Incomplete Clim Finder* button to open the *Incomplete Climate Finder* window (**Fig. 86**).

Once you have done this, go back to the *Set Up* window, navigate to the directory C:\NLEAP\Training_Data\Incomplete_Climate, select the file named "NLEAP_DB_Example_Inccomplete_Climate.mdb" and set it as your NLEAP DB. Now reopen the *Incomplete Climate Finder* window and click on the *Conduct Search* button. The ClimLong table in the "NLEAP_DB_Example_Incomplete_Climate.mdb" file is missing 120 data entries during the period from 1974 to 1997 (**Fig. 87**). The *Incomplete Climate Finder* brings the data to the newly created spreadsheet named CLIMLONG_MISSING. Note the new tab "CLIMLONG_MISSING" that appears at the bottom of the screen and the missing data in the spreadsheet (120 incomplete data).

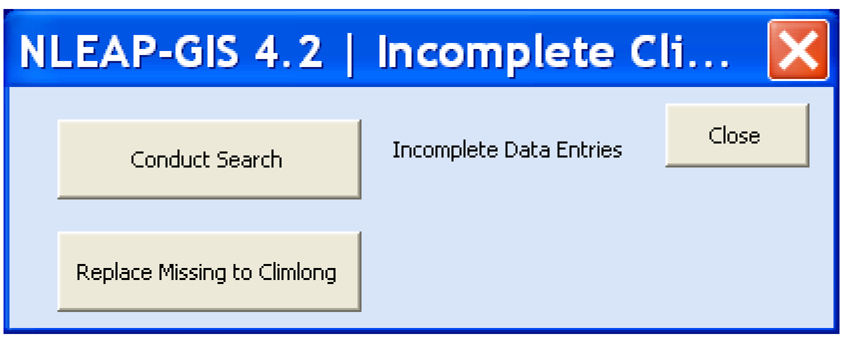


Figure 86

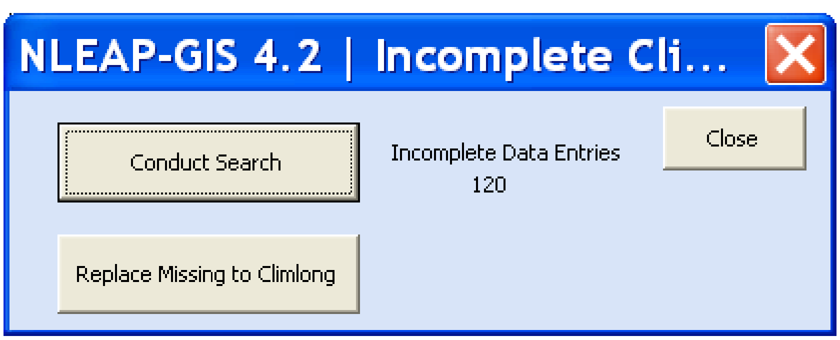


Figure 87

You can now go to the *File Management* window and save the file using the button *ClimLong Missing as .xls* to keep a record of the missing data. Remember that you will need to decide for yourself how to fill the missing climate information. Just as an example on how to do this, let's fill in some missing climate data in the CLIMLONG_MISSING spreadsheet now. Let's say that the maximum and minimum temperature were 77 and 35 ^{o}F, respectively and that the pan evaporation and pan coefficient were 0.2893 and 0.800, respectively for June 3, 1974. After you have entered these values in the appropriate columns, go back to the *Incomplete Climate Finder* window and click on the *Replace Missing to Climlong* button. Conduct a search of missing data again by clicking on the *Conduct Search* button. Notice that now there are only 119 incomplete data entries and that June 3, 1974 is not listed as a date with missing climate data.

This example was pretty simple, but you also have the option to edit all of the 120 dates with missing data and save the changes all at once. Of course, we recommend that as you edit the dates you periodically save the ClimLong_Missing spreadsheet, so that if you encounter a computer glitch you don't lose your edits before you replace the missing data with the correct and edited data. Remember that once you have corrected the missing data, you still have not saved the edits permanently into the Microsoft Access ClimLong table. To save these edits permanently into the Microsoft Access table you will have to export the CLIMLONG data to the given Microsoft Access file.

Once you have edited all of the data and clicked *Conduct Search*, an announcement that there were no climate data missing and the ClimLong spreadsheet should be empty. Return to the *Incomplete Climate Finder* window and click on the *Conduct Search* button. If there are no missing data a window will appear letting you know that the data set is complete and without missing data (**Fig. 88**). You will see a report of zero incomplete data entries in the *Incomplete Climate Finder* window (**Fig. 89**).

Figure 88

9.3 NLEAP-GIS Tools: Weather Station Information and High Climate Extractor (HCE)

The *Weather Station Info (HCE)* tool opens the *Weather Station Info* window

(**Fig. 90**). You can use this tool to find the code of a given weather station. By clicking on the *Weather Station Info (HCE)* button, you will get access to the list of weather stations that were used to complete the NRCS weather serial edited data. If you are interested in more information about the NRCS serial climate data, we recommend that you review Eischeid et al. 2000; Daly et al. 2008; and DiLuzio et al. 2008.

The information available in the *Weather Station Info* window can be very helpful. For example, in this window you can search for the weather station code, and then go to the archived climate data available at websites such as the official NRCS ftp site that we describe in Section 5.4 of this guide (ftp://ftp.wcc.nrcs.usda.gov/support/climate/daily-data/). You could use the *Weather Station Info* window to find the code for a listed weather station, go to the NRCS ftp site, and download and convert the data to NLEAP format. You need to be aware that the list of stations in the *Weather Station Info* window only includes the weather stations that were used to develop the NRCS serial complete data (Eischeid et al. 2000; Daly et al. 2008; Luzio et al. 2008).

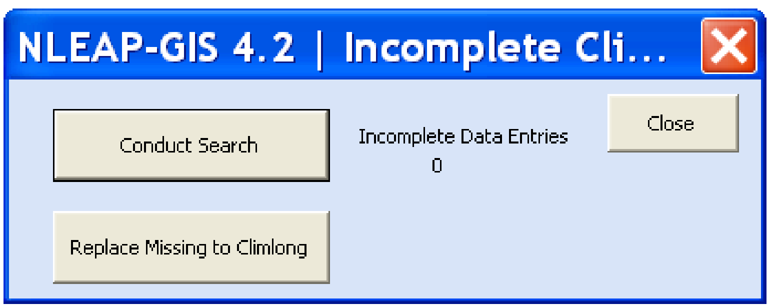


Figure 89

This user-friendly weather station code finder can help you quickly search across the data based on different weather stations located across the continental USA. For example, to find the code for the weather station of *DES MOINES SE 14th ST*, you simply would use the dropdown menu to search for the state, in this case Iowa (**Fig. 91**). Once the state is identified, a second dropdown menu can be used to locate any weather station within the state (in this case *DES MOINES SE 14th ST*) from an alphabetized list (**Fig. 92**). The corresponding data for *DES MOINES SE 14th ST* will automatically appear just below the two dropdown menus in the window (**Fig. 93**).

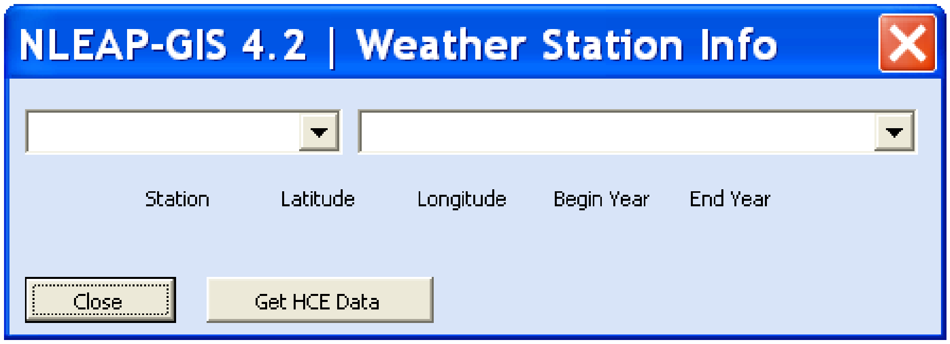


Figure 90

The *Weather Station Info* window can thus tell you the period for which the climate data is available (Begin Year and End Year). Additionally, this weather station code finder also provides the latitude and longitude for each weather station (Eischeid et al. 2000; Daly et al. 2008; DiLuzio et al. 2008) (**Fig. 93**).

You can also click on the *Get HCE Data* button; doing so will bring you to the High Climate Extractor webpage. This site is in development currently, but in the next section we will describe how to obtain data from the HCE prototype. Eventually users will be available to navigate to this website and download climate data that can be used to run NLEAP-GIS.

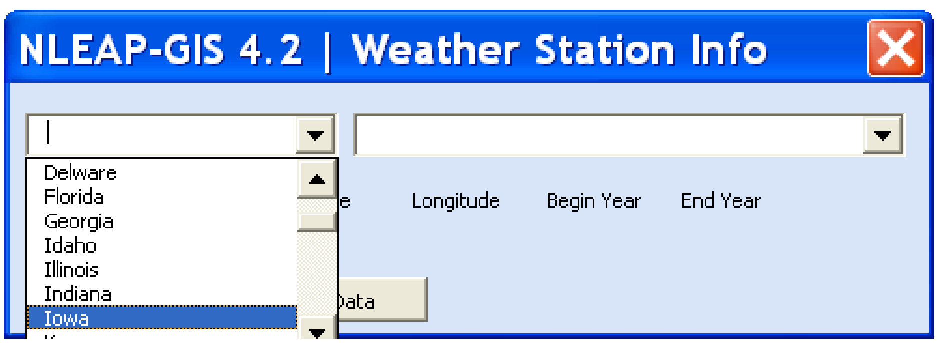


Figure 91

9.3.1 Get High-Resolution Climate Extractor (HCE) Data

NRCS is currently developing a website that will include access to the NRCS High-resolution Climate Extractor (HCE) data set. The HCE for weather stations provides climate data that have already been edited and will not have missing data (for information on how this weather station data set from the HCE was edited, review Eischeid et al. 2000; Daly et al. 2008; and DiLuzio et al. 2008). When the website is finished users will be able to use the HCE to select the weather station and click on the

Get HCE Data button to obtain climate data; at this point the climate data will be automatically downloaded and ready to be saved for later use in NLEAP simulations. Users can download the HCE weather station data and the data set will be very similar to the serially edited climate data. For advantages and disadvantages of the climate data provided by the HCE we recommend reviewing Eischeid et al. 2000; Daly et al. 2008; and DiLuzio et al. 2008.

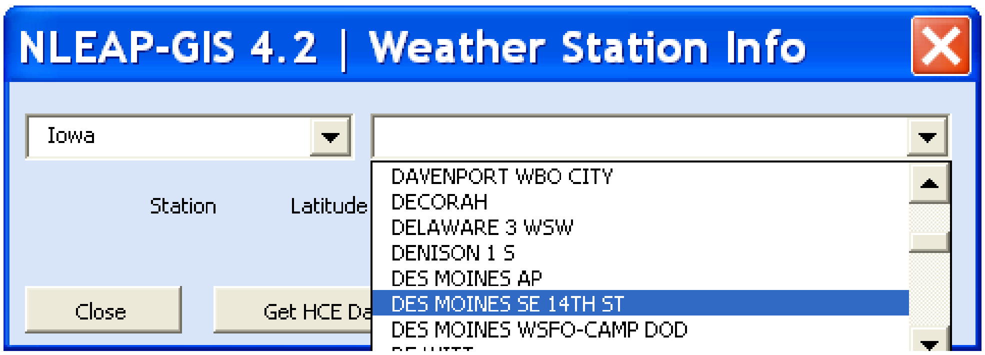


Figure 92

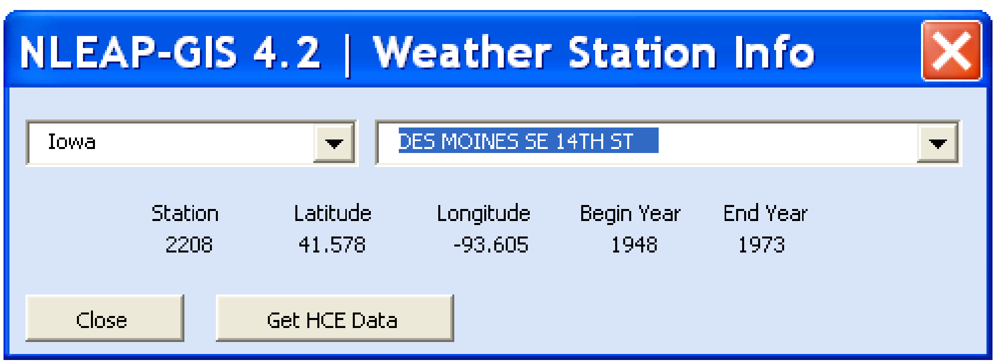


Figure 93

For studies where original measured climate data are needed, we recommend that you go to websites that contain archive climate data; one such example is the NRCS ftp site (ftp://ftp.wcc.nrcs.usda.gov/support/climate/daily-data/). As another option, you could go to the NOAA website (**Figs. 94**) and download climate data from there. At the NOAA website, you can quickly locate climate data by state and counties. If you use data from either of these sites, you will need to convert the data to NLEAP format and edit the data for missing values.

If you are conducting field studies and install a weather station to collect data at a given site, you could also format your own collected data from the site-specific field study and import the data to NLEAP-GIS. You would then need to correctly format the data and edit any missing values.

9.3.2 High Climate Extractor (HCE) Prototype

The instructions we describe in this section are tentative and based on a new website that will be available soon. This website will provide the NRCS serial data as well as data generated by the HCE (Eischeid et al. 2000; Daly et al. 2008; and DiLuzio et al. 2008). When these changes are complete, clicking the *Get HCE data* button will cause the data to be automatically extracted from the HCE. You will be able to navigate to the HCE site and enter the latitude, longitude, and the time period desired for the weather station they select. You will also be able to enter the latitude and longitude and found data for a given site (**Fig. 95**).

Clicking on the *Preview Data* button will allow you to look for the specific climate data set (**Fig. 96**). For our example, let's say you were looking for the January 1, 2000 to December 31, 2001 data for the *Des Moines SE 14th St* weather station in Ohio. You would go to the left panel and select the file type format to export the data (e.g. Excel format) (**Fig. 96**). You could then select the NLEAP Excel format from the dropdown menu to export the data set ready to be used by NLEAP-GIS 4.2 (**Fig. 96**).

Figure 94

Now that the climate data has been selected for a given period and latitude and longitude (weather station), and the file format and model to be exported has been selected, you could click on the *Get Data* button to download the climate data set (**Fig. 97**).

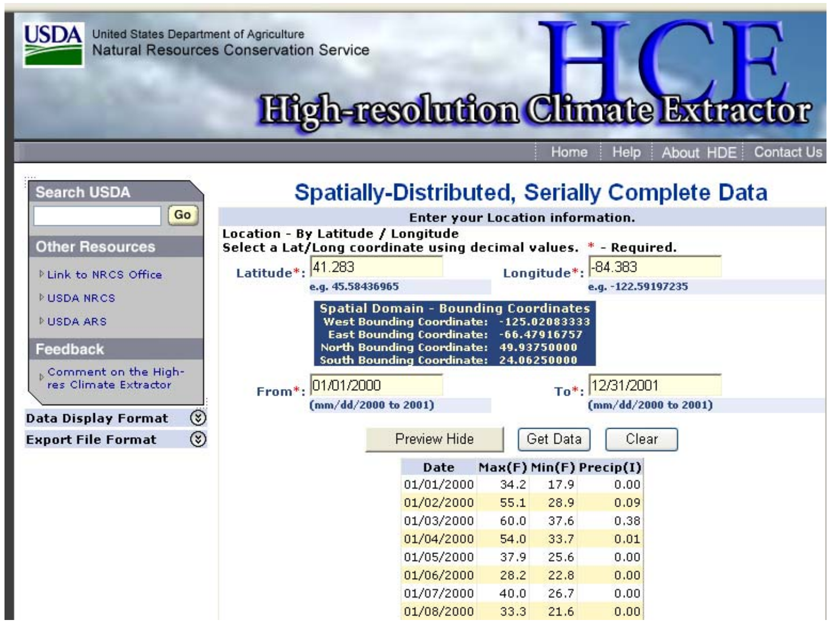


Figure 95

When the download window appears, you could select *Save* and navigate to the directory of your choosing to save the climate data. Since the default name is HCE_Export.xls, we recommend that you identify the files by name and weather station, (e.g. OH-Defiance_HCE_Export.xls).

The NRCS exported Excel file contains the climate data already formatted for NLEAP-GIS 4.2. You could open this file and paste the climate data into the ClimLong tab from the NLEAP-GIS 4.2 Excel file. You would then go back to the *File Management* window and export the ClimLong data to the *new* Microsoft Access database file.

9.4 Editing CROP.IN

To edit the CROP.IN, go to the *Tools* window and click on the *Edit CROP.IN* button, which will open the *Edit CROP.IN* window. This window allows current crop values to be edited or new crops to be added to the CROP.IN database (**Fig. 98**). You must set up a CROP.IN before entering the Crop Editor (*Edit CROP.IN* window).

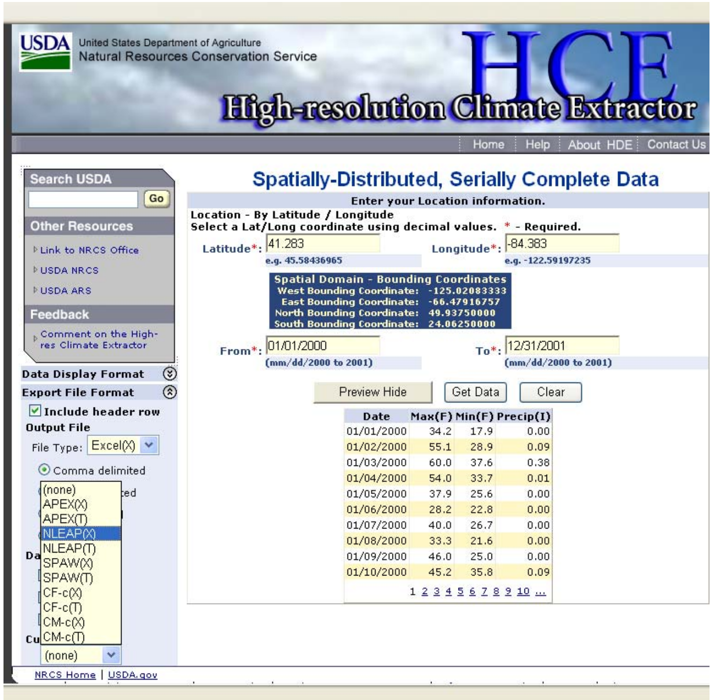


Figure 96

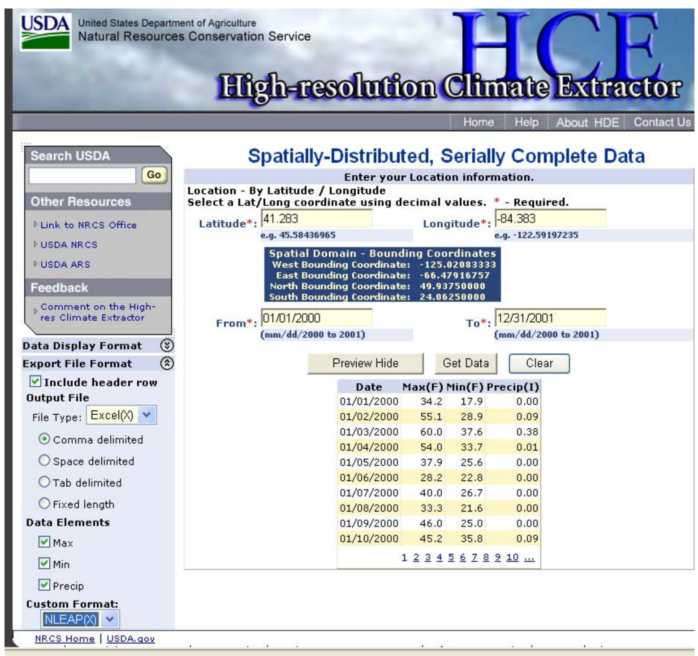


Figure 97

To set the CROP.IN for this example, go to the *Set Up* window, click on the *Set CROP.IN* button, and navigate to the directory C:\NLEAP\Training_Data\EDIT_CROP_IN_Example to select the file named Practice_editing_CROP.IN (**Figs. 98 and 99**).

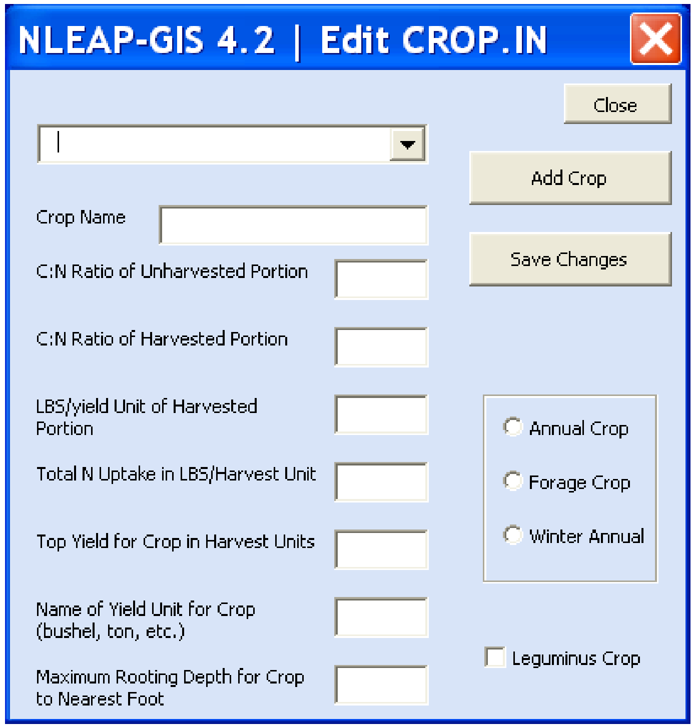


Figure 98

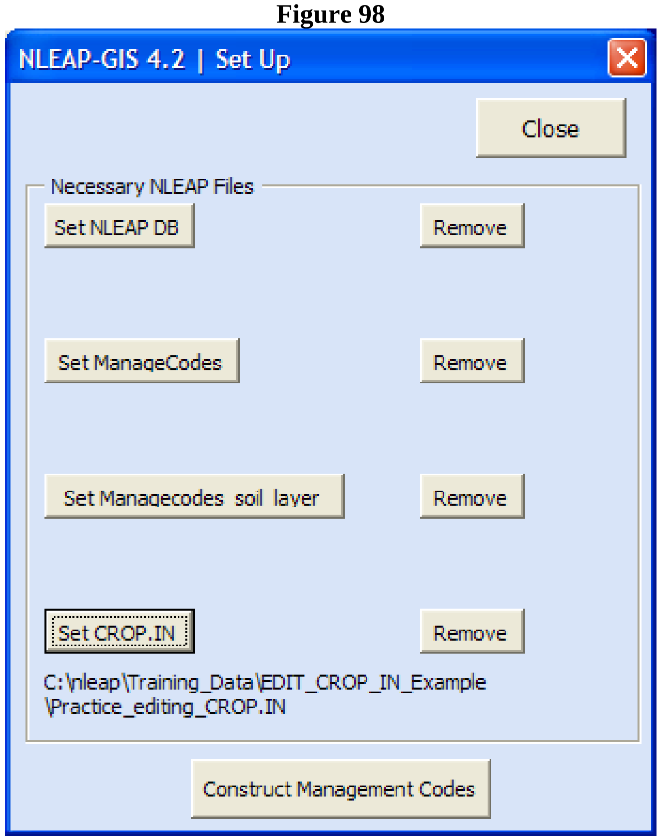


Figure 99

Go back to the *Tools* window and click on the *Edit Crop.IN* button.

From the dropdown menu, you can select the crop that is being used in the scenario. When you select a crop, its values will be displayed (**Figs. 100 and 101**). In this example the crop data for cotton (bale) is shown in **Figures 100 and 101**. For the purposes of this example the values can remain as they are, so just click on *Close*. The values of a crop can be edited and then saved by clicking *Save Changes*.

It is important to review your Crop.IN, since the names of the crops will be used to create the Events table.

To add a new crop to the list, simply enter a Crop Name which isn't already in use, enter valid values into each field, and click on *Add Crop* (**Figs. 102 and 103**). As you enter the new name, a window will pop out to let you know that the crop is not in the data list. Click *ok* until you enter the name of the new crop and then and click on *Add Crop* (**Figs. 102 and 103**). In this example the crop data for the new crop is shown on **Figures 102 and 103**. For the purposes of this example the values will not be saved, so just click on *Close*.

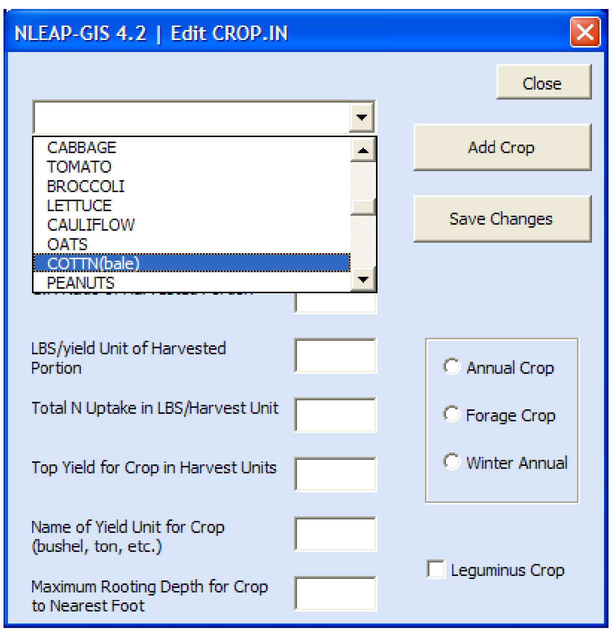


Figure 100

The default information for corn is shown in **Figure 103.** If desired, new crops or varieties can be entered.

9.5 Editing Crop Coefficients

KOMR = N mineralization rate coefficient for soil organic matter in slow pool (1/day). Program Default = .000072

PC(1) = fraction of carbon (dry wt. basis) in crop residues.

Default = .4

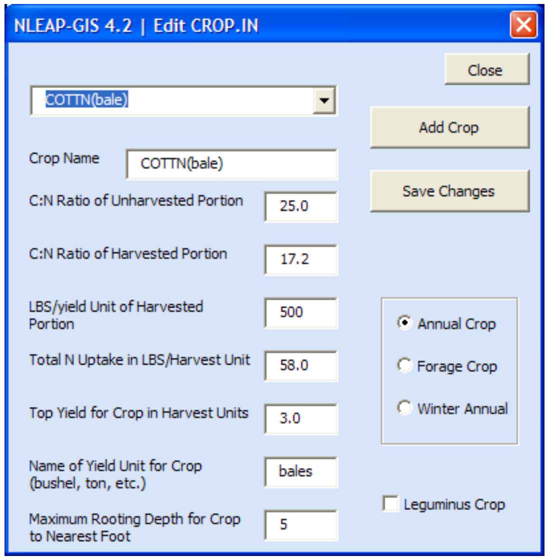


Figure 101

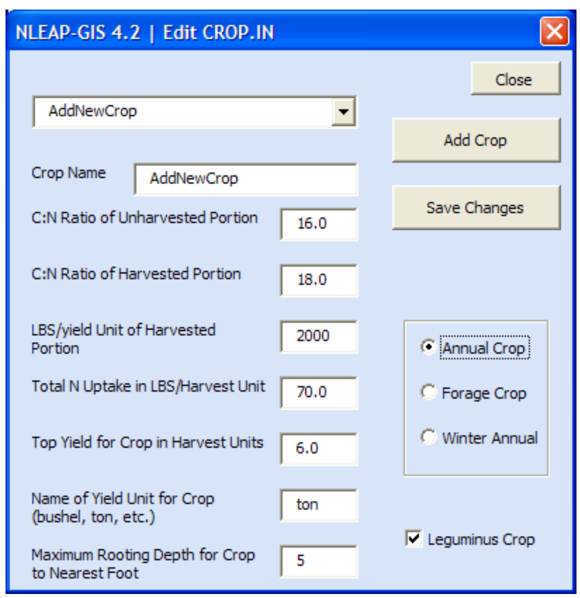


Figure 102

PC(2) = fraction of carbon (dry wt. basis) in manure.

Default = .37

PC(3) = fraction of carbon (dry wt. basis) in other organic wastes.

Default = .30

KRESR(1) = N mineralization rate coefficient for crop residues

(1/day).

Default = .06

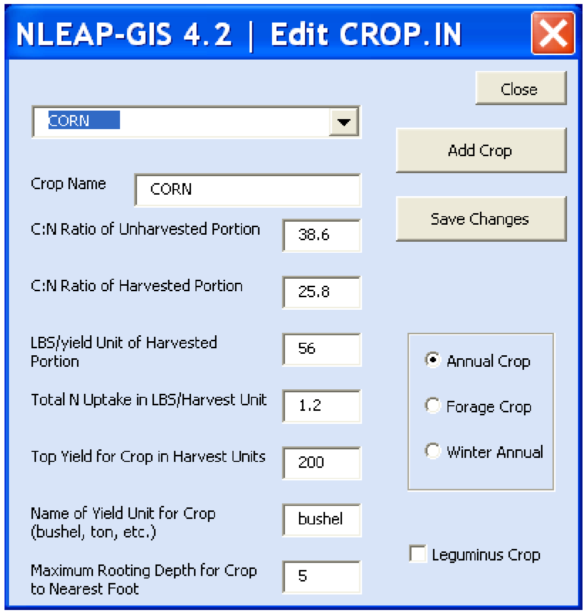


Figure 103

KRESR(2) = N mineralization rate coefficient for manure (1/day).
Default = .01

KRESR(3) = N mineralization rate coefficient for other organic waste (1/day).
Default = .003

KN = Nitrification rate coefficient (lb N/ac/day).
Default = 30.0

COMR = Carbon fraction of soil organic matter (no units).
. Default = .58

ROMR = Fraction of soil organic matter N-mineralized per year.
Default = .01

FRUN = adjustment factor for runoff.
Default = 1.0

OPOOL = % Organic Matter in the mineralizable (No) pool.
Default = 5.0

KOMRN0 = N mineralization rate coefficient for No pool (1/day)
Default = .0059

FRSLOW = fraction of NO pool mineral sent to slow pool.
Default = .05

KREDU = rate coefficient for attenuation of N inhibitor (NU).
Default = .067

REDUCN = Attenuation rate coefficient for effect of nitrification inhibitor (%).
Default = .5

KDENIT = Denitrification coefficient. Default ___

9.6 ClimLong Table (Variables)

The ClimLong table contains the daily climate data in NLEAP. The column headings for the ClimLong table are: MONTH, DAY, YEAR, RNFALL, TMAX, TMIN, PAN, and PAN-COEF. A description of each of these headings is provided by the chart below:

Table Column Heading	**Description**
MONTH	Month (e.g., 03)
DAY	Day (e.g., 01)
YEAR	Year (e.g., 2005)
RNFALL	Daily precipitation (inches)
TMAX	Daily maximum air temperature (F)
TMIN	Daily minimum air temperature (F)
PAN	Daily pan evaporation (inches)
PAN-COEF	Daily pan coefficient

Note that each NLEAP run starts with the first line of data in the ClimLong table.

The climate dataset must be complete for the entire duration of the run (there can be no missing data).

9.7 Events Table (Variables) Updated 01/2008

To create a table for your management event data, you will need to start with an empty spreadsheet or table containing the proper headings (MONTH, DAY, YEAR, EVENTTYPE, VAR1, VAR2 … VAR12). These headings are described in the charts that follow. The specific column entries under each heading depend on the event type, so *you'll want to be sure you are referring to the correct chart for each event. You can either use the Event Creator or enter the events directly in the Excel file (if you use this procedure, remember to save the file in Excel or Access format; see the File Management section for information on how to save files).*

You will also want to take care to ensure that you have entered *one event per line (row)* in your Excel spreadsheet or MS Access database.

9.7.1 Run Configuration (ASIM)

The first row of your table will contain data corresponding to the ASIM event.

Table Column Heading	**Description**
MONTH	Month run starts (e.g., 03)
DAY	Day run starts (e.g., 01)
YEAR	Year run starts (e.g., 2005)
EVENTTYPE	Event type (must be ASIM for run configuration): limited to one occurrence per file
VAR1	Number of years in run (e.g., 10)
VAR2	Month run ends (e.g., 11)
VAR3	Day run ends (e.g., 30)
VAR4	Depth of soil profile (inches)

9.7.2 Initialization of Misc. Site Properties (INIT)

Table Column Heading	Description
MONTH	Month of initialization (e.g., 05)
DAY	Day of initialization (e.g., 15)
YEAR	Year of initialization (e.g., 2005)
EVENTTYPE	Event type must be INIT for initialization events. Any number of initialization events are possible
VAR1	Slope of site (%): could be Group code (A, B, or C) for alternate variable sets
VAR2	Landscape position (1 = summit, 2 = sideslope, 3 = bottom (toe))
VAR3	Curve number 1 (prior to crop)
VAR4	Curve number 2 (during crop)
VAR5	Curve number 3 (after crop)
VAR6	NH4-N in precip (ppm)
VAR7	NO3-N in precip (ppm)
VAR8	Evaporation fraction (fraction of top foot of soil subject to surface evaporation)
VAR9	Standing residue percent (0-100)
VAR10	Flat residue percent (0-100)
VAR11	Thickness of surface residue mat. (inches)
VAR12	Management scenario code (any supplied by the user; e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc.)
VAR13	Surface residue mass (lb/ac)
VAR14	Surface residue cover (%)
VAR15	Surface residue C:N ratio

9.7.3 Initialization of Limited Soil Properties (INIS)

Table Column Heading	Description
MONTH	Month of initialization (e.g., 05)
DAY	Day of initialization (e.g., 15)
YEAR	Year of initialization (e.g., 2005)
EVENTTYPE	Event type must be INIS for soil initialization events. Any number of initialization events are possible, but should be done on first day of run

VAR1	% SOM
VAR2	% N_0
VAR3	NO3-N - top foot (lb/ac)
VAR4	NO3-N - second layer (lb/ac): assumes 2-layer soil at this stage (1st day of run).

9.7.4 Nitrification Inhibitor Application (INHB)

Table Column Heading	Description
MONTH	Month of application (e.g., 05)
DAY	Day of application (e.g., 15)
YEAR	Year of application (e.g., 2005)
EVENTTYPE	Event type must be INHB for inhibitor events. Any number of inhibitor events are possible within reason
VAR1	Inhibitor name
VAR2	Coefficient 1 – Effective time period for inhibitor (days)
VAR3	Coefficient 2 – Initial fraction reduction in zero order nitrification rate (0-1 range)
VAR4	Coefficient 3 – Exponential decay coefficient for initial effectiveness of inhibitor
VAR12	Management scenario code (any supplied by user; e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc.)

9.7.5 Chemical Fertilizer (NUTC)

Table Column Heading	Description
MONTH	Month of fertilizer application (e.g., 05)
DAY	Day of fertilizer application (e.g., 15)
YEAR	Year of fertilizer application (e.g., 2005)
EVENTTYPE	Event type must be NUTC for fertilizer events. Any number of fertilizer events are possible
VAR1	Fertilizer type (*must be one of following, entered exactly as shown*): Anhydrous ammonia Ammonium nitrate Ammonium chloride

	Ammonium polyphosphate Ammonium sulfate Aqueous ammonia Diammonium phosphate Monoammonium phosphate (MAP) Calcium nitrate Sodium nitrate UAN UREA Custom blend
VAR2	Percent nitrogen in bulk fertilizer
VAR3	Percent NO3-N (N portion) – needed only for custom blends
VAR4	Percent NH4-N (N portion) – needed only for custom blends
VAR8	Method of application (must be one of following): Knifed/Injected Surface broadcast Banded surface Surface dribble Incorporated broadcast Incorporated banded Sidedressed
VAR9	Bulk fertilizer applied (lbs/ac) -- total fertilizer, not just N portion
VAR12	Management scenario code (any supplied by user, e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc.)

9.7.6 Manure (NUTM)

Table Column Heading	**Description**
MONTH	Month of manure application (e.g., 06)
DAY	Day of manure application (e.g., 15)
YEAR	Year of manure application (e.g., 2005)
EVENTTYPE	(Must be NUTM for manure application events)
VAR1	Manure identifier (such as Beef, Dairy, Swine, Poultry, Sheep, Horse)
VAR2	Percent NO3-N in manure, dry weight basis

VAR3	Percent NH4-N in manure, dry weight basis
VAR4	Percent water in manure
VAR5	C/N ratio of manure (manure is assumed to contain 40% carbon, dry weight basis)
VAR6	Method of application (must be one of the following, entered exactly as shown): Knifed/Injected Incorporated solid broadcast Incorporated liquid broadcast Solid broadcast Liquid broadcast Sprinkler irrigation
VAR7	Amount of wet manure applied (t/ac)*
VAR8	Percent Organic Matter (OM) in manure (dry weight basis)
VAR12	Management scenario code (any supplied by user; e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc.)

* Note: Algorithm to compute N applied is: N applied (lbs/ac) = [Amount (t/ac)* 2000.*(1 – Percent water / 100.) * Percent OM / 100. * 0.40 / C:N ratio] + [Amount (t/ac)* 2000.*(1 – Percent water / 100.) * Percent NH4-N/100. + NO3-N term].

9.7.7 Sludge or Other Bio-solids (NUTO)

Table Column Heading	**Description**
MONTH	Month of sludge or other bio-solids application (e.g., 06)
DAY	Day of sludge or other bio-solids application (e.g., 15)
YEAR	Year of sludge or other bio-solids application (e.g., 2005)
EVENTTYPE	Event type (must be NUTO for sludge or other bio-solids application events)
VAR1	Identifier for sludge or other bio-solids application (sewage sludge, food processor waste, etc.)
VAR2	Percent NO_3-N in sludge (dry weight basis)
VAR3	Percent NH_4-N in sludge (dry weight basis)
VAR4	Percent water in sludge or other bio-solids
VAR5	C/N ratio of sludge or other bio-solids (sludge is assumed to contain 40% carbon, dry weight basis)

VAR6	Method of application (must be one of the following, entered exactly as shown): Knifed/Injected Incorporated solid broadcast Incorporated liquid broadcast Solid broadcast Liquid broadcast Sprinkler irrigation
VAR7	Amount of wet sludge or other bio-solids applied (t/ac)*
VAR8	Percent Organic Matter (OM) in sludge or other bio-solids, dry weight basis
VAR12	Management scenario code (any user supplied; e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc)

* Note: Algorithm to compute N applied is: N applied (lbs/ac) = [Amount (t/ac)* 2000.*(1 – Percent water/100.) * Percent OM / 100. *0.40 / C:N ratio] + [Amount (t/ac)* 2000.* (1 – Percent water / 100.) * Percent NH4-N / 100. + any NO3-N term].

9.7.8 Irrigation (IRRI)

Table Column Heading	**Description**
MONTH	Month of irrigation application (e.g., 07)
DAY	Day of irrigation application (e.g., 10)
YEAR	Year of irrigation application (e.g., 2005)
EVENTTYPE	Event type (must be IRRI for irrigation events)
VAR1	Irrigation amount (inches)
VAR2	Not used
VAR3	NO_3-N in background irrigation water (ppm)
VAR4	NO_3-N fertigated (lb N/ac)
VAR5	NH_4-N fertigated (lb N/ac)
VAR6	Runoff fraction (fraction of applied irrigation water that runs off from surface of field: range 0 to 1)
VAR12	Management scenario code (any supplied by user; e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc.)

9.7.9 Planting (PLNT)

Table Column Heading	Description
MONTH	Month of planting event (e.g., 05)
DAY	Day of planting event (e.g., 10)
YEAR	Year of planting event (e.g., 2005)
EVENTTYPE	Event type (must be PLNT for planting events)
VAR1	Crop type**
VAR2	Variety (the cultivar name: optional for identification by user)
VAR4	Days from planting to 1st cutting for alfalfa
VAR5	Days from planting to 2nd cutting for alfalfa
VAR6	Days from planting to 3rd cutting for alfalfa
VAR8	Crop yield (bu or t/ac)
VAR9	Days from planting to senescence (maturity). For Alfalfa: days from planting or spring green to fall shutdown
VAR12	Management scenario code (any supplied by user; e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc.)

Note: VAR1 for PLNT must be a common crop name (see the two charts below) known to NLEAP for crops currently in the user crop database file. CROP.IN **OR crop type must match a crop name entered in the CROP.IN database file. If your crop is not listed, it can be configured and added to your NLEAP CROP.IN file.

Examples of Crop Names Recognized by NLEAP		
Corn	Sweet Corn	Norkopotato
Corn Silage	Lettuce	Cntrypotato
Soybean	Broccoli	Centlpotato
Winter Wheat	Sunflower	Brbnkpotato
Winterwheat	Snap Bean	Asgrocarrot
Spring Wheat	Green Peas	821lettuce
Oats	Cabbage	Sumlettuce
Alfalfa	Cauliflower	Winryecover
Cotton(bale)	Tomato	Triumbarley
Proso Millet	Spinach	Moravbarley
Sugar Beets	Watermelon	Poliscanola
Grain Sorghum	Chilepepper	Colo37oats

Sorghum Silage	Flamecarrot	Monidaoats
Peanuts	Sngrepotato	Onion
Nuggtpotato		

Example Crop ID's in the CROP.IN Database		
MORAVBARLEY	SPINACH	ONION
TRIUMBARLEY	SPRINGWHEAT	SWT.CORN
POLISCANOLA	WINTERWHEAT	SNP.BEAN
FLAMECARROT	WINRYECOVER	GRN.PEAS
ASGROCARROT	SPRG.WHT	CABBAGE
821LETTUCE	WNTR.WHT	TOMATO
SUMLETTUCE	CORN	BROCCOLI
COLO37OATS	SUNFLWR	LETTUCE
MONIDAOATS	ALFALFA	CAULIFLOW
BRBNKPOTATO	SOYBEAN	OATS
CENTLPOTATO	SUGAR.BTS	COTTN(bale)
CNTRYPOTATO	POTATO	PEANUTS
NORKOPOTATO	SILG	
NUGGTPOTATO	SORGM.SILG	
SNGREPOTATO	GRN.SORGM	

9.7.10 Harvest (HARV)

Table Column Heading	Description
MONTH	Month of harvest event
DAY	Day of harvest event
YEAR	Year of harvest event
VAR1	Crop type (must be a common crop name known to NLEAP, or a specific crop ID currently in the user's CROP.IN database file). See above under PLNT for details
VAR4	Percent residue standing after harvest
VAR5	Percent reside flat-lying after harvest
VAR6	Percent residue cover on soil surface after harvest
VAR7	Percent stover returned to field
VAR8	Harvest index (HI): ratio of drymatter yield to total dry matter (yield/total)

VAR9	Fraction of total above ground biomass that is a measure of root mass to be returned to the fast SOM pool
VAR10	Percent water content of yield at harvest
VAR11	Harvest unit weight (lbs per unit of harvest; e.g., lbs wheat/bushel wheat)
VAR12	Management scenario code (supplied by user; e.g., potato-barley rotation)

9.7. 11 Tillage (TILL)

Table Column Heading	**Description**
MONTH	Month of tillage event (e.g., 04)
DAY	Day of tillage event (e.g., 15)
YEAR	Year of tillage event (e.g., 2005)
EVENTTYPE	Event type (must be TILL for tillage events)
VAR1	Tillage equipment: optional for identification only
VAR2	Tillage depth (inches)
VAR3	Incorporation efficiency for fragile surface residues (easily incorporated)
VAR4	Incorporation efficiency for non-fragile surface residues (more difficult to incorporate)
VAR5	Efficiency of flattening surface residues
VAR12	Management scenario code (any supplied by user; e.g., potato-barley rotation, wheat-corn-fallow-Jones farm, irrigated corn-pivot 36, etc.).

9.7. 12 Stop Configuration (STOP)

Table Column Heading	**Description**
MONTH	Month run ends (e.g., 12)
DAY	Day run ends (e.g., 15)
YEAR	Year run ends (e.g., 2005)
EVENTTYPE	Event type (must be STOP)

9.8 SoilLayer Table (Variables) Update May 9, 2008

The SoilLayer table contains soil data for a specific region. The following pages describe the meaning of the column headings used for the SoilLayer table and how to convert typical laboratory or NRCS SSURGO database values to the units needed for

NLEAP.

SoilLayer Table Column Headings in userdb.mdb

The chart below defines the column headings used for the SoilLayer table.

Table Column Heading	Description
MUID	GIS soil polygon identifier from NRCS SSURGO database (for use in GIS analyses)
SLID	soil layer identification number (first layer is 1, second is 2, etc.)
SERIES	the soil identification name (usually obtained from NRCS soils database, but must uniquely identify this particular soil)
UDEP	the upper boundary (depth) of the soil layer (inches)
LDEP	the lower boundary (depth) of the soil layer (inches)
SAND	percentage of sand for the soil layer (information only; NLEAP does not use this)
SILT	percentage of silt for the soil layer (information only; NLEAP does not use this)
CLAY	percentage of clay for the soil layer (information only; NLEAP does not use this)
TEXTR	not used, but reserved for texture class
BD	the field bulk density for the soil layer (whole soil basis - corrected* for any coarse fragments) (gm/cm3)
OM	the percentage of organic matter for the soil layer (whole soil basis - corrected* for any coarse fragments)
CEC	the cation exchange capacity for the soil layer (fine earth values OK; no CF corrections needed)
PH	the pH of this soil layer from a saturated paste extract (fine earth values OK; no CF corrections needed)
PAW	volumetric plant available soil water holding capacity (whole soil basis - corrected* for any coarse fragments) (cm^3/cm^3)
WC13	volumetric soil water content at 1/3 atm. (whole soil basis - corrected* for any coarse fragments) (cm^3/cm^3)
WC15	volumetric soil water content at 15 atm. (whole soil basis - corrected* for any coarse fragments) (cm^3/cm^3)
CF	percent coarse fragments (all particles > 2mm in size) – % by

	whole soil volume
SALIN	not used, but reserved for soil salinity
HORIZDESCI	NRCS soil mapping unit identifier
HORIZGEN	Soil drainage class
HORIZDESC2	Soil hydrologic group
NO3-N	Initial residual NO_3-N at the start of the run for this layer (whole soil basis - corrected* for any coarse fragments) (lbs N/ac)
P2O5	not used, but reserved for phosphorus
WCSTART	Initial volumetric soil water content at the start of the run (whole soil basis - corrected* for any coarse fragments) (cm^3/cm^3)

*Note on corrected values: Any lab analyses run or based on the fine soil portion (< 2mm fraction) may need values used in NLEAP to be corrected for the presence of coarse fragments (> 2mm fraction). See associated write-up below for instructions.

9.9 Converting typical laboratory or NRCS SSURGO database values to NLEAP units

Laboratory values are usually expressed as percent soil organic matter (% SOM) by weight in the fine earth (< 2mm) fraction. NLEAP needs % SOM by weight based on the whole soil (i.e., < 2mm fraction plus the > 2mm fraction). To convert your values to the ones used by NLEAP, you can use the following formula:

*% SOM (whole soil) = % SOM (< 2mm fraction) * Cm * BDm / BDf*

where:

Cm is the rock fragment conversion factor,
BDm is the moist bulk density of the <2mm fraction, and
BDf is the soil field moist bulk density.

Cm is defined as the [Volume < 2mm fraction] / [Volume whole soil] and can be computed from the % Coarse Fragments by Volume (%CFv) for the whole soil as follows:

Cm = 1 – [%CFv / 100]

%CFv [Volume > 2mm fraction] / [Volume whole soil] * 100 is available in the NRCS NASIS/SSURGO database or can be calculated.

BDf can be measured in the field or computed as follows:

$$BDf = 2.65 * \%CFv/100 + (BDm * Cm)$$

where BDf [Mass whole soil] / [Volume whole soil] is the moist bulk density for the whole soil in the field and is the bulk density value that NLEAP requires.

The above equation for BDf assumes that the voids between the coarse fragments are completely filled with the fine earth (< 2mm) fraction. If this is not the case, a coarse fragment bulk density less than 2.65 is needed. Likewise, the bulk density of the coarse material matrix may be less than 2.65; e.g., for limestone and some volcanic rock.

Useful References for Conversions:

Natural Resources Conservation Service. 2004. Soil Survey Laboratory Methods Manual (Soil Survey Investigations Report No. 42). Version 4.0. p. 72-73. Available at: http://soils.usda.gov/technical/lmm/ (verified 3 Feb. 2010).

Natural Resources Conservation Service. SSURGO Metadata – Table Column Descriptions. SSURGO Meradata Version: 2.2.3. Available at: http://soildatamart.nrcs.usda.gov/SSURGOMetadata.aspx (verified 3 Feb. 2010).

9.10 Site Data Table (Variables) Update 1/4/2006

Table Column Heading	**Description**
MUID	(Must be 10101)
SLOPE	Percent slope for the site
SLNGTH	Slope length (ft): information only; NLEAP does not use this
LANPOS	Landscape position for site (1 = summit, 2 = sideslope, 3 = bottom)
CURV1	Curve number for periods prior to cropping (if -1.0, use NLEAP default value)
CURV2	Curve number for cropping periods (if -1.0, use NLEAP

	default value)
CURV3	Curve number for periods after cropping (if -1.0, use NLEAP default value)
PRERNH4N	NH_4-N concentration in precipitation (ppm)
PRENO3N	NO_3-N concentration in precipitation (ppm)
EVAPFR	Fraction of top foot subject to surface evaporation
RESCOV	Percent residue cover on soil surface at start of run
STANDRES	Percent of surface residue standing at start of run
FLATRES	Percent of surface residue lying flat at start of run
RESMAT	Thickness of residue mat at start of run (cm)
RESMASS	Mass of residue on soil surface at start of run (lb/ac)
CRESCN	C:N ratio of surface residue at start of run

9.11 NITROGEN TRADING TOOL (NTT)

The new concept of the Nitrogen Trading Tool (NTT) was presented in Delgado et al. (2008, 2010). The NTT can be used to assess the effects of best management practices (BMPs) on the potential to reduce reactive nitrogen losses to the environment at a field level and to estimate nitrogen savings that may result from good management practices and may be available for potential trade in air and water quality markets. The new NTT is available in NLEAP-GIS 4.2. This section will offer a brief, general overview of how to conduct an NTT analysis in NLEAP-GIS. To compare different BMPs using the NTT:

1. You will first need to select and set the database that includes the region, soils, climate and BMPs that you want to evaluate. For this example, you will need to go to the *Driver* and navigate to the directory C:\NLEAP\Training_Data\Example_Run_1 and select the database named “NLEAP_DB_Example_1.mdb”.
2. Recalling the procedures discussed earlier in this user guide, run an NLEAP simulation for all management scenarios (OH-cc-NT-MF-BMPrtm; and OH-cc-NT-MF-BMP;) for the Bronson sandy loam, with 1 to 6 percent.

3. You are now ready to use the NTT. To reach the NTT, go to the *Driver* and click on the *Nitrogen Output Options* button, which will bring you to the *Nitrogen Options* window (**Fig. 104**).
4. Click on the *NTT* button in the *Nitrogen Options* window to reach the main screen of the Nitrogen Trading Tool (**105**).

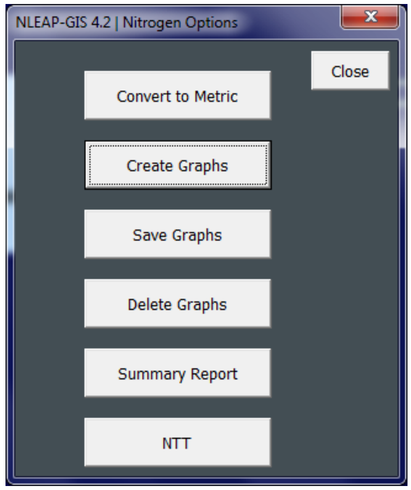


Fig. 104

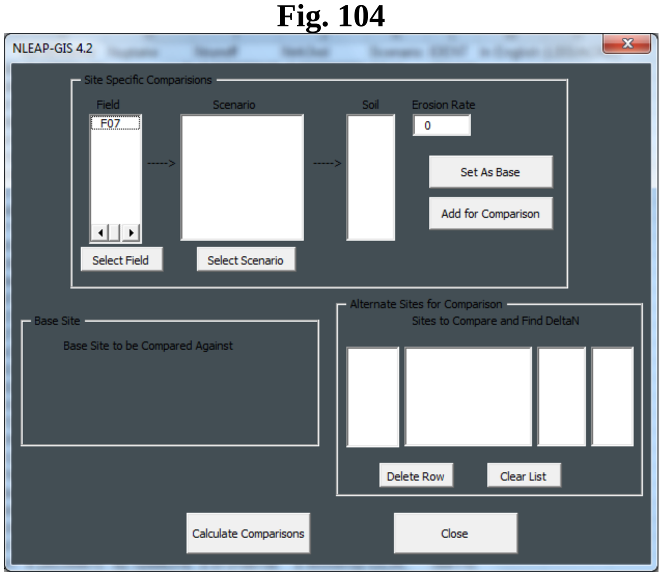


Fig. 105

5. In the main window of the Nitrogen Trading Tool, select the field, scenario, and soil needed so as to make your screen look like **Figure 106**. Be sure that you select OH-cc-NT-MF-BMP as your Base Scenario (Baseline).
6. You can repeat and add for as many combinations as you would like to test.
7. Click *Calculate Comparisons* to see a summary of the desired comparisons (**Fig. 107**).

Important Notes about Using the NTT

1. Although NLEAP-GIS 4.2 does not calculate erosion rate, you can enter the average erosion rate for the scenarios that you want to compare. If you enter the average erosion rate for each combination of management practices and soil type scenario, the NTT can estimate the N losses. The erosion rate will be multiplied by the initial soil organic matter content to estimate the soil nitrogen losses. For a more accurate value for soil erosion rate, you could use a simulation model such as AgES, USLE or RUSLE to estimate soil erosion.

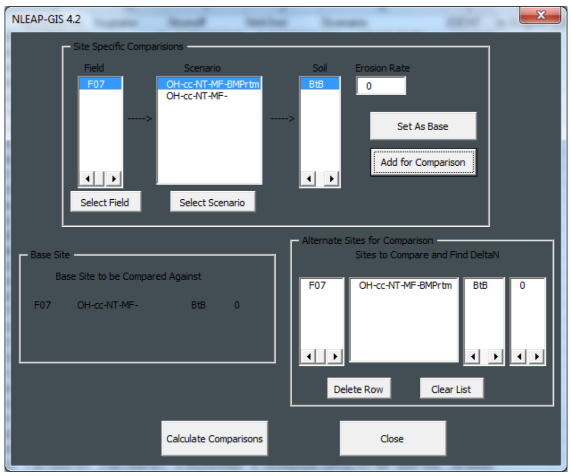


Fig. 106

2. Since NLEAP-GIS 4.2 does not simulate erosion rate, you will need to enter the erosion rate (**Fig. 107**).
3. This NTT shown in **Figure 107** expects that the user is conducting a 24-year simulation for all of the scenarios, as recommended in Delgado et al. (2008). If none of the simulations are conducted in a 24-year time frame, the screen will be blank when the user clicks on *Calculate Comparisons*. We don't recommend that the user use different time frames to compare scenarios (e.g. scenarios with different times frames), because the numbers generated and the interpretation may not be valid in such a case. Only the last twelve years of the simulations will be used to evaluate the effects of BMPs on reducing reactive nitrogen losses and to estimate the amount of any nitrogen savings that may be available for potential trade in air and water quality markets (**Figs. 106, 107**).
4. A prototype of an add-on application was developed to estimate the carbon sequestration equivalents from direct and indirect savings in N_2O emissions, but

this prototype application is still being tested. When released, this add-on application will be able to be used with the current version of NLEAP-GIS (NLEAP-GIS 4.2) and users will be able to assess the carbon sequestration equivalents that may be available for potential trade. For additional information about the prototype application for estimating carbon sequestration equivalents from direct and indirect reductions in N_2O emissions, e-mail Dr. Jorge Delgado at jorge.delgado@ars.usda.gov.

Fig. 107

9.12 NITROGEN TRADING TOOL (NTT) GIS

This section covers a general example on how to run an NTT analysis across the landscape. *Note that the numbers used in the provided files are just for instructional purposes, and they do **not** represent real values for the scenarios at the given site-specific farms.*

1. To conduct an NTT-GIS analysis, you will need to set up the file that has the database management scenarios and the crop.IN file. The database file "NLEAP_DB_Example_GIS_1" is the file we are going to use for this example, and it is located in C:\nleap\Training_Data\Example_Run_5_NTT.
2. Set the NLEAP DB and Crop.IN as shown in **Figure 108**.
3. Go back to the *Driver* and click on the *NTT-GIS* button to go to the main window for NTT-GIS (**Fig. 109**).

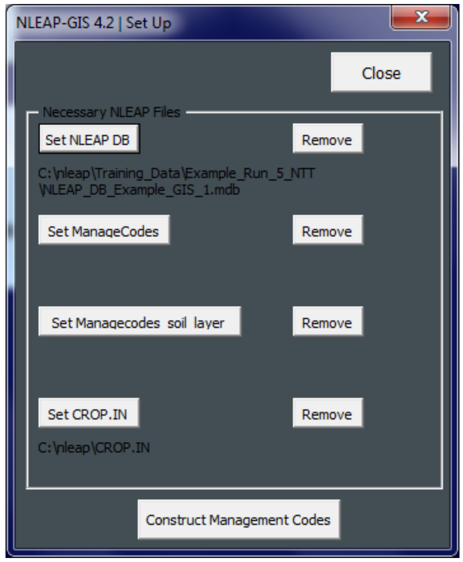


Fig. 108

4. You will need to set up a GIS baseline file with the baseline scenario. The NTT-GIS is basically conducting two spatial runs from NLEAP and subtracting them spatially; only the difference (delta) is exported to the GIS output file. Remember that you will need to keep track of all of these files, since the NTT-GIS output file contains the difference (delta) between the nitrogen numbers for the two scenarios. See Delgado et al. (2008, 2010) for additional information.

   The number in the GIS output file indicates whether there is any potential reduction in N loss (compared to the baseline scenario) that can be traded. If the number exported to the GIS output file is **positive**, that means that the NTT estimates that the new BMPs are likely to reduce the potential for nitrogen losses (if implemented). The extent of the estimated reduction in potential losses is indicated by the value of the number in the GIS output file. The reduction in potential nitrogen losses can be thought of as "N savings," which can then be traded.

   However, if the number in the GIS output file is **negative**, then this indicates that the NTT estimates that the new BMPs will likely increase the potential for nitrogen losses (relative to the baseline scenario). The extent of the estimated increase in potential for losses is indicated by the value of the number in the GIS output file. A negative number means that the model has estimated that the potential N losses will be greater with the proposed change in management (if implemented). *A negative number in the GIS output file thus indicates that there are no potential reductions in nitrogen loss that can be used for trade.*

5. For this example, let's use high nitrogen inputs across these farms as the baseline scenario. The example file that represents this scenario is named "NTT_H".
6. For our new, improved BMP scenario across the landscape, let's assume that cover crops are used and that better BMPs are applied across these sites. The example file that represents this scenario is, "NTT_L".
7. Set the .DBF files as shown in **Figure 110.**
8. Now click on the *Run NLEAP With Selected Files* button.
9. You will see that two sets of runs are being conducted. Once the run is complete, your screen should look like **Figure 111**, with all of the squares under the Available Calculations heading now being green, indicating that your simulation was successfully run.

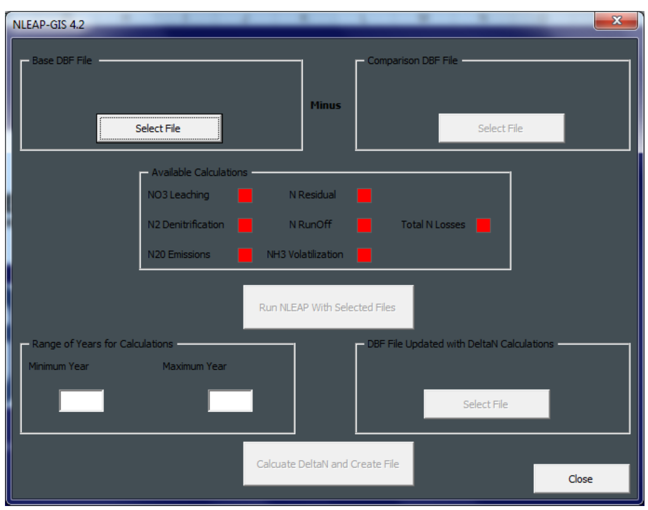


Fig. 109

10. Now you need to select a file to export your NTT analysis to. For this example, select the file "NTT_H_L_Comparison," which we will use as the GIS output file that will contain the difference (delta) between the baseline scenario and new BMPs. This file is in the same directory as the files you set

earlier for the baseline scenario and the high nitrogen input scenario. Your screen should look like **Figure 112**.

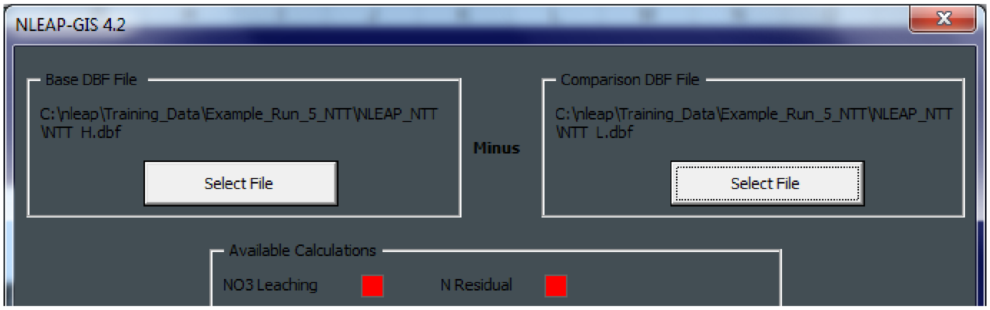


Fig. 110

11. For this example, use the period 1 to 24 years, and export the differences to the GIS file "NTT_H_L_Comparison" by clicking *Calculate DeltaN and Create File* (**Fig. 113**).

<u>Important Notes for NTT-GIS</u>

1. For this version of NTT-GIS, you will only have one opportunity to export the NTT-GIS output to the selected output GIS file. Unlike the NLEAP-GIS 4.2 setup, where you could export several times to send the NLEAP-GIS 4.2 output to several different files, until you close the window, this version of the NTT-GIS has only one export opportunity: you will only be able to export the data to one file before having to run the NTT analysis again. This will be changed in future versions to allow multiple exports.

2. If you open the table attributes in your GIS software for the example NTT-GIS files, you will notice that there are two additional variables, ER (erosion rate) and ERN (erosion rate nitrogen), with values provided for these variables. Again, although NTT-GIS does not calculate the erosion values, if you know the expected erosion losses for a given management scenario, you could enter those values and conduct an assessment of the eroded N losses with the NTT. The NTT will calculate the expected N losses due to erosion, using the erosion value you enter and the soil organic matter content for the soil type. For detailed analysis of erosion losses, users could use models such as the AgES, USLE or RUSLE. Note that if you create your own NTT-GIS files, rather than use the example ones, you will need to add these variables to the table yourself, and provide the values for these variables, to conduct an assessment of the N losses from erosion in your scenarios.

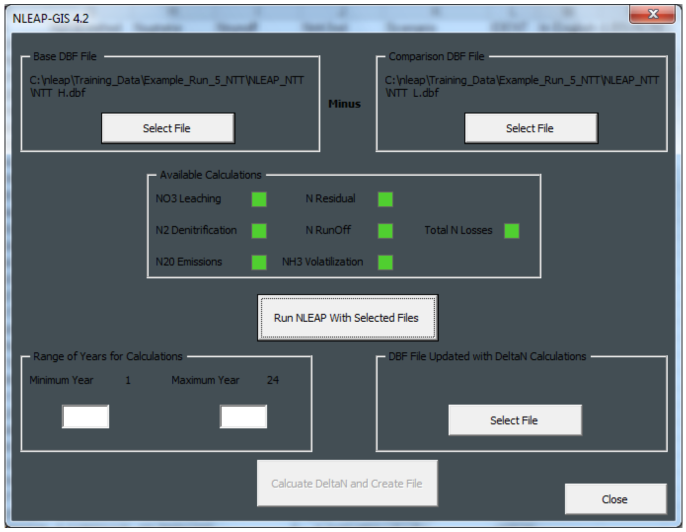


Fig. 111

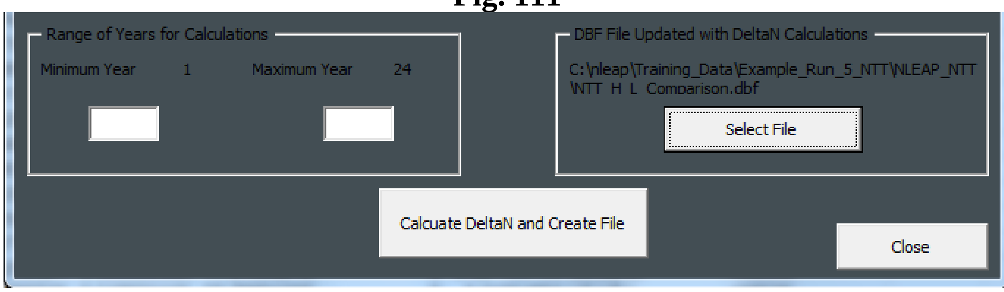
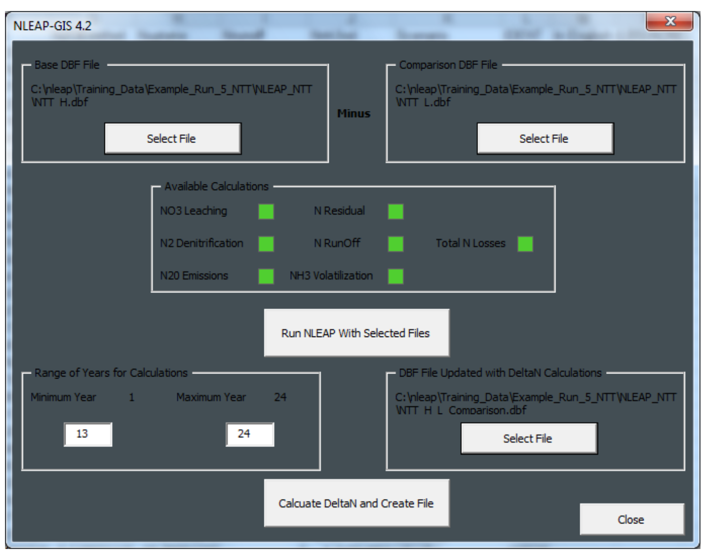


Fig. 112



(Fig. 113)

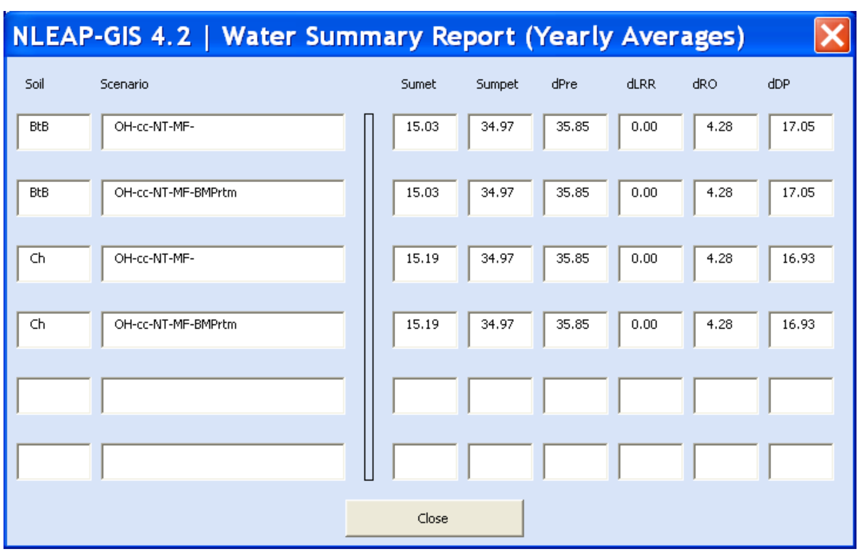
9.13 TO BE FIXED IN NEXT VERSION: SUMET & SUMPET

The variables SUMET and SUMPET generated in the Water Summary Report are not working properly (**Figure 19 from Section 4.7** below). This bug will be corrected in the next version of NLEAP-GIS 4.2.

If you would like to use these variables, you could navigate to the tab named *waterTable* and use the generated daily data for variables SUMET and SUMPET in the *waterTable*. The *waterTable* data set is correct. Additionally, you could use the values for SUMET and SUMPET in the generated graphs for these variables, because the values for these variables will be correct in the graphs as well. As an example, you could compare the Sumet value (15.03) and Sumpet value (34.97) below, with the correct values that can be calculated from the *waterTable* data. Find the values for December 31, 1997 (348.77 and 809.41), and divide them by the number of years in the simulation (24) to get the correct values for Sumet (14.53) and Sumpet (33.72).

Note: These values apply to the example file used in Section 4.7 (NLEAP_DB_Example1) for the management scenario "OH-cc-NT-MF-" and soil type Bronson sandy loam, 1 to 6 percent slopes.

Do not use the SUMET and SUMPET generated from the water summary report (Fig 19).



(Copy of Figure 19)