The Wind Erosion Prediction System

WEPS 1.5 User Manual

USDA-ARS
Agricultural Systems Research Unit
Fort Collins, Colorado USA

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Preface

Wind erosion is a serious problem on agricultural lands throughout the United States as well as the world. The ability to accurately predict soil loss by wind is essential for, among other things, conservation planning, natural resource inventories, and reducing air pollution from wind blown sources. The Wind Erosion Equation (WEQ) was widely used for assessing average annual soil loss by wind from agricultural fields. The primary user of WEQ was the United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). When WEQ was developed more than 35 years ago, it was necessary to make it a simple mathematical expression, readily solvable with the computational tools available. Since its inception, there have been a number of efforts to improve the accuracy, ease of application, and range of WEQ. Despite these efforts, the structure of WEQ precluded adaptation to many problems.

The USDA appointed a team of scientists to take a leading role in combining the latest wind erosion science and technology with databases and computers, to develop what would become a significant advancement in wind erosion prediction technology. The Wind Erosion Prediction System (WEPS) incorporates this new technology and is designed to be a replacement for WEQ.

Unlike WEQ, WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, management, and erosion. WEPS 1.5 consists of the WEPS science model with a user-friendly interface that has the capability of simulating spatial and temporal variability of field conditions and soil loss/deposition within a field. WEPS 1.5 can also simulate simple field shapes and barriers on the field boundaries. The saltation/creep, suspension, and PM10 components of eroding material also are reported separately by direction in WEPS 1.5. WEPS 1.5 is designed to be used under a wide range of conditions in the United States and is adaptable to other parts of the world. For further information regarding WEPS contact:

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USDA-ARS Agricultural Systems Research Unit
2150 Centre Ave. Bldg. D Suite 200
Fort Collins, Colorado 80526

Phone: 970-492-7382
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Acknowledgements

The Wind Erosion Prediction System (WEPS) resulted from the work of many individuals representing several agencies and institutions. In particular, appreciation is extended to the WEPS Core Team members:, D.V Armbrust (retired), J.D. Bilbro (retired), G.W. Cole (retired), A.A. Durar, F. Fox, D.W. Fryrear (retired), R.B. Grossman (retired), L.J. Hagen (retired), L. Lyles (retired), A. Retta, A. Saleh, H.H. Schomberg, H.R. Sinclair (retired), E.L. Skidmore (retired), J.L. Steiner, J. Tatarko, P.W. Unger (retired), S. Van Donk, and T.M. Zobeck (retired); the Agency liaisons to the Core Team, including: M.S. Argabright, NRCS (retired), H. Bogusch, NRCS (retired), R. Dunkins, EPA, and C. Voight, BLM; the ARS NPL, including: C.R. Amerman (retired), W.D. Kemper (retired), and Mark Weltz; and NRCS leaders including K. Flach (retired), M. Hubbs, A. King (retired), C. Lander (deceased), S. Rawlins (retired), D. Schertz (retired), M. Sporcic (Retired), G.L.Tibke (retired), D. Woodward (retired) and Joel Poore.

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Recognition is given to the support of many agencies and universities that made WEPS a reality. These include the USDA Agricultural Research Service, USDA Natural Resources Conservation Service, the US Department of Interior - Bureau of Land Management, the US Forest Service, the US Environmental Protection Agency, the US Army Corps of Engineers, and Kansas State University.

The contribution of the NRCS state and field offices and other individuals who participated in the WEPS validation studies is also recognized.

Finally, acknowledgment is made of the many other individuals who have made this release of WEPS possible by reviewing this document and those who contributed through fundamental research on which many of the underlying concepts of WEPS are based.

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Table of Contents

1 INTRODUCTION

1.1 How To Use This Document

The Wind Erosion Prediction System or 'WEPS' is a process-based, daily time-step, wind erosion simulation model. It represents the latest in wind erosion prediction technology and is designed to provide wind erosion soil loss estimates from cultivated, agricultural fields. WEPS 1.5 consists of the computer implementation of the WEPS science model with a graphical user interface designed to provide easy to use methods of entering inputs to the model and obtaining useful user output reports. WEPS was developed by the former Wind Erosion Research Unit (WERU), now Agricultural Systems Research Unit (ASRU) of the United States Department of Agriculture, Agricultural Research Service.

The WEPS 1.4 User Manual is designed to provide information to different levels of users. Those users who are completely new to WEPS should start by reading all of this chapter to get an introduction to WEPS. It is recommended that, as a minimum preparation to use WEPS, the user should read the "Overview of the Wind Erosion Prediction System."

The minimum computer requirements and the steps to install WEPS onto your computer are described in this chapter. Once WEPS has been installed on your computer, you should learn how to make a simple simulation run using the "Quick Start for WEPS 1.5." More experienced users should become familiar with the "Interface Reference - How to Operate WEPS", which goes into detail of how to use all of the capabilities of WEPS 1.5. These details are also available in the 'Online Help,' accessible through the toolbars on the WEPS 1.5 interface screen.

"Using WEPS in Conservation Planning" contains sections on 'Interpreting Outputs', 'Special Field Configurations', and 'Using Barriers for Erosion Control in WEPS.' This section also has 'Exercises,' which guide the user through scenarios that describe how to use WEPS to design conservation systems.

The "Science Overview" contains information for more advanced users. For users interested in more detail on the interface and science behind WEPS, 'Interface Implementation and Science Model' is recommended. An even more detailed description of the science of the WEPS model is available in the "WEPS Technical Description," which can be obtained from ASRU.

The Science Overview also contains information for more advanced users, such as the WEPS 'Databases' and a listing of 'Submodel Report Flags and Command Line Options.' Databases are described for the Weather, Soil, Management, Crop, Operation and Barrier sections of WEPS. Submodel Report Flags and Command Line Options are set under the 'Configurations' tabs available through the "Tools" menu on the Main Screen of the interface. Certain permissions may be required to alter some of these flags and options. There is a section on "Using WEPS with Measured Data" that will be useful to researchers and other users, such as those outside the United States who do not have their soils data in the SSURGO database format.

Finally this manual contains a series of "How To" Guides which provide the user with in-depth detail of simulating barriers and strip cropping. There are also "How To" Guides that guide the user in developing additional crop and operation database records.

Throughout this manual, the term “user” refers to the person(s) using WEPS 1.5 to set up and make a simulation run. The term “operator” refers to the producer or land manager whose actual field is being simulated with WEPS. This manual contains many graphics that are examples of what can be seen on the computer screen using WEPS. In addition, WEPS will continually be improved and the screens may change. Therefore, the user may or may not see the exact same screens as those illustrated in this manual.

WEPS is a model developed primarily for use by the USDA, Natural Resources Conservation Service (NRCS). As such, many of the capabilities of WEPS reflect the needs of NRCS for use in cultivated agricultural systems. But, WEPS has capabilities to be used in many other situations where wind affected soil movement is a problem. Contact ASRU if you wish to use WEPS to predict erosion for situations other than traditional cultivated agricultural systems.

Minimum Computer Requirements

The minimum recommended requirements to install and operate WEPS 1.5 are: an Intel Pentium class processor, or equivalent, personal computer (PC); Windows 7 or newer Microsoft operating system; 1 Gb RAM; 2 Gb free disk space; internet web access to download for installation; and a VGA color monitor with a minimum screen resolution of 800 x 600 pixels. WEPS also requires Java 1.8 or later (must be installed prior to installing WEPS). WEPS has been run in the past on older releases of Windows, but is no longer tested on them. Configurations for Linux and Unix are also available. Contact ASRU if you need versions for Linux/Unix assistance.

The recommended requirements to install and operate WEPS 1.5 effectively are: an equivalent of an Intel Core I-3 processor, or better, personal computer; Windows 7 or newer Microsoft operating system; greater than 2 Gb RAM; greater than 20 Gb of free disk space, internet web access to download WEPS for installation; and a color monitor with 1024 x 800 or better pixel resolution. Java 1.8 or later must be installed prior to installing WEPS.

Installation

To install the packaged version of WEPS, one must be logged in as “Administrator” or as a user with sufficient “privileges” to install Windows programs. To initiate the installation process, just double click with the left mouse button on the “WEPS” msi file package, which will at least contain the name “weps”, the version number and the build date, for example: weps_1.5.10_(2016-03-04).msi Simply follow the installation prompts and provide the requested information.

Again, note that on Windows 7 and newer machines (and possibly XP and Vista, depending on how they are configured), the user must either be logged in as “Administrator” or have sufficient privileges to successfully install WEPS. The WEPS installation program will inform the user attempting installation if they do not have sufficient privileges to perform the installation.

WEPS 1.5 is available for download on the ARS web site at: https://www.ars.usda.gov/services/software/download.htm?softwareid=415#downloadForm. Fill in the required form fields and click on the “Take me to the download”. If you fill out the registration form, ASRU will provide email notices of updates to the model. The download file consists of an executable “msi” file that will install WEPS onto your Windows computer. Contact ASRU if you need assistance at:

USDA-ARS Agricultural Systems Research Unit
2150 Centre Ave., Bldg. D Suite 200
Fort Collins, CO 80526

Phone: 970-492-7382
E-mail: weps@ars.usda.gov

NOTE: NRCS users must obtain official copies of WEPS through their agency’s official channels. The release of WEPS provided by NRCS is pre-configured to their specifications. Contact Joel Poore, Wind Erosion Specialist, for the NRCS specific release of WEPS at:

Joel Poore, NRCS
Phone: 817-509-3213
E-mail: Joel.Poore@ftc.usda.gov

1.2 WEPS Installation Steps

Installation

To install the packaged version of WEPS, one must be logged in as "Administrator" or as a user with sufficient "privileges" to install Windows programs. On Windows 7 and newer machines (and possibly XP and Vista, depending on how they are configured), the user must either be logged in as "Administrator" or have sufficient privileges to successfully install WEPS. The WEPS installation program will inform the user attempting installation if they do not have sufficient privileges to perform the installation.

To initiate the installation process, just double click with the left mouse button on the "WEPS" msi file package, which will at least contain the name "weps", the version number and the build date, for example: weps_1.5.10_(2016-03-04).msi Simply follow the installation prompts and provide the requested information. Screenshots of the process are shown below.

In some instances, the first window that will display is the **Open File – Security Warning** message (Figure 1-1). Simply click on the "Run" button in that window if it appears.

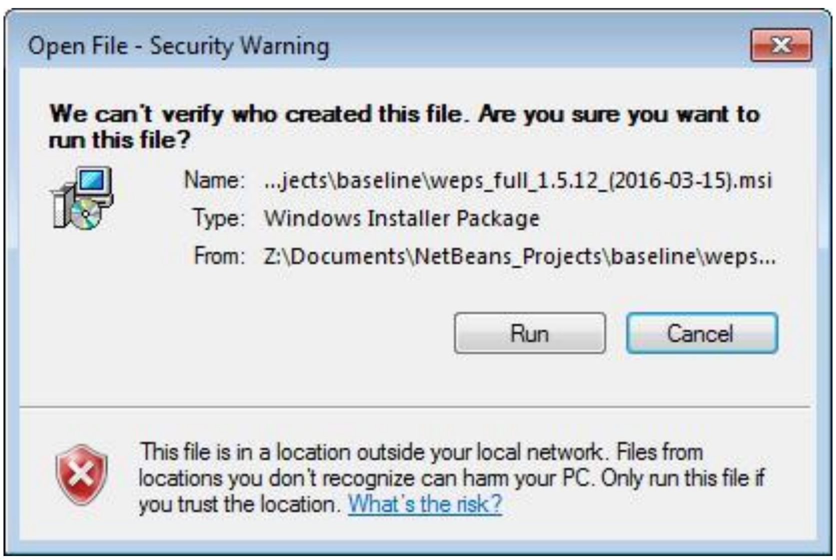

Figure 1-1 Security warning message that may appear when attempting to install WEPS.

The first WEPS window to appear is the setup welcome screen (Figure 1-2).

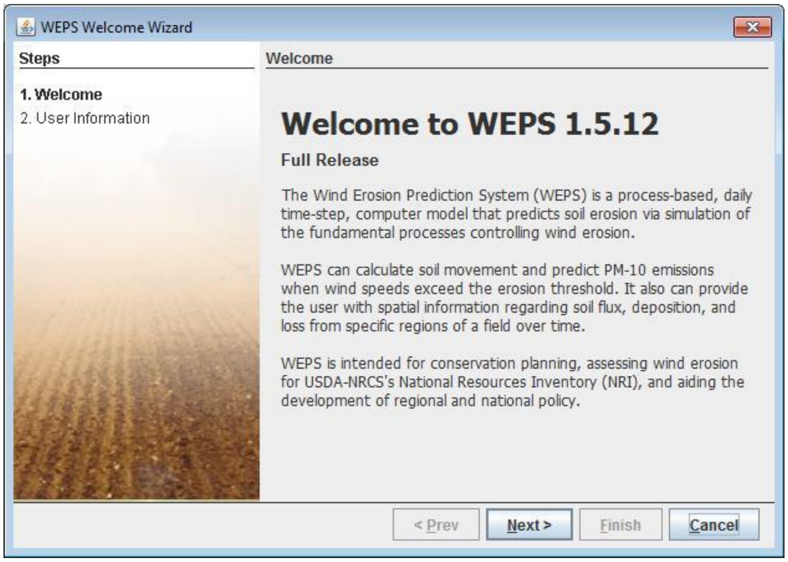

Figure 1-2 WEPS initial setup window.

The next window that will appear is the WEPS Setup Destination Folder (Figure 1-3). It will display the default WEPS installation folder and allow the user to change that location if desired. Once the desired location is specified, click on the "Next" button at the bottom of the screen.

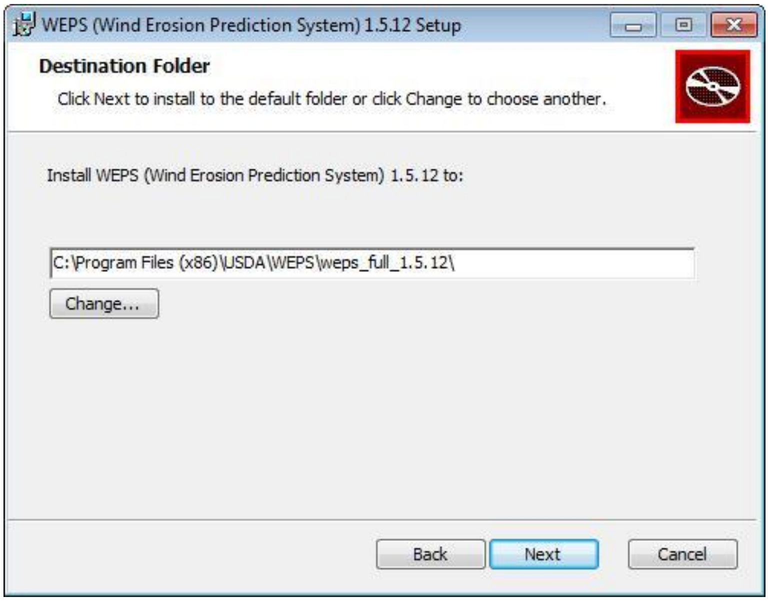

Figure 1-3 WEPS Setup Destination Folder Screen.

A **Ready to install WEPS** screen will now display (Figure 1-4).

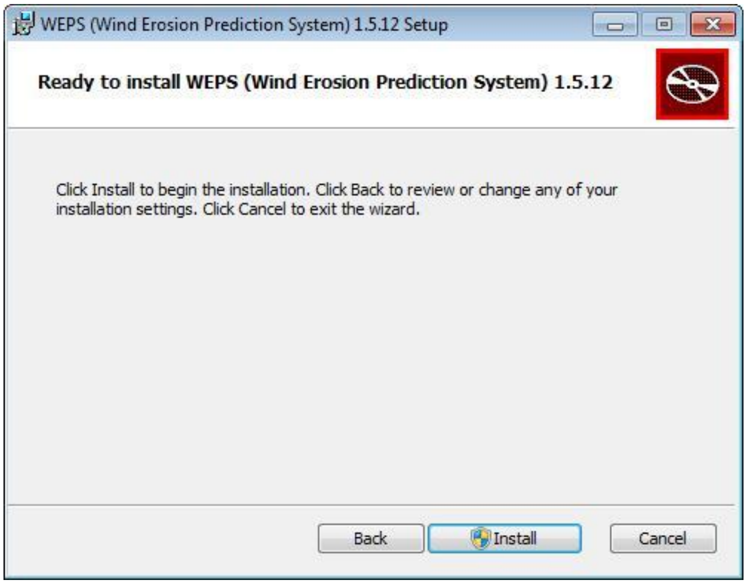

Figure 1-4 Ready to Install WEPS screen.

A **WEPS Installation Progression** screen will now display (Figure 1-5). When installation finishes, click on the "Next" button at the bottom of the screen. If installing under Windows 7 or later, usually the user will be presented with a security screen that they will have to select "Yes" to continue the installation.

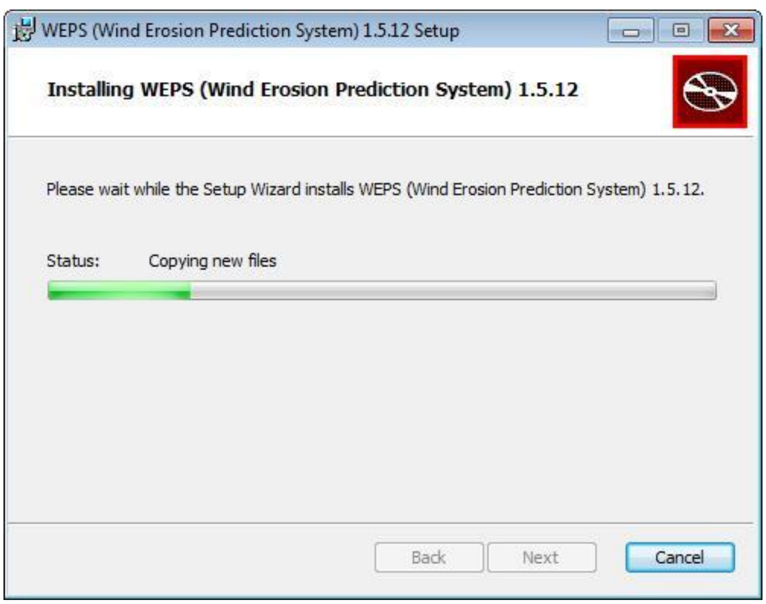

Figure 1-5 WEPS installation progression window.

A **WEPS Installation Complete** screen will now display (Figure 1-6). Click on the "Finish" button to close the window. WEPS has now been installed.

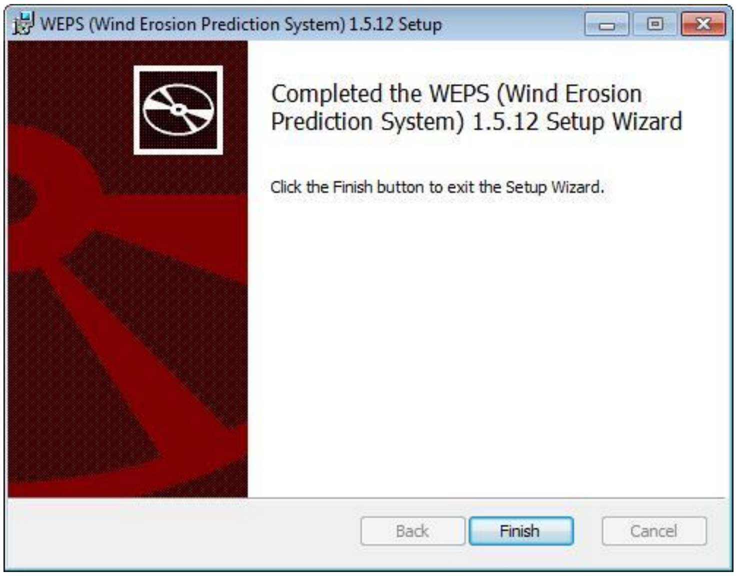

Figure 1-6 WEPS installation complete window.

Running the WEPS Wizard

The **WEPS Wizard** automatically runs the first time WEPS is initiated. The **WEPS Wizard** ensures that the user registers their contact information (name and email address) so that if they submit questions/comments/bug reports, we will know who sent the message.

Initiate WEPS from the Startup Menu (select “All Programs”, “USDA Applications”, “WEPS 1.5.x” and then the desired configuration of WEPS). Note that for the official NRCS WEPS release, the user will select “All Programs”, “USDA Applications”, then “WEPS”. The first window that will appear following the splash screen will be the WEPS Welcome Wizard screen (Figure 1-7). Select the “Next” button to proceed to the next Wizard screen.

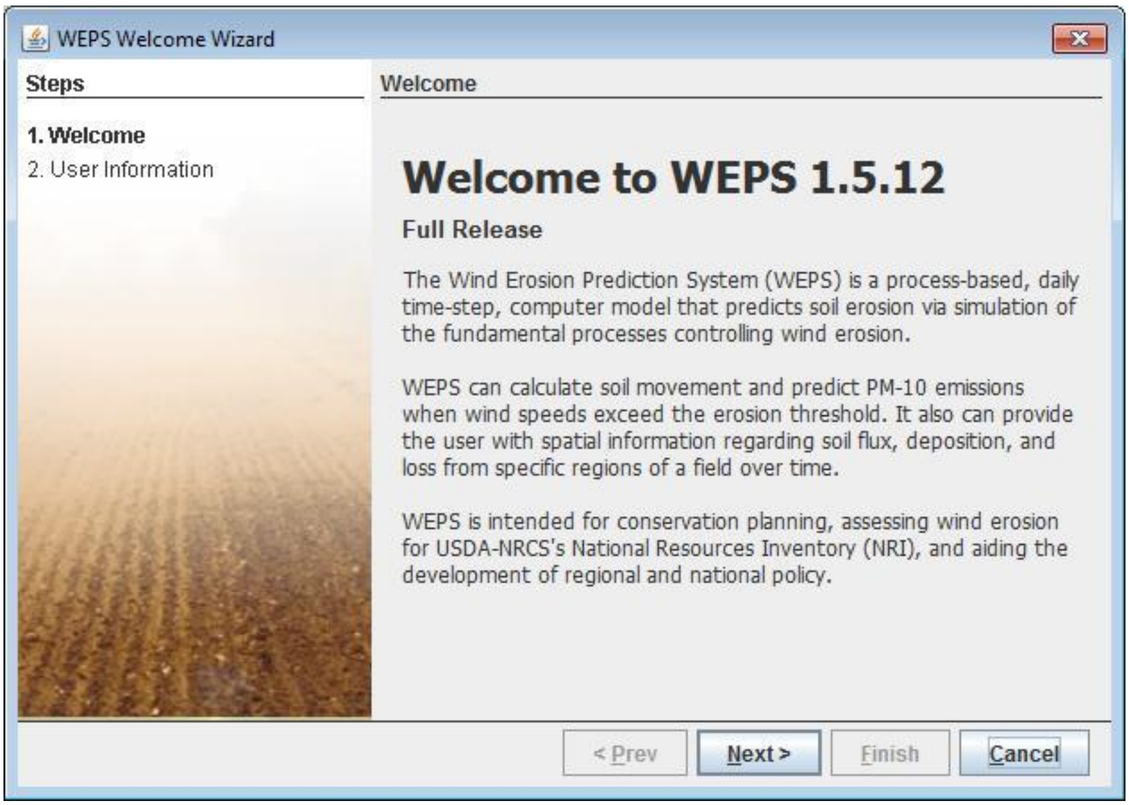

Figure 1-7 WEPS Welcome Wizard Window.

The **Welcome Wizard** requests the user's full name and email address (Figure 1-8). Fill in the appropriate information (the email address field will not accept text that does not contain an "@" character), select the "Next" button at the bottom of the screen.

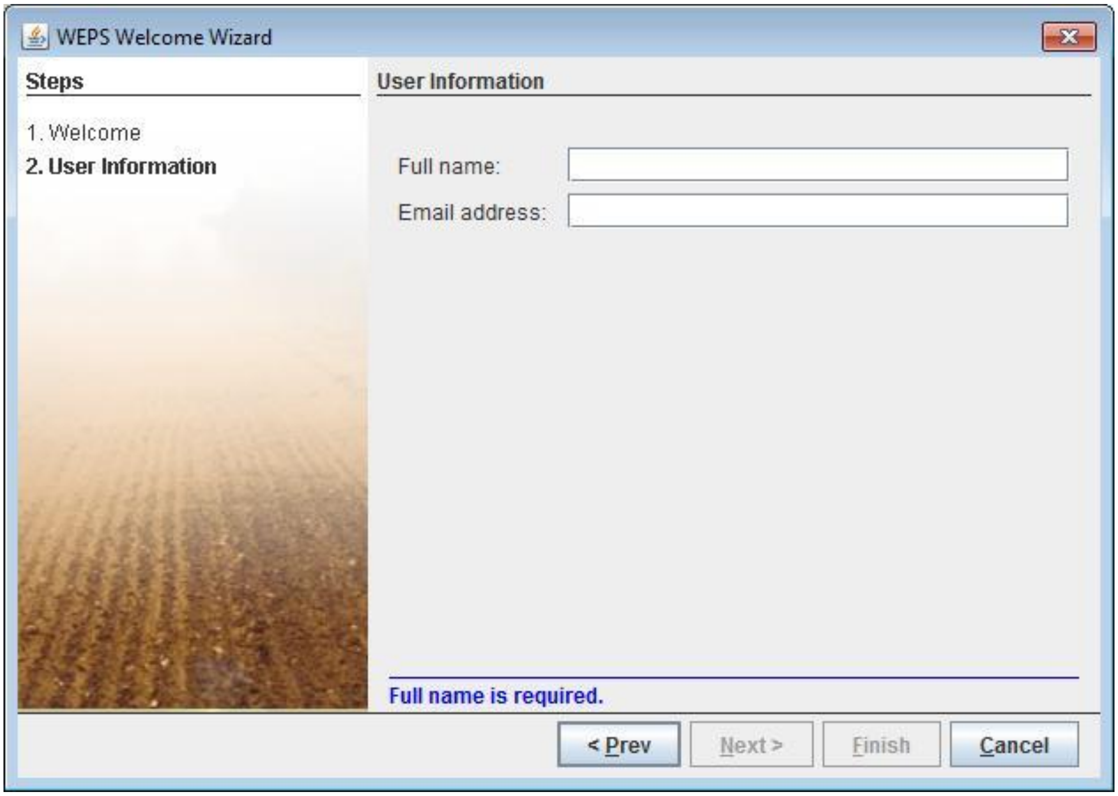

Figure 1-8 WEPS Welcome Wizard Window requesting name and email address.

The final WEPS **Welcome Wizard** screen will now display showing the absolute path and filename containing the user's local WEPS configuration file (Figure 1-9). Select the "Close" button to finish the **Welcome Wizard** and close the window to begin work with WEPS.

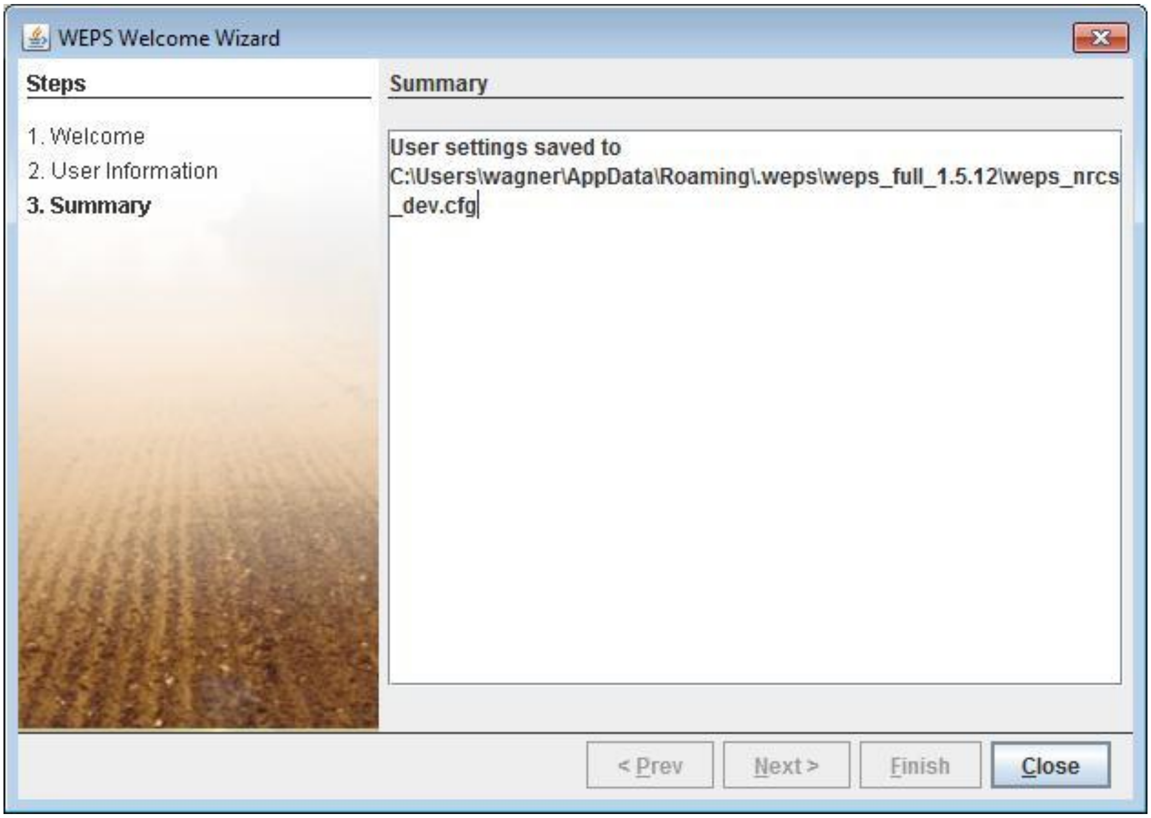

Figure 1-9 WEPS Welcome Wizard summary window.

1.3 Quick Start for WEPS 1.5

WEPS is a comprehensive wind erosion model with many options for inputs and outputs. For basic simulations however, WEPS is simple to operate. The following quick start guide will describe how to make a simple simulation run. To learn the more detailed features of WEPS, see the WEPS User Manual. For NRCS users, see the "Quick Start for NRCS Users of WEPS 1.5" for NRCS specific instructions related to your agency's use of WEPS.

For Windows 7 users, to start WEPS, go to the circular colored globe "Start" menu at the bottom left corner of the display and select "All Programs". Navigate to the "USDA Applications" menu, select the "WEPS ver. no." menu (where "ver. no." is the WEPS version) and then click the left mouse button on the "WEPS ver. no." menu option. It will contain the following WEPS icon to the left of potentially several menu options. Select the desired menu option ("WEPS" in this case). The WEPS main screen will then appear. In summary:

"Start>All Programs>USDA Applications>WEPS ver. no. >WEPS"

Note that the user may see variations on the naming scheme mentioned here, depending upon which release the user has installed and what options they selected during installation. Also, the user may also be able to start WEPS from desktop shortcuts, if selected for inclusion during the installation process.

A Simple Simulation

For a simple simulation, only four types of information are entered on the main WEPS screen.

1. Describe the simulation field geometry by selecting the field shape, dimensions and orientation in the panel labeled "Region".

   Type in the specific coordinate and/or area information (dependent upon the "shape" selected), e.g.: X-Length and Y-Length field dimensions for a "Rectangle" shape, as well as specific field orientation (±45° max) relative to true north, in the "Orientation" box.

2. Select a field location (for weather file selections).

   In the panel labeled "Location", use the mouse to select a Country (if enabled), State (or other country specific designation) and County (or other local designation) from the drop down menu . Coordinates for a location will be automatically selected near the center of the County. The weather stations, both "Cligen and Windgen", for the selected location will be automatically determined and displayed immediately below the elevation field. The "elevation field" itself will be automatically populated with the value from the currently selected "Cligen" station, which can overridden by the user, if desired.

3. Select a soil.

In the bottom panel of the window, to the far right of the button labeled 'Soil', use the mouse to select a soil from the drop down menu or via the filechooser "Template" button (if enabled) next to the labeled "Soil" button.

4. Select a management scenario.

In the bottom panel of the window, to the far right of the button labeled 'Man', use the mouse to select a crop rotation from the drop down menu or via the filechooser "Template" button (if enabled) next to the labeled "Man" button.

Once these items are complete, click the 'Run' button on the tool bar at the top of the screen. You will be asked to enter a name for the simulation run and click 'OK'. Once a run name is entered, you will then see indicators that WEPS is running. When the simulation run is finished, the "Run Summary" report screen will automatically appear on the computer screen .

Run Summary
The Run Summary displays user information, input parameter files, and basic soil loss information by rotation year, crop interval and the average annual soil loss for the total simulation. Soil loss (erosion) output in the Run Summary includes: ***Gross Loss***, the average erosion within the field; ***Total***, the average total net soil loss from the field; ***Creep/Salt***, the average creep plus saltation (≥100 µm dia. particles) net erosion from the field; ***Suspension***, the average net suspension size (<100 µm dia. particles) soil loss from the field; and ***PM10***, the average net loss of particulate matter less than 10 microns in size from the field.

Exiting WEPS
To exit WEPS click the "Project" (or "File") menu option on the far left of the menu bar at the top right corner of the main screen, then click "Exit". You will be asked if you want to save your current WEPS Project (state of selections made on the interface screen). You will also be asked to confirm if you really want to exit WEPS. Select "Yes" to exit WEPS.

Additional Information
WEPS has the capability for many simulation input options, including adding barriers and specifying numerous management options. WEPS also can optionally produce very detailed output to provide the user with a better understanding of what field conditions and management situations cause soil loss by wind and when. Consult the WEPS User Manual for complete details. For further information regarding WEPS, users should contact:

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Phone: 970-492-7382
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WEPS is a comprehensive wind erosion model with many options for inputs and outputs. For basic simulations however, WEPS is simple to operate. The following NRCS Users quick start guide will describe how to make a simple simulation run. To learn the more detailed features of WEPS, see the WEPS User Manual. For non-NRCS users, see the "Quick Start for WEPS 1.5" for specific instructions related to the use of the public release of WEPS.

For Windows 7 NRCS users, to start WEPS, go to the circular colored globe "Start" menu at the bottom left corner of the display and select "All Programs". Navigate to the "USDA Applications" menu, select the "WEPS" menu by clicking the left mouse button on that menu option. It will contain the following WEPS icon to the left of potentially several menu options. Select the desired menu option ("WEPS Wind Erosion Prediction" in this case). The WEPS main screen will then appear. In summary:

"Start>All Programs>USDA Applications>WEPS >WEPS Wind Erosion Prediction"

A Simple Simulation

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1. Describe the simulation field geometry by selecting the field shape, dimensions and orientation in the panel labeled "Region".

   Type in the specific coordinate and/or area information (dependent upon the "shape" selected), e.g.: X-Length and Y-Length field dimensions for a "Rectangle" shape, as well as specific field orientation (±45° max) relative to true north, in the "Orientation" box.

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Exiting WEPS

To exit WEPS click the "File" menu option on the far left of the menu bar at the top right corner of the main screen, then click "Exit". You will be asked if you want to save your current WEPS Project (state of selections made on the interface screen). You will also be asked to confirm if you really want to exit WEPS. Select "Yes" to exit WEPS.

Additional Information

WEPS has the capability for many simulation input options, including adding barriers and specifying numerous management options. WEPS also can optionally produce very detailed output to provide the user with a better understanding of what field conditions and management situations cause soil loss by wind and when. Consult the WEPS User Manual for complete details. For further information regarding WEPS, NRCS users should first contact:

Joel Poore, NRCS
Phone: 817-509-3213
E-mail: Joel.Poore@ftc.usda.gov

1.5 Overview: Wind Erosion Prediction System

Introduction

Soil erosion by wind is a serious problem in the United States and the world. Wind erosion is a threat to agriculture and the earth's natural resources. It renders soil less productive by removing the most fertile part of the soil, namely, the clays and organic matter. This removal of clays and organic matter also damages soil structure. In addition to the soil, wind erosion can damage plants, primarily by the abrasive action of saltating particles on seedlings and fruits. Eroded soil can also be deposited into waterways where it impacts water quality and emitted into the air where it degrades the air resources. By affecting these resources, wind erosion can also become a health hazard to humans and other animals. The ability to accurately simulate soil loss by wind is essential for, among other things, environmental and conservation planning, natural resource inventories, and reducing air and water pollution from wind blown sources.

The Wind Erosion Equation (WEQ) was published in 1965 by Woodruff and Siddoway (1965). For many years, WEQ has represented the most comprehensive and widely used model in the world for estimating soil loss by wind from agricultural fields. The functional form of WEQ is:

$$E = f(I, C, K, L, V) \tag{1.1}$$

where, E is the average soil loss (tons/acre/year), I is the soil erodibility, K is the soil ridge roughness, C is the climatic factor, L is the field length along the prevailing wind erosion direction, and V is the vegetative factor. WEQ is largely empirical in nature and was derived from nearly 20 years of field and laboratory studies by scientists at the USDA-Agricultural Research Service (ARS), Wind Erosion Research Unit (Chepil, 1958, 1959, 1960; Chepil and Woodruff, 1959). Many improvements were made to WEQ over the next 30 years (Tatarko, et al. 2013). Because of the limitations of adapting WEQ to many problems and environments, as well as advancements in wind erosion science and computer technology, the USDA Natural Resources Conservation Service requested that ARS develop a replacement for WEQ (Hagen, 1991).

Development of WEPS

Research in the 1980's (Cole et. al., 1983; Cole, 1984; and Lyles, et. al., 1985) provided the initial attempt to outline a processed based approach to simulating wind erosion that would replace WEQ. Following this initial work, the initial modular structure used in the current WEPS model was developed (Hagen, 1991), which was later revised (Wagner, 1996) and the experimental research needed to support that structure was outlined. Numerous field and laboratory studies were conducted to develop relationships for surface conditions and erosion. Experimental data were collected for weather (Skidmore and Tatarko, 1990), hydrology (Durar and Skidmore, 1995), crop growth (Retta and Armbrust, 1995), residue decomposition (Steiner et. al., 1995), soil (Hagen, et. al., 1995; Potter, 1990, Zobeck and Popham, 1990, 1992), management (Wagner and Ding, 1995), and erosion (Hagen, 1995). Experiments were also conducted to validate that the erosion routines were producing accurate and precise erosion estimates (Fryrear, et. al, 1991). A brief history of WEPS development has been documented (Wagner, 2013).

A multi-disciplinary team was assembled to develop WEPS that included climate modelers, agronomists, agricultural engineers, soil scientists, and crop modelers. The WEPS development project had a multi-agency commitment consisting of the Agricultural Research Service, Natural Resources Conservation Service, and the Forest Service from the U.S. Department of Agriculture, along with the Environmental Protection Agency, the Army Corps of Engineers, and the Bureau of Land Management. In 2005, WEPS was released to the NRCS for testing and further development for field office conservation planning. In 2008, WEPS was released to NRCS for field office implementation. In 2010 NRCS officially adopted WEPS and is now their primary tool for wind erosion assessments on cropland agricultural fields.

WEPS User Requirements

Early in the WEPS development process, input was requested from potential users on the needed capabilities of a new wind erosion simulation model. These user requirements were summarized by Hagen (1991). Based on these requirements, WEPS was designed to:

1. **Provide more accurate and detailed estimates of soil loss by wind from agricultural fields.** Results for WEQ were an annual average soil loss based essentially on average weather and field conditions. Since erosion is often the result of extreme weather events (e.g., high wind or dry soil conditions), an approach that accounts for such extreme conditions was needed to simulate the extreme soil loss for these situations. In addition, WEPS is capable of outputting erosion loss and surface conditions on a relatively fine temporal scale (e.g., hourly). However, for practical purposes, the default time step for WEPS output is two weeks. Such detail allows the user to observe the periods when excessive erosion occurs and the wind or surface conditions which caused the soil loss (e.g., low vegetative cover, etc.). These conditions can then be addressed by altering management or other control measures.

2. **Develop more cost-effective erosion control methods.** Because of the detail in the soil loss and field conditions provided by WEPS, it is a valuable tool for testing various management scenarios or control methods through simulation. Each scenario can be evaluated before a change in farming practices is made in the field. Surface conditions and management can be observed during periods of excessive loss and adjusted to minimize erosion.

3. **Simulate the amount of soil loss by direction.** With increasing concern of the offsite impacts of wind erosion on soil, water, and air quality, the capability of WEPS to provide the direction of soil loss is useful. For example, creep and saltation loss to a roadside ditch or waterway will impact water quality, so attention can be focused in these scenarios to controlling loss in that direction. Similarly, suspension loss in the direction of highly populated areas or nearby heavily trafficked roadways can be simulated with WEPS and specific control strategies simulated.

4. **Separate soil loss into creep/saltation, suspension, and PM10 components.** Each of these components have specific characteristics and effects. Creep/saltation are typically deposited locally where they can affect soil and water quality, bury crops, roads, and irrigation ditches, or be deposited as dunes in fences or windbreaks. Suspension, by definition, can be lifted into the air

and carried great distances. As such, it can be a detriment to air quality, become a health hazard, and reduce visibility along transportation systems. PM10 has been determined by the U.S. Environmental Protection Agency to be a hazard to air quality and a respiratory hazard in particular (U.S. EPA, 1996). Estimating soil loss of each of these components can aid in environmental assessments.

Taking all user requirements into consideration, WEPS is designed to be an aid in: 1) soil conservation planning, 2) environmental assessment and planning; and 3) determining off-site impacts of wind erosion.

WEPS Modeling Approach

WEPS is a process-based, daily time-step model that simulates weather, field conditions, and erosion. As such, it simulates not only the basic wind erosion processes, but also the field management and weathering processes that modify a soil's susceptibility to wind erosion. The current model release is WEPS 1.5 and is designed to provide the user with a simple tool for inputting initial field conditions, calculating soil loss, and displaying either simple or detailed outputs for conservation planning and design of erosion control systems.

WEPS 1.5 Geometries

To simplify inputs, WEPS 1.5 is designed with specific geometric constraints when specifying the simulation region or field (Figure 1-10). The simulation region is limited to a rectangular area. However other field shapes such as circles or half circles can also be simulated by defining a rectangle of the same length, width, or area of the desired field shape. The simulation area may be rotated to orient the field correctly on the landscape to account for the effects of varying tillage, planting, and wind directions.

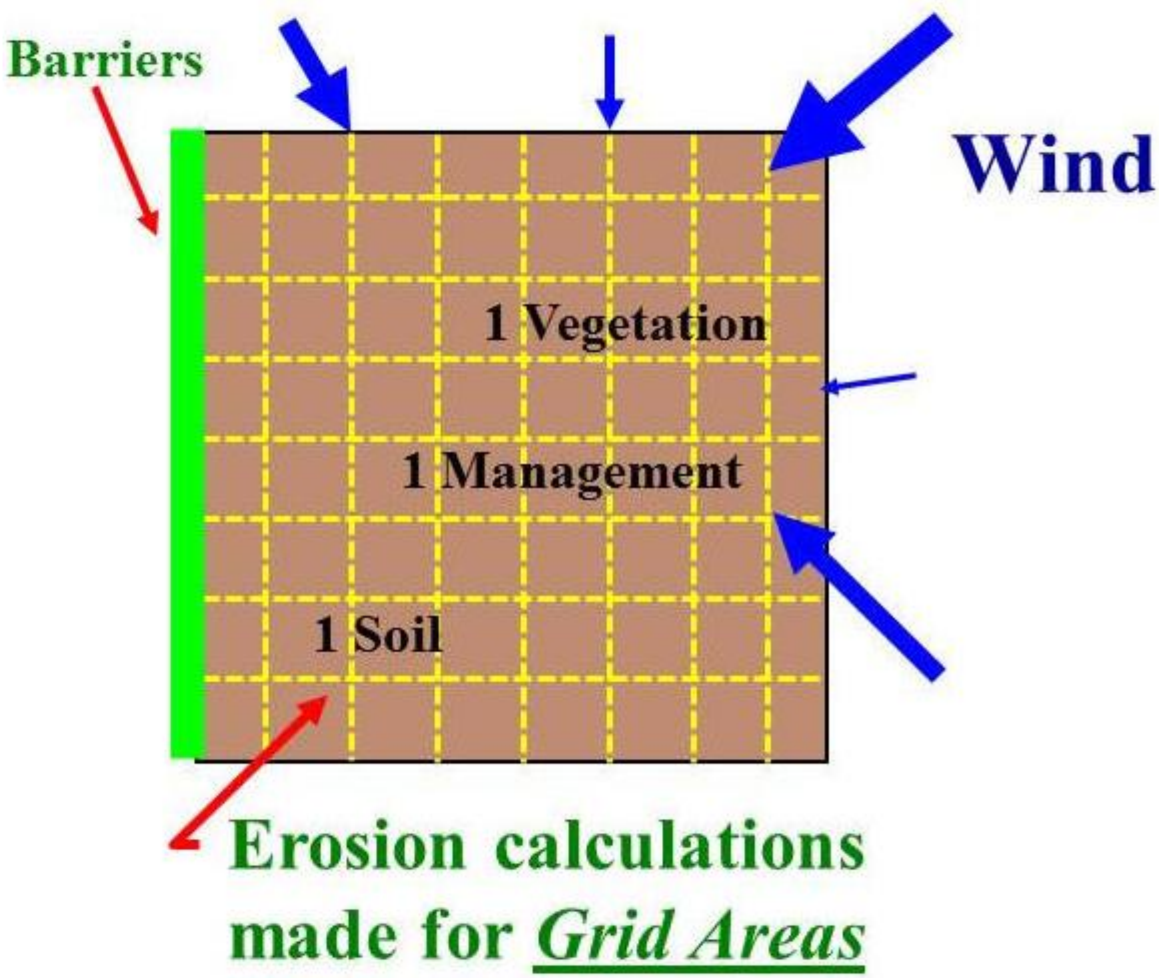

Figure 1-10 WEPS simulation geometries

A uniform simulation region surface is assumed in that only one soil type (uniform soil properties), crop type (biomass properties), and management are uniformly distributed over the field. In reality, fields are often not uniform so the user may select the dominant-critical (i.e., most erodible) soil or crop condition for a simulation. Barriers may be placed on any or all field boundaries. When barriers are present, the wind speed is reduced in the sheltered area on both the upwind and downwind sides of the barriers. Thus, WEPS can simulate deposition in front of downwind barriers. The erosion submodel determines the threshold friction velocity at which erosion can begin for each day's surface condition. When wind speeds exceed the threshold, the submodel calculates the loss/deposition over a series of individual grid cells representing the field. The soil loss and deposition is divided into components of saltation/creep and suspension, because each has unique transport modes, as well as off-site impacts. The field surface is periodically updated during erosion events to simulate the surface changes caused by erosion. Surface updating during an erosion event includes changes to aggregate size distribution of the surface as fine particles are removed and surface aggregates breakdown into smaller sizes due to impacts from moving particles, smoothing of ridge roughness as ridges are eroded and furrows fill with eroded materials, etc.

WEPS 1.5 Model Implementation

The structure of WEPS 1.5 is modular and consists of the science model, coded in FORTRAN 95 coupled with a graphical user interface, which is coded in JAVA. The model also includes five databases, two weather simulation generators, and six submodels (Figure 1-11).

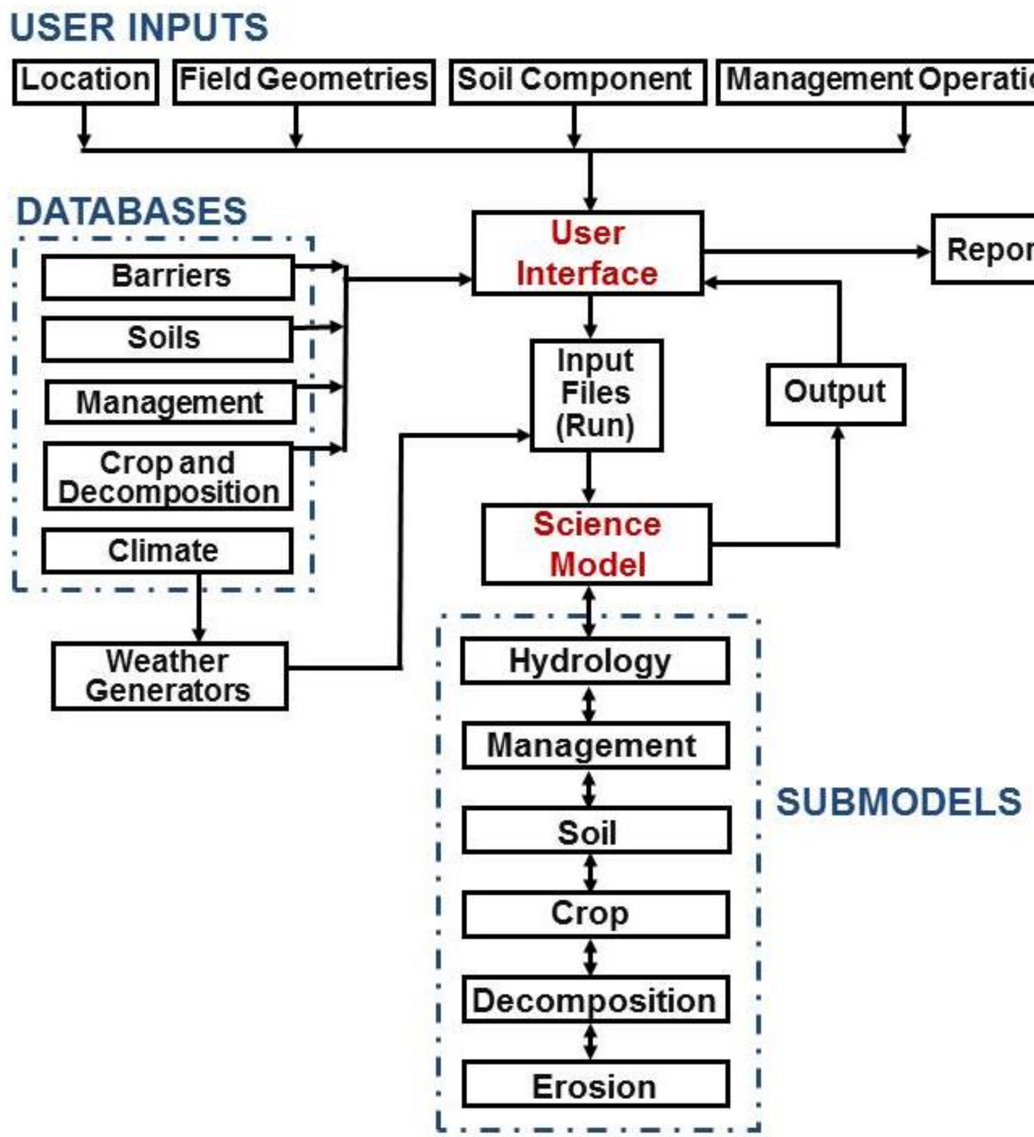

Figure 1-11 Structure of the WEPS model.

The user interface provides a means for the user to enter initial conditions such as the field dimensions, orientation, barriers, location, management operations, and soil component desired for the simulation region. Field dimensions are entered as a length and width and orientation as an angle deviation from north. The user selects the barrier type from a list accessed through the interface. For location, the user can either select the country (if configured for non-U.S. usage), state and county or enter a latitude and longitude directly for simulation. Based upon the latitude and longitude of the location, the interface then selects the weather stations for which statistical weather parameters based upon historical measured meteorological data are used to simulate daily (and hourly for wind) weather parameters. The soil component is selected from a list of soils supplied by the NRCS Soil Survey Geographic (SSURGO) database for the Soil Survey Area of the simulation region or, when online, directly from the NRCS Soil Data Mart website (http://soildatamart.nrcs.usda.gov). Management operation and dates are compiled in the Management/Crop Rotation Editor for WEPS (MCREW) in a spreadsheet style table editor.

Given the user supplied inputs, the interface accesses five databases for climate, soils, management, barriers, and crop growth and residue decomposition for the simulation. These databases provide needed parameters for location and conditions simulated as specified by the user. The interface writes the information needed for a WEPS simulation, obtained from the user and the databases, into WEPS input files. The interface also executes the weather generators which create weather files containing daily precipitation, maximum and minimum temperatures, solar radiation, and dew-point temperature as well as daily wind direction and subdaily (e.g., hourly) wind speeds. These input files for a given simulation are collectively known in WEPS as a “WEPS Run”. To reduce computation time, a daily time step is used in WEPS, except for selected subroutines in the Hydrology and Erosion submodels, which may use hourly or sub-hourly time steps (e.g., 15 minutes). The science model reads the input run files and calls the Hydrology, Soil, Crop, and Decomposition submodels daily which account for changes in the soil surface erodibility as influenced by management and weather. If surface conditions for a given day are such that erosion can occur for the maximum wind speed for that day, Erosion submodel routines are called to calculate soil loss and deposition. Soil erosion by wind is initiated when the wind speed exceeds the saltation threshold speed for a given soil and biomass condition. After initiation, the duration and severity of an erosion event depend on the wind speeds and the evolution of the surface conditions.

WEPS Model Use

WEPS is a comprehensive wind erosion model with many options for inputs and outputs. For basic simulations however, WEPS 1.5 is simple to operate. Only four types of information are entered on the main screen: 1) description of the simulation region geometry by defining the field dimensions and field orientation; 2) select the field location for which to generate simulated weather; 3) select the soil; and 4) select a management scenario. For U.S. simulations, the last three may be selected from lists provided with the WEPS model or from NRCS. New input files will usually be created using previous input files as templates modified within the user-interface. By varying inputs, particularly the field management, users can compare various alternatives to control soil loss by wind. Interpreting the outputs of WEPS is an integral part of using WEPS as a tool to develop conservation plans for controlling wind erosion. WEPS provides options for viewing very detailed outputs by periods (default is two weeks) including soil loss as saltation/creep, suspension, and PM10. Period output is also available for weather parameters such as wind energy, as well as surface conditions such as soil erodibility and biomass amounts. Such information is useful in determining which period is resulting in severe erosion and the conditions that are contributing to the loss. WEPS outputs also include amount of loss for each direction which aid the user in the placement of barriers, strip cropping, or other directional erosion control methods. More detailed features of WEPS and information on use of WEPS outside the U.S. are covered later in this manual. WEPS also has a Multiple Run Management View option to allow easier comparisons of alternative outputs.

Conclusion

The Wind Erosion Prediction System is a process-based, daily time-step model that simulates weather, field conditions, and erosion. WEPS development was in response to customer requests for improved wind erosion technology. It was intended to replace the predominately empirical Wind Erosion Equation as a prediction tool for those who plan soil conservation systems, conduct environmental planning, or assess offsite impacts caused by wind erosion. The WEPS model is continually being improved with periodic updates. Plans are in place to develop the following enhancements to WEPS for future upgrades: i) provide plant damage estimates, ii) integration with the Water Erosion Prediction Project (WEPP) model, iii) add capabilities for other, non-cropped lands such as range lands, iv) predict visibility effects of dust storms, v) dust prediction via weather forecasting, vi) prediction of PM2.5 and PM-coarse (PM10 minus PM2.5), and vii) include capabilities for complex fields in terms of relief (terrain elevation), multiple soils, crops, and management on one simulated field.

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2 WEPS INTERFACE REFERENCE

2.1 WEPS Interface Main Screen Components

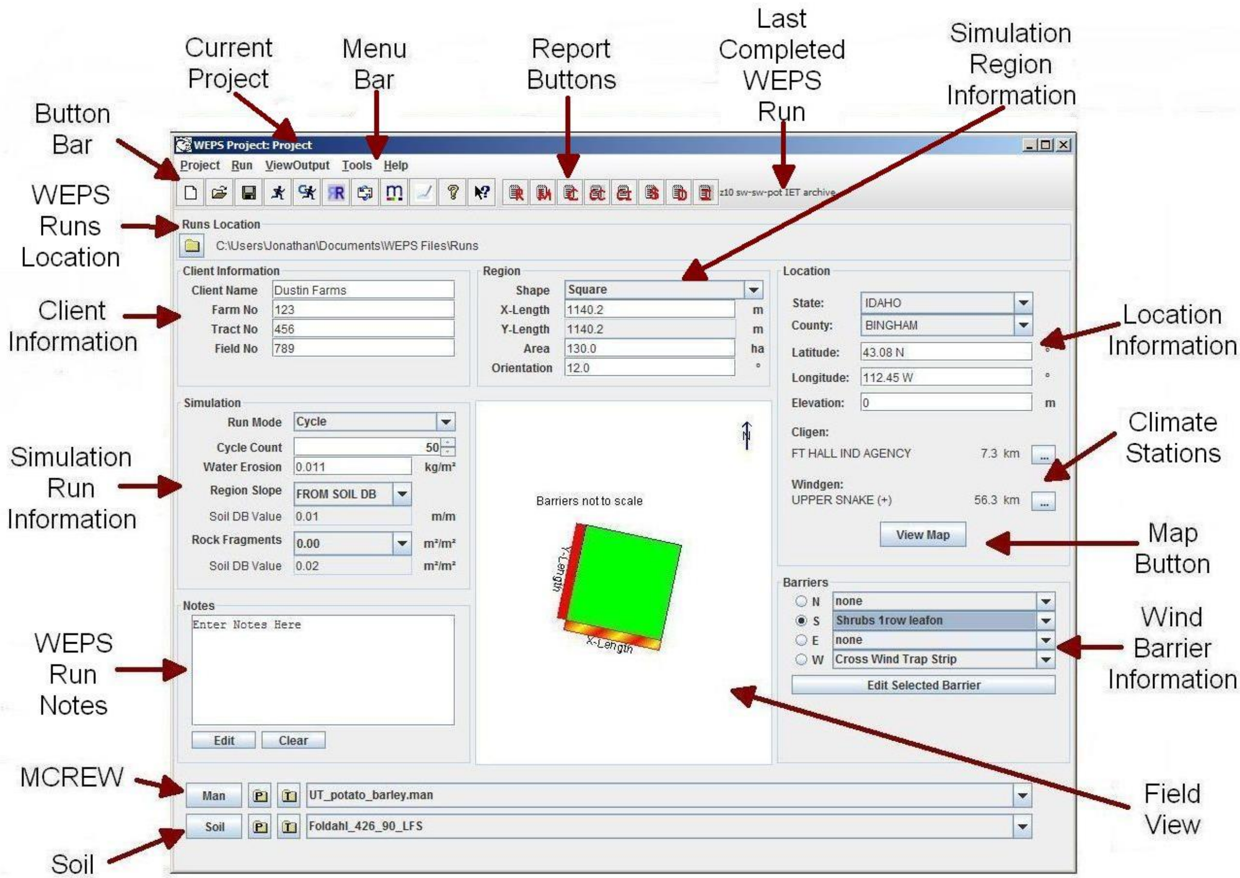


Figure 2-1 Main screen of the Wind Erosion Prediction System.

The WEPS main screen (Figure 2-1) should appear at model startup. Each part of the main screen is labeled in the Figure with regard to its function. A brief description of each part is given below. More detailed descriptions of their functions and use follow later in this chapter.

- The **Button Bar** and **Menu Bar** are collectively referred to as Toolbars. The **Menu Bar** provides the user with access to many of the operational functions of WEPS. The **Button Bar** provides a shortcut method of executing some of the **Menu Bar** functions.

- The **Report Buttons** are part of the **Button Bar** and provide quick access to the most commonly referred to WEPS reports. The **Last Completed WEPS Run** is also displayed just to the right of the last WEPS report button on the **Button Bar**.

- The current **WEPS Runs Location** (**Runs Location** panel) is displayed immediately below the **Button Bar** which lists the default directory where individual WEPS Runs are stored.

- The **Client Information** (**Client Information** panel**)** is used to enter customer information for a simulation run. The customer information is for information use only and is not required for the operation of WEPS.

- The **Simulation Region Information** (**Region** panel) provides the physical dimensions (i.e., shape, length and width or radius, and area) and the orientation with respect to north of the simulation field.

- The **Simulation Run Information** (**Simulation** panel) is used to enter specific information for a simulation run, as well as information regarding the run mode.

- **WEPS Run Notes** (**Notes** panel) in the lower left section of the screen is where the user can enter specific information regarding the upcoming WEPS simulation Run. These notes are retained as part of the upcoming WEPS simulation run and can also be further edited and printed from the Run Summary report after the conclusion of the WEPS simulation run.

- Access to **MCREW** (Management/Crop Rotation Editor for WEPS) is provided in the (**Man** panel) and allows for the selection, creation, and editing of management scenarios. Only one management rotation sequence is currently allowed for the WEPS simulation region.

- Access to the **Soil** viewer/editor is available from the (**Soil** panel) and is where the user can select and view the soil information for the upcoming WEPS simulation run. Only one soil is currently allowed for the WEPS simulation region.

- The **Location Information** (**Location** panel) is used to specify the location of the simulation field. This information is used to assist in determining the climate and wind stations (**Climate Stations**) selected for the upcoming WEPS simulation run. The **Map Button** (**View Map** button) is used to access a map viewer displaying weather and wind station locations as well as other GIS related information.

- **Wind Barrier Information** (**Barriers** panel) is where the selection and placement of wind barriers on the specified field borders is entered.

○

- The **Field View** (**Field View** panel) displays the physical dimensions and orientation of the field and location of wind barriers. This panel is for information only and is not directly editable. The **Field View** panel contents are updated automatically when information is changed in the **Region** and **Barriers** panels.

2.2 WEPS Toolbars

WEPS Menu Bar

The menu bar is the top line of the WEPS main screen. A description of each item on the menu bar is given below. Note that the NRCS configured WEPS release contains a slightly modified version of the menu bar. The **Project** menu option is replace with the **File** menu option. The specific differences between the two menu options' sub-options are highlighted below.

○ Project (or File) menu options

The "**Project**" menu is a drop down list of various computer operations pertaining to WEPS Projects, Runs and files. The Project menu contains the following options:

- **New** (Ctrl-N) - Allows user to create a new "Project" folder. Note that the NRCS configured WEPS release does not contain this submenu option since it is configured to only use a single "Project" folder.
- **Open...** (Ctrl-O) - Allows user to open a different pre-existing "Project" folder. Note that the NRCS configured WEPS release does not contain this submenu option since it is configured to only use a single "Project" folder.
- **Save** (Ctrl-S) - Saves currently displayed information on the main WEPS screen to the current "Project" folder.
- **Save As...** (Ctrl-A) - Saves the currently displayed information under a different "Project" folder. Note that the NRCS configured WEPS release does not contain this submenu option since it is configured to only use a single "Project" folder.
- **Set Run Location** (Ctrl-U) - Allows the user to change the default WEPS Run Directory.
- **Reset** – Resets the main WEPS screen to the default values. Note that the NRCS configured WEPS release does not provide this option.
- **Delete Project** (Ctrl-P) - Opens a file chooser in the folder containing the current "Project" to allow the user to select WEPS Projects for deletion. Note that the NRCS configured WEPS release does not contain this submenu option since it is configured to only use a single non-removable "Project" folder.
- **Export Run** - Allows the user to move or copy (user specified toggle in the popup screen determines if the original WEPS Run is deleted or not) previous WEPS Runs into other folder locations.
- **Delete Run** (Ctrl-D) - Opens a file chooser in the folder containing WEPS Runs to delete user selected WEPS runs.
- **Delete Management Rotation File** (Ctrl-M) - opens a file chooser in the current "Project" folder to delete user selected WEPS management files.

- **Delete IFC Soil File** (Ctrl-L) - Opens a file chooser in the current "Project" folder to delete user selected WEPS soil files.
- **Browse Database Folder…** - Opens up a copy of the computer system's file manager (Windows Explorer in Windows). The starting location is the folder specified in the WEPS configuration settings where the WEPS database files reside
- **Exit** (Ctrl-X) - Exit the WEPS program.

Run menu options

This allows the user to run WEPS using the current inputs specified on the WES main screen or to restore inputs from previous WEPS Runs. Details of each of these options are provided in detail here (Making a WEPS Run) and here (Restore a WEPS Run). The **Run** menu on the WEPS Main Screen displays the following options:

- **Make a WEPS Run** (Ctrl-R) - Begin a WEPS simulation using the currently selected inputs specified on the main WEPS screen.
- **Make a Yield Calibration WEPS Run** (Ctrl-C) - Begins a WEPS simulation running WEPS in "yield calibration mode" using the currently selected inputs specified on the main WEPS screen. See section titled "Making a WEPS Run" for more information on yield calibration runs.
- **Restore WEPS Run** (Ctrl-E) - Opens a file viewer listing previous WEPS Runs from which the user can select one from and load that previous WEPS Run inputs into the WEPS interface screen.

ViewOutput menu options

This menu allows the user to view output for the most recent (i.e., last completed) WEPS run or any other previous WEPS runs. Discussion of the specific contents of all the reports are provided here (Viewing WEPS Output).

- **Most Recent Run –** Clicking on this menu item opens a list of output options.
  - **Crop** (Ctrl+Shift-C) - Displays a summary of crop yields and water usage statistics for the most recent WEPS simulation run.
  - **Cover Crop** (Ctrl+Shift-V) - Displays a summary of all cover crops (non-harvested crops) biomass production parameters and water usage statistics for the most recent WEPS run.
  - **Crop Interval** (Ctrl+Shift-I) - Displays a summary of each crop interval's biomass production parameters and water usage statistics for the most recent WEPS run.
  - **Management** (Ctrl+Shift-M) - Displays a summary of management operations, operation dates and crops associated with the planting and harvesting operations for the most recent WEPS run.
  - **STIR Energy** (Ctrl+Shift-E) - Displays an SCI (Soil Quality Index) summary and both Rotation STIR Energy and Crop Interval Stir Energy reports.
  - **Crop Detail** - Displays a detail year by year report of all crop yields and water usage statistics for the most recent WEPS run.

- **Cover Crop Detail** - Displays a detail year by year report for all cover crops (non-harvested crops) biomass production parameters and water usage statistics for the most recent WEPS run.
- **Crop Interval Detail** - Displays a detail of each crop interval and breaks each crop interval into its component "Crop Periods" and reports their biomass production parameters and water usage statistics for the most recent WEPS run.
- **Confidence Interval** - Displays the "Confidence Interval" information on the wind erosion soil loss in a yearly plot and a quartile distribution plot, which includes outliers.
- **Tabular Detailed Report** (Ctrl+Shift-T) - Displays a detailed output in a spreadsheet format for the most recent WEPS run.
- **Science Model Reports** (Ctrl+Shift-D) - Displays a window to view additional science model text-based output files from the most recent WEPS run.

➢ **Previous Run -** Clicking on this menu item opens the following list of output options. Selecting any of these options will bring up a file chooser where the user can select the desired previous WEPS Run folder, which will then display the selected report.

- **Run** (Ctrl+Alt-R) - Displays a brief output summary for the selected WEPS run.
- **Crop** (Ctrl+Alt-C) - Displays a summary of crop yields and water usage statistics for the selected WEPS run.
- **Cover Crop** (Ctrl+Alt-V) - Displays a summary of all cover crops (non-harvested crops) biomass production parameters and water usage statistics for the selected WEPS run.
- **Crop Interval** (Ctrl+Alt-I) - Displays a summary of each crop interval's biomass production parameters and water usage statistics for the selected WEPS run.
- **Management** (Ctrl+Alt-M) - Displays a summary of management operations, operation dates and crops associated with the planting and harvesting operations for the selected WEPS run.
- **STIR Energy** (Ctrl+Alt-E) - Displays an SCI (Soil Quality Index) summary and both Rotation STIR Energy and Crop Interval Stir Energy reports.
- **Crop Detail** - Displays a detail year by year report of all crop yields and water usage statistics for the selected WEPS run.
- **Cover Crop Detail** - Displays a detail year by year report for all cover crops (non-harvested crops) biomass production parameters and water usage statistics for the selected WEPS run.
- **Crop Interval Detail** - Displays a detail of each crop interval and breaks each crop interval into its component "Crop Periods" and reports their biomass production parameters and water usage statistics for the selected WEPS run.
- **Confidence Interval** - Displays the "Confidence Interval" information on the wind erosion soil loss in a yearly plot and a quartile distribution plot, which includes outliers.
- **Tabular Detailed Report** (Ctrl+Alt-T) - Displays a detailed output in a spreadsheet format for the selected WEPS run.

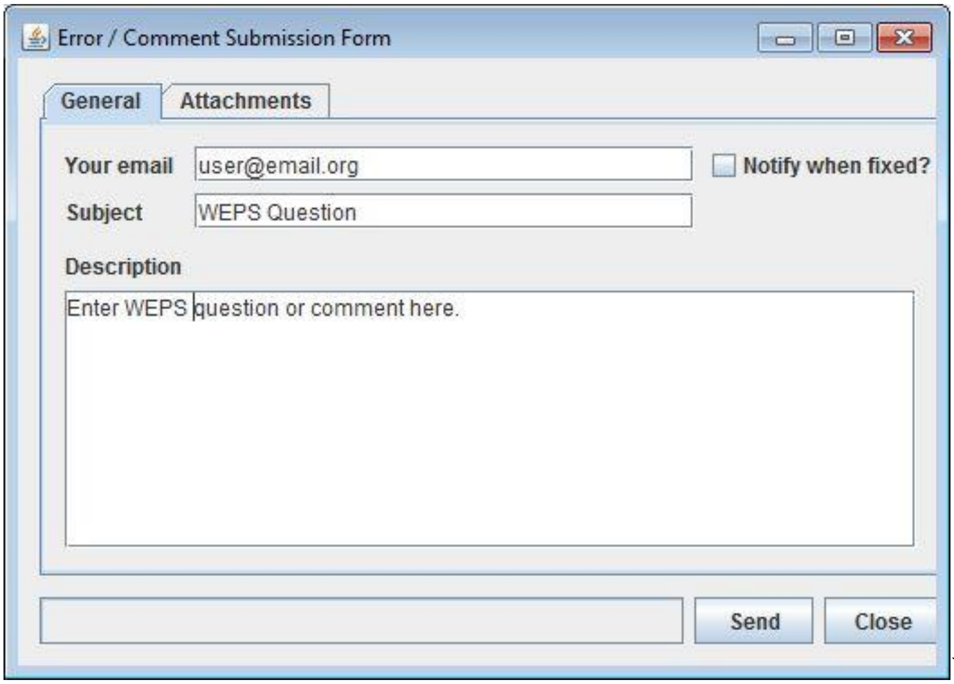
- **Science Model Reports** (Ctrl+Alt-D) - Displays a window to view additional science model text-based output files from the selected WEPS run.

- **Multiple Run Manager -** Opens a window displaying output information from multiple WEPS Runs for "side-by-side" comparisons of the results. The "Run" menu at the top of the screen contains items that allow the user to add a directory of runs, or a single run. The user can also restore a selected run in WEPS so that its results can be viewed in more detail or modified for another run. The "Help" menu item allows the user to display version information about the Multiple Run Manager. Additional information regarding this screen is provided later. The Multiple Run Manager is discussed in more detail here (WEPS Multiple Run Manager (WMRM)).

Tools menu options

This menu contain various tools available for use with WEPS, including:

- **Database Reports** - Display reports of the "user notes" for the following WEPS crop, operation and management database records:
  - **Crops** - Prints out the "user notes" for each crop record in the crops database folder(s), if available, else only the name of the crop record is printed.
  - **Operations** - Prints out the "user notes" for each operation record in the operations database folder(s), if available, else only the name of the operation record is printed.
  - **Managements** - Prints out the "user notes" for each management/crop rotation file in the management database template folder(s), if available, else only the name of the management/crop rotation file is printed.
- **Send Email** (Alt-E) - Send email comments to ARS, providing the computer is connected to the Internet and the email configuration options are properly configured. The "Send Bug/Comment Report" (the next menu option and mentioned next) is now the preferred communication method.
- **Send Bug/Comment Report** (Alt-B) - Send comments and bug reports directly to ARS, provided the computer is connected to the internet. Selecting this option brings up an "Error/Comment Submission Form" (



) that requests the user's email address and name. It also provides a "Description" field to allow the user to enter a message. In addition, the user can also attach individual files, the most current WEPS run and also an entire WEPS Project directory to the message, if desired (Figure 2-3). The WEPS log file is automatically zipped and attached to the message by default. This is the preferred communication method to use.

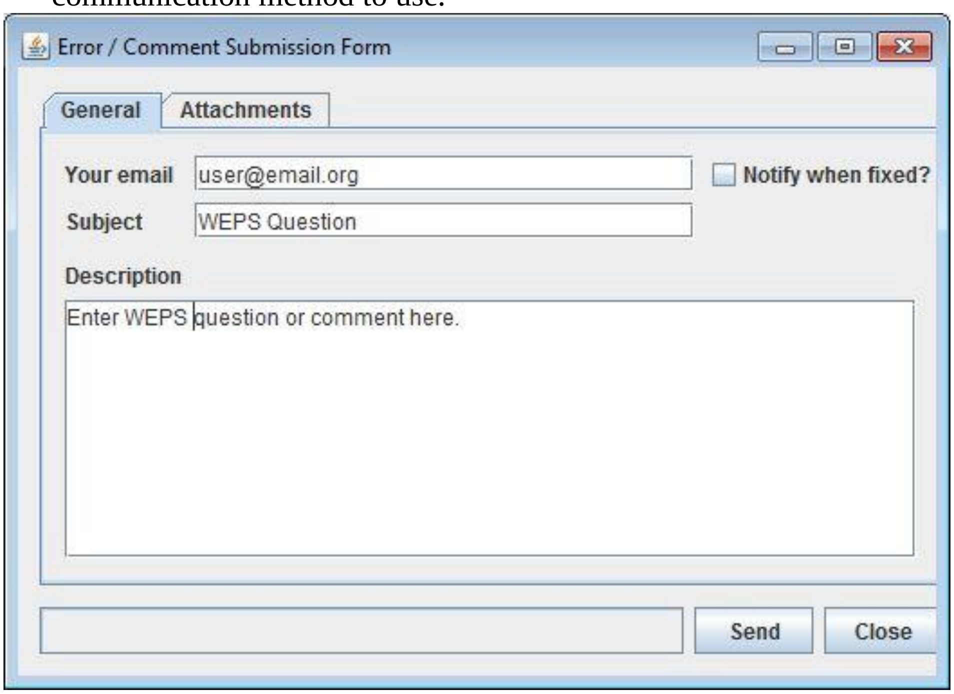


Figure 2-2 Error/Comment Submission form displaying the "General" tab.

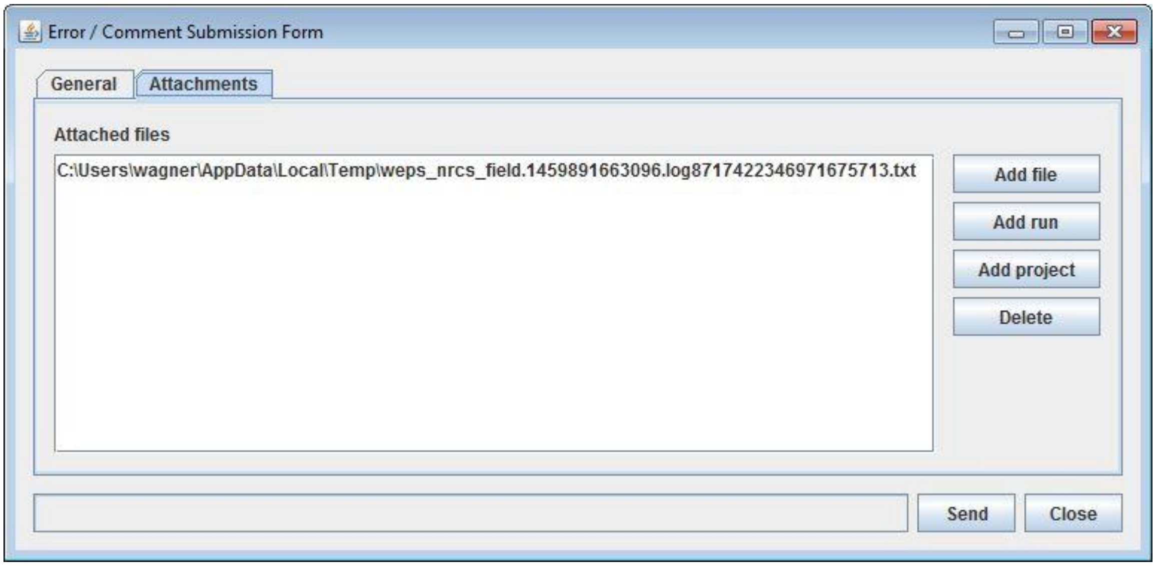


Figure 2-3 Error/Comment Submission form displaying the "Attachments" tab.

- **Display Wind Station Info** (Ctrl+Alt-W) - Displays wind information for the selected Windgen station including wind parameters by month in a popup window. For the selected Windgen wind station and the specified wind speed threshold (m/s), the average wind energy for the year (kJ/m^2/day), the percent of winds greater than the specified threshold, the monthly percent of the annual erosive wind energy, the preponderance (maximum ratio of parallel to perpendicular erosive winds) and prevalence of prevailing erosive wind direction for each month). The parameters are displayed for each month. Additional information regarding the Wind Station Data information popup window is fully described here (Displaying Wind Station Data Information).
- **Diff WEPS Files** - Opens a window that allows a comparison of differences in two WEPS files. Additional information regarding the WEPS Diff tool is provided here (Comparing WEPS Files for Differences).

Edit Configuration (Alt-C) - Opens up the tabbed configuration window allowing the user to view/set various configuration options for WEPS. Details on the Configuration panel and all options, etc. are provided here (WEPS Configuration Options and Settings).

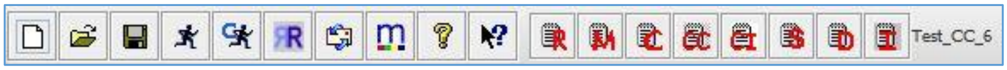
Help Menu Option

This menu contains various help related and miscellaneous options for WEPS.

- **Help Topics** (Ctrl+Alt-T) - Displays a window containing the WEPS online help system.
- **User Guide** - Displays a copy of the PDF formatted WEPS User's Guide (a PDF viewer must be installed on the computer for this function to work.
- **Welcome Wizard** - Runs the initial configuration wizard which requests the user's name and email address and sets them in the local WEPS configuration file.
- **About WEPS** (Ctrl+Alt-A) - Displays the Build Date, Release Number, and Java Runtime Version used for WEPS, etc.
-

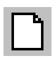
WEPS Button Bar

At the top of the main WEPS window (below the menu bar) is a series of buttons with icons. They provide shortcuts to some of the menu option functions to assist the user in the operation of WEPS.



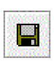
Some buttons may or may not be visible because WEPS can be configured to not display some of them or disable specific features that these button bar icons are use with. Note that the NRCS configured version of WEPS also does not display all of the icons shown here. The specific NRCS differences are highlighted below.

WEPS Project Buttons



This button allows user to create a new WEPS Project from scratch. This has the same function as selecting **New** under **Project** on the menu bar. If multiple WEPS Project functionality is not enabled, this button is not available, such as on NRCS configured versions of WEPS.

- This button opens an existing WEPS Project. This has the same function as selecting **Open** under **Project** on the menu bar. If multiple WEPS Project functionality is not enabled, this button is not available, such as on NRCS configured versions of WEPS.



- This button saves the currently displayed WEPS Project to its current file name (the current WEPS Project filename is displayed in the upper left corner of the main WEPS screen). This has the same function as selecting **Save** under **Project** on the menu bar. If multiple WEPS Project functionality is not enabled, this button is equivalent to **Save** under **File** on the menu bar.

-

WEPS Run Buttons

The **Run** button begins a; WEPS simulation run. This has the same function as **Make a WEPS Run** under **Run** on the menu bar.

The **Run Calibration** button begins a WEPS yield calibration simulation run. This has the same function as **Make a Yield Calibration WEPS Run** under **Run** on the menu bar.

The **Reload** button allows the user to “restore the inputs from a previous WEPS run” into the main WEPS interface window. This has the same function as **Restore a WEPS Run** under **Run** on the menu bar.

WEPS Communication and Help Buttons

The **Email** button allows the user to email comments to ARS. Clicking the **Email** button brings up the user’s email window, if appropriately configured. This has the same function as **Send Email** under **Tools** on the menu bar.

The **Mantis** button allows the user to send comments and/or bug reports to ARS, along with the contents of a WEPS Project, WEPS run or individual files, if desired. Clicking this button brings up a separate window. That windows functions are described fully here (Reporting Errors and Submitting Questions/Comments). This has the same function as **Send Bug/Comment Report** under **Tools** on the menu bar.

The **Question** button opens the general online help system for WEPS.

The **Context Help** button provides help for a particular item on the WEPS screen. Clicking the **Context Help** button on the tool bar and then clicking on the item on the screen for which help is desired brings up a help screen for that specific item.

WEPS Report Buttons

These buttons display the last (current) WEPS Run results, e.g. **Run Summary**, **Management/Crop Rotation**, **Crop Summary**, **Cover Crop Summary**, **Crop Interval Summary**, **Stir Energy**, **Detailed Report** and **Confidence Interval** reports respectively. All of these reports are also accessible under the **ViewOutput** menu option along with additional, more detailed reports for both current and previous WEPS Runs. Full explanations of each report and their contents are described here (Viewing WEPS Output).

➢ Following the report icon buttons, the last (current) WEPS Run name is displayed. If the run name is too long to fit on the button bar row, it will be truncated. The main WEPS interface screen can be resized though, so it is usually possible for one to widen the screen to see the complete WEPS Run name if desired.

2.3 Specifying WEPS Run Information

There are several items that a user needs to address prior to using WEPS. Most of these items are not critical for most WEPS Runs, but are beneficial for keeping track of previous runs, documenting what was done for each run, listing who the client is and why the WEPS Run(s) were being made, etc. Other items are purely useful for better organization of previous WEPS Runs, clean up of temporary results and deletion of old temporary simulation runs, etc.

WEPS Runs Location

The first item is determining where one wants to store WEPS runs and setting the default location for them. This can be configured within the "Configuration" panel, but was added to the WEPS main screen to allow the user the ability to easily override the default configuration setting, if desired. The WEPS **Runs Location** panel (Figure 2-4) is located immediately below the "**Button Bar**" on the Main WEPS screen (see Figure 2-1).

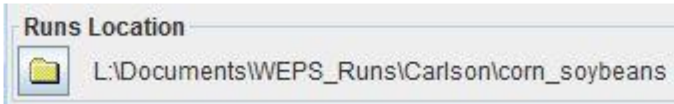
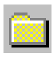


Figure 2-4 WEPS Runs Location panel on Main WEPS Screen.



This **Set Run Location** button allows the user to change the default WEPS Run Directory by popping up a modified file chooser window (Figure 2-5). The field immediately to the right (Figure 2-4) lists the currently selected WEPS **Runs Location** folder. The user can also revert back to the configuration default setting by clicking on the 

button in the right side panel of the file chooser window.

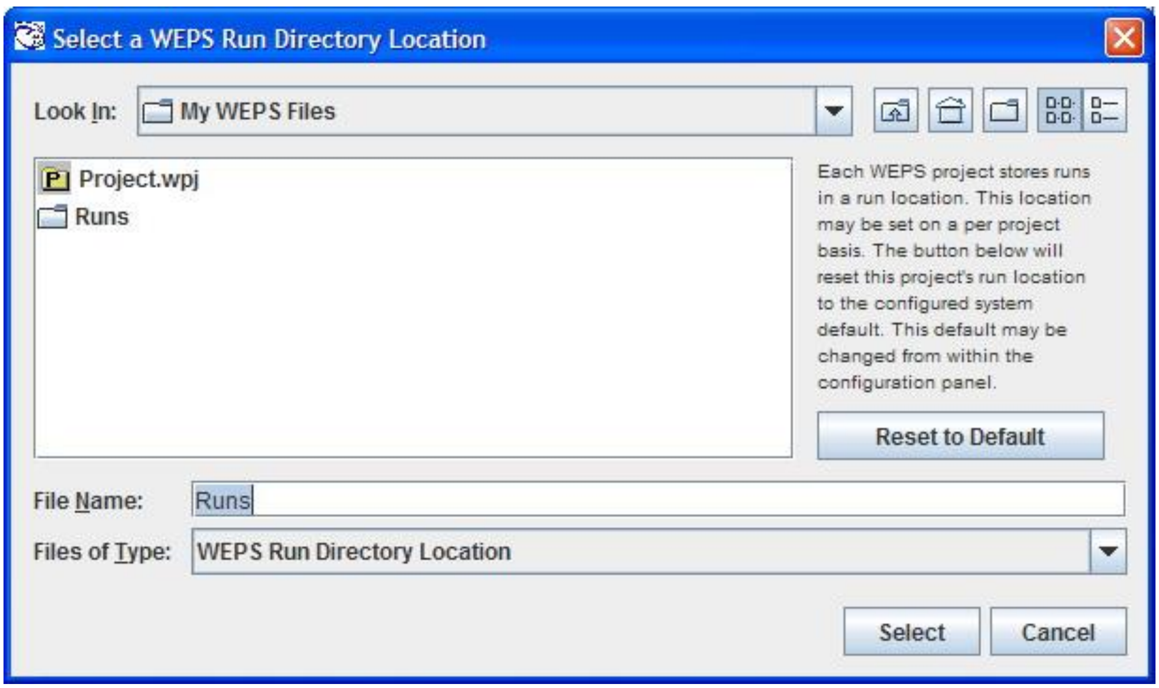


Figure 2-5 File chooser window to select/set the desired WEPS Run Directory Location.

Simulation Run Information

Simulation information is entered in the **Simulation** panel on the WEPS main screen (Figure 2-6 and Figure 2-7). The run-length mode determines the length and type of WEPS Run that will be simulated. There are three options for **Run Mode**: 1) An **NRCS** mode indicates that the number of simulation cycles is fixed to "50 cycles per rotation year in the selected management rotation". This option is specified and locked (read-only) for official NRCS field use in the "NRCS configured" release of WEPS; 2) The **Cycle** mode indicates that the user can specify the number of simulation cycles to run (number of years to simulate for each rotation year in the selected management rotation). The larger the value specified, in general the more accurate (consistent) the simulation results will be. The default value of 50 cycles is generally considered a good compromise between accuracy and simulation runtime. The default length of run (number of cycles) is controlled through the "Run" tab in the "Configuration Settings" panel (see the discussion on "Configuration" for more details); 3) The **Dates** mode allows the user to specify the exact starting and ending dates for the simulation. This mode is only intended for researchers and developers for specific experimental scenarios are being evaluated. The “Dates” mode does not guarantee that the WEPS interface reports will display accurate information like the “NRCS” and “Cycle” modes do.

Figure 2-6 Simulation panel displaying the "Run Mode" input field.

There are additional fields in the **Simulation** panel besides **Run Mode**: a) **Water Erosion**; b) **Region Slope** with its **Soil DB Value**; and d) **Rock Fragments** with its **Soil DB Value** (Figure 1-7).

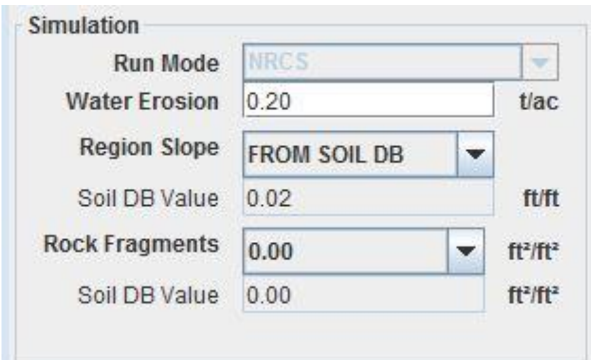


Figure 2-7 Full simulation panel display.

The **Water Erosion** value is required for true estimates of the Soil Quality Index, which uses both wind and water erosion estimates in its computation. The Soil Quality Index is used by NRCS as an indicator of whether a particular set of management practices are improving or degrading the relative quality of the soil based upon the management practices specified for a WEPS simulation run. NRCS requested that the index be computed as an ancillary byproduct of each WEPS wind erosion simulation. This input field therefore has no impact on wind erosion estimates and is not required to be properly populated for a non-NRCS WEPS simulation run.

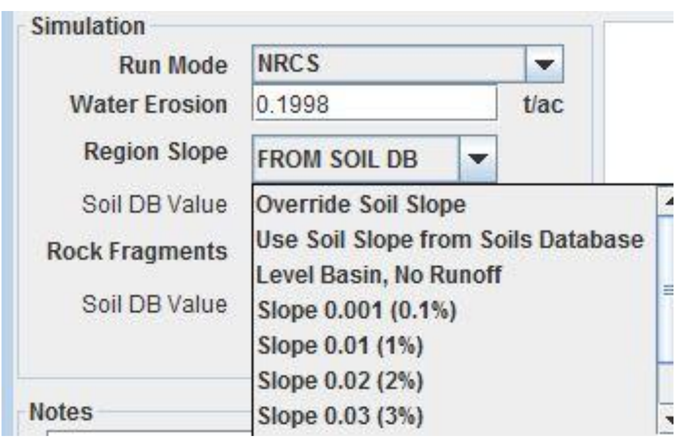


Figure 2-8 Region Slope field choices in the Simulation panel display.

The **Region Slope** field (Figure 2-8) provides the user with the option to override the slope specified in the selected soil record (The **Soil DB Value** field displays the soil record value immediately below this field). The slope value is used within the WEPS model to determine the amount of rainfall and applied irrigation water that will runoff the site and not infiltrate into the soil under the surface conditions present at the time the water is received. The reason this input is made available for user modification is because NRCS specifies a "typical" slope for all the soil components in their NASIS soil database. However, there is usually a range of slopes that a soil component may exist on. Providing the **Region Slope** field allows the user to specify a more representative slope value for a particular field site if it is significantly different than the soil record default value. The possible values are: **Override Soil Slope** (user specifies the specific slope value); **Use Soil Slope from Soils Databas**e; **Level Basin, No Runoff (0 degree slope)**; **Slope 0.001 (0.1%)**; **Slope 0.01 (1%)**; **Slope 0.02 (2%)**; **Slope 0.03 (3%)**; **Slope 0.04 (4%)**; **Slope 0.05 (5%)**; and **Slope 0.1 (10%)**.

The **Rock Fragments** field (Figure 2-9) provides the user with the option to override the surface rock fragments value specified in the selected soil record (The **Soil DB Value** field displays the soil record value immediately below this field). The rock fragments value is used within the WEPS model when determining the fraction of the surface considered non-erodible, which directly impacts the soil surface's overall susceptibility to soil loss by wind erosion. The reason this input is made available for user modification is because of the known variability of the values within specific soil components listed in the NRCS NASIS soil database and the level of sensitivity to erosion estimates from this input parameter. The possible values are: Override Rock Fragments (user specifies the specific rock fragments ratio); or Use Rock Fragments from Soils Database.

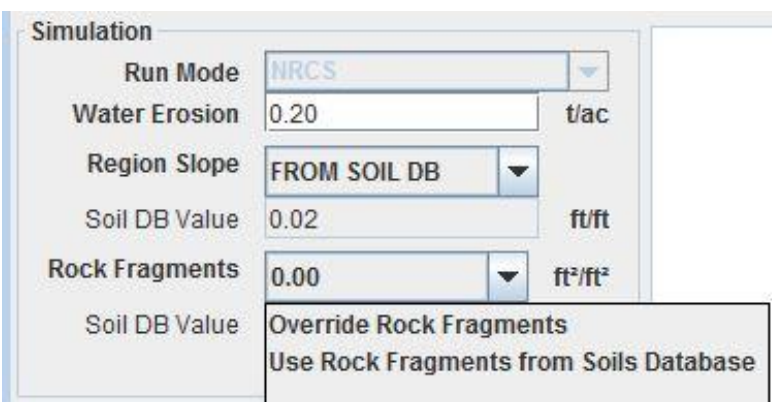


Figure 2-9 Rock Fragments field choices in the Simulation panel display.

WEPS Simulation Run Notes

If desired, each pending WEPS simulation run can be fully documented with specific user specified information into the **Notes** text panel on the main WEPS screen (Figure 2-10). The "Edit" button pops up a bigger display window for the user to type information into. The "Clear" button clears the **Notes** field of any previous run's contents. (Note calibration values displayed in Figure 2-10 for various crops from a previous WEPS simulation run.) The WEPS simulation run **Notes** content is also available for post-editing after completion of the WEPS simulation run. The **Notes** content resides at the bottom of the last page of the WEPS Summary Report. That report provides editing functionality where the **Notes** content is displayed.

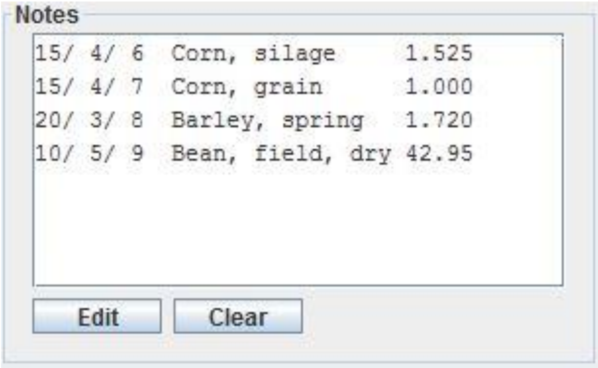


Figure 2-10 Notes panel for documenting pending WEPS simulation run information.

Client Information

Customer information for a simulation run is entered by using the upper left panel Figure 2-11) of the WEPS main screen labeled **Client Information**. The **Client Name** as well as the **Farm No**, **Tract No**, and **Field No** for the simulation run can be entered by typing the information into the appropriate boxes in the panel. These four items (Client Name and Farm No, Tract No, and Field No) are for informational purposes only and are not required to conduct a WEPS simulation run. These fields and their names were provided primarily for NRCS business purposes, but any user can populate them with appropriate information to help them keep track of individual WEPS simulation runs.

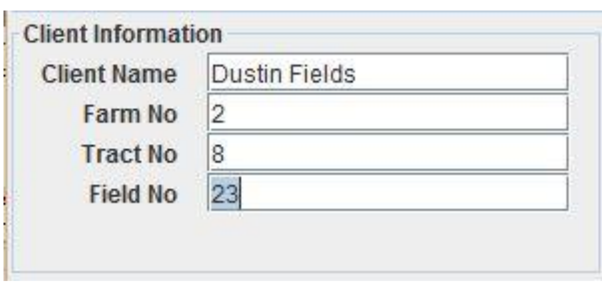


Figure 2-11 Client Information panel.

Simulation Region Information

The Simulation Region Information (**Region** panel) is shown in Figure 2-12. To describe the simulation region, the field dimensions are entered. For example, the X-Length and Y-Length are entered for a rectangle. Note that the area of the region will be displayed. To orient the field, simply type in the angle in degrees of deviation from north for the north/south field border and accept the value (tab or click outside the field). Note that the field will only rotate in a range of ±45 degrees. By rotating and adjusting the field length and width, the user should be able to obtain the desired size and orientation for any field.

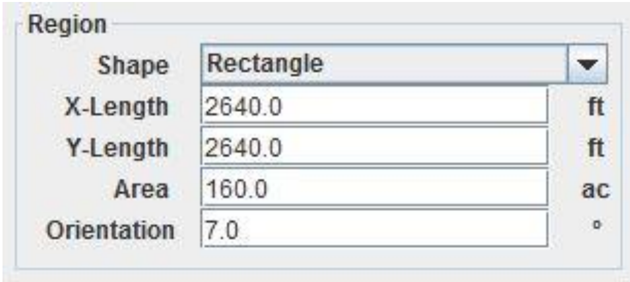


Figure 2-12 Simulation Region Information panel with rectangular field selected.

Other field shapes can be specified by clicking the down arrow to the right of the **Shape** box to display a list of valid field shapes. Figure 2-13 illustrates the panel entry for a circular field. To describe a circular field, either the radius or the area of the field can be specified and the other value is automatically computed. For simulation purposes within WEPS, fields that are circles or partial circles (i.e., half or quarter circle) are approximated as a square or rectangular field with an area equal to that specified in the **Region** panel. Field shapes that can be selected include Rectangle, Square, Circle, Half Circle VE (vertical east), Half Circle VW (vertical west), Half Circle HS (horizontal south), Half Circle HN (horizontal north), Quarter Circle NE (northeast), Quarter Circle SE (southeast), Quarter Circle SW (southwest), and quarter Circle NW (northeast). For a square, enter either the X-Length or the area. If area is entered, the field side length will be calculated and displayed. For rectangular fields enter either the X-Length and Y-Length or the area and one length. For circles or partial circles, enter the radius or the area and the other value is automatically calculated and displayed. The shape and orientation of the simulation region is displayed in the **Field View** and automatically updated when any of the field values are modified.

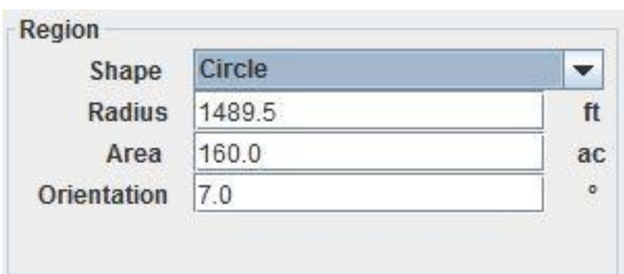


Figure 2-13 Simulation Region Information panel with circular field selected.

Special shapes or configurations such as circles and strip cropping are further discussed under the “Special Field Configurations” section of the chapter titled “Using WEPS for Conservation Planning” in the WEPS User Manual. Strip cropping is further discussed in detail in the “WEPS How To Guide” for Strip Cropping. The orientation of tillage direction is specified within the Management Crop Rotation Editor for WEPS (MCREW).

The Simulation Region must be considered carefully. The boundaries of this region are assumed to be non-erodible. This is assumed so that unknown quantities of material will not be entering from a neighboring area. Typically, stable boundaries do not allow creep and saltation sized material to pass through and include barriers or a surface at least 15 feet wide that has vegetation sufficient to stop erosion. However there are situations where one may want to simulate a field with erodible boundaries such as an area within an erodible field. In these situations the user should consult their agency’s policy for simulating such areas.

Field View

The Field View panel (Figure 2-14) is located in the center of the WEPS main screen. It is designed to give the user a view of the field size, shape, and orientation (green). The placement of any barriers present is also displayed in red. A yellow bar on the side of the field in the Field View panel indicates which side of the field has been selected for barrier placement using the radio buttons ○ in the **Barriers** panel. This is useful for selecting field barrier placement when the field is oriented at angles close to 45 degrees. A red barrier shaded with yellow, as shown for the south barrier in Figure 1-10, indicates a selected barrier that has already been placed on the field border. Note that if the ratio of length to width of the field or barriers is too great to display to scale, this will be indicated within the panel, and an approximation of the field or barrier shape will be displayed. This panel is for viewing only and is not directly editable.

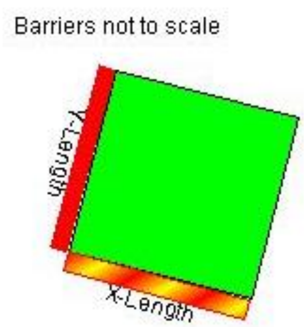


Figure 2-14 Field View panel for a rectangular field.

When a full, half, or quarter circle field is simulated (Figure 2-15), it is approximated within WEPS as a square or rectangular field with an area equal to that specified in the **Region** panel. The **Field View** panel displays an approximate inscribed circle (or half or quarter) within the simulated rectangular field. When a non-rectangular field is selected, the field described in the **Region** panel has an area equal to that of the simulated rectangular field.

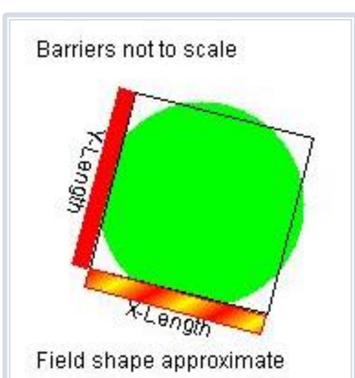


Figure 2-15 Field View panel for a circular field.

2.4 Choosing a Location

Choosing a location within WEPS defines the physical location of the field to be simulated. This location information is then normally used within WEPS to automatically select the weather stations (Cligen and Windgen) to be used for the simulation.

State/County Selection Method

Location information is entered through the rightmost panel of the main interface screen, labeled **Location** (Figure 2-16). Select the country, if configured to display that input field (Note that the NRCS configured version of WEPS does not display this field and assumes the country is the United States), state (or province) and county (or parish) of interest from their respective drop-down lists by clicking the down arrow to the right of the individual fields. The centroid[1] latitude and longitude coordinates of the county will automatically be displayed. By default, the Cligen and Windgen stations nearest to the latitude and longitude coordinates will automatically be determined, and made available in a sorted list. The nearest stations are selected and displayed by default. The Elevation field will automatically be populated with the elevation of the selected Cligen station.

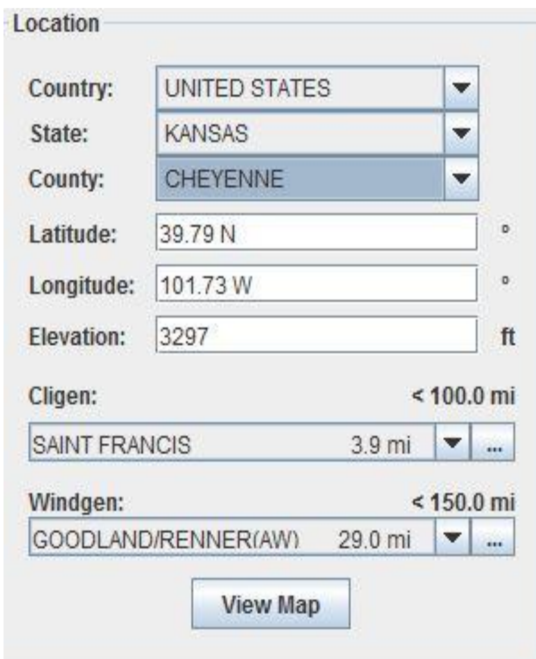


Figure 2-16 Location information panel.

Notice that the **Cligen** and **Windgen** fields display not only the station name, but also the distance from the specified lat/lon location above. By clicking on the down arrow to the right of the individual station fields, the user can override the default nearest station selection if desired. The

[1] We use the term "centroid" in this document, but if the county polygon is shaped such that the true centroid is located outside the county, we adjust the coordinates such that the lat/lon displayed will always fall within the county boundary.

radius range distance used for populating the nearest station lists is displayed immediately above weather station fields. There are other options available that can be used to determine the stations selected. They are accessible via the ... button left of the weather station fields (This button does not display if only one weather station selection option has been specified in the WEPS configuration settings). These options are discussed later in this section. Note that the default weather station selection behavior can be modified and is in fact configured differently for various WEPS versions, such as the NRCS WEPS releases. Likewise, there are configuration options that control whether the “Country”, “State” and “County” fields are displayed, or the “lat/lon” fields and even the “View Map” button. Thus, the **Location** panel will often appear somewhat differently than the one shown in Figure 1-16 for those alternatively configured WEPS versions.

Lat/Lon Selection Method

As an alternative, the Latitude and Longitude of the location can also be directly entered, which will automatically display the country (if configured for display), state and county in which the coordinates reside and then select the nearest Cligen and Windgen stations to that latitude and longitude coordinates. Note that the hemisphere is displayed in the lat/lon fields. The “N” (northern) and “E” (eastern) hemispheres are represented as positive values and the “S” (southern) and “W” (western) hemispheres are represented as negative values when a user clicks in those fields to edit them.

Note that the default hemispheres are the Northern and Western hemispheres for the United States. If the Southern hemisphere is desired, the user should select Cligen stations and management files with appropriate operation dates for this hemisphere. Once the stations are displayed, the user can click on the down arrow next to the stations to bring up a list of nearby stations from which to choose an alternative station if desired. The search radius for the list of stations (maximum distance to all stations on the list) is listed to the right of ‘Cligen Station’ and ‘Windgen Station.’ The State and County, as well as the Longitude and Latitude, fields are optional and can be added to or removed from the interface through the ‘Display’ tab of the ‘Configuration’ panel (see the discussion on ‘Configuration’ for more details).

Map Viewer Selection Method

Another alternative method to choosing a location is by using the **Map Viewer**, if configured to display the **View Map** button. Clicking on the **View Map** button (as shown in Figure 2-16) will bring up a window containing a map of the world zoomed into the region centered about the currently listed lat/lon coordinates, which is highlighted as a red cross (+ sign) on the map (Figure 2-17). The user can select any location on the map to change the lat/lon values in the **Location** panel on the main WEPS interface screen, by moving the mouse cursor to the desired lat/lon location (current mouse cursor lat/lon coordinates are displayed in the bottom right corner of the screen and are continuously updated when the mouse cursor is moved) on the map and double clicking the left mouse button. The **Map Viewer** window will automatically close and populate the **Location** panel lat/lon fields as well as update the Country, State and County fields as well as re- select the default Cligen and Windgen stations, if necessary.

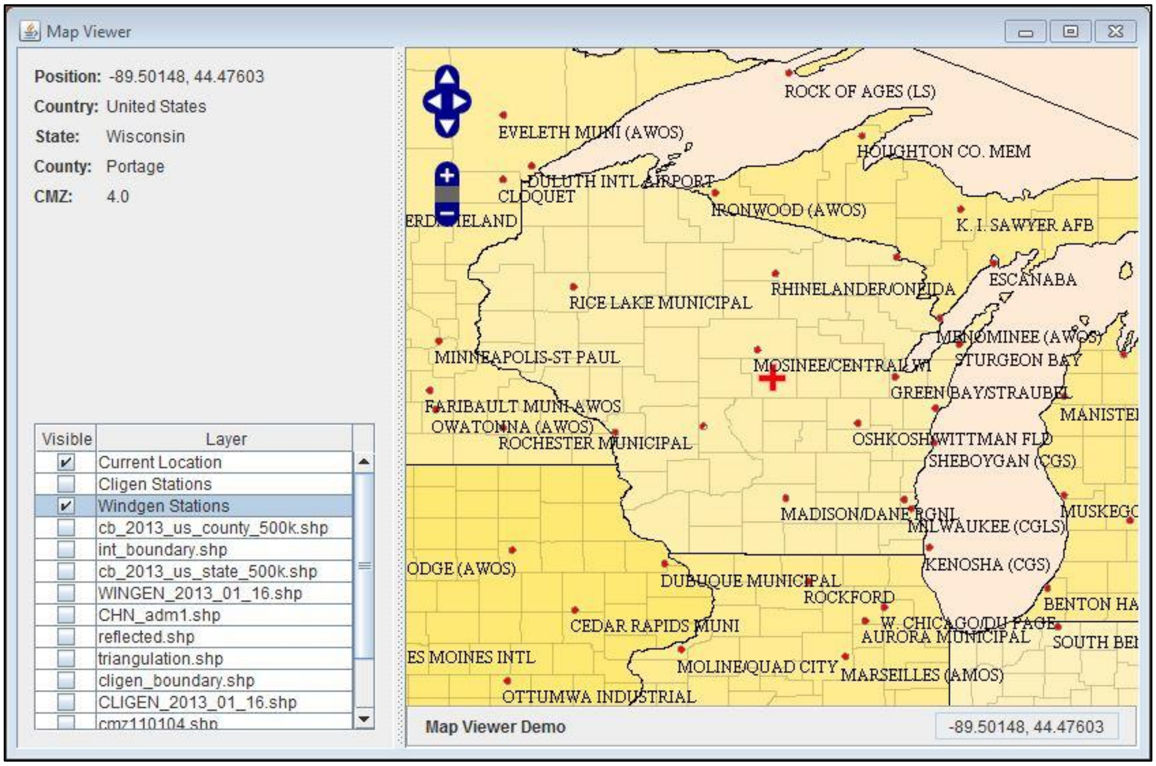


Figure 2-17 WEPS Map Viewer with wind stations displayed.

The user can move the map left, right, up and down by selecting the appropriate directional controls (4 white arrows surrounded by a blue background) at the top left of the screen. By clicking the appropriate arrows, the user can move the map in the specified direction in the window. Likewise, the user can zoom the map in or out by selecting the "+/-" controls (+/- symbols surrounded by a blue background) that are located directly beneath the directional controls. The user may also perform these functions directly with the mouse and mouse cursor. By selecting a location within the map using the mouse cursor. By pressing and holding the right mouse button down, the user can move (drag) the map left, right, up or down within the window. By clicking the left mouse button with the cursor in the map and then scrolling the mouse wheel, the user can zoom the map in and out on the screen. The currently selected lat/lon coordinates are displayed in the upper left corner of the window and the Country, State and County, including the Crop Management Zone (CMZ)[2] the lat/lon coordinates reside in are also displayed.

Clicking the check boxes at the left side of the **Map Viewer** window will enable (display) various GIS (Graphical Information System) layers on the map (Figure 1-17). Map layers currently enabled by default are: a) world (country) borders; b) U.S. State borders; c) U.S. County borders; and d) the current lat/lon coordinates (identified by a red cross (+ sign) on the map) as listed in the **Location** panel on the main WEPS screen. Additional map layers available include: a) Cligen station names and locations; b) Windgen station names and locations; c) nearest Cligen station boundaries; d) Cligen polygon regions; e) Windgen polygon regions; f) Windgen interpolation

[2] The NRCS Crop Management Zones (CMZs) are geographical regions within the U.S. that NRCS has defined as having common enough management practices and planting/harvesting dates to be grouped together. They have developed a series of "template" management practices by CMZ that can be used by WEPS as initial starting points when developing WEPS management rotation files.

region; g) Windgen triangulation lines (used for displaying station interpolation regions); and f) reflected Windgen stations (identifies location of "reflected" stations outside the interpolation region for use in interpolation calculations near the interpolation region border).

Alternative Weather Station Selection Methods

As mentioned previously, WEPS can be configured to automatically select both Cligen and Windgen stations differently than the default method specified above. All methods will be described here, including the NRCS method (last method listed), which employs several of the other methods, depending upon where the lat/lon location resides.

- Station Choice List
  - This is the default method and has been explained above. Briefly, a list of stations within a specified radius of the lat/lon location is determined and sorted by distance from the lat/lon location. The nearest station in the list is displayed as the default choice, but the user has the option of overriding that selection, if desired.
- Nearest Station
  - This method selects and displays the nearest station to the lat/lon location specified. No option is available to override this selection.
- File
  - This method allows the user to specify a previously generated weather file (in the Cligen or Windgen format) to use rather than having the weather generators create them automatically prior to the WEPS simulation being run. This option is useful for developers and researchers if they need to use field weather data for research needs, etc. This option is not normally selected for use in typical WEPS usage.
- GIS
  - This option allows GIS (Graphical Information System) map (shape) files consisting of polygon maps with stations assigned to the polygons to be used. If the lat/lon location resides within a polygon, the assigned station is selected and displayed. If the lat/lon location does not reside within a polygon region, then the weather station field will display "None Selected". The user will not be allowed to make a WEPS run until both weather stations, Cligen and Windgen, are selected.
- Interpolated
  - This option only applies to Windgen stations at this time. Based upon a specific Windgen interpolation polygon map and a corresponding "reflected" Windgen stations map, if the lat/lon location falls within an "interpolated region" polygon, then the Windgen record is interpolated from data within three nearby Windgen stations. The lat/lon location is used for the "interpolated" station's location. Note that since Windgen generated data is dependent upon the statistical parameters in the station record, having an interpolated station that is even slightly different, e.g. even a few feet from another location will give a completely different sequence of weather (wind) data, even though, statistically, the two interpolated stations would be essentially the same. Thus, care must be taken when

selecting the use of the "interpolated" mode alone. (See NRCS mode for how this issue is addressed there)

- NRCS
  - This option was developed for use by NRCS and is the default, and only option, configured for "NRCS configured specific versions of WEPS. It is also the recommended mode for most other WEPS users to use in the United States as well. The NRCS mode uniquely combines several of the above listed options. Note that this mode uses the list of NRCS Windgen stations for interpolation purposes, even if the entire list of available Windgen stations has been selected for use, e.g. like most alternative WEPS configurations available in the public release are configured. Here is the decision tree that defines the "NRCS" Windgen station selection mode:

1. For Windgen only, if the lat/lon location is within an "interpolated" polygon, then an "interpolated" Windgen station is created and used. In this case, the lat/lon used for interpolation is always the "centroid" lat/lon for the specified county, which may or may not be the lat/lon specified on the main WEPS **Location** panel. This guarantees that the NRCS user will always get the same sequence of generated wind data in that county because it will produce the same "interpolated" Windgen record for all locations within the county.
   - Due to sometimes big differences in Windgen station data and the relatively large distances between stations (at least compared to Cligen stations), it was deemed beneficial to use interpolation rather than the "nearest station" approach and have potentially very large differences in generated wind data occur across those nearest station boundaries. Most of the eastern half of the U.S. is currently contained in the "interpolated" polygon region. These Windgen interpolated polygon region(s) are selectable for viewing within the **Map Viewer**.
2. If the lat/lon falls within a Cligen or Windgen polygon region, it will use the assigned station for that polygon.
   - Most of the Cligen and Windgen polygons have been created by NRCS for use in the western U.S. due to mountains separating neighboring valleys, large elevation differences between nearby weather stations, etc. not being conducive to allowing the nearest station or interpolation selection methods to work well in these regions. These polygon regions are selectable for viewing within the **Map Viewer**.
3. If the lat/lon location does not fall within either an "interpolated" polygon region (Windgen only) or a Windgen/Cligen polygon region, then the nearest station is automatically selected with the user having the option to override that selection from a sorted list of other nearby weather stations.

2.5 Selecting a Management Rotation

The selected management scenario can be selected and accessed for editing from the bottom "man/soil" panel on the main WEPS screen (Figure 2-1) and is shown here (Figure 2-18.

Figure 2-18 Bottom panel of the WEPS main screen with the MCREW box at the top.

A management rotation scenario for a WEPS simulation run can be selected from pre-generated management (template) files. Management rotation scenarios can be selected from a dropdown choice list (Figure 2-19) by using the "Man" down arrow box on the far right side of the bottom panel of the WEPS 1.5 main screen (Figure 2-19). Navigation is performed by clicking on the 'closed key' symbol or select the folder and press the right arrow key to open the folder to display its contents. To close a folder, click the 'open key' symbol or press the left arrow key to quit displaying the folder contents.

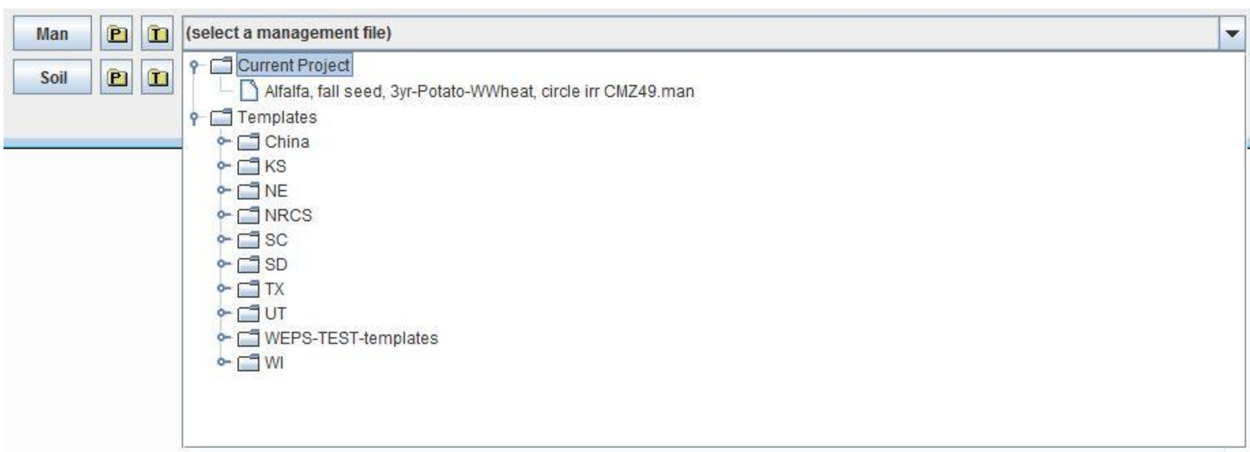


Figure 2-19 Management scenario drop down choice list.

The user can also select a management rotation by clicking on the **"Template"** folder button to the left of the management rotation name, which will bring up a standard file chooser. The user may also select previously used management files stored in the current WEPS Project directory by clicking on the Project folder button. Management rotation files in a WEPS Project directory are usually derivatives of those selected previously from the "Template" directory with local "Project-specific" modifications. Note that the and buttons are not displayed by default for the official NRCS configured releases of WEPS. Therefore, these users can only use the down arrow box to access the dropdown choice list for selecting management rotation scenarios from the main WEPS screen. Management rotation scenarios for a simulation run can also be created/selected within the rotation editor which can be opened by using the '**Man**' button on the left side of the bottom panel of the WEPS main screen (Figure 2-20).

To open the Management/Crop Rotation Editor for WEPS (MCREW), double click on the '**Man**' button, on the left side of the management box. This will open the MCREW window Figure 2-20), which allows the user to view, edit, and save management rotation information. Details on editing a management rotation file are discussed here: Editing with the Management/Crop Rotation Editor for WEPS (MCREW).

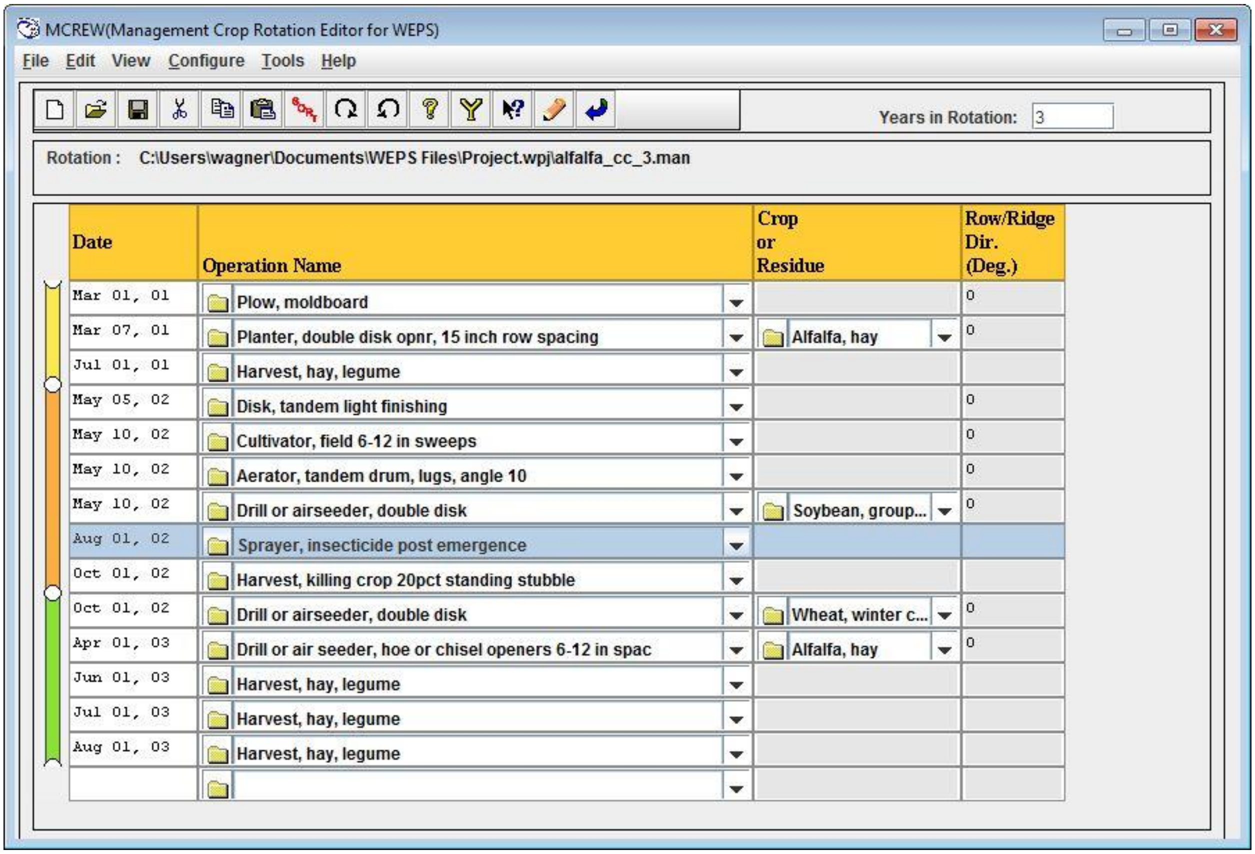


Figure 2-20 Management/Crop Rotation Editor for WEPS (MCREW) window.

2.6 Choosing a Soil

A soil for a WEPS simulation run is usually selected by using the ' Soil' down arrow box on the far right side of the bottom panel of the WEPS 1.5 main screen (Figure 2-21) or by clicking on the ' **Template'** folder button to the left of the soil name. The user may also select previously used soil files stored in the current WEPS Project directory by clicking on the Project folder button. Note that the and buttons are not displayed by default for the official NRCS configured releases of WEPS. Therefore, these users can only use the down arrow box to access the dropdown choice list for selecting soils from the main WEPS screen.

Figure 2-21 Bottom panel of the WEPS main screen with the Soil box on the bottom.

A soil for a WEPS simulation run is typically selected from a list of soils contained in the NRCS Soil Survey Geographic (SSURGO) database via a live "**NRCS Soil Data Mart**" internet connection option. There are other options available though, through the "**Soil Templates**" subfolder with "**Exercise Soils**", "**NRCS Generic Soils**" and optionally Microsoft Access NRCS SURRGO ".mdb" files. Note that NRCS and other users can also provide MS Access SSURGO files for use in offline (no internet access) conditions. In addition, the current WEPS "**Project**" folder containing previously selected ".ifc" soil files is also available.

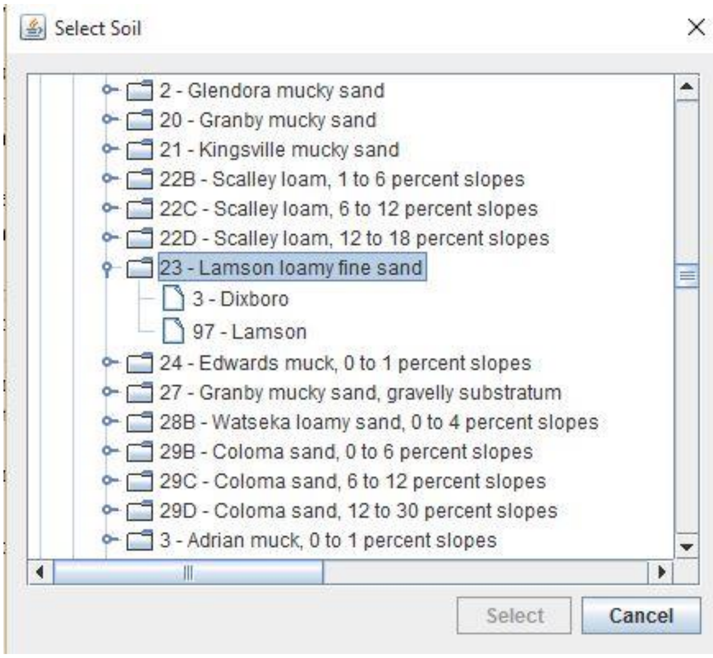


Figure 2-22 The "Select Soil" window.

Clicking on the 'Template' folder opens a window titled 'Select Soil' (Figure 2-22). Navigate through the database tree to find the soil survey area (or county) desired. Navigation is performed by clicking on the 'closed key' symbol to open the folder to display its contents. To close a folder, click the 'open key' symbol to quit displaying the folder contents. The soil files are listed according to the soil map unit symbol, map unit name, surface texture, and local phase. Selecting a soil then displays its components and the percentage that each component contributes to the map unit. Click a soil component to highlight it and click the 'Select' button at the bottom of the screen (or double click the component with the left mouse button). This action converts the soil from the SSURGO database to a WEPS soil file format (with an 'ifc' file extension), places a copy in the current "Project" folder and returns the user to the main screen. The loaded soil file name will appear in the soil box window. Clicking the '**Cancel**' button in the '**Select Soil**' window aborts the selection of a new soil.

Soils that have been previously selected or modified and saved to another name (and stored in the current "Project" folder) can be opened by clicking on the ' **Project**' folder button. This will open a window in which the user can select the desired soil or type in the soil file name.

Users have the option to view the parameters for the soil file displayed in the soil box by clicking on the button labeled '**Soil**', on the left side of the soil box. This will open the WEPS Soil User Interface screen (Figure 2-23). The details of the soil screen contents and the functionality are provided here.

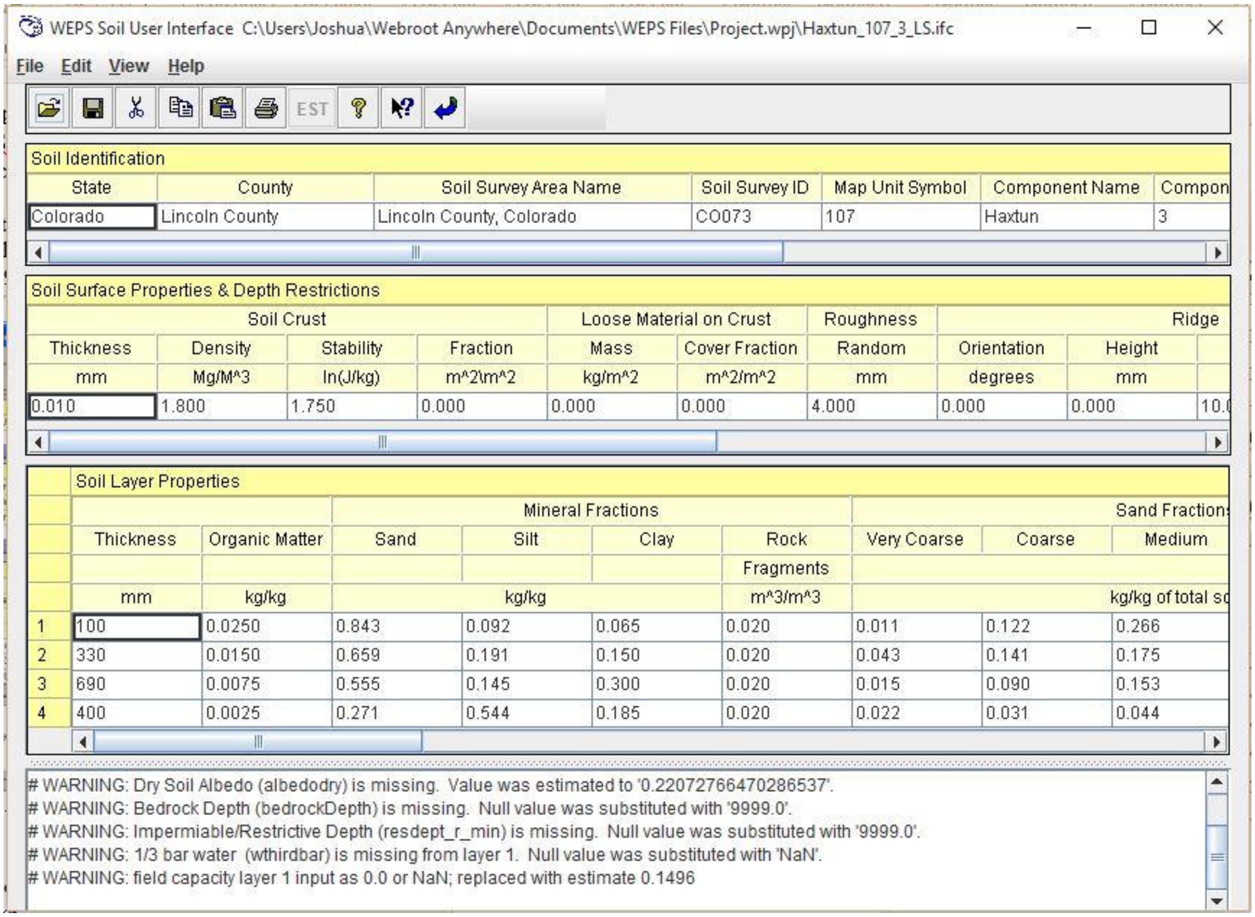


Figure 2-23 WEPS Soil User Interface screen.

2.7 Selecting a Wind Barrier

The Wind Barrier Information (**Barriers** panel) (Figure 2-24) is used to add barriers to the field borders. Note that WEPS 1.5 only allows barriers on the borders of the field, not within the field. The barrier location is labeled for the side of the field on which the barrier is to be placed, such as 'N' for north, 'S' for south, 'E' for east, and 'W' for west. If the field is rotated, the location is labeled for the direction closest to one of the four cardinal directions. The barrier type can be selected from the drop-down list in the panel by clicking the down arrow box to the right of the barrier type to bring up the list of available barriers and clicking on the appropriate barrier. Once a barrier type is selected, the barrier properties may be viewed and edited by clicking the Edit Selected Barrier button at the bottom of the panel. This displays a separate panel where one may enter the barrier width, height, and porosity in the appropriate fields. Note that the area of the barrier is displayed but cannot be edited. If barrier properties are modified, it will be noted in the type list with a **<mod>** designation before the type name (Figure 2-24). To remove a barrier from the field, click the radio button to select it (notice the barrier will be 'highlighted' when selected), then select the barrier type 'None' to remove it. To 'deselect' all barrier locations, click the enabled radio button to the off position. The **Field View** will automatically display the placement of selected barriers in red and highlight the currently selected location in yellow if no barrier exists there. If there is already a barrier for the selected location, it will display with a mixture of both red and yellow stripes. See the "WEPS How To Guide" for Barriers for further explanations on how to use barriers within WEPS and how to modify the barrier database.

Figure 2-24 Wind Barrier Information panel.

Note that the **Barriers** panel is not the best way to simulate the effects of strip cropping, but it may be useful in strip cropping designs that include barriers along the edge of the strips. See the "WEPS How To Guide" for Strip Cropping for a detailed description of simulating strip cropping with WEPS 1.5.

2.8 WEPS Projects

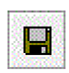
A "WEPS Project" is a directory that can be thought of as a working area where WEPS simulation run files are created, edited and stored. A WEPS Project stores all the parameters for the current simulation run being prepared within the WEPS interface, as well as any past WEPS simulation runs. For example, a particular WEPS Project may represent a directory for an individual farm under which all the simulation runs for each field and management alternatives on that farm can stored. When a WEPS Project is saved, all of the information contained on the current interface screen is stored in the project directory along with the currently selected management and crop files. Multiple WEPS Projects can be created and given various names by the user. These directories can also be managed (i.e., renamed, deleted, or moved) with a file manager such as Windows Explorer (not provided with WEPS). One can also remove unnecessary WEPS Project and WEPS Run directories from within the WEPS interface via the pertinent options under the "Project" or "Run" menus. Note that the following characters cannot be used in WEPS file names: \ / < > | ? * & " ~ ` '

Working with WEPS Projects

Clicking the '**Project**' menu item displays a list of various options pertaining to WEPS Projects. These options are discussed below. Note: Multiple WEPS Projects functionality is not available for the NRCS configured version of WEPS.

The ‘New’ menu item (same as  on the button bar) allows the user to create a new Project from scratch. Clicking on this menu item causes WEPS to check for any unsaved changes to the parameters displayed on the screen. If there are unsaved changes, the user is asked if they want to ‘**Save current project?**. If the user clicks ‘**Yes**’, the current parameters are saved to the old (current) Project. A file chooser then appears that allows the user to specify a name for the new WEPS Project. The current WEPS interface screen is then cleared, and the newly created WEPS Project becomes the current WEPS Project. If the user clicks ‘**No**’, a file chooser opens immediately, allowing the user to name the new WEPS Project to be created, and resets the parameters to the system defaults without saving any changes to the previous (current) WEPS Project. In either case, the user can then proceed to build the new WEPS Project by entering information on the interface screens. If the user clicks ‘**Cancel**’, the process of creating a new WEPS Project is aborted and the screen returns to the previous Project.

The ‘**Open...**’ menu item (same as  on the button bar) opens an existing WEPS Project. Clicking on this menu item causes WEPS to check for any unsaved changes to the displayed parameters. If there are unsaved changes, the user is asked if they want to ‘**Save current project?**’. If the user clicks ‘**Yes**’, the current parameters are saved to the old (current) WEPS Project. A file chooser then appears that allows the user to specify the name of an existing WEPS Project to open. The newly opened Project becomes the current WEPS Project. If the user clicks ‘**No**’, the old WEPS Project is closed without saving any changes and a file chooser opens that allows the user to select an existing WEPS Project to be re-opened. In either case, the user can then proceed to view the WEPS Project information or modify the WEPS Project by entering information on the interface screens. If the user clicks ‘**Cancel**’, the process of selecting a previous WEPS Project is aborted and the screen returns to the old WEPS Project. When leaving the WEPS Project or WEPS, the user is asked if they want to save the current WEPS Project.

The ‘**Save**’ menu item (same as  on the button bar) saves the current WEPS Project to the current Project name.

‘**Save As...**’ allows the user to save a copy of the currently displayed WEPS Project to a new name. The name must be new and cannot overwrite the name of an existing WEPS Project. The user must enter a unique name. The copy then becomes the current WEPS Project.

The **‘Delete Project’** and the **‘Delete Run’** menu item opens a file chooser to delete a WEPS Project and run.

The **‘Delete Management Rotation File’** menu item opens a file chooser to delete a WEPS management file. The **‘Delete IFC Soil File’** item opens a file chooser to delete a WEPs soil file. **‘Exit’,** exits the WEPS program.

The default WEPS Project folder (i.e., directory) for these various WEPS Project options, under which new WEPS Projects will be created and existing WEPS Projects will be opened, can be specified under the ‘**Directories**’ tab of the ‘**Configuration**’ window. Enter the default directory on the line labeled ‘**Projects Dir**’. By default, the last WEPS Project that was open when WEPS was exited is the current WEPS Project when WEPS is restarted.

"WEPS Run" Directories

All WEPS simulation run results can be stored in subdirectories within the current WEPS Project directory, if configured to do so. A WEPS Run directory is created every time a simulation run is made. A WEPS Run directory stores a copy of all input files used to make the simulation run, together with the output files generated from those inputs by the WEPS science model. Thus, one is able to reproduce the identical WEPS Run at a later date (and get the same output results assuming they are using the same version of WEPS and weather generators/databases used when making the original simulation) because the original input files are still available. Typically, 're-running' a previous WEPS Run is not necessary since the outputs are stored in the WEPS Run directory and can be reviewed via the "ViewOutput" menu options. However, a user may want to "restore" a previous WEPS Run and use it as a template to for editing prior to making a subsequent simulation run. This functionality is available via the button or the "Restore WEPS Run" option under the "Run" menu. Storing the input and output files for each WEPS Run in individually named directories makes it relatively easy to manage, archive and remove selected WEPS Runs as necessary.

2.9 Making a WEPS Run

Making a Standard WEPS Run

Once the desired information is entered through the interface screens, a simulation run can be initiated. Clicking on the '**Run**' menu, then selecting '**Make a WEPS Run**' (Figure 2-25), begins a WEPS simulation run. One can also click the run button on the button bar or press the Ctrl-R keys simultaneously to begin a WEPS simulation run. WEPS run status window.

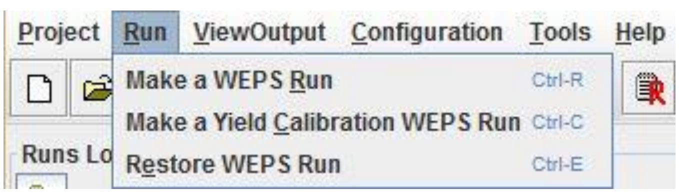


Figure 2-25 The Run menu on the main WEPS screen.

A "WEPS Run Name" window will appear (Figure 2-26), allowing the user to edit the default WEPS Run name displayed in the first (top) field labeled "Run Name". Note that some special characters are not allowed in file names. Known characters that are not allowed include: ? ' ` & ~ / \ < > | : * ". The user also also has the option to change the default "WEPS Run" location in the middle field labeled "Run Location". If the user does not remember the exact path they desire the WEPS Run to be placed in, they can use the folder icon to bring up a file chooser to select the WEPS Run directory location. The complete WEPS "Run File" name and path are displayed in the third (bottom) read-only field.

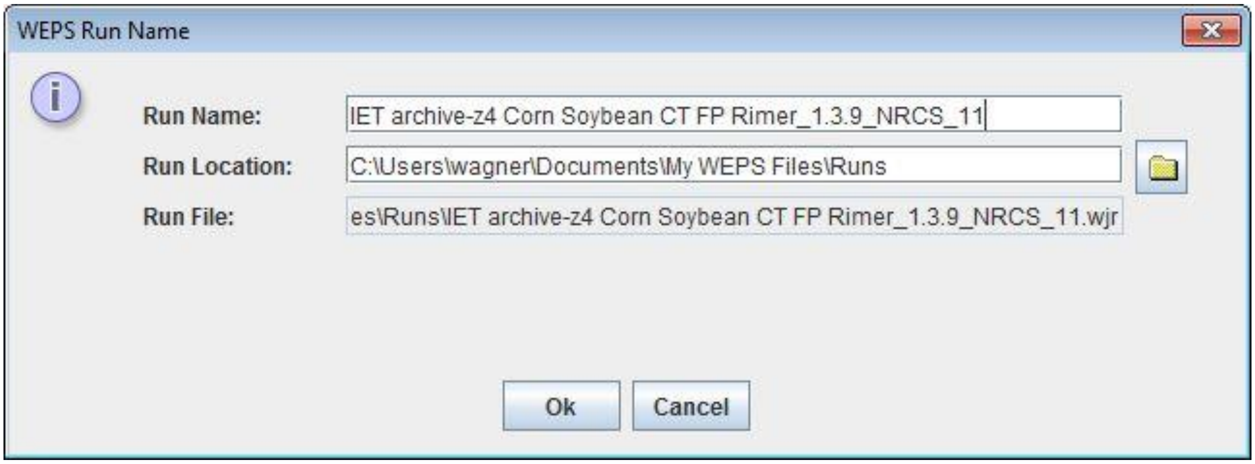


Figure 2-26 WEPS Run Name window.

When a run name has been entered, the simulation begins and a window appears that shows the status and progress of the run (Figure 2-27). At the conclusion of the run, a window may appear, if warranted, displaying any warnings that have been generated. These warnings are for informational purposes and may or may not be of interest to the user.

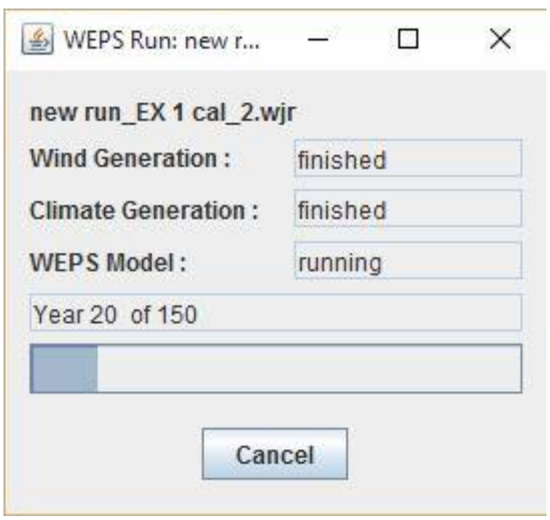


Figure 2-27 WEPS Run status window.

Upon completion of a run, a WEPS Run Summary report will appear for the user to review and print if desired. The Run Summary is saved in the run directory, along with more detailed output reports for later retrieval. The summary and detailed reports for a run can be viewed or created any time by the user. See the section of the WEPS User Manual titled "Viewing WEPS Output" for more detailed descriptions of the WEPS output types and how to select them for viewing or printing.

If a crop does not reach maturity, a warning will appear (Figure 2-28), indicating that the crop only reached the specified percent of the expected maturity for a given year. This warning can result from one of two causes. First, the crop variety chosen has a growing season too short for the climate being simulated. For example, a 120-day corn variety may be specified for a location that usually grows 110-day corn. In this case, a variety that matures over a longer period for that location should be chosen. If a variety of suitable length is not available in the crop drill-down list, a new variety can be created by following the method outlined in the WEPS How To Guide: Crop Database Record Development. Another cause of this warning may be that the growing season as specified by plant and harvest dates are too close together, not allowing the crop enough days to reach maturity. In this case, be sure the planting and harvest dates are correct, and adjust accordingly. If a crop is harvested before full maturity (e.g., for alfalfa or silage), a warning message will also appear.

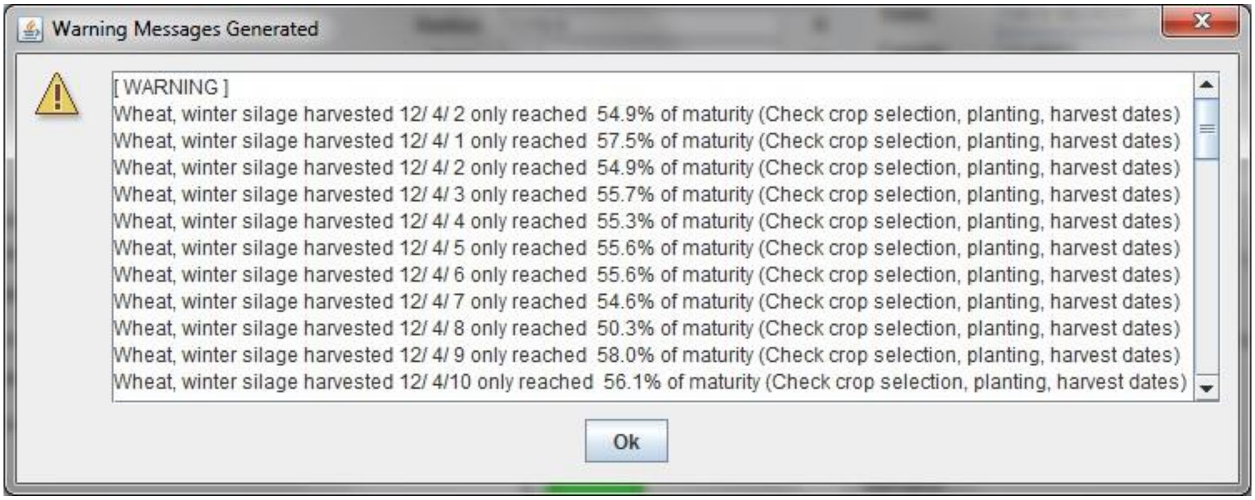


Figure 2-28 Crop growth/maturity warning message popup window.

Make a Yield Calibration WEPS Run

Differences in crop management by producers or local climate and soil variances may result in crop yields, generated by WEPS that do not reflect the actual yields observed by a producer. WEPS provides a method to "calibrate" yields and associated crop residue biomass from WEPS so that they more accurately reflect those of individual producers or a county as a whole. The following steps describe how, to make a yield calibration run.

a) Within MCREW, press the '**Yield Calibrate**' button  to display additional columns related to the crop-yield calibration function in WEPS.

b) Within MCREW, select the crop (or crops) that you want to calibrate by checking the box in the '**Calib. Yield?**' column for the respective row the crop planting operation is in.

c) Fill in the desired '**Target Yield**' for the selected crop(s). The yield units are displayed but not editable. The units may be changed in the Crop Drill-down window under the "Harvest" tab and the "Harvest yield conversion factor" must be adjusted to reflect the new units. Note that changing the water content requires changing the columns labeled "Yield Coef." and "Residue Intercept" because all three parameters are interrelated. See the Crop How To Guide for more information on these parameters.

d) Save the rotation management file in MCREW. This currently can be done by: i) pressing the '**Save**' icon , ii) via the '**File** > **Save**' menu option, iii) using the '**Ctrl-S**' keyboard shortcut, or iv) by clicking the Save and Close button , which saves the displayed data to the current file name and closes MCREW.

e) Exit MCREW. This can be done either by: i) clicking on the operating system's "Close Window" button in the top right corner of the MCREW window frame or ii) via the '**File** > **Exit**' menu option. Note that if one forgets to save the management file before attempting to exit MCREW, the user will be notified and given the opportunity to do so before exiting MCREW.

f) Click the '**Make a Yield Calibration WEPS Run**' via the '**Run**' menu bar option on the main screen (Figure 2-29) or the 'Calibrate Run' button on the main screen button bar. The shortcut '**Ctrl-C**' will also work if the main WEPS screen has focus.

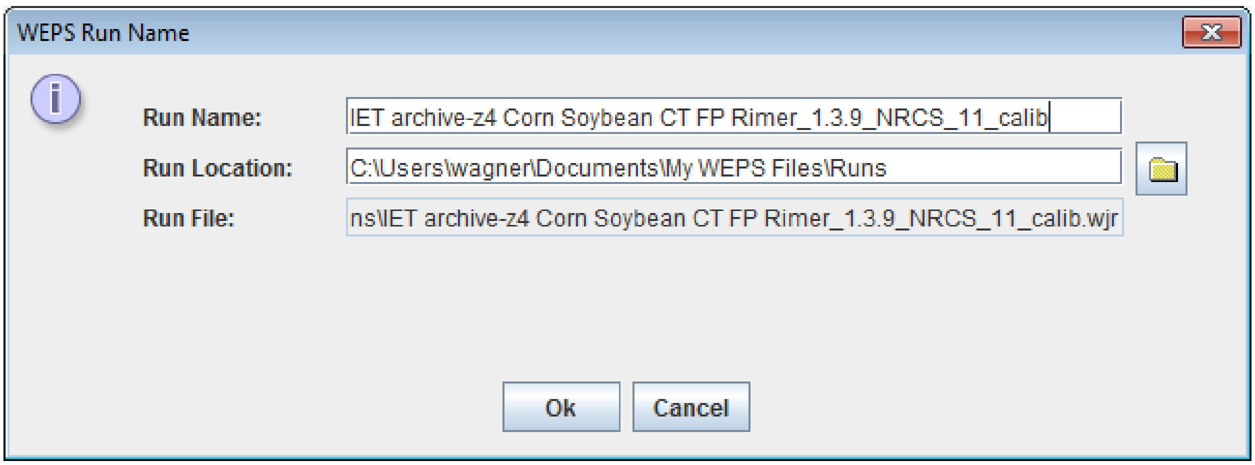


Figure 2-29 WEPS Yield Calibration Run Name window.

g) After the Calibration Run has completed, a popup dialog window (Figure 2-30) will appear that displays the '**Calibration Factors**' for each crop selected for calibration (see figure to the left). One may then save each crop record as a new crop by clicking the "Save As" button Save As for each crop. The user may also use the Biomass Adjustment factor in the current Project by clicking the "Use in Current Project" button at the bottom of the window. The biomass adjustment factor determined for each crop is also written into the 'notes' file for the calibration run.

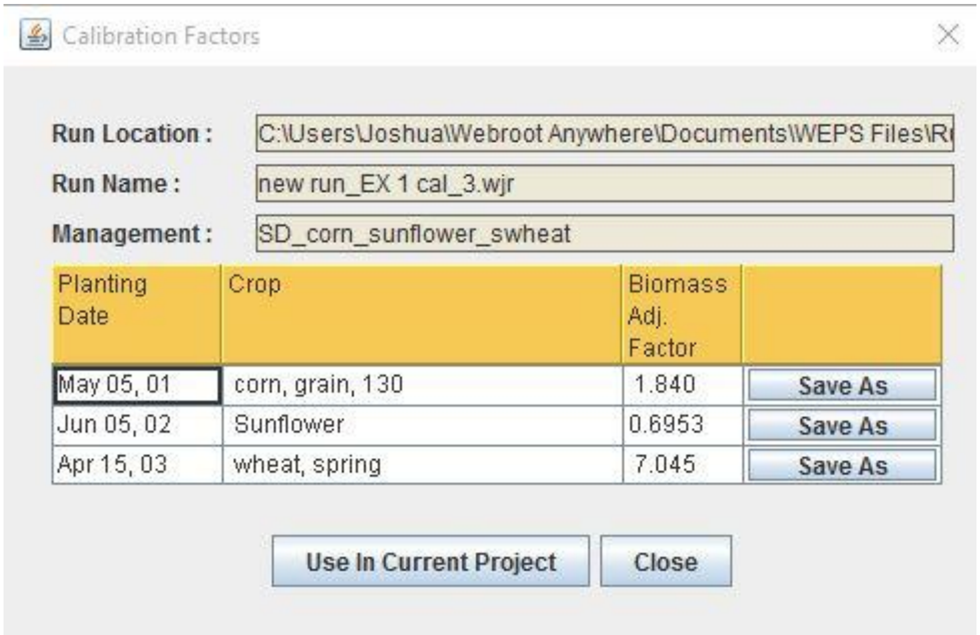


Figure 2-30 WEPS Run Calibration Factors window.

2.10Restore a WEPS Run

A previously created WEPS run can be restored by clicking on the **Run** menu and selecting **Restore a WEPS Run**. This will open a file chooser that allows the user to select a previously created WEPS run. One can also click the restore button  to restore a WEPS Run. "Restoring a WEPS Run" actually loads the inputs of the previous WEPS Run into the WEPS interface. These inputs can be modified and a new simulation run again with a new WEPS Run name. The new Run will be saved into a new subdirectory; previous WEPS Runs cannot be overwritten. Runs can be removed via the "Project>Delete Run" menu option. It is recommended that the user remove unwanted WEPS Runs regularly to prevent these directories and their contents from using too much storage space.

2.11 Viewing WEPS Output Reports

WEPS provides numerous outputs to aid the user in conservation planning. These outputs are accessed through the **ViewOutput** menu on the main screen with some reports also being accessible via the button bar. Clicking on this menu displays two choices, **Current Run** and **Previous Run**. Clicking on **Current Run** displays a list of output options for the most recent WEPS run. The **Previous Run** choice allows the user to view results of previous WEPS Runs. A description of the choices under these two submenus follows. All of the report options, except the **Tabular Detail Report** and the **Science Model Reports** contain a header that lists:

- Name of WEPS Run
- WEPS Run Date
- Client Name
- Farm No, Tract No and Field No
- WEPS Run folder location
- Management scenario file name
- Soil file name

For each of those same reports there is a button bar included at the top of the display screen (Figure 2-31).

Figure 2-31WEPS output reports button bar.

The following button bar functions are provided:

○ This button allows the user to print the report.

○

○ This button allows the user to create a file of the report in any of the following formats: a) PDF (Adobe Postscript), b) RTF (Rich Text Format), c) ODT (Open Document Format), d) HTML (Hypertext Markup Language), e) CSV (Comma Separated Values), f) XML (Extensible Markup Language) and g) Embedded Images XML.

○

○ This button allows the user to view the report using the operating system's default PDF viewer to display the PDF generated version of the report. If the selected report does not have a PDF version available, a popup message will alert the user to that fact. However, the user can use the previous button bar button  to generate the PDF file themselves, if desired.

○

○ This button allow the user to jump back to the 1st page of the report.

○

 ○ This button allows the user to go to the previous page of the report.

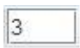
○

 ○ This button allows the user to go to the next page of the report.

○

 ○ This button allow the user to go to the last page of the report.

○

 ○ This button allows the user to go to the specified page number entered into the field.

○

 ○ This button allows the user to resize the report to the default (100%) size.

○

 ○ This button allows the user to shrink the report size.

○

 ○ This button allows the user to magnify the report size.

○

 ○ This button allows the user to magnify the report by 25% increments.

○

 ○ This button allows the user to shrink the report by 25% increments.

 ○ This button allows the user to specify the exact size of the report or to select a specified size through the dropdown arrow button which provides a choice list menu of pre-selected sizes ranging from 50% to 800%.

○

○ The remaining buttons provide quick access to a subset of the “current WEPS Run” reports:

○

 ○ This button allows the user to access the current WEPS Run Summary Report.

○

 ○ This button allows the user to access the current WEPS Run Crop Summary Report.

○

 ○ This button allows the user to access the current WEPS Run Cover Crop Summary Report.

○

 ○ This button allows the user to access the current WEPS Run Crop Interval Summary Report.

○

- This button allows the user to access the current WEPS Run Soil Report.
-

- This button allows the user to access the current WEPS Run Tabular Detail Report.

Run Summary Report

The Run Summary report screen (Figure 2-32) will automatically display at the conclusion of a WEPS simulation run. If the Run Summary screen has been closed, the user can re-display the Run Summary screen for the most recent WEPS Run by selecting the  button on the main WEPS screen button bar or a previous WEPS Run by clicking the "**ViewOutput**" menu and selecting the "**Previous Run**" and then the "**Run**" option from the WEPS main screen menu bar.

The Run Summary contains the header information mentioned above along with the following additional information:

- Graphical representation of the field site
- Dimensions, orientation, area and elevation of the field site
- What "simulation mode" and number of "cycles" were used for the WEPS Run
- Site location, e.g. country, state and county, latitude and longitude coordinates, etc.
- Name of Cligen station used in WEPS Run
- Name of Windgen station, or if interpolated, the "lat/lon" coordinates, used in WEPS Run

The Run Summary WEPS report has the following sections which provide:

- Summarized rotation year and average annual soil loss by wind erosion
- Crop Interval period erosion rates
- Summarized harvested crop information
- SCI (Soil Conditioning Index) summarization
- Rotation Stir Energy summary for the management rotation
- Crop Interval period Stir Energy summary
- Management user notes

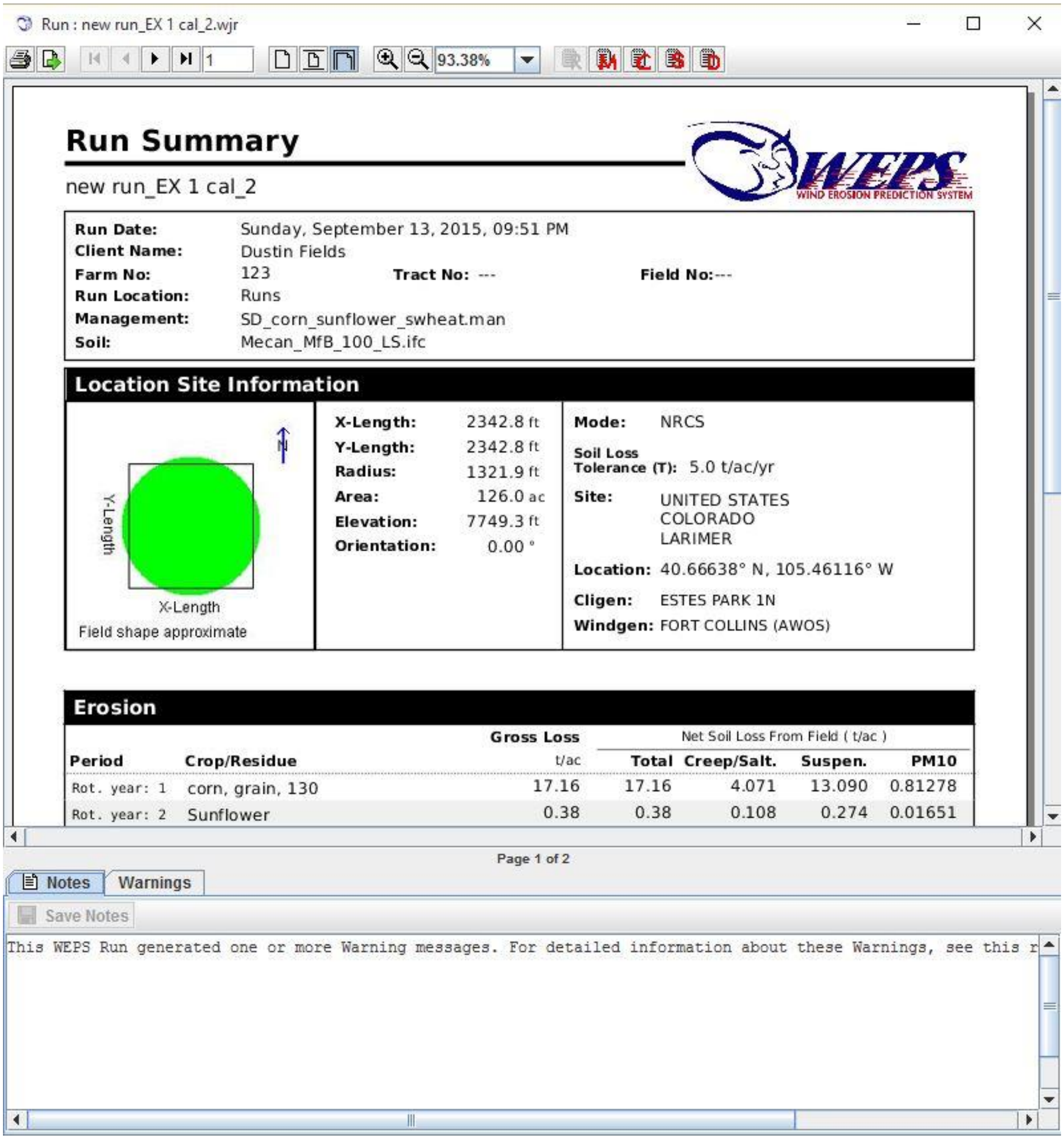


Figure 2-32 1st page of WEPS Run Summary Report.

Erosion

This section of the Run Summary reports the wind erosion results from the simulation by specific periods in a tabular report (Figure 2-33). The values are reported in units of mass per area, e.g. for SI (kg/m^2) and English (t/ac). The columns of this report section consist of:

-

Column 1, labeled **Period**, consists of the individual rotation years within the management/crop rotation cycle (Rot. Year: #) and the complete management/crop rotation cycle (Ave. Annual).

Column 2, labeled **Crop/Residue**, consists of the crops harvested during the specified rotation years.

Column 3, labeled **Gross Loss**, which is the average erosion within the field (i.e., removal of soil with no deposition taken into account).

Column 4-7, labeled "Net Soil Loss From Field", which is the average total net soil losses from the field (net losses are gross losses minus deposition within the field. These values are broken down and reported by the size class of the particulates.

Column 4, labeled **Total**, which is total average net soil loss from the field for all size classes.

Column 5, labeled **Creep/Salt.**, which is the average net soil loss from the field for creep and saltation size particles (≥100µ).

Column 6, labeled **Suspen.**, which is the average net soil loss from the field for suspension size particles (<100µ).

Column 7, labeled **PM10**, which is the average net soil loss from the field for the fraction of suspension size particles less than 10µ in size.

Erosion

Period	Crop/Residue	Gross Loss kg/m²	Net Soil Loss From Field (kg/m²) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Alfalfa, hay	0.00	0.00	0.000	0.000	0.000
Rot. year: 2	Soybean, group II, III and IV	0.00	0.00	0.000	0.000	0.000
Rot. year: 3	Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.00	0.00	0.000	0.000	0.000
Ave. Annual		0.00	0.00	0.000	0.000	0.000

Figure 2-33 WEPS Run Summary Erosion report.

Deposition occurs when the wind speed drops as it travels across the field or the surface conditions become less erodible in a downwind part of the field (i.e., transport capacity of the wind exceeds transport capacity for the surface conditions). In WEPS 1.5, deposition only occurs with a drop in wind speed across the field due to a barrier present on the downwind side of the field or surface conditions changing across the field because of the erosion process. In many simulations, however, it is not uncommon to have equal gross and net total loss.

If an erosion event occurred, but values generated by the model are too small to be displayed on the output table (i.e., <0.001 kg/m^2), then the amount is listed as "trace". If amounts are too large to be accurately displayed, then the amount is listed simply as greater than a specified amount (i.e., > 300 kg/m^2). In these cases, erosion amounts are so large that they are generally unacceptable. If any barriers were present on the field borders, a summary of their properties is also listed.

Crop Interval Erosion

This section of the Run Summary (Figure 2-34) reports the wind erosion results from the simulation by crop interval, which is defined as the time from the previous crop's termination (final harvest or crop kill process) until the termination of this crop (final harvest or crop kill process). The soil loss values (last 5 columns) are reported exactly as they are for the **Erosion** sub-report previously described. The first three columns consist of:

Column 1, labeled **Date Range**, consists of the start and ending dates for each crop interval.

Column 2, labeled **Days**, consists of the crop interval period length in days.

Column 3, labeled **Crop**, consists of the crops defining each "crop interval".

Crop Interval Erosion

			Gross Loss	Net Soil Loss From Field (kg/m²)			
Date Range	**Days**	**Crop**	kg/m²	**Total**	**Creep/Salt.**	**Suspen.**	**PM10**
Aug 02, 03 - Jul 01, 01	335	Alfalfa, hay	0.00	0.00	0.000	0.000	0.000
Jul 02, 01 - Oct 01, 02	457	Soybean, group II, III and IV	0.00	0.00	0.000	0.000	0.000
Oct 02, 02 - Aug 01, 03	303	Alfalfa, hay	0.00	0.00	0.000	0.000	0.000

Figure 2-34 WEPS Run Summary Crop Interval report.

Harvests

This section of the Run Summary (Figure 2-35) provides a summarization of the average yield and after-harvest residue amounts for each harvested crop grown in the management/crop rotation scenario. The information is presented in tabular form where the columns consist of:

Column 1, labeled **Date**, consists of the harvest date for the specified crop.

Column 2, labeled **Crop**, consists of the crops that are harvested.

Column 3, labeled **Residue**, consists of the average after harvest crop residue left on the field and is reported in kg/m^2 when SI units are specified and lbs/ac when English units are used.

Column 4, labeled **Harvest Yield**, consists of the average yield produced by the crop and is reported in kg/m^2 when SI units are specified. When English units are used, the units displayed are obtained from the crop record, e.g. ton/ac, bu/ac, etc.

Column 5, labeled **Yield % Moisture**, consists of the percent water content value specified in the crop record and is used for reporting the yield.

Harvests				
Date	**Crop**	**Residue** lb/ac	**Harvest Yield**	**Yield % Moisture**
Jul 01, 01	Alfalfa, hay	475	1.6 ton/ac	15.0
Oct 01, 02	Soybean, group II, III and IV	3,685	42.4 bu/ac	13.0
Jun 01, 03	Alfalfa, hay	945	0.5 ton/ac	15.0
Jul 01, 03	Alfalfa, hay	526	1.2 ton/ac	15.0

Figure 2-35 WEPS Run Summary Harvests report.

SCI Summary

This section of the Run Summary (Figure 2-36) provides a summary of the SCI (Soil Condition Index), Energy Calculator, Average STIR, and other inputs required for computing the SCI, including the SCI subfactors. The SCI is an index developed by NRCS to reflect trends in soil organic matter, which are assumed to be an indicator of soil quality trends. A negative value generally implies that the soil organic matter is decreasing and thus soil quality would be degrading over time. A positive value implies that soil organic matter is increasing and thus soil quality is generally improving over time. A value of zero or near zero implies that soil organic matter is not changing over time and thus the soil quality is sustainable. The values presented in this summary are:

- **Soil Condition Index** - Index developed and used by NRCS to reflect the relative quality of a soil due to the management/crop rotation practices being applied.
- **Energy Calculator** - Average annual energy per acre expended for operations specified in the management/crop rotation.
- **Average Annual STIR** - Computed for the management/crop rotation sequence from the listed operations.
- **Wind Erosion Soil Loss -** An input required for SCI calculation. Obtained from the WEP simulation run.
- **Water Erosion Loss** - An input required for SCI calculation. User is expected to specify the value on the main WEPS screen prior to the WEPS simulation being executed.

SCI Subfactors

- **OM** - It is the organic material or biomass subfactor. This component accounts for the effect of biomass returned to the soil, including material from plant or animal sources, and material either imported to the site or grown and retained on the site.
- **FO** - It is the field operations subfactor. This component accounts for the effect of field operations that stimulate organic matter breakdown. Tillage, planting, fertilizer application, spraying, harvesting, and other operations crush and shatter plant residues and aerate or compact the soil. These effects increase the rate of residue decomposition and affect the placement of organic material in the soil profile.
- **ER** - It is the erosion subfactor. This component accounts for the effect of removal and sorting of surface soil organic matter by sheet, rill, or wind erosion processes as predicted by water and wind erosion models. It does not account for the effects of concentrated flow erosion, such as ephemeral or classic gullies.

SCI Summary

Soil Conditioning Index:	0.070	**SCI Subfactors**	
Energy Calculator:	5.120 gal diesel/ac	**OM:**	-0.5558
Average Annual STIR:	62.585	**FO:**	0.3803
Wind Erosion Soil Loss:	0.000 t/ac	**ER:**	0.7007
Water Erosion Soil	0.760 t/ac		

Figure 2-36 WEPS Run Summary SCI report.

Rotation Stir Energy

This section of the Run Summary (Figure 2-37) provides a summarization of the STIR (Soil Tillage Intensity Rating) for the operations listed in the management/crop rotation file. The STIR value is an indication of the overall "intensity" of the tillage applied for each specific operation in a given management/crop rotation scenario.

Rotation Stir Energy

Date	Operation	Fuel	Stir	Energy Btu/ac	Cost USD/ac
Feb 07, 01	Sprayer, post emergence and fert. tank mix	Diesel	0.15	15,865	0.45
Mar 01, 01	Plow, moldboard	Diesel	65.00	229,144	6.55
Mar 07, 01	Planter, double disk opnr, 15 inch row spacing	Diesel	4.88	78,427	2.24
Jul 01, 01	Harvest, hay, legume	Diesel	0.15	235,130	6.72
May 05, 02	Disk, tandem light finishing	Diesel	19.50	48,942	1.40
May 10, 02	Cultivator, field 6-12 in sweeps	Diesel	26.00	90,700	2.59
May 10, 02	Aerator, tandem drum, lugs, angle 10	Diesel	35.10	79,624	2.28
May 10, 02	Drill or airseeder, double disk	Diesel	6.34	44,152	1.26
Jun 07, 02	Sprayer, post emergence	Diesel	0.15	15,865	0.45
Aug 01, 02	Sprayer, insecticide post emergence	Diesel	0.15	15,865	0.45
Oct 01, 02	Harvest, killing crop 20pct standing stubble	Diesel	0.15	187,386	5.36
Oct 01, 02	Drill or airseeder, double disk	Diesel	6.34	44,152	1.26
Apr 01, 03	Drill or air seeder, hoe or chisel openers 6-12 in spac	Diesel	23.40	90,700	2.59
Jun 01, 03	Harvest, hay, legume	Diesel	0.15	235,130	6.72
Jul 01, 03	Harvest, hay, legume	Diesel	0.15	235,130	6.72
Aug 01, 03	Harvest, hay, legume	Diesel	0.15	235,130	6.72
		Total / ac		1,881,343	53.77
		Total	187.76	140,079,311	4,003.45

Figure 2-37 WEPS Run Summary Rotation Stir Energy report.

The Rotation Stir Energy table columns are:

Column 1, labeled **Date**, consists of operation date for the specified operation.

Column 2, labeled **Operation**, consists of the operation used on the specified date.

Column 3, labeled **Fuel**, consists of type of fuel used for energy estimates for the specified operation.

Column 4, labeled **Stir**, consists of the computed Stir value for the specified operation.

Column 5, labeled **Energy**, consists of the total computed energy consumed per unit area (kJ/ha for SI units and Btu/ac for English units) for the specified operation.

Column 6, labeled **Cost**, consists of the total computed cost in dollars per unit area (US dollars/ha for SI units and US dollars/ac for English units) for the specified operation.

The last row displays the rotation's **Total/unit area** values for the **Energy** and **Cost** columns as well as the management rotation's **Total** values for the entire field for the **Stir**, **Energy** and **Cost** columns.

Crop Interval Stir Energy

This section of the Run Summary (Figure 2-38) provides a summarization of the STIR (Soil Tillage Intnesity Rating), Energy and Energy Costs associated with each specific crop interval. The STIR value is an indication of the overall "intensity" of the tillage applied during each specific crop interval in a given management/crop rotation scenario.

Crop Interval Stir Energy

Date Range	Crop	Stir	Energy Btu/ac	Cost USD/ac
Aug 02, 03 - Jul 01, 01	Alfalfa, hay	70.18	558,566	15.96
Jul 02, 01 - Oct 01, 02	Soybean, group II, III and IV	87.39	482,534	13.79
Oct 02, 02 - Aug 01, 03	Alfalfa, hay	30.19	840,243	24.01

Notes

This WEPS Run generated one or more Warning messages. For detailed information about these Warnings, see this run's 'warnings.txt' output file.

Figure 2-38 WEPS Run Summary Crop Interval Stir Energy report.

The Crop Interval Stir Energy table columns are:

Column 1, labeled **Date Range**, consists of the beginning and ending dates for the specified crop interval.

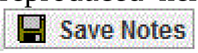
Column 2, labeled **Crop**, consists of the crop grown during the specified crop interval.

Column 4, labeled **Stir**, consists of the computed Stir value for the specified crop interval.

Column 5, labeled **Energy**, consists of the total computed energy consumed per unit area (kJ/ha for SI units and Btu/ac for English units) for the specified crop interval.

Column 6, labeled **Cost**, consists of the total computed cost in dollars per unit area (US dollars/ha for SI units and US dollars/ac for English units) for the specified crop interval.

Notes

The Notes section consists of two parts, the “Notest tab and the “Warnings” tab (Figure 2-39). The Notes section consists of any text entered prior to the simulation on the main WEPS screen’s **Notes** section (Figure 2-1 and Figure 2-10). Any notes entered on the main WEPS screen for this run are reproduced here. They can be edited or added to, if desired, and saved via the appropriate 

button at the top of the Notes form. Any warnings generated during the simulation are listed under the “Warnings” tab.

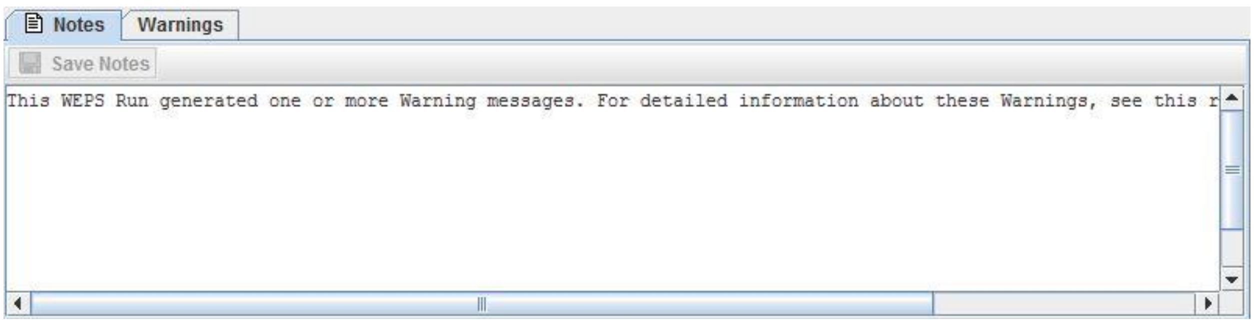
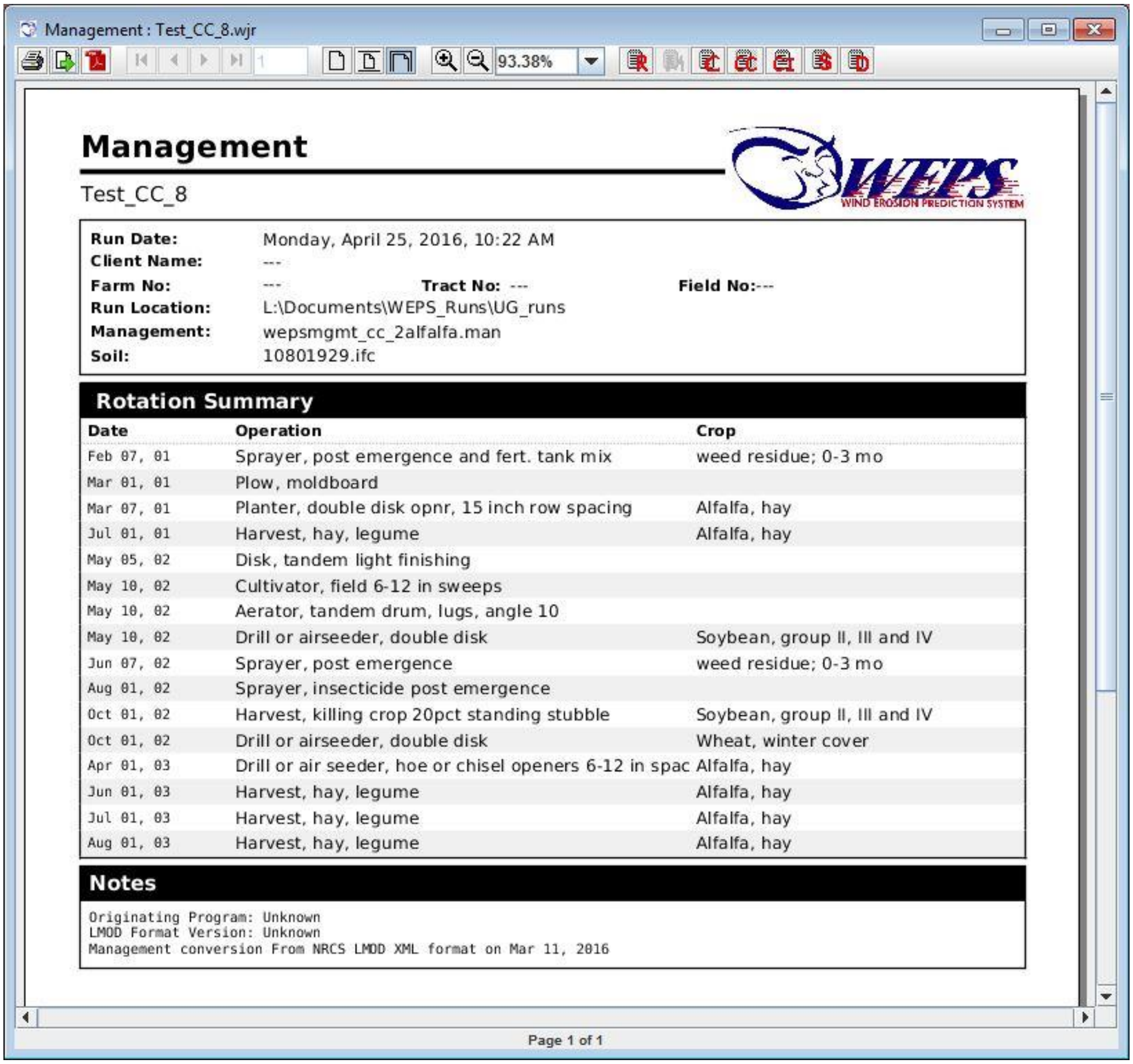


Figure 2-39 WEPS Run Notes listed in Run Summary.

Management Rotation Summary Report

The Management Summary Report screen (Figure 2-40) contains general run information as well as a summary of the management information for the WEPS run. The Management Summary Report displays the management operation date, operation name and crop name for the run with the management notes content listed at the bottom of the screen.



Management : Test_CC_8.wjr

Management

Test_CC_8

Run Date:	Monday, April 25, 2016, 10:22 AM
Client Name:	---
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	L:\Documents\WEPS_Runs\UG_runs
Management:	wepsmgmt_cc_2alfalfa.man
Soil:	10801929.ifc

Rotation Summary

Date	Operation	Crop
Feb 07, 01	Sprayer, post emergence and fert. tank mix	weed residue; 0-3 mo
Mar 01, 01	Plow, moldboard	
Mar 07, 01	Planter, double disk opnr, 15 inch row spacing	Alfalfa, hay
Jul 01, 01	Harvest, hay, legume	Alfalfa, hay
May 05, 02	Disk, tandem light finishing	
May 10, 02	Cultivator, field 6-12 in sweeps	
May 10, 02	Aerator, tandem drum, lugs, angle 10	
May 10, 02	Drill or airseeder, double disk	Soybean, group II, III and IV
Jun 07, 02	Sprayer, post emergence	weed residue; 0-3 mo
Aug 01, 02	Sprayer, insecticide post emergence	
Oct 01, 02	Harvest, killing crop 20pct standing stubble	Soybean, group II, III and IV
Oct 01, 02	Drill or airseeder, double disk	Wheat, winter cover
Apr 01, 03	Drill or air seeder, hoe or chisel openers 6-12 in spac	Alfalfa, hay
Jun 01, 03	Harvest, hay, legume	Alfalfa, hay
Jul 01, 03	Harvest, hay, legume	Alfalfa, hay
Aug 01, 03	Harvest, hay, legume	Alfalfa, hay

Notes

Originating Program: Unknown
LMOD Format Version: Unknown
Management conversion From NRCS LMOD XML format on Mar 11, 2016

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Figure 2-40 WEPS Management Rotation Summary Report.

Crop Reports

There are two crop reports, a Crop Summary Report (Figure 2-41**Error! Reference source not found.**), which only contains a statistical summarization of the individual management rotation year crop data consisting of the mean, standard deviation, minimum and maximum values and a Crop Detail Report (Figure 2-42), which also contains the individual management rotation year-by-year crop data results along with the statistical summarization data. Both reports contain the standard simulation run information in its initial header section, including the names of the input files. All crops that are harvested are reported here. This includes any multiply harvested crops like alfalfa, which are reported for each cropping period harvest individually.

The table heading lists the beginning (usually planting date) and the end (harvest date) of the cropping period, the total numbers of days for the period and the name of the crop being harvested. The individual column labels are:

Column 1, labeled **Dry Yield**, consists of the crop yield reported on a dry matter basis in lbs/ac (English units) or kg/m^2 (SI units).

Column 2, labeled **Harvest Residue**, consists of the remaining above ground residue reported on a dry matter basis in lbs/ac (English units) or kg/m^2 (SI units) after the harvest operation.

Column 4, labeled **Rain**, consists of the total precipitation received in inches (English units) or mm (SI units) during the crop growing period specified.

Column 5, labeled **Irrig**, consists of the total irrigation water applied in inches (English units) or mm (SI units) during the crop growing period specified.

Column 6, labeled **Initial SWC**, consists of the initial soil water content in the soil profile reported in inches (English units) or mm (SI units) of water.

Column 7, labeled **Final SWC**, consists of the final soil water content in the soil profile reported in inches (English units) or mm (SI units) of water.

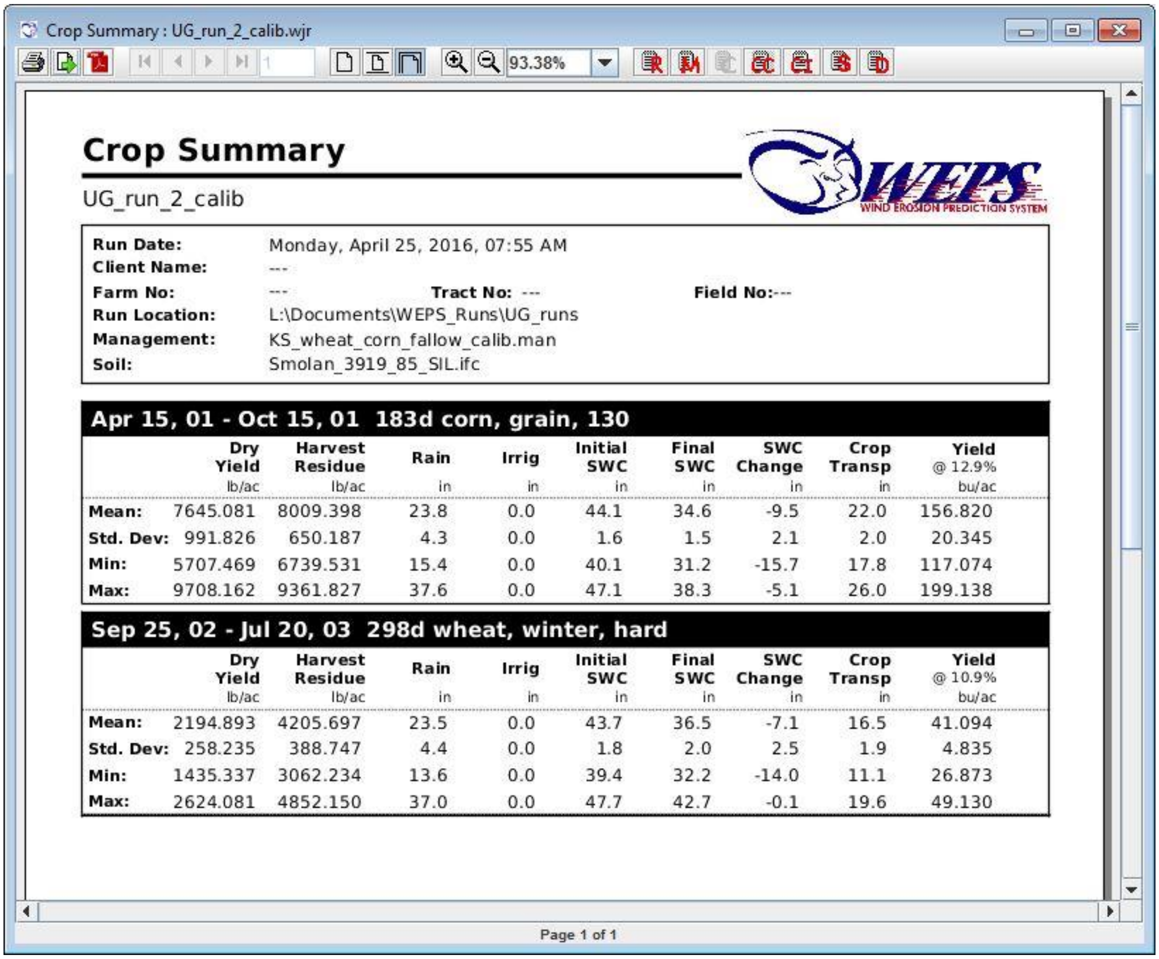
Column 8, labeled **SWC Change**, consists of the change in soil water content in the soil profile reported in inches (English units) or mm (SI units) of water for the crop growing period specified. A negative value means that the stored soil water amount has decreased during the period. A positive value means that the stored water increased during the period.

Column 9, labeled **Crop Transp**, consists of the water transpired through the crop reported in inches (English units) or mm (SI units) of water during the growing period specified.

Column 10, labeled **Yield**, consists of the crop yield reported at the water content specified (obtained from the value provided in the crop record) in the units specified (also obtained from the crop record) when English units are used and kg/m^2 for SI units.

Crop Summary

The Crop Summary Report screen only contains a statistical summarization of the individual management rotation year crop data consisting of the mean, standard deviation, minimum and maximum values for each harvested crop as shown in (Figure 2-41).



Crop Summary : UG_run_2_calib.wjr

93.38%

Crop Summary

UG_run_2_calib

Run Date: Monday, April 25, 2016, 07:55 AM
Client Name: ---
Farm No: --- **Tract No:** --- **Field No:**---
Run Location: L:\Documents\WEPS_Runs\UG_runs
Management: KS_wheat_corn_fallow_calib.man
Soil: Smolan_3919_85_SIL.ifc

Apr 15, 01 - Oct 15, 01 183d corn, grain, 130

	Dry Yield lb/ac	Harvest Residue lb/ac	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in	Yield @ 12.9% bu/ac
Mean:	7645.081	8009.398	23.8	0.0	44.1	34.6	-9.5	22.0	156.820
Std. Dev:	991.826	650.187	4.3	0.0	1.6	1.5	2.1	2.0	20.345
Min:	5707.469	6739.531	15.4	0.0	40.1	31.2	-15.7	17.8	117.074
Max:	9708.162	9361.827	37.6	0.0	47.1	38.3	-5.1	26.0	199.138

Sep 25, 02 - Jul 20, 03 298d wheat, winter, hard

	Dry Yield lb/ac	Harvest Residue lb/ac	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in	Yield @ 10.9% bu/ac
Mean:	2194.893	4205.697	23.5	0.0	43.7	36.5	-7.1	16.5	41.094
Std. Dev:	258.235	388.747	4.4	0.0	1.8	2.0	2.5	1.9	4.835
Min:	1435.337	3062.234	13.6	0.0	39.4	32.2	-14.0	11.1	26.873
Max:	2624.081	4852.150	37.0	0.0	47.7	42.7	-0.1	19.6	49.130

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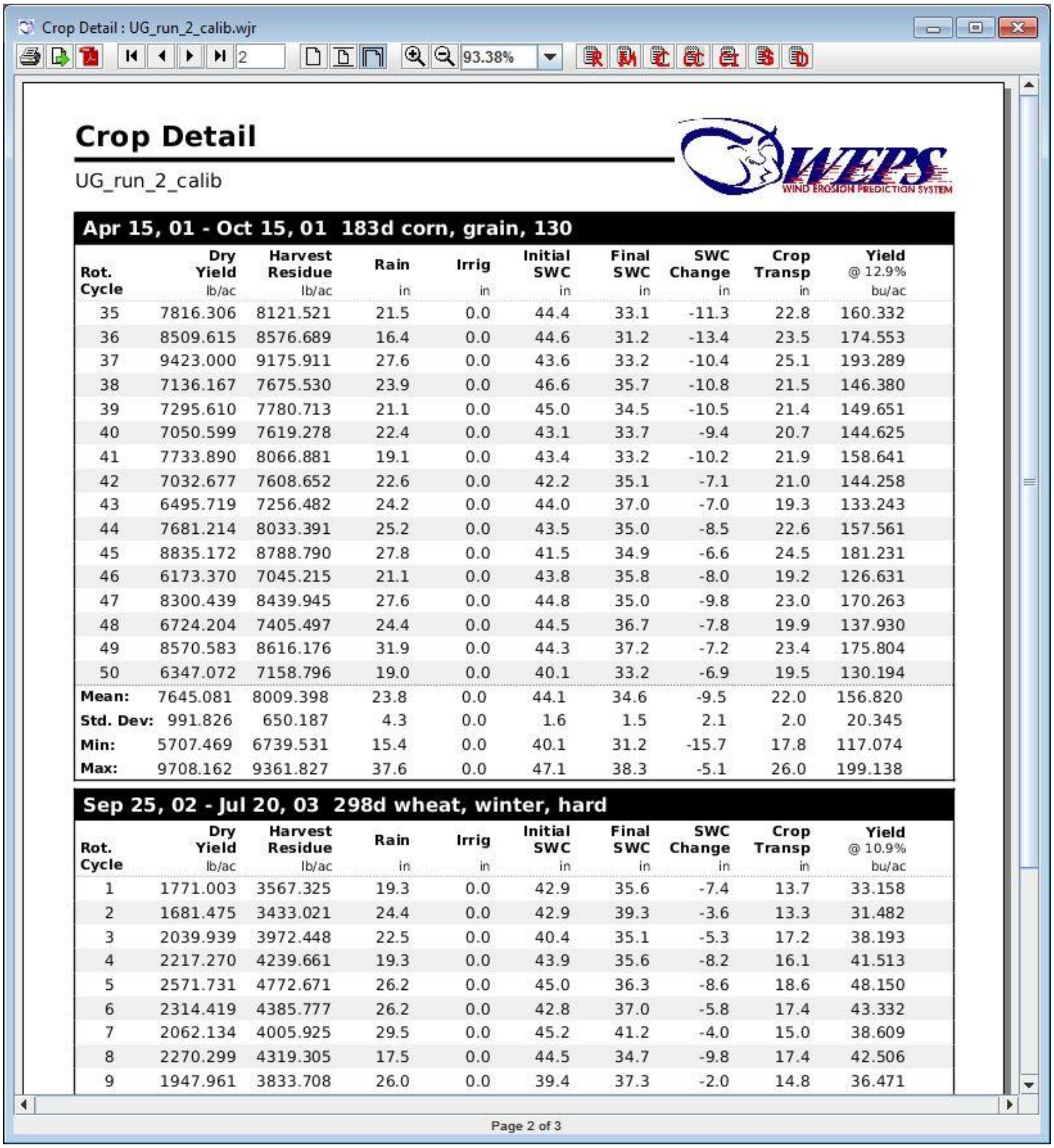
Figure 2-41 WEPS Crop Summary Report.

Crop Detail Report

The Crop Detail Report screen (Figure 2-42), consists of the individual management rotation year-by-year crop data results along with the statistical summarization data provided in the Crop Summary Report. The individual management rotation crop years are listed with a column heading of **Rot. Cycle** to indicate which management rotation cycle is being reported for each row.



Crop Detail

UG_run_2_calib

Apr 15, 01 - Oct 15, 01 183d corn, grain, 130

Rot. Cycle	Dry Yield lb/ac	Harvest Residue lb/ac	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in	Yield @ 12.9% bu/ac
35	7816.306	8121.521	21.5	0.0	44.4	33.1	-11.3	22.8	160.332
36	8509.615	8576.689	16.4	0.0	44.6	31.2	-13.4	23.5	174.553
37	9423.000	9175.911	27.6	0.0	43.6	33.2	-10.4	25.1	193.289
38	7136.167	7675.530	23.9	0.0	46.6	35.7	-10.8	21.5	146.380
39	7295.610	7780.713	21.1	0.0	45.0	34.5	-10.5	21.4	149.651
40	7050.599	7619.278	22.4	0.0	43.1	33.7	-9.4	20.7	144.625
41	7733.890	8066.881	19.1	0.0	43.4	33.2	-10.2	21.9	158.641
42	7032.677	7608.652	22.6	0.0	42.2	35.1	-7.1	21.0	144.258
43	6495.719	7256.482	24.2	0.0	44.0	37.0	-7.0	19.3	133.243
44	7681.214	8033.391	25.2	0.0	43.5	35.0	-8.5	22.6	157.561
45	8835.172	8788.790	27.8	0.0	41.5	34.9	-6.6	24.5	181.231
46	6173.370	7045.215	21.1	0.0	43.8	35.8	-8.0	19.2	126.631
47	8300.439	8439.945	27.6	0.0	44.8	35.0	-9.8	23.0	170.263
48	6724.204	7405.497	24.4	0.0	44.5	36.7	-7.8	19.9	137.930
49	8570.583	8616.176	31.9	0.0	44.3	37.2	-7.2	23.4	175.804
50	6347.072	7158.796	19.0	0.0	40.1	33.2	-6.9	19.5	130.194
Mean:	7645.081	8009.398	23.8	0.0	44.1	34.6	-9.5	22.0	156.820
Std. Dev:	991.826	650.187	4.3	0.0	1.6	1.5	2.1	2.0	20.345
Min:	5707.469	6739.531	15.4	0.0	40.1	31.2	-15.7	17.8	117.074
Max:	9708.162	9361.827	37.6	0.0	47.1	38.3	-5.1	26.0	199.138

Sep 25, 02 - Jul 20, 03 298d wheat, winter, hard

Rot. Cycle	Dry Yield lb/ac	Harvest Residue lb/ac	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in	Yield @ 10.9% bu/ac
1	1771.003	3567.325	19.3	0.0	42.9	35.6	-7.4	13.7	33.158
2	1681.475	3433.021	24.4	0.0	42.9	39.3	-3.6	13.3	31.482
3	2039.939	3972.448	22.5	0.0	40.4	35.1	-5.3	17.2	38.193
4	2217.270	4239.661	19.3	0.0	43.9	35.6	-8.2	16.1	41.513
5	2571.731	4772.671	26.2	0.0	45.0	36.3	-8.6	18.6	48.150
6	2314.419	4385.777	26.2	0.0	42.8	37.0	-5.8	17.4	43.332
7	2062.134	4005.925	29.5	0.0	45.2	41.2	-4.0	15.0	38.609
8	2270.299	4319.305	17.5	0.0	44.5	34.7	-9.8	17.4	42.506
9	1947.961	3833.708	26.0	0.0	39.4	37.3	-2.0	14.8	36.471

Figure 2-42 WEPS Crop Detail Report.

Cover Crop Reports

There are two cover crop reports, a Cover Crop Summary Report (Figure 2-43), which only contains a statistical summarization of the individual management rotation year cover crop data consisting of the mean, standard deviation, minimum and maximum values and a Cover Crop Detail Report (Figure 2-46), which also contains the individual management rotation year-by-year cover crop data results along with the statistical summarization data. Both reports contain the standard simulation run information in its initial header section, including the names of the input files. Crops that are not being harvested are considered cover crops. In addition, any multiply-harvested crop like alfalfa that is terminated on a later date than the last harvest operation will have that last “crop period” following the last reported harvest as a cover crop.

The table heading lists the beginning (usually planting date) and the end (cover crop termination date) of the cover crop period, the total numbers of days for the period and the name of the cover crop. The individual column labels are:

Column 1, labeled **Standing Stem**, consists of the cover crop standing stem mass reported on a dry matter basis in lbs/ac (English units) or kg/m^2 (SI units) on the cover crop termination date.

Column 2, labeled **Standing Leaf**, consists of the cover crop standing leaf mass reported on a dry matter basis in lbs/ac (English units) or kg/m^2 (SI units) on the cover crop termination date.

Column 3, labeled **Avg Height**, consists of the average cover crop height reported in inches (English units) or mm (SI units) on the cover crop termination date.

Column 4, labeled **Stem Count**, consists of the number of standing stems reported in number stems per in^2 (English units) or number stems per m^2 (SI units) on the cover crop termination date.

Column 5, labeled **Rain**, consists of the total precipitation received in inches (English units) or mm (SI units) during the cover crop growing period specified.

Column 6, labeled **Irrig**, consists of the total irrigation water applied in inches (English units) or mm (SI units) during the cover crop growing period specified.

Column 7, labeled **Initial SWC**, consists of the initial soil water content in the soil profile reported in inches (English units) or mm (SI units) of water.

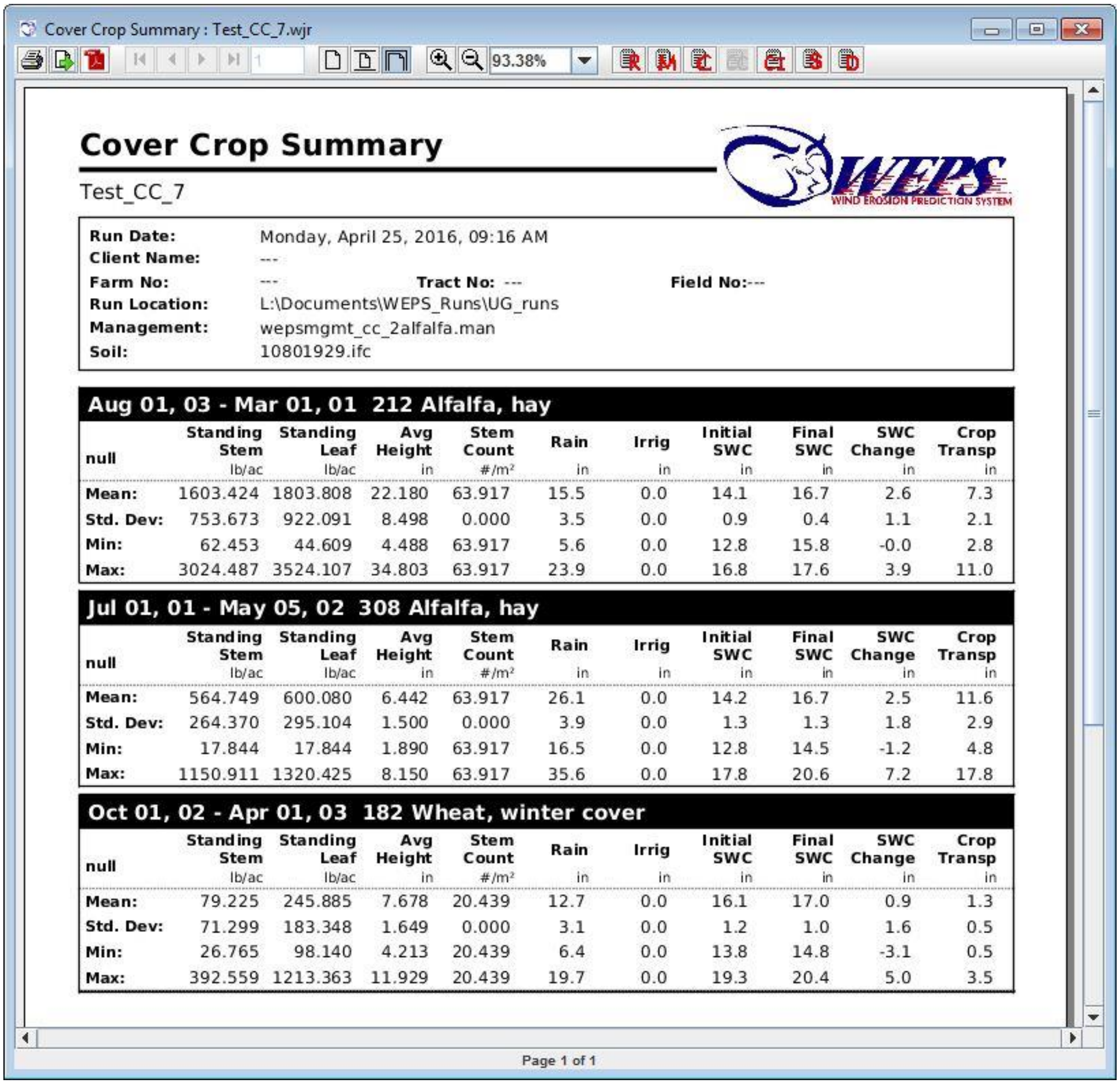
Column 8, labeled **Final SWC**, consists of the final soil water content in the soil profile reported in inches (English units) or mm (SI units) of water.

Column 9, labeled **SWC Change**, consists of the change in soil water content in the soil profile reported in inches (English units) or mm (SI units) of water for the cover crop growing period specified. A negative value means that the stored soil water amount has decreased during the period. A positive value means that the stored water increased during the period.

Column 10, labeled **Crop Transp**, consists of the water transpired through the cover crop reported in inches (English units) or mm (SI units) of water during the growing period specified.

Cover Crop Summary

The WEPS Cover Crop Summary Report screen only contains a statistical summarization of the individual management rotation year cover crop data consisting of the mean, standard deviation, minimum and maximum values for each harvested crop as shown in (Figure 2-43).



Cover Crop Summary : Test_CC_7.wjr

Cover Crop Summary

Test_CC_7

Run Date: Monday, April 25, 2016, 09:16 AM
Client Name: ---
Farm No: --- **Tract No:** --- **Field No:**---
Run Location: L:\Documents\WEPS_Runs\UG_runs
Management: wepsmgmt_cc_2alfalfa.man
Soil: 10801929.ifc

Aug 01, 03 - Mar 01, 01 212 Alfalfa, hay

null	Standing Stem lb/ac	Standing Leaf lb/ac	Avg Height in	Stem Count #/m²	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in
Mean:	1603.424	1803.808	22.180	63.917	15.5	0.0	14.1	16.7	2.6	7.3
Std. Dev:	753.673	922.091	8.498	0.000	3.5	0.0	0.9	0.4	1.1	2.1
Min:	62.453	44.609	4.488	63.917	5.6	0.0	12.8	15.8	-0.0	2.8
Max:	3024.487	3524.107	34.803	63.917	23.9	0.0	16.8	17.6	3.9	11.0

Jul 01, 01 - May 05, 02 308 Alfalfa, hay

null	Standing Stem lb/ac	Standing Leaf lb/ac	Avg Height in	Stem Count #/m²	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in
Mean:	564.749	600.080	6.442	63.917	26.1	0.0	14.2	16.7	2.5	11.6
Std. Dev:	264.370	295.104	1.500	0.000	3.9	0.0	1.3	1.3	1.8	2.9
Min:	17.844	17.844	1.890	63.917	16.5	0.0	12.8	14.5	-1.2	4.8
Max:	1150.911	1320.425	8.150	63.917	35.6	0.0	17.8	20.6	7.2	17.8

Oct 01, 02 - Apr 01, 03 182 Wheat, winter cover

null	Standing Stem lb/ac	Standing Leaf lb/ac	Avg Height in	Stem Count #/m²	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in
Mean:	79.225	245.885	7.678	20.439	12.7	0.0	16.1	17.0	0.9	1.3
Std. Dev:	71.299	183.348	1.649	0.000	3.1	0.0	1.2	1.0	1.6	0.5
Min:	26.765	98.140	4.213	20.439	6.4	0.0	13.8	14.8	-3.1	0.5
Max:	392.559	1213.363	11.929	20.439	19.7	0.0	19.3	20.4	5.0	3.5

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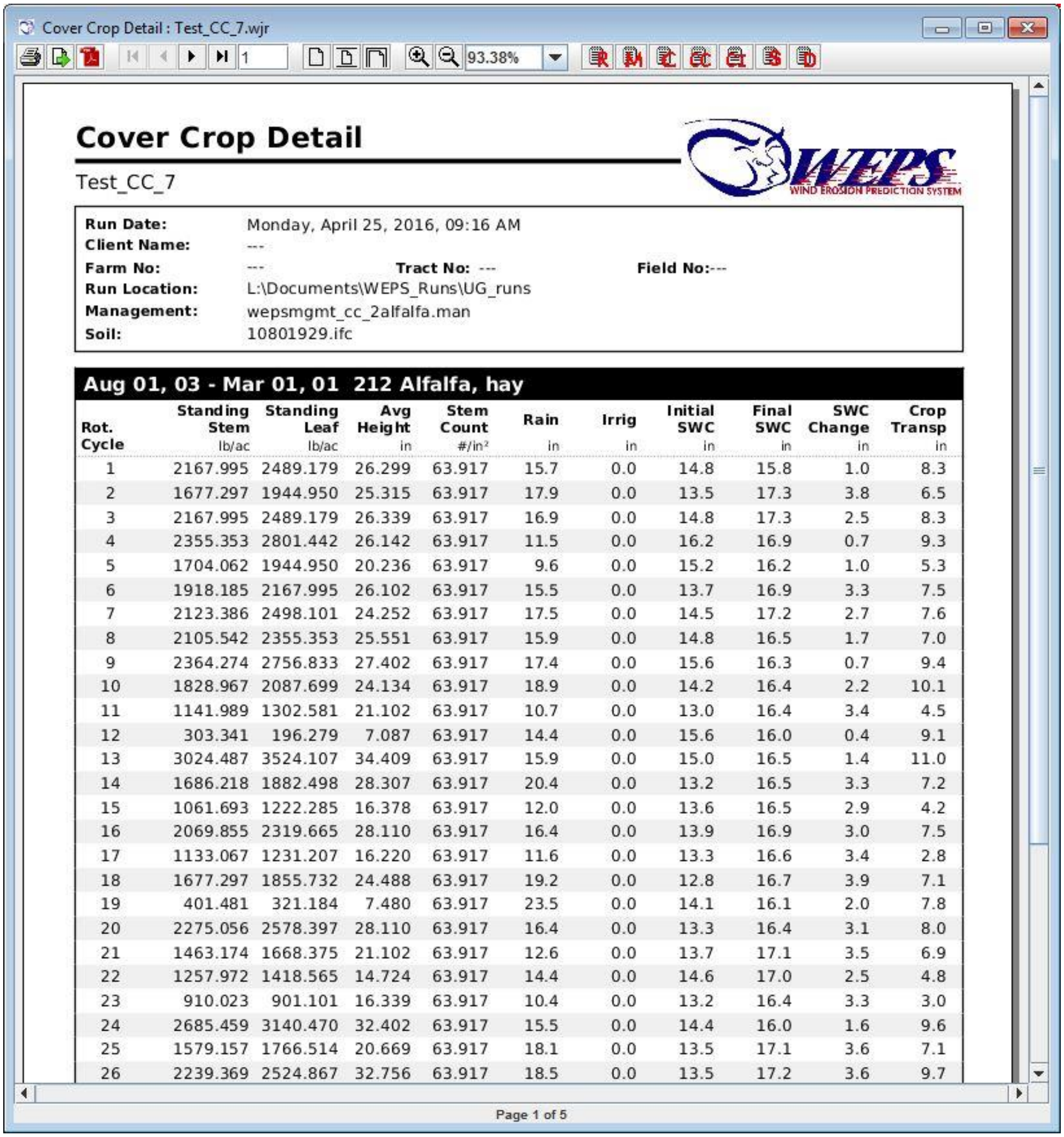
Figure 2-43 WEPS Cover Crop Summary Report.

Cover Crop Detail Report

The Cover Crop Detail Report screen (Figure 2-44), consists of the individual management rotation year-by-year crop data results along with the statistical summarization data provided in the Cover Crop Summary Report. The individual management rotation cover crop years are listed with a column heading of **Rot. Cycle** to indicate which management rotation cycle is being reported for each row.



Cover Crop Detail : Test_CC_7.wjr

Cover Crop Detail

Test_CC_7

Run Date: Monday, April 25, 2016, 09:16 AM
Client Name: ---
Farm No: --- **Tract No:** --- **Field No:**---
Run Location: L:\Documents\WEPS_Runs\UG_runs
Management: wepsmgmt_cc_2alfalfa.man
Soil: 10801929.ifc

Aug 01, 03 - Mar 01, 01 212 Alfalfa, hay

Rot. Cycle	Standing Stem lb/ac	Standing Leaf lb/ac	Avg Height in	Stem Count #/in²	Rain in	Irrig in	Initial SWC in	Final SWC in	SWC Change in	Crop Transp in
1	2167.995	2489.179	26.299	63.917	15.7	0.0	14.8	15.8	1.0	8.3
2	1677.297	1944.950	25.315	63.917	17.9	0.0	13.5	17.3	3.8	6.5
3	2167.995	2489.179	26.339	63.917	16.9	0.0	14.8	17.3	2.5	8.3
4	2355.353	2801.442	26.142	63.917	11.5	0.0	16.2	16.9	0.7	9.3
5	1704.062	1944.950	20.236	63.917	9.6	0.0	15.2	16.2	1.0	5.3
6	1918.185	2167.995	26.102	63.917	15.5	0.0	13.7	16.9	3.3	7.5
7	2123.386	2498.101	24.252	63.917	17.5	0.0	14.5	17.2	2.7	7.6
8	2105.542	2355.353	25.551	63.917	15.9	0.0	14.8	16.5	1.7	7.0
9	2364.274	2756.833	27.402	63.917	17.4	0.0	15.6	16.3	0.7	9.4
10	1828.967	2087.699	24.134	63.917	18.9	0.0	14.2	16.4	2.2	10.1
11	1141.989	1302.581	21.102	63.917	10.7	0.0	13.0	16.4	3.4	4.5
12	303.341	196.279	7.087	63.917	14.4	0.0	15.6	16.0	0.4	9.1
13	3024.487	3524.107	34.409	63.917	15.9	0.0	15.0	16.5	1.4	11.0
14	1686.218	1882.498	28.307	63.917	20.4	0.0	13.2	16.5	3.3	7.2
15	1061.693	1222.285	16.378	63.917	12.0	0.0	13.6	16.5	2.9	4.2
16	2069.855	2319.665	28.110	63.917	16.4	0.0	13.9	16.9	3.0	7.5
17	1133.067	1231.207	16.220	63.917	11.6	0.0	13.3	16.6	3.4	2.8
18	1677.297	1855.732	24.488	63.917	19.2	0.0	12.8	16.7	3.9	7.1
19	401.481	321.184	7.480	63.917	23.5	0.0	14.1	16.1	2.0	7.8
20	2275.056	2578.397	28.110	63.917	16.4	0.0	13.3	16.4	3.1	8.0
21	1463.174	1668.375	21.102	63.917	12.6	0.0	13.7	17.1	3.5	6.9
22	1257.972	1418.565	14.724	63.917	14.4	0.0	14.6	17.0	2.5	4.8
23	910.023	901.101	16.339	63.917	10.4	0.0	13.2	16.4	3.3	3.0
24	2685.459	3140.470	32.402	63.917	15.5	0.0	14.4	16.0	1.6	9.6
25	1579.157	1766.514	20.669	63.917	18.1	0.0	13.5	17.1	3.6	7.1
26	2239.369	2524.867	32.756	63.917	18.5	0.0	13.5	17.2	3.6	9.7

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Figure 2-44 WEPS Cover Crop Detail Report.

Crop Interval Reports

There are three crop interval reports, a Crop Interval Summary Report, Crop Interval Detail Report and a Crop Interval Period Detail Report. The Crop Interval Summary Report (Figure 2-45) only contains a statistical summarization of the individual management rotation year crop interval data consisting of the mean, standard deviation, minimum and maximum values. The Crop Interval Detail Report (Figure 2-46) contains the summarized crop period data results along with the statistical summarization data. The Crop Interval Period Detail Report (Figure 2-47) contains the individual management rotation year-by-year crop period and crop interval data results along with the statistical summarization data for the crop periods and crop intervals. All three reports contain the standard simulation run information in its initial header section, including the names of the input files.

Crops intervals consist of the period following the previous crop's termination until the termination of that crop. For typical row crops, these dates usually correspond to the previous crop's harvest date to this crop's harvest date, assuming the harvest dates. Cropping periods are defined as the period between the previous crops' termination and the planting of the current crop, if this period exists, and is identified as **CP_0** in the crop interval reports. The cropping (crop growth) period that refers to crop planting until harvest is identified as **CP_1** in the crop interval reports. For multiply harvested crops, such as alfalfa, the additional crop growth/harvest periods are referred to as **CP_2**, **CP_3**, etc. If a crop can continue to grow (re-grow) after the final harvest and is not explicitly terminated by that harvest operation, a final cover crop period is defined for that period.

The table heading lists the beginning and the end dates for the periods indicated, the total numbers of days for the period and the name of the crop (for crop intervals) or the operation that concludes the crop period. The individual column labels are:

Column 1, labeled **Biomass**, consists of the above ground biomass grown during the period indicated and reported on a dry matter basis in lbs/ac (English units) or kg/m^2 (SI units).

Column 2, labeled **Rain**, consists of the total precipitation received in inches (English units) or mm (SI units) during the period specified.

Column 3, labeled **Irrig**, consists of the total irrigation water applied in inches (English units) or mm (SI units) during the period specified.

Column 4, labeled **Runoff**, consists of the total surface runoff of water in inches (English units) or mm (SI units) during the period specified.

Column 5, labeled **Drainage**, consists of the total drainage of water through the soil profile in inches (English units) or mm (SI units) during the period specified.

Column 6, labeled **Evap**, consists of the total soil surface evaporation of water in inches (English units) or mm (SI units) during the period specified.

Column 7, labeled **Crop Transp**, consists of the total water transpired through the growing crop reported in inches (English units) or mm (SI units) of water during the specified.

Column 8, labeled **Initial SWC**, consists of the initial soil water content in the soil profile reported in inches (English units) or mm (SI units) of water.

Column 9, labeled **Final SWC**, consists of the final soil water content in the soil profile reported in inches (English units) or mm (SI units) of water.

Column 10, labeled **SWC Change**, consists of the change in soil water content in the soil profile reported in inches (English units) or mm (SI units) of water for the period specified. A negative value means that the stored soil water amount has decreased during the period. A positive value means that the stored water increased during the period.

Column 11, labeled **Runoff Loss**, consists of the percent of surface water runoff lost during the period specified.

Column 12, labeled **Drainage Loss**, consists of the percent of total water lost through the soil during the period specified.

Column 13, labeled **Evap Loss**, consists of the percent of total water lost to surface evaporation during the period specified.

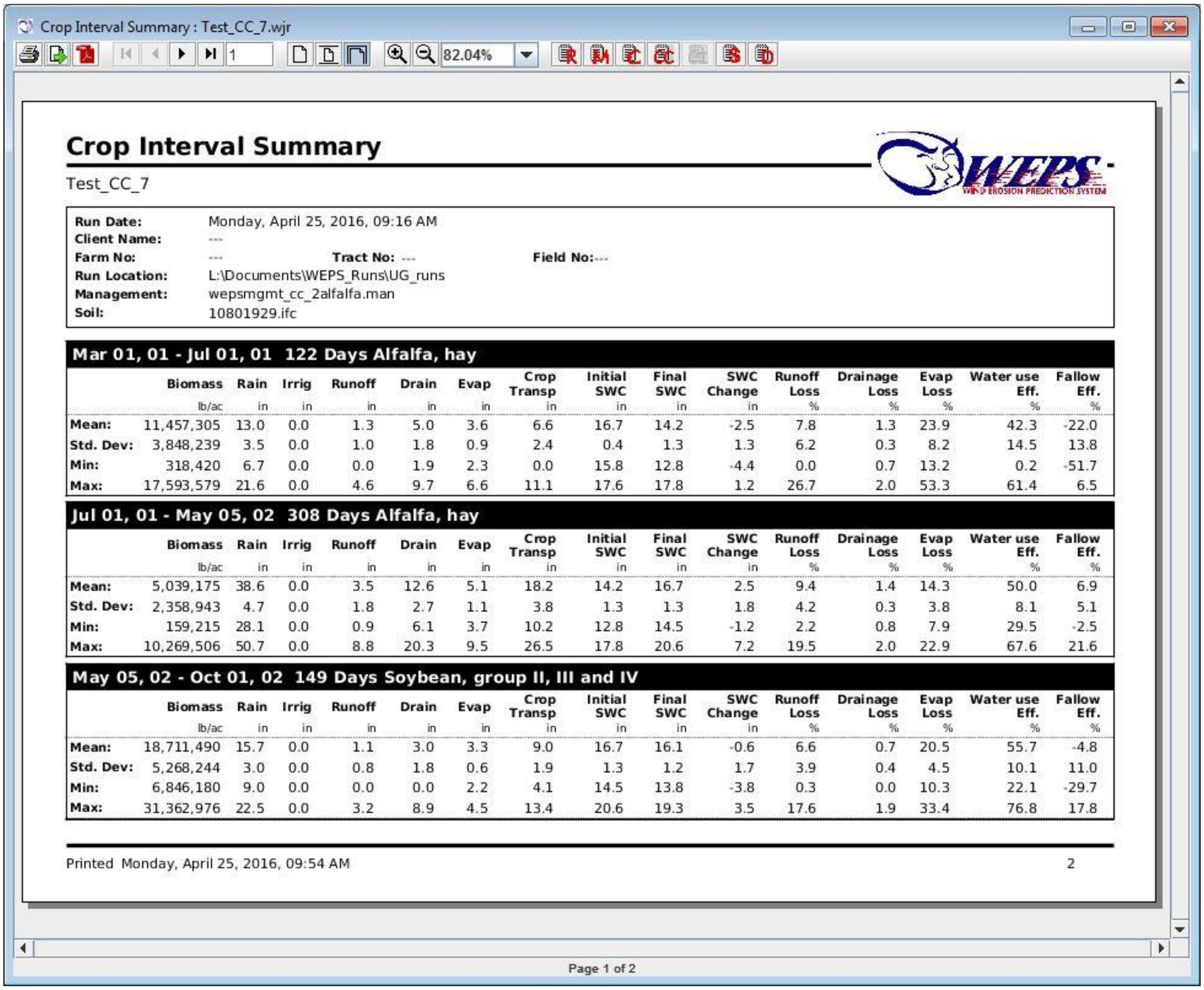
Column 14, labeled **Water use Eff.**, consists of the percent of total water transpired through the growing crop during the period specified. Note that not all periods contain a growing crop (**CP_0**), thus not all report sections will display this column.

Column, 14, labeled **Water Storage Ratio**, consists of the fraction of water stored during a non-crop period (**CP_0**). It is not displayed for periods consisting of a growing crop and the **Water use Eff.** value is displayed instead.

Column 15, labeled **Fallow Eff.**, consists of the total water gained or lost during the period specified and is expressed as a fraction. This term is only useful for periods where there is no crop growing, e.g. a “fallow period” or **CP_0** labeled periods in the Crop Interval Detail Report and the Crop Interval Period Detail Report.

Crop Interval Summary

The WEPS Crop Interval Summary Report screen only contains a statistical summarization of the individual management rotation year crop interval data consisting of the mean, standard deviation, minimum and maximum values for each crop interval as shown in (Figure 2-45).



Crop Interval Summary : Test_CC_7.wjr

Crop Interval Summary

Test_CC_7

Run Date:	Monday, April 25, 2016, 09:16 AM
Client Name:	---
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	L:\Documents\WEPS_Runs\UG_runs
Management:	wepsmgmt_cc_2alfalfa.man
Soil:	10801929.ifc

Mar 01, 01 - Jul 01, 01 122 Days Alfalfa, hay

	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
Mean:	11,457,305	13.0	0.0	1.3	5.0	3.6	6.6	16.7	14.2	-2.5	7.8	1.3	23.9	42.3	-22.0
Std. Dev:	3,848,239	3.5	0.0	1.0	1.8	0.9	2.4	0.4	1.3	1.3	6.2	0.3	8.2	14.5	13.8
Min:	318,420	6.7	0.0	0.0	1.9	2.3	0.0	15.8	12.8	-4.4	0.0	0.7	13.2	0.2	-51.7
Max:	17,593,579	21.6	0.0	4.6	9.7	6.6	11.1	17.6	17.8	1.2	26.7	2.0	53.3	61.4	6.5

Jul 01, 01 - May 05, 02 308 Days Alfalfa, hay

	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
Mean:	5,039,175	38.6	0.0	3.5	12.6	5.1	18.2	14.2	16.7	2.5	9.4	1.4	14.3	50.0	6.9
Std. Dev:	2,358,943	4.7	0.0	1.8	2.7	1.1	3.8	1.3	1.3	1.8	4.2	0.3	3.8	8.1	5.1
Min:	159,215	28.1	0.0	0.9	6.1	3.7	10.2	12.8	14.5	-1.2	2.2	0.8	7.9	29.5	-2.5
Max:	10,269,506	50.7	0.0	8.8	20.3	9.5	26.5	17.8	20.6	7.2	19.5	2.0	22.9	67.6	21.6

May 05, 02 - Oct 01, 02 149 Days Soybean, group II, III and IV

	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
Mean:	18,711,490	15.7	0.0	1.1	3.0	3.3	9.0	16.7	16.1	-0.6	6.6	0.7	20.5	55.7	-4.8
Std. Dev:	5,268,244	3.0	0.0	0.8	1.8	0.6	1.9	1.3	1.2	1.7	3.9	0.4	4.5	10.1	11.0
Min:	6,846,180	9.0	0.0	0.0	0.0	2.2	4.1	14.5	13.8	-3.8	0.3	0.0	10.3	22.1	-29.7
Max:	31,362,976	22.5	0.0	3.2	8.9	4.5	13.4	20.6	19.3	3.5	17.6	1.9	33.4	76.8	17.8

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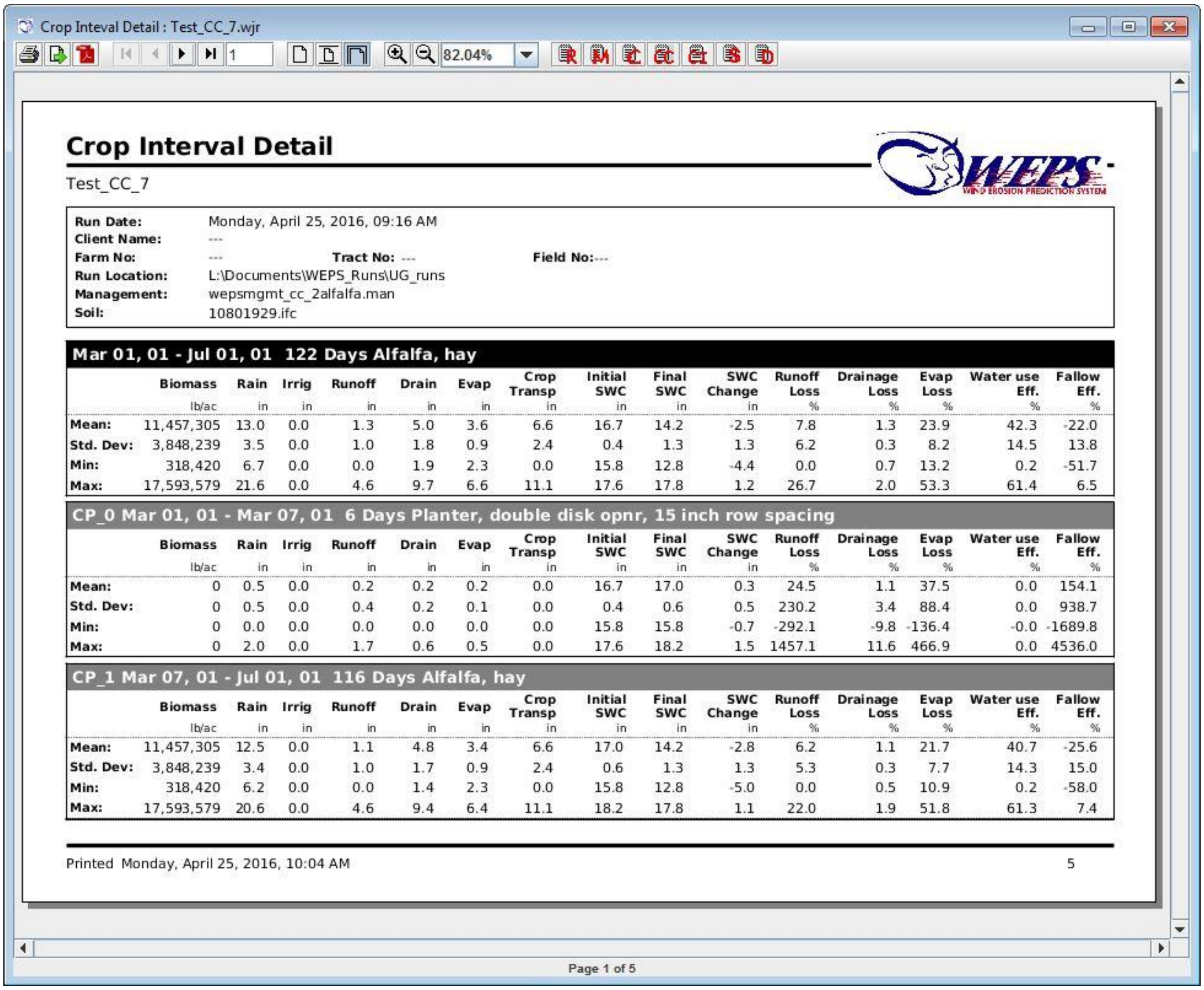
Figure 2-45 WEPS Crop Interval Summary Report.

Crop Interval Detail Report

The Crop Interval Detail Report screen (Figure 2-46) consists of the individual crop periods (**CP_0**, **CP_1**, **CP_2**, etc.) results along with the statistical summarization of the crop interval data provided in the Crop Interval Summary Report.



Crop Inteval Detail : Test_CC_7.wjr

82.04%

Crop Interval Detail

Test_CC_7

Run Date: Monday, April 25, 2016, 09:16 AM
Client Name: ---
Farm No: --- **Tract No:** --- **Field No:**---
Run Location: L:\Documents\WEPS_Runs\UG_runs
Management: wepsmgmt_cc_2alfalfa.man
Soil: 10801929.ifc

Mar 01, 01 - Jul 01, 01 122 Days Alfalfa, hay

	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
Mean:	11,457,305	13.0	0.0	1.3	5.0	3.6	6.6	16.7	14.2	-2.5	7.8	1.3	23.9	42.3	-22.0
Std. Dev:	3,848,239	3.5	0.0	1.0	1.8	0.9	2.4	0.4	1.3	1.3	6.2	0.3	8.2	14.5	13.8
Min:	318,420	6.7	0.0	0.0	1.9	2.3	0.0	15.8	12.8	-4.4	0.0	0.7	13.2	0.2	-51.7
Max:	17,593,579	21.6	0.0	4.6	9.7	6.6	11.1	17.6	17.8	1.2	26.7	2.0	53.3	61.4	6.5

CP_0 Mar 01, 01 - Mar 07, 01 6 Days Planter, double disk opnr, 15 inch row spacing

	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
Mean:	0	0.5	0.0	0.2	0.2	0.2	0.0	16.7	17.0	0.3	24.5	1.1	37.5	0.0	154.1
Std. Dev:	0	0.5	0.0	0.4	0.2	0.1	0.0	0.4	0.6	0.5	230.2	3.4	88.4	0.0	938.7
Min:	0	0.0	0.0	0.0	0.0	0.0	0.0	15.8	15.8	-0.7	-292.1	-9.8	-136.4	-0.0	-1689.8
Max:	0	2.0	0.0	1.7	0.6	0.5	0.0	17.6	18.2	1.5	1457.1	11.6	466.9	0.0	4536.0

CP_1 Mar 07, 01 - Jul 01, 01 116 Days Alfalfa, hay

	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
Mean:	11,457,305	12.5	0.0	1.1	4.8	3.4	6.6	17.0	14.2	-2.8	6.2	1.1	21.7	40.7	-25.6
Std. Dev:	3,848,239	3.4	0.0	1.0	1.7	0.9	2.4	0.6	1.3	1.3	5.3	0.3	7.7	14.3	15.0
Min:	318,420	6.2	0.0	0.0	1.4	2.3	0.0	15.8	12.8	-5.0	0.0	0.5	10.9	0.2	-58.0
Max:	17,593,579	20.6	0.0	4.6	9.4	6.4	11.1	18.2	17.8	1.1	22.0	1.9	51.8	61.3	7.4

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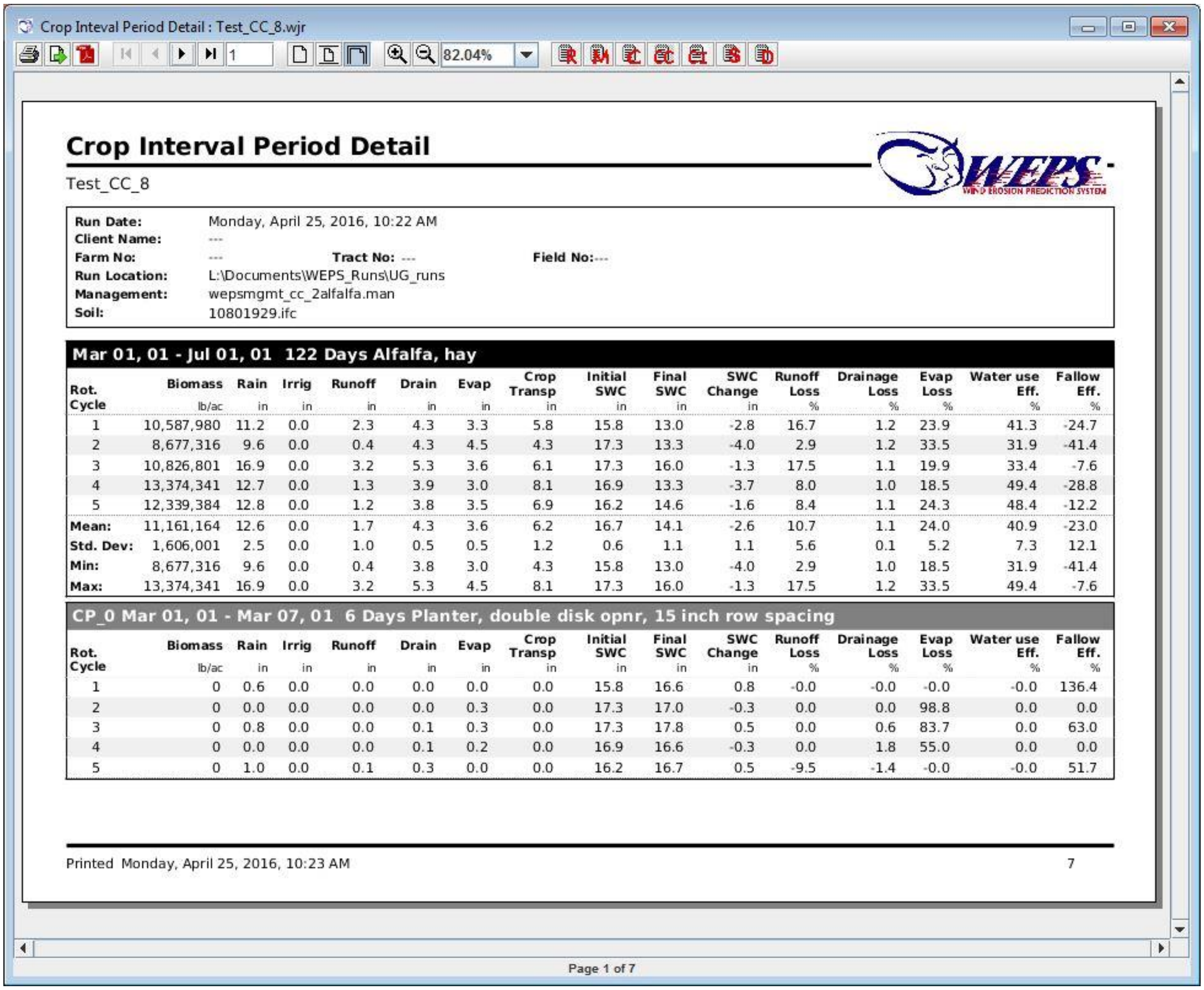
Figure 2-46 WEPS Crop Interval Detail Report.

Crop Interval Period Detail Report

The Crop Interval Period Detail Report screen (Figure 2-47) consists of the individual management rotation year-by-year crop interval and crop period data results along with the statistical summarization of the crop interval and crop period data provided in the Crop Interval Detail Report. The individual management rotation crop period and crop interval years are listed with a column heading of **Rot. Cycle** to indicate which management rotation cycle is being reported for each row.



Crop Inteval Period Detail : Test_CC_8.wjr

Crop Interval Period Detail

Test_CC_8

Run Date: Monday, April 25, 2016, 10:22 AM
Client Name: ---
Farm No: --- Tract No: --- Field No:---
Run Location: L:\Documents\WEPS_Runs\UG_runs
Management: wepsmgmt_cc_2alfalfa.man
Soil: 10801929.ifc

Mar 01, 01 - Jul 01, 01 122 Days Alfalfa, hay

Rot. Cycle	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
1	10,587,980	11.2	0.0	2.3	4.3	3.3	5.8	15.8	13.0	-2.8	16.7	1.2	23.9	41.3	-24.7
2	8,677,316	9.6	0.0	0.4	4.3	4.5	4.3	17.3	13.3	-4.0	2.9	1.2	33.5	31.9	-41.4
3	10,826,801	16.9	0.0	3.2	5.3	3.6	6.1	17.3	16.0	-1.3	17.5	1.1	19.9	33.4	-7.6
4	13,374,341	12.7	0.0	1.3	3.9	3.0	8.1	16.9	13.3	-3.7	8.0	1.0	18.5	49.4	-28.8
5	12,339,384	12.8	0.0	1.2	3.8	3.5	6.9	16.2	14.6	-1.6	8.4	1.1	24.3	48.4	-12.2
Mean:	11,161,164	12.6	0.0	1.7	4.3	3.6	6.2	16.7	14.1	-2.6	10.7	1.1	24.0	40.9	-23.0
Std. Dev:	1,606,001	2.5	0.0	1.0	0.5	0.5	1.2	0.6	1.1	1.1	5.6	0.1	5.2	7.3	12.1
Min:	8,677,316	9.6	0.0	0.4	3.8	3.0	4.3	15.8	13.0	-4.0	2.9	1.0	18.5	31.9	-41.4
Max:	13,374,341	16.9	0.0	3.2	5.3	4.5	8.1	17.3	16.0	-1.3	17.5	1.2	33.5	49.4	-7.6

CP_0 Mar 01, 01 - Mar 07, 01 6 Days Planter, double disk opnr, 15 inch row spacing

Rot. Cycle	Biomass lb/ac	Rain in	Irrig in	Runoff in	Drain in	Evap in	Crop Transp in	Initial SWC in	Final SWC in	SWC Change in	Runoff Loss %	Drainage Loss %	Evap Loss %	Water use Eff. %	Fallow Eff. %
1	0	0.6	0.0	0.0	0.0	0.0	0.0	15.8	16.6	0.8	-0.0	-0.0	-0.0	-0.0	136.4
2	0	0.0	0.0	0.0	0.0	0.3	0.0	17.3	17.0	-0.3	0.0	0.0	98.8	0.0	0.0
3	0	0.8	0.0	0.0	0.1	0.3	0.0	17.3	17.8	0.5	0.0	0.6	83.7	0.0	63.0
4	0	0.0	0.0	0.0	0.1	0.2	0.0	16.9	16.6	-0.3	0.0	1.8	55.0	0.0	0.0
5	0	1.0	0.0	0.1	0.3	0.0	0.0	16.2	16.7	0.5	-9.5	-1.4	-0.0	-0.0	51.7

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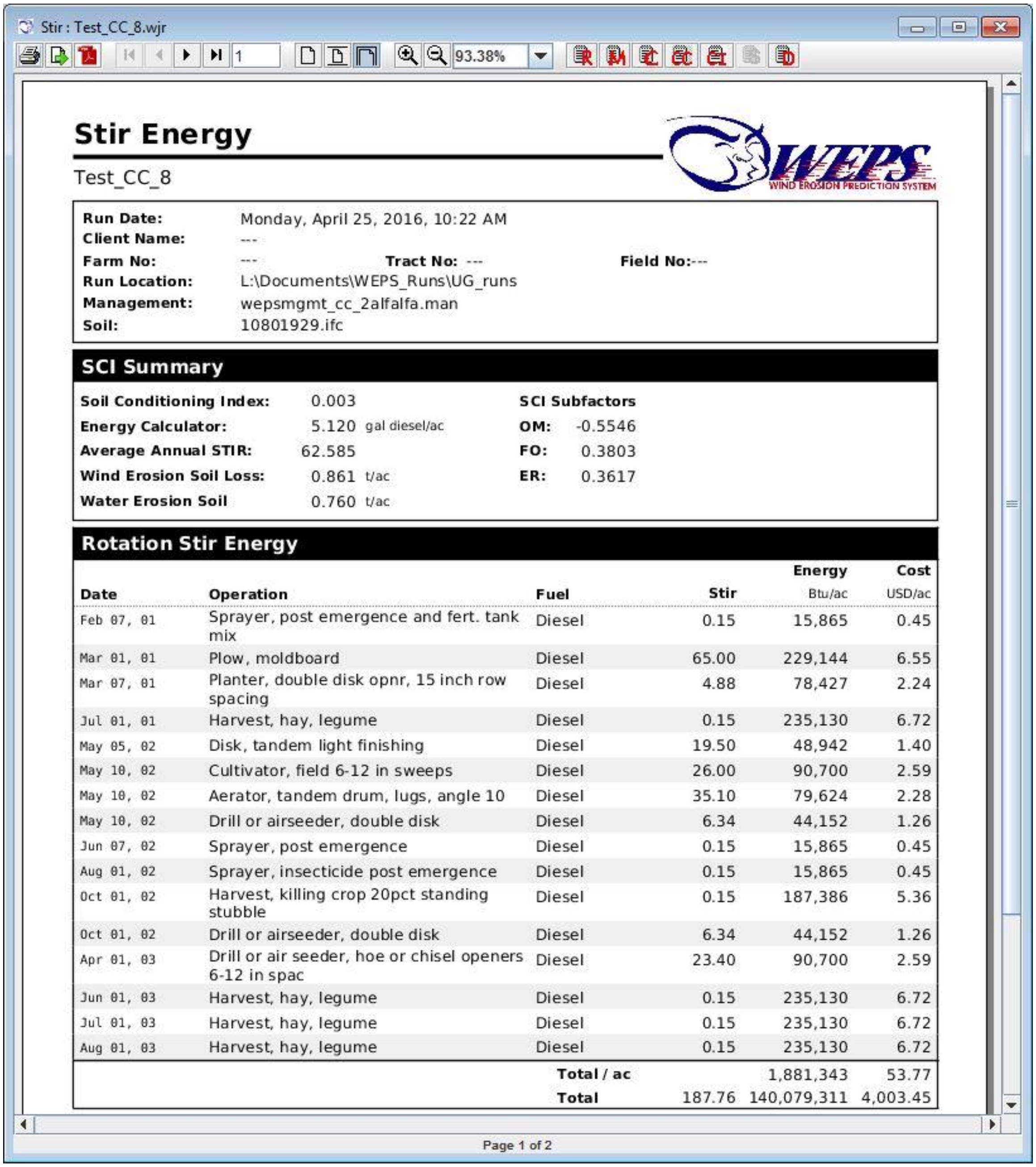
Figure 2-47 WEPS Crop Interval Period Detail Report.

STIR Energy Report

The STIR Energy Report screen (Figure 2-48) contains general run information as well as a summary of the STIR energy and SCI (Soil Conditioning Index) information for the WEPS run. The STIR Energy Report displays the three sections (SCI Summary, Rotation STIR Energy and Crop Interval STIR Energy).


Stir : Test_CC_8.wjr

Stir Energy

Test_CC_8

Run Date:	Monday, April 25, 2016, 10:22 AM
Client Name:	---
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	L:\Documents\WEPS_Runs\UG_runs
Management:	wepsmgmt_cc_2alfalfa.man
Soil:	10801929.ifc

SCI Summary

Soil Conditioning Index:	0.003	**SCI Subfactors**	
Energy Calculator:	5.120 gal diesel/ac	**OM:**	-0.5546
Average Annual STIR:	62.585	**FO:**	0.3803
Wind Erosion Soil Loss:	0.861 t/ac	**ER:**	0.3617
Water Erosion Soil	0.760 t/ac		

Rotation Stir Energy

Date	Operation	Fuel	Stir	Energy Btu/ac	Cost USD/ac
Feb 07, 01	Sprayer, post emergence and fert. tank mix	Diesel	0.15	15,865	0.45
Mar 01, 01	Plow, moldboard	Diesel	65.00	229,144	6.55
Mar 07, 01	Planter, double disk opnr, 15 inch row spacing	Diesel	4.88	78,427	2.24
Jul 01, 01	Harvest, hay, legume	Diesel	0.15	235,130	6.72
May 05, 02	Disk, tandem light finishing	Diesel	19.50	48,942	1.40
May 10, 02	Cultivator, field 6-12 in sweeps	Diesel	26.00	90,700	2.59
May 10, 02	Aerator, tandem drum, lugs, angle 10	Diesel	35.10	79,624	2.28
May 10, 02	Drill or airseeder, double disk	Diesel	6.34	44,152	1.26
Jun 07, 02	Sprayer, post emergence	Diesel	0.15	15,865	0.45
Aug 01, 02	Sprayer, insecticide post emergence	Diesel	0.15	15,865	0.45
Oct 01, 02	Harvest, killing crop 20pct standing stubble	Diesel	0.15	187,386	5.36
Oct 01, 02	Drill or airseeder, double disk	Diesel	6.34	44,152	1.26
Apr 01, 03	Drill or air seeder, hoe or chisel openers 6-12 in spac	Diesel	23.40	90,700	2.59
Jun 01, 03	Harvest, hay, legume	Diesel	0.15	235,130	6.72
Jul 01, 03	Harvest, hay, legume	Diesel	0.15	235,130	6.72
Aug 01, 03	Harvest, hay, legume	Diesel	0.15	235,130	6.72
		Total / ac		1,881,343	53.77
		Total	187.76	140,079,311	4,003.45

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Figure 2-48 WEPS STIR Energy Report displaying the “SCI Summary” and “Rotation STIR Energy” sections.

This **SCI Summary** section consists of the SCI (Soil Conditioning Index) value, the Energy Calculator (fuel/ac for English units and fuel/ha for SI units), average annual STIR value, wind and water erosion values (t/ac for English units and kg/m^2 for SI units) and the SCI subfactors: OM, FO and ER.

The SCI is an index developed by NRCS to reflect trends in soil organic matter, which are assumed to be an indicator of soil quality trends. A negative value generally implies that the soil organic matter is decreasing and thus soil quality would be degrading over time. A positive value implies that soil organic matter is increasing and thus soil quality is generally improving over time. A value of zero or near zero implies that soil organic matter is not changing over time and thus the soil quality is sustainable. The values presented in this summary are:

- **Soil Condition Index** - Index developed and used by NRCS to reflect the relative quality of a soil due to the management/crop rotation practices being applied.
- **Energy Calculator** - Average annual energy per acre expended for operations specified in the management/crop rotation.
- **Average Annual STIR** – STIR stands for Soil Tillage Intensity Rating and is computed for the entire management/crop rotation sequence from the listed operations.
- **Wind Erosion Soil Loss** - An input required for SCI calculation. Obtained from the WEPS simulation run.
- **Water Erosion Loss** - An input required for SCI calculation. User is expected to specify the value on the main WEPS screen prior to the WEPS simulation being executed.

SCI Subfactors

- **OM** - It is the organic material or biomass subfactor. This component is an indicator of organic matter preservation and accounts for the effect of biomass returned to the soil, including material from plant or animal sources, and material either imported to the site or grown and retained on the site.
- **FO** - It is the field operations subfactor. This component accounts for the effect of field operations that stimulate organic matter breakdown. Tillage, planting, fertilizer application, spraying, harvesting, and other operations crush and shatter plant residues and aerate or compact the soil. These effects increase the rate of residue decomposition and affect the placement of organic material in the soil profile.
- **ER** - It is the erosion subfactor. This component accounts for the effect of removal and sorting of surface soil organic matter by sheet, rill, or wind erosion processes as predicted by water and wind erosion models. It does not account for the effects of concentrated flow erosion, such as ephemeral or classic gullies.

The **Rotation STIR Energy** section (Figure 2-48) summarizes the effect of the management/crop rotation operations on the health of the soil and the energy required to perform them. It consists of the individual operation names, date of use, **STIR** values along with their **Fuel** type, estimated **Energy** use (Btu/ac for English units and kJ/ha for SI units) and **Costs** ($/ac for English units and $/ha for SI units). The total STIR energy value (But/ac if English units are used and kJ/ha if SI units are specified) and Cost ($/ac for English units and $/ha if SI units are specified) are also tallied and reported at the bottom of this section.

The **Crop Interval STIR Energy** section (**Error! Reference source not found.**) summarizes the effect of the management/crop rotation operations used over the specified crop interval dates (from termination of the last crop to the harvest or termination of this crop) values for **STIR**, **Energy** and **Cost** are displayed.

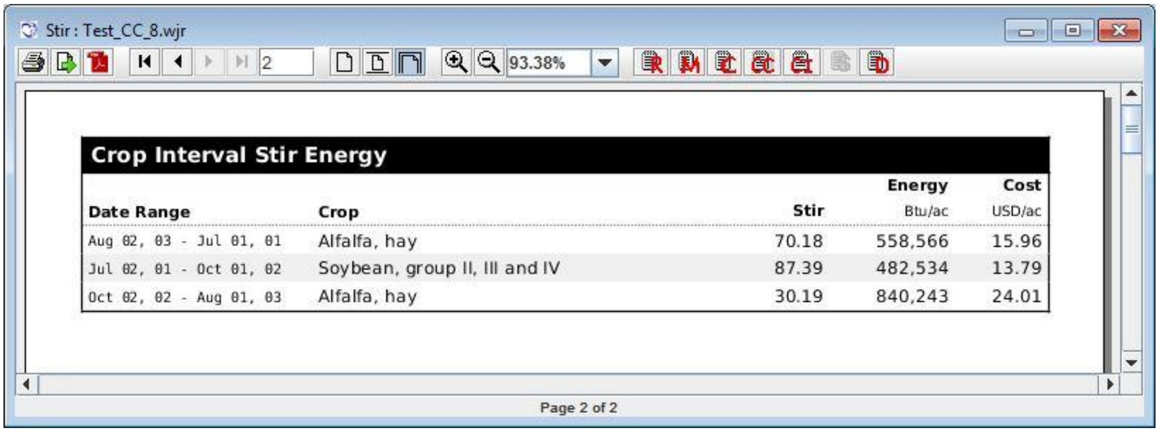


Figure 2-49 WEPS STIR Energy Report displaying the "Crop Interval STIR Energy" section.

Confidence Interval Report

The WEPS Confidence Interval Report screen (**Error! Reference source not found.**) contains a statistical summarization of the estimated erosion loss from the field in terms of a "confidence interval" and reports the nonlinearity of the erosion data in terms of quartiles. A **Final Cycle Gross Loss Confidence Interval** box and whisker graph is shown in the first section. In the middle section, a **Cycle Gross Loss Confidence Interval** graph of the gross average soil for each rotation cycle, the gross soil loss upper and lower 90% confidence intervals and the running average soil loss are plotted against the rotation cycles. There is also an **Annual Gross Loss Quartile Distribution** box and whisker graph that plots the "Mean", Median" and "Extreme-Outlier annual soil loss data against erosion loss. In addition, there is a table starting on page 2 displaying the individual rotation cycle values reporting the annual soil loss for the individual cycle, a running average annual soil loss, and the upper and lower 90% confidence interval values through each rotation cycle.

Final Cycle Gross Loss Confidence Interval: A box and whisker graph providing a statistical picture of the final minimum, maximum and median annual erosion values, the annual average (mean) erosion total and 90% confidence interval values are shown. Each data point is the average of the individual year values for each rotation cycle, e.g. a 3-year cycle would be the average of the 3 individual yearly average values. The whiskers show the maximum and minimum values for the cycles. The box ends indicate the upper and lower values of the 90% confidence interval and the box itself representing the confidence interval range. The black dot is placed at the mean value and the black vertical bar at the median value.

Cycle Gross Loss Confidence Interval Plot: Each value of the annual erosion total is averaged over each rotation cycle (blue line), and the running average mean (red line) and confidence interval (green line/fill region) values are calculated as each cycle is added. When fewer cycles have been simulated, the mean and confidence interval values can change dramatically when a large cycle erosion value is included in the calculation. As more years are simulated, the mean and confidence interval become more stable, even when large cycle erosion values occur. The final results at the end of the plot are presented more clearly in the previous box and whisker graph. Note that the auto-scaling is based upon the maximum average annual erosion value, so the upper 90% CI values are truncated if they exceed that maximum Y-axis plot limit.

Annual Gross Loss Quartile Distribution: A box and whisker graph providing a statistical picture of total erosion for each year, irrespective of the cycles, is shown. The lower quartile is the 25% of values which are below the lower end of the red bar. When at least 25% of the years have no erosion, then the lower end of the red bar would be at zero, signifying a zero erosion amount. The second quartile is the 25% of values which are between the lower end of the red bar and the median (as shown by the black vertical bar). The third quartile are the 25% of values which are between the median and the upper end of the red bar. The fourth quartile is all values above the upper end of the red bar. The inter-quartile range is the distance between the lower and upper ends of the red bar (represented by the red box). The lower and upper “fences” are shown by the lower and upper whiskers, which are the values which are 1.5 times the inter-quartile range below the lower end of the red bar, or 1.5 times the interquartile range above the upper end of the red bar. All values below the lower whisker or above the upper whisker are considered to be extreme outliers and are plotted with a blue × symbol. Note that this graph is plotting the individual yearly erosion values and not the individual rotation cycle average values.

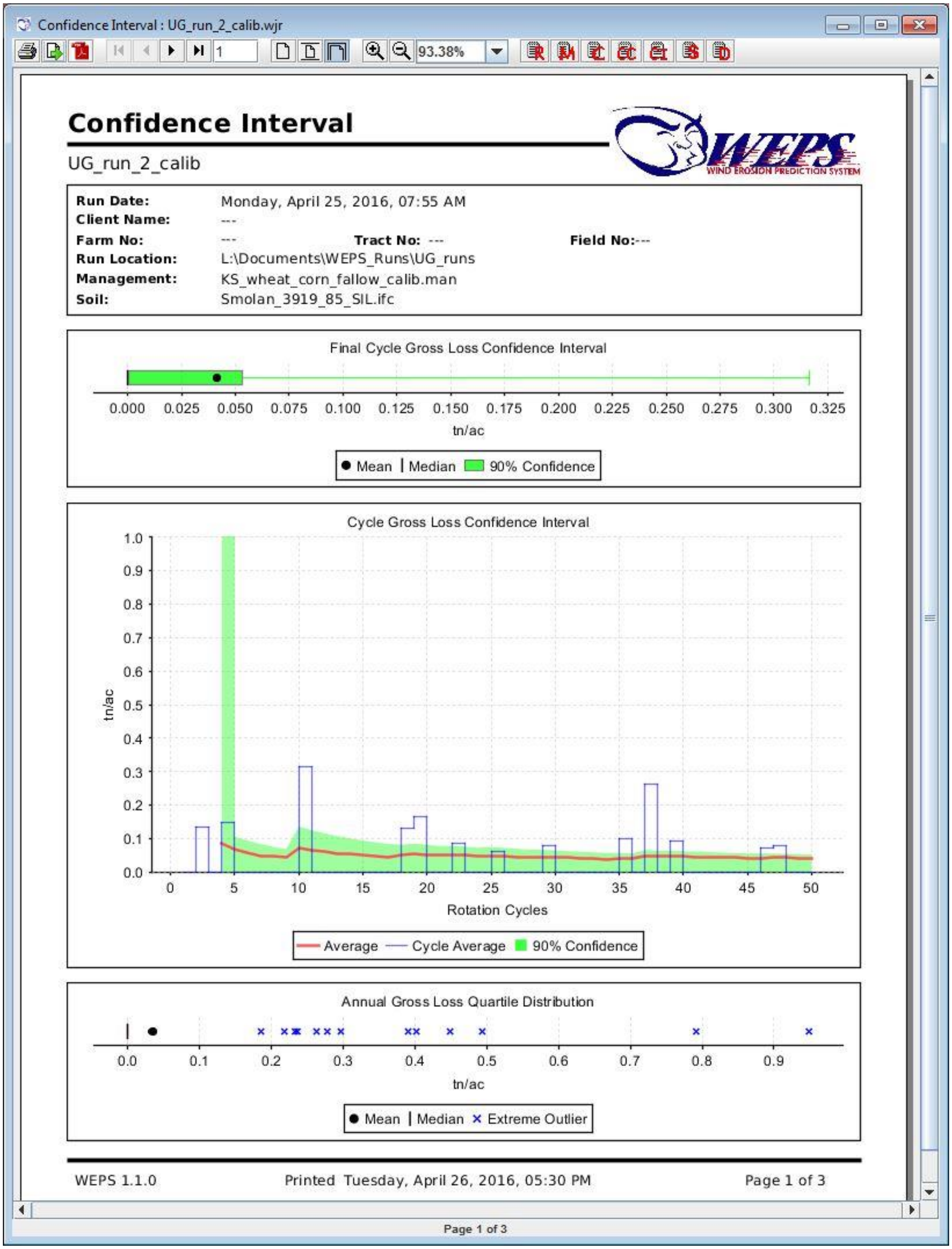


Figure 2-50 WEPS Confidence Interval Report.

Viewing Previous WEPS Output Reports

Output from either the current run or previous runs can be viewed by using the '**ViewOutput**' menu. This menu allows the user to view output for the most recent (current) or previous runs. Clicking on the '**Current Run**' menu item displays a list of output reports for the current (last completed WEPS simulation) run. Clicking on the '**Previous Run**' menu item displays a list of output reports for previous runs. For this menu option, a file chooser opens to allow the user to pick the desired run for which to view the output. The **"Multiple Run Manager**" also allows the user to open a list of previous WEPS runs. See the section of the WEPS User Manual titled "Viewing WEPS Output Reports", "Viewing Tabular Detail Reports" and "

Viewing Science Model Reports" for a more detailed description of the individual WEPS output reports available.

Viewing Science Model Reports

The Science Model Reports screen (Figure 2-51), accessible from the ViewOutput menu on the WEPS main screen, provides a means of directly accessing all output files generated by the WEPS science model, including those that are used by the WEPS user interface to generate reports.

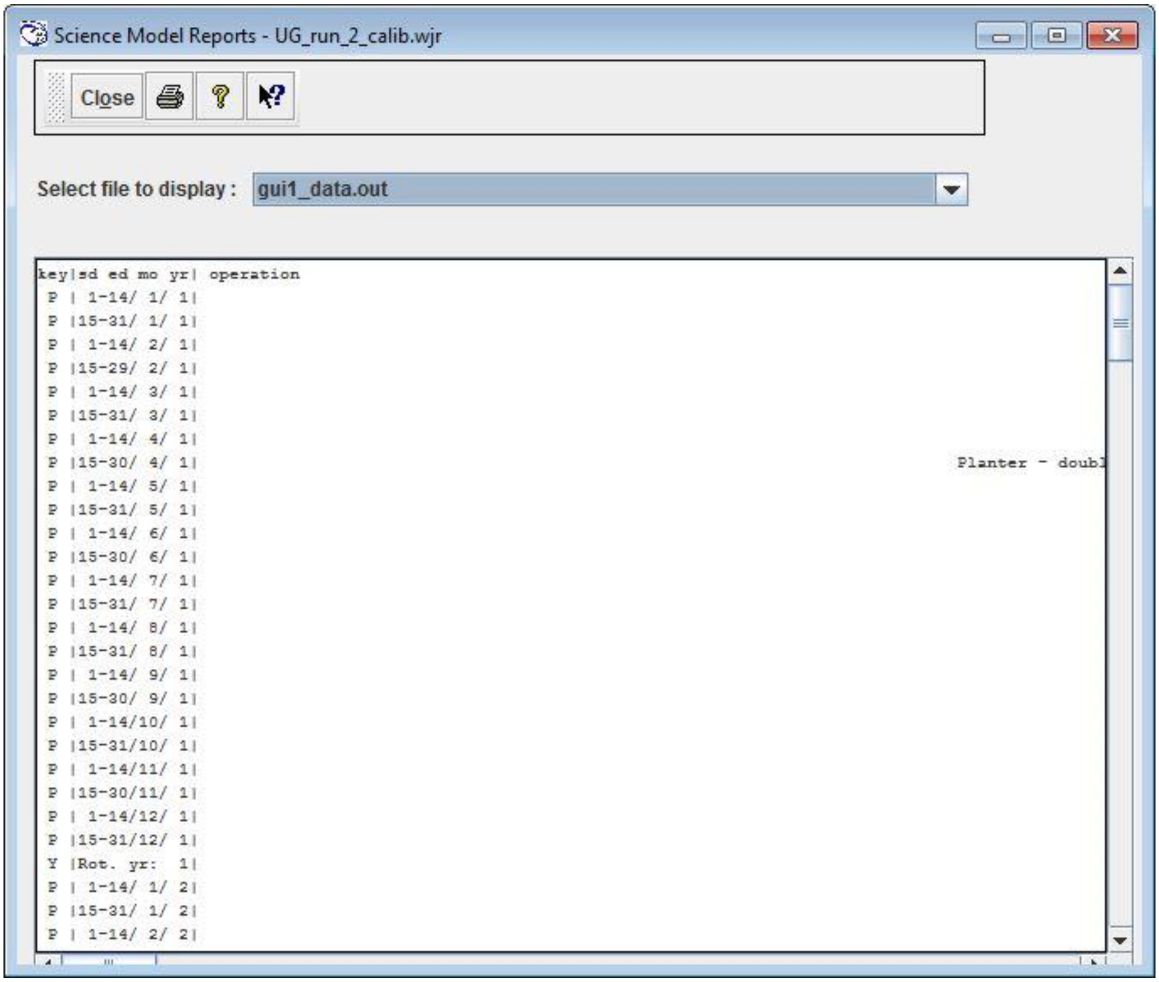


Figure 2-51WEPS science model report screen.

The Science Model Report contains a toolbar which consists of the following functions:

○ This button allows the user to close the Science Model Report window.


○ This button allows the user to print the Science Model Report.


○ This button allows the user to bring up the online help for the Science Model Report.

○


○ Selecting this button produces a question mark mouse pointer which allows the user to select a specific location on the Science Model Report to obtain specific context sensitive help regarding the selected location on the screen.

A list of selectable output files are available on a drop-down list. Clicking the down arrow  to the right of '**Select file to display**' will show a list of ASCII text output files available for viewing. Click the desired list entry and it will be displayed below in the view area of the window. These files are generally for advanced users and model developers. For more information on accessing and interpreting the WEPS science model output files, contact WEPS support.

2.12 Viewing Tabular Detail Reports

The Tabular Detail Reports screen (Figure 2-52) displays a multitude of data in a table (spreadsheet) format. The data is provided on a “period” basis with the “periods” being roughly biweekly in length (half of month) with these period intervals being spit into smaller sub-periods when an operation event is specified on a date within a “period”. In addition, the rotation year averages are also provided along with the entire rotation averages. Data that is cumulative through a period are reported as the average values for all rotation cycles. Data that has a fixed value for a given date have the “end of period” values reported as the average “end of period” values for all rotation cycles.

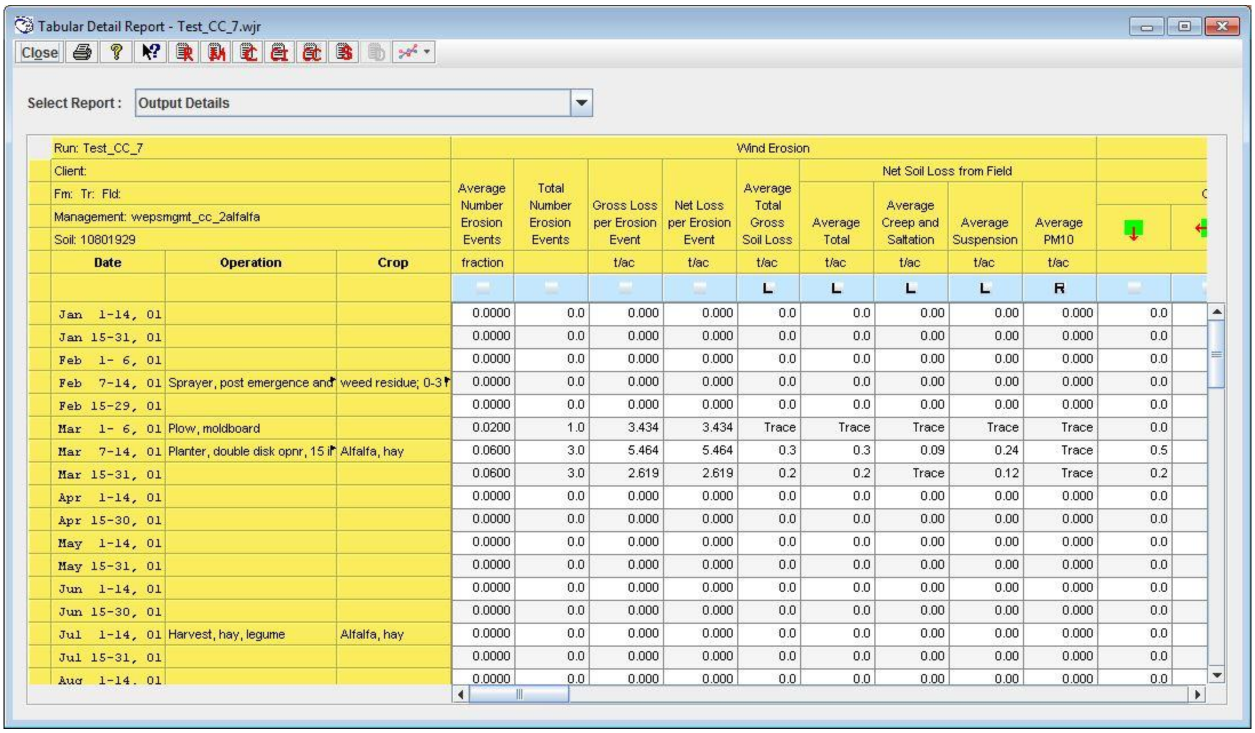


Figure 2-52 Tabular Detail Report.

The Tabular Detail Report contains a toolbar which consists of the following functions:

This button allows the user to close the Tabular Detail Report window.

This button allows the user to print the Tabular Detail Report.

This button allows the user to bring up the online help for the Tabular Detail Report.

Selecting this button produces a question mark mouse pointer which allows the user to select a specific location on the Tabular Detail Report to obtain specific context sensitive help regarding the selected location on the screen.

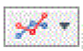
This button allows the user to access the current WEPS Run Summary Report.

 This button allows the user to access the current WEPS Run Crop Summary Report.

 This button allows the user to access the current WEPS Run Cover Crop Summary Report.

 This button allows the user to access the current WEPS Run Crop Interval Summary Report.

 This button allows the user to access the current WEPS Run Soil Report.

 This button allows the user to graph the selected columns of data in a “Quick Plot”. Selecting the “down arrow” component on this button will present the user with a dropdown menu of choices:

- Plot Style (sets the default plot style to be graphed)
  - Line (default plot style)
  - Bar
  - Bar Stacked
  - Area
  - Scatter
- Restore Defaults (resets the selected columns to the defaults)
- Select All (selects all columns to be plotted)
- Clear All (clears all columns from being selected for plotting)

The Tabular Detail Report also includes some WEPS Run information consisting of:

- The WEPS Run name.
- The Client name.
- The Farm, Tract and Field numbers.
- The Management scenario file name.
- The Soil file name.

Tabular Report Column and Row Definitions

The columns of the Tabular Detail Report are defined as follows (Note that not all columns listed here are available for the NRCS configured version of WEPS):

Date - The start and end dates (day/month/rotation year) of the reporting period.

Operation - The management operation that occurred on the specified date (if multiple operations have been specified on the same date, only the last one listed on that date will be displayed).

Crop -The crop planted on the specified date.

Wind Erosion

Field erosion related data are presented here, e.g. the number of erosion event:, gross, net and average value per period specified as well as particulate size classification.

Average Number Erosion Events - This column displays the average number of erosion events per period (fraction).

Total Number Erosion Events - The total number of erosion events during that period for the simulation.

Gross Loss per Erosion Event - The gross erosion within the field for each event, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Net Loss per Erosion Event - The net erosion within the field for each event, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre). Some deposition within a field can occur, especially when barriers are present downwind. Net soil loss is the amount of gross loss minus deposition.

Average Total Gross Soil Loss - The average erosion (soil loss) within the field, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre). This value is the total amount of soil being removed from the surface of the field. It does not take into consideration the amount of that entrained soil that may be re-deposited downwind within the field due to wind barriers, etc. The "gross" soil loss values are most important when evaluating the "onsite" effects of wind erosion.

Net Soil Loss from Field

The 'Net Soil Loss from Field' columns display the "actual" soil loss from the field (net losses are gross losses minus deposition within the field). Specific areas within the field may experience: 1) a net soil loss, 2) a net soil gain (deposition), 3) no soil movement, or 4) soil movement, but the soil loss is equal to the deposition within the specified area. Under some scenarios, a portion of soil entrained upwind can get deposited within the field borders, due to a reduction in wind speed (and thus its soil-carrying capacity) caused by downwind barriers, changes in surface roughness across the field, etc. Therefore, the "net" soil loss reported will be less than the "gross" soil loss in these situations. The "net" soil loss values are most important when evaluating "offsite" effects of wind erosion.

Average Total - The average total net soil loss from the field (kg/m^2 or tons/acre). This value represents the average amount of soil actually leaving the field boundaries. If there are any downwind barriers, this value will be somewhat less than the ‘Average Total Gross Soil Loss’ value due to deposition occurring within the field.

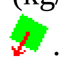
Average Creep & Saltation - The quantity of creep plus saltation-size material leaving the field for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each year of the crop rotation (kg/m^2 or tons/acre).

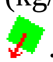
Average Suspension - The quantity of suspension-size material leaving the field for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

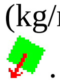
Average PM10 - The quantity of PM10 (particulate matter less than 10 microns) material leaving the field for the period, averaged across the field grid areas, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Mass of Soil Passing Indicated Field Boundary (per Unit Length of Field Border)

These columns display the average soil loss across the indicated field boundary, per unit length of field border, for the specified size range of eroding material.

Creep+Saltation - Average mass of creep plus saltation-size material passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated  .

Suspension - Average mass of suspension-size material passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated  .

PM10 - Average mass of PM10 size material passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated  .

Within Field Wind Erosion Activity

The information in this section is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding how much of the field is actively eroding, and thus may be causing plant or soil damage, or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Saltating Emission Region

Soil Loss - The amount of soil loss from that area of the field that had significant saltation emission (kg/m^2 or tons/acre).

Field Area - Both the area (acres or hectares) and fraction of the field area that had saltation emission.

Deposition Region

Soil Deposition - The amount of soil deposited in that area of the field where deposition is the primary activity (kg/m^2 or tons/acre).

Deposition Field Area - Both the area (acres or hectares) and fraction of the field area that had deposition.

High Flux Region

High Flux Field Area - Both the area (acres or hectares) and fraction of the field area that was near transport capacity.

Sheltered Region

Sheltered Field Area - Both the area (acres or hectares) and fraction of the field area that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers.

Weather Information

Wind Energy >8 m/s - The average daily wind energy for the period for winds greater than 8 m/s (18 mi/h), averaged over the simulation years in each year of the crop rotation (KJ/m^2/day).

Snow Depth > 20 mm - The total average fraction of time that snow cover on the field which is greater than 20 mm (0.787 in) in depth (mm or inches).

Total Period Precipitation - The total precipitation for the period averaged over the simulation years in each year of the crop rotation (mm or inches).

Crop/Soil Water Information

Irrigation - The total average irrigation water applied for the period (mm or inches).

Runoff - Quantity of water (precipitation and irrigation) for the period that does not infiltrate into the soil and leaves the field (mm or inches).

Drainage - Quantity of water in the soil that drains out of the bottom of the soil profile for the period (mm or inches).

Soil Water - Quantity of water stored in the soil profile at the end of the period (mm or inches).

Soil Surface Evaporation - Quantity of water lost to surface evaporation for the period (mm or inches).

Plant Transpiration - Quantity of water used by the crop (growing plants) for the period (mm or inches).

Average Biomass Surface Conditions on Date (at end of period)

Crop Vegetation (Live)

Canopy Cover - The fraction of live crop biomass cover (vertical view) at the period end, averaged over the simulation years for the period listed (fraction).

Effective Standing Silhouette - The standing silhouette area index of live plants, expressed on a fraction basis. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end, averaged over the simulation years in each rotation year.

Leaf and Stem Mass - The total live crop biomass, above ground, at the period end, averaged over the simulation years for the period listed (kg/m^2 or lbs/acre).

Root Mass - The total live crop biomass, below ground, at the period end, averaged over the simulation years for the period listed (kg/m^2 or lbs/acre).

Crop Height - The height of the crop above the soil surface (mm or inches).

Number of Crop Stems - The number of live crop stems at the end of the period (number per m^2 or per acre).

Crop Residue (Dead)

Surface Cover - The amount of flat residue cover (dead) on the soil surface, expressed as a fraction. These are values at the period end, averaged over the simulation years in each rotation year (fraction).

Effective Standing Silhouette - The standing silhouette area index of plant residues, expressed on a fraction basis. These are values at the period end, averaged over the simulation years in each rotation year.

Flat Mass - The amount of flat residue mass on the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Standing Mass - The amount of standing residue mass on the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Buried Mass - The amount of buried residue mass including roots, below the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Buried Root Mass - The amount of root mass, below the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Weighted Residue Height - The height of residue weighted by residue pool (residue is various stages of decomposition) (mm or inches).

Number of Residue Stems - The number of standing residue stems per m^2 or per acre.

Live and Dead Biomass

Surface Cover - The amount of flat surface cover from live vegetation and dead plant residue (flat cover) biomass on the soil surface, expressed on a fraction basis. These are values at the period end, averaged over the simulation years in each rotation year (fraction).

Effective Standing Silhouette - The standing silhouette area index of live vegetation plus dead plant residue. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. These are values at the period end, averaged over the simulation years in each rotation year (fraction).

Flat Mass - The amount of flat live vegetation (air dried) and dead plant residue biomass on the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Effective Standing Mass - The amount of standing live vegetation and plant residue biomass. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind.

These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

All Buried Mass - The amount of vegetative material, both live and dead below the soil surface. These are values at the period end, averaged over the simulation years in each rotation year (kg/m^2 or lbs/acre).

Average Soil Surface Conditions on Date (at end of period)

Oriented Roughness

Ridge Orientation - The orientation of soil ridges, with zero degrees (0°) representing north/south ridges.

Ridge Height - The height of ridges. This is the value, at the period end, averaged over the simulation years in each rotation year (mm or inches).

Ridge Spacing - The spacing between ridges. This is the value at the period end, averaged over the simulation years in each rotation year (mm or inches).

Random Roughness

Random Roughness - The standard deviation of the soil surface random roughness. This is the value at the period end, averaged over the simulation years in each rotation year (mm or inches).

Aggregation

Aggregates < 0.84 mm - The fraction of aggregates less than 0.84 mm (0.033 inches). Aggregates < 0.84 mm are generally considered to be erodible. This is the value at the period end, averaged over the simulation years in each rotation year.

Dry Aggregate Stability - The dry aggregate stability is the log of crushing energy of dry soil aggregates (ln(J/kg)), which is related to abrasion resistance. This is the value at the period end, averaged over the simulation years in each rotation year.

Aggregate Density - The density of the surface aggregates (Mg/m^2 or lbs/in^2).

Aggregate Coefficient of Abrasion - The wind erosion abrasion coefficient for the surface aggregates (1/m or 1/ft).

Crust Properties

Crust Cover - The fraction of the soil surface that is crusted. This is the value at the period end, averaged over the simulation years in each rotation year.

Crust Stability - The stability is related to abrasion resistance. This is the value at the period end, averaged over the simulation years in each rotation year.

Loose Material on Crust - The quantity of loose material on the crusted surface (kg/m^2 or lbs/ac).

Crust Thickness - The thickness of the surface crust (mm or inches).

Crust Density - The density of the surface crust (Mg/m^3 or lbs/ft^3).

Crust Loose Fraction - Fraction of the crusted surface that contains loose, erodible material.

Crust Coefficient of Abrasion - The wind erosion abrasion coefficient for the crust (m^{-1} or ft^{-1}).

The **rows** in the Tabular Details Report table differ, depending on the number of cropping years in the rotation and the number of management operations in each year of the rotation.

Each year of the rotation has output displayed for the two week periods, as well as for each management operation date. This output allows the user to view the erosion and other output for each year of the rotation. At the end of each year in the rotation is a row that contains the average annual value for that rotation year.

The last row in the complete table contains the average annual values for the complete crop rotation.

Tabular Detail Report Display Options

A dropdown choice list is available, "Select Report:" button, where the user can select various subsets of the tabular output data for display. Note that the default report option and the available reports may be different for various configured versions of WEPS, like the NRCS configured version. The specific view report options are listed here:

Output Details

The Output Details report option contains all of the erosion, weather, and surface information available by period, by rotation year, and for the entire simulation run. The remaining menu list items on the Tabular Detail Reports screen are essentially a subset of the Output Details report option.

Erosion

The Erosion report displays soil loss parameters for each rotation year and the average annual for all rotation years.

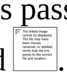
Field Loss (summary)

The Field Loss summary report displays average soil loss by rotation year and for the entire simulation run. The values displayed include: Average Total Gross Soil Loss, the average erosion within the field; Net Average Total, the average total net loss from the field; Net Average Creep/Salt, the average creep plus saltation net loss from the field; Net Average Suspension, the average suspension net loss from the field; and Net Average PM10, the average PM10 net loss from the field.

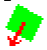
Field Loss (details)

The Field Loss detailed report displays average soil loss by period, by rotation year, and for the entire simulation run. The values displayed include: Average Total Gross Soil Loss, the average erosion within the field; Net Average Total, average total net loss from the field; Net Average Creep/Salt, the average creep plus saltation net loss from the field; Net Average Suspension, the average suspension net loss from the field; and Net Average PM10, the average PM10 net loss from the field.

Boundary Loss (summary)

The Boundary Loss summary report displays the average mass passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated . These parameters are reported for each rotation year and for the simulation run. The columns labeled 'Creep + Saltation' contain the mass per unit boundary length of creep plus saltation-size material that passed the field boundary for each direction. The Suspension columns contain the mass per unit boundary length of suspension-size material that passed the field boundary for each direction. The PM10 columns contain the mass per unit boundary length of PM10-size material that passed the field boundary for each direction.

Boundary Loss (details)

The Boundary Loss detailed report displays the average (by period, rotation year, and simulation run) mass passing each field boundary (kg/m or tons/1000 ft of field border length) in the direction indicated . These parameters are reported by period, for each rotation year, and for the simulation run. The columns labeled 'Creep + Saltation' contain the mass per unit boundary length of creep plus saltation-size material that passed the field boundary for each direction. The Suspension columns contain the mass per unit boundary length of suspension-size material that passed the field boundary for each direction. The PM10 columns contain the mass per unit boundary length of PM10-size material that passed the field boundary for each direction.

Within-field Erosion (summary)

The Within-field Erosion summary report displays information for various types of erosion activity by rotation year and for the simulation run. These activities include amounts, as well as area and fraction of the field that had significant saltation emission and deposition. In addition, high flux and sheltered areas and fraction of the field are given. The high flux region is that area that is near transport capacity. A sheltered area is one that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers. This information is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding how much of the field is actively causing plant or soil damage or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Within-Field Erosion (details)

The Within-Field Erosion detailed report displays information for various types of erosion activity by period, by rotation year, and for the simulation run. These activities include amounts, as well as areas and fraction of the field that had significant saltation emission and deposition. In addition, high flux and sheltered area and fraction of the field are given. The high flux region is that area that is near transport capacity. A sheltered area is one that had no saltation or suspension material being emitted. Sheltered areas are typically those immediately downwind of barriers. This information is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding how much of the field is actively causing plant or soil damage, or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss.

Erosion (summary)

The erosion summary report displays all of the information available on erosion contained in the Field Loss (summary), Boundary Loss (summary), and Within-field Loss (summary) reports.

Erosion (details)

The erosion detailed report displays all of the information available on erosion contained in the Field Loss (details), Boundary Loss (details), and Within-field Loss (details) reports.

Erosion (monthly details)

The erosion monthly detailed report displays all of the information available on erosion contained in the Erosion (summary) report, but includes monthly average values (averaged across rotation years).

Erosion (yearly details)

The erosion yearly detailed report displays all of the information available on erosion contained in the Erosion (summary) report, but includes individual simulation-year values.

Weather (summary)

The weather summary report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported for each rotation year and for the simulation run.

Weather (details)

The weather detailed report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported by period, for each rotation year, and for the simulation run.

Weather (monthly details)

The weather monthly detailed report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported for each rotation year, by month and for the simulation run.

Weather (yearly details)

The weather yearly detailed report displays average total precipitation, the average wind energy for winds greater than 8 m/s (erosive winds), and average fraction of time that snow cover on the field is greater than 20 mm. These parameters are reported for each rotation year, each individual simulation year and for the simulation run.

Crop Vegetation (details)

The crop vegetation detailed report displays average live above-ground biomass conditions that existed on the end date for the period reported. The conditions displayed include canopy cover, effective standing silhouette, and above ground mass. Canopy cover is the fraction of live crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of live plants. These values are standing silhouette area per area of soil surface, expressed as a fraction. If the plants are planted in the furrow, as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Above-ground mass is the total above-ground biomass.

Crop Residue (details)

The crop residue detailed report displays average dead above-ground biomass conditions that existed on the end date for the period reported. The conditions displayed include flat cover, effective standing silhouette, flat mass, and standing mass. Flat cover is the fraction of dead crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of dead plants. These values are standing silhouette area per area of soil surface, expressed as a fraction. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Flat mass is the above-ground biomass that is lying flat on the soil surface. Standing mass is the above-ground biomass that is in a standing or upright position on the soil surface.

Crop Biomass (details)

The crop biomass detailed report displays the average live plus dead above-ground biomass conditions that existed on the end date for the period reported. The conditions displayed include flat cover, effective standing silhouette, flat mass, and standing mass. Flat cover is the fraction of live plus dead crop biomass cover from a vertical view. Effective standing silhouette is the standing silhouette area index of live plus dead plants. These values are standing silhouette area per area of soil surface, expressed as a fraction. If the plants are planted in the furrow as opposed to the ridge top, the index is adjusted (down) to have less of an effect on the wind. Flat mass is the above-ground biomass that is lying flat on the soil surface. Standing mass is the above-ground biomass that is in a standing or upright position on the soil surface.

Crop Veg, Res & Biomass (details)

The crop vegetation, residue and biomass detailed report displays the all information on vegetative material contained in the Crop reports as described above.

Soil Surface (details)

The soil surface detailed report displays average soil conditions at the surface that existed on the end date for the period reported. The conditions displayed includes ridge orientation, ridge height, ridge spacing, random roughness, aggregates greater than 0.84 mm, aggregate stability, and crust cover. Ridge orientation is the orientation of the ridges, with zero degrees (0°) representing north/south ridges. Random roughness is the standard deviation of the soil surface roughness height. Aggregates greater than 0.84 mm are expressed as a fraction and are those aggregates generally considered to be non-erodible. Aggregate stability is the log of crushing energy of dry soil aggregates (ln(J/kg)).

Surface Conditions (details)

The surface conditions detailed report displays all of the information available on the field surface contained in the Crop, Residue, Biomass, and Soil Surface reports.

Erosion and Crop (details)

These reports contain a combination of the erosion and crop reports as described above.

2.13 Reporting Errors and Submitting Questions/Comments

If an error happens to occur during a WEPS simulation run, an error message will appear. Once the error message is closed, an Error/Comment Submission Form window opens that allows the user to report the error to USDA-ARS Agricultural Systems Research Unit (Figure 2-53). Note that the user can also submit a report manually by clicking on the button on the button bar or via the "Send Bug/Comment Report" option under the "Tools" menu. The user should enter an e-mail address and a short message describing what happened and what one was doing immediately prior to the event that triggered this submission form to appear.

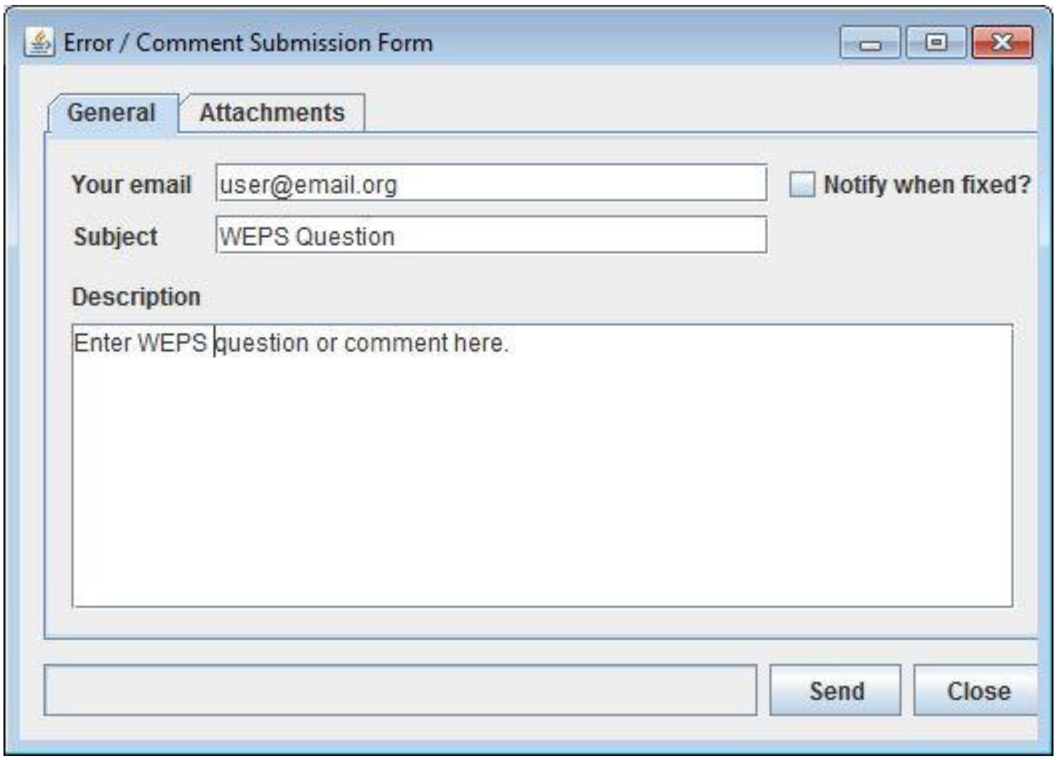


Figure 2-53. Error/Comment Submission Form.

Click the "Attachments" tab at the top of the window to attach either the current Project (with all associated WEPS Run directories), current WEPS Run, or any individual files deemed useful by the submitter as a part of your submission. If WEPS crashed, it will include both the current log file and the WEPS Run being simulated if that is when the problem occurred (Figure 2-54). If the problem occurred prior to making a WEPS run, the current management and soil files will automatically be included. One typically would only attach a WEPS Run, unless there is a specific reason to attach an entire Project directory that may contain all its associated WEPS Run directories, etc. Because of the number of potential files within a Project, attaching a WEPS Project directory could create an attachment too large to transmit to USDA-ARS. If you are connected to the Internet, clicking 'Send' will transmit the message to ASRU, along with any attached directories/files, so that your inquiry can be answered. The user cannot send a submission from WEPS unless they have provided an email address and are connected to the Internet.

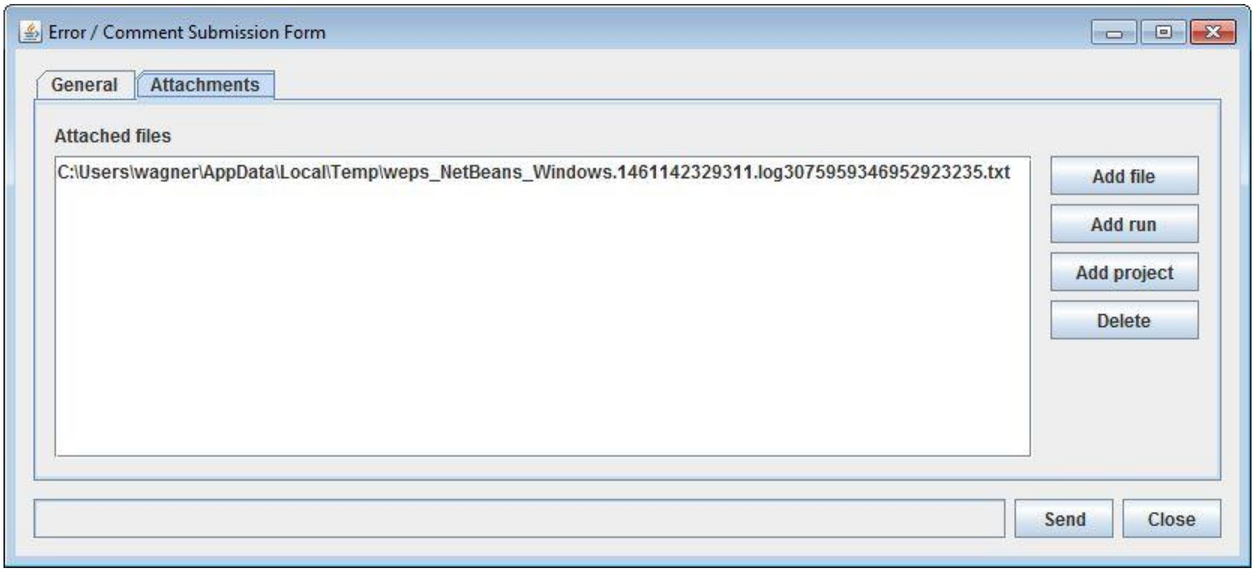


Figure 2-54. Error/Comment Submission Form displaying the Attachments tab.

Note that an individual can also send an email message as an alternative method of communication, but that method is deprecated and requires the user to have correctly configured the WEPS e-mail client in the WEPS ‘Configuration’ settings.

2.14Editing with the Management/Crop Rotation Editor for WEPS (MCREW)

To open the Management/Crop Rotation Editor for WEPS (MCREW), double click on the ‘**Man**’ button 

, on the left side of the management box as shown in Figure 2-1. This will open the MCREW window (Figure 2-55), which allows the user to view, edit, and save management rotation information.

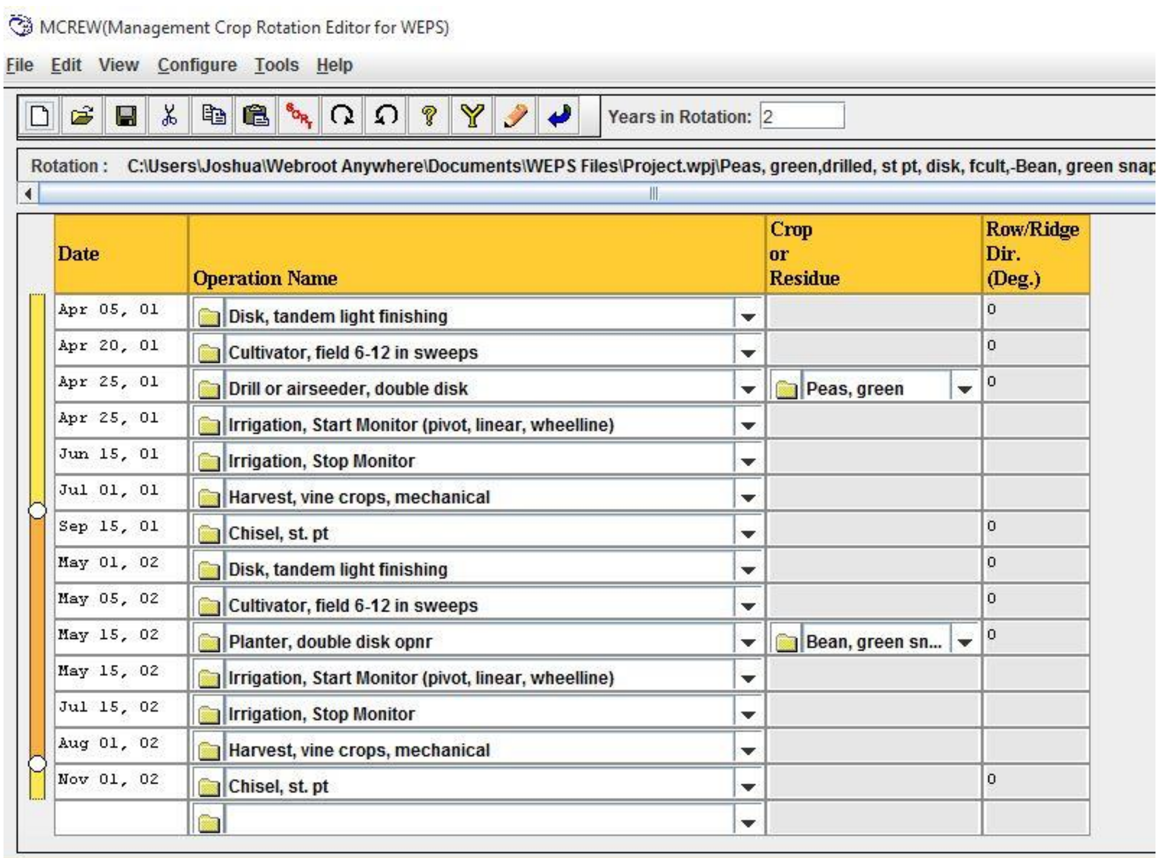


Figure 2-55 Management/Crop Rotation Editor for WEPS (MCREW) window.

MCREW's principle purpose is to create/modify/construct management rotation files required for making WEPS simulation runs. Although it is an integral component of the WEPS 1.5 interface, it can be used as a stand-alone program to edit management rotation files independent of the WEPS interface and was designed to be configurable for uses outside of WEPS. Much of MCREW's functionality, behavior, and visual appearance is controlled via ASCII XML-based configuration files. Changing the appropriate configuration files allows one to specify the structure and definition of the management/crop rotation file format and control the user's ability to view and edit specific operation, and/or crop properties, etc.

MCREW is fundamentally a date-ordered list of management operations. This release of MCREW provides the user with a tabular, row-oriented view of the operations and their associated dates. In WEPS, a management operation is defined as any human-initiated process, such as a tillage event, seeding, irrigation application, etc. If the operation triggers the WEPS model to start simulating the growth of a crop (or any other plant vegetation supported with a crop database record containing the necessary vegetation growth parameters), e.g., a planting/seeding/transplanting operation, then the name of that crop is listed in the same row in the column next to the name of the operation.

Since surface roughness (both random and oriented) affects a surface's susceptibility to wind erosion, especially when little or no vegetation cover exists, it is important to represent not only the degree of roughness, but the direction it is oriented. Since many management operations have a direction associated with them, e.g., many tillage operations for example, these operations will create an oriented roughness with the direction of travel. Since this direction of travel is not known until it is associated with a particular site, the final column displayed by default in the table provides the user the option of setting that direction in the management file and is labeled **Row/Ridge Dir. (Deg.)**.

Using MCREW

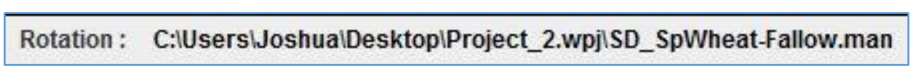
MCREW is designed to allow easy creation and editing of management rotation files for WEPS. The MCREW screen consists of 5 major components:

1. **Menu bar** - The menu bar consists of assorted menu options that provide access to MCREW's functions. Functions of the menu bar are discussed later in this document.

2. **Button bar** - The button bar consists of an assortment of icons that provide quick access to special functions for MCREW. Those functions are discussed later in this document.

3. **Years in Rotation** - On the right of the button bar, the user may view and edit the number of years in a rotation cycle.

4. **Rotation** - This window displays the name and full path of the management rotation file that is loaded. If the management rotation name is too large, a scroll bar is automatically provided so the user can view the entire rotation name.



5. **Table View** - The Table View displays the sequence of operations, with their associated dates and any crops planted, in a tabular format. Spreadsheet-style editing functions are available to manipulate the order, selection, and removal of operations and/or crops, etc. More details of the editing functions of the Table View are given later in this section.

Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)
Apr 15, 01	Chisel plow - 2 inch wide straight pts		0
Apr 20, 01	Drill - double disk openers (8 inch row spacing)	wheat, spring	0
Aug 15, 01	Harvest Small Grain (cutter bar)		
May 15, 02	Cultivator, Field (9 inch shovels)		0
Jul 15, 02	Cultivator, Field (9 inch shovels)		0
Sep 15, 02	Cultivator, Field (9 inch shovels)		0

Opening and Saving MCREW files

In WEPS 1.5, there are two primary locations in which management rotation files exist:

1 In the " Management Templates" directory.

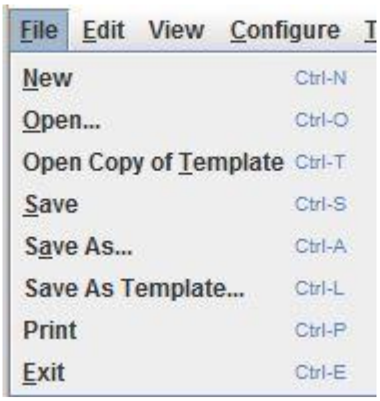
This is the location in which complete or partial (single or multi-crop year) management rotation files are kept. Files in this directory always show up on the management rotation selection choice lists. Management rotation files to be used in WEPS Projects can be selected and edited from previously built management rotation files, or they can be constructed and then edited from several partial management rotation template files located in this directory.

2 Within a "WEPS Projects" directory.

Any edited or viewed management rotation file used in a WEPS Project simulation run is always located in that WEPS Project's directory. There can be more than one management rotation file in a WEPS Project. The current management rotation file to be used when making a WEPS run is the one specified in the "weps.run" file (e.g., the one listed in the "management" input field on the WEPS main screen. Management rotation files in a WEPS Project usually are simply copies of those selected from the "Template" directory, with local "Project- or run-specific" modifications.

MCREW Menu Bar Functions

File Menu (Alt-F)



Once the MCREW window is open, rotation files can be created from scratch and saved in the desired location, and/or other rotation files may be opened for editing. The **“ File”** menu allows access to the file management functions for MCREW. It contains all of the options listed here, with the common functions (**“New”**, **“Open”**, and **“Save”**) also being available on the button bar:

- **New Ctrl-N**

Opens an empty, unnamed rotation file.

- **Open... Ctrl-O**

Displays an “**Open File**” file chooser window from which the user can select the desired rotation file from those in the current Project. This is not accessible if the “Enable full MCREW editing functionality in WEPS” option is not enabled in the “Display” tab of the WEPS interface Configuration panel.

- **Open Copy of Template Ctrl-T**

Displays an “**Open File**” file chooser window from which the user can select the desired rotation file from the “Management Templates” directory. A copy of the selected file is then added to the current WEPS Project and made available for editing in MCREW. To edit a management file, the “Enable full MCREW editing functionality in WEPS” option must be enabled in the “Display” tab of the WEPS interface Configuration panel. If desired, the actual default location can be changed under the “Directories” tab in the WEPS interface Configuration panel as well.

○

- **Save Ctrl-S**

Saves the current Project’s rotation file being edited (in the current WEPS Project directory). The “saved” filename will become the selected management file in the main WEPS interface screen upon exit of MCREW.

- **Save As... Ctrl-A**

Displays a “**Save File**...” dialog box from which the user can specify the desired filename with which to save the rotation file for the current Project (the default location is in the current WEPS Project directory). The “saved” filename will become the selected management file in the main WEPS interface screen upon exit of MCREW.

○ **Save As Template Ctrl-L**

Displays a "**Save File**" dialog box from which the user can specify the desired filename with which to save a copy of the currently edited rotation file into the "Management Templates" directory. The original file is still the current file being edited within MCREW.

○ Print **Ctrl-P**

Displays a print dialog box through which the MCREW table view can be printed.

○ **Exit Ctrl-E**

Exits MCREW. If MCREW finds that the rotation file has been modified and not saved, it will display a popup message and ask if the user wants to save it before leaving.

Edit Menu (Alt-E)

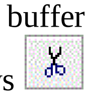
A WEPS 1.5 management rotation file is a date-ordered list of management operations. MCREW provides basic editing functionality to insert, delete, modify, and change dates for those operations. In WEPS, each operation is defined by a list of physical processes, such as residue burial, soil inversion, flattening standing residue, creation of ridges, planting a crop, etc., which are described to the model via one or more parameter values.

In its most basic form then, a WEPS management rotation file can be viewed within MCREW via the table view.

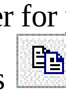
The primary editing functions available are accessible via the ' Edit' menu option. The table view editing functions are:

○

Cut Row(s) Ctrl-X

Removes the currently selected operation row(s) from the rotation and stores in a temporary buffer for possible pasting back into the rotation table later. This function is also via the cut rows  button available on the toolbar.

○ **Copy Row(s) Ctrl-C**

Copies the selected operation row(s) from the rotation and stores in a temporary buffer for possible future pasting back into the rotation table. This function is also via the copy rows  button available on the toolbar.

- **Paste Row(s)   Ctrl-V**

Pastes the previously cut or copied operation row(s) above the selected operation row. This function is also via the paste rows  button available on the toolbar.

- **Delete Row(s)   Ctrl-D**

Deletes the selected operation row(s).

- **Undo Delete   Ctrl-Z**

Restore a deleted item. Note, this item is not active for the current version.

- **Sort by Date   Ctrl-R**

Sorts the operations in ascending order by date. See “Management File Date Adjustment Functions” section later in this chapter for alternate methods of manipulating dates.

- **Insert Row   Ctrl-I**

Inserts a blank row above the selected row.

- **Insert Operation**

Inserts a row, then opens a window that allows the selection of an operation to be placed in that new blank row.

- **Cycle Forward   Ctrl-F**

Causes the last year in the rotation to become the first year in the rotation, while the other rotation years are incremented by one year. See “Management File Date Adjustment Functions” section later in this chapter for alternate methods of manipulating dates.

- **Cycle Backward   Ctrl-B**

Causes the first year in the rotation to become the last year in the rotation, while the other rotation years are decremented by one year. See “Management File Date Adjustment Functions” section later in this chapter for alternate methods of manipulating dates.

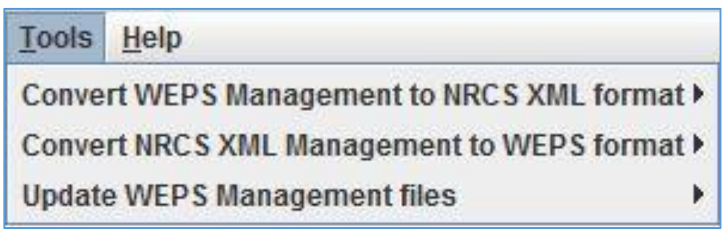
- **Notes   Ctrl-M**

Displays the Management Field Notes, where the user may enter notes regarding the management file. These notes are saved with the management file and can also be accessed and viewed by clicking the Notes  button on the toolbar.

View Menu

The View menu allows the user to select from a list of columns to display in the MCREW window. Select each item to display by clicking on that item and note that the item will be displayed in the table display and that item will also be checked in the View menu. To remove items from the display columns, similarly click the item on the View menu and those columns will be removed from the MCREW table and the item will be unchecked in this menu list.

Tools Menu (Alt-T)



The 'Tools' menu item provides access to tools and utilities related to the use of MCREW.

○

○ **Convert WEPS Management to NRCS XML Format (this item has two options)**

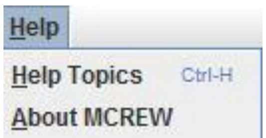
- **select individual files**
  Converts a single WEPS management file to the NRCS standardized summary management XML file format.
- **select directory (recursively)**
  Converts multiple WEPS management files recursively in a single directory to the NRCS standardized summary management XML file format.

○ **Convert NRCS XML Management to WEPS Format (this item has two options)**

- **select individual files**
  Converts single NRCS standardized summary management XML format files to the WEPS management file format.
- **select directory (recursively)**
  Converts multiple NRCS standardized summary management XML format files recursively to the WEPS management file format.

- **Update WEPS Management Files (this item has two options)**
  - **select individual files**
    Updates individual WEPS management files with the most current crop and operation database parameters.
  - **select directory (recursively)**
    Updates WEPS management files recursively with the most current crop and operation database parameters.

Help Menu (Alt-H)



The ‘ Help’ menu item displays help options about MCREW and includes:

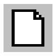
- **Help Topics Ctrl-H**

Opens a window containing the MCREW online help system.

- **About MCREW**

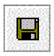
Displays the current version, build date, and other information about the current version of MCREW.

MCREW Button Bar Functions



Opens a blank MCREW screen. This has the same function as selecting **New** under **File** on the menu bar.

Opens an existing MCREW file. This has the same function as selecting **Open** under **File** on the menu bar.



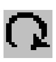
Saves the rotation file being edited to the current Project. This has the same function as selecting **Save** under **File** on the menu bar.

Cuts a selected row or rows of the management file and places into the clipboard. This has the same function as selecting **Cut Row(s)** under **Edit** on the menu bar.

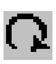
Copies a selected row or rows of the management file and places into the clipboard. This has the same function as selecting **Copy Row(s)** under **Edit** on the menu bar.

Pastes a row or rows of the management file from the clipboard above the selected row. This has the same function as selecting **Paste Row(s)** under **Edit** on the menu bar.

Sorts the rows of the management operations into date order. This has the same function as selecting **Sort by Date** under **Edit** on the menu bar.



Cycles the rotation year for the management operations forward. This has the same function as selecting **Cycle Forward** under **Edit** on the menu bar.



Cycles the rotation year for the management operations backward. This has the same function as selecting **Cycle Backward** under **Edit** on the menu bar.

Enables context-sensitive help. Click on this button, then click on any item on the screen for help on that item.

Toggles the display of extra columns in the table for yield calibration use. When this option is on (columns displayed), a red border surrounds the button.

Opens the Management File Notes display, where the user may enter notes regarding the management file. These notes are saved with the management file and can be viewed by clicking the Notes Button or the **Edit** menu item **Notes**.

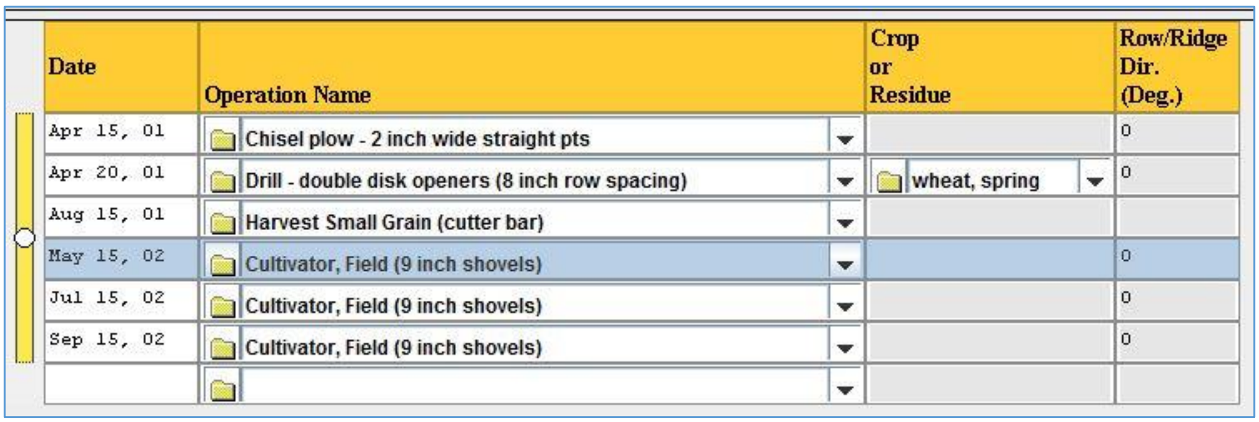
Saves the displayed data to the current file name and closes MCREW.

MCREW Table View Editing

MCREW's table view is where most of the editing occurs when working with management/crop rotation sequences.

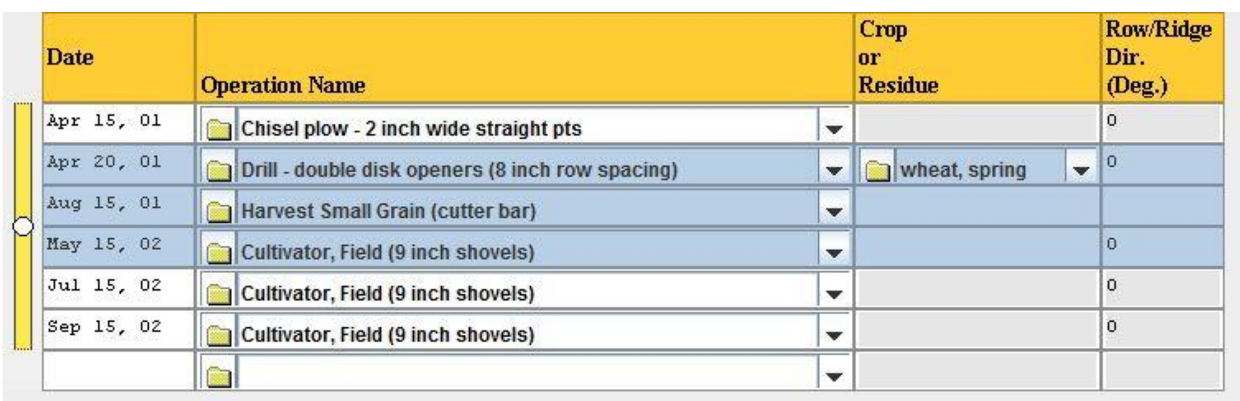
MCREW Row and Cell Selection Functions

The mouse is currently the primary method used to "select" either a row and/or an individual table cell. If a particular table cell cannot be directly edited within the cell, this is indicated by a gray background, (e.g., Date, Operation Name, or Crop) and the row is selected (indicated by the blue background in all cells within the row). The following figure shows an example of a row selection after a left mouse click within the "Date" column.



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)
Apr 15, 01	Chisel plow - 2 inch wide straight pts		0
Apr 20, 01	Drill - double disk openers (8 inch row spacing)	wheat, spring	0
Aug 15, 01	Harvest Small Grain (cutter bar)		
May 15, 02	Cultivator, Field (9 inch shovels)		0
Jul 15, 02	Cultivator, Field (9 inch shovels)		0
Sep 15, 02	Cultivator, Field (9 inch shovels)		0

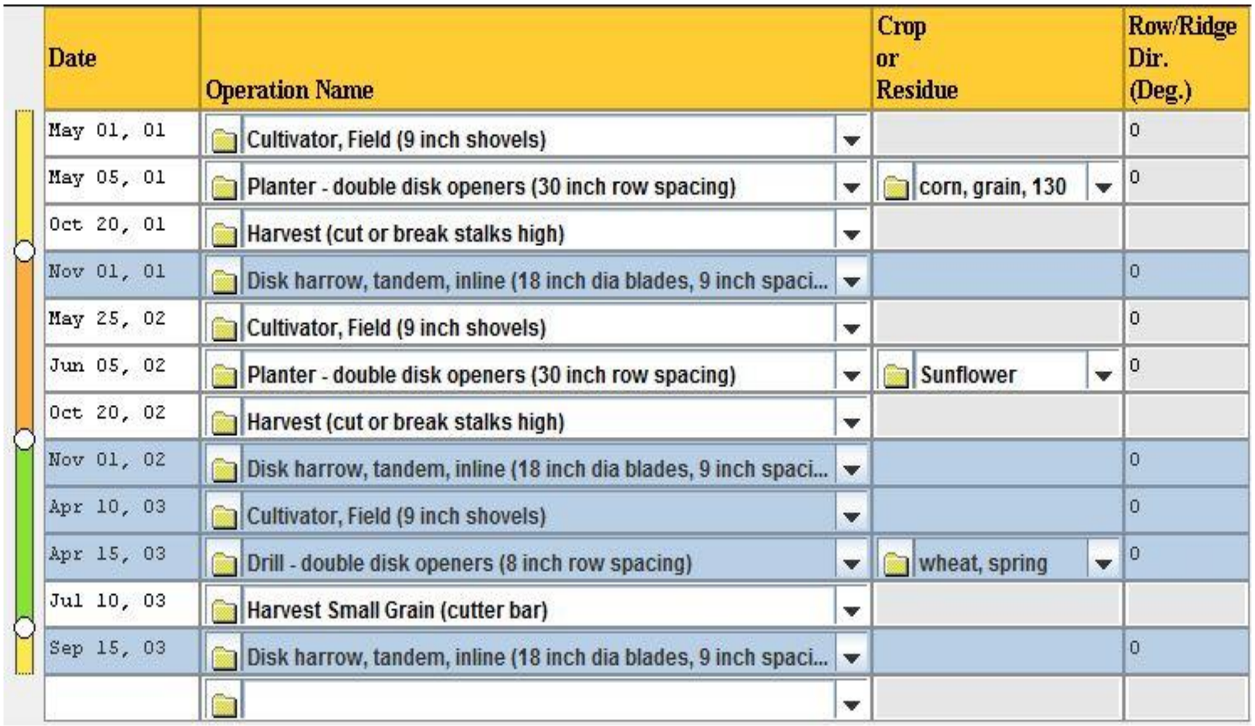
One can select multiple rows at one time by depressing and holding down the left mouse button on the first row to be selected and dragging the mouse cursor over the additional contiguous rows to also be selected. Release the left mouse button on the last row to be selected. All selected rows will be highlighted with a blue background (see following figure for example of multiple row selection).



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)
Apr 15, 01	Chisel plow - 2 inch wide straight pts		0
Apr 20, 01	Drill - double disk openers (8 inch row spacing)	wheat, spring	0
Aug 15, 01	Harvest Small Grain (cutter bar)		
May 15, 02	Cultivator, Field (9 inch shovels)		0
Jul 15, 02	Cultivator, Field (9 inch shovels)		0
Sep 15, 02	Cultivator, Field (9 inch shovels)		0

The user can append contiguous rows adjacent to a previously selected row or multi-row selection, by holding down the "shift" key and clicking the left mouse button on the last desired contiguous row to append to the selection. This is similar to how Microsoft Windows append selection works with the "shift" key depressed.

Similarly, one can append non-contiguous rows by holding down the "ctrl" key and making an additional multi-row (or single row) selection similar to the original row or multi-row selection (see following figure for example of non-contiguous row selection). As many non-contiguous rows can be selected, as desired, via this method. Again this is similar to how Microsoft Windows non-contiguous selection method works with the "ctrl" key depressed.



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)
May 01, 01	Cultivator, Field (9 inch shovels)		0
May 05, 01	Planter - double disk openers (30 inch row spacing)	corn, grain, 130	0
Oct 20, 01	Harvest (cut or break stalks high)		
Nov 01, 01	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spaci...		0
May 25, 02	Cultivator, Field (9 inch shovels)		0
Jun 05, 02	Planter - double disk openers (30 inch row spacing)	Sunflower	0
Oct 20, 02	Harvest (cut or break stalks high)		
Nov 01, 02	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spaci...		0
Apr 10, 03	Cultivator, Field (9 inch shovels)		0
Apr 15, 03	Drill - double disk openers (8 inch row spacing)	wheat, spring	0
Jul 10, 03	Harvest Small Grain (cutter bar)		
Sep 15, 03	Disk harrow, tandem, inline (18 inch dia blades, 9 inch spaci...		0

Any row or multi-row selection can be de-selected and replaced by simply clicking the left mouse button anywhere within the MCREW table display (with no keyboard keys pressed).

MCREW Row Editing Functions

Using the **Edit** menu, the user can cut, copy, paste, and delete rows. One can also insert a new blank row (**Insert Row**) immediately above the currently selected row. In addition, the user can press the right mouse menu button (when the mouse is in any row cell except in the date column) to display a popup menu that contains row editing functions. The **Set Date** and **Adjust Date** options will be described under “Management File Date Adjustment Functions”.

The contents of another (previously created) management file can also be inserted via the **Insert Management File** option immediately above the currently selected row. The "File Chooser" dialog will pop up, allowing the user to select the desired management file from which to include all the operations and their associated dates into the current management file being edited.

The **Cut, Copy** and **Paste** functions apply to the selected (both single and multiple) rows. These functions are accessible via the **Edit** menu, button bar and the dropdown operation and crop

column menus. The **Paste** function should only be active if there has been a previous **Cut** or **Copy** function conducted previously. The **Delete** function applies to all selected rows. Only if a previous **Delete** function has been conducted will the **Undelete** function be accessible.
The **Insert Row** and **Insert Operation** functions insert a blank row or selected operation respectively above the currently selected row. The date for this new row will automatically be set to the date of the row above the previously selected (now the newly inserted) row.

MCREW Date Adjustment Functions

There are several date adjustment functions available in MCREW, in the **Edit** menu and the icon button bar. These operations are:

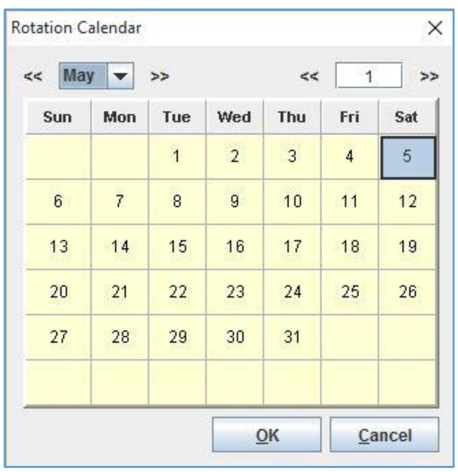

Sort by Date - The **Sort by Date** function sorts the management operations by ascending date order. Thus, the user can adjust/set the dates of management operations without having to worry about whether they are in the correct sequential order at that time. When the user wants to see the list of operations in the correct date-ordered format, they can simply select the **Sort by Date** function from the button bar icon or the **Edit** menu.


Cycle Forward - MCREW will not allow the user to save a WEPS management file without the operations being listed in date order. The user is given the options to automatically sort them, if they are not sorted during a management file save operation, or to go back to the editor and allow the user to correct the date order problem(s) manually.

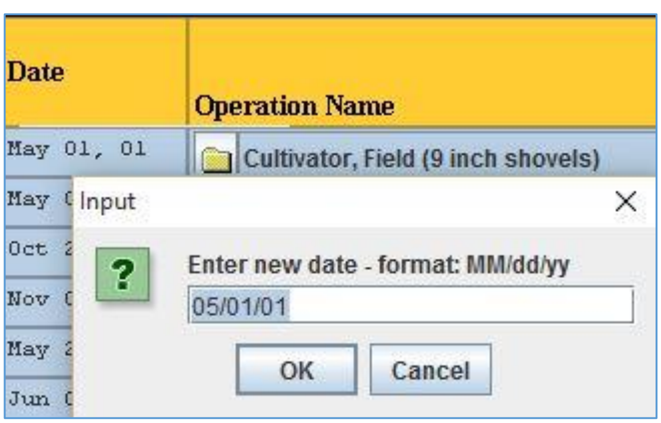

Cycle Backward - The **Cycle Forward** and **Cycle Backward** functions will rotate the "rotation year" of the management operation dates forward or backward in increments of one year. For example, a three-year management file rotation ‘cycled forward’ would change the operation dates in the first year to the 2nd year, those in the 2nd year to the 3rd year and those in the 3rd year to the 1st year. Thus, the crops grown and harvested in the first year would now occur in the second year, etc. Likewise, a rotation ‘cycled backward’ would shift the rotation the opposite direction, making the 2nd year operations occur in the first year, etc.

MCREW Date Column Editing Functions

Limited date editing functions are available by right clicking on a cell in any column. Clicking the right mouse button while the cursor is on a date column cell causes a date editing popup menu to appear that has additional date editing functions (see figure to the left). These functions allow the user to adjust dates for one row or all operation rows selected (highlighted in blue) simultaneously (single-row date editing operations are made inaccessible and are greyed out if multiple rows are selected). Currently, the top item, **Calendar Date**, is the only function specific to single rows, and if multiple rows are selected, the **Calendar Date** item will be greyed out and inaccessible.

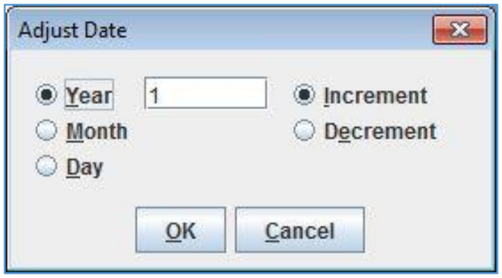


The **Calendar Date** option displays a popup calendar to aid in adjusting dates. A shortcut to accessing the **Calendar Date** is available by double left mouse clicking in a date cell, which will also display the popup calendar. This calendar window allows the user to select the desired date. The calendar allows the user to increment (>>) or decrement (<<) the month and year values if desired. Then the day of the operation within that month/year can be selected. The user can either double right mouse click on the day value or click on the "OK" button to accept the specified date (see the figure to the left). The **Calendar Date** function is only applicable when a single date cell is selected.



Selecting the **Set Date** option will display a dialog box that allows the user to type in a specific date (day/month/rotation year) for the selected operation row (highlighted in blue). The figure to the left shows an example of the **Set Date** popup window.

The **Adjust Date** function is available from this menu, with year, month, and day increment and decrement functions available. They apply to all dates in the rows that are selected. The user can adjust the operation dates on the selected rows. Selecting the **Adjust Date** option will display a dialog box allowing the user to adjust the operation dates in the selected rows by a specified ± number of days, months, or years (see left figure). Additional menu options are also available to increment (increase) or decrement (decrease) the dates of selected rows by a day, week, month, or year.



The remaining date menu options below the line are specific menu shortcuts to the **Adjust Date** function and are listed here:

Increment Year - Increments the selected rows by one rotation year.
Decrement Year - Decrements the selected rows by one rotation year.

Increment Month - Increments the selected rows by one month.
Decrement Month - Decrements the selected rows by one month.

Increment by week - Increments the selected rows by one week.
Decrement by week - Decrements the selected rows by one week.

Increment Day - Increments the selected rows by one day.
Decrement Day - Decrements the selected rows by one day.

MCREW General Editing Functions within the Column Menus

All left mouse click menus that come up when one has the cursor in any column cell other than the date column contain general functions that pertain to the row and are not necessarily specific to the column the user produced the menu from. These general functions are confined to the bottom of the column menus and are always located below the horizontal line in the menu. Some of these functions do not apply when multiple rows have been selected, in which case those functions will still display but be greyed out and inaccessible for use under those conditions. The complete list of "general editing functions are:

Set Date - Set the date of the selected row(s) to the specified date.

Adjust Date - Brings up the **Adjust Date** dialog box, which allows the user to increment or decrement the rotation year, month or day by the specified value.

Insert Blank Row - Inserts a blank row immediately above the selected row or cell. This function is inaccessible if multiple rows have been selected.

Insert Operation - Inserts a new row immediately above the selected row or cell and brings up a file chooser window allowing the user to select the desired operation to place in that new row. This function is inaccessible if multiple rows have been selected.

Insert Operation - Inserts a new row immediately above the selected row or cell and brings up a file chooser window allowing the user to select the desired operation to place in that new row. If the user aborts the operation selection process, the new row is removed from the table. This function is inaccessible if multiple rows have been selected.

Insert Rotation - Inserts a management rotation file (".rot" extension filenames) only if the bottom row is selected, otherwise it will be greyed out and inaccessible. Note this function has not been completely implemented at this time. There are no ".rot" management rotation files available for WEPS yet.

Insert Management - Brings up a file chooser window allowing the user to select the desired management rotation file to be placed immediately above the selected row. The rotation year dates are automatically altered to make the first operation in the newly selected management rotation file to follow chronologically the operation immediately above the selected operation row. This function is inaccessible if multiple rows have been selected.

Insert Management Unadjusted - Brings up a file chooser window allowing the user to select the desired management rotation file to be placed immediately above the selected row, but does not modify the dates within the newly selected management rotation file. This function is inaccessible if multiple rows have been selected.

Cut Row(s) - Cut the selected row(s) and store them in a temporary buffer for possible re-insertion in the management rotation file with the **Paste** function later.

Copy Row(s) - Copy the selected row(s) and store them in a temporary buffer for possible re-insertion in the management rotation file with the **Paste** function later.

Paste Row(s) – Paste (insert) previously cut or copied row(s) immediately above the selected row in the management rotation file. This function is inaccessible if multiple rows have been selected.

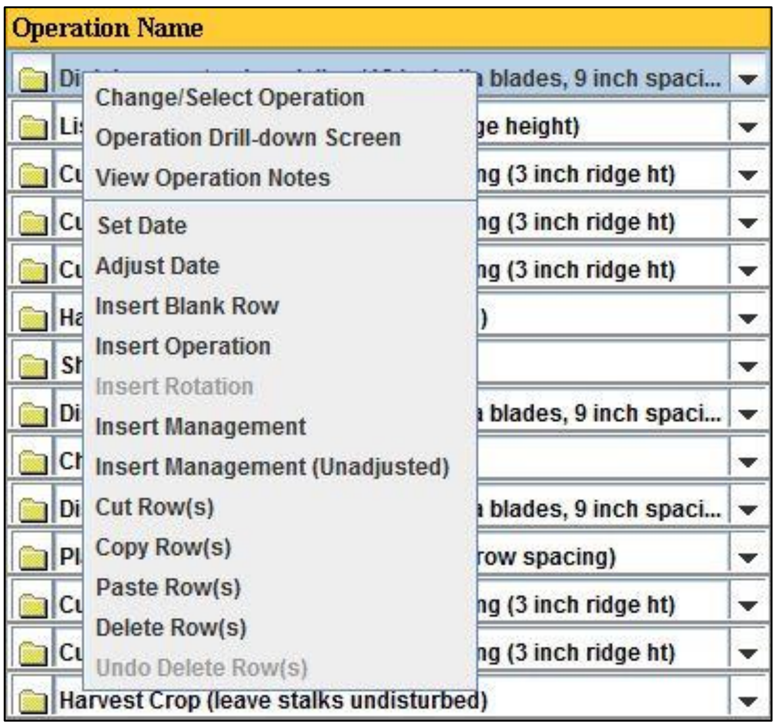
Delete Row(s) - Delete the selected row(s) and store them in a temporary buffer for possible re-insertion into the management rotation file with the **Undelete Row(s)** function later.

Undelete Row(s) – Undoes a previous **Delete Row(s)** operation, if possible, and re-inserts the previously deleted rows into the management rotation file where they were prior to executing the delete function. If other editing functions have been conducted after deleting the row(s), then the undelete function may no longer be accessible (greyed out) because it cannot correctly perform the undelete function any more. One can best think of and use this function as an "immediate undelete" function to undo the previous delete action.

MCREW Operation Column Editing Functions

A new operation can be added to a blank line or a different operation can be selected to replace an existing operation by clicking the down arrow to the right of the **Operation Name** column and selecting the desired operation. An operation can also be replaced in the selected cell by double clicking the left mouse button with the mouse cursor in an operation cell (including the blank cell at the bottom of the table where it will insert a new operation). This action will display the operation file chooser window. It allows the user to select a management operation record and place it into the selected row. The user can also access this operation file chooser dialog from the **Change/Select Operation** menu option via the right mouse menu.

Additional editing functions for the Operation column are displayed by right clicking within the column (see figure below). Clicking on one of the menu options available will apply the function to the highlighted row(s). The top items above the line are specific to the operation column. The items below the line are the general editing functions described previously in the **MCREW General Editing Functions within the Column Menus** section.



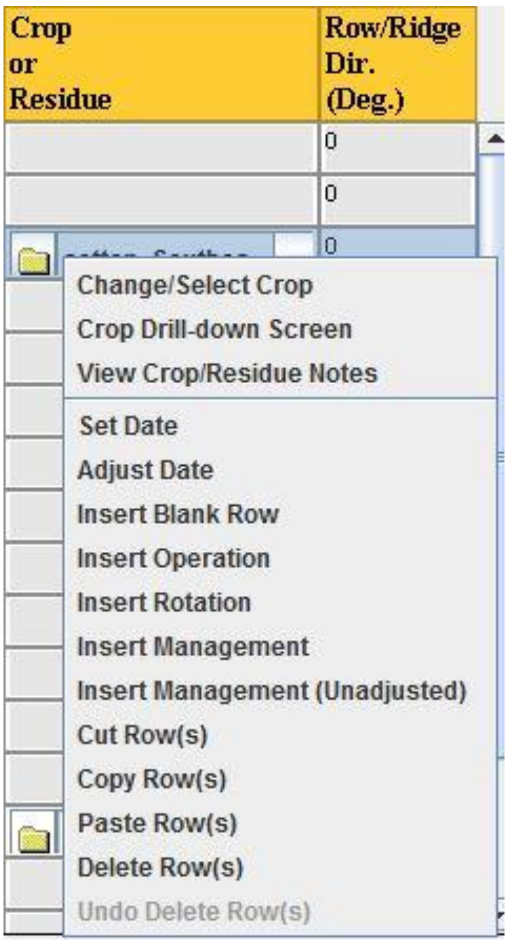
The **Change/Select Operation** menu option via the right mouse menu will also bring up the operation file chooser window. It allows the user to select a management operation record and place it into the selected row(s). This function works with multiple selected rows and replaces the specified operation in each of the selected rows.

The **Operation Drill-down Screen** option provides access to the operation's process list and its parameters, which is discussed in more detail later in the **MCREW Operation and Crop Dialog Drill-Down** Screens section.

The **View Operation Notes** shows the user notes content in a popup screen for the selected operation. These two functions will be greyed out and not accessible if multiple rows are selected.

MCREW Crop or Residue Column Editing Functions

Operations that contain planting/seeding processes require a crop or residue to be specified. Those that have this process defined will either display the name of the crop to be planted in the Crop or Residue column or display the string "No crop", signifying that no crop is to be planted or it hasn't yet been selected by the user. A different crop or residue can be selected to replace or fill the existing crop or residue entry by clicking the down arrow to the right of the Crop or Residue column cell and selecting the desired crop or residue. A crop or residue can also be replaced in the selected cell by double clicking the left mouse button with the mouse cursor in a Crop or Residue cell. This action will display the crop or residue file chooser window for the user to select the desired crop or residue and place it into the selected cell. The user can also access this crop or residue file chooser dialog from the **Change/Select Crop** menu option via the right mouse menu.



Additional editing functions for the Crop or Residue column are displayed by right clicking within the column (see figure below). Clicking on one of the menu options available will apply the function to the highlighted row(s). The top items above the line are specific to the Crop or Residue column. The items below the line are the general editing functions described previously in the **MCREW General Editing Functions within the Column Menus** section.

The **Change/Select Crop** menu option via the right mouse menu will also bring up the crop or residue file chooser window. It allows the user to select a crop or residue record and place it into the selected row(s). This function works with multiple selected rows and replaces the specified crop or residue in each of the selected rows.

The **Crop Drill-down Screen** option provides access to the crop or residue's process list and its parameters, which is discussed in more detail later in the **MCREW Operation and Crop Dialog Drill-Down** Screens section.

The **View Crop/Residue Notes** shows the user notes content in a popup screen for the selected crop or residue. These two functions will be greyed out and not accessible if multiple rows are selected.

MCREW Operation and Crop Dialog Drill-Down Screens

Both the MCREW Operation and Crop or Residue columns have a "drill-down" function available that allows the user to display a popup screen that makes many of the specific operation or crop/residue parameter values viewable or editable. The operation parameters specify how WEPS operations simulate soil and biomass properties that influence wind erosion. Similarly, the crop parameters specify how WEPS simulates crop planting, growth, and harvest, as well as residue decomposition. The specific content of these screens depends upon both the type of crop or operation and specific configuration file settings. The configuration files describe which parameters are viewable or hidden to the user and, if viewable, whether or not they are editable by the user. In addition, for each parameter that is displayed, the prompt information for the parameter is described in these configuration files. Examples of Operation and Crop Dialog drill-down screens are shown in Figure 2-56 and Figure 2-57.

The drill-down functions are cell specific and are available only when a single operation or crop/reisdue cell is selected. The Operation drill-down screen is accessible if the selected cell is in the operation column and a Crop drill-down screen is accessible if the selected cell is in the crop column. To access the Operation or Crop drill-down screen, click the folder icon to the right of the Operation or Crop name in the MCREW table. An alternative method is to left click in the operation or crop/residue cell and selecting "Operation Drill-down Screen" or "Crop Drill-down Screen" respectively.

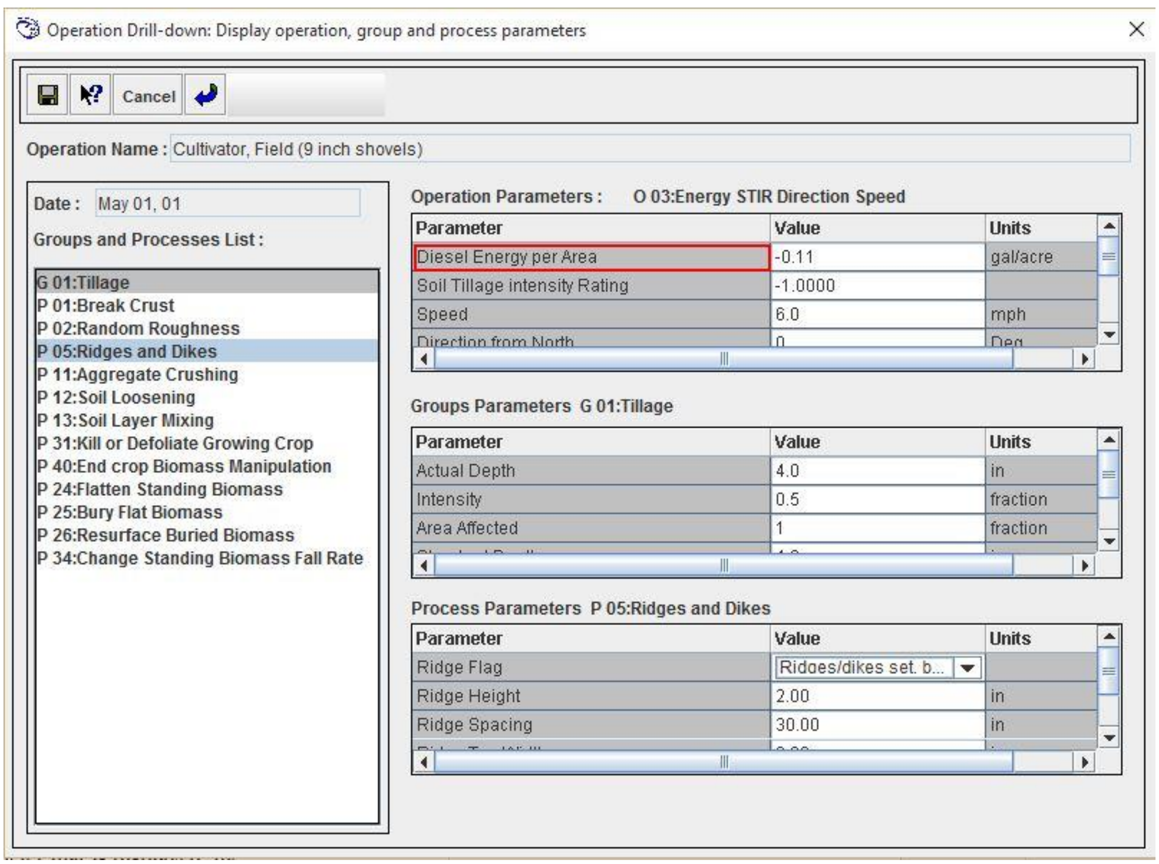


Figure 2-56 Example Operation Dialog drill-down screen.

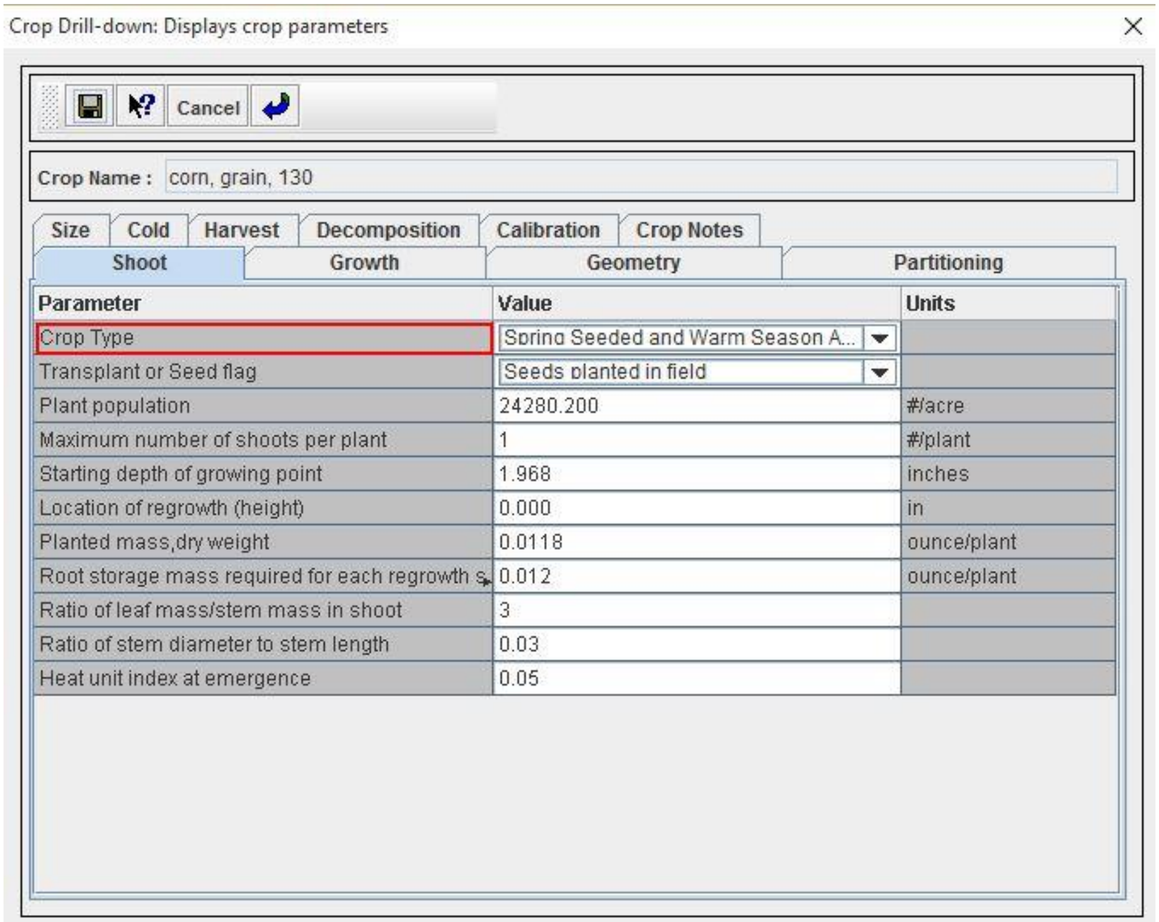


Figure 2-57 Example Crop Dialog drill-down screen.

Definitions and ranges for specific operation parameters are also available in the WEPS How To Guide, **"Management Operation Database Record Development"**. Definitions and ranges for specific crop/residue parameters are available in the WEPS How To Guide, **"Crop Database Record Development"**. These guides also provide guidelines for determining parameters for crops not listed in the operation or crop/residue databases.

2.15 Viewing and Editing a Soil Record

Users have the option to view and edit the parameters for the soil record displayed in the soil box by clicking on the button labeled ‘**Soil**’, on the left side of the soil box in the bottom left corner of the main WEPS screen (Figure 2-1). This will open the WEPS Soil User Interface screen (Figure 2-58).

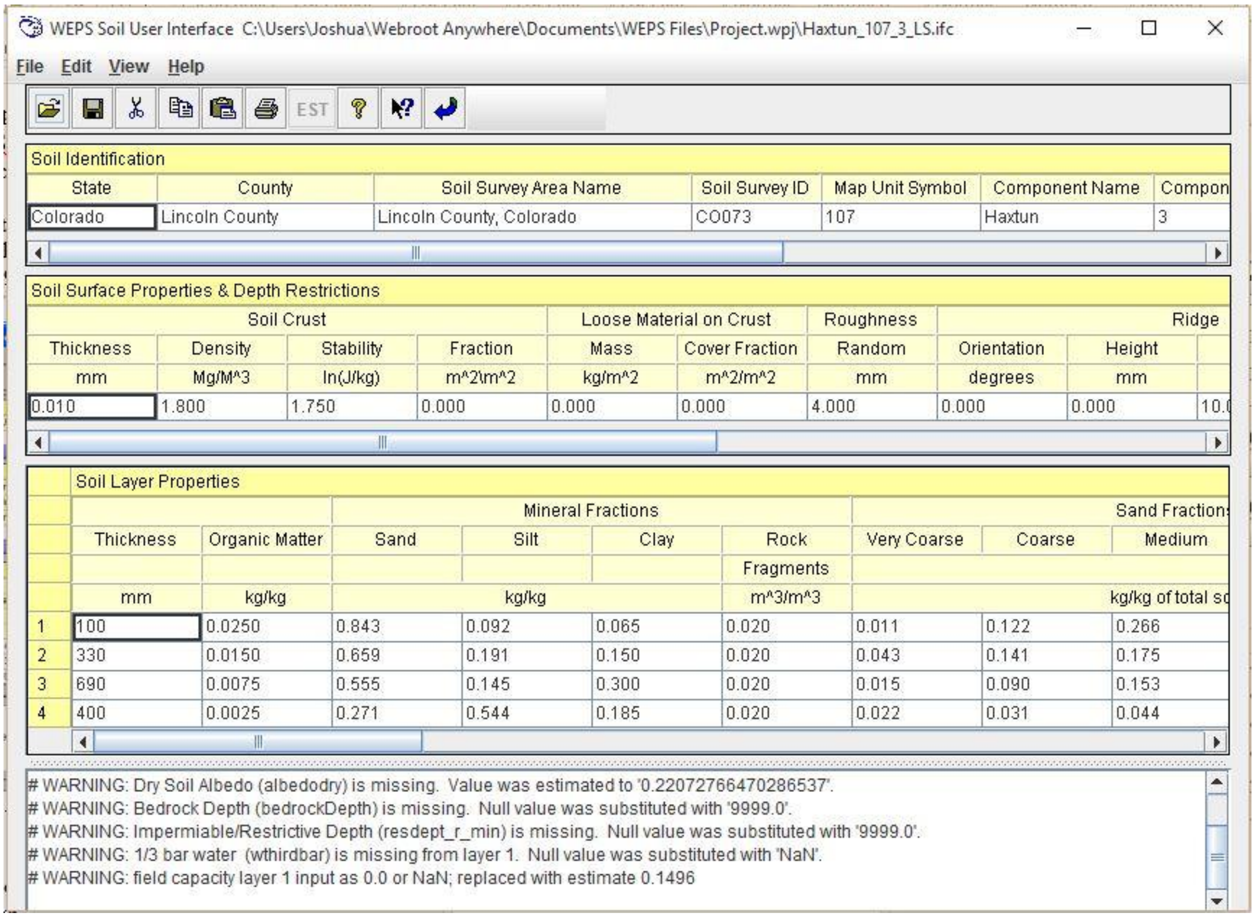


Figure 2-58 WEPS Soil User Interface screen.

Many soil properties that affect soil wind erodibility vary with time as a result of weather and management. The parameters displayed in the Soil User Interface only represent the initial soil conditions and properties that exist prior to the first day of simulation. Beginning with the first day of simulation, the soil parameters change in response to weather and management conditions.

Soil properties greatly affect the erodibility of a field surface directly through their effects on such things as roughness and aggregate size distribution. The soil properties also affect erodibility indirectly through their effects on soil hydrology and plant growth. The Soil User Interface allows the user to view, edit (disabled for NRCS), and save the initial soil information under a new file name for the Project. Users typically are discouraged from editing parameters derived from a SSURGO database file unless the user has specific knowledge of the parameter and more suitable values. A more detailed description of the soil parameters required by WEPS, as well as directions for obtaining a SSURGO database file for WEPS use, are found in Appendix 2 of the WEPS User Manual.

Users whose soils are not contained in a SSURGO database can create their own soil file by opening a new file and entering the appropriate parameters. It is recommended that in this case, the user enter the minimum set of parameters and let the Soil User Interface generate all parameter fields. The generation function is described under the Menu Bar function **View**, later in this section. Again, if the user has specific knowledge of the parameter and more suitable values, they may then edit those values. As an alternative, the user may wish to find an existing soil file within a SSURGO database with properties similar to the soil they want to simulate with WEPS and edit any parameters that may differ.

The various functions of the WEPS Soil User Interface are described next. More detailed definitions of soil parameters are available in Appendix 2 of the WEPS User Manual.

Soil Menu Bar Functions

The menu bar provides the following options:

- **File** - This menu displays a drop-down list of various file options.
  - **New (Ctrl-N)** - Opens an empty, unnamed soil screen.
  - **Open... (Ctrl-O)** - Displays an "Open a Soil File" dialog box from which the user can select a soil (ifc) file from those in the current Project.
  - **Open Database (Ctrl-L)** - Opens the "Select Soil" window (Fig. 2.18) to select a soil from a file, local database residing on your computer or from the NRCS SSURGO (NASIS) database.
  - **Save (Ctrl-S)** - Saves the current file.
  - **Save As... (Ctrl-A)** - Saves the current soil file to a new name in the current Project directory.
  - **Save As Template… (Ctrl-T)** - Save the current soil file to a new name in the default soil database directory location.
  - **Print (Ctrl-P)** - Opens a print dialog window to allow printing the soil file table display.
  - **Exit (Alt-F4)** - Exits the soil interface.
-
- **Edit -** This menu displays a drop-down list of various layer editing functions.
  - **Estimate Values (Ctrl-E)** - Estimates the values for all fields that can be estimated. Usually used when building a new soil record manually. Can only be used in conjunction with the **Minimum Fields** option under the **View** menu.

- **Cut Layer (Ctrl-X)** - Cuts a soil layer or layers and places it into the clipboard. The layer(s) (contiguous only) must be first selected by dragging the mouse while holding the left mouse button down.
- **Copy Layer (Ctrl-C)** - Copies a soil layer or layers and places it into the clipboard. The layer(s) (contiguous only) must be first selected by dragging the mouse while holding the left mouse button.
- **Paste Before Layer (Ctrl-B)** - Pastes a soil layer or layers from the clipboard above the highlighted row.
- **Paste After Layer (Ctrl-V)** - Pastes a soil layer f or layers from the clipboard after the highlighted row.
- **Insert Before Layer (Ctrl-Insert)** - Inserts a blank soil layer before the highlighted row.
- **Insert After Layer (Insert)** - Inserts a soil layer after the highlighted row.
- **Delete Layer (Delete)** - Deletes the selected soil layer or layers that are highlighted.

The edit functions for layers are also available by highlighting a row or set of contiguous rows then right clicking within the selected row(s) to display the edit functions.

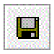
- **View -** This menu displays options for changing the parameters displayed in the Soil User Interface. Two exclusive options are available, of which only one can be chosen.
  - **All fields** - When selected, it displays all the fields required by WEPS in the Soil User Interface screen.
  - **Minimum fields** - When selected, it displays only the minimum input parameters required by the Soil User Interface. The minimum parameters displayed when the **Minimum fields** box is checked are used by the soil interface as inputs to estimate or generate the parameters required by WEPS. This functionality is accessible from the **Edit** menu with the **Estimate Values** menu option or using **Ctrl-E**. These generated parameters are displayed when the **All fields** box is checked. Any parameters that were adjusted because of out-of-range values, as well as the old and new values, are displayed in the Notes table at the bottom of the Soil User Interface screen.

- **Help** - This menu displays a drop down list of help options.
  - **Help Topics (Ctrl-H)** - Opens the Soil User Interface online help system.
  - **About Soil** - Displays the current version of the Soil User Interface.

Soil Button Bar Functions

The button bar provides a shortcut to some of the menu items.

Opens an existing soil file. This has the same function as selecting '**Open**' under '**File**' on the menu bar.



Saves the soil file being edited to the current Project. This has the same function as selecting '**Save**' under '**File**' on the menu bar.

Cuts the row or rows of the soil file and places into the clipboard. This has the same function as selecting '**Cut Layer**' under '**Edit**' on the menu bar.

Copies a row or rows of the soil file and places into the clipboard. This has the same function as selecting '**Copy Layer**' under '**Edit**' on the menu bar.

Pastes a row or rows of the soil file from the clipboard to a row above the currently selected row. This has the same function as selecting '**Paste Before Layer**' under '**Edit**' on the menu bar.

Prints the soil properties currently displayed.

Estimates the values for all fields that can be estimated. Active only when used in conjunction with the **Minimum Fields** option under the **View** menu.

Opens the general help system for the Soil User Interface.

Enables context-sensitive help. Click on this button, then on any item on the screen, for help on that item.

Saves the currently displayed data and closes the Soil User Interface.

The Soil User Interface displays data in four sections with three of them being parameter tables:

- The Soil Identification table provides information regarding the soil identification, location, and classification. The Soil Identification parameters are not critical to the operation of WEPS and are used for identification purposes only.
  ○
- The Soil Surface Properties & Depth Restrictions table provides information pertaining to the configuration of the soil surface in terms of crusts, roughness, albedo, slope, and rock cover. It also contains the depth to root and water restrictive layers.
  ○
- The Soil Layer Properties table contains soil properties by layer or horizon. At the bottom of the screen is the Soil Notes table. The user may enter any notes pertaining to the soil file. These notes are appended to the bottom of the Soil file.
  ○

- The Soil Notes may also contain notes generated by the interface. These generated notes specify parameters that were adjusted because of out-of-range values, and lists the old and new values. The notes are not critical to the operation of WEPS and are used for information purposes only.

Downloading Soil Data

This section describes how to download soil data from the NRCS Soil Data Mart and how to extract it for use within WEPS. A Microsoft Access database template is available for importing the data from the export file. You must have Microsoft Access 97 or later installed on your PC.

Soil data for NRCS and most other users in the US, is currently available for download from the NRCS Soil Data Access site's URL at: http://sdmdataaccess.nrcs.usda.gov/ for specific soil data requests using custom scripts, etc. For simpler manual downloads, use the NRCS Web Soil Survey site at: http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx of required WEPS soil data elements. The soil survey data that is exported from the Soil Data Access and the Web Soil Survey sites are in what is referred to as "SSURGO" (Soil Survey Geographic) format. There are multiple ways to obtain WEPS soil data from these sites. The easiest method is to select the "Download Soils Data" tab on the NRCS Web Soil Survey site and follow the instructions provided to download the desired soil data. Note that there may be both "tabular" and "spatial" data available. Only the "tabular" data is required for this release of WEPS.

After the zipped file has been downloaded to your PC, it must be unzipped by using either WinZip or a similar program. For additional information, please see the file named README.txt in the root directory that is created by unzipping the zipped soil file. For additional soil survey areas, each zipped file should be copied and unzipped into individual directories. When a file is unzipped, the following directory hierarchy is produced in the directory to which the file was unzipped:

\spatial
\tabular

The top-level directory contains the following files:

soil_metadata_ssasymbol.txt - a Federal Geographic Data Committee (FGDC) metadata file in plain ASCII format.

soil_metadata_ssasymbol.xml - the same FGDC metadata file in XML format.

readme.txt - a text file containing additional information.

The root directory will also contain an empty MS Access SSURGO template database, if one was requested as part of the download. This file is currently named "soildb_US_2003.mdb".

The directory "tabular" contains any tabular data that was requested. The directory "spatial" contains any spatial data that was requested. Note that spatial data is not required nor recommended (due to large file sizes) for WEPS. It should still be possible to request tabular data from the Soil Survey download site without including the corresponding spatial data, and vice versa.

Tabular data is provided as a set of ASCII delimited files. Each file corresponds to a table in the SSURGO 2.1 data model. The tabular data isn't particularly useful until it has been imported into the MS Access SSURGO template database. Current Web Soil Survey downloads include a template database, if requested. The database is the "soildb_US_2003.mdb".

To import tabular data, load the template file into MS Access. A 'SSURGO Import' screen will display, asking for the full path to the tabular data directory (Figure 2-59). Type (or cut and paste) the full path of the tabular directory and click 'OK'. A list of database tables will appear and a folder will be created in the top level directory. The folder will have the base name (non-extension part) of the template name. At the same time, an MS Access database file (*.mdb), which contains the data required for WEPS, will be created in the template folder.

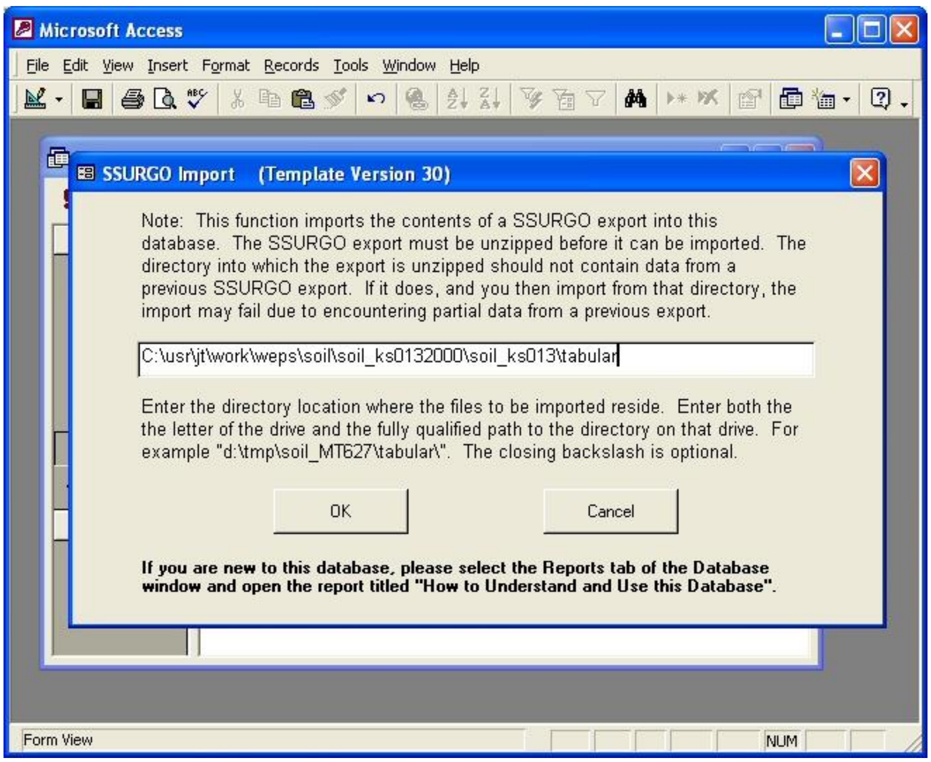


Figure 2-59 WEPS SSURGO Import screen.

To import more than one soil survey area into a single MS Access database, run the Import macro specifying the full path to the directory the SSURGO data was unzipped into. Repeat the Import macro for each area desired. When done, save the template database with the imported data to a new name (*.mdb).

The WEPS 1.5 soil selection process extracts data elements stored in the following SSURGO text data files located in the \tabular directory (tables in the MS Access database), when connected to a Microsoft Access SSURGO database file:

chfrags.txt
chorizon.txt
chtexgrp.txt
comp.txt
crstrcts.txt
legend.txt
mapunit.txt
muaggatt.txt
version.txt

If multiple soil survey areas are imported into a single MS Access database, the database may become very large. To reduce the size of the Access database file, one may run the Export macro and delete the SSURGO data (*.txt) files created in the tabular directory that are not listed above before importing into a template Access database.

Using SSURGO Data in Microsoft Access format with WEPS

Within WEPS, open the "**Configuration**" window, then click the "**Directories**" tab. Fill out the full path and SSURGO soil database file name (*.mdb) for "**Soil DB**" and close the configuration window (click "Save" if you want to use that path in subsequent WEPS runs). Selecting the Soil Template folder  at the bottom of the main WEPS screen will display the list of soil survey areas to choose from. Select the desired soil survey area and select the soil map unit and component for the simulation run. If the SSURGO database is not populated with data required by WEPS, you will get an error message when selecting that soil. More detailed information on selecting soils, see the "**Interface Reference: Choosing a Soil**" section of the WEPS User Manual.

How to Handle Missing Soil Data

In one mode of operation the Soil User Interface estimates limited values if they are not populated in the SSURGO database. NRCS users must click the check box for "Do not estimate missing values from SSURGO database" under the "Miscellaneous" tab of the "Configuration" window so that these values are not estimated. If a soil database record generates an error listing missing data upon loading, contact your local NRCS office for assistance.

2.16 WEPS Multiple Run Manager (WMRM)

One can view erosion results from multiple WEPS Runs simultaneously from the **WEPS Multiple Run Manager (WMRM)** shown in Figure 2-60. It is accessible from the Main WEPS window (Figure 2-1) by selecting the **Multiple Run Manager** option under the **ViewOutput** menu.

The left side of the screen consists of a tree of directories that contain WEPS Runs that can be selected for display. A subset of the total available runs can be selected by clicking on the desired WEPS Runs to display. Use Ctrl-right mouse button to select multiple, non-contiguous WEPS Runs for display.

The table consists of the following columns (columns can be selectively displayed or hidden):

Run Name – The WEPS Run directory name.

Run Location – The path containing the WEPS Run directories.

Management Name – The name of the management/crop rotation file used in the WEPS Run.

Soil Name – The name of the soil ifc file used in the WEPS Run.

Field Size – The simulation field size used in the WEPS Run.

Gross – The gross annual soil loss on the field.

Net Total – The annual net soil loss leaving the field.

Net Creep/Salt – The annual net creep and saltation size particles leaving the field.

Net Suspension – The annual net suspension size particles leaving the field.

Net PM10 – The annual net PM10 (<10µ) particles leaving the field.

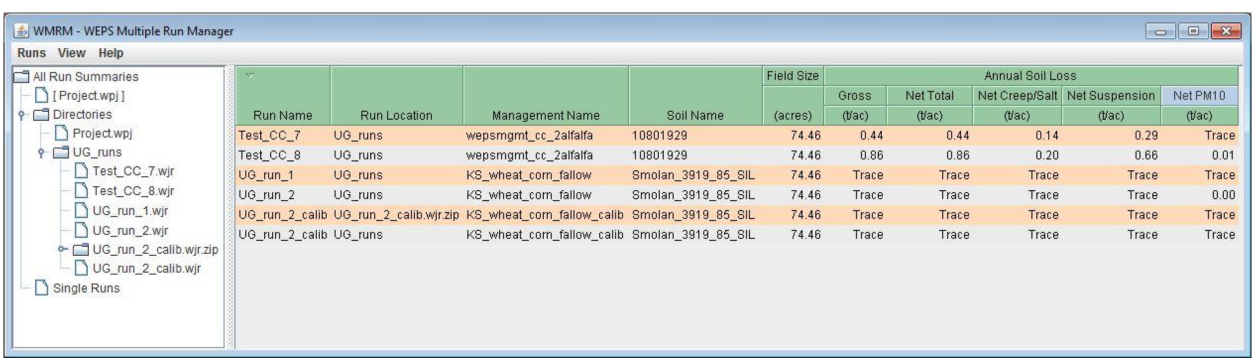


Figure 2-60 WEPS Multiple Run Manager (WMRM).

The WMRM Menus options are: **Run**, **View** and **Help.**

The **Runs** menu consists of:

Add Directory - Add a directory containing WEPS Runs for display in WMRM.

Add Single Run - Add a single WEPS Run for display in WMRM.

Restore Selected Run in WEPS - Restore the selected WEPS Run inputs into the main WEPS interface screen.

Export Selected Run - Export the selected WEPS Run into the user specified directory location in a popup window. The user has the option of deleting the original copy if desired from within that window.

Delete Selected Run - Delete the selected WEPS Run.

Refresh Table - Refresh the WMRM table so that it contains all the WEPS Runs in the specified locations. Useful if the WMRM window is open and additional WEPS Runs have been made since opening it.

Print… - Print the contents of the WMRM table.

Close - Close the WMRM window.

The **View** menu consists of:

Default - Resets the WMRM table to the default list of columns (currently all of them).

Run Name - Selects the WEPS Run name column to be displayed.

Run Location - Selects the WEPS Run location name column to be displayed.

Management Name - Selects the WEPS Run Management name column to be displayed.

Soil Name - Selects the WEPS Run Soil name column to be displayed.

Field Size - Selects the WEPS Run Field Size column to be displayed.

Gross - Selects the average annual Gross soil loss column to be displayed.

Net Total - Selects the average annual Net Total soil loss column to be displayed.

Net Creep/Salt - Selects the average annual Net Creep/Salt column to be displayed.

Net Suspension - Selects the average annual Net Suspension column to be displayed.

Net PM10 - Selects the average annual Net PM10 column to be displayed.

The **Help** menu consists of:

About WMRM - Displays a popup window that provides information about the WMRM window.

2.17 Displaying Wind Station Data Information

One can view wind information on selected Windgen records (even interpolated Windgen records) from the Main WEPS window (Figure 2-1) by selecting the **Display Wind Station Info** option under the **Tools** menu or by pressing the Alt+W keys simultaneously to bring up the “Wind Station Data” window (Figure 2-61). The wind information for the selected Windgen station, including wind parameters by month are displayed in a popup window. Clicking the down arrow to the right of the station name displays a list of available wind stations from which to choose. Multiple windows can be displayed simultaneously, so an individual can compare two or more station’s data if desired.

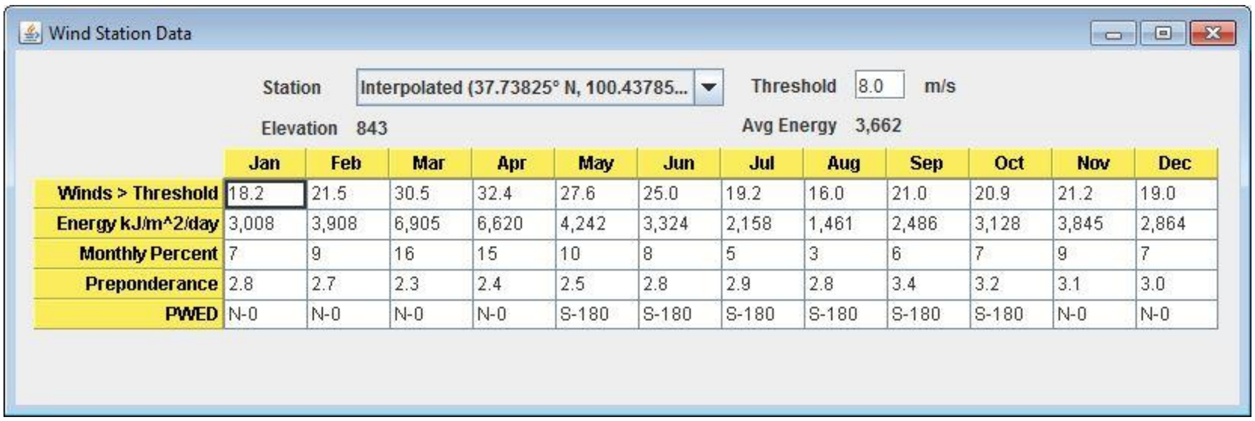


Figure 2-61. Wind Station Data information window.

The assumed wind speed threshold (see discussion below) for the calculations (m/s), the station elevation (m), and the average wind energy for the year (kJ/m^2/day) are displayed at the top of the window. The following parameters are displayed for each month in tabular form:

Winds > Threshold - the percentage of the time the wind is above the given threshold. This parameter will give the user an indication of the percentage of time winds are near or above erosive speeds and should only be used for general purposes. The actual threshold of wind erosion used in WEPS varies with the surface conditions. The default threshold value is 8.0 m/s.

Energy - the erosive wind energy greater than the given threshold (kJ/m^2/day).

Monthly Percent - percentage of the annual erosive wind energy.

Preponderance - the prevalence of the prevailing wind erosion direction for the month (maximum ratio of parallel to perpendicular erosion forces). A preponderance value of 1.0 indicates no prevailing wind erosion direction. A value of 2.0 indicates a prevailing wind erosion direction, with wind erosion forces twice as great parallel as perpendicular to prevailing wind erosion direction.

2.18 Comparing WEPS Files for Differences

One can compare WEPS Runs, WEPS “weps.run” files, WEPS Management files and WEPS Soil files and determine what is different between them. The **Diff WEPS Files** menu option is accessible under the **Tools** menu on the main WEPS Screen. The differencing window is shown in Figure 2-62. This function is very useful to determine exactly what is different between to WEPS Runs or files when one is not sure what is different between them anymore.

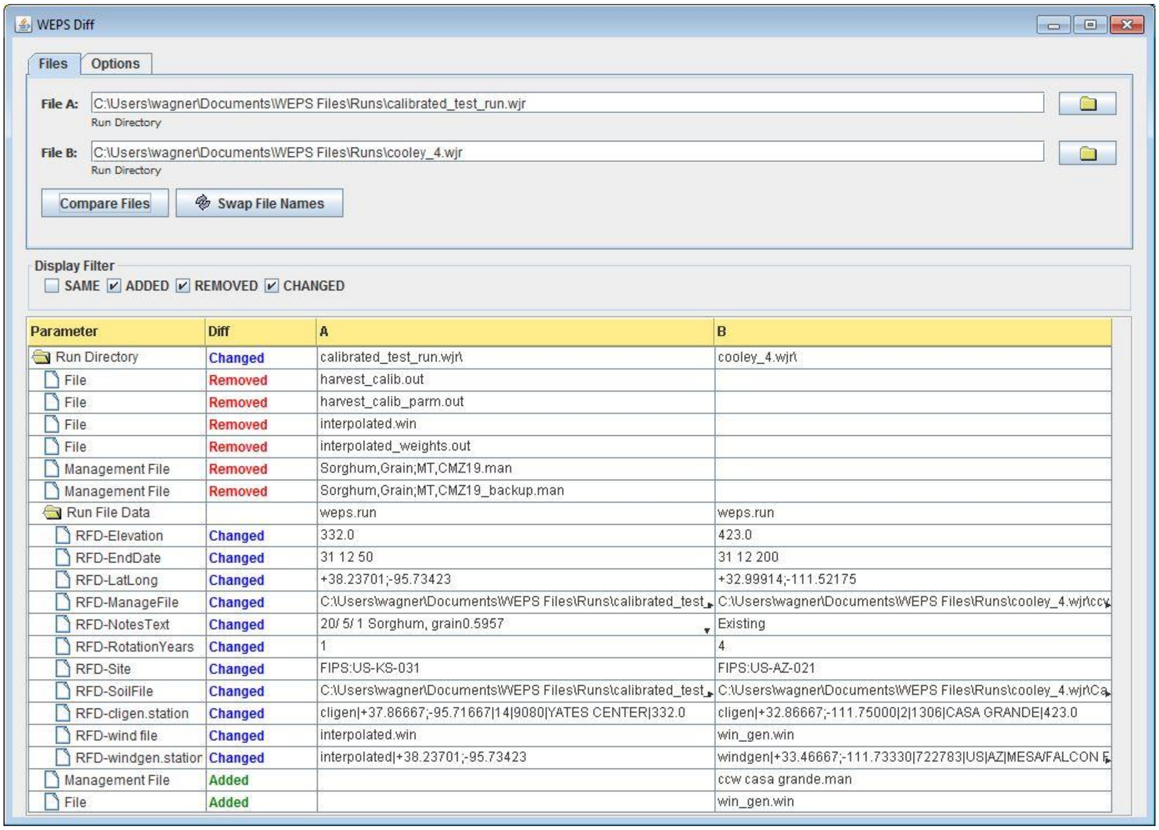
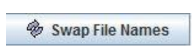


Figure 2-62 WEPS Differencing Window.

There are two tabs in the top section: **Files** and **Options**. The **Files** section, as shown in Figure 2-62, allows the user to select the two files or directories to compare. The comparison is made when the 

button is pressed. The 

button switches File A and File B positions. The **Options** tab (Figure 2-63) contains the options that WEPS operations are matched on: Operation Date, Operation Name and Crop Name and whether an AND or OR comparison is made.

Figure 2-63 WEPS Differencing window Options tab.

The **Display Filter** section allows one to check what is to be displayed in the differencing window below. The options are: **Same, Added, Removed** and **Changed**.

The differencing window in the bottom section displays a table with the “differences” displayed. The column headings are:

Parameter - The specific parameter or object being compared on the line.

Diff - The type of difference between the two files/directories being compared.

A - The **File A:** file or directory being compared.

B - The **File B:** file or directory being compared.

2.19 WEPS Configuration Options and Settings

The Configuration Panel window is accessible from the main WEPS screen menu as **Edit Configuration** as the last option under the **Tools** menu. It can also be accessed with the **Alt-C** key combination when the main WEPS screen has focus. The configuration panel consists of several labeled tabs and three buttons at the bottom of the screen. Those buttons are:

OK - Saves the changes permanently to the WEPS configuration file and closes the configuration panel window.

Cancel - Cancels all changes and closes the WEPS configuration panel window.

Help - Opens the general help for the WEPS configuration panel window.

The WEPS Configuration Panel consists of the following tabs:

WEPS - Displays the commandline options for the WEPS science model.

Windgen - Displays the settings pertaining to the Windgen generator, interpolation functions available and settings on how the interface determines which Windgen record to use for a specified WEPS Run.

Cligen - Displays the settings pertaining to the Cligen generator and settings on how the interface determines which Cligen record to use for a specified WEPS Run.

Directories - A list of directories and configuration files used by the WEPS interface.

Soil - Specifies the location of the soil database directory, organic soil file and other options and settings specific to how WEPS treats the soil data provided.

GIS - Provides the location of the GIS files needed by the MAP tool in the WEPS interface.

Reporting - Provides setting options for specific detail and debug reports available from the WEPS science model.

Email - Provides settings for the built-in email function and the Mantis ticket system connectivity for the WEPS interface.

Run - Specifies the WEPS Run length settings and other related parameters.

Fuels - Provides access to the Fuels database and displays the current contents of that file.

Display - Provides numerous general settings and options for the WEPS interface.

Configuration Panel - WEPS Tab

The **WEPS** tab is shown here (Figure 2-64). It displays the command line options for the WEPS science model and its directory location, etc.

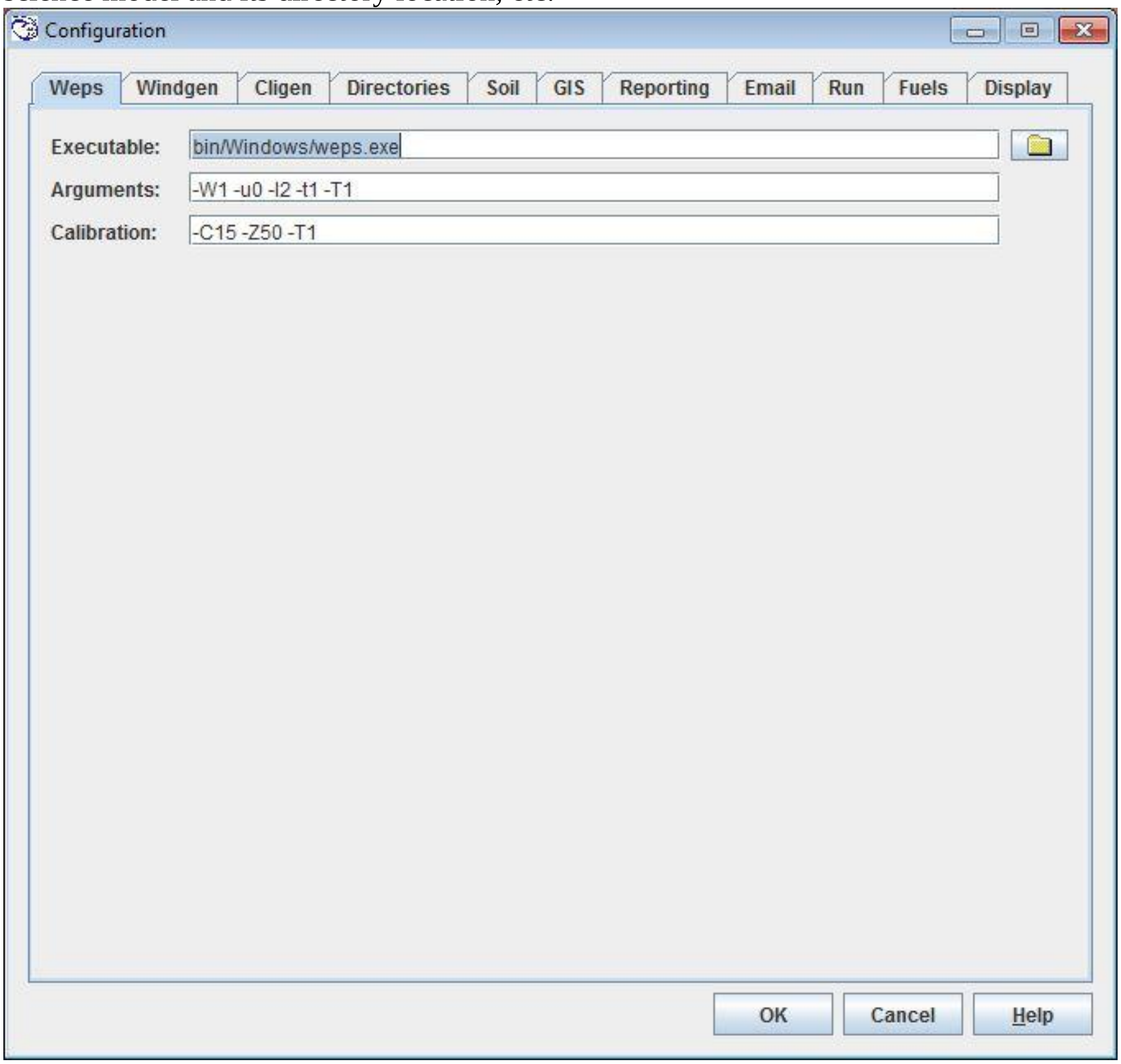
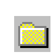


Figure 2-64 WEPS Configuration Panel displaying the WEPS tab.

Executable – Displays the path and file name of the WEPS science executable. The folder  button allows the user to browse and select an alternate WEPS executable if desired.

Arguments – Displays the WEPS science model default command line arguments (see Appendix for argument list).

Calibration – Display the WEPS science model default command line arguments to be used for a yield calibration run (see Appendix for argument list).

Configuration Panel – Windgen Tab

Displays the settings pertaining to the Windgen generator, interpolation functions available and settings on how the interface determines which Windgen record to use for a specified WEPS Run (Figure 2-74).

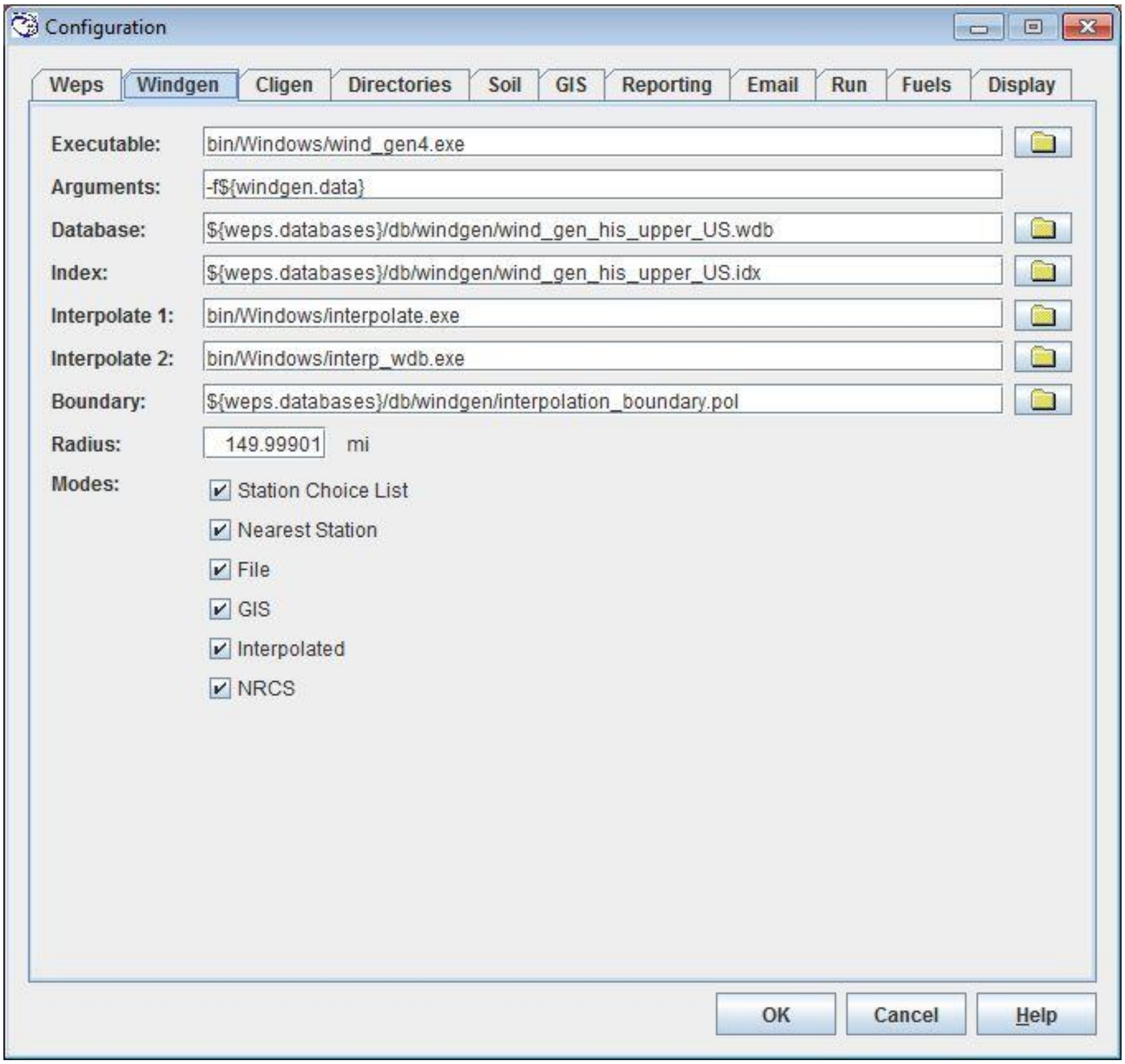


Figure 2-65 WEPS Configuration Panel displaying Windgen tab.

Executable – Displays the path and file name of the Windgen generator executable. The folder  button allows the user to browse and select an alternate Windgen generator executable if desired.

Arguments – Displays the Windgen generator executable default command line arguments (see Appendix for argument list). The "${windgen.data}" argument option refers to the default location of the Windgen station database file, which is defined in the **Database** field on this form.

Database – Displays the path and file to the Windgen station database file. The folder button allows the user to browse and select an alternate Windgen database file if desired. The "${weps.databases}" property is set to the default location where the WEPS database file resides.

Index – Displays the path and file to the Windgen station database index file. This file contains a list of the Windgen stations in the corresponding database file to use in WEPS. The folder button allows the user to browse and select an alternate Windgen database index file if desired. This file must be kept in sync with the Windgen database file listed above, otherwise WEPS may not find the desired Windgen station for WEPS Runs.

Interpolate 1 – Displays the path and file to the spatial interpolation executable file which determines which three Windgen stations to use for station parameter interpolation at a given location. The folder button allows the user to browse and select an alternate interpolation executable file if desired.

Interpolate 2 - Displays the path and file to the interpolation executable file which interpolates the station parameters for the three Windgen stations obtained from the **Interpolate 1** program listed above. The folder button allows the user to browse and select an alternate interpolation executable file if desired.

Boundary - Displays the path and file to the GIS polygon "interpolation boundary" file which specifies the spatial polygon boundary that defines the region where Windgen stations are interpolated. The folder button allows the user to browse and select an alternate GIS polygon boundary file if desired.

Radius- Displays the radius limit that is used in the Windgen station selection field on the main WEPS screen when the **Station Choice List** option is active. It constrains the number of stations to be displayed in the dropdown choice list

Modes – Lists the modes that can be enabled for Windgen station selection on the main WEPS screen. There are several Windgen station selection methods described here: **Alternative Weather Station Selection Methods** that employ these modes, when set. The mode options are:

Station Choice List – Provides a dropdown list of stations sorted by distance from the specified lat/lon on the main WEPS screen, with the nearest station the default option.

Nearest Station – Provides the nearest Windgen station to the specified lat/lon coordinates on the main WEPS screen.

File – Allows the user to select a file that is in the format of a Windgen generator created Windgen hourly wind data file for use in WEPS.

GIS – Allows the user to use the GIS polygon map for selecting Windgen stations.

Interpolated – Allows Windgen station records to be interpolated if they fall within the polygon boundary specified in the GIS polygon **Boundary** file listed above.

NRCS – A special mode that employs several other modes in a prescribed sequence for determining the Windgen station, based upon the selected lat/lon coordinates specified in the WEPS main screen. The sequence is defined in the **Alternative Weather Station Selection Methods** section.

Configuration Panel – Cligen Tab

Displays the settings pertaining to the Cligen generator, interpolation functions available and settings on how the interface determines which Cligen record to use for a specified WEPS Run (Figure 2-66).

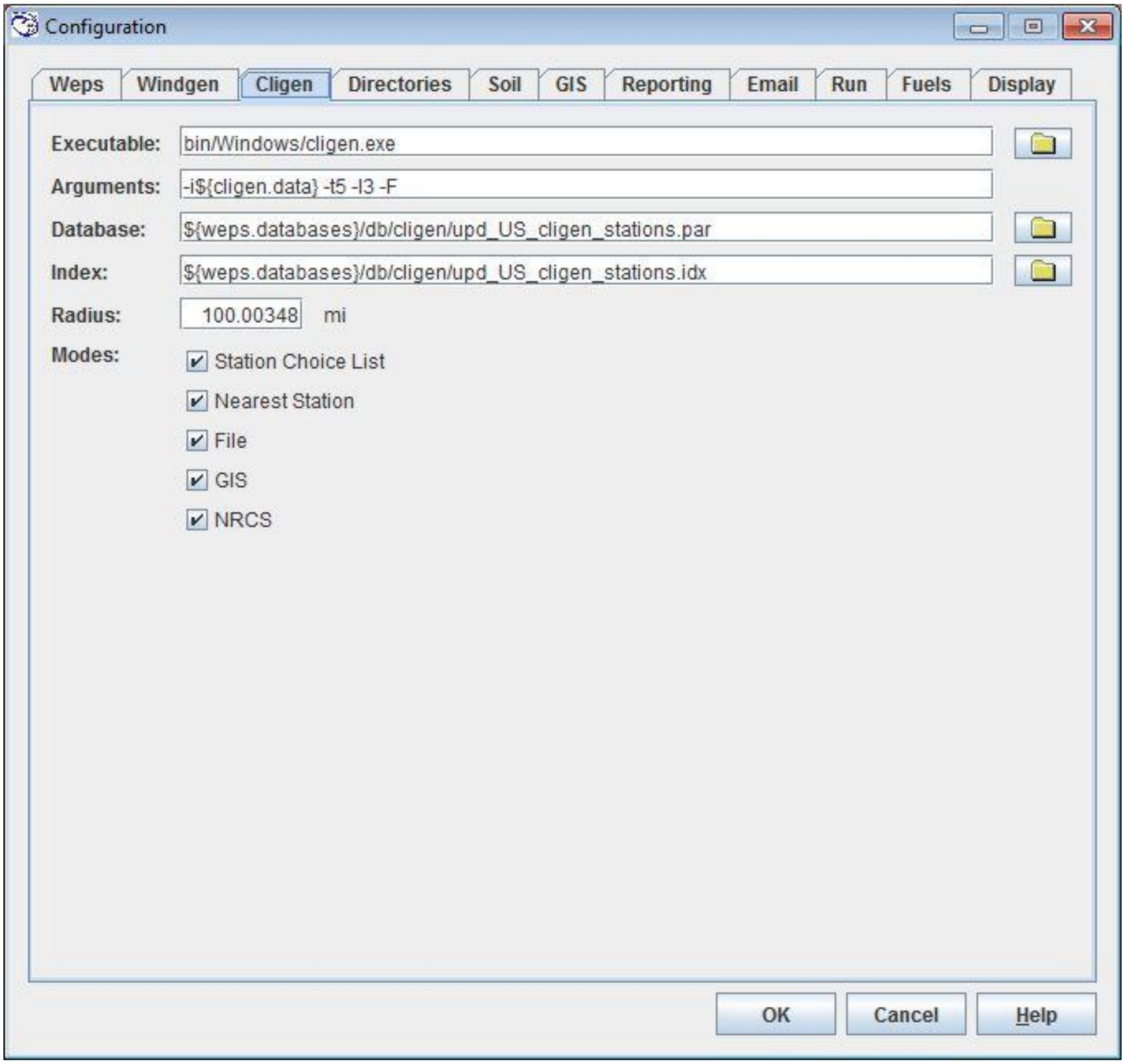


Figure 2-66 WEPS Configuration Panel displaying Cligen tab.

Executable – Displays the path and file name of the Cligen generator executable. The folder  button allows the user to browse and select an alternate Cligen generator executable if desired.

Arguments – Displays the Cligen generator executable default command line arguments (see Appendix for argument list). The "${cligen.data}" argument option refers to the default location of the Cligen station database file, which is defined in the **Database** field on this form.

Database – Displays the path and file to the Cligen station database file. The folder button allows the user to browse and select an alternate Cligen database file if desired. The "${weps.databases}" property is set to the default location where the WEPS database file resides.

Index – Displays the path and file to the Cligen station database index file. This file contains a list of the Cligen stations in the corresponding database file to use in WEPS. The folder button allows the user to browse and select an alternate Cligen database index file if desired. This file must be kept in sync with the Cligen database file listed above, otherwise WEPS may not find the desired Cligen station for WEPS Runs.

Radius- Displays the radius limit that is used in the Cligen station selection field on the main WEPS screen when the **Station Choice List** option is active. It constrains the number of stations to be displayed in the dropdown choice list

Modes – Lists the modes that can be enabled for Cligen station selection on the main WEPS screen. There are several Cligen station selection methods described here: **Alternative Weather Station Selection Methods** that employ these modes, when set. The mode options are:

> **Station Choice List** – Provides a dropdown list of stations sorted by distance from the specified lat/lon on the main WEPS screen, with the nearest station the default option.
>
> **Nearest Station** – Provides the nearest Cligen station to the specified lat/lon coordinates on the main WEPS screen.
>
> **File** – Allows the user to select a file that is in the format of a Cligen generator created Cligen daily weather data file for use in WEPS.
>
> **GIS** – Allows the user to use the GIS polygon map for selecting Cligen stations.
>
> **NRCS** – A special mode that employs several other modes in a prescribed sequence for determining the Cligen station, based upon the selected lat/lon coordinates specified in the WEPS main screen. The sequence is defined in the **Alternative Weather Station Selection Methods** section.

Configuration Panel – Directories Tab

The **Directories** tab allows the user to select the directories used for templates, skeleton files, databases, and Projects as well as other WEPS related configuration files, etc. by entering the path/file name or clicking the folder icon to display a file chooser to select the files or locations (Figure 2-67).

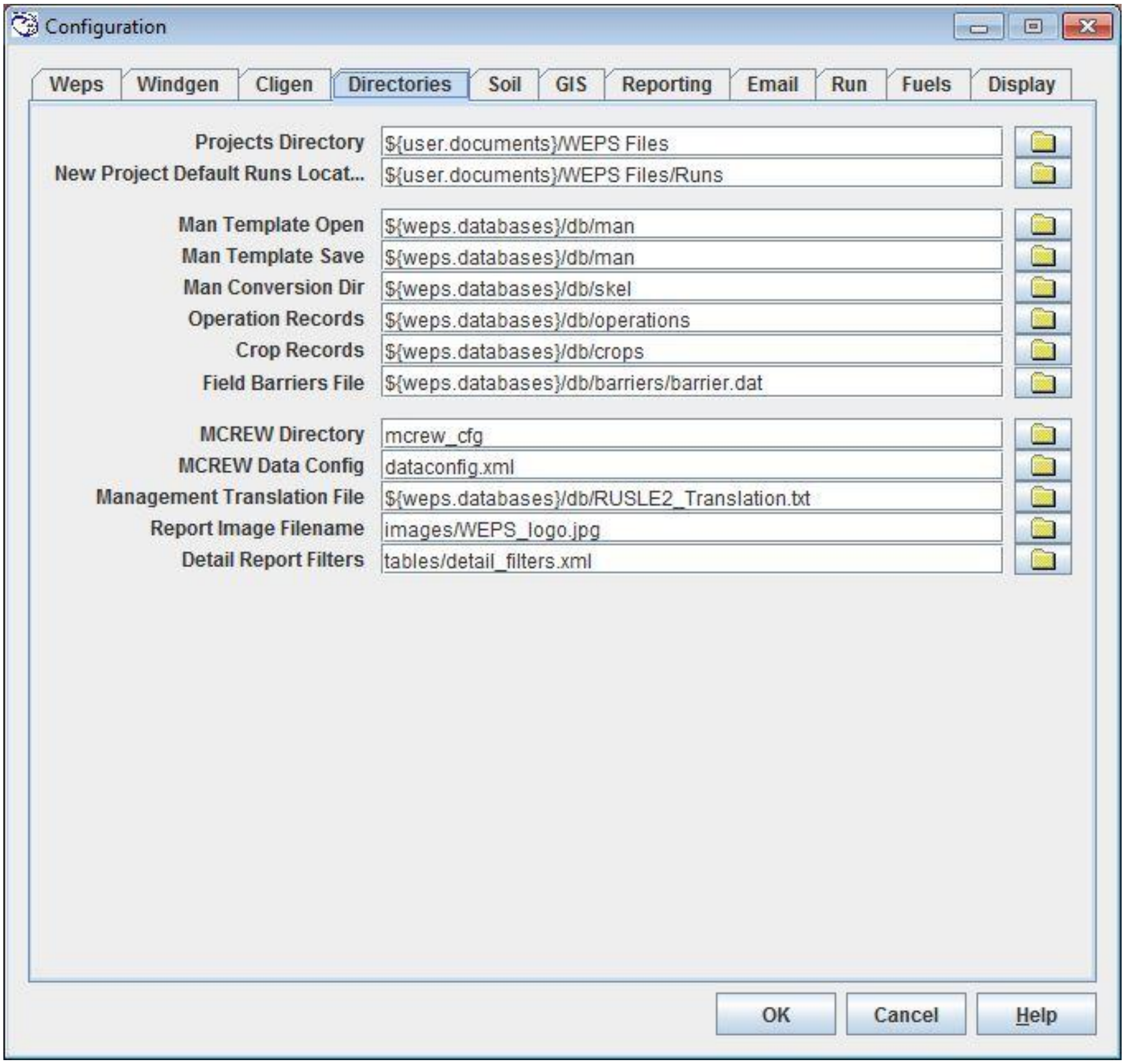


Figure 2-67 WEPS Configuration Panel displaying the Directories tab.

Projects Directory - The default directory for WEPS Projects. ${user.documents} is an operating system variable that defines the user's documents directory (typically the **My Documents** folder in Microsoft Windows).

New Project Default Runs Locat… - The default WEPS Runs location that is used when a new Project directory is specified from within the WEPS main screen **Projects** menu.

Man Template Open - The default directory location for storing management template files.

Man Template Save - The default directory for saving management template files.

Man Conversion Dir – The directory specified for use when converting management files between the intermediate RUSLE2/WEPS “skel” format and the WEPS format.

Operation Records - The default directory location for the management operation database files.

Crop Records - The default directory location for the management crop database files.

Field Barriers – The default directory location and filename for the WEPS wind barrier data file.

MCREW Directory - The default directory location for MCREW configuration files.

MCREW Data Config - The default directory and filename for the MCREW data configuration file.

Management Translation File - The translation file used for converting NRCS RUSLE2 "skel" format management files to WEPS format management files.

Report Image Filename - The file name of the image to be displayed on the WEPS report files such as an Agency logo.

Detail Report Filters – The default directory location and filename for the WEPS Tabular Detail Report filters.

Configuration Panel – Soil Tab

The **Soil** tab allows the user to select the directories and specify specific options related to WEPS soil data (Figure 2-68). One can click on the folder icon to display a file chooser to select the files or locations for those type of configuration fields.

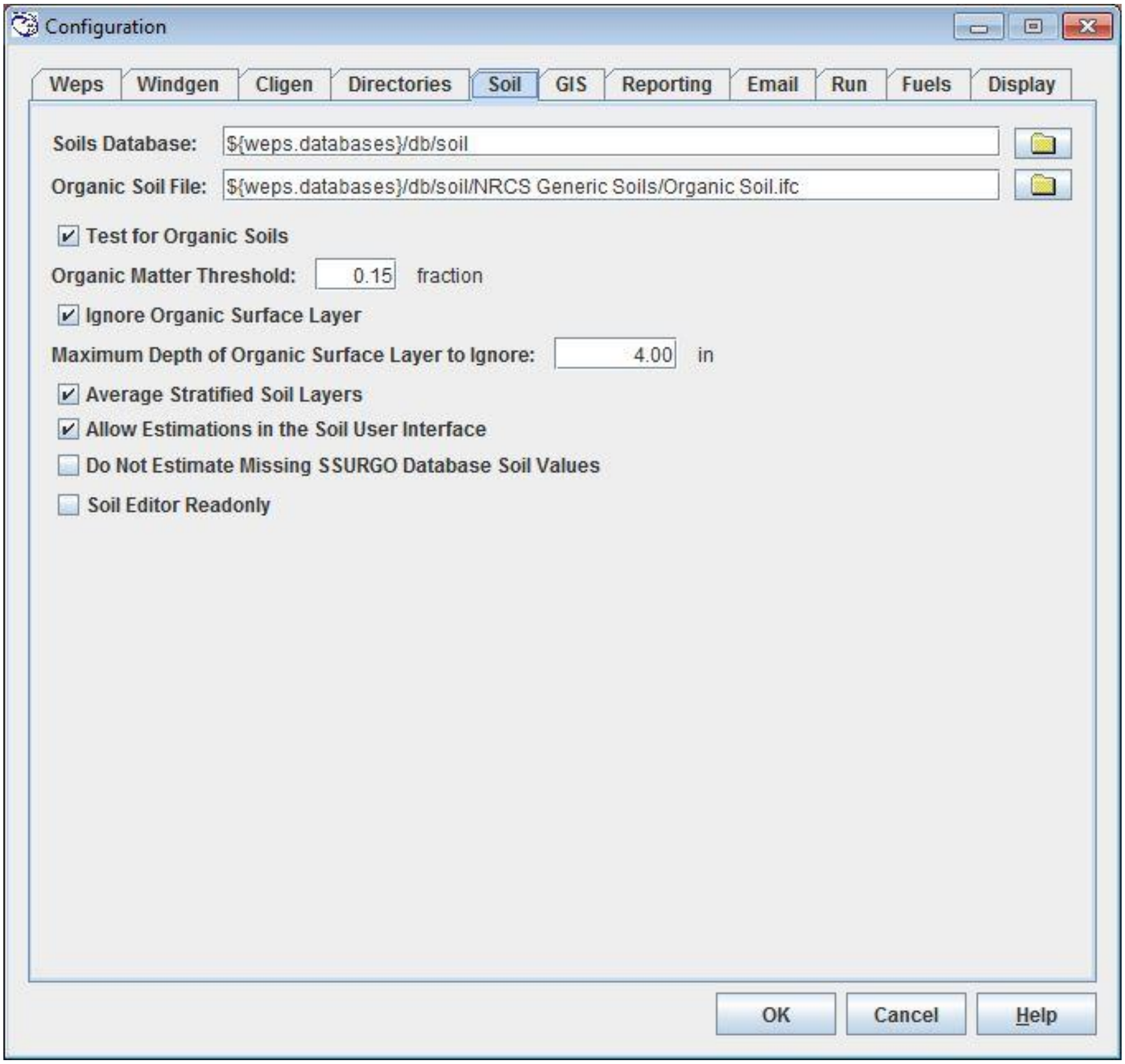


Figure 2-68 WEPS Configuration Panel displaying the Soil tab.

Soil Database - The default directory for local "ifc" and NRCS SSURGO Microsoft Access "mdb" soil database files. It is also where the "SDMDataAccess.nrc.usda.gov.db" file resides containing the link information to the NRCS online SSURGO soil database.

Organic Soil File – The default directory location and filename of the WEPS soil file used as a surrogate for organic soils by NRCS.

Test for Organic Soils – Enables the check for organic soils that is used by NRCS.

Organic Matter Threshold – Sets the threshold value for organic matter that the NRCS Organic Soils test uses.

Ignore Organic Surface Layer – Enables the feature to ignore a surface layer that is high in organic matter when reading in a soil file within WEPS.

Maximum Depth of Organic Surface Layer to Ignore – Sets the maximum depth for the **Ignore Organic Surface Layer** feature.

Average Stratified Soil Layers – Enables the feature to average "stratified" soil layers specified in an NRCS soil data record.

Allow Estimations in the Soil User Interface – Enables the manually triggered soil property estimation functions in the Soil User Interface to work if specific soil properties are missing in the displayed soil record.

Do Not Estimate Missing SSURGO Database Soil Values – Disables the automated soil property estimation functions in WEPS if specific soil properties are missing in the selected soil record.

Soil Editor Readonly – Configures the Soil User Interface editor to not allow editing.

Configuration Panel – GIS tab

The **GIS** tab (Figure 2-69) allows the user to specify the GIS directory containing GIS files used in the MAP component that is accessible from the main WEPS interface screen.

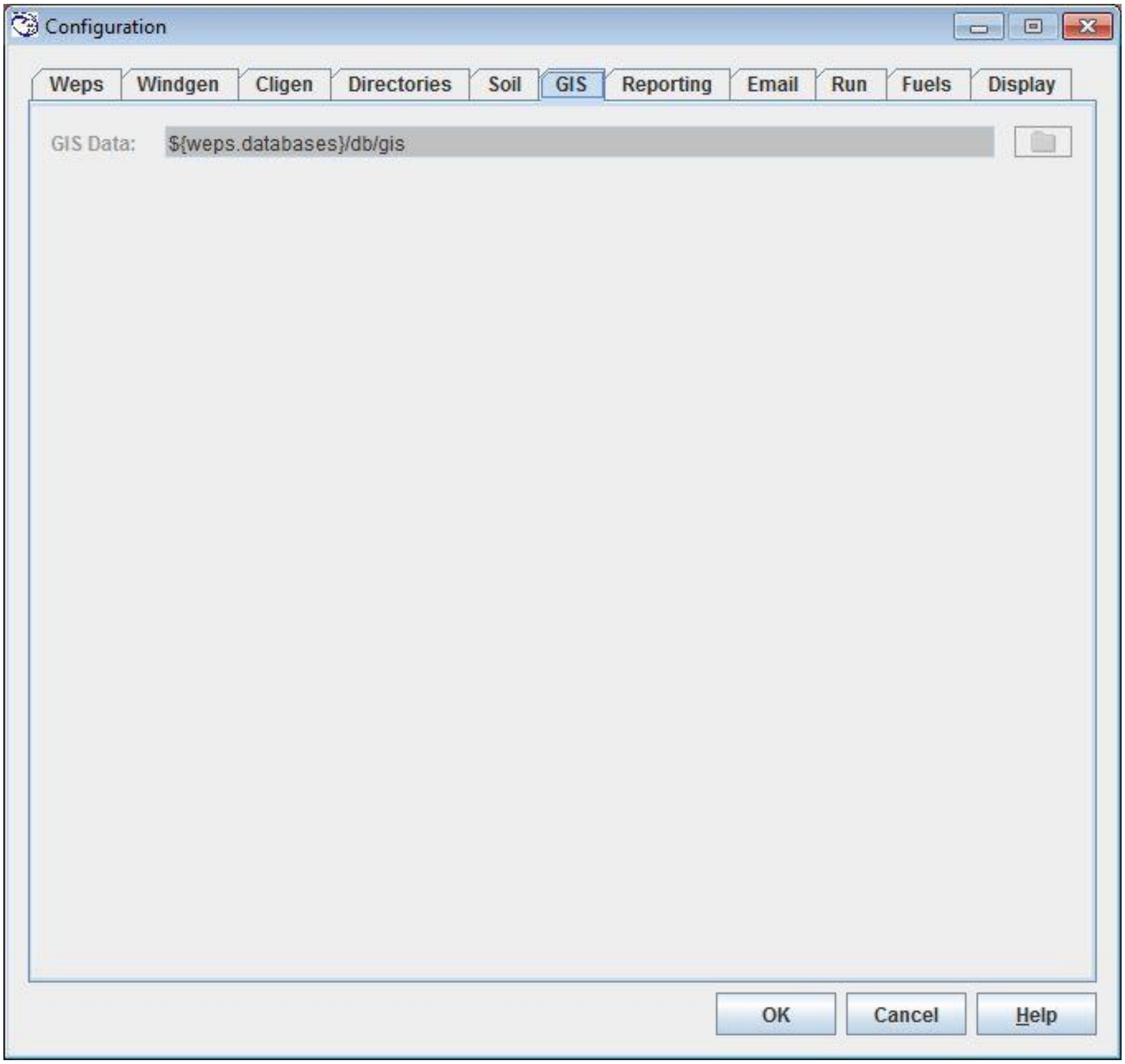


Figure 2-69 WEPS Configuration Panel displaying the GIS tab.

GIS Data – Sets the directory location that the GIS files used by the MAP component, which is accessed from the WEPS Interface screen. The folder icon  can be clicked on to display a file chooser to select an alternative location, if desired.

Configuration Panel – Reporting Tab

The **Reporting** tab (Figure 2-70) allows the user to specify additional WEPS science model output. The additional output is specified by setting the values to numbers greater than zero for the selected submodels. Larger numbers produce reports with more detail, if the submodel has multiple levels of reports. There are two levels of reports, Detail and Debug. The specific type of output produced at the different levels are provided here:

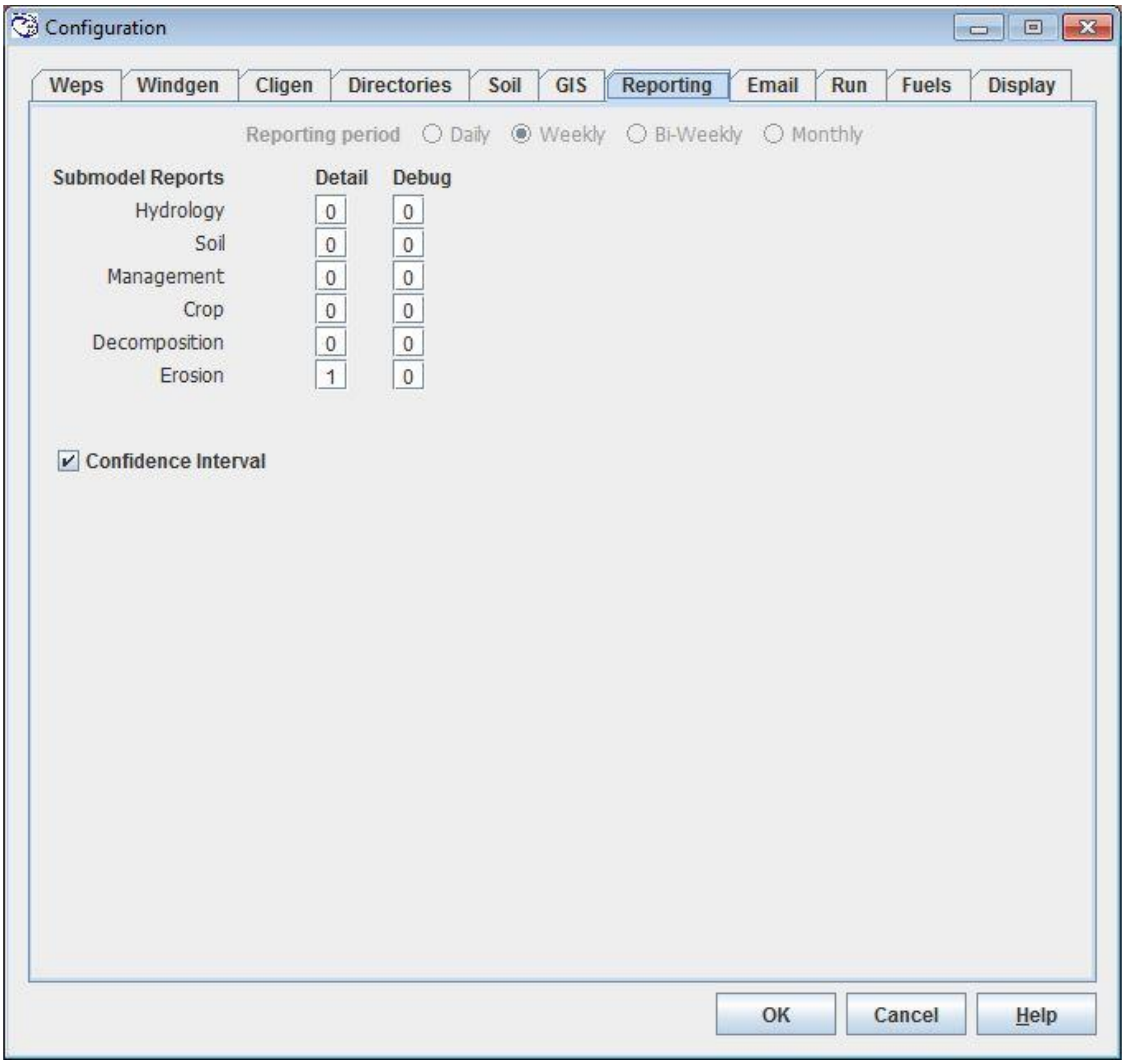


Figure 2-70 WEPS Configuration Panel displaying the Reporting tab.

Confidence Interval – Determines whether the WEPS interface Confidence Interval report is made available to users or not.

Configuration Panel – Email tab

The **Email** tab (Figure 2-71) allows the user to specify the necessary information for the built-in WEPS email client and the Mantis bug/comment reporting system.

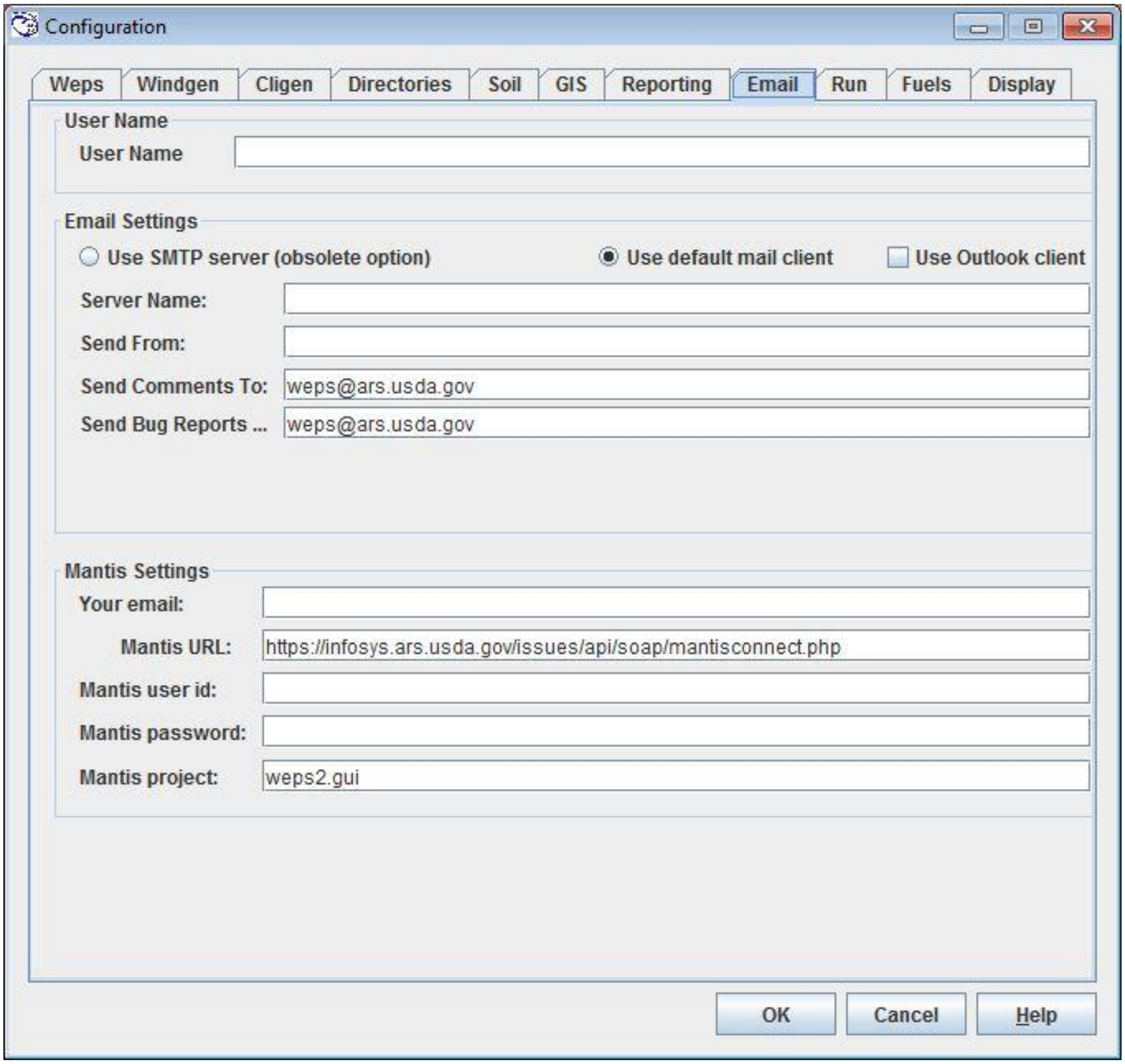


Figure 2-71 Configuration Panel displaying the Email tab.

User Name – Contains the user name. It is normally set from the WEPS Wizard that runs the first time a user executes the WEPS interface and requests their name and email address.

Email Settings

> **Use SMTP server (obsolete option)** – Selecting this option allows the user to use the SMTP server specified in the fields immediately below this option.

Use default mail client – Selecting this option allows the user to use their default email client, such as Thunderbird, for sending email messages from WEPS. Note that this setting does not work for all clients.

Use Outlook client – Selecting this option allows the user to use their Microsoft Outlook email client when sending email messages from WEPS. This is the preferred setting for NRCS users.

Server Name – The default name of the email server to use.

Send From – The default name of the individual sending the email message.

Send Comments To – The default email address for sending email comments regarding WEPS.

Send Bug Reports … - The default email address for sending email bug reports regarding WEPS.

Mantis Settings

Your email – The user's email address.

Mantis URL – The URL internet address for the WEPS Mantis ticket system.

Mantis user id – The Mantis user id (tickets are submitted anonymously from WEPS so it is not required to fill out this field). Note that the user can be identified and replied to if they complete the **User Name** and **Your email** fields above.

Mantis Password The Mantis user's password (since tickets are submitted anonymously, it is also not required to fill out this field).

Mantis project- The default Mantis project that submitted tickets are assigned to.

Configuration Panel – Run tab

The **Run** tab (Figure 2-72) allows the user to specify default required WEPS runtime configuration settings.

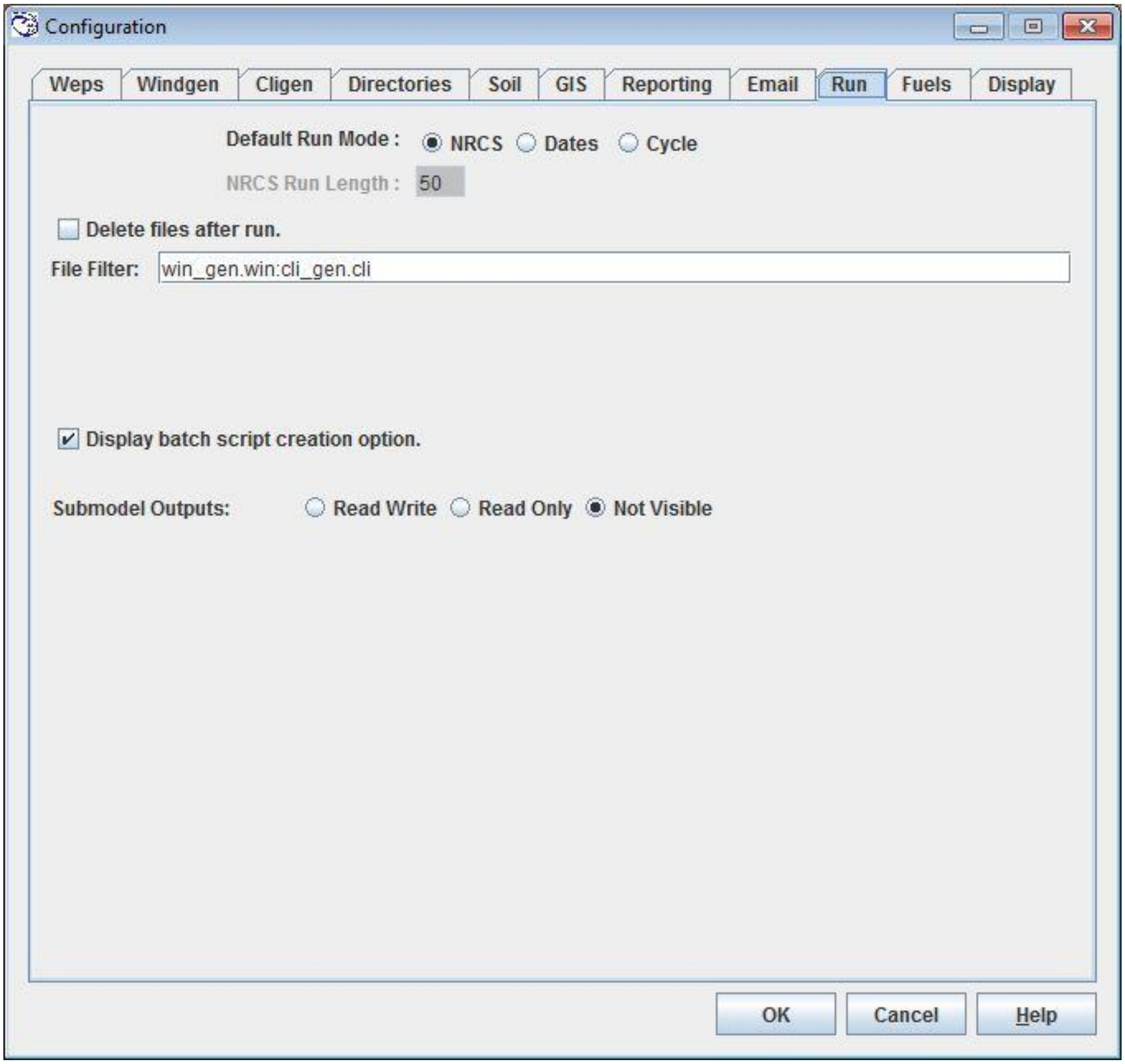


Figure 2-72 Configuration Panel displaying the Run tab.

Default Run Mode options are:

NRCS – This mode is specified for NRCS users. Note that if this mode is selected, the user cannot change the run mode from the WEPS interface screen nor change the number of cycles that are simulated in a WEPS Run.

Dates – This mode allows the user to set the beginning and ending dates for a simulation run. It is intended for advanced users and developers who may be wanting to compare real world field results with what WEPS is sumulating. Thus, it is generally used with real weather data rather than generated data. Note that the beginning date should be set to January 1 of the calendar year selected and the ending date being December 31 of the calendar year selected. Also, the user must be aware tha t the WEPS interface reports assume that the length of a management cycle divides evenly into the total simulation runtime length in years. If not, then those reports will likely be in error.

Cycle – The mode that ensures that the total WEPS simulation length gets set to a value that is evenly divisible by the length of the management rotation (rotation years). The number of "cycles" can be specified by the user on the main WEPS interface screen. Note that the NRCS mode is identical to **Cycle** mode, except the number of cycles is fixed and not allowed to be changed.

NRCS Run Length – The length of a WEPS simulation run in management rotation "cycles" for an NRCS mode WEPS run.

Delete files after run – If checked, delete the files listed in the **File Filter** field at the conclusion of a WEPS run.

File Filter – The list of files that are to be deleted if the **Delete files after run** option is enabled.

Display batch script creation option – Determines if the batch script option is presented at the start of a WEPS run.

Submodel Outputs – Specifies whether the submodel output options are presented to the user at the start of a WEPS run. The options are: Read Write, Read Only and Not Visible.

Configuration Panel – Fuels tab

The **Fuels** tab (Figure 2-73) allows the user to specify default related information in WEPS.

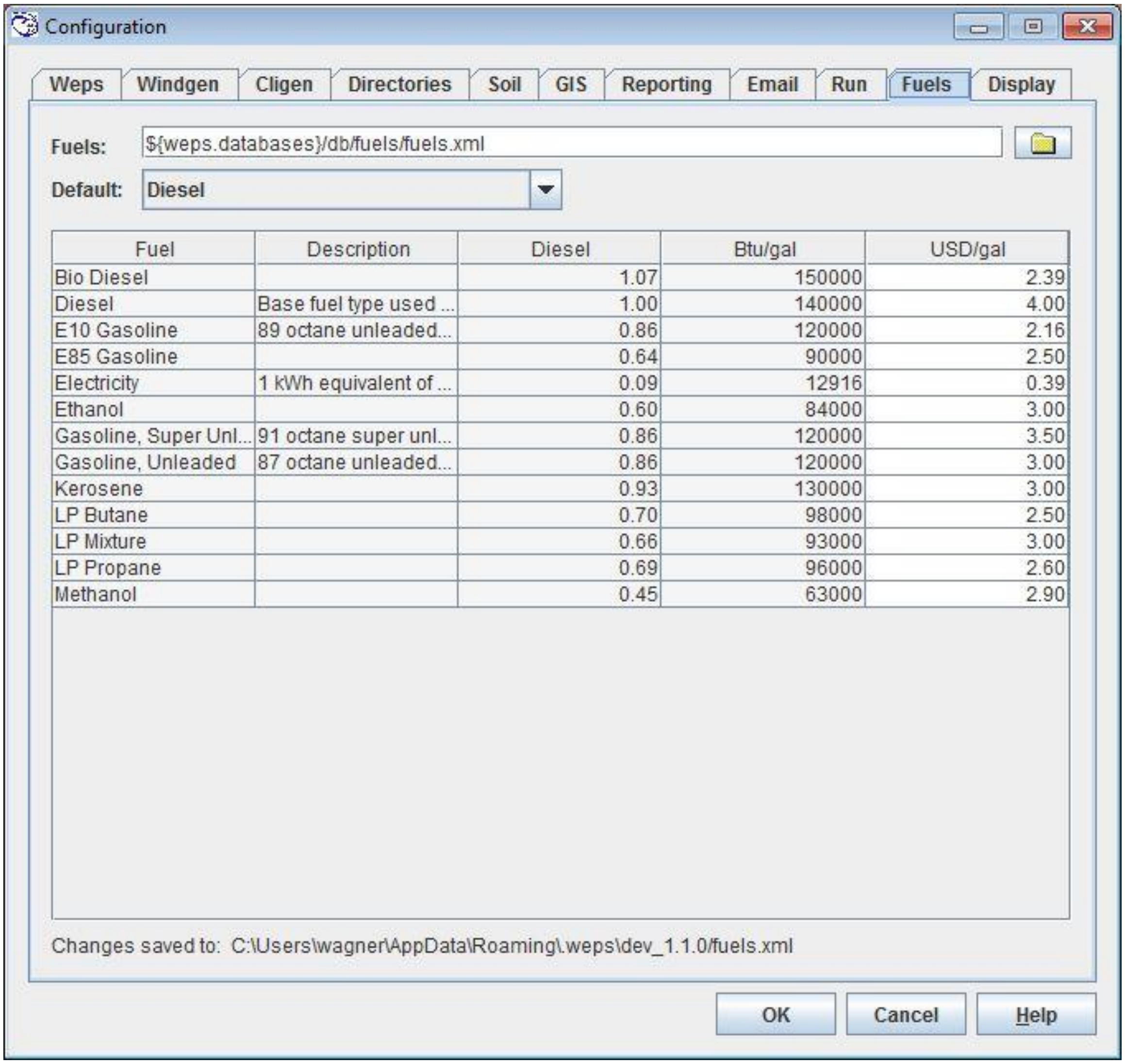


Figure 2-73 Configuration Panel displaying the Fuels tab.

Fuels - Sets the directory location and name for the fuel data file. The folder icon can be clicked on to display a file chooser to select an alternative location and file, if desired.

Default – The default fuel type to use for displaying operation fuel usage in WEPS.

Fuel Table – The fuel table consists of the following columns:

- **Column 1** – Fuel type.
- **Column 2** – Description of fuel type.
- **Column 3** – Diesel energy equivalent of fuel type.
- **Column 4** – Btu/gal for the specified fuel type.
- **Column 5** – USD/gal for the specified fuel type.

Configuration Panel - Display Tab

The **Display** tab is shown here (Figure 2-74). It consists of general configuration options for the WEPS interface.

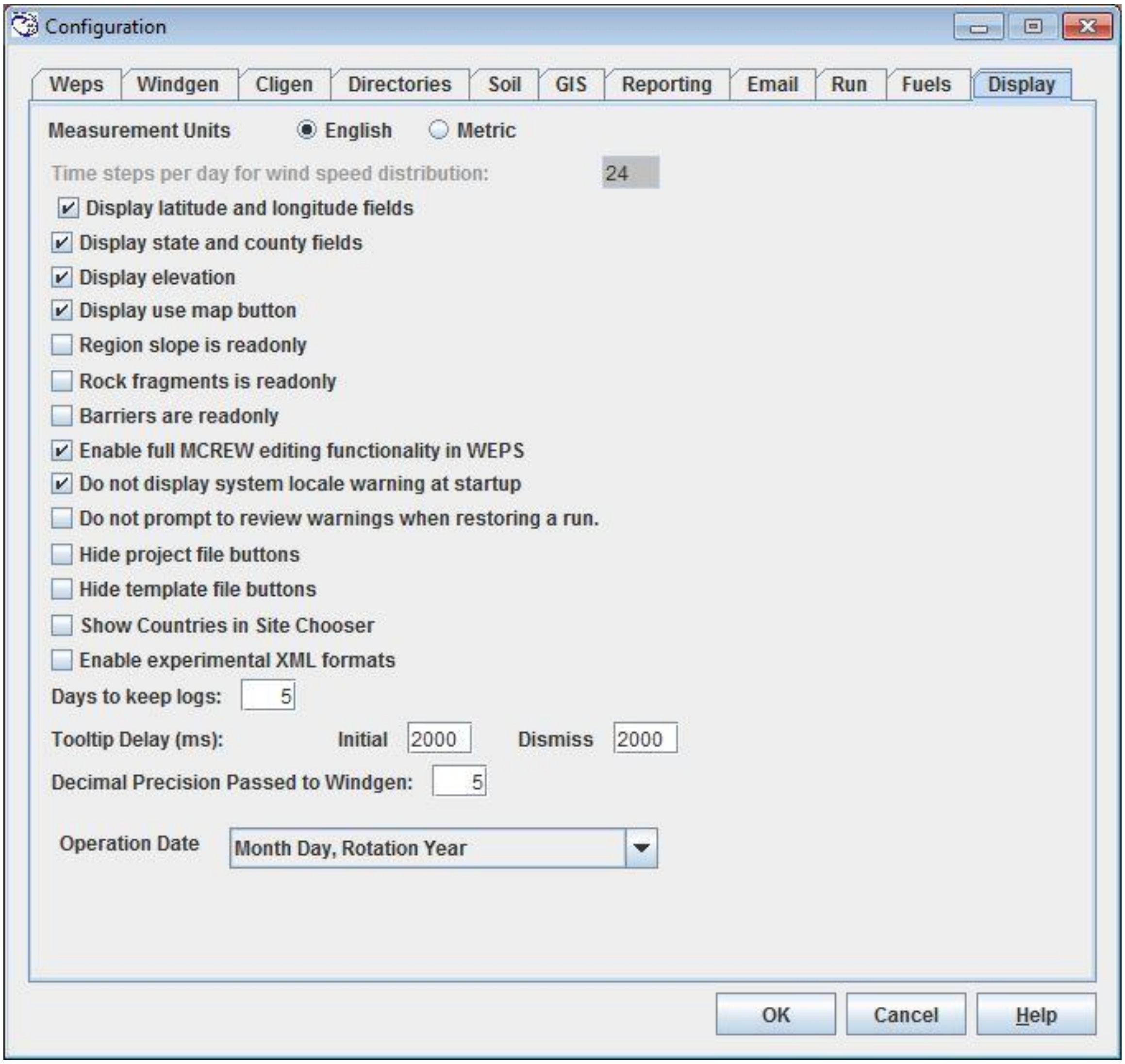


Figure 2-74 WEPS Configuration Panel displaying the Display tab.

Measurement Units - Display either Metric (SI) or English units on WEPS screens.

Time steps per day for wind speed distribution - Enter the number of time steps used for the daily distribution of simulated wind speed. It cannot be changed and should be greyed out.
Display latitude and longitude fields - Check box to display the latitude and longitude fields in the **Location Information** panel on the Main screen. Un-check the box to hide these fields.

Display state and county fields - Check box to display the state and county fields in the **Location Information** panel on the Main screen. Un-check the box to hide these fields.

Display elevation - Check box to display the elevation field in the **Location Information** panel on the Main screen. Un-check the box to hide this field.

Display use map button - Check box to display the **Use Map** button in the **Location Information** panel on the Main screen. Un-check the box to hide this button.

Region slope is read only - Check box to only display the simulation region slope field on the main WEPS interface screen and not allow it to be edited.

Rock fragments is read only - Check box to only display the rock fragments field on the main WEPS interface screen and not allow it to be edited.

Barriers are read only - Check box to only display the barriers information and not allow them to be edited.

Enable full MCREW editing functionality in WEPS - Check box to enable the full MCREW editing functionality in WEPS. Allows additional editing functionality of MCREW. Un-check the box to disable this functionality. When this functionality is disabled, the MCREW File **Open** and **Open Copy of Template** menu items are disabled.

Allow estimations in the Soil UI - Check box to enable the estimation of soil parameters in the WEPS Soil user interface (UI) when they are missing from the soil database.

Do not display system locale warning at startup - Check box to turn off the display of a warning when WEPS is installed in a non-US locale. To avoid problems, WEPS is always installed using the "US locale", regardless of the local PC settings. The following is an example of the warning message displayed if the box is not checked and WEPS is installed in a non-US locale.

> **WEPS has detected that this machine is using the German (Germany) locale. WEPS uses the English (United States) locale. You do not need to change your machine's locale, but be aware that numbers will be formatted in the English (United States) style.**
>
> - **For more info about what a "locale" is, see:**
> - **www.microsoft.com/globaldev/DrIntl/faqs/Locales.mspx**

Do not estimate missing soil values from SSURGO database - Check box to disable the estimation of soil parameters in the user interface when they are missing from the soil database.
Organic matter fraction minimum- enter the minimum fraction of organic matter in the soil surface
Do not prompt to review warnings when restoring a run - Check box to turn off warnings displayed from a previous WEPS Run when it is restored.

Hide project file buttons – Check box to turn off the Project  button displayed on the Man and Soil fields on the main WEPS screen.

Hide template file buttons – Check box to turn off the Template  button displayed on the Man and Soil fields on the main WEPS screen.

Show Countries in Site Chooser – Check box to turn on the **Country** field above the **State** and **County** fields on the main WEPS screen.

Enable experimental XML formats – Check box to turn on use of XML formatted files. This field should not be checked, if displayed for normal WEPS users.

Tooltip Delay - Sets the delay time for the initial appearance of the tooltip and for the dismissal of the tooltip box from the screen. The units are in milliseconds. To disable tooltip display, set the “Initial” value to 1000 (1 second) and the “Dismiss” value to zero.

Decimal Precision Passed to Windgen – Sets the number of digits right of the decimal to be passed for writing out the lat/lon values in the weps.run file and for use in the interpolation functions. This value should be set to 5 for WEPS releases 1.5 or greater. A value of 2 should be used if strict compatibility with WEPS version 1.3.9 is required.

Operation Date - Click the down arrow to the right of the box displays a list of available formats for the operation date. The format is displayed on this tab, next to “Operation Date” when a format is selected.

Search Radius- enter the search radius for the climate station choice lists (kilometers or miles, depending upon the “Measurement Units” setting). The user usually will want the nearest station to their simulation site. The user may want to select a different station more typical of the climate for the field being simulated if the nearest station doesn’t meet their criteria. An example of not selecting the closest station might occur in mountainous areas where the nearest station does not always typify the climate for the simulated field.

3 USING WEPS IN CONSERVATION PLANNING

3.1 Interpreting Outputs

Interpreting outputs of WEPS is an important part of controlling wind erosion through conservation planning. By observing how the soil loss is affected by weather and field conditions, the management operations can be adjusted to reduce soil loss. In developing new conservation plans, the user should build or modify several different scenarios and compare outputs to determine the best management to control wind erosion. Existing or current field conditions should be evaluated to determine if an erosion problem exists.

Tabular Detail Report

The Tabular Detail Report screen (Figure 3-1) is a date ordered list of parameters generated by the WEPS model. The Tabular Detail Report can be accessed by clicking the Tablular Detail Report button on the Main or Run Summary screens as well as through the ViewOutput menu. At the top of the Tabular Detail Report window is a button bar that allows the user to close the window Close , print the data , or view other summary reports via the toolbar buttons.

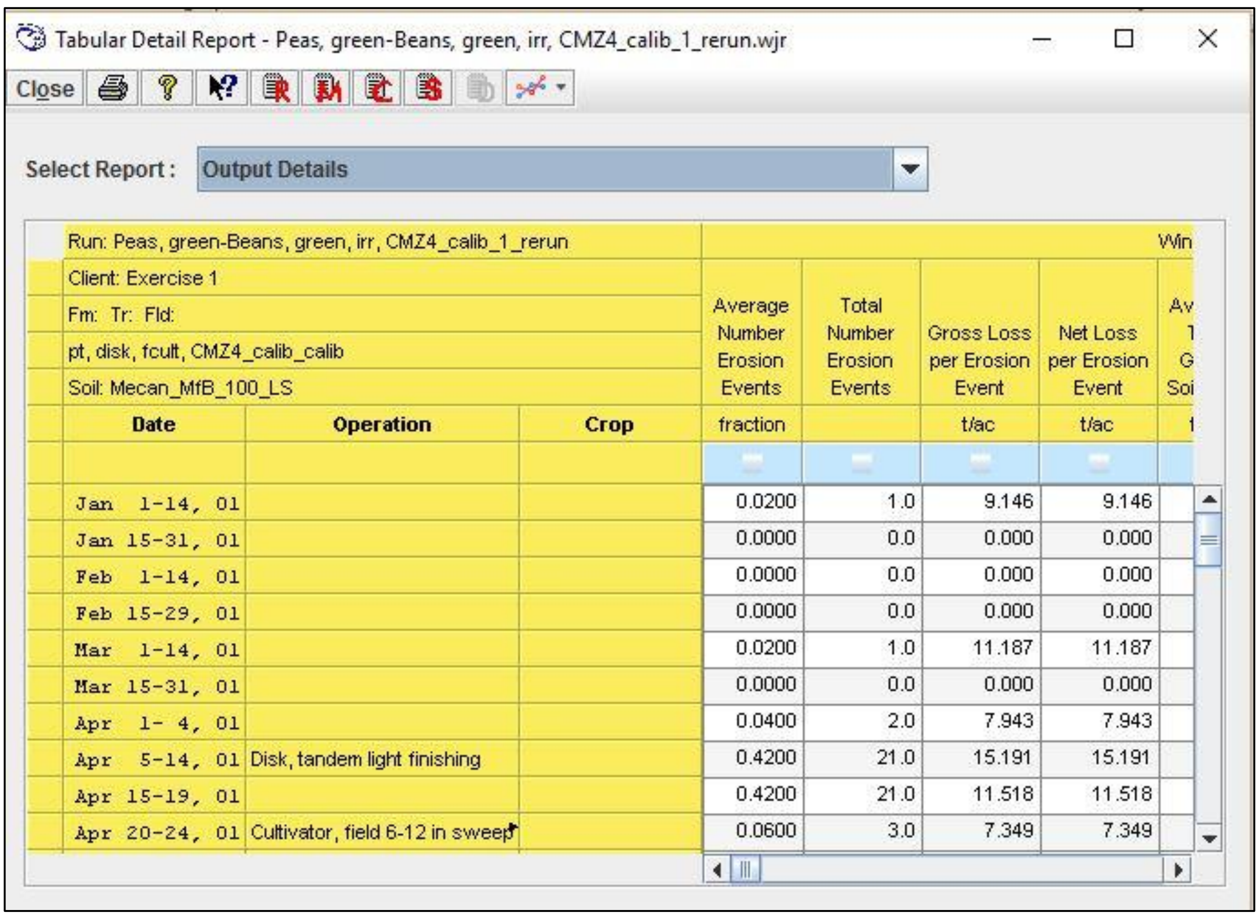


Figure 3-1 Tabular Detail Report window.

Since this report contains large amounts of information, a method is provided to select smaller portions of information to view. Below the menu bar is a drop down list labeled Select Report.

Clicking the down arrow  to the right displays a list of reports that are subsets of all data available. This allows the user to pick a smaller, easier to view, subset of the complete report. The **Output Details** is the most comprehensive report and is displayed by default for most WEPS configurations. Note that the NRCS configured version of WEPS defaults to the **Erosion & Crop Veg, Res & Biomass (details)** report.

The following section outlines the content of the Output Details portion of the Detail Reports screen and describes how they can be used to interpret results and design management systems to control erosion by wind. The WEPS User Guide section titled “Interface Reference: Output” contains the definition of each row and column in the Tabular Detail report.

Date

This column contains the start and end date of the period for which the row information is reported (start day-end day, month, rotation year). Items in each row represent values from the end of the previous period to the current date (unless the parameter only makes sense for a specific date, then it represents the value on the ending date). The date column, along with soil loss, will indicate which periods have the greatest wind erosion and are thus in need of changes of management to control wind erosion.

The number of **rows** in the Output Details screen differ, depending on the number of cropping years in the rotation and the number of management operations in each year of the rotation. Each year of the rotation has regular output displayed for either fifteen day periods (1^{st} of month to 14^{th} and 15^{th} to the end of the month) or from the date of an operation to the end of the regular period. Occasional reporting from the date of a management operation are reported since operations can change field conditions. This output allows the user to view the erosion and other output for each year of the rotation. At the end of each year in the rotation is a row that contains the average annual value for that rotation year. The last row in the output form contains the average annual values for the complete crop rotation.

Operation

This column contains the management operation that occurred on the specified date (start date of the listed period). It is the management operation or the date of operation that most users will modify to affect field conditions and thus wind erosion.

Crop

This column lists the name of the crop planted on the date shown (start date of the listed period). Crop is another choice the land manager may change to control wind erosion. Crops that produce substantial residue (e.g., corn or small grain) will tend to lower the erosion rate if the residue is managed properly.

Wind Erosion

The Wind Erosion columns provide a summary of all the wind erosion soil loss for the simulation run. The numbers in these columns are those that the user will try to affect by adjusting management dates and operations. If an erosion event occurred, but values generated by the model are too small to be displayed on the output table (i.e., < 0.001 kg/m^2 or 0.00455 tons/acre), then the amount is listed as " trace". If amounts are too large to be accurately displayed then, the amount is listed simply as greater than a specified amount (i.e., > 300 kg/m^2 or 1338 tons/acre). In these cases, erosion amounts are so large that they are generally considered unacceptable. The simulated absolute values are usually not relevant in such scenarios anyway (the model's accuracy is also questionable at these high erosion rates because they are outside the erosion levels the model has been validated against).

Number and Loss per Erosion Event

These columns give the user an indication of the frequency and severity of erosion events. Some periods will have numerous events while others may have one, or even none. One event may have severe erosion while many others may have only slight erosion totaling less erosion than another single event.

Average Total Gross Soil Loss

This column contain the gross erosion within the field, averaged across the field, as well as averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre).

Net Soil Loss from Field

These columns contain net soil loss from the field averaged over the number of simulation years in each rotation year (kg/m^2 or tons/acre). Some deposition within a field can occur, especially when barriers are present downwind. Net soil loss is the amount of gross loss minus deposition. **Average Total** is the average total net loss from the field, **Average Creep and Saltation** is the average creep plus saltation net loss from the field, **Average Suspension** is the average suspension net loss from the field, and **Average PM10** is the average PM10 (particulate matter less than 10 microns) net loss from the field.

Mass Passing Indicated Field Boundary

These columns  contain the mass per unit length of various-sized material that passed the field boundary for each direction (kg/m or tons/1000 ft). This information is useful in determining how much material is leaving the field in each direction. For the **Creep+Saltation** size, the material will most likely be deposited on the field boundary, such as a stream, fence, ditch, or road. If deposited in a ditch, subsequent rainfall may wash the material into waterways, where it can affect water quality. If deposited on a roadway, the roadway will likely need to be cleared. For **Suspension** and **PM10** sizes, the material may travel great distances, affecting air quality and possibly visibility, especially on nearby roadways. The material passing each boundary may indicate that barriers may be needed on the opposite or upwind side of the field to control wind erosion. The direction of soil loss may also indicate a needed change in the direction of tillage.

Within Field Wind Erosion Activity

The information in these columns is useful in determining how much of the field is actively eroding and how much is not, which may impact what control measures, if any, should be applied and where. This information is also useful in understanding to what extent the field is actively eroding and thus causing plant or soil damage, or how much is subject to burial. Finally, this information is useful in understanding how much of the field is contributing to overall (net) field loss. Acres indicate the size of the eroding area and the fraction is the proportion of the field eroding.

Weather Information
The Weather columns provide a summary of some of the weather information for the simulation run and help the user understand which periods are erosive and why.

Average Total Precip.
This column contains the total precipitation for the period, averaged over the simulation years in each year of the crop rotation (mm or inches). This section is useful in determining how precipitation amounts may be affecting biomass production as well as residue and surface roughness decay.

Average Wind Energy > 8m/s (18 miles/hour)
This column contains the average daily wind energy for the period for winds greater than 8 m/s (~18 mph), averaged over the simulation years in each year of the crop rotation (KJ/day). This will indicate which periods have the most erosive winds.

Snow Depth > 20 mm (~0.75 in)
Fractions of the field covered with snow greater than 20 mm (~0.75 in) deep are considered non-erodible.

Crop and Soil Water Information
The Crop and Soil Water columns provide a summary of important crop and soil water data for the simulation and help the user understand the amount of water available during specific periods and where it is going (crop growth, storage, runoff, etc.).

Irrigation
This column provides the amount of irrigation water applied during the specified period in mm or inches.

Runoff and Drainage
These columns provide the amounts of water lost due to surface runoff and drainage for the specified period in mm or inches. Reducing these losses usually will result in higher yields and biomass crop production, which tends to reduce a field's susceptibility to wind erosion if managed correctly.

Soil Water
This column provides the amount water stored in the soil at the end of the specified period in mm or inches. The amount of stored water available during the crop growing season affects a crop's susceptibility to droughty conditions.

Soil Surface Evaporation
This column provides the amount of water lost to evaporation for the specified period in mm or inches. Reducing the amount of surface evaporation, for example with additional residue retained on the surface, will usually mean more water for the crop and thus, indirectly reduce wind erosion susceptibility.

Plant Transpiration
This column provides the amount of water that has transpired in the growing crop for the specified period in mm or inches.

Average Biomass Surface Conditions on Date
The Average Surface Biomass Conditions on Date columns provide a summary of average surface conditions, including crop biomass and soil roughness, for the simulation run on the ending date of the period.

Crop Vegetation (Live)
These columns provide information on the structural configuration of live growing biomass. By observing the canopy cover, the standing silhouette area index, and the above-ground mass, the user can determine which periods are not providing sufficient cover to control wind erosion.

Crop Residue (Dead)
These columns provide information on the structural configuration of dead biomass or residue. By observing the flat cover, the standing silhouette area index, the flat mass, and the standing mass, the user can determine which periods are not providing sufficient residue cover to control wind erosion.

Live and Dead Biomass
These columns provide information on the structural configuration of both the live growing biomass and the dead biomass or residue. By observing the flat cover, the standing silhouette area index, the flat mass, and the standing mass, the user can determine which periods are not providing sufficient cover to control wind erosion.

Average Soil Surface Conditions on Date
The Average Soil Surface Conditions on Date columns provide a summary of average soil surface conditions for the simulation run on the ending date of the period.

Roughness
For cropping systems that do not produce sufficient residue for erosion control (e.g., cotton and most vegetable crops), roughness management is often used to reduce wind surface friction velocity at the soil surface. This reduces the amount of soil detachment and transport and increases deposition and thus reduces soil loss.

Oriented Roughness
Oriented roughness is also known as ridge roughness. These columns refer to regularly spaced roughness elements caused by tillage implements such as ridges, furrows and dikes. Ridge orientation, width, and height may be adjusted for periods of high soil loss to determine its effect on wind erosion. The user can also follow the roughness decay over time as a result of rainfall or wind erosion.

Random Roughness
This column contains soil surface random roughness, defined as the standard deviation of the elevation from a plane across a tilled area. Random roughness does not take into account oriented

roughness. Random roughness is the value at the period end, averaged over the simulation years in each rotation year (inches or mm). Random roughness is primarily the result of aggregate size distribution, but is also affected by various types of tillage tools. Random roughness values for typical field operations are listed in Table 3.1. Photographs (Figure 3-2 through Figure 3-10) can be used as a guide to determine relative random roughness values. These photos were taken at an oblique angle to provide an image similar to that seen by an observer standing a few feet from the plot.

Aggregation

Soil aggregate size and aggregate dry stability affect erosion by wind. Soil aggregates less than 0.84 mm (0.03 inches) in diameter are generally considered to be erodible and so the higher the fraction of aggregates < 0.84mm, the more erodible the surface. Dry stability is related to abrasion resistance where harder, more stable aggregates result in a lower erodibility of the soil. The larger the dry stability value ($\ln(J/m^2)$), the more resistant the aggregates to abrasion and erosion by wind.

Crust Cover

A soil crust will resist abrasion and erosion more than a loose, finely divided soil surface. In general, the more of the surface is covered by a crust, the less erosion occurs. Crusts are transient and generally represent a degraded soil quality, and therefore, crusts should not be relied upon to control erosion by wind. But a greater crust cover may explain a lesser erosion amount that would normally be expected.

Table 3.1 Random roughness values for typical management operations, based on a silt loam soil (from USDA Agriculture Handbook 537 and National Agronomy Manual 703, Tab 5-5).

Field Operation	Random Roughness (inches)	Field Operation	Random Roughness (inches)
Chisel, sweeps	1.2	Fertilizer applicator, anhydrous knife	0.6
Chisel, straight point	1.5	Harrow, spike	0.4
Chisel, twisted shovels	1.9	Harrow, tine	0.4
Cultivator, field	0.7	Lister	0.8
Cultivator, row	0.7	Manure injector	1.5
Cultivator, ridge till	0.7	Moldboard plow	1.9
Disk, 1-way	1.2	Mulch threader	0.4
Disk, heavy plowing	1.9	Planter, no-till	0.4
Disk, Tandem	0.8	Planter, row	0.4
Drill, double disk	0.4	Rodweeder	0.4
Drill, deep furrow	0.5	Rotary hoe	0.4
Drill, no-till	0.4	Vee ripper	1.2
Drill, no-till into sod	0.3		

Figure 3-2 Random roughness of 0.25 inches (6mm).

Figure 3-3 Random roughness of 0.40 inches (10 mm).

Figure 3-4 Random roughness of 0.65 inches (17 mm).

Figure 3-5 Random roughness of 0.75 inches (19 mm).

Figure 3-6 Random roughness of 0.85 inches (22 mm).

Figure 3-7 Random roughness of 1.05 inches (27 mm).

Figure 3-8 Random roughness of 1.60 inches (41 mm).

Figure 3-9 Random roughness of 1.70 inches (43 mm).

Figure 3-10 Random roughness of 2.15 inches (55 mm).

3.2 Special Field Configurations

Although WEPS 1.3.9 is designed to simulate rectangular field shapes, special field configurations such as circles or strip cropping can be simulated. By manipulating the field shape to represent a field with the same area and rotating the field along, with any barriers, many field shapes can be approximated.

Circular Fields

A circular field can be simulated by selecting a field shape **Circle** in the Simulation Region Information panel. Note that the circle is approximated within WEPS as a square field with an area equal to that specified in the Simulation Region Information panel. The Field View panel displays an approximate inscribed circle within the simulated rectangular field (Figure 3-11). When a circular field is selected, the field described in the Simulation Region Information panel has an area equal to that of the simulated rectangular field. For such fields, barriers should be added and the field rotated to best approximate the actual field configuration.

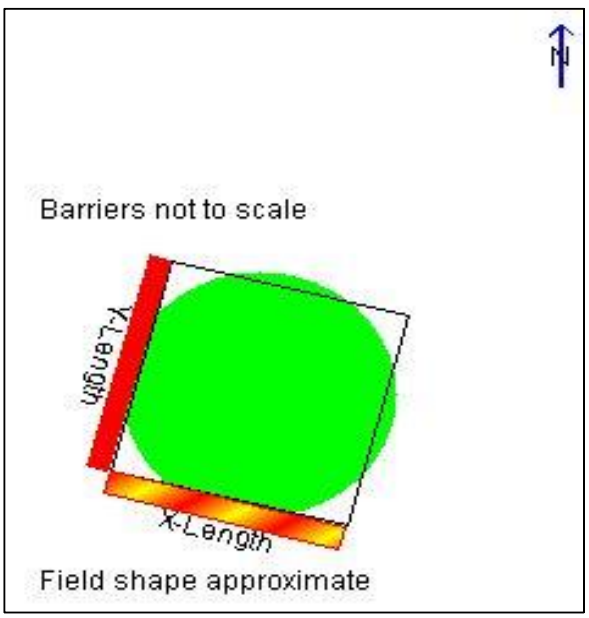


Figure 3-11 Example of the Field View panel for a circular field.

Irregular Field Shapes

Half circles can also be simulated by selecting **Half Circle** in the Simulation Region Information panel. A half circle is approximated within WEPS as a rectangular field with an area equal to that specified in the Simulation Region Information panel. The Field View panel displays an approximate inscribed half circle within the simulated rectangular field (Figure 3-12). To simulate an irregular field shape such as a field along a stream, select the shape in Simulation Region Information panel that most represents the shape of the actual field with the same area.

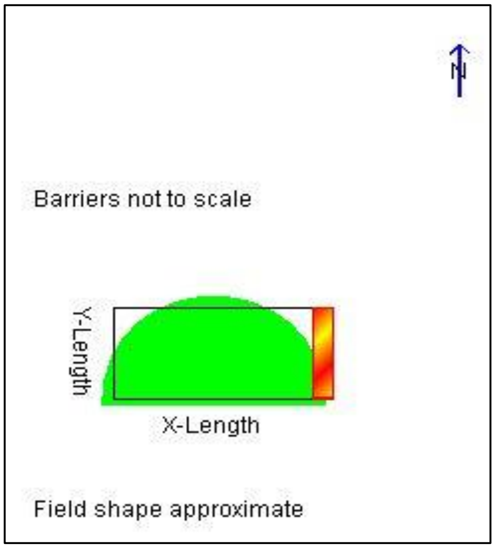


Figure 3-12 Example of the Field View panel for a half circle field.

Strip Cropping

Fields managed for wind erosion control by strip cropping in WEPS 1.5 are simulated as linear strips, with each strip of unique management as an individual rectangular field and the erosion losses for each unique strip multiplied by the number of those strips (for suspension and PM10 loss only). A tract of land where strips are installed ideally will have strips with the long side perpendicular to prevailing winds. They will also be of equal width across the field, thus allowing for the shortest width of the field against the most erosive winds. The field will usually be resized down to the strip width that a producer agrees with and accommodates the width(s) of his equipment. Multiple simulations can be run to demonstrate the effect of different strip widths for evaluation purposes. We can change the strip width and length by just typing in the field dimensions. See the Interface Reference section “How To Guide: Barriers” for more details on adding and modifying field barriers. Figure 3-13 illustrates a field layout for simulating strip cropping with grass barriers.

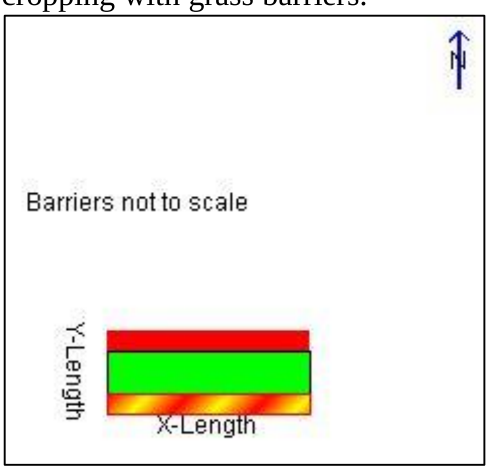


Figure 3-13 Example of the Field View panel for simulating strip cropping with grass barriers.

Tillage Direction. WEPS 1.5 only allows tillage in one direction, typically parallel to the field border (e.g., Northwest/Southeast for a field oriented in that direction). Observing the effects that tillage direction may have for a particular simulation may illustrate the need to alter tillage directions in the actual field to control wind erosion. Multiple tillage directions for an individual field, such as the operator tilling parallel to each border of the field in a spiraling pattern, or a circular tillage pattern on circular fields, cannot be directly simulated with WEPS 1.5. However, wind erosion on fields with tillage parallel to each border can be estimated by averaging outputs from two runs. Each run should be made with tillage direction perpendicular to each other and the results averaged.

3.3 Using Barriers for Erosion Control in WEPS

Using WEPS, we can quickly determine the field edge where the greatest amount of eroded soil is leaving the field. In most cases, a field windbreak would be most effective on the upwind side of this field.

Wind barriers in WEPS include any structure designed to reduce the wind speed on the downwind side of the barrier. Barriers trap moving soil and reduce abrasion of the downwind immobile clods, crusts, and residues along the prevailing wind erosion direction. Barriers include, but are not limited to, linear plantings of single or multiple rows of trees, shrubs, or grasses established for wind erosion control, crop protection, and snow management. Snow fences, board walls, bamboo and willow fences, earthen banks, hand-inserted straw rows, and rock walls have also been used as barriers for wind erosion control in limited situations. Barriers also reduce evapotranspiration, shelter livestock, and provide wildlife habitat. One advantage of barriers over most other types of wind erosion control is they are relatively permanent. During drought years, barriers (excepting annual types) may be the only effective and persistent control measure on crop land. Annual barriers such as small grain or corn are used primarily to provide temporary protection during the most critical wind erosion period and can be removed and replaced every year. Barriers can also be used in sand dune areas to aid the initial stabilization of the areas while grass and trees are being established.

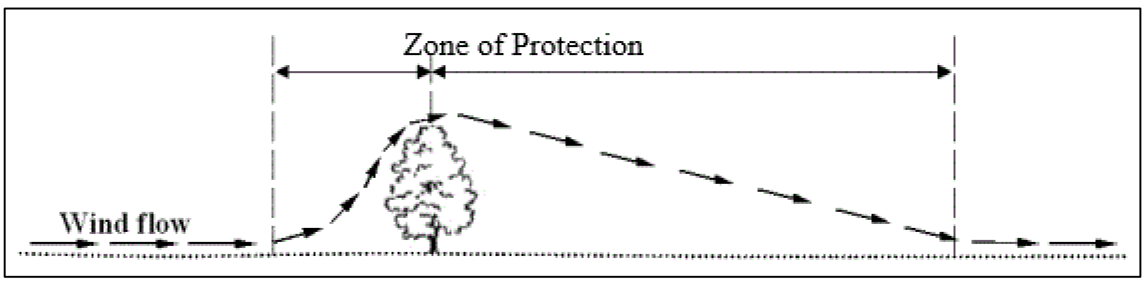


Figure 3-14 Diagram showing wind flow pattern over a barrier.

Barriers primarily alter the effect of the wind force on the soil surface by reducing wind speed on the downwind side of the barrier but also reduce wind speed to a lesser extent upwind of the barrier (Figure 3-14). Research has shown that barriers significantly reduce wind speed downwind, sheltering a portion of the field from erosion and, in effect, reducing the field length along the erosive wind direction. The protected zone of any barrier diminishes as porosity increases however, and is reduced significantly when barrier porosity exceeds 60 percent. Protection is also reduced as wind velocity increases, but the protected area diminishes as the wind direction deviates from the perpendicular to the barrier. Various types of barriers are used for wind erosion control in WEPS 1.5. The WEPS interface provides a method of selecting from a list of barriers to place on the field and editing the barrier properties. The user can also modify properties in the barrier database that appear in the drop-down list. Each of these properties are described here.

The length of a barrier is defined by field length along the border on which the barrier is placed.

Width The width of a barrier is defined as the distance from one side of the barrier to the other, in the units of measure displayed on the screen (feet or meters) (Figure 3-15). For a single-row wind barrier, the width is equal to the diameter of the tree, shrub, or grass; for artificial barriers, it is the thickness of the material (e.g. slat fence). This is illustrated as “a” in Figure 3-15. For multiple-row barriers, the width is the distance from one side of the barrier to the other as illustrated by “b” in Figure 3-15.

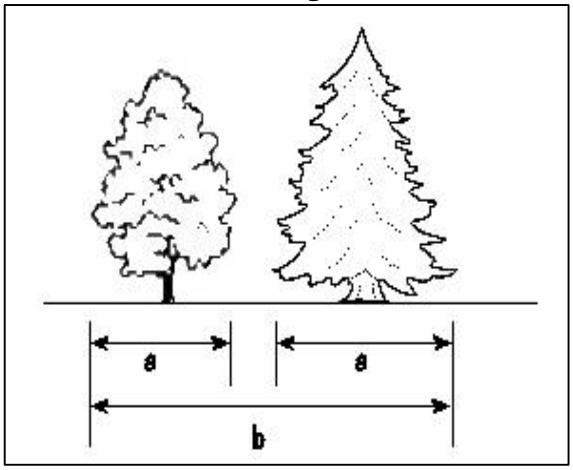


Figure 3-15 Barrier width for single (a) and multiple (b) row barriers.

Height The height of a barrier is the average height of individual elements (e.g., trees) in the barrier (“a” in Figure 3-16 for single-row barriers). The units of measure for barrier height are displayed on the input screen in feet or meters. For multiple-row barriers, use the height of the tallest barrier row (“b” in Figure 3-16).

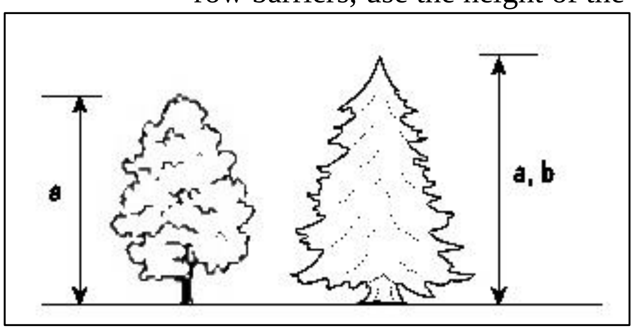


Figure 3-16 Barrier height for single (a) and multiple (b) row barriers.

Area The area of the barrier is calculated from the barrier width and length (i.e., barrier width x field length). This is not an editable item, but is calculated within WEPS 1.5.

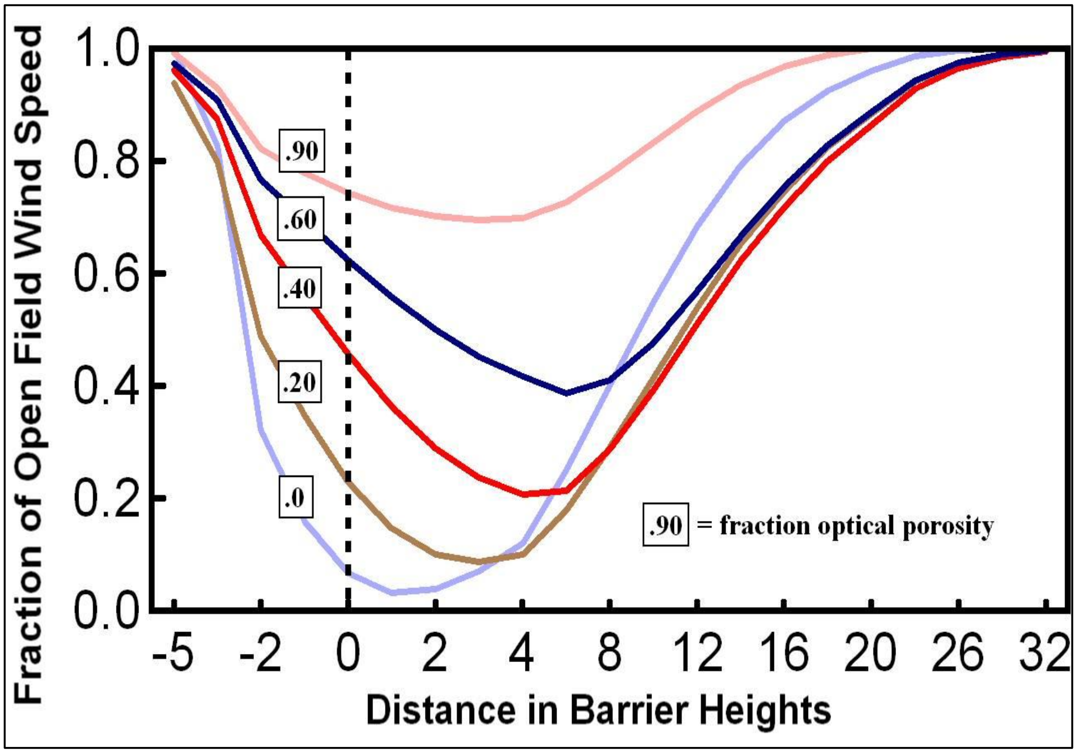


Figure 3-17 Effect of the fraction of optical porosity on near-surface wind speed along the wind direction relative to barrier.

Porosity Barrier porosity is defined as the total optical porosity of all rows in the barrier. It is the open space (i.e., absence of leaves and stems) as viewed looking perpendicular to the barrier, expressed as a percentage of the total area, i.e., (1.0 - silhouette area) x 100. WEPS 1.5 does not "grow" living barriers. Barriers in WEPS do not increase or decrease porosity with leaf growth and leaf drop (senescence) throughout the year, nor do they increase in size from one year to the next. As such, the porosity of barriers in WEPS does not change with the seasons nor from year to year. Therefore the user should input the porosity of the barrier that is present when the erosion hazard is the greatest. Figure 3-17 illustrates the effect of porosity on the near-surface wind speed relative to an open field without a barrier (see also Figure 3-14). The "Distance in Barrier Heights" refers to the distance from the barrier at distance 0, measured in multiples of the barrier height.

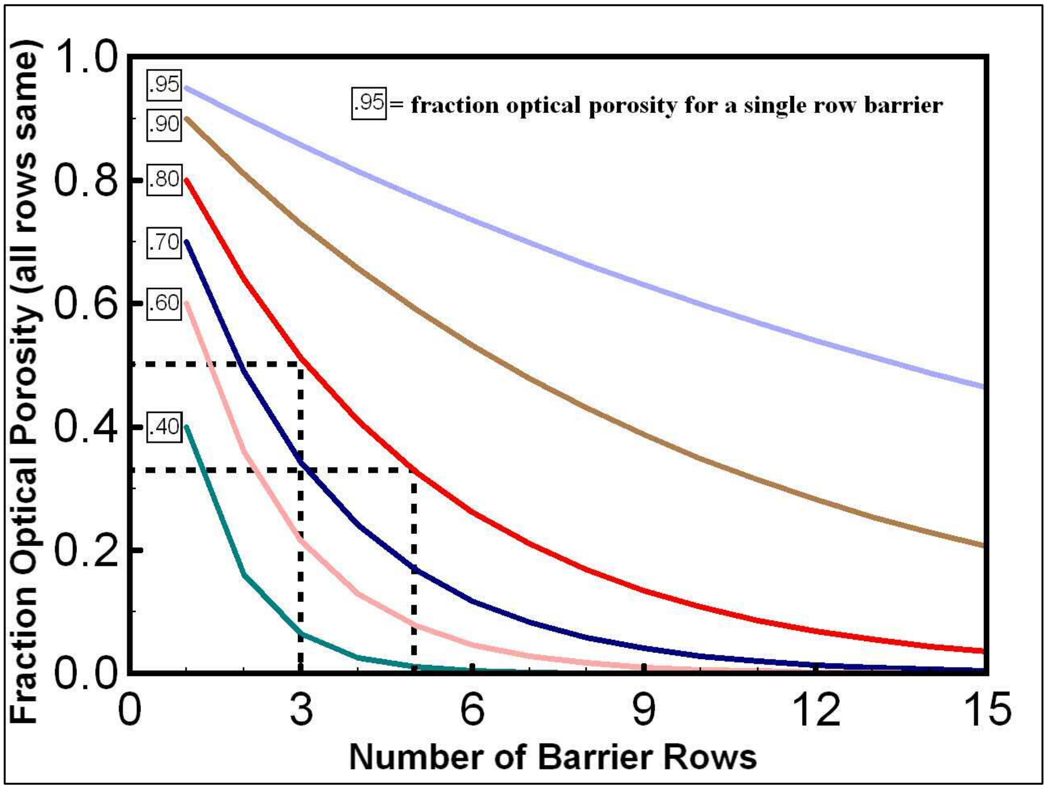


Figure 3-18 Effect of number of barrier rows on optical porosity where all barrier rows are the same.

At times, it is most efficient to estimate optical porosity for a single row, particularly for crop barriers. Then, for multiple-row barriers, the optical porosity decreases for the entire barrier as illustrated in Figure 3-18. For example, a single row of corn has an optical porosity of 0.80. Three rows of corn have an optical porosity of 0.50, and five rows of corn have an optical porosity of 0.33.

Exercises

Introduction - Evaluating Wind Erosion Problems with WEPS

These exercises are designed to provide the user with step-by-step examples of some common tasks performed with the Wind Erosion Prediction System (WEPS) model. These exercises cover many topics, including basic model operation, file management, and building and editing field management rotations within the Management/Crop Rotation Editor of WEPS (MCREW). The focus of the exercises should be on learning to use WEPS for conservation planning.

The training scenarios use a variety of locations in the United States, as well as various crops, with the intention of building the users' proficiency to apply WEPS in many regions for different crops. Therefore, new users are encouraged to complete all the exercises regardless of location and crop in the scenario. Since WEPS is continually being improved and its parameters modified, the results you get may not exactly match those reported in the exercises. This is to be expected.

As the WEPS model finishes a given run, it may sometimes display a **warning message** that one or more of the crops simulated did not reach maturity prior to harvest (Figure 3-19). This is not uncommon, especially for crops that are harvested before reaching maturity such as forage crops. However, this can also often occur if the user has selected a management template developed for a significantly different climatic zone than the location it is being used in. Since WEPS after harvest residue results are dependent upon crop yields, which often influence the wind erosion simulation results, it provides a quick check for the user that has not properly vetted his management rotation file for the conditions and location he is using it in.

If such a message is obtained, click "OK" to complete the run. If most of the year's crops reach about 95% maturity the run is OK to use. However, if many of the years are reporting crops with a value less than 95%, check to make sure planting and harvesting dates for the crop are as expected for the location being simulated. If it still does not reach 95%, NRCS users contact the Natural Resources Conservation Service (NRCS) Database Manager or NRCS Wind Erosion Specialist. All other users should submit a Mantis ticket with a copy of the WEPS Run attached and a note about what the issue is. The user should always attempt to resolve such maturity issues for crops that are harvested prior to reaching maturity, if those crops are normally expected to reach maturity prior to harvest.

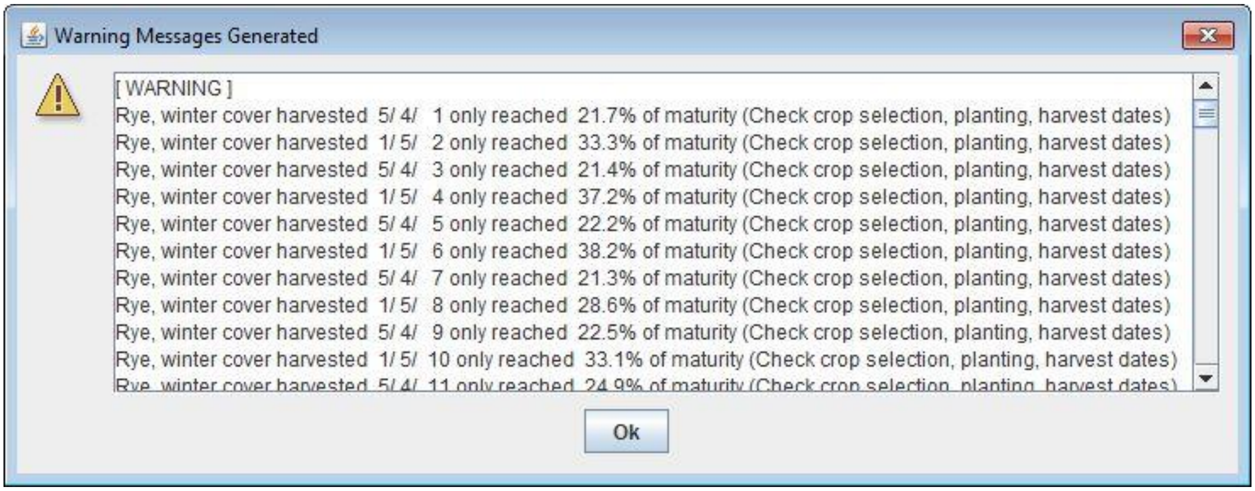


Figure 3-19 WEPS Warning Messages Generated window displaying warning messages about crop not reaching maturity.

Definitions and Considerations

Projects and Runs

A **WEPS Project** is a directory that can be thought of as a working area where WEPS simulation runs are created. The standard location for the Project.wpj is *C:\Users\user.name\Documents\My WEPS Files\Project.wpj*, where *user.name* refers to the user's login name on the computer. This default location applies to NRCS Field Office configured versions of WEPS running Windows 7. Other WEPS configurations and operating systems may vary as to the location of this directory. The Project directory stores all the parameters and files for the current simulation run being prepared within the WEPS interface, as well as any files used in the past for previous runs. For example, the Project will contain soils *.ifc* files and management *.man* files. The users should make it a habit to "clean out" those files when they are no longer needed. This is done by clicking the File menu on the main interface and selecting the appropriate delete functions.

A **WEPS Run** refers to a single simulation of a field with all associated input and output files. Each run is stored in a separate folder or subdirectory which by default is located under the current WEPS run directory. It is located at *C:\\user.name\Documents\My WEPS Files\Runs*. Again, this default location applies to NRCS Field Office configured versions of WEPS running Microsoft Windows 7. Other WEPS configurations and operating systems may vary as to the location of this directory. A WEPS run subdirectory stores a copy of all input files used to make the simulation run, together with the output files generated from those inputs. Thus, one is able to recall the identical WEPS run at a later date (and get the same outputs when using the same version of WEPS 1.5 and the weather generators/databases) because the original input files are still available. Typically, "re-running" a previous run is not necessary since the outputs are stored in the Run directory and can be reviewed via the "ViewOutput" menu options. However, if additional outputs not generated with the original run are desired, it will be necessary to load the previous run and re-run it using the desired output options.

The Run directories make it relatively easy to archive or remove WEPS runs as alternative erosion planning scenarios are tested for a field or farm. For example, if a change is made to create a different management alternative, all the information pertaining to this new scenario will be saved to a new subdirectory under a new WEPS Run name, when the simulation is made. These Run directory files can also be sent to another location using the “Export Run” option under the “File” or “Project” menu on the main interface.

Naming WEPS Files

Naming of all runs and files in WEPS should be considered carefully. Management or run names should be long enough to uniquely describe them but not so long so that the name is difficult to view in file chooser windows. Some special characters are not allowed in file or directory names used in WEPS. Known characters not allowed or recommended include: @ ? ‘ ` & ~ / \ < > | : * ”

WEPS Templates

A **Template** is a pre-built management rotation file operation file or crop file. Management templates are accessible through the Management Template folder. For NRCS configured versions of WEPS running Microsoft Windows 7, they are located here:

C:\Program Data\USDA\WEPS\Databases\nrcs\man

Other WEPS configurations and operating systems may vary as to the location of this directory.

User-made Management templates are accessible through the Management Template folder. For NRCS configured versions of WEPS running Microsoft Windows 7, they are located here:

C:\Program Data\USDA\WEPS\Databases\nrcs\man\local

Other WEPS configurations and operating systems may vary as to the location of this directory.

User-made Crop templates are accessible through the Crop Template folder. For NRCS configured versions of WEPS running Microsoft Windows 7, they are located here:

C:\Program Data\USDA\WEPS\Databases\nrcs\crops\local

Other WEPS configurations and operating systems may vary as to the location of this directory.

User-made Operation templates are accessible through the Operation Template folder. For NRCS configured versions of WEPS running Microsoft Windows 7, they are located here:

C:\Program Data\USDA\WEPS\Databases\nrcs\operations\local

Other WEPS configurations and operating systems may vary as to the location of this directory.

These can be crops, operations or managements saved locally by users with a Biomass Adjustment Factor determined for their location and climatic conditions. It is very helpful to save a calibrated local management file to a place where all users in a work group can have access to it. The location for the local management files can be moved to a shared server location by selecting “Edit Configuration” option under the “Tools” menu on the main WEPS screen, then selecting the “Directories” tab and editing the appropriate field titled: “Management Template Open” and “Management Template Save” (Figure 3-20).

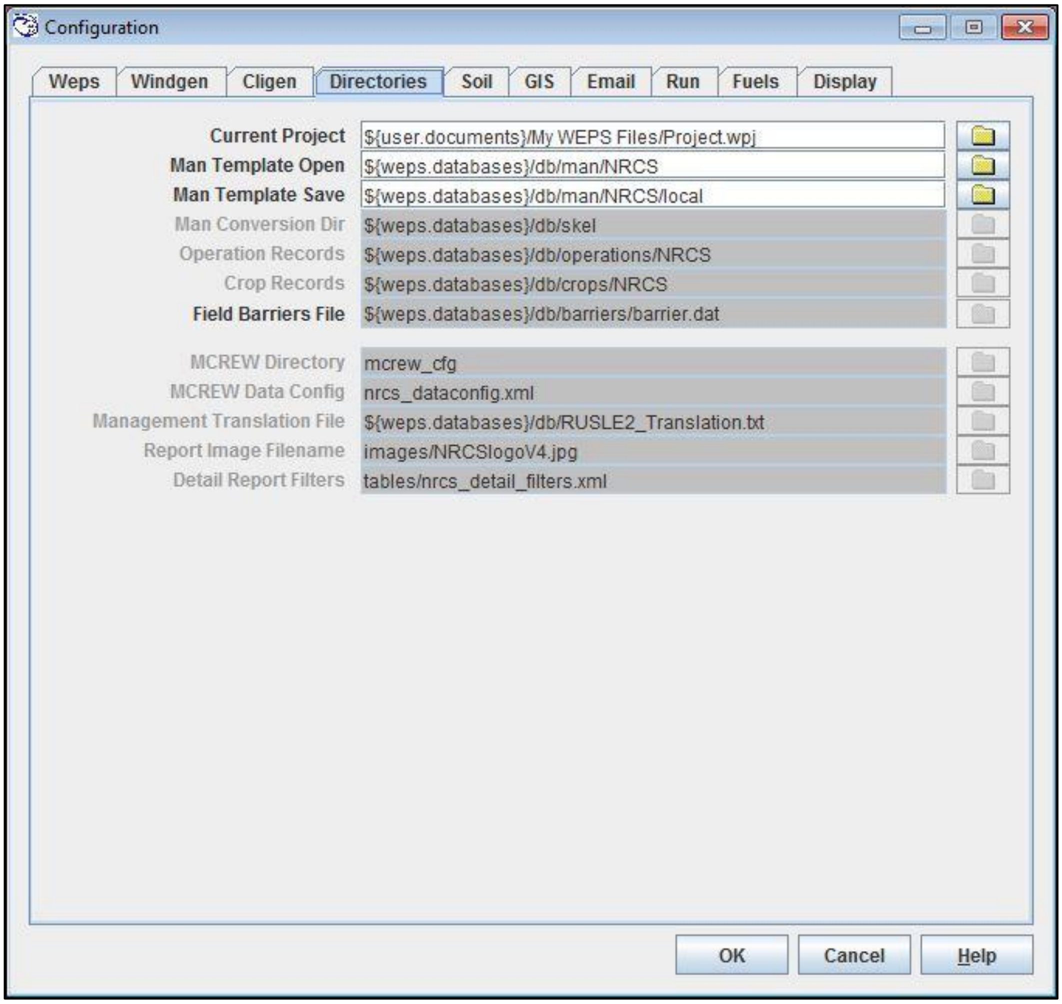


Figure 3-20 WEPS Configuration window opened to the Directories tab, showing directory locations which the user may change.

In Figure 3-20, the bright yellow folders  indicate those directory paths which the user can change, while the shaded folders  show those the user cannot change. To change a location, click the yellow folder, select the directory or file, and click *OK* to save the configuration settings and close the window. Note: The database locations shown in (Figure 3-20) are different for the official NRCS WEPS 1.5 release.

Soil files are accessible through the Soil folder. For NRCS configured versions of WEPS running Microsoft Windows 7, they are located here:

C:\Program Data\USDA\WEPS\Databases\nrcs\soil

Other WEPS configurations and operating systems may vary as to the location of this directory.

One set of soil files will usually be placed on a shared drive in an NRCS Field Office. Users must "map to" that drive to access the common group of soils. This can be done accessing the Configuration panel through the "Tools" menu on the main interface and selecting "Edit Configuration". The user must then select the "Soil" tab and edit the "Soils Database" field. If the user needs to run the model separate from the server, the common soils directory can be reset to the local machine and the necessary soil files downloaded to that location.

Soil files may also be obtained directly from the National Soil Survey Center in Lincoln, NE by using the Soils pull down and selecting NRCS Soil Data Mart function. Users must have an Internet connection to use this function.

Simulation Region Orientations and Angles

Field orientation and direction of tillage within the simulation region in WEPS are independent and measured relative to true North (0 degrees). Angles are important in WEPS because wind directions are simulated to mimic the historic wind direction distribution for the selected location. Since wind direction varies from day to day, erosion losses will also vary relative to field angle or ridge orientation. The field orientation in WEPS should be rotated to represent the actual orientation on the landscape. Note that the field will only rotate in a range of ±45 degrees. By rotating and adjusting the field length and width, the user should be able to obtain the desired size and orientation for a field. Tillage direction should also be entered relative to true North in the Management Crop Rotation Editor (MCREW). For example, if a rectangular field has its long side oriented 20.0 degrees from true North and tillage is performed parallel to that long side of the field, the tillage direction should also be entered as 20.0 degrees within MCREW.

Plant Damage

Although soil loss is the primary concern in wind erosion, damage to plants should also be considered. Crops can be damaged by blowing soil particles, exposure of plant roots, burial of plants by drifting soil, or desiccation and twisting of plants by the wind. In two exercises, we will examine and take into account the crop tolerance to blowing soil, even though the erosion estimate may already be within NRCS guidelines. NRCS has published a table listing the tolerance of various crops to blowing soil (USDA-NRCS, 2000; National Agronomy Manual; Table 502-4, pg. 502-19). Refer to this table as needed during the exercises (Table 3.2) Crops can tolerate greater amounts of blowing soil than shown, but yield and quality may be adversely affected.

Users should review the detailed report and the first two-week management periods to see if the combined total loss is less than the listed rate of erosion on Table 3.2. If the rate exceeds the crop tolerance then adjustments in the system are in order. Either a cover crop or more crop residue at plant time may be needed.

Table 3.2 Crop tolerances used by Natural Resource Conservation Service (NRCS) to design wind erosion control methods (USDA-NRCS, 2000).

Tolerant * "T"	Moderate 2 ton/ac	Low Tolerance 1 ton/ac	Very Low 0 to 0.5 ton/ac
Barley	Alfalfa (mature)	Broccoli	Alfalfa (seedlings)
Buckwheat	Corn	Cabbage	Asparagus
Flax	Onions (> 30 days)	Cotton	Cantaloupe
Grain Sorghum	Orchard Crops	Cucumbers	Carrots
Millet	Soybeans	Garlic	Celery
Oats	Sunflowers	Green/Snap Beans	Eggplant
Rye	Sweet Corn	Lima Beans	Flowers
Wheat		Peanuts	Kiwi Fruit
		Peas	Lettuce
		Potatoes	Muskmelons
		Sweet Potatoes	Onion (seedlings)
		Tobacco	Peppers
			Spinach
			Squash
			Strawberries
			Sugar Beets
			Table Beets
			Tomatoes
			Watermelons

*Crop tolerance is defined as the maximum wind erosion that a growing crop can tolerate, from crop emergence to field stabilization, without an economic loss to stand, yield, or quality

- **References**

USDA-NRCS. 2011. National Agronomy Manual, Part 502-Wind Erosion, 190-V NAM. 4th Edition. Washington, D. C.

4 EXAMPLE EXERCISES

WEPS
WIND EROSION PREDICTION SYSTEM

Exercise 1 - A Basic Simulation

Skill Building: This example introduces some basic skills needed to perform simple wind erosion simulations with WEPS. It uses the rotations saved in the NRCS CMZ (Crop Management Zone) Management Files. It also demonstrates Target Yield adjustment. Note that these exercises are run using the “WEPS NRCS Field” configured version of WEPS 1.5 from the Public release. The official “NRCS release of WEPS 1.5” should produce the same results. Regardless, it is possible that the results may not be identical due to changes made to the science code and the databases since these exercises were last reviewed.

Getting Started: Double-click the WEPS short-cut on the desktop to open the main WEPS interface. The user’s name and email address are required to help track any comment or error messages sent by the user. If it is the user’s first time running WEPS, the “WEPS Wizard” should display and lead the user through the process of setting their name and email address into the WEPS configuration files. Alternatively, the user can select the **Tools** menu from the main WEPS screen and pick the **Edit Configuration** option to bring up the WEPS Configuration Panel. Selecte the **E-mail** tab and enter your name and email address in the appropriate fields (**User Name, Send From and Your email**). Note in Figure 4-1 the default run location: *C:\Users\${user.name}\Documents\My WEPS Files\Runs* where *${user.name}* refers to the user’s login name on the Microsoft Windows computer system. Red boxes are added for instruction purposes throughout these exercises and are not seen in the actual WEPS windows.

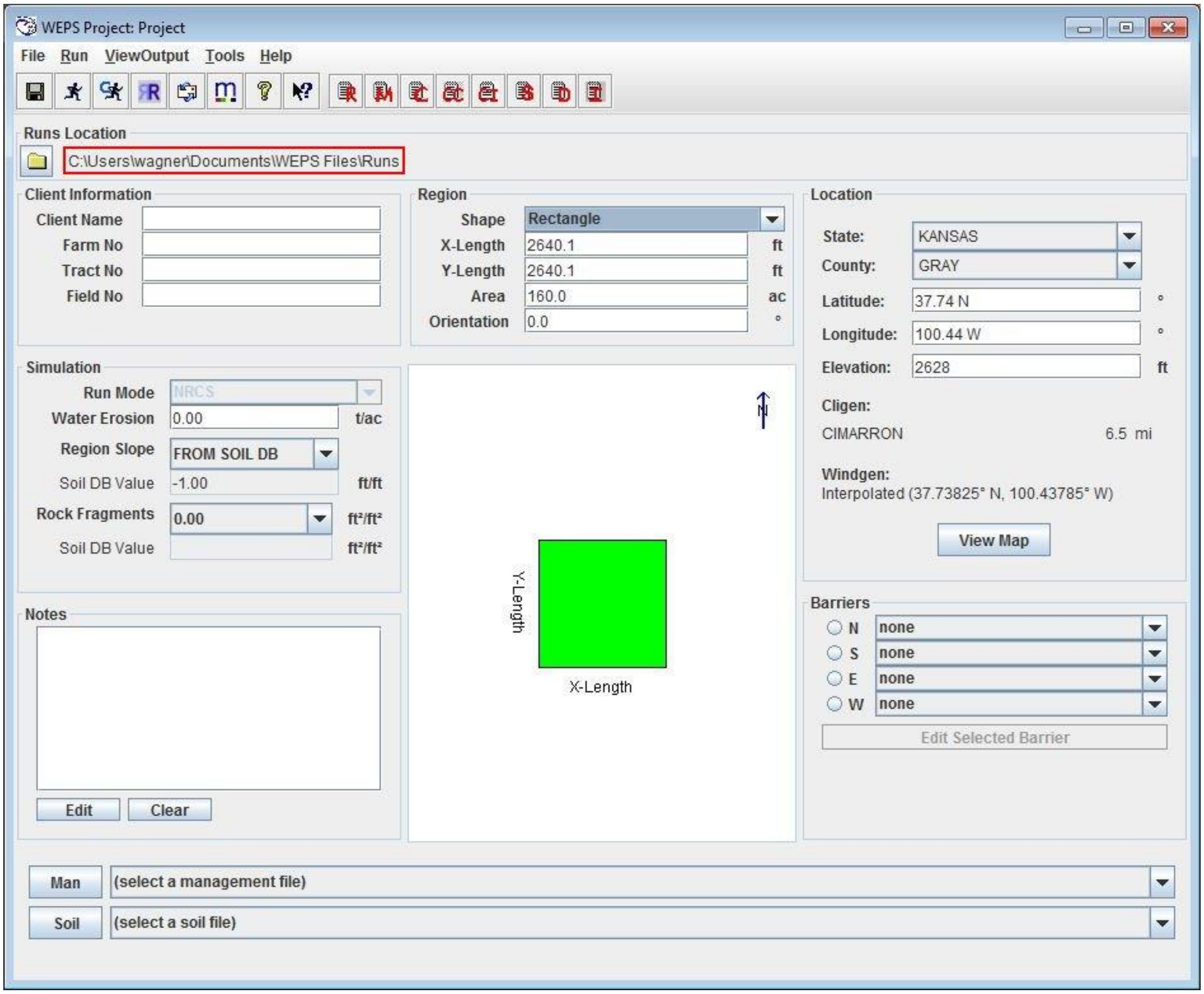


Figure 4-1 The WEPS main interface with default settings.

Exercise 1 Scenario

- The farm is located near **Stevens Point, Wisconsin**, in **Portage County**.
- Use a Climate station within the county.
- The Soil Map Unit for this evaluation is **Mecan_MfB_100_LS**.
- The grower's two-year cropping system is **Peas, green, drilled** and **Bean, green snap**.
- The harvest machines are viners that remove the beans and peas, returning all residue to the field.
- The field is circular with a size of about **126 acres** and is fully irrigated with a circle system.
- The WEPS evaluation of the cropping system will be run for 50 rotation cycles (NRCS mode).

Complete the following steps:

Step 1: Under the Client Information panel, enter **Exercise 1** for Client Name.

Step 2: Under the Region panel, for Shape select *Circle* by clicking the drop-down arrow next to 'Shape.' For 'Area' enter **126** acres. The circle radius automatically synchronizes with acreage values when 'Area' is deselected.

Step 3: Under the Location panel, for the 'State,' select **Wisconsin**; for the "County", select **Portage**. The correct weather stations (Cligen and Windgen) are then auto-selected based upon the centroid of the county selected, so that the interface reads "Cligen: **STEVENS POINT** and Windgen: **Interpolated (44.47603º N, 89.50148º W)**." The Central and Eastern regions of the United States use wind station interpolation, where the three surrounding wind stations' data are combined to make a unique weather record for each run. At this point, WEPS has selected the center of Portage County. To confirm that the location is nearest to Stevens Point, click the View Map button View Map for an overhead view of the station placement (Figure 4-2). The red cross denotes the current location. Now click the check box by Cligen Station in the Layer column in the lower left corner of the screen to display the Cligen station locations. See that the current location is near Stevens Point. Close the Map Viewer to return to the main interface screen.

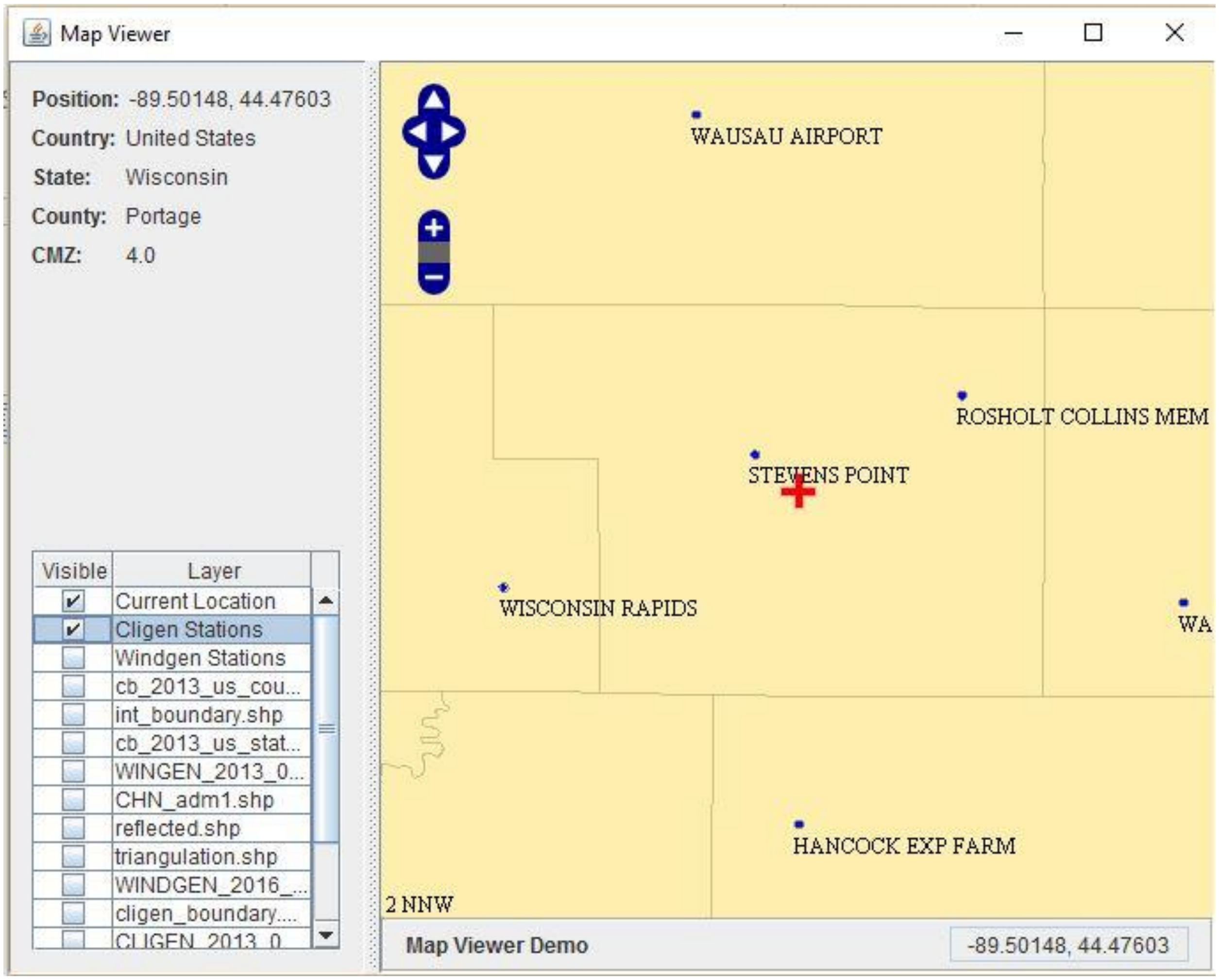


Figure 4-2 Map Viewer with Cligen Stations Layer turned on.

Step 4: Click the drop-down arrow opposite the Man button near the bottom of the WEPS screen (Figure 4-3). To open or close a folder on the list, click the key symbol beside it . To select a management file, click the desired file. From the list, select *Templates*, then *NRCS*, then *Example Mgt. files*, then **Peas, green, drilled, st pt, disk, fcult,-Bean, green snap, st pt, disk, fcult, CMZ4.man**. Note: the management files are displayed with *.man* file extension. The crop management file name will be displayed in the Man bar near the bottom of the WEPS interface when selected.

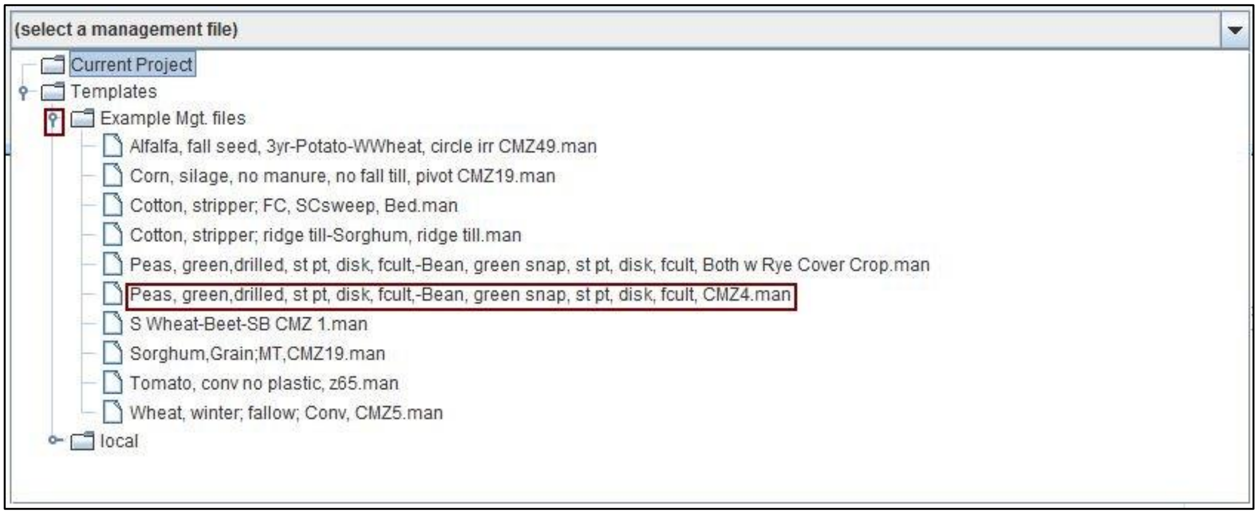


Figure 4-3 Selecting a template (Example Mgt. files) management file using the management selection drop-down box.

Step 5: Click the drop-down arrow  opposite the Soil button 

near the bottom of the WEPS screen (Figure 4-4). Select *Soil Templates*, then *Exercise Soils*, then the **Mecan_MfB_100_LS.ifc** soil. Note: the soil files have an *.ifc* extension. When selected, the soil name is displayed near the bottom of the WEPS interface. You will normally use the drop-down arrow  to select a soil from the SSURGO survey database in this directory or other locations determined by the configuration settings. SSURGO files have an *.mdb* extension. With an internet connection, you can load the soil files directly from the NRCS Soil Data Mart by clicking the NRCS Soil Data Mart folder. Last on the drop-down list is a set of generic soil files to use when there is no soil survey or when the soil in the field is different than mapped. They can also be used for disturbed sites, such as landfill, mining reclamation, and construction sites.

Figure 4-4 Selecting a template (Exercise Soils) soil file using the soil selection drop-down box.

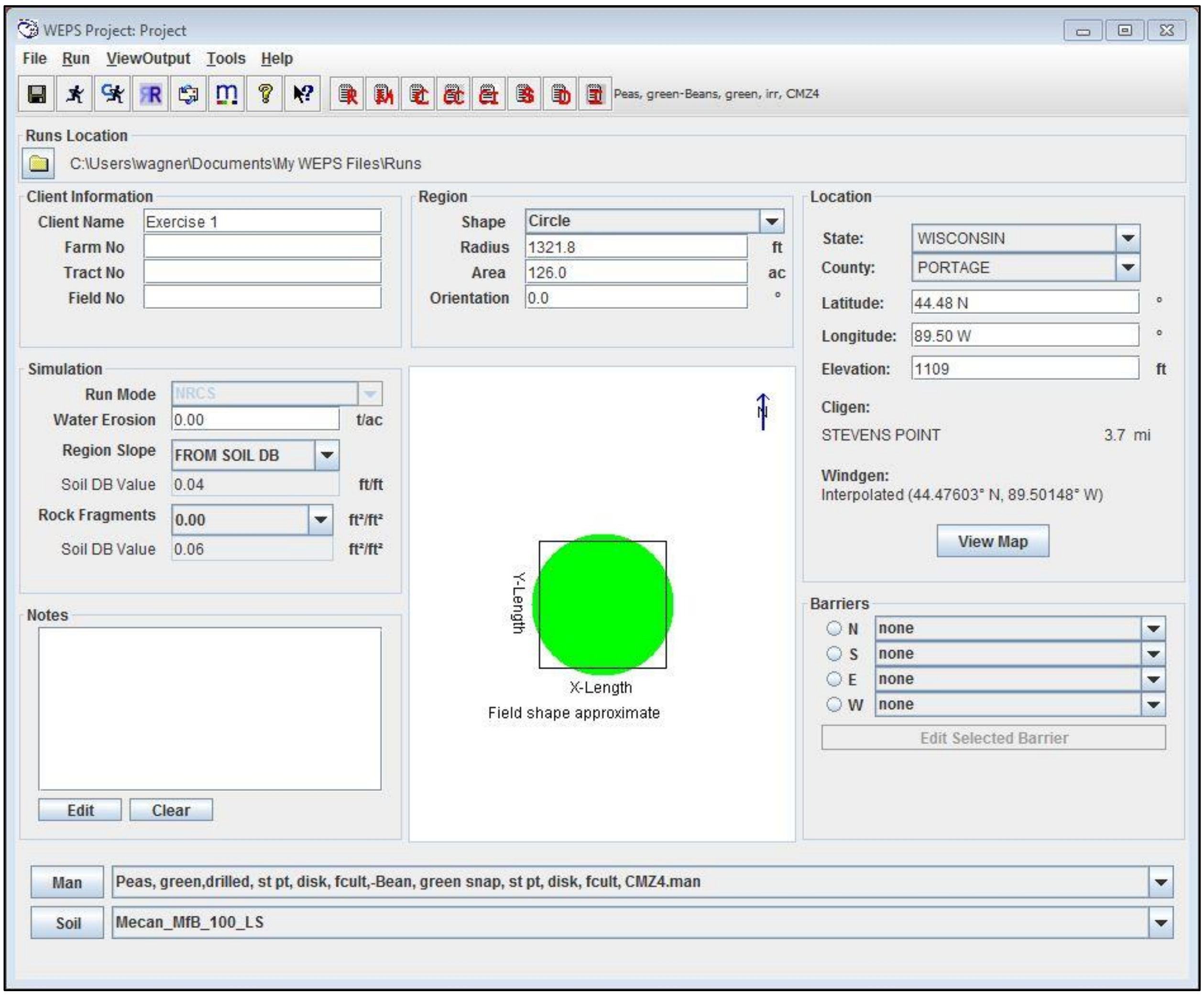


Figure 4-5 The WEPS interface with the correct information for the initial scenario of Exercise 1.

Simulation Run

All required information has now been entered (Figure 4-5). To begin the simulation run, click the Run button. WEPS will prompt you to name the run. Enter **Peas, green-Beans, green, irr, CMZ4** and click **OK** (Figure 4-6).

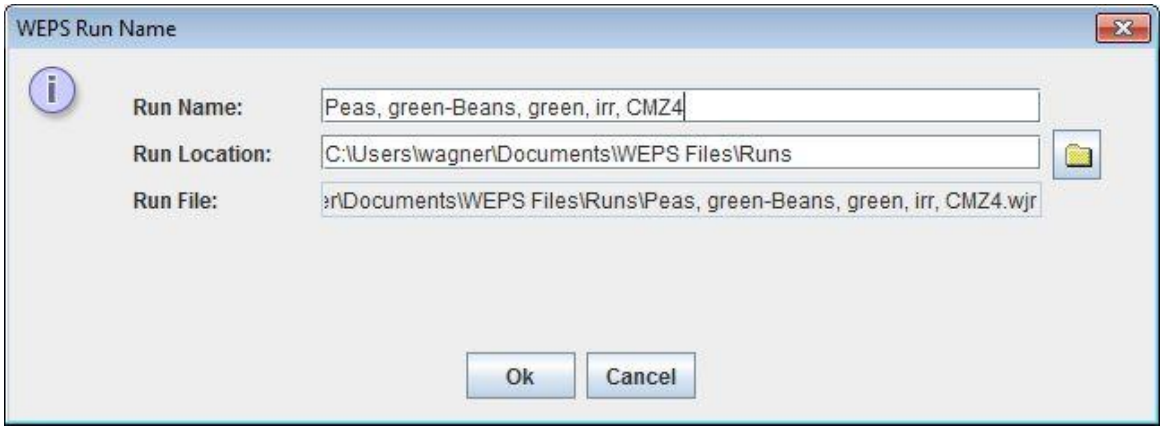
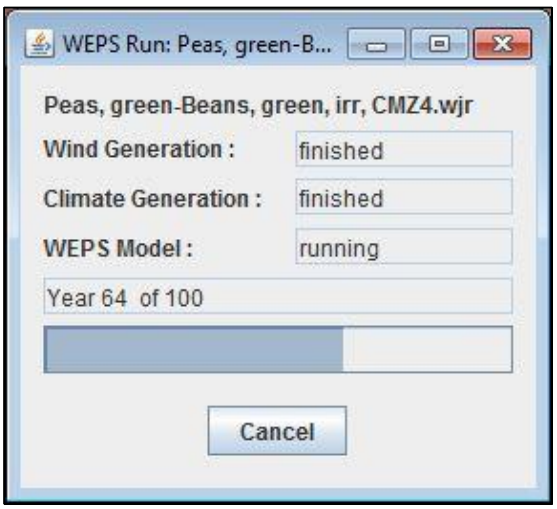


Figure 4-6 The WEPS Run Name box, showing the run name, location, and file.



During a simulation run, a window (shown left) will appear, showing the simulation progress.

The WEPS Run Summary report window automatically appears on the screen upon completion of the simulation (Figure 4-7). The simulation reports an Average Annual Soil Loss of **26.1 t/ac**; several times the acceptable soil loss of **5 t/ac/yr**. Since crop yields determine the amount of residue, which affects erosion, the user should check to see if the crop yields are as expected.

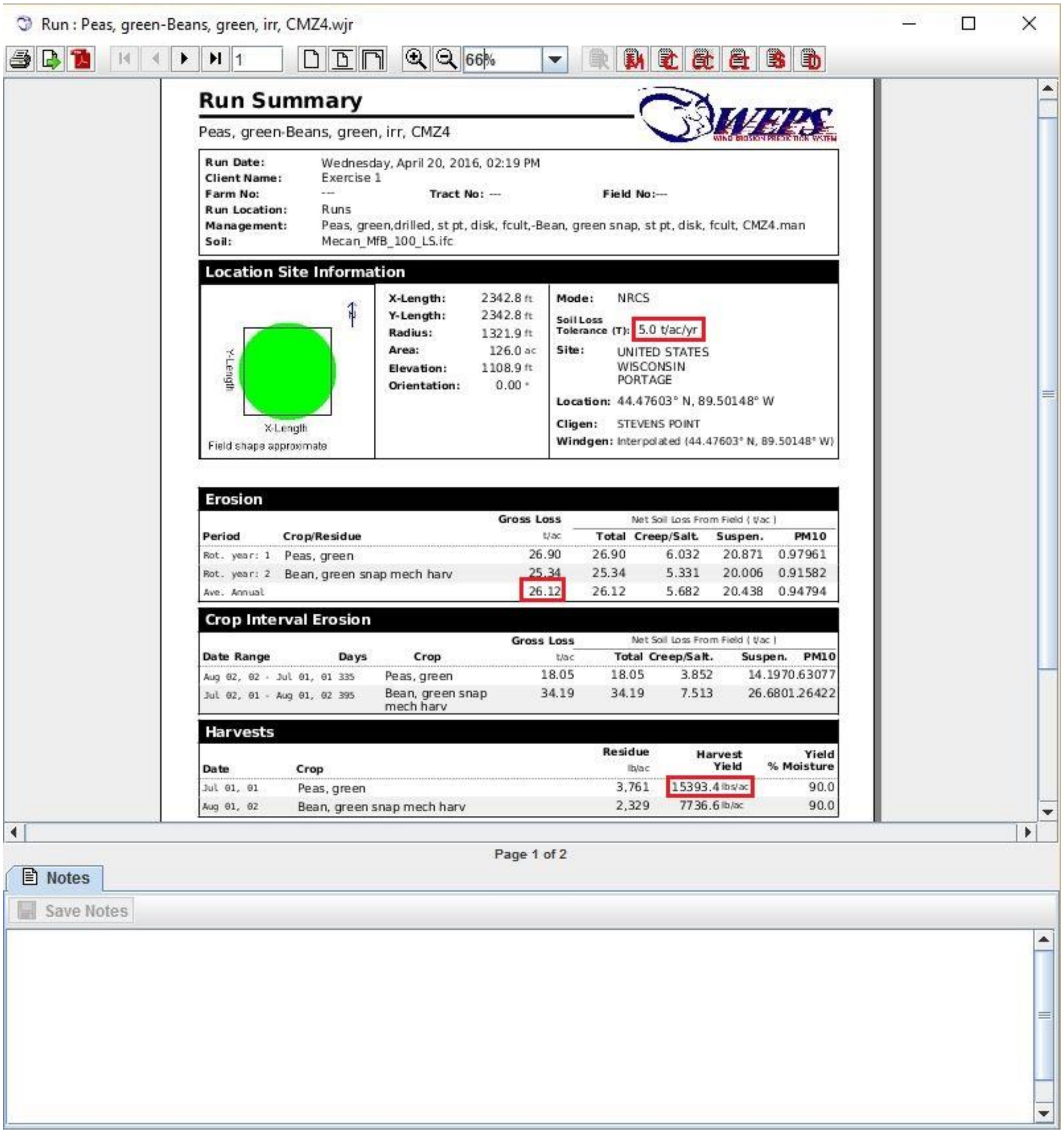


Figure 4-7 WEPS Run Summary report with the Soil Tolerance, Average Annual Soil Loss and Harvest Yield for the green peas highlighted.

The expected yields for this area are **3400 lbs/ac** for green peas and **8100 lbs/ac** for the green beans. For this example the green bean yield is within +/-95% of the expected yield, so it is ok. However, WEPS calculated **15393 lbs/ac** for the peas (Figure 4-7) which is far too high and should be calibrated.

Yield Calibration Run

The calibration function allows WEPS to recalculate the crop growth based on the actual yield history of the field evaluated. It adjusts the Harvested Yield simulated to within ±5% of the expected or historic yield entered. To calibrate the example run, first close the Run Summary. The main interface screen should remain.

Complete the following steps:

Step 1: On the main screen, click the Man button to open the Management Crop Rotation Editor for WEPS (MCREW). The MCREW displays a calendar year date-ordered list of all management operations and crops for the rotation (Figure 4-8). A more detailed explanation of MCREW use will be covered in later exercises. For now, click the Yield Calibrate button on the tool bar. This displays eight additional columns. The first three pertain to the target yield and calibration. The target yields can be edited on this screen. Remember, the target yield is 3400 lbs/ac for peas and 8100 lbs/ac for beans. Change the peas from **2860** to the **3400** lbs/ac desired. Then make sure box in the 'Calib. Yield?' column in the green peas column is checked. Although we don't need to calibrate the green beans, note that it is also checked for calibration with the desired target yield as well.

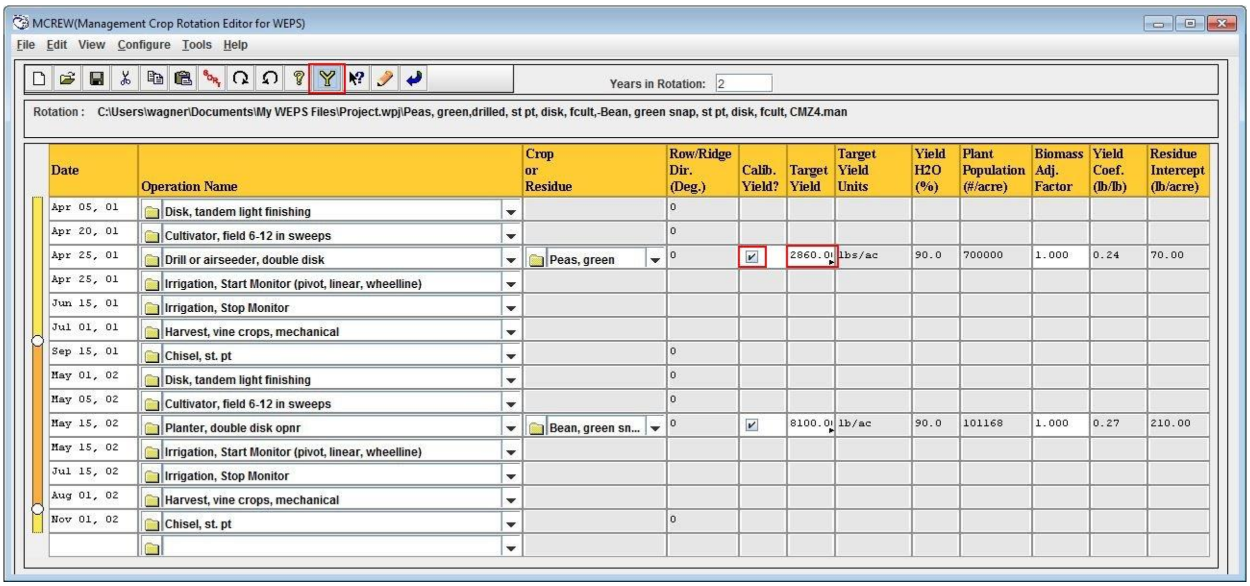


Figure 4-8 The Management Crop Rotation Editor for WEPS (MCREW) is shown highlighting the "Yield Calibration" button as well as the "Calib. Yield?" and "Target Yield" columns for the green peas.

Click the Return button to save the green peas target yield change by clicking 'Yes' to save. This closes MCREW for the user to view the remaining WEPS interface. This changes the copy of this MCREW file stored in the Project directory and not in the original crop template directory we grabbed a copy from.

Step 2: On the main interface screen, click *Run* on the main screen menu and then select *Make a Yield Calibration WEPS Run*. Another way to do this is to click the Yield Calibration Run button  on the main toolbar. You will be prompted to enter a Run Name. The default Run Name is the last run name plus '_calib'. Note, if previous calibration runs have been made with the same run name, an auto-incremented number, beginning with "1" will also be appended to the end of the run name. Click *OK* to begin the Yield Calibration Run (Figure 4-9). A calibration run can take several minutes.

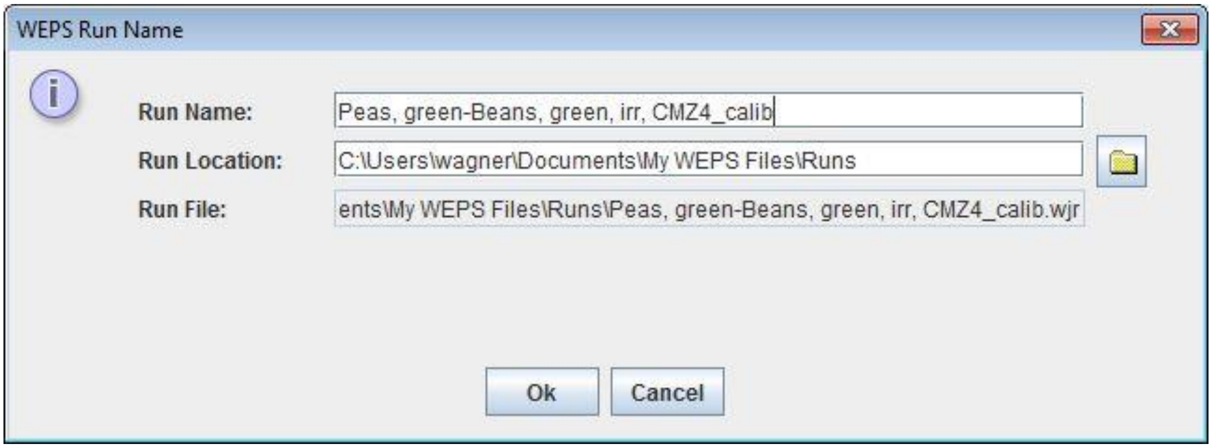


Figure 4-9 WEPS Run Name window showing "_calib" automatically appended to the end of the run name for a Yield Calibration run.

WEPS now displays a table showing two Calibration Factors; one for peas and one for beans (Figure 4-10). For WEPS to produce the expected pea residue for this farm, yields must be reduced from 15382 lbs/ac to 3400 lbs/ac. Therefore, we should expect the factor to be less than 1.0 and the Biomass Adjustment Factor is **0.3174**. The beans did not need adjustment, so the factor remained at 1.0. The Biomass Adjustment Factor is a number assigned to each crop and used as a multiplier to adjust how much the crop grows. Numbers greater than 1.0 increase the final yield, whereas numbers less than 1.0 decrease the final yield of the crop.

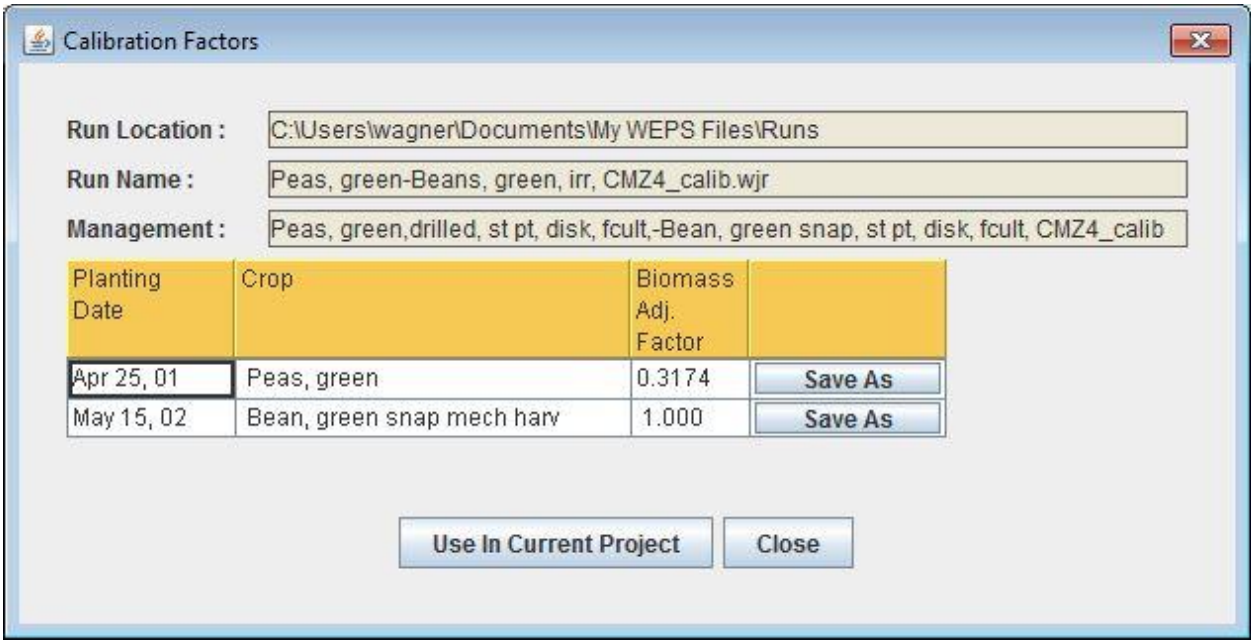
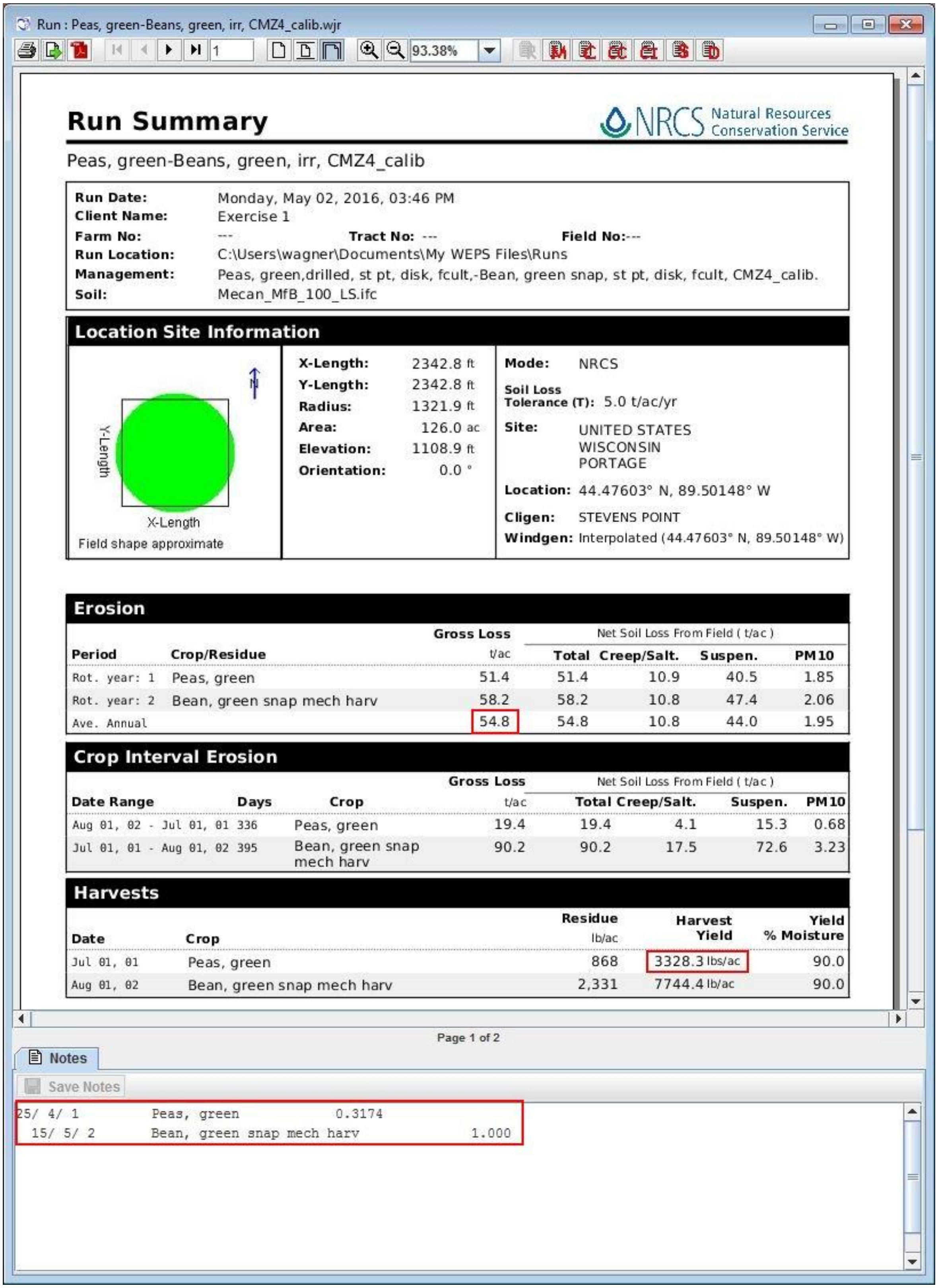


Figure 4-10 The Calibration Factors window displaying the Biomass Adjustment Factor for each crop.

The user has three options at the Calibration Factors screen: 1) Clicking the *Use in Current Project* button to apply these calibration factors to all peas and beans in the current WEPS MCREW file being used in this project. 2) Clicking the *Save As* button(s) to individually save locally calibrated versions of the crop records into the *local* crop database subdirectory for use in later management/crop rotation files being edited for future simulation runs in the same region. Since each run takes some time to complete, it is helpful to save a copy for the next time you run the model. The full path to the storage location is: *C:\Documents and Settings\All Users\Application Data\USDA\WEPS\Databases\nrcs\crops\local*. 3) Clicking the *Close* button to use the factors only in the current run.

For this exercise, click *Use In Current Project* to change the management/crop rotation file stored only in the project directory, not in any template file. WEPS will then display a message informing the user that "The current project is now using the calibrated management file." Click the "*OK*" button to close both the Calibration message window and the Calibration Factors window.

Upon completion of the calibration run, the WEPS Run Summary report window also appeared (Figure 4-11). The Run Summary simulation reports an Average Annual Gross Soil Loss of 54.4 tons/acre. This greatly exceeds the T-value (Soil Loss Tolerance) of 5 t/ac/yr. Note, the Biomass Adjustment Factors for the two calibrated crops appear in the "Notes" box near the bottom of the Run Summary report.



Run : Peas, green-Beans, green, irr, CMZ4_calib.wjr

Run Summary

NRCS Natural Resources Conservation Service

Peas, green-Beans, green, irr, CMZ4_calib

Run Date:	Monday, May 02, 2016, 03:46 PM
Client Name:	Exercise 1
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	C:\Users\wagner\Documents\My WEPS Files\Runs
Management:	Peas, green,drilled, st pt, disk, fcult,-Bean, green snap, st pt, disk, fcult, CMZ4_calib.
Soil:	Mecan_MfB_100_LS.ifc

Location Site Information

X-Length:	2342.8 ft
Y-Length:	2342.8 ft
Radius:	1321.9 ft
Area:	126.0 ac
Elevation:	1108.9 ft
Orientation:	0.0 °

Mode:	NRCS
Soil Loss Tolerance (T):	5.0 t/ac/yr
Site:	UNITED STATES WISCONSIN PORTAGE
Location:	44.47603° N, 89.50148° W
Cligen:	STEVENS POINT
Windgen:	Interpolated (44.47603° N, 89.50148° W)

Erosion

		Gross Loss	Net Soil Loss From Field (t/ac)			
Period	**Crop/Residue**	t/ac	**Total**	**Creep/Salt.**	**Suspen.**	**PM10**
Rot. year: 1	Peas, green	51.4	51.4	10.9	40.5	1.85
Rot. year: 2	Bean, green snap mech harv	58.2	58.2	10.8	47.4	2.06
Ave. Annual		54.8	54.8	10.8	44.0	1.95

Crop Interval Erosion

			Gross Loss	Net Soil Loss From Field (t/ac)			
Date Range	**Days**	**Crop**	t/ac	**Total**	**Creep/Salt.**	**Suspen.**	**PM10**
Aug 01, 02 - Jul 01, 01	336	Peas, green	19.4	19.4	4.1	15.3	0.68
Jul 01, 01 - Aug 01, 02	395	Bean, green snap mech harv	90.2	90.2	17.5	72.6	3.23

Harvests

Date	**Crop**	**Residue** lb/ac	**Harvest Yield**	**Yield % Moisture**
Jul 01, 01	Peas, green	868	3328.3 lbs/ac	90.0
Aug 01, 02	Bean, green snap mech harv	2,331	7744.4 lb/ac	90.0

Page 1 of 2

Notes

Save Notes

```
25/ 4/ 1        Peas, green             0.3174
  15/ 5/ 2      Bean, green snap mech harv          1.000
```

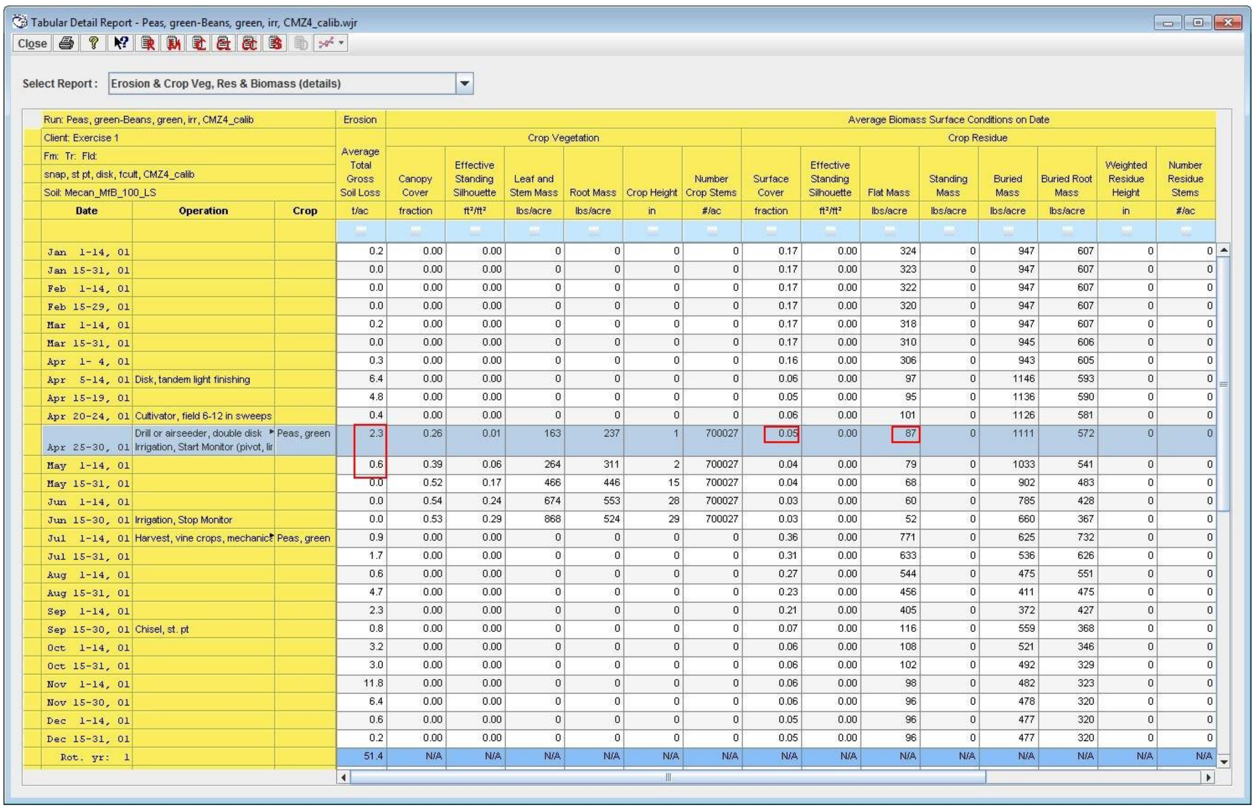
Figure 4-11 The WEPS Run Summary report showing new results from the Yield Calibration run.

Is the yield within the 5% needed now? Yes, 3328.3 lbs/ac of peas is close enough to 3400, and 7744.4 lbs/ac is close enough to 8100.

Is the percent ground cover and mass of flat residue after seeding adequate to protect both seedling stages of both crops?

Hint: Click the Detailed Tabular Report button in the Summary Report toolbar. Near the top of the Detailed Report there is a window that allows the user to 'Select Report.' This should display *Erosion & Crop Veg, Res & Biomass (details)* as the default. If not, click the drop-down arrow and select it from the list.

The Detail Tabular Report includes a date-ordered list of output parameters by periods (every 15 days or the period between management operations). This detail tabular report shows the viewer the amount of cover and flat residue after seeding each crop (Figure 4-12 and Figure 4-13).



Date	Operation	Crop	Average Total Gross Soil Loss (t/ac)	Canopy Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Leaf and Stem Mass (lbs/acre)	Root Mass (lbs/acre)	Crop Height (in)	Number Crop Stems (#/ac)	Surface Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Flat Mass (lbs/acre)	Standing Mass (lbs/acre)	Buried Mass (lbs/acre)	Buried Root Mass (lbs/acre)	Weighted Residue Height (in)	Number Residue Stems (#/ac)
Jan 1-14, 01			0.2	0.00	0.00	0	0	0	0	0.17	0.00	324	0	947	607	0	0
Jan 15-31, 01			0.0	0.00	0.00	0	0	0	0	0.17	0.00	323	0	947	607	0	0
Feb 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.17	0.00	322	0	947	607	0	0
Feb 15-29, 01			0.0	0.00	0.00	0	0	0	0	0.17	0.00	320	0	947	607	0	0
Mar 1-14, 01			0.2	0.00	0.00	0	0	0	0	0.17	0.00	318	0	947	607	0	0
Mar 15-31, 01			0.0	0.00	0.00	0	0	0	0	0.17	0.00	310	0	945	606	0	0
Apr 1- 4, 01			0.3	0.00	0.00	0	0	0	0	0.16	0.00	306	0	943	605	0	0
Apr 5-14, 01	Disk, tandem light finishing		6.4	0.00	0.00	0	0	0	0	0.06	0.00	97	0	1146	593	0	0
Apr 15-19, 01			4.8	0.00	0.00	0	0	0	0	0.05	0.00	95	0	1136	590	0	0
Apr 20-24, 01	Cultivator, field 6-12 in sweeps		0.4	0.00	0.00	0	0	0	0	0.06	0.00	101	0	1126	581	0	0
Apr 25-30, 01	Drill or airseeder, double disk; Irrigation, Start Monitor (pivot, lir	Peas, green	2.3	0.26	0.01	163	237	1	700027	0.05	0.00	87	0	1111	572	0	0
May 1-14, 01			0.6	0.39	0.06	264	311	2	700027	0.04	0.00	79	0	1033	541	0	0
May 15-31, 01			0.0	0.52	0.17	466	446	15	700027	0.04	0.00	68	0	902	483	0	0
Jun 1-14, 01			0.0	0.54	0.24	674	553	28	700027	0.03	0.00	60	0	785	428	0	0
Jun 15-30, 01	Irrigation, Stop Monitor		0.0	0.53	0.29	868	524	29	700027	0.03	0.00	52	0	660	367	0	0
Jul 1-14, 01	Harvest, vine crops, mechanic	Peas, green	0.9	0.00	0.00	0	0	0	0	0.36	0.00	771	0	625	732	0	0
Jul 15-31, 01			1.7	0.00	0.00	0	0	0	0	0.31	0.00	633	0	536	626	0	0
Aug 1-14, 01			0.6	0.00	0.00	0	0	0	0	0.27	0.00	544	0	475	551	0	0
Aug 15-31, 01			4.7	0.00	0.00	0	0	0	0	0.23	0.00	456	0	411	475	0	0
Sep 1-14, 01			2.3	0.00	0.00	0	0	0	0	0.21	0.00	405	0	372	427	0	0
Sep 15-30, 01	Chisel, st. pt		0.8	0.00	0.00	0	0	0	0	0.07	0.00	116	0	559	368	0	0
Oct 1-14, 01			3.2	0.00	0.00	0	0	0	0	0.06	0.00	108	0	521	346	0	0
Oct 15-31, 01			3.0	0.00	0.00	0	0	0	0	0.06	0.00	102	0	492	329	0	0
Nov 1-14, 01			11.8	0.00	0.00	0	0	0	0	0.06	0.00	98	0	482	323	0	0
Nov 15-30, 01			6.4	0.00	0.00	0	0	0	0	0.06	0.00	96	0	478	320	0	0
Dec 1-14, 01			0.6	0.00	0.00	0	0	0	0	0.05	0.00	96	0	477	320	0	0
Dec 15-31, 01			0.2	0.00	0.00	0	0	0	0	0.05	0.00	96	0	477	320	0	0
Rot. yr: 1			51.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

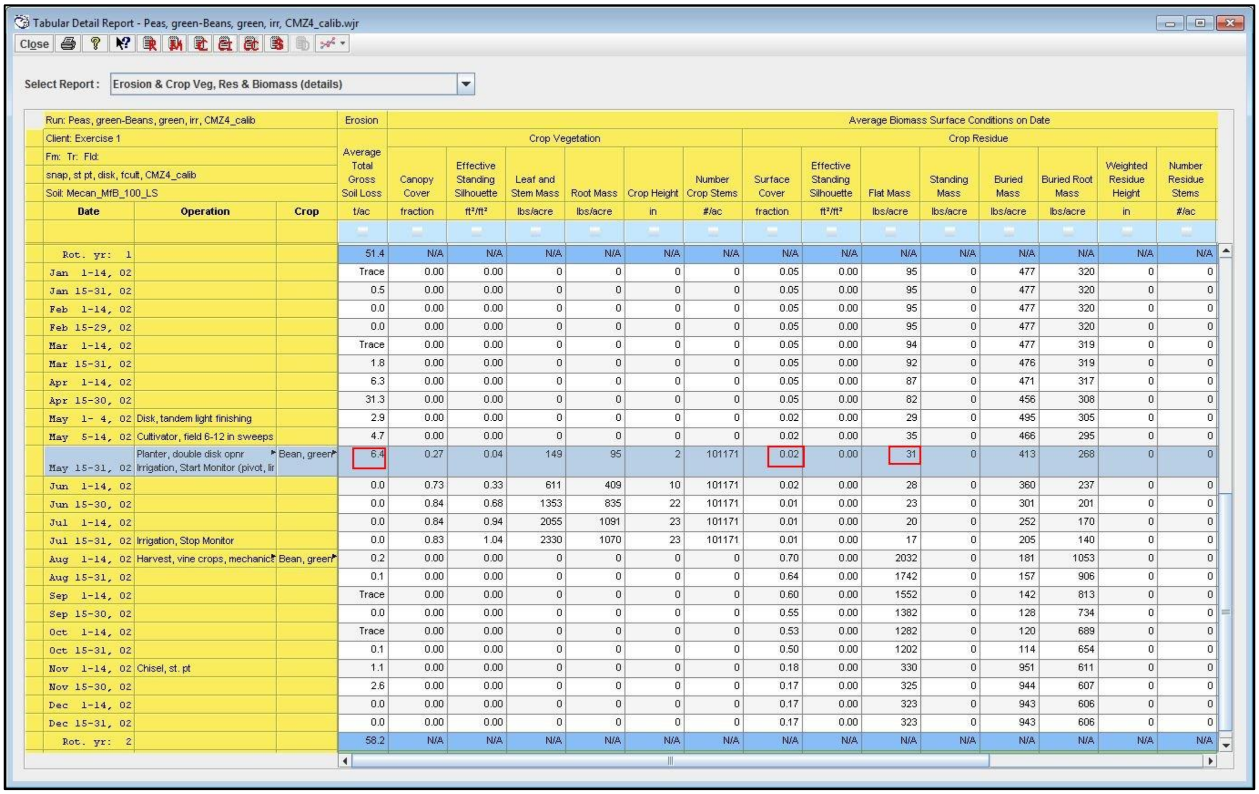
Figure 4-12 The Detailed Report showing soil loss and residue amounts after planting Peas and Beans, Year 1.

By examining the Detailed Report table, you will see that bean residue after planting peas during April 25-30, 01 was **5% (0.05 fraction) Surface Cover** and **87 lbs/ac flat mass** (Figure 4-12). The pea residue after planting beans (May 15-31, 02) was **2% (0.02 fraction) surface cover** and about **31 lbs/ac flat mass** (Figure 4-13).

Answer: These amounts provide little wind erosion protection and WEPS estimates an Average Total Gross Soil Loss after planting the peas to be **2.9 t/ac**, the sum of gross soil losses (2.3 + 0.6) for the period

April 25 - May 14, 01 and **6.4 t/ac** after planting the beans for the period May 15 -Jun 14, 02, there is a high probability of damage to the young peas and beans by blowing soil.

This is verified by checking the NRCS National Agronomy Manual which has a Crop Tolerance to Blowing Soil table that lists Green/snap beans and Peas under heading of **no more than 1 t/ac** in the low tolerance column (see Table 3.2 in Chapter 3). Thus, there is an issue with both crops with this management scenario.



Tabular Detail Report - Peas, green-Beans, green, irr, CMZ4_calib.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Run: Peas, green-Beans, green, irr, CMZ4_calib
Client: Exercise 1
Fm: Tr: Fld:
snap, st pt, disk, fcult, CMZ4_calib
Soil: Mecan_MfB_100_LS

Date	Operation	Crop	Erosion: Average Total Gross Soil Loss (t/ac)	Crop Vegetation: Canopy Cover (fraction)	Crop Vegetation: Effective Standing Silhouette (ft²/ft²)	Crop Vegetation: Leaf and Stem Mass (lbs/acre)	Crop Vegetation: Root Mass (lbs/acre)	Crop Vegetation: Crop Height (in)	Crop Vegetation: Number Crop Stems (#/ac)	Crop Residue: Surface Cover (fraction)	Crop Residue: Effective Standing Silhouette (ft²/ft²)	Crop Residue: Flat Mass (lbs/acre)	Crop Residue: Standing Mass (lbs/acre)	Crop Residue: Buried Mass (lbs/acre)	Crop Residue: Buried Root Mass (lbs/acre)	Crop Residue: Weighted Residue Height (in)	Crop Residue: Number Residue Stems (#/ac)
Rot. yr: 1			51.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jan 1-14, 02			Trace	0.00	0.00	0	0	0	0	0.05	0.00	95	0	477	320	0	0
Jan 15-31, 02			0.5	0.00	0.00	0	0	0	0	0.05	0.00	95	0	477	320	0	0
Feb 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	95	0	477	320	0	0
Feb 15-29, 02			0.0	0.00	0.00	0	0	0	0	0.05	0.00	95	0	477	320	0	0
Mar 1-14, 02			Trace	0.00	0.00	0	0	0	0	0.05	0.00	94	0	477	319	0	0
Mar 15-31, 02			1.8	0.00	0.00	0	0	0	0	0.05	0.00	92	0	476	319	0	0
Apr 1-14, 02			6.3	0.00	0.00	0	0	0	0	0.05	0.00	87	0	471	317	0	0
Apr 15-30, 02			31.3	0.00	0.00	0	0	0	0	0.05	0.00	82	0	456	308	0	0
May 1- 4, 02	Disk, tandem light finishing		2.9	0.00	0.00	0	0	0	0	0.02	0.00	29	0	495	305	0	0
May 5-14, 02	Cultivator, field 6-12 in sweeps		4.7	0.00	0.00	0	0	0	0	0.02	0.00	35	0	466	295	0	0
May 15-31, 02	Planter, double disk opnr Irrigation, Start Monitor (pivot, lir	Bean, green	6.4	0.27	0.04	149	95	2	101171	0.02	0.00	31	0	413	268	0	0
Jun 1-14, 02			0.0	0.73	0.33	611	409	10	101171	0.02	0.00	28	0	360	237	0	0
Jun 15-30, 02			0.0	0.84	0.68	1353	835	22	101171	0.01	0.00	23	0	301	201	0	0
Jul 1-14, 02			0.0	0.84	0.94	2055	1091	23	101171	0.01	0.00	20	0	252	170	0	0
Jul 15-31, 02	Irrigation, Stop Monitor		0.0	0.83	1.04	2330	1070	23	101171	0.01	0.00	17	0	205	140	0	0
Aug 1-14, 02	Harvest, vine crops, mechanic	Bean, green	0.2	0.00	0.00	0	0	0	0	0.70	0.00	2032	0	181	1053	0	0
Aug 15-31, 02			0.1	0.00	0.00	0	0	0	0	0.64	0.00	1742	0	157	906	0	0
Sep 1-14, 02			Trace	0.00	0.00	0	0	0	0	0.60	0.00	1552	0	142	813	0	0
Sep 15-30, 02			0.0	0.00	0.00	0	0	0	0	0.55	0.00	1382	0	128	734	0	0
Oct 1-14, 02			Trace	0.00	0.00	0	0	0	0	0.53	0.00	1282	0	120	689	0	0
Oct 15-31, 02			0.1	0.00	0.00	0	0	0	0	0.50	0.00	1202	0	114	654	0	0
Nov 1-14, 02	Chisel, st. pt		1.1	0.00	0.00	0	0	0	0	0.18	0.00	330	0	951	611	0	0
Nov 15-30, 02			2.6	0.00	0.00	0	0	0	0	0.17	0.00	325	0	944	607	0	0
Dec 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.17	0.00	323	0	943	606	0	0
Dec 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.17	0.00	323	0	943	606	0	0
Rot. yr: 2			58.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 4-13 The Detailed Report showing soil loss and residue amounts after planting Peas and Beans, Year 2.

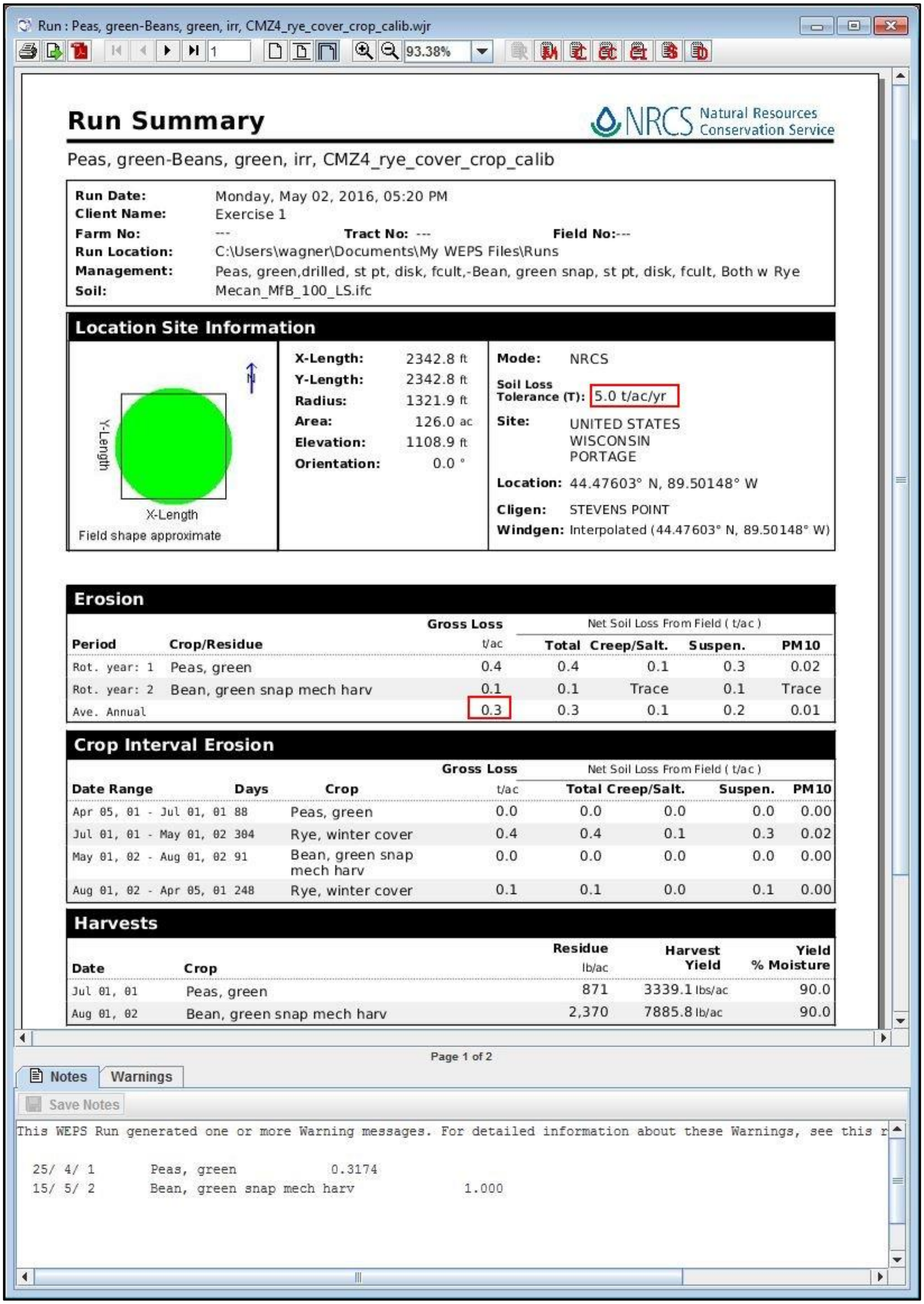
In addition, the annual erosion rate from the field for the two low-residue crops is also too high at **54.8 ton/ac**. Since most of the erosion occurs after both the peas and beans are harvested, and there is good rainfall in that time period, a winter annual such as winter wheat or a rye cover crop could be the solution for conserving the soil.

Select Cover Crop Template

Return to the interface and select the pre-built management/crop rotation template in the *Example Mgt. Files* directory by using the Man drop-down arrow . Select *Peas, green, drilled, st pt, disk, fcult,-Bean, green snap, st pt, disk, fcult, Both w Rye Cover Crop.man* file, which already contains the rye cover crop following the bean harvest. Since we are starting from a new template, be sure the pea yield is set to 3400 lbs/ac, and the bean yield is set to 8100 lbs/ac. Click the Run Calibration button to make another calibrated run with the rye cover crop.

The WEPS Run Summary report (Figure 4-14) now shows the Average Annual Soil Loss at **0.3 t/ac**; well within the Soil Loss Tolerance of **5 tons/acre**.

Reviewing the Tabular Detail Report also shows that the erosion loss around the planting time for both peas and the beans is zero, so the cover crop has also protected the young seedlings from erosion damage as well.



Run : Peas, green-Beans, green, irr, CMZ4_rye_cover_crop_calib.wjr

93.38%

Run Summary

NRCS Natural Resources Conservation Service

Peas, green-Beans, green, irr, CMZ4_rye_cover_crop_calib

Run Date: Monday, May 02, 2016, 05:20 PM
Client Name: Exercise 1
Farm No: --- **Tract No:** --- **Field No:**---
Run Location: C:\Users\wagner\Documents\My WEPS Files\Runs
Management: Peas, green,drilled, st pt, disk, fcult,-Bean, green snap, st pt, disk, fcult, Both w Rye
Soil: Mecan_MfB_100_LS.ifc

Location Site Information

X-Length: 2342.8 ft
Y-Length: 2342.8 ft
Radius: 1321.9 ft
Area: 126.0 ac
Elevation: 1108.9 ft
Orientation: 0.0 °

Mode: NRCS
Soil Loss Tolerance (T): 5.0 t/ac/yr
Site: UNITED STATES WISCONSIN PORTAGE
Location: 44.47603° N, 89.50148° W
Cligen: STEVENS POINT
Windgen: Interpolated (44.47603° N, 89.50148° W)

Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Peas, green	0.4	0.4	0.1	0.3	0.02
Rot. year: 2	Bean, green snap mech harv	0.1	0.1	Trace	0.1	Trace
Ave. Annual		0.3	0.3	0.1	0.2	0.01

Crop Interval Erosion

Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Apr 05, 01 - Jul 01, 01	88	Peas, green	0.0	0.0	0.0	0.0	0.00
Jul 01, 01 - May 01, 02	304	Rye, winter cover	0.4	0.4	0.1	0.3	0.02
May 01, 02 - Aug 01, 02	91	Bean, green snap mech harv	0.0	0.0	0.0	0.0	0.00
Aug 01, 02 - Apr 05, 01	248	Rye, winter cover	0.1	0.1	0.0	0.1	0.00

Harvests

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Jul 01, 01	Peas, green	871	3339.1 lbs/ac	90.0
Aug 01, 02	Bean, green snap mech harv	2,370	7885.8 lb/ac	90.0

Page 1 of 2

Notes Warnings

Save Notes

```
This WEPS Run generated one or more Warning messages. For detailed information about these Warnings, see this r

 25/ 4/ 1      Peas, green             0.3174
 15/ 5/ 2      Bean, green snap mech harv          1.000
```

Figure 4-14 The third Summary Report, predicting that the Rye cover crop would reduce Gross Loss to below Soil Loss Tolerance.

Exercise 2 - Adding a Crop to a Rotation

Skill Building: In this exercise, we begin with a pre-built management file and make a WEPS run. Then we add another crop to the rotation in the management editor (MCREW) and make a second run. We will also consider a strip tillage system and reduced tillage to address the erosion problem.

Exercise 2 Scenario

- The farm is located in **Lubbock County**, **Texas,** south of the airport (use the default location for Lubbock Co.).
- The soil in the field is **Amarillo Loamy Fine Sand**.
- The crop rotation is continuous **Cotton, stripper**. It may be helpful to add Milo or Sorghum to the rotation.
- There is also some new technology from Texas A&M, using Strip Tillage and Ridge Till Planters that we would like to model for an alternative.
- The field is a **half section of land (320 acres)** and is oriented east and west.
- Normal yield for the Cotton is ¾ bale or **375 lbs lint/ac**.
- Sorghum should yield an average of **25 bu/ac**.

Complete the following steps:

Step 1: Start up the WEPS interface and add the information shown in Figure 4-15. Be sure to show the field as a rectangle (simulation area as 5280 by 2640 feet) with the short side (Y-length = 2640 ft) on the east and west, as shown in Figure 4-15.

Step 2: Click the 'Man' pull down black arrow (lower right side) to display the managements in the "Example Mgt. files" under the "Templates" folder. Load the pre-built file called *Cotton, stripper; FC, SCsweep, Bed.man* by clicking the name of the file on the list.

Step 3: Click the 'Soil' pull down black arrow (lower right side) to display the soils in the "Exercise Soils" under the "Soil Templates" folder. Load the pre-built file called *Amarillo _4_100_LFS* by clicking the name on the list.

Step 4: Make a standard run as shown in Exercise 1 (Figure 4-1) by clicking the Run button. Type in the run name of: **Cotton, stripper, Conv, TX**. Upon completion, the Run Summary will appear as seen in Figure 4-16.

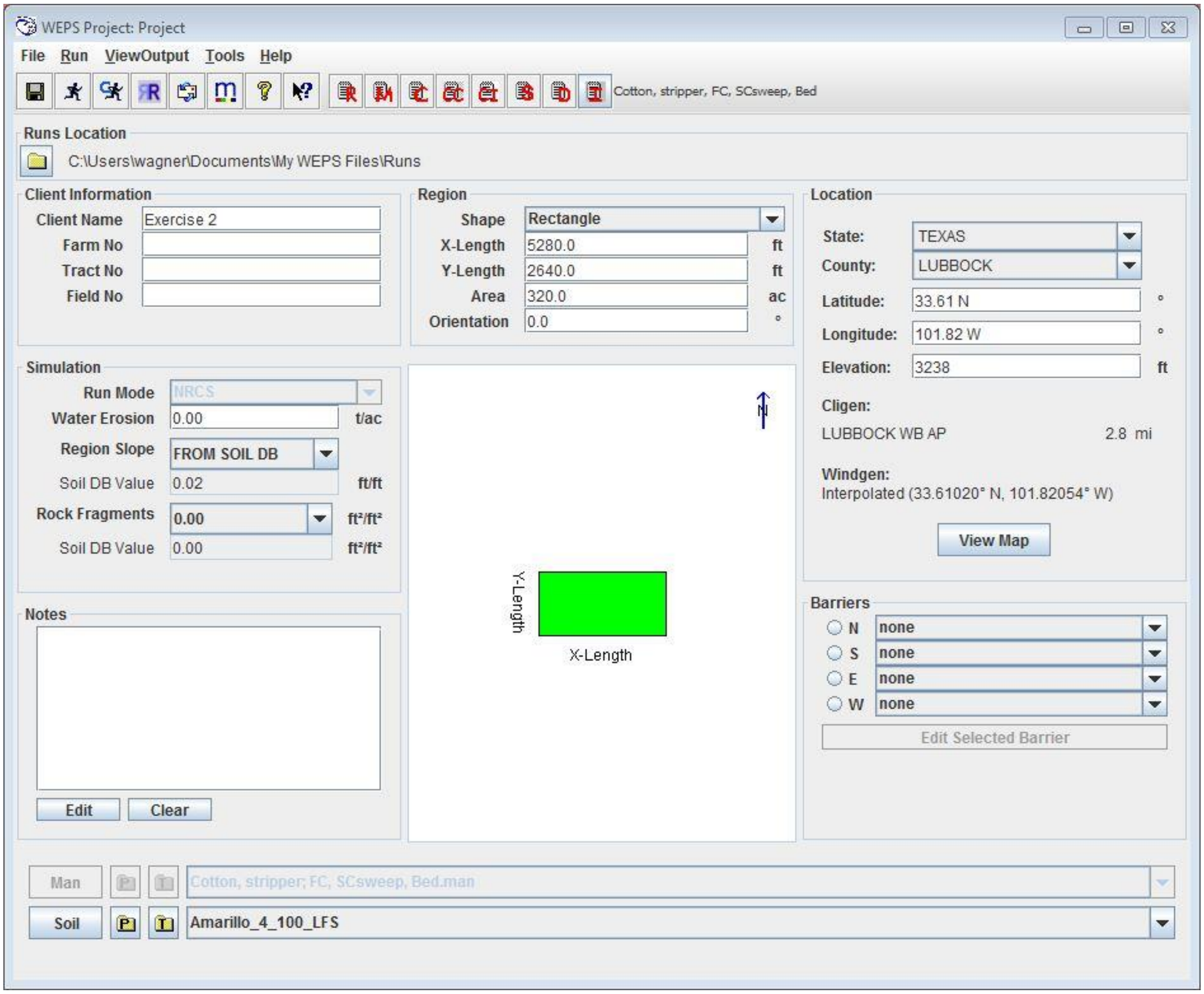
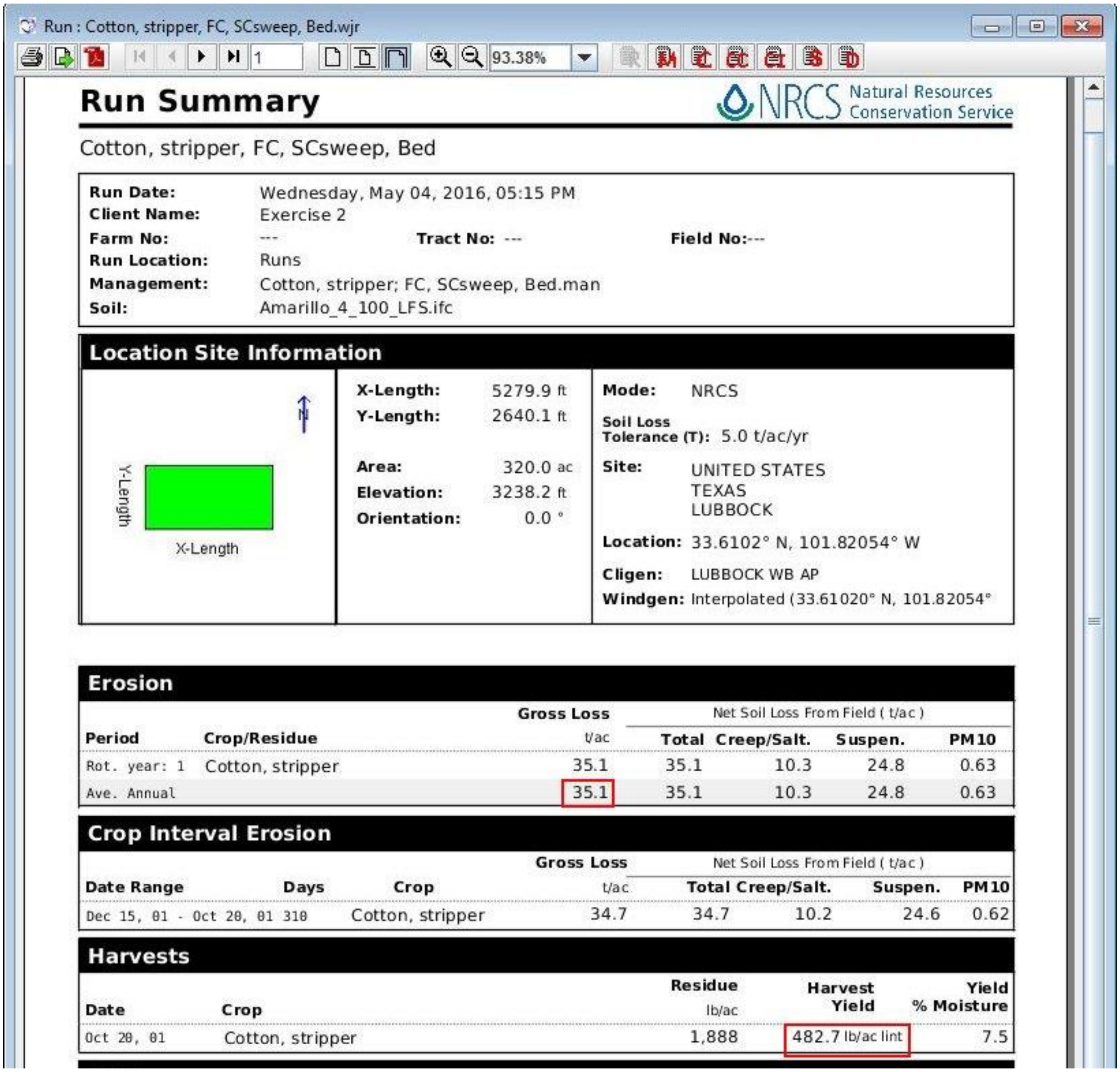


Figure 4-15 The WEPS interface loaded for Exercise 2 initial run.



Run : Cotton, stripper, FC, SCsweep, Bed.wjr

Run Summary

NRCS Natural Resources Conservation Service

Cotton, stripper, FC, SCsweep, Bed

Run Date:	Wednesday, May 04, 2016, 05:15 PM
Client Name:	Exercise 2
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	Runs
Management:	Cotton, stripper; FC, SCsweep, Bed.man
Soil:	Amarillo_4_100_LFS.ifc

Location Site Information

Y-Length / X-Length / N

X-Length:	5279.9 ft
Y-Length:	2640.1 ft
Area:	320.0 ac
Elevation:	3238.2 ft
Orientation:	0.0 °
Mode:	NRCS
Soil Loss Tolerance (T):	5.0 t/ac/yr
Site:	UNITED STATES TEXAS LUBBOCK
Location:	33.6102° N, 101.82054° W
Cligen:	LUBBOCK WB AP
Windgen:	Interpolated (33.61020° N, 101.82054°

Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Cotton, stripper	35.1	35.1	10.3	24.8	0.63
Ave. Annual		35.1	35.1	10.3	24.8	0.63

Crop Interval Erosion

Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Dec 15, 01 - Oct 20, 01	310	Cotton, stripper	34.7	34.7	10.2	24.6	0.62

Harvests

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Oct 20, 01	Cotton, stripper	1,888	482.7 lb/ac lint	7.5

Figure 4-16 Cropped WEPS Summary Report showing average annual soil loss and the yield of lint.

The continuous Cotton run gave a 35.1 t/ac/yr soil loss. **How much cotton lint is harvested? Answer:** 482.7 lbs/ac/yr. The inventory states that we should have 375 lbs/ac lint. Is this different enough to calibrate the cotton yield? Yes, because the predicted Harvest Yield exceeds the Expected Yield by greater than 5%. Following what was learned in Exercise 1, calibrate the yield to **375 lbs/ac lint**. After the calibration run has completed, a Biomass Adjustment Factor of **0.8594** is displayed. Select *Use in Current Project.* The new harvest yield estimate is realistic at 386.7 lbs/ac lint, but soil loss is even more excessive at 48.2 t/ac/yr.

What can be done when the soil loss is too high? Let's consider some options for lowering soil loss.

What is the total residue (flat mass) at planting time? Hint: Open the Detailed Report and check the total flat mass of residue at that time on the Erosion & Crop Veg Res & Biomass (details) report.
Answer: About 82 lbs/ac and 2% surface cover (Figure 4-17) are present at planting.

Tabular Detail Report - Cotton, stripper, FC, SCsweep, Bed_calib_calib.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Run: Cotton, stripper, FC, SCsweep, Bed_calib_calib
Client: Exercise 2
Fm: Tr: Fld:
Management: Cotton, stripper; FC, SCsweep, Bed_calib
Soil: Amarillo_4_100_LFS

Date	Operation	Crop	Erosion: Average Total Gross Soil Loss (t/ac)	Crop Vegetation: Canopy Cover (fraction)	Crop Vegetation: Effective Standing Silhouette (ft²/ft²)	Crop Vegetation: Leaf and Stem Mass (lbs/acre)	Crop Vegetation: Root Mass (lbs/acre)	Crop Vegetation: Crop Height (in)	Crop Vegetation: Number Crop Stems (#/ac)	Crop Residue: Surface Cover (fraction)	Crop Residue: Effective Standing Silhouette (ft²/ft²)	Crop Residue: Flat Mass (lbs/acre)	Crop Residue: Standing Mass (lbs/acre)	Crop Residue: Buried Mass (lbs/acre)
Jan 1-14, 01			2.0	0.00	0.00	0	0	0	0	0.13	0.01	582	63	836
Jan 15-31, 01			2.9	0.00	0.00	0	0	0	0	0.12	0.01	554	63	815
Feb 1-14, 01			3.3	0.00	0.00	0	0	0	0	0.12	0.01	530	62	792
Feb 15-29, 01	Chisel, sweep shovel		2.7	0.00	0.00	0	0	0	0	0.09	0.00	417	49	869
Mar 1-14, 01			11.5	0.00	0.00	0	0	0	0	0.09	0.00	397	48	831
Mar 15-31, 01	Bedder, hipper, disk hiller		8.2	0.00	0.00	0	0	0	0	0.02	0.00	82	4	1101
Apr 1-14, 01			3.5	0.00	0.00	0	0	0	0	0.02	0.00	79	3	1022
Apr 15-30, 01			5.8	0.00	0.00	0	0	0	0	0.02	0.00	74	1	926
May 1-14, 01			0.8	0.00	0.00	0	0	0	0	0.02	0.00	70	0	835
May 15-31, 01	Planter, double disk opener on	Cotton, stripper	1.5	0.01	0.00	8	8	0	32501	0.02	0.00	67	0	722
Jun 1-14, 01			0.3	0.06	0.00	29	31	1	32501	0.01	0.00	62	0	641
Jun 15-19, 01			1.2	0.10	0.00	49	52	1	32501	0.01	0.00	59	0	615
Jun 20-30, 01	Cultivator, row 3 in ridge		1.6	0.29	0.01	145	148	3	32501	0.01	0.00	46	0	557
Jul 1-14, 01			0.0	0.64	0.13	468	444	10	32501	0.01	0.00	43	0	501
Jul 15-31, 01	Cultivator, row 3 in ridge		0.0	0.77	0.23	894	796	17	32501	0.01	0.00	34	0	422
Aug 1-14, 01			0.0	0.78	0.24	1025	891	18	32501	0.01	0.00	30	0	373
Aug 15-31, 01			0.0	0.78	0.24	1145	774	18	32501	0.01	0.00	28	0	321
Sep 1-14, 01			0.0	0.76	0.23	1234	637	18	32501	0.01	0.00	25	0	285
Sep 15-30, 01			0.0	0.67	0.17	1288	517	18	32501	0.01	0.00	22	0	252
Oct 1-14, 01			0.0	0.61	0.14	1282	477	18	32501	0.01	0.00	21	0	233
Oct 15-19, 01			0.0	0.61	0.14	1282	477	18	32501	0.00	0.00	21	0	228
Oct 20-31, 01	Harvest, cotton	Cotton, stripper	0.0	0.58	0.12	1154	477	18	29251	0.04	0.00	161	0	216
Nov 1-14, 01			0.0	0.58	0.12	1154	477	18	29251	0.04	0.00	153	0	207
Nov 15-30, 01			0.0	0.58	0.12	1154	477	18	29251	0.03	0.00	145	0	199
Dec 1-14, 01	Shredder, flail or rotary		1.4	0.00	0.01	87	477	2	29251	0.27	0.00	1355	0	194
Dec 15-31, 01	Chisel, st. pt		1.5	0.00	0.00	0	0	0	0	0.13	0.01	614	65	866
Rot. yr: 1			48.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ave. Annual			48.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 4-17 Detailed Report showing loss and residue at the planting and vegetative material at harvest.

What management period has the highest erosion loss?
Answer: After the *Chisel, sweep, shovel operation* (Mar 1-14, 01), **11.5 tons/ac** in the period right before planting (Figure 4-17).

How much total residue do we have after the *Shredder, flail or rotary* operation?
Answer: The residue after shredding is **1441 lbs/ac** (87 leaf and stem [crop] + 1355 lbs/ac flat mass [residue] + 0 lbs/ac standing mass [residue]) (Figure 4-17).

Note: Cotton in this case was not killed by the stripper harvest so some of the biomass is still listed under the crop columns. Cotton is a perennial so the harvest and the shredding **does not** kill the crop. However, frost or tillage would kill the crop. If a defoliant was used before harvest, the leaf residue would have shown up at that time. Cotton does not produce enough residue by itself to control the erosion. After the *Chisel, st. pt* the crop is killed, Dec 1 and there is now only 65 lbs/ac of standing residue left in the field.

We will add sorghum to the rotation to see how it affects the residue and erosion rates.

Adding a Crop to a Rotation

Close all the report windows, leaving only the main interface window open. Click the 'Man' button Man to open the MCREW management editor.

Step 1: Right-click the last row in the Operation Name column of the cotton file. Select *Insert Management* and double-click the *Example Mgt. files* directory. Choose *Sorghum,Grain;MT,CMZ19.man* and click the Select button Select.

Note: The sorghum crop comes into the rotation in the second year, yet the dates are correct, because both single management files have all their tillage in one year, (not 0 and 1 as with some RUSLE2 files) with fall tillage. The dates seem reasonable. Be sure to click the Yield Calibration button and enter **25 bu/ac** yield as expected for the new sorghum crop. Check that you have 375 lbs/ac yield for the cotton and that both "Calib. Yield?" boxes are checked.

Step 2: The file must be saved with a new name. The rotation name in the Rotation box has turned blue, showing that it has been modified (Figure 4-18).

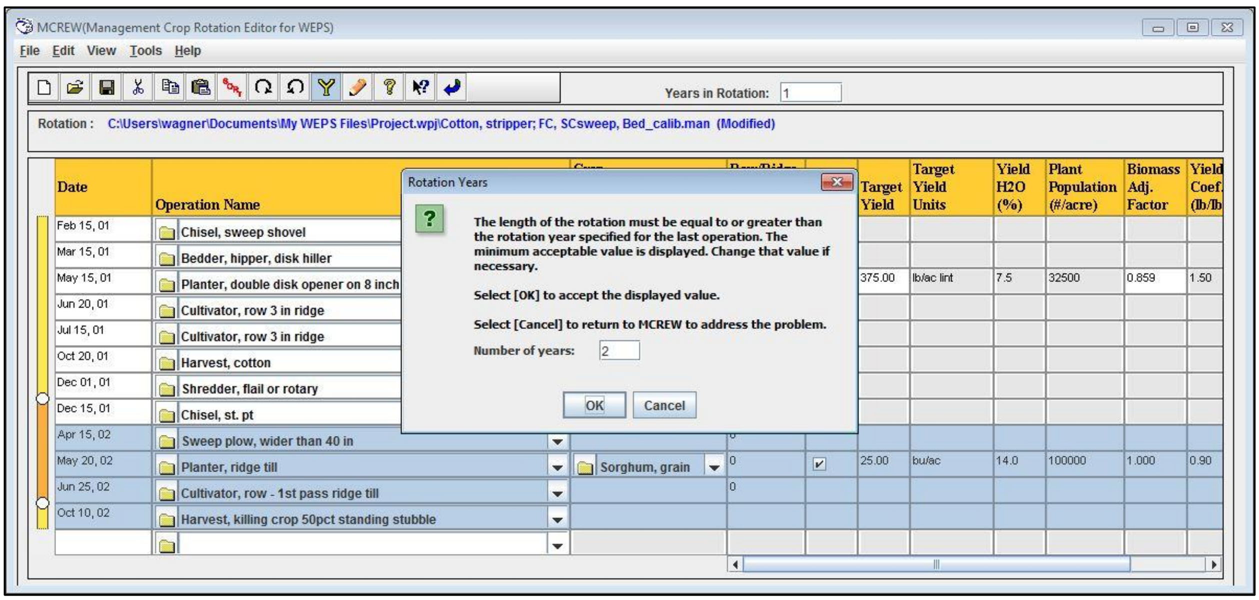
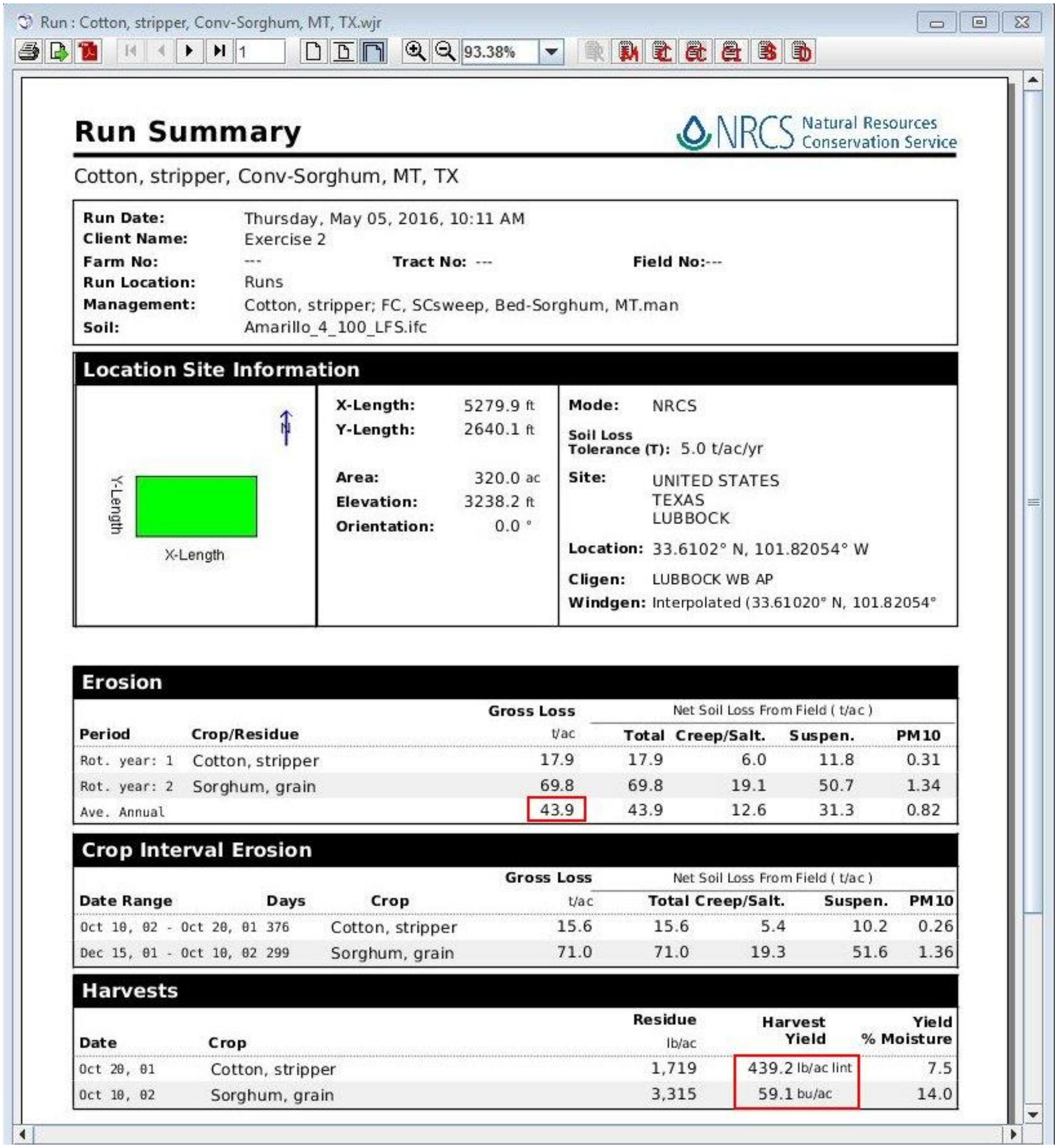


Figure 4-18 MCREW will ask for a number of rotation years if a crop was added with dates that increase the number of years.

Click *File* then *Save as....* Notice MCREW has detected that we only have "1" in the year box (Figure 4-18). We must either change the value in the box to a number other than 1 or accept 2. Click *OK* to accept the change to a 2 year rotation. MCREW then asks for a new name for the 2 year rotation. Enter **Cotton, Stripper; FC, SCsweep-Sorghum, MT.man**, and click 'Save'. Note that it saved the new 2 year rotation to the *C:\Users\user.name\Documents\My WEPS Files\ Project.wpj* where *user.name* refers to the user's login name on the computer. This default location applies to NRCS Field Office configured versions of WEPS running Windows 7. Other WEPS configurations and operating systems may vary as to the location of this directory. This is a temporary working directory. To save this as a local template management file, you must (in MCREW) click 'file,' 'save as Template…', and 'save.' You have the option to either change the name or leave it as it was. It will be stored in the *C:\Program Data\USDA\WEPS\Databases\nrcs\man\local* folder. Again, this default location applies to NRCS Field Office configured versions of WEPS running Microsoft Windows 7. Other WEPS configurations and operating systems may vary as to the location of this directory. You may wish to post it to a shared server site if others in your work group can use the same management.

Step 3: Make the new **non-calibrated** run since we previously calibrated the cotton yeild. This time let's see if WEPS will give us an appropriate yield for the sorghum in this rotation. Return to the main interface by clicking the Close button  . Click the Run button  and call the run **Cotton, stripper, Conv-Sorghum, MT, TX**.

What is the soil loss?
Answer: The Run Summary shows an unacceptable predicted average loss of **43.9 t/ac/yr** (Figure 4-19). The yields for both crops are also too high at **439.2 lb/ac** of Cotton lint and **59.1 bu/ac** for Sorghum grain.



Run : Cotton, stripper, Conv-Sorghum, MT, TX.wjr

Run Summary

Natural Resources Conservation Service

Cotton, stripper, Conv-Sorghum, MT, TX

Run Date: Thursday, May 05, 2016, 10:11 AM
Client Name: Exercise 2
Farm No: --- **Tract No:** --- **Field No:**---
Run Location: Runs
Management: Cotton, stripper; FC, SCsweep, Bed-Sorghum, MT.man
Soil: Amarillo_4_100_LFS.ifc

Location Site Information

X-Length: 5279.9 ft
Y-Length: 2640.1 ft
Area: 320.0 ac
Elevation: 3238.2 ft
Orientation: 0.0 °

Mode: NRCS
Soil Loss Tolerance (T): 5.0 t/ac/yr
Site: UNITED STATES TEXAS LUBBOCK
Location: 33.6102° N, 101.82054° W
Cligen: LUBBOCK WB AP
Windgen: Interpolated (33.61020° N, 101.82054°

Erosion

		Gross Loss	Net Soil Loss From Field (t/ac)			
Period	**Crop/Residue**	t/ac	**Total**	**Creep/Salt.**	**Suspen.**	**PM10**
Rot. year: 1	Cotton, stripper	17.9	17.9	6.0	11.8	0.31
Rot. year: 2	Sorghum, grain	69.8	69.8	19.1	50.7	1.34
Ave. Annual		43.9	43.9	12.6	31.3	0.82

Crop Interval Erosion

			Gross Loss	Net Soil Loss From Field (t/ac)			
Date Range	**Days**	**Crop**	t/ac	**Total**	**Creep/Salt.**	**Suspen.**	**PM10**
Oct 10, 02 - Oct 20, 01	376	Cotton, stripper	15.6	15.6	5.4	10.2	0.26
Dec 15, 01 - Oct 10, 02	299	Sorghum, grain	71.0	71.0	19.3	51.6	1.36

Harvests

Date	**Crop**	**Residue** lb/ac	**Harvest Yield**	**Yield % Moisture**
Oct 20, 01	Cotton, stripper	1,719	439.2 lb/ac lint	7.5
Oct 10, 02	Sorghum, grain	3,315	59.1 bu/ac	14.0

Figure 4-19 Cropped WEPS Run Summary screen showing the soil loss and the yields without calibration.

Close the run summary and make a calibrated run by clicking the Calibrate Run button. Name this run *Cotton, stripper, Conv-Sorghum, MT, TX_calib.* Click *Use in the Current Project* (Figure 4-20).

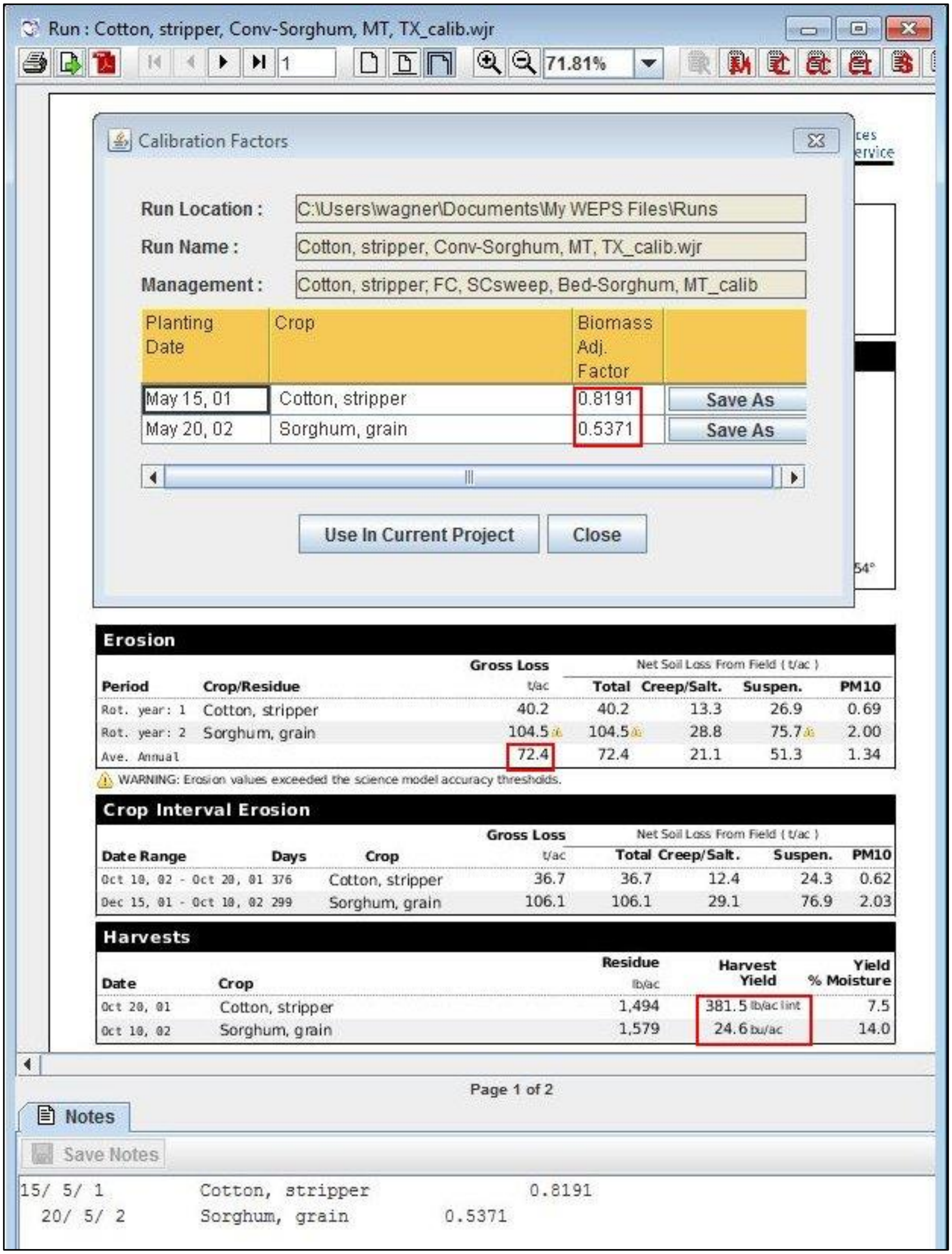
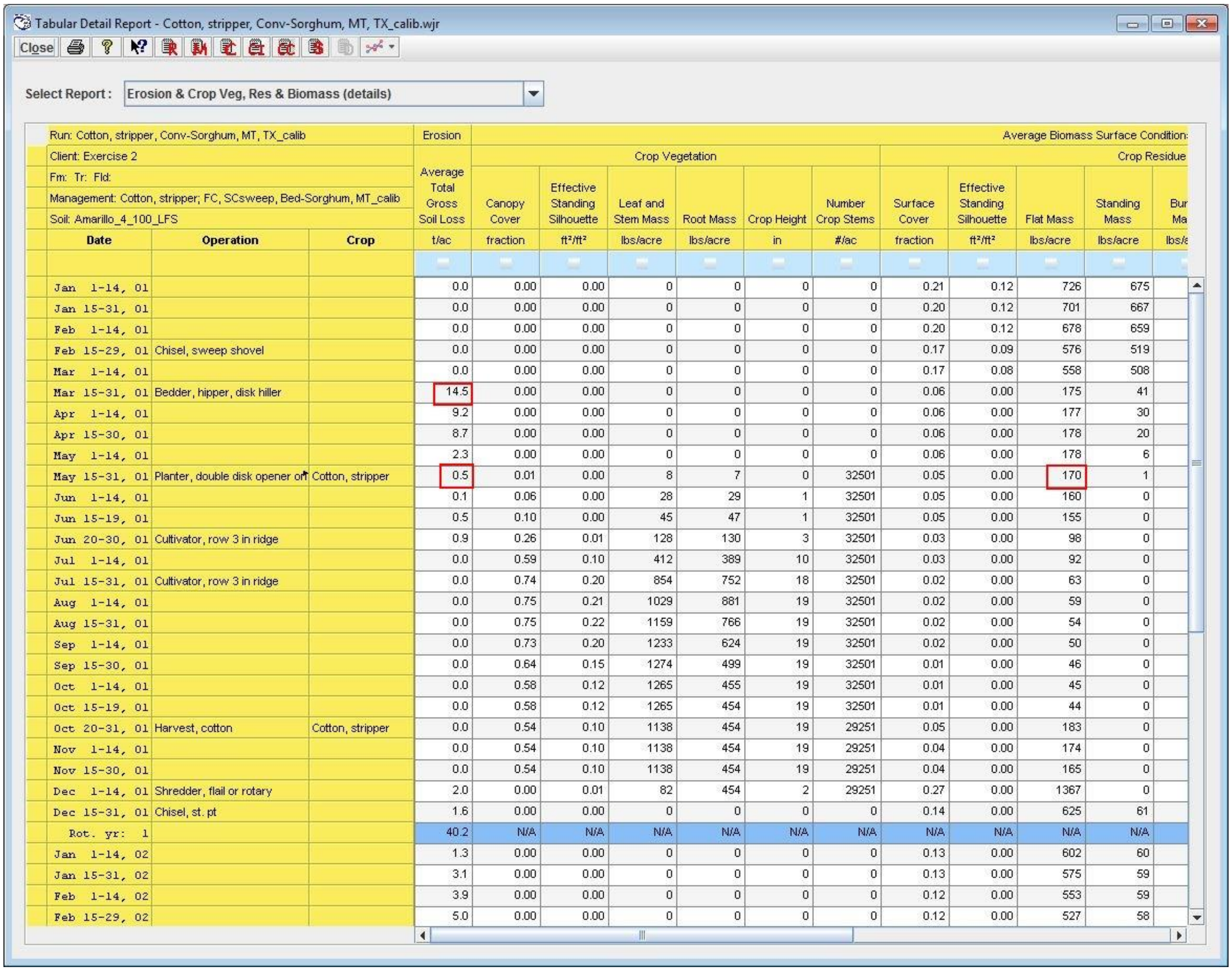


Figure 4-20 Calibration window and Run Summary Report showing Biomass Adjustment Factors for each crop.

Predicted yields for the calibration run are reasonable at 381.5 lb/ac cotton lint and 24.6 bu/ac sorghum. The problem of yield overestimation is resolved, but soil loss is even higher now at 72.4 t/ac (Figure 4-20)

How much flat mass do we have now after planting Cotton on the detailed report?
Answer: Remember to click the Detailed Report and select the Erosion and Crop Veg, Res & Biomass (details) screen (default). On May 15-31, there is about **170 lbs/ac** flat mass, and the erosion rate is **0.5 tons/ac** at cotton planting (Figure 4-21).



			Erosion	Average Biomass Surface Condition:										
				Crop Vegetation						Crop Residue				
Date	Operation	Crop	Average Total Gross Soil Loss t/ac	Canopy Cover fraction	Effective Standing Silhouette ft²/ft²	Leaf and Stem Mass lbs/acre	Root Mass lbs/acre	Crop Height in	Number Crop Stems #/ac	Surface Cover fraction	Effective Standing Silhouette ft²/ft²	Flat Mass lbs/acre	Standing Mass lbs/acre	Bur Ma lbs/a
Jan 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.21	0.12	726	675	
Jan 15-31, 01			0.0	0.00	0.00	0	0	0	0	0.20	0.12	701	667	
Feb 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.20	0.12	678	659	
Feb 15-29, 01	Chisel, sweep shovel		0.0	0.00	0.00	0	0	0	0	0.17	0.09	576	519	
Mar 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.17	0.08	558	508	
Mar 15-31, 01	Bedder, hipper, disk hiller		14.5	0.00	0.00	0	0	0	0	0.06	0.00	175	41	
Apr 1-14, 01			9.2	0.00	0.00	0	0	0	0	0.06	0.00	177	30	
Apr 15-30, 01			8.7	0.00	0.00	0	0	0	0	0.06	0.00	178	20	
May 1-14, 01			2.3	0.00	0.00	0	0	0	0	0.06	0.00	178	6	
May 15-31, 01	Planter, double disk opener or	Cotton, stripper	0.5	0.01	0.00	8	7	0	32501	0.05	0.00	170	1	
Jun 1-14, 01			0.1	0.06	0.00	28	29	1	32501	0.05	0.00	160	0	
Jun 15-19, 01			0.5	0.10	0.00	45	47	1	32501	0.05	0.00	155	0	
Jun 20-30, 01	Cultivator, row 3 in ridge		0.9	0.26	0.01	128	130	3	32501	0.03	0.00	98	0	
Jul 1-14, 01			0.0	0.59	0.10	412	389	10	32501	0.03	0.00	92	0	
Jul 15-31, 01	Cultivator, row 3 in ridge		0.0	0.74	0.20	854	752	18	32501	0.02	0.00	63	0	
Aug 1-14, 01			0.0	0.75	0.21	1029	881	19	32501	0.02	0.00	59	0	
Aug 15-31, 01			0.0	0.75	0.22	1159	766	19	32501	0.02	0.00	54	0	
Sep 1-14, 01			0.0	0.73	0.20	1233	624	19	32501	0.02	0.00	50	0	
Sep 15-30, 01			0.0	0.64	0.15	1274	499	19	32501	0.01	0.00	46	0	
Oct 1-14, 01			0.0	0.58	0.12	1265	455	19	32501	0.01	0.00	45	0	
Oct 15-19, 01			0.0	0.58	0.12	1265	454	19	32501	0.01	0.00	44	0	
Oct 20-31, 01	Harvest, cotton	Cotton, stripper	0.0	0.54	0.10	1138	454	19	29251	0.05	0.00	183	0	
Nov 1-14, 01			0.0	0.54	0.10	1138	454	19	29251	0.04	0.00	174	0	
Nov 15-30, 01			0.0	0.54	0.10	1138	454	19	29251	0.04	0.00	165	0	
Dec 1-14, 01	Shredder, flail or rotary		2.0	0.00	0.01	82	454	2	29251	0.27	0.00	1367	0	
Dec 15-31, 01	Chisel, st. pt		1.6	0.00	0.00	0	0	0	0	0.14	0.00	625	61	
Rot. yr: 1			40.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Jan 1-14, 02			1.3	0.00	0.00	0	0	0	0	0.13	0.00	602	60	
Jan 15-31, 02			3.1	0.00	0.00	0	0	0	0	0.13	0.00	575	59	
Feb 1-14, 02			3.9	0.00	0.00	0	0	0	0	0.12	0.00	553	59	
Feb 15-29, 02			5.0	0.00	0.00	0	0	0	0	0.12	0.00	527	58	

Figure 4-21 Detailed Report showing soil loss and flat mass.

What is the date of the first erosion period after harvest of the sorghum?
Answer: After the Bedder, hipper, disk hiller, '**Mar 15-31, 01**' at 14.5 tons/ac/yr (Figure 4-21).

The average annual wind erosion of 72.4 tons/ac is still too high. Reduced tillage may save a considerable amount of soil.

Reduced Tillage

Let’s try one last set of adjustments to our set of runs. We know cotton is glyphosate ready for weed control, and strip-till works for cotton. We also know that standing residue is much more effective than flat residue at controlling erosion. We will start with the last run and reduce some of the tillage. Close the report windows, leaving only the main interface window open.

Step 1: Click the ‘Man’ button on the main interface. Be sure that you have the *Cotton,Stripper; FC,SCsweep*, *Bed-Sorghum*, *MT_calib.man* file loaded. We are going to change, remove, or replace most of the tillage operations. Pressing and holding the Control Key on your keyboard while clicking enables you to select nonconsecutive operations. When all unnecessary operations are highlighted, right-click under the Operation Name column to select “Delete row(s)” as shown in Figure 4-22.

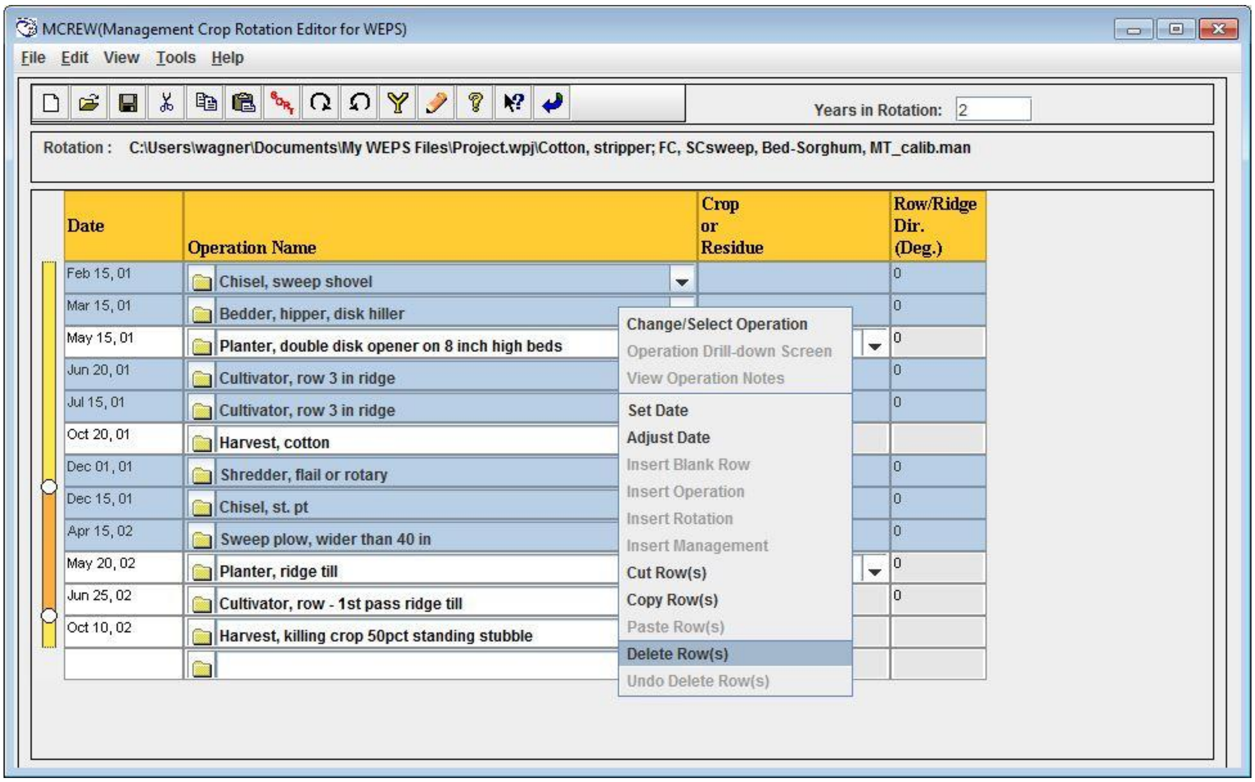


Figure 4-22 Removing excess tillage operations.

Step 2: Change the standard planter for the cotton from *Planter*, *double disk* to *Planter*, *ridge till* by clicking the drop-down arrow  on the *Planter double disk* row and first selecting the *Seeding*, planter folder and then selecting the *Planter*, *ridge till* operation (Figure 4-23).

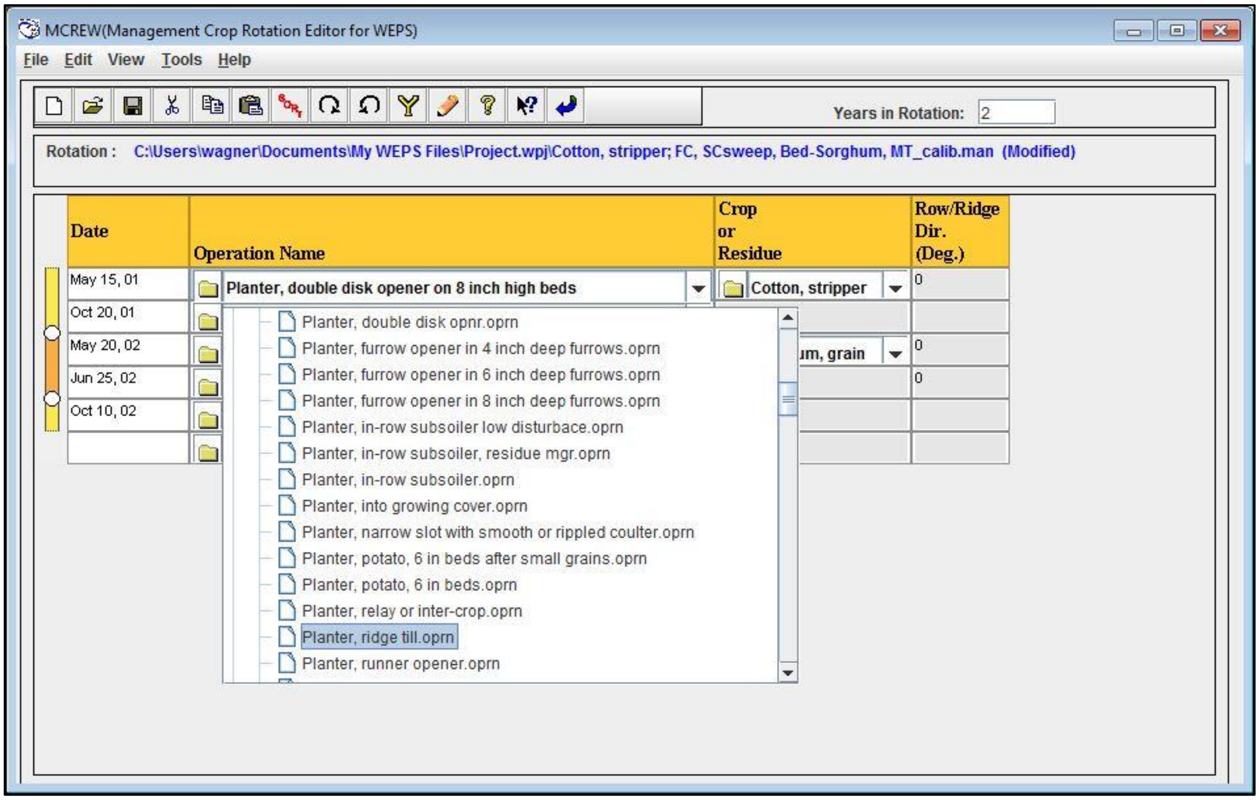


Figure 4-23 Illustration of changing operations.

Step 3: In the same way, change *Cultivator, row – 1st pass ridge till* on June 25 to *Sprayer, post emergence* (under the *Application, agchem, nutrient row* folder).

Step 4: Add alternative operations. Right-click the May 15 operation *Planter, ridge till* and select *Insert Operation*. Double-click the *Tillage, seedbed, beds* folder and scroll to find *Strip till bed conditioner* operation (Figure 4-24). Once selected, this operation will be placed above the operation name you clicked to insert it. They will also share the same date as the operation above it (or below it if it is the one at the top) until modified appropriately.

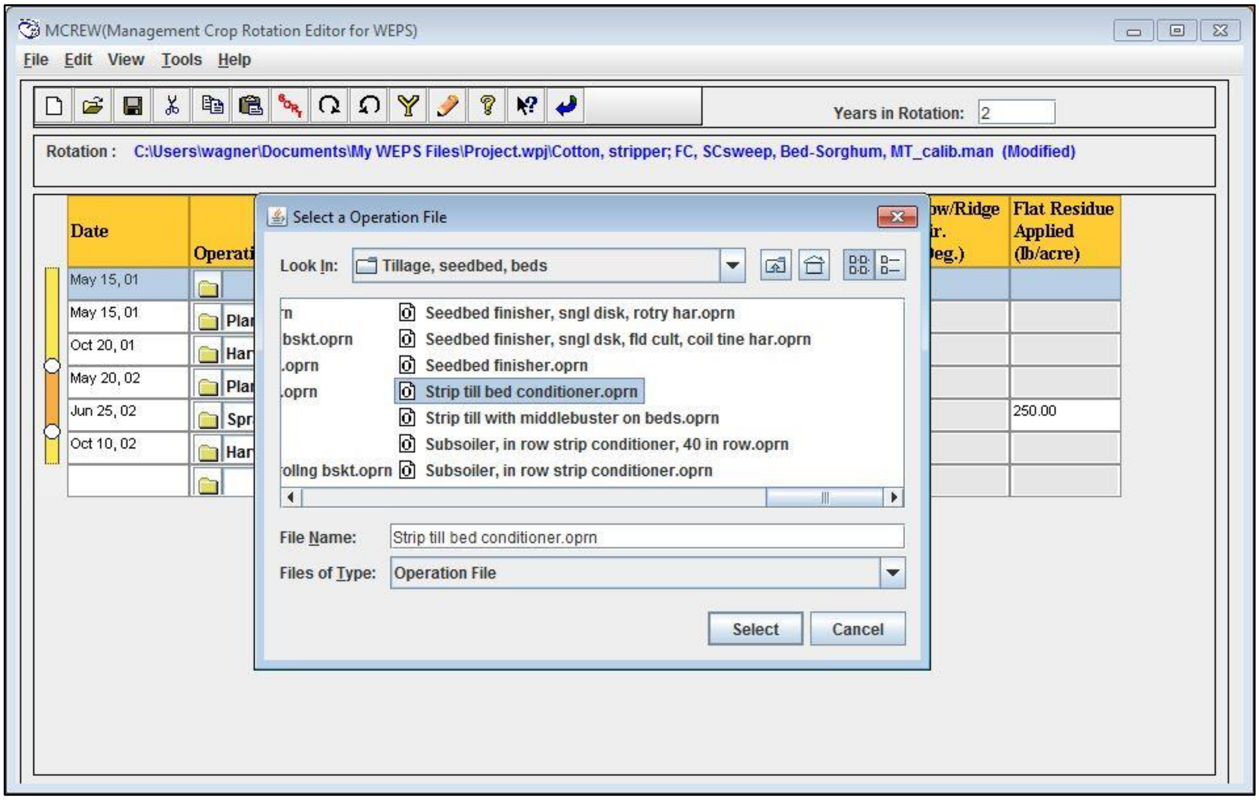


Figure 4-24 Inserting Operation into MCREW.

Step 5: Continue to delete, change or add operations until the MCREW matches Figure 4-25, e.g. add another *Strip till bed conditioner* operation following the cotton harvesting operation.

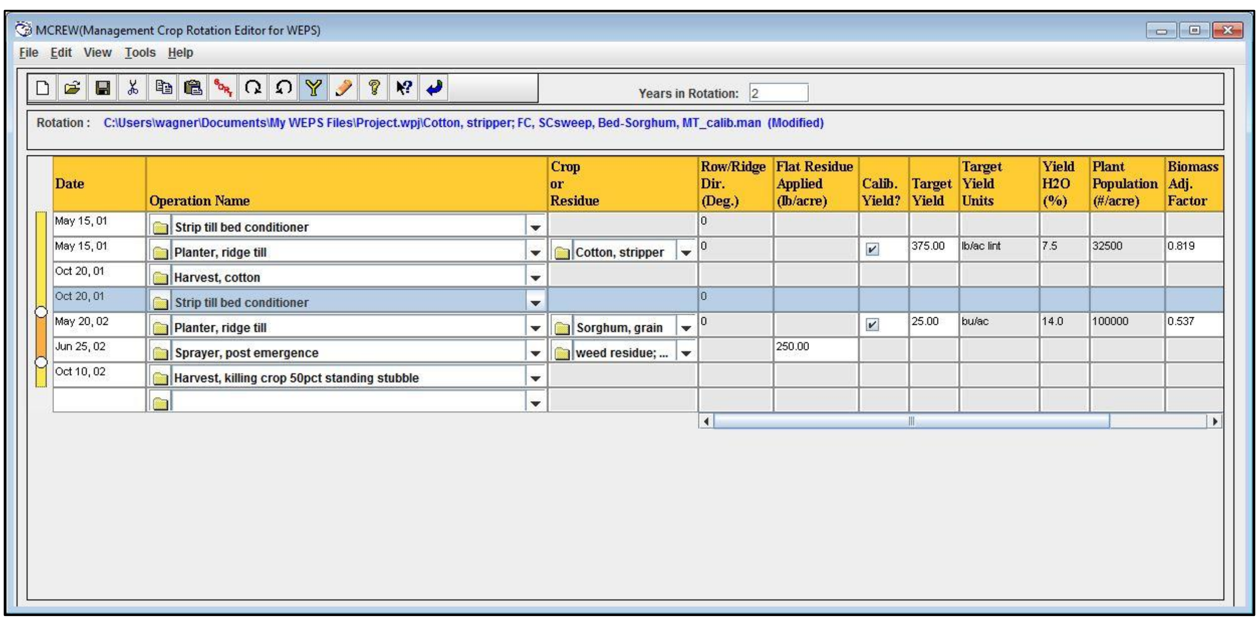


Figure 4-25 Window showing all dates and operations for the reduced tillage ridge till alternative calibration run.

Be sure the yields are set to 375 lbs/ac for cotton and 25 bu/ac for sorghum. Save the new file as *Cotton, stripper, striptill-Sorghum, striptill CMZ19,* and close MCREW to return to the interface.

Note: In the future you may decide that a new management file is worthy of addition to what is known as the Local Management subdirectory. To do this, follow these steps:

1) Start with the edited and tested management file loaded in MCREW. It must have any Biomass Adjustment Factors to make the run for that locality where it will be used.
2) The default location to save a Template Management Local file is *C:\Program Data\USDA\WEPS\Databases\db\man\NRCS\local*.
3) Save the file by clicking 'File,' then 'Save as Template', and navigate to the above directory. Use the name you have given it or one consistent with any naming conventions the FO has chosen to use.
4) Click 'Save'.

Note: NRCS field offices are able to save templates to a networked server drive. The user must create a subdirectory in order to store runs for an individual farm or customer. This allows the local work group to have access to any locally made records.

Step 5: Make the calibrated run, since there were major revisions to the tillage. Call it *Cotton, stripper, striptill-Sorghum, striptill CMZ19_calib.* When the run is complete and the factors are displayed, click 'Use in Current Project' in the Calibration Factors window.

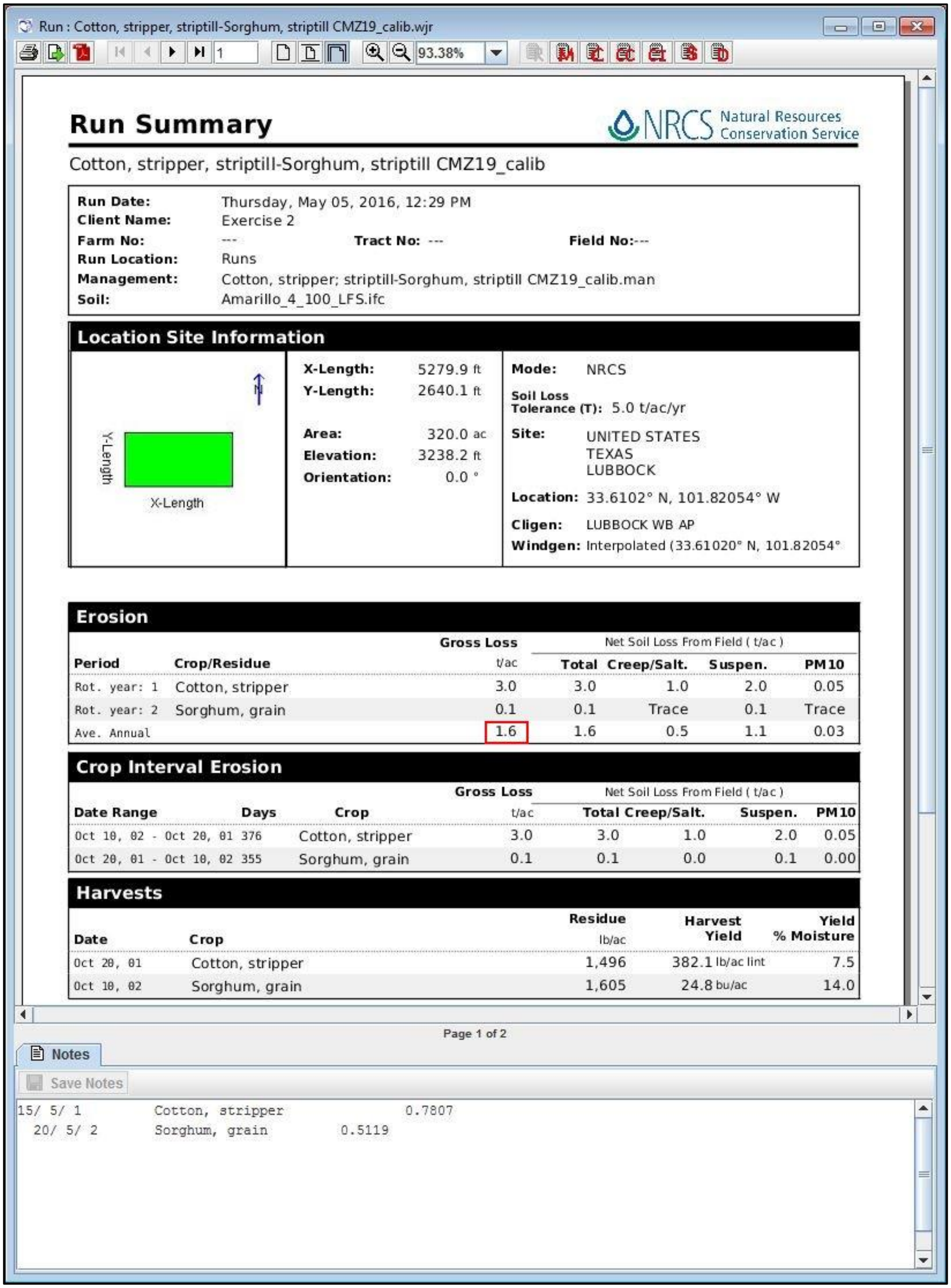
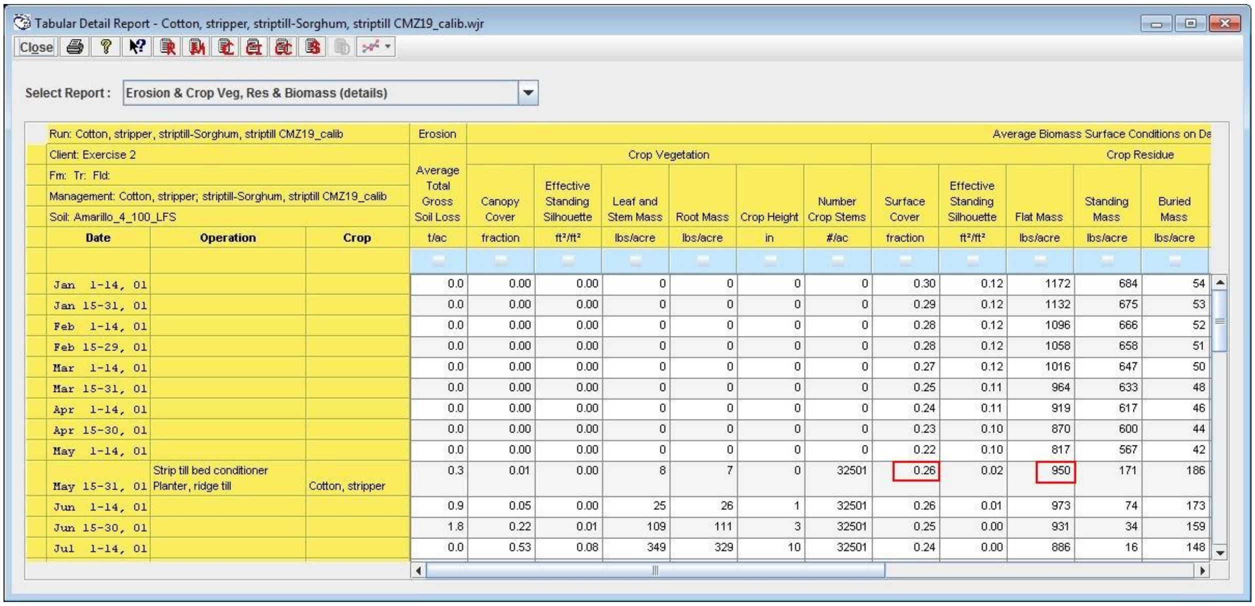


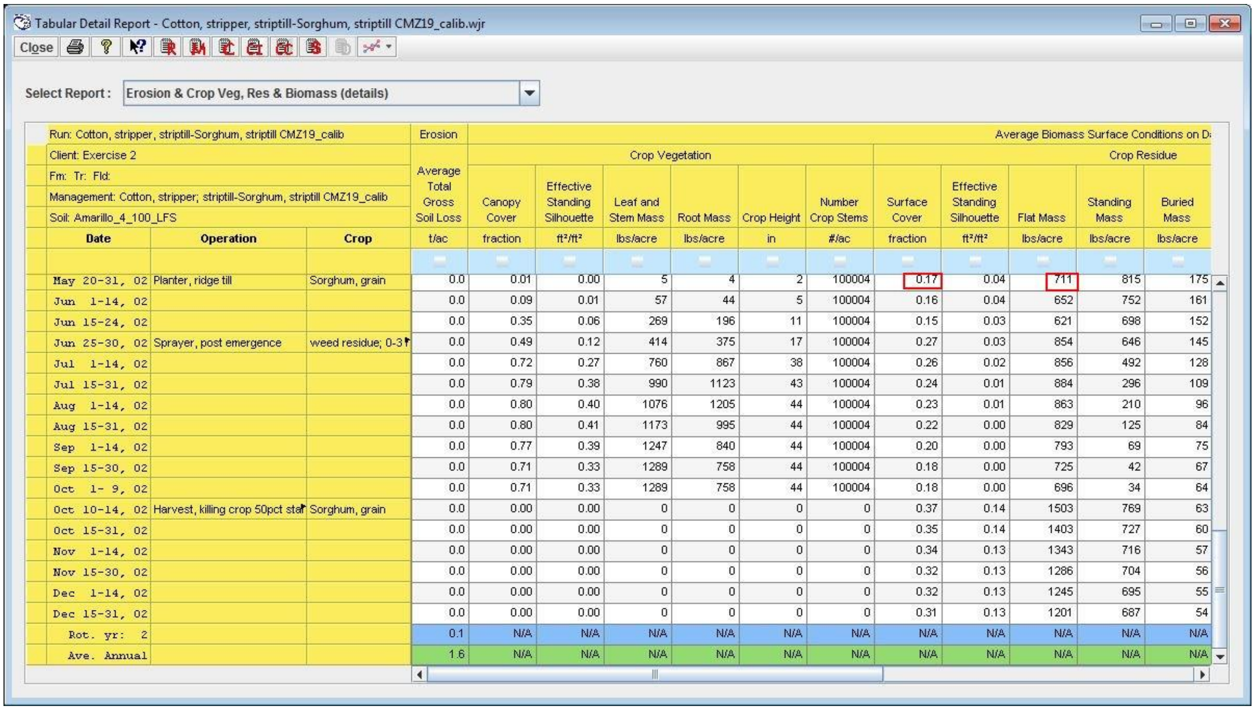
Figure 4-26 Run summary showing Average Annual Soil Loss of 1.58 tons/acre.

Average Annual Soil Loss is now predicted to be only **1.6 tons/ac** (Figure 4-26). This run shows that it is possible to effectively control erosion using a cotton-sorghum rotation as designed in Figure 4-25. Leaving the cotton stalks standing is very effective at controlling wind erosion. The Detailed Report shows there is **950 lbs/ac Flat Mass** and **26% Surface Cover** of sorghum residue after planting cotton ((Figure 4-27), and **711 lbs/ac Flat Mass** and **17% Surface Cover** of cotton residue after planting sorghum (Figure 4-27).



Date	Operation	Crop	Average Total Gross Soil Loss (t/ac)	Canopy Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Leaf and Stem Mass (lbs/acre)	Root Mass (lbs/acre)	Crop Height (in)	Number Crop Stems (#/ac)	Surface Cover (fraction)	Effective Standing Silhouette (ft²/ft²)	Flat Mass (lbs/acre)	Standing Mass (lbs/acre)	Buried Mass (lbs/acre)
Jan 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.30	0.12	1172	684	54
Jan 15-31, 01			0.0	0.00	0.00	0	0	0	0	0.29	0.12	1132	675	53
Feb 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.28	0.12	1096	666	52
Feb 15-29, 01			0.0	0.00	0.00	0	0	0	0	0.28	0.12	1058	658	51
Mar 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.27	0.12	1016	647	50
Mar 15-31, 01			0.0	0.00	0.00	0	0	0	0	0.25	0.11	964	633	48
Apr 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.24	0.11	919	617	46
Apr 15-30, 01			0.0	0.00	0.00	0	0	0	0	0.23	0.10	870	600	44
May 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.22	0.10	817	567	42
May 15-31, 01	Strip till bed conditioner Planter, ridge till	Cotton, stripper	0.3	0.01	0.00	8	7	0	32501	0.26	0.02	950	171	186
Jun 1-14, 01			0.9	0.05	0.00	25	26	1	32501	0.26	0.01	973	74	173
Jun 15-30, 01			1.8	0.22	0.01	109	111	3	32501	0.25	0.00	931	34	159
Jul 1-14, 01			0.0	0.53	0.08	349	329	10	32501	0.24	0.00	886	16	148

Figure 4-27 Tabular Detail Report showing surface cover needed to meet the Soil Loss Tolerance, year 1 Cotton stripper, ridge till.



Tabular Detail Report - Cotton, stripper, striptill-Sorghum, striptill CMZ19_calib.wjr

Close

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Run: Cotton, stripper, striptill-Sorghum, striptill CMZ19_calib
Client: Exercise 2
Fm: Tr: Fld:
Management: Cotton, stripper; striptill-Sorghum, striptill CMZ19_calib
Soil: Amarillo_4_100_LFS

			Erosion	Average Biomass Surface Conditions on D:										
				Crop Vegetation						Crop Residue				
			Average Total Gross Soil Loss	Canopy Cover	Effective Standing Silhouette	Leaf and Stem Mass	Root Mass	Crop Height	Number Crop Stems	Surface Cover	Effective Standing Silhouette	Flat Mass	Standing Mass	Buried Mass
Date	Operation	Crop	t/ac	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/acre	lbs/acre	lbs/acre
May 20-31, 02	Planter, ridge till	Sorghum, grain	0.0	0.01	0.00	5	4	2	100004	0.17	0.04	711	815	175
Jun 1-14, 02			0.0	0.09	0.01	57	44	5	100004	0.16	0.04	652	752	161
Jun 15-24, 02			0.0	0.35	0.06	269	196	11	100004	0.15	0.03	621	698	152
Jun 25-30, 02	Sprayer, post emergence	weed residue; 0-3	0.0	0.49	0.12	414	375	17	100004	0.27	0.03	854	646	145
Jul 1-14, 02			0.0	0.72	0.27	760	867	38	100004	0.26	0.02	856	492	128
Jul 15-31, 02			0.0	0.79	0.38	990	1123	43	100004	0.24	0.01	884	296	109
Aug 1-14, 02			0.0	0.80	0.40	1076	1205	44	100004	0.23	0.01	863	210	96
Aug 15-31, 02			0.0	0.80	0.41	1173	995	44	100004	0.22	0.00	829	125	84
Sep 1-14, 02			0.0	0.77	0.39	1247	840	44	100004	0.20	0.00	793	69	75
Sep 15-30, 02			0.0	0.71	0.33	1289	758	44	100004	0.18	0.00	725	42	67
Oct 1- 9, 02			0.0	0.71	0.33	1289	758	44	100004	0.18	0.00	696	34	64
Oct 10-14, 02	Harvest, killing crop 50pct sta	Sorghum, grain	0.0	0.00	0.00	0	0	0	0	0.37	0.14	1503	769	63
Oct 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.35	0.14	1403	727	60
Nov 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.34	0.13	1343	716	57
Nov 15-30, 02			0.0	0.00	0.00	0	0	0	0	0.32	0.13	1286	704	56
Dec 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.32	0.13	1245	695	55
Dec 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.31	0.13	1201	687	54
Rot. yr: 2			0.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ave. Annual			1.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 4-28 Tabular Detail Report showing surface cover needed to meet the Soil Loss Tolerance, year 2 Sorghum, ridge till.

Exercise 3 – Management Templates and Adding Irrigation

Skill Building: This exercise begins with a template management run of winter wheat and fallow. The user will make a run, calibrate the run with an alternative crop, some added operations, and finally, supplemental irrigation.

Exercise 3 Scenario

- The field is located in **Haakon County, South Dakota**.
- The **Cligen** station is **Milesville.**
- The **Windgen** station is **Interpolated**.
- The critical dominant Soil Map Unit is **CRAFT_Cv_85_VFSL**.
- The existing cropping system is **Winter Wheat-fallow**.
- The field is a **160 acre square,** oriented **45 degrees** from North.
- Management includes **fall chisel at a 45º angle** to the field borders after the winter wheat harvest, producing about 40 bu/ac/yr.
- The dry land yield for sudangrass added later should be 1.5 ton/ac/yr.

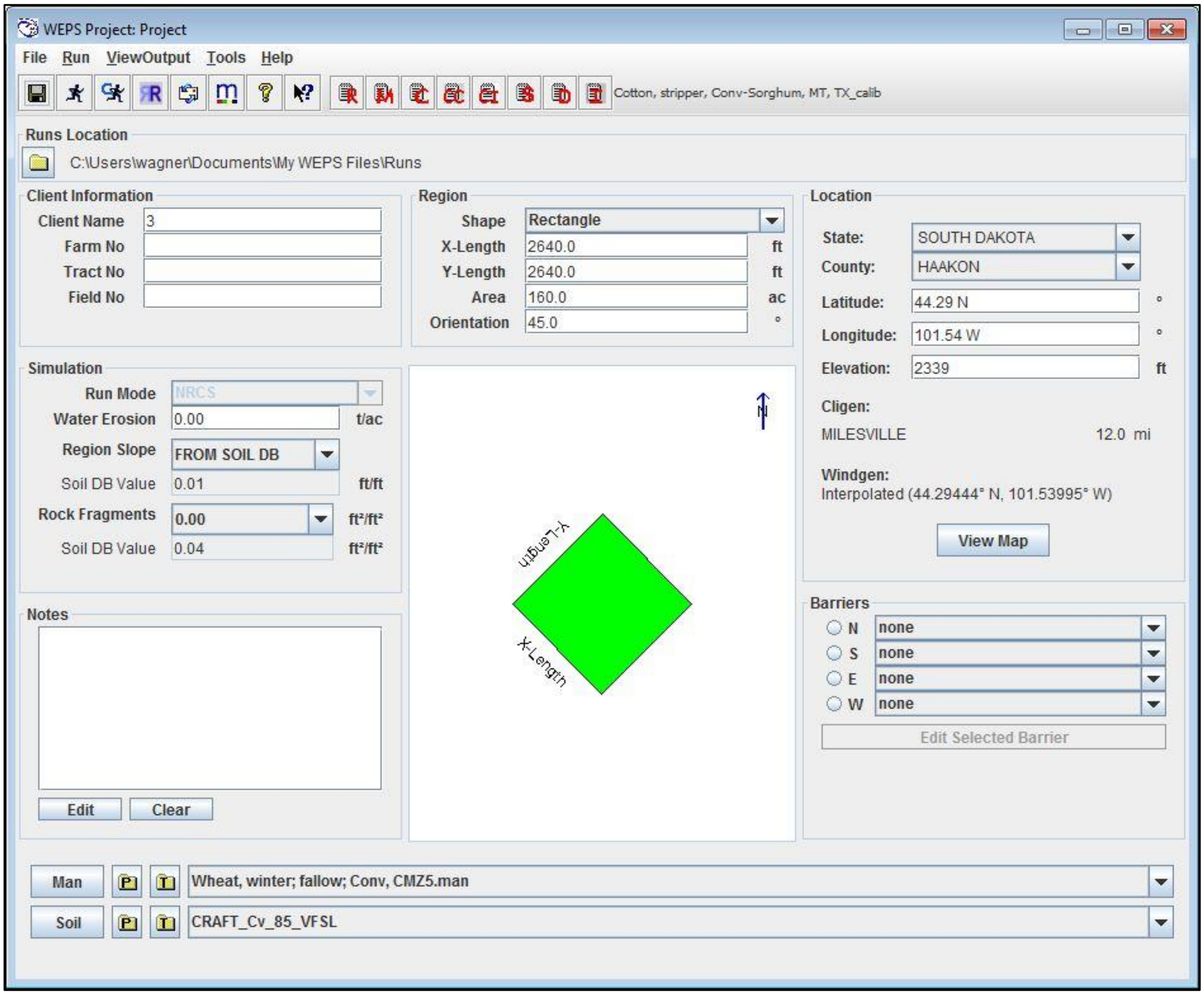


Figure 4-29 The WEPS interface set with the basic information for Exercise 3.

Complete the following steps:

Step 1: Enter all the data shown in Figure 4-29. Be sure to change the field Orientation to 45.0° in the Simulation Region information panel. You will see the field orientation rotate in the Field View panel. Open a template file by clicking the 'Man' dropdown button to the lower right of the screen. Scroll down to '*Templates*', then click *'Example Mgt. Files*', then select *Wheat, winter; fallow; Conv, CMZ5*.

Step 2: Open MCREW and see that the operations are set to 45° as well. If they are not already oriented, click and drag to highlight all the operations, right-click in the Row/Ridge Dir. (Deg.) column, and select *Set to 45 deg*.

Step 3: The fall chisel (Oct 20, 02) direction should be 0° or North because the field angle is 45°. If you do not make these changes, there will be a different result that what is presented in this exercise. Figure 4-30 displays the correct MCREW setup for this run.

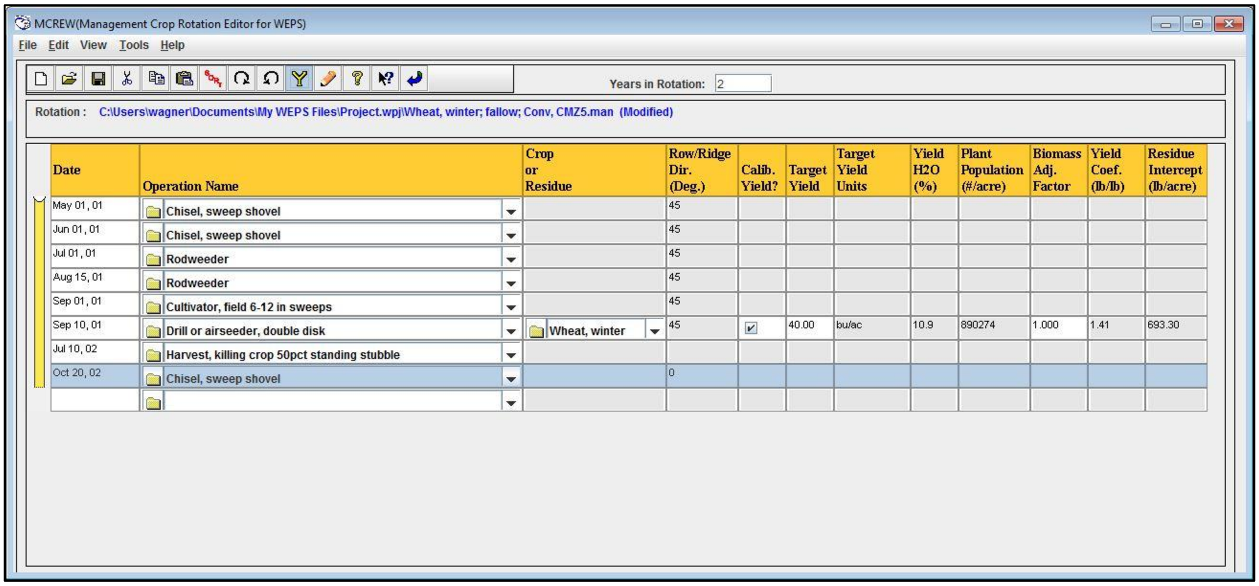


Figure 4-30 Management Crop Rotation Editor showing correct Row/Ridge direction.

Step 4: Click the Yield Calibrate button to turn on the yield function and ensure Target Yield is set to 40 bu/ac. Click the Return button to close MCREW and return to the WEPS interface.

Step 5: Make a Yield Calibration WEPS Run and name the run **WWheat-Fallow, Conv, CMZ5_calib**. On completion, the Biomass Adjustment Factor of **0.7656** is displayed. Click *Use in Current Project.*

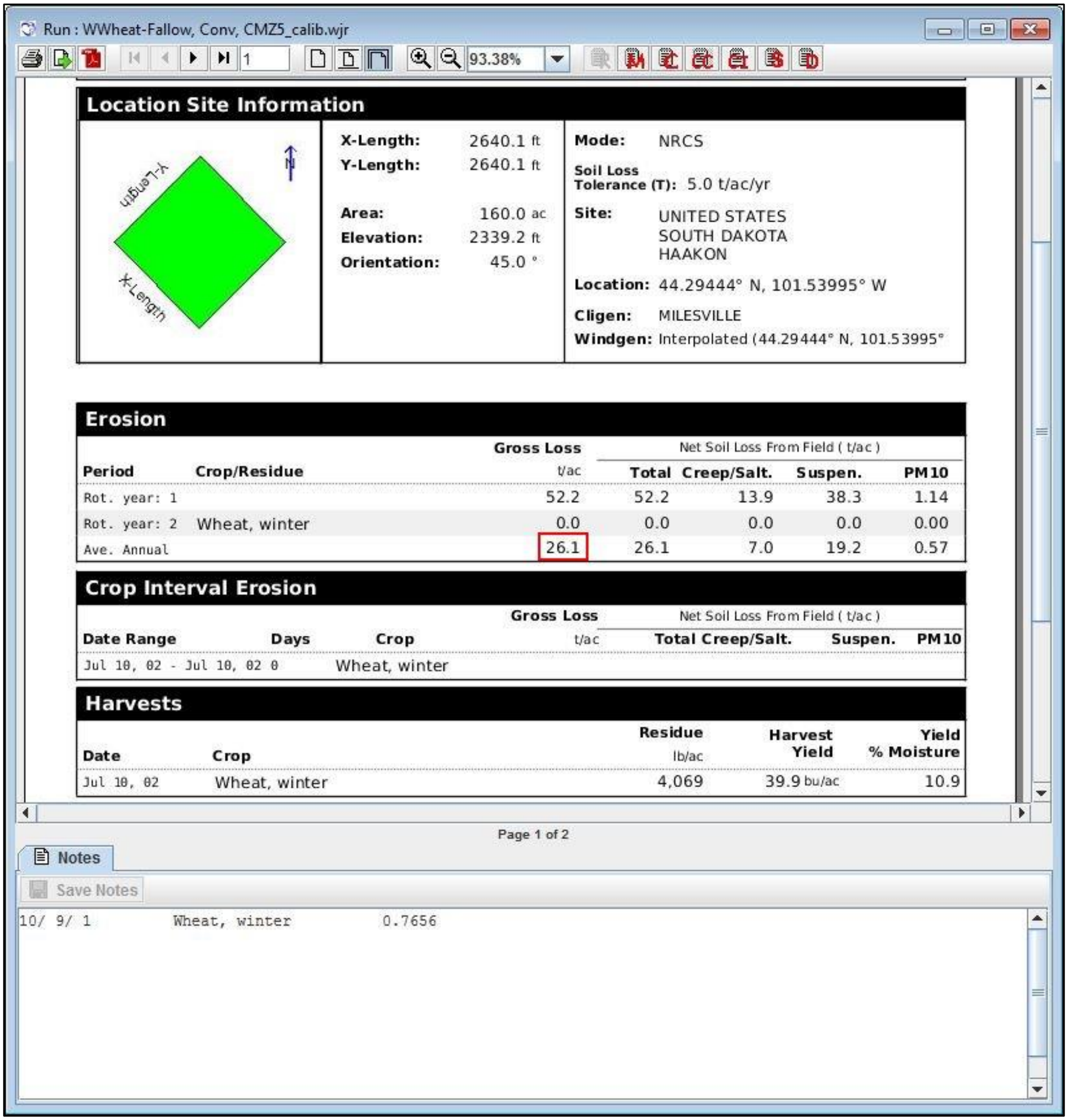


Figure 4-31 WEPS Calibration Run Summary.

The Average Annual Soil Loss is **26.1 ton/ac (**Figure 4-31**)**.

Adding Sudangrass

It may be beneficial to replace the fallow with a short sudangrass forage crop. Note that forage crops are not calibrated. WEPS will simulate the crop growth without calibration.

Step 1: Reopen MCREW. Make a new management file called **Wheat, winter-Sudangrass, forage,**

Conv, CMZ5, by clicking ‘File’, ‘Save as...’, and type the new name before saving.

Step 2: Planting time for sudangrass is April 15, so we need to add a chisel and a field cultivator to the file before planting. These operations must be scheduled with two-day intervals, beginning in the spring time of the second year. Change the date of the spring chisel from ‘May 01, 01’ to ‘Apr 11, 01’.

Step 3: Right-click the date on the next line (June 1), and change the date to ‘Apr 13, 01’. Then change the operation to *Cultivator, field 6-12 in sweeps* (under the *Tillage, cultivator, disk* folder).

Step 4: On the next line, change the date on the first Rodweeder line from Jul 01, 01 to to Apr 15, 01 and the operation to *Drill or airseeder, double disk* (under the *Seeding, drill, other* folder). A drop-down box appears to the right, in the Crop or Residue column, saying “no crop”. Click the drop-down arrow and scroll to find *Sorghum, forage*. Sudangrass is a type of sorghum.

Step 5: Next, change the ‘Aug 15, 01’ line to a hay harvest line (*Harvest, hay, no regrowth* operation under the *Harvest, hay, biomass* folder) with a ‘Sep 01, 01’ harvest date.

Step 6: Now we shall add another *Chisel, sweep shovel* before the *Cultivator, field 6-12 in sweeps*. Right-click the *Chisel, sweep shovel* operation on the top row and select ‘Copy Row(s)’. Right-click the Sep 01, 01 *Cultivator, field 6-12 in sweep*s and select ‘Paste Row(s)’. Now change the date of the pasted operation to Sep 03, 01 and the following cultivator to Sep 05, 01.

Step 7: Next, correct the information in the Row/Ridge Dir. (Deg.) column so that the direction of all the tillage operations is 45^{o}, except for the Oct 20, 02 chisel, which must remain at 0^{o}. The updated management file should look as in Figure 4-32. Finally, click the Save button  to save the management. Return to the WEPS interface.

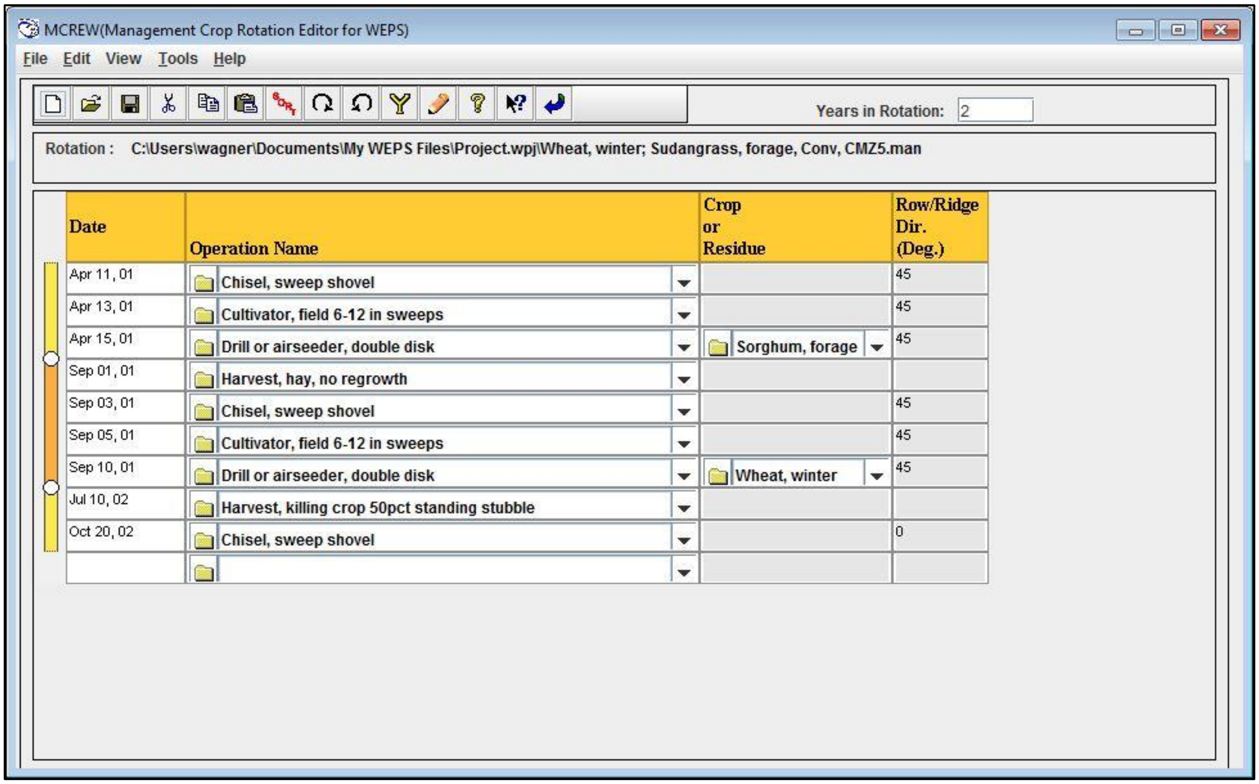
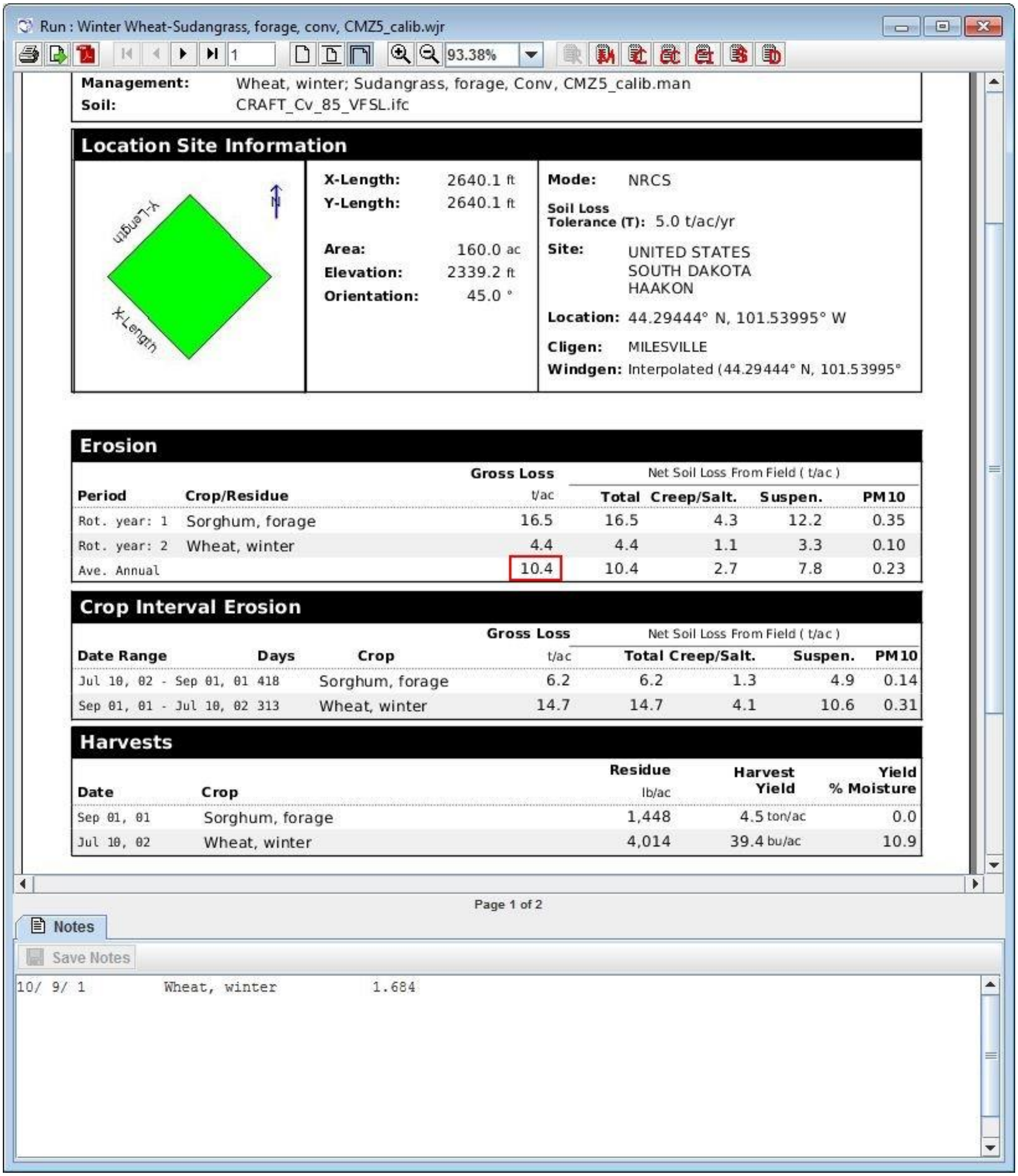


Figure 4-32 WEPS Management file with Sudangrass added.

Step 8: Since the Sudangrass uses soil moisture where it had been saved in the previous fallow period, the winter wheat will need recalibrated, since we are assuming the wheat yield is not affected by the Sudangrass. Make the calibration run and call it **Winter Wheat-Sudangrass, forage, conv, CMZ5_calib**.



Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Sorghum, forage	16.5	16.5	4.3	12.2	0.35
Rot. year: 2	Wheat, winter	4.4	4.4	1.1	3.3	0.10
Ave. Annual		10.4	10.4	2.7	7.8	0.23

Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Jul 10, 02 - Sep 01, 01	418	Sorghum, forage	6.2	6.2	1.3	4.9	0.14
Sep 01, 01 - Jul 10, 02	313	Wheat, winter	14.7	14.7	4.1	10.6	0.31

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Sep 01, 01	Sorghum, forage	1,448	4.5 ton/ac	0.0
Jul 10, 02	Wheat, winter	4,014	39.4 bu/ac	10.9

Figure 4-33 Run Summary showing reduced soil loss after growing the Sudangrass forage crop.

The Calibration Factors window appears on completion of the calibration run, showing that the Biomass Adjustment Factor of the winter wheat is **1.684**. The Run Summary shows a soil loss prediction of **10.4 ton/ac** (Figure 4-33). This is a substantial reduction of the erosion rate from the previous annual average of 26.1 t/ac, but further protection is still necessary.

Adding Supplemental Irrigation

The producer can apply about 12 inches of water per year to the crops and would like to see what the effect would be on the yield and erosion loss. This question is rather easy to answer.

Step 1: Click the Man button to open up the last management we ran: *Wheat, winter-Sudangrass, forage, Conv***,** *CMZ5.man*. Save a new version of this rotation by clicking *File*, *Save as*... and adding irrigation to the name: *Wheat, winter-Sudangrass, forage, Conv,* ***irr supplemental****, CMZ5*.

Step 2: The producer wants to add supplemental irrigation to see the effect on yields. Right-click the first line in the Operation Name column and click 'Insert Operation'. Select *Irrigation (2 inch, Pivot, Linear, Wheelline)* under the *Application, irrigation* folder, and change the date to Apr 01, 01.

Step 3: Now use the copy-paste function by right-clicking on the irrigation operation just created and click 'Copy Row(s)'. Now right-click in the *Harvest, hay, no regrowth* row and click 'Paste Row(s)'. Repeat until there are six irrigation operations, then change the dates to Apr 01, Apr 20, May 15, Jun 15, Jul 15, and Aug 15, all with year of 01.

Step 4: The wheat also needs the two-inch irrigations on Sep 15, of year 01, and Mar 01, Apr 01, May 01, Jun 01, and Jun 15 of year 02. You can copy the six lines of irrigation for the sudangrass by left-clicking and dragging the mouse over the five consecutive sudangrass irrigations to highlight them, then holding down the 'Ctrl" key while clicking the separate Apr 01, 01 irrigation operation (Figure 4-34).

Step 5: With all six irrigations highlighted, right-click, copy, and paste in the blank row at the bottom of the file. When all the correct dates have been entered, the file must be sorted by clicking the Sort button in the tool bar.

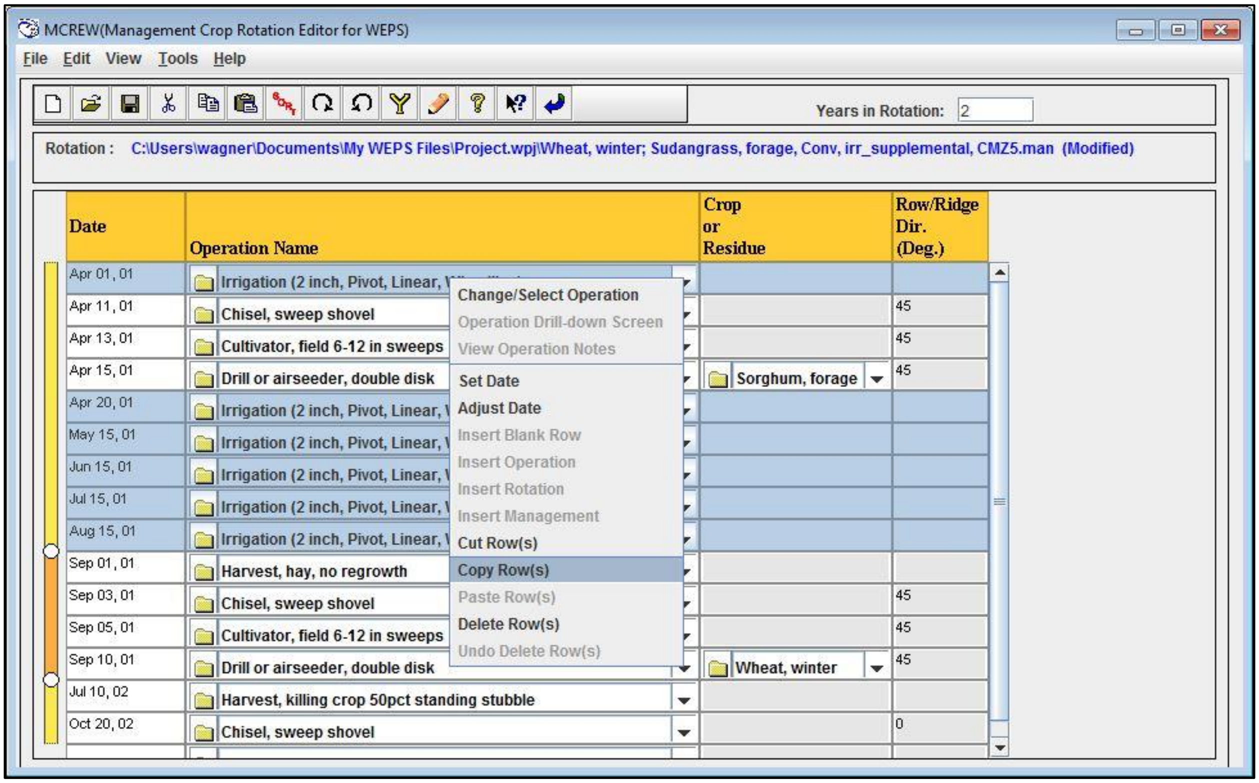


Figure 4-34 Clicking, dragging, and using the 'Ctrl' key to highlight all six irrigation operations for copying.

Step 6: Click the Yield Calibration button  and make sure the Biomass Adjustment Factor for wheat is reset back to the original value of 10. This management file will be run without calibration in order to show how much the irrigation might increase the yield over the calibrated dryland yield. The completed MCREW file should match Figure 4-35. Click Save .

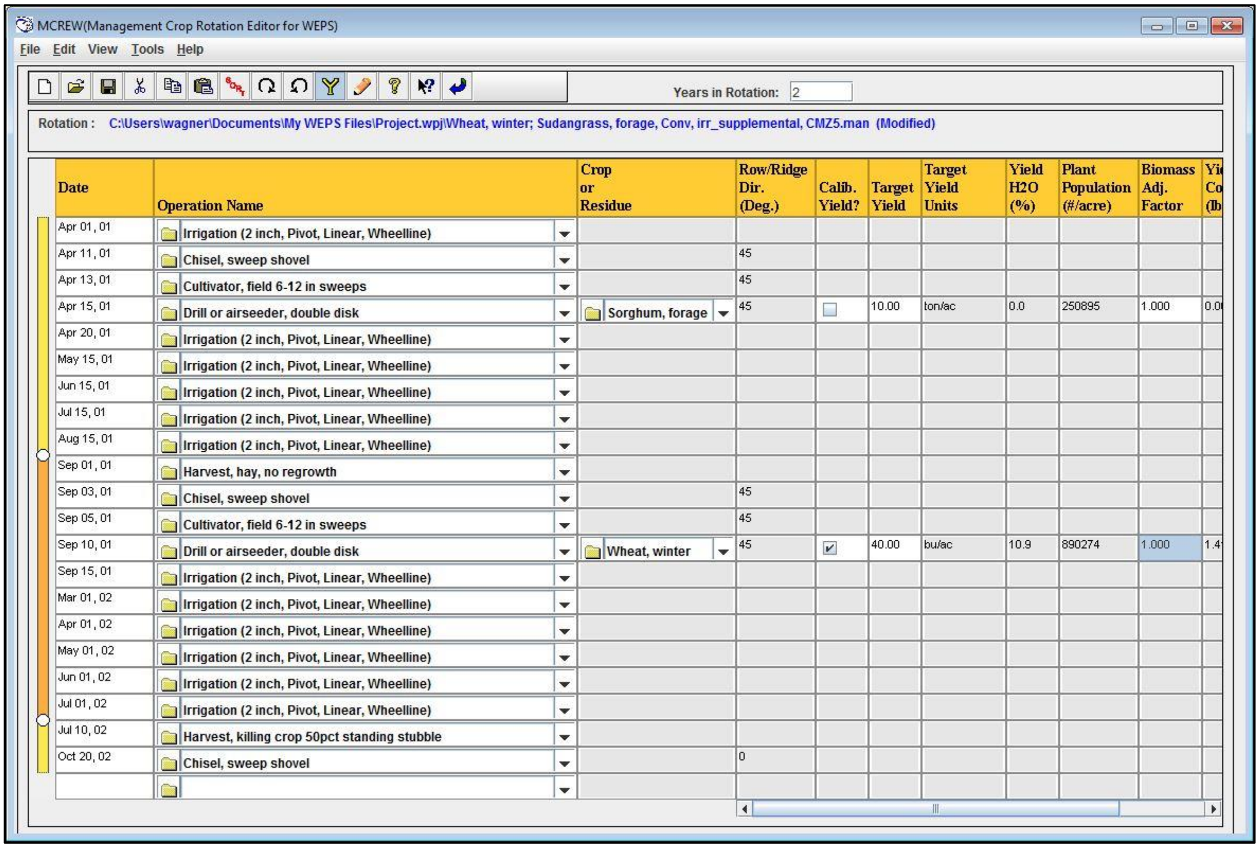
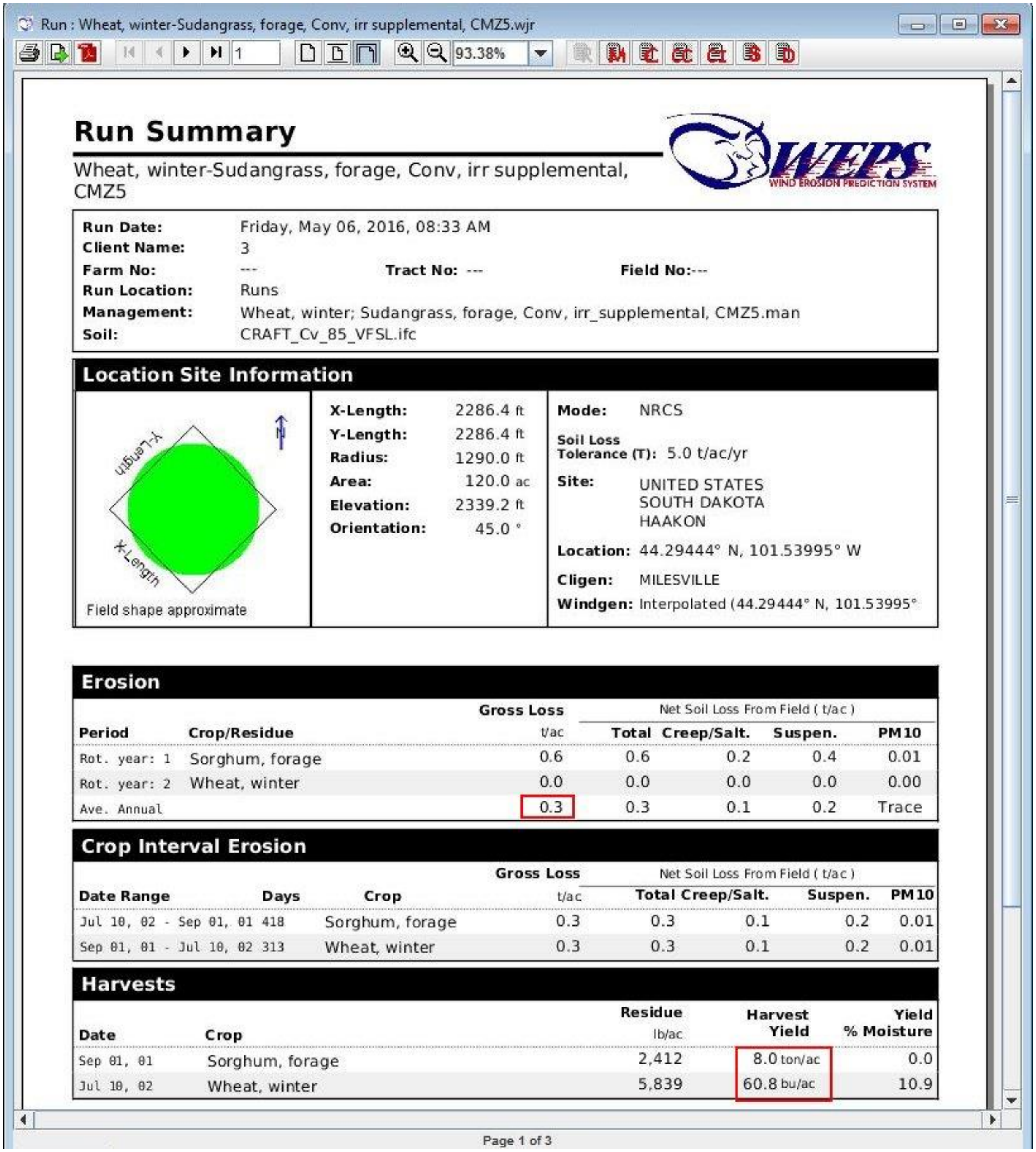


Figure 4-35 MCREW with the irrigation operations.

Step 2: Return to the main interface. Change the Simulation Region Shape to *Circle*, then type **120 ac** in the area box. Click the Run button and name this run **Wheat, winter-Sudangrass, forage, Conv, irr supplemental, CMZ5**.



Run : Wheat, winter-Sudangrass, forage, Conv, irr supplemental, CMZ5.wjr

Run Summary

Wheat, winter-Sudangrass, forage, Conv, irr supplemental, CMZ5

Run Date:	Friday, May 06, 2016, 08:33 AM
Client Name:	3
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	Runs
Management:	Wheat, winter; Sudangrass, forage, Conv, irr_supplemental, CMZ5.man
Soil:	CRAFT_Cv_85_VFSL.ifc

Location Site Information

Field shape approximate

X-Length:	2286.4 ft
Y-Length:	2286.4 ft
Radius:	1290.0 ft
Area:	120.0 ac
Elevation:	2339.2 ft
Orientation:	45.0 °

Mode:	NRCS
Soil Loss Tolerance (T):	5.0 t/ac/yr
Site:	UNITED STATES SOUTH DAKOTA HAAKON
Location:	44.29444° N, 101.53995° W
Cligen:	MILESVILLE
Windgen:	Interpolated (44.29444° N, 101.53995°

Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Sorghum, forage	0.6	0.6	0.2	0.4	0.01
Rot. year: 2	Wheat, winter	0.0	0.0	0.0	0.0	0.00
Ave. Annual		0.3	0.3	0.1	0.2	Trace

Crop Interval Erosion

Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Jul 10, 02 - Sep 01, 01	418	Sorghum, forage	0.3	0.3	0.1	0.2	0.01
Sep 01, 01 - Jul 10, 02	313	Wheat, winter	0.3	0.3	0.1	0.2	0.01

Harvests

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Sep 01, 01	Sorghum, forage	2,412	8.0 ton/ac	0.0
Jul 10, 02	Wheat, winter	5,839	60.8 bu/ac	10.9

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Figure 4-36 Run Summary showing Gross Loss of soil and Harvest Yields after supplemental irrigation.

The wind erosion problem has been resolved, with the estimated average annual soil loss having decreased to **0.3 t/ac/yr**. The wheat yield increased to **60.8 bu/ac** and the sudangrass hay yield increased to **8.0 t/ac** (Figure 4-36). This may not be a good investment to add the full 12 inches of water per year.

Note: This example shows how to use supplemental irrigation. If you want to use full irrigation to meet crop consumptive use, put a *Start Monitor (Pivot, Linear, Wheelline)* operation just after planting and an *Irritation, Stop Monitor* operation 15 days before harvest. Note both operations are available under the *Application, irrigation* folder. This will auto-irrigate the crop during the growing season similarly to the way Exercise 1 was run.

Exercise 4 – Simulating a Cover Crop and Windbreak

Skill Building: This exercise begins with a template management, then adding a spring barley cover crop to protect the sugarbeets for the first 40 days of growth. WEPS (version 1) only grows one crop at a time for this exercise, so the user must know how to build a workaround for these special management rotations. We will also explore the effects of a windbreak.

Exercise 4 Scenario

- The farm is located in **Clay County, Minnesota**.
- The Cligen station is **FARGO WB AIRPORT.**
- Windgen station is **Interpolated**.
- The critical dominant soil in the field is **426 Foldahl loamy fine sand** (because it spans 13.4% of the field and is the most erodible by wind) (Figure 4-37).
- The field is an **80-acre rectangle** (1320 ft north and south and 2640 ft east and west).
- There is a single row of elm trees on the north side of the field, and the leaves are on the trees during the period of erosive winds in the spring. The trees are 25 ft tall and about 20 ft in width.
- The porosity of the windbreak is about 50% during the critical wind period.

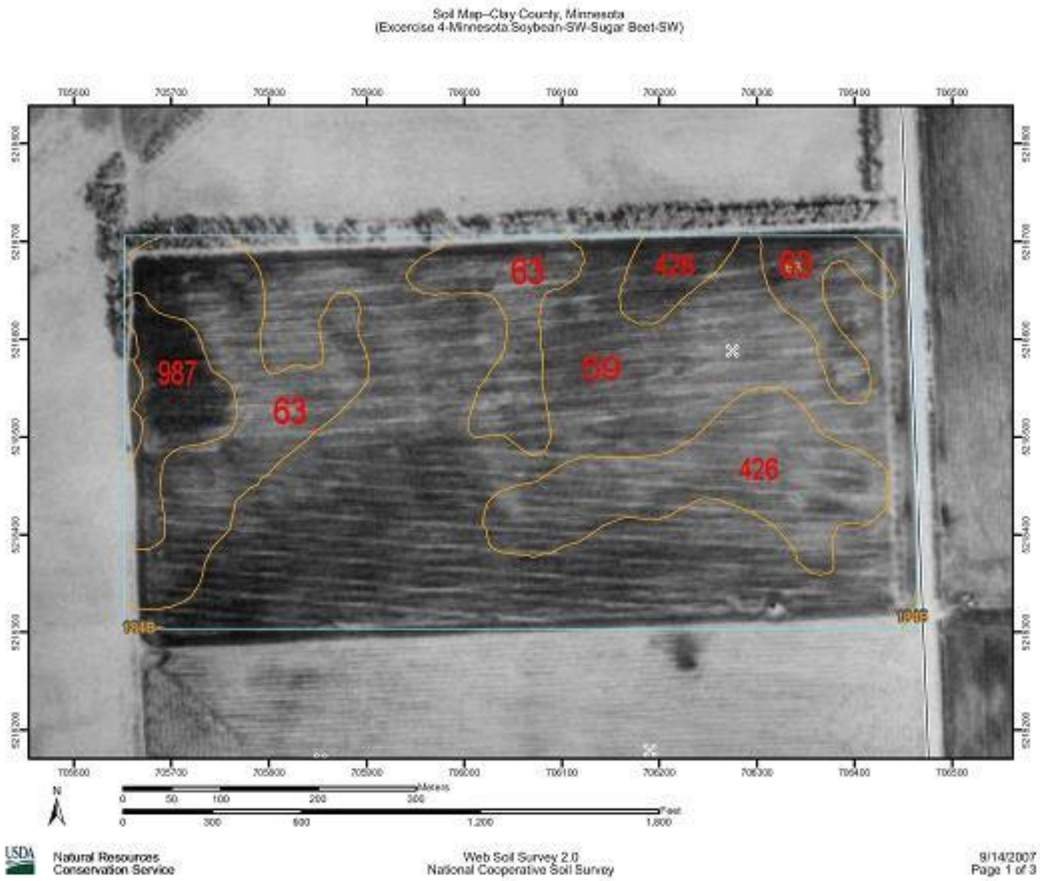


Figure 4-37 Soil map showing the critical dominant soil: 426 Foldahl loamy fine sand. Notice there is a windbreak on the north border of the field.

The crop rotation is **Spring Wheat-Sugarbeets-Soybean**. There is a problem with the sugarbeets just after planting. One out of three years that sugarbeets are planted in this field, they have to be replanted because of abrasion of the young beet plants by blowing soil. The rotation name is **S Wheat-Beet-SB CMZ 1**. Crop yields are as follows: Spring Wheat, 45 bu/ac; Sugarbeets, 20 t/ac; and Soybean, 40 bu/ac.

Complete the following steps:

Step 1: Enter all the above information **except** the wind break on the main WEPS interface (Figure 4-38).

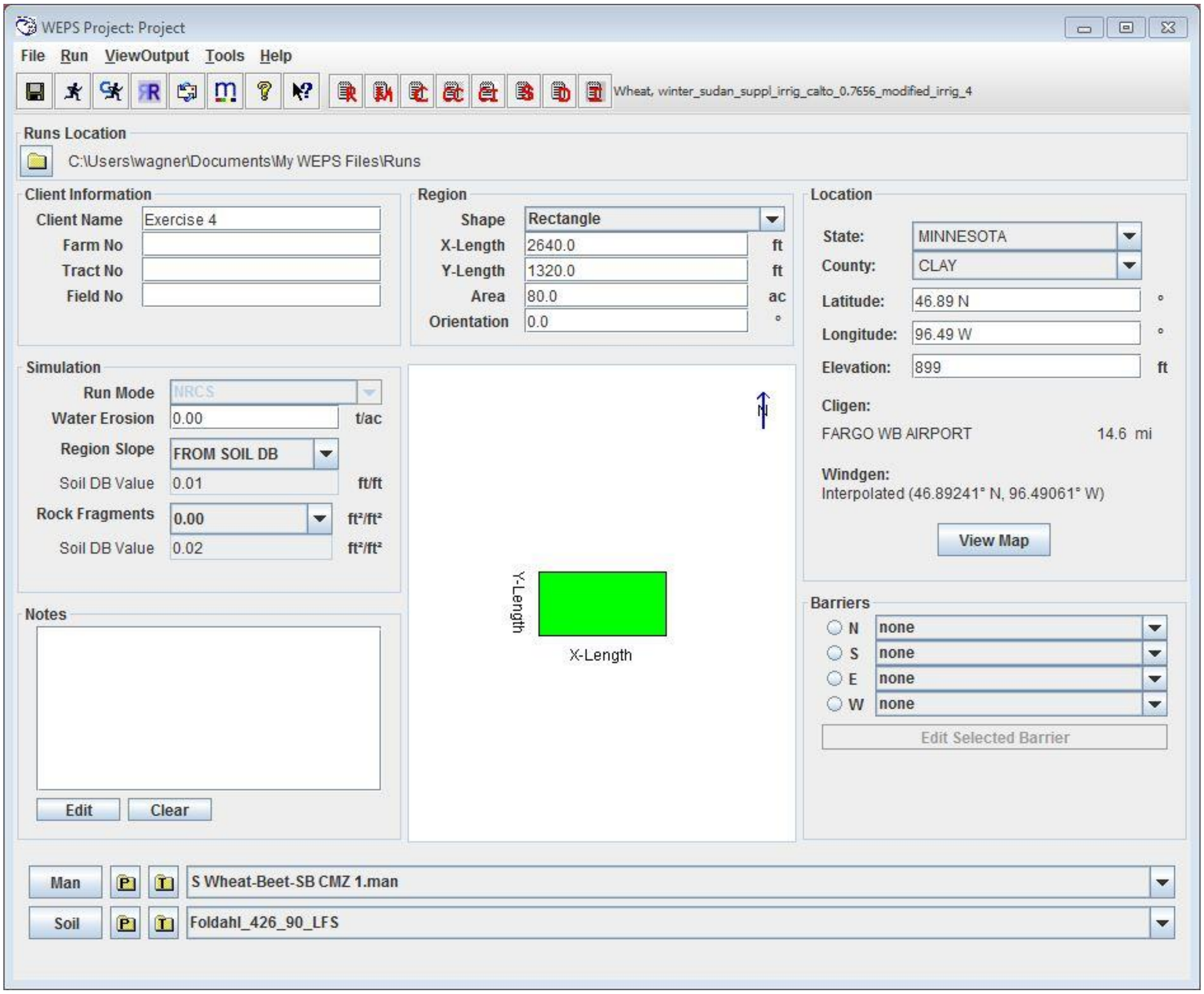
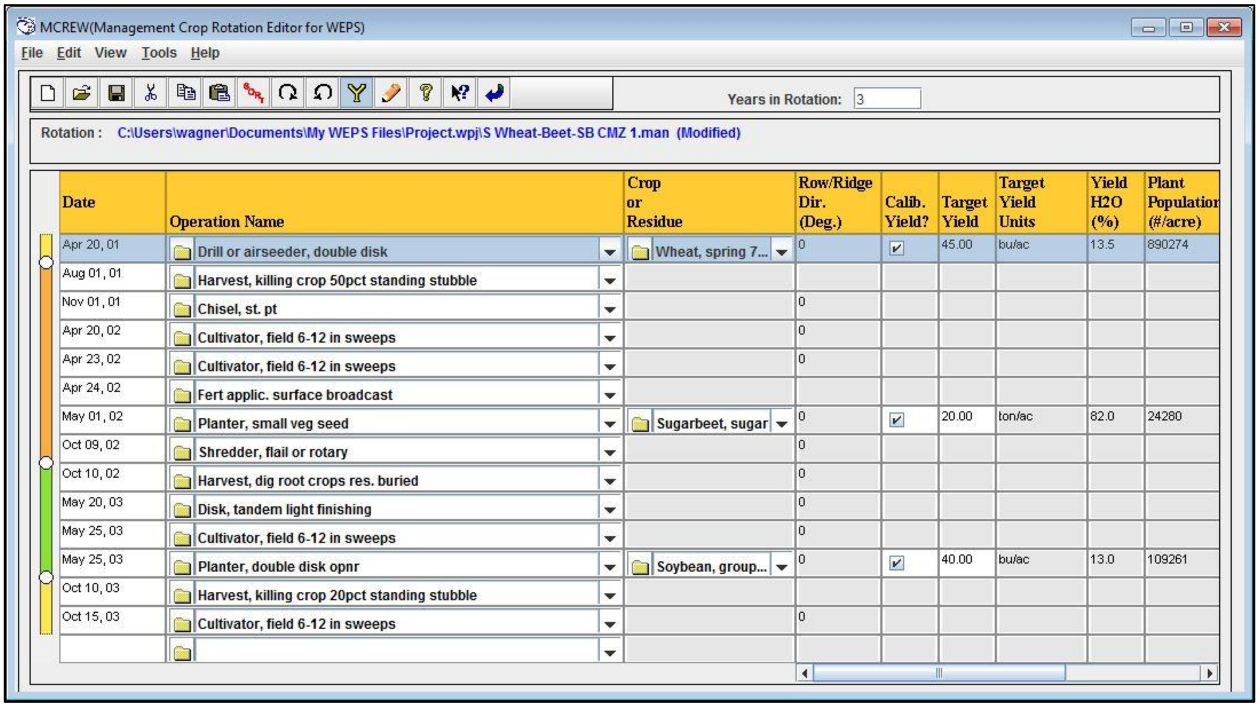


Figure 4-38 The WEPS interface loaded for the first run in this exercise.

When the wheat, beet, and soybean management template has been selected, click the Man button 

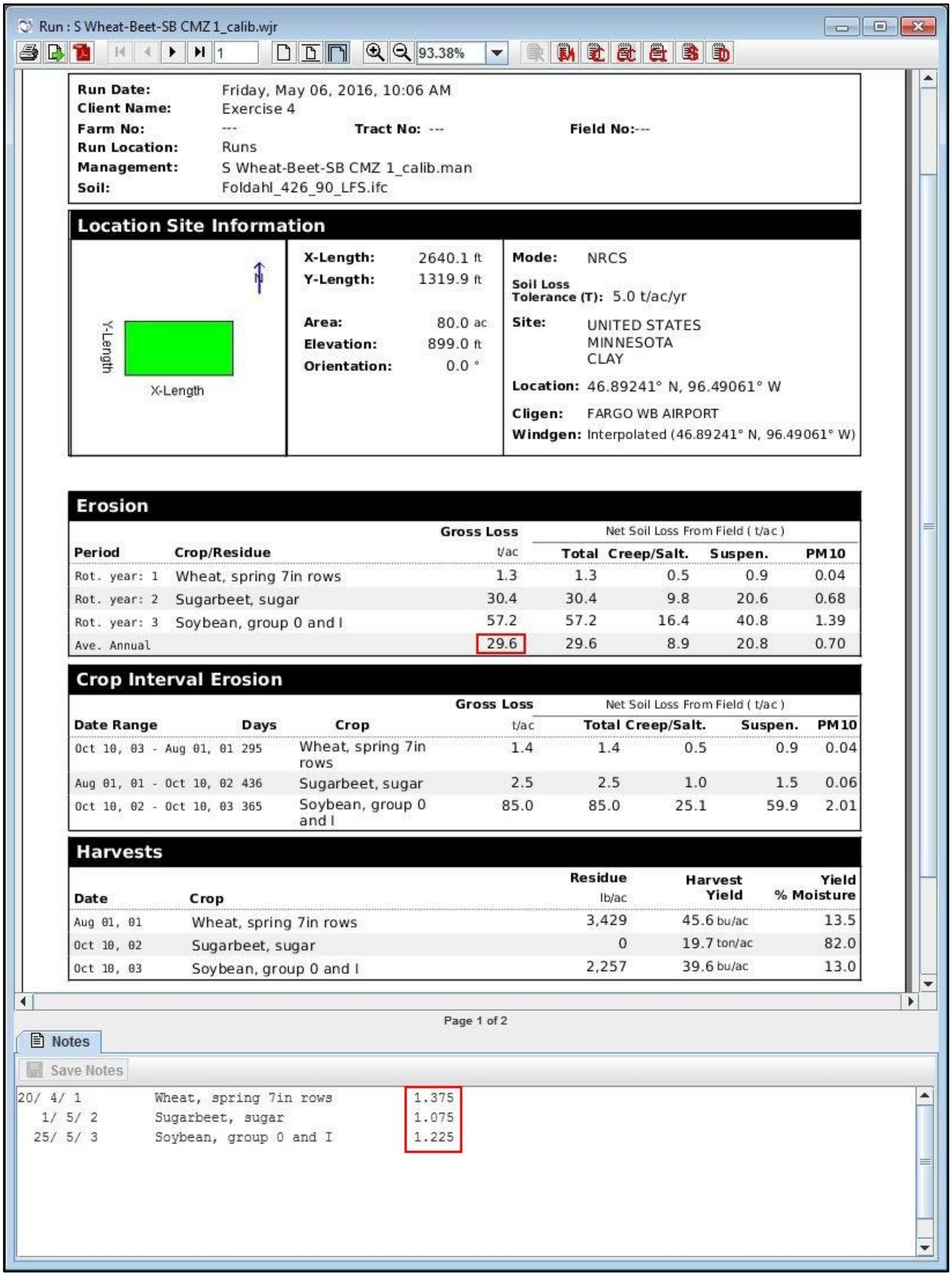
to open MCREW and click the Yield Calibrate button  to make sure the yields match the inventory values above. Also check that all tillage directions are set to 90° (parallel to the long dimension, Figure 4-39).



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Calib. Yield?	Target Yield	Target Yield Units	Yield H2O (%)	Plant Population (#/acre)
Apr 20, 01	Drill or airseeder, double disk	Wheat, spring 7...	0	✔	45.00	bu/ac	13.5	890274
Aug 01, 01	Harvest, killing crop 50pct standing stubble							
Nov 01, 01	Chisel, st. pt		0					
Apr 20, 02	Cultivator, field 6-12 in sweeps		0					
Apr 23, 02	Cultivator, field 6-12 in sweeps		0					
Apr 24, 02	Fert applic. surface broadcast							
May 01, 02	Planter, small veg seed	Sugarbeet, sugar	0	✔	20.00	ton/ac	82.0	24280
Oct 09, 02	Shredder, flail or rotary		0					
Oct 10, 02	Harvest, dig root crops res. buried		0					
May 20, 03	Disk, tandem light finishing		0					
May 25, 03	Cultivator, field 6-12 in sweeps		0					
May 25, 03	Planter, double disk opnr	Soybean, group...	0	✔	40.00	bu/ac	13.0	109261
Oct 10, 03	Harvest, killing crop 20pct standing stubble							
Oct 15, 03	Cultivator, field 6-12 in sweeps		0					

Figure 4-39 Initial MCREW settings for Exercise 4.

Step 2: Make a Calibration Run and call it **S Wheat-Beet-SB CMZ 1_calib**. You will see that all of the Biomass Adjustment Factors exceed 1.0 by more than 0.05. Use them in the Project. Select the "Use in Current Project" when asked.



Run : S Wheat-Beet-SB CMZ 1_calib.wjr

Run Date:	Friday, May 06, 2016, 10:06 AM
Client Name:	Exercise 4
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	Runs
Management:	S Wheat-Beet-SB CMZ 1_calib.man
Soil:	Foldahl_426_90_LFS.ifc

Location Site Information

X-Length:	2640.1 ft	**Mode:**	NRCS
Y-Length:	1319.9 ft	**Soil Loss Tolerance (T):**	5.0 t/ac/yr
Area:	80.0 ac	**Site:**	UNITED STATES MINNESOTA CLAY
Elevation:	899.0 ft	**Location:**	46.89241° N, 96.49061° W
Orientation:	0.0 °	**Cligen:**	FARGO WB AIRPORT
		Windgen:	Interpolated (46.89241° N, 96.49061° W)

Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Wheat, spring 7in rows	1.3	1.3	0.5	0.9	0.04
Rot. year: 2	Sugarbeet, sugar	30.4	30.4	9.8	20.6	0.68
Rot. year: 3	Soybean, group 0 and I	57.2	57.2	16.4	40.8	1.39
Ave. Annual		29.6	29.6	8.9	20.8	0.70

Crop Interval Erosion

Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Oct 10, 03 - Aug 01, 01	295	Wheat, spring 7in rows	1.4	1.4	0.5	0.9	0.04
Aug 01, 01 - Oct 10, 02	436	Sugarbeet, sugar	2.5	2.5	1.0	1.5	0.06
Oct 10, 02 - Oct 10, 03	365	Soybean, group 0 and I	85.0	85.0	25.1	59.9	2.01

Harvests

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Aug 01, 01	Wheat, spring 7in rows	3,429	45.6 bu/ac	13.5
Oct 10, 02	Sugarbeet, sugar	0	19.7 ton/ac	82.0
Oct 10, 03	Soybean, group 0 and I	2,257	39.6 bu/ac	13.0

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Notes

Save Notes

20/ 4/ 1	Wheat, spring 7in rows	1.375
1/ 5/ 2	Sugarbeet, sugar	1.075
25/ 5/ 3	Soybean, group 0 and I	1.225

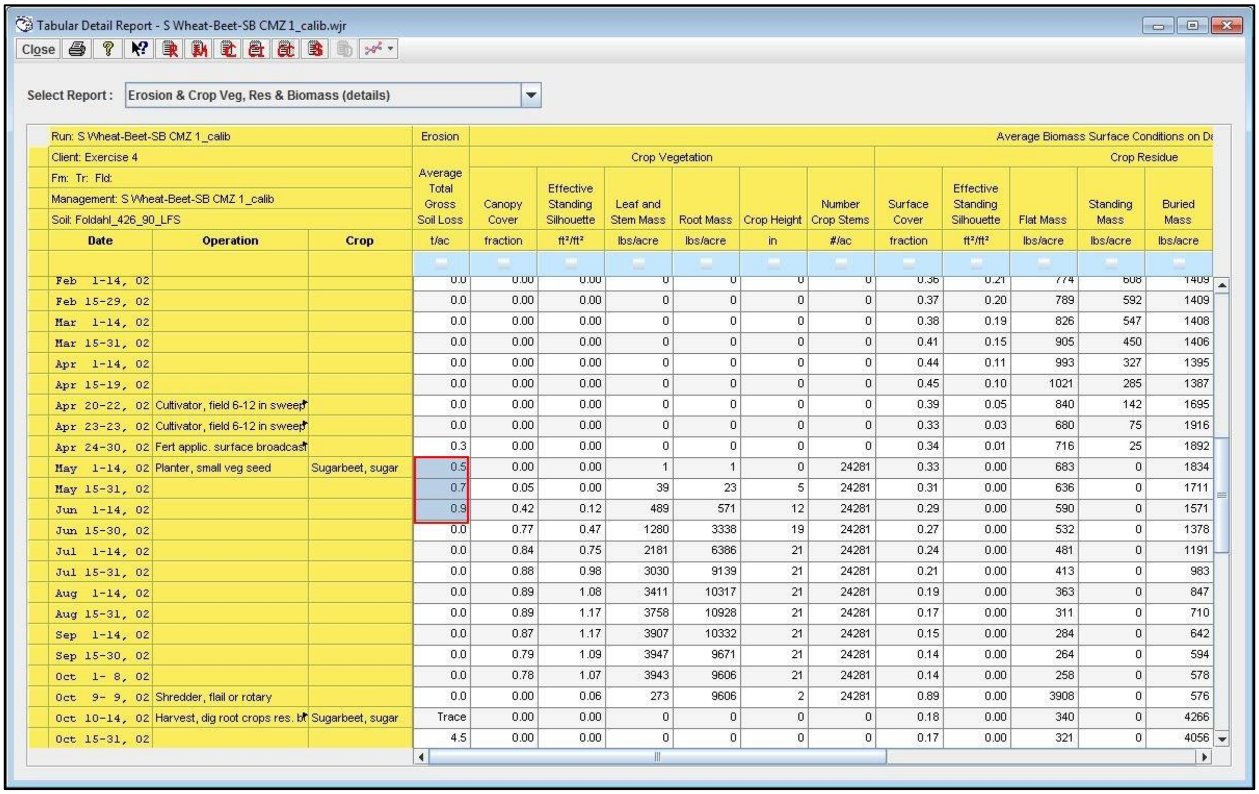
Figure 4-40 Run Summary showing calibration factors, soil loss, and crop yields.

The Run Summary shows the average annual soil loss is **29.6 ton/ac**, and that the yields are as approximately expected in the inventory (Figure 4-40).

The producer has also had trouble with the sugarbeets being damaged by blowing soil just after planting. Open the Detailed Report and find the soil loss for the period just after the beets are planted.

What is the sum of soil lost just after planting the beets?

Answer: The first three periods sum to 2.2 ton/ac (Figure 4-41).
The NRCS National Agronomy Manual, Crop Tolerance to Blowing Table lists crop sensitivity to wind erosion after planting. Sugarbeets have a 0.0 - 0.5 ton/ac tolerance (see Table 3.2 in the Exercises Introduction).



Date	Operation	Crop	Erosion: Average Total Gross Soil Loss (t/ac)	Crop Vegetation: Canopy Cover (fraction)	Crop Vegetation: Effective Standing Silhouette (ft²/ft²)	Crop Vegetation: Leaf and Stem Mass (lbs/acre)	Crop Vegetation: Root Mass (lbs/acre)	Crop Vegetation: Crop Height (in)	Crop Vegetation: Number Crop Stems (#/ac)	Crop Residue: Surface Cover (fraction)	Crop Residue: Effective Standing Silhouette (ft²/ft²)	Crop Residue: Flat Mass (lbs/acre)	Crop Residue: Standing Mass (lbs/acre)	Crop Residue: Buried Mass (lbs/acre)
Feb 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.36	0.21	774	608	1409
Feb 15-29, 02			0.0	0.00	0.00	0	0	0	0	0.37	0.20	789	592	1409
Mar 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.38	0.19	826	547	1408
Mar 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.41	0.15	905	450	1406
Apr 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.44	0.11	993	327	1395
Apr 15-19, 02			0.0	0.00	0.00	0	0	0	0	0.45	0.10	1021	285	1387
Apr 20-22, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00	0	0	0	0	0.39	0.05	840	142	1695
Apr 23-23, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00	0	0	0	0	0.33	0.03	680	75	1916
Apr 24-30, 02	Fert applic. surface broadcast		0.3	0.00	0.00	0	0	0	0	0.34	0.01	716	25	1892
May 1-14, 02	Planter, small veg seed	Sugarbeet, sugar	0.5	0.00	0.00	1	1	0	24281	0.33	0.00	683	0	1834
May 15-31, 02			0.7	0.05	0.00	39	23	5	24281	0.31	0.00	636	0	1711
Jun 1-14, 02			0.9	0.42	0.12	489	571	12	24281	0.29	0.00	590	0	1571
Jun 15-30, 02			0.0	0.77	0.47	1280	3338	19	24281	0.27	0.00	532	0	1378
Jul 1-14, 02			0.0	0.84	0.75	2181	6386	21	24281	0.24	0.00	481	0	1191
Jul 15-31, 02			0.0	0.88	0.98	3030	9139	21	24281	0.21	0.00	413	0	983
Aug 1-14, 02			0.0	0.89	1.08	3411	10317	21	24281	0.19	0.00	363	0	847
Aug 15-31, 02			0.0	0.89	1.17	3758	10928	21	24281	0.17	0.00	311	0	710
Sep 1-14, 02			0.0	0.87	1.17	3907	10332	21	24281	0.15	0.00	284	0	642
Sep 15-30, 02			0.0	0.79	1.09	3947	9671	21	24281	0.14	0.00	264	0	594
Oct 1- 8, 02			0.0	0.78	1.07	3943	9606	21	24281	0.14	0.00	258	0	578
Oct 9- 9, 02	Shredder, flail or rotary		0.0	0.00	0.06	273	9606	2	24281	0.89	0.00	3908	0	576
Oct 10-14, 02	Harvest, dig root crops res. b	Sugarbeet, sugar	Trace	0.00	0.00	0	0	0	0	0.18	0.00	340	0	4266
Oct 15-31, 02			4.5	0.00	0.00	0	0	0	0	0.17	0.00	321	0	4056

Figure 4-41 Tabular Detailed Report with soil loss periods following sugarbeet planting.

Is this run OK?

Answer: No; this amount of wind erosion is unacceptable because of the sensitivity of sugarbeets to abrasion caused by airborne soil particles and the total erosion rate from the field is excessive.

Running the Model with a Windbreak

Step 1: See if the windbreak will help the abrasion problem on sugarbeets just after planting.
There is a one-row windbreak on the north side of the field. In the Barriers panel on the right side of the WEPS interface, click the radio button next to the 'N' ◯ N to place a barrier on the north side of the simulated field (see Figure 4-42). The trees for this windbreak are stated to be 25 ft tall and 20 ft wide, with a porosity fraction in April of 0.50 (i.e., 50%). Click the drop-down arrow ▼ next to the barrier in the Barriers panel. Select the barrier template **Trees 1r decd 20yr leafon**. Next, click the 'Edit Selected Barrier' button. Change the values if necessary to have the following dimensions: Width: **20.0 ft**; Height: **25.0 ft**; Porosity: **0.50** (Figure 4-43).

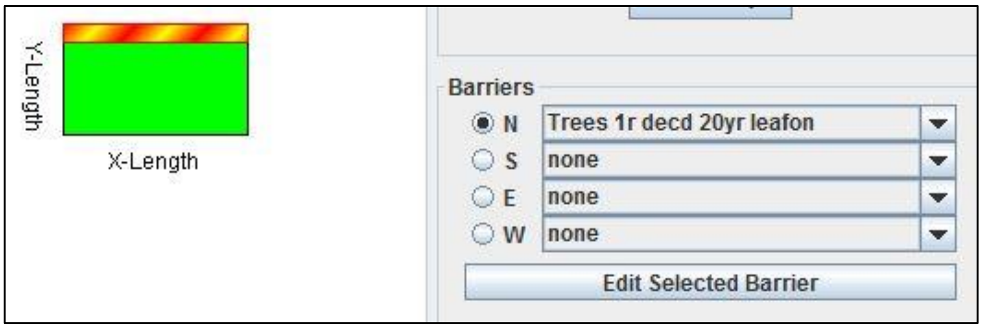
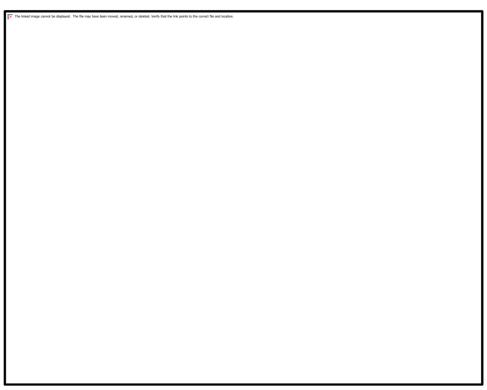


Figure 4-42 Simulated field with the windbreak and the Barriers panel showing that the template has been selected and modified.



Save the settings. Notice the barrier type has *<mod>* added in front of the name, indicating that the barrier properties have been modified by the user (Figure 4-44).

Figure 4-43 Correct dimensions for the windbreak.

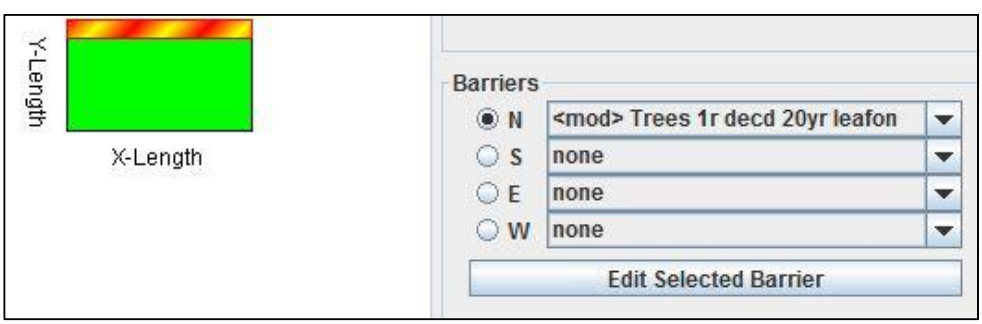
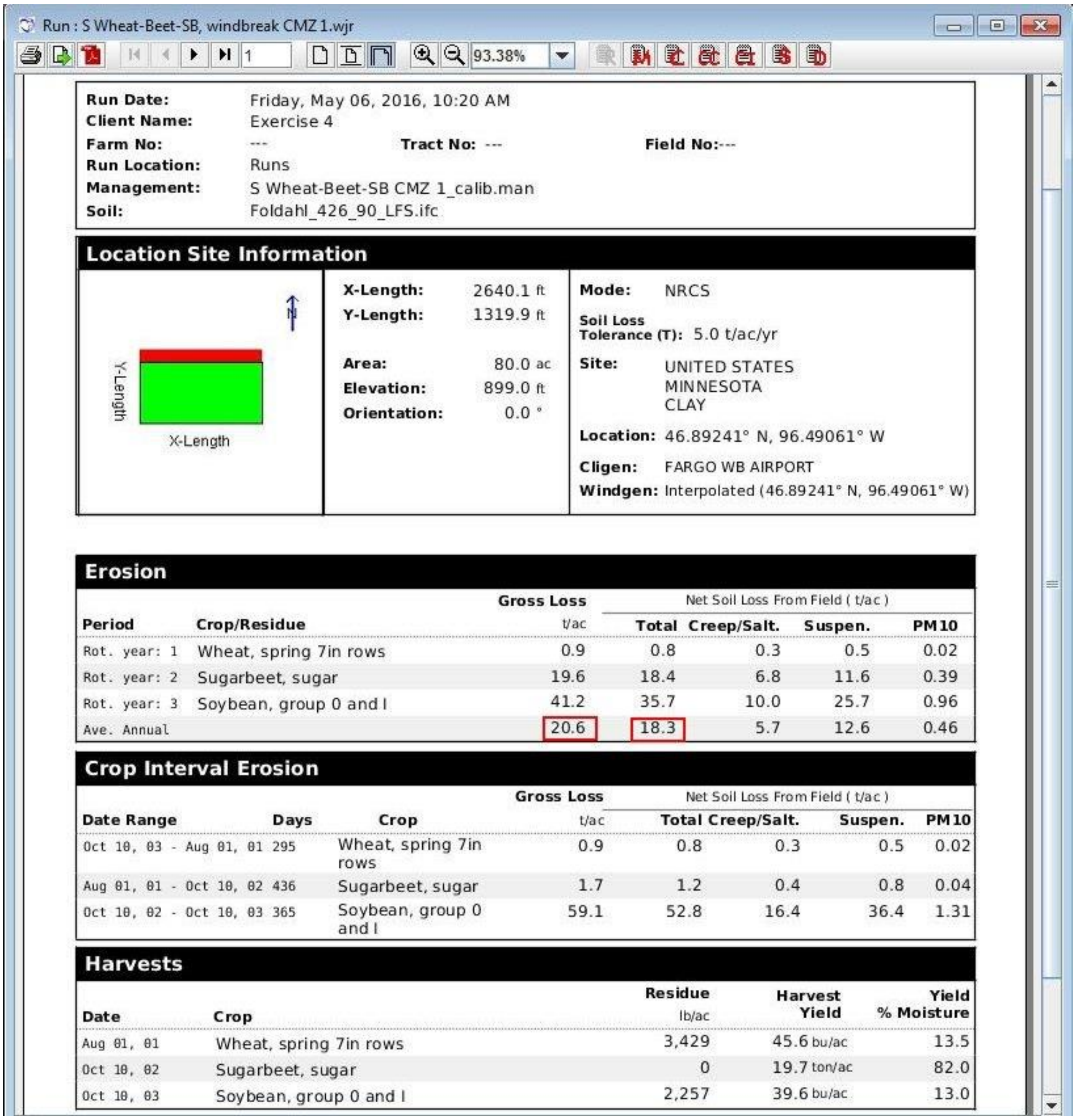


Figure 4-44 Simulated field with the windbreak and the Barriers panel showing that the template has been selected and modified.

Step 2: Click the Run button on the interface tool bar and call the run **S Wheat-Beet-SB, windbreak CMZ 1**.


Run : S Wheat-Beet-SB, windbreak CMZ 1.wjr

Run Date:	Friday, May 06, 2016, 10:20 AM
Client Name:	Exercise 4
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	Runs
Management:	S Wheat-Beet-SB CMZ 1_calib.man
Soil:	Foldahl_426_90_LFS.ifc

Location Site Information

X-Length:	2640.1 ft
Y-Length:	1319.9 ft
Area:	80.0 ac
Elevation:	899.0 ft
Orientation:	0.0 °
Mode:	NRCS
Soil Loss Tolerance (T):	5.0 t/ac/yr
Site:	UNITED STATES MINNESOTA CLAY
Location:	46.89241° N, 96.49061° W
Cligen:	FARGO WB AIRPORT
Windgen:	Interpolated (46.89241° N, 96.49061° W)

Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Wheat, spring 7in rows	0.9	0.8	0.3	0.5	0.02
Rot. year: 2	Sugarbeet, sugar	19.6	18.4	6.8	11.6	0.39
Rot. year: 3	Soybean, group 0 and I	41.2	35.7	10.0	25.7	0.96
Ave. Annual		20.6	18.3	5.7	12.6	0.46

Crop Interval Erosion

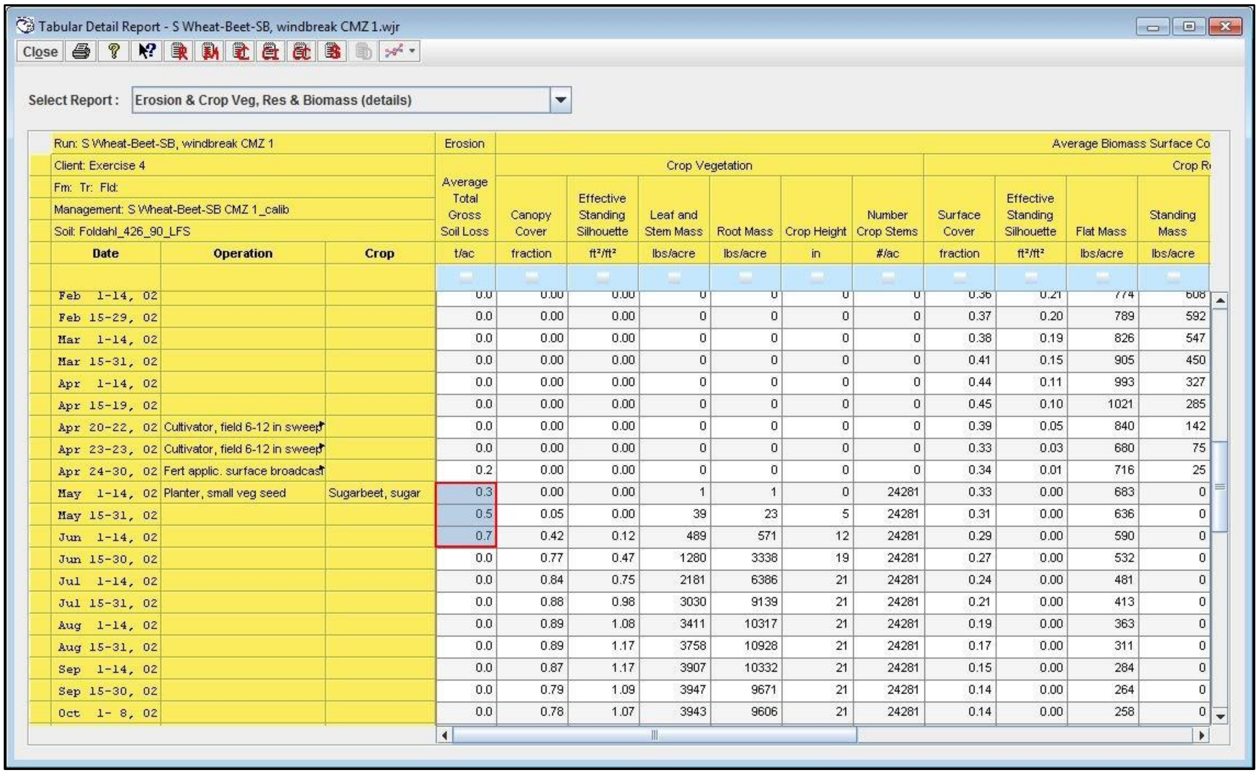
Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Oct 10, 03 - Aug 01, 01	295	Wheat, spring 7in rows	0.9	0.8	0.3	0.5	0.02
Aug 01, 01 - Oct 10, 02	436	Sugarbeet, sugar	1.7	1.2	0.4	0.8	0.04
Oct 10, 02 - Oct 10, 03	365	Soybean, group 0 and I	59.1	52.8	16.4	36.4	1.31

Harvests

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Aug 01, 01	Wheat, spring 7in rows	3,429	45.6 bu/ac	13.5
Oct 10, 02	Sugarbeet, sugar	0	19.7 ton/ac	82.0
Oct 10, 03	Soybean, group 0 and I	2,257	39.6 bu/ac	13.0

Figure 4-45 Run Summary showing the effect of the tree line windbreak.

On the run summary, the windbreak is shown to have reduced soil loss by 9.0 ton/acre (29.6 – 20.6 tons/acre) (Figure 4-40 and Figure 4-45. If we multiply the 9.0 ton/acre by the 80 acres in the field, we see that the barrier saved about 720 tons of soil per year on a field basis. Also notice that the total net soil loss 18.3 t/ac) is lower than the gross loss (20.6 t/ac). This is because soil was deposited in front of the windbreak before leaving the field during storms with a southerly wind. Examine the Detailed Report to see the management periods.



Date	Operation	Crop	Erosion: Average Total Gross Soil Loss (t/ac)	Crop Vegetation: Canopy Cover (fraction)	Crop Vegetation: Effective Standing Silhouette (ft²/ft²)	Crop Vegetation: Leaf and Stem Mass (lbs/acre)	Crop Vegetation: Root Mass (lbs/acre)	Crop Vegetation: Crop Height (in)	Crop Vegetation: Number Crop Stems (#/ac)	Crop R: Surface Cover (fraction)	Crop R: Effective Standing Silhouette (ft²/ft²)	Crop R: Flat Mass (lbs/acre)	Crop R: Standing Mass (lbs/acre)
Feb 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.36	0.21	774	608
Feb 15-29, 02			0.0	0.00	0.00	0	0	0	0	0.37	0.20	789	592
Mar 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.38	0.19	826	547
Mar 15-31, 02			0.0	0.00	0.00	0	0	0	0	0.41	0.15	905	450
Apr 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.44	0.11	993	327
Apr 15-19, 02			0.0	0.00	0.00	0	0	0	0	0.45	0.10	1021	285
Apr 20-22, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00	0	0	0	0	0.39	0.05	840	142
Apr 23-23, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00	0	0	0	0	0.33	0.03	680	75
Apr 24-30, 02	Fert applic. surface broadcast		0.2	0.00	0.00	0	0	0	0	0.34	0.01	716	25
May 1-14, 02	Planter, small veg seed	Sugarbeet, sugar	0.3	0.00	0.00	1	1	0	24281	0.33	0.00	683	0
May 15-31, 02			0.5	0.05	0.00	39	23	5	24281	0.31	0.00	636	0
Jun 1-14, 02			0.7	0.42	0.12	489	571	12	24281	0.29	0.00	590	0
Jun 15-30, 02			0.0	0.77	0.47	1280	3338	19	24281	0.27	0.00	532	0
Jul 1-14, 02			0.0	0.84	0.75	2181	6386	21	24281	0.24	0.00	481	0
Jul 15-31, 02			0.0	0.88	0.98	3030	9139	21	24281	0.21	0.00	413	0
Aug 1-14, 02			0.0	0.89	1.08	3411	10317	21	24281	0.19	0.00	363	0
Aug 15-31, 02			0.0	0.89	1.17	3758	10928	21	24281	0.17	0.00	311	0
Sep 1-14, 02			0.0	0.87	1.17	3907	10332	21	24281	0.15	0.00	284	0
Sep 15-30, 02			0.0	0.79	1.09	3947	9671	21	24281	0.14	0.00	264	0
Oct 1- 8, 02			0.0	0.78	1.07	3943	9606	21	24281	0.14	0.00	258	0

Figure 4-46 Section of the Tabular Detailed Report with the erosion following sugar beet planting.

What was the saving for the sugarbeets after planting on the detailed report?

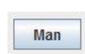
Answer: Soil loss was reduced from 2.2 t/ac (Figure 4-41) to 1.5 t/ac after sugarbeet planting (Figure 4-46). This is beneficial, but still not acceptable. Perhaps a spring barley cover crop could minimize the loss even more.

Adding a Spring Barley Cover crop

The producer recorded that the sugarbeets blow out 1 out of 3 years. We need to consider an alternative that can keep the sugarbeets from being killed by blowing soil. Adding a cover crop (spring barley) that grows simultaneously with a crop (sugarbeets) requires special crop files and special operations. These require the NRCS user to contact the National Wind Erosion Specialist to develop these files.

Figure 4-47 A barley cover crop after spraying and planting to fall planted winter wheat.

WEPS currently can only simulate the growth of one crop at a time. In this case, we will model the barley growth for the first 40 days, and then switch to the sugarbeets that are growing under the cover of the spring barley. Refer to Figure 4-48 when working with the following instructions.

Step 1: On the WEPS interface, click the ‘Man’ button 

to open the MCREW, and make sure you have the original management file loaded: *S Wheat-Beet-SB CMZ 1_calib*. Click ‘File’, ‘Save as...’ and rename the file *S Wheat-Beet, cover crop-SB CMZ 1_calib*.

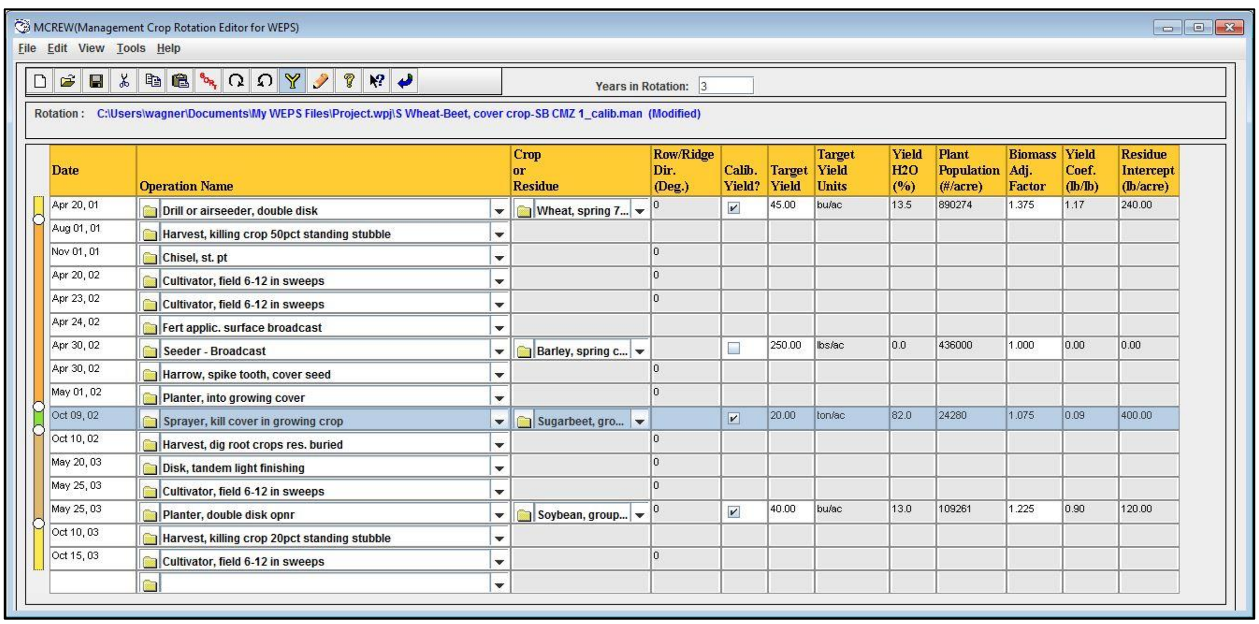
Step 2: On the ‘May 1, 02' line, right-click the Operation Name column and add two operations. The first operation will be the *Seeder-Broadcast* (under the *Seeder, drill,* other folder) and the second will be the *Harrow, spike tooth, cover seed* operation (under the *Tillage, surface, shallow* folder). The seeder operation requires a crop name in the next column. Select *Barley, spring covercrop*. This file is a standard barley file that will grow about 250 lbs/ac biomass during the 40 days it will be in the field. Change both the seeder and harrow to the same date of ‘Apr 30, 02'.

Step 3: Now, click the drop-down arrow by ‘May 01, 02’ *Planter, small veg seed* and select the operation *Planter, into growing cover* (available under *Seeding, planter* folder). This is a special planter that shows tilled ground on the day the planter was used, but does not call in a growing crop of sugarbeets yet. You have planted them in the field on that day, but for now we shall continue to grow only the spring barley cover crop until the sugarbeets produce a dominant amount of vegetation.

Step 4: On the next line (Oct 09, 02) in the operation cell, right click and add the operation *Sprayer, kill cover in growing crop* (under *Application, agchem, nutrient* folder). Set the date to 40 days after the planting of the cover crop (Jun 10, 02). In the next column over, click the drop-down arrow and select *Sugarbeet, growing after cover crop kill*. This is a modified Sugarbeet file that will show some biomass growth in the roots and leaves on the date the beets were planted.

Note: This type of logic will be necessary when a growing cover crop is planted and then killed after both crops grow for a time. The same logic may be used if a cover such as rye is seeded and grown in a growing crop.

Step 5: Click the Yield Calibrate button and make sure the barley cover crop line is unchecked, because this is a forage crop and we want WEPS to control the yield growth. The Biomass Adjustment Factors must be the same as the first run (Wheat: 1.375; Sugarbeets: 1.075; and Soybeans: 1.225). Since the previous sugarbeet planting operation has been replaced, its Biomass Adjustment Factor may have to be typed in. The cover crop is not to be calibrated since it will be killed before planting the sugarbeets.



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Calib. Yield?	Target Yield	Target Yield Units	Yield H2O (%)	Plant Population (#/acre)	Biomass Adj. Factor	Yield Coef. (lb/lb)	Residue Intercept (lb/acre)
Apr 20, 01	Drill or airseeder, double disk	Wheat, spring 7...	0	✓	45.00	bu/ac	13.5	890274	1.375	1.17	240.00
Aug 01, 01	Harvest, killing crop 50pct standing stubble										
Nov 01, 01	Chisel, st. pt		0								
Apr 20, 02	Cultivator, field 6-12 in sweeps		0								
Apr 23, 02	Cultivator, field 6-12 in sweeps		0								
Apr 24, 02	Fert applic. surface broadcast										
Apr 30, 02	Seeder - Broadcast	Barley, spring c...		☐	250.00	lbs/ac	0.0	436000	1.000	0.00	0.00
Apr 30, 02	Harrow, spike tooth, cover seed		0								
May 01, 02	Planter, into growing cover		0								
Oct 09, 02	Sprayer, kill cover in growing crop	Sugarbeet, gro...		✓	20.00	ton/ac	82.0	24280	1.075	0.09	400.00
Oct 10, 02	Harvest, dig root crops res. buried		0								
May 20, 03	Disk, tandem light finishing		0								
May 25, 03	Cultivator, field 6-12 in sweeps		0								
May 25, 03	Planter, double disk opnr	Soybean, group...	0	✓	40.00	bu/ac	13.0	109261	1.225	0.90	120.00
Oct 10, 03	Harvest, killing crop 20pct standing stubble										
Oct 15, 03	Cultivator, field 6-12 in sweeps		0								

Figure 4-48 MCREW showing new operations for the simultaneous cover crop.

Step 6: Click Return to close MCREW and view the WEPS interface.

Step 7: In order to view the effects of the cover crop alone, uncheck the radio button for the windbreak by selecting ‘*none*’ in the Barriers drop-down list and deselecting the radio button.

Step 8: Click the "Run" button to make a statndard WEPS Run with the previous calibration factors. Name it **S Wheat-Beet, cover crop-SB CMZ 1_calib**.

Note that a warning message appears mentioning that the Barley cover crop is terminated before reaching maturity. This message can be ignored as it is referring to a cover crop in this instance (WEPS currently doesn't have the ability to not produce this message for cover crops).

The biomass adjustment factor for the beets changed from 1.075 to 1.236 (Figure 4-48 and Figure 4-49). This means that WEPS needed to make additional adjustment to produce the expected 20 ton/ac yield. We know this is possible in this field, but there may be times when the effect of the barley on the main crop is unknown. With less moisture, there may be a yield reduction. Click "Use in the Current Project" to save the new factors.

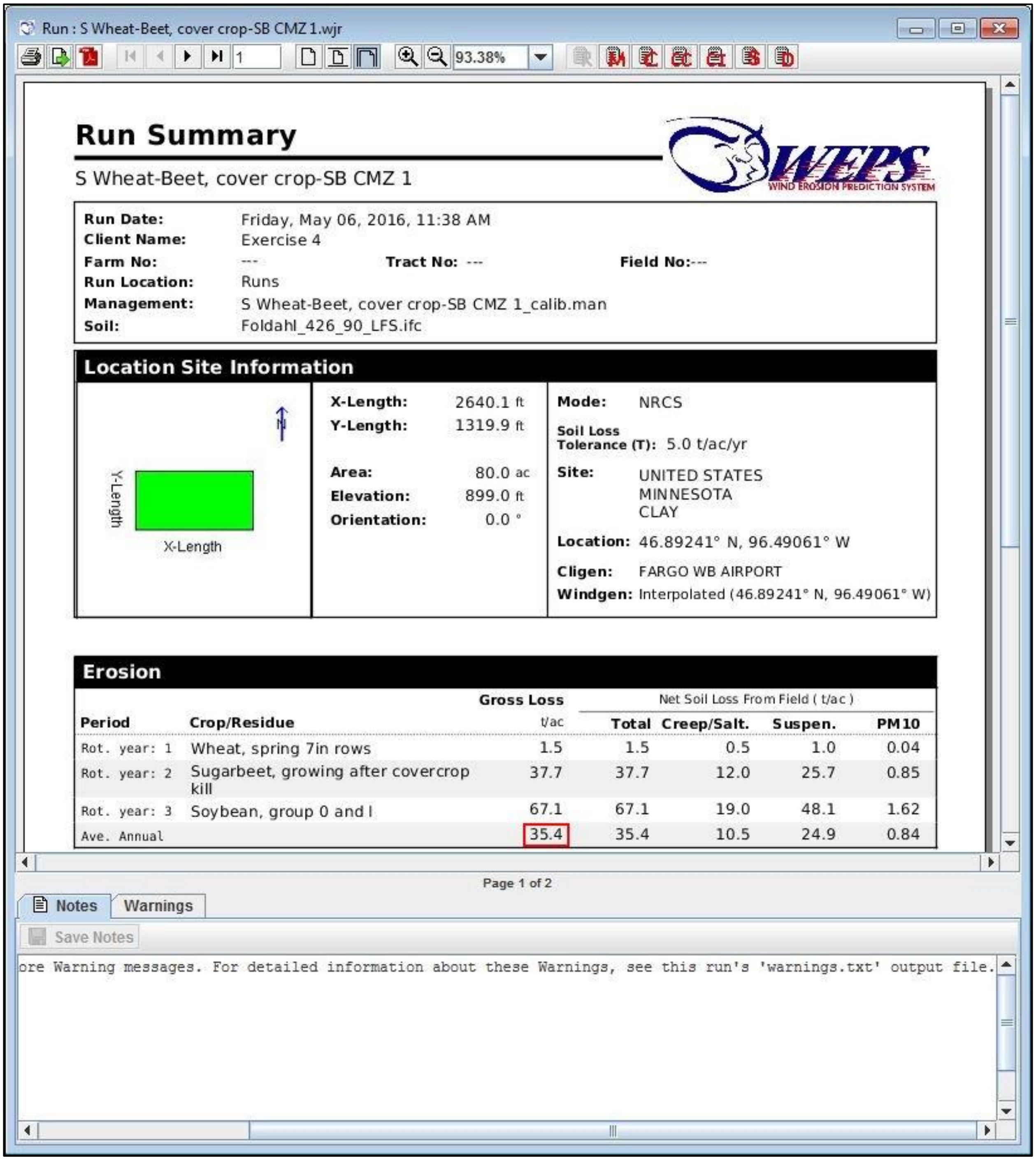
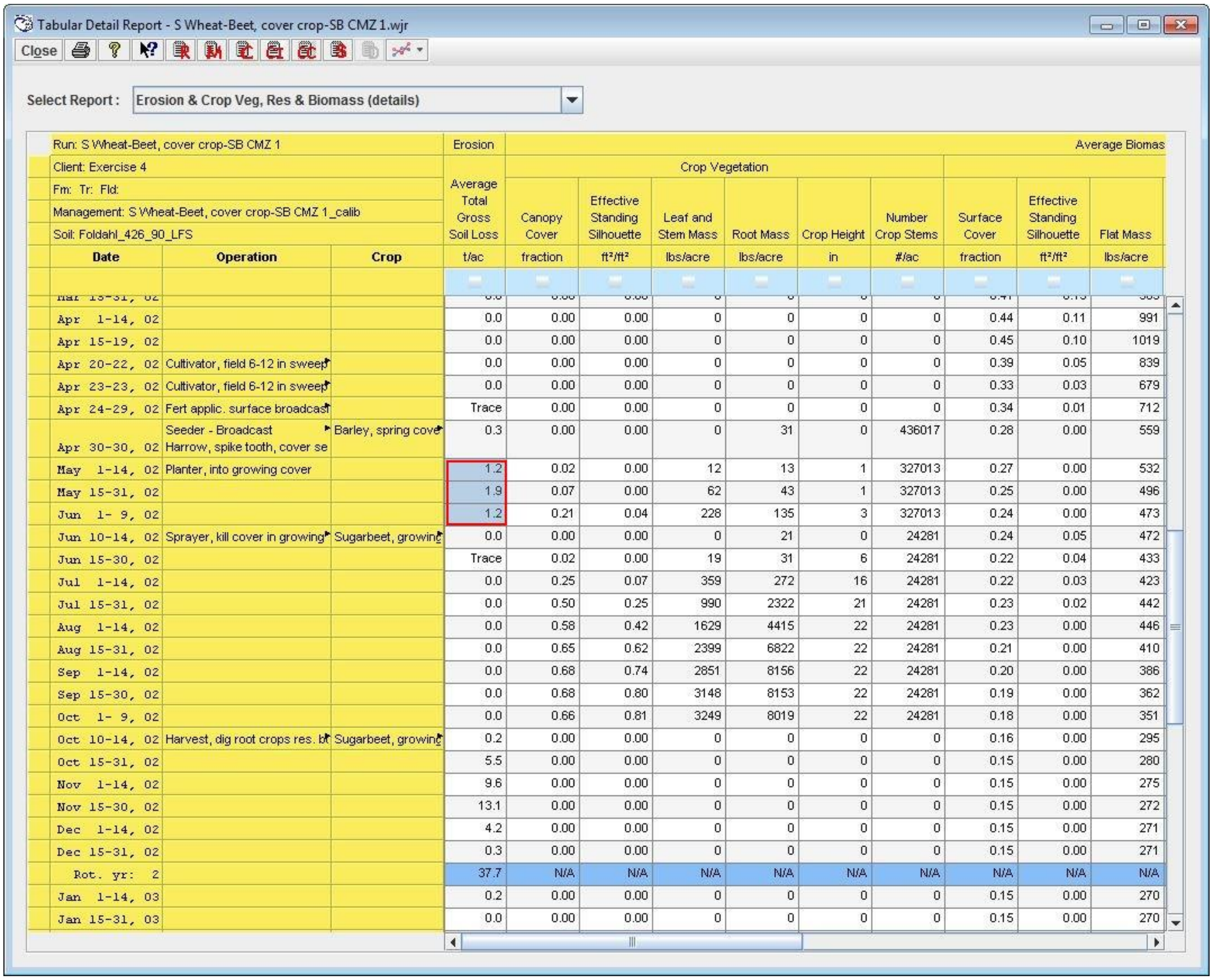


Figure 4-49 Run Summary showing the adjusted biomass factor and the effect of the barley cover crop on soil loss.

Without the windbreak on this sandy site, the 40-day cover crop does little to reduce the overall erosion (Figure 4-49). We started at 28.0 t/ac and actually increased erosion to 35.4 tons/acre, probably due to the cover crop taking water that the sugar beets would be using. It is advisable to make additional runs with less tillage to find a system where the rate is closer to the desired 5 ton/acre rate.

Also, if we look at the Tabular Detail Report, we see that the erosion occurring during the early growth of the sugarbeets has not been adequately addressed either (Figure 4-50).



Run: S Wheat-Beet, cover crop-SB CMZ 1 Client: Exercise 4 Fm: Tr: Fld: Management: S Wheat-Beet, cover crop-SB CMZ 1_calib Soil: Foldahl_426_90_LFS			Erosion	Crop Vegetation							Average Biomas		
			Average Total Gross Soil Loss	Canopy Cover	Effective Standing Silhouette	Leaf and Stem Mass	Root Mass	Crop Height	Number Crop Stems	Surface Cover	Effective Standing Silhouette	Flat Mass
Date	Operation	Crop	t/ac	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/acre
Apr 1-14, 02			0.0	0.00	0.00	0	0	0	0	0.44	0.11	991
Apr 15-19, 02			0.0	0.00	0.00	0	0	0	0	0.45	0.10	1019
Apr 20-22, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00	0	0	0	0	0.39	0.05	839
Apr 23-23, 02	Cultivator, field 6-12 in sweep		0.0	0.00	0.00	0	0	0	0	0.33	0.03	679
Apr 24-29, 02	Fert applic. surface broadcast		Trace	0.00	0.00	0	0	0	0	0.34	0.01	712
Apr 30-30, 02	Seeder - Broadcast Harrow, spike tooth, cover se	Barley, spring cove	0.3	0.00	0.00	0	31	0	436017	0.28	0.00	559
May 1-14, 02	Planter, into growing cover		1.2	0.02	0.00	12	13	1	327013	0.27	0.00	532
May 15-31, 02			1.9	0.07	0.00	62	43	1	327013	0.25	0.00	496
Jun 1- 9, 02			1.2	0.21	0.04	228	135	3	327013	0.24	0.00	473
Jun 10-14, 02	Sprayer, kill cover in growing	Sugarbeet, growing	0.0	0.00	0.00	0	21	0	24281	0.24	0.05	472
Jun 15-30, 02			Trace	0.02	0.00	19	31	6	24281	0.22	0.04	433
Jul 1-14, 02			0.0	0.25	0.07	359	272	16	24281	0.22	0.03	423
Jul 15-31, 02			0.0	0.50	0.25	990	2322	21	24281	0.23	0.02	442
Aug 1-14, 02			0.0	0.58	0.42	1629	4415	22	24281	0.23	0.00	446
Aug 15-31, 02			0.0	0.65	0.62	2399	6822	22	24281	0.21	0.00	410
Sep 1-14, 02			0.0	0.68	0.74	2851	8156	22	24281	0.20	0.00	386
Sep 15-30, 02			0.0	0.68	0.80	3148	8153	22	24281	0.19	0.00	362
Oct 1- 9, 02			0.0	0.66	0.81	3249	8019	22	24281	0.18	0.00	351
Oct 10-14, 02	Harvest, dig root crops res. b	Sugarbeet, growing	0.2	0.00	0.00	0	0	0	0	0.16	0.00	295
Oct 15-31, 02			5.5	0.00	0.00	0	0	0	0	0.15	0.00	280
Nov 1-14, 02			9.6	0.00	0.00	0	0	0	0	0.15	0.00	275
Nov 15-30, 02			13.1	0.00	0.00	0	0	0	0	0.15	0.00	272
Dec 1-14, 02			4.2	0.00	0.00	0	0	0	0	0.15	0.00	271
Dec 15-31, 02			0.3	0.00	0.00	0	0	0	0	0.15	0.00	271
Rot. yr: 2			37.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jan 1-14, 03			0.2	0.00	0.00	0	0	0	0	0.15	0.00	270
Jan 15-31, 03			0.0	0.00	0.00	0	0	0	0	0.15	0.00	270

Figure 4-50 WEPS Tabular Detail Report showing the erosion during the early growth of the sugarbeets.

Reducing tillage and adding a fall rye cover crop

We will now reduce the tillage and add a fall cover crop to hopefully increase the amount of residue prior to planting sugarbeets.

Step 1: Remove the Chisel and two Culivator operations in years 1 and 2.

Step 2: Insert a *Drill, heavy, direct seed, dbl disk opnr* (available under the *Seeding, drill, other* folder) on Sep. 1, 01. Select *Rye, winter cover* for the crop to be grown.

Step 3: Replace the Barley seeder operation with a *Planter, double disk opnr* (available under the *Seeding, planter* folder) and specify *Sugarbeet, sugar* for the crop to be planted.

Step 4: Remove all the operations following the Sugarbeet planting down to the 0ct. 10, 02 Sugarbeet harvest operation.

Step 5: Name the management file **S Wheat-Beet, rye cover crop-SB CMZ 1_calib** (Figure 4-51).

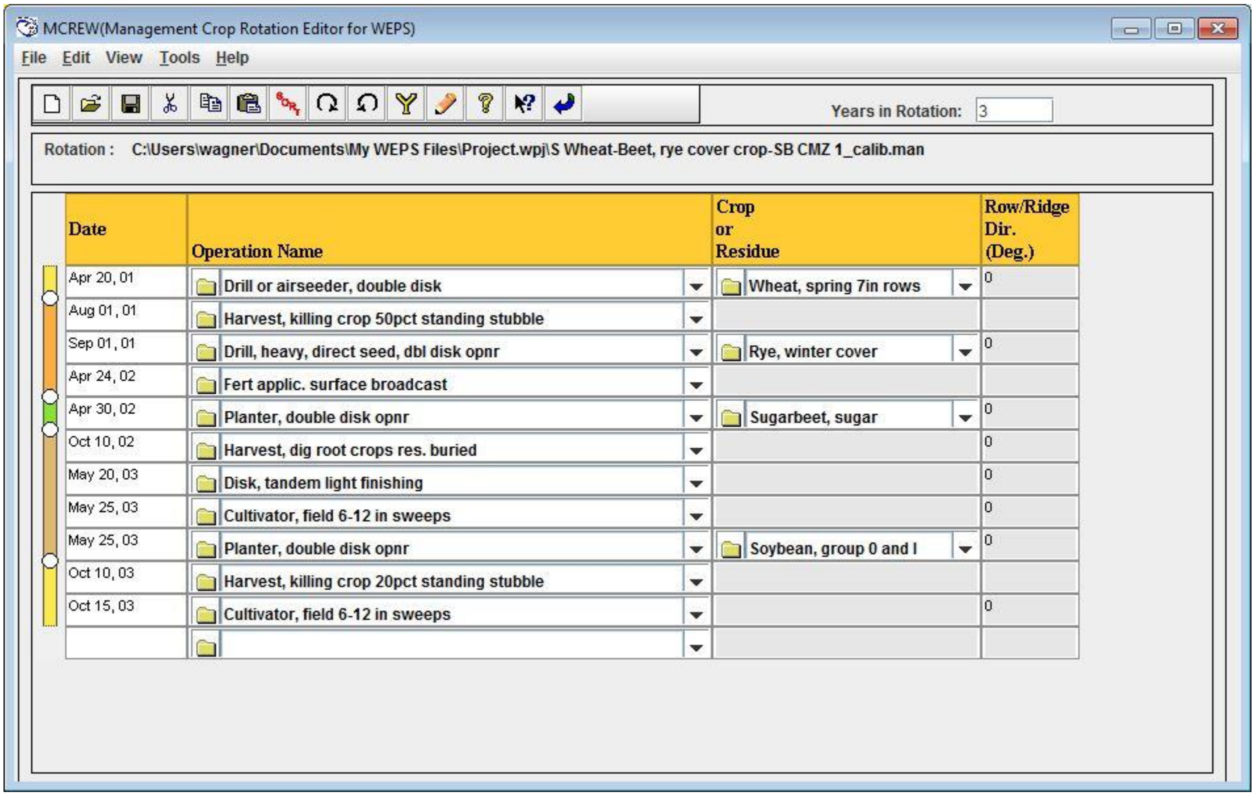


Figure 4-51MCREW displaying rye cover crop and reduced tillage in the rotation.

Step 6: Make a new WEPS Run and name it **S Wheat-Beet, rye cover crop-SB CMZ 1**. This now produces 22.2 tons/acre soil loss (Figure 4-52). However, if we look at the Tabular Detail Report, we see that we have now resolved the issue of excessive erosion during the early growth of the sugar beets (Figure 4-53).

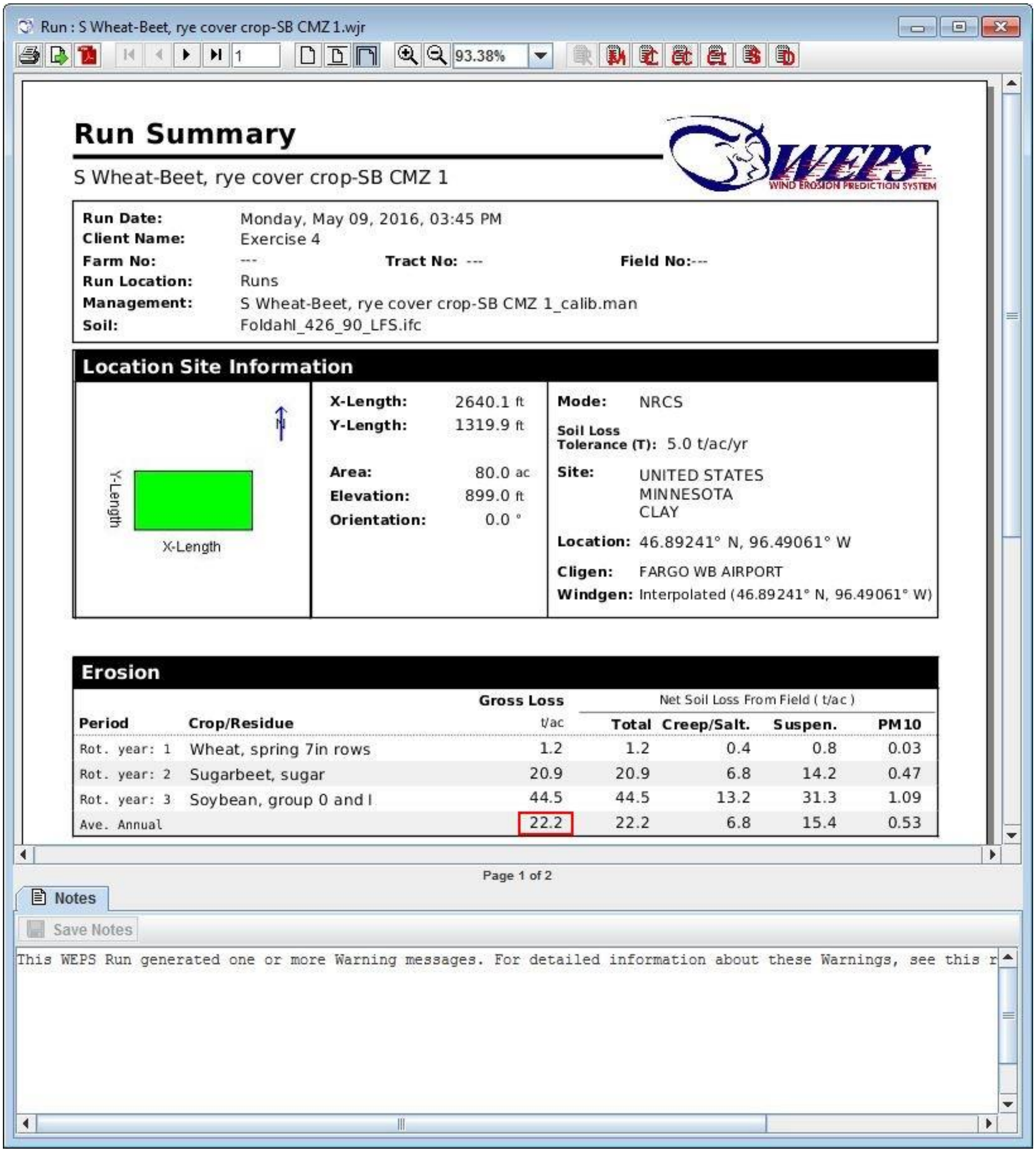
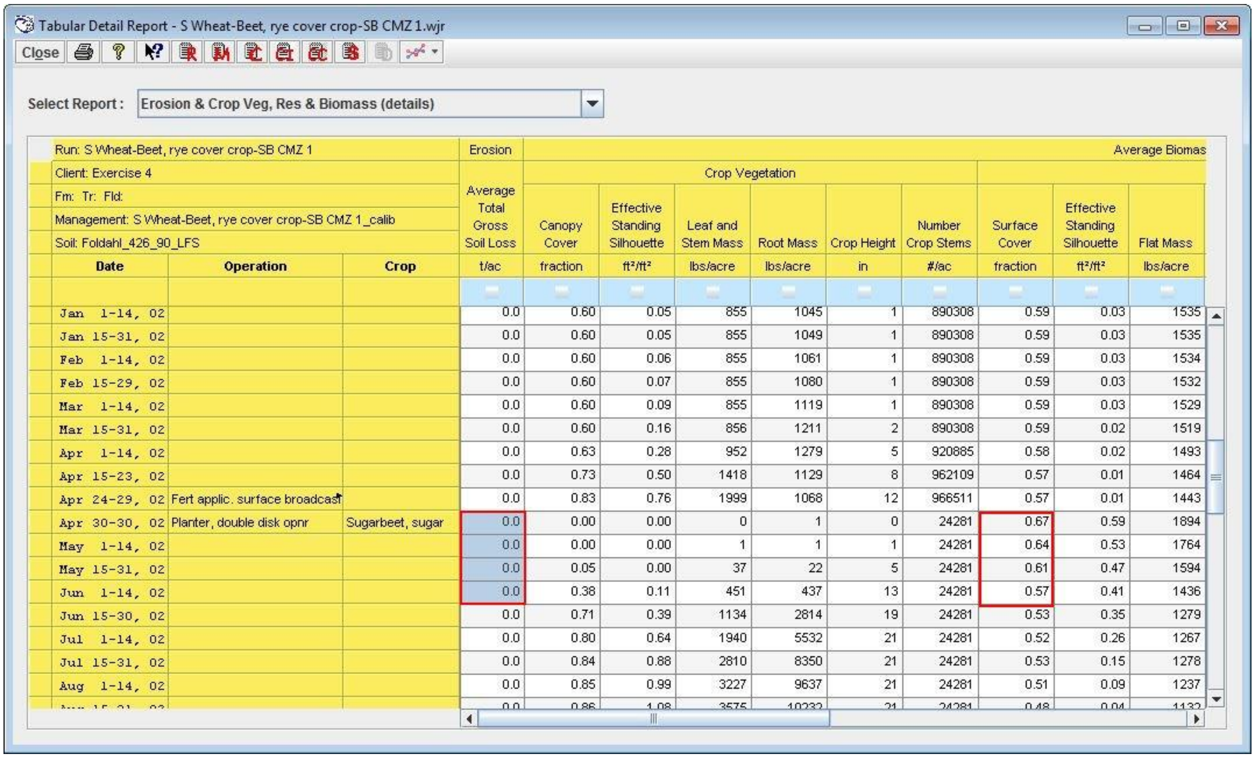


Figure 4-52WEPS Run Summary showing erosion rate with reduced tillage and a rye cover crop added to the rotation.


Tabular Detail Report - S Wheat-Beet, rye cover crop-SB CMZ 1.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Run: S Wheat-Beet, rye cover crop-SB CMZ 1			Erosion										Average Biomas
Client: Exercise 4				Crop Vegetation									
Fm: Tr: Fld: / Management: S Wheat-Beet, rye cover crop-SB CMZ 1_calib / Soil: Foldahl_426_90_LFS			Average Total Gross Soil Loss	Canopy Cover	Effective Standing Silhouette	Leaf and Stem Mass	Root Mass	Crop Height	Number Crop Stems	Surface Cover	Effective Standing Silhouette	Flat Mass
Date	Operation	Crop	t/ac	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/acre
Jan 1-14, 02			0.0	0.60	0.05	855	1045	1	890308	0.59	0.03	1535
Jan 15-31, 02			0.0	0.60	0.05	855	1049	1	890308	0.59	0.03	1535
Feb 1-14, 02			0.0	0.60	0.06	855	1061	1	890308	0.59	0.03	1534
Feb 15-29, 02			0.0	0.60	0.07	855	1080	1	890308	0.59	0.03	1532
Mar 1-14, 02			0.0	0.60	0.09	855	1119	1	890308	0.59	0.03	1529
Mar 15-31, 02			0.0	0.60	0.16	856	1211	2	890308	0.59	0.02	1519
Apr 1-14, 02			0.0	0.63	0.28	952	1279	5	920885	0.58	0.02	1493
Apr 15-23, 02			0.0	0.73	0.50	1418	1129	8	962109	0.57	0.01	1464
Apr 24-29, 02	Fert applic. surface broadcast		0.0	0.83	0.76	1999	1068	12	966511	0.57	0.01	1443
Apr 30-30, 02	Planter, double disk opnr	Sugarbeet, sugar	0.0	0.00	0.00	0	1	0	24281	0.67	0.59	1894
May 1-14, 02			0.0	0.00	0.00	1	1	1	24281	0.64	0.53	1764
May 15-31, 02			0.0	0.05	0.00	37	22	5	24281	0.61	0.47	1594
Jun 1-14, 02			0.0	0.38	0.11	451	437	13	24281	0.57	0.41	1436
Jun 15-30, 02			0.0	0.71	0.39	1134	2814	19	24281	0.53	0.35	1279
Jul 1-14, 02			0.0	0.80	0.64	1940	5532	21	24281	0.52	0.26	1267
Jul 15-31, 02			0.0	0.84	0.88	2810	8350	21	24281	0.53	0.15	1278
Aug 1-14, 02			0.0	0.85	0.99	3227	9637	21	24281	0.51	0.09	1237

Figure 4-53WEPS Tabular Detail Report showing the protection provided by the rye cover crop and reduced tillage for the early growth of sugar beets.

One can now address the excessive erosion following the soybean harvest using similar approaches. I likely scenario here would be to also include another winter cover crop and possibly reduce the fall tillage specified. Optionally, the windbreak could also be added back to see the effects with the cover crop(s) as well. These options are left as an exercise for the reader.

Exercise 5 – Alfalfa Hay, Editing, and More Irrigation

Skill Building: In this exercise use WEPS to simulate a forage crop cut for hay. A year of alfalfa will be added to the three year rotation. This will show the power of the MCREW. There are many ways to edit data using the copy-paste and increment/decrement functions of operations editing to move seeding dates. This exercise will help the user understand the basic format to build other forage crop files. Irrigation can be added in preset or custom amounts, or as needed as the plant uses it. In this example we will model full irrigation and apply water as the crop uses it. Many circles on a quarter section of land (160 acres) have 120 acres "under the iron". For this example there is an end gun that turns on and off as needed when the circle turns. The producer can irrigate 10 more acres for a total of 130 acres.

WEPS can simulate crops being cut multiple times in a growing season. However, forage crop biomass is not calibrated in the same way as it is for grain crops. We will not calibrate the forage crop with WEPS. Saving a calibrated crop to the local crop folder for use in future runs can save run time on subsequent runs. Each forage cutting yield that under-performs usually does not affect the erosion rate since there is more than adequate cover to shut down the erosion during a subsequent growing of a forage crop. So, if the hay yield is low, do not reject the run unless there is substantial erosion occurring in that 2 week management period.

Exercise 5 Scenario

- The producer is near **Moses Lake, Washington** in **Grant County**.
- The soil is a **Quincy Fine Sand** (*Quincy_97_100_FS.ifc*).
- The field has full pivot or **circle irrigation**.
- Potatoes are a high dollar cash rental crop and must be rotated with other crops for disease and nematode control. The rotation is **Alfalfa 3 yrs-Potato-Winter Wheat**. If the alfalfa stand is good and the price for hay is strong they will leave the hay for 4 years.
- The irrigated circle is **130 acres**.
- The annual yield for the **alfalfa crop is about 6-7 t/ac/yr** cut 4 times with a 5th cut in some years. Alfalfa is cut on 30 day cycles.
- The **potato yield is 30 t/ac** or (600 cwt/ac).
- The **winter wheat yield is 100 bu/ac**.
- The erosive wind comes in the spring from the west and tillage/planting direction is north and south.

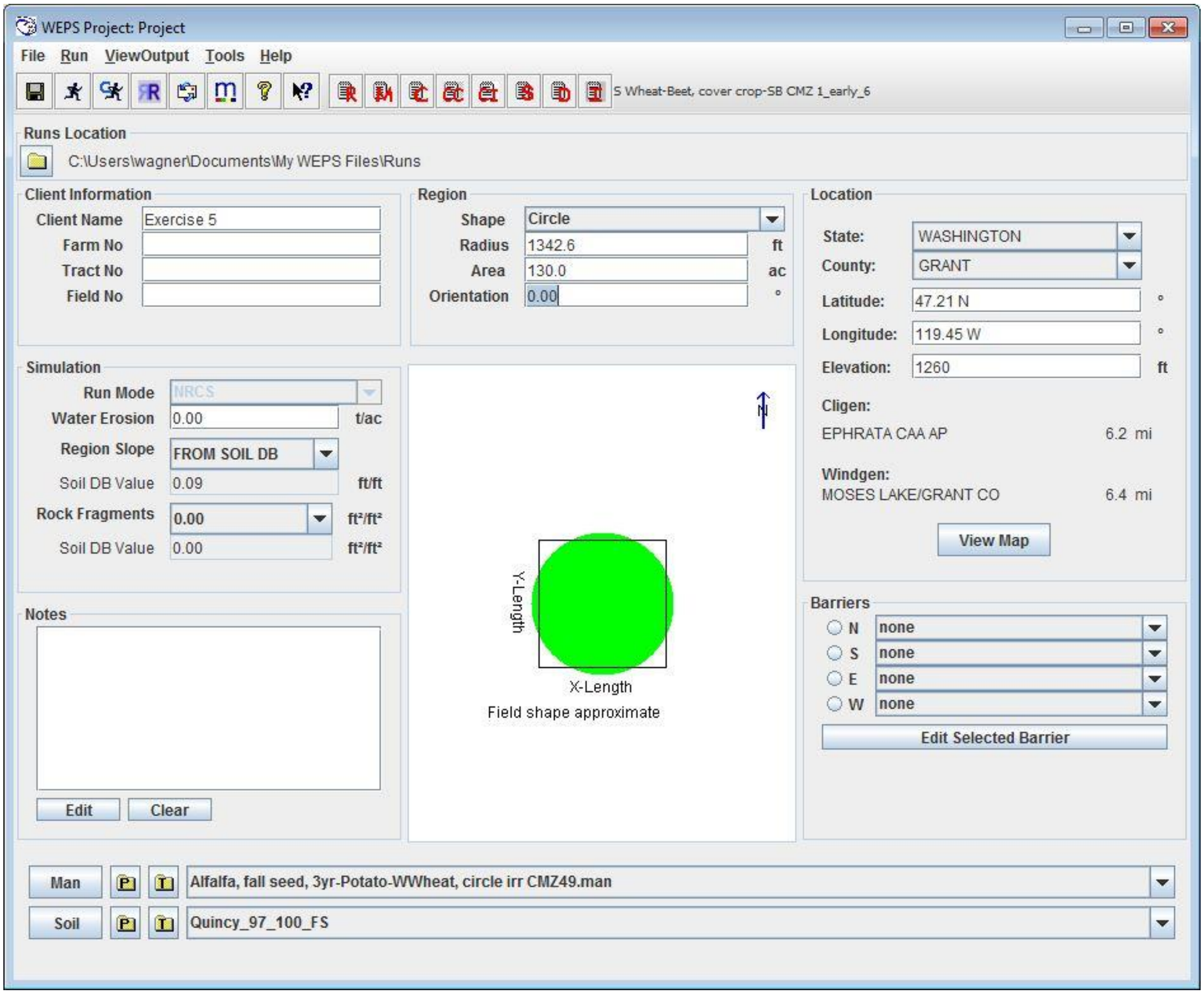


Figure 4-54 WEPS interface loaded for Exercise 5.

Complete the following steps:

Step 1: Enter all the information into the WEPS interface as shown in Figure 4-54. Notice when you enter the acreage value of 130 that the radius changes to 1342.6 feet, slightly bigger than the 1320 foot border to border of a 160 acre quarter section.

Step 2: Select the management/crop rotation file from the *Example Mgt. Files* folder in the *Templates* location and the soil from the *Exercise Soils* folder in the *Soil Templates* location.

Step 3: Open MCREW and Click the Yield Calibrate button to check the yields for all the crops. Correct the yields if necessary. Make sure they all match the inventory (**100 bu/ac, WWheat, 600 cwt/ac Potato, and 6.5 t/ac Alfalfa**). Also make sure there is no check mark in the "Calib. Yield?" column for the Alfalfa crop (Figure 4-55). The other crops will be calibrated if checked (Figure 4-56MCREW showing potatoes and winter wheat checked for calibration and their target yields set to the specified values.), while the Alfalfa left unchecked will not be calibrated. Click the Return button to save and return.

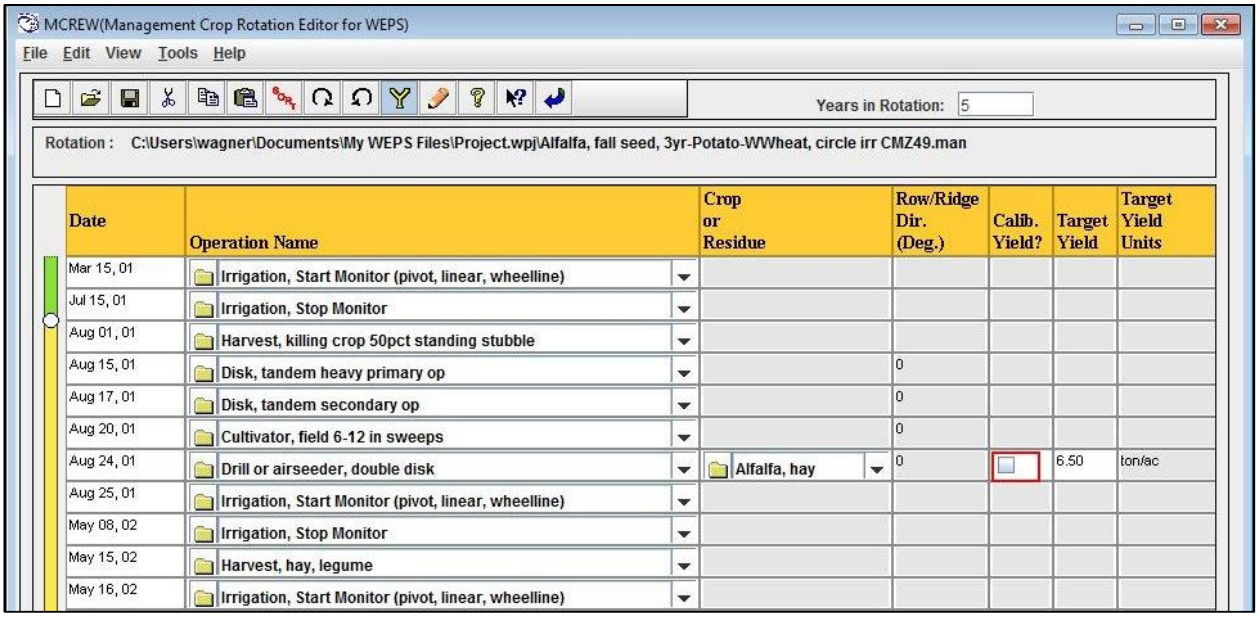


Figure 4-55 MCREW showing alfalfa yield and the box unchecked in the Calibrate Yield column.

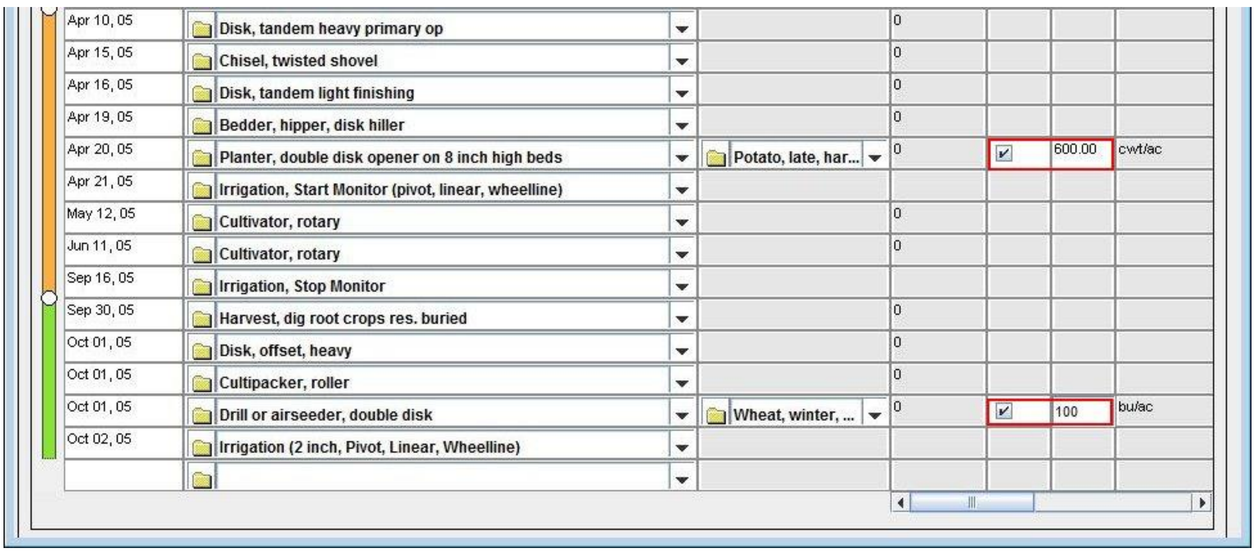


Figure 4-56MCREW showing potatoes and winter wheat checked for calibration and their target yields set to the specified values.

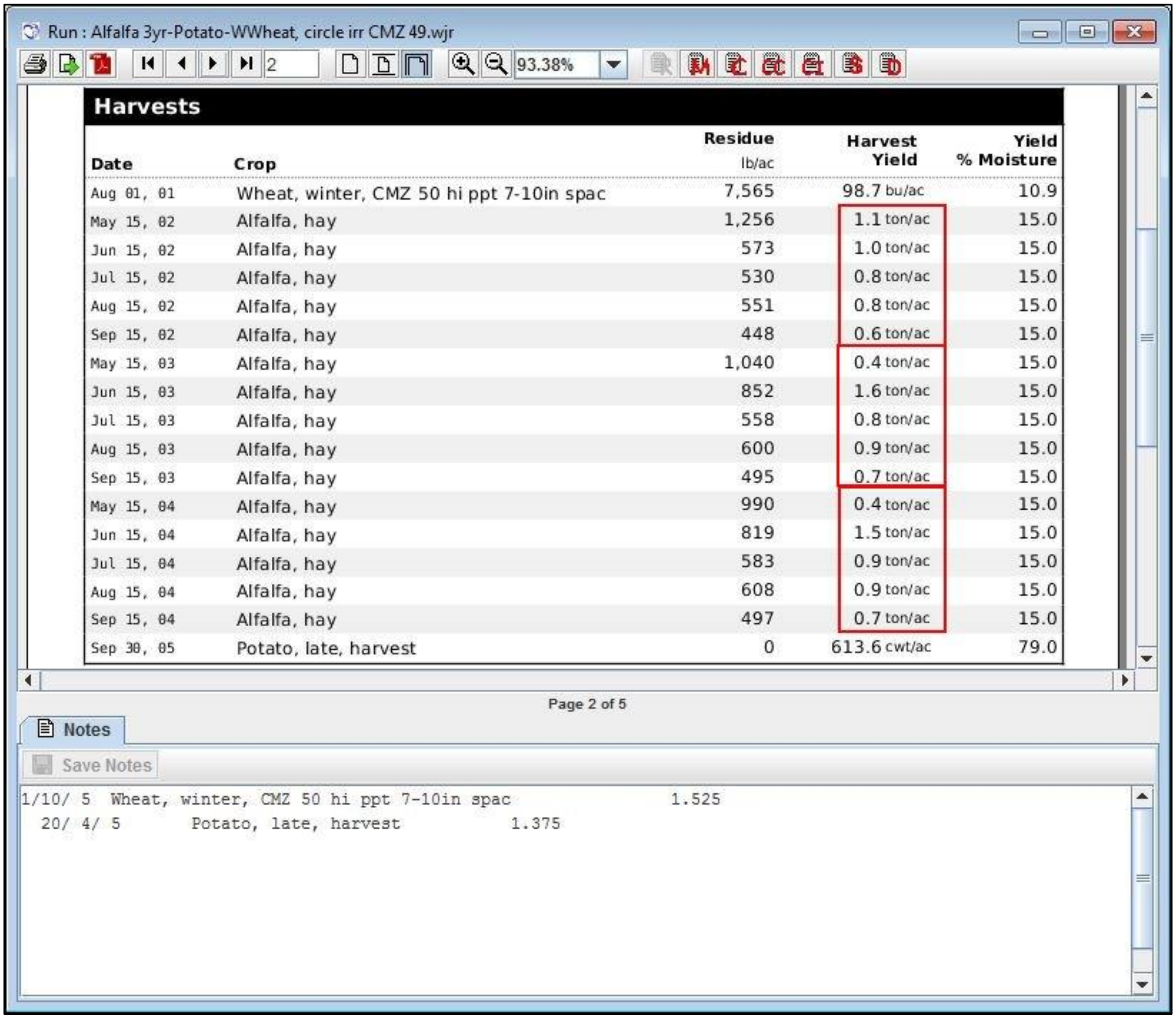
Notice the way the alfalfa crop irrigation and harvests are modeled. Each hay harvest has an *Irrigation, Start Monitor (Pivot, Linear, Wheelline); Irrigation, Stop Monitor* (both available in the *Application, irrigation* folder)*;* and *Harvest, hay, legume* operation associated with the harvest (available in the *Harvest, biomass, residue* folder). The irrigation is stopped 7 days before harvest to allow the soil surface to dry out enough to help cure the hay.

Step 4: Click the Calibration Run button  and name the run:

Alfalfa 3yr-Potato-WWheat, circle irr CMZ 49

This file is a long 5 year rotation. It will take the computer several minutes to calibrate the 250 year run.

If you plan to use these crops in future runs that were similar to this run, you should use the ‘Save as...’ button to store the 1.525 Biomass Adjustment Factor for wheat to a local record in the crops file. For now, click ‘Use in Current Project’. The yields in this Run Summary are on the second page. To flip to it, click the right-arrow in the tool bar.



Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Aug 01, 01	Wheat, winter, CMZ 50 hi ppt 7-10in spac	7,565	98.7 bu/ac	10.9
May 15, 02	Alfalfa, hay	1,256	1.1 ton/ac	15.0
Jun 15, 02	Alfalfa, hay	573	1.0 ton/ac	15.0
Jul 15, 02	Alfalfa, hay	530	0.8 ton/ac	15.0
Aug 15, 02	Alfalfa, hay	551	0.8 ton/ac	15.0
Sep 15, 02	Alfalfa, hay	448	0.6 ton/ac	15.0
May 15, 03	Alfalfa, hay	1,040	0.4 ton/ac	15.0
Jun 15, 03	Alfalfa, hay	852	1.6 ton/ac	15.0
Jul 15, 03	Alfalfa, hay	558	0.8 ton/ac	15.0
Aug 15, 03	Alfalfa, hay	600	0.9 ton/ac	15.0
Sep 15, 03	Alfalfa, hay	495	0.7 ton/ac	15.0
May 15, 04	Alfalfa, hay	990	0.4 ton/ac	15.0
Jun 15, 04	Alfalfa, hay	819	1.5 ton/ac	15.0
Jul 15, 04	Alfalfa, hay	583	0.9 ton/ac	15.0
Aug 15, 04	Alfalfa, hay	608	0.9 ton/ac	15.0
Sep 15, 04	Alfalfa, hay	497	0.7 ton/ac	15.0
Sep 30, 05	Potato, late, harvest	0	613.6 cwt/ac	79.0

Figure 4-57 Alfalfa yields displayed on page 2 of the Run Summary.

WEPS does not calibrate each cutting of hay in a year, but the average yield for all years can be manually adjusted by using the Biomass Adjustment Factor. However, the user **can** calibrate a multiply harvested crop by selecting a “single” harvest operation for calibration (all other harvests will use the same calibration factor. The steps to do so are beyond what is covered in this exercise). In this example, adding up the yield in each of the three years gives 4.3 t/ac in year 02 and 4.4 t/ac in both years 03 and 04, for an annual average of 4.37 t/ac yield of hay per year (Figure 4-57). Remember the reported yield was 6 to 7 t/ac/yr.

Step 5: We can approximate how WEPS adjusts yield by dividing the expected yield by the observed (6/4.37 = 1.373). Thus, we will try the new Biomass Adjustment Factor of 1.408, which should provide an average yield closer to the 6 t/ac desired (Figure 4-55).

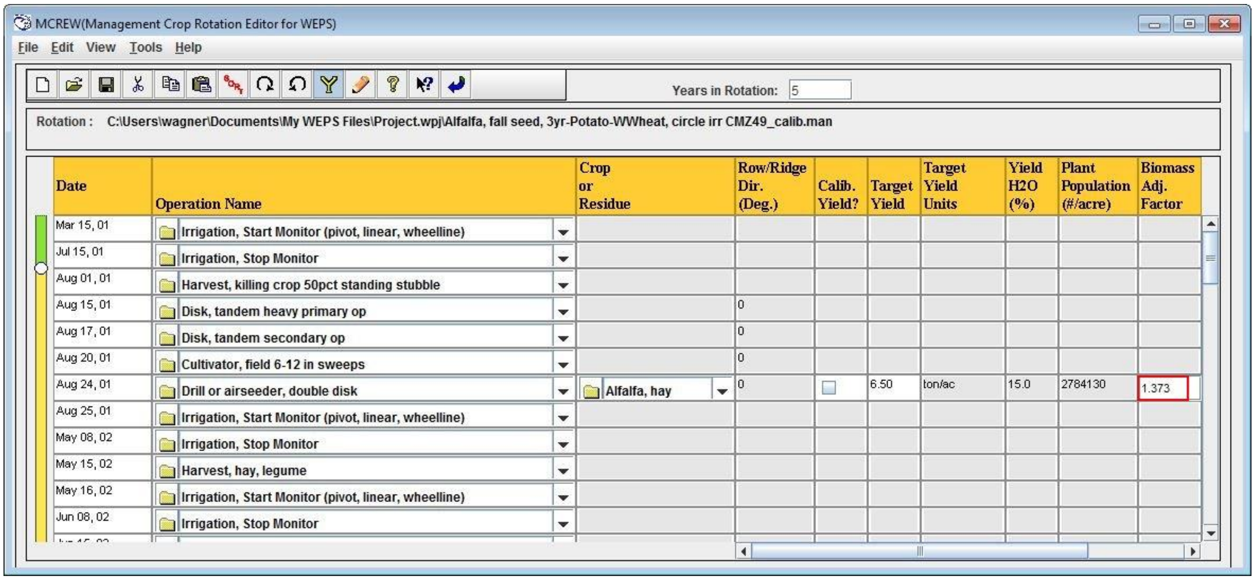


Figure 4-58 MCREW showing the new biomass adjustment factor for alfalfa hay.

Step 6: Make a second run using the new Biomass Adjustment Factor, but do not calibrate the run since we did that on the first run and will be using those factors in this Project. Use the same name, but with *Adj* appended to indicate the yields were adjusted.

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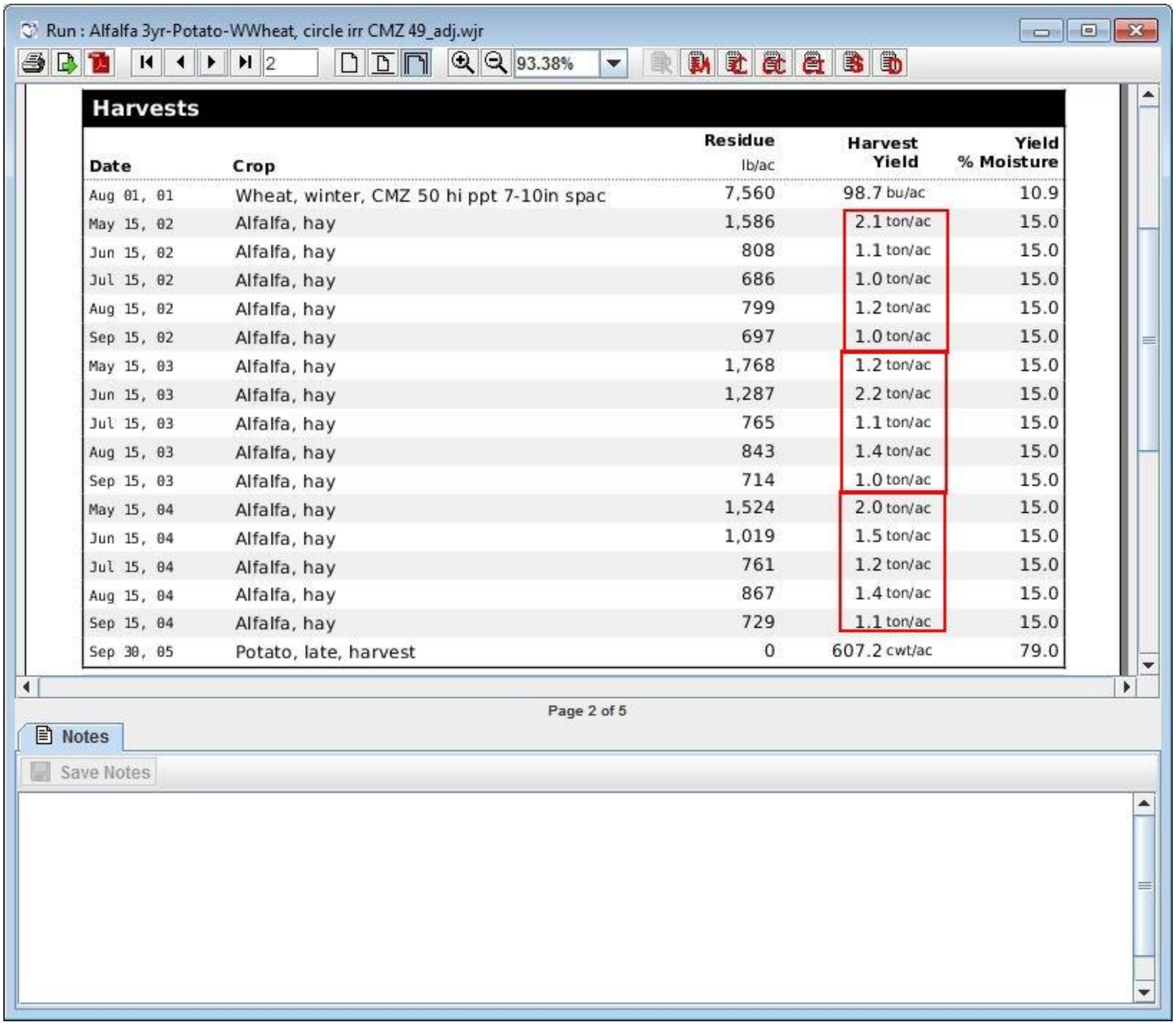


Harvests

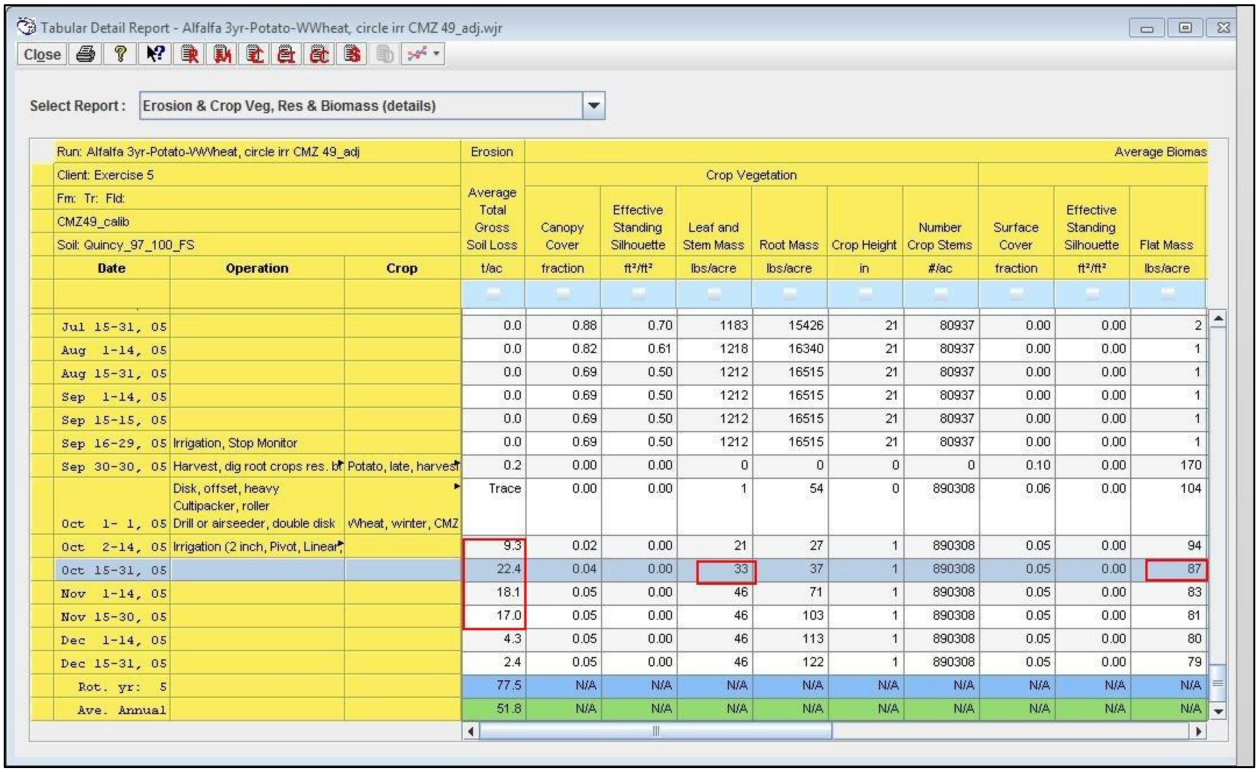
Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Aug 01, 01	Wheat, winter, CMZ 50 hi ppt 7-10in spac	7,560	98.7 bu/ac	10.9
May 15, 02	Alfalfa, hay	1,586	2.1 ton/ac	15.0
Jun 15, 02	Alfalfa, hay	808	1.1 ton/ac	15.0
Jul 15, 02	Alfalfa, hay	686	1.0 ton/ac	15.0
Aug 15, 02	Alfalfa, hay	799	1.2 ton/ac	15.0
Sep 15, 02	Alfalfa, hay	697	1.0 ton/ac	15.0
May 15, 03	Alfalfa, hay	1,768	1.2 ton/ac	15.0
Jun 15, 03	Alfalfa, hay	1,287	2.2 ton/ac	15.0
Jul 15, 03	Alfalfa, hay	765	1.1 ton/ac	15.0
Aug 15, 03	Alfalfa, hay	843	1.4 ton/ac	15.0
Sep 15, 03	Alfalfa, hay	714	1.0 ton/ac	15.0
May 15, 04	Alfalfa, hay	1,524	2.0 ton/ac	15.0
Jun 15, 04	Alfalfa, hay	1,019	1.5 ton/ac	15.0
Jul 15, 04	Alfalfa, hay	761	1.2 ton/ac	15.0
Aug 15, 04	Alfalfa, hay	867	1.4 ton/ac	15.0
Sep 15, 04	Alfalfa, hay	729	1.1 ton/ac	15.0
Sep 30, 05	Potato, late, harvest	0	607.2 cwt/ac	79.0

Figure 4-59 Run Summary showing alfalfa yields with the new Biomass Adjustment Factor.

This report shows 6.4 t/ac for year 02 and 6.9 t/ac for year 03 and 7.2 t/ac for year 04. By using the 1.489 factor for alfalfa we have an average alfalfa yield of 6.8 t/ac (Figure 4-59).

Click back to page 1 of the Run Summary. Potatoes have a high soil loss in Rotation year 5 of 77.5 t/ac. **Why is that?** Go to the Detailed Report .

Answer: Potatoes do not produce much residue and the harvest process leaves very little residue on the surface. The winter wheat grown behind the potatoes is seeded very late in the year and does not produce the growth required to control erosion. The average annual soil loss is 51.8 t/ac.



Date	Operation	Crop	Erosion: Average Total Gross Soil Loss (t/ac)	Crop Vegetation: Canopy Cover (fraction)	Crop Vegetation: Effective Standing Silhouette (ft²/ft²)	Crop Vegetation: Leaf and Stem Mass (lbs/acre)	Crop Vegetation: Root Mass (lbs/acre)	Crop Vegetation: Crop Height (in)	Crop Vegetation: Number Crop Stems (#/ac)	Average Biomas: Surface Cover (fraction)	Average Biomas: Effective Standing Silhouette (ft²/ft²)	Average Biomas: Flat Mass (lbs/acre)
Jul 15-31, 05			0.0	0.88	0.70	1183	15426	21	80937	0.00	0.00	2
Aug 1-14, 05			0.0	0.82	0.61	1218	16340	21	80937	0.00	0.00	1
Aug 15-31, 05			0.0	0.69	0.50	1212	16515	21	80937	0.00	0.00	1
Sep 1-14, 05			0.0	0.69	0.50	1212	16515	21	80937	0.00	0.00	1
Sep 15-15, 05			0.0	0.69	0.50	1212	16515	21	80937	0.00	0.00	1
Sep 16-29, 05	Irrigation, Stop Monitor		0.0	0.69	0.50	1212	16515	21	80937	0.00	0.00	1
Sep 30-30, 05	Harvest, dig root crops res. bl	Potato, late, harvest	0.2	0.00	0.00	0	0	0	0	0.10	0.00	170
Oct 1- 1, 05	Disk, offset, heavy Cultipacker, roller Drill or airseeder, double disk	Wheat, winter, CMZ	Trace	0.00	0.00	1	54	0	890308	0.06	0.00	104
Oct 2-14, 05	Irrigation (2 inch, Pivot, Linear		9.3	0.02	0.00	21	27	1	890308	0.05	0.00	94
Oct 15-31, 05			22.4	0.04	0.00	33	37	1	890308	0.05	0.00	87
Nov 1-14, 05			18.1	0.05	0.00	46	71	1	890308	0.05	0.00	83
Nov 15-30, 05			17.0	0.05	0.00	46	103	1	890308	0.05	0.00	81
Dec 1-14, 05			4.3	0.05	0.00	46	113	1	890308	0.05	0.00	80
Dec 15-31, 05			2.4	0.05	0.00	46	122	1	890308	0.05	0.00	79
Rot. yr: 5			77.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ave. Annual			51.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 4-60 Detailed Report showing high soil loss and low biomass after Potato year 5.

What is the highest period of loss in the Potato year?

Answer: 'Oct 15-31, 05', at 22.4 t/ac.

Why is it so high?

Answer: After potatoes, there is only a small amount of residue as Flat Mass (87 lbs/ac) and the growing winter wheat is small (33 lbs/ac Leaf and Stem Mass) (Figure 4-60).

Adding another year of alfalfa

The producer reports that sometimes he adds another year of alfalfa to the rotation if the hay market is promising and the stand of alfalfa is OK. In this part of the exercise, the editing power of MCREW will be put to use.

Step 1: Close any remaining report screens. From the main interface, open the management editor 

. Scroll down the operation list until you get to the 'Mar 15, 04', *Irrigation, Start Monitor (pivot, linear, wheelline)*. From there, click and drag to select all the operations of year 04. Right click in the Operation column and select "Copy Row(s)" (Figure 4-61).

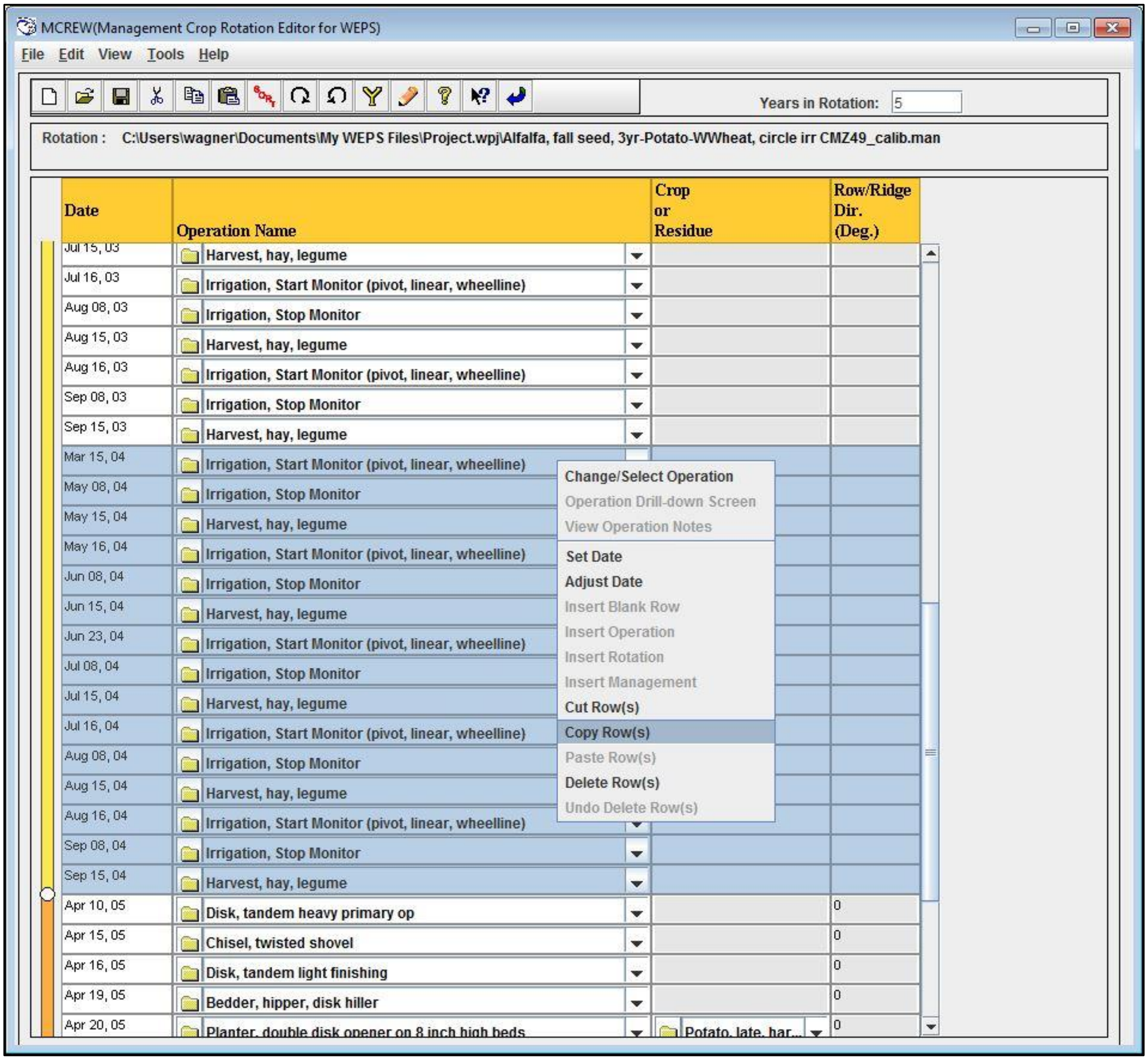


Figure 4-61 Operations for Alfalfa year 04 selected for copying.

Step 2: Now right-click the Disk on ‘Apr 10, 05’ and select “Paste Row(s)”. You have now made a complete set of operations for a year of alfalfa. Note that the dates still have year 4 instead of year 5. With the group of cells still highlighted, right-click the date column and select “Increment Year” (Figure 4-62).

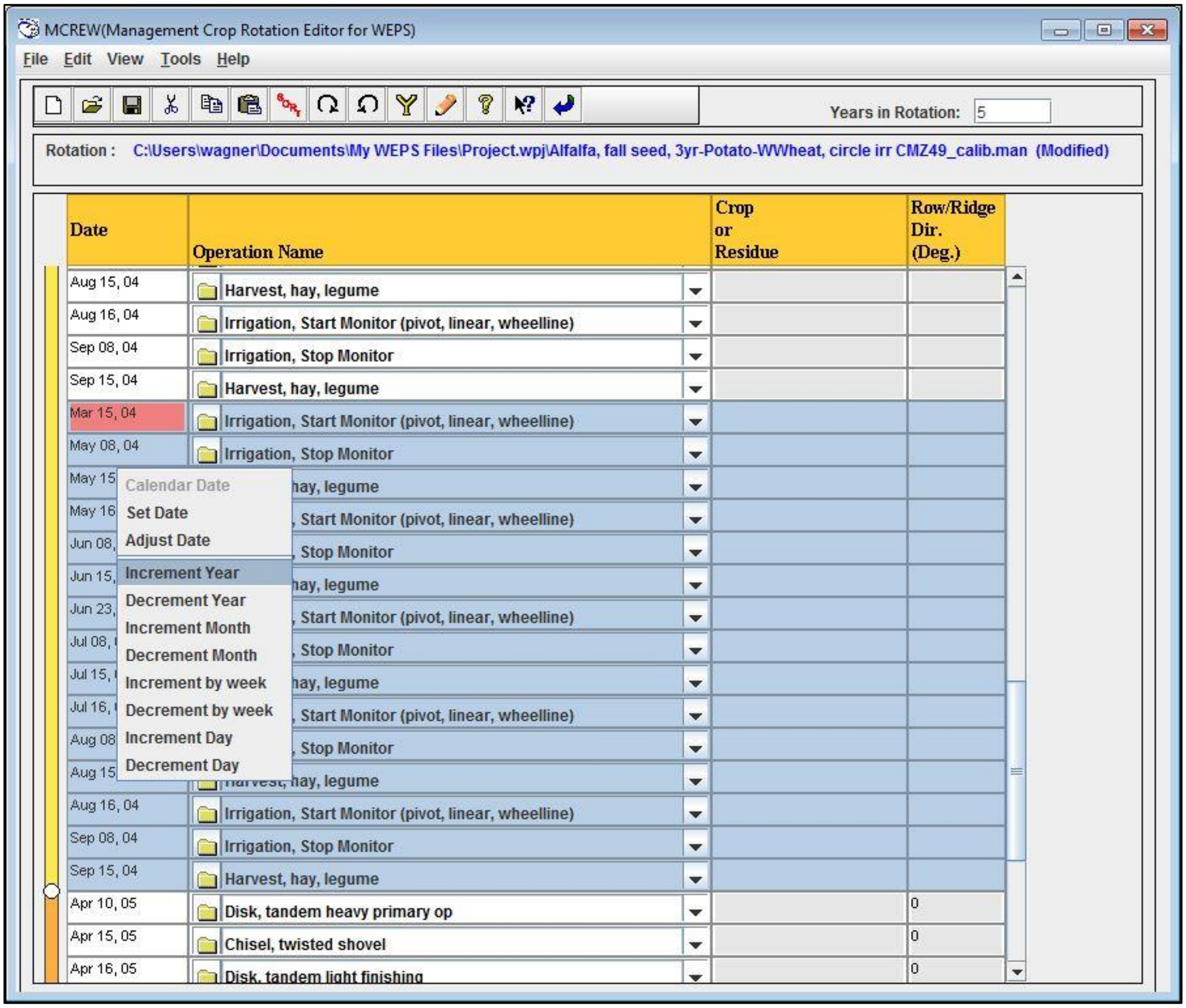


Figure 4-62 Incrementing the year of the copied operations.

Step 3: Finally, highlight the Disk from 'Apr 10, 05' through the end of the file. Right click the date column and increment the year. The year should now be 06 for the potato crop year. We have added a year to the rotation so we must change the "Years in Rotation" box at the top of the editor screen from 5 to 6 (Figure 4-63).

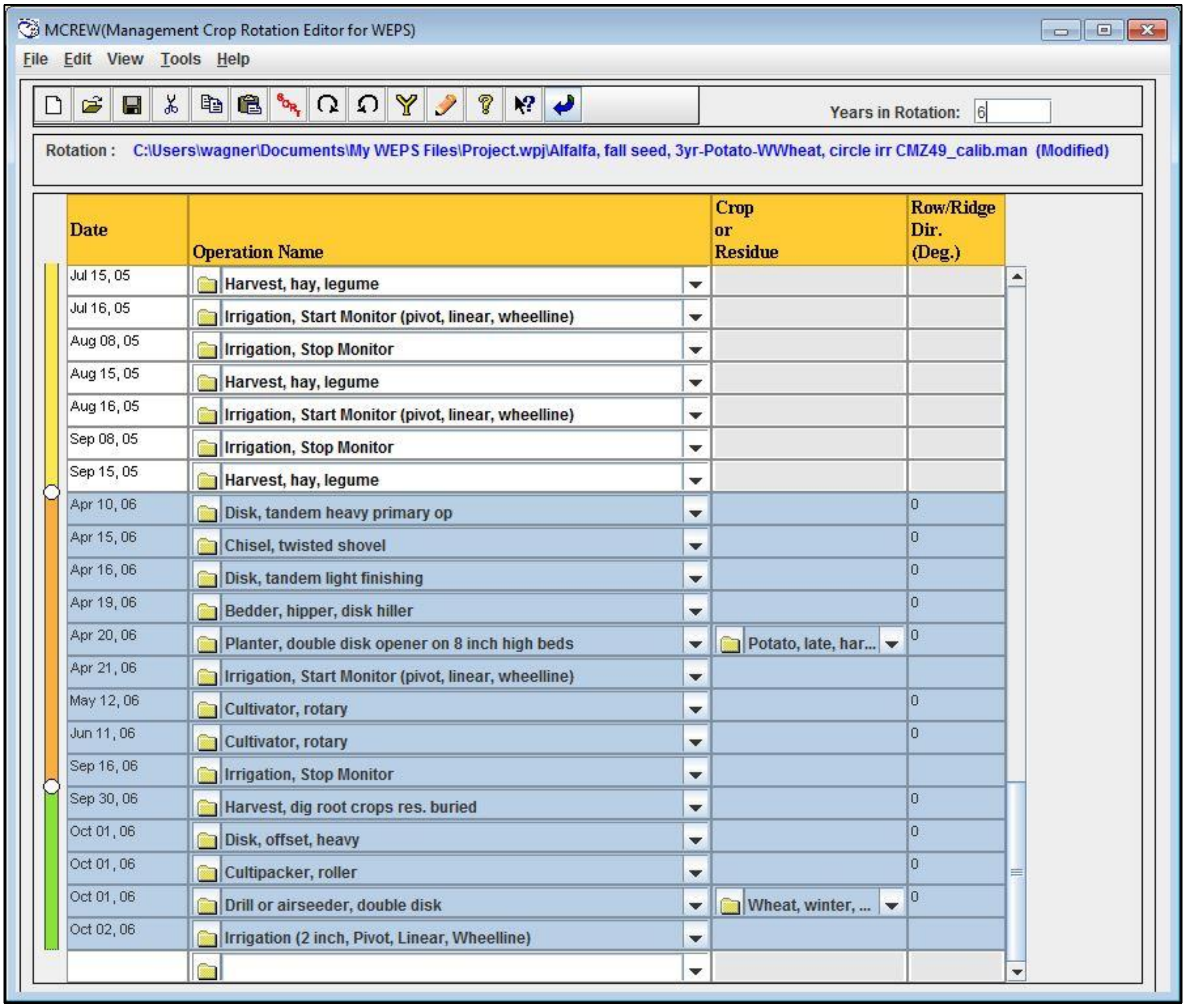


Figure 4-63 MCREW window after adding another year of alfalfa, with corrected dates.

Once you are sure all the dates are correct and sequential, click 'File', Save as...', and name the file **Alfalfa, fall seed, 4yr-Potato-WWheat, circle irr CMZ49_calib**.

Step 2: We can now run the management without calibration since we saved the previous run and added back to the management file the Biomass Adjustment Factors for alfalfa (1.373), potatoes (1.375), and the winter wheat (1.525).

Step 3: Click Run and name it **Alfalfa 4yr-Potato-WWheat, circle irr CMZ 49_adj**.

The erosion rate is now 40.3 t/ac/yr (Figure 4-64). This is an improvement from the previous 51.8 tons, but more will have to be done to conserve the soil of this field.

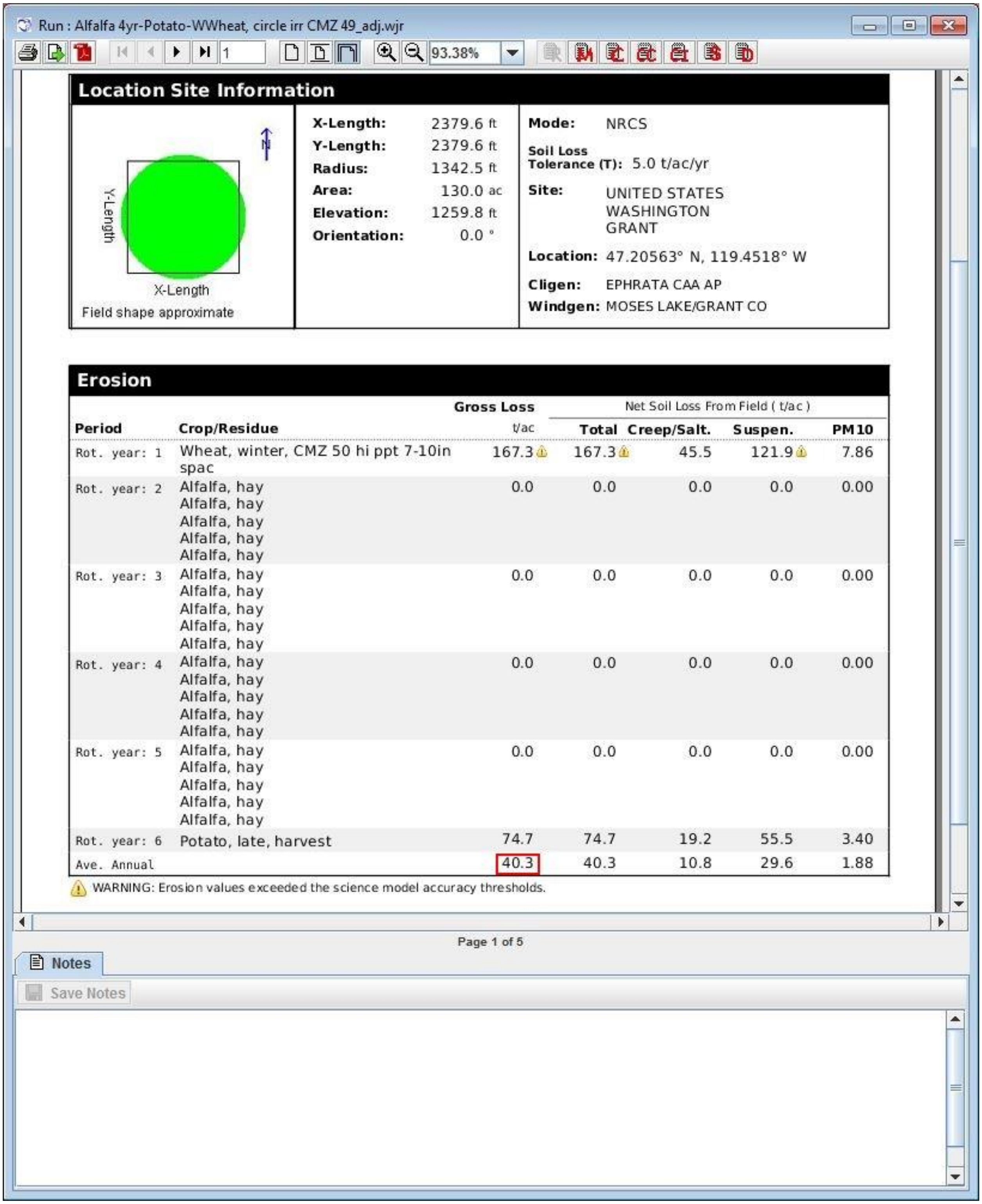
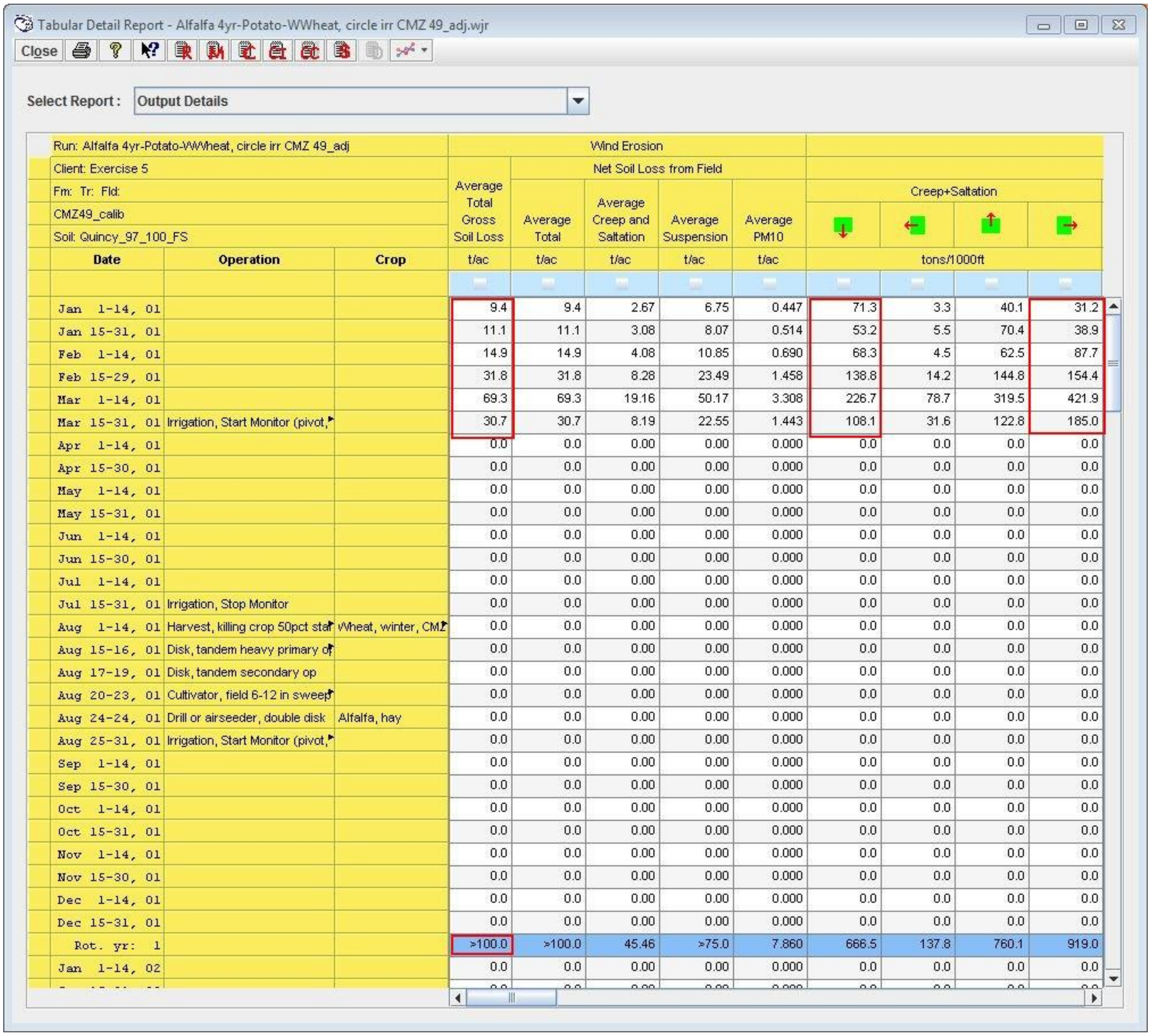


Figure 4-64 Run Summary showing Average Annual Soil Loss.

Reducing wind erosion to acceptable levels

Since this particular scenario is simulating excessive erosion results, even with four years of alfalfa in the rotation, we must make additional changes in the rotation practices to get it under control. From the

Tabular Detail Report (Figure 4-65), we can see that almost all erosion is occurring after the potato harvest operation because it is not leaving any residue on the field. This rotation is specifying winter wheat to be planted immediately following to potato harvest, but we aren't getting enough heat units to generate adequate wheat cover prior to winter. Also, the Tabular Detail Report is showing that most of the erosion is occurring from the primary directions the soil is leaving the field. We will attempt to provide some ridging during the wheat planting operation and orient the ridges to help bring the erosion under control.



Tabular Detail Report - Alfalfa 4yr-Potato-WWheat, circle irr CMZ 49_adj.wjr

Close

Select Report : Output Details

Run: Alfalfa 4yr-Potato-WWheat, circle irr CMZ 49_adj
Client: Exercise 5
Fm: Tr: Fld:
CMZ49_calib
Soil: Quincy_97_100_FS

Date	Operation	Crop	Wind Erosion: Average Total Gross Soil Loss (t/ac)	Net Soil Loss from Field: Average Total (t/ac)	Average Creep and Saltation (t/ac)	Average Suspension (t/ac)	Average PM10 (t/ac)	Creep+Saltation ↓ (tons/1000ft)	← (tons/1000ft)	↑ (tons/1000ft)	→ (tons/1000ft)
Jan 1-14, 01			9.4	9.4	2.67	6.75	0.447	71.3	3.3	40.1	31.2
Jan 15-31, 01			11.1	11.1	3.08	8.07	0.514	53.2	5.5	70.4	38.9
Feb 1-14, 01			14.9	14.9	4.08	10.85	0.690	68.3	4.5	62.5	87.7
Feb 15-29, 01			31.8	31.8	8.28	23.49	1.458	138.8	14.2	144.8	154.4
Mar 1-14, 01			69.3	69.3	19.16	50.17	3.308	226.7	78.7	319.5	421.9
Mar 15-31, 01	Irrigation, Start Monitor (pivot,		30.7	30.7	8.19	22.55	1.443	108.1	31.6	122.8	185.0
Apr 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Apr 15-30, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
May 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
May 15-31, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Jun 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Jun 15-30, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Jul 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Jul 15-31, 01	Irrigation, Stop Monitor		0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Aug 1-14, 01	Harvest, killing crop 50pct sta	Wheat, winter, CMZ	0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Aug 15-16, 01	Disk, tandem heavy primary op		0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Aug 17-19, 01	Disk, tandem secondary op		0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Aug 20-23, 01	Cultivator, field 6-12 in sweep		0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Aug 24-24, 01	Drill or airseeder, double disk	Alfalfa, hay	0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Aug 25-31, 01	Irrigation, Start Monitor (pivot,		0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Sep 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Sep 15-30, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Oct 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Oct 15-31, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Nov 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Nov 15-30, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Dec 1-14, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Dec 15-31, 01			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0
Rot. yr: 1			>100.0	>100.0	45.46	>75.0	7.860	666.5	137.8	760.1	919.0
Jan 1-14, 02			0.0	0.0	0.00	0.00	0.000	0.0	0.0	0.0	0.0

Figure 4-65 WEPS Tabular Output report showing periods of high erosion and the directions the soil is leaving the field.

Step 1: Go to MCREW and select the "*Planter, double disk opener on 12 inch high beds"* operation in the "Seeding, *Planter"* folder. We are selecting this operation because we don't have any "drills" that we can configure to plant on large ridges at this time (probably an oversight on our part).

Step 2: Select the folder "drilldown" icon and select the "Seeding Configuration" option at the bottom of the panel (Figure 4-66).

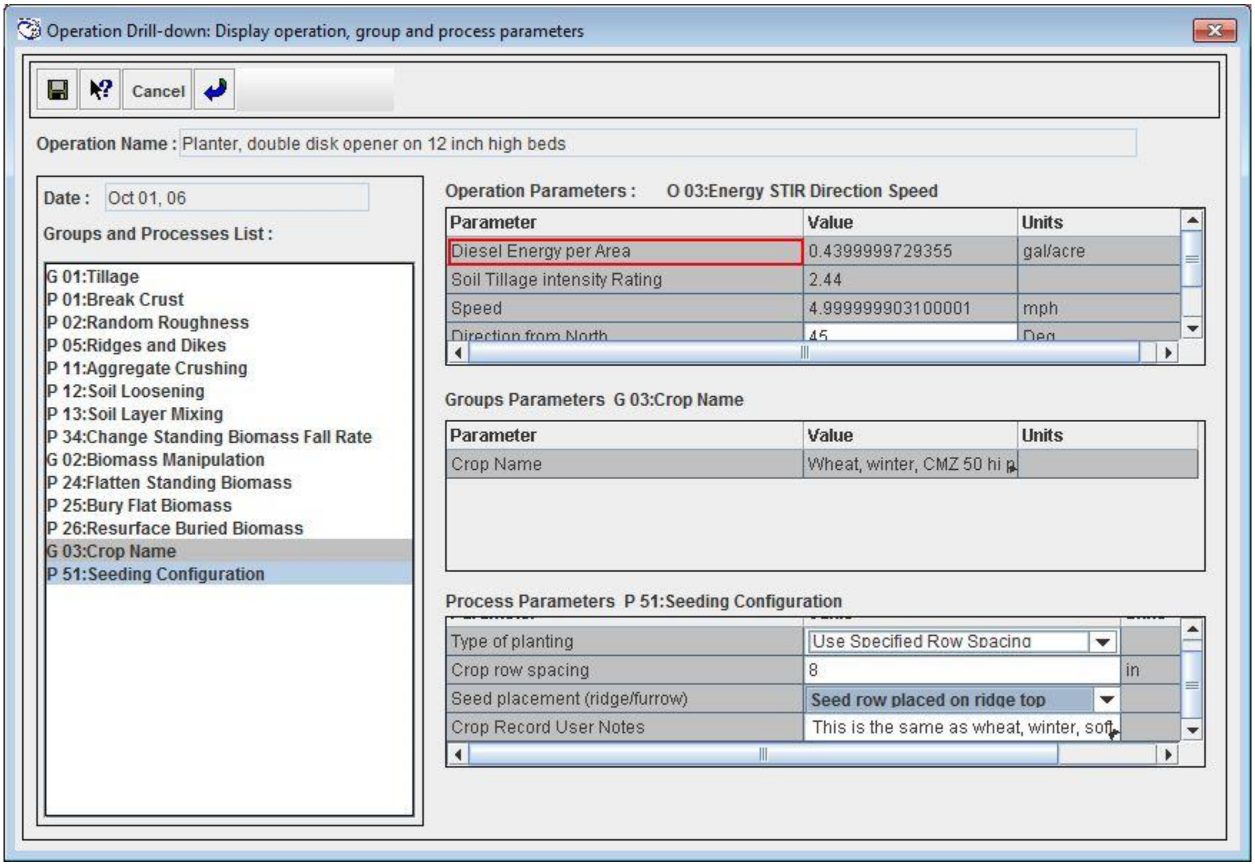


Figure 4-66WEPS Operation drilldown panel displaying "Seeding Configuration" options.

Step 3: As shown in Figure 4-66:

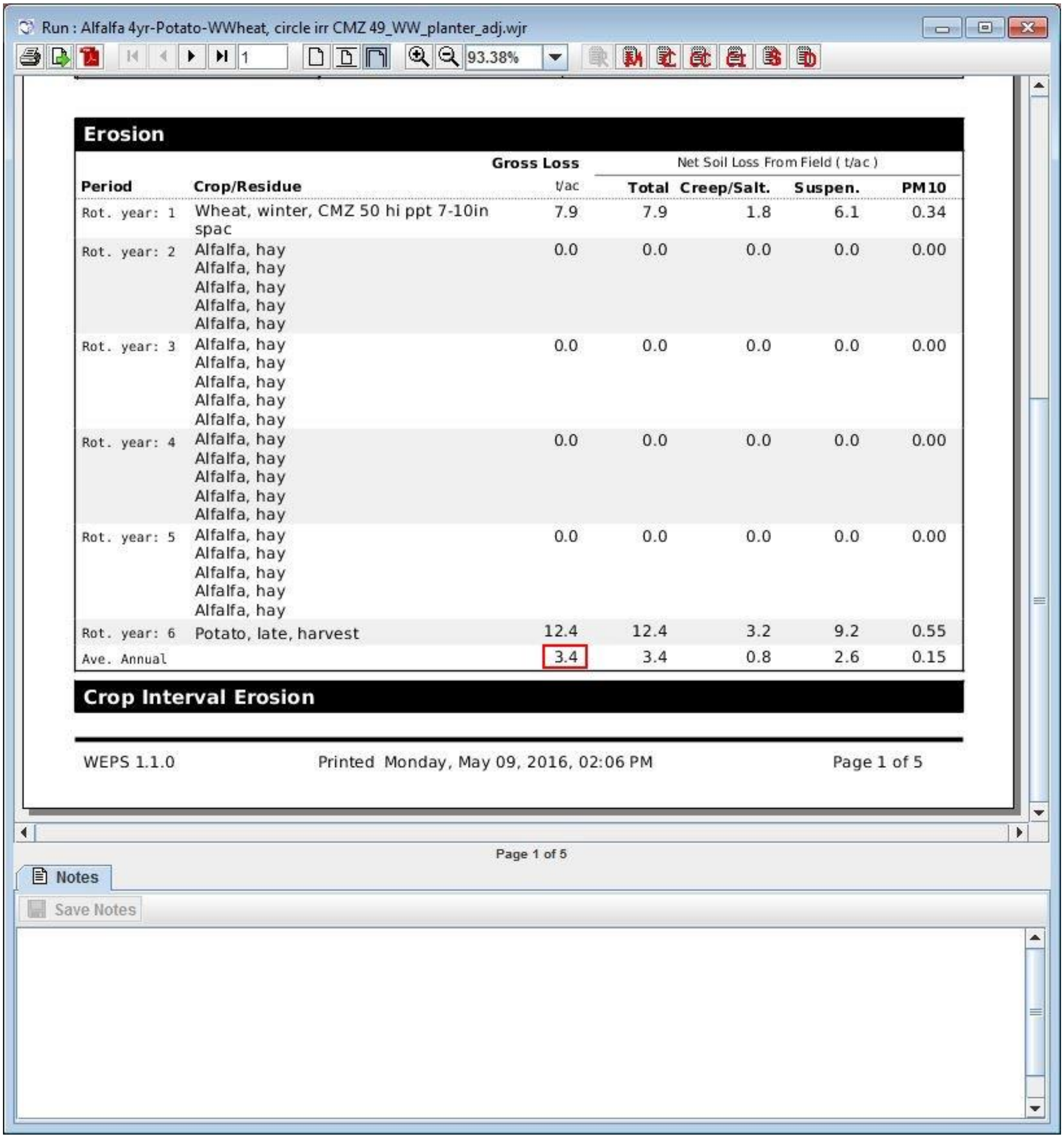
a) Select the "Use Specified Row Spacing" for the "Type of Planting" field.
b) Change the "Crop row spacing field" to 8 inches.
c) Select the "Seed row placed on the ridge top" for the "Seed placement (ridge/furrow)" field.

These settings will allow the wheat to be planted on the ridges as well as the furrows to help the limited wheat cover produced better protect the field from wind erosion and allow the ridge roughness to be oriented across the prevailing wind directions.

Step 4: Save and name the management file: Alfalfa, fall seed, 4yr-Potato_WWheat, circle irr CMZ49-drill_on_ridges_calib.

Step 5: Make a standard WEPS run using the previous calibrated values and name the run: Alfalfa, fall seed, 4yr-Potato_WWheat, circle irr CMZ49_WW_planter_adj.

The average annual erosion rate is now **3.4 t/a** (Figure 4-67), which is well within NRCS limits.



Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Wheat, winter, CMZ 50 hi ppt 7-10in spac	7.9	7.9	1.8	6.1	0.34
Rot. year: 2	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.0	0.0	0.00
Rot. year: 3	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.0	0.0	0.00
Rot. year: 4	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.0	0.0	0.00
Rot. year: 5	Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay Alfalfa, hay	0.0	0.0	0.0	0.0	0.00
Rot. year: 6	Potato, late, harvest	12.4	12.4	3.2	9.2	0.55
Ave. Annual		3.4	3.4	0.8	2.6	0.15

Crop Interval Erosion

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Figure 4-67WEPS Run Summary Report showing the erosion results after planting on top of ridges and orienting the planting operation to 45 degrees.

Note that there are additional options that can be explored as solutions for the erosion which occurs on this site:

1. Stay with late season potato, use series of herbaceous wind barriers using WEPS to help design them. This works in other parts of country.
2. Sudan or cheap corn etc. - need height decent height - width of strip 120" or 10 ft (3 rows), between strips, max 100 ft (use WEPS to assist in design).

3. Harvest strips of early potato, get wheat established in strips, then harvest remaining strips of later maturity potato and plant later wheat.
4. Plant whole field to earlier maturity potato if possible to allow earlier wheat seeding in early Sept.
5. When precision irrigation becomes more common, strip cropping the field will be more feasible under a pivot.

Exercise 6 – Tomatoes, Rye Cover Crop, and Plastic Mulch

Skill Building: This exercise begins with a template rotation. Rye for winter cover and plastic mulch are added to the basic run. Often there is no cover between crop rows. This exercise should give the user a sense of value for these conservation practices. The picture below (Figure 4-68) is an example of plastic mulch with a rye inter-furrow cover crop and onions. The current version of WEPS does not directly model temporary barriers (between the rows) or two crops growing simultaneously as shown below, but it can simulate these situations nonetheless.

Figure 4-68 Onions with plastic mulch and rye between the rows.

We will model systems with cover crops planted either in the fall or spring and plastic mulch added to the field at or near planting time for the crop (in this case tomatoes). The mulch is accounted for in WEPS as 'special residue'. Therefore we can grow any other crop with plastic mulch in place. We can count the green cover crop as residue when we plant the tomatoes if we place a 'kill crop' operation before planting the tomatoes. This means that even though the rye is still growing, WEPS will not show rye growth. WEPS will however show the amount of rye biomass as dead residue when the tomatoes are planted thus providing the intended protection.

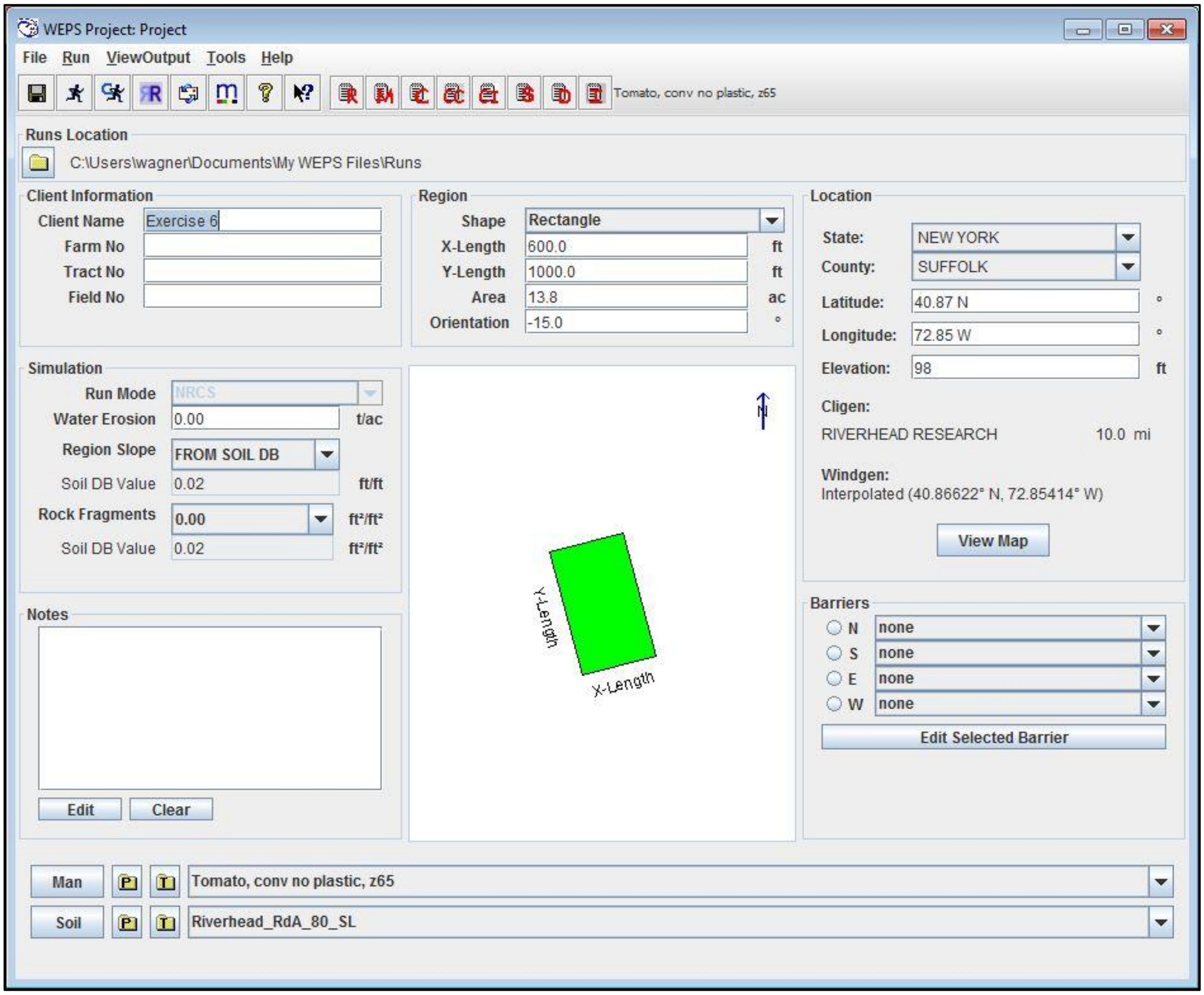


Figure 4-69 WEPS interface with initial run information.

Exercise 6 Scenario

- The field we are working with is in **Suffolk County, New York**.
- The soil is a Riverhead Sandy Loam (**Riverhead_RdA_80_SL.ifc**).
- The Cligen station is **Riverhead Research**
- The Windgen station is **Interpolated**.
- The simulation region is **600 ft for the X-Length** and **1000 feet for the Y-Length** to give a field size of **13.8 acres**.
- The field is oriented **-15.0 degrees** from true North (i.e., 345 degrees).
- The producer grows tomatoes, expecting yields of **300 cwt/ac**.
- The field is tilled parallel to its long side. The producer indicates that in some years, there is damage to the young tomato transplants from abrasion by blowing soil.

Step 1: Open the WEPS interface and enter the information as shown (Figure 4-69). Select the soil *Riverhead_RdA_80_SL* and the Template management file *Tomato, conv, no plastic Z6*. This is the management without the rye cover crop or the plastic mulch applied.

Step 2: Open MCREW to check the settings. The tillage must be parallel to the orientation of the field, so the Row Direction column should have all operations set to -15^{o}. To set the direction, select all the rows in the "Row/Ridge Dir." Column with values and right-click to bring up the column specific menu and select "Decrement 15 deg." Or adjust the direction by using alternate appropriate options. When the settings match, Figure 4-70 click Return.

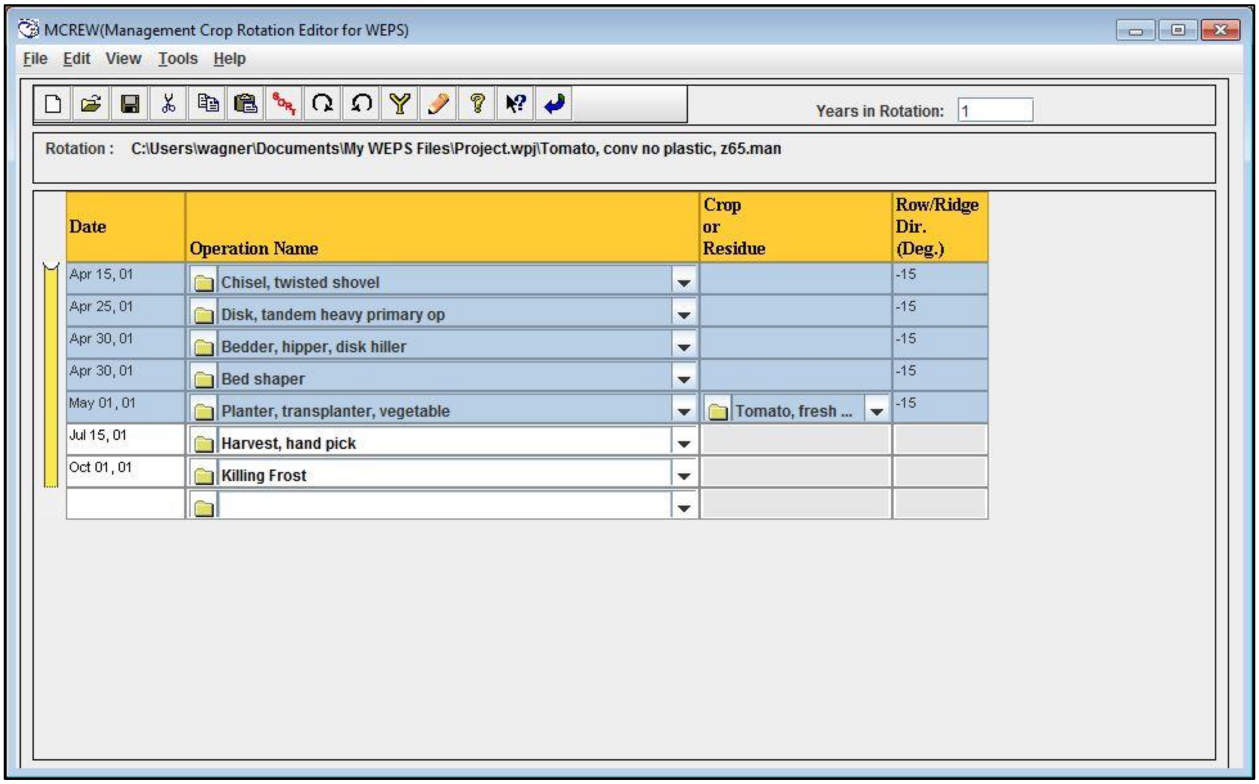


Figure 4-70 Management adjustments for the run.

Step 3: Make the run and save it as **Tomato, conv, no plastic, z65**.

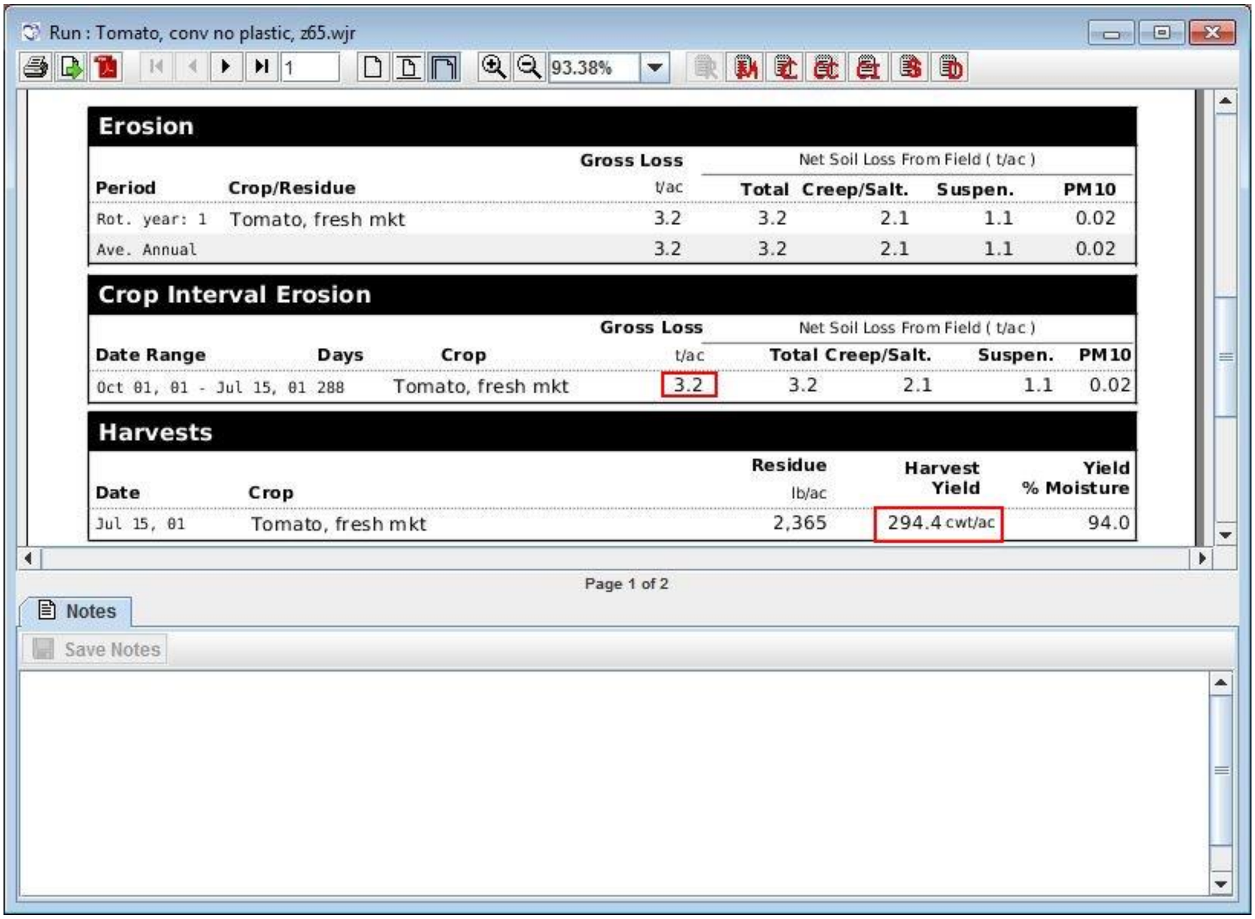
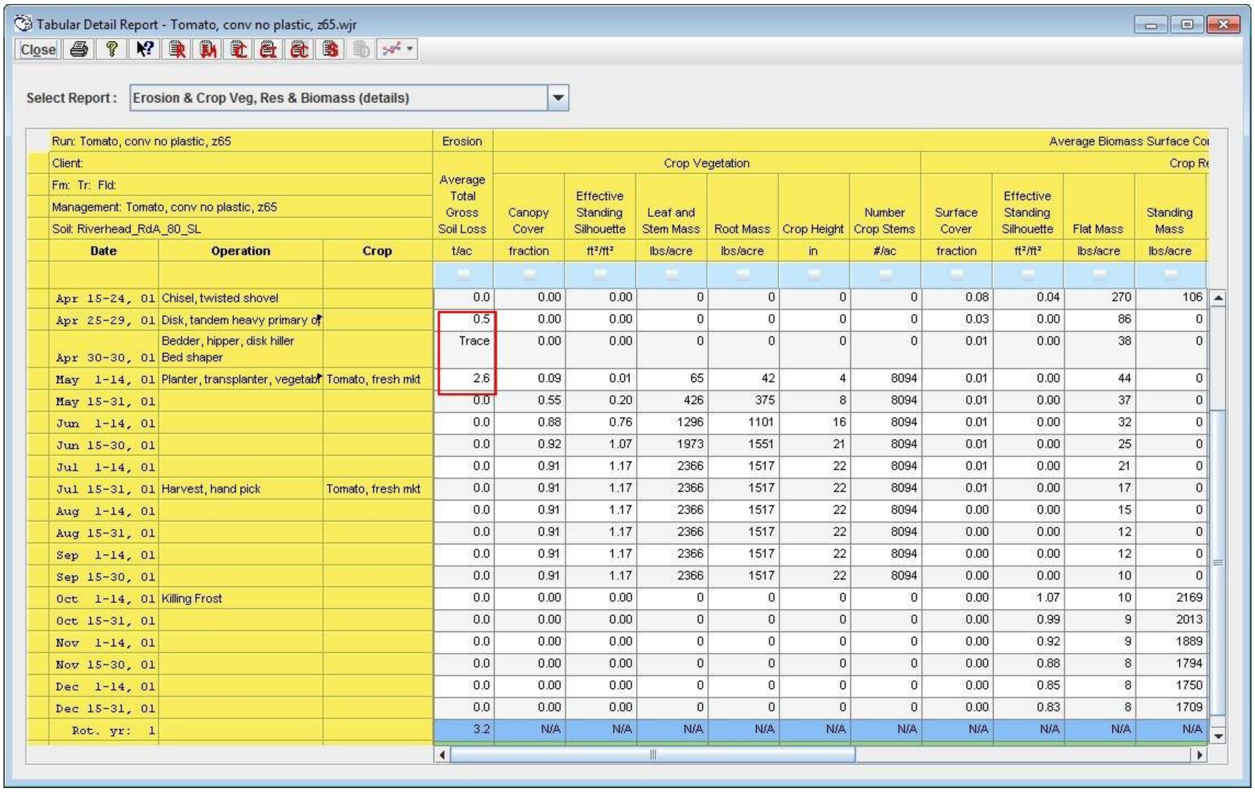


Figure 4-71 Run Summary showing soil loss and yields for the tomato crop.

The yield is close to the expected 300 cwt/ac at **294.4 cwt/ac** (Figure 4-71). The average annual gross loss is **3.2 t/ac**. If we look at the Tabular Detail Report though, we will see that most of the erosion occurs at planting time (Figure 4-72), so we must protect the young tomatoes better. See the tolerance for tomatoes (see Table 3.2 in the Exercises Introduction) so we will test the effect of a rye cover crop.



Tabular Detail Report - Tomato, conv no plastic, z65.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Run: Tomato, conv no plastic, z65
Client:
Fm: Tr: Fld:
Management: Tomato, conv no plastic, z65
Soil: Riverhead_RdA_80_SL

Date	Operation	Crop	Erosion: Average Total Gross Soil Loss	Crop Vegetation: Canopy Cover	Crop Vegetation: Effective Standing Silhouette	Crop Vegetation: Leaf and Stem Mass	Crop Vegetation: Root Mass	Crop Vegetation: Crop Height	Crop Vegetation: Number Crop Stems	Crop Re…: Surface Cover	Crop Re…: Effective Standing Silhouette	Crop Re…: Flat Mass	Crop Re…: Standing Mass
			t/ac	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/acre	lbs/acre
Apr 15-24, 01	Chisel, twisted shovel		0.0	0.00	0.00	0	0	0	0	0.08	0.04	270	106
Apr 25-29, 01	Disk, tandem heavy primary op		0.5	0.00	0.00	0	0	0	0	0.03	0.00	86	0
Apr 30-30, 01	Bedder, hipper, disk hiller Bed shaper		Trace	0.00	0.00	0	0	0	0	0.01	0.00	38	0
May 1-14, 01	Planter, transplanter, vegetab	Tomato, fresh mkt	2.6	0.09	0.01	65	42	4	8094	0.01	0.00	44	0
May 15-31, 01			0.0	0.55	0.20	426	375	8	8094	0.01	0.00	37	0
Jun 1-14, 01			0.0	0.88	0.76	1296	1101	16	8094	0.01	0.00	32	0
Jun 15-30, 01			0.0	0.92	1.07	1973	1551	21	8094	0.01	0.00	25	0
Jul 1-14, 01			0.0	0.91	1.17	2366	1517	22	8094	0.01	0.00	21	0
Jul 15-31, 01	Harvest, hand pick	Tomato, fresh mkt	0.0	0.91	1.17	2366	1517	22	8094	0.01	0.00	17	0
Aug 1-14, 01			0.0	0.91	1.17	2366	1517	22	8094	0.00	0.00	15	0
Aug 15-31, 01			0.0	0.91	1.17	2366	1517	22	8094	0.00	0.00	12	0
Sep 1-14, 01			0.0	0.91	1.17	2366	1517	22	8094	0.00	0.00	12	0
Sep 15-30, 01			0.0	0.91	1.17	2366	1517	22	8094	0.00	0.00	10	0
Oct 1-14, 01	Killing Frost		0.0	0.00	0.00	0	0	0	0	0.00	1.07	10	2169
Oct 15-31, 01			0.0	0.00	0.00	0	0	0	0	0.00	0.99	9	2013
Nov 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.00	0.92	9	1889
Nov 15-30, 01			0.0	0.00	0.00	0	0	0	0	0.00	0.88	8	1794
Dec 1-14, 01			0.0	0.00	0.00	0	0	0	0	0.00	0.85	8	1750
Dec 15-31, 01			0.0	0.00	0.00	0	0	0	0	0.00	0.83	8	1709
Rot. yr: 1			3.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Average Biomass Surface Co…

Figure 4-72WEPS Tabular Detail Report highlighting the wind erosion during the early growth of the tomato crop.

Adding a Rye Cover Crop after Tomato Harvest

Step 1: In the MCREW, change the *Killing Frost* operation to *Drill or airseeder, double disk* (in the *Seeding, drill, other* folder). Select *Rye, winter cover* for the crop to be planted. Change the date to Aug. 1, 01 for this planting. Now insert a light disk 5 days after harvest (*Disk, tandem light finishing, Jul 20, 01* in the *Tillage, cultivator, disk* folder). Click the Sort icon to arrange the operations in chronological order. Correct the operation directions to -15° (Figure 4-73).

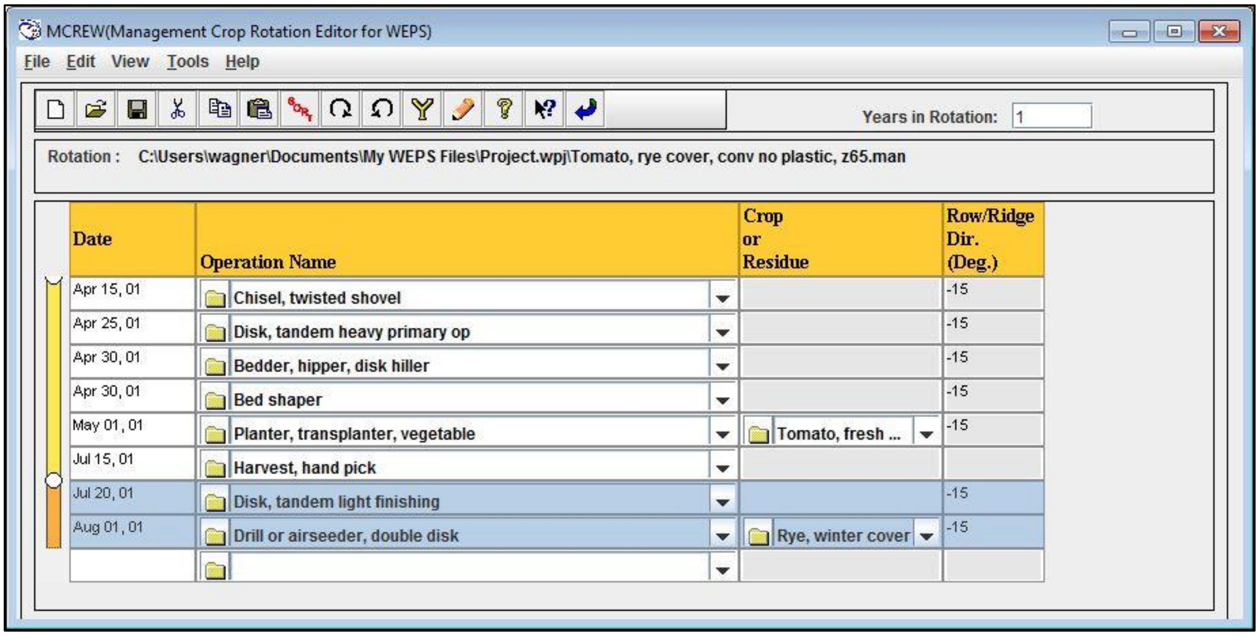


Figure 4-73 MCREW set for the second run.

Save the file with a new name by clicking ‘File’, ‘Save as...’, and enter **Tomato, rye cover, conv no plastic, z65.man**. Click the Return button .

Step 2: Make the run and call it **Tomato, rye cover, conv, no plastic, z65**.

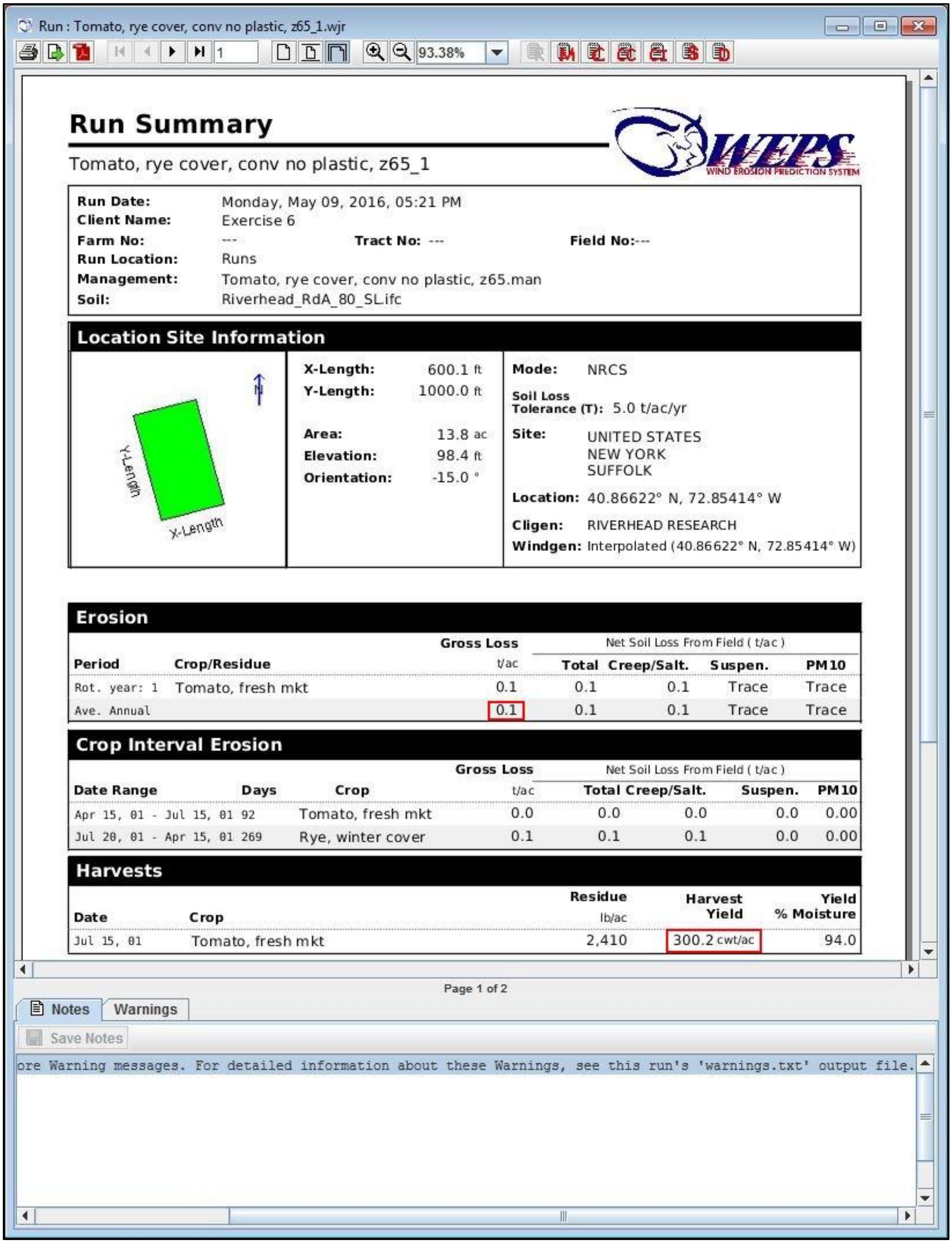
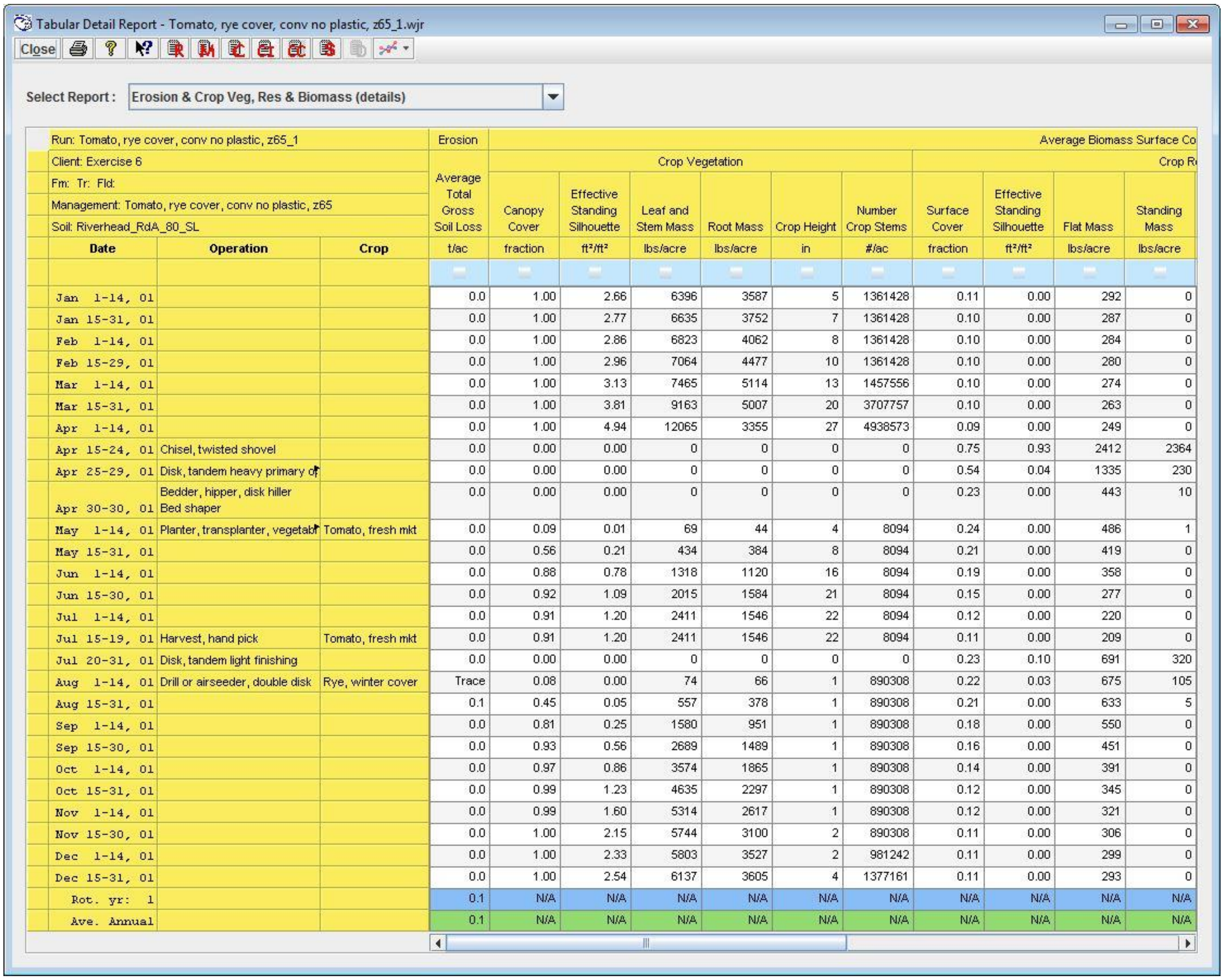


Figure 4-74 Run Summary showing soil loss after adding the rye cover crop.

Soil loss is down to **0.1 t/ac**. This is a significant reduction (Figure 4-74); well below the tolerance level. Harvest yield is very close to the target at **300.2 cwt/ac**.

In this case, we are now showing no erosion during the early growth of the tomato crop. With a sensitive crop like tomatoes, it may be worthwhile to protect them even more. Open the Detailed Report to determine which erosion period is the priority.


Tabular Detail Report - Tomato, rye cover, conv no plastic, z65_1.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Run: Tomato, rye cover, conv no plastic, z65_1
Client: Exercise 6
Fm: Tr: Fld:
Management: Tomato, rye cover, conv no plastic, z65
Soil: Riverhead_RdA_80_SL

			Erosion	Average Biomass Surface Co										
				Crop Vegetation							Crop R			
			Average Total Gross Soil Loss	Canopy Cover	Effective Standing Silhouette	Leaf and Stem Mass	Root Mass	Crop Height	Number Crop Stems	Surface Cover	Effective Standing Silhouette	Flat Mass	Standing Mass
Date	Operation	Crop	t/ac	fraction	ft²/ft²	lbs/acre	lbs/acre	in	#/ac	fraction	ft²/ft²	lbs/acre	lbs/acre
Jan 1-14, 01			0.0	1.00	2.66	6396	3587	5	1361428	0.11	0.00	292	0
Jan 15-31, 01			0.0	1.00	2.77	6635	3752	7	1361428	0.10	0.00	287	0
Feb 1-14, 01			0.0	1.00	2.86	6823	4062	8	1361428	0.10	0.00	284	0
Feb 15-29, 01			0.0	1.00	2.96	7064	4477	10	1361428	0.10	0.00	280	0
Mar 1-14, 01			0.0	1.00	3.13	7465	5114	13	1457556	0.10	0.00	274	0
Mar 15-31, 01			0.0	1.00	3.81	9163	5007	20	3707757	0.10	0.00	263	0
Apr 1-14, 01			0.0	1.00	4.94	12065	3355	27	4938573	0.09	0.00	249	0
Apr 15-24, 01	Chisel, twisted shovel		0.0	0.00	0.00	0	0	0	0	0.75	0.93	2412	2364
Apr 25-29, 01	Disk, tandem heavy primary of		0.0	0.00	0.00	0	0	0	0	0.54	0.04	1335	230
Apr 30-30, 01	Bedder, hipper, disk hiller Bed shaper		0.0	0.00	0.00	0	0	0	0	0.23	0.00	443	10
May 1-14, 01	Planter, transplanter, vegetab	Tomato, fresh mkt	0.0	0.09	0.01	69	44	4	8094	0.24	0.00	486	1
May 15-31, 01			0.0	0.56	0.21	434	384	8	8094	0.21	0.00	419	0
Jun 1-14, 01			0.0	0.88	0.78	1318	1120	16	8094	0.19	0.00	358	0
Jun 15-30, 01			0.0	0.92	1.09	2015	1584	21	8094	0.15	0.00	277	0
Jul 1-14, 01			0.0	0.91	1.20	2411	1546	22	8094	0.12	0.00	220	0
Jul 15-19, 01	Harvest, hand pick	Tomato, fresh mkt	0.0	0.91	1.20	2411	1546	22	8094	0.11	0.00	209	0
Jul 20-31, 01	Disk, tandem light finishing		0.0	0.00	0.00	0	0	0	0	0.23	0.10	691	320
Aug 1-14, 01	Drill or airseeder, double disk	Rye, winter cover	Trace	0.08	0.00	74	66	1	890308	0.22	0.03	675	105
Aug 15-31, 01			0.1	0.45	0.05	557	378	1	890308	0.21	0.00	633	5
Sep 1-14, 01			0.0	0.81	0.25	1580	951	1	890308	0.18	0.00	550	0
Sep 15-30, 01			0.0	0.93	0.56	2689	1489	1	890308	0.16	0.00	451	0
Oct 1-14, 01			0.0	0.97	0.86	3574	1865	1	890308	0.14	0.00	391	0
Oct 15-31, 01			0.0	0.99	1.23	4635	2297	1	890308	0.12	0.00	345	0
Nov 1-14, 01			0.0	0.99	1.60	5314	2617	1	890308	0.12	0.00	321	0
Nov 15-30, 01			0.0	1.00	2.15	5744	3100	2	890308	0.11	0.00	306	0
Dec 1-14, 01			0.0	1.00	2.33	5803	3527	2	981242	0.11	0.00	299	0
Dec 15-31, 01			0.0	1.00	2.54	6137	3605	4	1377161	0.11	0.00	293	0
Rot. yr: 1			0.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ave. Annual			0.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 4-75 Detailed report with the preeminent erosion period selected.

Although erosion is still occurring in August, that period is of little concern, because the growing rye is more tolerant of soil loss than tomatoes. May 1-14, 01 is the important time window because there are fragile tomato plants being subjected to soil abrasion (Figure 4-75). Even though we are showing 0.0 t/ac for that period, the farmer is concerned about using the rye cover crop approach due to potential disease issues. He is interested in looking at additional alternatives that can protect his tomato plants.

Adding Plastic Mulch

Step 1: Close the reports so that only the WEPS interface remains. Open MCREW to view the *Tomato, rye cover, conv no plastic Z65.man* file. Save the file as **Tomato, plastic mulch, conv z65**. Right-click in the operation column on the 'May 01, 01', *Planter, transplanter, vegetable* operation. Select *Insert operation*. Select *Plastic mulch applic. 48 inch beds 80 percent cover* (in the *Application, other* folder) and set the date to May 01, 01. The mulch application requires a Crop or Residue. Select '*plastic mulch*'. Set the angle of tillage to -15 degrees. Do not adjust the default amount of 2000.00 lbs/acre under 'Flat Residue Applied.'

Step 2: Right-click 'Jul 20, 01' *Disk, tandem light finishing* operation and insert the operation *Plastic mulch, remove* (in the *Application, other* folder). Set the date to Apr 14, 01.

Step 3: Change the harvest operation for the tomatoes *to Harvest, vine crops* (in the *Harvest, crops* folder).

Step 4: Finally Remove the *Drill or air seeder, double* disk operation.

Step 5: Click the Sort icon  to arrange the operations in chronological order.. The completed management file should appear as in Figure 4-76.

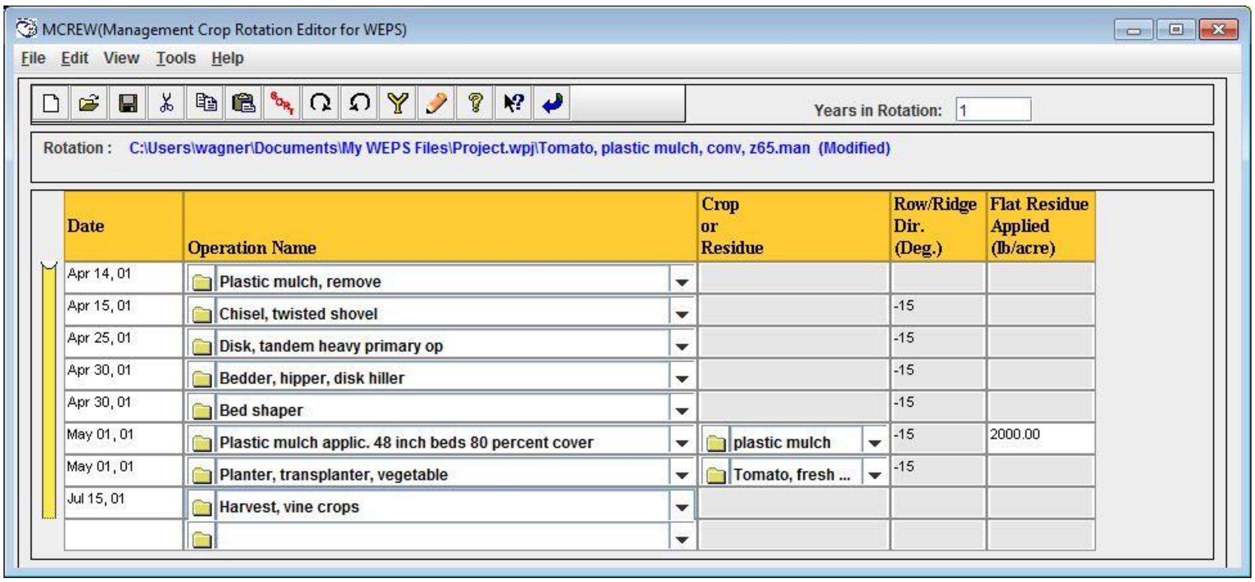
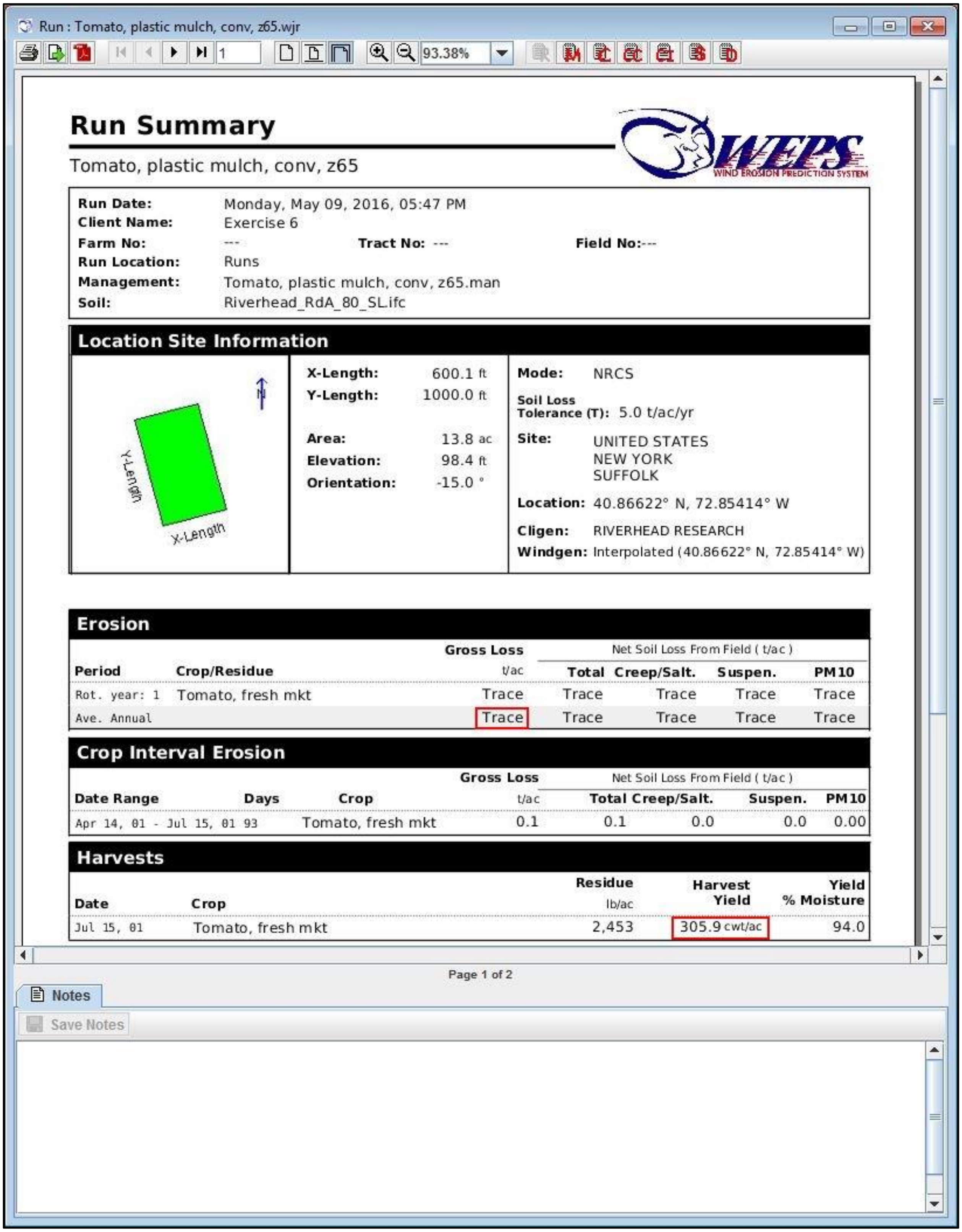


Figure 4-76 Management with plastic mulch added.

Step 6: Click the blue Return button . Click Run  and name it **Tomato, plastic mulch, conv, z65**.



Run : Tomato, plastic mulch, conv, z65.wjr

93.38%

Run Summary

Tomato, plastic mulch, conv, z65

WEPS WIND EROSION PREDICTION SYSTEM

Run Date:	Monday, May 09, 2016, 05:47 PM
Client Name:	Exercise 6
Farm No:	--- **Tract No:** --- **Field No:**---
Run Location:	Runs
Management:	Tomato, plastic mulch, conv, z65.man
Soil:	Riverhead_RdA_80_SL.ifc

Location Site Information

Y-Length

X-Length

N

X-Length:	600.1 ft	**Mode:**	NRCS
Y-Length:	1000.0 ft	**Soil Loss Tolerance (T):**	5.0 t/ac/yr
Area:	13.8 ac	**Site:**	UNITED STATES NEW YORK SUFFOLK
Elevation:	98.4 ft	**Location:**	40.86622° N, 72.85414° W
Orientation:	-15.0 °	**Cligen:**	RIVERHEAD RESEARCH
		Windgen:	Interpolated (40.86622° N, 72.85414° W)

Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Tomato, fresh mkt	Trace	Trace	Trace	Trace	Trace
Ave. Annual		Trace	Trace	Trace	Trace	Trace

Crop Interval Erosion

Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Apr 14, 01 - Jul 15, 01	93	Tomato, fresh mkt	0.1	0.1	0.0	0.0	0.00

Harvests

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Jul 15, 01	Tomato, fresh mkt	2,453	305.9 cwt/ac	94.0

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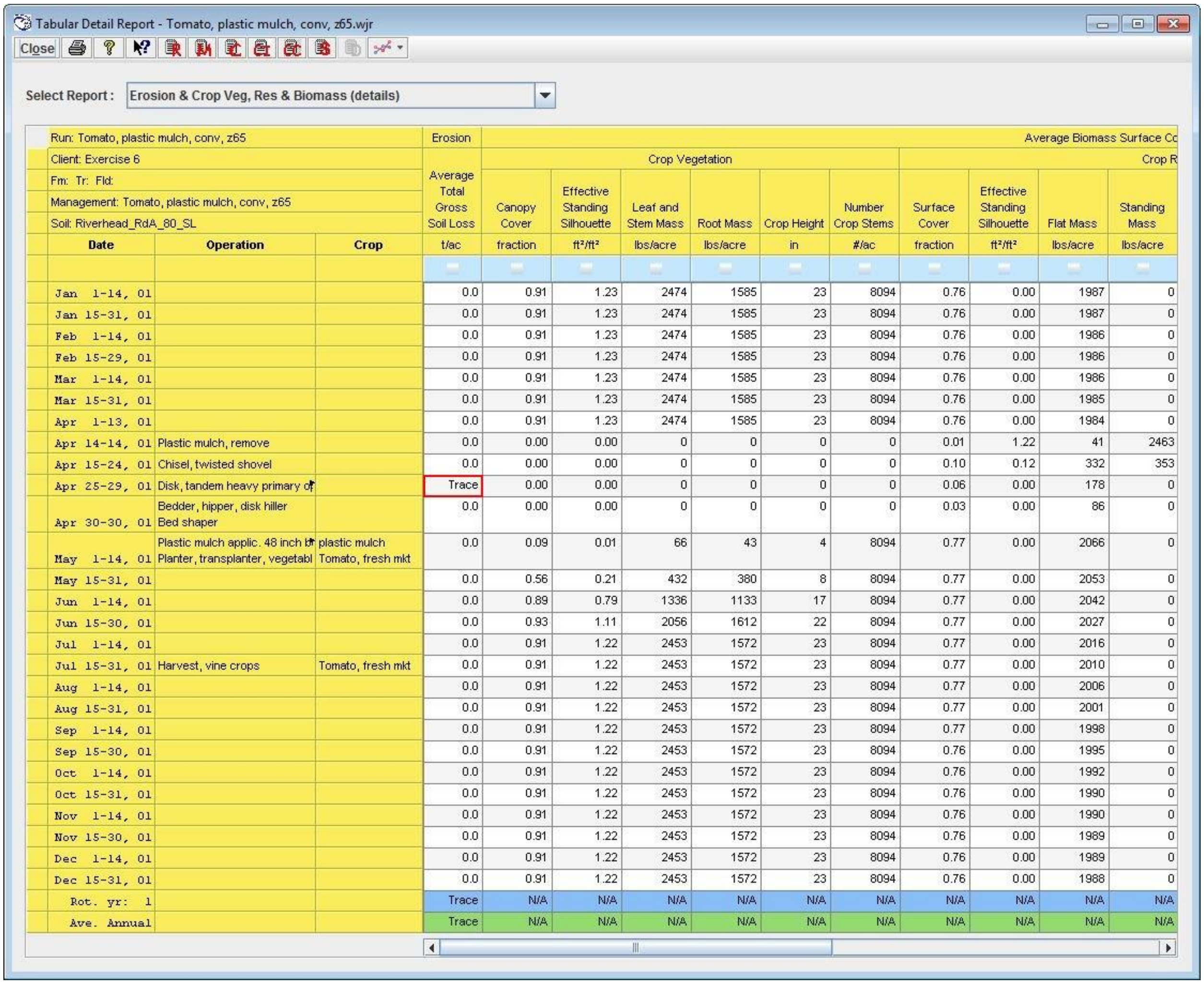
Notes

Save Notes

Figure 4-77 Run Summary after adding the plastic mulch.

The Run Summary shows slightly improved yield (probably due to less water loss due to evaporation) and decreased Average Annual Gross Soil Loss (Figure 4-77), but the concern is specifically about the erosion during tomato planting and growth times.

The Tabular Detailed Report reveals how well the mulch protected both the soil and the tomato plants at the most critical time (May 1-14, 01) (Figure 4-78). With the plastic mulch in place, only a trace amount of soil is lost to wind erosion. The obvious benefits of the mulch are that the tomatoes are not damaged using the plastic, the yield is slightly higher, and the crop does not have to be replanted.



Tabular Detail Report - Tomato, plastic mulch, conv, z65.wjr

Select Report: Erosion & Crop Veg, Res & Biomass (details)

Run: Tomato, plastic mulch, conv, z65
Client: Exercise 6
Fm: Tr: Fld:
Management: Tomato, plastic mulch, conv, z65
Soil: Riverhead_RdA_80_SL

Date	Operation	Crop	Erosion: Average Total Gross Soil Loss (t/ac)	Crop Vegetation: Canopy Cover (fraction)	Crop Vegetation: Effective Standing Silhouette (ft²/ft²)	Crop Vegetation: Leaf and Stem Mass (lbs/acre)	Crop Vegetation: Root Mass (lbs/acre)	Crop Vegetation: Crop Height (in)	Crop Vegetation: Number Crop Stems (#/ac)	Crop R: Surface Cover (fraction)	Crop R: Effective Standing Silhouette (ft²/ft²)	Crop R: Flat Mass (lbs/acre)	Crop R: Standing Mass (lbs/acre)
Jan 1-14, 01			0.0	0.91	1.23	2474	1585	23	8094	0.76	0.00	1987	0
Jan 15-31, 01			0.0	0.91	1.23	2474	1585	23	8094	0.76	0.00	1987	0
Feb 1-14, 01			0.0	0.91	1.23	2474	1585	23	8094	0.76	0.00	1986	0
Feb 15-29, 01			0.0	0.91	1.23	2474	1585	23	8094	0.76	0.00	1986	0
Mar 1-14, 01			0.0	0.91	1.23	2474	1585	23	8094	0.76	0.00	1986	0
Mar 15-31, 01			0.0	0.91	1.23	2474	1585	23	8094	0.76	0.00	1985	0
Apr 1-13, 01			0.0	0.91	1.23	2474	1585	23	8094	0.76	0.00	1984	0
Apr 14-14, 01	Plastic mulch, remove		0.0	0.00	0.00	0	0	0	0	0.01	1.22	41	2463
Apr 15-24, 01	Chisel, twisted shovel		0.0	0.00	0.00	0	0	0	0	0.10	0.12	332	353
Apr 25-29, 01	Disk, tandem heavy primary o		Trace	0.00	0.00	0	0	0	0	0.06	0.00	178	0
Apr 30-30, 01	Bedder, hipper, disk hiller Bed shaper		0.0	0.00	0.00	0	0	0	0	0.03	0.00	86	0
May 1-14, 01	Plastic mulch applic. 48 inch b Planter, transplanter, vegetabl	plastic mulch Tomato, fresh mkt	0.0	0.09	0.01	66	43	4	8094	0.77	0.00	2066	0
May 15-31, 01			0.0	0.56	0.21	432	380	8	8094	0.77	0.00	2053	0
Jun 1-14, 01			0.0	0.89	0.79	1336	1133	17	8094	0.77	0.00	2042	0
Jun 15-30, 01			0.0	0.93	1.11	2056	1612	22	8094	0.77	0.00	2027	0
Jul 1-14, 01			0.0	0.91	1.22	2453	1572	23	8094	0.77	0.00	2016	0
Jul 15-31, 01	Harvest, vine crops	Tomato, fresh mkt	0.0	0.91	1.22	2453	1572	23	8094	0.77	0.00	2010	0
Aug 1-14, 01			0.0	0.91	1.22	2453	1572	23	8094	0.77	0.00	2006	0
Aug 15-31, 01			0.0	0.91	1.22	2453	1572	23	8094	0.77	0.00	2001	0
Sep 1-14, 01			0.0	0.91	1.22	2453	1572	23	8094	0.77	0.00	1998	0
Sep 15-30, 01			0.0	0.91	1.22	2453	1572	23	8094	0.76	0.00	1995	0
Oct 1-14, 01			0.0	0.91	1.22	2453	1572	23	8094	0.76	0.00	1992	0
Oct 15-31, 01			0.0	0.91	1.22	2453	1572	23	8094	0.76	0.00	1990	0
Nov 1-14, 01			0.0	0.91	1.22	2453	1572	23	8094	0.76	0.00	1990	0
Nov 15-30, 01			0.0	0.91	1.22	2453	1572	23	8094	0.76	0.00	1989	0
Dec 1-14, 01			0.0	0.91	1.22	2453	1572	23	8094	0.76	0.00	1989	0
Dec 15-31, 01			0.0	0.91	1.22	2453	1572	23	8094	0.76	0.00	1988	0
Rot. yr: 1			Trace	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ave. Annual			Trace	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 4-78 Detailed Report showing only trace loss of soil prior to the time of tomato planting and growth.

Exercise 7 – Irrigated Corn Silage, Adding Manure and a Winter Forage Crop

Skill Building: In this exercise, the user must add each operation independently, without using management templates (i.e., from scratch).

Corn silage is of interest here for being a low residue crop from the wind erosion standpoint because most of the biomass is harvested. There is manure from a dairy to be added, as well as winter wheat, cut for silage in the spring.

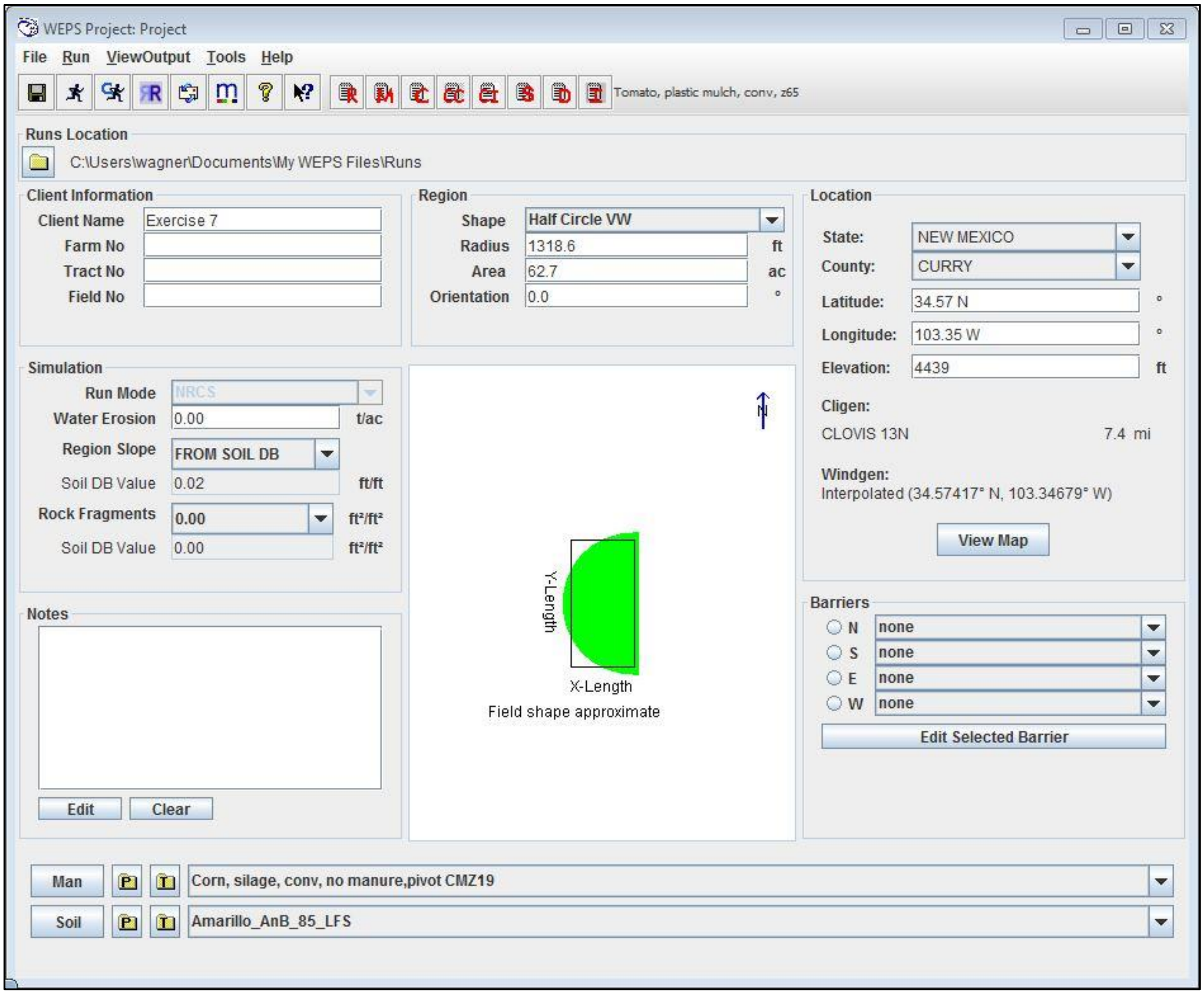


Figure 4-79 WEPS interface ready except for the management.

Exercise 7 Scenario

- The dairy is located in **Curry County, New Mexico**, just south of Clovis.
- The Cligen station is **CLOVIS 13N.**
- The Windgen station is **Interpolated**.
- This field is an irrigated **half circle** on the **west half** of a quarter section of land. It is **62.7 acres** (see soils maps in Figure 4-88, Figure 4-89, and Figure 4-90).
- The soil is an Amarillo loamy fine sand, **Amarillo_AnB_85_LFS**.
- The producer has a Compressive Nutrient Management Plan that requires him to **apply 15 t/ac of very dry manure, 25% moisture by weight** (15 tons/ac x 2000 lbs/ton = 30,000 lbs/ac wet wt. or 30,000 lbs/ac x 0.75 = 22,500 lbs/ac on a dry weight basis).
- The option of fall application exists since there is no surface or ground water near the dairy and little rainfall runoff over the winter, but spring application fits the work schedule. A Low Elevation Spray Application (LESA) nozzle package on the pivot can meet the Consumptive Use of both corn and winter forage crops.

Table 4.1 System operations for corn silage alone.

Date	Operation	Crop or Residue	Flat Residue Amt Added (lbs/ac)
April 1	Manure spreader, solid and semi-solid manure, semi-solid	Manure, semi-solid	22,500
April 15	Disk, offset, heavy		
April 18	Cultivator, field 6-12 in sweeps		
April 20	Planter, double disk opener	Corn, silage	
April 21	Irrigation, Start Monitor (Pivot, Linear, Wheelline)		
Sep 1	Irrigation, Stop Monitor		
Sep 20	Harvest, silage, kill crop		
Sep 25	Disk, tandem heavy primary operation		

The expected wet weight yield for the **corn silage is 23 t/ac** at 65% moisture. The wet weight for the **winter wheat silage is 7 t/ac** at about 70% moisture. The amount of residue added (22,500 lbs/ac) contains fairly fine, quickly decomposable organic material. This organic material will have a long-term impact on soil quality.

Table 4.2 Additional operations for the winter wheat silage.

Date	Operation	Crop	Flat Residue Amt Added (lbs/ac)
Mar 1	Irrigation, Start Monitor (Pivot, Linear, Wheelline)		
Apr 12	Irrigation, Stop Monitor		
Apr 12	Harvest, silage		
Oct 3	Drill or airseeder, double disk	Wheat, winter silage	

Make initial run without applying manure

Step 1: Enter all the information listed above on the main interface. For the field shape, select the *Half Circle VW* in the Simulation Region panel, indicating the **V**ertical **W**est half of a circle (Figure 4-79).

Step 2: Open up the management editor and enter one at a time all the operations listed in Table 4.1 except for the April 1 manure spreader (Figure 4-80). Click 'File', 'Save as...', and call it, **Corn, silage, conv, no manure, pivot CMZ19**. Click the Return button to leave the editor.

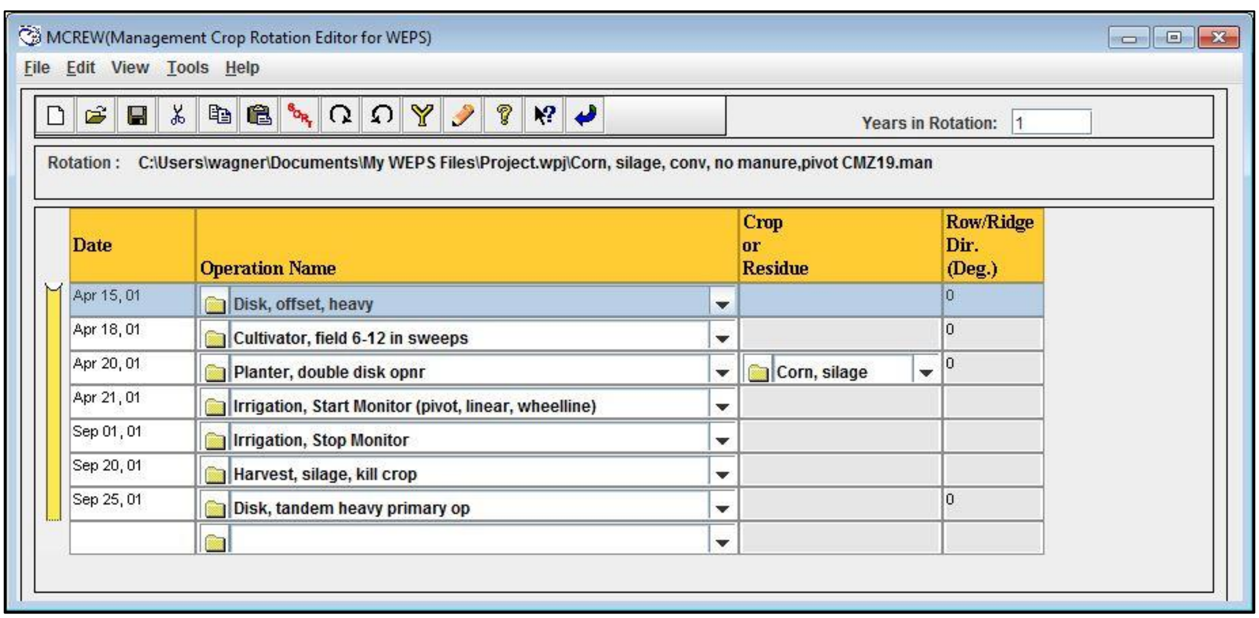
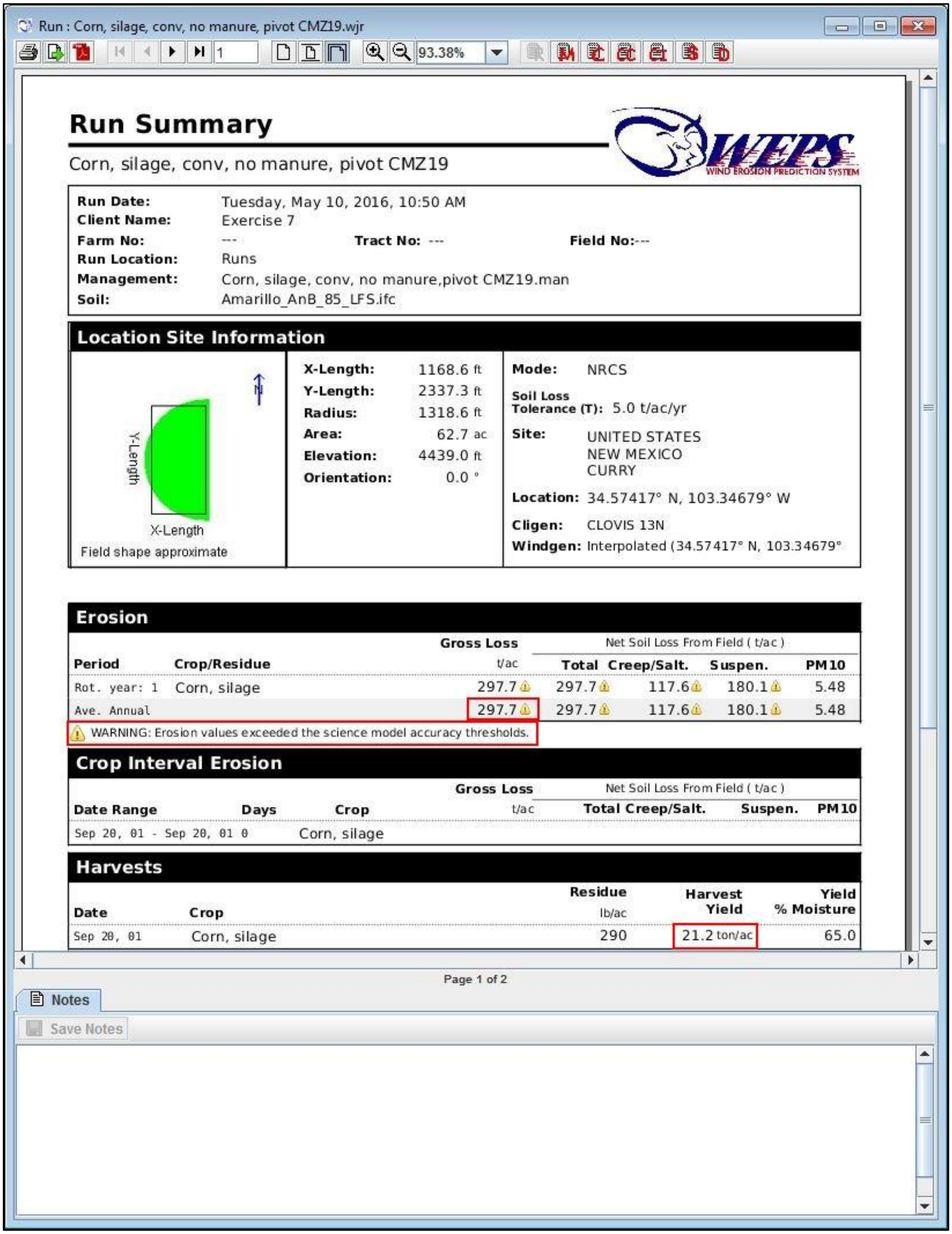


Figure 4-80 Management rotation for 'Corn, silage, conv, no manure, pivot CMZ19'.

Step 3: Click the Run button and name the run after its management file: **Corn, silage, conv, no manure, pivot CMZ19.**



Run : Corn, silage, conv, no manure, pivot CMZ19.wjr

Run Summary

Corn, silage, conv, no manure, pivot CMZ19

Run Date: Tuesday, May 10, 2016, 10:50 AM
Client Name: Exercise 7
Farm No: --- **Tract No:** --- **Field No:**---
Run Location: Runs
Management: Corn, silage, conv, no manure,pivot CMZ19.man
Soil: Amarillo_AnB_85_LFS.ifc

Location Site Information

Y-Length
X-Length
Field shape approximate

X-Length: 1168.6 ft
Y-Length: 2337.3 ft
Radius: 1318.6 ft
Area: 62.7 ac
Elevation: 4439.0 ft
Orientation: 0.0 °

Mode: NRCS
Soil Loss Tolerance (T): 5.0 t/ac/yr
Site: UNITED STATES NEW MEXICO CURRY
Location: 34.57417° N, 103.34679° W
Cligen: CLOVIS 13N
Windgen: Interpolated (34.57417° N, 103.34679°

Erosion

Period	Crop/Residue	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Rot. year: 1	Corn, silage	297.7	297.7	117.6	180.1	5.48
Ave. Annual		297.7	297.7	117.6	180.1	5.48

WARNING: Erosion values exceeded the science model accuracy thresholds.

Crop Interval Erosion

Date Range	Days	Crop	Gross Loss t/ac	Net Soil Loss From Field (t/ac) Total	Creep/Salt.	Suspen.	PM10
Sep 20, 01 - Sep 20, 01	0	Corn, silage					

Harvests

Date	Crop	Residue lb/ac	Harvest Yield	Yield % Moisture
Sep 20, 01	Corn, silage	290	21.2 ton/ac	65.0

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Notes

Save Notes

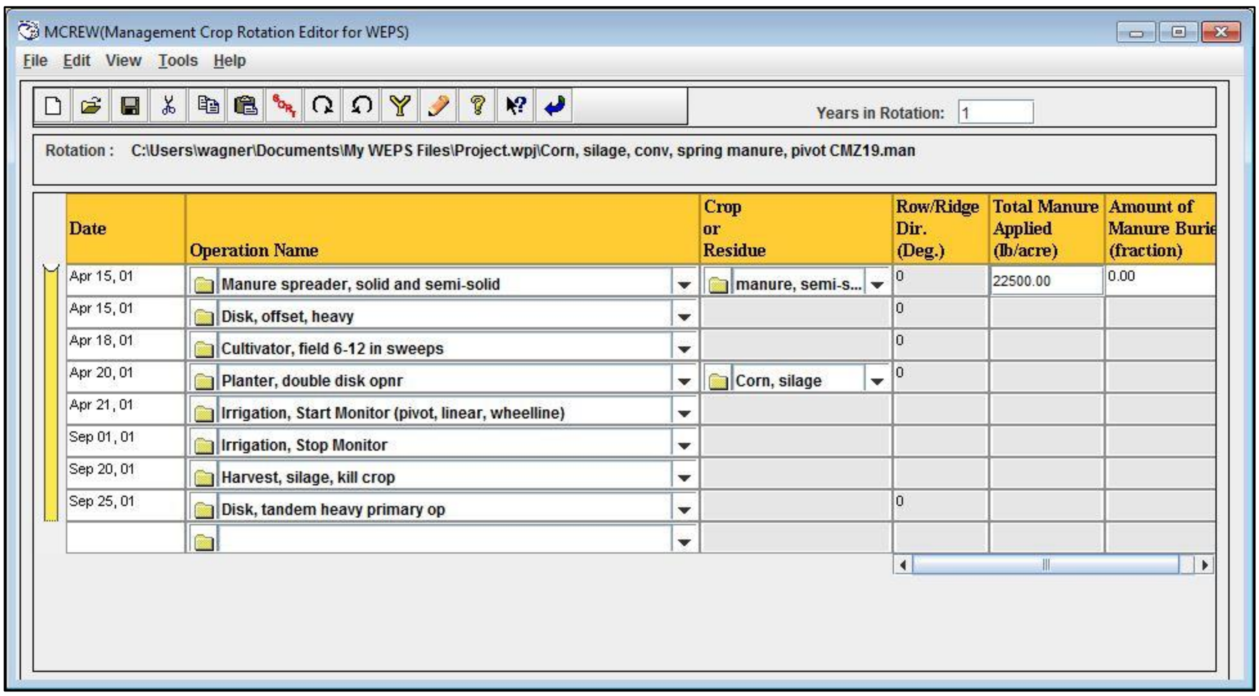
Figure 4-81 Run Summary for “Corn, silage, conv, no manure, pivot, CMZ19”.

What is the yield of silage? Answer: 21.2 t/ac (Figure 4-81). This is close enough to the 23 t/ac expected.

How much soil loss was calculated?
Answer: An excessive **297.7 t/ac** (Figure 4-81).

Add manure in the Spring

Step 1: Open the MCREW and add the April 1 *Manure spreader, solid and simi-solid* (in the *Application, agchem, nutrient* folder) as seen in Table 4.1. Now in the Crop or Residue column, select *manure, semi-solid* (in the *Residue* folder). Move to the Total Manure Applied column, and type in the **22,500** lbs/ac manure applied in the spring (Figure 4-82). Now, click ‘File’, ‘Save As...’, and save the file as **Corn, silage, conv, spring manure, pivot CMZ19**. Finally, click Return to close MCREW and view the main interface.



Date	Operation Name	Crop or Residue	Row/Ridge Dir. (Deg.)	Total Manure Applied (lb/acre)	Amount of Manure Burie (fraction)
Apr 15, 01	Manure spreader, solid and semi-solid	manure, semi-s...	0	22500.00	0.00
Apr 15, 01	Disk, offset, heavy		0		
Apr 18, 01	Cultivator, field 6-12 in sweeps		0		
Apr 20, 01	Planter, double disk opnr	Corn, silage	0		
Apr 21, 01	Irrigation, Start Monitor (pivot, linear, wheelline)				
Sep 01, 01	Irrigation, Stop Monitor				
Sep 20, 01	Harvest, silage, kill crop				
Sep 25, 01	Disk, tandem heavy primary op		0		

Figure 4-82 The management rotation for ‘Corn, silage, conv, spring manure, pivot, CMZ19'.

Step 2: Click the Run button on the main toolbar to make the run. Call it **Corn, silage, conv, spring manure, pivot CMZ19**.

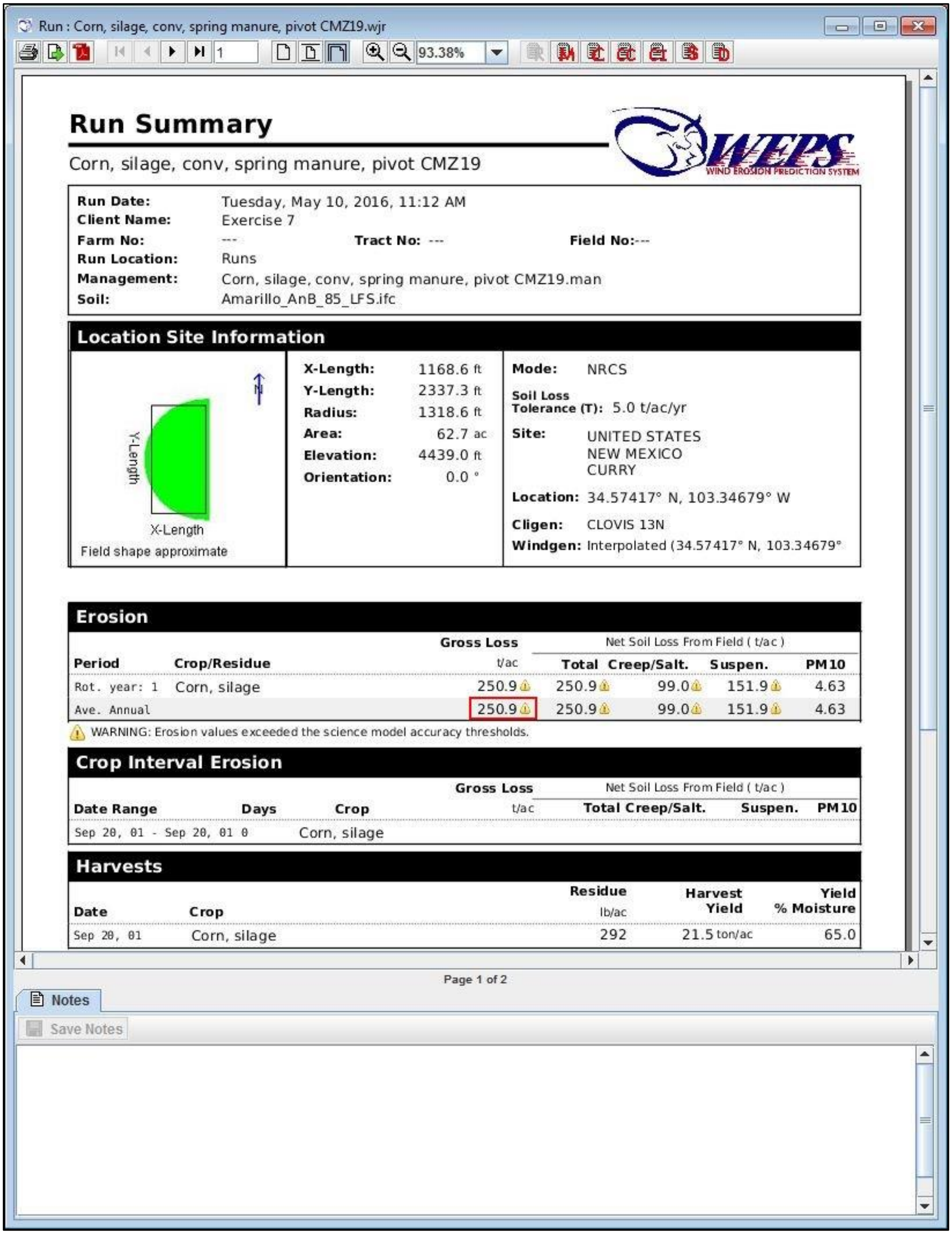


Figure 4-83 Run Summary for ‘Corn, silage, conv, spring manure, pivot CMZ19’.

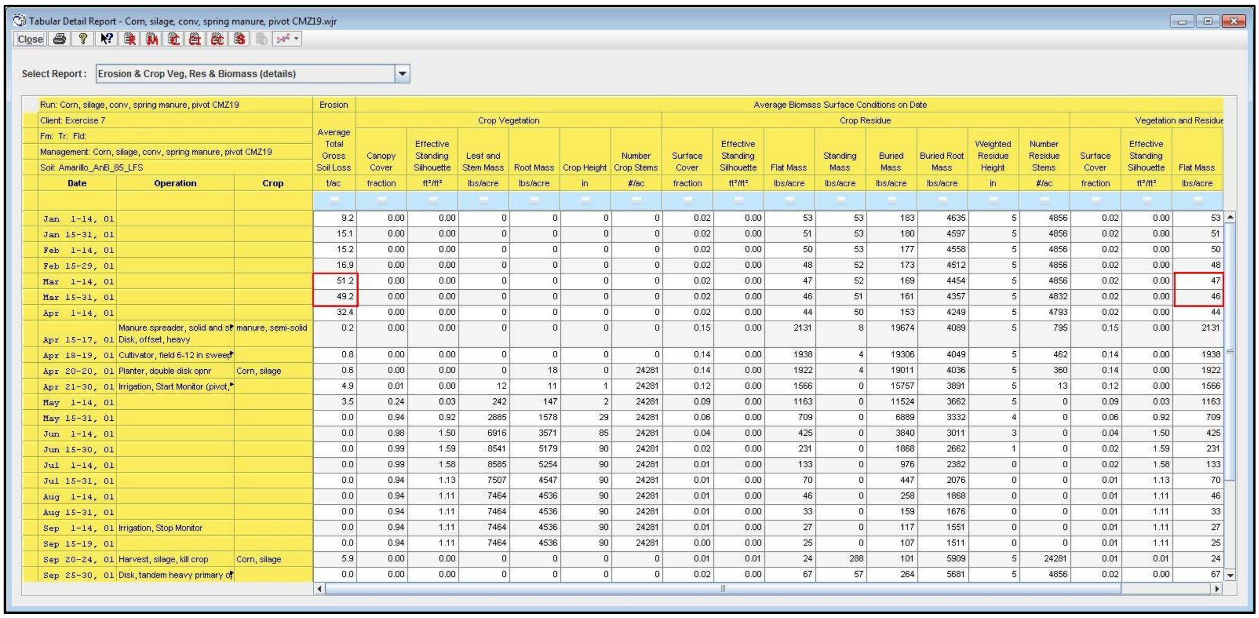
What is the soil loss with the manure applied in the spring and tilled in?

Answer: 250.9 t/ac (Figure 4-83). This is quite a reduction from 297.7 tons per acre, but still far in excess of the Soil Loss Tolerance (5 t/ac/yr).

Open the Detailed Report.

When and where are the high erosion trouble spots?

Answer: March is the worst month with over 100 tons of soil per acre blown away before the manure is applied. March also has little Flat Mass at 46 lbs/ac (Figure 4-84).


Tabular Detail Report - Corn, silage, conv, spring manure, pivot CMZ19.wjr

Select Report : Erosion & Crop Veg, Res & Biomass (details)

Run: Corn, silage, conv, spring manure, pivot CMZ19
Client: Exercise 7
Fm: Tr: Fld:
Management: Corn, silage, conv, spring manure, pivot CMZ19
Soil: Amarillo_AnB_85_LFS

Date	Operation	Crop	Erosion: Average Total Gross Soil Loss (t/ac)	Crop Vegetation: Canopy Cover (fraction)	Crop Vegetation: Effective Standing Silhouette (ft²/ft²)	Crop Vegetation: Leaf and Stem Mass (lbs/acre)	Crop Vegetation: Root Mass (lbs/acre)	Crop Vegetation: Crop Height (in)	Crop Vegetation: Number Crop Stems (#/ac)	Crop Residue: Surface Cover (fraction)	Crop Residue: Effective Standing Silhouette (ft²/ft²)	Crop Residue: Flat Mass (lbs/acre)	Crop Residue: Standing Mass (lbs/acre)	Crop Residue: Buried Mass (lbs/acre)	Crop Residue: Buried Root Mass (lbs/acre)	Crop Residue: Weighted Residue Height (in)	Crop Residue: Number Residue Stems (#/ac)	Vegetation and Residue: Surface Cover (fraction)	Vegetation and Residue: Effective Standing Silhouette (ft²/ft²)	Vegetation and Residue: Flat Mass (lbs/acre)
Jan 1-14, 01			9.2	0.00	0.00	0	0	0	0	0.02	0.00	53	53	183	4635	5	4856	0.02	0.00	53
Jan 15-31, 01			15.1	0.00	0.00	0	0	0	0	0.02	0.00	51	53	180	4597	5	4856	0.02	0.00	51
Feb 1-14, 01			15.2	0.00	0.00	0	0	0	0	0.02	0.00	50	53	177	4558	5	4856	0.02	0.00	50
Feb 15-29, 01			16.9	0.00	0.00	0	0	0	0	0.02	0.00	48	52	173	4512	5	4856	0.02	0.00	48
Mar 1-14, 01			51.2	0.00	0.00	0	0	0	0	0.02	0.00	47	52	169	4454	5	4856	0.02	0.00	47
Mar 15-31, 01			49.2	0.00	0.00	0	0	0	0	0.02	0.00	46	51	161	4357	5	4832	0.02	0.00	46
Apr 1-14, 01			32.4	0.00	0.00	0	0	0	0	0.02	0.00	44	50	153	4249	5	4793	0.02	0.00	44
Apr 15-17, 01	Manure spreader, solid and s… Disk, offset, heavy	manure, semi-solid	0.2	0.00	0.00	0	0	0	0	0.15	0.00	2131	8	19674	4089	5	795	0.15	0.00	2131
Apr 18-19, 01	Cultivator, field 6-12 in sweep…		0.8	0.00	0.00	0	0	0	0	0.14	0.00	1938	4	19306	4049	5	462	0.14	0.00	1938
Apr 20-20, 01	Planter, double disk opnr	Corn, silage	0.6	0.00	0.00	0	18	0	24281	0.14	0.00	1922	4	19011	4036	5	360	0.14	0.00	1922
Apr 21-30, 01	Irrigation, Start Monitor (pivot,…		4.9	0.01	0.00	12	11	1	24281	0.12	0.00	1566	0	15757	3891	5	13	0.12	0.00	1566
May 1-14, 01			3.5	0.24	0.03	242	147	2	24281	0.09	0.00	1163	0	11524	3662	5	0	0.09	0.03	1163
May 15-31, 01			0.0	0.94	0.92	2885	1578	29	24281	0.06	0.00	709	0	6889	3332	4	0	0.06	0.92	709
Jun 1-14, 01			0.0	0.98	1.50	6916	3571	85	24281	0.04	0.00	425	0	3840	3011	3	0	0.04	1.50	425
Jun 15-30, 01			0.0	0.99	1.59	8541	5179	90	24281	0.02	0.00	231	0	1868	2662	1	0	0.02	1.59	231
Jul 1-14, 01			0.0	0.99	1.58	8585	5254	90	24281	0.01	0.00	133	0	976	2382	0	0	0.02	1.58	133
Jul 15-31, 01			0.0	0.94	1.13	7507	4547	90	24281	0.01	0.00	70	0	447	2076	0	0	0.01	1.13	70
Aug 1-14, 01			0.0	0.94	1.11	7464	4536	90	24281	0.01	0.00	46	0	258	1868	0	0	0.01	1.11	46
Aug 15-31, 01			0.0	0.94	1.11	7464	4536	90	24281	0.01	0.00	33	0	159	1676	0	0	0.01	1.11	33
Sep 1-14, 01	Irrigation, Stop Monitor		0.0	0.94	1.11	7464	4536	90	24281	0.01	0.00	27	0	117	1551	0	0	0.01	1.11	27
Sep 15-19, 01			0.0	0.94	1.11	7464	4536	90	24281	0.00	0.00	25	0	107	1511	0	0	0.01	1.11	25
Sep 20-24, 01	Harvest, silage, kill crop	Corn, silage	5.9	0.00	0.00	0	0	0	0	0.01	0.01	24	288	101	5909	5	24281	0.01	0.01	24
Sep 25-30, 01	Disk, tandem heavy primary o…		0.0	0.00	0.00	0	0	0	0	0.02	0.00	67	57	264	5681	5	4856	0.02	0.00	67

Figure 4-84 Detailed Report showing soil loss and flat mass in the month of March.

Adding the Winter Wheat Forage Crop

Step 1: Close all reports and reopen the management editor. Add the additional operations for the winter wheat silage listed in to the existing system (Table 4.2 and Figure 4-85). These can be added to the end of the run and arranged afterward by clicking the Sort button. When you have them entered and sorted, then click 'File', 'Save as...', and enter the management name as **Corn, silage-WWheat, silage, conv, spring manure, pivot CMZ19**. Close MCREW and return to the main interface.

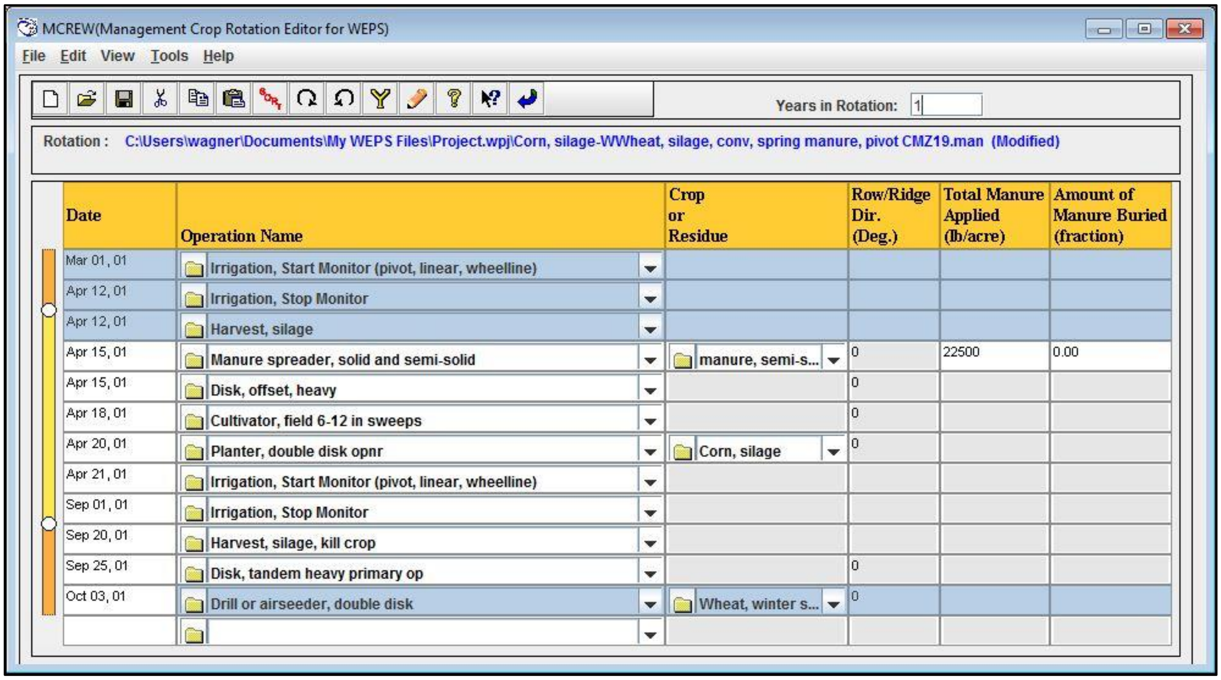


Figure 4-85 MCREW showing winter wheat operations.

Step 2: Run the management and call it **Corn, silage-WWheat, silage, conv, spring manure, pivot CMZ19**.

At the end of the run, some warnings are generated (Figure 4-86). These warnings tell you that the winter wheat did not reach maturity. This is because, as silage, it was harvested before its growth cycle was finished. Close the warning to view the Run Summary.

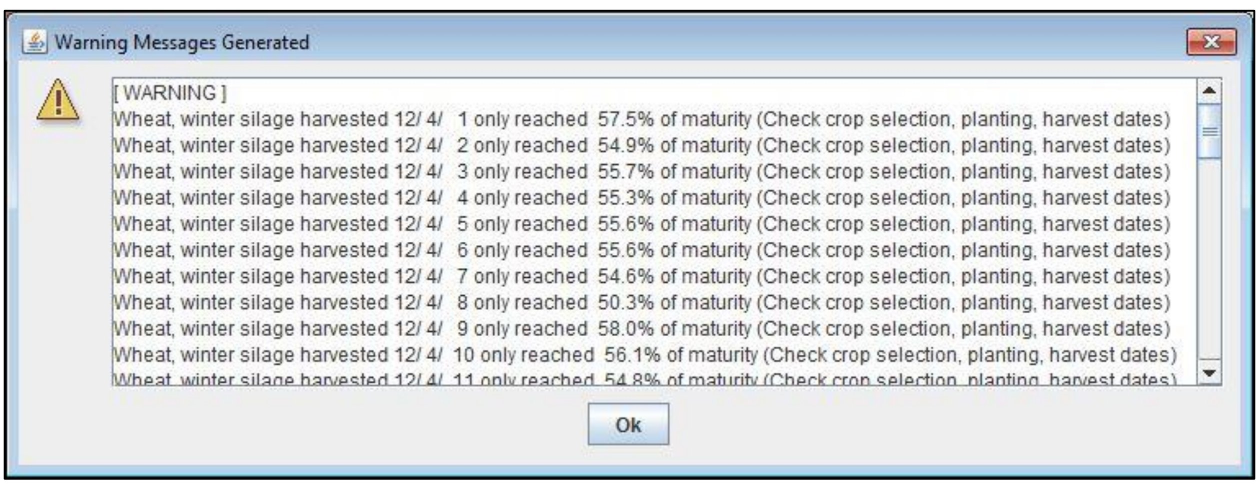


Figure 4-86 Warnings generated after addition of winter wheat silage to the rotation.

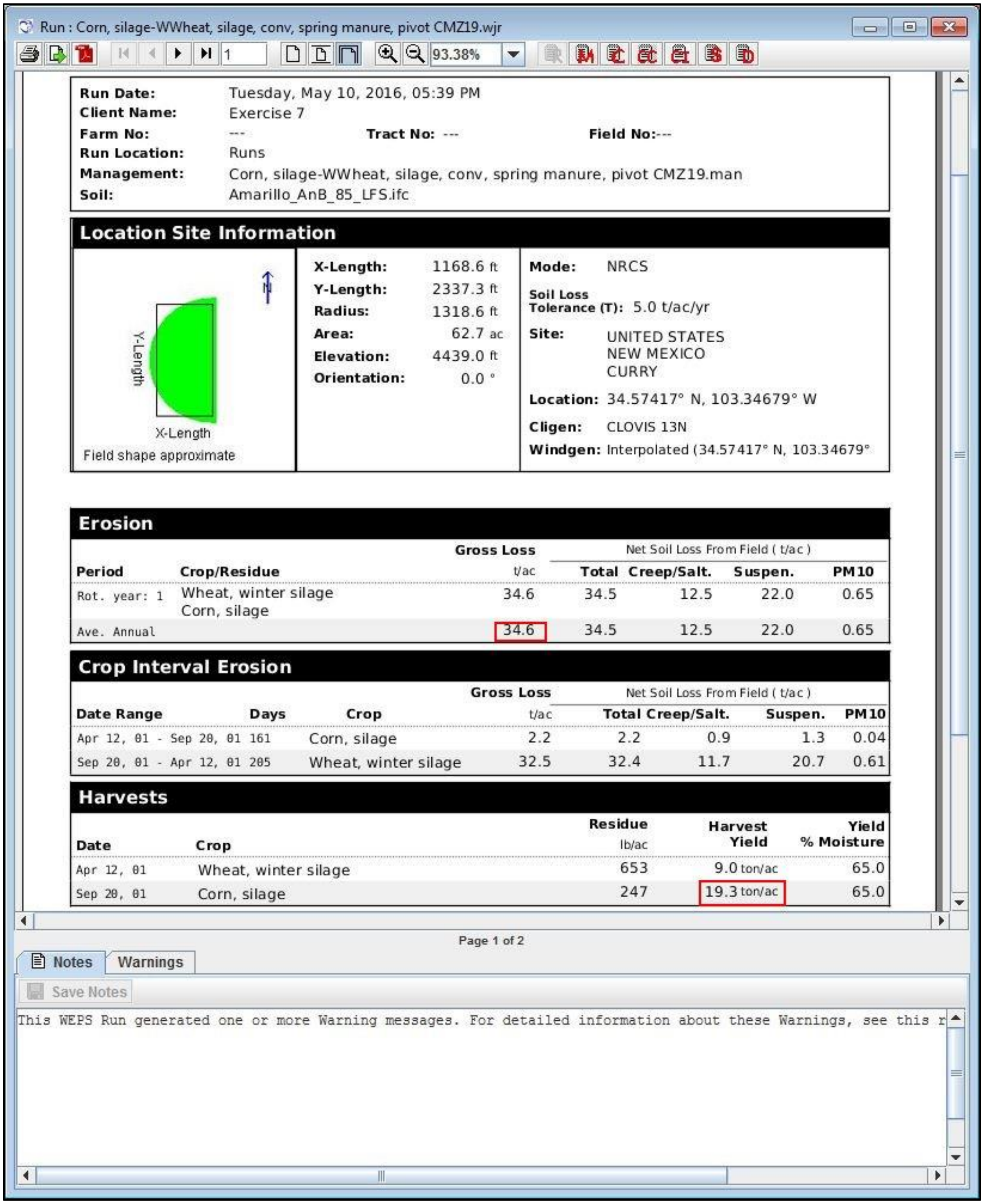


Figure 4-87 Run Summary showing soil loss for the corn and winter wheat silage crops.

How does the soil loss look now?

Answer: It has decreased significantly from the previous 250.9 tons to **35.6 t/ac** (Figure 4-87). The soil loss may be reduced below loss tolerance "T" by harvesting less of the silage for each crop. Also, looking at the Tabular Detail Report, most of the erosion is occurring after planting the winter wheat. Applying some irrigation water may also control erosion during that time period and also likely boost the amount of water available for the wheat crop and possibly the corn crop the following year.

The yield has decreased for the corn silage to **19.3 t/ac.** This is a little low, considering an expected 23 tons per acre, but remember that forage crops (including winter wheat cut for silage) cannot be calibrated (well, they can be calibrated, but one must do it manually). Regardless, the drop in yield would not be unexpected if the winter wheat is using up some of the soil moisture available at planting time, even with irrigation enabled (the auto-irrigate operations do not apply water if no crop is growing and only irrigate if the crop reaches a predefined stress level). If you have trouble with this, contact your NRCS State Wind Erosion Specialist.

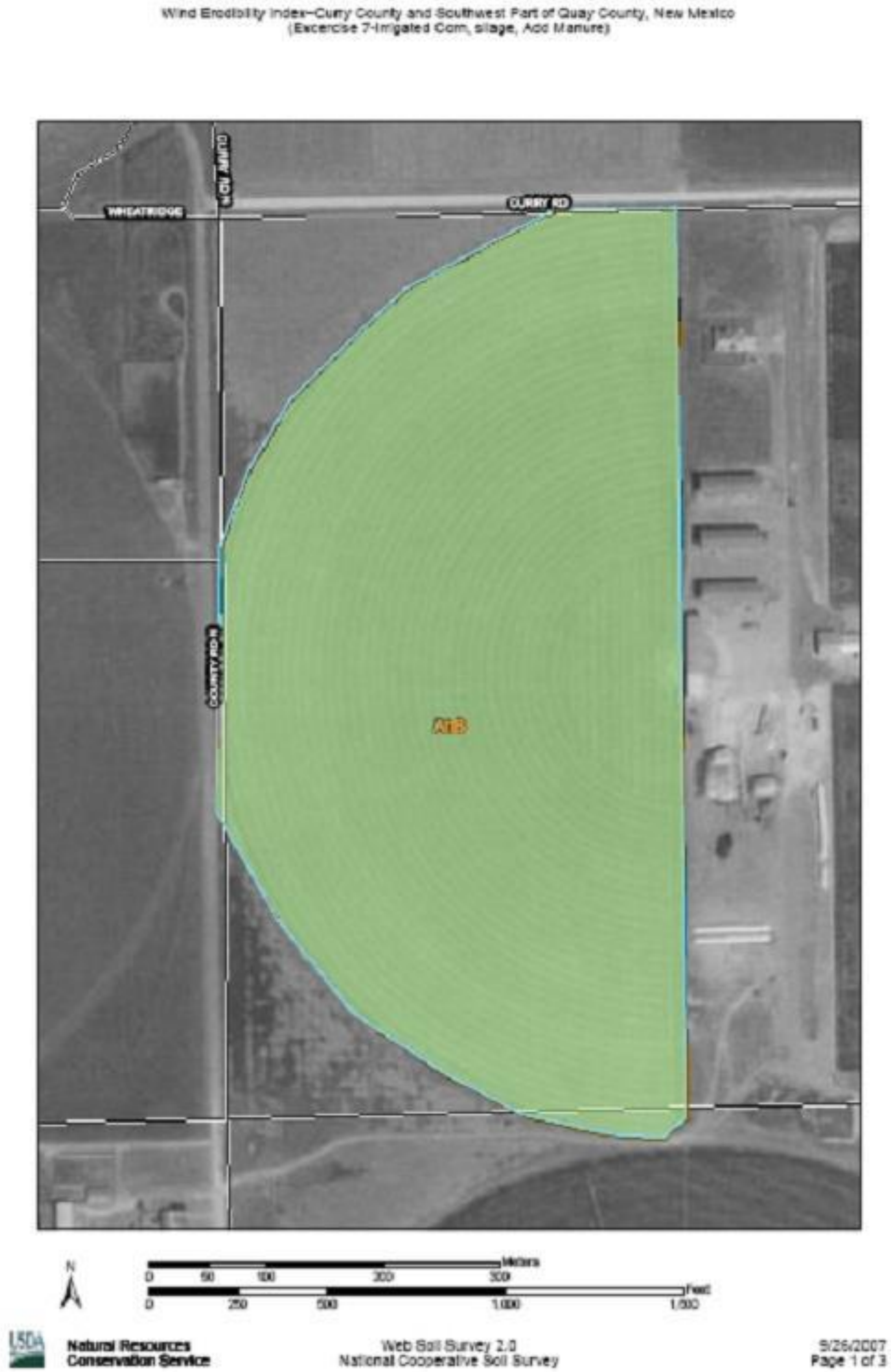
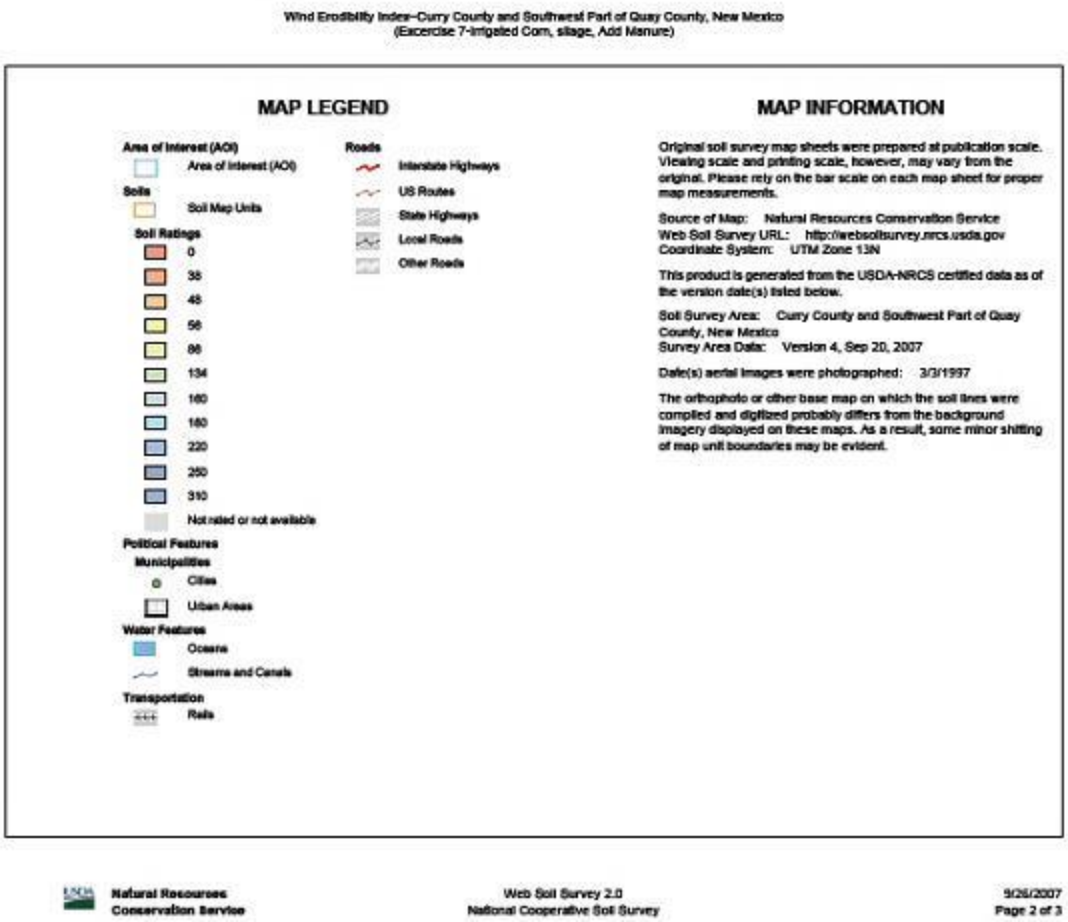


Figure 4-88 Map of the field for Exercise 7.


Wind Erodibility Index—Curry County and Southwest Part of Quay County, New Mexico
(Excercise 7-Irrigated Corn, silage, Add Manure)

MAP LEGEND

Area of Interest (AOI)
Area of Interest (AOI)
Soils
Soil Map Units
Soil Ratings
0
38
48
56
86
134
160
180
220
250
310
Not rated or not available
Political Features
Municipalities
Cities
Urban Areas
Water Features
Oceans
Streams and Canals
Transportation
Rails
Roads
Interstate Highways
US Routes
State Highways
Local Roads
Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Curry County and Southwest Part of Quay County, New Mexico
Survey Area Data: Version 4, Sep 20, 2007

Date(s) aerial images were photographed: 3/3/1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

USDA Natural Resources Conservation Service
Web Soil Survey 2.0
National Cooperative Soil Survey
9/26/2007
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Figure 4-89 Map Legend and Map Information for the field in Exercise 7.

Wind Erodibility Index–Curry County and Southwest Part of Quay County, New Mexico

Exercise 7–Irrigated Corn, silage, Add Manure

Wind Erodibility Index

Wind Erodibility Index— Summary by Map Unit — Curry County and Southwest Part of Quay County, New Mexico				
Map unit symbol	Map unit name	Rating (tons per acre per year)	Acres in AOI	Percent of AOI
AnB	Amarillo loamy fine sand, 1 to 3 percent slopes	134	62.7	100.0%
Totals for Area of Interest (AOI)			62.7	100.0%

Description

The wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Rating Options

Units of Measure: tons per acre per year

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

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Figure 4-90 The Wind Erodibility Index for the field in Exercise 7.

Exercise 8 - Critical Dominant Soil

Skill Building: WEPS currently estimates only one soil map unit in a field at a time. Therefore, it is recommended that the user select the most erodible soil of a "manageable size". This is called the "Critical Dominant Soil." The Critical Dominant Soil is that which typically is the first to blow on the field and dominate the wind erosion process and is therefore critical for conservation planning.

The most erodible soil can be considered to be the one with the highest percentage of sand. For example, a fine sandy loam will be more susceptible to erosion than a loam. It is important to pay attention to the soils within the field when setting up a WEPS run. The WEQ (Wind Erosion Equation 1.1) **I factor** may be used to get some idea of the erodibility of the soils.

Exercise 8 Scenario

Consider the soil map of a field in Grant County, Washington (Figure 4-91). There are three map units in the semicircle. When determining the Critical Dominant Soil, the general guideline is to use the **most erodible** soil composing **greater than 10%** of the field **or greater than 10 acres** in size (i.e., a manageable size).

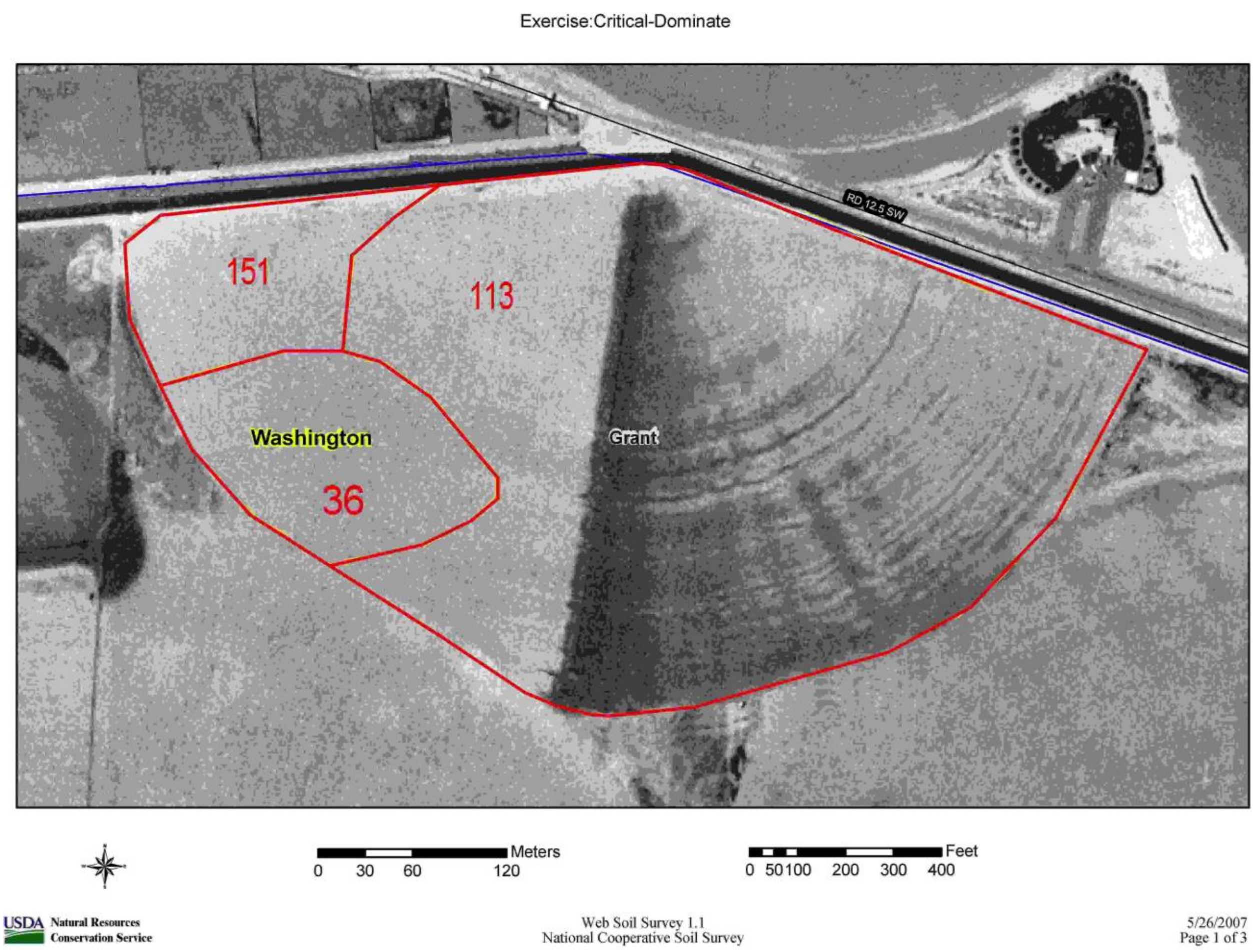


Figure 4-91 Map showing the soil map units of a field.

Soil Survey of Grant County, Washington — Exercise:Critical-Dominate

Map Unit Legend Summary

Grant County, Washington

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
36	Ekrub fine sand, 0 to 25 percent slopes	4.5	11.5
113	Royal loamy fine sand, 0 to 10 percent slopes	30.4	77.2
151	Taunton loamy fine sand, 0 to 10 percent slopes	4.4	11.3

Figure 4-92 Map Unit Legend Summary for Figure 4-91. The total field size is 39.3 acres.

Question: What soil should be used to estimate the soil loss?

Answer: From the figures we see that the Royal loamy fine sand (map unit 113) and Taunton loamy fine sand (map unit 151), comprise the majority of the field with 88.5% of the area. The Ekrub fine sand (map unit 36) makes up 11.5% of the area (Figure 4-92). However, the **Ekrub fine sand should be used since it is the Critical Dominant Soil**. It was selected because 1) it is the most erodible soil in the field; 2) it comprises more than 10% of the field; and 3) it is upwind of the damaging westerly spring winds.

Exercise 9 – Selecting Correct Simulation Region Shape and Size

Skill Building: The **X-length** is the longest (one dimension) distance from a stable boundary to the opposite side of the field running east-west with the orientation angle set at 0°. The **Y-length** is the longest (perpendicular to the X-length) distance from a stable boundary to the opposite side of the field running north-south with the orientation angel set at 0. These are the **unsheltered distances** which WEPS uses to calculate the erosion rate. A **stable boundary** is one that stops surface creep and saltation phases of wind erosion. A grass strip at least 13 feet wide and 1.5 feet high is an example of a stable boundary. Vegetation width, height, and porosity are to be considered when declaring a stable boundary. Most barriers, such as a windbreak, also can function as a stable boundary.

This exercise is intended to assist the user in selecting the correct distance to enter for the X-length and the Y-length in the Simulation Region panel of the WEPS interface.

Example 9 Scenario

- A 40-acre field (shown in light tan) is to be evaluated for wind erosion. The remaining land (green) is not controlled by the owner of the 40 acres and the management on the remaining land cannot be controlled by the owner of the 40-acre field. The remaining land may however contribute to the wind erosion process on the 40-acre field.
- The green land (one section in size, 640 ac) has a road on all sides with a 50-ft band of green vegetation (grass, 1.5 ft perimeter buffer).
- The non-erodible buffer is represented in dark brown.
- Both the 40 acres and the remaining 600 acres are farmed in a winter wheat-summer fallow, conventional tillage rotation.

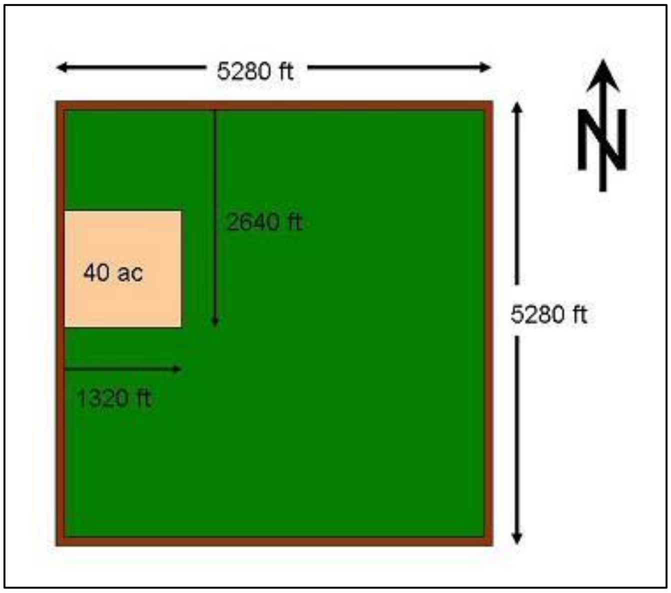
Question: Which of the following selections is the correct X-Length and Y-Length combination to evaluate or enter in the Simulation Region panel on the WEPS interface?

A. Y=1320 ft by X=2640 ft

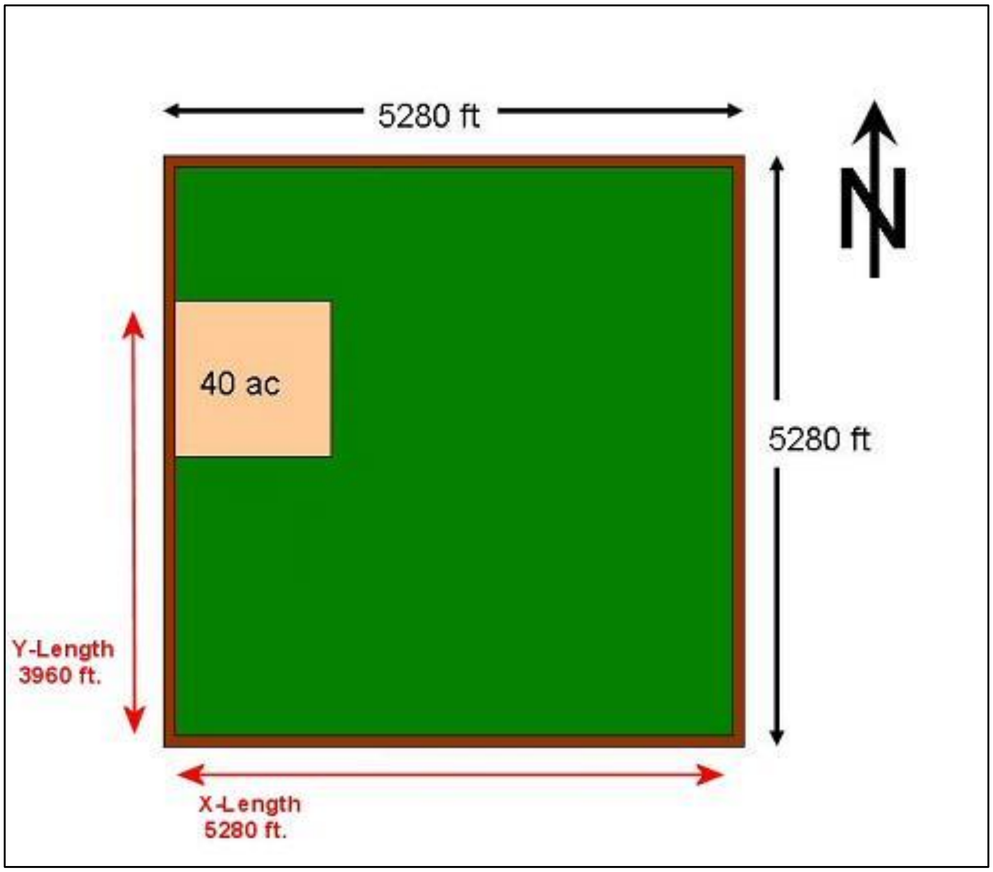
B. Y=3960 ft by X=5280 ft

C. Y=1320 ft by X=1320 ft

D. Y=5280 ft by X=5280 ft



In WEPS, wind directions are simulated to vary from day to day throughout the simulation. Because the management outside the field is not controlled by the same owner for conservation planning purposes, the unsheltered distance should be the **longest distance** from a stable boundary through the length of the field to the down-wind edge of the field. On the X axis the longest distance (X-Length) starts at the east boundary and extends west, all the way through the 40 acre field (5280 ft). On the Y axis, the longest distance (Y-Length) starts at the south boundary and extends north all the way though the 40 acre field (3960 ft). Therefore, the dimensions (X-Length, Y-Length, and acres) entered on the WEPS interface will be larger than the actual field for this scenario.



By using the Critical Dominant Soil within the field, we can ensure that we are considering the most erodible part of the field. By controlling wind erosion on that portion, it is highly likely that erosion will controlled on the entire field.

5 SCIENCE OVERVIEW

5.1 Interface and Science Model Implementation

Interface

This section describes the WEPS 1.5 User Interface program implementation and how it interacts with the WEPS science model. The WEPS 'science' model refers to the computer code and executable program that performs the actual calculations of field conditions and erosion processes for a simulation run. A simple flow diagram of the WEPS science model and User Interface is shown in Figure 5-1. A detailed description of how to operate the WEPS 1.3.9 User Interface is described elsewhere in the WEPS User's Guide in a chapter titled 'Interface Reference'.

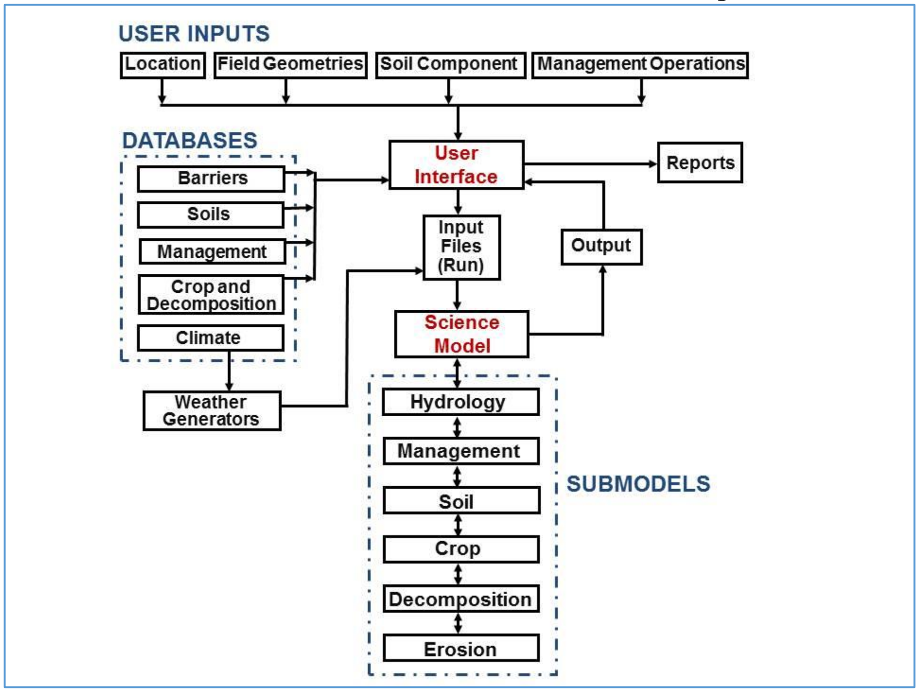


Figure 5-1 A flow diagram of the WEPS science model and User Interface.

A simplified description of the science model is provided later in this chapter. The inputs to the science model reside in a series of ASCII input files. These input files are: a Windgen file (*.win), a Cligen file (*.cli), an initial field conditions file (*.ifc), a management file (*.man), and a run file (weps.run). The science model can be executed from the command line or through the interface. When WEPS is executed, the science model reads the input files, calls each submodel performing daily time-step simulations, and writes output files. The output is written to one or more ASCII files. Building input files by hand, executing the model on the command line, and interpreting the output files can be time consuming and confusing; the WEPS 1.3.9 User Interface simplifies this process.

The WEPS 1.3.9 User Interface is written in Java. The interface can be thought of as a 'shell' or 'wrapper' around the science model, which does not affect the execution of the science model. Through the interface program, the user can easily enter the information necessary to create and edit the input files. A description of how to enter this information is given elsewhere in the WEPS User's Guide in a chapter titled 'Interface Reference'. Once the field, location, soil, and management are described, pressing the ‘Run’ button performs a series of commands to execute the science model. The interface first calls the CLIGEN and WINDGEN weather generators, which create the WINDGEN and CLIGEN files for the simulation. Then the WEPS science model is called and executed as described earlier. When the science model is finished, the interface reads and displays the output.

Main Program

The MAIN program is the portion of the science model that controls the initialization and execution of a WEPS simulation run. It calls subroutines that read input data and generates the summary and other reports. In addition, MAIN calls submodels on a daily basis, which update the field conditions. If the maximum wind speed for the day exceeds a set velocity great enough to cause soil movement (i.e., 8 m/s or 18 mi/hr), MAIN then calls the EROSION submodel to simulate erosion processes. The current version of WEPS reads in the climate data produced by the WEATHER submodel; performs daily simulation of the hydrologic and soil conditions, crop growth, and residue decomposition; and accounts for management effects. Finally, the model determines soil erosion by wind for the desired simulation period.

Program Description

The current version of MAIN requires the following files for a WEPS simulation run: a) a simulation run file that describes the field shape and barriers, simulation period, location of other input files, and types of output ; b) an initial field conditions file that describes soil conditions at the start of a simulation; d) a tillage/management file that describes the management system; and e) two climate files, one each in the CLIGEN and WINDGEN formats, that provide climate data on a daily basis.

The MAIN program begins by initializing local variables and then calls the subroutine INPUT, which reads the simulation run file and the initial field conditions file. The simulation then is executed as a daily loop that controls the counters for the current day. The model can perform any length of simulation on a daily time step, but WEPS performs a simulation for one rotation cycle to initialize surface conditions before simulations of wind erosion are performed. For each simulation day, the daily weather is read from the CLIGEN and WINDGEN data files. As some of the submodels are executed, summary information may be compiled for output. All submodels except EROSION are called within the subregion loop. Once field conditions are updated, if maximum wind speed for the day exceeds a set minimum (i.e., 8 m/s), the EROSION submodel then is called to determine threshold conditions and compute soil erosion. Finally, the MAIN program calls routines to account for field conditions and soil loss for periods throughout the rotation.

The “WEPS Technical Description” provides a more detailed description of the science behind WEPS and is available from WERU. The current WEPS science model is coded in FORTRAN conforming to the ANSI FORTRAN 77 and Fortran 95 standards. The inputs to the science model reside in a series of ASCII input files. These input files are: a WINDGEN file (*.win), a CLIGEN file (*.cli), an initial field conditions file (*.ifc), a management file (*.man), and a run file (weps.run). The science model can be executed from the command line or the interface. When WEPS is executed, the science model reads the input files, accesses necessary databases, calls each submodel daily and performs the simulation, and writes output files. The output is written to one or more ASCII files.

5.2 Weather Generators and Databases

WEPS requires wind speed and direction to simulate the process of soil erosion by wind. These and other weather variables (precipitation, air temperature, and solar radiation) are also needed to drive temporal changes in hydrology, soil erodibility, crop growth, and residue decomposition in WEPS.

Often it is not practical to use measured historical wind data with WEPS, because many wind records have missing data. Also, one may want to simulate wind erosion for a longer period than the length of the measured data record (e.g., for 40 years, is the length of a typical WEPS simulation run). In addition, the measured data require much more computer disk space than do wind summary statistics combined with a stochastic wind generator. Therefore, a stochastic wind generator is often more appropriate for use with WEPS than is using the measured data directly.

WINDGEN was developed specifically for use with WEPS. It stochastically generates daily wind direction and hourly wind speed (van Donk et al., 2004). An earlier version of WINDGEN was described by Skidmore and Tatarko (1990). CLIGEN is the weather generator developed for the Water Erosion Prediction Project (WEPP) family of erosion models (Nicks et al., 1987). It is used by WEPS to stochastically generate daily precipitation, maximum and minimum temperature, dew point temperature, and solar radiation. Those interested in CLIGEN and how it simulates these variables should consult the WEPP documentation (Nicks et al., 1995) and the CLIGEN web site (USDA, 2004). Both CLIGEN and WINDGEN are executed under the WEPS user interface.

Statistical distributions of weather variables are needed by stochastic weather generators to be able to generate data. There are two steps in the stochastic generation of wind data. First, statistics need to be calculated from a historical record of measured data, describing the distributions of wind direction and speed. Second, the wind data are stochastically generated from these statistics.

Calculation of statistics used for stochastic wind generation

A quality-controlled hourly wind data set (TD-6421, version 1.1), including 1304 stations in the 48 contiguous states of the USA, was obtained from the National Climatic Data Center (NCDC). Stations with less than 5 years of data were excluded, leaving 971 stations for use with a stochastic generator. Wind direction frequencies were calculated for each of 16 directions for each month. Wind speeds less than or equal to 0.5 m/s were treated as ‘calm’. For the wind speeds that were not calm, the fraction less than or equal to certain wind speeds was calculated for each month-direction combination (12*16 = 192 combinations per station). The wind speeds used were 0.5, 1.5, 2.5, ..., 20.5, 25.5, ..., and 45.5 m/s. Rather than using the Weibull model, we chose to use the measured wind speed distributions themselves, without fitting to any model, but instead using linear interpolation between the measured distribution points. The reasons for this choice are described by van Donk et al. (2004).

Stochastic wind generation

First, one of the 16 cardinal wind directions or calm is selected by using a random number generator with the distribution for the current month. The selected direction is applied for an entire day. Next, 24 hourly wind speeds are generated for this day. If calm was selected in the previous step, 24 wind speeds of 0 m/s are generated. Otherwise, if one of 16 directions was selected, 24 wind speeds are generated from the cumulative wind speed distribution. The distribution for the current month and wind direction is selected, and a wind speed is generated from the linearly interpolated distribution, by using a random number generator.

For more detail on the science behind this submodel, please see the WEPS technical documentation.

References

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Nicks, A.D., J.R. Williams, C.W. Richardson, and L.J. Lane. 1987. Generating climatic data for a water erosion prediction model. Paper No. 87-2541, International Winter Meeting ASAE, December 15-18, Chicago, IL.

Skidmore, E.L., and J. Tatarko. 1990. Stochastic wind simulation for erosion modeling. Transactions of the ASAE. 33(6): 1893-1899.

USDA. 2004. Cligen Weather Generator, expanded and improved by USDA Agricultural Research Service and U. S. Forest Service. http://horizon.nserl.purdue.edu/Cligen

Van Donk, S.J., L.E. Wagner, E.L. Skidmore, and J. Tatarko. 2004. Stochastic wind generation, comparing the Weibull model with a more direct approach. Submitted to Transactions of the ASAE.

5.3 Hydrology Submodel

HYDROLOGY submodel of the Wind Erosion Prediction System (WEPS) uses inputs generated by other WEPS submodels, such as WEATHER, CROP, SOIL, MANAGEMENT, and DECOMPOSITION, to predict the water content in the various layers of the soil profile, and at the soil-atmosphere interface, throughout the simulation period. Accurate simulation by the other WEPS submodels requires prediction of the daily changes in soil water profiles. Estimating soil wetness at the soil-atmosphere interface is emphasized however, because it significantly influences the susceptibility of the soil to wind erosion.

The HYDROLOGY submodel of WEPS maintains a continuous, daily, soil water balance by using the equation:

$$\mathrm{SWC} = \mathrm{SWCI} + (\mathrm{PRCP} + \mathrm{DIRG}) + \mathrm{SNOW} - \mathrm{RUNOFF} - \mathrm{ETA} - \mathrm{DPRC} \quad \text{Equation 5.1}$$

where SWC is the amount of water on the soil profile in any given day, SWCI is the initial amount of water in the soil profile, PRCP is the amount of daily precipitation, DIRG is the amount of daily irrigation, SNOW is the daily snow melt minus daily snow accumulation, RUNOFF is the amount of daily surface runoff, ETA is the amount of daily actual evapotranspiration, and DPRC is the amount of daily deep percolation.

The amount of daily precipitation (PRCP) is partitioned between rainfall and snowfall on the basis of the average daily air temperature. If the average daily temperature is 0℃ or below, the precipitation takes the form of snowfall; otherwise, it takes the form of rainfall.

The snow term (SNOW) can be either positive, equaling the daily snow melt, or negative, equaling the daily snow accumulation. The melted snow is treated as rainfall and added to the precipitation term in Equation 5.1 when accounting for daily runoff and infiltration. On the other hand, the accumulated snow is subtracted from the daily precipitation during the estimation of the daily soil water balance with Equation 5.1.

Simulation of soil-water dynamics on a daily basis by the HYDROLOGY submodel involves three major sequences. First, the submodel partitions the total amount of water available from precipitation, irrigation, and/or snow melt into surface runoff and infiltration. The submodel stores the daily amount of water available for infiltration into the soil profile. Second, the submodel determines the influence of ambient climatic conditions by calculating the potential evapotranspiration. Third, the submodel redistributes soil water in the soil profile on an hourly basis, which provides hourly estimations of water content in the soil profile. The submodel estimates the actual rate of evapotranspiration by adjusting the potential rate on the basis of soil water availability. Deep percolation from the soil profile is estimated to be equal to the conductivity of the lowermost simulation layer, assuming a unit hydraulic gradient.

HYDROLOGY submodel estimates surface runoff and infiltration for each simulation day that has precipitation and/or irrigation. The submodel estimates the daily amount of water available for infiltration into the soil by subtracting the amount of daily surface runoff from the amount of daily precipitation, snow melt, and/or irrigation. The infiltration water is stored in the uppermost simulation layer, until its water content reaches field capacity. Any excess water then is added to the succeeding lower layer, where it is stored with the same maximum storage restriction. This is repeated until complete water storage is obtained. Any excess water that flows out from the lowest simulation layer becomes a part of deep percolation.

Potential evapotranspiration is calculated by using a revised version of Penman's combination method (Van Bavel, 1966). The total daily rate of potential evapotranspiration then is partitioned on the basis of the plant leaf area index into potential soil evaporation and potential plant transpiration. The potential rate of soil evaporation is adjusted to account for the effect of plant residues in the simulation region. Furthermore, the daily potential rates of soil evaporation and plant transpiration are adjusted to actual rates on the basis of water availability in the soil profile.

The HYDROLOGY submodel uses a simplified, forward finite-difference technique to redistribute soil water with the one-dimensional Darcy equation for water flow. The time step of the soil water redistribution is 1 hour, which allows for an hourly estimation of soil wetness as needed for WEPS. Knowledge of the relationship between unsaturated hydraulic conductivity and soil water content is required for solving the governing transport equations of water movement through the soil. The submodel uses Campbell's (1974) method to calculate the unsaturated hydraulic conductivity of the soil from the more readily available soil water characteristic curve and saturated hydraulic conductivity data. Because water release curve data of the soil are not always available, the submodel provides alternative options to estimate the hydraulic parameters of the water release curve that are needed as inputs to run the soil water redistribution segment of the submodel.

The HYDROLOGY submodel predicts, on an hourly basis, soil wetness at the soil-atmosphere interface by using a combination of two techniques. The submodel extrapolates water content to the soil surface from the three uppermost simulation layers. A numerical solution known as Cramer's rule (Miller, 1982) is used to obtain an estimate of the extrapolated water content at the soil surface by solving the three simultaneous equations that describe the relationship between water content and soil depth for the three uppermost simulation layers. The submodel also interpolates the functional relationship between surface-soil wetness and the hourly evaporation ratio.

References

Campbell, G. S. 1974. A simple method for determining unsaturated conductivity from moisture retention data. Soil Sci. 117(6):311-314.

Miller, A. R. 1982. FORTRAN programs for scientists and engineers. SYBEX Inc., Berkeley, CA.

Van Bavel, C. H. M. 1966. Potential evaporation: the combination concept and its experimental verification. Water Resources Res. 2(3):455-467.

5.4 Management Submodel

Introduction

WEPS is expected to reflect effects of various management practices upon wind erosion. The diversity of current practices applied to crop land by land managers makes this a daunting task, but WEPS must adequately simulate typical cultural practices to accurately assess their effects upon wind erosion control. The MANAGEMENT submodel is assigned the task of handling the cultural practices that affect the soil/surface "state" within WEPS.

Purpose

All cultural practices are by definition "human initiated". These human-controlled processes affecting the soil and field surface "state" are initiated by typical management practices such as tillage operations, planting, harvesting, irrigation, etc. Therefore, the purpose of the MANAGEMENT submodel is to model what are considered the *major* human-controllable actions that can affect the "system state" within WEPS, in particular the system state variables defining the temporal soil and surface conditions.

Objectives

The MANAGEMENT submodel objectives are:

1. To model the primary human-initiated processes that can affect a site's susceptibility to wind erosion.
2. To provide the framework necessary to process a list of specified human-initiated actions (i.e., the cultural practices applied to a field such as a tillage/crop rotation sequence).

Keeping with the WEPS philosophy, The MANAGEMENT submodel simulates processes via a physical basis if possible, incorporates the conservation of mass and energy concepts, and uses a minimum number of parameters with readily available and/or attainable values.

Assumptions and Limitations

Several assumptions and limitations have been imposed on the MANAGEMENT submodel. The reasons range from simply limiting the scope of the submodel, to inadequate knowledge of specific processes that may have a significant impact on the soil and/or surface. Here is the list of current assumptions and limitations, provided in no particular order, that impact the MANAGEMENT submodel:Total soil water content within the current tillage zone is assumed to be unaffected by a tillage operation.

1. The HYDROLOGY submodel is expected to handle changes in surface water content and, therefore, appropriately represent the usual rapid drying of the surface layer after tillage.
2. Tillage depth is assumed not to influence how a tillage operation affects the soil and surface, except for determining which soil layers are directly affected by a tillage operation.
3. Effects of tillage operations on soil layers below the tillage depth are not considered, (i.e., subsoil compaction below the tillage zone due to tillage).
4. Effects of a management operation are assumed homogeneous within a subregion. Effects due to tractor tires will not be considered (except where they may knock down a significant proportion of standing residue). Certain zone-related tillage operations, such as row cultivator, will be treated in a manner such that the result will be "averaged" or "equivalent" values that represent the homogeneous region.
5. Ridge and dike geometric specifications (oriented roughness) will be provided by the user. If the tillage depth specified is not sufficient to create or destroy them (for a particular

tillage operation that does so), the MANAGEMENT submodel will modify the tillage depth accordingly to obtain the desired ridge and/or dike specifications. Tillage operations that do not modify the current ridge and/or dike specifications will not do so (i.e., ridge tillage equipment).

6. Soil tillage depths will be adjusted to the nearest soil layer boundary. This will ensure that the most recent tillage operation modifications on the soil "state" are adequately represented.

7. Aggregate stability and aggregate density are assumed to be unaffected by tillage operations. This decision is based on limited field data analysis. Future research may provide statistically significant affects that could then be modeled. These properties may still change among soil layers within the tillage zone due to aggregate mixing among layers caused by tillage operations.

Submodel Description

The approach taken within the MANAGEMENT submodel to deal with the variety of land management actions was to:

8. Identify the primary physical processes involved.
9. Represent individual management operations as a sequence of those primary physical processes.
10. Develop a MANAGEMENT file format allowing the input of user-specified sequences of management operations (i.e. a management practices/crop rotation file). All operations modeled within the MANAGEMENT submodel fall within the defined management categories as listed in (Table 5.1).

Table 5.1 Management Operation Classes

Operation Class	**Description**
Primary Tillage	Tillage performed to primarily reduce surface residue, increase short-term infiltration rates, loosen subsoil hardpans, and control weed growth. After-harvest tillage operations usually fall in this category.
Secondary Tillage	Tillage typically performed in preparation for seeding or planting operations. These operations usually are intended to smooth the soil surface, reduce the average aggregate size, and control weed growth, if present.
Cultivation	Tillage specifically designed to eliminate weed growth after crop germination.
Planting/Seeding	Operations required to plant or seed a crop into a field.
Harvesting	Operation to remove biomass from a field. Biomass removed may be grain, root material, or the entire above-ground biomass.
Irrigation	The artificial application or addition of water to the soil.
Fertilization	The application or addition of specific nutrients to a soil.
Burning	The removal of surface biomass via burning.

When a management or tillage operation is performed, it is simulated through a group of individual physical processes that represent the total effects of that operation. The basic individual physical processes to be modeled within the MANAGEMENT submodel of WEPS have been grouped according to the target of their actions and outlined in Table 5.2.

Table 5.2 Management Submodel Processes.

Action	Process	Description
Soil Mass Manipulation	Crush	The application of forces to the soil to modify the soil aggregate structure by breaking down soil aggregates.
	Loosen / Compact	The process of decreasing soil bulk density and increasing porosity (incorporation of air), or the inverse process of increasing soil bulk density by removing air from the soil.
	Mix	The process of uniting or blending of soil layer properties, including biomass.
	Invert	The reversing of the vertical order of occurrence of soil layers within the current specified tillage zone.
Surface Manipulation	Ridge / Dike	The process of creating or destroying ridges and/or dikes (oriented surface roughness).
	Roughen	The process of modifying the random surface roughness
	Crush	The process of modifying the soil surface crust characteristics.
Biomass Manipulation	Bury / Lift	The process of moving above-ground biomass into the soil, or the inverse process of bringing buried biomass to the surface.
	Cut	The process of cutting standing biomass to a prescribed height.
	Drop	The process of moving a portion of the standing biomass to the soil surface.
	Kill	The death of live biomass.
	Remove	The removal of biomass from the system (harvest, grazing, and burning).
Soil Amendments	Plant	Addition of seeds/plants to the soil.
	Irrigate	Addition of water to the soil.

The underlying philosophy behind the MANAGEMENT submodel was to attempt to develop representations based on physical law, if possible, for each of the chosen physical processes. These processes are assumed to be independent with respect to each other and are to be simulated sequentially, even though many of them occur simultaneously in the real world. The order they are initiated in the submodel is dependent upon the specific operation.

The list of management operations performed for a given management plan (crop rotation or cyclical management practices) is specified in a MANAGEMENT input file. The MANAGEMENT submodel checks on a daily basis for any operations to be performed on that day. If operations are needed, the MANAGEMENT submodel will execute the specified routines required to simulate the effects of those operations as instructed in the MANAGEMENT input file. When the last operation is performed for that particular crop rotation cycle, the same sequence will be repeated for the next year(s) of simulation.

A single MANAGEMENT input file may include multiple management operation lists, one for each subregion being simulated.

5.5 Crop Submodel

Introduction

The primary purpose of the WEPS plant growth submodel (CROP) is to obtain realistic estimates of plant growth so that the influence of vegetative cover on soil loss by wind erosion can be properly evaluated. The CROP submodel (Retta and Armbrust, 1995) was adapted from the Erosion Productivity Impact Calculator (EPIC) crop-growth model (Williams et al., 1990). Additional capabilities and modifications have been developed and incorporated into the CROP submodel to meet the need for predicting effects of a growing crop on wind erosion.

Young seedlings provide some protection from wind erosion, but not all plant parts are equally effective. Stems of young plants, on a per-unit area basis, are roughly 10 times more effective than leaves in depleting wind energy. Other differences between leaves and stems are that: a) leaves are more sensitive to sandblast damage than are stems; and b) leaf and stem residues decompose at different rates. To properly account for these differences, the CROP submodel gives daily estimates of leaf and stem growth in mass and area. At harvest, the ‘grain’ is removed and the ‘straw’ may consist of leaves, stems, and ‘chaff’. In most cases, the leaf and ‘chaff’ residue is short-lived, and only the stem residue may provide protection on a longer-term basis. The CROP submodel gives estimates of the amount of leaf, stem, ‘grain’, and ‘chaff’ mass produced on a daily basis.

An important consideration is the effect of plant density on the amount of cover provided by growing seedlings during the early vegetative growth period. Many management practices leave the soil vulnerable to the forces of wind erosion from before seeding until the growing plants develop sufficient cover. During the period from emergence to the development of adequate cover, the amount of cover is directly proportional to the number of seedlings per unit area. The greater the number of plants per unit area, the greater the cover provided by the growing vegetation. To account for the differences in cover due to initial plant density, the leaf and stem area indexes at emergence (which are used by the EROSION submodel in computations of soil loss) are calculated by multiplying the initial areas per plant by the number of seedlings per unit area. Thus, the greater the number of seedlings per unit area at emergence, the greater the protection provided by the young seedlings from wind erosion.

The CROP submodel uses data inputs of plant, weather, hydrology, and management to estimate leaf mass, stem mass, reproductive mass, yield mass, ‘chaff’ mass, and root mass of ‘live’ plants (crops) on a daily basis. Other plant characteristics estimated daily are root mass by soil layer, rooting depth, plant height, and canopy cover.

Phenological development

Phenological development of the crop is based on growing-degree-day (GDD) accumulation. The crop growth parameters, for each crop, consist of: a) the potential GDD from planting to physiological maturity; and b) the relative GDD from planting to emergence, to the start of the reproductive phase, and to the start of leaf senescence. CROP uses the same procedures as EPIC for simulating annual or perennial plants and winter or summer crops. Annual plants 'grow' from planting to the date when the accumulated GDD equal the potential GDD for the crop. For annual winter crops, such as wheat, GDD accumulation (therefore growth) does not occur during the period of dormancy. Perennial crops maintain their root systems throughout the year, although the plant may become dormant after a frost. After the end of dormancy, plants start growing when the average daily air temperature exceeds the base temperature of the plant.

Emergence

Emergence occurs when the GDD accumulation from date of planting equals 6% of the seasonal GDD. The CROP submodel does not account for effects of soil temperature, soil water, soil crusting, soil strength, seeding depth, or soil removal or deposition caused by wind erosion, any of which can influence germination, seedling emergence, survival, and growth.

Biomass Production

Biomass production is determined on the basis of a) the amount of shortwave radiation received, which is used to estimate the amount of photosynthetically active radiation (PAR) intercepted by the canopy; and b) the biomass efficiency factor assigned to the crop.

Growth Constraints

Potential growth and yield seldom are achieved, because of stress caused by sub-optimal conditions. The CROP submodel adjusts daily biomass and area growth for water and temperature stresses. Water and temperature stress factors range from 0, where no growth will occur, to 1, no limitation in normal growth. For any simulation day, the minimum value of the water or temperature stress factor determines the adjustment to daily produced biomass.

References

Retta, A. and D.V. Armbrust. 1995. WEPS technical documentation: Crop submodel. Proceedings of the WEPP/WEPS Symposium. Soil and Water Conservation Society, Ankeny, IA.

Williams, J.R., C.A. Jones, and P.T. Dyke. 1990. The EPIC Model. An Erosion/Productivity Impact Calculator: 1. Model Documentation. eds. A.N. Sharply and J.R. Williams. USDA Tech. Bulletin No. 1768.l 235pp.

Residue Decomposition Submodel

This submodel simulates the decrease in crop residue biomass due to microbial activity. The decomposition process is modeled as a first-order reaction with temperature and moisture as driving variables. Decomposition is a function of decomposition days. Under optimum temperature and moisture conditions, one decomposition day per day is accumulated. Only a fraction of a decomposition day is accumulated if conditions are less than optimum. Biomass remaining after harvest is partitioned between standing, flat, buried, and root pools. Below-ground biomass decomposition is calculated for each soil layer.

Residue from different crops may decompose at different rates. Because residue decomposition can require a long period of time, crop residue biomass from sequential harvests is accounted for in three separate pools. Biomass from the most recently harvested crop will be in pool one, biomass from the penultimate crop in pool two, and there is a third pool for biomass from the oldest crop(s). After harvest, any residue biomass remaining from a previous crop is moved into the older age pools, and residue from the just harvested crop is moved into the first residue-decomposition pool.

Standing residue losses not only result from microbial activity, but also from physical forces. Physical transfer of crop residue from the standing biomass pool will reduce both the stem population and standing biomass. A daily estimate of the standing stem population is required to evaluate the vertical stem area that the wind encounters. This area is quantified by the stem area index, which is calculated from standing stem number, stem height, and stem diameter. It affects aerodynamic resistance and, ultimately, wind erosion. Stems start to fall over after a threshold of cumulative decomposition days since harvest has been reached. Stem area index decreases proportionally with decreasing standing stem number.

Both standing and flat crop residue provide cover to the soil surface, protecting it against wind erosion. Soil cover from standing residue is typically small. It is calculated from stem number and stem diameter. Soil cover from flat residue is calculated from flat residue mass. Tillage may alter the amount of residue in the different pools.

For more detail on the science behind this submodel, please see the WEPS technical documentation.

5.6 Soil Submodel

Introduction

All the soil properties that control soil wind erodibility vary with time. Hence, the objective of the soil submodel is to simulate these temporal soil properties on a daily basis in response to various driving processes. On days when wind erosion or management activities occur, the EROSION and MANAGEMENT submodels may also update some of the same temporal variables. The driving processes that change soil temporal properties are mostly weather related; hence, the sequence of occurrence of individual driving processes is highly variable. Thus, the submodel must be able to update the soil variables, given an arbitrary driving process and the soil conditions for the prior day. This section provides a brief overview of the major processes that are simulated, and the temporal variables that are updated by the SOIL submodel. For an in-depth discussion of the equations used in the SOIL submodel, see the SOIL Submodel Technical Document (Hagen et al., 1995).

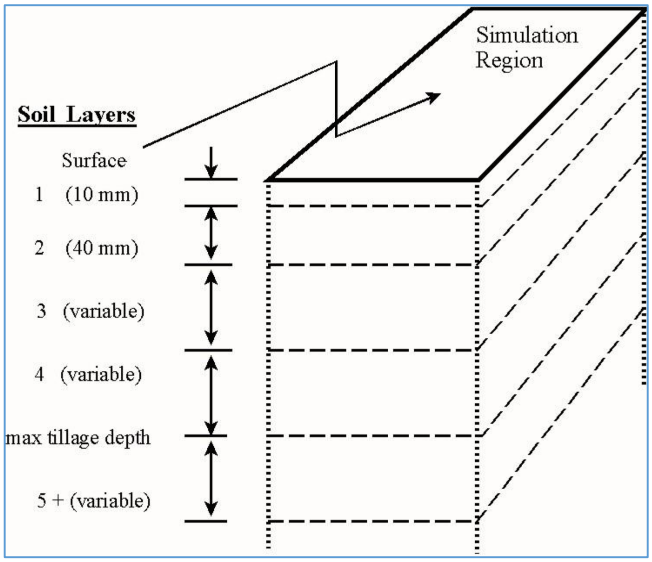

Figure 5-2 Diagram representing the spatial domain of the SOIL submodel

Spatial Regime

In the SOIL submodel, the spatial regime is considered to be uniform in the horizontal direction over the simulation region, but non-uniform in the vertical direction (Figure 5-2). Hence, the vertical direction is divided into layers in each soil profile. Some of the layer boundaries are selected to coincide with the layers determined by the NRCS Soil Survey of each soil. Layers one and two are initially set at 10 and 40 mm (0.39 and 1.57 inches), respectively, to allow simulation of sharp gradients in temporal soil properties near the surface.

Soil Layering Scheme

The HYDROLOGY and CROP submodels of WEPS depend upon the soil being stratified by layers. Hydrology moves water up and down within the soil in response to the relative wetness of adjacent layers. The CROP submodel estimates of plant growth are based upon several factors, one of the most important being availability of water within the root zone. It is important that WEPS keep track of how much water is available at various soil depths. Hence, WEPS views the soil as a series of layers, each layer possibly having distinct physical characteristics.

WEPS divides the soil into layers on the basis of the National Soil Information System (NASIS) input data. The layering scheme respects the underlying NASIS data. That is, no NASIS layers are combined when creating WEPS layers. Much of the complexity of the layering process is due to the creation of the very thin top layers. The design criteria are:

- Preserve NASIS layering, (i.e., a WEPS layer cannot cross a NASIS layer boundary).
- Define the first three layers to be 10, 40 and 50 mm, if possible.
- Preserve the relative sizes, 1:4:5:5, of the top layers if the absolute size cannot be attained.
- Divide the remaining layers into relatively uniform thicknesses, somewhat thinner at the top and thicker as depth increases.

Processes Simulated and Variables Updated

The processes simulated and the variables updated are summarized in Table 5.3. The effect of the processes on roughness is always to reduce the roughness. In contrast, many of the other variables either increase or decrease in value depending upon the prior-day value, soil intrinsic properties, and the driving process. To simulate the dry stability and aggregate size distribution for a wide range of soils, these variables were first normalized by using the means and standard deviations of the variables for each soil series to give a range from 0 to 1 for each variable. The driving processes were then applied to the normalized ranges to determine the change in the normalized variable. Finally, the updated normalized values were converted to the real values of these variables

Table 5.3 SOIL submodel variable and process matrix.

	Surface Processes			Layer Processes		
Soil Temporal Variables	Rain	Sprinkler Irrigation	Snow Melt	Wet/dry	Freeze/thaw	Freeze/dry
Roughness						
Ridge Height	X	X	X			
Dike Height	X	X	X			
Random	X	X	X			
Crust						
Depth	X	X	X			
Cover fraction	X	X	X			
Density	X	X	X			
Stability	X	X	X	X	X	X
Loose mass	X	X	X			
Loose cover	X	X	X			
Aggregates						
Size distribution	X	X	X	X	X	X
Dry stability	X	X	X	X	X	X
Density	X	X	X	X	X	X
Layers						
Bulk density	X	X	X			

In summary, the Soil submodel outputs updated values on a daily basis for each of the variables listed in Table 5.3 in response to the occurrence of the various driving processes.

References

Hagen, L.J., T.M. Zobeck, E.L. Skidmore, and I. Elminyawi. 1995. WEPS technical documentation: soil submodel. Proceedings of the WEPP/WEPS Symposium, Soil and Water Conservation Society, Ankeny, IA.

5.7 Erosion Submodel

Introduction

The objective of the EROSION submodel is to simulate the components of soil loss/deposition over a rectangular field in response to wind speed, wind direction, field orientation, and surface conditions, on a sub-hourly basis (Figure 5-3). In WEPS 1.3.9, barriers may be placed on any or all field boundaries. When barriers are present, the wind speed is reduced in the sheltered area on both the upwind and downwind sides of the barriers. The submodel determines the threshold friction velocity at which erosion can begin for each surface condition. When wind speeds exceed the threshold, the submodel calculates the loss/deposition over a series of individual grid cells representing the field. The soil/loss deposition is divided into components of saltation/creep and suspension, because each has different transport modes, as well as off-site impacts. Finally, the field surface is periodically updated to simulate the changes caused by erosion. This paper provides users with a brief overview of the submodel. For an in-depth description of the equations used in this submodel, see the WEPS Erosion Submodel Technical Description (Hagen, 1995).

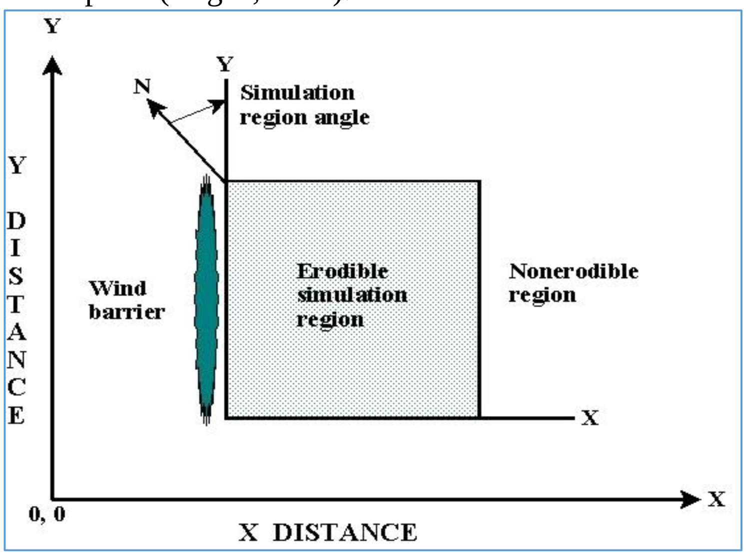

Figure 5-3 Schematic of simulation region geometry. Field orientation, end points of barriers, and opposite corners of the rectangular simulation region are input to the EROSION submodel.

Parameters Describing Soil Surface Conditions

Surface roughness is represented by both random roughness and oriented roughness. The parameters used are standard deviation of the surface heights for random roughness and the height, width of ridge tops, and spacing of ridges for oriented roughness.

Surface cover is represented on three levels (Figure 5-4). In the first level, surface rock, aggregates and crust compose 100 percent of the cover. In the second level, the parameter is the fraction of the crusted surface covered with loose, erodible soil. When there is no crust, this parameter is always zero. In the third level, the parameter is the fraction of total surface covered by flat, random biomass.

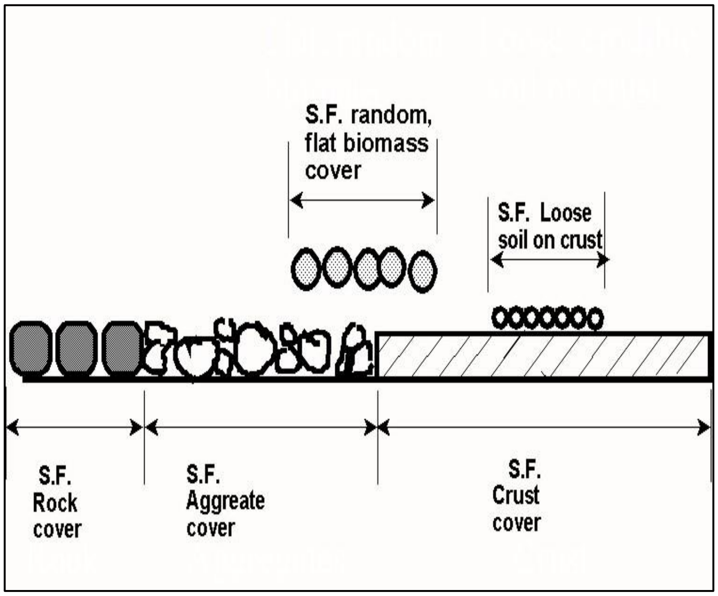

Figure 5-4 Diagram illustrating components of flat surface cover inputs to the EROSION submodel.

The aggregate density and size distribution are soil parameters that indicate soil mobility. The dry mechanical stability of the clods/crust are input parameters that indicate their resistance to abrasion from impacts by eroding soil. Surface soil wetness is also input and used to increase the threshold friction velocity at which erosion begins.

Uniformly distributed standing biomass is 5 to 10 times more effective in controlling wind erosion than is flat biomass, and thus, standing biomass is treated separately. The wind friction velocity above standing biomass is depleted by the leaves and stems to obtain the friction velocity at the surface that is used to drive erosion (Figure 5-5). Leaves are represented by a leaf area index and stems are represented by a stem silhouette area index.

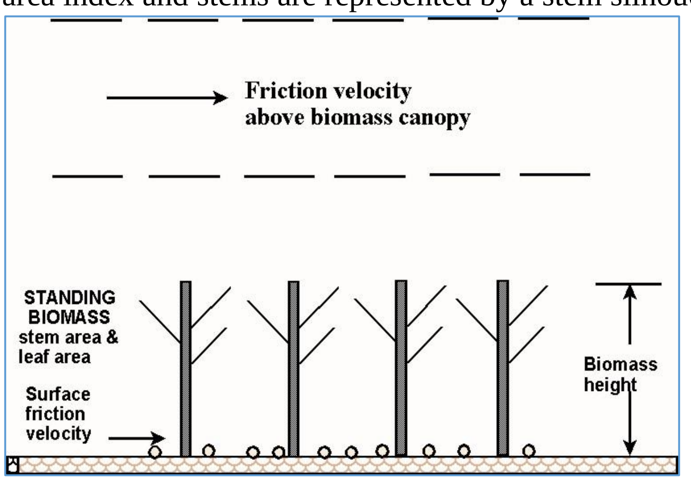

Figure 5-5 Diagram illustrating friction velocity above standing biomass that is reduced by drag of stems and leaves to the surface friction velocity below the standing biomass.

Erosion Processes Simulated

Soil transport during wind erosion occurs in three modes: creep-size aggregates, 0.84 to 2.0 mm (0.033 - 0.079 in.) in diameter, roll along the surface; saltation-size aggregates, 0.10 to 0.84 mm (0.004 - 0.033 in.) in diameter, hop over the surface; and suspension-size aggregates, less than 0.10 mm (0.004 in.) in diameter, move above the surface in the turbulent flow. Variations in friction velocity, aggregate density, and sediment load obviously may change the mass of aggregates moving in a given mode. Saltation and creep are simulated together because they have a limited transport capacity that depends mainly upon friction velocity and surface roughness. The suspension component is simulated with no upper limit on its transport capacity at the field scale. A portion of the suspension component also is simulated as PM-10 (i.e., particulate matter less than 10 micrometers (0.0004 in.) in diameter), which is regulated as a health hazard.

Multiple physical erosion processes are simulated in the erosion submodel, and these are illustrated for a single grid cell in Figure 5-6. The two sources of eroding soil are emission of loose soil and entrainment of soil abraded from clods and crust. These sources are apportioned between saltation/creep and suspension components on the basis of the source process and soil characteristics. Three processes deplete the amount of moving saltation/creep. These include trapping in surface depressions, interception by plant stems/leaves, and breakage of saltation/creep size particles and aggregates into suspension-size.

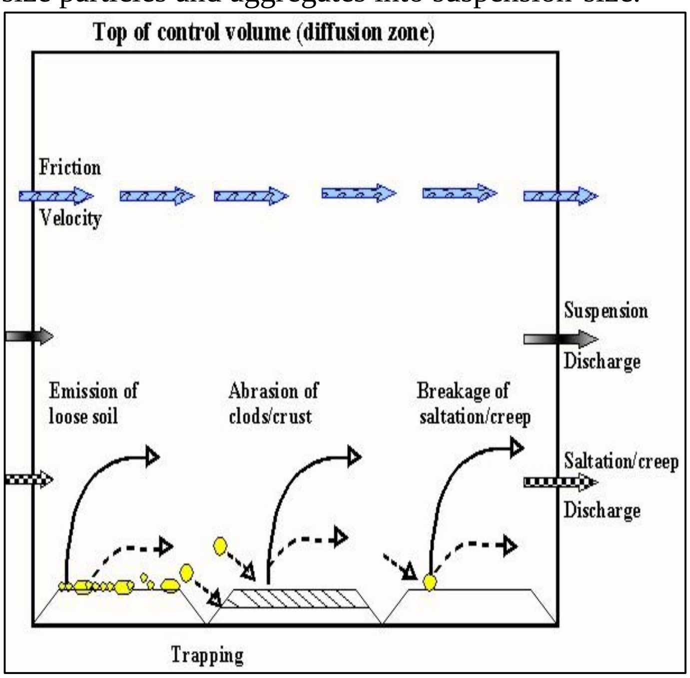

Figure 5-6 Diagram illustrating processes simulated by the EROSION submodel on a bare soil surface in an individual grid cell.

Simulation of surface rearrangement is accomplished by allowing emissions to deplete the loose soil and armor the surface in the upwind field area. In contrast, processes such as abrasion of the protruding aggregates and trapping in depressions dominate in downwind areas and lead to smoothing the surface and a build-up of loose saltation/creep. A build-up of saltation/creep often occurs, because the transport capacity may be satisfied, but abrasion of clods/crust continues to create additional saltation/creep-size soil.

Typical behavior of the downwind soil discharge simulated along a line transect for the saltation/creep and suspension components is illustrated in Figure 5-7. The suspension component keeps increasing with downwind distance, even though saltation/creep reaches transport capacity. This is because the sources for suspension-size soil are usually active over the entire field. These sources include emissions from impacts on loose soil, abrasion from clods/crust, and breakage from impacting saltation/creep-size aggregates. Moreover, the suspension component has a transport capacity many times larger than that of saltation/creep, so on large fields it is the 'freightliner' for moving soil whereas saltation/creep is merely the 'pickup truck'.

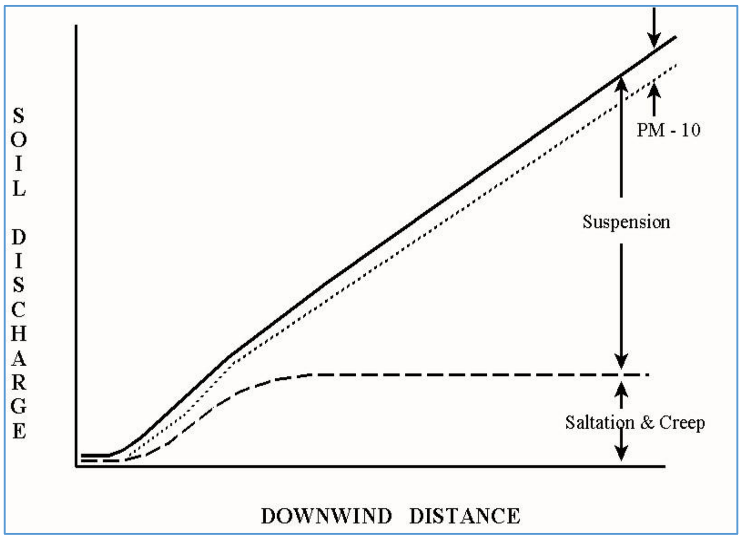

Figure 5-7 Diagram illustrating downwind transport capacity for saltation & creep, but a continuing increase in transported mass of suspension-size soil downwind.

Outputs

The EROSION submodel calculates total, suspension, and PM-10 soil loss/deposition at each grid cell in the field. The grid cell data are summarized in other parts of WEPS and reported to users as averages over the field for selected periods. The submodel also calculates the components of soil discharge crossing each field boundary. These are reported to users, according to the size ranges of aggregates as saltation/creep, suspension, and PM-10. These latter outputs are useful for evaluating off-site impacts in any given direction from the eroding field.

References

Hagen, L.J. 1995. Wind Erosion Prediction System (WEPS) Technical Description: Erosion submodel. Proceedings of the WEPP/WEPS Symposium. Soil and Water Conservation Society, Ankeny, IA

6 HOW TO GUIDES

WEPS How To Guide

6.1 Barriers

Wind barriers in WEPS include any structure designed to reduce the wind speed on the downwind side of the barrier. They also trap moving soil. Barriers include, but are not limited to, linear plantings of single or multiple rows of trees, shrubs, or grasses established for wind erosion control, crop protection, and snow management. Snow fences, board walls, bamboo and willow fences, earthen banks, hand-inserted straw rows, and rock walls have also been used as barriers for wind erosion control in limited situations. Barriers also reduce evapotranspiration, shelter livestock, and provide wildlife habitat. One advantage of barriers over most other types of wind erosion control is that they are relatively permanent. During drought years, barriers may be the only effective and persistent control measure on crop land. Barriers primarily alter the effect of the wind force on the soil surface by reducing wind speed on the downwind side of the barrier, but they also reduce wind speed to a lesser extent upwind of the barrier (Figure 6.1).

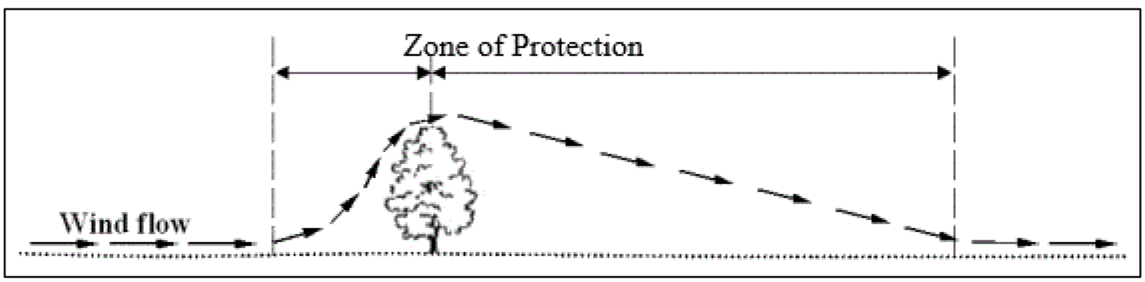

Figure 6.1 Diagram showing wind flow pattern over a barrier.

Research has shown that barriers significantly reduce wind speed downwind, sheltering a portion of the field from erosion and in effect, reducing the field length along the erosive wind direction. The protected zone of any barrier diminishes as porosity increases, and is reduced significantly when barrier porosity exceed 60 percent. Protection is also reduced as wind velocity increases, but the protected area diminishes as the wind direction deviates from the perpendicular to the barrier. Various types of barriers are used for wind erosion control in WEPS 1.3.9. The WEPS interface provides a method of selecting from a list of barriers to place on the field and editing the barrier properties. The user can also modify properties in the barrier database that appear in the drop-down list. Each of these properties are described in this section.

Adding and Removing Barriers Using the Interface

The Field View panel (Figure 6.2**Error! Reference source not found.**), located in the center of the WEPS 1.3.9 main screen, is designed to give the user a view of the field size, shape, and orientation (green). The placement of any barriers present is displayed in red. Note that if the ratio of actual length to width of the field or barriers is too great to display to scale, this will be indicated within the panel, and an approximation of the field or barrier shape will be displayed. This panel is for viewing only and is not editable.

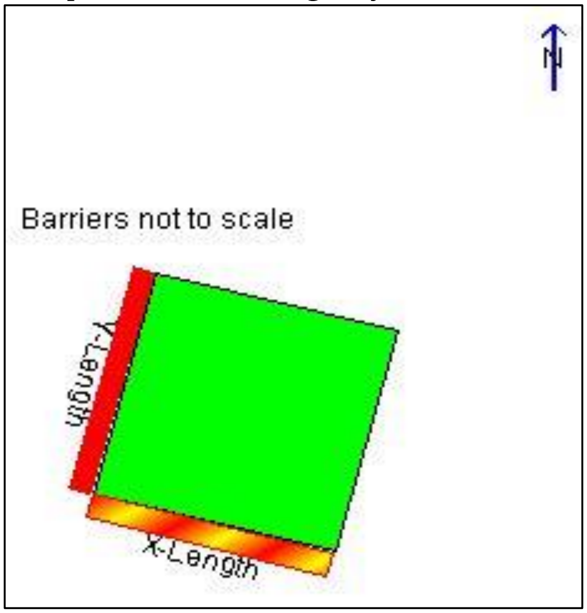

Figure 6.2 Field View Panel.

The Wind Barrier Information panel (Figure 6.3) is used to add barriers to the field. Note that WEPS 1.3.9 only allows barriers on the borders of the field. The barrier location for each field border is labeled ‘N’ for north, ‘S’ for south, ‘E’ for east, and ‘W’ for west. The barrier type can be selected from the drop-down list in the panel by clicking the down arrow to the right of the barrier type to bring up the list of available barriers, and then clicking on the appropriate barrier. Once a barrier type is selected, the barrier properties may be viewed and edited by clicking the ‘Edit Selected Barrier’ button at the bottom of the panel. A separate panel opens, in which the user may change the default barrier width, height, and porosity values in the appropriate fields. The modified barrier parameters are stored with the project. If a barrier other than ‘None’ is selected, the ‘Edit Selected Barrier’ button will open the properties panel when the radio button is clicked on for that barrier. To remove a barrier from the field, click the radio button to select it (notice the barrier in the View Panel will be ‘highlighted’ when selected), then select the barrier type ‘None’ to remove it.

Figure 6.3 Wind Barrier Information Panel.

Edit Selected Barrier

To view and edit the properties of a barrier, click the radio button for the corresponding barrier , then click the ‘Edit Selected Barrier’ button. A window will open displaying the properties described next. If properties are modified by the user through the interface, the barrier type will display ‘<mod>’ in front of the barrier type name.

The length of a barrier is defined by the field length along the border on which the barrier is placed.

Width The width of a barrier is defined as the distance from one side of the barrier to the other, in the units of measure displayed on the screen (feet or meters) (Figure 6.4). For a single-row wind barrier, the width is equal to the diameter of the tree, shrub, or grass, or for artificial barriers, the thickness of the material (e.g., slat fence). This is illustrated as “a” in Figure 6.4 For multiple-row barriers, the width is the distance from one side of the barrier to the other as illustrated by “b” in Figure 6.4).

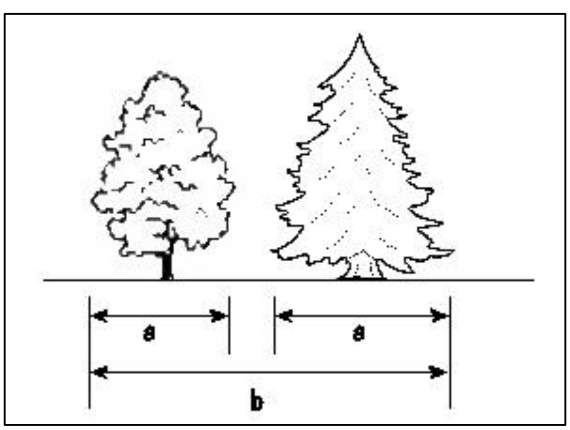

Figure 6.4 Barrier width for single row (a) and multiple row (b) barriers.

Height The height of a barrier is the average height of individual elements (e.g., trees) in the barrier ("a" in Figure 6.5 for single-row barriers). The units of measure for barrier height are displayed on the input screen in feet or meters. For multiple-row barriers, use the height of the tallest barrier row ('b" in Figure 6.5).

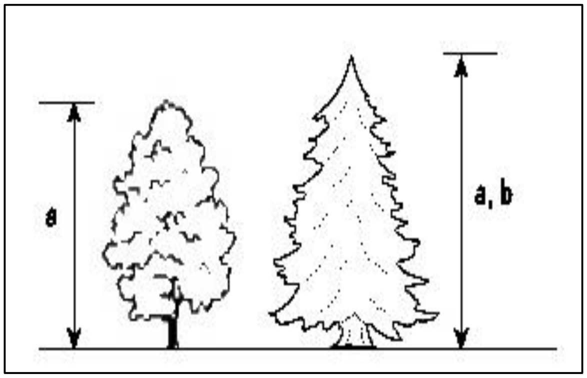

Figure 6.5 Barrier height for single row (a) and multiple row (b) barriers.

Area The area of the barrier is calculated from the barrier width and length (i.e., barrier width x field length). This is not an editable item, but is calculated within WEPS 1.3.9.

Porosity Barrier porosity is defined as the total optical porosity of all rows in the barrier. It is the open space (i.e., absence of leaves and stems) as viewed looking perpendicular to the barrier, expressed as a percentage of the total area (i.e., (1.0 - silhouette area) x 100). WEPS 1.3.9 does not "grow" living barriers. They do not increase or decrease porosity with leaf growth and leaf drop (senescence), nor do they increase in size from one year to the next. As such, the porosity of barriers in WEPS does not change with the seasons nor from year to year. Therefore, the user should input the porosity of the barrier that is present when the erosion hazard is the greatest. Figure 6.6**Error! Reference source not found.** illustrates the effect of porosity on the near-surface wind speed, relative to an open field without a barrier (see also Figure 6.1).

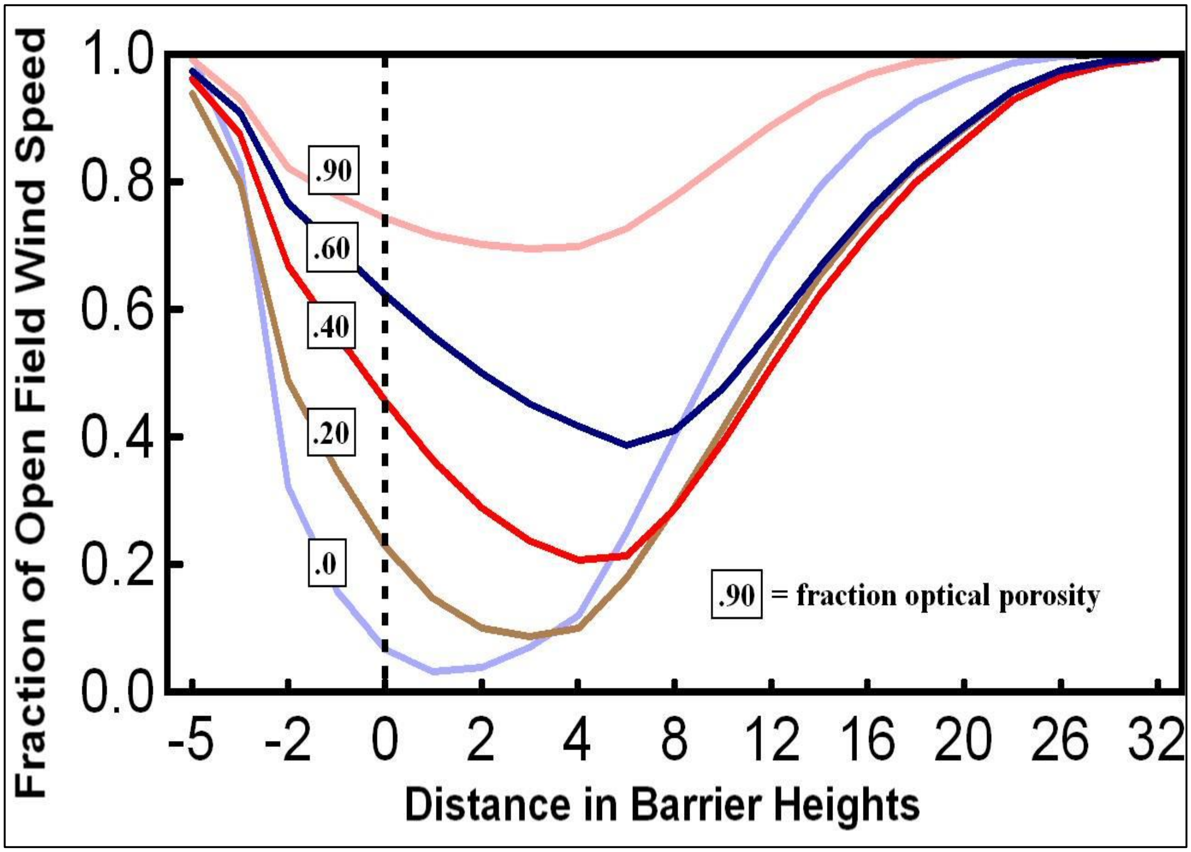

Figure 6.6 Effect of the fraction of optical porosity on near-surface wind speed along the wind direction relative to barrier. The “Distance in Barrier Heights” refers to the distance from the barrier at 0, measured in multiples of the barrier height.

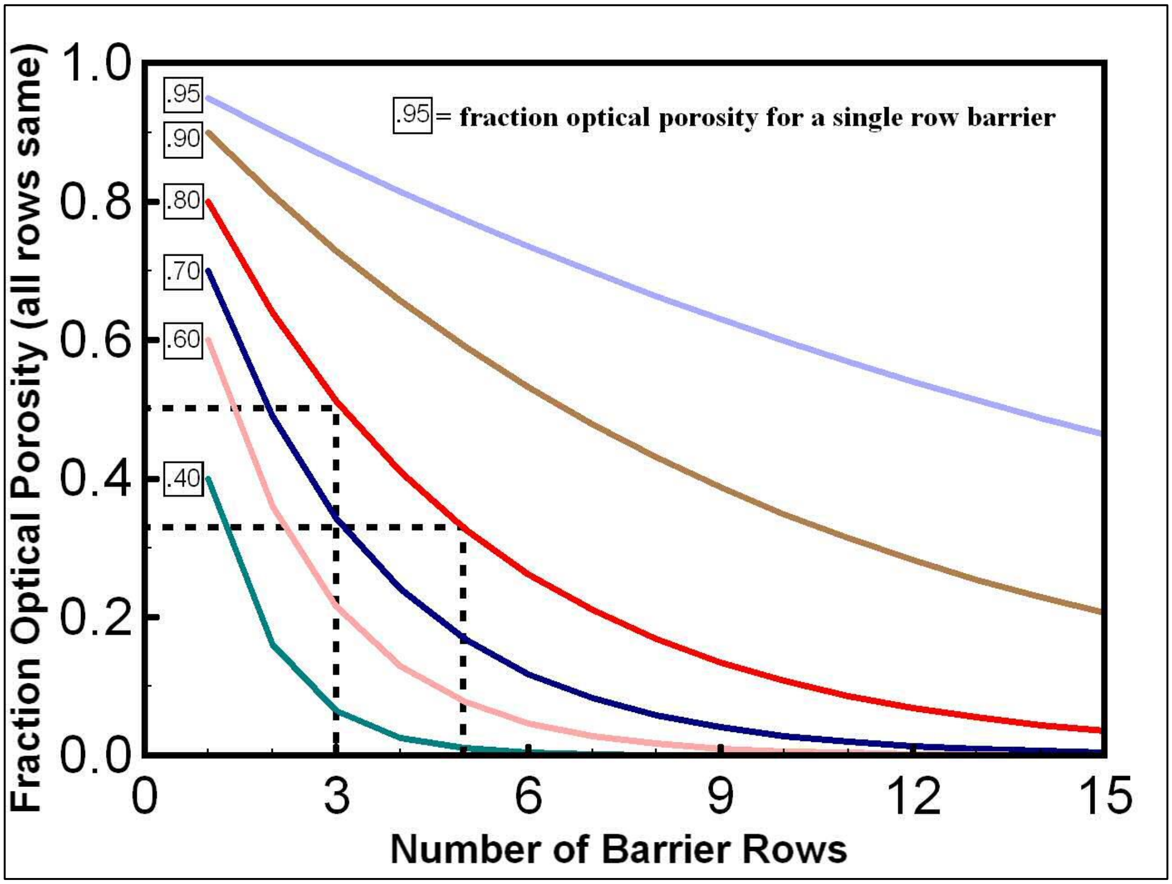

Figure 6.7 Effect of number of barrier rows on optical porosity when all barrier rows are the same.

At times, it is most efficient to estimate optical porosity for a single row, particularly for crop barriers. Then for multiple row barriers, the optical porosity decreases for the entire barrier as illustrated in Figure 6.7. For example, a single row of corn has an optical porosity of 0.80. Three rows of corn have an optical porosity of 0.50, and five rows of corn have an optical porosity of 0.33.

Barrier Property Database

Default barrier properties specified in the barrier property database cannot be permanently changed through the WEPS interface. But they can be modified and stored with the current project. Barrier properties may, however, be modified in the barrier database file. Figure 6.8 shows the barrier database file, ‘barrier.dat’, which is located in the “WEPS 1.3.9 Install” directory. This ASCII file may be edited (for NRCS only by designated qualified agronomists) by using a standard text editor to add new barriers or modify parameters of existing barriers. The file separates barriers into various categories (i.e., TREES, SHRUBS, HERBACEOUS, etc.). The user interface does not read nor display these barrier categories, and they only serve as a visual aid within the database. Actual database values are in rows which begin with a blank in column one, and each database parameter is separated by the pipe symbol, ‘|’. The parameters are listed as follows: barrier name | height (meters) | number of rows (not used) | porosity (fraction) | width (meters). Barrier height, width, and porosity were defined previously in this document. The barrier name is a character descriptor of the barrier and is the name displayed in the choice lists. The ‘number of barrier rows’ parameter is not currently used by WEPS nor is it displayed in the interface. Once the barrier database file has been updated, restart WEPS and the new barrier and/or modified parameter values should appear in the barrier drop-down list on the WEPS user interface.

```
TREES
 Trees w/o leaves(1 row)|8|1|0.8|3
 Trees w/o leaves(2 row)|8|2|0.7|7
 Trees w/o leaves(4 row)|8|4|0.6|15
 Trees w/ leaves(1 row)|8|1|0.6|3
 Trees w/ leaves(2 row)|8|2|0.5|7
 Trees w/ leaves(4 row)|8|4|0.4|15
SHRUBS
 Shrubs w/o leaves(1 row)|2|1|0.7|2
 Shrubs w/o leaves(2 row)|2|2|0.5|5
 Shrubs w/ leaves(1 row)|2|1|0.5|2
 Shrubs w/ leaves(2 row)|2|2|0.3|5
HERBACEOUS
 Grass Barrier(1 row)|0.8|1|0.7|0.5
 Grass Barrier(2 row)|0.8|2|0.5|1.0
CROP
 Kenaf(1 row)|2.5|1|0.7|1
 Kenaf(2 row)|2.5|2|0.5|2
 Sorghum(1 row)|2|1|0.7|1
 Sorghum(2 row)|2|2|0.5|2
 Flax(1 row)|0.5|1|0.7|0.5
 Flax(2 row)|0.5|2|0.5|1
 Corn(2 row)|1.5|2|0.7|2
 Corn(3 row)|1.5|2|0.6|3
 Corn(4 row)|1.5|2|0.5|4
 Wheat/Rye(1 row)|0.8|1|0.7|0.5
 Wheat/Rye(2 row)|0.8|2|0.6|0.6
 Wheat/Rye(3 row)|0.8|3|0.6|0.8
 Wheat/Rye(4 row)|0.8|4|0.5|1.0
 Wheat/Rye(1 row)|0.8|4|0.5|1.0
ARTIFICIAL
 Snow fence|1.2|1|0.6|1
```

Figure 6.8 Barrier database file "barrier.dat".

Supplemental Barrier Information for Users Manual

The following are some of the assumptions used in building the default property values for the barriers. For the Tree and Shrub barriers, the heights used are based on the 20-year heights which is the standard height used for designing windbreaks. Since the model does not grow the barriers, it needs to be recognized that erosion rates will gradually decrease during the growth of the barrier. Because of this, alternative treatment options will need to be used during this growth period such as annual barriers, herbaceous barriers and/or changes in crop residue management.

The Herbaceous barriers were divided between perennial and annual. The perennial barriers include species such as switchgrass, tall wheatgrass, elephant grass, etc. The annual barriers were divided into three height categories: short, medium and tall. The short annual barriers could include small grains e.g, wheat, barley, or rye. These small grains provide protection to wind sensitive crops in the early growth stages and are usually sprayed with herbicide. The medium annual barriers also include the small grains as well as flax that are allowed to grow nearly to maturity before being sprayed. The tall annual barriers may include corn, sunflowers, or sorghum reaching heights of 4 to 5 feet. The default porosities assigned to these annual barriers are based on the assumption that the planting rate/acre is the same whether it is one row or two rows or three rows. The porosity of a single row could be altered by increasing the number of plants per acre.

The orchard default values include two age categories: one year old and mature height. They are also divided into three size classes: dwarf, semi-dwarf, and standard. The height of some fruit trees can be controlled by the type of root stock such as an apple tree that is dwarf may have a 7 to 8 foot mature size while a standard tree may reach 16 to 18 feet. It was assumed that the dwarf size trees were spaced about 12 feet apart, the semi-dwarf about 20 feet and the standard up to 30 feet for the larger nut trees such as walnut and pecan.

The “Forest Edge” example is trying to account for large patches of forest on the field edge. These forest patches are assumed to be “wide” i.e. several hundred feet wide. These patches do not function the same as a windbreak in modifying wind flow. The tendency is for the wind reduction profile adjacent to these wide patches to be reduced in length acting more similarly to the wind profile of a more porous barrier where the wind will return to open field velocity more quickly than a narrower windbreak.

Two artificial fences were also included. One assumes a four foot height with a 50 percent porosity similar to a slatted snow fence. The other is a solid board fence with a similar height but very low porosity.

WEPS How To Guide

6.2 Crop Database Record Development

Introduction

In the plant growth submodel of the Wind Erosion Prediction System (WEPS), biomass is converted from solar radiation and partitioned to root and shoot parts (Figure 6.9). The shoot mass is partitioned into leaf, stem, and reproductive masses. Finally, the reproductive mass is partitioned into grain and chaff parts. Development of the crop in WEPS is a function of the heat-unit index, which is the ratio of the heat units (growing degree days) at any time during the growing season to the total amount of heat units required to grow a crop from planting to maturity. The heat-unit index is 0 at planting, and the crop reaches maturity when the heat-unit index is 1.

To perform these and other operations, crop growth in WEPS is configured by a set of parameters that define and drive the growth processes represented in the model code. Reasonable crop growth in different environments is achieved by setting the appropriate parameter values for the type of crop being grown. The purpose of this guide is to define and describe the process of obtaining reasonable parameter values based on knowledge of crop characteristics.

After estimating a parameter value, specific WEPS output can be examined to see if the parameter setting gives reasonable results. Not all WEPS output is available through the WEPS interface output reports. Therefore, the user is sometimes referred to other output files, such as ‘crop.out’ which contains daily output for many crop variables and ‘decomp.out’, which contains daily output for many decomposition variables. A parameter should be adjusted if a related simulated variable does not look reasonable. After adjusting the parameter(s), run WEPS again and inspect the variable again to see if it matches what is expected. If not, continue to adjust the parameter values on this trial-and-error basis. Be sure to look at simulation output for more than one growing season.

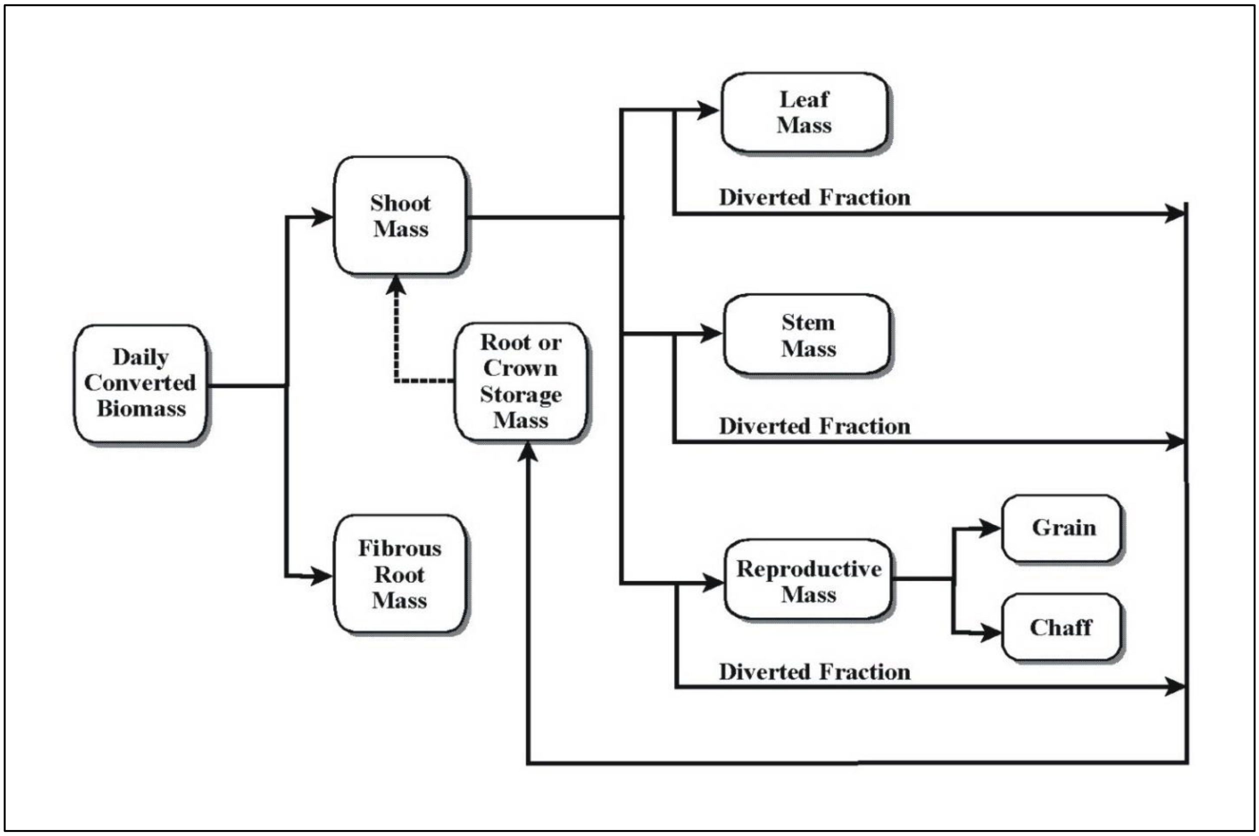

Figure 6.9 Schematic of biomass partitioning in WEPS. Biomass is converted from solar radiation and partitioned to 'fibrous root' and 'shoot' parts. The shoot mass is partitioned into leaf, stem, and reproductive masses, with some fraction of these masses diverted into a storage pool for crop regrowth. Finally, the reproductive mass is partitioned into grain and chaff parts.

Crop Database Structure Files and Definitions

Crop database records are stored in an XML format file with the extension ***.crop*** for use by the WEPS interface. Supporting files that define the database structure are part of the MCREW configuration files. New individual crop database records are most directly created by using MCREW to edit an existing crop file and saving it to a new name. New files can also be created with a text editor to edit the ***.crop*** file directly. The parameter descriptions herein provide the keys to enable the reader to know which parameter is being edited by either method.

The parameters are defined with units and are identified by a **Parameter Prompt**, which is the text that appears in the MCREW Crop drill-down screen. Some parameters have **Parameter Choices**, a list of choices that will be displayed when the parameter is defined as a discrete set of values, often integer flags. The parameters are grouped according to similar function, just as they are grouped by tabs on the Crop drill-down screen. Some parameters have both primary and alternate units which, along with a conversion factor, are given in Table 6.1.
Note that for NRCS most parameter choices will not be editable by Field Office Users. NRCS will use a database manager to adjust and distribute new or revised database file.

Table 6.1 Parameters having both primary and alternate units. The WEPS science model uses the primary units. Alternate units are used if English units are selected in the WEPS configuration. To convert from primary units to alternative units multiply by the given conversion factor (and add 32 where indicated).

Parameter Prompt	*Primary Units*	*Alternative Units*	*Conversion Factor*
Plant population	#/m^2	#/acre	4046.7
Planted mass, dry weight	mg/plant	ounce/plant	3.5274*10^{-5}
Root storage mass required for each regrowth shoot	mg/shoot	ounce/shoot	3.5274*10^{-5}
Heat units to maturity	℃ day	℉ day	1.8
Minimum temperature for plant growth	℃	℉	1.8 + 32
Optimum temperature for plant growth	℃	℉	1.8 + 32
Maximum growth diameter of a single plant	m	ft	3.281
Residue : Yield intercept	kg/m^2	lb/acre	8921.8
Maximum root depth	m	ft	3.2808
Maximum crop height	m	ft	3.2808
Lower temperature	℃	℉	1.8 + 32
Higher temperature	℃	℉	1.8 + 32
Stalk diameter	m	inches	39.3696
Mass to cover factor	m^2/kg	acre/lb	0.00011209

Crop Parameter Definitions

Shoot Tab

The emergence of plant shoots, from either seeds, stored root mass, or the pseudo emergence of transplants, is controlled by four crop parameters: “Planted mass, dry weight”, m_p , “Root storage mass required for each regrowth shoot”, m_{sh}, “Ratio of leaf mass/stem mass in shoot”, r_{ls}, and “Ratio of stem diameter to stem length”, r_{dl}, and two parameters described later in this document: “Stem silhouette area coefficient *a*” and “Stem silhouette area coefficient *b*”. Note that the “Root storage mass required for each regrowth shoot” is mostly used in regrowth calculations. If the “Planted mass, dry weight” is greater than the “Root storage mass required for each regrowth shoot”, then multiple shoots per plant will be generated. The number of shoots per plant, n_{sh}, that will grow from the planted (stored) mass, is calculated from:

$$n_{sh} = \max\left[1, \min\left[n_{ms}, \frac{m_p}{m_{sh}}\right]\right] \qquad 6.1$$

$$N_{sh} = N_p n_{sh}$$

where n_{ms} is the "Maximum number of shoots per plant" and N_{sh} is the number of shoots per square meter. Note that n_{sh} does not have to be an integer. The shoot growth subroutines assume a 70% conversion efficiency from stored to live biomass. When growth is from seed or a transplant, 40% of growth biomass will become roots. The stem length at full extension is calculated as:

$$m_{st} = \frac{0.7(1-0.4)m_p}{(r_{ls}+1)} \qquad 6.2$$

$$A_{st} = a\left(\frac{m_{st}}{10^6}\frac{N_{sh}}{N_p}\right)^b \frac{N_p}{N_{sh}}$$

$$l_{st} = \sqrt{\frac{A_{st}}{r_{dl}}}$$

where m_{st} is the mass of stem generated in the complete emergence process, A_{st} is the silhouette area of a single stem, and l_{st} is the length of stem generated at full extension. Full extension has been realized when all of the planted (stored) mass (m_p) has been converted to generated shoot mass. Emergence occurs when l_{st} is greater than the "Starting depth of growing point". An error message is generated if emergence never occurs.

Parameter Prompt: Crop Type

Parameter Choices: 1 - Warm-season legume (soybeans, etc.)
2 - Cool-season legume (peas, etc.)
3 - Perennial legume (alfalfa, etc.)
4 -Spring seeded and warm-season annuals (spring wheat, cotton, sunflowers, corn, etc.)
5 - Cool-season annuals (winter wheat, winter canola)
6 - Perennials (pasture, etc.)

This selection determines crop growth processes, such as vernalization (crop types 2 and 5 implement a vernalization delay to overwinter heat-unit accumulation), and the ability to regrow after cutting (crop types 3 and 6 will regrow if sufficient root or crown storage has been accumulated).

Parameter Prompt: Transplant or Seed flag
Parameter Choices: 0 - Seeds planted in field.
1 - Transplants planted in field (mass immediately divided into root, leaf, stem).

This flag is set to indicate that plant growth begins with a transplant or with a seed being placed in the field. If growth begins with a transplant (as opposed to grown from seed), a number of additional parameters need to be adjusted: the length of the growing season will need to be shortened, by either days or heat-units, to represent the time from transplant to maturity; the planted mass, dry weight, should be adjusted to represent the size of the transplant; and the heat-unit index at (pseudo) emergence, should be adjusted to represent a reasonable transplant-shock recovery time.

Parameter Prompt: Plant population, N_p (#/m^2)
The number of plants expected in a normal stand. This should be the estimated plant population after germination. If the maximum number of shoots per plant (next parameter) is set to one, then this is the total number of stems expected.

Parameter Prompt: Maximum number of shoots per plant, n_{ms} (#/plant)
Growth of multiple shoots occurs when this value is greater than one and root (crown) storage mass is greater than “Root storage mass required for each regrowth shoot” at the time regrowth commences. The number of stems produced can be examined by viewing the number of stems per square meter (the variable ‘#stems' in the output file ‘crop.out’) and comparing it with the “Plant Population” (previous parameter).

Parameter Prompt: Starting depth of growing point (m)
Crop growth begins at this depth in the soil. Root extension proceeds downward from this depth, while shoot extension proceeds upward from this depth at equal rates. It is necessary that the shoot growth parameters result in a shoot length greater than this depth or seedlings will not emerge. This depth is used as the depth from which regrowth begins for crop types 3 and 6 at all times. For crop types 1 and 4, the growing point is moved to the surface at the completion of seedling emergence. For crop types 2 and 5, the growing point is moved to the surface after the initiation of spring growth.

Parameter Prompt: Planted mass, dry weight, m_p (mg/plant)
At planting time, total plant biomass is initialized to this value. From the time of growth initialization until the completion of emergence, this mass is allocated to roots, stems, and leaves. For a crop grown from a seed, the mass should be set to the individual seed weight. For a crop that is placed in the field as a transplant, the total plant dry weight, including roots, should be entered.

Parameter Prompt: Root storage mass required for each regrowth shoot, m_{sh} (mg/shoot)
As described previously, the number of shoots that grow from stored root mass is calculated based on this parameter. For crops that can regrow from stored root or crown mass, this value is used, along with the “Maximum number of shoots per plant” and the stored root mass of the crop to determine how many shoots will re-sprout. The partitioning of mass to be stored for regrowth is set by using the parameters “Fraction of leaf mass partitioning diverted to root storage”, “Fraction of stem mass partitioning diverted to root storage”, and “Fraction of standing store mass partitioning diverted to root storage”. The quantity stored varies depending on growth conditions.

Parameter Prompt: Ratio of leaf mass/stem mass in shoot, r_{ls}
This is the ratio at full extension. When the growth of a shoot from stored mass occurs, as in germination, regrowth after cutting, or the pseudo growth used to initialize a transplant, mass is divided into leaf and stem according to this ratio. This value should be large enough to generate

the leaf area required to get crop growth started. If a crop does not grow adequately, examine the variable ‘eff_lai’ in the output file ‘crop.out’. It should show a value of 0.01 or greater at the heat-unit index at emergence.

Parameter Prompt: Ratio of stem diameter to stem length, r_{dl}
This is the ratio at full extension. When the growth of a shoot from stored mass occurs, as in germination, regrowth after cutting, or the pseudo growth used to initialize a transplant, stem length is calculated from stem mass according to this ratio. This parameter is the prime candidate for adjustment to ensure that plant emergence occurs when growing from seed.

Parameter Prompt: Heat-unit index at emergence
Setting this value to zero will cause the program to fail.

<u>Growth Tab</u>

Parameter Prompt: Crop maturity measurement method
Parameter Choices: 0 - Crop matures on average in Days shown
1 - Crop matures in Heat Units shown

For some types of crops, corn being the best example, the length of the growing season is genetically manipulated, and the average length of the crop growth period for that area is expressed in days, not heat units. When this option is set to 0, the average weather for the location being simulated is used to find the heat unit accumulation from the planting day through the number of days shown in the “Days to maturity” parameter. The simulation is then run using this heat unit total as the season length. For option 1, the value entered for “Heat units to maturity” is used directly, regardless of location. Because the effect of vernalization on the calculation of average heat units is not implemented, all crop types 2 (cool season legumes like peas) and 5 (cool season annuals like winter wheat and winter canola) should be configured to use option 1.

Parameter Prompt: Days to maturity (days)
For annual grain crops, the average number of days from planting to maturity of seed. For vegetable, fruit, and root crops; sugarcane; and tobacco, it is the number of days from planting (or ratooning) to harvest. For perennials (e.g., alfalfa), it is the number of days from spring growth to maturity of seed.

Parameter Prompt: Heat units to maturity (^{o}C day)
For annual grain crops, the average seasonal heat units from planting to maturity of seed. For vegetable, fruit, and root crops; sugarcane; and tobacco, it is the average seasonal heat units from planting (or ratooning) to harvest. For perennials (e.g., alfalfa), it is the average seasonal heat units from spring growth to maturity of seed.

Parameter Prompt: Heat unit index at start of senescence (fraction)

This is the fraction of the growing season (expressed as heat-unit index) during which plant senescence begins. Examine the variable ‘eff_lai’ in the output file ‘crop.out’ to see the effect of adjusting this parameter.

Parameter Prompt: Minimum temperature for plant growth (^oC)
The average daily air temperature below which the model will not allow plant growth (full temperature stress). This is commonly known as the minimum cardinal growth temperature and forms the base temperature for calculating heat-unit accumulation.

Parameter Prompt: Optimum temperature for plant growth (^oC)
The average daily air temperature at which the model will allow maximum growth (no temperature stress). This is commonly known as the maximum cardinal growth temperature and forms the upper temperature for calculating heat unit accumulation. When the average daily air temperature exceeds this value, heat-units accumulate at the maximum rate for the day, and temperature stress increases.

Geometry Tab

Parameter Prompt: Maximum growth diameter (m) of a single plant
Some cropping systems use plant densities that do not result in canopy closure. In these systems, the plant will grow to cover a ground area that is characteristic of the plant. WEPS assumes that the covered ground area is round. This parameter is the diameter of the circle that encloses the covered area. Biomass production is reduced by the decrease in intercepted light (some of the light reaches the soil), unless the reduced densities are used to reduce water stress for the remaining plants.

Parameter Prompt: Stem silhouette area coefficient a

Parameter Prompt: Stem silhouette area coefficient b
For many crops, the relationship of stem silhouette area to its mass is described well by a 2-parameter power function, which is used to compute stem silhouette area from stem mass: $SSA = a M^b$, where SSA is stem silhouette area (m^2 / plant), M is stem mass (kg / plant), and a and b are coefficients. Retta and Armbrust (1995) obtained values for alfalfa, corn, sorghum, oat, winter wheat, and soybean.

Parameter Prompt: Specific leaf area (m^2 / kg)
For many crops, the relationship of leaf area to its mass is described well by a linear relationship, which is used to compute leaf area from leaf mass: LA = a M, where LA is leaf area (m^2 / plant), M is leaf mass (kg / plant), and a is specific leaf area (m^2 / kg).

Parameter Prompt: Light extinction coefficient
Canopy light utilization is specified by an exponential relationship for the attenuation of light with distance into the canopy. Combined with the leaf-area index, this coefficient determines the amount of light interception by the canopy according to the relationship:

$$fraction = 1 - exp^{-k\,LAI} \qquad 6.3$$

where fraction is the ratio of photosynthetically active radiation (PAR) that is intercepted by the crop and total PAR received above the crop canopy, k is light extinction coefficient, and LAI is leaf area index (Figure 6.10). A higher number indicates more light interception by a given leaf area index, as occurs with broadleaf plants with a horizontal leaf orientation, such as cotton. A lower number indicates decreased light interception by a given leaf area index, as occurs with narrow leaf plants with a vertical leaf orientation, such as the grasses.

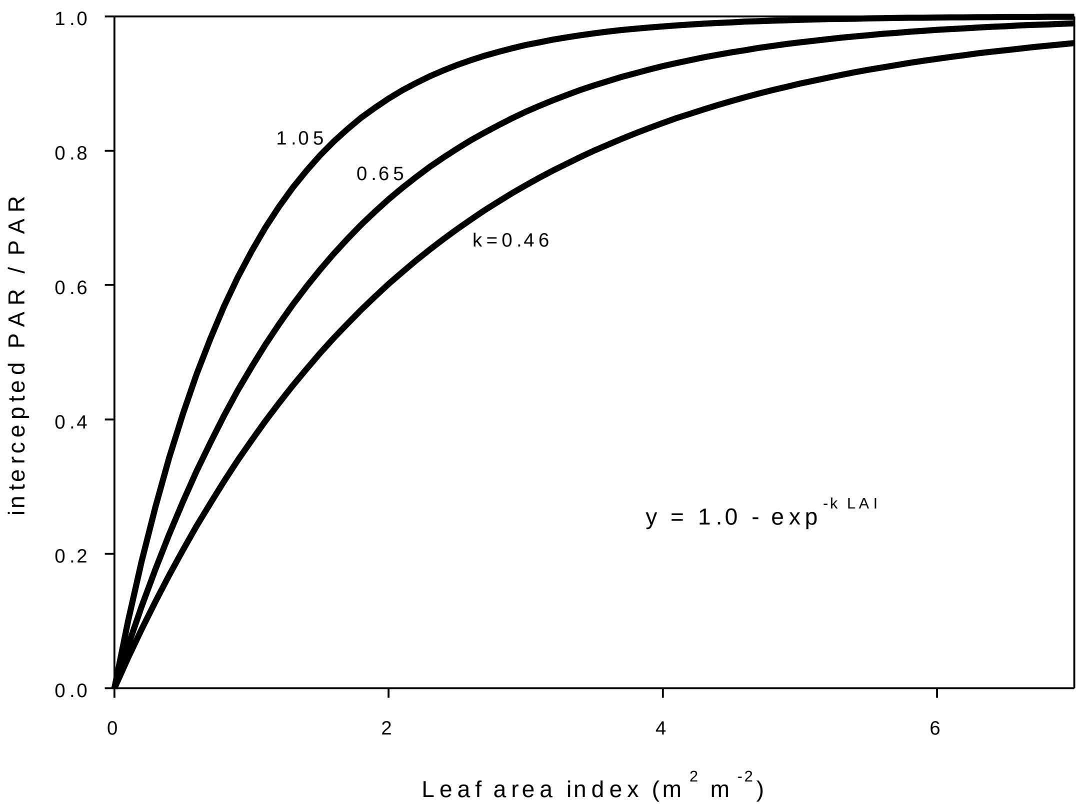

Figure 6.10 Relationship between leaf-area index and fraction of light intercepted (intercepted PAR / PAR) for three different values of the light extinction coefficient k. WEPS uses k = 1.05 for cotton; k = 0.65 for corn, soybean, potato and sugar beet; and k = 0.46 for sorghum and millet.

Parameter Prompt: Biomass Conversion Efficiency (t/ha) / (MJ/m^2)

The unstressed (potential) growth rate per unit of intercepted photosynthetically active radiation. EPIC values were used as a starting point for the major crops. Literature searches revealed that this value is difficult to measure exactly. This parameter is key to making the crop grow correctly.

Partitioning Tab

The daily converted (grown) biomass is partitioned between root and shoot mass (Figure 6.9). The shoot mass (above-ground biomass) is further partitioned into leaf, stem, and reproductive mass (Figure 6.11). Both the leaf curve and the reproductive curve are defined by a 4-parameter function. The remaining mass is considered stem mass. The three fractions always add to 1.0.

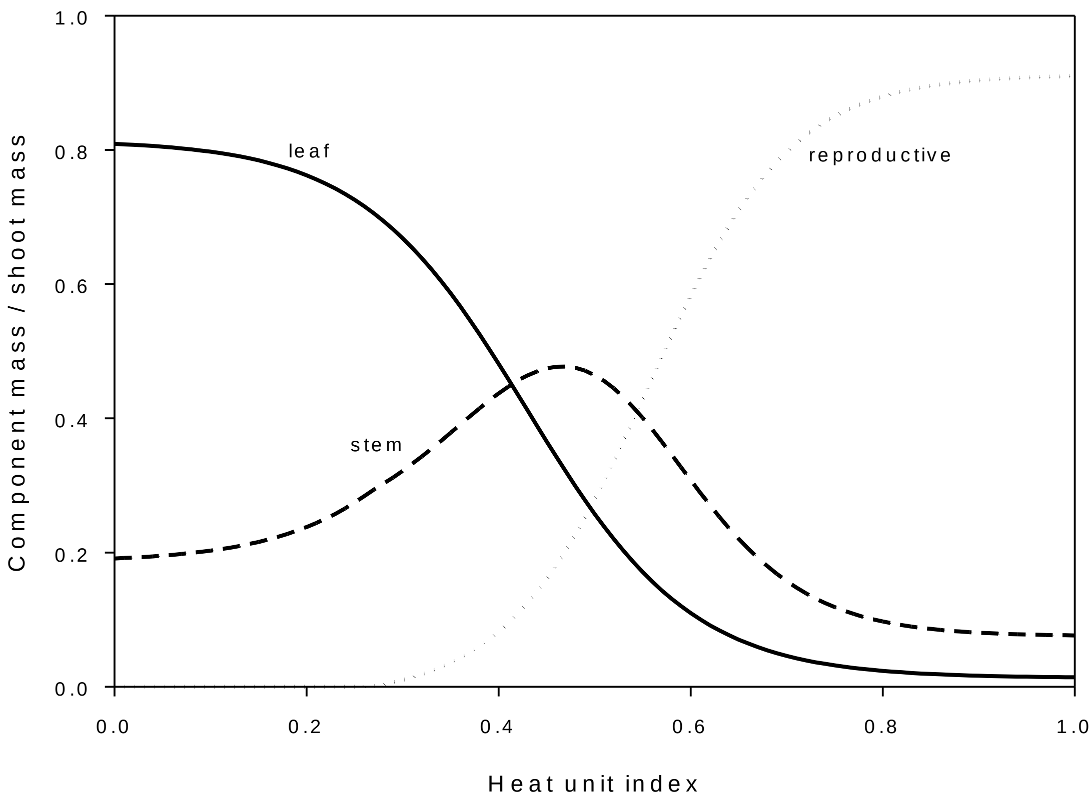

Figure 6.11 Partitioning of shoot mass (above-ground biomass) into component mass for winter wheat. Components are leaf, stem, and reproductive mass. By definition, these three fractions always add to 1.0.

Specify the four parameters for the leaf curve (Figure 6.12):

Parameter Prompt: Leaf fraction coefficient a
The lower asymptote.

Parameter Prompt: Leaf fraction coefficient b
The range between the upper and lower asymptote.

Parameter Prompt: Leaf fraction coefficient c
The heat-unit index at the inflection point. The leaf mass / shoot mass ratio at the inflection point is half way between the lower and upper asymptote (a + b/2).

Parameter Prompt: Leaf fraction coefficient d

Determines the slope of the curve. A negative d produces a descending curve (leaf) and a positive d gives an ascending curve (reproductive).

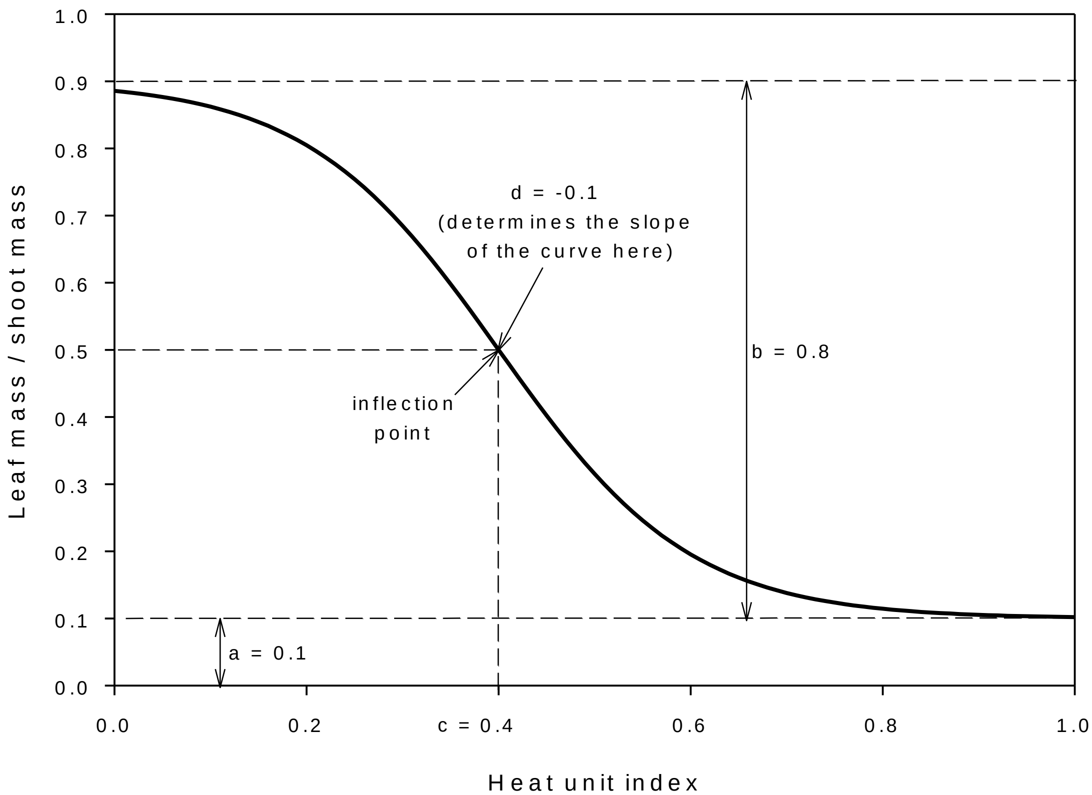

Figure 6.12 Partitioning of shoot mass into leaf mass. In this example, a = 0.1, b = 0.8, c = 0.4, and d = -0.1. The leaf mass / shoot mass ratio at the inflection point = a +b/2 = 0.5.

Specify the four parameters for the reproductive curve:

Parameter Prompt: Reproductive mass coefficient a
The lower asymptote.

Parameter Prompt: Reproductive mass coefficient b
The range between the upper and lower asymptote.

Parameter Prompt: Reproductive mass coefficient c
The heat-unit index at the inflection point.

Parameter Prompt: Reproductive mass coefficient d
Determines the slope of the curve at the inflection point.

For a new crop, the four leaf parameters can be adjusted on the basis of total leaf mass development (the variable 'total leaf' in the output file 'crop.out'). Check total stem mass development by inspecting the variable ‘total stem' in the output file ‘crop.out’. If stem mass development seems unsatisfactory, adjust both leaf and reproductive parameters to change the stem partitioning curve.

Reproductive mass should be equal to zero before time of flowering. This may be used as a point on the reproductive partitioning curve. Inspect the variable ‘standing store' in the output file ‘crop.out’. If ‘standing store’ is greater than zero before flowering is expected, partitioning to reproductive mass starts too early in the growing season. Adjust the reproductive parameters accordingly.

By default (option Y1), WEPS does not use the reproductive parameters. WEPS will only use them if the Y0 option is specified. If using the reproductive parameters for partitioning then harvest index is also something to look at. Adjust partitioning parameters if the harvest index seems incorrect. Remember that adjusting leaf and/or reproductive parameters will automatically affect stem mass partitioning.

The default method for partitioning and to calculate crop yield from total above-ground biomass uses parameters *r* and *b* to specify the relationship between yield and residue, where yield (at market-standard moisture content) plus residue (dry weight) equals total above-ground biomass. The equation is:

$$resdidue = r\ x\ yield + \mathrm{b} \qquad 6.4$$

where *b* is the minimum above ground biomass required for a crop to generate any yield, and *r* is the incremental increase in residue for each additional unit of yield in excess of the minimum. The two parameters were estimated for the major crops from field data gathered for this purpose.

Parameter Prompt: Residue : Yield ratio (kg/kg)
Parameter *r*. As defined for the residue equation, this is the incremental increase in residue for each additional unit of yield in excess of the minimum (i.e., yield mass / residue mass).

Parameter Prompt: Residue : Yield intercept (kg/m^2 or lbs/ac)
Parameter *b*. As defined for the residue equation, this is the minimum biomass required for a crop to generate any yield.

Biomass is estimated to be stored in the root (or crown) storage pool on the basis of the values of the following three parameters. They are tied to the three biomass partitioning components (leaf, stem, reproductive) of plant growth, allowing the modeling of plants that store biomass during different periods of the growing season (Figure 6.9).

Parameter Prompt: Fraction of leaf mass partitioning diverted to root storage
For crops that store biomass early in the growth season, set this value greater than zero.

Parameter Prompt: Fraction of stem mass partitioning diverted to root storage

For crops that store biomass in the middle of the growth season, set this value greater than zero.

Parameter Prompt: Fraction of reproductive mass partitioning diverted to root storage

For crops that store biomass late in the growth season, set this value greater than zero. For root crops, this value should be very close to 1, indicating that most reproductive biomass is stored below ground.

Size Tab

Parameter Prompt: Maximum root depth (m)

The maximum depth of roots attained by the crop under ideal (unstressed) growth conditions. The main modeling impact of this value is the depth of soil water extraction. Examine the variable 'rootd' in the output file 'crop.out' to see the effect of adjusting this parameter.

Parameter Prompt: Maximum crop height (m)

The maximum height attained by the crop under ideal (unstressed) growth conditions. For a new crop, this parameter can be adjusted based on the crop height (the variable 'height' in the output file 'crop.out'). If WEPS simulates a crop that is too tall (inspect 'height'), then decrease the parameter value. After adjustment, inspect the height variable again to see if it matches what is expected. If not, continue to adjust the parameter values on this trial-and-error basis. Be sure to look at simulation output for more than one growing season. Note that the crop height at the end of the growing season will usually be less than this maximum crop height. Only if the crop grows under unstressed conditions for the entire growing season will the crop height at the end of the season be equal to the maximum crop height.

Crop height development through the growing season, as it would be without any stresses (potential), is defined by a 2-parameter function (Figure 6.13). This curve should be in harmony with the partitioning curves discussed earlier (i.e., the greatest increase in plant height should coincide with the greatest stem partitioning ratio).

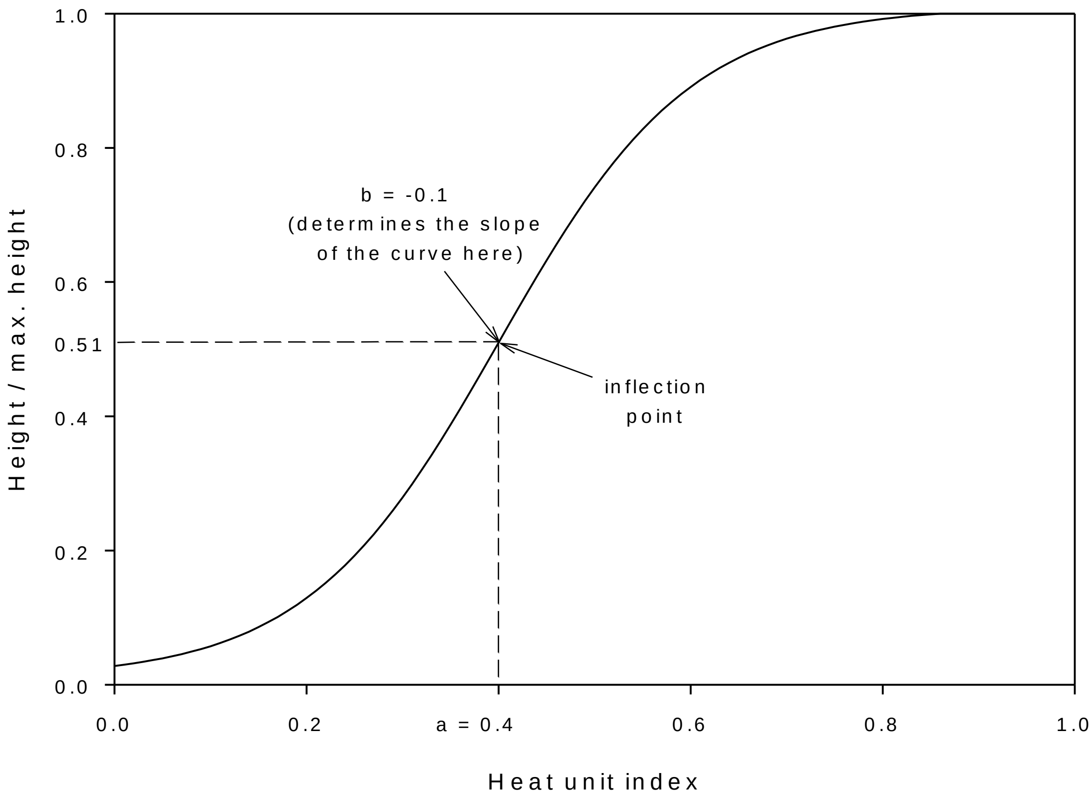

Figure 6.13 Crop height development function as it would be without any stresses. In this example, a = 0.4 and b = -0.1. The height ratio at the inflection point = 0.51.

Specify the two parameters for the crop height development curve (Figure 6.13):

Parameter Prompt: Crop height coefficient a
The heat unit index at the inflection point.

Parameter Prompt: Crop height coefficient b
Determines the slope of the curve at the inflection point. A negative b produces an ascending curve.

For a new crop, the two crop height parameters can be adjusted based on the crop height (the variable ‘height' in the output file ‘crop.out’). If WEPS simulates a crop that is too tall too early in the growing season (inspect ‘height’), then increase the “a” parameter value. If WEPS simulates too gradual a crop height increase (inspect ‘height’), then increase the “b” parameter value (make b less negative). Changing a and/or b may cause the final crop height to change. This can be adjusted by changing the maximum plant height.

Cold Tab

In WEPS, freezing temperatures can reduce green leaf area. This reduction is calculated from a curve (Figure 6.14). For example, using Figure 6.14, if the daily minimum temperature of the top soil layer equals -15 ^oC, the green leaf area is reduced by 95% on this day.

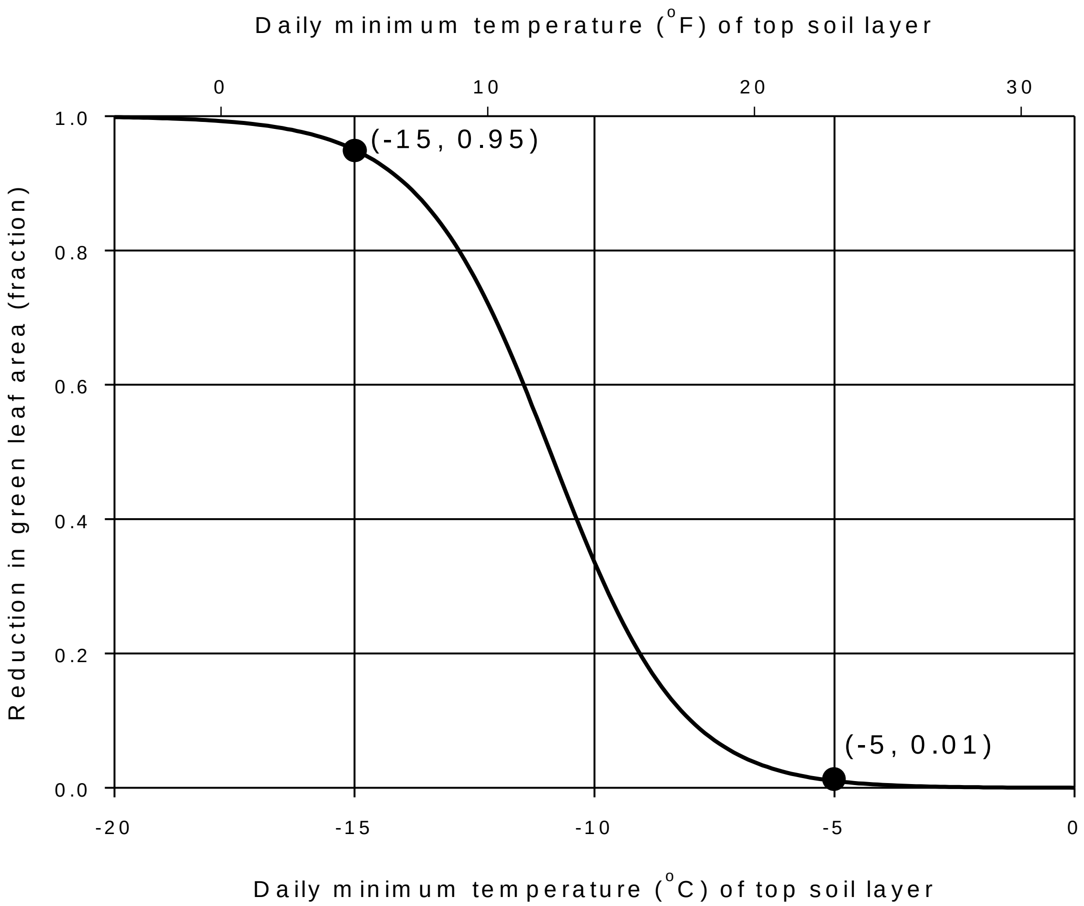

Figure 6.14 Reduction in green leaf area due to frost damage for corn.

The user can specify the frost damage curve by specifying two points on the curve. The curve for corn in Figure 6.14 is specified by the points (-5, 0.01) and (-15, 0.95). Use the Excel spreadsheet tool to visualize the curve after specifying two points on the curve. The following four parameters specify the two points:

Parameter Prompt: Higher temperature (^oC)
This is -5 ^oC (23 ^oF) for the example in Figure 6.14.

Parameter Prompt: Reduction in green leaf area at higher temperature (fraction)
This is 0.01 (1%) for the example in Figure 6.14.

Parameter Prompt: Lower temperature (^oC)
This is -15 ^oC (5 ^oF) for the example in Figure 6.14.

Parameter Prompt: Reduction in green leaf area at lower temperature (fraction)

This is 0.95 (95%) for the example in Figure 6.14.

For a new crop, these four parameters can be adjusted based on the green leaf area (the variable 'eff_lai' in the output file 'crop.out'). Example: the new crop is a winter crop. If WEPS simulates too much reduction in green leaf area over the winter (inspect eff_lai), then adjust the four parameter values so that there is less reduction in green leaf area for the same freezing temperatures.

Parameter Prompt: Thermal delay coefficient pre-vernalization

For winter annual crops (crop types 2 and 5), the rate of heat-unit accumulation is reduced if the plants have not been exposed to cool temperatures. The method implemented is from Ritchie, J.T. (1991). For crops that do not experience vernalization, the value is set to 0.0. A crop requiring a high degree of vernalization would have a value around 0.04. Examine the variable 'hu_del' in the output file 'crop.out' to see the effect of adjusting this parameter. This variable is 0.0 when vernalization has not yet started, and it is 1.0 when the crop is fully vernalized.

<u>Harvest Tab</u>

Parameter Prompt: Which plant component is (partly) harvested?

Parameter Choices:
0 - constant fraction of reproductive mass (grain+)
1 - increasing fraction of reproductive mass (grain)
2 - all or fraction of aboveground biomass
3 - all or fraction of the leaf mass
4 - all or fraction of the stem mass
5 - all or fraction of underground mass

Crop harvesting operations remove parts of plants that are not explicitly specified as a plant part in the model. To compensate for this, a mass fraction can be specified (see parameter "Harvested fraction of plant component") to divide the plant component into harvested fraction (fraction removed from the field) and fraction left in the field. For example, the reproductive component of wheat is divided into grain and chaff during harvest, and only the grain is removed from the field. This entry specifies the plant component that will be divided if that plant component is harvested. Choice 1 specifies a type of crop in which early-season reproductive development is all chaff and awns, not grain. If the crop is harvested before maturity, grain development is incomplete. The model internally, increases the actual harvested fraction from zero early in the season, until the value entered in "Harvested fraction of plant component" is reached at maturity.

Examples:

0 - Stripper cotton, for which all the reproductive mass is removed from the field. In this instance, the "Harvested fraction of plant component" for this example would be set to 1. Expression of final yield in bales of lint then requires accounting for the amount of trash and seed in the yield conversion factor;

1 - harvested grains, such as wheat, oats, barley, milo, corn. For a crop like corn, ear corn would have a larger value for the “Harvested fraction of plant component” than shelled corn has, for which the cob is left in the field;
2 - hay or forage crops, green vegetable crops. The “Harvested fraction of plant component” in most instances would be 1.0, indicating that all above-ground biomass above the cutting height is removed from the field. It should be less than 1.0 for a crop in which significant portions of the above-ground biomass above the cutting height are left behind in the field. This comment also applies to choices 3 and 4.
3 - tobacco and similar crops;
4 - Sugarcane and similar crops;
5 - Potatoes, peanuts, sugar beets.

In all crops, this setting and the corresponding “Yield fraction of harvested yield component” should be used to divide mass removed from mass left in the field, NOT mass removed from mass actually counted as yield. The parameter “Harvested yield conversion factor” should be used to account for post-harvest processing into marketable components.

Parameter Prompt: Harvested fraction of plant component (grain fraction etc.)
See parameter “Which plant component is (partly) harvested” for a full explanation.

Parameter Prompt: Units for reporting harvested yield
This field contains the units label that will be displayed for yield reporting. It should match the “Harvested yield conversion factor (kg/m^2 to units shown)” value that is entered.

Parameter Prompt: Moisture content for reporting harvested yield (%)
In WEPS, all biomass values are tracked as oven-dry weight. Crop yields are normally reported at a “standard” moisture content other than oven dry weight. For yield reporting, oven-dry weight is converted to the moisture content entered in this field. To match yield numbers from other sources, this value should be the “standard” moisture content used for this product.

Parameter Prompt: Harvested yield conversion factor (kg/m^2 to units shown)
This parameter should match the “Units for reporting harvested yield” value that is entered. The conversion factor is applied to the WEPS internal yield amount units (which is in kilograms per square meter) to report the yield in the units that are specified. This conversion is applied directly to the material removed from the field, as defined in “Which plant component is (partially) harvested?” and “Harvested fraction of plant component” and implemented by the appropriate harvest operation. If the component removed from the field is post-processed into a marketable product and a byproduct, and the yield reported in units of marketable product (cotton lint yield is an excellent example), the fraction of marketable product should be included in this conversion factor.

Decomposition Tab

For a better understanding of the decomposition parameters, also consult the Residue Decomposition Sub-model technical documentation.

Parameter Prompt: Residue size/toughness class
Parameter Choices: 1 - Fragile, very small residue (e.g., soybeans)
2 - Moderately tough, short residue (e.g., wheat)
3 - Non-fragile, medium residue (e.g., corn)
4 - Woody, large residue (sticks, hard wood)
5 - Gravel, rock

This class is used to determine what percentage of residue should be buried by certain management operations. For example, a tillage operation such as disking will bury a larger percentage of small, fragile residue and a smaller percentage of large, woody residue.

Parameter Prompt: Decomposition days after which stalks begin to fall (day)
The Number of days after which stalks begin to fall under optimum moisture and temperature conditions. After this threshold has been reached, stalks will begin to fall at the rate discussed. Example: a threshold of 20 decomposition days means that standing stalks begin to fall 20 days after harvest if moisture and temperature conditions are optimum during these 20 days. If conditions are not optimum, the number of days that stalks remain standing increases.

For a new crop, this parameter can be adjusted based on the number of stalks in residue pool 1 (the variable 'stem1' in the output file 'decomp.out'). Example: the new crop is a winter crop that is harvested in July. It is known that, on average, stalks begin to fall down in the middle of October. If WEPS simulates that stalks begin to fall down only in the next Spring (inspect stem1), then decrease the parameter value to start stem fall earlier. Increase the parameter value if WEPS makes the stalks fall too early.

Parameter Prompt: Fall rate for standing stalks (day^{-1})
The rate at which standing stalks fall to a flattened (horizontal) position on the soil surface. A larger number means that stalks fall faster. Only after a threshold has been reached, will stalks begin to fall at this rate. Example: a fall rate of 0.12 day^{-1} means that 12% of the total number of standing stalks fall down per day if moisture and temperature conditions are optimum on this day. If conditions are not optimum, the fall rate is reduced.

For a new crop, this parameter can be adjusted based on the number of stalks in residue pool 1 (the variable 'stem1' in the output file 'decomp.out'). Example: the new crop is a winter crop that is harvested in July. There is a fallow period of 14 months in which it is known that, on average, 50% of the stalks fall down. If WEPS simulates that less than 50% falls down (inspect stem1), then increase the parameter value to increase stem fall. Decrease the parameter value if WEPS makes the stalks fall too fast. Adjust ‘Decomposition days after which stalks begin to fall’ before adjusting this parameter.

Parameter Prompt: Decomposition rate for standing stalks (kg kg^{-1} day^{-}1)

The rate at which standing stalks decompose under optimum conditions. A larger number means faster decomposition. Example: a decomposition rate of 0.02 kg kg^{-1} day^{-1} means a 2% standing stalk mass loss per day if moisture and temperature conditions are optimum for decomposition on this day. If conditions are not optimum, the rate is reduced. Leaves, if any are present, decompose at 3 times the rate of stalks, and reproductive material, if any is present, decomposes at 1.5 times the rate of stalks. Other models, such as WEPP and RUSLE, simulate the effect of moisture and temperature on decomposition differently from WEPS (see WEPS technical documentation). Thus, the same parameter value results in different rates of decomposition. Therefore, if a new WEPS crop already exists in one of these other models, this parameter value should not be used in WEPS.

For a new crop, this parameter can be adjusted based on the amount of standing residue biomass in residue pool 1 (the variable ‘stand1' in the output file ‘decomp.out’). Be sure to look at this variable only before stalks start falling. After stalks start falling, stand1 decreases due to two things: decomposition and stem fall. Example: the new crop is a winter crop that is harvested in July. It is known that, on average, stalks begin to fall down in the middle of the next April. Inspect stand1 between July and April. If stand1 is decreasing too rapidly, then decrease the parameter value. Increase the parameter value if stand1 decreases too slowly.

Parameter Prompt: Decomposition rate for surface (flat) stalks (kg kg^{-1} day^{-1})

The decomposition rate (under optimum conditions) of stalks that have fallen to a flattened (horizontal) position on the soil surface. For a new crop, this parameter can be adjusted based on the amount of flat residue biomass in residue pool 1 (the variable ‘flat1' in the output file ‘decomp.out’). Be sure to only look at this variable before stalks start falling. After stalks start falling, flat1 is affected by two things: decomposition and stem fall. It will actually increase if the mass received from the standing pool exceeds the flat mass that is decomposed. Example: the new crop is a winter crop that is harvested in July. It is known that, on average, stalks begin to fall down in the middle of the next April. Inspect flat1 between July and April. If flat1 is decreasing too rapidly, then decrease the parameter value. Increase the parameter value if flat1 decreases too slowly.

Parameter Prompt: Decomposition rate for buried stalks (kg kg^{-1} day^{-1})

The decomposition rate (under optimum conditions) of stalks that have been buried below the soil surface by tillage. For a new crop, this parameter can be adjusted based on the amount of buried residue biomass in residue pool 1 (the variable ‘belo1' in the output file ‘decomp.out’).

Parameter Prompt: Decomposition rate for roots (kg kg^{-1} day^{-1})

The rate at which roots decompose under optimum conditions. For a new crop, this parameter can be adjusted based on the amount of root residue biomass in residue pool 1 (the variable 'root1' in the output file 'decomp.out').

In WEPS, the four parameters (decomposition rate for standing, flat, buried, and root mass) currently have the same values for a given crop. It is recommended to also do this for new crops, unless there is solid research data to do otherwise. For these six decomposition parameters, be sure to look at a no-till situation, because tillage operations will also make stalks fall down.

Parameter Prompt: Stalk diameter (m)
Stalk diameter at the base (at the soil surface) of a fully grown plant.

Parameter Prompt: Mass to cover factor (m^2 kg^{-1})
WEPS calculates soil cover from flat residue mass:

$$C_f = 1 - \exp^{-b\,M_f} \qquad 6.5$$

where C_f is flat residue cover (m^2 m^{-2}), b is mass-to-cover factor (m^2 kg^{-1}), and M_f is flat residue mass (kg m^{-2}) (Figure 6.15, Figure 6.18).

Use the Excel spreadsheet to estimate a b value for a new crop, comparing with curves for crops that already exist in WEPS. If reliable mass and cover data are available for the new crop, the spreadsheet can be used to calculate a b value from this data.

RUSLE also uses the mass-to-cover equation to calculate soil cover from flat residue mass. Therefore, if a new WEPS crop already exists in RUSLE, and there is a high degree of confidence in the value of the RUSLE b parameter, this value could be used in WEPS.

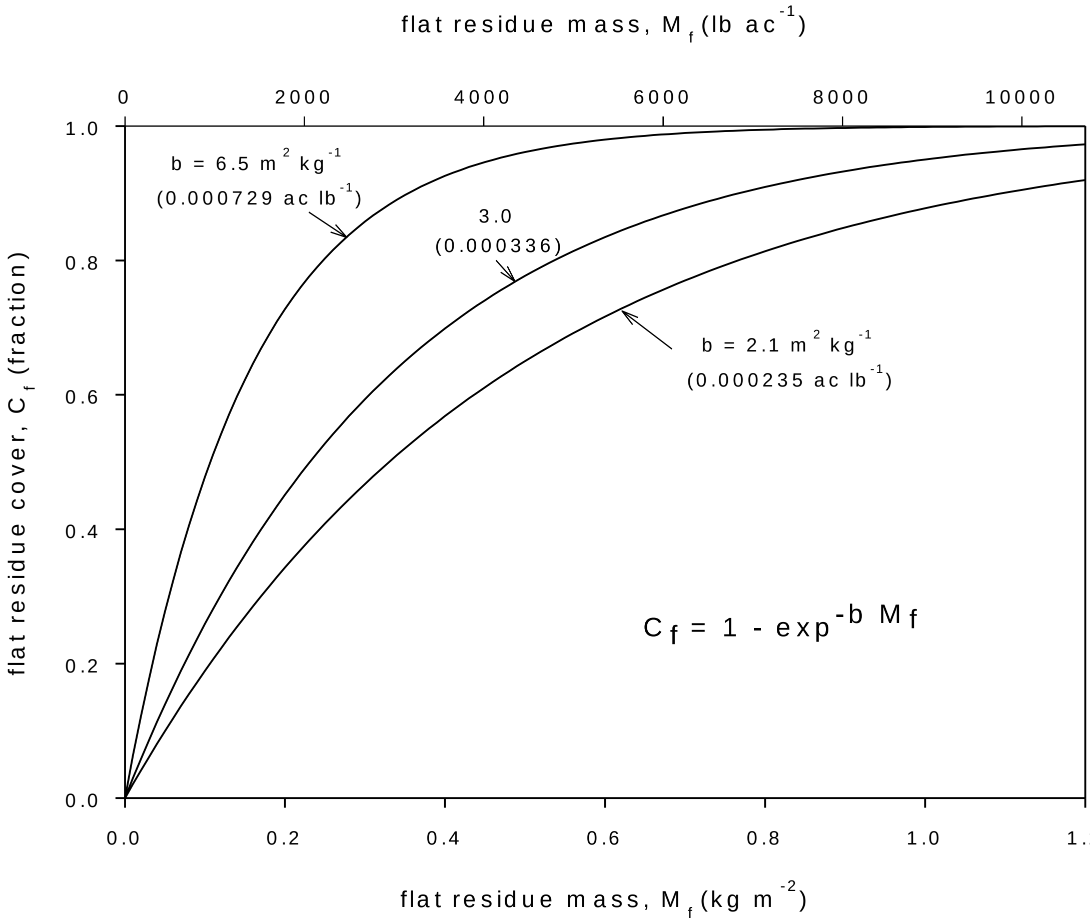

Figure 6.15 Relationship between flat residue mass and the cover provided by this flat residue for three different values of the mass-to-cover factor b. WEPS uses b = 6.5 $m^2\ kg^{-1}$ for wheat, barley, oats, rye, and triticale; b = 3.0 $m^2\ kg^{-1}$ for corn, sorghum, and millet; and 2.1 $m^2\ kg^{-1}$ for cotton and sunflower.

Crop residue laying flat on the soil surface has the effect of reducing the water evaporation rate from the soil surface. Research done by Steiner (1989) showed that the effect varied for different crops. The data from Steiner for cotton, sorghum, and wheat, was refit to an exponential power relationship

$$r_e = exp^{(a_e M_f^{b_e}} \qquad 6.6$$

where re is the ratio of evaporation from residue covered soil to bare soil evaporation and M_f is flat residue mass (kg/m^2). This equation has better mathematical properties than the curve used by Steiner. If additional research is available, intermediate curves can be developed by using the "evaporation suppression" tab within the spreadsheet "howtopcropdb.xls" (available from WERU). Otherwise, use the numbers for the crop that most closely characterize the evaporation-suppression characteristics of the crop you are developing.

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient a

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient b

<u>Calibration Tab</u>

Parameter Prompt: Crop growth calibration selection
Parameter Choices: 0 - Crop NOT selected for calibration
1 - Select Crop for calibration to match target harvested yield

This flag is only effective when the model is run in calibration mode. It should be set to zero for all crop records.

Parameter Prompt: Target harvested yield
This value is only used when the model is run in calibration mode. It should be set to 0 for all crop records. NRCS will add RUSLE yield values as a starting point for calibration.

Parameter Prompt: Biomass adjustment factor
Multiplier used with the "Yield/biomass ratio adjustment factor" to enhance or suppress the conversion of solar radiation to biomass. This is the factor that is automatically adjusted when calibrating a crop. When developing a new crop record, this value should be set to 1.0. Locally adjusted records can be saved with numbers other than 1.0.

Parameter Prompt: Yield/biomass ratio adjustment factor
Intended use has not been implemented. Was to allow adjusting the ratio between total yield and total biomass for calibration purposes. Set to 1.0 for all crop records.

We created a new crop (flax), and documented the process in Appendices A and B. Appendix A is a list of questions about flax that was given to people with knowledge about how flax grows. Some questions are directly related to a parameter; others are more indirectly related. Appendix B shows how the answers to these questions were used to determine parameter values for flax.

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Flax (seed) questions for WEPS crop growth model

The Wind Erosion Prediction System (WEPS) includes a crop-growth model that simulates a few dozen crops (Table 6.2). It does not yet include flax (seed). The USDA-NRCS has requested the inclusion of flax in WEPS. The following questions are meant to give information needed to include flax (seed) in the WEPS model. For these questions, we are always asking for the average, if not specified otherwise (e.g., average plant population, average planting depth, etc). Similar questions can be asked if other crops are developed for the WEPS model.

In general, which one of the current WEPS crops (Table 6.2) is flax (seed) most similar to? Please list only one crop.

For the following questions, you may not always know the answer (value) in an absolute sense, but you may know it in a relative sense. For this reason, we always ask: Which of the current WEPS crops are similar to flax (seed) regarding the aspect being discussed? Please list more than one current WEPS crop if applicable. Even if you know the answer in an absolute sense, please also list current WEPS crops that are similar.

What is the plant population ($\#/m^2$)? Please give the number of plants expected in a normal stand. This should be the estimated plant population after germination. Which of the current WEPS crops have a similar plant population?

What is the planting depth? Which of the current WEPS crops have a similar planting depth?

Dry weight of one planted seed? Which of the current WEPS crops have a similar dry weight per planted seed?

What is the ratio **leaf mass/stem mass** in the shoot after seed mass has been converted to root and shoot? Which of the current WEPS crops have a similar ratio?

What is the ratio **stem diameter/stem length** after seed mass has been converted to root and shoot? Which of the current WEPS crops have a similar ratio?

How many days after planting (DAP) do plants emerge?

Does the crop regrow? If yes:
At what growth stage will it regrow?
What do regrowth shoots look like (size, length)?
What is the maximum number of shoots per plant?

Number of days from planting to maturity of seed? Which of the current WEPS crops have a similar number of days?

When (DAP) does senescence start (when do green leaves start to turn yellow/brown)?

Minimum temperature for plant growth? Which of the current WEPS crops have a similar minimum temperature?

Optimum temperature for plant growth? Which of the current WEPS crops have a similar optimum temperature?

Some cropping systems use plant densities that do not result in canopy closure. In these systems, the plant will grow to cover a ground area that is characteristic of the plant. WEPS assumes that the covered ground area is round. What is the diameter of the circle that encloses the area covered by a full-grown plant? Which of the current WEPS crops have a similar diameter?

Ratio of leaf area to leaf mass (m^2 / kg)? Which of the current WEPS crops have a similar ratio?

Ratio of stem silhouette area to stem mass (m^2 / kg)? Which of the current WEPS crops have a similar ratio?

Canopy light utilization is specified by an exponential relationship for the attenuation of light with distance into the canopy. Combined with the leaf area index, this coefficient determines the amount of light interception by the canopy, according to the relationship:

fraction~=~1~-~exp sup {-k~LAI}

where fraction is the ratio of photosynthetically active radiation (PAR) that is intercepted by the crop and total PAR received above the crop canopy, k is light extinction coefficient, and LAI is leaf area index. A larger number indicates increased light interception by a given leaf area index, as occurs with broadleaf plants with a horizontal leaf orientation, such as cotton. A smaller number indicates decreased light interception by a given leaf area index, as occurs with narrow-leaf plants with a vertical leaf orientation, such as the grasses.

What is k? Which of the current WEPS crops have a similar k (similar light interception at a given amount of leaf area)?

Biomass conversion efficiency (t/ha) / (MJ/m^2) is the unstressed (potential) growth rate per unit of intercepted photosynthetically active radiation. What is the biomass conversion efficiency? Which of the current WEPS crops convert light (PAR) to biomass with a similar efficiency?

Throughout the growing season, the above-ground biomass is partitioned into leaf, stem, and reproductive mass. In the beginning of the season most, of the above-ground biomass is allocated to leaf mass, and at the end of the season most is allocated to reproductive mass. Which of the current WEPS crops show a similar pattern of partitioning?

What are the growth stages? How many days for each of these stages?

What is the harvest index? Which of the current WEPS crops have a similar harvest index?

We use the equation:

residue~=~r~x~yield~+~b

where yield plus residue equals total above-ground biomass, b is the minimum above-ground biomass required for a crop to generate any yield, and r is the incremental increase in residue for each additional unit of yield in excess of the minimum. Do you have field data that can be used to estimate r and b? Which of the current WEPS crops have a similar relationship (similar r and b)?

The maximum depth of roots attained by the crop under ideal (unstressed) growth conditions? Which of the current WEPS crops have a similar rooting depth?

The maximum height attained by the crop under ideal (unstressed) growth conditions? Which of the current WEPS crops have a similar height?

When (DAP) does the crop reach 25%, 50%, 75% of its final height? Which of the current WEPS crops have a similar pattern of crop height development through the growing season?

In WEPS, freezing temperatures can reduce green leaf area. Which of the current WEPS crops experience a similar amount of damage caused by freezing temperatures?

Fraction of reproductive mass that is harvested (grain fraction)? Which of the current WEPS crops have a similar grain fraction?

Market-standard moisture content? Which of the current WEPS crops have a similar market-standard moisture content?

How many pounds per bushel at market-standard moisture content?

Residue size/toughness class?

Choices:
- 1 - Fragile, very small residue (e.g., soybeans)
- 2 - Moderately tough, short residue (e.g., wheat)
- 3 - Non fragile, medium residue (e.g., corn)
- 4 - Woody, large residue (sticks, hard wood)
- 5 - Gravel, rock

Which of the current WEPS crops have a similar residue size/toughness?

Which of the current WEPS crops have a similar rate of residue decomposition?

Stem diameter at the base (at the soil surface) of a fully grown plant? Which of the current WEPS crops have a similar stem diameter?

Crop residue laying flat on the soil surface provides a certain amount of cover to the soil surface. Which of the current WEPS crops provide a similar amount of soil surface cover for a given mass of flat (not standing) residue?

Crop residue laying flat on the soil surface has the effect of reducing the water evaporation rate from the soil surface. Which of the current WEPS crops cause a similar amount of evaporation reduction for a given mass of flat (not standing) residue?

Please contact us if you have any questions. Thank you very much for helping us to include flax (seed) in our model.

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Table 6.2 Crops currently simulated by the WEPS crop submodel.

Alfalfa	Cucumber	Rice
Asparagus	Eggplant	Rye, cereal
Barley, spring	Flax	Rye, spring
Barley, winter	Garlic	Rye, winter,cover
Bean, field, dry	Grama, sideoats	Rye, winter, grain
Bean, green snap	Grass seed, cool season	Rye, winter, silage
Bean, lima	Grass seed, warm season	Safflower
Beans, garbonzo	Horseradish	Sorghum, forage
Bluestem, old world	Lentils	Sorghum, grain
Brassicas, forage	Lettuce, head	Sorghum, sudangrass
Broccoli	Lettuce, leaf	Soybean, group 0 and I
Bromegrass	Millet, foxtail	Soybean, group II, III and IV
Buckwheat	Millet, proso	Soybean, groups V, VI, VII, and VIII
Cabbage	Mint	Spinach
Camelina	Mustard seed, spring	Squash
Canola, spring	Mustard, cover crop	Strawberry
Canola, winter	Mustard, greens	Sugarbeet, sugar
Cantaloupe, Muskmelon, Honeydew	Oats, fall	Sugarcane
Carrot	Oats, spring	Sunflower
Cauliflower	Oats, winter	Switchgrass, biomass prod
Celery	Onion	Tall Fescue
Chickpea	Peanut, runner	Timothy
Chile, green, direct seed	Peas, field, dry	Tobacco, burley
Chile, green, transplant	Peas, forage	Tobacco, dark
Clover, alsike	Peas, green	Tobacco, flue cured
Clover, red	Peppers, bell	Tomato
Clover, sweet	Peppers, chili	Triticale
Collard, greens	Pineapple, transplants	Turfgrass
Corn, grain	Potato, early, harvest	Vetch, hairy
Corn, pop	Potato, late, harvest	Watermelon
Corn, silage	Potato, sweet	Wheat, spring
Corn, sweet	Pumpkin	Wheat, winter
Cotton	Radish	

Documentation of crop parameter values for flax (seed)

This appendix documents crop parameter values for flax (seed) and describes how knowledge about flax is used to determine flax parameter values. We started the database record for flax with a copy of the record for spring oats (Myers, 2005). Whenever there are no flax parameter values shown in the example, we use the same value as for spring oats.

We used the WEPS DB Viewer to create the flax crop from spring oats:
Select Spring Oats
Right click
Select ‘Create a copy of this crop’
You are prompted to give it a name. Enter: ‘flax’
You have now a crop named ‘flax’ with the same parameter values as spring oats.
To be able to change parameter values, select Options - Allow Changes on the menu.

<u>Shoot Tab</u>

Parameter Prompt: Crop type: 4 - Spring Seeded

Parameter Prompt: Transplant or Seed flag: 0 - Seeds planted in field

Parameter Prompt: Plant population: 3,000,000/ac
3,040,000/ac (Tanaka, 2005)
2,800,000 (Myers, 2005)
3,500,000/ac (Berglund, 2005)
30-70/ft^2 (Berglund and Zollinger, 2002)
(70/ft^2 = 3,050,000/ac)

Parameter Prompt: Maximum number of shoots per plant, n_{ms} (#/plant)
no regrowth (Berglund, 2005)

Parameter Prompt: Starting depth of growing point: 2 cm planting depths:

- 1 in (Berglund, 2005)
- 0.75-1.5 in (Tanaka, 2005)
- <= 1 in (Martin et al., 1976)
- 0.75-1.5 in (Berglund and Zollinger, 2002)
- 2.5-3.2 cm (Duke, 1983)

At first, the simulated crop did not emerge. A flax seed is much smaller than a wheat seed. To ensure emergence, a value of 2 cm was used. Also, the value for ‘Ratio of stem diameter to stem length’ was adjusted, by using the Excel spreadsheet, to ensure emergence.

Parameter Prompt: Planted mass, dry weight: 5.5 mg/plant

- 180 seeds/g for flax seed (Martin et al., 1976)
- 5.7 mg/seed (Tanaka, 2005)
- 5 mg/seed (Myers, 2005)
- 3-12 g/1000 seeds (Duke, 1983)
- 3.8-7.0 g/1000 seeds (Martin et al., 1976)

Parameter Prompt: Root storage mass required for each regrowth shoot, m_{sh} (mg/shoot)
no regrowth (Berglund, 2005)

Parameter Prompt: Ratio of leaf mass/stem mass in shoot: 0.111
ratio = 1/9 = 0.111 (Myers, 2005)

Parameter Prompt: Ratio of stem diameter to stem length: 0.01
Reduced 0.015 (spring oats) to 0.01 to ensure emergence. See comments under 'Starting depth of growing point' diameter = 1-2 mm, stem length = 25 mm (Myers, 2005). This would translate to a ratio of 1.5/25 = 0.06, but we don't get emergence with this value.

Parameter Prompt: Heat unit index at emergence: 0.05

- Plants emerge 5 - 10 days after planting (Berglund, 2005)
- Plants emerge 7 - 14 days after planting (Tanaka, 2005)
- Plants emerge 5 - 8 days after planting (Myers, 2005)

The USDA-NASS (1997) planting and harvest dates were used for Foster County, ND (east-central ND, in the heart of flax growing country [Martin et al., 1976]). Ten (10) cycles of the crop were simulated. The simulated emergence date can be found by finding the first day that the crop height (variable 'height' in the output file 'crop.out') is greater than 0.0. For 10 cycles, the earliest emergence date was 5 days after planting and the latest, 10 days after planting. Thus, the parameter value of 0.05 for spring oats works for flax.

<u>Growth Tab</u>

Parameter Prompt: Crop maturity measurement method: 0 - Crop matures, on average, in days shown

Parameter Prompt: Days to maturity (days): 100

- 95 days (Berglund, 2005)
- 110 days (Tanaka, 2005)
- 110 days (Myers, 2005)
- 50+25+35 = 110 days (Berglund and Zollinger, 2002)

- 90 to 120 days (Duke, 1983)

planting date:

- 25 May for North Dakota (USDA-NASS, 1997)
- desired: April or early May for Minnesota and North Dakota (Duke, 1983)
- desired: same as wheat (Duke, 1983)
- as soon after possible after planting of small grains is completed (Duke, 1983)
- desired: late April (Berglund and Zollinger, 2002)

harvest date:

- 17 Sept. for North Dakota (USDA-NASS, 1997)

In all 10 simulated cycles, the crop reached maturity before being harvested (the variable 'heatui' in the output file 'crop.out' reached 1.0 before being harvested). Also, the crop was not harvested too late: the earliest maturity date (variable 'doy') was 245, the latest was 254, with a harvest date 260 (17 Sept.). Thus, 100 days for 'days to maturity' works well. Note that, on the basis of the planting date of 25 May (day 145), we would expect the crop to mature, on average, on day 245. But the simulations show an average maturation date of about 250 (range is from 245 to 254). This discrepancy is caused by different methods of heat-unit calculation in WEPS. So, to get this parameter value correct, do not only look at the planting and harvest dates. Always inspect 'crop.out', as discussed here.

Parameter Prompt: Heat units to maturity (^{o}C day)

Parameter Prompt: Heat-unit index at start of senescence: 0.85

Senescence starts 85 to 90 days after planting (Tanaka, 2005)

Leaves stay green long. In North Dakota, senescence starts late July or early August (Myers, 2005)

With the 0.85 value in our simulations for North Dakota, senescence started, on average, 80 days after planting (variable 'eff_lai' is at a maximum). This is in the middle of August.

Parameter Prompt: Minimum temperature for plant growth: 40 ^{o}F

- 40 ^{o}F (Berglund, 2005)
- similar to spring wheat (Tanaka, 2005)

Parameter Prompt: Optimum temperature for plant growth: 70 ^{o}F

- 65 -75 ^{o}F (Berglund, 2005)
- similar to spring wheat (Tanaka, 2005)

Geometry Tab

Parameter Prompt: Maximum growth diameter (m) of a single plant: 0.3 m
1 ft (Myers, 2005)

Parameter Prompt: Stem silhouette area coefficient a
Parameter Prompt: Stem silhouette area coefficient b

Parameter Prompt: Specific leaf area: 20.6 m^2 / kg
like crimson clover (Myers, 2005)

Parameter Prompt: Light extinction coefficient: 0.45
This coefficient (k) is much lower than that of any small grain. There is never complete shading (Myers, 2005).

Simulated biomass production is very sensitive to k. Using the default k-value of spring oats resulted in yield and residue values similar to those of spring wheat. But, field data shows that flax yield and residue is about half that of spring wheat yield and residue (Tanaka et al., 2001; USDA-NASS, 2005). Using a k of 0.45 resulted in simulated biomass that matches this observation. Using a k of 0.40 resulted in too little biomass.

Parameter Prompt: Biomass Conversion Efficiency (t/ha) / (MJ/m^2)

Partitioning Tab

Parameter Prompt: Leaf fraction coefficient a: 0.0006
Parameter Prompt: Leaf fraction coefficient b: 0.7149
Parameter Prompt: Leaf fraction coefficient c: 0.4297
Parameter Prompt: Leaf fraction coefficient d: -0.072
Parameter Prompt: Reproductive mass coefficient a: -0.0195
Parameter Prompt: Reproductive mass coefficient b: 0.995
Parameter Prompt: Reproductive mass coefficient c: 0.5077
Parameter Prompt: Reproductive mass coefficient d: 0.0849
Partitioning is like spring canola (Myers, 2005)
50 days vegetative + 25 days flowering + 35 days maturing (Berglund and Zollinger, 2002)

Parameter Prompt: Residue : Yield ratio (kg/kg): 0.82
Parameter Prompt: Residue : Yield intercept (kg/m^2): 0.168
Used values of spring wheat (none available for flax, spring canola, or spring oats)

Parameter Prompt: Fraction of leaf mass partitioning diverted to root storage
no regrowth (Berglund, 2005)

Parameter Prompt: Fraction of stem mass partitioning diverted to root storage no regrowth (Berglund, 2005)

Parameter Prompt: Fraction of reproductive mass partitioning diverted to root storage
no regrowth (Berglund, 2005)

Size Tab

Parameter Prompt: Maximum root depth: 40 in

- 40 in (Berglund and Zollinger, 2002)
- short, flax gets its moisture largely from the top 2 ft (Martin et al., 1976)
- shallow rooted (Duke, 1983)
- not deep, like spring canola (Myers, 2005)

Parameter Prompt: Maximum crop height: 36 in

- 36 in (Berglund and Zollinger, 2002)
- 30 in for flax seed (Martin et al., 1976)
- 30 in (Myers, 2005)

Parameter Prompt: Crop height coefficient a
Parameter Prompt: Crop height coefficient b

Cold Tab

Parameter Prompt: Higher temperature: -5 ^{o}C
Parameter Prompt: Reduction in green leaf area at higher temperature: 0.01
Parameter Prompt: Lower temperature: -15 ^{o}C
Parameter Prompt: Reduction in green leaf area at lower temperature: 0.95
Freeze damage similar to that of spring canola (Myers, 2005)

Parameter Prompt: Thermal delay coefficient pre-vernalization: 0

Harvest Tab

Parameter Prompt: Which plant component is (partly) harvested:
1 - increasing fraction of reproductive mass (grain)

Parameter Prompt: Harvested fraction of plant component (i.e., grain fraction):
0.9 grain fraction = 90% (Myers, 2005)

Parameter Prompt: Units for reporting harvested yield: bu/ac

Parameter Prompt: Moisture content for reporting harvested yield: 8%

- 7.1-8.3% (Carter, 2005)

- 8-9% (Berglund, 2005)
- 10% (Tanaka, 2005)
- 8% (Myers, 2005)

Parameter Prompt: Harvested yield conversion factor (kg/m2 to units shown):

- 159.4 Pounds per bushel at market standard moisture content:
- 56 lbs/bu (Martin et al., 1976)
- 56 lbs/bu (Berglund, 2005)

Using 56 lbs/bu:

$$1\frac{kg}{m^2} = 1\frac{kg}{m^2}\ 2.205\frac{lb}{kg}\ \frac{1}{56}\frac{bu}{lb}\ 4047\frac{m^2}{ac} = 159.4\frac{bu}{ac}$$

Decomposition Tab

Parameter Prompt: Residue size/toughness class: 3

- 3 - Non fragile, medium residue (e.g., corn) (Berglund, 2005; Myers, 2005).
- 2 - Moderately tough, short residue (e.g., wheat) (Tanaka, 2005)

Parameter Prompt: Decomposition days after which stalks begin to fall (day)
Parameter Prompt: Fall rate for standing stalks (day-1)
Parameter Prompt: Decomposition rate for standing stalks (kg kg-1 day-1)
Parameter Prompt: Decomposition rate for surface (flat) stalks (kg kg-1 day-1)
Parameter Prompt: Decomposition rate for buried stalks (kg kg-1 day-1)
Parameter Prompt: Decomposition rate for roots (kg kg-1 day-1)
Parameter Prompt: Stalk diameter (m)

Parameter Prompt: Mass to cover factor:
3.0 m2 kg-1 like proso millet (Myers, 2005)

Parameter Prompt: Residue Evaporation Suppression multiplier coefficient a: -1.20379
Parameter Prompt: Residue Evaporation Suppression multiplier coefficient b: 0.604887
like proso millet (Myers, 2005)

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WEPS How To Guide

6.3 Management Operation Database Record Development

Introduction

In the Wind Erosion Prediction System (WEPS), changes in the "state" of the surface, soil, and biomass (residue and live vegetation) during a simulation are modeled, because they have a direct impact upon a site's susceptibility to wind erosion. Cultural practices applied during management of a site can significantly influence a site's "surface, soil, and biomass" state over time. It is an important variable because it is the primary factor that a land manager can most easily change in the field to affect a site's susceptibility to wind erosion. Therefore, WEPS simulates many management practices, which typically include operations like tillage, cultivation, planting, harvesting, irrigation, residue burning, etc.

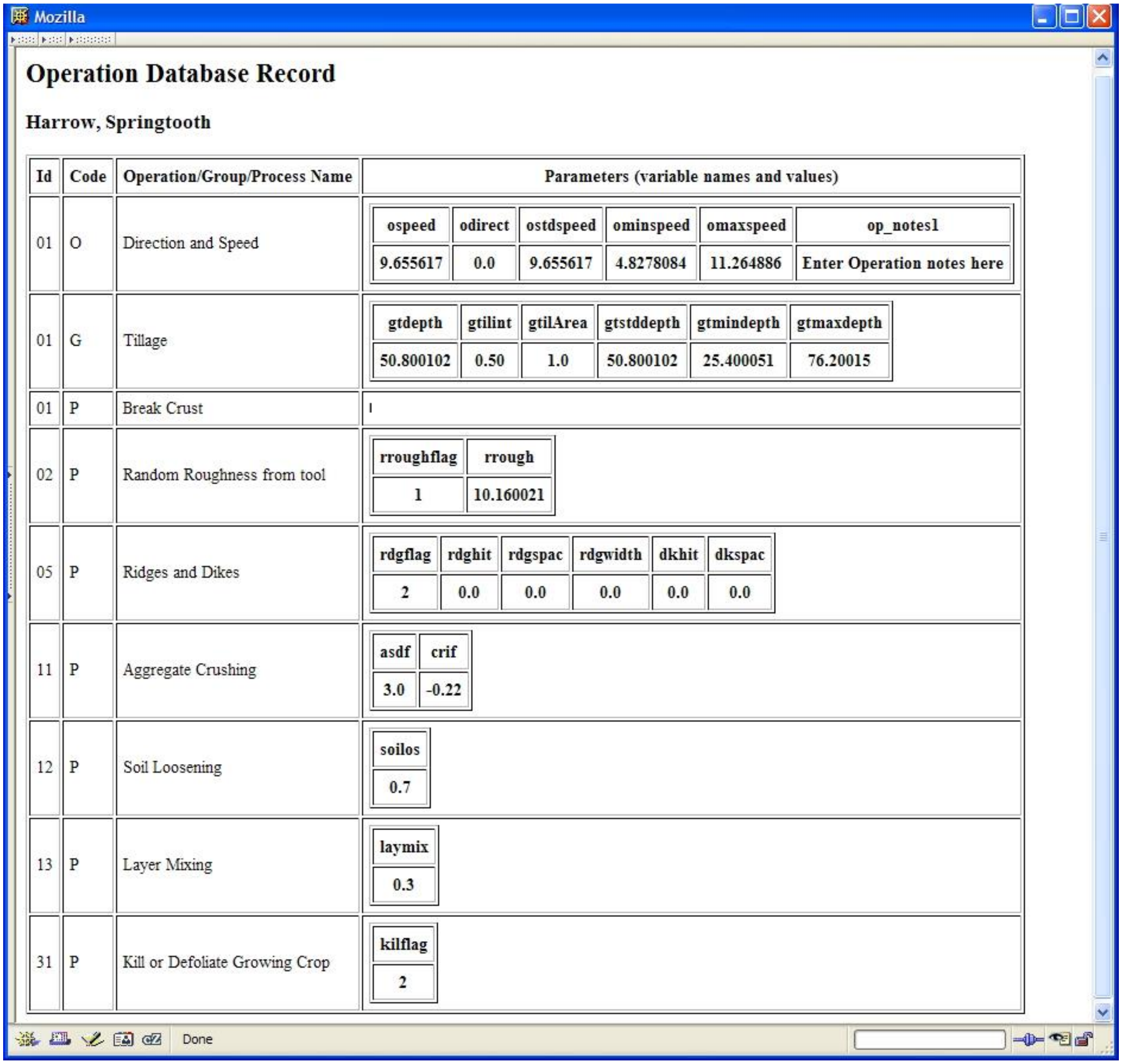
WEPS can represent a wide range of typical management operations used on agricultural crop land. It does so by defining each operation as an ordered list of "processes", which represent physical actions like residue burial, soil loosening and mixing, etc., that occur when that operation is performed on the field. By simulating these physical processes, WEPS can reflect the changes made by an operation to a site's "surface, soil, and biomass" state.

The purpose of this guide is to describe the process of: a) developing accurate WEPS representations of management operations as correctly ordered lists of processes or actions; b) obtaining reasonable parameter values for the list of individual processes describing each management operation, based upon knowledge of that operation's characteristics; and c) providing a reference description for each of the physical "processes" simulated by WEPS.

Operation Database Records

WEPS management operation database records are stored in an XML file format with the extension .oprn for use by the WEPS interface. Supporting files, which define the database structure are part of the MCREW (Management/Crop Rotation Editor for WEPS) configuration files. New individual operation database records can be created in several ways: 1) using a text editor to edit the .oprn file (operation record) directly; 2) using MCREW to edit an existing operation record, via its "operation drill-down" feature, and saving it to a new name; or 3) using the WEPS crop/op database viewer/editor program. We will be focusing on the use of the WEPS crop/op database viewer/editor program here because it provides the best user environment for creating and editing WEPS management operation records. Note that for NRCS most parameter choices will not be editable by Field Office Users. NRCS will use a database manager to adjust and distribute new or revised database file.

Each operation record is simply an ordered list of "actions" or "processes" that represent the physical effects that a management operation is to perform. An example operation record for a springtooth harrow is shown in Figure 6.16.



Operation Database Record

Harrow, Springtooth

Id	Code	Operation/Group/Process Name	Parameters (variable names and values)
01	O	Direction and Speed	ospeed: 9.655617; odirect: 0.0; ostdspeed: 9.655617; ominspeed: 4.8278084; omaxspeed: 11.264886; op_notes1: Enter Operation notes here
01	G	Tillage	gtdepth: 50.800102; gtilint: 0.50; gtilArea: 1.0; gtstddepth: 50.800102; gtmindepth: 25.400051; gtmaxdepth: 76.20015
01	P	Break Crust	
02	P	Random Roughness from tool	rroughflag: 1; rrough: 10.160021
05	P	Ridges and Dikes	rdgflag: 2; rdghit: 0.0; rdgspac: 0.0; rdgwidth: 0.0; dkhit: 0.0; dkspac: 0.0
11	P	Aggregate Crushing	asdf: 3.0; crif: -0.22
12	P	Soil Loosening	soilos: 0.7
13	P	Layer Mixing	laymix: 0.3
31	P	Kill or Defoliate Growing Crop	kilflag: 2

Figure 6.16 Partial WEPS definition of a springtooth harrow tillage operation.

Note in Figure 6.16 that the definition of the operation simply consists of a list of parameters that are grouped under an "operation", "group" or "process" name. An "operation" line, which is labeled with a code letter of "O", contains parameters that apply to the operation as a whole. For example, the direction and speed of travel are specified by the parameters "odirect" and "ospeed". Each operation will contain a single "operation" line in its definition. There are several types of valid "operation" lines defined for WEPS operations, each of which has a unique identification number. All the valid operation lines are listed and defined later.

The second line in Figure 6.16 is a "group" line. To explain the purpose of a "group" line, we must first define the "process" lines that follow. WEPS attempts to simulate the "physical effects" a management operation has on the soil, surface, and vegetation. Within WEPS, the individual, specific identified actions that represent an operation are simulated in the order specified in the management operation record. In this example, the springtooth harrow performs the following actions in the given order: 1) breaks surface crust if it exists; 2) creates a specified random roughness on the surface; 3) removes any ridges and dikes that may be present before to this tillage operation; 4) breaks down (crushes) soil aggregates, resulting in a new distribution of the aggregate sizes; 5) reduces the soil bulk density (loosens the soil); 6) does some mixing of the soil within the depth of tillage; and 7) kills any growing vegetation.

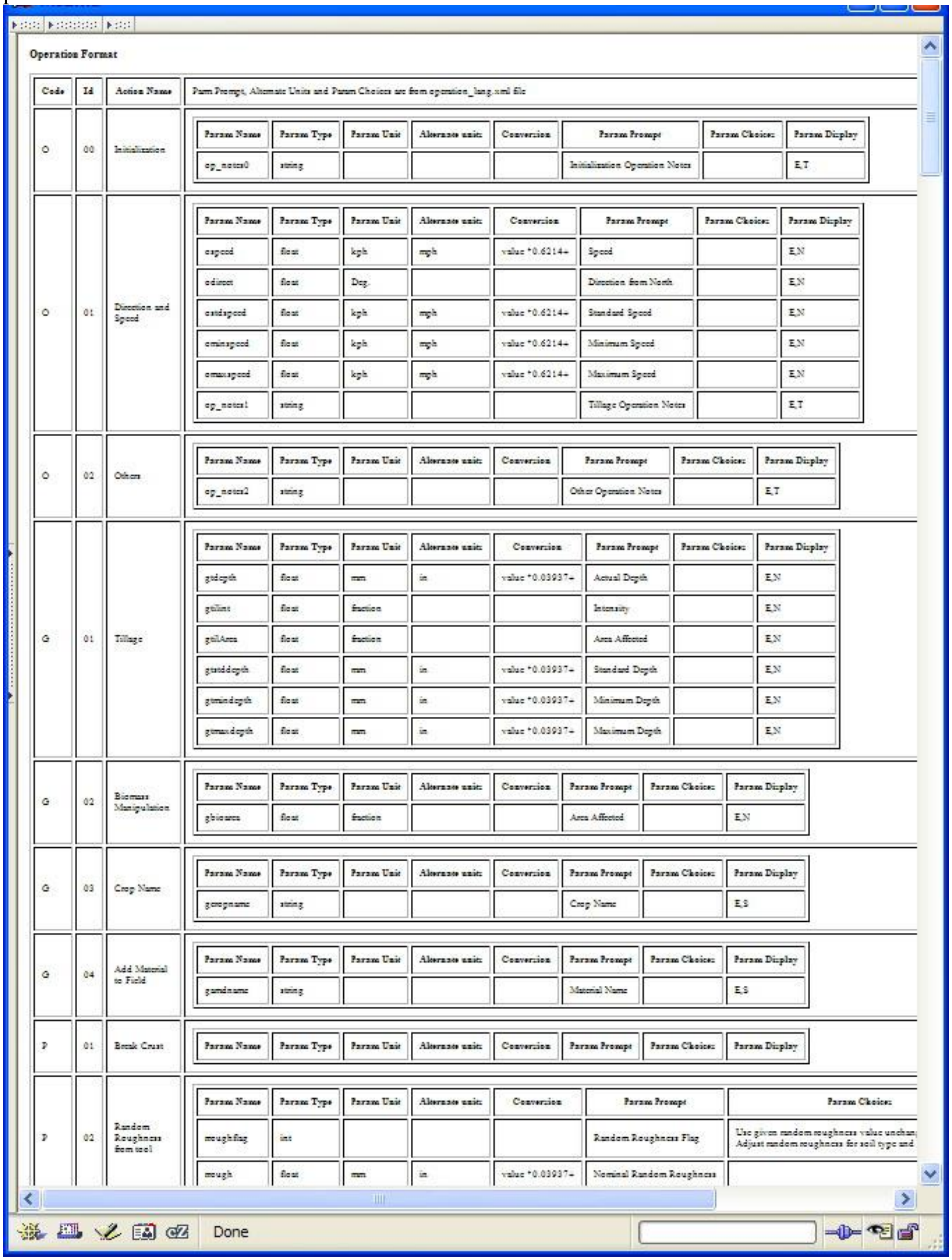
Therefore, each "process" line may contain one or more parameters required for WEPS to simulate the particular physical process or action represented by that line in the model. Some of these physical processes may require additional parameters needed by other, related processes. For example, the "Layer Mixing" and the "Soil Loosening" process lines represent the physical loosening and mixing of the soil by the springtooth. The parameter values "soilos" and "laymix" define the degree of mixing and loosening of soil that will occur. To properly simulate these physical actions, however we need the depth of tillage so that we know how deep the mixing and loosening of the soil will occur. That information is provided in the "group" line by the variable "gtdepth". Thus, the "shared" tillage depth parameter value required to simulate both the mixing and loosening actions is made available in one place, because it will have the same value for both the mixing and loosening actions being simulated. This is desirable because there is only one tillage depth parameter whose value needs to be changed if the tillage depth is altered for the operation.

So, in summary, each WEPS management operation will consist of a single "operation" line and one or more "process" lines, where each "process" line typically represents a single physical action or event that the operation does on the field. If specific "process" lines require additional "shared" parameters for WEPS to simulate the physical action they represent, then the appropriate "group" line containing those parameters will be specified before those "process" lines. Because WEPS simulates the physical actions represented by the "process" lines in the order they are specified in the management operation record, the order of the listed "process" lines is important and must be correct for WEPS to properly simulate the operation's total effect on the field.

Operation Database Structure Files and Definitions

The parameter descriptions provide the keys to enable the user to know which parameter is being edited. A current reference table is easily viewed by opening the ***operation_defn.xml*** file in the ***mcrew_cfg*** directory using a web browser, as seen in Figure 6.17.

The parameters defined in this section are described by a **Parameter Prompt**, the text that appears in MCREW; **Parameter Unit**, the named unit that the WEPS science model expects the parameter value to be in; **Conversion Factor**, the combination of multiplier and additive terms that will convert the parameter value from the default Parameter Units; **Param Units** (SI), to the specified Alternate Units, **Alternate Units** (English), the named unit that values will be displayed in, given the selection of units in the WEPS configuration; and **Parameter Choices**, a list of choices displayed when the parameter is defined as a discrete set of values, often integer flags. The parameters are grouped according to the specific "process", "group", or "operation" line they pertain to.



Operation Format

Code	Id	Action Name	Param Name	Param Type	Param Unit	Alternate units	Conversion	Param Prompt	Param Choices	Param Display
			Parm Prompt, Alternate Units and Param Choices are from operation_lang.xml file							
O	00	Initialization	op_notes0	string				Initialization Operation Notes		E,T
O	01	Direction and Speed	ospeed	float	kph	mph	value *0.6214+	Speed		E,N
			odirect	float	Deg.			Direction from North		E,N
			ostdspeed	float	kph	mph	value *0.6214+	Standard Speed		E,N
			ominspeed	float	kph	mph	value *0.6214+	Minimum Speed		E,N
			omaxspeed	float	kph	mph	value *0.6214+	Maximum Speed		E,N
			op_notes1	string				Tillage Operation Notes		E,T
O	02	Others	op_notes2	string				Other Operation Notes		E,T
G	01	Tillage	gtdepth	float	mm	in	value *0.03937+	Actual Depth		E,N
			gtilint	float	fraction			Intensity		E,N
			gtilArea	float	fraction			Area Affected		E,N
			gtstddepth	float	mm	in	value *0.03937+	Standard Depth		E,N
			gtmindepth	float	mm	in	value *0.03937+	Minimum Depth		E,N
			gtmaxdepth	float	mm	in	value *0.03937+	Maximum Depth		E,N
G	02	Biomass Manipulation	gbioarea	float	fraction			Area Affected		E,N
G	03	Crop Name	gcropname	string				Crop Name		E,S
G	04	Add Material to Field	gamdname	string				Material Name		E,S
P	01	Break Crust								
P	02	Random Roughness from tool	proughflag	int				Random Roughness Flag	Use given random roughness value unchan[...] Adjust random roughness for soil type and	
			prough	float	mm	in	value *0.03937+	Nominal Random Roughness		

Done

Figure 6.17 Partial listing of a WEPS "operation_defn.xml" file that defines management operation actions, their parameters, and their various attributes.

Management Operation Parameter Definitions

<u>O 00: Initialization</u>

The “Initialization” operation line represents a special type of operation. It is intended to be used when one needs to “initialize” a WEPS simulation run in a special manner. Therefore, any operation defined with an “Initialization” operation line will only be executed once, during the initialization cycle, and will not be repeated like other normal operations. This type of operation will usually only be created and used by researchers or for special WEPS uses.

Parameter Prompt: Initialization Operation Notes

The “Initialization” operation line contains only this one parameter. It allows the user to document the specific purpose of the operation, special considerations specific to its use, creation date, author, any subsequent changes, etc.

<u>O 01: Direction and Speed</u>

In many management events, like tillage operations, the actual speed of the operation and/or the direction in which the operation is performed on the field can influence the degree to which it impacts the physical state of the soil, surface, and vegetation. These types of management events will be defined with the “Direction and Speed” operation line.

Parameter Prompt: Speed
Actual speed at which the operation is performed.
Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Direction from North
This parameter defines the principle direction, relative to north, in which the operation is performed. Zero (0.0) degrees represents a north/south direction. 90.0 degrees represents an east/west direction. This parameter defines the predominant direction of tillage ridges and/or planted rows. It is important because oriented surface roughness and row direction relative to wind direction affect the susceptibility of the field to wind erosion.
Parameter Unit: degrees

Parameter Prompt: Standard Speed

Speed at which some of the physical processes, like residue burial efficiency, have coefficients specified. In WEPS, many of these coefficients are then adjusted internally based upon actual travel speed, as well as other parameters.

Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Minimum Speed
Minimum speed at which the operation would typically be performed. This speed value is used to determine the lower limit at which WEPS will adjust certain process-specific parameters that are influenced by travel speed.

Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Maximum Speed
Maximum speed at which the operation would typically be performed. This speed value is used to determine the upper limit at which WEPS will adjust certain process-specific parameters that are influenced by travel speed.

Parameter Unit: m/s
Conversion factor: mph = 2.237 * (m/s)
Alternate units: mph

Parameter Prompt: Tillage Operation Notes
This parameter allows the user to document the specific purpose of the operation, special considerations specific to its use, creation date, author, any subsequent changes, etc.

<u>O 02: Others</u>

Management events that are not influenced by speed of operation or direction of travel. Examples would be most grain-harvest, herbicide-spraying, baling, burning, and irrigation operations.

Parameter Prompt: Other Operation Notes
This parameter allows the user to document the specific purpose of the operation, special considerations specific to its use, creation date, author, any subsequent changes, etc.

<u>G 01: Tillage</u>

Many tillage operations perform several physical processes as they modify the soil and surface condition (e.g., loosening the soil, mixing soil properties within the tillage zone, burial of residue, etc.). All of these physical processes require some information that is common among them. These “shared” parameter values, like tillage depth, surface area disturbed, etc., have been grouped together into a single “group” line so that they don’t have to be specified repeatedly as parameters for each individual process that needs them. This allows one to conveniently make a single change to a “shared” parameter listed in a group line and have it impact all the succeeding processes that require it. But it also requires one to ensure that any process line that requires a “shared” parameter has the appropriate "group" line specified before the process line in the definition file of that operation.

Often, a tillage operation may contain multiple tillage tool components on a single implement (e.g., disk gang, followed by a row of chisel shanks) or consist of a several individual implements one behind the other (e.g. a springtooth harrow with a straight tine drag harrow behind it). These types of tillage operations/implements can be represented as a single operation in WEPS by specifying the physical processes each tillage tool component performs on the soil/surface/vegetation. Often, this is done by specifying a "Tillage" group line, followed by the appropriate "process" lines to represent the tillage/residue burial effects of the individual tillage tool components. Thus, multiple tillage "group" lines, followed immediately by several "process" lines, will be used to represent multi-tool and multi-implement tillage operations in WEPS.

Parameter Prompt: Actual Depth
Actual tillage depth of the implement or tillage tool component represented.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Intensity
Tillage intensity of the implement or tillage tool component represented. It can have a value from 0.0 to 1.0, where zero represents no soil disturbance and 1.0 would represent maximum soil disturbance. This parameter value impacts the soil layer "mixing" process simulated within WEPS, as well as soil loosening. An example of a tool with a high tillage intensity would be a rotary tiller.
Parameter Unit: fraction

Parameter Prompt: Area Affected
The fractional surface area affected by the tillage processes. It can have a value from 0.0 to 1.0, where zero would represent no surface area disturbed. A value of 1.0 would mean that the tillage processes occurred across the entire width of the implement. A value between 0.0 and 1.0 would mean that only a fraction of the surface and the soil below would be disturbed, (e.g., a row crop cultivator may only till the soil between the plant rows).
Parameter Unit: fraction

Parameter Prompt: Standard Depth
Tillage depth at which some of the physical processes, like residue burial efficiency, have coefficients specified. In WEPS, many of these coefficients are then internally adjusted based upon actual tillage depth, as well as other parameters.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Minimum Depth

Minimum tillage depth at which the operation would typically be performed. This depth value is used to determine the lower limit at which WEPS will adjust certain process-specific parameters that are influenced by tillage depth.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Maximum Depth
Maximum tillage depth at which the operation would typically be performed. This depth value is used to determine the upper limit at which WEPS will adjust certain process specific parameters which are influenced by tillage depth.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

G 02: Biomass Manipulation

The “Biomass Manipulation” group contains a “shared” parameter that is required by many WEPS processes that simulate the manipulation of biomass (e.g., the removal of biomass, flattening of standing residue, etc.). This “group” line is commonly used for operations that do not affect (till) the soil, where the “shared” parameters dealing with tillage depth in the “Tillage” group are not required. Examples of operations that would use this group line are harvesting and spraying operations.

Parameter Prompt: Area Affected
The fractional surface area affected by the tillage processes. It can have a value from 0.0 to 1.0, where zero would represent no surface area disturbed. A value of 1.0 would mean that the biomass manipulation processes occurred across the entire width of the implement. A value between 0.0 and 1.0 would mean that only a fraction of the surface and biomass would be affected (e.g., a grain harvesting operation in which 1/3 of the crop was to be left in the field for wildlife purposes or in which the implement’s wheel tracks flattened a fraction of the standing residue during the operation).
Parameter Unit: fraction

G 03: Crop Name

The “Crop Name” group consists of a single parameter, the name of a crop being planted or transplanted. It is required by the planting/seeding and transplanting processes.

Parameter Prompt: Crop Name
This parameter specifies the name of the crop being planted/seeded or transplanted.

G 04: Add Material to Field

The "Add Material to Field" group consists of a single parameter, the name of the residue type being applied. It is required by the "Add Residue" and "Set Residue" processes.

Parameter Prompt: Material Name
This parameter specifies the name of the type of residue added to the field.

P 01: Break Crust

If this process is specified, it means that the operation will physically remove any crust on the soil surface. No process-level parameters are required for the simulation of this effect in WEPS. It does require a shared, group-level parameter that specifies the fraction of the surface area to which this effect applies.

P 02: Random Roughness

Parameter Prompt: Random Roughness Flag
Some tillage operations will create a specific random surface roughness, regardless of the pre-existing soil surface/biomass conditions, and others are highly dependent upon the soil type, pre-tillage surface cloddiness, and quantity of buried residue present. To allow for these differences, a "Random Roughness Flag" is used to specify how WEPS should treat a specific tillage tool.
Parameter Choices: 0 - Always use specified random roughness value
1 - Allow WEPS to auto-adjust random roughness value

Parameter Prompt: Nominal Random Roughness
If the "Random Roughness Flag" is set to zero (0), then this value is the Allmaras random roughness value that the soil surface will have after using this tillage tool.

If the "Random Roughness Flag" is set to one (1), then this is to be the typical Allmaras random roughness value expected on a silt loam soil with lots of buried residue present. Internally, WEPS will use the "shared" group parameter values of "tillage intensity", soil type, and residue quantity to determine the actual surface roughness created by the tillage tool. In general, a high tillage intensity value will mean that the "Nominal Random Roughness" will not be affected much by the pre-tillage surface roughness. A low tillage intensity value would affect the final random roughness. In general, a sandier soil will result in a lower random roughness value, and a soil with more clay will create a surface with a higher random roughness value. Because most field conditions are performed with less residue than specified for the "Nominal Random Roughness" value, the resulting surface roughness will be less than the specified value.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

<u>P 05: Ridges and Dikes</u>

Parameter Prompt: Ridge Flag

Tillage operations will either: a) leave existing ridges alone; b) create a specified ridged and/or diked surface, regardless of pre-existing surface conditions; or c) create a specific ridged and/or diked surface based upon tillage depth. The "Ridge Flag" specifies which of these situations should represent how WEPS should treat a specific tillage tool.

Parameter Choices: 0 - Pre-existing ridges/dikes left unchanged
1 - Ridges/dikes set to specified values
2 - Ridges/dikes set, based upon tillage depth

Parameter Prompt: Ridge Height

Ridge height is measured from the top of the ridge to the bottom of the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Ridge Spacing

Ridge spacing is measured from ridge top to ridge top across the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Ridge Top Width

Ridge width is measured across the top of the ridge.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Dike Height

Dike height is measured from the top of the dike to the bottom of the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Dike Spacing

Dike spacing is measured from dike top to dike top down the furrow.

Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

P 11: Aggregate Crushing

Parameter Prompt: Aggregate Size Distribution Factor
Parameter Unit: unitless

Parameter Prompt: Crushing Intensity Factor
Parameter Unit: unitless

P 12: Soil Loosening

Parameter Prompt: Soil Loosening Factor
Specifies degree to which air is added to the soil layers within the tillage zone. A minimum value of zero (0.0) means no change in soil layer bulk density occurs. A maximum value of 1.0 means the soil layers reach their "loosest" state (i.e., the lowest bulk density possible for the soil type, based upon the pre-tilled bulk density value).
Parameter Unit: fraction

P 13: Soil Layer Mixing

Parameter Prompt: Layer Mixing Factor
Specifies degree of mixing among soil layer properties. A minimum value of zero (0.0) means no mixing occurs, and a maximum value of 1.0 means full mixing occurs, (i.e., all layers within the tillage zone become homogeneous).
Parameter Unit: fraction

P 14: Soil Layer Inversion

Specifies that the current tillage tool inverts the soil layers within the specified tillage zone.
This process line has no parameter values.

P 24: Flatten Standing Biomass

This process specifies the degree to which standing crops and/or residue are flattened. There are "flattening coefficients" specified for each type of "residue", on the basis of its "toughness/size". The five types of residue classes are:

fragile	- Residue that is easily broken down (e.g., soybean residue)
moderately tough	- Similar to size and toughness of wheat residue
non-fragile/large	- Similar to size and toughness of corn residue
woody	- Similar to size and toughness of woody brush residue
small stones/gravel	- Non-decomposing material

Parameter Prompt: Flatten Biomass Flag
This parameter specifies which type of biomass is flattened, the "growing crop" and/or the standing crop residue remaining after previous crop harvests.

Parameter Choices: 0 - Flatten crop and residue
1 - Flatten crop only
14 - Flatten residue only

Parameter Prompt: Mass Flattened (fragile residue)
Fraction of standing crop and/or residue flattened, if considered "fragile residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (moderately tough residue)
Fraction of standing crop and/or residue flattened, if considered "moderately tough residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (non-fragile/large residue)
Fraction of standing crop and/or residue flattened, if considered "non-fragile/large residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (woody residue)
Fraction of standing crop and/or residue flattened, if considered "woody residue".
Parameter Unit: fraction

Parameter Prompt: Mass Flattened (small stones/gravel residue)
Fraction of standing crop and/or residue flattened, if considered "small stones/gravel residue". Tire traffic areas should be included in this fraction.
Parameter Unit: fraction

P 25: Bury Flat Biomass

This process specifies distribution and the degree to which crops and/or residue are buried. There are "burial coefficients" specified for each type of "residue", on the basis of its "toughness/size". The five types of residue classes are specified under "Flatten Standing Biomass". The burial distribution pattern by depth is specified based upon the "Bury Biomass Flag" values. The five types of burial distribution patterns are:

Uniform - Biomass is buried uniformly by depth
Mixing and inversion - Biomass is inverted and mixed during burial
Mixing - More biomass is buried near the soil surface
Inversion - Biomass buried at bottom of tillage zone
Lifting, fracturing - Biomass buried similar to a chisel plow

Parameter Prompt: Bury Biomass Flag
This parameter specifies how residue is buried into the tillage zone.
Parameter Choices: 0 - Uniform burial distribution
1 - Mixing and inversion burial distribution

2 - Mixing burial distribution
3 - Inversion burial distribution
4 - Lifting/fracturing burial distribution

Parameter Prompt: Mass Buried (fragile residue)
Fraction of above ground crop and/or residue buried, if considered “fragile residue”.
Parameter Unit: fraction

Parameter Prompt: Mass Buried (moderately tough residue)
Fraction of above ground crop and/or residue buried, if considered “moderately tough residue”.
Parameter Unit: fraction

Parameter Prompt: Mass Buried (non-fragile/large residue)
Fraction of above ground crop and/or residue buried, if considered “non-fragile/large residue”.
Parameter Unit: fraction

Parameter Prompt: Mass Buried (woody residue)
Fraction of above ground crop and/or residue buried, if considered “woody residue”.
Parameter Unit: fraction

Parameter Prompt: Mass Buried (small stones/gravel residue)
Fraction of above ground crop and/or residue buried, if considered “small stones/gravel residue”.
Parameter Unit: fraction

<u>P 26: Resurface Buried Biomass</u>

This process specifies the degree to which buried residue are brought back to the surface. There are “re-surfacing coefficients” specified for each type of “residue”, on the basis of its “toughness/size”. The five types of residue classes are specified under “Flatten Standing Biomass”.

Parameter Prompt: Mass Resurfaced (fragile residue)
Fraction of below-ground crop and/or residue resurfaced, if considered “fragile residue”.
Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (moderately tough residue)
Fraction of below ground crop and/or residue resurfaced, if considered “moderately tough residue”.
Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (non-fragile/large residue)
Fraction of below ground crop and/or residue resurfaced if, considered “non-fragile/large residue”.

Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (woody residue)
Fraction of below ground crop and/or residue resurfaced, if considered “woody residue”.
Parameter Unit: fraction

Parameter Prompt: Mass Resurfaced (small stones/gravel residue)
Fraction of below ground crop and/or residue resurfaced, if considered “small stones/gravel residue”.
Parameter Unit: fraction

P 31: Kill or Defoliate Growing Crop

This process determines whether a growing crop is defoliated or killed, based upon the type of crop (perennial or annual).

Parameter Prompt: Kill/Defoliate Flag
This parameter specifies how different crop types are treated (e.g., killed or defoliated).
Parameter Choices: 1 - Annual crop killed, perennial crop regrows
2 - All crop types are killed
3 - Crop defoliated

P 32: Cut/Remove Biomass to Height

This process cuts the specified standing biomass (crop and residue if present) to the specified height. This process is also a harvest process if components of the cut material are removed from the field as specified by the removal parameter values. Based upon the “Cut Biomass Flag” setting, the cut height is measured from the ground up or from the top of the crop down.

Parameter Prompt: Cut Biomass Flag
This parameter specifies how the cut height is determined.
Parameter Choices: 0 - Cut Value = Height of standing stubble remaining
1 - Cut Value = Length of standing plant stalks removed

Parameter Prompt: Cut Value
Either the cutting height or the length (height) of crop removed, based upon the “Cut Biomass Flag” value.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Cut Yield Removed
Mass fraction of crop yield removed during the “Cut/Remove Biomass to Height” process.
Parameter Unit: fraction

Parameter Prompt: Cut Plant Removed
Mass fraction of "cut" crop biomass removed during the "Cut/Remove Biomass to Height" process.
Parameter Unit: fraction

Parameter Prompt: Cut Standing Residue Removed
Mass fraction of "cut" standing residue removed during the "Cut/Remove Biomass to Height" process.
Parameter Unit: fraction

P 33: Cut/Remove Biomass by Fraction

This process cuts the specified standing biomass (crop and residue if present) to a fraction of the crop height. This process is also a harvest process if components of the cut material are removed from the field as specified by the removal parameter values.

Parameter Prompt: Plant Height Removed
Fraction of crop (and residue if present) height removed during the "Cut/Remove Biomass by Fraction" process.
Parameter Unit: fraction

Parameter Prompt: Cut Yield Removed
Mass Fraction of crop yield removed during the "Cut/Remove Biomass by Fraction" process.
Parameter Unit: fraction

Parameter Prompt: Cut Plant Removed
Mass fraction of "cut" crop biomass removed during the "Cut/Remove Biomass by Fraction" process.
Parameter Unit: fraction

Parameter Prompt: Cut Standing Residue Removed
Mass fraction of "cut" standing residue removed during the "Cut/Remove Biomass to Height" process.
Parameter Unit: fraction

P 34: Change Standing Biomass Fall Rate

This process allows an operation to modify the fall rate of decay for standing residue stalks. The purpose is to simulate the effects of undercutting the supporting roots, which decreases the ability of residue stalks to remain standing over time.

Parameter Prompt: Select Biomass Pool Type

This parameter specifies how the cut height is determined.

Parameter Choices: 1 - Crop
2 - Temporary
3 - Crop and Temporary
4 - Residue
5 - Crop and Residue
6 - Temporary and Residue
7 - Crop, Temporary and Residue

Parameter Prompt: Standing Biomass Fall Rate Multiplier (fragile residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (moderately tough residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (non-fragile/large residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (woody residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Rate Multiplier (small stones/gravel residue)
Multiplier value to increase or decrease the fall rate value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (fragile residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (moderately tough residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (non-fragile/tough residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (woody residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.

Parameter Unit: multiplier

Parameter Prompt: Standing Biomass Fall Threshold Multiplier (small stones/gravel residue)
Multiplier value to increase or decrease the threshold fall value for the specified type of residue.
Parameter Unit: multiplier

P 37: Thin Biomass to Population

This process reduces the crop plant population to the specified value. This process is also a harvest process if components of the "thinned" plants are removed from the field as specified by the removal parameter values.

Parameter Prompt: Thinning Value
Resulting plant population desired.
Parameter Unit: #/m^2
Conversion factor: #/ft^2 = 0.0929 * (#/m^2)
Alternate units: #/ft^2

Parameter Prompt: Thinned Yield Removed
Mass fraction of "thinned" crop yield removed during the "Thin Biomass to Population" process.
Parameter Unit: fraction

Parameter Prompt: Thinned Plant Removed
Mass fraction of "thinned" crop plants removed during the "Thin Biomass to Population" process.
Parameter Unit: fraction

Parameter Prompt: Thinned Standing Residue Removed
Mass fraction of "thinned" standing residue removed during the "Thin Biomass to Population" process.
Parameter Unit: fraction

P 38: Thin Biomass by Fraction

This process reduces the crop plant population by the specified value. This process is also a harvest process if components of the "thinned" plants are removed from the field as specified by the removal parameter values.

Parameter Prompt: Thinning Value
Reduction factor to reach desired population.
Parameter Unit: fraction

Parameter Prompt: Thinned Yield Removed
Mass fraction of "thinned" crop yield removed during the "Thin Biomass by Fraction" process.

Parameter Unit: fraction

Parameter Prompt: Thinned Plant Removed
Mass fraction of "thinned" crop plants removed during the "Thin Biomass by Fraction" process.
Parameter Unit: fraction

Parameter Prompt: Thinned Standing Residue Removed
Mass fraction of "thinned" standing residue removed during the "Thin Biomass by Fraction" process.
Parameter Unit: fraction

P 40: End Crop Biomass Manipulation

This process is required after all "crop" related biomass manipulation processes have been completed, for WEPS to correctly account for changes in vegetation pools within the simulation. There are no parameters associated with this process line.

P 50: Set Crop Residue Amounts

Parameter Prompt: Number of Standing Residue Stems
Desired residue standing stem population.
Parameter Unit: #/m^2
Conversion factor: #/ft^2 = 0.0929 * (#/m^2)
Alternate units: #/ft^2

Parameter Prompt: Standing Residue Height
Desired standing residue height.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Standing Residue Mass
Desired standing residue mass.
Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre
Parameter Prompt: Flat Surface Residue Mass
Desired flat residue mass.
Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre

Parameter Prompt: Residue Size/toughness Class
This flag specifies the "class" of residue on the basis of its relative size and toughness.

Parameter Choices: 1-Fragile, very small residue (e.g., soybeans)
2-Moderately tough, short residue (e.g., wheat)
3-Non fragile, medium residue (e.g., corn)
4-Woody, large residue
5-Gravel, rock

Parameter Prompt: Buried Residue Mass
Desired buried residue mass (not roots).
Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre

Parameter Prompt: Buried Residue Depth
Desired buried residue depth.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Root Residue Mass
Desired root residue mass.
Parameter Unit: kg/m^2
Conversion factor: lb/acre = 8921.8 * (kg/m^2)
Alternate units: lb/acre

Parameter Prompt: Root Residue Depth
Desired root residue depth.
Parameter Unit: mm
Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Decomposition Rate for Standing Stalks
The rate at which standing stalks decompose under optimum conditions. Example: a decomposition rate of 0.02 kg kg-1 day-1 means a 2% standing stalk mass loss per day if moisture and temperature conditions are optimum for decomposition on this day. If conditions are not optimum, the rate is reduced. Leaves, if any are present, decompose at 3 times the rate of stalks, and reproductive material, if any is present, decomposes at 1.5 times the rate of stalks.
Parameter Unit: kg kg-1 day-1

Parameter Prompt: Decomposition Rate for Surface (flat) Stalks
The decomposition rate of stalks that have fallen to a flattened (horizontal) position on the soil surface. See comments for standing stalks.
Parameter Unit: kg kg-1 day-1

Parameter Prompt: Decomposition Rate for Buried Stalks
The decomposition rate of stalks that have been buried below the soil surface by tillage. See comments for standing stalks.

Parameter Unit: kg kg-1 day-1

Parameter Prompt: Decomposition Rate for Roots
See comments for standing stalks.
Parameter Unit: kg kg-1 day-1

Parameter Prompt: Fall Rate for Standing Stalks
The rate at which standing stalks fall to a flattened (horizontal) position on the soil surface. Only after a threshold has been reached, stalks will begin to fall at this rate. Example: a fall rate of 0.12 day-1 means a 12% of the total number of standing stalks fall down per day if moisture and temperature conditions are optimum on this day. If conditions are not optimum, the fall rate is reduced.
Parameter Unit: day-1

Parameter Prompt: Average Stalk Diameter
Parameter Unit: m
Conversion factor: inches = 39.3696 * (m)
Alternate units: inches

Parameter Prompt: Decomposition Days After Which Stalks Begin to Fall
Only after this threshold has been reached, stalks will begin to fall at the rate previously discussed. Example: a threshold of 20 decomposition days means that standing stalks only begin to fall after 20 days after harvest if moisture and temperature conditions are optimum, during these 20 days. If conditions are not optimum the number of days increases.
Parameter Unit: day

Parameter Prompt: Mass to Cover Factor
Soil cover from flat residue mass is predicted by equation 5.5:

$$C_f = 1 - exp^{-bM_f}$$

where Cf is flat residue cover (m2 m-2), b is mass-to-cover factor (m2 kg-1), and Mf is flat residue mass (kg m-2) (Figure 6.40, 43).
Parameter Unit: m2 kg-1
Conversion factor: value * 0.00011209
Alternate units: acres lb-1

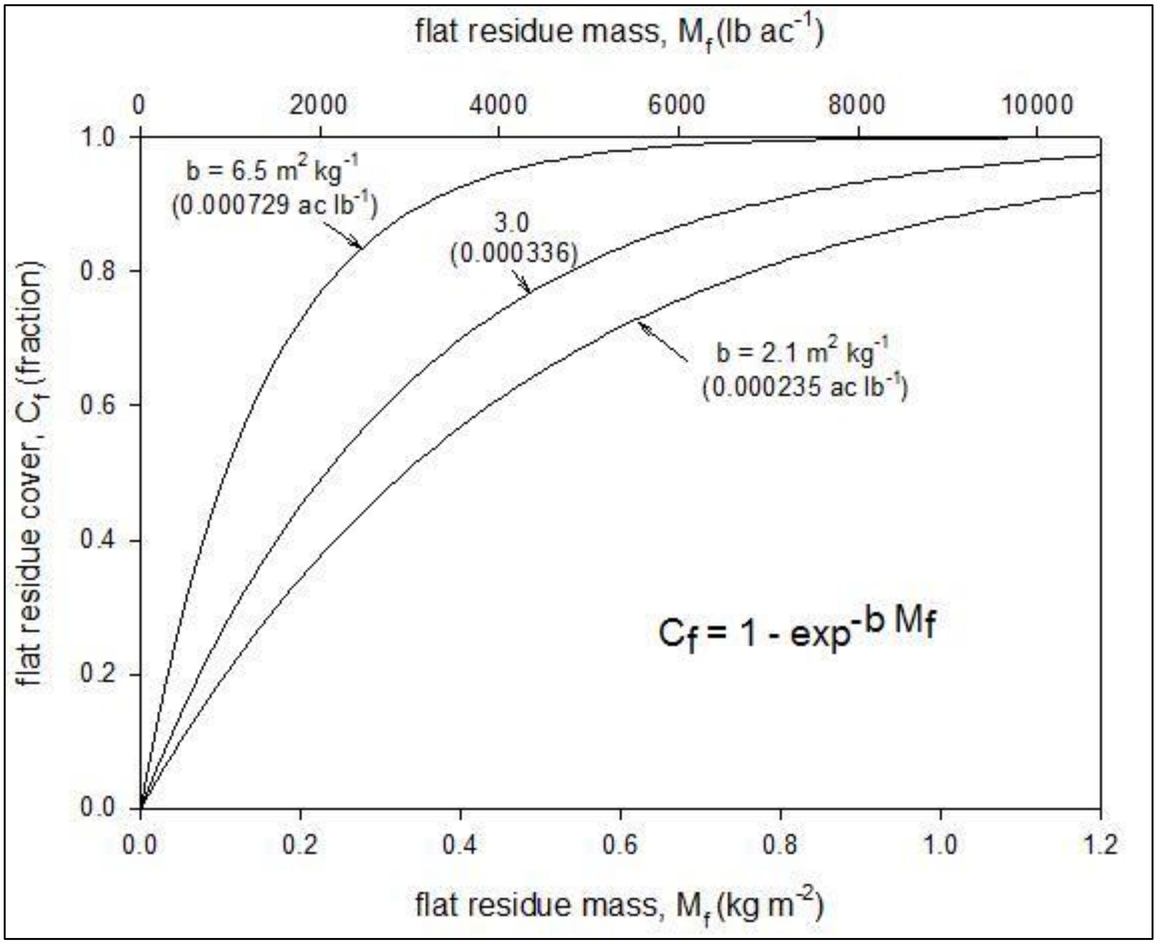


Figure 6.18 Relationship between flat residue mass and the cover provided by this flat residue.

Parameter Prompt: Residue Evaporation Suppression Multiplier Coefficient a
Parameter Unit: eratio = resevapa(kg/m2)**resevapb
Parameter Choices:

Parameter Prompt: Residue Evaporation Suppression Multiplier Coefficient b
Parameter Unit: eratio = resevapa(kg/m2)**resevapb

P 51: Seeding Configuration

Parameter Prompt: Type of Planting
Specifies how the crop is being planted.
Parameter Choices: 0-Broadcast Planting
2-Use Implement Ridge Spacing
3-Use Specified Row Spacing

Parameter Prompt: Crop Row Spacing
Parameter Unit: mm

Conversion factor: inches = 0.03937 * (mm)
Alternate units: inches

Parameter Prompt: Seed Placement (ridge/furrow)
Specifies where seed is to be placed when planting in rows.
Parameter Choices: 0-Seed row placed in bottom of furrow.
2-Seed row placed on ridge top.

Parameter Prompt: Plant Population
Parameter Unit: #/m^2
Conversion factor: #/acre = 4046.7 * (#/m^2)
Alternate units: #/acre

Parameter Prompt: Maximum number of Tillers (stems) per Plant
Parameter Unit: #/plant

NOTE: All remaining process 51 parameters consist of the "crop" database record parameters. They are fully defined in the crop "how to" guide. One normally would not need to deal with those parameters when defining/modifying an operation record, so they are not individually listed here.

P 61: Remove Plant/Residue Material

Parameter Prompt: Select Plant/residue Material
This flag specifies the "location" of the biomass to be removed.
Parameter Choices: 1-Standing with Roots
2-Flat
3-Standing with Roots and Flat
4-Buried
5-Standing with Roots and Buried
6-Flat and Buried
7-Standing with Roots, Flat and Buried

Parameter Prompt: Select Plant/residue Material
This flag specifies the biomass pool type(s) to be removed.
Parameter Choices: 1-Crop
2-Temporary
3-Crop and Temporary
4-Residue
5-Crop and Residue
6-Temporary and Residue
7-Crop, Temporary and Residue

Parameter Prompt: Grain (fruit) Removed
Parameter Unit: fraction

Parameter Prompt: Leaf Removed
Parameter Unit: fraction

Parameter Prompt: Stem Removed
Parameter Unit: fraction

Parameter Prompt: Storage Root Removed
Parameter Unit: fraction

Parameter Prompt: Fibrous Roots Removed
Parameter Unit: fraction

P 71: Irrigation

This process simulates the application of water.

Parameter Prompt: Irrigation Application Method
This flag specifies the type of irrigation method.
Parameter Choices: 1-Sprinkler
2-Other

Parameter Prompt: Depth of Water Applied
Parameter Unit: mm
Conversion factor: inches = 0.3937 * (mm)
Alternate units: inches

WEPS How To Guide

6.4 Using WEPS with Measured Data

Introduction

The Wind Erosion Prediction System (WEPS) is designed to simulate soil loss by wind from cultivated fields by simulating weather and field conditions (Wagner, 1997). In some situations however, WEPS may be run using measured or simulated data from other models. This is typically done to validate various components or submodels of WEPS, particularly the erosion portion of the model. For example, a user may have measured soil loss data and limited weather and soil data. This user can input the measured weather and soil data to compare the model soil loss with the measured loss. This section will explore the use of WEPS with measured or other simulated data.

WEPS is a process-based, continuous, daily time-step model that simulates weather, field conditions, and erosion by wind. It has the capability of simulating spatial and temporal variability of a field's soil, crop, and residue conditions and soil loss/deposition within a field. The saltation/creep, suspension, and PM10 components of eroding material are also reported separately by direction. The WEPS model is modular, with submodels that simulate weather, soil conditions, crop growth, residue decomposition, management operations, and soil loss by wind. It is designed to be used by the USDA-NRCS, under a wide range of conditions throughout the United States. With proper inputs however, WEPS is easily adapted to other parts of the world.

In typical applications, input files are created within the user interface, which supplies these files to the science portion of the model to calculate field conditions and erosion. WEPS requires the following input files for a simulation run: a 'Run file', WINDGEN file', 'CLIGEN file', 'Soil file', and a 'Management file'. These files can be modified with measured or other data and run with WEPS under certain constraints. All input files except the Management file, may be easily altered using a standard text editor or the WEPS user interface to reflect measured data. All input files must be formatted to meet the requirements for WEPS. These input files and considerations for their creation with measured data are described in this Appendix.

It is important to note that the purpose of the WEPS model is to simulate changes in field conditions as a result of management and weather to estimate wind erosion. To simulate these changes in field conditions, WEPS is intended for simulations of multiple-day periods of time. If one desires to simulate only a single storm, field conditions are essentially static and the full WEPS model is not necessary. To simulate single erosion events of one day or less, the standalone erosion submodel is recommended. The use of the standalone submodel is also described in this Appendix.

WEPS can be run from either the interface or the command line. Users typically will run the model through the interface, in which modified input files can be selected. See the individual input file descriptions for information on how to select modified files within the interface. Some input files are best modified within the interface (e.g., soil and management files), whereas others require some sort of separate editing or creation with a separate program (e.g., weather files). Files that are modified by the user but input via the interface must be placed in the appropriate project directory (i.e., folder). Those wishing to run WEPS via the command line are advised to see the section titled "Flags and Command Line Options" in the WEPS User Manual.

Output files obtained from WEPS are described elsewhere in the WEPS User Manual. For additional assistance using measured data with WEPS, please contact WERU (office@weru.ksu.edu) or go to (http://www.weru.ksu.edu/weps).

Run File

The default file name of the WEPS run file is 'weps.run'. This file contains general information for a simulation run, including the dates of the simulation, the field and barrier dimensions, the field location, and the path and names of the other input files. The 'run file' parameters can be modified to match the parameters for the field simulated. The list of the other input files should specify the path and name of measured data to be used. This file contains comments (indicated by a '#' in column one) which describes each line of input data to aid in checking and modifying input data.

An example Run File is shown in Figure 6.19. Note that lines beginning with '#' character are comment lines. Lines beginning with '# RFD' are comments used by the interface. Some of the parameters are critical to the science model (SC), some are critical to the operation of the interface (IC), and some are critical to both (SC+IC); others are not critical to either (NC). An example of non-critical parameters would be the User Name, which does not affect the operation of WEPS and is used for informational purposes only. In all cases however, some sort of 'placeholder' is required, even for non-critical parameters. In other words, blank lines are not allowed and each expected line must be present and filled with some characters.

The interface is a simple way to input data into the Run file and is recommended. The information herein is presented for the benefit of those users who wish to modify the input file themselves.

Run File Parameters:

--USER INFORMATION
UserName - This character variable holds the user name. (NC)

FieldNo - This character variable is a part of a field tract that is separated by permanent boundaries. (NC) Note that FieldNo, TractNo, FarmNo, RunMode, RunCycle, and RotCycle are all entered on one line, with each parameter separated by the pipe "|" symbol.

TractNo - This character variable is often used by FSA and NRCS to identify a field. (NC)

FarmNo - This character variable is a farm identification number. (NC)

RunMode - This character variable specifies the type of run length as either the NRCS method (specifies a fixed number of cycles), use simulation run start and end dates on the main screen, or specify the use of management rotation cycles on the main screen. (IC)

RunCycle - This variable specifies the number of management rotation cycles to simulate in a WEPS run. (IC)

RotCycle - This character variable specifies the number of years in the rotation cycle. (IC)

SiteCounty and SiteState - This character variable specifies the county and state to be simulated. (NC)

--SITE INFORMATION
LatitudeSign - This parameter is used to specify the specify the hemisphere of the latitude. Enter a plus sign (+) for the Northern hemisphere and a minus sign (-) for the Southern hemisphere. (IC)

Latitude -The latitude of the location modeled in degrees and fraction of degrees. The CLIGEN and WINDGEN stations nearest to the center of the location county will then be determined by the interface and listed. Latitude is also used by the science model to determine day length and time of sunrise. (SC+IC)

LongitudeSign - This parameter is used to specify the specify the hemisphere of the longitude. Enter a plus sign (+) for the Eastern hemisphere and a minus sign (-) for the Western hemisphere. (IC)

Longitude -The longitude of the location modeled in degrees and fraction of degrees. The CLIGEN and WINDGEN stations nearest to the center of the location county will be determined by the interface. Longitude is used by the science model to determine day length and time of sunrise. (SC+IC)

Elevation (meters) - The average elevation for the location to be modeled in the units of measure displayed on the screen (feet or meters). The science model requires elevation in meters, and converts feet to meters. (SC+IC)

CliGenStationID - The name of the CLIGEN station used to generate many of the weather parameters for WEPS. (IC)

WindGenStationID - The name of WINDGEN station used to generate the wind parameters for WEPS. (IC)

--*SIMULATION PERIOD*
StartDate (day, month, year) - The "Start Date" is the date from which you want the simulation to begin. The format is the numerical value for day, month (e.g., 03 for March), and year (two or four characters), each value separated by a blank space. (SC+IC)

> A typical run begins on January 1 and ends on December 31 with multiple years of simulation. For those using WEPS with historical data however, other start and ending days and months may be entered. The correctness of output has not been tested in these situations.

EndDate (day, month, year) - The "End Date" is the date on which you want the simulation to end. The format is the numerical value for day, month (e.g., 03 for March), and year (two or four characters), each separated by a blank space. (SC+IC)

> A typical run begins on January 1 and ends on December 31 with multiple years of simulation. For those using WEPS with historical data however, other start and ending days and months may be entered. The correctness of output has not been tested in these situations.

TimeSteps (per day) - The number of time steps per day used for the daily distribution of simulated wind speed for erosion calculations. If none is entered through the interface Configuration Screen, the number of time steps is assumed to be 24. (SC)

--*RUN FILE NAMES (INPUT)*
climate file - This character variable holds the path and CLIGEN input file name. (SC+IC)

wind file - This character variable holds the path and WINDGEN input file name. (SC+IC)

soil file - This character variable holds the path and soil input file name. (SC+IC)
management file - This character variable holds the path and management input file name. (SC+IC)

--*WEPS OUTPUT OPTIONS*
OutputFile - This character variable holds the path and general output file name. (SC+IC)

ReportForm - This variable was intended to hold six (6) flags for selecting various general report forms, but is not used in the current version of WEPS. (NC)

OutputPeriod - This variable was intended to hold a flag for selecting the period of output, but is not used in the current version of WEPS. (NC)

SubmodelOutput - This variable holds numerical flags to print detailed reports for various submodels. Submodel detail report flags are described elsewhere in the WEPS User Manual. (SC+IC)

DebugOutput - This variable holds numerical flags to print debug reports for various submodels. Submodel debug report flags are described elsewhere in the WEPS User Manual. (SC+IC)

--*SIMULATION REGION INFORMATION*
RegionAngle (degrees from North) - This is the angle of the field with respect to North. (SC enter angle 0-360 decrees, clockwise from North) or (IC enter angle up to +/- 45 degrees)

SimCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the simulation region. This is typically the lower left corner for the North-South oriented rectangular simulation region. (SC+IC)

SimCoords2 (meters) - These two variables hold the X and Y coordinates of the opposite corner of the simulation region (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular simulation regions. (SC+IC)

ScaleFactors - These two variables were intended to hold scale factors for displaying the simulation region in the interface, but are not used in the current version of WEPS. (NC)

AcctRegNo - This variable holds the number of accounting regions in the simulation region. If more than one accounting region is present (i.e., AcctRegNo > 1), then the accounting region coordinates are repeated in succession to account for each accounting region. (SC+IC)

AcctCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the accounting region. This is typically the lower left corner for the North-South oriented rectangular accounting region. (SC+IC)

AcctCoords2 (meters)- These two variables hold the X and Y coordinates of the opposite corner of the accounting region (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular accounting regions. (SC+IC)

SubRegNo - This variable holds the number of subregions in the simulation region. If more than one accounting region is present (i.e., SubRegNo > 1), then the subregion coordinates are repeated in succession to account for each subregion. (SC+IC)

SubCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the current subregion. This is typically the lower left corner for the North-South oriented rectangular subregion. (SC+IC)

SubCoords2 (meters) - These two variables hold the X and Y coordinates of the opposite corner of the subregion (furthest from the origin). This is typically the upper right corner for the North-South oriented rectangular subregions. (SC+IC)

AverageSlope (%) - The average slope of the subregion. This information is now obtained from the soil input file. (NC)

-- *BARRIERS*
NumberBar - This variable holds the number of barriers in the simulation region. If more than one barrier is present (i.e., NumberBar > 1), then the barrier information (i.e., barrier coordinates and parameters) are repeated in succession to account for each barrier. (SC+IC)

BarrierCoords1 (meters) - These two variables hold the X and Y coordinates of the origin of the barrier. This is typically the lower left corner of the barrier. (SC+IC)

BarrierCoords2 (meters) -These two variables hold the X and Y coordinates of the opposite corner of the barrier (furthest from the origin). This is typically the upper right corner of the barrier. (SC+IC)

BarrierType - This character variable specifies the name of the type of barrier. (NC)

BarrierHeight (meters) - This parameter is the barrier average height. (SC+IC)

BarrierWidth (meters) - This parameter is the barrier average width (not length). (SC+IC)

BarrierPorosity (%) - The barrier porosity is expressed as an optical porosity. It is the open space as viewed looking perpendicular through the barrier expressed as a percentage of the total area (i.e., ((1.0 - silhouette area) x 100).

Figure 6.19 Example Run file

```
#------------ WEPS SIMULATION RUN FILE ------------
# Note: Lines beginning with '#' are comment lines.
#       Lines beginning with '#   RFD' are comments used by the interface.
#
# --USER INFORMATION
#   RFD-UserName
Dustin Fields
#   RFD-FieldNo RFD-TractNo RFD-FarmNo RFD-RunMode RFD-RunCycle RFD-RotCycle
789 | 456 | 123 | cycle | 2 | 2
#   RFD-SiteCounty and SiteState
Finney, Kansas
#
# --SITE INFORMATION
#   RFD-LatitudeSign RFD-Latitude
+38.00
#   RFD-LongitudeSign RFD-Longitude
-100.66
#   RFD-Elevation (meters)
801
#   RFD-CliGenStationID
CIMARRON
```

```
#   RFD-WindGenStationID
GARDEN CITY MUNI
#
# --SIMULATION PERIOD
#   RFD-StartDate (day_month_year)
01 01 01
#   RFD-EndDate (day_month_year)
31 12 4
#   RFD-TimeSteps (per_day)
24
#
# --RUN FILE NAMES (INPUT)
#   RFD-climate file
cli_gen.cli
#   RFD-wind file
win_gen.win
#   RFD-sub-daily file
none
#   RFD-SoilFile
Otero_101OF_100_FSL.ifc
#   RFD-ManageFile
KS_wheat_fallow.man
#
# --WEPS OUTPUT OPTIONS
#   RFD-OutputFile
output.tmp
#   RFD-ReportForm
0 0 0 0 0 0
#   RFD-OutputPeriod
2
#   RFD-SubmodelOutput
0 0 0 0 0 0
#   RFD-DebugOutput
0 0 0 0 0
#
# --SIMULATION REGION INFORMATION
#   RFD-RegionAngle (deg_clockwise_north)
21
#   RFD-SimCoords1 (meters)
0.0  0.0
#   RFD-SimCoords2 (meters)
1500.2  1500
#   RFD-ScaleFactors (place holder - needed for older versions of WEPS)
5.5 5.5
#
#   RFD-AcctRegNo
1
#   RFD-AcctCoords1 (meters)
    0.0  0.0
#   RFD-AcctCoords2 (meters)
1500.2  1500
#
#   RFD-SubregionNo
1
#   RFD-SubCoords1 (meters)
0.0  0.0
#   RFD-SubCoords2 (meters)
1500.2  1500
#   RFD-AverageSlope (%)
0.50
#  --BARRIERS
#   RFD-NumberBar
2
```

```
#   RFD-BarrierCoord1 (meters)
-1 0
#   RFD-BarrierCoords2 (meters)
0 1500
#   RFD-BarrierType
Snow fence
#   RFD-BarrierHeight (meters)
1.2
#   RFD-BarrierWidth (meters)
1
#   RFD-BarrierPorosity (%)
0.6
#   RFD-BarrierCoord (meters)
0 -2
1500.2 0
#   RFD-BarrierType
Sorghum(2 row)
#   RFD-BarrierHeight (meters)
2
#   RFD-BarrierWidth (meters)
2
#   RFD-BarrierPorosity (%)
0.5
#
#---------- END OF SIMULATION RUN FILE ------------
```

Weather Files

WEPS runs are made for multiple years in full-year increments beginning on January 1. If only a partial year of weather data is available (typical), the user has two options. One option is to substitute measured data within the simulated weather file for the desired location, and observe the output for the period with measured data. For this option, the user should note that the field conditions cannot be input into the simulation at the point the measured data begins (although future versions of WEPS with this capability are planned). The field conditions will be the result of the simulation up to that point and may not exactly match actual field conditions for the measured data site. The second option is to use the stand-alone Erosion model (described later) for single-day simulations. Two weather files are required by the full WEPS model, a WINDGEN file and a CLIGEN file.

If alternative weather files are to be used in the full WEPS model, they are input through the interface. Alternative weather files are designated by first checking the appropriate wind or climate box in the "Run" tab of the "Configuration" window, then entering the file name and path or choosing the file by clicking the folder icon on the "Location Information" panel of the main screen.

WINDGEN File

The WINDGEN file extension is "win" (e.g., wind_gen.win). This file contains both the wind speed (m s^{-1}) on a subdaily time step and one wind direction (degrees clockwise from North) for each day of the simulation. If more than one wind direction is measured for the day (typical), an average wind direction should be calculated. A wind direction can be calculated by using average weighted by wind speed. This weighting is recommended to provide more weight to stronger, erosive winds. Average wind direction for a day is calculated as:

$$Ue = \sum_{i=1}^{k} (Si * \sin Ti) \qquad \text{Equation 6.7}$$

$$Un = \sum_{i=1}^{k} (Si * \cos Ti) \qquad \text{Equation 6.8}$$

$$Tu = \arctan \frac{Ue}{Un} \qquad \text{Equation 6.9}$$

where

k = number of directions per day,
Si = wind speed (any units),
Ti = wind directions (0 - 360 degrees),

Tu = average wind direction (0 - 360 degrees). If *Tu* < 0, then *Tu* = *Tu* + 360.

The subdaily wind speeds, are by default, the average hourly speeds (i.e., 24, 1-hour averages of point measurements), but can be of other time steps of equal length (e.g., 96, 15-minute averages of point measurements) if specified in the weps.run file. If data are available, it is recommended that time steps less than or equal to1 hour be used, because the smaller the time step (more periods) are more accurate representation of the true winds. Also, the height of the wind measurement in WEPS is assumed to be 10 meters. If wind speeds were taken at a height other than 10 meters, speeds should be adjusted to what they would be at a 10-meter height. WEPS ignores the WINDGEN file header information which is in the first seven rows. Figure 6.20 shows an example WINDGEN file.

WINDGEN File Parameters:

Lines 1 - 7: Comment lines (ignored). These do not need to be filled out, but WEPS does need to have these seven lines present with a '#' at the beginning of the line.

Line 8 +: wind data, one day at a time as described next.

Items 1, 2, 3: **day mo year** - the day, month, and year of simulation (integer).

Item 4: **dir** - wind direction for the day. WEPS assumes that the direction is constant for the day (real- degrees clockwise with North = 0.0, East = 90.0, South = 180.0, etc.).

Items 5 - end: **hr1 hr2 hr3 . . .** - average 1-hour wind speeds, distributed throughout the entire day. These represent, by default, twenty-four 1-hour average wind speeds (real-meters/second). If other time steps are used, they should be of equal length and the number of these periods should be specified in the weps.run file.

Figure 6.20 Example WINDGEN file.

```
#    WIND_GEN3  $Revision: 1.12 $ Hourly values per day output
# station: 13985 DODGE_CITY, KS  USA
# lat:  37deg  46min N  lon:  99deg  58min W
# period: 19610421-19781231  el: 796m
# day mo year dir   hr1   hr2   hr3   hr4   hr5   hr6   hr7   hr8   hr9  .  .  .
#              deg   m/s   m/s   m/s   m/s   m/s   m/s   m/s   m/s   m/s  .  .  .
# ---------------------------------------------------------------------------------
  1  1    1   0.0   3.7   4.7   6.1   6.4   6.9   7.7   8.3   9.3  14.4  .  .  .
  2  1    1 180.0   3.5   4.7   5.5   5.8   6.4   6.9   7.5   7.9   8.5  .  .  .
  3  1    1   0.0   3.7   4.7   6.1   6.4   6.8   7.7   8.1   9.3  12.1  .  .  .
  4  1    1 157.5   2.9   3.5   4.1   4.3   4.6   5.0   5.4   5.6   7.4  .  .  .
  5  1    1 135.0   2.3   2.9   3.5   3.8   4.5   4.8   5.4   6.0   8.2  .  .  .
  6  1    1  22.5   3.5   4.6   5.2   5.8   6.6   7.2   7.9   8.8  11.0  .  .  .
  7  1    1 180.0   3.8   4.9   5.6   5.8   6.5   7.1   7.7   8.0   9.4  .  .  .
  8  1    1 202.5   4.0   4.8   5.2   5.7   5.9   6.2   6.7   7.2   8.1  .  .  .
  9  1    1  22.5   3.5   4.6   5.1   5.8   6.4   7.1   7.7   8.8  10.3  .  .  .
 10  1    1 135.0   2.1   2.8   3.4   3.8   4.4   4.7   5.3   5.8   6.7  .  .  .
 11  1    1 202.5   4.2   5.0   5.3   5.7   5.9   6.4   6.9   7.4   9.5  .  .  .
 12  1    1 337.5   3.1   3.6   4.4   4.9   5.5   6.5   7.1   8.0   9.0  .  .  .
 13  1    1 270.0   3.0   3.3   3.8   4.2   4.6   4.8   5.0   5.5   6.3  .  . .
 14  1    1   0.0   3.6   4.4   5.7   6.3   6.6   7.2   7.9   9.0  10.1  .  .  .
 15  1    1   0.0   3.7   4.5   6.1   6.3   6.7   7.7   8.0   9.1  11.3  .  .  .
 16  1    1 157.5   2.5   3.4   3.9   4.3   4.5   4.9   5.2   5.6   6.1  .  .  .
 17  1    1 292.5   3.4   4.0   4.3   4.6   5.2   5.4   5.8   6.2   7.2  .  .  .
 18  1    1  22.5   3.3   4.5   5.0   5.6   6.2   7.0   7.7   8.5   9.0  .  .  .
 19  1    1 157.5   3.0   3.6   4.1   4.4   4.7   5.1   5.4   5.7   8.2  .  .  .
 20  1    1 180.0   3.8   4.8   5.6   5.8   6.4   7.0   7.7   8.0   8.9  .  .  .
 21  1    1   0.0   3.7   4.4   6.0   6.3   6.7   7.5   8.0   9.1  10.5  .  .  .
 22  1    1  22.5   3.5   4.7   5.2   5.8   6.6   7.3   8.0   8.9  11.7  .  .  .
 23  1    1 270.0   3.1   3.4   3.9   4.2   4.6   4.8   5.0   5.5   6.5  .  .  .
 24  1    1 135.0   2.0   2.8   3.4   3.7   4.2   4.7   5.3   5.8   6.5  .  .  .
 25  1    1 157.5   2.7   3.5   4.0   4.3   4.5   5.0   5.2   5.6   6.9  .  .  .
 26  1    1  22.5   3.4   4.6   5.1   5.7   6.2   7.1   7.7   8.6   9.7  .  .  .
 27  1    1 180.0   3.8   4.9   5.6   6.0   6.6   7.1   7.7   8.0  10.0  .  .  .
 28  1    1 315.0   2.8   3.5   4.1   4.5   4.9   5.5   6.1   6.4   7.1  .  .  .
 29  1    1 202.5   4.0   4.9   5.2   5.7   5.9   6.2   6.7   7.2   8.4  .  .  .
 30  1    1 247.5   2.6   3.1   3.6   4.2   4.5   4.9   5.2   5.6   6.7  .  .  .
 31  1    1   0.0   3.7   4.4   5.9   6.5   7.4   8.2   9.2  10.1  12.2  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
  .  .    .     .     .     .     .     .     .     .     .     .     .  .  .  .
```

CLIGEN File
The default CLIGEN file extension is “cli” (e.g., cligen.cli). The CLIGEN weather generator was developed for use with the Water Erosion Prediction Project (WEPP) (Flanagan, et.al., 2001) and is used by WEPS to simulate other weather parameters. The input file created by CLIGEN includes precipitation amount (mm), duration (hr), time to peak (fraction of duration), and peak intensity (mm hr^{-1}), as well as maximum and minimum air temperature (℃), solar radiation (ly d^{-1}), and dew point temperature (℃). This file also contains historical monthly averages for maximum and minimum temperature (℃), which are required by WEPS.

Although WEPS ignores non-needed data in the CLIGEN file, WEPS reads the entire file, so each line and column in WEPS must be populated, even though some elements may be ‘dummy’ variables not used by WEPS. For example, line 2 contains information not used by WEPS, but it must be present with any characters present. The CLIGEN file is read in free format. Figure 6.21 shows an example CLIGEN file.

CLIGEN File Parameters:

Line 1: CLIGEN	version number. Must be “5.110" for the file format described in this document.
Lines 2-6:	Information in these lines are not required by WEPS, but must be present as placeholders.
Line 7:	Observed monthly average maximum temperatures (°C).
Line 8	Comment line.
Line 9:	Observed monthly average minimum temperatures (°C).
Lines 10-15:	Comment lines.
Line 16 +:	daily weather data.
Columns 1, 2, 3:	**day mon year** - the day, month, and year of simulation (integer).
Column 4:	**prcp** - total precipitation for the day, including snow, hail, and rain (real-millimeters).
Column 5:	**dur** - duration of the rainfall event (real- hours).
Column 6:	**tp** - fraction of time to peak (real- time to peak in hours/duration in hours).
Column 7:	**ip** - WEPP data (real mm/hr).
Columns 8, 9:	**tmax tmin** - the maximum and minimum daily air temperature (real - C).

Column 10: **rad** - daily solar radiation (real - ly/day).

Columns 11-12: WEPP wind data, ignored in WEPS, but numbers must be present (e.g., 0.0) (real).

Column 13: **dew** - dew point temperature (real - C).

Figure 6.21 Example CLIGEN File.

```
5.110
  1   0   0
  Station:  CIMARRON KS                                 CLIGEN VERSION 5.110 -r:    0 -I: 0
Latitude Longitude Elevation(m) Obs. Years  Beginning year  Years simulated Command Line:
   37.80  -100.35      801         54           1             6        -S14 -s1522 -idb\cligen_fs.db -
b1
Observed monthly ave max temperature ©
  6.9  10.1  14.5  20.8  25.3  31.1  34.2  33.2  28.8  22.8  13.8   8.3
Observed monthly ave min temperature ©
 -8.1  -5.8  -2.1   4.1   9.8  15.3  18.0  17.0  12.2   5.3  -2.4  -6.7
Observed monthly ave solar radiation (Langleys/day)
253.0 317.0 420.0 525.0 564.0 643.0 635.0 578.0 491.0 374.0 307.0 234.0
Observed monthly ave precipitation (mm)
 14.3  17.0  33.6  48.3  90.9  89.8  87.2  68.4  45.1  37.0  21.5  13.4
da mo year  prcp  dur   tp     ip  tmax  tmin  rad  w-vl w-dir  tdew
            (mm)  (h)               ©    © (l/d) (m/s)(Deg)    ©
 1  1    1   0.0  0.00 0.00   0.00   3.9  -2.6 250.  5.5   75.  -0.4
 2  1    1   0.0  0.00 0.00   0.00  -2.5  -5.5 143.  6.0  297.  -6.8
 3  1    1   0.0  0.00 0.00   0.00   0.3  -4.0 219.  8.2  238. -16.9
 4  1    1   0.0  0.00 0.00   0.00  17.8 -10.2 253.  4.0  227. -16.5
 5  1    1   0.0  0.00 0.00   0.00   6.3 -12.3 254.  5.9  314.  -4.9
 6  1    1   0.0  0.00 0.00   0.00  15.3  -3.6 148.  8.3  238.  -4.0
 7  1    1   0.0  0.00 0.00   0.00   0.5 -10.2 257.  7.0   23.  -9.4
 8  1    1   0.4  1.66 0.01   1.01  13.9 -14.2 258.  7.9  355.  -8.5
 9  1    1   0.0  0.00 0.00   0.00   7.1  -5.6 230.  2.6  328.  -6.5
10  1    1   0.0  0.00 0.00   0.00  10.1  -6.2 283.  8.6   49.  -4.8
11  1    1   0.0  0.00 0.00   0.00  10.0  -9.0 263.  0.0    7. -20.9
12  1    1   0.0  0.00 0.00   0.00   2.8 -12.2 231.  6.9  222.  -4.8
13  1    1   0.0  0.00 0.00   0.00  -0.3 -14.1 267.  1.2  317.  -7.3
14  1    1   0.0  0.00 0.00   0.00  -4.0  -6.7 173.  3.4  313. -12.1
15  1    1   0.0  0.00 0.00   0.00  -1.7 -14.8 270.  2.7  132. -18.0
16  1    1   2.3  1.29 0.04   1.01   0.6  -4.9 262.  9.9   15. -13.7
17  1    1   0.0  0.00 0.00   0.00   6.0  -5.0 241.  7.0  338. -12.3
18  1    1   0.0  0.00 0.00   0.00   7.8  -9.1 203.  4.2  262. -13.5
19  1    1   0.0  0.00 0.00   0.00  12.3 -10.5 181.  3.7  275.  -8.1
20  1    1   0.0  0.00 0.00   0.00  -8.9 -10.5 266.  6.0    6. -17.9
21  1    1   0.0  0.00 0.00   0.00  14.7  -9.8 283.  5.7  264.  -3.7
22  1    1   0.0  0.00 0.00   0.00   3.9  -8.0 132.  3.5  233.  -8.2
23  1    1   0.0  0.00 0.00   0.00  11.2 -10.0 196.  4.9  150.  -6.5
24  1    1   0.0  0.00 0.00   0.00   2.3 -15.9 230.  4.6  136. -19.5
25  1    1   0.0  0.00 0.00   0.00  12.6 -13.7 172.  6.2  312.  -0.7
26  1    1   0.0  0.00 0.00   0.00  14.4  -6.0 272.  7.5  156.   4.0
27  1    1   0.0  0.00 0.00   0.00   2.6   0.9 213.  5.7  176.  -5.1
28  1    1   4.2  1.19 0.00   1.01  15.2 -15.3 173.  7.7  170. -14.8
29  1    1  10.6  1.73 0.05   1.01  24.8  -3.5 302.  4.8  206.  -7.3
```

```
30  1    1   3.5  1.92 0.29   4.81   8.3  -5.9 280.  2.7  277. -14.0
31  1    1   0.0  0.00 0.00   0.00  20.9   2.3 228.  2.9  240.   1.3
 1  2    1   0.0  0.00 0.00   0.00   7.5  -4.9 241.  7.3  316.  -5.8
 2  2    1   0.0  0.00 0.00   0.00   7.6  -4.6 316.  2.2  169. -10.1
 3  2    1   0.0  0.00 0.00   0.00   3.6 -12.8 326.  4.3  322.  -4.7
 .  .    .    .    .    .      .      .     .    .   .      .    .
 .  .    .    .    .    .      .      .     .    .   .
```

Soil File

The default soil file name has an "ifc" extension (e.g., amarillo.ifc). This file contains the initial soil conditions at the start of a simulation run. The soil and management submodels then simulate changes in these conditions as affected by weather, management, and erosion for each simulation day. Even intrinsic parameters such as particle size distribution will change with tillage as layers are mixed. If simulated soil parameters differ significantly from measured values, it is recommended that the user use the stand-alone Erosion model (described in this chapter) to simulate single storms using measured values. The soil input file includes the taxonomic order, number, and thickness (mm) of soil layers; detailed particle size distribution (fraction); wet and dry bulk density (Mg m^{-3}); aggregate stability (ln(J m^{-2})), density (Mg m^{-3}), and size distribution (fraction); soil crust properties (varies); random and oriented (ridge) roughness (mm); soil water characterization parameters (varies); dry albedo (fraction); organic matter (fraction); pH; calcium carbonate (fraction); and cation exchange capacity (meq $100g^{-1}$). This file also contains comments (indicated by a '#' in column one) that describe each line of input data to aid in checking and modifying input data. A description of the items required by WEPS follows, which can be viewed and edited within soil panel of the WEPS interface. The absolute range is that allowable by WEPS; the typical range lists the range of values to be expected with typical soils. An example Soil file is shown in Figure 6.22.

The WEPS soil interface is a simple way to edit input data in the Soil file and is recommended. It is also recommended that the user select an existing soil file from the database with similar properties to the desired soil and modify its properties. Soil database files that were derived from the NRCS SSURGO database are accessed through the bottom of the WEPS main screen. Once a soil is selected, the soil interface is accessed by clicking the "Soil" button at the bottom of the main screen. The information presented here is for the benefit of those users who wish to modify the input file themselves.

Soil File Parameters:

Version

Version: - A version number to allow the user to choose between an older ifc file format and the newer format, which is Version 1.0 (described here). Contact WERU if you have ifc files in an older format that you want to use with WEPS.

Soil Identification

Soil ID - Soil identifying information consisting of the following (separated by a dash). Note that these items are not critical to the operation of WEPS, and are used for identification purposes only.

Soil Survey Area ID - The soil survey area identification for the soil (character). The soil survey area identification is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Map Unit Symbol - The symbol used to uniquely identify the soil map unit in the soil survey (character). The map unit symbol is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Component Name - The name of the soil (character). The soil component name is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Component Percent - The percentage of the soil component of the map unit (integer). The soil component percentage is not critical to the operation of WEPS, and is used for identification purposes only.
Absolute range = >0 to 100 Typical range = >0 to 100
Estimated by: “Unknown”

Surface Texture Class - The class of the surface layer based on USDA system for particle size (character). The texture class is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

State - The state in which the soil occurs (character). The state is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

County - The county in which the soil occurs (character). The county is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Soil Survey Area Name - The soil survey area name in which the soil occurs (character). The soil survey area name is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Local Phase - Phase criterion used at the local level to help identify soil components (character). The local phase is not critical to the operation of WEPS, and is used for identification purposes only.
Estimated by: “Unknown”

Soil Order - The taxonomic soil order is the name for the highest level in soil taxonomy (character). The taxonomic soil order is not critical to the operation of WEPS, and is used for identification purposes only.

Estimated by: "Unknown"

Soil Loss Tolerance (T factor) - The maximum amount of erosion at which the quality of a soil as a medium for plant growth can be maintained. (Tons/acre/year) The soil loss tolerance is not critical to the operation of WEPS, and is used for identification purposes only.

Absolute range = 1 - 5 Typical range = 1 - 5

Estimated by: "Unknown"

Dry Soil Albedo - The estimated ratio of the incident short-wave (solar) radiation that is reflected by the air dry, less than 2 mm fraction of the soil surface (unitless).

Absolute range = 0.00 to 1.00 Typical range = 0.05 to 0.25

Estimated by: method of method of Post et.al., (2000) or Baumer (1990).

Slope Gradient - The difference in elevation between two points on the overall field surface, expressed as a fraction of the distance between those points. (real fraction)

Absolute range = 0.0 - 0.999 Typical range = 0.0 - 0.3

Estimated by: slope = 0.01

Soil Surface Properties & Depth Restrictions

Surface Fragment Cover - The fraction of the surface area covered by rock greater than 2.0 mm (m^3/m^3).

Absolute range = 0.0 to 1.0 Typical range = 0.0 - 0.5

Estimated by: Surface layer fragment volume

Depth to Bedrock - The observed depth to the top of the bedrock layer, if present (mm).

Absolute range = 0.0 to 99990.0 Typical range = ?

Estimated by: depth to bedrock = 99990.0

Depth to Root Restricting Layer - The depth to the upper boundary of a restrictive layer, if present (mm).

Absolute range = 0.0 to 99990.0 Typical range = ?

Estimated by: depth to bedrock = 99990.0

Soil Layer Properties

Number of Soil Layers - The number of soil horizons of layers for which properties are reported.

Layer Thickness - The thickness of each soil layer (mm). WEPS requires a specific layer structure, which is determined by the soil interface.

Estimated by: user defined (required)

Sand - Mineral particles 0.05 to 2.0 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).

Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (silt + clay)]
Estimated by: sand = 1.0 - (silt + clay)

Silt - Mineral particles 0.002 to 0.05 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).

Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (sand + clay)]
Estimated by: silt = 1.0 - (sand + clay)

Clay - Mineral particles less than 0.002 mm in equivalent diameter as a weight fraction of the less than 2.0 mm fraction (kg/kg).

Absolute range = (>0.0) to 1.0 Typical range = [1.0 - (sand + silt)]
Estimated by: clay = 1.0 - (silt + sand)

Rock Fragments - The volume fraction of the layer occupied by the 2.0 mm or larger (20 mm or larger for wood fragments) on a whole soil basis (m^3/m^3).

Absolute range = 0.0 to 1.0 Typical range = 0.0 - 0.5
Estimated by: rock fragments = 0.0

Sand Fractions

Sand Fractions: Coarse - Mineral particles 0.5 to 1.0 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: CS = 0.0

Sand Fractions: Very Coarse - Mineral particles 1.0 to 2.0 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: VCS = 0.0

Sand Fractions: Medium - Mineral particles 0.2 to 0.5 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: MS = 0.0

Sand Fractions: Fine - Mineral particles 0.1 to 0.2 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: FS = 0.0

Sand Fractions: Very Fine - Mineral particles 0.05 to 0.1 mm in equivalent diameter as a weight fraction of the less than 2 mm fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0
Estimated by: user defined (required)

Bulk Density

Bulk Density 1/3 Bar - The oven dry weight of the less than 2 mm soil material per unit volume of soil at a tension of 1/3 bar (Mg/m^3).

Absolute range = (>0.0) to 10.0 Typical range = 0.8 to 1.6

Estimated by: user defined (required)

Other Layer Properties

Organic Matter - The amount by weight of decomposed plant and animal residue expressed as a weight fraction of the less than 2 mm soil material (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0005 to 0.05

Estimated by: user defined (required)

pH - The negative logarithm to the base 10, of the hydrogen ion activity in the soil according to the 1:1 soil:water ratio method (unitless). A numerical expression of the relative acidity or alkalinity of a soil sample.

Absolute range = 1.0 to 14.0 Typical range = 4.0 to 9.0

Estimated by: pH = 7.0

$CaCO_3$ - The quantity of carbonate (CO_3) in the soil expressed as $CaCO_3$ and as a weight percentage of the less than 2 mm size fraction (kg/kg).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 0.3

Estimated by: user defined (required)

CEC - The cation exchange capacity (meq/100g).

Absolute range = 0.0 to 400.0 Typical range = 0 to 400.0

Estimated by: user defined (required)

Linear Extensibility Percent - The linear expression of the volume difference of natural soil fabric at 1/3 or 1/10 bar water content and oven dryness. The volume change is reported as a percentage change for the whole soil (%).

Absolute range = 0.0 to 30.0 Typical range = ?

Estimated by: Soil Survey Staff (1996).

Aggregates

Aggregate Geometric Mean Diameter - Soil aggregate geometric mean diameter of the modified log-normal distribution (mm).

Absolute range = 0.03 to 30.0 Typical range = 0.1 to 15.0

Estimated by: aggr. gmd = exp(3.44 – 7.21*(0.2909 + 0.31*sand 0.17* silt + 0.0033*sand/clay -4.66 * om – 0.95 * $CaCO_3$) * (1.0 + 0.006 * layer depth)

Aggregate Geometric Standard Deviation - Soil aggregate geometric standard deviation of the modified log-normal distribution (dimensionless).

Absolute range = 1.0 to 20.0 Typical range = 4.0 to 15.0

Estimated by:

aggr. gsd = 1.0 / (0.0203 + 0.00193(aggr. gmd) + 0.074 / $(aggr.gmd)^{0.5}$)

Maximum Aggregate Size - Upper limit of the modified log-normal aggregate size distribution (mm).

Absolute range = 1.0 to 1000.0 Typical range = 2.0 to 100.0

Estimated by: aggr.max. size = $(aggr.\ gsd)^{p}$ * (aggr. gmd) + 0.84

where p = 1.52 * $(aggr.\ gmd)^{-0.449}$

Minimum Aggregate Size - Lower limit of the modified log-normal aggregate size distribution (mm).

Absolute range = 0.001 to 5.0 Typical range = 0.006 to 0.020

Estimated by: aggr min. size = 0.01

Aggregate Density - The aggregate density for (Mg/m^3).

Absolute range = 0.6 to 2.5 Typical range = 0.8 to 2.0

Estimated by: Rawls (1983)

aggr density = 2.0 for layer depth > 300 mm

aggr density = 2.01 *(0.72 + 0.00092 * layer depth) for layer depth < 300 mm

Aggregate Stability - Mean of natural log of aggregate crushing energies (ln(J/kg)).

Absolute range = 0.1 to 7.0 Typical range = 0.5 to 5.0

Estimated by: aggr. stability = 0.83 + 15.7 * clay - 23.8 * $clay^{2}$

Soil Crust

Soil Crust Thickness - Average thickness of the consolidated zone in the surface layer (mm).

Absolute range = 0.0 to 23.0 Typical range = 0.0 to 10.0

Estimated by: crust thickness = 0.01

Soil Crust Density - The density of the soil crust (Mg/m^3).

Absolute range = 0.6 to 2.0 Typical range = 0.8 to 1.6

Estimated by: aggregate density

Soil Crust Stability - Mean of natural log of crust crushing energies (ln(J/kg)).

Absolute range = 0.1 to 7.0 Typical range = 0.3 to 5.0

Estimated by: aggregate stability

Crust Surface Fraction - Fraction of surface covered with consolidated soil, as opposed to aggregated soil (m^2/m^2).

Absolute range = 0.0 to 1.0 Typical range = 0.0 to 1.0

Estimated by: 0.0

Mass of Loose Material on Crust - Mass of the loose, saltation-size soil on the surface soil crusted area (kg/m^2).

Absolute range = 0.0 to 3.0 Typical range = 0.0 to 1.0

Estimated by: 0.0

Fraction of Loose Material on Crust - Fraction of total soil surface area covered with loose material on the crust (m^2/m^2).

Absolute range = 0.0 to soil crust fraction Typical range = 0.0 to 0.5
Estimated by: 0.0

Roughness

Random Roughness - The standard deviation of elevation from a plane of a random soil surface, including any flat biomass adjusted as suggested by Allmaras et.al., (1966) (mm).

Absolute range = 1.0 to 70.0 Typical range = 2.0 to 10.0
Estimated by: 4.0

Ridge Orientation - Direction of the tillage ridge, clockwise from true north (degrees).

Absolute range = 0.0 to 179.99 Typical range = 0.0 to 179.99
Estimated by: 0.0

Ridge Height - The height of soil ridges from bottom of furrow to top of ridge (mm).

Absolute range = 0.0 to 500. Typical range = 0.0 to 300.0
Estimated by: 0.0

Spacing Between Ridge Tops - Spacing between ridge tops (mm).

Absolute range = 10.0 to 2000.0 Typical range = 60.0 to 1000.0
Estimated by: 10.0

Ridge Width - Width of the top of the ridge (i.e. bed width) (mm)

Absolute range = 10.0 to 4000.0 Typical range = 100.0 to 2000.0
Estimated by: 10.0

Hydrologic properties

Initial Bulk Density (1/3 Bar) - The oven dry weight of the less than 2 mm soil material per unit volume of soil at a tension of 1/3 bar (Mg/m^3).

Absolute range = (>0.0) to 10.0 Typical range = 0.8 to 1.6
Estimated by: user defined (required)

Initial Water Content - Soil water content at the beginning of the simulation (cm^3/cm^3).

Absolute range = 0.0 to field capacity Typical range = varies with soil texture
Estimated by: ½ (field capacity + wilting point)

Saturation Water Content - Soil water content when soil pores are completely filled (i.e. zero soil matric potential) (cm^3/cm^3).

Absolute range = 0.0 to > field capacity Typical range = varies with soil texture
Estimated by: Saxton, et al. (1986)

Note: Saturated water content > Field capacity water content > Wilting point water content

Field Capacity Water Content - The amount of soil water retained at 1/3 bar (33 kPa), expressed as a fraction of the less than 2 mm, oven-dry soil by volume (cm^3/cm^3).

Absolute range = 0.0 to < saturation Typical range = varies with soil texture
Estimated by: Saxton, et al. (1986)
Note: Saturated water content > Field capacity water content > Wilting point water content

Wilting Point Water Content - The amount of soil water retained at 15 bars (1500 kPa), expressed as a percentage of the less than 2 mm, oven-dry soil by volume (cm^3/cm^3).

Absolute range = 0.0 to < field capacity Typical range = varies with soil texture
Estimated by: Saxton, et al. (1986)
Note: Saturated water content > Field capacity water content > Wilting point water content

Soil CB Value - The power of Campbell's model of the soil water characteristics curve (unitless).

Absolute range = 0.917 to 27.027 Typical range = varies with soil texture
Estimated by: Saxton, et al. (1986)

Air Entry Potential - The air entry potential is defined as the potential at which the largest water-filled pores start to drain and hence gas flow can be observed (Joules/kg).

Absolute range = -17.91 to 0.0 Typical range = varies with soil texture
Estimated by: Saxton, et al. (1986)

Saturated Hydraulic Conductivity - The amount of water that would move vertically through a unit area of saturated soil in a unit time under unit hydraulic gradient (m/s).

Absolute range = 0.0 to 1E-3 Typical range = 0.0 to 1E-3
Estimated by: Saxton, et al. (1986)

Notes - The user may enter any notes pertaining to the soil file. These notes are appended to the bottom of the soil file. The soil notes may also contain notes generated by the interface. These generated notes specify parameters that were adjusted because of out-of-range values, and lists the old and new values. The notes are not critical to the operation of WEPS, and are used for information purposes only.

Figure 6.22 Example Soil file.

```
Version: 1.0
#
# Soil ID
CO631-Se-San Luis-100-SL-Colorado-Rio Grande County Area-Rio Grande County Area,
Colorado
#
# Local Phase
DRAINED
# Soil Order
Aridisols
# Soil Loss Tolerance (tons/acre/year)
```

```
3
# Dry soil albedo (fraction)
0.230
# Slope gradient (fraction)
0.010
# Surface fragment cover or surface layer fragments (area fraction)
0.000
#
# Depth to bedrock (mm)
99990
# Depth to root restricting layer (mm)
99990
#
# Number of layers
3
# Layer thickness (mm)
150     460     910
#
# Sand fraction
0.659     0.340     0.960
# Silt fraction
0.191     0.370     0.015
# Clay fraction
0.150     0.290     0.025
# Rock fragments
0.000     0.000     0.260
# Sand fraction very coarse
0.043     0.030     0.007
# Sand fraction coarse
0.141     0.043     0.131
# Sand fraction medium
0.175     0.059     0.372
# Sand fraction fine
0.196     0.106     0.378
# Sand fraction very fine
0.104     0.102     0.072
#
# Bulk Density (1/3 bar)(Mg/m^3)
1.350     1.250     1.400
# Organic matter (kg/kg)
0.0075     0.0025     0.0025
# Soil PH (0-14)
8.50     9.80     7.90
# Calcium carbonate equivalent (CaCO3)
0.08     0.15     0.06
# Cation exchange capacity (CEC) (meq/100g)
10.00     15.00     2.50
# Linear extensibility
0.015     0.045     0.015
#
# Aggregate geometric mean diameter (mm)
2.647     15.675     2.929
# Aggregate geometric standard deviation
13.086     13.393     13.463
# Maximum aggregate size (mm)
33.055     49.322     33.579
# Minimum aggregate size (mm)
0.010     0.010     0.010
# Aggregate density (Mg/m^3)
1.725     2.000     2.000
# Aggregate stability (ln(J/m^2))
2.650     3.381     1.208
#
```

```
# Crust thickness (mm)
0.010
# Crust density (Mg/m^3)
1.725
# Crust stability (ln(J/m^2))
2.65
# Crust surface fraction (m^2/m^2)
0.00
# Mass of loose material on crust (kg/m^2)
0.00
# Fraction of loose material on crust (m^2/m^2)
0.00
#
# Random roughness (mm)
4.00
# Ridge orientation (deg)
0.00
# Ridge height (mm)
0.00
# Spacing between ridge tops (mm)
10.00
# Ridge width (mm)
10.00
#
# Initial Bulk Density (1/3 bar)(Mg/m^3)
1.350     1.250     1.400
# Initial soil water content (m^3/m^3)
0.140     0.222     0.037
# Saturation soil water content (m^3/m^3)
0.434     0.494     0.313
# Field capacity water content (m^3/m^3)
0.188     0.296     0.060
# Wilting point water content (m^3/m^3)
0.091     0.148     0.014
#
# Soil CB value (exponent to Campbell's SWRC)
5.909     6.175     3.957
# Air entry potential (J/kg)
-0.429     -1.633     -0.423
# Saturated hydraulic conductivity (m/s)
2.821E-5     2.819E-6     9.174E-5
#
# Notes:
#  The user may enter notes here.
```

Management File

The default file name is **'*.man'**. This file contains parameters for the manipulation of soil and biomass properties as a result of various management operations performed on the field on a given date. These operations include planting, harvesting, cultivation, defoliation, fertilization, and irrigation. The management file should only be altered by using the Management Crop Rotation Editor for WEPS (MCREW), to guarantee that parameters are correct. MCREW is accessed through the WEPS user interface.

Stand-alone Erosion Submodel

The Erosion submodel (tsterode) can also be operated as a stand-alone model to simulate erosion for a single storm (i.e., daily). Input parameters that must be provided for the day include the field and barrier dimensions, as well as biomass, soil, hydrology, and weather parameters. Wind speed can be entered either as Weibull distribution parameters or listed as average wind speeds for each time period throughout the day. Valid command line options for the stand-alone erosion submodel are:

Command Line Options

Usage: tsterode -i"input_filename" -x# -y# -t# -u -E -Plot -? -h

Valid command line options:

-? or -h	Display the available command line options.
-x#	Number of grid points in x direction (min. = 3; max. = 500). The submodel calculates the loss/deposition over a series of individual, equal-sized grid cells representing the entire simulation region. The more grid points, the smaller the area in each grid cell. The recommended total number of grid cells is 30 for a field without a barrier and 60 for a field with a barrier. Increasing the number of grid cells increases the accuracy of the soil loss/deposition estimates, as well as increases the run time. If not specified, the number of grid points is calculated within the model.
-y#	Number of grid points in y direction (min. = 3; max. = 500). The submodel calculates the loss/deposition over a series of individual, equal-sized grid cells representing the entire simulation region. The more grid points, the smaller the area in each grid cell. The recommended total number of grid cells is 30 for a field without a barrier and 60 for a field with a barrier. Increasing the number of grid cells increases the accuracy of the soil loss/deposition estimates, as well as increases the run time. If not specified, the number of grid points is calculated within the model.
-t#	Interval for surface updating in seconds (min. = 60 seconds; max. = 86400 seconds). This is used to specify a fixed surface updating interval and is primarily for testing and evaluation purposes. Because the erosion code contains an update loop dependent upon the number of time intervals/day and an inner loop that allows more frequent surface updating to occur, the imp interval must be evenly divisible into both the number of time intervals/day and 24 (hours in a day). If these conditions are not met, the program aborts with an error message.
-u	Disable erosion surface updating.

-i"input_filename"	Specify input filename. The input filename must be specified and listed before the -Einp, -Erod, -Egrd, and -Emit options. Quotes are required if spaces are within the file name.
-Einp	Writes (echos) the input file to "input_filename.einp". This is useful for debugging purposes. The "input_filename" is the same name as the input filename with a ".eimp" extension, and will be created in the same directory specified for the input filename.
-Erod	Output erosion summary (kg/m^2) (positive values are soil loss). The one line output in the file contains the following: Total loss, saltation plus creep, suspension, PM10, and the input filename The "-Erod' option requires that the input file (-i"input_filename") be specified as a command line argument before the "-Erod" option, e.g.: tsterode -iinput_filename.ext -Erod The "input_filename" in the erosion summary is the same name as the input filename with a ".erod" extension, and will be created in the same directory specified for the input filename.
-Egrd	Output grid summary results (kg/m^2) (positive values are soil loss). The "-Egrd' option requires that the input file (-i"input_filename") be specified as a command line argument before the "-Egrd" option, e.g.: tsterode -iinput_filename.ext -Egrd The "input_filename" in the grid summary is the same name as the input filename with a ".egrd" extension, and will be created in the same directory specified for the input filename.
-Emit	Output hourly erosion results (kg/m^2) (positive values are soil loss). The "-Emit' option requires that the input file (-i"input_filename") be specified as a command line argument before the "-Emit" option, e.g.: tsterode -iinput_filename.ext -Emit The "input_filename" in the hourly erosion results is the same name as the input filename with a ".emit" extension, and will be created in the same directory specified for the input filename.
-Eplt	Enable printing of a file that can be used to plot various data. The data is appended to the file for each run.

-Esgrd Output all grid cell values for selected grid cell variables (e.g., RR, ridge ht, friction velocity, etc.) as well as the standard erosion results for each subdaily period. Each "period" is identified by the "yy mm dd hr variable_name_title" prior to the grid cell values. The “-Esgrd’ option requires that the input file (-i"input_filename") be specified as a command line argument before the “-Esgrd” option, e.g.:

tsterode -iinput_filename.ext -Esgrd

The “input_filename” in the grid summary is the same name as the input filename with a “.sgrd” extension, and will be created in the same directory specified for the input filename.

Default options are set to:
-t900

Note that these command line options cannot be specified when the erosion submodel is run through the WEPS interface.

The input file contains comments (indicated by a ‘#’ in column one) that describe each line of input data to aid in checking and modifying input data, which follows the comments. Specific definitions of these parameters are documented within the comment lines within the input file (Figure 6.23)

Figure 6.23 Example stand-alone erosion input file.

```
#*****************************************************************
#    erod_template.in   Template INPUT DATA FILE
#                       Updated January 2006 - LEW
#*****************************************************************
#
#     +++ PURPOSE +++
#
#     Input file for standalone erosion submodel program (tsterode)
#
#     All lines beginning with a "#" character are assumed to
#     be comment lines and are skipped.
#
#     +++ DEFINITIONS +++
#
#     All comments prior to each line of data input
#     in this template input file have the following format:
#
#     Variable_Name, Var_type, Text Definition
#
```

```
#     where Var_type is: I = integer L = logical R = real
#
#
# +++ DEBUG STUFF +++
#
#     debugflg - debug flag for providing different levels of debug info
#                currently useful to debug/check input file data format
#
#                value of 0 will print no debug information
#                value of 1 will print out and number all input file lines
#                value of 2 will print out and number all data input lines
#                value of 3 will do both 1 and 2
 0
#
#
# +++ INIT STUFF +++
#
#     am0eif, L, EROSION "initialization" flag
#                Must be set to .TRUE. for standalone erosion runs
 .TRUE.
#
#     am0efl, I, EROSION "print" flag
#               NOTE:  Not sure if all of these have yet been replaced by
#                      "tsterode" cmdline options.  Regardless, this flag
#                      should be considered deprecated in this file. - LEW
#               Range: 0 to 6
#               0 = print input, no output
#               1 = print input, standard output
#               2 = print input, 1 line output
#               3 = used in WEPS to print input, then create file "emit.out"
#                       containing hourly suspended emission rates
#            4 = used in standalone to print input, then create file "emit.out"
#                       containing hourly suspended emission rates
#               5 = not used at present
#               6 = print input, detail output each step using calls
#                       to sb1out and sb2out
 1
#
# +++ SIMULATION REGION +++
#
#     amxsim(x,y), R, Simulation Region diagonal coordinates (meters)
#                     Input (x,y) coordinates in this form: x1,y1 x2,y2
#                      Typical Range: 10.0 to 1600.0
#
#                     NOTE:  Accounting region and Subregion coordinates
#                            must also be set to the same values
#
  0.0, 0.0 1000.0, 200.0
#
#
#     amasim, R, Simulation Region orientation angle (degrees from North)
 0.0
#
#
# +++ ACCOUNTING REGIONS +++
#
#     nacctr, I, Number of accounting regions (must always be 1 for now)
 1
#
#     amxar(x,y,a), R, Accounting Region diagonal coordinates (meters)
```

```
#                       Input (x,y) coordinates in this form: x1,y1 x2,y2
#                       for each Accounting Region specified (nacctr)
#
#                       NOTE:  Accounting Region coordinate values must
#                              match Simulation Region coordinates above
#
 0.0, 0.0 1000.0, 200.0
#
#
# +++ BARRIERS +++
#
#     nbr, I, Number of barriers (0-5)
 2
#     NOTE: Remaining BARRIER inputs are repeated for each barrier specified
#           If no barriers specified (nbr=0), then no BARRIER inputs will
#           be listed here.
#
#     amxbr(x,y,b), R, Barrier linear coordinates (meters)
#                       Input (x,y) coordinates in this form: x1,y1 x2,y2
#                       for each barrier specified (nbr)
 0.0, 0.0 0.0, 200.0
#
#       amzbr(b),  R, Barrier height (meters)
#       ampbr(b),  R, Barrier porosity (m^2/m^2)
#       amxbrw(b), R, Barrier width (meters)
#
 0.2 0.5 15.0
#
#       Repeat previous two input lines for each additional barrier
#
#       Barrier #2 coordinates (x1,y1) (x2,y2)
 0.0, 0.0 1000.0, 0.0
#       Barrier #2 height, porosity and width
 0.2 0.5 15.0
#
#
# +++ SUBREGION REGIONS +++
#
#     nsubr, I, Number of subregions (1-5)
#               NOTE:  Currently not fully tested for multiple subregions
#                      Only use value of 1
#
 1
#
#     NOTE: Remaining SUBREGION inputs (BIOMASS, SOIL, and HYDROLOGY,
#     ie. variables defined by subregion) are repeated for "nsubr"
#     subregions specified
#
#     amxsr(x,y,s), R, Subregion diagonal coordinates (m)
#                       Input (x,y) coordinates in this form: x1,y1 x2,y2
#                       for each subregion specified (subr)
#
#                       NOTE:  Since only one subregion is currently supported,
#                              subregion coordinate values must match
#                              Simulation Region coordinates above
#
 0.0, 0.0 1000.0, 200.0
#
#
#     +++ BIOMASS +++
```

```
#
#
#       adzht_ave(s), R, Height of standing residue (meters)
#                        WEPS generated input files will provide
#                        "SAI weighted" average residue height
#                        across all residue pools.
#            Typical Range: 0.0 to 3.0
 0.21
#
#       aczht(s), R, Average height of growing crop (meters)
 0.0
#
#       acrsai(s), R, Growing crop stem area index (m^2/m^2)
#               Typical Range: 0.0 to 3.0
#       acrlai(s), R, Growing crop leaf area index (m^2/m^2)
#               Typical Range: 0.0 to 8.0
 0.0 0.0
#
#       adrsaitot(s), R, Residue stem area index (m^2/m^2)
#       adrlaitot(s), R, Residue leaf area index (m^2/m^2)
#                        WEPS generated input files will provide
#                        total "SAI" and "LAI" values
#                        across all residue pools.
 0.02 0.00
#
#      acxrow(s), R, Growing crop row spacing (meters)
#                    Use value of 0.0 if not planted in rows,
#                    e.g. broadcast seeded
#      ac0rg(s) , I, Specify seed location (0=furrow,1=ridge)
#                    Value doesn't matter if no ridges exist
 0.3, 0
#
#       abffcv(s), R, Flat biomass cover (m^2/m^2)
 0.0
#
#
#     +++ SOIL +++
#
#     nslay(s), I, (s1layr.inc) Number of soil layers (1-100)
#                  NOTE:  Only surface soil layer necessary
 1
#
#     NOTE: Remaining SOIL inputs are repeated on each input line
#           for each layer specified
#
#     aszlyt(l,s), R, Thickness (mm)
 1000.0
#
#     asdblk(l,s), R, Bulk density of soil layer (Mg/m^3)
#                  Typical Range: >0.0 to 10.0
 1.8
#     asfsan(l,s), R, Fraction of sand content in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (sand + silt + clay = 1.0)
 0.90
#     asfvfs(l,s), R  Fraction of very fine sand in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (fraction of total soil < 2.0 mm)
 0.21
#     asfsil(l,s), R, Fraction of silt content in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (sand + silt + clay = 1.0)
 0.08
```

```
#     asfcla(l,s), R, Fraction of clay content in soil layer (Mg/Mg)
#                  Range: 0.0 to 1.0 (sand + silt + clay = 1.0)
 0.02
#
#     asvroc(l,s), R, Rock volume in soil layer (m^3/m^3)
#                  Range: 0.0 to 1.0
 0.30
#
#     asdagd(l,s), R, Average aggregate density of soil layer (Mg/m^3)
#                  Typical Range: 0.5 to 2.5
 1.8
#     aseags(l,s), R, Average dry aggregate stability of soil layer [ln(J/kg)]
#                  Typical Range: 0.1 to 7.0
 2.50
#
#       ---- Size distribution of soil aggregates ----
#         GMD - Geometric Mean Diameter of aggregates
#         GSD - Geometric Mean Standard Deviation of aggregates
#
#     aslagm(l,s), R, GMD of aggregate sizes in soil layer (mm)
#                  Typical Range: 0.03 to 30.0
 0.47
#     aslagn(l,s), R, Minimum aggregate size in soil layer (mm)
#                  Typical Range: 0.001 to 5.0
 0.043
#     aslagx(l,s), R, Maximum aggregate size in soil layer (mm)
#                  Typical Range: 1.0 to 1000.0
 89.8
#     as0ags(l,s), R, GSD of aggregate sizes in soil layer (mm/mm)
#                  Typical Range: 1.0 to 40.0
 12.0
#
#     +++ SOIL SURFACE +++
#
#     asfcr(s),  R, Surface crust fraction (m^2/m^2)
#              Range: 0.0 to 1.0
#     aszcr(s),  R, Surface crust thickness (mm)
#              Typical Range: 0.0 to 23.0
#     asflos(s), R, Fraction of crusted surface with loose material on top of crust #
(m^2/m^2)
#              Range: 0.0 to 1.0
#     asmlos(s), R, Mass of loose material on top of crust (kg/m^2)
#              Typical Range: 0.0 to 3.0
#     asdcr(s),  R, Density of soil crust (Mg/m^3)
#              Typical Range: 0.6 to 2.0
#     asecr(s),  R, Dry crust stability [ln(J/kg)]
#              Typical Range: 0.0 to 7.0
 0.6 7.0 0.2 0.4 0.1 1.0
#
#     aslrr(s),  R, Allmaras random roughness (mm)
#              Typical Range: 1.0 to 60.0
 5.0
#     aszrgh(s), R, Ridge height (mm)
#              Typical Range: 0.0 to 500.0
#     asxrgs(s), R, Ridge spacing (mm)
#              Typical Range: 0.0 to 2000.0
#     asxrgw(s), R, Ridge width (mm)
#              Typical Range: 0.0 to 4000.0
#     asxrgo(s), R, Ridge orientation (degrees)
#              Range: 0.0 to 179.99
```

```
#                 NOTE: If no ridges, then specify 0.0 for height, width and spacing
 0.0 0.0 0.0 0
#     asxdks(s), R, Dike spacing (mm)
#             Typical Range: 0.0 to 1000.0
#                   NOTE: If no dikes, then specify 0.0
 0.0
#
#     +++ HYDROLOGY +++
#
#     ahzsnd(s), R, Snow depth (mm)
#             Typical Range: 0.0 to 1000.0
 0.0
#
#     ahrwcw(l,s), R, Wilting point water content of soil layer (Mg/Mg)
#             Typical Range: 0.0 to 0.25
 0.077
#
#     ahrwca(l,s), R, Current water content of soil layer (Mg/Mg)
#             Typical Range: 0.0 to 0.50
 0.0
#
#
#     ahrwc0(h,s), R, Surface layer water content (Mg/Mg)
#             Typical Range: 0.0 to 0.50
#                  NOTE: The near surface water content is specified on an
#                        hourly basis.  We read in the hourly water content
#                        on two lines, with 12 values in each line.
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
#
#
# NOTE: This is the end of the SUBREGION variables
#
#     +++ WEATHER +++
#
#     awdair, R, Air density (kg/m^3)
#             Typical Range: 0.7 to 1.5
 1.2
#
#     awadir, R, Wind direction (degrees) measured clockwise from North
#             Typical Range: 0.0 to 359.9
 270.0
#
#     ntstep, I, Number of intervals/day to run EROSION
#             Range: 24 to 96
#
#                NOTE:  ntstep = 24 means hourly updates
#                       ntstep = 48 means 30 minute updating
#                       ntstep = 96 means 15 minute updating
 24
#
#     anemht, R  anemometer height (m)
#             Typical Range: 0.5 to 30.0
#     awzzo,  R  aerodynamic roughness at anemometer site (mm)
#             Typical Range: 0.5 to 2000.0
#     wzoflg, I (global variable) zo location flag
#               (flag =0 - at weather station location - zo is a constant)
#               (flag = 1 - on field location - zo varies based on field surface)
    10.0,  10.00  0
#
```

```
#     wflg, I, Wind/Weibull flag
#              (0 - read in Weibull parameters, 1 - read in wind speeds)
 1
#
# NOTE: This is only present when (wflg=0)
#     wfcalm, R, Fraction of time winds are calm (hr/hr)
#             Range: 0.0 to 1.0
#     wuc, R, Weibull "c" factor (m/s)
#             Typical Range: >0.0 to 30.0
#     w0k, R, Weibull "k" factor
#             Typical Range: 1.0 to 3.0
#  0.217 7.125 2.971  <--- Example data line for wind expressed as Weibull parameters
#
# NOTE: The remaining data is only present when (wflg=1)
#     awu(i), R, Wind speed for (ntstep) intervals (m/s)
#             Typical Range: 0.0 to 30.0
#
#                NOTE: We can read multiple lines with 6 values per line
#                      Wind data should be AVERAGES for the period.
#                      Hourly averages will often under estimate wind erosion.
#                      30 minute averages or shorter time interval is more suitable.
8.181  4.068  4.068  4.426  5.052  5.052
4.739  4.292  4.515  3.353  3.621  2.280
5.275  6.750  7.242  7.868  9.835  13.814
17.211 12.651 11.712 12.964 10.014 8.583
#
#
# *******************************************************
#    NOTE:  Not necessary to modify any information below this line
#           unless one is interested in generating a "plot.out" file.
# *******************************************************
#
#    + + + DATA TO PLOT + + +
#
#      "xplot" flag for writing variables to file 'tsterode.eplt'.
#       -1 = write nothing
#        0 = write erosion variables;
#      Actual variables listed below are only written if flagged with a 1
#
#      NOTE:  This flag is deprecated.  Tsterode cmdline options determine
#             if this file is create and/or data appended to it.
  0
#
#      Next are 2 lines per variable:
#       1st line: flag (0=don't write, 1=do write) and variable description
#       2nd line: this info is used as a header in 'plot.out'
#           place header within first 12 positions of the line
#
# xin(i), R, (field length)
   1
  Length(m)
# abzht, R, (biomass ht.(m))
   1
 bio_ht(m)
# abrsai, R (stem area index)
  1
 stem_area
#   abrlai(s), R, Biomass leaf area index (m^2/m^2)
  1
 lai_area
```

```
# abffcv, R, (biomass flat fraction cover)
  0
 flat_cov
#     asfvfs(1,s), R, (soil fraction very fine sand in layer 1)
  0
  vfsand
#     asfsan(1,s), R, (soil fraction sand in layer 1)
  1
   sand
#     asfsil(1,s), R (soil fraction silt in layer 1)
  0
  silt
#     asfcla(1,s), R (soil fraction clay in layer 1)
  0
  clay
#     asvoc(1,s), R (soil volume roc in layer 1)(m^3/m^3)
  0
  rock_vol
#     aseags(1,s), R (soil aggregate stability) (ln J/m^3)
  0
  ag_stab
#     aslagm(1,s), R (soil aggregate geom. mean dia.) (mm)
  0
  ag_gmd
#     aslagn(1,s), R (soil aggregate min. dia.) (mm)
  0
  ag_min
#     aslagx(1,s), R (soil aggregate max. dia.) (mm)
  0
  ag_max
#     as0ags(1,s), R (soil aggregate geo. std. dev.)
  0
  ag_std
#     asfcr(s), R, (s1surf.inc) Surface crust fraction (m^2/m^2)
  0
  crust_cv
#     aszcr(s), R, (s1surf.inc) Surface crust thickness (mm)
  0
 crust_z(mm)
#     asflos(s), R, (s1surf.inc) Fraction of loose material on surface (m^2/m^2)
  0
  los_cv
#     asmlos(s), R, (s1surf.inc) Mass of loose material on crust (kg/m^2)
  0
  los(kg/m^2)
#     asdcr(s), R, (s1surf.inc) Soil crust density (Mg/m^3)
  0
  cr_den(Mg/m^3)
#     asecr(s), R, (s1surf.inc) Soil crust stability ln(J/kg)
  0
  cr_se
#     aslrr(s), R, (s1sgeo.inc) Allmaras random roughness (mm)
  0
  rr(mm)
#     aszrgh(s), R, (s1sgeo.inc) Ridge height (mm)
  0
  z_rgh(mm)
#     asxrgs(s), R, (s1sgeo.inc) Ridge spacing (mm)
  0
  x_rgs(mm)
```

```
#     asxrgw(s), R, (s1sgeo.inc) Ridge width (mm)
  0
  x_rgw(mm)
#     asxrgo(s), R, (s1sgeo.inc) Ridge orientation (deg)
  0
  a_rgo(deg)
#
```

Figure 6.24 is an example of a stand-alone erosion submodel output file. It contains a listing of the inputs to the submodel, followed by the generated results labeled 'OUTPUT FROM ERODOUT.FOR'. This section lists the amount of total, suspension, and PM10 leaving each boundary and field grid cell. At the bottom of the file is the field average of each of these grid cells.

Figure 6.24 Example stand-alone erosion output file.

```
REPORT OF INPUTS (read by erodin.for)

+++ Control Flags, etc. +++

ntstep  am0eif  nsubr  nacctr  nbr am0efl
 48      T      1      1      0      1

+++ SIMULATION REGION +++

orientation and dimensions of sim region
amasim(deg)  amxsim - (x1,y1) (x2,y2)
    0.00    0.00    0.00  276.00  276.00

+++ ACCOUNTING REGIONS +++

nacctr - number of accounting regions
1
accounting region dimensions (x1,y1) (x2,y2)
    0.00    0.00  276.00  276.00

+++ BARRIERS +++

 no barriers

+++ SUBREGIONS +++

nsubr - number of subregions
1
subregion dimensions (x1,y1) (x2,y2)
    0.00    0.00  276.00  276.00

********************** Subregion  1  **********************

+++ BIOMASS +++

Biomass ht, SAI,    LAI,  flat cover
   0.000   0.000   0.000   0.000

+++ SOIL +++

nslay - number of soil layers
3

layer depth b.density vfsand   sand   silt   clay    rock vol
  1  230.00    1.05    0.14    0.22    0.71    0.08    0.00
  2  680.00    1.05    0.14    0.22    0.71    0.08    0.00
  3  610.00    1.05    0.14    0.22    0.71    0.08    0.00

layer    AgD      AgS  GMD    GMDmn      GMDmx    GSD
  1    1.87    1.00    1.64    0.01   36.73   15.13
  2    2.00    1.87    7.68    0.01   41.79   16.17
  3    2.00    1.87   30.00    0.01   70.96    9.98

Cr frac mass LOS frac.LOS, density stability
    0.00    0.00    0.00    1.87    1.87

    RR,    Rg ht,  width, spacing, orient., dike spacing
    1.50    0.00    0.00    0.00    0.00    0.00
```

```
+++ HYDROLOGY +++

Snow depth (mm)
0.00000000E+00

layer  wilting and actual water contents
  1    0.05    0.02
  2    0.05    0.02
  3    0.05    0.02
Hourly water contents - ahrwc0
    0.02    0.02    0.02    0.02    0.02    0.02
    0.02    0.02    0.02    0.02    0.02    0.02
    0.02    0.02    0.02    0.02    0.02    0.02
    0.02    0.02    0.02    0.02    0.02    0.02
+++ WEATHER +++

 anemht    awwzo   wzoflg
2.00000000 25.0000000 1
 wind dir (deg) and max wind speed (m/s)
  250.00   11.86

Wind speeds (m/s) -  48  intervals
    0.00    0.00    0.00    0.00    0.00    1.19
    2.76    3.47    4.00    4.44    4.84    5.20
    5.54    5.87    6.20    6.53    6.86    7.20
    7.56    7.95    8.39    8.91    9.57   10.64
   11.86   10.02    9.21    8.64    8.16    7.75
    7.38    7.03    6.69    6.36    6.04    5.71
    5.37    5.02    4.64    4.23    3.75    3.15
    2.24    0.00    0.00    0.00    0.00    0.00

END OF INPUTS

OUTPUT FROM ERODOUT.FOR

Total grid size: ( 31 , 31 )   Inner grid size: ( 29 , 29 )

  Passing Border Grid Cells - Total    egt (kg/m)
  top(i=1,imax-1,j=jmax) bottom(i=1,imax-1,j=0) right(i=imax,j=1,jmax-1) left(i=0, j=1,jmax-1)
      0.72      1.98      3.58      5.51      7.90     10.63     13.56     16.56     19.55     22.35     24.57
26.02     26.87     27.36     27.64     27.79     27.88     27.92     27.95     27.96     27.97     27.98
27.98     27.98     27.98     27.98     27.98     27.98     27.98
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
     13.93     37.80     59.60     70.80     74.85     76.21     76.66     76.81     76.86     76.87     76.88
76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88     76.88
76.88     76.88     76.88     76.88     76.88     76.88     76.88
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00

  Passing Border Grid Cells - Suspension     egtss (kg/m)
  top (i=1,imax-1, j=jmax) bottom (i=1,imax-1, j=0) right (i=imax, j=1,jmax-1) left (i=0, j=1,jmax-1)
      0.21      0.72      1.65      3.09      5.03      7.52     10.57     14.18     18.34     23.03     28.15
33.59     39.21     44.95     50.76     56.59     62.45     68.32     74.20     80.08     85.96     91.85
97.73    103.61    109.50    115.38    121.26    127.15    133.03
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00
     10.00     33.70     67.44    105.62    144.28    181.22    215.22    245.57    271.88    294.03    312.14
326.54    337.67    346.04    352.18    356.56    359.62    361.70    363.09    364.00    364.58    364.95
365.17    365.31    365.39    365.44    365.46    365.48    365.49
      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00      0.00      0.00

  Passing Border Grid Cells - PM10    egt10 (kg/m)
  top (i=1,imax-1, j=jmax) bottom (i=1,imax-1, j=0) right (i=imax, j=1,jmax-1) left (i=0, j=1,jmax-1)
    0.0046    0.0193    0.0473    0.0912    0.1488    0.2196    0.3027    0.3977    0.5039    0.6207    0.7463
0.8784    1.0145    1.1531    1.2931    1.4338    1.5750    1.7164    1.8579    1.9995    2.1412    2.2828
2.4245    2.5662    2.7079    2.8496    2.9913    3.1329    3.2746
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
    0.3050    0.9706    1.8304    2.7605    3.6919    4.5786    5.3937    6.1209    6.7510    7.2814    7.7153
8.0603    8.3271    8.5281    8.6755    8.7810    8.8547    8.9051    8.9387    8.9607    8.9748    8.9836
8.9891    8.9924    8.9944    8.9956    8.9963    8.9966    8.9969
```

```
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

  Leaving Field Grid Cells - Total    egt (kg/m^2)
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.75     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.51     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.73     -1.91     -2.06     -2.16     -2.12
-1.99     -1.87     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.72     -1.91     -2.06     -2.16     -2.12
-1.99     -1.88     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.72     -1.91     -2.06     -2.16     -2.13
-1.99     -1.88     -1.80     -1.76     -1.73     -1.72     -1.71     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.72     -1.90     -2.05     -2.16     -2.13
-2.00     -1.89     -1.81     -1.76     -1.74     -1.72     -1.71     -1.71     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.25     -1.50     -1.71     -1.89     -2.04     -2.15     -2.14
-2.02     -1.90     -1.82     -1.77     -1.74     -1.72     -1.71     -1.71     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.97     -1.24     -1.49     -1.70     -1.88     -2.03     -2.14     -2.15
-2.04     -1.93     -1.84     -1.79     -1.75     -1.73     -1.72     -1.71     -1.71     -1.71     -1.71     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.27     -0.51     -0.73     -0.96     -1.23     -1.48     -1.68     -1.86     -2.00     -2.12     -2.16
-2.09     -1.97     -1.88     -1.82     -1.78     -1.75     -1.74     -1.73     -1.72     -1.72     -1.72     -
1.71     -1.71     -1.71     -1.71     -1.71     -1.71     -1.71
     -0.27     -0.51     -0.73     -0.95     -1.21     -1.45     -1.65     -1.81     -1.96     -2.08     -2.16
-2.14     -2.05     -1.96     -1.89     -1.84     -1.80     -1.78     -1.77     -1.76     -1.75     -1.75     -
1.74     -1.74     -1.74     -1.74     -1.74     -1.74     -1.74
     -0.26     -0.50     -0.72     -0.93     -1.18     -1.40     -1.59     -1.75     -1.89     -2.01     -2.10
-2.16     -2.15     -2.09     -2.02     -1.97     -1.92     -1.89     -1.87     -1.85     -1.84     -1.83     -
1.82     -1.82     -1.82     -1.81     -1.81     -1.81     -1.81
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     -0.26     -0.49     -0.70     -0.88     -1.12     -1.32     -1.50     -1.65     -1.78     -1.89     -1.98
-2.07     -2.13     -2.16     -2.17     -2.15     -2.13     -2.10     -2.08     -2.06     -2.04     -2.03     -
2.02     -2.01     -2.01     -2.00     -2.00     -1.99     -1.99
     -0.26     -0.47     -0.67     -0.81     -1.01     -1.19     -1.35     -1.49     -1.61     -1.71     -1.79
-1.87     -1.94     -1.99     -2.04     -2.08     -2.11     -2.13     -2.15     -2.16     -2.17     -2.18     -
2.18     -2.18     -2.18     -2.18     -2.18     -2.18     -2.18
     -0.24     -0.41     -0.59     -0.72     -0.81     -0.96     -1.08     -1.20     -1.30     -1.38     -1.45
-1.52     -1.57     -1.62     -1.66     -1.69     -1.72     -1.74     -1.76     -1.78     -1.80     -1.81     -
1.82     -1.82     -1.83     -1.83     -1.84     -1.84     -1.84
     -0.20     -0.30     -0.40     -0.50     -0.59     -0.65     -0.70     -0.74     -0.76     -0.79     -0.82
-0.84     -0.86     -0.87     -0.88     -0.89     -0.90     -0.90     -0.91     -0.91     -0.91     -0.91     -
0.92     -0.92     -0.92     -0.92     -0.92     -0.92     -0.92

  Leaving Field Grid Cells - Suspension     egtss (kg/m^2)
     -0.06     -0.15     -0.27     -0.41     -0.56     -0.72     -0.88     -1.04     -1.20     -1.35     -1.48
-1.57     -1.62     -1.66     -1.68     -1.69     -1.69     -1.69     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.06     -0.15     -0.27     -0.41     -0.56     -0.72     -0.88     -1.04     -1.20     -1.35     -1.48
-1.57     -1.62     -1.66     -1.68     -1.69     -1.69     -1.69     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
     -0.06     -0.15     -0.27     -0.41     -0.56     -0.72     -0.88     -1.04     -1.20     -1.35     -1.48
-1.57     -1.62     -1.66     -1.68     -1.69     -1.69     -1.69     -1.70     -1.70     -1.70     -1.70     -
1.70     -1.70     -1.70     -1.70     -1.70     -1.70     -1.70
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  Leaving Field Grid Cells - PM10    egt10 (kg/m^2)
   -0.0013   -0.0043   -0.0081   -0.0127   -0.0166   -0.0204   -0.0240   -0.0274   -0.0307   -0.0337   -0.0363
-0.0381   -0.0393   -0.0400   -0.0404   -0.0406   -0.0408   -0.0408   -0.0409   -0.0409   -0.0409   -0.0409   -
0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409
   -0.0013   -0.0043   -0.0081   -0.0127   -0.0166   -0.0204   -0.0240   -0.0274   -0.0307   -0.0337   -0.0363
-0.0381   -0.0393   -0.0400   -0.0404   -0.0406   -0.0408   -0.0408   -0.0409   -0.0409   -0.0409   -0.0409   -
0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409
   -0.0013   -0.0043   -0.0081   -0.0127   -0.0166   -0.0204   -0.0240   -0.0274   -0.0307   -0.0337   -0.0363
-0.0381   -0.0393   -0.0400   -0.0404   -0.0406   -0.0408   -0.0408   -0.0409   -0.0409   -0.0409   -0.0409   -
0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409   -0.0409
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**Averages - Field
     Total    salt/creep      susp       PM10
     egt                      egtss      egt10
   -----------------kg/m^2--------------------
     -1.58       -0.34       -1.24     -0.0308

**Averages - Crossing Boundaries
Location      Total      Suspension      PM10
--------------------kg/---------------------
top           21.59        55.45         1.39
bottom         0.00         0.00         0.00
right         72.45       287.44         7.12
left           0.00         0.00         0.00

   Comparision of interior & boundary loss
      interior       boundary    int/bnd ratio
   -120593.77      120593.91            -1.00

repeat of total, salt/creep, susp, PM10:      1.58      0.34      1.24    0.0308
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