

**Graphical User Interface (GUI) User's Manual**

Appendix 8-G includes the Graphical User Interface (GUI) user's manual. This document describes the creation and use of a GUI that streamlines the process of conducting an Integrated Model run. The GUI allows a single individual to conduct an entire Integrated Model run. Full use of the GUI depends upon system and software requirements that are listed in the manual.

# COHYST Integrated Model GUI

## Introduction

COHYST is a hydrologic study of the Platte River drainage basin in the central part of Nebraska. The COHYST 2010 project involved developing an integrated computer-based model (Integrated Model) that can be used to calculate the effects of different management scenarios on streamflows and the regional aquifer. The Integrated Model is composed of a land and soil water (watershed) model, a surface water model (referred to as STELLA), and a groundwater model (referred to as MODFLOW). While there are only three primary components, some of these components involve multiple steps, and many data conversions are required to complete an Integrated Model analysis. This document describes the creation and use of a Graphical User Interface (GUI) that streamlines the process of conducting an Integrated Model run. The GUI copies files, modifies input files, converts data, and runs the component executables, which allows a single individual to conduct an entire Integrated Model run.

Prior to the GUI, Integrated Model runs were usually performed by coordinating efforts from multiple individuals at different organizations and locations at different entities. After each component was completed, output data were provided to the other team members. Data transfers required file format conversions on one end or the other and sometimes both. The complexities and coordination involved in performing the modeling steps made it difficult to complete Integrated Model analyses. While the GUI makes it easier to conduct Integrated Model runs, subject matter experts are required to properly set up the input files. The GUI has specific setup and use requirements that are described in this document.

## System and Software Requirements

The GUI is setup to run on 64-bit windows operating systems. The GUI is written in Python and is converted to an executable for distribution to facilitate ease of use. The GUI distribution includes an install executable that installs the GUI and the executables required to run the watershed, STELLA, and MODFLOW models.

Running integrated models requires significant hard drive space. Uncompressed the GUI distribution takes up about 100 GB of hard drive space which must be on the machine running the models. Running the Integrated Model requires about 70 GB of space per iteration for both the input and output files (running 2 iterations is typical for a run). Additional files may be created during post-processing but these occupy far less space.

The STELLA model definition is setup outside of the GUI and exported into the NetSim format that can be utilized by the GUI. STELLA version 10.1 or newer is required to create the STELLA model definition. STELLA does not have to be on the machine running the Integrated Model it only needs to create the NetSim input files.

After running an Integrated Model, the GUI can create Excel files with spreadsheets and graphics comparing STELLA results. These files are written in the xlsx file format that is supported by Excel versions 2007 and later.

The GUI can create NetCDF raster files from watershed landuse and precipitation inputs as well as the gridded outputs. The NetCDF format is a binary format with an option to compress the data in the file. NetCDF files are smaller than the original files, quicker to read, and you can extract specific portions of the data that you are interested in. NetCDF is a generic file format supported by many freely available and proprietary visualization software packages. The file format is a binary format that stores data and associated metadata. The GUI creates raster data for multiple time values within a single NetCDF file. ArcGIS version 10.1 and the open source GIS QGIS are both able to view NetCDF data. The support for multiple time values is more user friendly within ArcGIS where you can use the time slider to choose a specific time or create animations. The organization and values (in a spreadsheet format) within the file can be viewed using the freely available HDFview developed by The HDF Group but is not required for mapping the values within GIS.

Minimum and recommended values for system requirements are listed in Table 1.

Table 1 - Minimum and Recommended System Requirements

<b>Component</b>	<b>Minimum</b>	<b>Recommended</b>
OS	64-bit Windows	N/A
CPU	Intel Core i3-370M	The faster the better
RAM	4 GB	8 GB
Available hard drive space	250 GB	1+ TB

The GUI was developed using the Python programming language. Python was chosen because it is a popular language and has strong math and visualization support. The NumPy (numerical Python library) and pandas (Python data analysis library) were particularly helpful for converting data between file formats. The Python scripts are converted to a Microsoft Windows executable using the PyInstaller utility, which enables the GUI to run on computers without Python and the required libraries installed.

Running the GUI requires having a license to run STELLA in batch mode which is a separate license from the base STELLA executable. These licenses are much less costly than a STELLA license can be bought in bulk to save licensing costs. Because this licensing scheme favors licensing by the software distributor, we have proposed to the COHYST group that they purchase licenses and distribute the software accordingly.

## Installation

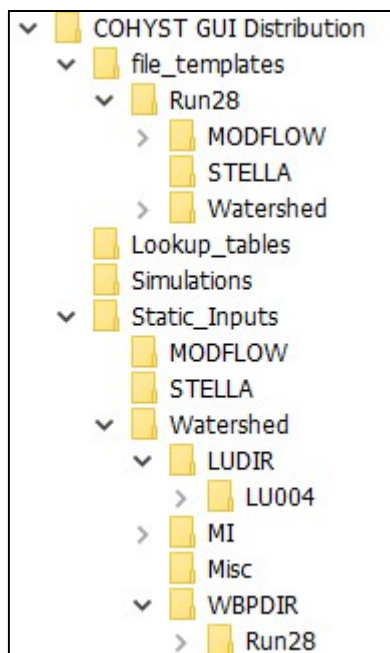
The GUI and the associated model files are available from the [COHYST Website](#) by downloading the distribution files. The distribution includes the GUI installer, documentation, and the input files for

integrated run #28. Run #28 can be used as a baseline model and the inputs can be modified to do look at different scenarios.

The GUI installer is in the main folder of the distribution. Running the installer (requires Admin privileges) installs the GUI and the executables required to run the different components (such as the watershed model executables).

The majority if the files in the distribution are input files setup to run integrated run #28. The files are organized into the folder structure shown in Figure 1. These files need to be copied to the machine doing the simulations (the files can be accessed across a network but performance is better on a local hard drive). Because the GUI by default looks for the files in the folder “C:\cohyst\_gui” it is easiest if you create this folder and copy the files into it but a different path can also be used. Some of the component models don’t support file paths with spaces so put it in a path without any spaces.

**Copy the folders in the COHYST distribution to a path on your machine that doesn’t have any spaces (default path c:\cohyst\_gui).**



**Figure 1 COHYST distribution folder structure**

The top level folders within the distribution package are:

- file\_templates – The GUI uses the files in this folder as templates to create the actual input files used in an integrated run. More information about these files and how they are setup is provided later. Generally creating a new simulation requires a modified set of template files. It is recommended that the user copy the folder “Run28” to create the new set of template files modifying them as needed.
- Lookup\_tables – These files contain information on how data is mapped between the groundwater, surface water and watershed models. These files only need to be modified on rare occasions when the STELLA model has structural changes that impact how variables are mapped to the other models.

- Simulations – This blank folder is the default location to run GUI simulations but another folder may also be selected. The GUI and the component models will write the input and output files for a simulation in the simulations folder.
- Static Inputs – This folder contains input files that are expected to rarely change. However, some scenarios require modifications to these input files. For example, land use data is contained in the “Static\_Inputs\Watershed\LUDIR\” folder. The folder “LU004” contains the files used in run #28. To create a modified land use scenario, create a new folder in the “LUDIR” folder with the appropriate input files. Instructions for choosing the modified folder in the COHYST GUI will be given later. The WBPDIR contains data such as irrigation demand for the different crop types being simulated. Modified parameters can be used by creating a new folder adjacent to the “Run28” folder with the appropriate parameters.

## Quickstart

This section describes how to start Run #28 which is provided in the distribution package. The GUI interface and details are described in more detail in following sections. Running this simulation is recommended before utilizing the GUI for other scenarios even if it isn't used as a baseline (often the case) to ensure that everything is setup correctly.

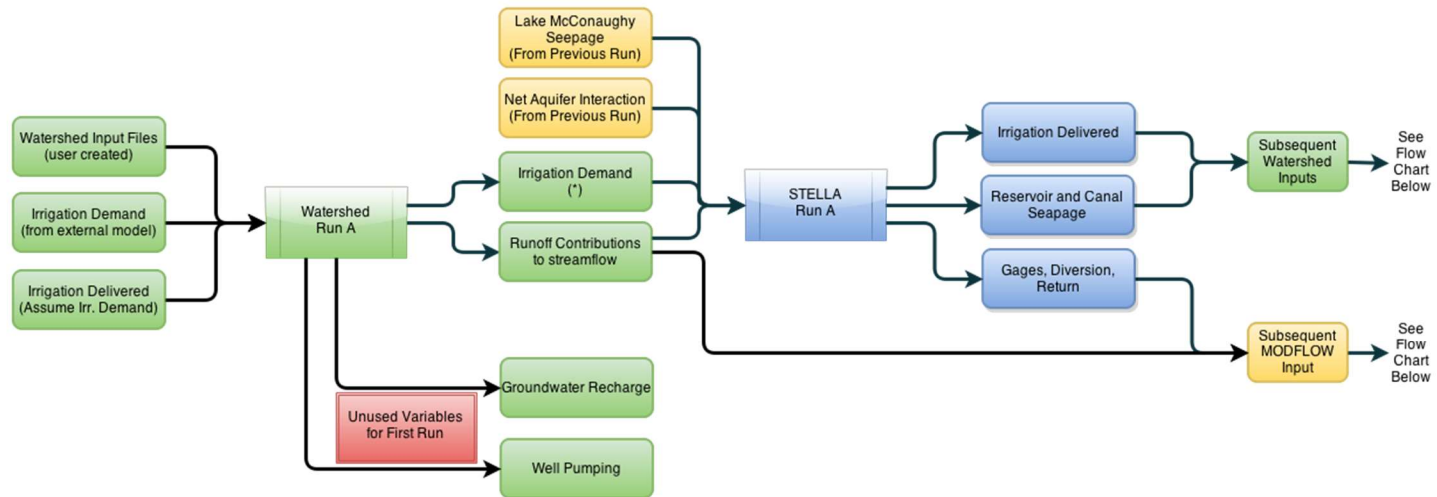
To run the provided simulation:

1. Make sure you run the GUI installer and copied the files to your hard drive as instructed above.
2. Launch the COHYST GUI from the windows start menu. The “Run COHYST” tab should be active.
3. If you installed the COHYST GUI to the default location, the executable folder should be correct. If you installed to a different location, change the executable folder to the “Executables” folder in the installation folder.
4. If you copied the COHYST distribution folders to “c:\cohyst\_gui\” the simulation, lookup tables, static files, and file template folders should be correct. If you copied them to a different folder change the first part of each of these to match the folder you are running from.
5. The rest of the parameters should default to the correct values. Click Run. This will bring up a new window where you can monitor the run as it progresses. The simulation will likely take several hours to complete but will depend upon the hardware it is running on.

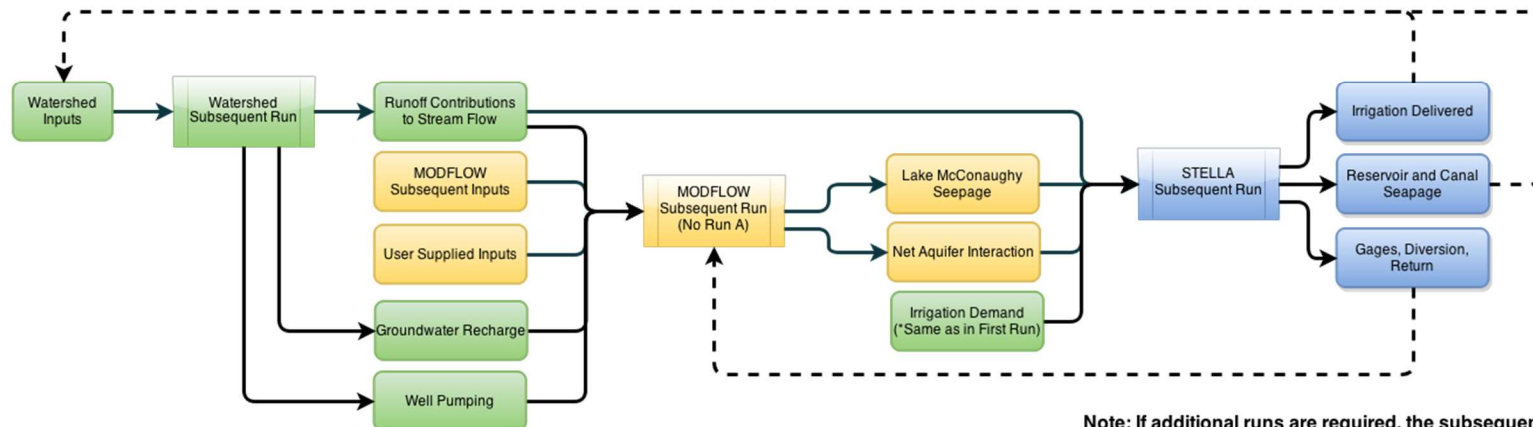
## Graphical User Interface

The GUI is organized into three tabs Run COHYST, Compare Models, and Mapping. The Run COHYST tab runs the integrated model creating files, converting data, and running executables as needed. Figure 2 shows the modeling steps completed by the COHYST GUI. The \Compare Models tab can create a water balance spreadsheet based upon two model runs and can create spreadsheets with plots comparing STELLA outputs. The Mapping tab generates NetCDF raster files from watershed model files including landuse input, precipitation input, and raw output.

## First Run (Run A)



## Subsequent Runs (Runs B,C,D,...)



**Note:** If additional runs are required, the subsequent runs will follow the order of the second run (B). (Watershed, MODFLOW, STELLA) Inputs for runs past the second run, are marked with a dashed line.

Figure 2 Primary steps for the integrated model runs

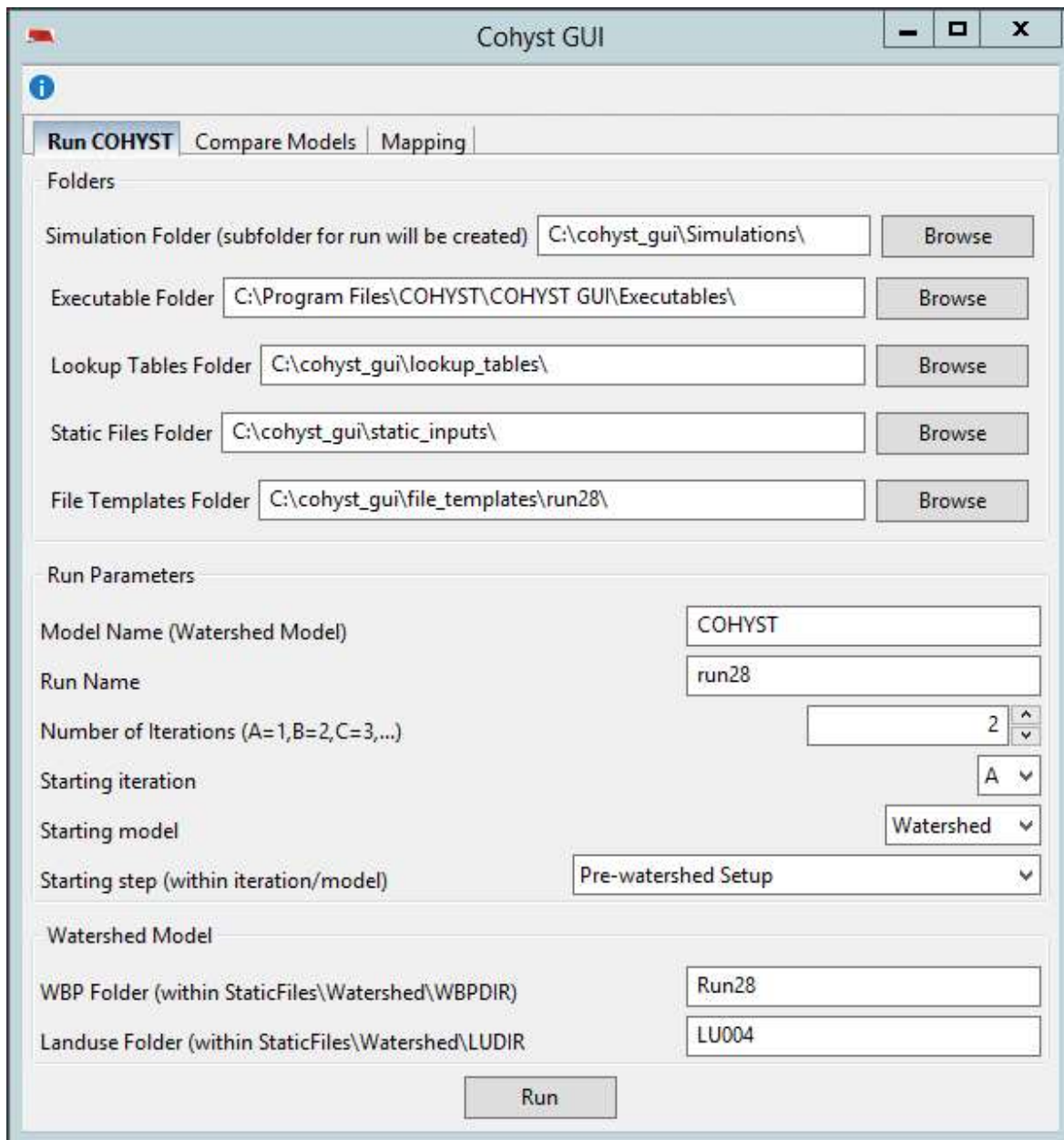
## Run COHYST Tab

The Run COHYST tab (Figure 3) is used to run the integrated sequence of models. The top section identifies the folders that will be utilized in the run. The executable folder, the lookup tables folder, and static files folder rarely need to be changed after being set for the first time on a computer. There are exceptions such as some large structural changes which will require changes to the lookup tables. The file templates folder changes for the majority of simulations as this folder is copied and modified as needed to generate an alternative simulation. The simulation folder will control where input and output files are written. The same folder can be reused because the GUI will create a subfolder for each simulation by name.

The run parameters box has some general settings for the simulation. The model name is only used by the watershed model. The run name will be used to create the simulation folder and many of the filenames will be based upon this name. The number of iterations controls how many times the watershed, groundwater, and STELLA models are run (there isn't a groundwater simulation in the first iteration). Typically at least two iterations are used. It is possible to specify a starting iteration, model, and run step. This requires that the previous steps have been previously completed successfully. For example, a user may complete a run and identify a problem in the groundwater or STELLA models. After fixing the input files for these models, the user can start the run at the first step that would be affected eliminating the need to rerun the watershed model.

The WBP folder and landuse folders are specified in the watershed model box. The default folders will run the land use and precipitation information used in run 28. If the precipitation or land use information needs to change for a simulation new folders must be setup with the appropriate subfolder structure and filenames (match setup of files provided in the distribution). The landuse data is created by the CROPSIM utility.

Clicking on the run button will bring up a COHYST runner dialog that provides feedback on the current simulation and steps performed. This dialog will be discussed in more detail later.



**Figure 3 COHYST GUI main dialog**

### **Watershed Model Setup**

The watershed model setup files are located under File\_templates\Watershed\Inputs and must contain specific subfolders and files. If the watershed files need to be changed (to run a different scenario through the GUI), it is easiest to start from the files provided rather than set up a new set of files to run through the GUI. To run through the GUI, the “MasterInput.txt” and “CanalMaster.txt” use special keywords, as described in the following paragraph.

The following information is for those running different scenarios through the GUI that require changes in the watershed model. The “MasterInput.txt” and “CanalMaster.txt” contain values that depend on a specific simulation and/or iteration, such as file paths (which may be iteration



specific) and run name. The other watershed input files do not contain simulation- and iteration-specific values and can be modified without affecting execution of the model through the GUI. The GUI uses a search-and-replace methodology to allow changes or additions to the contents of these files without requiring changes to the GUI code. Specific keywords are used that are replaced by the GUI when setting up the input files. Keywords must be enclosed with angle brackets <> and must match exactly the keywords in 2. To set up the files for an iteration, the GUI copies the template files and replaces keywords with the values for the run. The files for each iteration are kept in a separate folder, so the results from any iteration can be reviewed later. The keywords currently used by the GUI for watershed input files are listed in Table 2. The keywords are used with the “MasterInput.txt” file unless specified otherwise.

Table 2 - Keywords and Descriptions Used by GUI for Watershed Input Files

<b>Keyword</b>	<b>Description</b>
<RunName>	This is the name of the model run as specified in the GUI.
<ModelName>	This is the model name (MODname in the watershed master input file) specified in the GUI.
<InputFolder>	This folder is used for input files for the watershed model and is created by the GUI in the simulation folder.
<ResultFolder>	This folder is used for output files for the watershed model and is created by the GUI in the simulation folder.
<WBPFolder>	This folder is where the water balance partitioning data can be found. This folder is in the StaticFiles folder based on the WBP folder, both of which are specified in the GUI.
<LanduseFolder>	This folder is where the land use input data can be found. This folder is in the StaticFiles folder based on the Landuse folder, both of which are specified in the GUI.
<CanalFolder>	This folder is in the CNLDIR folder in the watershed “Input” files folder, which is copied from the File_templates folder. The name of the folder and the prefix for the files in the folder are specified in the GUI.
<MiscFolder>	This folder contains miscellaneous water demands (optional) and is in the StaticFiles folder.
<MunicipalFolder>	This folder contains miscellaneous water demands and is contained within the StaticFiles folder.
<LanduseFolderName>	This is name of the folder specified in the GUI for the Landuse folder (no path). It is generally used for some of the Landuse folder specifications in the “MasterInput.txt” file because they are named based on the root folder name.
<CanalFolder>	This folder is used in the “CanalMaster.txt” file. This is the name of the folder that the watershed input files will use for canal water demands within the InputFiles\CNLDIR folders. For the first iteration, this folder name is specified in the GUI. After the first iteration, this is based on the STELLA model run for the previous iteration.
<FilenamePrefix>	This is used in the “CanalMaster.txt” file and represents the prefix used to identify canal demand inputs (the year is tacked onto the end to find the file for each year) in the Canal folder. For the first iteration, this is provided in the GUI. After the first iteration, the prefix is based on the STELLA model run for the previous iteration.

### **STELLA Setup**

STELLA is a software product that allows users to define a mathematical representation of a process and simulate different inputs. STELLA models can be run within the STELLA software but needs to be run in batch mode when used with the COHYST GUI. When using the GUI, the STELLA simulation is modified as needed within the STELLA software. When the STELLA model is opened in the STELLA software, there are four tabs on the left side of the screen that the user can toggle among. These tabs include Interface, Map, Model, and Equation. Some of

the model options are specified in the Interface tab, while more significant changes, such as adding or removing canals, are made in the Model tab.

The way that the STELLA model is executed through the GUI, only components set up on the Interface tab can be used for input or output. All the time-series data that need to be updated by the GUI, such as irrigation demands, must exist as graphical user functions on the Interface tab of the STELLA model. A graphical user function represents a curve of values; in our case, this is usually a value for each day of the simulation. When the STELLA model is run through the GUI, all the open tables (which must be pinned open) on the Interface tab are exported to .csv files. To pin open a table, the user must first open the table by double clicking on the table icon (positioned where desired) and then click on the pin icon. The COHYST distribution package includes a STELLA model with graphical functions and tables set up to provide the required inputs and outputs for a model run. As components that need to be used as input or output are added to the model, they need to be added to the STELLA Interface tab.

The isee.NET Framework, a STELLA add-on, is used to run STELLA through the GUI. This framework allows users to create programs that can set up, run, and review results for STELLA models. In the COHYST distribution package, there is a file named "RunStellaCs.exe" that runs the model. The RunStellaCs application takes the name of a "RunParams.xml" file that contains input files, run parameters, and output information for the model run. Model data can be provided in .csv files. The first row of the .csv file must contain names of graphical user inputs in the STELLA Interface tab. The number of values should match the number of values in the graphical user input. All the open tables (pinned open) on the Interface tab are exported as .csv files in the output folder.

A STELLA model must be exported into the NetSim format (txm) to use it with the COHYST GUI. To export the NetSim file, choose "Export for NetSim" in the file menu of the STELLA software. The model file needs to be in the File\_templates folder (generally a copy of the one provided) with the filename "StellaSw.txm."

In summary, to prepare a model to run through STELLA:

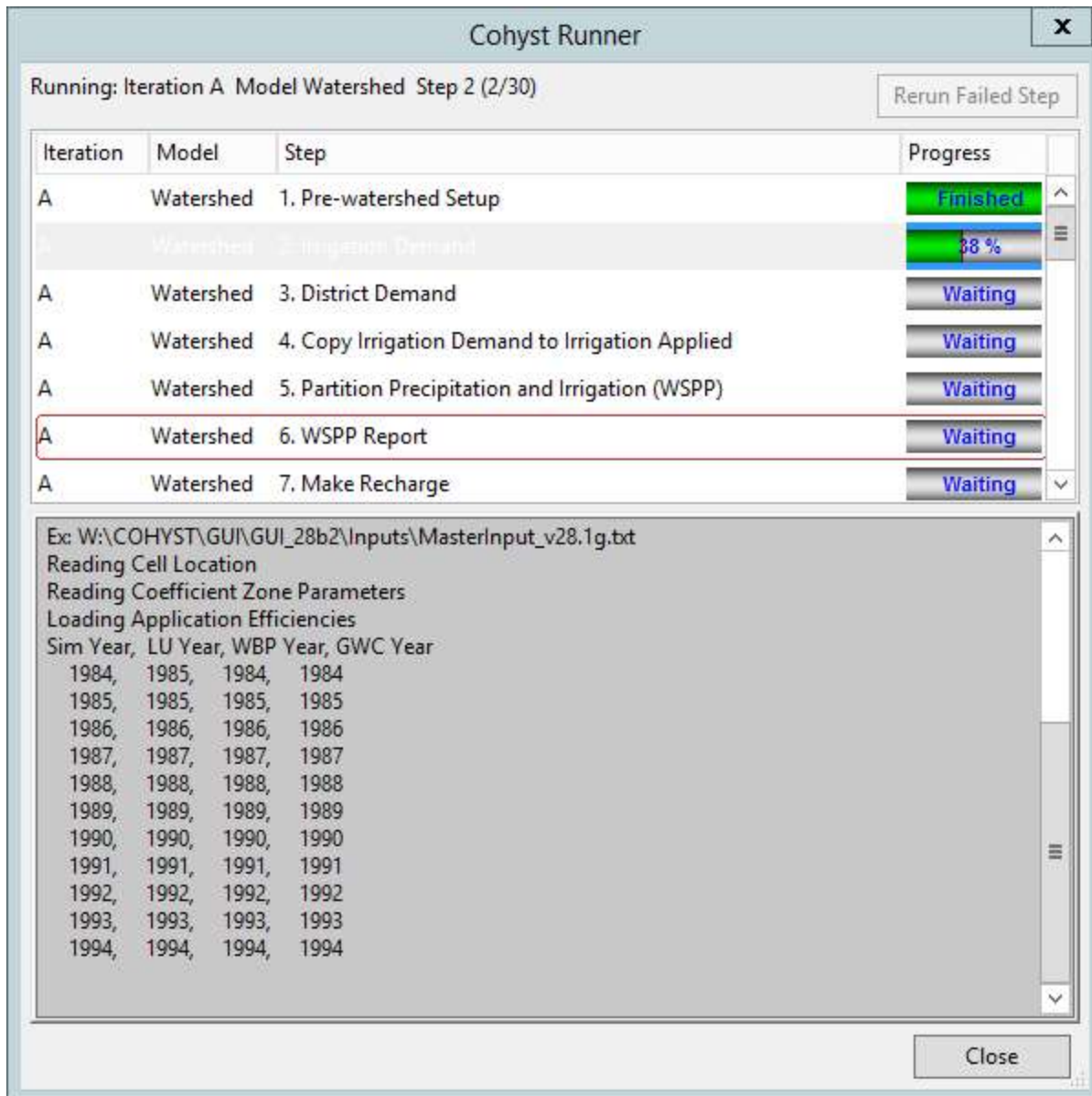
1. All graphical user functions for input must be on the Interface tab. At a minimum, the graphical user functions used in the model provided in the COHYST distribution package should be on the Interface tab.
2. All output used by other models or required for the user must be included in open (pinned) tables on the STELLA Interface tab.
3. The options and values for the switches, knobs, and sliders must be set in the associated components in the Model tab (not the interface tab). If the user opens the interface component, the user can turn on the option to show a Nav button, which can be used to jump to the underlying model component in the Model tab.
4. The model must be exported into NetSim format (txm) and placed in the File\_templates folder using the same folder structure and naming as the COHYST distribution package.

### **MODFLOW Setup**

The MODFLOW well (.wel), recharge (.rch), and streamflow (.sfr) inputs are extracted from the watershed and STELLA models, but the rest of the files must be set up independent of the GUI. The files set up for MODFLOW must be put in the File\_templates folder following the same structure and naming as the COHYST distribution package. All the template files must be named “cohyst\_template” followed by the appropriate extension. The MODFLOW Name File (.nam) contains filenames used in the MODFLOW simulation. All the files except for “sfr.out” (which the GUI creates based on STELLA output) must use the keyword “<cohyst\_template>” for the filename entries in the name file. This keyword is automatically replaced by the GUI with the actual filenames, which are based on the model name and iteration.

### **COHYST Runner Dialog**

When the run is executed, a COHYST runner dialog comes up which provides feedback on the running simulation as shown in Figure 4. If the simulation has finished, the top line identifies if it finished successfully or failed early. Otherwise the current step is reported. The dialog includes a grid (spreadsheet) showing iterations, models, run steps, and progress for the current step. Many of these steps are running external executables while some are conversion steps performed by the GUI. Some steps don't report progress and show a spinning progress bar. Clicking on a step in the grid makes it active and the bottom box will show the screen output for steps running external simulations or conversion feedback for GUI steps.



**Figure 4 COHYST Runner dialog**

### Output File Locations

The GUI will create a subfolder for the run files under the simulation folder specified in the run tab of the COHYST GUI. Within this folder, the GUI creates a folder for each of the models (watershed, MODFLOW, STELLA). In each model folder, there will be a folder for each iteration (A, B, C, etc.); these folders contain the associated run files (input and output). The complete set of files for a COHYST run are rather large (perhaps as much as 140 GB for two iterations), with additional iterations taking up even more space (approximately 70 gb per iteration).

### Compare Models Tab

The compare models tab generates water balance spreadsheets based upon all three models as well as comparisons of STELLA output files. All the options require completed base and

alternative simulations. The user should maintain an organized file structure and keep related scenarios together as described below. When running the GUI, you provide a simulation folder. The GUI creates a subfolder under this simulation folder based upon the run name. You can use the same simulation folder for alternatives and each of them will be in its own folder. When using the compare models tab, you specify the simulation folder used when running the model. Typically this will be the same for the base and alternate scenarios. The run name must also match the name specified when run from the GUI.

The compare models tab will create and populate a water balance spreadsheet based upon the results from the watershed, STELLA, and MODFLOW models. The spreadsheet includes multiple pages. Most of the pages apply to either the base or alternate model but some contain comparisons of the two models.

The compare models tab can also generate spreadsheets with plots comparing STELLA model runs. When the integrated model is run, the GUI reformats the output data into spreadsheets representing the daily, monthly, and yearly outputs from the STELLA model. The STELLA output includes all the tables on the interface tab that are pinned open. A separate spreadsheet is created for each of the pinned STELLA tables. The spreadsheet has a data sheet containing the base value, alternate value, and difference through time for all the variables in the STELLA table. There is also a tab for each variable with a plot showing the base, alternate, and difference curves. The difference curves are plotted on a separate y-axis.

## Mapping Tab

The mapping tab has controls to generate NetCDF raster files that can be visualized in GIS or other software based upon watershed input and outputs. Landuse and precipitation inputs and gridded output data (raw output) are currently supported. The NetCDF files contain multiple timesteps. Landuse is on a yearly timestep while precipitation and gridded output is a monthly timestep.

The mapping tab has a few options to select the data to map. Regardless of the type of data selected, you must choose an output filename for the NetCDF raster file and the range of years to extract. Unless disk space is an issue extracting all the years provides the ability to view any of the data applicable.

The type of file used as input must be provided as each has a slightly different format. The filename that corresponds to the first year of data must be selected so the GUI can infer the pattern used by the files. The location of the files depends upon the type of data as described below:

- Precipitation data is in the static input files inside of a named WBP folder like:  
..\Static\_Inputs\Watershed\WBPDIR\{Name}\Precip\PRECIP1984.txt.
- Landuse data is also in the static input files folder in named folders to support multiple sets of landuse data. However, within the landuse folder there are multiple subfolders that can be mapped depending upon the categories of landuse to map (comingled, dry, groundwater, surface or all). An example filename would be something like:  
..\Static\_Inputs\Watershed\LUDIR\LU001\COLU001\COLU1984.txt.

- The raw output files are found within the watershed folder in the simulation files. They are organized by run name and iteration for example “RunNameB”. The files used for mapping are in “Results\RAW.”

You can visualize NetCDF files in ArcGIS, QGIS, and other software. Each software package has its own tools for importing and visualizing NetCDF raster data. The following links provide some information about using NetCDF in ArcGIS and QGIS. The coordinate system of the NetCDF file created by the GUI is State Plane NAD 1983 Nebraska FIPS 2600 (US Feet).

### **ArcGIS**

<http://help.arcgis.com/en/arcgisdesktop/10.0/pdf/netcdf-tutorial.pdf>

<http://www.slideshare.net/HDFEOS/working-with-hdf-and-netcdf-data-in-arcgis-tools-and-case-studies>

### **QGIS**

[http://www.ggiuliani.ch/download/netcdf\\_qgis\\_GG.pdf](http://www.ggiuliani.ch/download/netcdf_qgis_GG.pdf)

## Detailed Explanation of GUI Steps

This appendix provides a short description of each of the steps performed when running the model through the GUI. Most of the steps describe running watershed, STELLA, or MODFLOW executables. The remaining steps describe setting up model runs using data from the File\_templates folder or taking data from one model to use as input data for another.

The estimated times are based on a computer with an Intel Xeon E5-1560 (6-core 3.8GHz) with 16GB of ram at 1866Mhz using a SATA 3.0 connection to the HDD. Runtimes are intended as estimates to help users determine if a program has hung, and will vary based on a number of factors, such as computer components, other running programs, and whether the files are accessed locally or over a network.

The individual steps are grouped by iteration and model, similar to how they are presented in the GUI, to make it easier to find specific steps in the documentation.

### Iteration A Watershed Model

1. Pre-watershed Setup
  - Copies files from File\_templates\Watershed and creates a new run folder named \Run(xxx)\watershed\Run(xxx)A, where input and output values will be stored for Iteration A.
  - Estimated Run Time: 1 second
2. Irrigation Demand
  - Launches Irr\_Demand from \Executables\Watershed, which calculates the irrigation demand for crops.
  - Estimated Run Time: 5 minutes
3. District Demand
  - Launches Dist\_Demand from \Executables\Watershed, which calculates the demand for water of industrial and municipal users.
  - Estimated Run Time: 1 second
4. Copy Irrigation Demand to Irrigation Applied
  - Copies the files from \Run(xxx)\watershed\Run(xxx)A\Results\DemIrr to \Run(xxx)\watershed\Run(xxx)A\Results\ApplIrr because in the first iteration, we assume that the irrigation demand calculated from Step 2 in the watershed process is met.
  - Estimated Run Time: 1 second
5. Partition Precipitation and Irrigation (WSPP)
  - Launches \Executables\Waterhsed\WSPP which uses the CROPSIM model results to partition precipitation and irrigation into grown water recharge, runoff, and ET. The code is reading the values that define cell location and properties, and applying the proper application efficiency from \Run(xxx)\watershed\Run(xxx)A\Inputs\.
  - Estimated Run Time: 1 hour



6. WSPP Report
  - Launches \Executables\Watershed\WSPP\_Report which generates a summary of the partition of precipitation.
  - Estimated Run Time: 45 minutes
7. Make Recharge
  - Launches \Executables\Watershed\Make\_Rch which extracts the aquifer recharge data that will be used in the “Compile Recharge” step.
  - Estimated Run Time: 10 minutes
8. Compile Recharge
  - Launches \Executables\Watershed\Compile\_Rch which formats the recharge data make it useable to the MODFLOW model.
  - Estimated Run Time: 1 minute
9. Make Well
  - Launches \Executables\Watershed\Make\_Wel which extracts the well data which will be used in the “Compile Well” step.
  - Estimated Run Time: 1 minute
10. Compile Well
  - Launches \Executables\Watershed\Compile\_Wel which formats the well data for the MODFLOW model.
  - Estimated Run Time: 1 minute
11. Canal Check Summary
  - Launches \Executables\Watershed\Cnlchk\_Summary which develops data summaries for the canal output data.
  - Estimated Run Time: 5 seconds
12. Water Balance Summary
  - Launches \Executables\Watershed\WaterBalanceSum which develops data summaries of the water balance model output data.
  - Estimated Run Time: 40 minutes

### **Iteration A STELLA Model**

1. Pre-STELLA Setup
  - Converts “watershed\Run(xxx)\A\Results\COHYST\_Run(xxx)\ASF.txt” into .csv files named “IrrDem” and “SFByZone\_stella” for the STELLA run (STELLA\Run(xxx)\A\Input).
    - Uses lookup table “zone2reach” to convert watershed zones into STELLA reaches.
    - Converts monthly to average daily values.
  - Converts irrigation demand from the watershed model to .csv file for STELLA input (“IrrDem.csv”).
    - Sums values for irrigation season (June-September).

- Removes unused columns.
  - Uses lookup table “StellaDemandVarToSWDistrict.csv” to convert watershed district into STELLA input variable.
- Estimated Run Time: 5 seconds
- 2. Run STELLA Surface Water Model
  - Launches “Executables\Stella\RunStellaCs” which executes the STELLA model.
  - Uses inputs that include “RunParams.xml” and several .csv files.
  - Outputs results into folder STELLA\Run(xxx)A\Output\.
  - Estimated Run Time: 5 minutes

### **Iteration B Watershed Model**

1. Pre-watershed Setup
  - Creates a new run folder where input and output values will be stored for Iteration B
  - Uses reservoir seepage, canal seepage, and irrigation delivery inputs from the STELLA results for Iteration A.
  - Estimated Run Time: 5 seconds
2. Irrigation Supply
  - Calculates irrigation supply using the executable for Irr\_Supply. This step replaces Iteration A, Step 2, Irrigation Demand.
  - Estimated Run Time: 5 minutes
3. Partition Precipitation and Irrigation (WSPP)
  - Same as Iteration A, Step 5
  - Estimated Run Time: 1 hour
4. WSPP Report
  - Same as Iteration A, Step 6
  - Estimated Run Time: 1 hour
5. Make Recharge
  - Same as Iteration A, Step 7
  - Estimated Run Time: 10 minutes
6. Compile Recharge
  - Same as Iteration A, Step 8
  - Estimated Run Time: 1 minute
7. Make Well
  - Same as Iteration A, Step 9
  - Estimated Run Time: 1 minute
8. Compile Well
  - Same as Iteration A, Step 10
  - Estimated Run Time: 1 minute
9. Canal Check Summary

- Same as Iteration A, Step 11
- Estimated Run Time: 5 seconds

#### 10. Water Balance Summary

- Same as Iteration A, Step 12
- Estimated Run Time: 30 minutes

### **Iteration B MODFLOW Model**

#### 1. Pre-MODFLOW Setup – B

- Uses gages, diversions, and returns from STELLA Iteration A results.
  - Uses lookup tables to convert STELLA reaches to MODFLOW cells.
  - Averages daily values to generate average monthly values.
  - Converts acre-feet to cubic feet.
  - Copies values from October-December 1985 to fill in October-December 1984, which was not output from STELLA.
  - Writes MODFLOW .sfr file.
- Copies files from MODFLOW template folder, replacing keywords as appropriate.
- Copies .wel and .rch files from the watershed results folder for Iteration B.
- Estimated Run Time: 20 seconds

#### 2. Run MODFLOW.

- Runs the MODFLOW model.
- Estimated Run Time: 10 minutes

### **Iteration B STELLA Setup**

#### 1. Prepare MODFLOW→STELLA (Run sum\_str).

- Launches “Run sum\_str,” which creates “net.out” file based on MODFLOW results.
- Estimated Run Time: 5 seconds

#### 2. Pre-STELLA Setup

- Sets up surface flow (SF.txt) same as Iteration A.
- Copies irrigation demand from Iteration A because this does not change.
- Converts MODFLOW results to Net Aquifer interaction for STELLA.
  - Reads Net Aquifer interaction file.
  - Adds dates based on simulation start and time step.
  - Uses lookup table “ModflowNetToStellaVariable.csv” to convert MODFLOW grid cell ids to STELLA reach identifiers.
  - Reads cell budget file and uses Lake McConaughy mask to determine Lake McConaughy seepage.
  - Interpolates MODFLOW outputs to daily values (MODFLOW outputs values twice a month).
- Estimated Run Time: 20 seconds

#### 3. Run STELLA Surfacewater Model

- Same as Iteration A, Step 2
- Estimated Run Time: 5 minutes