ArcSLAMM for use with WinSLAMM 10.3 User Guide

Contact:

This user guide was updated in March 2017 by John DeGroote.

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Overview:

The ArcSLAMM package is a set of ArcGIS script tools organized in a single toolbox as well as a set of database files and this and user guide documentation. The purpose of the ArcSLAMM package is to provide geoprocessing functionality that will allow the urban stormwater quality model WinSLAMM (Source Loading and Management Model for Windows) to be more efficiently applied for small to moderate sized urban watersheds. The tools in the ArcSLAMM toolbox are meant to be used as part of a workflow that results in the creation of WinSLAMM compliant database files that can be used in WinSLAMM for individual or batch modeling of multiple drainage areas or catchments. The ArcSLAMM tools work with a customized intelligent geodatabase(s) created to allow easy creation of WinSLAMM compliant files.

The ArcSLAMM package constitutes a loose coupling with WinSLAMM software in which the ArcSLAMM tools are used for pre-processing and post-processing data to prepare for WinSLAMM modeling and for visualizing output from WinSLAMM.

This document attempts to give an overview of the process that a user (e.g. municipality, academic, consultant) would use to work through the process of using ArcSLAMM and WinSLAMM software together. We provide this guidance using example data from Cedar Falls, Iowa. We provide very limited details about running the WinSLAMM model itself, rather we focus on using ArcSLAMM in conjunction with WinSLAMM.

WinSLAMM can be run using either detailed source areas or the Standard Land Use (SLU) module. The standard ArcSLAMM package is used for when you have detailed source areas. ArcSLAMM Plus extends the standard ArcSLAMM package by providing extra database files and tools to work with the SLU module of WinSLAMM. The GeoTREE Center has partnered with PV&Associates to develop and support ArcSLAMM Plus through charging a small amount for ArcSLAMM Plus. You can purchase the ArcSLAMM Plus package at http://www.winslamm.com/. It was decided to have a small charge in order to allow the GeoTREE Center to develop and support the software.

For more information about SLU see www.winslamm.com/select_documentation.html.

There are a few known/issues/bugs with the ArcSLAMM tools. These are noted and workarounds are described.

Credits:

The ArcSLAMM package was originally created by the GeoTREE Center as part of the Iowa Water Center grant entitled 'Community-wide Urban Storm Water Planning Utilizing LiDAR, the WinSLAMM Model, and GIS' (Subaward No. 424-17-04C). The Iowa Water Center is a federally funded center located at Iowa State University (http://www.water.iastate.edu/) which funds research related to water quality, water quantity, and human dimensions of water-resources management in Iowa. PV & Associates, the developer of WinSLAMM also provided a small amount of funding to complete the development of the ArcSLAMM package. In addition, the GeoTREE Center presently has a grant from the Iowa Department of Agriculture and Land Stewardship State Soil Conservation Committee that is supporting continued improvement of ArcSLAMM.

The development of these tools was based on the hard work of a number of UNI Geography undergraduate and graduate students including Bernard Conrad, Rebecca Gronewold, Dan Murphy, Garrett Jepsen, Megan Schneider, and Arif Masrur.

Requirements, assumptions, and support:

The basic ArcSLAMM toolset and associated geodatabase and lookup files are provided free of charge with limited support based on the discretion/time availability of the GeoTREE Center. An extended version of the package, named ArcSLAMM Plus is made available for a minimal cost through PV & Associates, the developer/distributor of the WinSLAMM software. ArcSLAMM Plus includes further tools and another geodatabase to extend capabilities to work with the Standard Land Use module of WinSLAMM. The WinSLAMM modeling software is not part of this distribution and can be acquired at cost at http://winslamm.com/purchase.html. This documentation is not going to give a thorough description or details regarding the workings of the WinSLAMM software. Details on WinSLAMM can be found at http://winslamm.com.

The ArcSLAMM package described here has been tested using ArcGIS 10.4.1, the Spatial Analyst extension and WinSLAMM v10.3.16. Major changes to WinSLAMM database formats in future versions could render the database files created with this version of ArcSLAMM software unusable. The GeoTREE Center intends to endeavor to work with PV & Associates in the future to keep the software working together.

The documentation here assumes you are familiar with using ArcGIS Desktop (ArcMap and ArcCatalog). The document also assumes familiarity with WinSLAMM software itself. The *Elevation and Catchment Area Tools* require a Spatial Analyst license. The other tools should work with any ArcGIS license level.

Data Provided:

A variety of files are provided as part of the download of ArcSLAMM. Below you will find a description of the directory structure and an overview of the purpose of files in those directories. Before doing anything with this data it is recommended that you make a backup copy of all the data.

\data
    \base_data
        \lookup
        \WinSLAMMSourceArea.gdb
    \example_data

- The \base_data\lookup directory holds
    - a database file called BaseWinSLAMM_10_3.mdb which is an empty base WinSLAMM database file provided by PV & Associates. Before using this file with ArcSLAMM a user should make a copy, open the file in WinSLAMM and set parameters such as whether to use a winter range or climatic file to use, and save the file for future use with ArcSLAMM. When prompted to choose a 'Base WinSLAMM Database' when running the *Create WinSLAMM Compliant Databases* tool you should choose the file. That tool will make a copy of that .mdb file and then populate data from the Geodatabase feature class for each WinSLAMM compliant database it is creating. As mentioned above, the BaseWinSLAMM_10_3.mdb database has certain things set that you might want to change before creating WinSLAMM compliant database files for each catchment area such as which pollutants are being modeled and several parameter files (e.g. rainfall file) to use. If you want to change these parameters so they will be used in your ArcSLAMM-WinSLAMM-ArcSLAMM workflow you should make a copy of BaseWinSLAMM_10_2.mdb, rename and save it, open in WinSLAMM, make the relevant changes and then use this version with the *Create WinSLAMM Compliant Databases* tools as the 'Base WinSLAMM Database'.
    - WinSLAMMSourceArea.gdb is a customized geodatabase file, created for the ArcSLAMM package, which contains a feature class called WinSLAMMSourceArea_FC. This feature class allows the creation of polygon features that represent detailed WinSLAMM source area categories that are needed for WinSLAMM modeling. As delivered, the feature class is empty with no records (a blank slate). See the description under \docs\SourceAreaFieldGuide.pdf for a detailed description of source areas. You should make a copy of this WinSLAMMSourceArea.gdb before you begin digitizing your own features in it. After making a copy you can rename the .gdb and feature dataset as you

would like to be more meaningful to the study area you are working on. The name of the feature class (WinSLAMMSourceArea_FC) cannot be changed as it is participating in a topology within the feature dataset as well as utilizing domains. You can change the feature dataset name. You should change the coordinate system of the feature dataset to match those of your local study area before you actually digitize any polygon features. You can do this by right-clicking on the feature dataset, choosing Properties, and setting under XY Coordinate System.

- \example_data
    - This directory contains two Digital Elevation Model (DEM) raster datasets, a streams Shapefile, a pour points Shapefile, a watershed shapefile as well as a file geodatabase (ArcSLAMM_CFExample.gdb) with example detailed source area feature polygon data. All of the data are for an area in Cedar Falls, Iowa. You can follow steps under ArcSLAMM Practice/Demonstration Steps below using the data in this directory to learn how to use the ArcSLAMM tools in conjunction with WinSLAMM.

\docs

- Contains this user guide documentation
- SourceAreaFieldGuide.pdf
    - In this document each potential WinSLAMM source area type is listed and the associated attributes are detailed. WinSLAMM uses the concept of 'source areas' which are analogous to detailed land use/cover classes with qualifications based on certain things like whether the source area is connected to an impervious area and what type of soil falls in that area. There are several main classes such as roofs, parking, unpaved parking, driveways, sidewalks, landscaped areas, undeveloped areas, streets, and other areas which then are subdivided based on qualifying attributes. So for example, there are actually 12 separate Roofs classes as they are broken out based on whether they are pitched or flat, which soil type they fall in (drain to), etc. In total, there are approximately 80 separate source area types. When creating these features in ArcMap you choose just the source area type and the associated attributes are taken care of by the geodatabase intelligent features. When digitizing source area features you must also indicate whether each source area feature is within a wider land use class of institutional, commercial, residential, industrial, or other urban. There are certain source area types that are only associated with certain land use types. These are controlled by the geodatabase also.

\tools

- This directory contains the ArcSLAMM toolbox (ArcSLAMM_For_WinSLAMM_10_3.tbx)

Tool Overview:

Below we give a brief overview of the ArcGIS script tools available in ArcSLAMM and their general purpose. The tools have a number (letter) associated with them to indicate the general order they

might be used. However, it is possible that you might not need to use the 1 and 2 tools as they are pre-processing tools provided to assist the user in defining soil types and catchment/drainage areas. The general flow of using the tools would be as below if you are starting with a non-hydrologically enforced DEM:

- *1-Derive Soil Type from SSURGO* is a preprocessing step and should be run before developing detailed source area spatial data using the WinSLAMMSourceArea.gdb. The tool takes publicly available SSURGO soils databases, clips the soils data to study area, reclassifies hydrological soil group attribute to WinSLAMM soil types, and produces a new feature class that can be used in creating detailed source areas. *This step is ideally carried out before digitizing detailed source areas in the WinSLAMMSourceArea_FC as the soil type helps decide which source area to set*.
- *2a-Hydrologically Enforce Digital Elevation Model (DEM)* is used to burn a stream network into a DEM in order to aid in the creation of drainage area/catchment boundaries.
- To derive catchment/drainage area boundaries you can use either of these tools:
    - *2b-Catchment Delineation for Stream Segments* if you want to derive catchments for your whole study area based on ArcGIS defined stream segments OR
    - *2c-Catchment Delineation for Pour Points* if you want to only derive catchments for specific outlet points in your study area
- *3-Intersect Catchments with WinSLAMM Detailed Source Areas* is used to develop an interesected feature class that holds all of the necessary WinSLAMM attributes for detailed source areas and a catchment identifier which is carried forward to the next tool.
- The *4-Create WinSLAMM Compliant Databases* tool is used to derive a unique WinSLAMM compliant database for each unique catchment/drainage area.
    - In between this and next step you would run WinSLAMM in a batch mode with files created by the *Create WinSLAMM Compliant Databases* tool
- The 5-*Join WinSLAMM Output Back to Spatial* tool is used after running WinSLAMM simulations for each individual catchment/drainage area using the batch mode in WinSLAMM. This tool allows the results from those simulations to be tied back to the GIS data for map-based visualization.

Below you will find an example which details steps to carry out for a complete ArcSLAMM –> WinSLAMM –> ArcSLAMM workflow. A detailed step-by-step example, based on data provided in the data download package, will take the user through data creation, using ArcSLAMM tools for pre-processing, running WinSLAMM, and using ArcSLAMM tools for post-processing map-based visualization of WinSLAMM outputs.

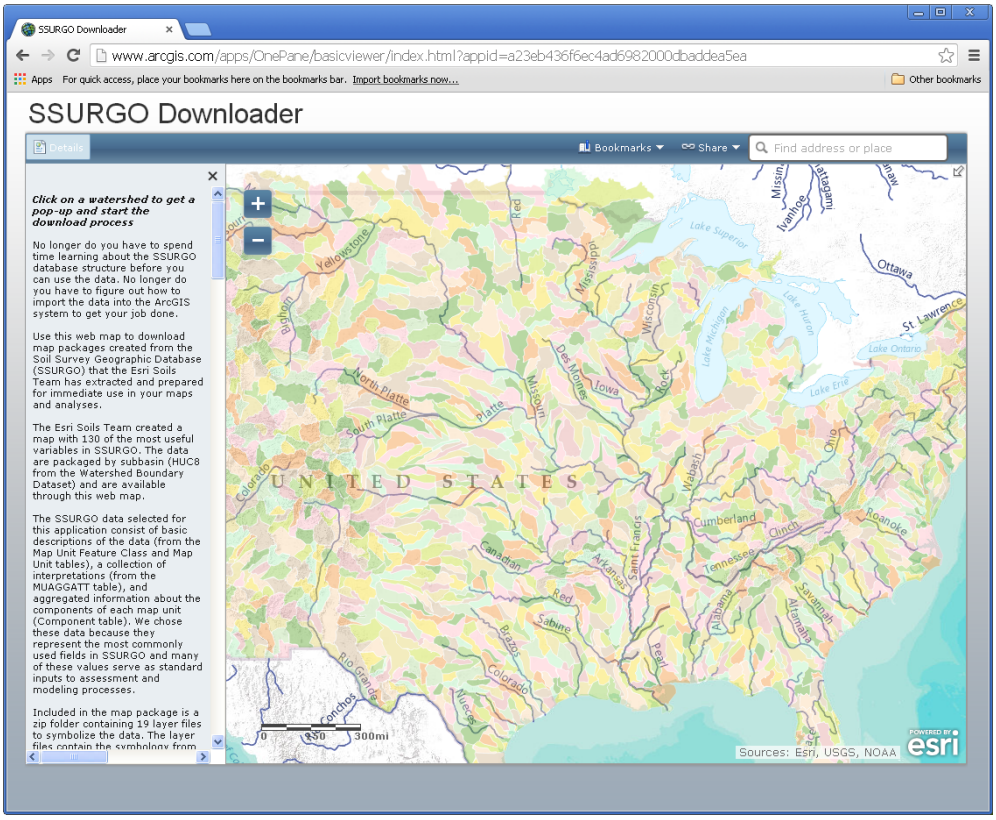
Pre-processing steps to prepare detailed source area data for use with ArcSLAMM

The overall purpose of the ArcSLAMM package is to allow the use of ArcGIS as a pre- and post-processing utility that greatly expands upon and improves the efficiency of using GIS and WinSLAMM to carry out modeling for urban study areas. Part of the ArcSLAMM distribution package is a customized file geodatabase which allows the use of ArcGIS editing tools to create polygons which hold the

necessary detailed source area attributes necessary to run WinSLAMM. The general process is to prepare these detailed source areas, intersect with catchment/drainage areas, create WinSLAMM compliant databases for each catchment/drainage area, carry out WinSLAMM modeling for single catchment/drainage areas or in a batch mode, and finally to bring modeled WinSLAMM results back to ArcGIS for visualizing modeled outputs in map form.

One attribute that is necessary to develop WinSLAMM detailed source area features is a simplified soils characterization of 'silty', 'sandy', or 'clayey'. The *Derive Soil Type from SSURGO* ArcSLAMM tool provides an easy mechanism to process SSURGO soil data into a format that will make it easier to include when digitizing polygon features in the source area feature class in the customized geodatabase (WinSLAMMSourceArea.gdb).

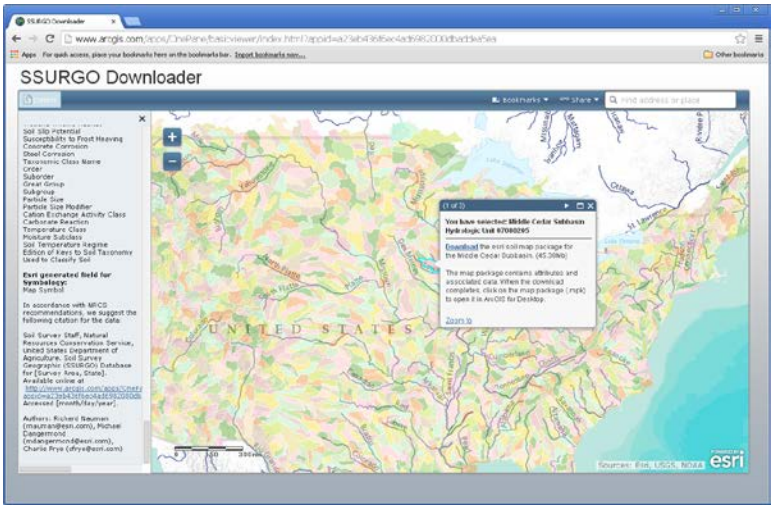
You can download SSURGO soils data by watershed from an ArcGIS Online site created by ESRI (http://www.arcgis.com/apps/OnePane/basicviewer/index.html?appid=a23eb436f6ec4ad6982000dbaddea5ea). ***Warning:*** *This is a secondary product derived from USDA NRCS SSURGO soils data and does not necessarily represent the most up to date official SSURGO soils data. Please read ESRI's explanation of how these data were derived at the above site.* The ESRI site provides a convenient method to access SSURGO soils data and the *Derive Soil Type from SSURGO* ArcSLAMM tool provides an efficient method to derive the soil attribute necessary to run WinSLAMM. The *Derive Soil Type from SSURGO* ArcSLAMM tool is a pre-processing tool which makes it easy to derive the soils attribute but the user can derive the soil information from other sources using other methods. Reference the official website of USDA NRCS to learn more about soils data- http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/.



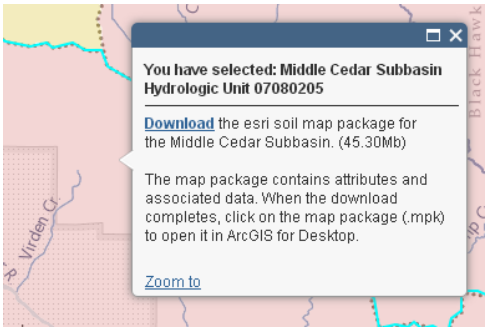
The steps below indicate how to download data from the above site and how to use the *Derive Soil Type from SSURGO* tool to process that data. These steps will require that you have a feature class (Shapefile or geodatabase feature class) representing the boundary of your study area. This feature class will be used to clip out the SSURGO soils data. You might want to create a directory called \soils which will hold the data you download in following steps.

Derive Soil Type from SSURGO

1. Open http://www.arcgis.com/apps/OnePane/basicviewer/index.html?appid=a23eb436f6ec4ad6982000dbaddea5ea and zoom to the watershed that contains your study area. If your study area crosses two (or more waterhseds) you will have to download both and repeat these steps. In this example we are choosing the Middle Cedar Subbasin in Iowa which contains the study area we will use below. You can type in Cedar Falls, IA if you want to search for a place.

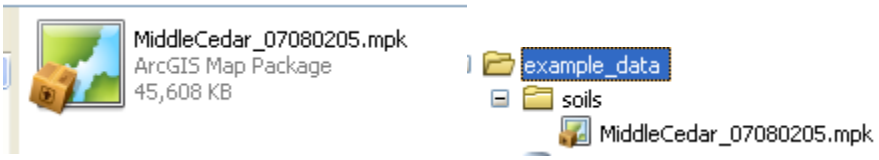


- In the mapping application, click on the watershed to open the popup. Click Download and save it to a location of your choice. For this example, a \soils directory was created in the \example_data folder. How your download occurs might depend on how your browser is set up to download files.

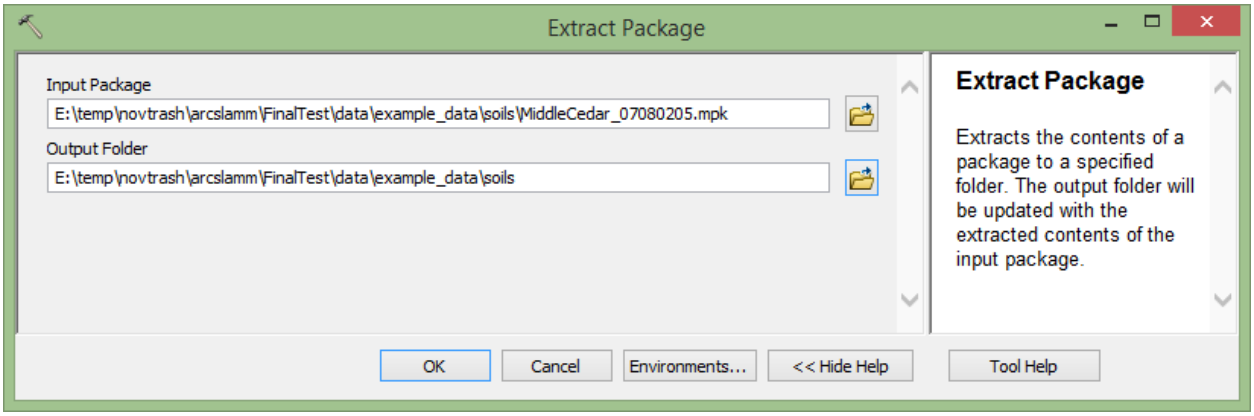


2. At this point you will have downloaded an ESRI Map Package (.mpk) file. Map Package files are a mechanism created by ESRI to easily distribute an ArcMap document (.mxd) and the data

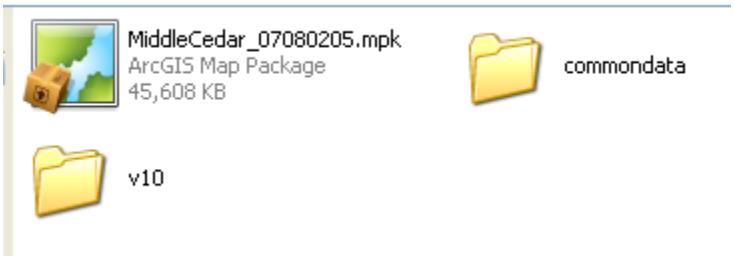
contents held in that .mxd. The SSURGO .mpk files will contain an .mxd file and all data associated with it – in this case a geodatabase containing feature classes representing the watershed boundary and the soils data for that watershed. Based on example above this is what the map package file looks like. The map package file is basically a zipped file.



3. There are multiple ways to extract the contents of the .mpk file including using an extraction program like 7-Zip, dragging and dropping the file onto ArcMap data frame, or using the Extract Package tool from ArcToolbox. We suggest using the Extract Package tool (Data Management Tools – Package – Extract Package) and demonstrate this below.
4. In ArcMap (or ArcCatalog) open the Extract Package tool (ArcToolbox – Data Management Tools – Package) and navigate to the directory holding the Input Package (.mpk file downloaded). Also indicate the directory that you would like to extract the data too. This is an intermediate step so you can put this data wherever you like but we suggest the \soils directory mentioned above.

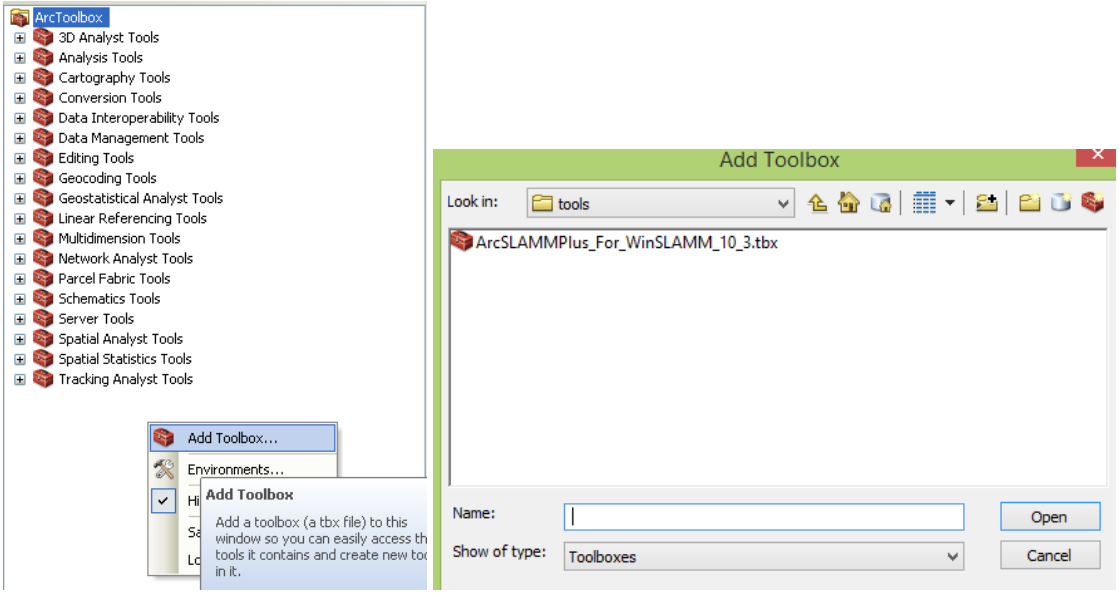


5. After running the Extract Package tool you should see the following in the directory you extracted to (in this case the .mpk file is in the same directory).

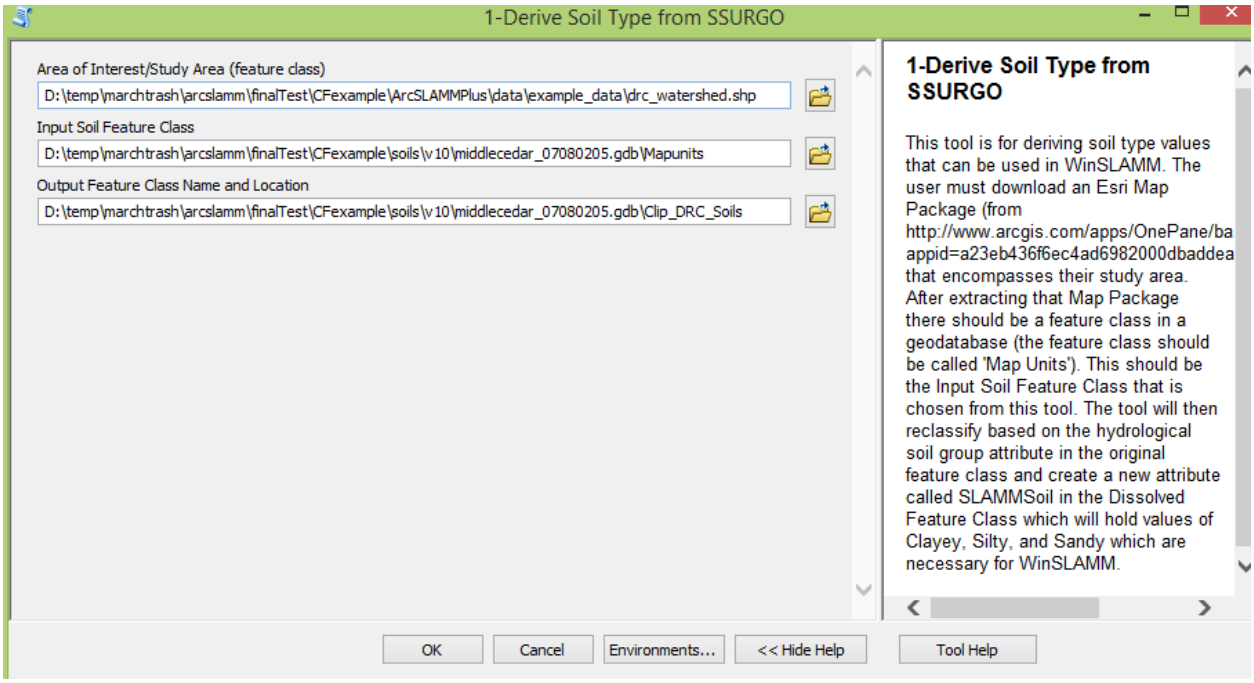


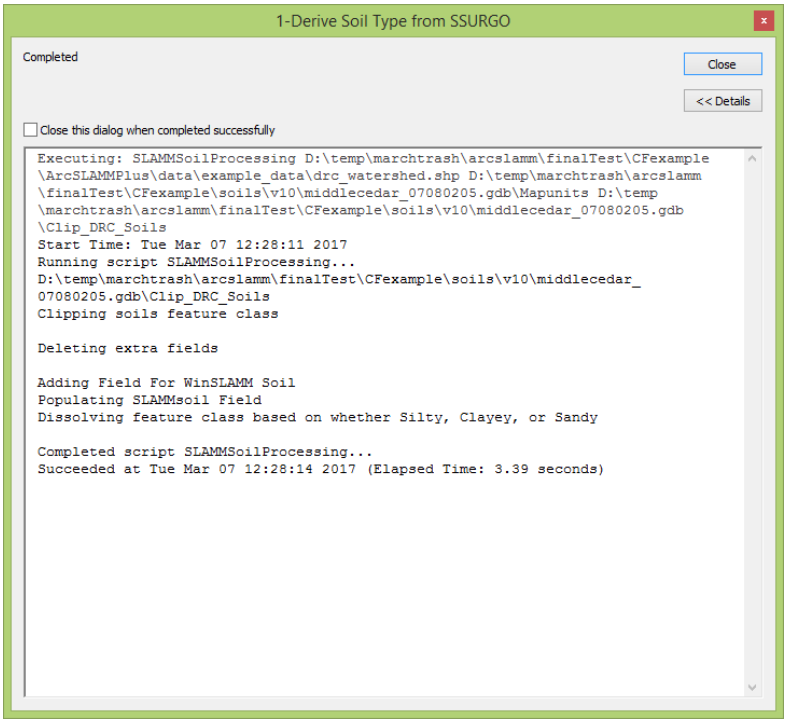
6. When looked at in ArcCatalog the v10 folder has a geodatabase which holds a geodatabase which holds two feature classes – Mapunits and Subbasin. The Mapunits feature class holds soil survey polygons with a large number of attributes including the hydgrpdcd (hydrological soil group). This attribute will be used by the *Derive Soil Type from SSURGO* tool to derive a new reclassified attribute called SLAMMSoil attribute which will hold values of silty, sandy, and clayey.

7. Open ArcMap and make sure that ArcToolbox is open and activated. Add the ArcSLAMM toolbox in the \tools directory by right-clicking, choosing Add Toolbox, navigating to the \tools directory which contains the toolbox, selecting it, and choosing Open.



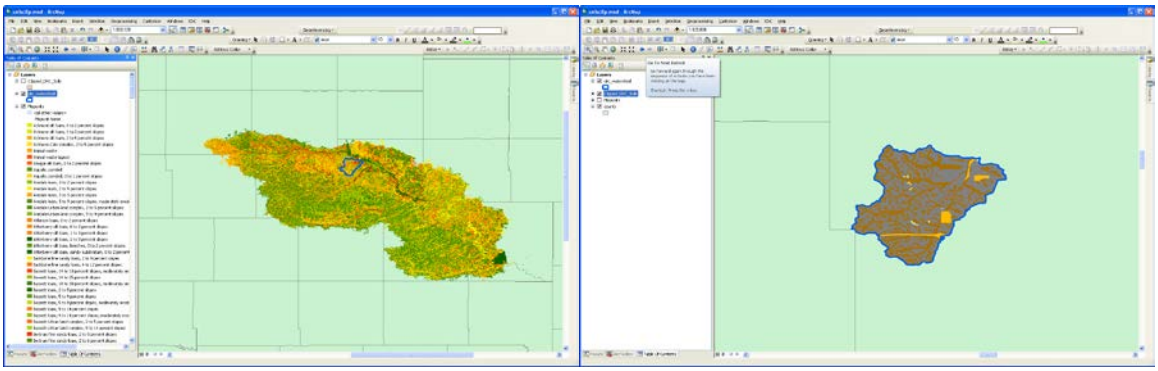
8. Double-click the 1-Derive Soil Type from SSURGO tool from ArcSLAMM toolbox. Choose the polygon feature class which you want to use to clip the soils data (Area of Interest/Study Area (feature class)). Choose the soils feature class (Mapunits) in the geodatabase you extracted from the .mpk file as the Input Soil Feature Class. Set the Output Feature Class Name and Location to either a directory or a file geodatabase where you want to store the data. You can store the new feature class in the same geodatabase that holds the original soils data. The clipped feature class will have the same spatial reference of the original data (GCS_North_American_1983 - WKID: 4269 Authority: EPSG).





9. After you run the tool the clipped soil layer with two soil related attributes in the table should be created and added to ArcMap. These two attributes: the Hydrologic Group – Dominant Condition (hygrpdcd) is an original attribute from the SSURGO data while the SLAMMSoil attribute holds the reclassified values of silty, sandy, and clayey which are required for WinSLAMM use. In the screenshots below the original SSURGO soils data, the clipped soils data, and the table demonstrating the fields after clipping are displayed. Note: the script tool does not automatically symbolize, this was done manually.

10. **Warning:** It is likely that some polygons do not have a value for the original SSURGO attribute – Hydrologic Group – Dominant Condition (hygrpdcd). Thus they will not have a reclassified SLAMMSoil value which you need to help you create WinSLAMM source area polygon features. Thus **it is up to the user to decide how to populate** the SLAMMSoil attribute on their own before creating detailed source area polygons (detailed below).



Table

Clipped_DRC_Soils

OBJECTID *	Shape *	Hydrologic Group - Dominant Condition	SLAMMsoil	Shape_Length	Shape_Area
87	Polygon	C	Clayey	0.006942	0.000002
88	Polygon	C	Clayey	0.0132	0.000003
89	Polygon	C	Clayey	0.012584	0.000004
90	Polygon	C	Clayey	0.007767	0.000001
91	Polygon	C	Clayey	0.015269	0.000004
92	Polygon	A	Sandy	0.01966	0.000006
93	Polygon	A	Sandy	0.007111	0.000002
94	Polygon	A	Sandy	0.00444	0.000001
95	Polygon	A	Sandy	0.004771	0.000001
96	Polygon	A	Sandy	0.005	0.000001
97	Polygon	A	Sandy	0.004809	0.000001
98	Polygon	A	Sandy	0.007884	0.000002
99	Polygon	A	Sandy	0.005462	0.000001
100	Polygon	A	Sandy	0.009778	0.000003
101	Polygon	A	Sandy	0.01306	0.000005
102	Polygon	B	Silty	0.009948	0.000005
103	Polygon	B	Silty	0.004828	0.000001
104	Polygon	B	Silty	0.008786	0.000002
105	Polygon	B	Silty	0.037492	0.000013
106	Polygon	B	Silty	0.266608	0.000128
107	Polygon	B	Silty	0.028695	0.000032
108	Polygon	B	Silty	0.008874	0.000003

1 (0 out of 157 Selected)

Clipped_DRC_Soils

Digitizing/creating WinSLAMM compliant source area feature classes

Having the soils feature class with sandy, silty, and clayey classification allows the user to move on to the steps necessary to create polygon features in the source area feature class in their copy of the customized geodatabase (WinSLAMMSourceArea.gdb). At this point we are going to give a short overview of steps to create and set attributes for source area polygons. This document will not provide highly detailed instructions on creating these features but will provide a basic overview of how to create features. To successfully populate a detailed source area feature class requires the user to have a basic understanding of editing in ArcMap including topological editing. Also, to fill in attributes properly requires the user to understand the concepts underlying the WinSLAMM source areas. You can seek help on these topic at http://winslamm.com/default.html and http://desktop.arcgis.com/en/arcmap/latest/manage-data/editing/what-is-editing-.htm. In the \docs

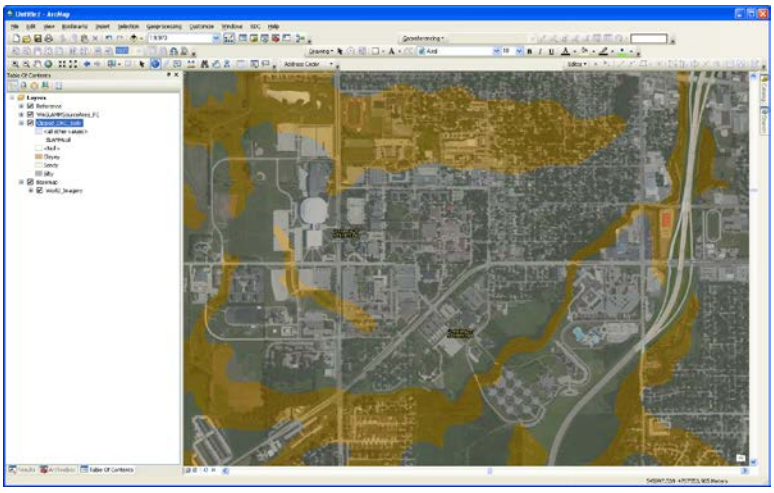
folder of the ArcSLAMM package download, there is a document (SourceAreaFieldGuide.pdf) which provides information on the WinSLAMM source area types to help guide you.

Before creating your own WinSLAMM source area features you should ***create a copy*** of the WinSLAMMSourceArea.gdb you downloaded for digitizing source areas. It is also likely you will want to rename the geodatabase to a more descriptive name for your study area. In addition, as mentioned previously ***you should change the spatial reference/coordinate system of the feature dataset*** to your local conditions. While digitizing you will also want to use, as referenced, the soils feature class created in steps above, and high-resolution imagery for your study area.

It is ***highly recommended*** that you change the spatial reference of the WinSLAMMSourceArea_FDS (WinSLAMMSourceArea_FC will also be set) in your copy of the WinSLAMMSourceArea.gdb to the projection/spatial reference that is best suited for your study area. You can do this by right-clicking on the WinSLAMMSourceArea_FDS, choosing Properties, and XY Coordinate System tab and then choosing the system you would like to use. As the base geodatabase is distributed the WinSLAMMSourceArea_FC has no features in it and is in the NAD_1983_UTM_Zone_15N coordinate system (used in Iowa).

The steps immediately below give a short example of how to create source area polygons and set the proper attributes for these features. Again, these steps assume you have made a copy of the geodatabase and reprojected the feature dataset (and contained feature class) to a local coordinate system. They also assume that you have some base imagery to use for digitizing features on-screen.

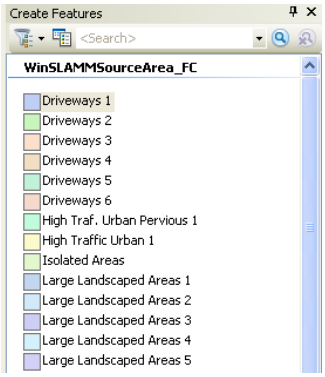
1. Open a new ArcMap document and add the reprojected WinSLAMMSourceArea_FC feature class from your copied geodatabase (add this one first), the imagery you would like to use, and the soils feature class with the SLAMMSoil attribute. It is a good idea to symbolize the soils data with the SLAMMSoil attribute. In the example below we have symbolized that way and have 50% transparency. In this view, there are silty (gray) and clayey soils (orange/brown).



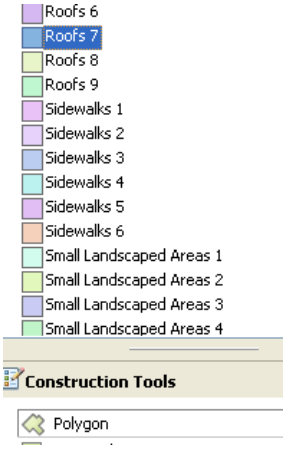
2. Zoom into an area to digitize. For the detailed digitizing necessary, you will want to be zoomed to a level (e.g. ~1:500-1:1000) where you can capture the level of detail necessary.

3. Add the Editor toolbar in ArcMap (Customize – Toolbars – Editor) and choose Editor – Start Editing. Choose the WinSLAMMSourceArea_FC to edit and click OK>.

4. Open the Create Features window.  You should see that in that window you have the list of potential source areas.



5. When creating an independent polygon (i.e. in this case the first polygon or one that is not going to share an edge with an existing polygon at time of polygon creation) choose the correct source area type and click Polygon. In the example below we are going to create a polygon of Roofs 7 source area polygon. The description of Roofs 7 is shown from the SourceAreaFieldGuide below. So in the WinSLAMM system, Roofs 7 represents a building with a pitched roof that is connected to impervious areas.



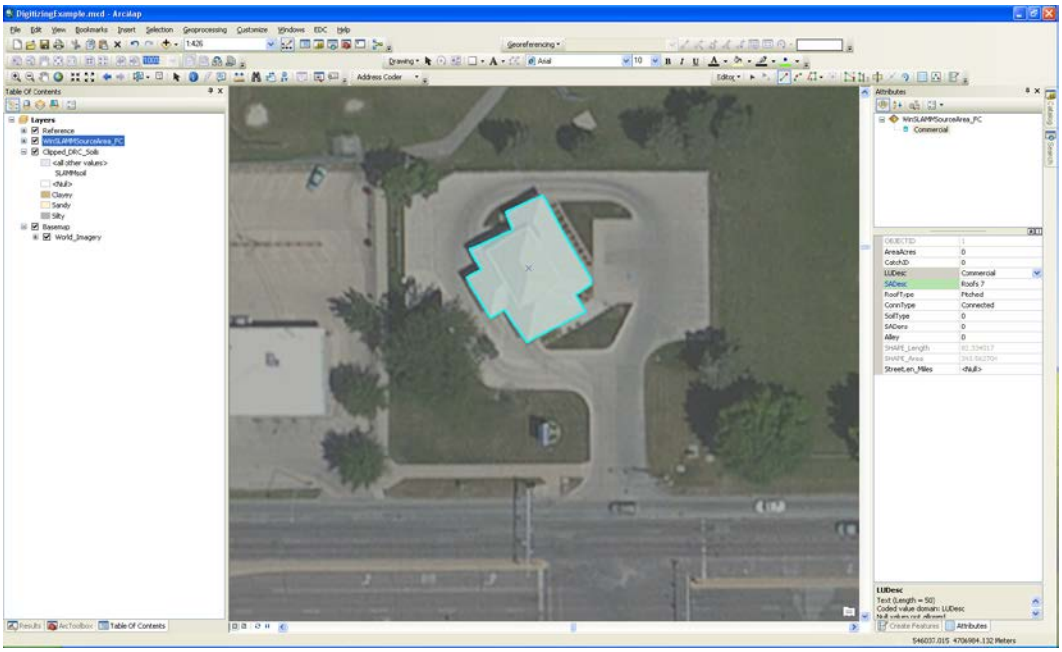
PITCHED ROOFS

Roofs 7:

Pitched roof
Connected

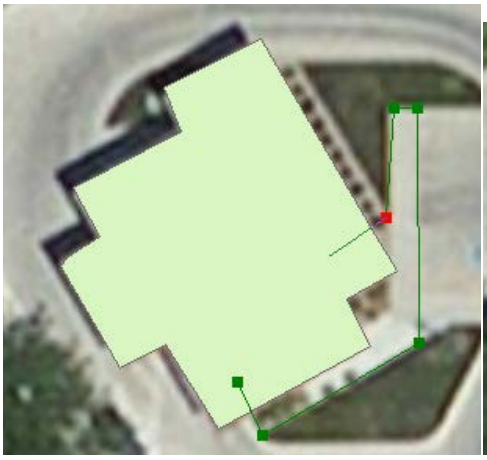
6. Digitize the polygon.

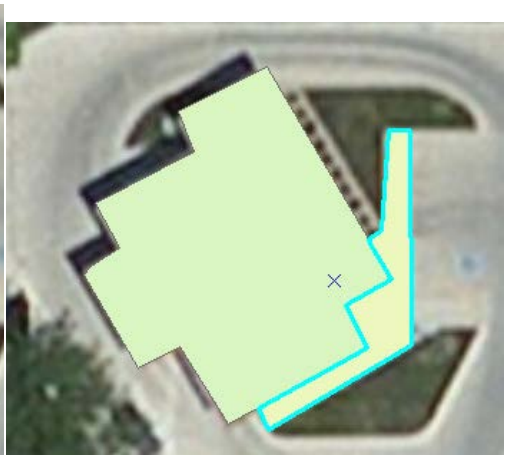
7. Open the Attributes window  . When you chose the source area type and then digitized the polygon, the other WinSLAMM required attributes (RoofType, Connected, SoilType, SADens, Alley) are automatically populated based on the domains/subtypes built into the geodatabase. However, the LUDesc (Residential, Institutional, Industrial, Commercial, Other Urban, Freeway) must be set. In this example, we have digitized a bank building setting it as a Roofs 7 (a connected building with a pitched roof that is in Commercial land use).



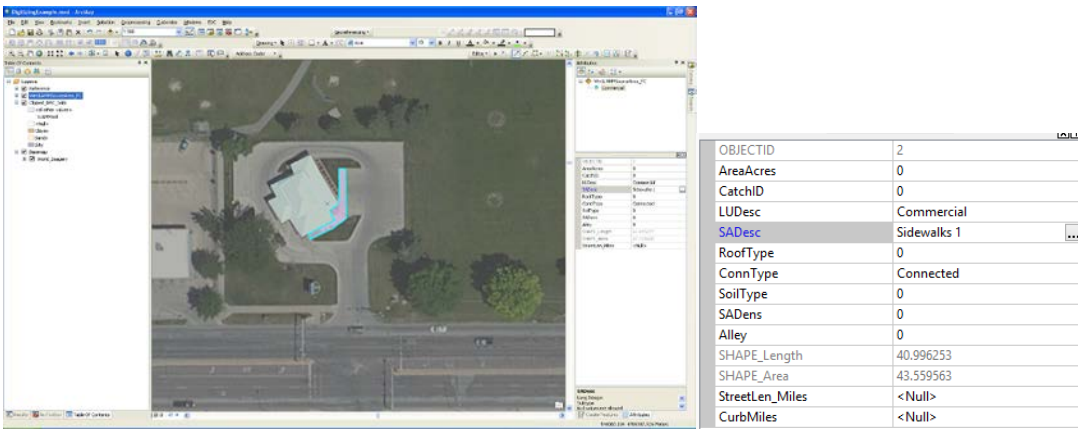
8. When creating a polygon with a shared edge choose the source area type and then choose Auto Complete Polygon construction tool. 

. By using this tool you ensure that the topological integrity will be enforced. When using this tool you want to start and end your digitizing within the existing polygon that will share the edge with polygon you are digitizing.



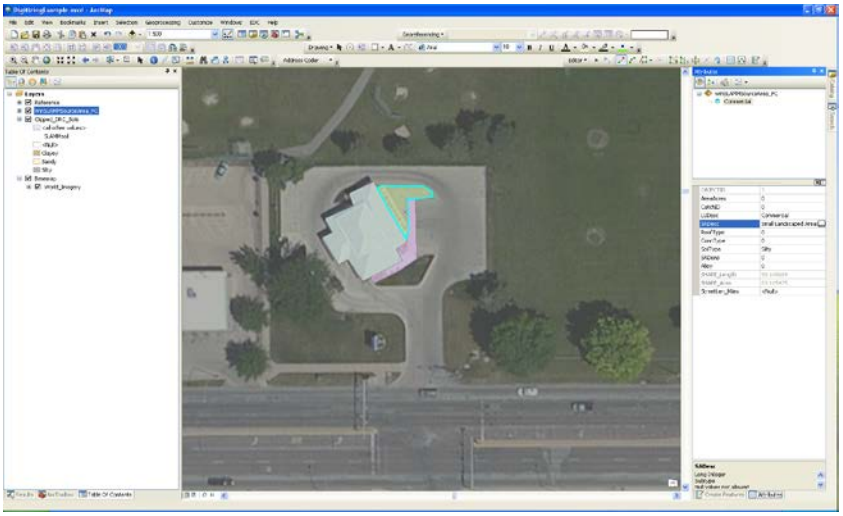


9. Digitize the polygon and then open the Attributes window. In this example we have digitized a polygon with Sidewalks 1 source area polygon (Connected) again in commercial land use.



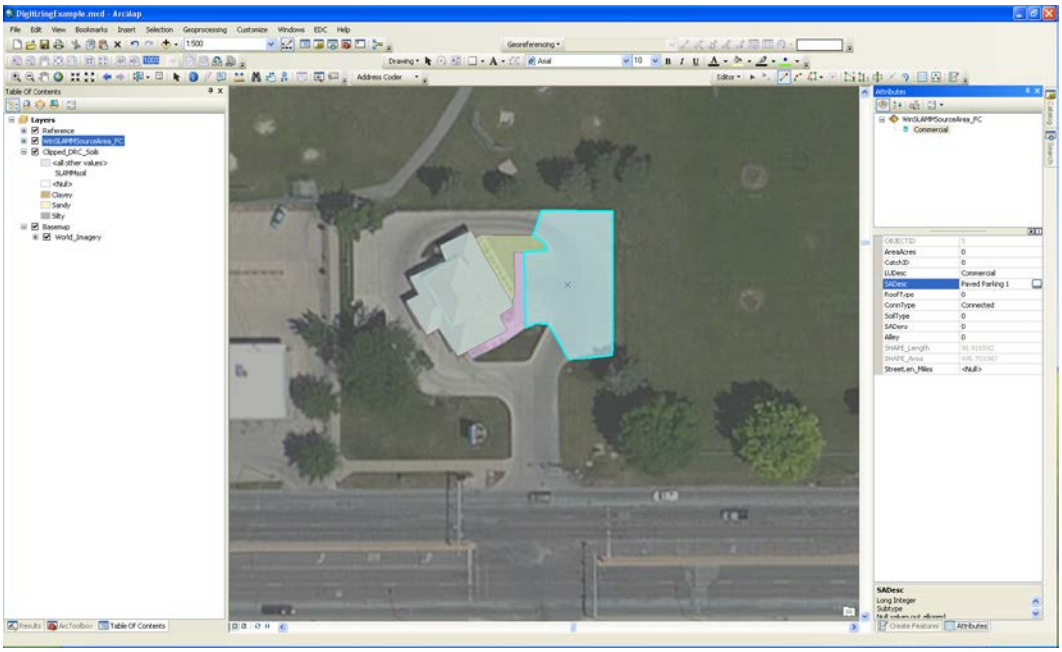
OBJECTID	2
AreaAcres	0
CatchID	0
LUDesc	Commercial
SADesc	Sidewalks 1
RoofType	0
ConnType	Connected
SoilType	0
SADens	0
Alley	0
SHAPE_Length	40.996253
SHAPE_Area	43.559563
StreetLen_Miles	<Null>
CurbMiles	<Null>

10. In the next screenshot we have created a polygon which is the source area Small Landscaped Areas 2 (disconnected, silty soil) in commercial land use.

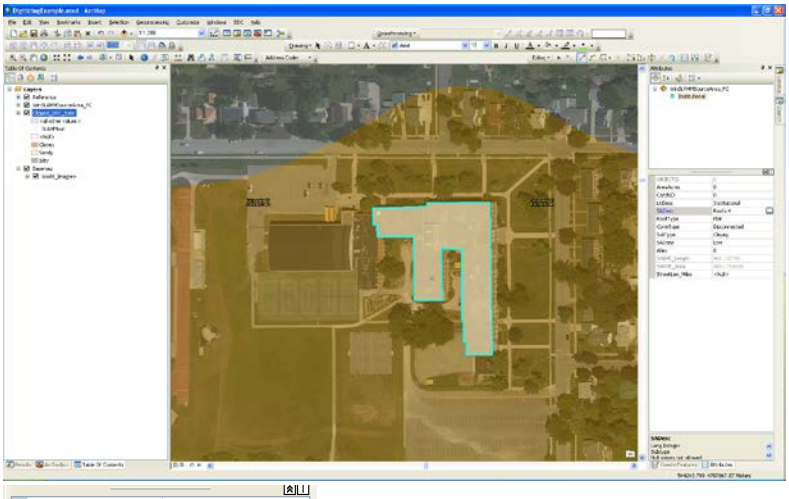


OBJECTID	3
AreaAcres	0
CatchID	0
LUDesc	Commercial
SADesc	Small Landscaped Areas
RoofType	0
ConnType	0
SoilType	Silty
SADens	0
Alley	0
SHAPE_Length	50.160689
SHAPE_Area	83.165475
StreetLen_Miles	<Null>

11. In the next screenshot we have created a polygon which is Paved Parking 1 (connected) in commercial land use. For each of these last three polygons we used the Auto Complete Polygon construction tool.



12. In the example below we have digitized a high school building in an area of clayey soils. This building is mainly surrounded by grass and is an area without a lot of other buildings around. Thus we have chosen a source area type of Roofs 4 (flat roof, disconnected, clayey soil, and low source area density) and Institutional. As this was created without any shared boundary the Polygon Construction Tool was used.



OBJECTID	6
AreaAcres	0
CatchID	0
LUDesc	Institutional
SADesc	Roofs 4
RoofType	Flat
ConnType	Disconnected
SoilType	Clayey
SADens	Low
Alley	0
SHAPE_Length	468.133786
SHAPE_Area	4881.754655
StreetLen_Miles	<Null>

13. While digitizing your detailed source area features you should use tools from the Topology toolbar () to interactively check for any

topological errors. This is an ongoing process during your digitizing process. There may be some limitations if you only have ArcGIS Basic license with topological editing.

14. In addition you should check for attribute errors – especially double-checking that you have identified the LUDesc class for each polygon feature created.
15. When digitizing a Streets1 polygon you also need to set the CurbMiles attribute appropriately. ArcSLAMM will use the dimensions (area/lengths) and this curb mile attribute to calculate the street length which gets populated to the WinSLAMM databases created with the ArcSLAMM tools. The curb miles would normally be set to 2. You can consult with PV & Associates if you have questions about this.
16. After digitizing all polygons in your study area you can go on to utilize the ArcSLAMM tools below. In the steps below we use a detailed digitized source area feature class for Cedar Falls, Iowa.

ArcSLAMM Practice/Demonstration Steps

This section will provide example steps to carry out a full modeling effort using ArcSLAMM and WinSLAMM for a detailed source area feature class. In this example we are using an area of Cedar Falls, Iowa in which several thousand features (~1000 acres) of detailed source areas have been digitized. These features are stored in the ArcSLAMM_CFExample.gdb\WinSLAMMSourceArea\WinSLAMMSourceArea_FCImport feature class that was delivered in the ArcSLAMM package in the \example_data directory.

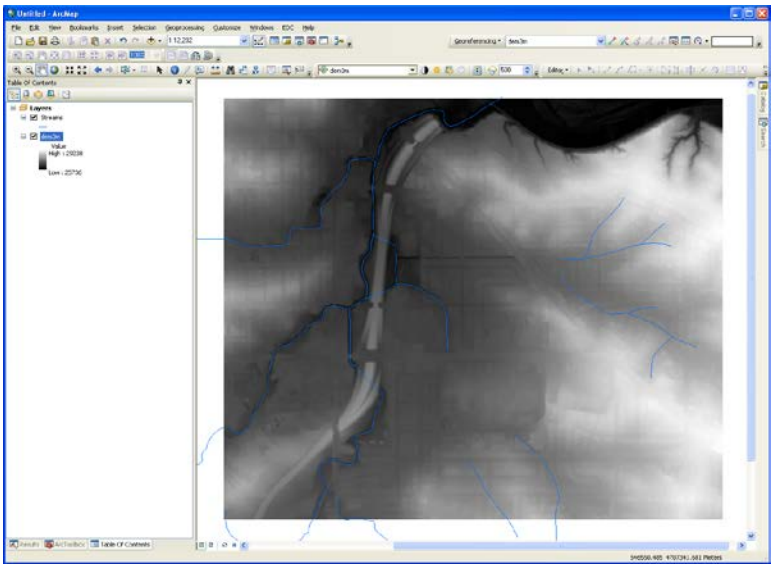
The first set of tools used under the *Elevation and Catchment Area Tools* toolbox are optional and if you already have defined drainage areas/catchments than you can skip these steps.

Before altering any data in any way it is a good idea to create a backup copy of the entire download package.

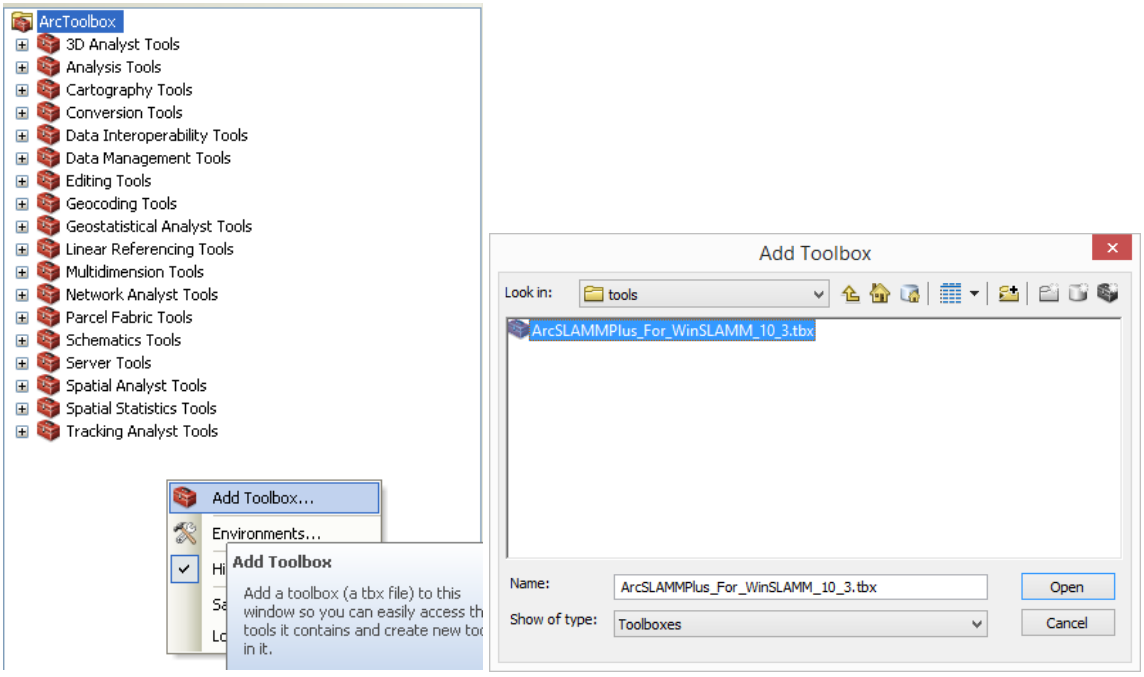
Hydrologically Enforce DEM

This tool is meant to use a stream network that matches the Digital Elevation Model that it is being used to burn into. This tool was built with LIDAR DEM data in mind. In Iowa, where there is statewide LiDAR data, it was often seen that there would be blockages or dams in the DEM. For example the stream might run under a road through a culvert but this is not reflected in the DEM. This tool is attempting to account for that type of situation. If you use a stream network which is a mismatch compared to the DEM you likely will have results that are not what you were hoping for. It might be that you need to manually create stream segments where you know water should be flowing.

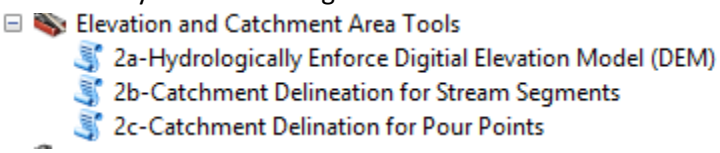
17. Open ArcMap and add the \data\example_data\dem3m raster dataset as well as the \ data\example_data\Streams.shp. The dem3m raster is a DEM derived from LiDAR data in Iowa and downloaded from the Iowa Department of Natural Resources.



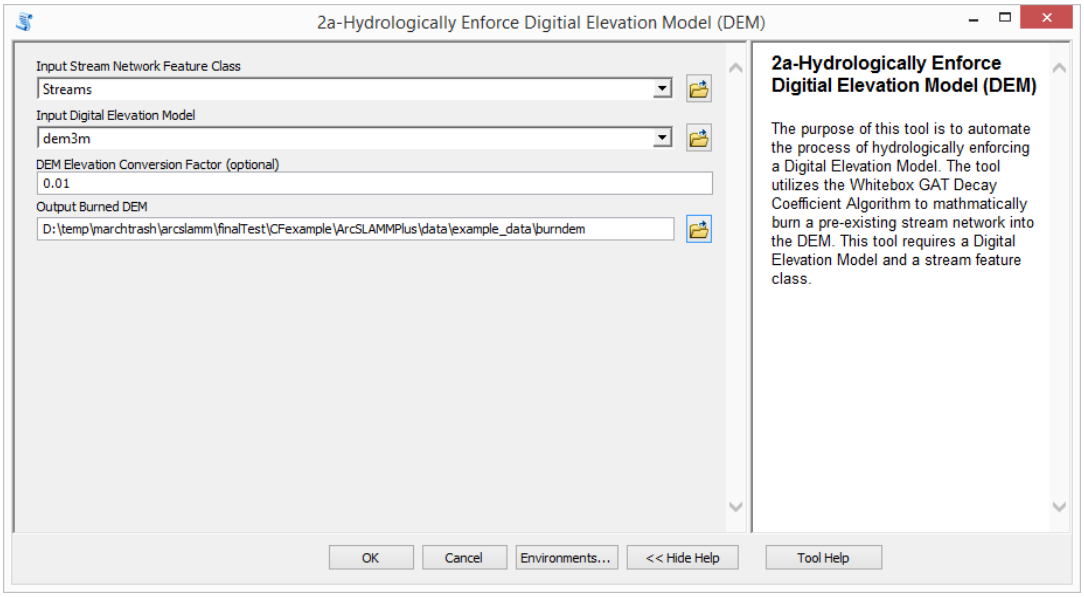
18. Save the .mxd file as with a name you choose in a location of your choice. Here it has been saved as DemoTest_1.mxd.
19. With ArcToolbox open in ArcMap add the ArcSLAMM toolbox from the \tools folder by right-clicking, choosing Add Toolbox, navigating to the \tools directory which contains the toolbox, selecting it, and choosing Open.



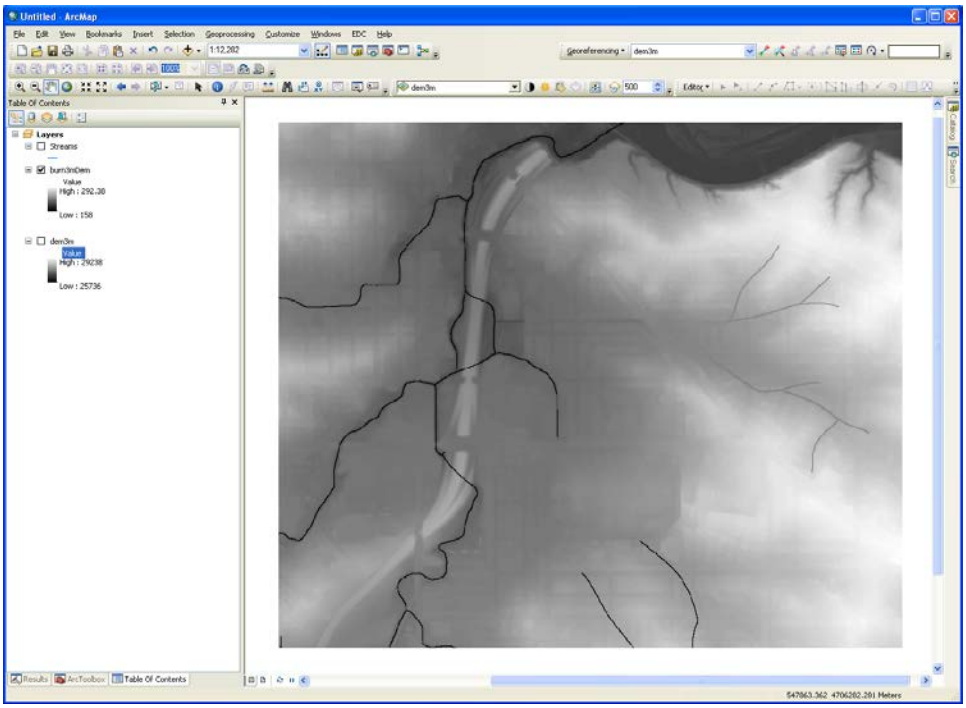
20. Open the Hydrologically Enforce Digital Elevation Model tool in the Elevation and Catchment Area Tools by double-clicking on it.



21. Fill in the first three parts of the tool dialog as seen below. We are choosing the Steams layer we added and the DEM we added. We set the DEM Elevation Conversion Factor to 0.01 because in this case our DEM (derived from Iowa LiDAR data) has elevation units in centimeters while the horizontal units of our coordinate system are meters (NAD 1983 UTM Zone 15N).

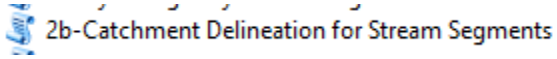


22. For the Output Burned DEM parameter, navigate to where you want to store the new DEM that is going to be created. In this example I named it burndem and stored it in same directory as the original DEM (see above). This new 'burned' DEM will be used as the hydrologically enforced DEM going forward. You can choose where you want to put it. When you have parameterized the tool dialog click OK to run the tool.
23. If the tool successfully runs you should have a new DEM which has had streams burned into it added to your ArcMap document. The purpose of this step is to attempt to make sure that the DEM will not have any artificial blockages. It is common, especially with LiDAR data, to have situations in which the DEM does not capture things like culverts going under roads which will then block water flow in any hydrological functions using that DEM.

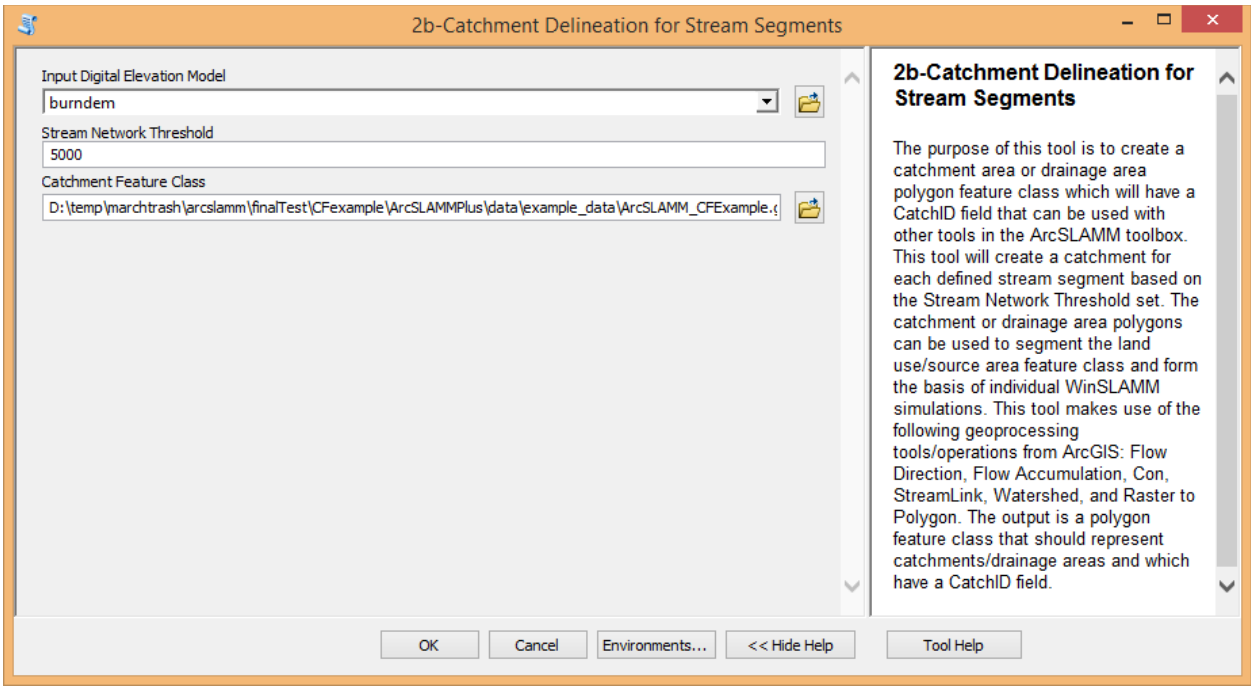


Catchment delineation for Stream Segments

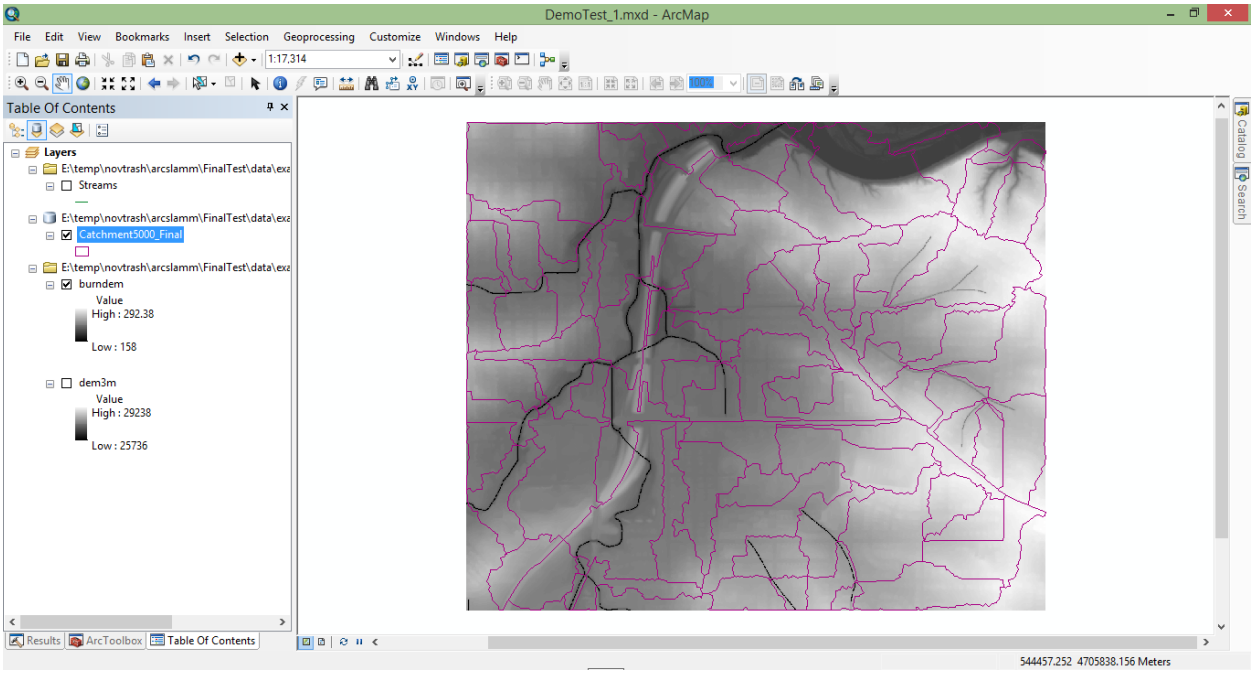
24. The purpose of this tool is to delineate drainage area/catchment boundaries for partitioning up the study area for WinSLAMM modeling. If you already have your drainage area/catchment boundaries defined than you don't need to carry out this step. This specific tool is meant to break up the entire study area into drainage/catchment areas based on a drainage area size threshold. If you only wanted to delineate drainage area/catchment boundaries for specific catchment outlet points you could skip to the next tool (*Catchment Delineation for Pour Points).*
25. Open the 2b-Catchment Delineation for Stream Segments tool and parameterize as follows



    a. Input Digital Elevation Model – output burned DEM from Step 5 above or an equivalent from your own source.
    b. Stream Network Threshold – in this case set the value to 5000. This means that each catchment derived will be approximately 5000 cells so the application will produce catchments that are approximately 45,000 sq. meters (~11 acres).
    c. Catchment Feature Class – navigate to where you want to store the output feature class which will be a polygon feature class representing catchments. It might be a good idea to put it in the same geodatabase that holds the source area feature class being used in this example - i.e. \example_data\ArcSLAMM_CFExample.gdb. Named Catchments5000 here.



26. After running the tool, the two catchment feature classes are added to the map. The second one has small catchment polygons dissolved into larger neighboring polygons (threshold is approximately < 0.25 acres). Screenshot below shows the second one displayed over the burned DEM. This catchment feature class can be used later with the *Intersect Catchments with WinSLAMM Detailed Source Areas* tool.

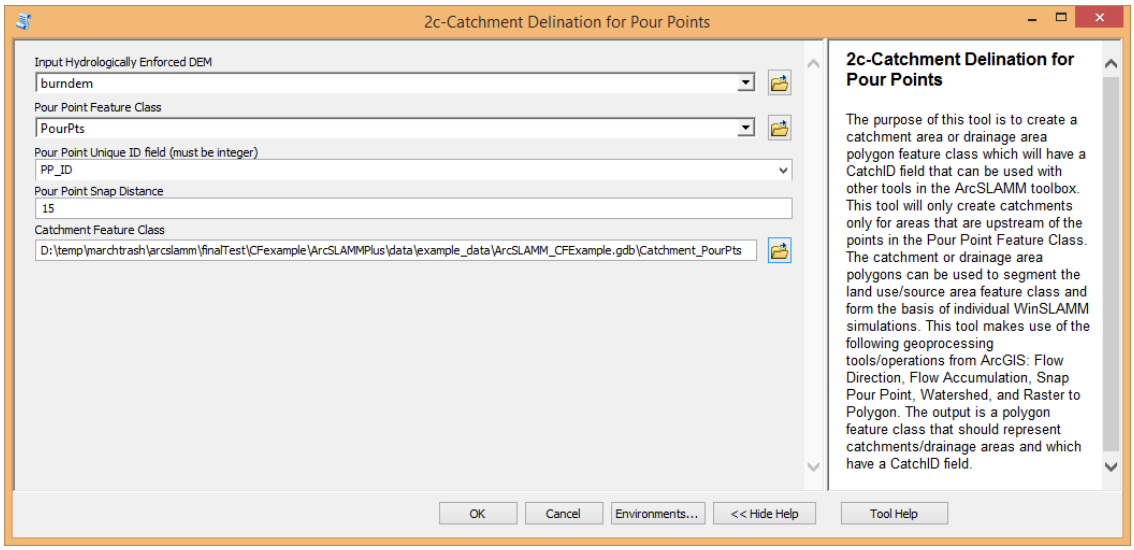


Catchment delineation for Pour Points

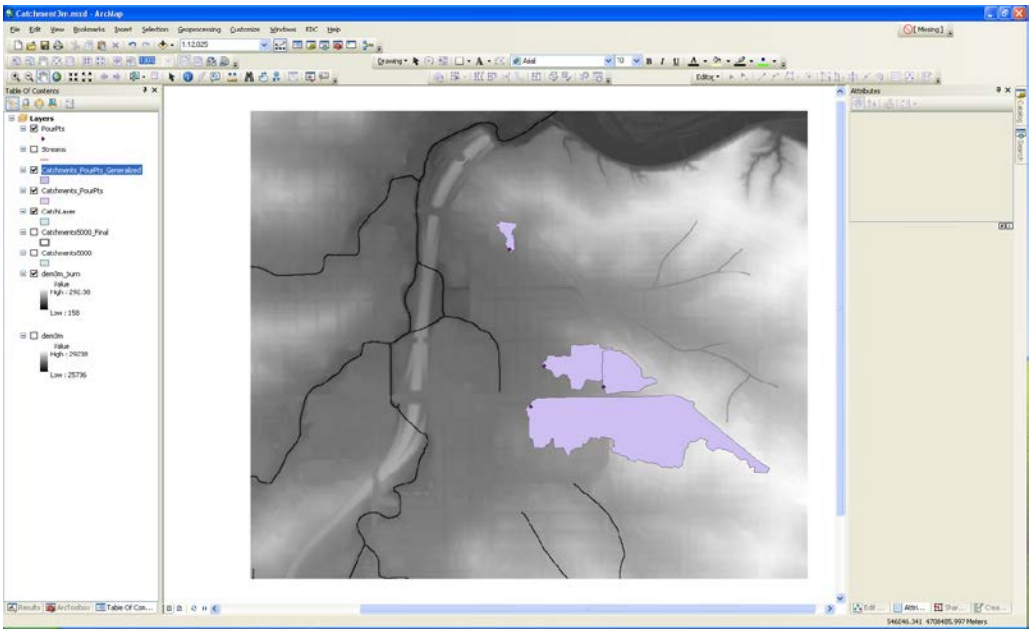
27. With this tool you are also going to derive catchment boundaries but in this case only for designated outlet points.
28. With the .mxd from above add the \data\example_data\PourPts.shp
29. Open the Catchment Delineation for Pour Points tool in the Elevation and Catchment Area Tools by double-clicking on it.

    2c-Catchment Delination for Pour Points

30. Populate the tool dialog as follows:
    a. Input Hydrologically Enforced DEM – the burned DEM created in steps above.
    b. Pour Point Feature Class – this should be a feature class that represents outlets for drainage areas that you want to calculate boundaries for. In this example use PourPts.shp added to map in step above.
    c. Pour Point Unique ID Field – this is the unique identifier associated with pour point that will be carried through to the catchment and on through the WinSLAMM modeling process. This must be an integer field. In this example choose PP_ID.
    d. Pour Point Snap Distance – this is a parameter that serves as a search tolerance to move the pour point to an area of high accumulated flow. The tool will look for the cell with the highest level of flow accumulation within the radius specified and use this as the outlet of the catchment to be derived. The unit is the same as the horizontal unit of the DEM. In this case set it to 15 (units are meters). *This parameter can affect the area defined as a drainage area so you might need to use trial and error to decide the correct distance.*
    e. Catchment Feature Class – this is the catchment feature class (drainage area for the outlet point) that will be created for the pour points. You could place this feature class where you like and name it what you want. In our case we are naming it Catchment_PourPts and putting it in ..\example_data\ArcSLAMM_CFExample.gdb.



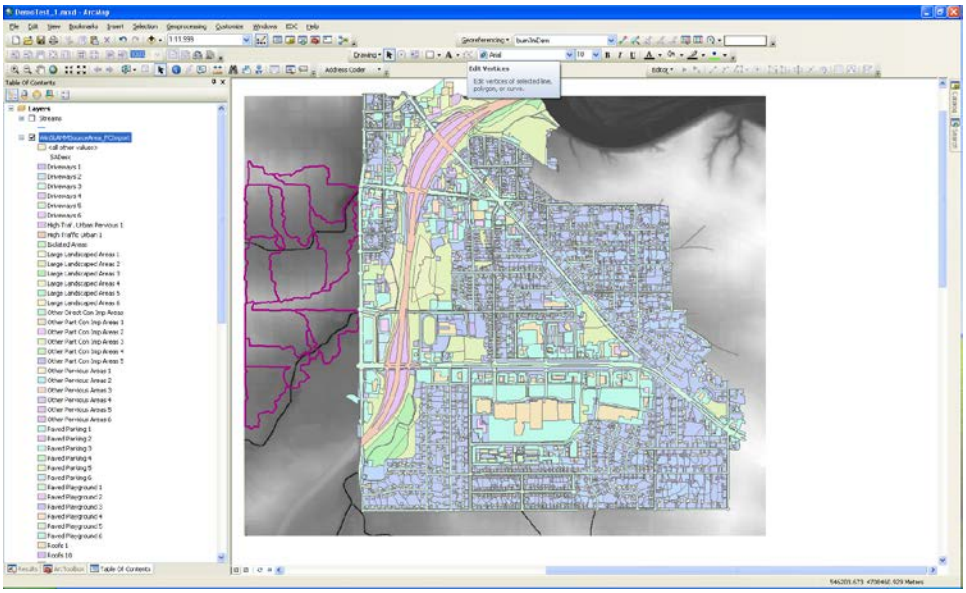
31. After running the tool, the catchment feature class is added to the map.



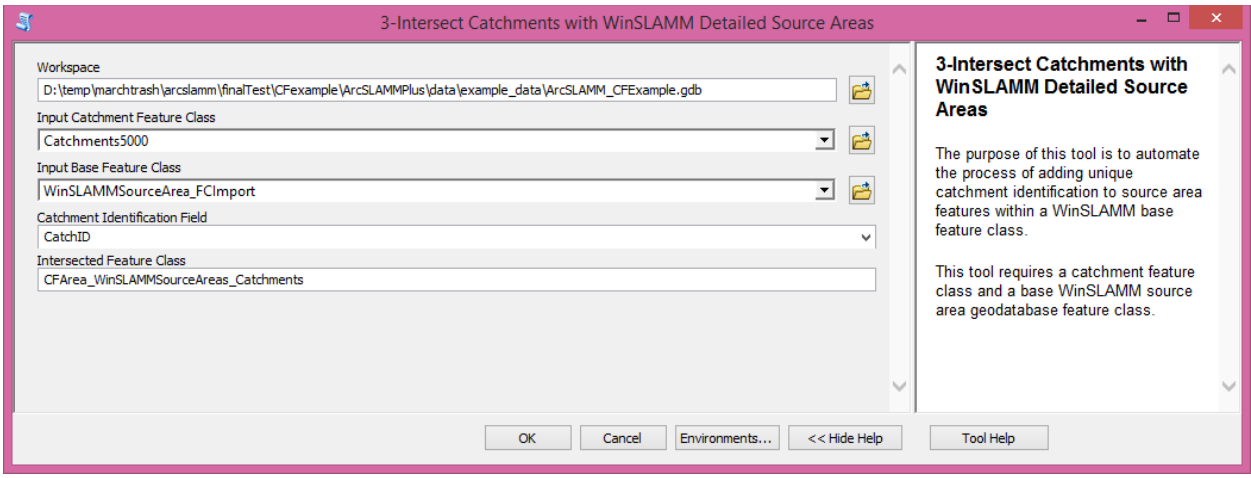
At this point you have two catchment feature classes that can be used moving forward. Either of these catchment feature classes could form the basis of WinSLAMM modeling.

Intersect Catchments with WinSLAMM Source Areas

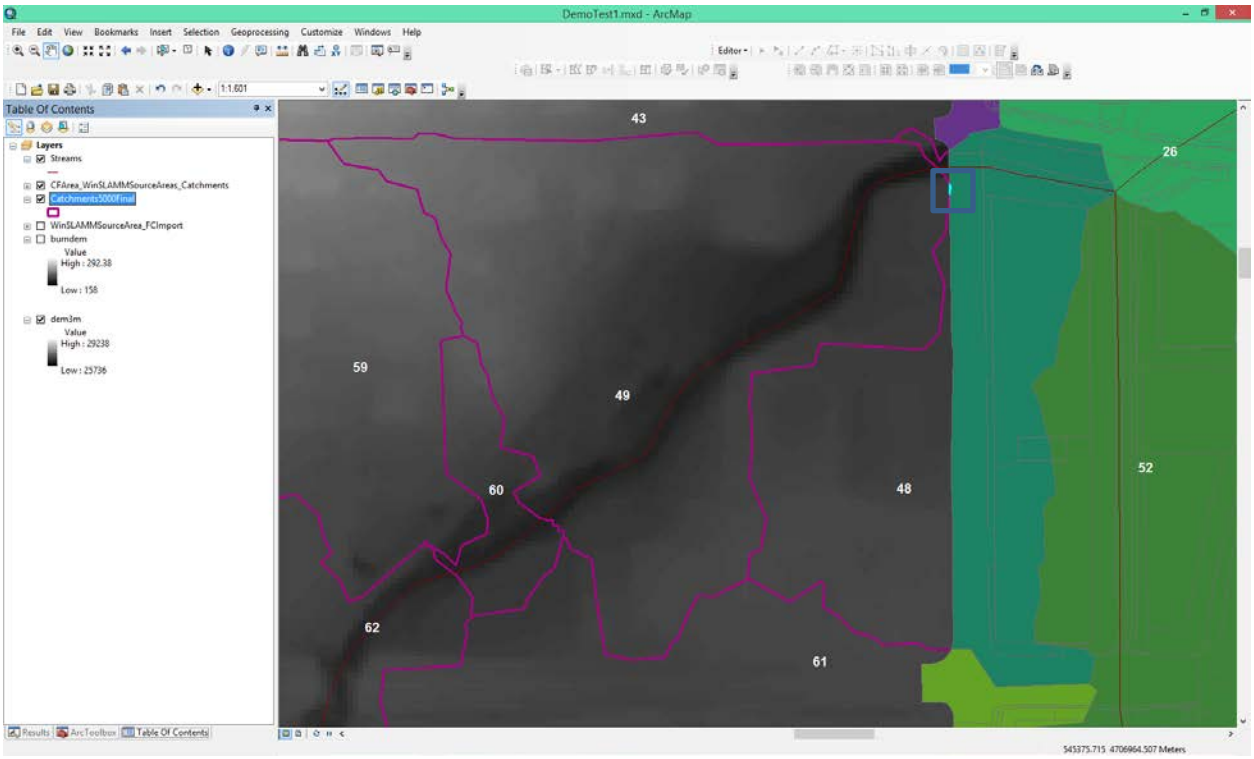
32. The purpose of this step is to intersect the catchments with the detailed WinSLAMM source areas that have been digitized for WinSLAMM modeling. This is a step necessary in order to prepare for the creation of a WinSLAMM compliant database for each drainage area/catchment using the C*reate WinSLAMM Compliant Databases* tool.
33. Add the WinSLAMMSourceArea_FCImport feature class from \data\example_data\ArcSLAMM_CFExample.gdb\WinSLAMMSourceArea. This feature class has detailed digitized features which have WinSLAMM source area classes created using the custom intelligent file geodatabase. Also add in the catchment feature class you want to use moving forward. In this case we are using the Catchment_5000 feature class we created in steps above. ***This would be a good time to double check that you have no missing attributes in the detailed source area feature class. Any errors in this database will carry through and cause problems later. A common error would be a missing land use type for a given polygon or no CurbMiles value set for a Streets1 source area.***



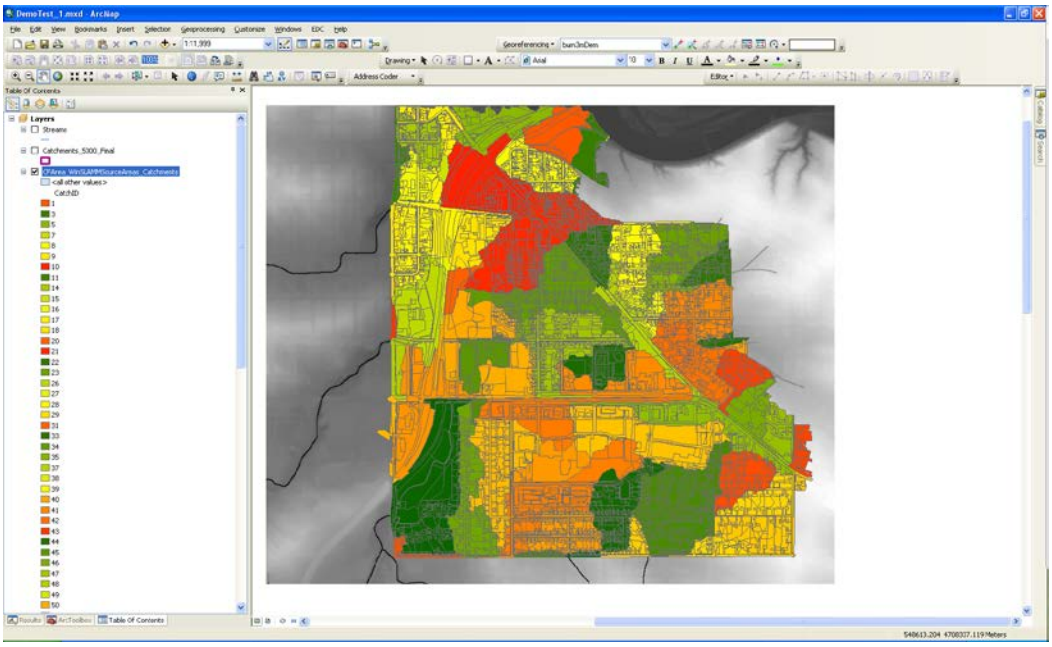
34. Open the *Intersect Catchments with WinSLAMM Source Areas* tool and parameterize as follows
    a. Workspace – set it equal to the geodatabase which contains the feature dataset which contains your feature class of source areas shown above. In our example it is ..\data\example_data\ArcSLAMM_CFExample.gdb.
    b. Input Catchment Feature Class – this is the feature class which was created using either the *Catchment Delineation from Stream Segments* or *Catchment Delineation for Pour Points* tools. We are using the one called Catchments5000 created using the *Catchment Delineation from Stream Segments* tool.
    c. Input Base Feature Class – this is the detailed WinSLAMM source areas feature class that is shown in Figure above. In this example it is called WinSLAMMSourceArea_FCImport.
    d. Catchment Identification Field – this is the field that holds a unique identifier from the catchment feature class identified in b. above. In this case we are using the CatchID field. The unique identifiers held in this field will be carried through to the WinSLAMM databases and used to join WinSLAMM outputs back.
    e. Intersected Feature Class – this should be the name of the feature class that is going to be created and will be placed in the Workspace indicated in a. above. In our case we are naming it CFArea_WinSLAMMSourceAreas_Catchments.



35. It is possible that you will see a message about deleting small catchments during the execution of the *Intersect Catchments with WinSLAMM Detailed Source Areas.* If you have a drainage area/catchment that has very small area (see screenshot below). This is usually due to a situation where the catchment is much larger than your digitized source area. In the second screenshot below we see in our example that CatchID = 49 is mainly outside of the digitized source areas. If these catchments are < 0.01 acres they are automatically deleted.

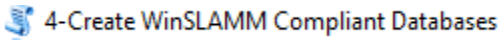


36. If you haven't already done so, add the resulting layer to the .mxd document and symbolize it with unique values using the CatchID field you will see that the intersected layer will look like the screenshot below.



Create WinSLAMM Compliant Databases

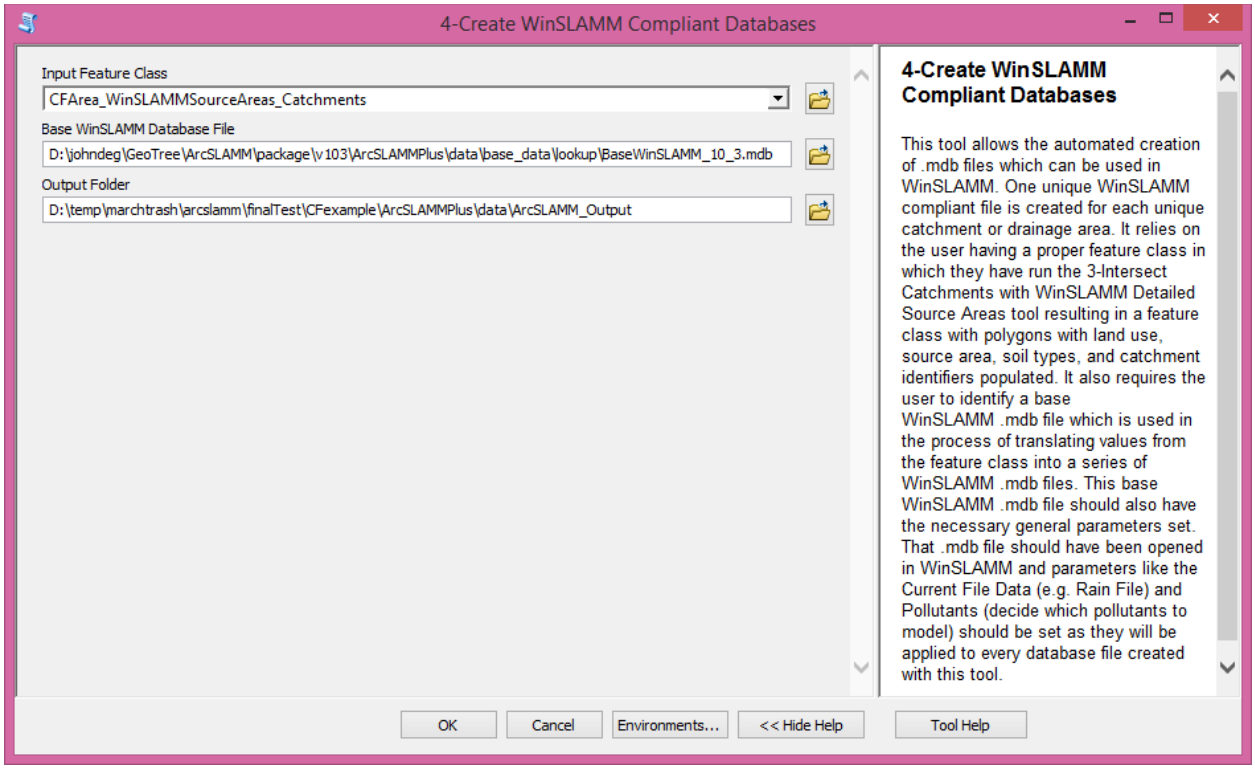
37. The purpose of this step is to create individual unique WinSLAMM compliant databases containing summarized source area information for each unique drainage area/catchment in the study area. The tool uses the intersected feature class created from steps above as well as a base template WinSLAMM database to translate to the necessary WinSLAMM details.
38. Before moving on with this tool it is a good idea to create a separate directory to hold the files that will be created. In this case we have created a directory called ArcSLAMM_Output in \data directory.
39. Open the *Create WinSLAMM Compliant Databases* tool.



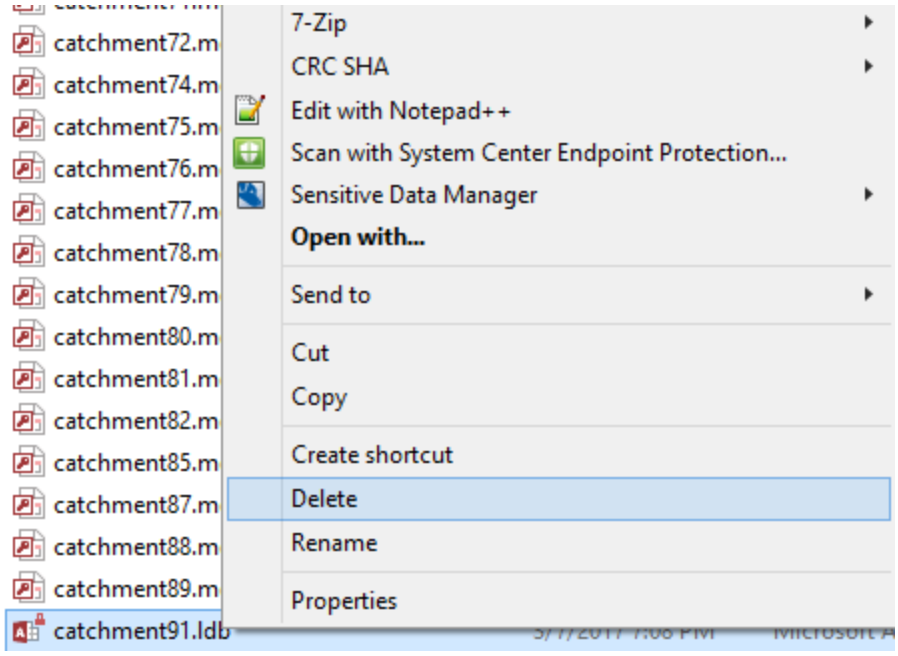
40. Parameterize the tool as follows:
    a. Input Feature Class – choose the intersected feature class that was created from running the *Intersect Catchments with WinSLAMM Source Areas* directly above (in this example called CFArea_WinSLAMMSourceAreas_Catchments.
    b. Base WinSLAMM Database – this is a version of a WinSLAMM datbabase (an .mdb file) that will be copied and populated by this tool with source area values from the feature class from figure above. You should use the database from base_data\lookup\BaseWinSLAMM_10_3.mdb or a copy of that file which has been modified for your particular location/situation. ***Warning: A copy of this file should have been made in advance of this step in order to save changes like the Pollutants being***

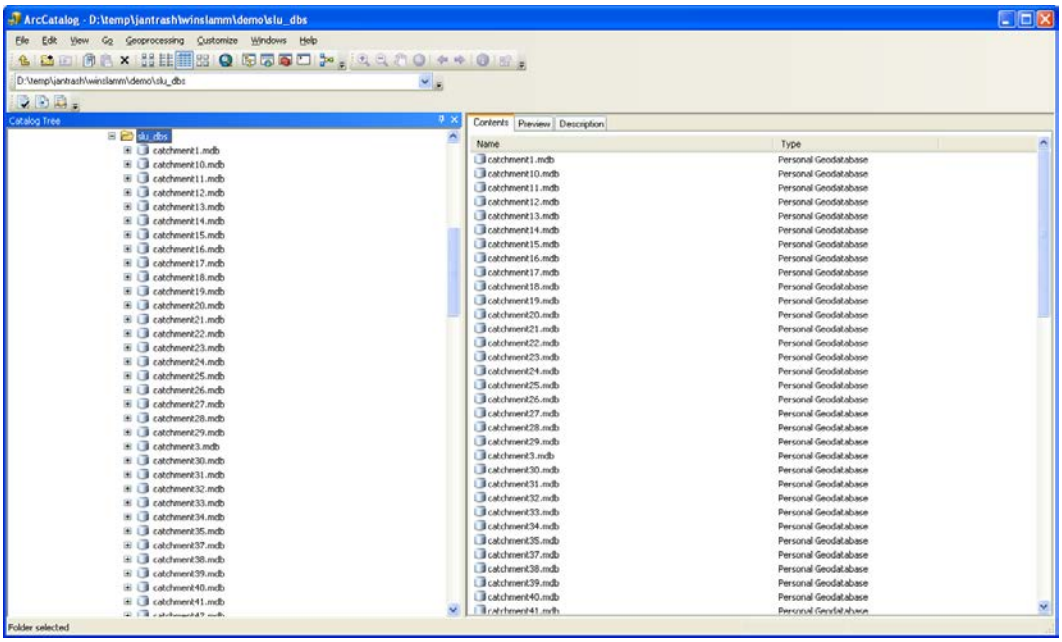
modeled, the rainfall or other files or other parameters that are being used for your particular modeling situation. This base file will be used as a base for each database file created with the land use/source areas being read from the intersected feature class. So you should make changes to the base WinSLAMM database prior to running the Create WinSLAMM Compliant Databases tool so those are stored in each database file created with this tool.

c. Output Folder – this should be an empty folder where you want to write the WinSLAMM database files. In this case we are using a folder called \ArcSLAMM_Output. When you run the tool it might take a few minutes as it is creating a database for every unique catchment. In the example shown, 70 unique catchments had databases created and it took approximately 5 minutes.



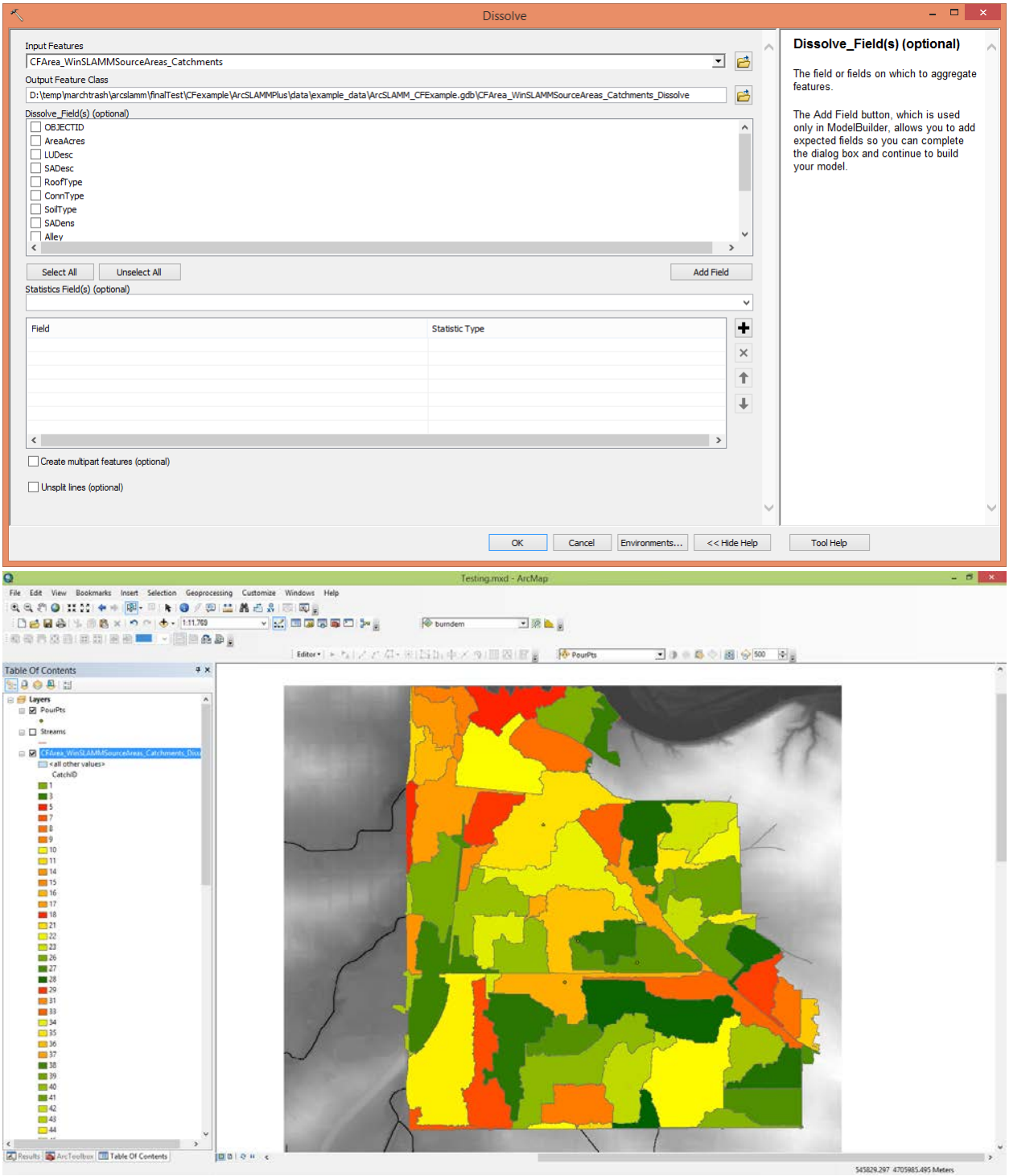
41. After running the tool you should see a set of output .mdb files (70 in this example) in the directory you indicated in dialog above (see below). ***Warning:*** *There is a known issue after running the Create WinSLAMM Compliant Databases tool. While writing files, the ArcSLAMM tool (ArcGIS) creates a lock file. On the last file, the lock stays after it creates the last database. In the small screenshot below you can see that there is a file called catchment91.ldb, in addition to the catchment91.mdb file. If this .ldb file is not deleted it will raise an error in WinSLAMM if you try run using the associated .mdb file. To work around this issue you should close ArcMap, wait a couple moments, and then go to Windows Explorer and manually delete the file with the .ldb extension (catchment91.ldb in this example).*



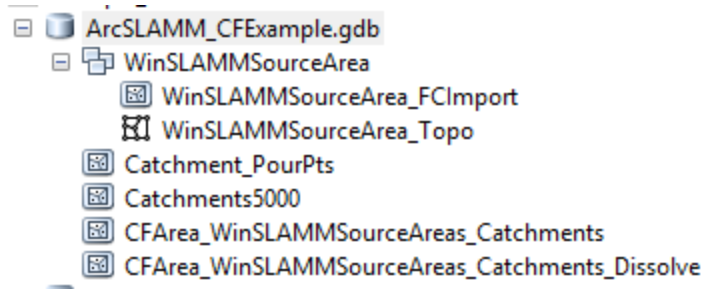


Hint:

It is a good idea to run the Dissolve tool from Data Management Tools\Generalization toolset on the intersected catchment feature class created by running the Intersect Catchments with WinSLAMM Detailed Source Areas tool. Below we run it on the intersected feature class we created above. By doing this we create a dissolved feature class that will be more useful for joining WinSLAMM results back to later. This basically gives you a copy of the original catchment feature class but limited to areas where you had detailed source areas to model in WinSLAMM.



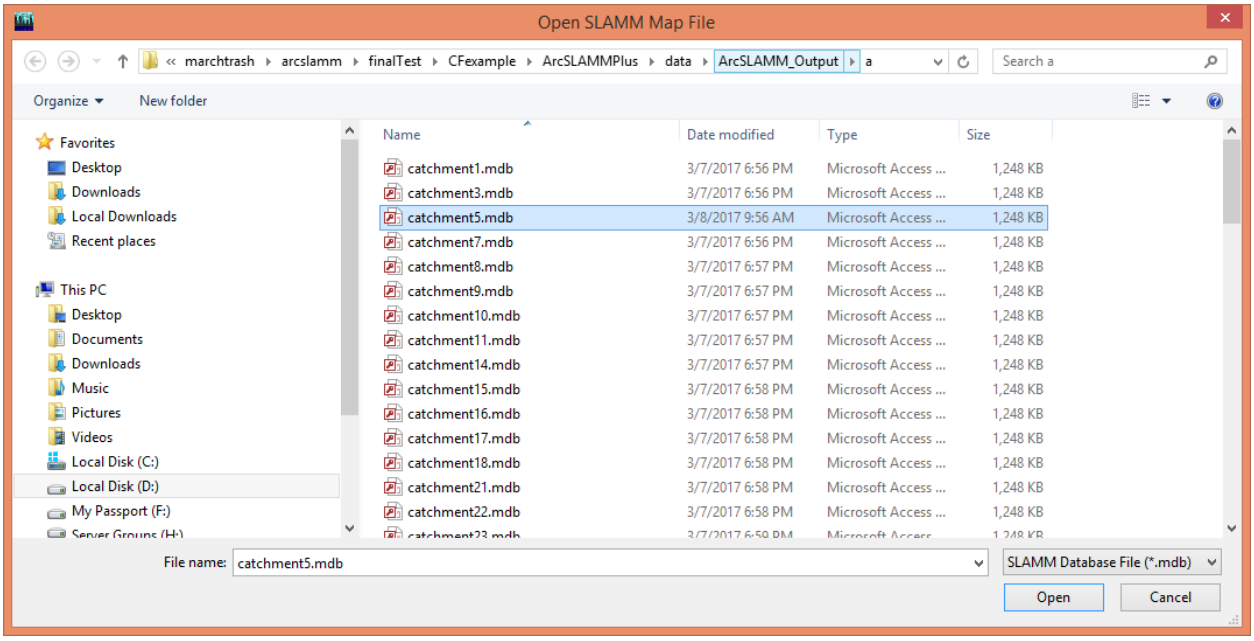
Dissolved catchments that can be used to join back to.



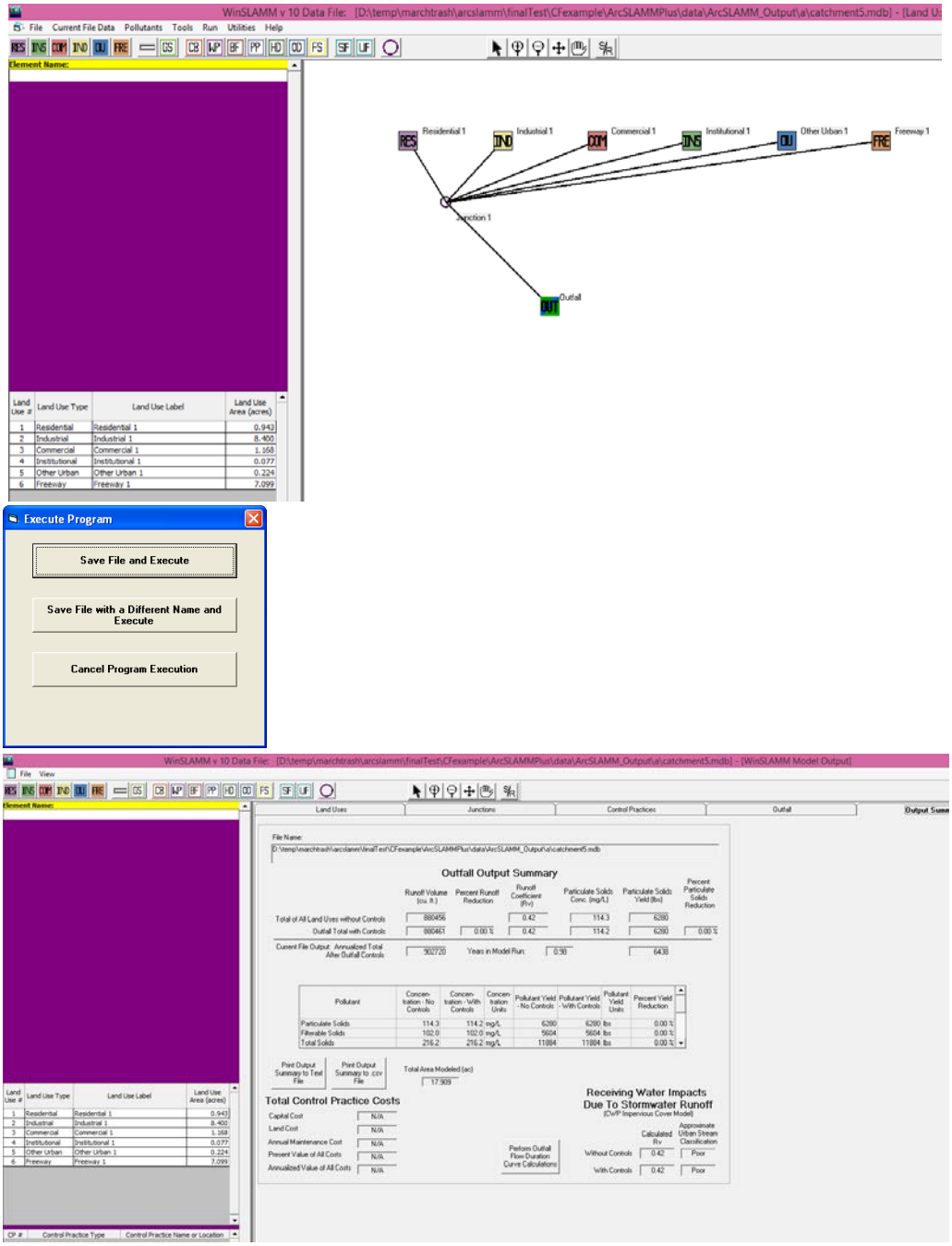
Catchments5000 created from running Catchment Delineation for Stream Segments, Catchment_PourPts from running Catchment Delineation for Pour Points, CFArea_WinSLAMMSourceAreas_Catchments from running Intersect Catchments with WinSLAMM Detailed Source Areas, and finally CFArea_WinSLAMMSourceAreas_Catchments_Dissolve from running Dissolve tool.

Using WinSLAMM Compliant files in WinSLAMM

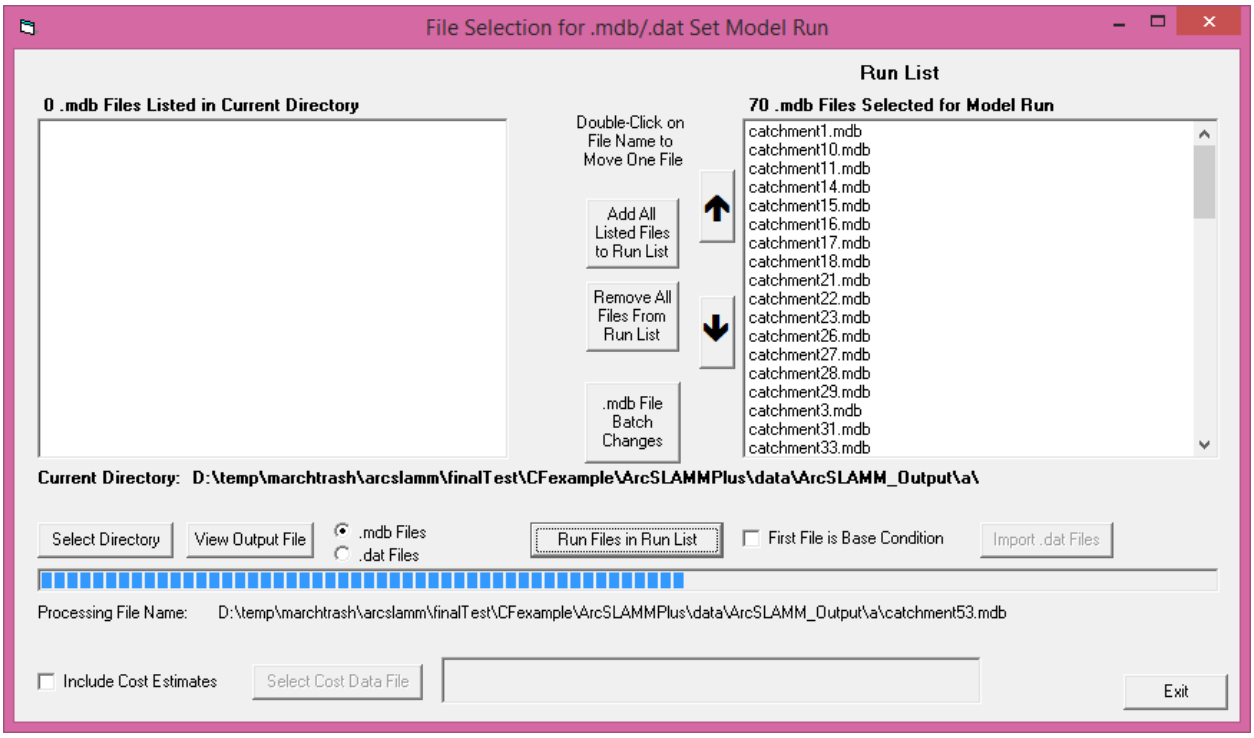
42. The databases created with the *Create WinSLAMM Compliant Databases* tool can be used in the WinSLAMM program to either run simulations for individual catchments or batch run simulations for multiple catchments. In addition, individual catchment files can be opened up in WinSLAMM and edited to introduce Best Management Practices (BMPs).
43. In order to run a single simulation the user should start WinSLAMM and choose File – Open Project File after entering the main screen and then select the file they want, and click Open.

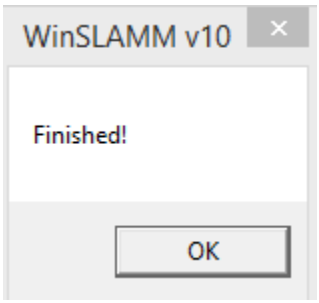


44. Then by choosing Run – Current Project File and clicking Save File and Execute on the opened dialog the user can run the simulation. In first screenshot below a single database file is opened in WinSLAMM while in the second screenshot the result of running the WinSLAMM model for that database is shown. The third screenshot shows the WinSLAMM model being run in batch mode.

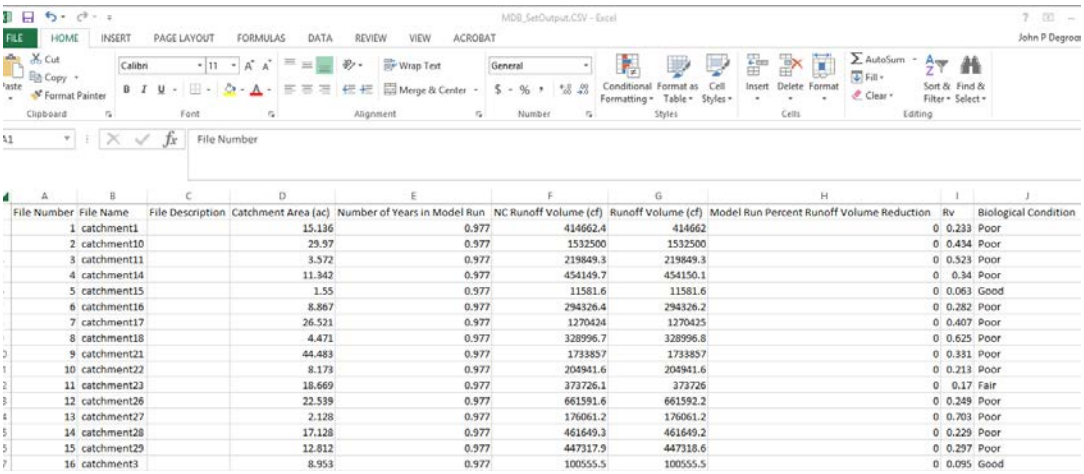


45. In order to run simulations for all of the WinSLAMM compliant database files created above choose Run – Set of Project files. Navigate to the correct directory and click OK. You will see a list of files in the left panel. Choose Add All Listed Files to Run List to add all of them. Click the Run Files in Run List button and WinSLAMM will batch run simulations for all files.





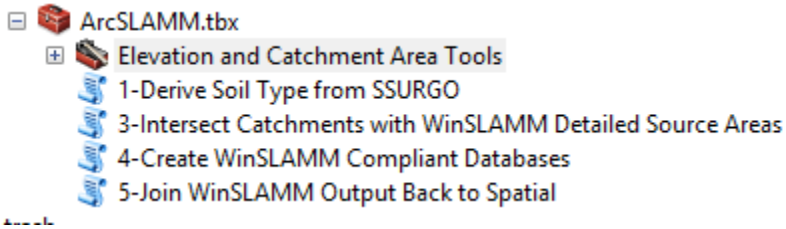
46. After running the WinSLAMM model in the batch mode you will see the Finished! Dialog. If it somehow failed on one of the catchment files you should make a note of that file. Then delete the MDB_SetOutput.csv in the directory where all the WinSLAMM .mdb files are. Re-run the batch simulation but remove the file that caused the problem (either by removing it from directory or by not selecting it in list of files to run in batch mode.
47. When you run WinSLAMM in batch mode for all of the catchment .mdb's, a .csv called MDB_SetOutput.csv is produced which holds certain outputs (depending on the Pollutants that were modeled) for each individual catchment. These outputs can be joined back to the dissolved feature class (dissolved from or the catchment feature class shown after Step 9. A screenshot of the .csv is shown below. ***Warning:*** *If you encounter any kind of error for any of the catchment files when running in batch mode it is likely that the output file WinSLAMM creates (MDB_SetOutput.csv) might be corrupted. Make a note of which catchment file had an error, delete or move that file, delete the MDB_SetOutput.csv file, and rerun the batch WinSLAMM simulation.*



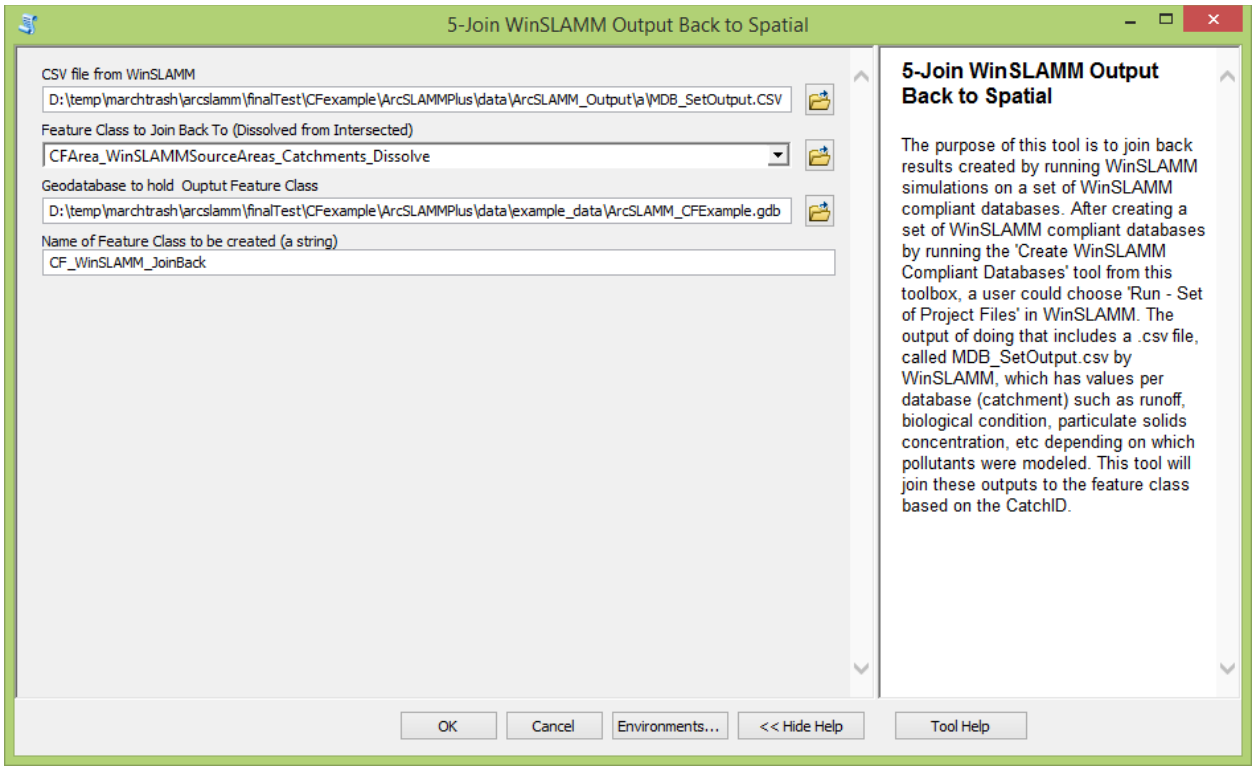
File Number	File Name	File Description	Catchment Area (ac)	Number of Years in Model Run	NC Runoff Volume (cf)	Runoff Volume (cf)	Model Run Percent Runoff Volume Reduction	Rv	Biological Condition
1	catchment1		15.136	0.977	414662.4	414662	0	0.233	Poor
2	catchment10		29.97	0.977	1532500	1532500	0	0.434	Poor
3	catchment11		3.572	0.977	219849.3	219849.3	0	0.523	Poor
4	catchment14		11.342	0.977	454149.7	454150.1	0	0.34	Poor
5	catchment15		1.55	0.977	11581.6	11581.6	0	0.063	Good
6	catchment16		8.867	0.977	294326.4	294326.2	0	0.282	Poor
7	catchment17		26.521	0.977	1270424	1270425	0	0.407	Poor
8	catchment18		4.471	0.977	328996.7	328996.8	0	0.625	Poor
9	catchment21		44.483	0.977	1733857	1733857	0	0.331	Poor
10	catchment22		8.173	0.977	204941.6	204941.6	0	0.213	Poor
11	catchment23		18.669	0.977	373726.1	373726	0	0.17	Fair
12	catchment26		22.539	0.977	661591.6	661592.2	0	0.249	Poor
13	catchment27		2.128	0.977	176061.2	176061.2	0	0.703	Poor
14	catchment28		17.128	0.977	461649.3	461649.2	0	0.229	Poor
15	catchment29		12.812	0.977	447317.9	447318.6	0	0.297	Poor
16	catchment3		8.953	0.977	100555.5	100555.5	0	0.095	Good

Join WinSLAMM Output Back to Spatial

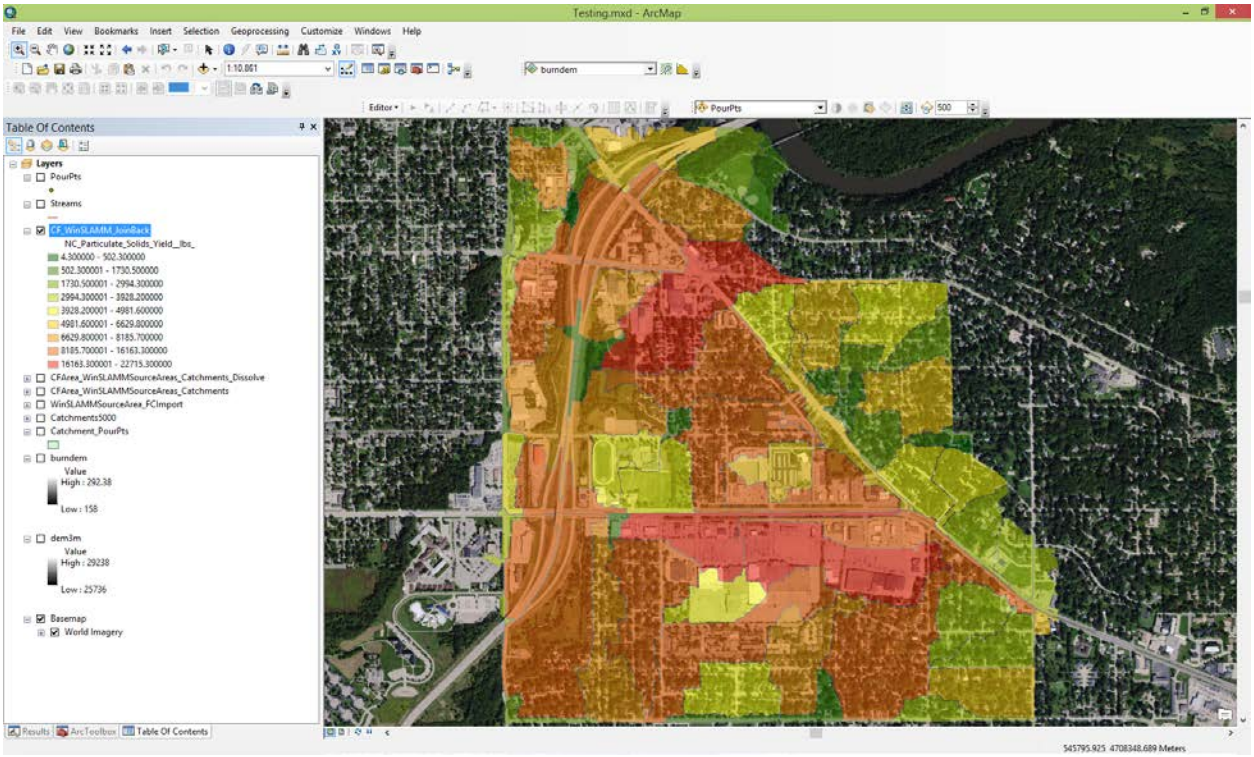
48. At this point we have run simulations for 70 separate drainage areas/catchments in WinSLAMM and we want to visualize the results from that back in ArcGIS. To do this we will use the MDB_SetOutput.csv file create and join the modeled values back to the dissolved (from intersected drainage area/catchment and source area feature class) feature class we created above.
49. Back in ArcMap, click the Join WinSLAMM Output Back to Spatial tool and parameterize as follows:

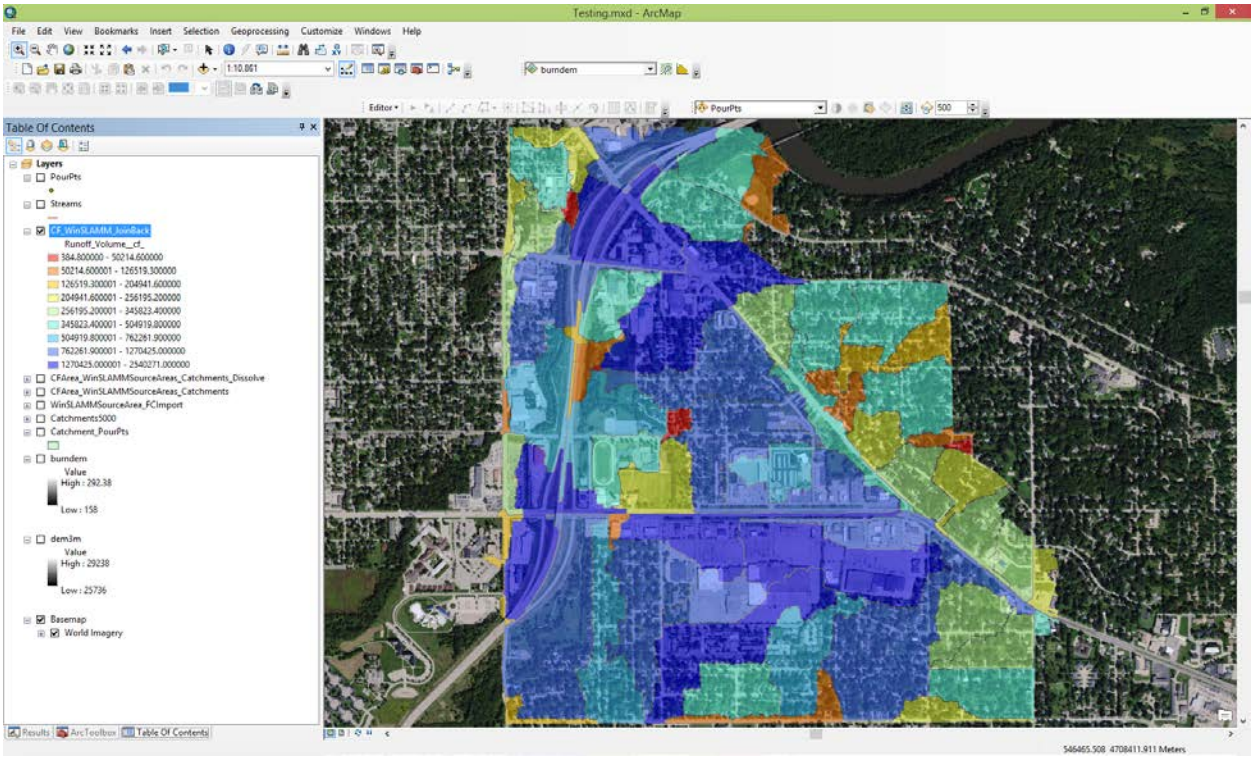


    a. CSV file from WinSLAMM – this should be the MDB_SetOutput.csv which is in the directory where the WinSLAMM databases were created. In the example below this was .. \Output\MDB_SetOutput.CSV.
    b. Feature Class to Join Back To (Dissolved from Intersected) – ideally you will join the output results back to the dissolved feature class as mentioned above. ***Warning:*** *If you have a selection on the feature layer you choose for this parameter only those features selected will be joined and exported to the newly created feature layer.*
    c. Geodatabase to hold Output Feature Class – this should be the geodatabase where you stored the catchment feature class and intersected feature class as well as the original detailed source area feature class.
    d. Name of Feature Class to be created (a string) – the result of this tool will be a feature class with output fields joined in. In this example we have named it CF_WinSLAMM _JoinBack.



50. After running the tool the feature class should automatically be added to ArcMap. You can symbolize by the numeric attributes that have been joined back to the spatial data using the standard symbolization methods in ArcMap. In the first screenshot example, the field 'NC_Particulate_Solids_Yield_lbs_) was used. In the second example Runoff_Volume_cf_ was used.

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