



Deicing Decision Support Tool Help and Quick Start Guide (Final)

The Deicing Decision Support Tool is a result of the Clear Roads Project # 20-05, Using GIS to Highlight Highway Segments Sensitive to Deicing Materials.

Problem

The effects of deicers on environmental resources are varied and complex. The impacts to sensitive species, protected resources, and human exposure are important factors when considering the appropriate use of deicers on roadways and must be balanced with public safety and expectations. With the difficulty in identifying environmentally sensitive corridors, states are unable to assign the proper equipment and apply chemicals at the appropriate rates to avoid further environmental degradation of both surface and ground water with chloride and sodium.

Objectives

The goal of this project is to improve operational planning to help agencies identify the roadway segments where vulnerable environmental resources may be impacted by snow and ice control activities.

Expected Results

This project will develop a geospatial tool that incorporates data about roadways, topography, hydrology, and ecology to model the impact of de-icing chemical application on the local environment. This information can then be used by maintenance personnel to adjust material application to balance mobility and environmental concerns.

*Literature review, survey, and criteria development were steps within the project to inform the development of the Deicing Tool. The Deicing Tool is currently designed for use on a state-wide scale, by state agencies, to provide a guide for agencies to determine the qualitative sensitivity of network environmental conditions to deicing chemicals. Using the same data types as noted in Data Requirements (below) smaller regions within a state or county level could also be analyzed.

Limitations

The tool is not intended to be a quantitative definitive guide, but rather an assessment indicator for agencies to identify key sensitive areas that meet criteria for consideration of different methods of deicing treatment.

The **Deicing Tool** is designed for use by all member agencies of Clear Roads consortium. Consistent tool performance requires the use of nationally curated datasets. The current exception is allowing users to also enter wellhead protection areas that may be unique in each jurisdiction. Accuracy of these nationally curated datasets should be understood via each file's metadata and source agency download locations. Other datasets unique only to individual states are not supported currently (with exception of the required agency plow route network file). Required datasets are listed below in the Mandatory Input Data Requirements section. Future work may move the logic for this tool to an online environment in order to provide ease of access to data, provide easier access with no installations, and expand user base into more member agencies.



Considerations

The tool leverages raster weighted overlay analysis, and each jurisdiction has different types of nuances within the ecosystems containing their plow network. Users should recognize that while default settings for weightings are provided, these only provide a starting point. Understanding the data and exploring weightings within the model suitable to those conditions and perceived environmental priorities of the users' particular jurisdiction will produce the best results for each agency. The user is advised to begin with mandatory data inputs and slowly add additional layers to best understand the weighted overlay process.

Minimum System Requirements

The Deicing Decision Support System is provided as an add-in for Esri ArcPro v 2.8 and higher. Extensive testing has been completed on ArcPro 2.9.2. Esri Spatial Analyst or Esri 3D Analyst are also prerequisites due to need for geoprocessing. Version 3 is not supported.

Mandatory Input Data Requirements

1. Agency Plow Route Network

- *Provided by agency – tool expects line feature
- *Will be buffered for use as clipping theme for all other datasets

2. USDA Natural Resource Conservation Service (NRCS) Soils

The Soil Survey Geographic Database Map Unit Polygon (MUPOLYGON). GSSURGO requires a polygon format. The GSSURGO database contains MUPOLYGON and MUAGGATT table. Map Unit Aggregated Attribute Table contains information of drainage classes and will be joined to the features found in the Map Unit Polygon. Both must be inserted to run the tool. GSURRGO database and table can be downloaded here. [soils | Powered by Box](#)

- *Download is by state
- *Polygon files come with associated soil drainage table (Muggatt).
- *User is prompted to load polygon file and join this table for use in the deicing tool.

3. USFWS National Wetlands Inventory (NWI)

The National Wetlands Inventory contains wetlands, lakes, rivers, and streams and must be in a polygon geometry format. National Wetlands Inventory can be downloaded by county in a shapefile/geodatabase format. National Wetlands can be downloaded here.

[Download Seamless Wetlands Data by State | U.S. Fish & Wildlife Service \(fws.gov\)](#)

- *Download by state
- *Tool expects polygon layer as shapefile or geodatabase feature layer

4. National Hydrological Dataset (streams/rivers) (NHD).

National Hydrography Dataset contains rivers and streams and can be downloaded by county in a shapefile/geodatabase format. National Hydrography Dataset can be downloaded here.

[The National Map \(prd-tnm.s3.amazonaws.com\)](#)

- *Download is by state
- *Use shp or GDB downloads but only “flowlines” are utilized as input to model



Non-Mandatory, Optional Datasets:

5. Wellhead Protection Areas

*Unique per jurisdiction – tool expects polygon geometry as shapefile or geodatabase layer.

6. USFWS Critical Habitat

National Critical Habitat must be downloaded in both polygon and line format. Critical Habitat geometry contains designated geographic regions for animals deemed in critical conditions. Data is downloaded from the National Critical Habitat Database and covers the entire nation.

https://ecos.fws.gov/docs/crithab/crithab_all/crithab_all_layers.zip

*Download only available by Conterminous United States (CONUS)

*Tool expects lines and polygons

7. USFWS Wild and Scenic Rivers.

National Wild and Scenic Rivers contains data on designated rivers and streams. National Wild and Scenic Rivers is available for download for the nation here:

https://data.fs.usda.gov/geodata/edw/edw_resources/shp/S_USA.WildScenicRiverSegment_LN.zip

*Download by CONUS

*Tool expects polylines

8. National Land Cover Dataset (raster image format).

National Land Cover Dataset (NLCD) must be in an image format (either .img/.tif). NLCD is available by download for the entire CONUS. NLCD contains information on types of land cover throughout the United States and is derivative of remote sensing classification methods. National Land Cover Dataset is not required to run the tool. National Land Cover Dataset can be downloaded here.

<https://www.mrlc.gov/data?f%5B0%5D=year%3A2019>

https://s3-us-west-2.amazonaws.com/mrlc/nlcd_2019_land_cover_l48_20210604.zip

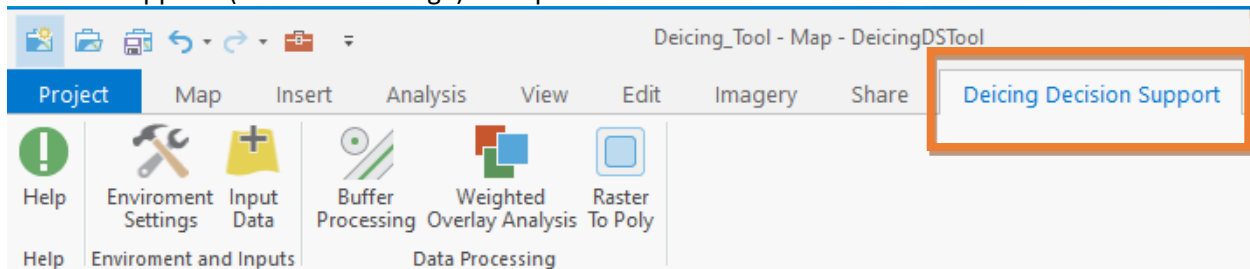
- Download by CONUS
- Tool expects raster image format (.img or .tif)

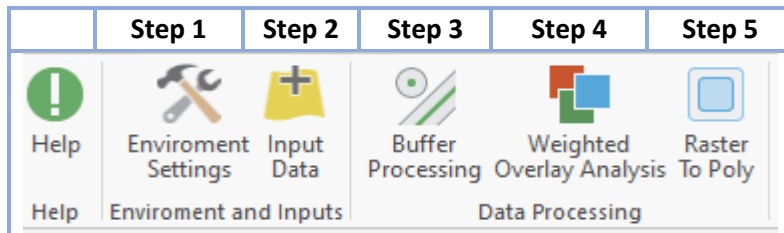
For questions or assistance sourcing data please contact:

- deicingtoolsupport@srfconsulting.com

Quick Start Guide

Once the add-in has been loaded (per installation guide) and a project template is started, the interface shown below will appear as a *menu* for the user in Esri ArcPro. Selecting the menu shown titled “Deicing Decision Support” (outlined in orange) will open the tool buttons below.





*The tool workflow provides five buttons intended for use in sequential order from left to right.
 *Each step is a prerequisite for the next button and the order cannot be substituted until the process has been completed at least once.

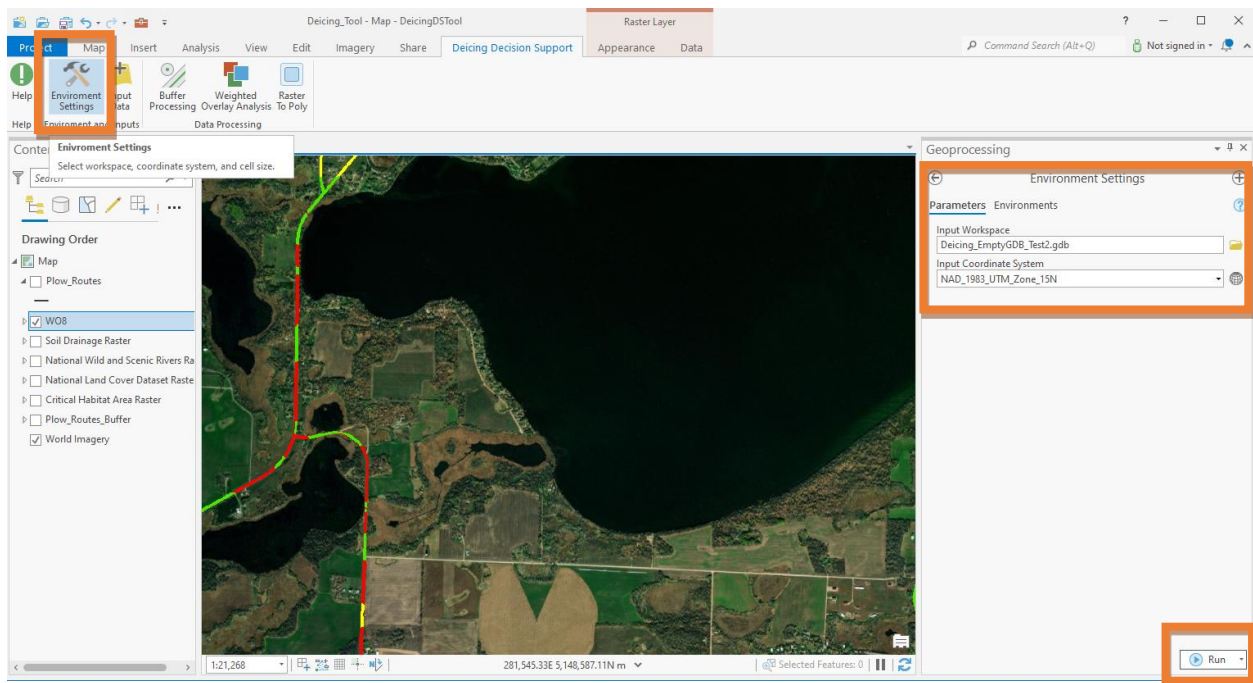
*Step 5 is an optional step if user desires to convert results back to vector coverage for ease of display, for use in further spatial analysis and mapping, or for distribution of a feature layer out to field staff.

Sequence for Preparing Data for Using the Deicing Decision Support Tool

1. Environment Settings (set GIS variables for data workspace and coordinate system)

In Step 1, the user is prompted to do the following:

- Input the workspace directory (where source input data and processed data will reside). Typically, use of a geodatabase would be a best practice, but is not a requirement.
- Input the desired data output coordinate system (typically UTM zone for your state since the analysis is intended to be ran statewide. However, local coordinate systems also work.
- Select the **Enter** button to set variables into system tool.

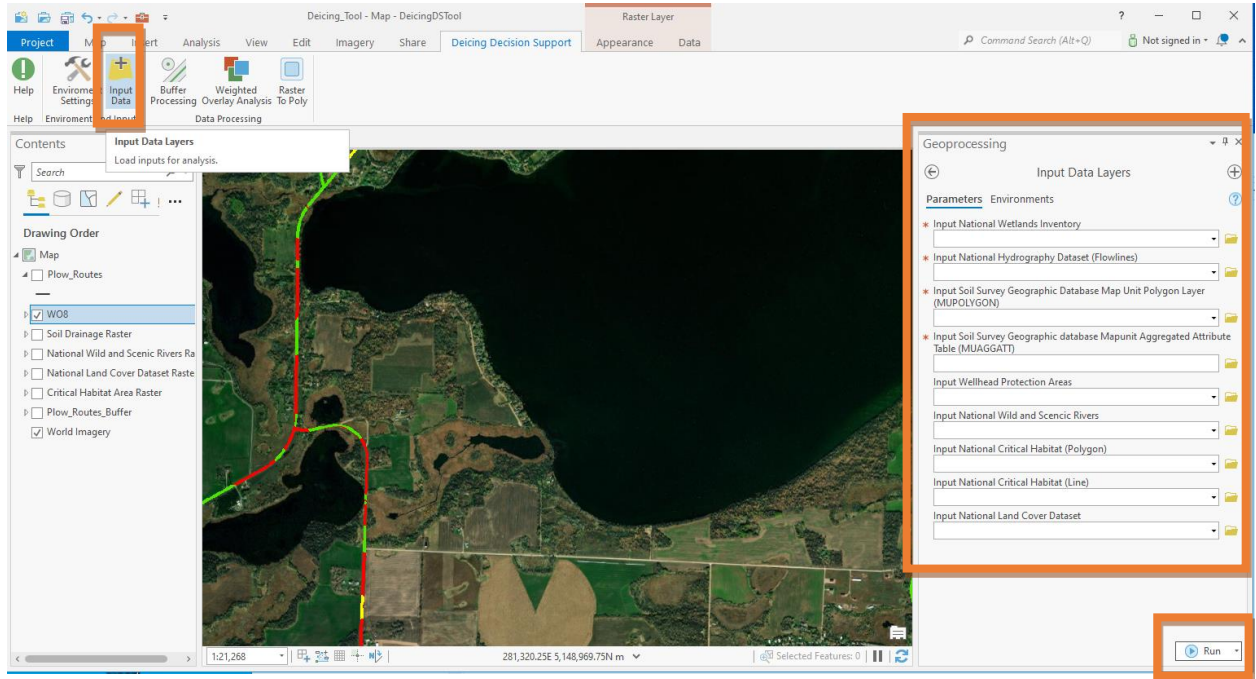


2. Input Data (Load Environmental Datasets)

User should pre-prepare data for input into this step. Desired input data sources have been provided, and the user should have this data unzipped and ready to go in the working directory setup in previous Step 1 (Environment Variables). For ease of use, users can also choose to pre-load

all datasets into a project template (that is then selected on startup). Once this data is ready, the user can move to Step 2:

- a. Load all datasets listed or load the mandatory datasets only. National Wetlands Inventory, National Hydrography, and NRCS Soils are the mandatory minimum requirements for the geoprocessing tool to run. Mandatory layers are indicated with a red asterisk as seen in graphic on page 6. *It is suggested that first-time users only load mandatory datasets, and once familiar with the workflow, go back and add additional datasets into future model runs.
- b. Note when clicking inside input field for data, user is given a prompt as to enter the location of that data, and in some cases a reminder as to the input type (vector lines, or vector polygons for example). For the National Hydrography dataset for example, user should only load “flowlines.” Another example of nuances includes national Critical Habitat data which in places, exists in both line and polygon formats. The tool allows for using both, if that data is available.
- c. Once the minimum mandatory requirement data inputs have been loaded (or all inputs if user chooses) data is entered into processing queue via the “Enter” button.



3. Input Plow Network & Buffer Processing

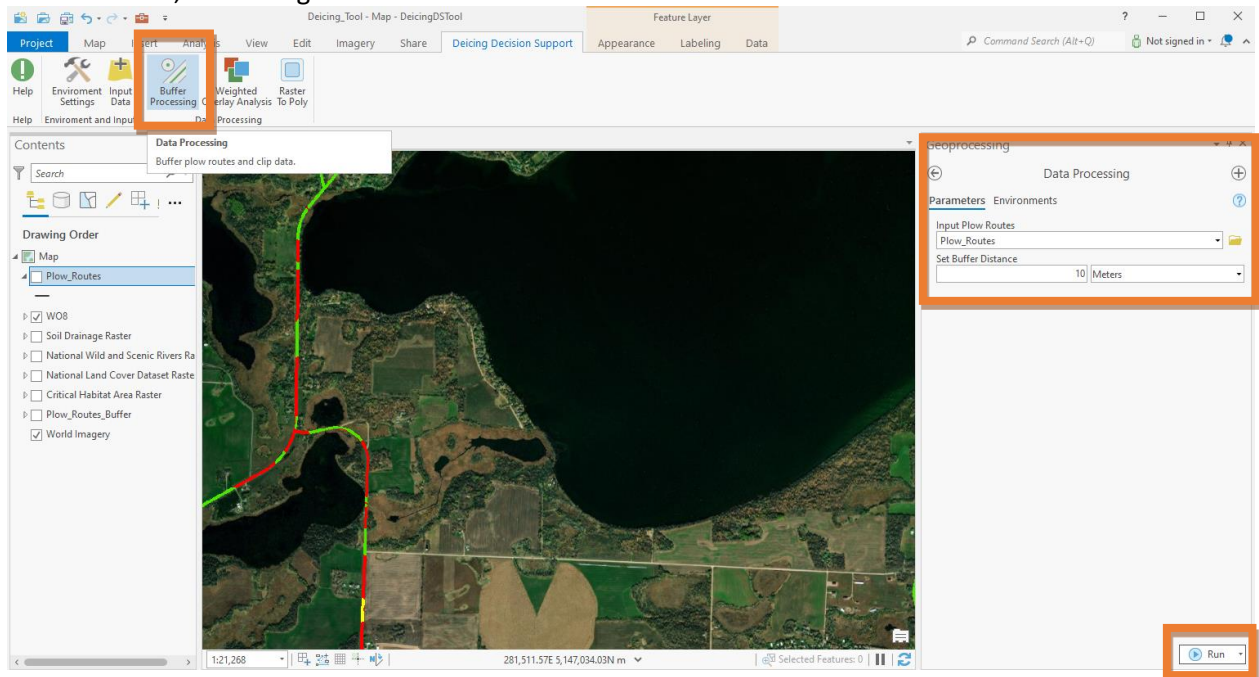
Step 3 creates a buffer that is used to pre-process all data inputs by clipping them down to manageable (and relevant) size.

**Please note: In general, buffer widths of 10-15 meters are sufficient, and research indicates that the highest salt concentrations are within 6 meters of a roadway. However, in high-speed high-traffic areas, airborne salt has been observed to affect vegetation over 30 meters from the roadway. Because buffer widths substantially affect data processing time, narrower widths should be used whenever possible (especially for 2-lane local roads), and in general buffer distance should not exceed 30 meters. Also note the buffer functions works from centerline, and if the roadway network has 4-lane, or has larger shoulders, then extra widths should be considered.*

User is prompted to do the following steps:

- Load shapefile or geodatabase feature layer of the agency plow network.
- Set desired buffer distance for analysis.
- Set buffer distance units (feet or meters).

In the example shown below, the user has input the plow network file as source, set a buffer distance of 10, and changed units to meters.



After entering plow network, setting distance, units, and selecting “Run” all other data loaded previously into tool is then automatically clipped down to match the buffer area for your plow network. This constricts analysis to those areas and reduces overall processing time and load on hardware. Note for state-wide data runs this step can take as long as 45 minutes. Early adopters can also consider using a smaller area for getting used to the workflow) by entering a smaller plow network (at county scale vs state for example).

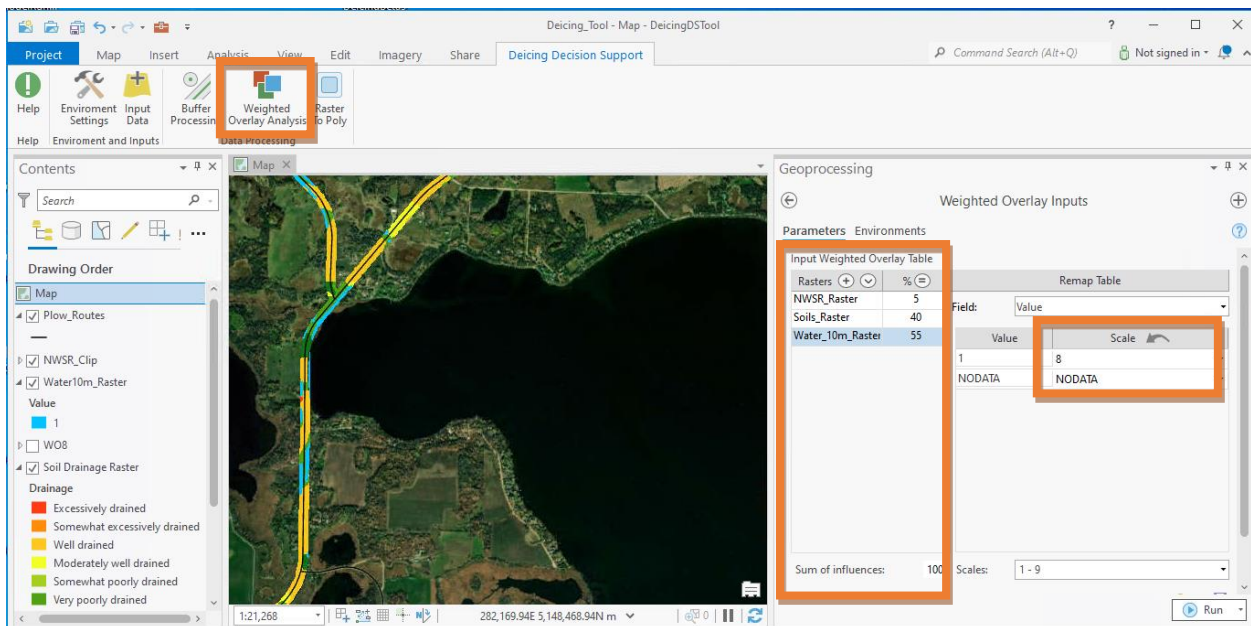
Outputs from Step 3 will be written to the source location set originally by the user in Step 1 environmental variables and all clipped raster layers will then be automatically loaded into your project contents pane. Note that the National Wetlands Inventory and the National Hydrological

Stream/River layers contain many duplicate features. To avoid double weighting these features in the analysis, these are merged, and duplicate features subsequently dissolved. The resulting dataset will be added to the ArcPro map contents pane as one single “Water” file.

4. Set Layer Weightings and Run Weighted Overlay Geoprocessing tool

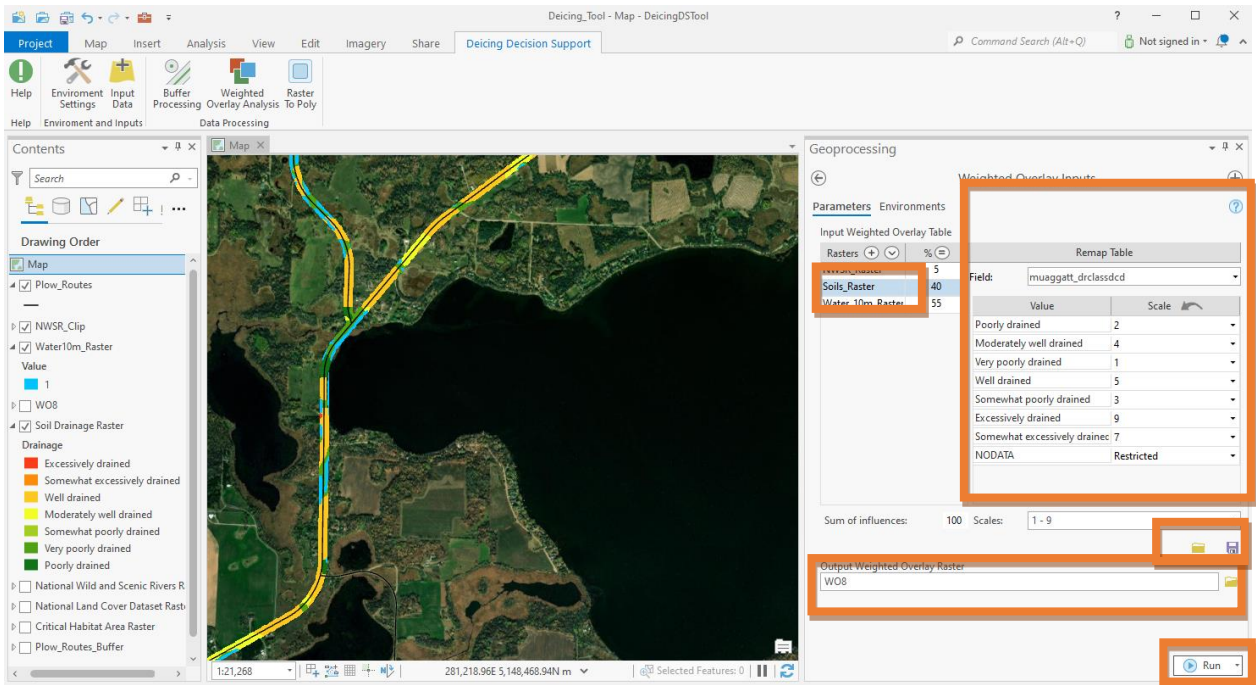
Step 4 is where the processed raster layers are individually and cumulatively weighted to determine potential for impact and involves the following:

- Push the Weighted Overlay Analysis button, then add clipped raster layers output from last step into the interface as shown on right. Note these can be manually dragged from your contents pane instead of reloading from storage location.
- Assign sum of influence per input raster layer. User first sets a % value for cumulative Sum of influences (must add up to 100%. In this example the user has weighted 55% Water, 40% Soils, and 5% Wild and Scenic.
- Select an evaluation scale of 1-9 for each layer. Higher number rankings = more influence. (A weighting value of 1 is no influence (excludes data from the model)). In the example below, user has loaded, Soils, Water (combined with wetlands in earlier step) and a wild and scenic layer. In this case user has given water a high rating of 8 (out of possible 9). Water is a binary layer (1 or no data). Do not select “Run” until all input layers have been weighted to your satisfaction.



As an added benefit user can introduce *sub-weightings* for layers that have additional attributes. The Soils raster layer (highlighted on page 9) has drainage attribute classes that can be further weighted. In this example the user has applied sub-weightings where poorly drained areas are assigned lower values, and more porous areas are assigned higher values. To expose these values the user only has to choose the drainage field (muaggatt_drclasscd) in the remap table.

NOTE: there is a companion multimedia guide (tutorial video) that discusses scenarios and considerations for user weightings in more detail – particularly to better understand the impacts of weighting choices, and to tailor results for unique end-user priorities.



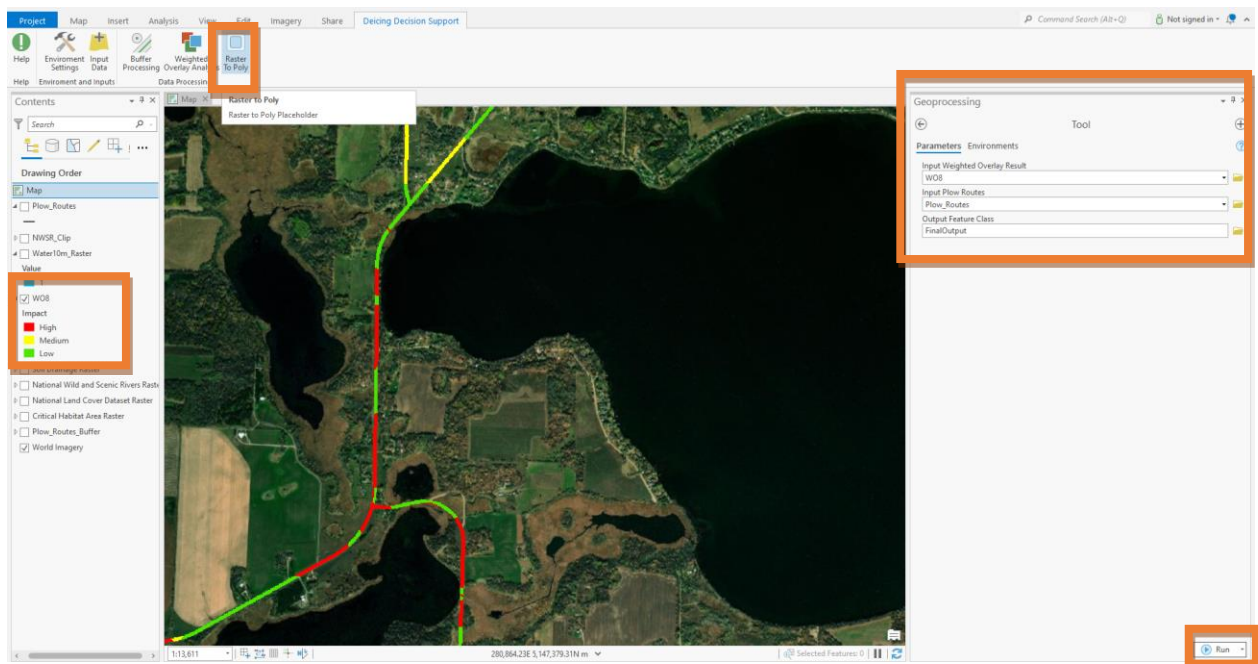
- d. When all layers are weighted to satisfaction, save the model name using the provided save button (lower middle right), then provide a path and name for your output results, and finally push “Run” to execute the Weighted Overlay Analysis process. *Saved model weightings can be reloaded to give a starting point for subsequent model run variants. Users are allowed to save multiple model-run iterations and reuse for a final solution, or to use as basis for new variants. *Iterative model runs using the same data inputs are only possible after all original data inputs have been pre-processed in Step 3.
- e. Once the weighted overlay analysis is complete the results are automatically loaded into your map contents pane for examination. For the beta tool, user will change color display to match a high, medium, or low impact (typically, Red, Yellow, Green) using the impact field. (See page 10).

Note: Tool by default uses Natural Breaks method to classify results, but user may choose to use a different classification scheme if desired. All data inputs have spatial variability and nuances so the user may choose to display results using classification of their choice.

5. Convert Raster Weighted Overlay to Vector Polyline.

The final Step 5 is optional, allowing the end-user to convert the model's weighted overlay output (raster) to a vector (polyline) file. This provides more ease of display and facilitates potential use in additional spatial analysis or for distribution to winter operations staff in the field.

- a. Examine output in contents pane (WO8 shown as example below), select Raster to Poly tool
- b. Enter output results raster back into field shown and enter original plow route vector file.
- c. Then provide name and path for final desired vector output and execute by choosing "Run".
- d. Final vector data results will be loaded into your map contents pane automatically.





The final output vector file loads itself into the map contents pane and mirrors the original raster results (once symbolization has been applied to the layer). * to be automated in final version.

