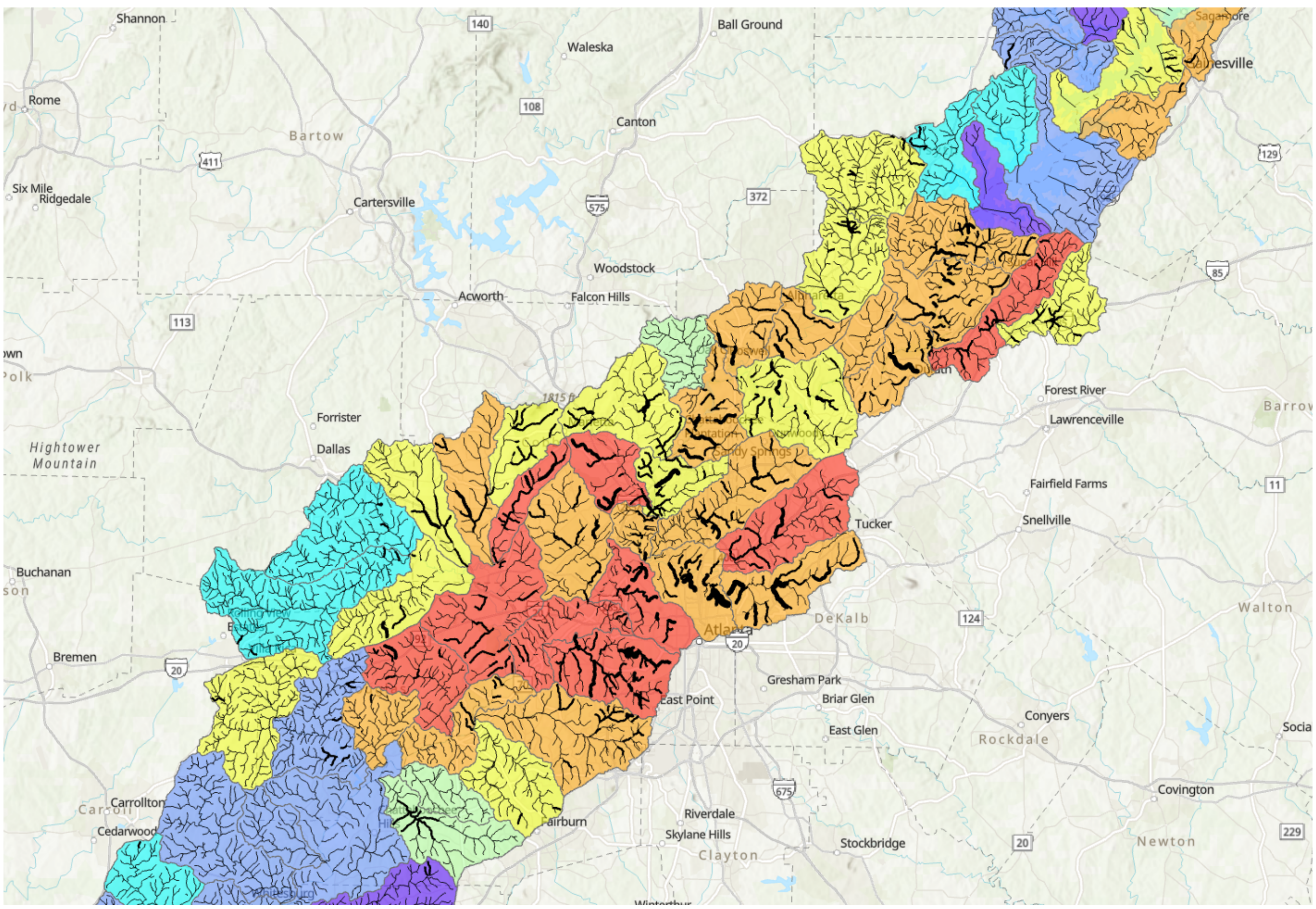
Trash Trap Location Prioritization Manual

A Watershed and Flowline Geospatial Analysis

April 22, 2024



Contents

Tables

Figures

Appendices

Acronyms and Definitions

AHP	Analytical Hierarchy Process
ATTAINS	Assessment, Total Maximum Daily Load Tracking, and Implementation System
cfs	cubic feet per second
CRB	Chattahoochee River Basin
CRK	Chattahoochee Riverkeepers
CWA	Clean Water Act
DEM	Digital Elevation Model
EJScreen	Environmental Justice Screening and Mapping Tool
EPA	Environmental Protection Agency
EROMMA	Enhanced Runoff Method Mean Annual
FDP	farthest downstream point
HUC12	12-digit hydrologic unit code
IMLS	Institute of Museum and Library Services
LiDAR	Light-detection and ranging
MCA	Multi-criteria analysis
Model	The overall trash trap model; made up of two toolsets
MRLC	Multi-Resolution Land Characteristics Consortium
NCES	National Center for Education Statistics
NHD	National Hydrography Dataset
NHDPlus	National Hydrography Dataset Plus
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
ParksServe	Trust for Public Land's United States ParksServe Dataset
PoC	People of Color
SECAS	Southeast Conservation Adaptation Strategy
SGCN	Species of Greatest Conservation Need
toolbox	ArcGIS terminology for a collection of toolsets
toolset	A collection of models created in ModelBuilder
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1 Introduction and Purpose

In 2019, Chattahoochee Riverkeeper (CRK) launched a pilot project deploying devices called "trash traps" to remove floating litter from tributaries of the Chattahoochee River. While CRK has a robust volunteer cleanup program, volunteer events are not capable of continuously collecting litter moving downstream after rain events. The trash traps pilot project aimed to address the wave of litter that travels through the Chattahoochee River Basin (CRB) every time it rains. Since 2019, the trash traps deployed by CRK have collected more than 4,000 pounds of floating trash; nearly 30% of that trash volume has been recycled.

Not all trash traps are created equal and the range of environmental, social, and economic factors in the CRB posed a challenge to determining the optimal location for trash traps. To address this problem, CRK designed a trash trap assessment modeling program using ArcGIS software. The analysis allowed for spatial and statistical modeling of the CRB, with the ability to visualize various environmental and demographic factors on a watershed-wide scale.

As an organization with a long history of knowledge-sharing, CRK wanted to move beyond the manual trash trap assessment model that they developed to a more replicable model that could be applied in watersheds across the country. CRK's goal in developing a replicable model was to provide other watershed groups, municipalities, and stakeholders with the tools to identify the optimal location for trash traps in their own watersheds.

Arcadis is a global environmental and civil design consulting firm with the express purpose of improving quality of life. Arcadis' Atlanta office has long been involved with CRK, participating in Sweep the Hooch and other clean ups as part of their broader volunteer efforts. Through the Local Sparks program, Arcadis funds projects with a focus on sustainability and environmental justice. Local Sparks grants fund capital and labor costs associated with the project which allows Arcadis employees to dedicate considerable time and expertise to ensure the completion of the project. A group of Arcadians approached CRK in spring of 2023 to identify projects that were of high priority to CRK and that fit within the criteria for the Local Sparks program. Arcadis and CRK (we) agreed that the creation of a replicable trash trap location prioritization model (Model) would have the greatest impact.

The Model described in this manual runs in two parts – each with its own toolset. The first part of the Model ranks 12-digit hydrologic unit code (HUC12) watersheds by their priority for trash trap installation. The priority of the watershed is based on the impact that a trash trap installation would have both in terms of quantity of trash removed and the level of environmental justice achieved. This part of the Model is referred to as the HUC12 Watershed Prioritization toolset.

The second part of the Model is the prioritization of National Hydrologic Dataset (NHD) flowlines. Flowlines are prioritized based on the ease with which trash traps could be managed and installed at each flowline. This portion of the Model is referred to as the NHD Flowline Prioritization toolset.

Naming conventions within ArcGIS and this Model can be difficult to keep track of due to their repetitive nature. For clarity of what is being referenced throughout this report, see Figure 1-1 below. The overall tras h trap location prioritization model is referred to as “Model” throughout this report. Contained within the Model is a toolbox called “Trash Trap Toolbox.” Within that toolbox are two toolsets named “HUC12 Watershed Prioritization” and “NHD Flowline Prioritization.” Each toolset is made up of several models, which are in turn made up of built-in ArcGIS Pro tools.

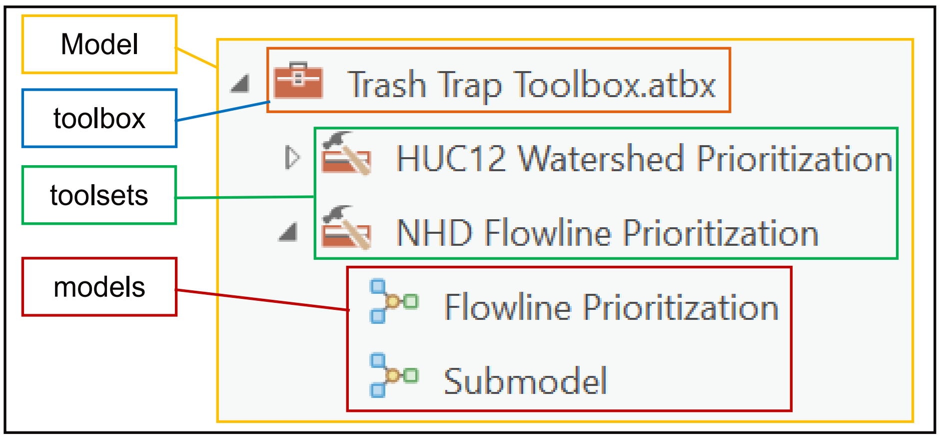


Figure 1-1: Model Naming Conventions

This manual details how to execute the Model, describes where the Model is applicable and what limitations exist, and provides some additional information about navigating ModelBuilder in ArcGIS Pro to edit and supplement the Model with relevant data.

The Model was developed in ArcGIS version 3.0.3 using ModelBuilder, a visual programming tool that allows users to set up a series of geospatial processes. In addition to making an accurate and comprehensive model, we wanted the Model to be accessible to users with any amount of experience with ArcGIS Pro. This manual, along with the Model itself, is designed for users with limited prior ArcGIS experience.

This manual pairs with CRK’s *Trash Traps: A Guide to Implementing In-Stream Litter Pollution Control* publication, which details the process for maintaining and installing trash traps. CRK’s trash trap installation guide was developed in conjunction with this manual to help users develop an effective trash traps program.

The Model can be downloaded at Trash Trap Guide Download - Chattahoochee Riverkeeper.

2 Methodology

As described in the introduction, the Model assesses both the priority of each HUC12 watershed for trash trap installation based on quantity of trash and level of environmental justice achieved and the priority of NHD flowlines based on the ease with which a trash trap at that location could be installed and managed. Table 1 and Table 2 list the trash quantity and environmental justice indicators analyzed for the prioritization of HUC12 watersheds and Table 3 provides the same for the prioritization of flowlines. The reasoning for the inclusion of each indicator is also provided.

Table 1: HUC12 Prioritization Trash Quantity Indicators

Trash Quantity Indicators	Justification of Trash Quantity Indicator
Land Cover	The type of land cover (i.e. developed or undeveloped) impacts the transport of litter through watersheds. Developed areas generate and transport more litter than less developed areas.
Impervious Cover	Areas with high levels of impervious cover generate and transport more litter than areas with less impervious cover.
Watershed Slope	Watersheds with higher average slopes transport trash into streams more easily than flat watersheds.
Depth of 2-year Rainfall	Watersheds with higher intensity rainfall events have more runoff and, therefore, transport more litter than watersheds with lower intensity rainfall events.
Population Density	People are the source of trash pollution. Therefore, watersheds with more dense population will have more litter than watersheds with less dense population.
Intersection of Roads and Streams	Intersections of roads and streams are locations at which concentrated litter can enter streams via storm sewer outfalls or over-road flow. Watersheds with more road and stream intersections will more easily discharge litter into streams.

Table 2: HUC12 Prioritization Environmental Justice Indicators

Environmental Justice Indicators	Justification of Environmental Justice Indicators
Length of Impaired Streams	The length of impaired streams in a watershed is indicative of the watershed's level of degradation. Impaired streams are more likely to occur in historically underserved communities.
Percent of Population People of Color	Watersheds with higher percentages of minority populations are likely more historically underserved than white communities.
Percent of Population Low-Income	Watersheds with high percentages of low-income populations are likely more historically underserved than affluent communities.
Priority of Habitat Conservation	Watersheds with higher priority habitat conservation areas will have the greatest ecological and social benefit if conserved.

Table 3: Flowline Prioritization Layers

Ease of Installation Indicators	Justification for Indicators
Mean Annual Flow	Installation on streams with flows higher than 100 cubic feet oer second (cfs) may impact the efficacy and longevity of trash traps. Traps installed on streams without consistent flow will not collect trash.
Proximity to Public Schools	Installation on public property is more feasible than installation on private property.
Proximity to Public Libraries	Installation on public property is more feasible than installation on private property.
Proximity to Public Parks	Installation on public property is more feasible than installation on private property.

The method used to analyze each indicator depended on the type of data and how it served as an indicator for prioritization of trash trap installation. The following sections provide a brief description of each indicator layer and how it was analyzed.

2.1 HUC12 Watershed Prioritization

The HUC12 watersheds are prioritized based on the quantity of trash expected to enter streams and the environmental justice impact that a trash trap installation would have in the watershed. For each indicator, a score is calculated and appended to the input HUC12 watershed feature attribute table. Area-dependent indicators like road and flowline intersections and length of impaired streams are normalized by area. As described in Section 2.1.3, a multicriteria analysis was performed to assign weights to each indicator score for combination into a final composite score. This multicriteria analysis used linear regression of indicators and existing traps trap data as well as CRK's trash trap experience to set relative weights. The next step in the toolset reclassifies each indicator score using the Natural Breaks (Jenks) classification method from one to four. Section 2.1.4 describes the combination of these reclassified scores using the weights assigned via multicriteria analysis.

2.1.1 Trash Quantity Indicators

Trash quantity indicators predict how much trash will flow into the streams within a watershed and are correlated with quantity of runoff, density of development, and opportunity for litter to enter waterways. Watersheds with higher runoff potential, density of development, and litter entry points lend themselves to higher quantities of litter.

2.1.1.1 Land Cover

Land cover data was downloaded from the National Land Cover Database (NLCD) which is developed by the Multi-Resolution Land Characteristics Consortium (MRLC). MRLC provides national land cover data as a raster with 30-meter cells. NLCD classifies land cover in sixteen groups (Open Water, Developed - High Intensity, Deciduous Forest, etc.). Land cover data is a trash quantity indicator because it indicates areas that would produce litter, such as developed areas, and correlates to quantity of runoff. Areas that are developed typically have higher rates of runoff because they have higher levels of impervious surfaces, whereas forested areas would retain runoff and prevent litter from entering waterways. Additionally, developed areas typically have population concentrations that contribute to litter generation. The land cover data was reclassified into four categories with the highest score (4) assigned to land cover types with high levels of human impact and the lowest score (1) assigned to land cover types with little to no human impact. The reclassification is summarized in Table 4. With each cell reclassified to one of the four scores, the model calculates the average score within each watershed. This average land cover score is one of the six trash quantity indicators.

Table 4: National Land Cover Database Reclassification

NLCD Land Cover Type	Reclassified Land Cover Score
Developed, High Intensity	4
Developed, Medium Intensity	4
Developed, Low Intensity	4
Developed, Open Space	3
Barren Land	2
Hay/Pasture	2
Cultivated Crops	2
Open Water	1
Perennial Snow/Ice	1
Deciduous Forest	1
Evergreen Forest	1
Mixed Forest	1
Shrub/Scrub	1
Herbaceous	1
Woody Wetlands	1
Emergent Herbaceous Wetlands	1

2.1.1.2 Impervious Cover

The impervious cover is also provided with national coverage by the MRLC. The impervious cover raster data has a resolution of 30-meter cells. The impervious cover data reports the percent of impervious cover in each cell. Impervious cover is relevant to determining the quantity of litter entering streams within a watershed because it indicates how much runoff will occur within the watershed. More runoff equates to more litter reaching streams. This model averages cells across each watershed to calculate the average percent impervious cover for each watershed. This is the second of six trash quantity indicator scores.

2.1.1.3 Watershed Slope

The watershed slope is an indicator of trash quantity because a watershed with a higher average slope will more easily transport litter to low elevations within the watershed. Litter will flow downhill to streams, rather than settle in flat areas. The watershed slope is derived from the United States Geological Survey (USGS) 1 arc-second digital elevation models (DEMs). These light-detection and ranging (LiDAR) raster files have an approximate cell size of 30 meters. ArcGIS Pro's "Slope" tool takes in a DEM and calculates the slope across each cell. The third model in the HUC12 Watershed Prioritization toolset called "3 – LiDAR and Slope" uses this tool to calculate the slope of each cell within the watershed. It then calculates the average slope across the watershed; this score is the third of six trash quantity indicators.

2.1.1.4 Rainfall Intensity

Intensity of rainfall indicates trash quantity because more intense rainfall correlates to higher runoff and more litter transport. The National Oceanic and Atmospheric Administration (NOAA) publishes rainfall raster files with approximately 800-meter resolution as part of its Atlas 14 Precipitation Frequency Data. The 2-year, 24-hour annual maximum series event is the rainfall event with a 24-hour duration that has a 50% chance of occurring each year. The rainfall raster files report the predicted rainfall depth, in inches, for each cell. The model calculates the average rainfall depth for each watershed. This is the fourth of six trash quantity indicators.

2.1.1.5 Population Density

Population density is a trash quantity indicator because more densely populated areas will produce more trash. The Environmental Protection Agency (EPA) publishes the Environmental Justice Screening and Mapping Tool (EJScreen), which compiles environmental justice data into a single geospatial layer. This dataset includes population by area. The model calculates the population density by dividing the population by area. It then converts this polygon shapefile into a raster file and calculates the average population density for each watershed. The average population density is the fifth of six trash quantity indicators.

2.1.1.6 Intersections of Roads and Streams

The last trash quantity indicator is the number of road and stream intersections that occur within each watershed. Roads are corridors along which litter can easily travel; therefore, intersections of roads and streams would indicate areas where litter can easily enter streams. Bridge and stream crossings are also typical locations for storm sewer outfalls that discharge concentrated litter into streams. The NHD flowline shapefiles and the state road shapefiles downloaded from the USGS National Map are polylines. The model uses the “Intersect” tool in ModelBuilder to create a point shapefile that contains each intersection of road and flowlines. The count of the intersection points, normalized by the watershed area, is the final trash quantity indicator.

2.1.2 Environmental Justice Indicators

Environmental justice is the pursuit of environmental health and quality in historically marginalized communities. Extensive research, both on a national scale and through local studies by CRK, shows that communities with a higher proportion of historically marginalized and low-income residents disproportionately bear the burden of pollution, in contrast to wealthier, predominantly white neighborhoods. This disproportionate pollution is caused by deficient infrastructure and unequal placement of industrial centers in marginalized communities[1]. Environmental justice aims to address these inequalities by prioritizing environmental restoration in marginalized communities. Our analysis incorporates environmental justice by prioritizing trash trap installation in communities likely experiencing disproportionate pollution.

2.1.2.1 Impaired Streams

The Clean Water Act (CWA) requires states to identify waters that are impaired or in danger of becoming impaired under Section 303(d). The level of impairment is determined by chemical and biological pollutants like fecal coliform, nitrogen, or mercury. While impaired waters are not determined by litter pollution, the dataset indicates streams that are degraded and most in need of restoration. Impaired waters do not meet water quality standards for their designated uses, labels that can be assigned to streams based on their primary uses. For example, a stream may be used primarily for fishing and swimming. These designated uses are said to be supported if water quality monitoring indicates that pollutant levels consistently fall below the water quality thresholds for both fishing and swimming[2]. The EPA stores national geospatial data for impaired streams in their Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS). The model calculates the length of impaired streams with a status of “Not Supporting” within each watershed. Streams classified as “Not Supporting” are streams that do not support their designated uses; and are therefore impaired. The length of impaired streams is then normalized by watershed area. This length is the first of four environmental justice indicators.

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[1] Environmental Justice Timeline | US EPA

[2] Section 303(d) of the Clean Water Act | US EPA

2.1.2.2 Percent of Population People of Color and Low Income

The EPA also manages EJScreen, which compiles several environmental justice indicators into a single polygon layer[3]. The Model uses two of these indicators: people of color (PoC) population percent and percent of population classified as low income. For both indicators, the Model calculates an average percentage for each HUC12 watershed by converting the polygon layer to a 30-meter raster and then taking the spatial average in each watershed. The average PoC population percent and low-income percent are two of the environmental justice indicators.

2.1.2.3 Habitat Conservation

The Southeast Conservation Adaptation Strategy (SECAS) is a coalition of public and private organizations that identifies high priority habitat conservation areas and accelerates restoration and conservation work in these areas[4]. SECAS publishes the SECAS Blueprint which combines environmental layers into a predictive model of highest impact habitat conservation areas. Habitats are classified as "highest," "high," and "medium" priority and as "connections" which are high priority corridors for migration. The model reclassifies the 30-meter resolution SECAS Blueprint raster using the key provided in Table 5. NoData cells were not included in the SECAS Blueprint because they were of especially low priority. Therefore, NoData cells were grouped with the lowest priority sites in the reclassification. The Model ultimately calculates the average of the cells of the reclassified raster within each HUC12 watershed. This score is the final environmental justice indicator.

Table 5: SECAS Blueprint Reclassification

SECAS Blueprint Classification	Reclassified Score
Highest	3
High	2
Connections	2
Medium	1
NoData/Low	0

2.1.3 Multi-Criteria Analysis

The Model uses a multi-criteria analysis (MCA) to combine the indicator scores into a final watershed priority score. MCA applies weights to each indicator score using Analytical Hierarchy Process (AHP)[5]. AHP uses a matrix of relative scores to create a composite weight for each indicator. Relative priority of

3 EJScreen: Environmental Justice Screening and Mapping Tool | US EPA
4 The Southeast Conservation Blueprint (secassoutheast.org)
5 Multi-Criteria Decision Analysis and GIS (arcgis.com)

indicator scores was determined iteratively using linear regression and the expertise of CRK employees. The linear regression analysis plots indicator scores against trash collection data from CRK's existing trash traps. The trash quantity indicator scores were the only indicator scores analyzed via linear regression. Because the environmental justice indicator scores would not necessarily be correlated to trash quantity within a watershed, weights were assigned based on CRK priorities.

2.1.3.1 Linear Regression

To accurately assign weights to the AHP matrix, Arcadis performed a linear regression analysis on the following data:

1. Qualitative analysis of the efficacy of existing trash traps, scored 1 (worst) to 10 (best)
2. Daily average accumulated pounds of trash in existing trash traps

Using GIS, the location of each existing trash trap was intersected with the scored HUC12 watersheds in the CRB. Ultimately, sixteen trash traps in eleven different HUC12 watersheds were used in the analysis. The coefficient of determination for the trash quantity indicator scores ranged from 0.00003 to 0.2 with rainfall showing the weakest correlation and watershed slope showing the strongest correlation. Coefficients of determination are provided in Table 6.

Coefficients of determination describe how correlated two sets of data are. A higher coefficient of determination indicates that the two datasets are well correlated. Expectations for the coefficient of determination depend on the type of relationship that is being compared. When testing a proven relationship with limited external influence, one would expect coefficients of determination above 0.9. Because watersheds are influenced by so many factors that were not controlled for in this analysis (i.e. seasonal changes, extreme weather events, inconsistency of trash collection), we expect coefficients of determination to be much lower. We compare the coefficients of determination to discern relative correlation rather than to determine if there is a correlation.

Table 6: Summary of Linear Regression Coefficients of Determination

Indicator Score	R^2 Value, Daily Average Pounds of Trash Accumulated	R^2 Value, Qualitative Analysis of Trash Trap Efficacy
Land Cover	0.1209	0.11070
Impervious Cover	0.1870	0.19200
Watershed Slope	0.2000	0.20000
Depth of 2-yr Rainfall	0.0002	0.00003
Population Density	0.0396	0.12260
Intersection of Roads and Streams	0.0092	0.02500

Through discussion with CRK staff and given the limited data available for linear regression, the AHP weights were adjusted slightly from the correlations indicated by the regression analysis. For example, the team determined that watershed slope was over-correlated, while population density was under-correlated. The environmental justice indicators were simply based on the priority that CRK assigned to them. It was determined that the environmental justice indicators and the trash quantity indicators would have the same priority and be combined without applying a weight to their composite score. Table 7 shows the weights determined for each indicator score using AHP. The AHP matrix used to develop these weights is discussed in more detail in **Appendix A**.

Table 7: Summary of Weights Applied to Indicator Scores

Indicator Score	Weight
Trash Quantity Indicator Score	**1**
Land Cover	0.20
Impervious Cover	0.25
Watershed Slope	0.20
Depth of 2-yr Rainfall	0.05
Population Density	0.20
Intersection of Roads and Streams	0.10
Environmental Justice Indicator Score	**1**
Length of Impaired Streams	0.18
People of Color Population Percent	0.27
Low-Income Population Percent	0.36
Priority of Habitat Conservation	0.18

2.1.4 Score Combination

To combine the indicator scores into a final watershed score, each indicator score is reclassified using the Natural Breaks (Jenks) method. This built-in ArcGIS reclassification identifies natural gaps in the data and groups them based on those gaps. This method maximizes the differences *between* groups and similarities *within* groups. Indicator scores are reclassified from one to four with four representing the highest scoring class and one representing the lowest scoring class. The reclassified scores are then combined into a final watershed score, which is calculated as

$$\text{Final Watershed Score} = TQW \sum TQ_i * tqw_i + EJW \sum EJ_i * ejw_i,$$

where TQ_i is each trash quantity indicator score with corresponding weight tqw_i, EJ_i is each environmental justice indicator score with corresponding weight ejw_i, and TQW and EJW are the overall weights for the composite trash quantity and environmental justice indicator scores, respectively. This analysis sets the default weights to 1, meaning that environmental justice and trash quantity are equally important.

2.2 National Hydrography Dataset Flowline Prioritization

The NHD Flowline Prioritization toolset prioritizes flowlines based on the ease with which trash traps could be installed. CRK worked with Arcadis to identify indicators for ease of trash trap installation. The first indicator identified was mean annual flow. Flowlines with no mean annual flow are likely too small to collect trash, while flowlines with mean annual flows above 100 cfs may be too large for trash trap installation and maintenance. Therefore, this toolset only analyzes flowlines with mean annual flows greater than zero and less than 100 cfs. Additionally, trash traps are easier to install on public land where coordination with private property owners is not required. Therefore, this toolset scores streams based on their proximity to public schools, libraries, and parks.

2.2.1 Ease of Installation Indicators

2.2.1.1 Mean Annual Flows

Flow and flowlines data were sourced from the National Hydrography Dataset Plus, Version 2 (NHDPlus) which is developed jointly by the EPA and USGS. The flows used for this toolset came from the Enhanced Runoff Method Mean Annual (EROMMA) gage-adjusted flow estimates in the NHDPlus tables, which, according to the NHDPlus user manual, “should be considered the ‘best’ NHDPlusV2 flow estimates for use in models and analyses.”

NHDPlus data is downloaded by state; therefore, the flowlines and EROMMA tables must be merged if the watershed study area covers more than one state. After the flowlines are merged and clipped and the EROMMA tables are merged, the mean annual flow field in the EROMMA tables is joined to the flowlines feature class via the “nhdplusid” field. The “Select By Attribute” tool is then applied to the flowline file to extract flowlines with a mean annual flow greater than zero and less than 100 cfs.

2.2.1.2 Proximity to Public Schools

Public school data is downloaded from the National Center for Education Statistics (NCES). NCES publishes public school locations in a geodatabase as a point feature class on their GIS portal. Public school data has national coverage. The toolset adds one point to the “Score” field of the final flowlines output for every public school that is within 500 feet of a given flowline. Only flowlines with mean annual flows greater than zero and less than 100 cfs are assessed.

2.2.1.3 Proximity to Public Libraries

Public library data is downloaded from the Institute of Museum and Library Services (IMLS). IMLS publishes library locations as a CSV file annually. Users must use the latitude-longitude data in the CSV file to generate a point feature class in the Inputs geodatabase. The IMLS public library data has national coverage. The toolset adds one point to the “Score” field of the final flowlines output for every public library that is within 500 feet of a given flowline. Only flowlines with mean annual flows greater than zero and less than 100 cfs are assessed.

2.2.1.4 Proximity to Public Parks

Park data is downloaded from the Trust for Public Land’s United States ParksServe Dataset (ParksServe). ParksServe publishes park locations in a geodatabase as a polygon feature class on their data portal. ParksServe data has national coverage. The toolset adds one point to the “Score” field of the final flowlines output for every park that is intersected by a given flowline. Only flowlines with mean annual flows greater than zero and less than 100 cfs are assessed.

2.2.2 Score Calculation

The toolset contains two models. First, the Flowline Prioritization model takes in the user inputs and does preprocessing on the input data.

The Flowline Prioritization model merges flowlines and EROMMA tables, joins mean annual flows from the EROMMA tables to the merged flowline feature class, and extracts flowlines with mean annual flows greater than zero and less than 100 cfs. The Flowline Prioritization model also clips school, library, and park data to the study watershed. Next, the library and school data are merged into a single point feature class. The combination of the point feature classes reduces model runtime. The park data is a polygon feature class and must be analyzed separately.

The school, library, park, and filtered flowlines data are then processed within the Submodel. The park data must be filtered to include only public parks. This is achieved by extracting features that have a “Park Status” field with a value of “Open” or “OpenFee.”

After park data is filtered to include just public parks, the Submodel executes two “Spatial Join” tools: one analyzing proximity of flowlines to features in the combined schools and libraries point feature class and another on the intersection of flowlines with features in the park polygon feature class. The output of these “Spatial Join” executions is two flowline feature classes with a “Join_Count” field indicating the number of times the spatial relationship was found to be true for a given flowline. For example, if a flowline was within 500 feet of one public school and two public libraries then the “Join_Count” for that “Spatial Join” execution would be three.

The Submodel then merges the two flowline feature classes into a single flowline feature class. This creates a file in which there are two features for each flowline. One of those features contains the

"Join_Count" value for the "Spatial Join" performed on the public school and library data. The second feature contains that same data for the "Spatial Join" performed on the public park data.

The next step in the Submodel is a "Dissolve" tool which uses the "nhdplusid" attribute to combine the two features representing the same flowline. This step also calculates the sum of the "Join_Count" fields and outputs the value to a "SUM_Join_Count" field in the dissolved flowline feature class. The "SUM_Join_Count" values represent the number of times the spatial relationship for proximity to schools, libraries, or parks is true. For example, a flowline that intersects a park and is within 500 feet of one school and two public libraries would have a "SUM_Join_Count" value of four. The "SUM_Join_Count" values are transferred to the "Score" field and extraneous fields are removed from the output flowline feature class.

The output of the Submodel is returned to the Flowline Prioritization model and the final feature class output "Scored_Flowlines" is stored in the Outputs geodatabase.

3 Model Execution

As described in Section 2, the Model includes two toolsets: HUC12 Watershed Prioritization and NHD Flowline Prioritization. The two toolsets are entirely independent of each other and can be run in unison or successively.

3.1 HUC12 Watershed Prioritization Toolset

The HUC12 Prioritization toolset includes nine models that analyze ten indicator scores and one model that combines each of these indicator scores into a composite watershed score. The Environmental Justice Screen model calculates both the people of color and low-income indicator scores. While models one through ten shown in Figure 3-1 can be run in any order, the final Score Combination model can be performed only after the other nine models have run successfully.

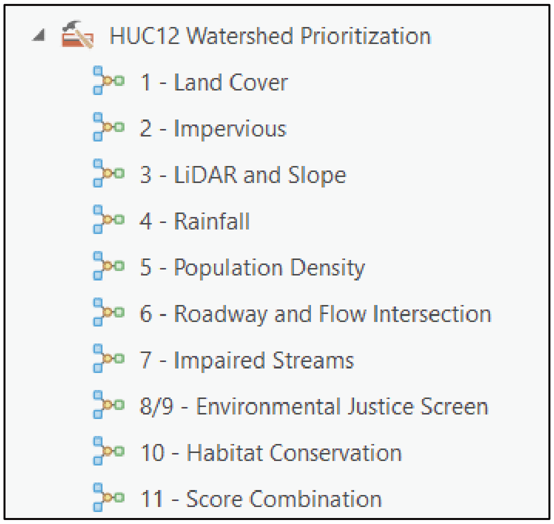


Figure 3-1: HUC12 Watershed Prioritization Toolset

There are three main steps to run the HUC12 Watershed Prioritization Toolset. The first step is data collection. This entails downloading data from various sources to build the Inputs geodatabase. These inputs will provide all the site-specific information to the HUC12 Watershed Prioritization toolset and ensure that all individual models can be run. As part of this data download step, the study area watershed, composed of many HUC12 watersheds, must be delineated. The second step in the HUC12 Watershed Prioritization toolset is quality control and further parameterization of the downloaded data. This includes updating field names and field values. The third step in executing the HUC12 Watershed Prioritization toolset is using the collected and parameterized data from step one and two to start running the models.

Each time a model is run, the study area watershed feature class that was generated and stored in the Inputs geodatabase in step one is updated with a field corresponding to the indicator score for the completed model. The Score Combination model also updates the study area watershed feature class and generates numerous fields: Natural Breaks reclassification fields, composite environmental justice and trash quantity indicator score fields, and an overall watershed score field. The overall watershed score is stored in a field, “Final_scor.” Environmental justice and trash quantity score field names are “EnviroJust” and “TrashQuant,” respectively. Natural breaks reclassification fields are the indicator score field name followed by “_NB.” Note that, for the HUC12 Watershed Prioritization toolset, the model results described above are always stored in the study area watershed feature class in the Inputs geodatabase rather than the Outputs geodatabase. The Outputs geodatabase stores summary tables that were generated for each indicator score, while the Scratch geodatabase stores intermediate data output while processing input data.

A detailed, step-by-step guide for running the HUC12 Watershed Prioritization toolset is included in **Appendix A**. This covers the details on setting up geodatabases, downloading and parameterizing the data, as well as running the models. Please refer to **Appendix A** to ensure proper execution of the model.

3.2 National Hydrography Dataset Flowline Prioritization Toolset

The NHD Flowline Prioritization toolset contains two models. The Flowline Prioritization model is the only model that the user must open and run. The Submodel runs automatically with the Flowline Prioritization model and does not require any user input. The models in the Flowline Prioritization toolset are shown in Figure 3-2.

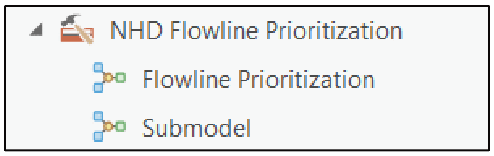


Figure 3-2: NHD Flowline Prioritization Toolset

The NHD Flowline Prioritization toolset uses the same Inputs geodatabase that was downloaded with the Model and updated with user-specific data. The Inputs geodatabase contains public schools, libraries, and park data. It should also contain state NHD flowline data and EROMMA tables corresponding to each state dataset. The first two steps necessary to execute the NHD Flowline Prioritization toolset are data collection and data parameterization. **Appendix B** describes these two steps in more detail.

The collected and parameterized datasets are used as inputs into the Flowline Prioritization model. Running the Flowline Prioritization model is the final step for execution of the NHD Flowline Prioritization toolset.

When the Flowline Prioritization model and Submodel are run, they output a “Scored_Flowlines” feature class into the Outputs geodatabase. The “Scored_Flowlines” feature class contains a field, “Score,” that reports the number of public schools, libraries, and parks within a search radius of a flowline. Flowlines with higher scores indicate flowlines on which trash trap installation would be easier. The Scratch geodatabase contains intermediate outputs like the merged flowlines, library data clipped to the study watershed, and flowline feature classes with the count of libraries and schools and public parks that fall within the predetermined search area. The Outputs and Scratch geodatabases are the same geodatabases that were downloaded with the Model and used with the HUC12 Watershed Prioritization toolset.

Detailed, step-by-step instructions for execution of the NHD Flowline Prioritization toolset can be found in **Appendix B**.

4 Interpreting Model Results

As previously stated, the Model assesses the priority of each HUC12 watershed for trash trap installation based on quantity of litter and level of environmental justice achieved. The Model also assesses the priority of NHD flowlines based on the ease with which a trash trap at that location could be installed and managed. This section will discuss how to best visualize the results of the HUC12 Watershed Prioritization and NHD Flowline Prioritization toolsets.

4.1 HUC12 Watershed Prioritization Results Interpretation

Higher composite environmental justice and trash quantity indicator scores from the Score Combination model of the HUC12 Watershed Prioritization toolset indicate watersheds with higher priority for trash trap installation. For example, if a watershed has high impervious cover and low-income population percentages, it is more likely to have a higher priority.

To visualize the results of the Model, the user should drag the study area watershed feature class from the Inputs geodatabase into the map contents pane on the left side of the ArcGIS window, right click on the newly added watershed layer, then select “Symbology.” In the symbology pane that opens, alter the “Primary Symbology” from “Single Color” to “Graduated Colors.” A color scheme should be chosen that the user can easily interpret. For example, in Figure 4-1, HUC12 watersheds in red indicate areas with highest priority (score > 5.53), while blue and purple indicate watersheds with lower priority. To select a color scheme from all the palettes available in ArcGIS, click on the dropdown and check “Show all.” Users can increase the number of classes to further distinguish between watershed scores. The method of classification can also be changed from “Natural Breaks (Jenks)” to another ArcGIS method. Review the application of each classification to determine which method works best for the study area. Users can select “Manual Interval” and create their own classification if they want to highlight a specific segment of watersheds.

Users should use visualization of results to confirm that their results make sense. The results shown in Figure 4-1 match what users would expect for the CRB in terms of trash quantities. Urban areas with higher impervious cover and more population density are higher priority than rural watersheds with fewer people and more natural cover. Additionally, from an environmental justice perspective, the scores make sense. Watersheds with higher priority correspond to areas with larger populations of PoC and low-income residents. The combination of these trash quantity and environmental justice indicators results in hot spots of watershed priority in Atlanta and Columbus.

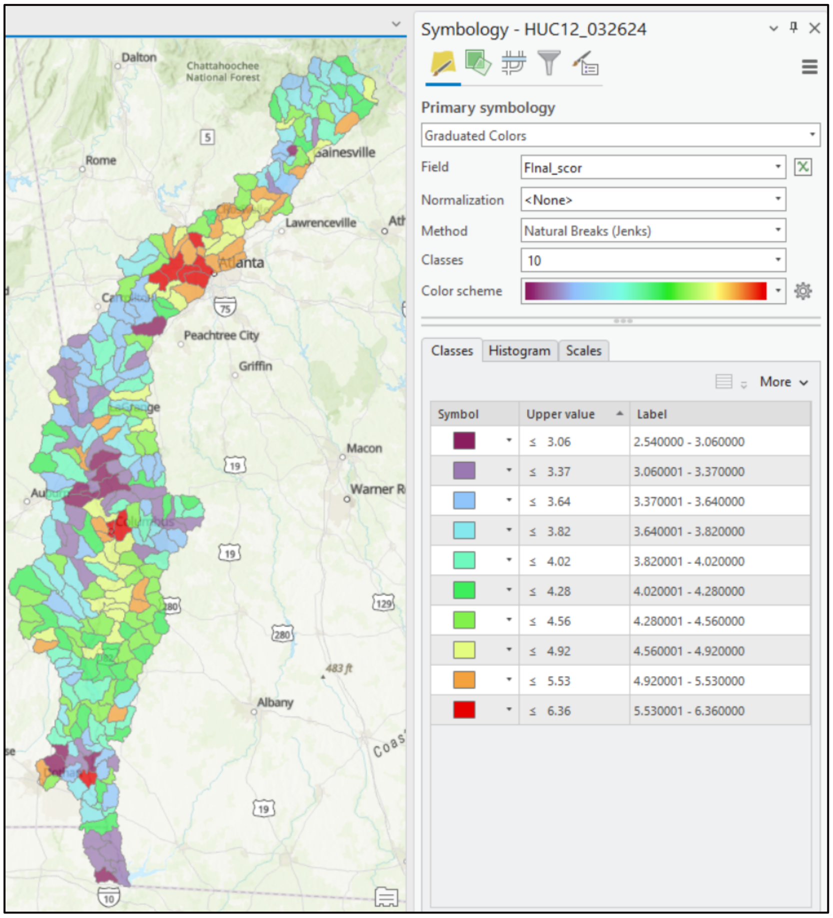


Figure 4-1: Visualization of HUC12 Watershed Prioritization

The user could adjust the "Field" dropdown in the Symbology pane to visually compare each indicator score across the watersheds. For example, the user could select the composite environmental justice indicator score in the "Field" dropdown. Users can visualize the individual indicator scores using the Natural Breaks reclassification or the raw scores before reclassification. Visualizing indicator scores is a good way to confirm that models are working properly. If the impervious cover results show higher scores in rural north Georgia, the user may need to review that step of the Model and ensure that they used the correct inputs.

To determine which indicators drove the watershed prioritization results, open the attributes table by right clicking the study area watershed layer and selecting "Attributes." The scores for each indicator should be listed in the final columns of the table. The user may want to compare the composite environmental justice score with the trash quantity score to establish which score is determining the prioritization of one HUC12 watershed over another. The user could also look more granularly at each indicator score that contributes to the composite trash quantity and environmental justice scores. Assessment of the driving factors for prioritization of one watershed over another will help users make educated decisions about which watersheds should be prioritized for trash trap installation.

4.2 NHD Flowline Prioritization Results Interpretation

Similar to the HUC12 Watershed Prioritization toolset, flowlines with higher scores have higher priority. If a waterway has mean annual flow greater than zero and less than 100 cfs, it will appear in the “Scored_Flowlines” feature class in the Outputs geodatabase. Waterways with flows outside of this range are excluded from the flowline prioritization. If the waterway is near publicly accessible areas, it will have a higher score and therefore, a higher priority.

To best visualize this data, open the “Outputs” geodatabase and drag the “Scored_Flowlines” feature class to the model space. Right click on the “Scored_Flowlines” feature layer in the contents pane and select “Symbology.” Figure 4-2 displays the recommended configuration for scored flowline data: “Unique Values” for “Primary Symbology,” “Score” for “Field,” and any distinguishable colors for “Color Scheme.”

Users may want to visualize only some of the scores. For example, flowlines with a score of zero may clutter the map and are unlikely to be selected for trash trap installation since they do not intersect any public spaces. To remove flowlines with scores of zero, the user can right click on the class in the symbology pane and select “Remove.” They must repeat this step with “<all other values>.” Now, the map will display only scores greater than zero.

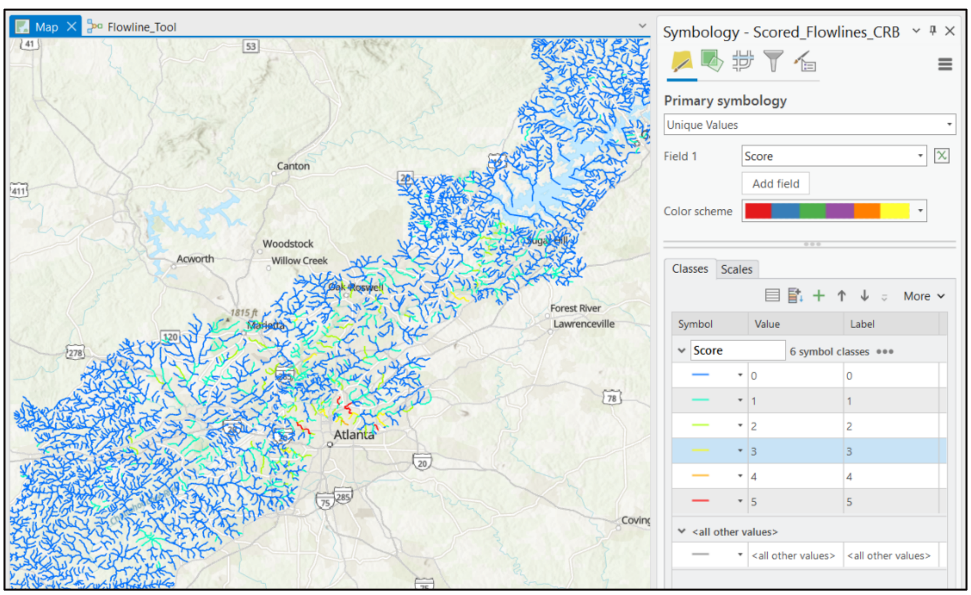


Figure 4-2: Visualization of NHD Flowline Prioritization

We recommend selecting a few of the highest priority watersheds identified by the HUC12 Watershed Prioritization toolset and then visualizing the flowlines within those selected watersheds. If users would like to see which public spaces intersect the flowlines, they can navigate to the Inputs geodatabase and drag the public libraries, schools, and park data into the map. This will allow users to further specify which flowlines they may want to select for trash trap installation.

5 Limitations

The Model is limited by the quality and coverage of the available data. Depending on the user's watershed location, some data may not be available or have lower resolution coverage. **Appendix C** provides details on how missing data can be addressed. In most cases, the data selected for this model is nationally available. However, the SECAS Blueprint and 2-year rainfall intensity data only have regional coverage. Similar data may be available for watersheds outside of these regions. Users should refer to **Appendices A** and **B** for details on data parameterization and meaning.

The Model is also limited by watershed type. Because this model was calibrated to HUC12 watersheds in the CRB, there may be slight variations in how much certain indicator scores should impact the final composite score. It is not recommended that users run this model on watersheds larger or smaller than HUC12 units. Changing the size of the watersheds being analyzed may also impact appropriate weighting of the indicator scores. Future suggestions for calibration of the model to different watershed locations and sizes are discussed in Section 6.2.

All watersheds are unique. The results of the Model should be verified by visual inspection on site and organization knowledge of the broader watershed. If visual inspection and institutional knowledge do not align with the results of the model, recalibration of indicator score weights should be considered.

The Model requires, at minimum, an ArcGIS Pro Basic license. Waterkeeper organizations that are part of the Waterkeeper Alliance were recently granted ArcGIS Pro Basic licensing. If the user's organization does not have an ArcGIS license, pricing options are available at: ArcGIS Pro Pricing. This model was developed in ArcGIS Pro version 3.0.3. The model should be compatible with a variety of ArcGIS versions, but we recommend accessing the model in version 3.0.3 or more recent versions.

Given the size of the data that must be downloaded for the Model, storage is also a limiting factor. The inputs geodatabase, alone, is expected to require about 25 GB of storage. Depending on the size of the user's watershed, this requirement may increase. The user must also have room to store scratch data and final outputs. The expected storage required for the scratch data and final outputs is about 5 GB. Users should ensure that their computer has sufficient storage before beginning data collection or model execution.

The Model is also limited by user knowledge of ArcGIS Pro and its ModelBuilder functionality. As described in **Appendix C**, the Model was designed to be modular and easy to edit. That said, making edits to the Model requires some level of familiarity with geoprocessing tools within GIS and an understanding of logic flow of the Model. While we provide detailed descriptions of model editing and methodology, changes to the Model should be approached with caution.

6 Future Considerations

The Model is designed to be fluid, with room for improvement as more data becomes available. This section describes additional data recommendations and possible areas of data exploration for model improvement.

6.1 Additional Data Recommendations

In developing the Model, we spoke with a variety of stakeholders about their experience working with trash traps in the field. This section describes the additional data that these stakeholders recommended we explore. Ultimately, the data in this section was not included in the Model. Reasons for the exclusion of the data are described. Details on how to add data to the Model are provided in **Appendix C**. Note that additional data recommendations are included for the Flowline Prioritization Model, but only experienced GIS users should attempt to edit this model.

6.1.1 Additional Indicators for HUC12 Watershed Prioritization

We discussed replacing the habitat conservation indicator with a more refined ecological indicator. The SECAS Blueprint prioritization is a composite score of many different factors, ranging from resilience of terrestrial sites to network complexity. SECAS Blueprint publishes each of the contributing factors in separate layers on its website. Through conversations with the United States Fish and Wildlife Service (USFWS), we identified several layers that might provide a more refined assessment of habitat priority.

One such layer was the imperiled aquatic species data. Imperiled aquatic species data reports the number of aquatic animal Species of Greatest Conservation Need (SGCN) found within a given HUC12 watershed. This dataset may be preferable to the composite habitat priority layer because it specifically provides information about aquatic habitats. These are the ecosystems impacted by trash traps. Ultimately, we excluded this data from the Model due to uncertainty about the impacts of trash traps in streams. The installation of trash traps likely has a net positive impact on the aquatic ecosystem, but there are some concerns about blocking travel of aquatic species and disrupting normal flow patterns. If users have interest in including imperiled aquatic species data, we recommend consulting ecologists before incorporation into the Model.

Other SECAS Blueprint data that was discussed but ultimately not included in the Model were the resilient terrestrial sites, intact habitat cores, and network complexity data. These indicators were determined to be less relevant than the composite habitat priority determinations.

For users that have existing trash trap programs, it may be useful to prioritize watersheds that do not already have trash traps installed. We determined that inclusion of this data in the Model would be infeasible since the format of input data would vary widely across users. Additionally, depending on how comprehensive the trash trap program is, visual inspection of the overlap between existing trash traps and HUC12 watersheds should be sufficient to inform this prioritization.

6.1.2 Additional Indicators for NHD Flowline Prioritization

Large debris, such as logs and trees, were one concern for the installation of trash traps. Depending on the design of the installed trash trap, large floating debris can severely damage installed trash traps. We discussed adjusting the flowline score to assess the land cover upstream of each stream. For example, a flowline with a high percentage of forested upstream land cover might be more likely to produce logs and tree trunks. In this case, the flowline score might be lowered by some amount to account for this characteristic. Ultimately, this indicator was not included in the Model due to technical challenges. Determining which areas are upstream of a flowline is possible but difficult and determined to be outside the scope of this project.

Channel side slopes were also discussed as an indicator for ease of trash trap installation. Because trash traps must be accessible by foot, steep channel side slopes would prove difficult to maintain. We attempted to analyze the side slopes using the USGS LiDAR and NHD flowlines, but the processing proved too challenging for the scope of this project. Delineating the bottom and top of slope requires robust analysis in GIS, especially given the range of channel sizes present in a watershed-wide analysis. We believe it is possible to determine the side slopes within GIS but did not ultimately complete development of this model.

The soil composition of the channel banks may also be an indicator for the ease of trash trap installation. Sandy banks provide less stability for trash traps that are anchored via stakes into the ground. Soil composition was excluded from the Model for two reasons. First, the technical challenge of delineating the channel bank proved to be outside the scope of the project. Second, CRK primarily secures inexpensive “boom-style” trash traps to trees rather than directly into the ground. Therefore, soil composition is less crucial to include in the analysis. If users plan to secure their trash traps directly into the ground, soil analysis may be a consideration.

Another consideration is the “flashiness” of streams. This refers to how quickly and drastically water surface elevations increase during storm events. Typically, more urban watersheds experience larger and more rapid water surface elevation increases due to higher percentages of impervious cover. Trash traps on flashy streams are more likely to be damaged during storm events because they must operate over a wide range of elevations. Therefore, less flashy streams should be prioritized for trash trap installation. We explored a range of datasets to determine the flashiness of streams including FEMA flood hazard layers, stream geometry data estimated from EROMMA tables, and USGS historical stream data. These datasets proved incompatible with our model structure. Further exploration of datasets may allow for analysis of stream flashiness.

Lastly, we discussed the inclusion of proximity to greenways and trails. Streams adjacent to greenways or trails might provide more educational opportunities and would be more accessible for maintenance. Ultimately, it was determined that proximity to parks would be well-correlated to greenway access. Therefore, proximity to greenways and trails was excluded to ensure that these locations were not double counted in the final score.

6.2 Future Data Exploration

Many questions about the correlation between indicator scores and trash quantities in watersheds still exist. This section describes these questions in more detail and proposes future work to address them.

6.2.1 Model Scalability

The Model's two toolsets, HUC12 Watershed and NHD Flowline Prioritization, differ in scalability. The NHD Flowline Prioritization toolset is infinitely scalable, meaning that a watershed of any size could be used as an input to the model. The results of the model would be accurate regardless of model size. This is because the flowline prioritization simply counts the number of public spaces near flowlines.

The HUC12 Watershed Prioritization toolset is not necessarily scalable to any watershed size. While the model will take in a watershed of any size and produce a score for the sub watersheds within that watershed, the score results may not be accurate. This is because the relative influence of the indicator scores is dependent on the size of the watershed. For example, if a new neighborhood development wanted to analyze the best location for trash traps within its watershed, it might delineate sub watersheds with sizes less than 3 acres each. In these smaller watersheds, watershed slope and impervious cover might be more highly correlated to trash production than population density. Indicators like population density and low income and PoC population percentages are likely somewhat homogenous across smaller watersheds. Because the weights for the indicator scores were determined based on a linear regression of HUC12 data in the CRB, the relative correlations are not necessarily transferrable to watersheds of different sizes.

We performed a test linear regression analysis on watersheds for urban outfalls in a coastal Virginia city. These watersheds were significantly smaller than HUC12 watersheds. The urban outfall data was very limited, but the relative coefficients of determination did vary slightly from the regression analysis for the larger HUC12 watersheds used in the CRB. Therefore, we believe that the applicability of this model is limited to HUC12 watersheds.

Future work should focus on determining the range of watershed sizes for which this model applies. Perhaps weights for indicator scores can be developed for different ranges of watershed sizes. To achieve this, more data on trash quantities in watersheds of many sizes is needed.

6.2.2 Indicator Variability Across Study Watersheds

Similarly, watershed location may have an impact on the weights assigned to indicator scores. As users expand their trash trap programs and collect field data about the quantity of trash collected at different trash traps, we recommend they perform linear regression analyses to reassess the relative weighting of indicator scores. This analysis is particularly relevant in watersheds with significantly different hydrology than the CRB, such as watersheds outside of the southeastern United States.

6.2.3 Indicator Selection

The Model analyzes a wide range of indicators in hopes of capturing as much information as possible. Because there is limited existing data about the impact of each of these indicators on trash quantities in watersheds, we relied largely on our understanding of watershed processes to select indicator data.

In using this method, one significant concern is that indicators are being duplicated. For example, land cover, impervious cover, and population density are very similar indicators. Though developed land cover types typically have higher population density and higher impervious coverage, this is not always true. High intensity developed areas might be industrial areas with lower average population density, but very high impervious coverage. Therefore, it may be important to include all three indicators to account for these discrepancies.

To determine the relative significance of these indicators, more analysis is required. A linear regression against trash quantity data of the composite scores with and without certain indicators might clarify what scores are most significantly impacting the HUC12 prioritization. It will also show which combination of indicators best matches field data.

All indicator scores should be assessed with this data-driven analysis. Because there was limited existing trash trap collection data available to us during model creation, we did not assess the impact of indicator scores on the final score's correlation to trash quantities in watersheds. We analyzed the individual indicator scores via linear regression but did not perform analysis on the final watershed prioritization score as different combinations of indicator scores. As more trash traps are installed in the CRB and across the country, the data needed to perform these more robust analyses will become available.

We recommend that users standardize their trash collection and recordkeeping as much as possible. At a minimum, trash collection should happen over standardized periods (i.e. every two weeks). If possible, all trash traps in a program should be cleaned in the same day or within a couple of days of each other. This will ensure that trash data is being recorded for similar meteorologic and hydrologic conditions in the watershed. It will eliminate some of the noise in the data when linear regression analyses are applied.

7 Conclusion

This report describes two toolsets: HUC12 Watershed and NHD Flowline Prioritization. The HUC12 Watershed Prioritization toolset takes in HUC12 watersheds within a larger study watershed and analyzes the impact of trash trap installation for each sub watershed. Sub watersheds are ranked based on the amount of trash expected to pollute the watershed and the environmental justice impact that trash trap installation might have. The toolset analyzes six trash quantity and four environmental justice indicators. The indicator scores are distributed via a Natural Breaks reclassification and combined into a weighted composite score. This weighted composite score represents the final watershed prioritization score. Watersheds with higher watershed scores are higher priority.

The NHD Flowline Prioritization toolset takes in the NHD flowlines and prioritizes them based on the expected ease of trash trap installation. It filters out streams with mean annual flows above 100 cfs or equal to zero cfs. The toolset then counts the number of public parks, schools, and libraries within a given radius of the flowline. Streams with higher scores are adjacent to more public spaces; therefore, they offer more opportunities for trash trap installation.

Users can use these two toolsets to identify both the most impactful and most simple location for trash trap installation. First, users can select several high priority watersheds based on the watershed prioritization score. Then, they can focus on the streams in these watersheds to identify which flowlines might be easiest for trash trap installation. Users should utilize these models in conjunction with in-field, visual inspections.

The Model should only be applied to HUC12 watersheds and is limited by the user's access to and ability to use GIS licensing. The relative weighting of indicator scores may vary slightly across the country and in watersheds of different sizes. Users should collect data as they advance their trash trap programs to better calibrate weights to the watershed where the Model is being executed. Users can also apply this data to assess the final watershed score with different indicator weights and combinations to better calibrate the results. Users may also consider adding models to assess new indicators for both the Flowline and HUC12 Prioritization toolsets.

This manual should be used in conjunction with CRK's *Trash Traps: A Guide to Implementing In-Stream Litter Pollution Control,* and is meant to help watershed organizations, municipalities, and other stakeholders implement or improve their own trash trap programs across the country. Trash removal advances several sustainability goals. It prevents breakdown of litter into microplastics that contaminate our drinking water and aquatic food sources. This improves health in local and downstream communities and potentially avoids expensive upgrades to water treatment processes. Removing litter from streams also enhances aesthetics and encourages recreation. Clean streams boost ecotourism and connect locals to their natural spaces. This makes citizens better stewards of their environment. Trash traps programs also provide ample opportunity for environmental education.

Our hope is that this manual, along with *Trash Traps: A Guide to Implementing In-Stream Litter Pollution Control,* will accelerate installation of trash traps across the country so that these significant benefits can be realized.

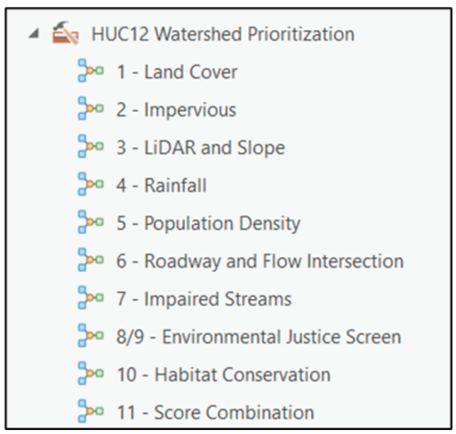
Appendix A

Appendix A: HUC12 Prioritization Model Execution

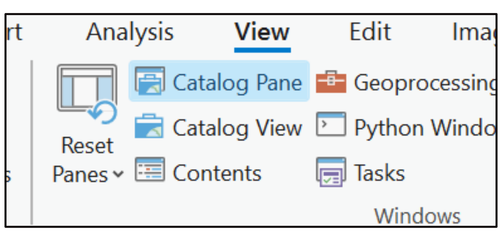
HUC12 Prioritization Model Execution

The first step to executing the 12-digit hydrologic unit code (HUC12) Watershed Prioritization toolset (HUC12 toolset) is collecting input data and downloading the toolbox from [Trash Trap Guide Download - Chattahoochee Riverkeeper](). Once the complete model (Model) and input data have been downloaded, some data parameterization may be required.

The Model includes two toolsets: HUC12 Watershed Prioritization and NHD Flowline Prioritization. The two toolsets are entirely independent of each other and can be run in unison or successively. This appendix focuses on the execution of the HUC12 toolset. As described in Section 3 of the main text, the HUC12 toolset includes nine models that analyze ten indicator scores and one model that combines each of these indicator scores into a composite watershed score. Models one through ten shown in the screenshot below can be run in any order; the final Score Combination model can be performed only after the other nine models have run successfully.



We recommend accessing the HUC12 toolset, as well as the NHD Flowline Prioritization toolset via the catalog pane in ArcGIS. Throughout this appendix, the catalog pane will be referenced. To access the catalog pane, navigate to the “View” toolbar and select “Catalog Pane.”



When the catalog pane opens, right click on “Folders,” and select “Add a Folder Connection.” The user must add the folder within which they have stored the Model.

1 Data Collection

The Model references data from a user-generated geodatabase, referred to in this appendix as the Inputs geodatabase. A geodatabase is a collection of geographic datasets of various types held in a common file system folder (What is a geodatabase?—ArcGIS Pro | Documentation). To populate the geodatabase, data will need to be collected from various sources. Note that the Inputs geodatabase downloaded with the Model contains national data, but not state or regional data. Users must download state and regional data themselves. The data included in the Inputs geodatabase was downloaded in 2024. As data updates become available, we recommend that users update the national datasets in the pre-populated Inputs geodatabase. See Table A-1 below for a summary of the data stored in the Inputs geodatabase that is relevant to the HUC12 toolset.

Table A-1: Input Geodatabase Files for HUC12 Prioritization Toolset

Files	Parameters	Model(s) That Use Input	Included in Inputs.gdb*	Update Frequency
National Hydrography Dataset HUC12 Watersheds	Single polygon shapefile	All models	☒	The USGS updates hydrography data annually.
National Land Cover Dataset	Single raster dataset	1 – Landcover	☑	The Earth Resources Observation and Science Center updates the National Land Cover Database (NLCD) every two to three years.
National Impervious Dataset	Single raster dataset	2 – Impervious	☑	
USGS LiDAR Tiles	Multiple 1-arc second resolution raster datasets	3 – LiDAR and Slope	☒	The USGS updates LiDAR whenever a new study is performed, irregularly and dependent on region. It is recommended to check the USGS data source annually.
Regional NOAA 2-yr Rainfall	Single raster dataset	4 – Rainfall	☒	NOAA updates precipitation frequency estimates with each Atlas they publish. Complete Atlas 15 Vol. 1 and Vol. 2 will deliver estimates, documentation, and supplementary products to stakeholders in 2027.
National EJ Screen	Single polygon feature class	5 – Population Density, 8 – Environmental Justice Screen	☑	The EPA uploads new data annually and often provides an update a few months after the upload.
State Roadway	Single or multiple line shapefiles	6 – Roadway and Flow Intersection	☒	No indication was given to the frequency USGS updates state roadway data. It is recommended to check the USGS data source annually.
National Hydrography Dataset Flowlines	Multiple line shapefiles	6 – Roadway and Flow Intersection	☒	No indication was given to the frequency USGS updates national hydrography dataset flowlines. It is recommended to check the USGS data source annually
National Impaired Streams	Multiple line feature classes	7 – Impaired Waters	☑	The EPA updates 303d Impaired Waters data every two years.
SECAS Blueprint	Single raster dataset	9 – Habitat Conservation	☑	SECAS uploads a new data .zip file annually, but often provides minor updates throughout the year. Subscribe to their monthly newsletter to be notified of updates.

*Note: Data included in the Inputs geodatabase may not be the most recent published data and should be updated as needed.

After downloading, users must import their datasets into the Inputs geodatabase. The process for importing datasets to a geodatabase is dependent on the type of data being imported (i.e. raster, feature class, shapefile). If the dataset is already stored in a geodatabase, the user may simply right click on the dataset in its downloaded geodatabase, select “Copy” and then navigate to the Inputs geodatabase. Right click on the Inputs geodatabase and select “Paste.” The dataset should begin copying into the Inputs geodatabase.

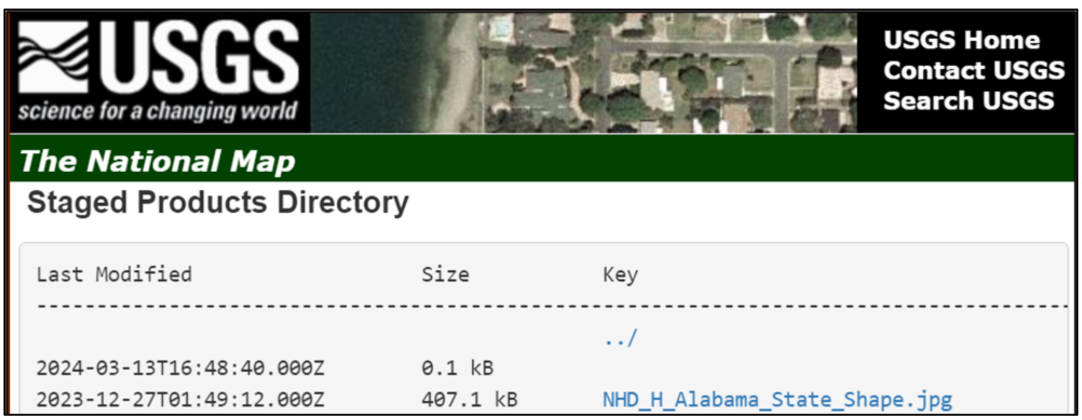
If the dataset is a shapefile, the user must right click on the Inputs geodatabase, hover over “Import,” and then select “Feature Class.” In the geoprocessing pane that opens, click on the yellow folder icon next to the “Input Features” drop down and navigate to the files to be imported. Click “Run” and ensure that the appropriate files have been added to the Inputs geodatabase.

If the dataset is a raster, the user must employ the “Raster to Geodatabase” tool in ArcGIS Pro. Navigate to the geoprocessing pane and type for “Raster to Geodatabase” in the search bar. Select the “Raster to Geodatabase” tool and click on the folder icon under “Input Rasters” to select the relevant rasters. Set the “Output Geodatabase” to the file path of the Inputs geodatabase.

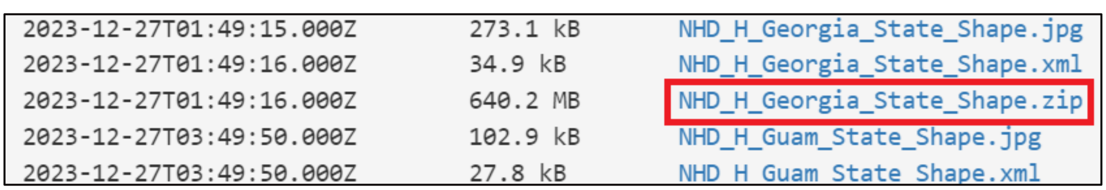
For more information on how to combine the downloaded data into a geodatabase visit: Create a file geodatabase—ArcGIS Pro | Documentation.

1.1 National Hydrography Dataset HUC12 Watersheds

Download location: The National Map (prd-tnm.s3.amazonaws.com)

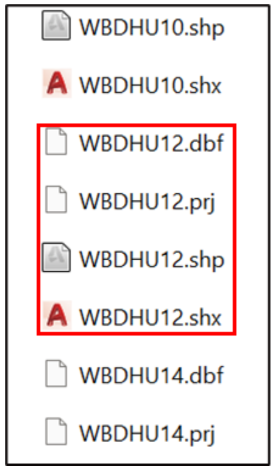


Click on the .zip file for the state(s) of interest.

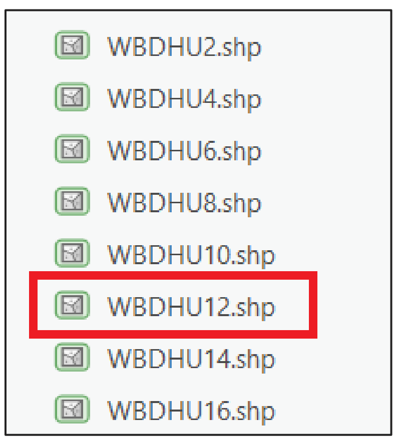


Once downloaded, navigate to the “Shape” folder in the .zip file and identify the WBDHU12 file.

From the File Explorer, the data might look like this:



In ArcGIS, it should look more like this:



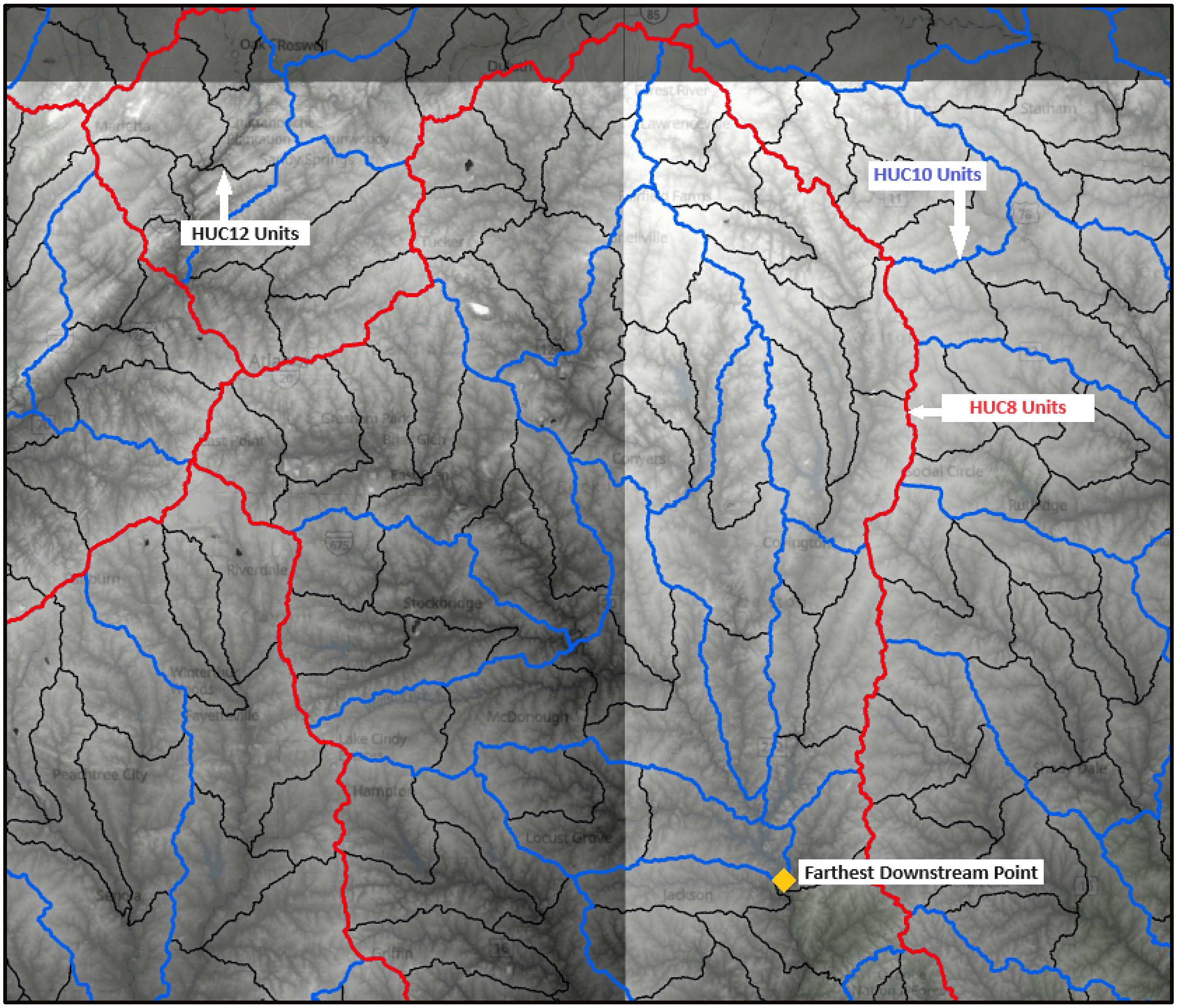
If the planned analysis uses multiple states' data, the user will need to rename the 12-digit hydrologic unit code (HUC12) watershed file to include the state name. The user will need to identify which HUC12 watersheds contribute to the broader study watershed, select these watersheds, and export them to a new "HUC12_project" shapefile. Detailed instructions for delineation of the HUC12 watersheds contributing to the study area are provided in the following section.

1.1.1 Study Area HUC12 Watershed Delineation

All models in this toolset use a HUC12 watershed study area feature class to determine indicator scores. Therefore, the HUC12 watershed study area file is the single-most important file used to run the model. As described in Table A-1, the HUC12 project file is generated from the National Hydrography Dataset (NHD) state download. The state data downloads as a .zip file within which is a folder titled “Shape.” The HUC12 watersheds for the state are stored within this folder as a shapefile named “WBDHU12.” If the user’s study area crosses state boundaries, the user may need multiple HUC12 watershed files. In this case, we recommend the user rename the HUC12 watershed files to reflect the state that they represent (e.g., “HUC12_GA”). The user will want only a segment of the HUC12 watersheds stored in the state watershed shapefile(s). To create a feature class of project-specific watersheds to input into the Model, the user must drag the state HUC12 watersheds into the map contents pane in ArcGIS. If the study watershed crosses state lines, drag all the HUC12 watersheds for each relevant state into the map contents pane.

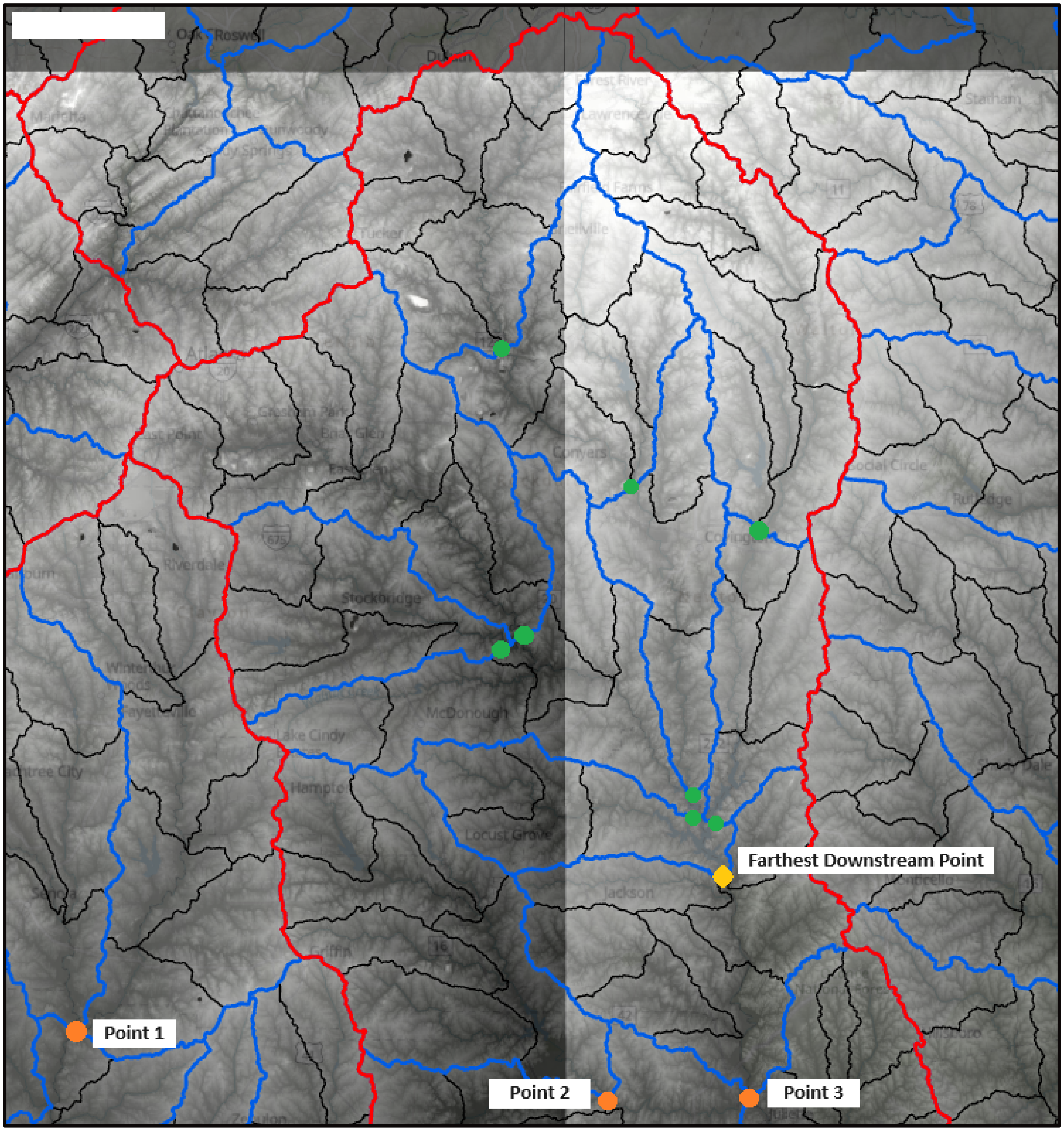
Depending on the user’s familiarity with the study watershed, they may be able to select the HUC12 watersheds that comprise the study watershed from memory. If this is not possible, we recommend pulling in larger HUC unit watersheds to better identify the boundary of the study watershed. Larger HUC unit watersheds have smaller numbers. For example, a HUC10 watershed is larger than a HUC12 watershed.

After the user drags their state(s)’ HUC12 watersheds into the map, they must also add the HUC10 and HUC8 units. Adjust the symbology to make each watershed layer visible. We also recommend adding the United States Geological Survey (USGS) light-detection and ranging (LiDAR) tiles for the area of interest into the map. This helps the user understand the topography of the watershed as they delineate their study watershed. Now, the user’s map should look something like what is shown below.



The user must also identify the farthest downstream point (FDP) in their watershed. The FDP will demarcate the end of the study watershed. Rainwater falling in the HUC12 watersheds in the study watershed must eventually converge to this point. Note that the larger HUC unit watersheds exactly contain the smaller HUC unit watersheds. All the HUC12 watersheds contained by a given HUC10 watershed flow into the same downstream point. Likewise, all the HUC12 *and* HUC10 watersheds contained by a given HUC8 watershed flow into the same downstream point.

Starting from the FDP in the study watershed, the user should move upstream in the FDP downstream point. When the user comes to a junction of that watershed with a watershed unit of equal or larger size they should determine if the downstream point of that intersecting watershed is downstream or upstream of the FDP in the study watershed. If the downstream point of the intersecting watershed is upstream of or intersecting the FDP, it should be included in the study watershed. If not, it should be excluded. Points are upstream of the FDP if they connect to a watershed that ultimately flows into the FDP. Points are downstream if they do not connect to a watershed that flows into the FDP. The figure below shows examples of upstream points in green and downstream points in orange.



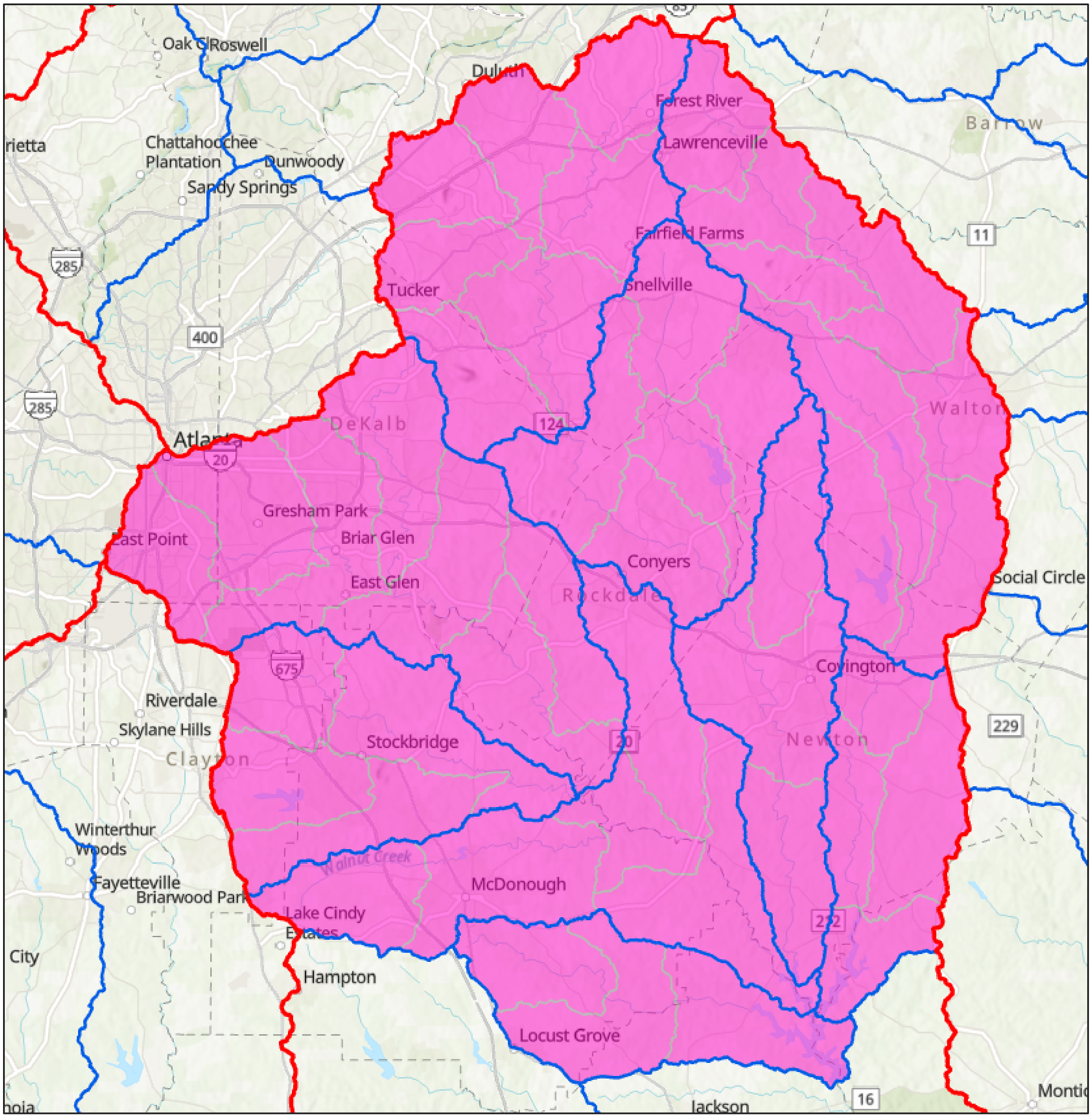
Point 1 in the figure is a downstream point because it is outside of the HUC8 unit that contains the FDP for the study watershed. If the FDP intersected two HUC8 units then it would be possible for a downstream point in a separate HUC8 watershed to be part of the study watershed. However, since the FDP for this watershed sits at the bottom of a HUC10 watershed, it can only include watersheds within the same HUC8 watershed.

Point 2 in the figure is a downstream point because the downstream point does not flow into a watershed that contributes to the FDP. Similarly, Point 3 in the figure is not included because it does not flow into the study watershed. Another way of conceptualizing this is considering whether the water flowing through each of these points can flow through the FDP in the study watershed.

The USGS LiDAR is also a valuable tool for watershed delineation. Note that in the figures provided in this section, the LiDAR is shown in grayscale. The lower elevations are shown in darker gray, and the higher elevations are shown in white. The streams sit at lower elevations than the terrain of the surrounding watershed. Therefore, one way to determine if a watershed connects to the FDP is to follow the low points in the LiDAR through watersheds. If the user can trace a path from the downstream point of a given watershed to the FDP, then the watershed is part of the study watershed.

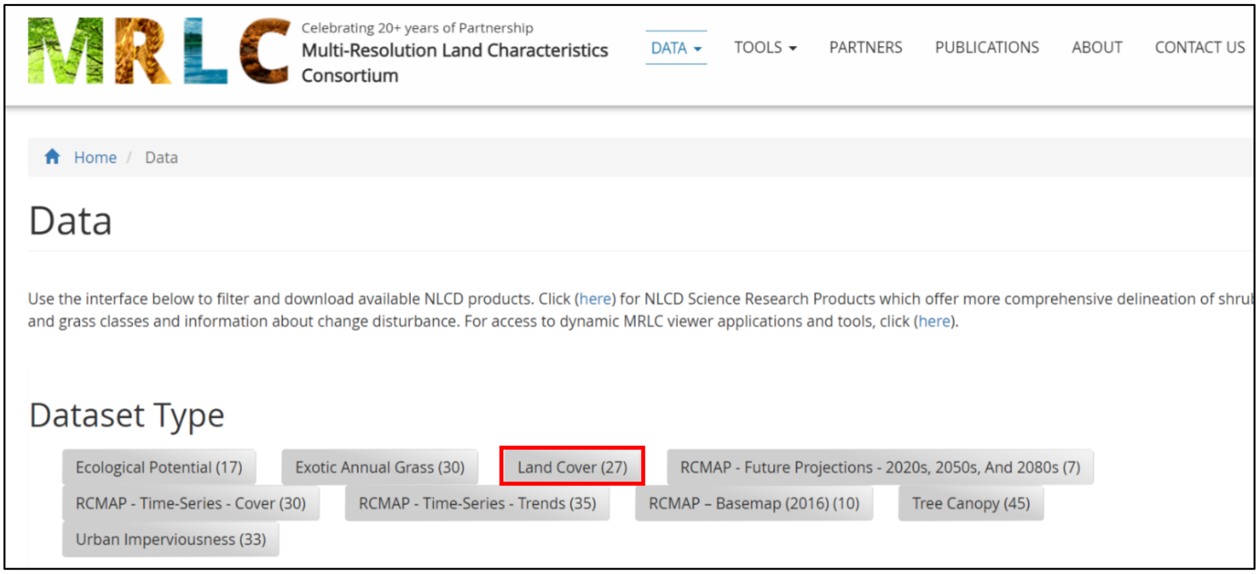
By following the boundary of the HUC10 units and determining if watersheds at junctions have downstream points upstream or downstream of the study watershed's FDP, the user can delineate the HUC12 watersheds contributing to the study watershed. In ArcGIS, select each of the HUC12 watersheds within the study watershed. When watersheds are selected, they will highlight in light blue. Right click on the HUC12 watersheds in the contents pane, navigate to "Data" and then select "Export Features." Export the features to the Inputs geodatabase that was downloaded with the Model. The user can name the file as they see fit.

The HUC12 watersheds delineated for this farthest downstream point are shown in pink with gray outlines in the figure below. The HUC10 and HUC8 boundaries are also shown in blue and red outlines, respectively.

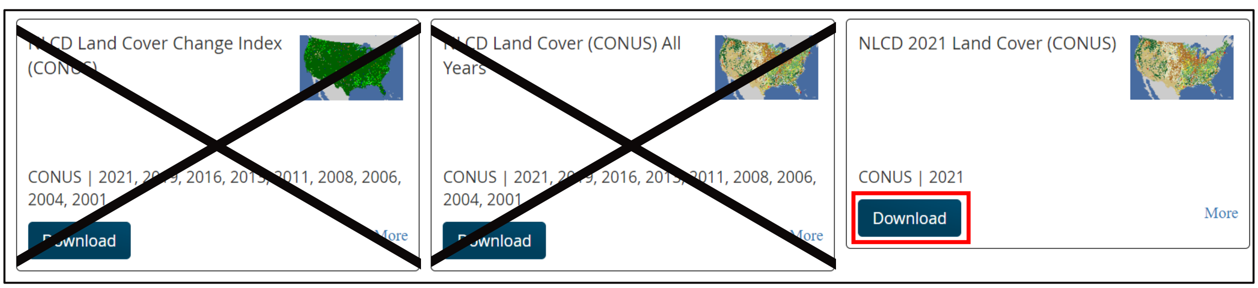

Oak Grove
Roswell
Duluth
Forest River
Lawrenceville
Barrow
Marietta
Chattahoochee Plantation
Dunwoody
Sandy Springs
Fairfield Farms
11
285
Tucker
Snellville
400
285
124
Walton
DeKalb
Atlanta
20
Gresham Park
Briar Glen
East Point
Conyers
Social Circle
East Glen
Rockdale
675
Covington
Riverdale
229
Skylane Hills
Stockbridge
Newton
Clayton
20
Winterthur Woods
Walnut Creek
Fayetteville
Briarwood Park
McDonough
Lake Cindy Estates
212
City
Hampton
Locust Grove
16
Jackson
Monticello

1.2 National Land Cover Dataset

Download location: Data | Multi-Resolution Land Characteristics Consortium



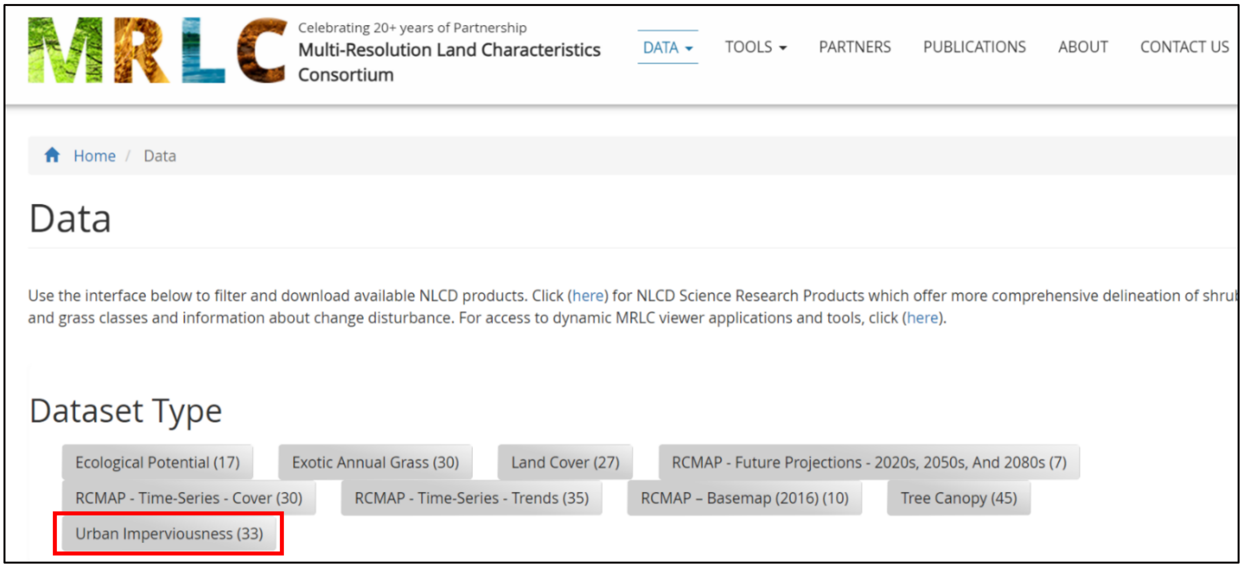
Under “Dataset Type” click “Land Cover.” Under “Time Period” select the most recent year. Scroll down and download “NLCD 20[XX] Land Cover (CONUS)” for just that year.



In this example, the user would then add “NLCD_2021_land_cover” to their Inputs geodatabase.

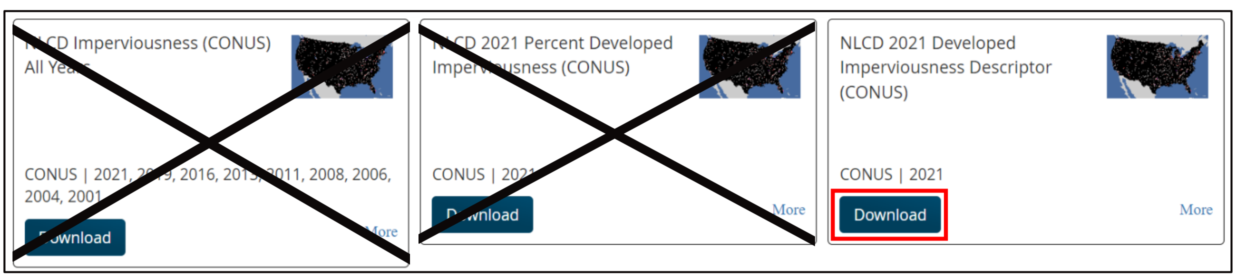
1.3 National Impervious Dataset

Download location: Data | Multi-Resolution Land Characteristics Consortium



Under "Dataset Type" click "Urban Imperviousness." Under "Time Period" select the most recent year. Scroll down and download "NLCD 20[XX] Developed Imperviousness Descriptor (CONUS)" for just that year.

Note: do NOT download the similarly named "NLCD 20[XX] Percent Developed Imperviousness (CONUS)."



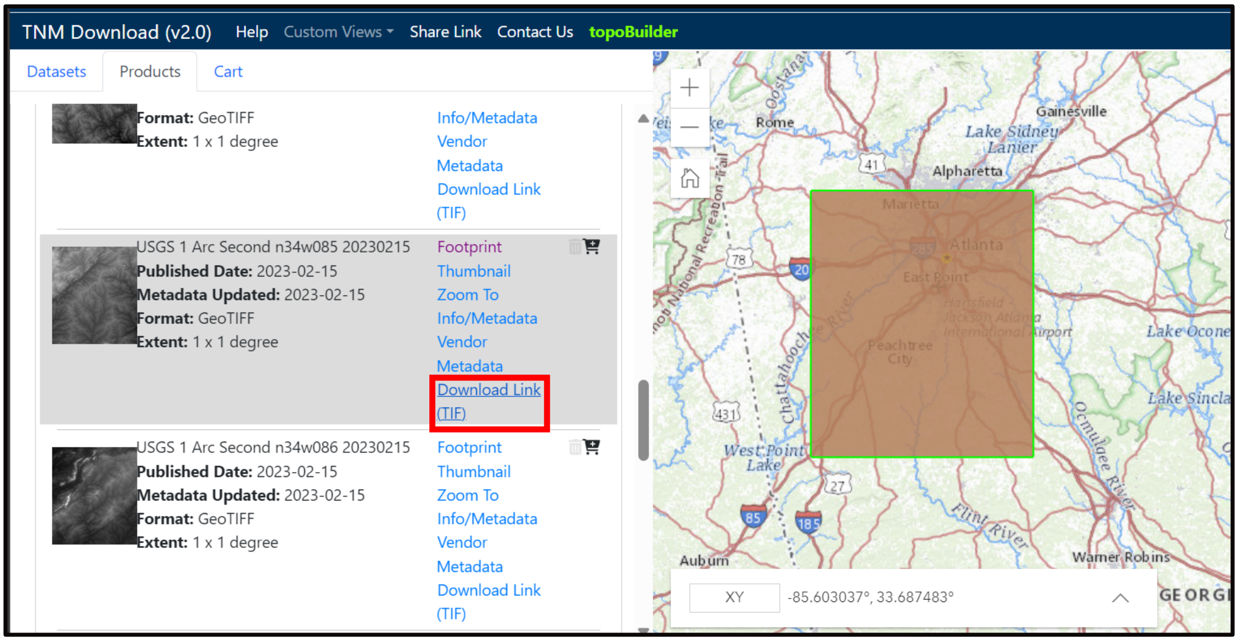
In this example, the user would then add "NLCD_2021_Impervious" to their Inputs geodatabase.

1.4 USGS LiDAR Tiles

Download location: TNM Download v2 (nationalmap.gov)

Select "Elevation Products (3DEP)" and select "1 arc-second DEM" and "current" underneath that. Deselect other options that may be auto selected. Zoom to the area of interest and click "Search Products." In the "Products" tab, add a "Footprint" of relevant LiDAR tiles to ensure that the entire area is covered. Click footprint on however many tiles are needed to cover the study area. When the entire study area is covered, click "Download Link (TIF)" for all the tiles that have been selected.

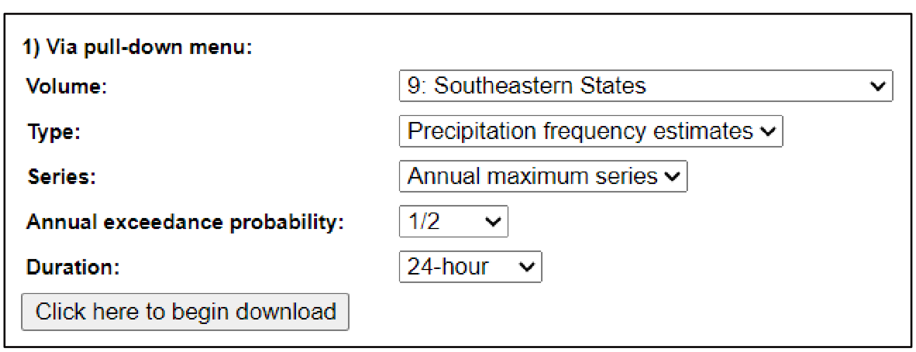
It is preferred that tiles come from the same study. Tiles from the same study will have the same naming conventions. For example, in a file titled “USGS_1_n31w085_2023215,” n31 indicates a latitude of 31°, w085 indicates a longitude of -85°, and 2/15/2023 is the publishing date. Other studies may have different file name formats.



1.5 Regional NOAA 2-yr Rainfall

Download location: National Oceanic and Atmospheric Administration (NOAA) Atlas 14

Via the pull-down menu, select the appropriate region for the planned study area. Set “Type” to “Precipitation frequency estimates,” “Series” to “Annual maximum series,” “Annual exceedance probability” to “1/2,” and “Duration” to “24-hour.” The file will be of the format “[xx]2yr24ha_ams,” where “[xx]” is the chosen region. For example, the file for the Southeast States would be named “se2yr24ha_ams.” Save this file to the Inputs geodatabase.



1.6 National EJ Screen

Download location: Environmental Justice Screening and Mapping Tool (EJScreen) Data | US EPA

Download "Geodatabase of National EJScreen Data at the Block Group Level." There is only one file in the downloaded geodatabase.

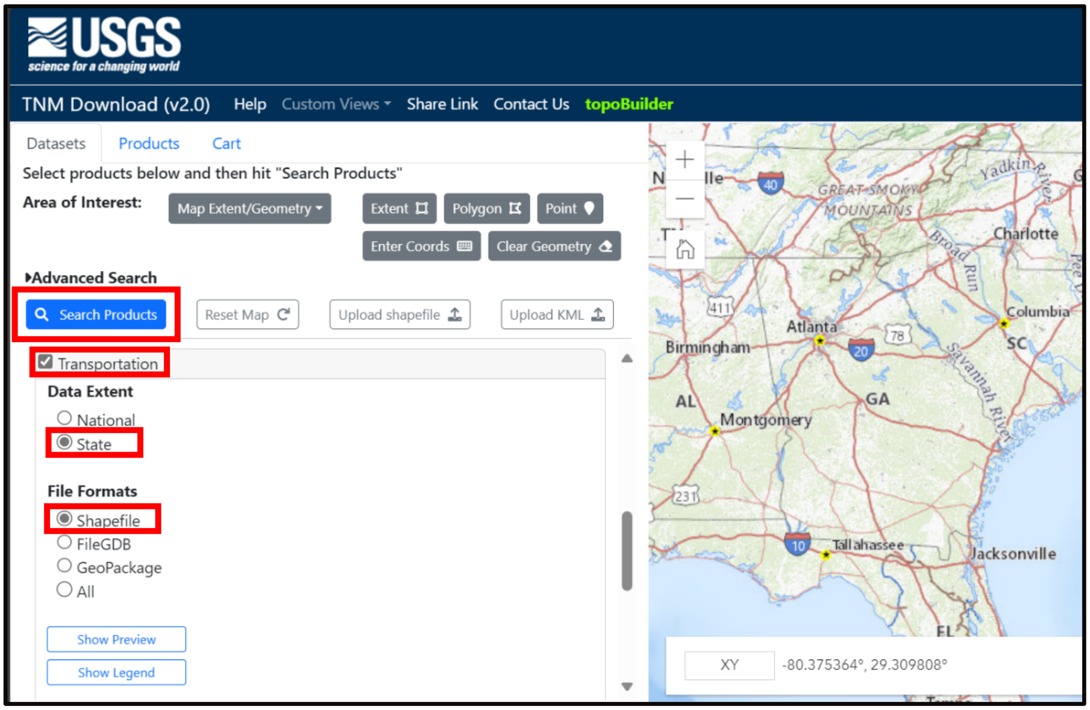
Save this file, "EJSCREEN_StatePCTILES_with_AS_CNMI_GU_VI," to the Inputs geodatabase.

Format (Level of Comparison)	Block Group Level	Tract Level
Data Dictionary Spreadsheet	Download EJScreen Data Dictionary	Download EJScreen Data Dictionary
CSV file (National Level)	Download CSV File of National EJScreen Data at the Block Group Level	Download CSV File of National EJScreen Data at the Tract Level
CSV file (State Level)	Download CSV File of State EJScreen Data at the Block Group Level	Download CSV File of State EJScreen Data at the Tract level
Geodatabase (National Level)	Download Geodatabase of National EJScreen Data at the Block Group Level	Download Geodatabase of National EJScreen Data at the Tract Level
Geodatabase (State Level)	Download Geodatabase of State EJScreen Data at the Block Group Level	Download Geodatabase of State EJScreen Data at the Tract Level
Feature Service (National Level)	View Feature Service of National EJScreen Data at the Block Group Level	View Feature Service of National EJScreen Data at the Tract Level
Feature Service (State Level)	View Feature Service of State EJScreen Data at the Block Group Level	View Feature Service of State EJScreen Data at the Tract Level

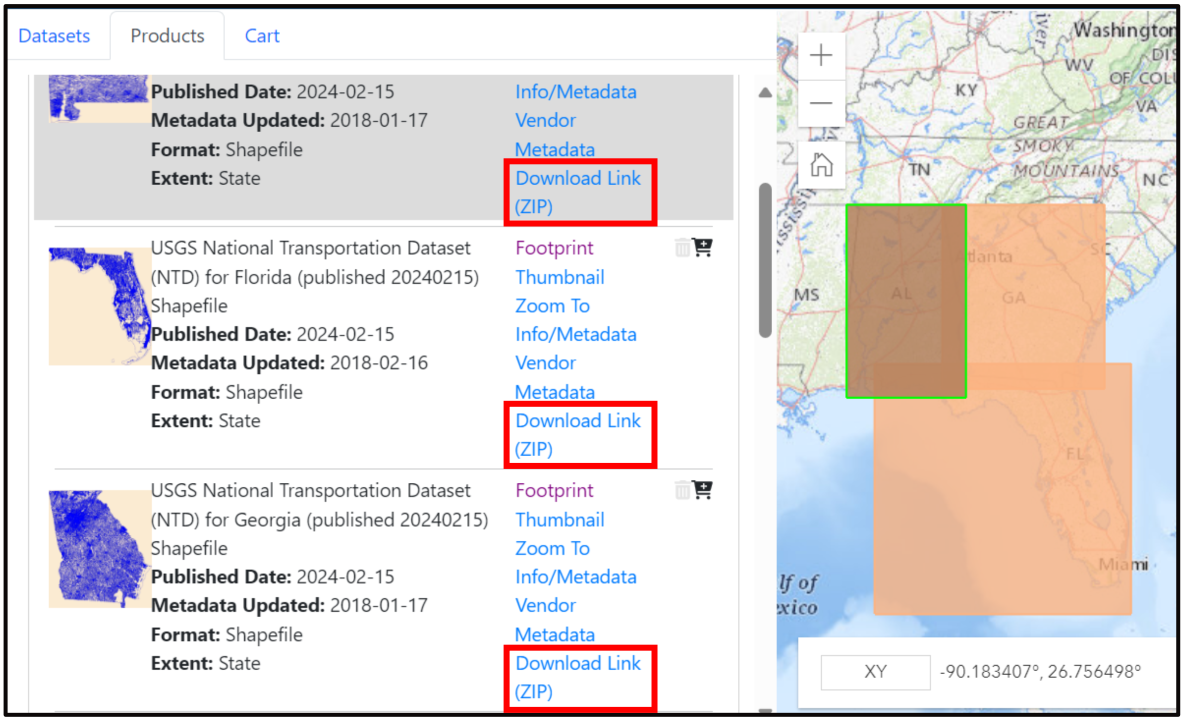
1.7 State Roadway

Download location: TNM Download v2 (nationalmap.gov)

Select “Transportation” with a data extent of “State” and a file format of “Shapefile.” Zoom into the area of interest and click “Search Products.”



In the “Products” tab, add a “Footprint” of relevant roadway extents. When the entire area is covered, click “Download Link (ZIP)” for all the extents that have been selected.



The downloaded .zip file contains a folder named "Shape." Within the "Shape" folder, select any files named "Trans_RoadSegment_X.shp" and import them into the Inputs geodatabase. There are often multiple road segment shapefiles per state. Ensure that all files are added to the Inputs geodatabase.

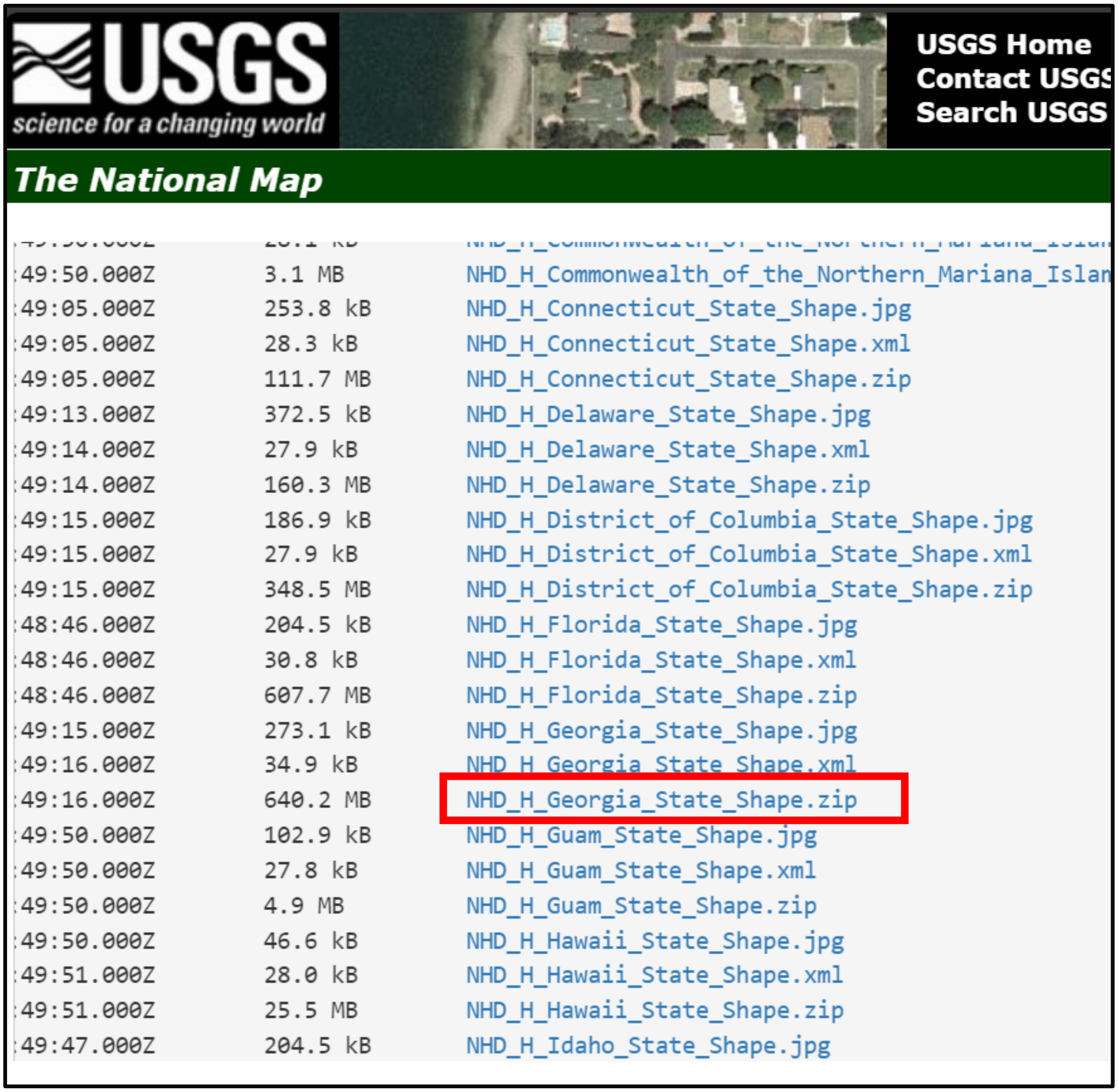
If the study area covers multiple states, rename the roadway feature classes for their corresponding state (e.g., "GA_Roads") in the Inputs geodatabase before importing more state roadway files.

1.8 National Hydrography Dataset Flowlines

Download location: The National Map (prd-tnm.s3.amazonaws.com)

Click on the .zip file for the state(s) of interest. Once downloaded, navigate to the "Shape" folder within the .zip file and identify the "NHDFlowline_X" file(s). Import all "NHDFlowline_X" files into the Inputs geodatabase. Sometimes, there are multiple flowline shapefiles per state. Ensure that all files are added to the Inputs geodatabase.

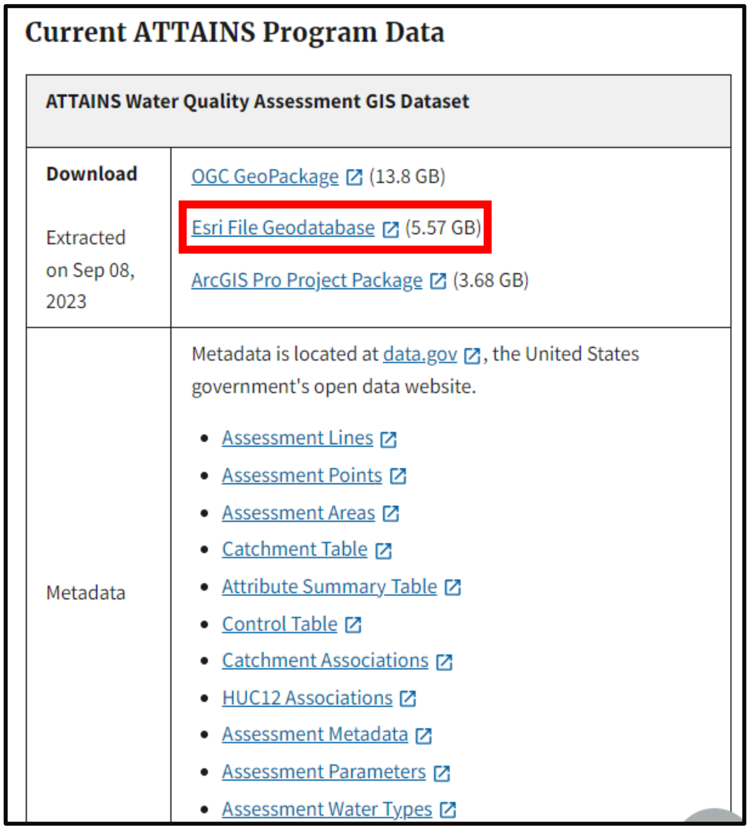
If the analysis uses multiple states' data, the user will need to rename the flowline feature class in the Inputs geodatabase to include the state name (e.g., "GA_NHDFlowline") before importing more state flowline files.



1.9 National Impaired Streams

Download location: Watershed Assessment, Tracking & Environmental Results System Geospatial Data Downloads | US EPA

Download the "Esri File Geodatabase." In the ArcGIS catalog pane, save the file "attains_au_lines" to the Inputs geodatabase as "Impaired_ATTAINS."



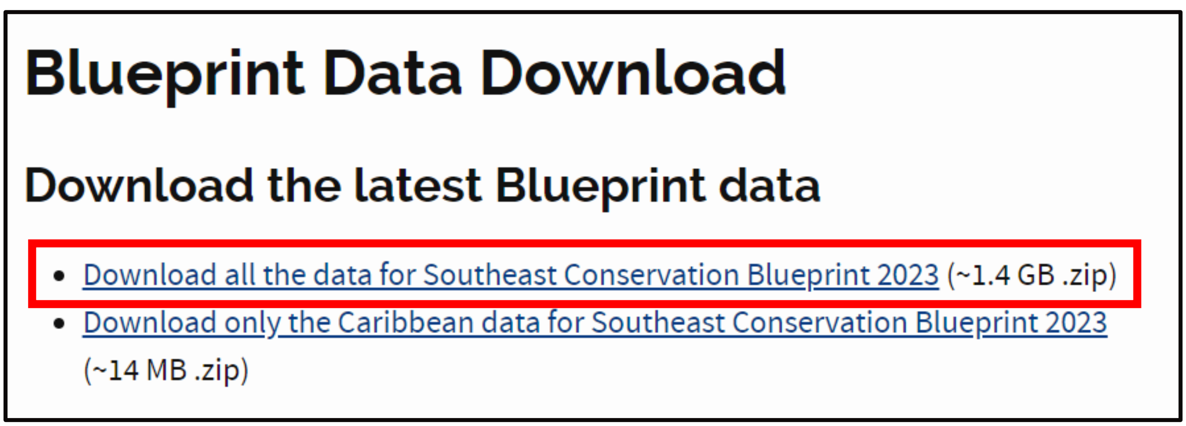
Current ATTAINS Program Data

ATTAINS Water Quality Assessment GIS Dataset	
Download Extracted on Sep 08, 2023	OGC GeoPackage (13.8 GB) Esri File Geodatabase (5.57 GB) ArcGIS Pro Project Package (3.68 GB)
Metadata	Metadata is located at data.gov, the United States government's open data website. • Assessment Lines • Assessment Points • Assessment Areas • Catchment Table • Attribute Summary Table • Control Table • Catchment Associations • HUC12 Associations • Assessment Metadata • Assessment Parameters • Assessment Water Types

1.10 SECAS Blueprint

Download location: Blueprint Data Download (secassoutheast.org)

Download all the data for Southeast Conservation Blueprint [Year].

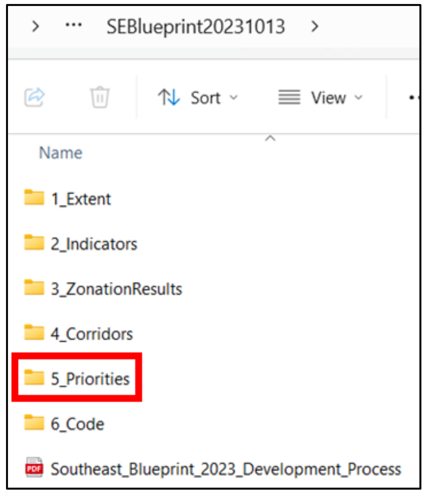


Blueprint Data Download

Download the latest Blueprint data

- Download all the data for Southeast Conservation Blueprint 2023 (~1.4 GB .zip)
- Download only the Caribbean data for Southeast Conservation Blueprint 2023 (~14 MB .zip)

From the File Explorer, the data might look like this:



In the geoprocessing pane of GIS, open the “Raster to Geodatabase” tool. Click on the yellow folder next the “Raster Inputs” box and navigate to the “5_Priorities” folder within the SE Blueprint download folder. Select the “SEBlueprint[Year]” raster. Select the Inputs geodatabase as the output geodatabase for the tool. Run the tool and ensure that the raster inside of the “5_Priorities” folder was imported to the Inputs geodatabase.

1.11 Completed Inputs Geodatabase Example

A completed Inputs geodatabase for the HUC12 toolset should look something like this:


Inputs.gdb
AL_NHDFlowline_1
AL_Rd_1
AL_Rd_2
EJScreen_Full
FL_NHDFlowline
FL_Rd_1
FL_Rd_2
FL_Rd_3
GA_NHDFlowline
GA_Rd_1
GA_Rd_2
HUC12_project
Impaired_ATTAINS
nlcd_2021_impervious_l48_20230630
nlcd_2021_land_cover_l48_20230630
se100yr24ha_ams
SEBlueprint2023
USGS_1_n31w085_20230215
USGS_1_n31w086_20230306
USGS_1_n32w085_20230215
USGS_1_n32w086_20230306
USGS_1_n33w085_20230215
USGS_1_n33w086_20230215
USGS_1_n34w085_20230215

2 Data Quality Control and Parameterization

The models contained within the HUC12 and NHD Flowline Prioritization toolsets are hardcoded to certain field names. This means that if naming conventions for data sources change over time, the models and data may become incompatible. This issue can be avoided by ensuring that relevant data is stored in field names with field values and data types that match those in the model. Table A-2 shows each data source and the field names that are referenced in the models, as well as the field aliases. In ArcGIS, field names are the internal references used by the software, while field aliases are the usually more user-friendly names that are seen in attribute table headers. The table also provides the data type required for each referenced parameter in parentheses. Data types define how field values appear in the attribute table and whether they can be processed by certain tools.

Table A-2: Input Data Parameterization

Dataset	Referenced Parameters	Parameter Meaning
National Landcover Dataset	Field Name: "Value" (Long) Field Alias: "Value"	"Value" assigns a land cover type to each raster cell. "Value" must have values ranging from 0-255. Field Alias does not need to match exactly.
National Impaired Streams	Field Name: "ircategory" (Text) Field Alias: "IR Category"	"ircategory" classifies a streamline as supporting or not supporting its designated uses. "ircategory" must contain the values "4A," "4B," "4C," "5," or "5A" because the tool selects streams that are not supporting their designated uses based on these values. This parameter is hardcoded into the model. User must update naming in the input file before running the model. Field Alias does not need to match exactly.
USGS LiDAR Tiles	Data projection: "GCS_North_American_1983"	At the time of publication 1-arc second LiDAR tiles were published in GCS NAD83 projection. This parameter is hardcoded in the model. If the data is not in the GCS NAD83 projection, reproject or change the projection in the LiDAR and Slope tool.

Dataset	Referenced Parameters	Parameter Meaning
National Hydrography Dataset HUC12 Watersheds	Field Name: “name” (Text) Field Alias: “name” Field Name: “areaacres” (Double) Field Alias: “areaacres”	“Name” defines the name of each HUC12 watershed. “AreaAcres” provides the area of the HUC12 watershed in acres. These parameters are hardcoded into the model. User must update naming in the input file before running model. Field Alias does not need to match exactly.
National EJScreen	Field Name: “PEOPCOLORPCT” (Double) Field Alias: “PEOPCOLORPCT” Field Name: “LOWINCPCT” (Double) Field Alias: “LOWINCPCT” Field Name: “ACSTOTPOP” (Long) Field Alias: “ACSTOTPOP” Field Name: “Shape_Area” (Double) Field Alias “Shape_Area”	“PEOPCOLORPCT” provides the percentage of the population that is minority. “LOWINCPCT” provides the percentage of the population that is low income. These parameters are input to the model by the user so if the naming convention changes, the user will just need to identify the new field names with the same meaning and input those to the model. Field Alias does not need to match exactly. “ACSTOTPOP” provides the total population in the EJScreen block. “Shape_Area” provides the area of the EJScreen block. These parameters are hardcoded into the model. The user needs to update naming in the input file before running the model. Field Alias does not need to match exactly.

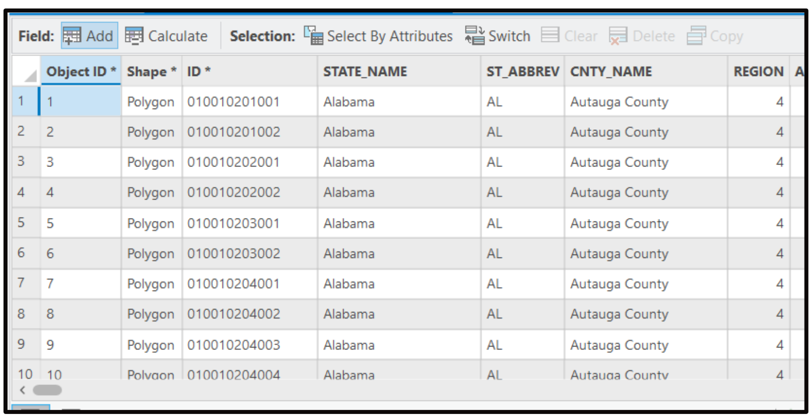
Dataset	Referenced Parameters	Parameter Meaning
SECAS Blueprint	Field Name: “Value” (Long) Field Alias: “Value”	“Value” classifies the priority of habitat conservation. “Value” must have values ranging from 0 to 4. 0: No priority 1: Priority connections 2: Medium priority 3: High priority 4: Highest priority If this scoring changes, the tool is no longer valid. Field Alias does not need to match exactly.

To confirm that the downloaded data fits within the parameters outlined above, open the attribute table for each dataset by dragging the data into the contents pane on the left side of the ArcGIS window. Right click on the data and select “Open Attribute Table.” Fields aliases will appear as the headers of each column in the attribute table. Navigate to the field names by right clicking on any field alias in the attribute table. Select “Fields.” In the pop-up window, identify the field names listed in Table A-2 and confirm that the column in the attribute table contains the required values or range of values.

2.1 Updating Field Names

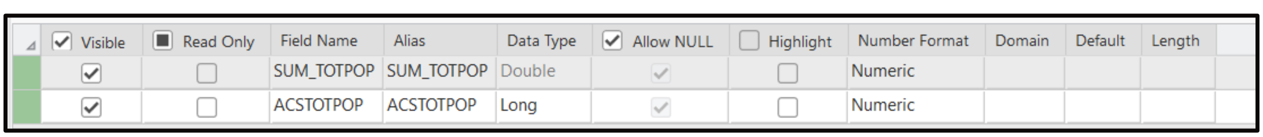
If the attribute table does not have the necessary field name, look for a field name in the attribute table that has the meaning described in the “Parameter Meaning” column of Table A-2. For example, if the EJScreen data is missing the “ACSTOTPOP” field, but it has a “SUM_TOTPOP” field, it is possible that the “ACSTOTPOP” field was renamed to “SUM_TOTPOP” in a more recent data release. To ensure that new fields record the same data as the field originally used in this model, review the data documentation included on data source websites.

When it is confirmed that the new field (“SUM_TOTPOP”) represents the same data, add a field by selecting “Add” in the top left-hand corner of the attribute table (see figure below).



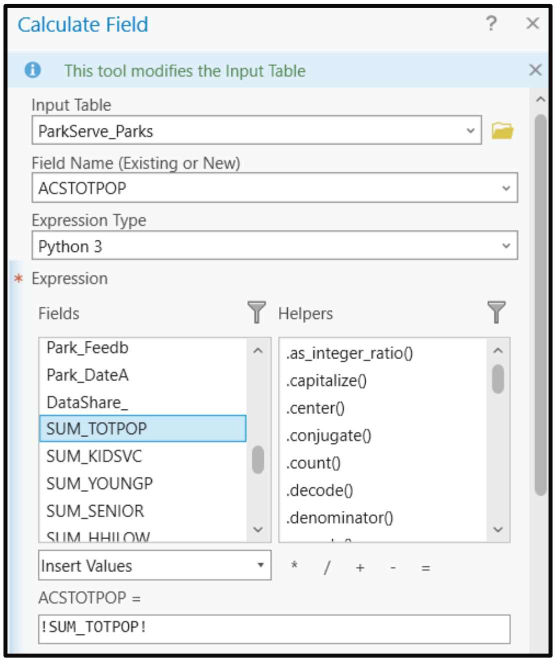
	Object ID *	Shape *	ID *	STATE_NAME	ST_ABBREV	CNTY_NAME	REGION
1	1	Polygon	010010201001	Alabama	AL	Autauga County	4
2	2	Polygon	010010201002	Alabama	AL	Autauga County	4
3	3	Polygon	010010202001	Alabama	AL	Autauga County	4
4	4	Polygon	010010202002	Alabama	AL	Autauga County	4
5	5	Polygon	010010203001	Alabama	AL	Autauga County	4
6	6	Polygon	010010203002	Alabama	AL	Autauga County	4
7	7	Polygon	010010204001	Alabama	AL	Autauga County	4
8	8	Polygon	010010204002	Alabama	AL	Autauga County	4
9	9	Polygon	010010204003	Alabama	AL	Autauga County	4
10	10	Polygon	010010204004	Alabama	AL	Autauga County	4

Name the added field to match the field in the “Referenced Parameters” column of Table A-2. In this example, the field should be named “ACSTOTPOP.” Ensure that the field parameters of the “ACSTOTPOP” field match the parameters described in Table A-2 as shown in the figure below.



Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Domain	Default	Length
✓	☐	SUM_TOTPOP	SUM_TOTPOP	Double	✓	☐	Numeric			
✓	☐	ACSTOTPOP	ACSTOTPOP	Long	✓	☐	Numeric			

Save the changes by clicking “Save” in the top of the window. Close the “Fields” window and return to the attribute table for the dataset that is being edited. Scroll through the columns of the attribute table until the “ACSTOTPOP” field is visible. Right click on the heading of this field and select “Calculate Field.” As shown in the figure below, set the “ACSTOTPOP” field equal to the “SUM_TOTPOP” field and click “Apply.”

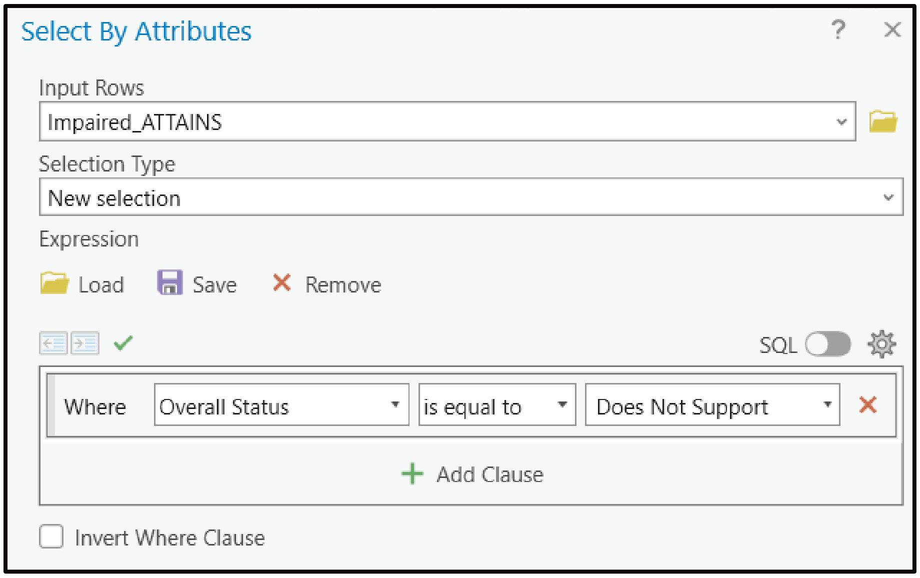


Confirm that the row values in the “ACSTOTPOP” field match the values in the “SUM_TOTPOP” field. The data is ready for input into the Model.

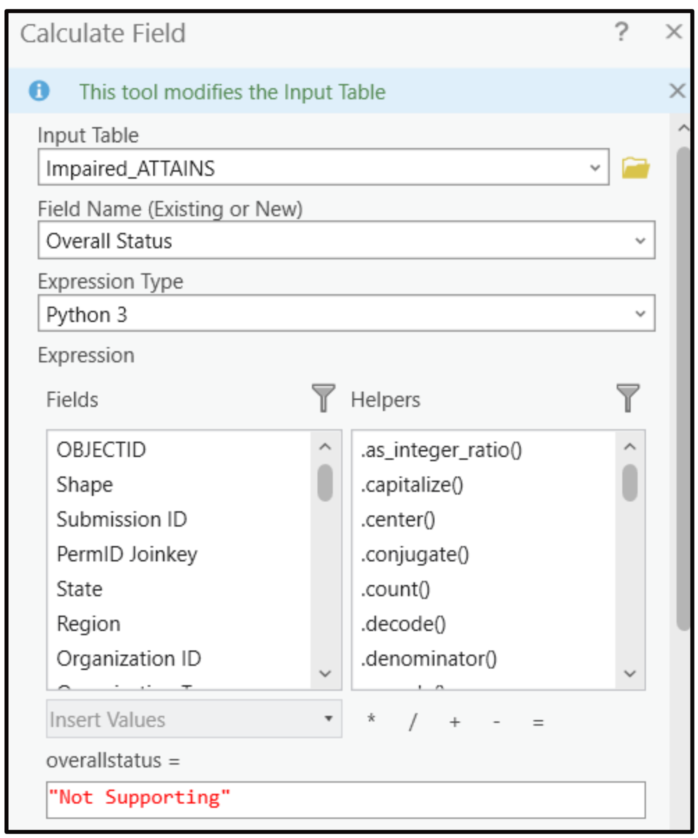
2.2 Updating Field Values

Alternatively, if the attribute table has the proper field name, but the values in the column do not match the values described in Table A-2, these values will need to be updated. First, identify the renamed value that corresponds to the description of the data used in the original model. For example, the value in the impaired streams data for the “overallstatus” field may have changed from “Not Supporting” to “Does Not Support.” Consult online documentation to confirm that the renamed values match the description of data used in the original model.

To update the values in the “overallstatus” field so that the model will run, select “Select by Attributes” at the top of the attribute table window. Create a clause that selects rows with “overallstatus” equal to “Does Not Support” and click apply (see figure below). This selects all rows with the attribute “Does Not Support.”



Click “Apply” and close the “Select by Attributes” window to confirm that the rows with “Does Not Support” values in the “overallstatus” field are selected. These rows will appear in light blue. Right click on the field “overallstatus.” Select “Calculate Field.” As shown in the figure below, set the “overallstatus” field equal to “Not Supporting.” Click “Apply” and the values “Does Not Support” in the attribute table will be updated to “Not Supporting.” The data is ready for input into the Model.



3 Running the HUC12 Watershed Prioritization Toolset

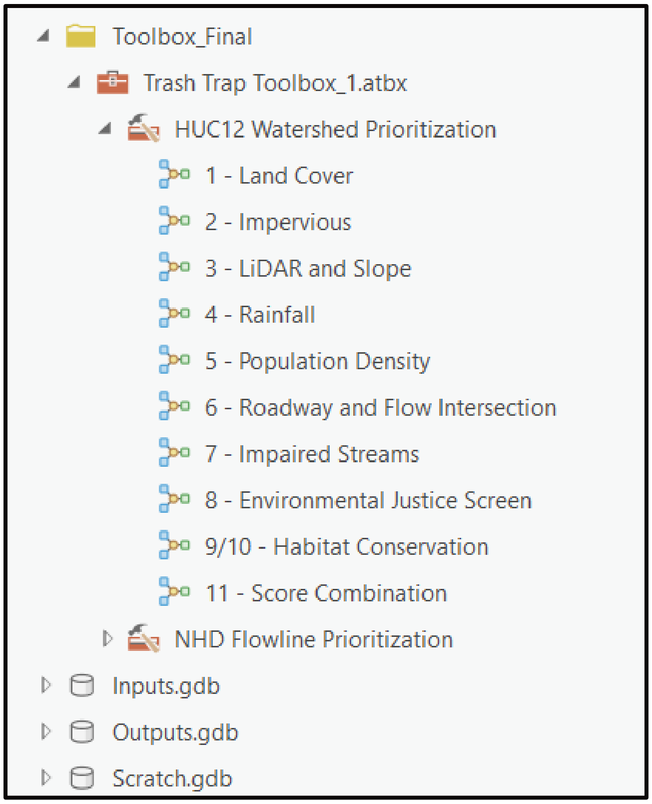
Section 1 of this appendix described what data should be pulled into the Inputs geodatabase. Once complete, and the data has been parameterized according to Section 2, the data can be used to run different geospatial analyses contained within the HUC12 Watershed Prioritization toolset. This section describes how to use the data collected in Section 1 to run these models. For each of the below analyses, the output will be a new column in the attribute table of the project specific HUC12 watershed feature class that was created in Section 1.1.1. Therefore, the results of each model, as well as the final output score will be stored in the Inputs geodatabase. To visualize and interpret HUC12 toolset results, the user must open the HUC12 project feature class from the Inputs geodatabase. Intermediate outputs that can be used for data quality control are stored in the Scratch geodatabase. Tables containing the same data that is appended as columns, or fields, to the project specific HUC12 watershed feature class are stored in the Outputs geodatabase.

3.1 Land Cover Processing

Land cover is considered a trash quantity indicator because it indicates areas that would produce litter, such as developed areas, and correlates to quantity of runoff.

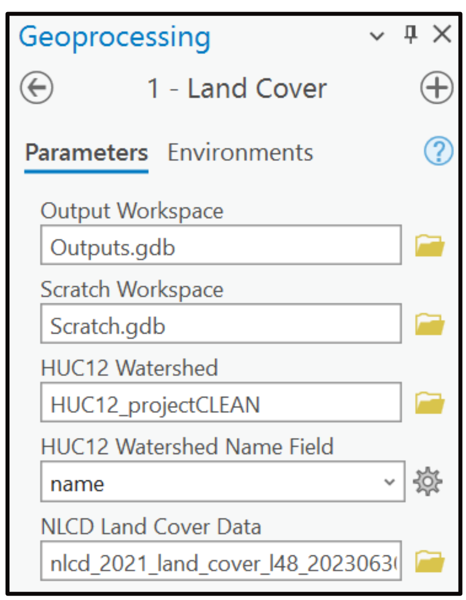
This section will use the National Land Cover Dataset that was previously downloaded in Section 1 above. This raster dataset is updated every 2-3 years.

To run this model, click on the "toolbox" folder within the model folder in the ArcGIS catalog pane. Open the “HUC12 Watershed Prioritization” toolset within that folder. The model folder should look like the figure below. The overall model folder throughout this step-by-step guide is called "Toolbox_Final,” and the inputs folder is called “Inputs.gdb.” The names do not matter and may be different depending on the user’s naming preferences. The Model will run regardless of model folder naming conventions.

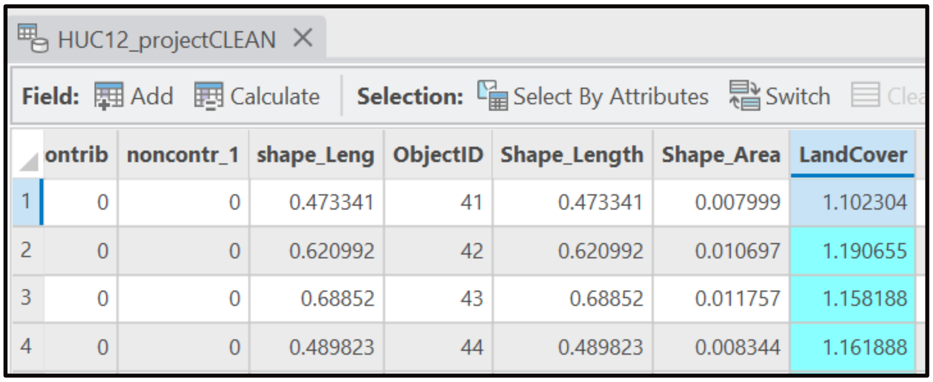


Once in the model folder within the catalog pane, double click on "1 - Land Cover". This will open a geoprocessing pane. If the geoprocessing pane opens in the same pane as the catalog pane and covers the model folder, click and drag the geoprocessing pane out of the catalog pane. Situate the geoprocessing pane somewhere else within the ArcGIS window.

Input information to match the figure below by dragging data from the catalog pane into the correct location within the geoprocessing pane. Note that the “NLCD Land Cover Data” and “HUC12 Watershed” information can be accessed in the Inputs geodatabase.



Press "Run" on the bottom right of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that intermediate data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 project feature class. From here, press “Open Table.” There should be a new column labeled "LandCover" as seen below.

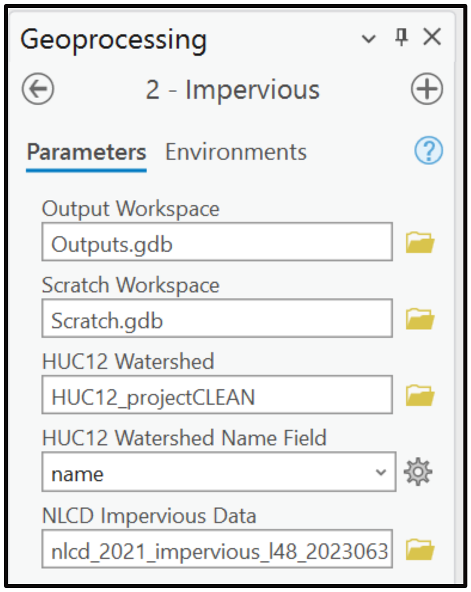


	ontrib	noncontr_1	shape_Leng	ObjectID	Shape_Length	Shape_Area	LandCover
1	0	0	0.473341	41	0.473341	0.007999	1.102304
2	0	0	0.620992	42	0.620992	0.010697	1.190655
3	0	0	0.68852	43	0.68852	0.011757	1.158188
4	0	0	0.489823	44	0.489823	0.008344	1.161888

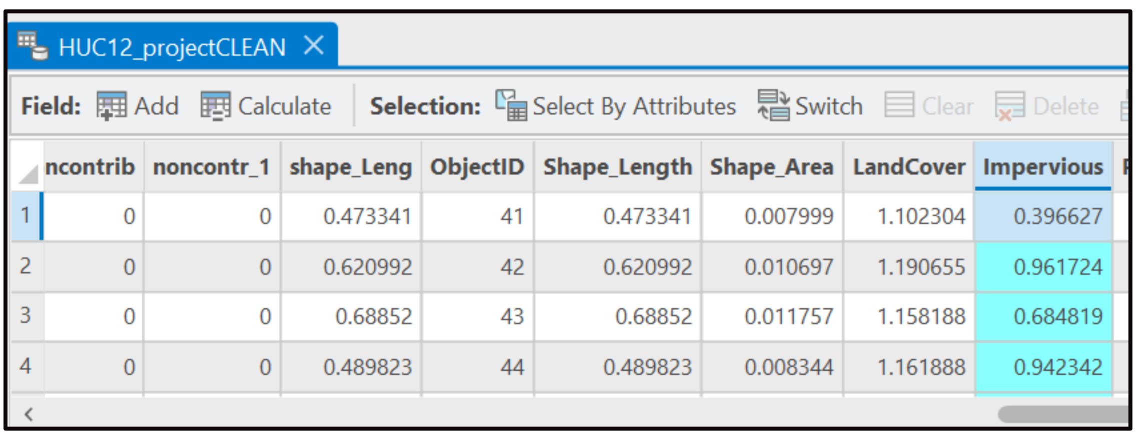
3.2 Impervious Processing

Impervious cover is relevant to determining the quantity of trash entering streams within a watershed because it indicates how much runoff will occur within the watershed. More runoff equates to more litter reaching streams.

This model can be run by opening the HUC12 toolset. Click on "2 - Impervious" to launch the impervious cover processing model. This will open a geoprocessing pane. Drag the data from the Inputs geodatabase into the geoprocessing pane to match the figure below. The “HUC12 Watershed” and “NLCD Impervious Data” are stored in the Inputs geodatabase and the Output Workspace and Scratch Workspace are the two other geodatabases in the model folder.



Press "Run" on the bottom right of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that intermediate data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 project feature class. From here, press “Open Table.” There should be a new column labeled "Impervious" as shown below.

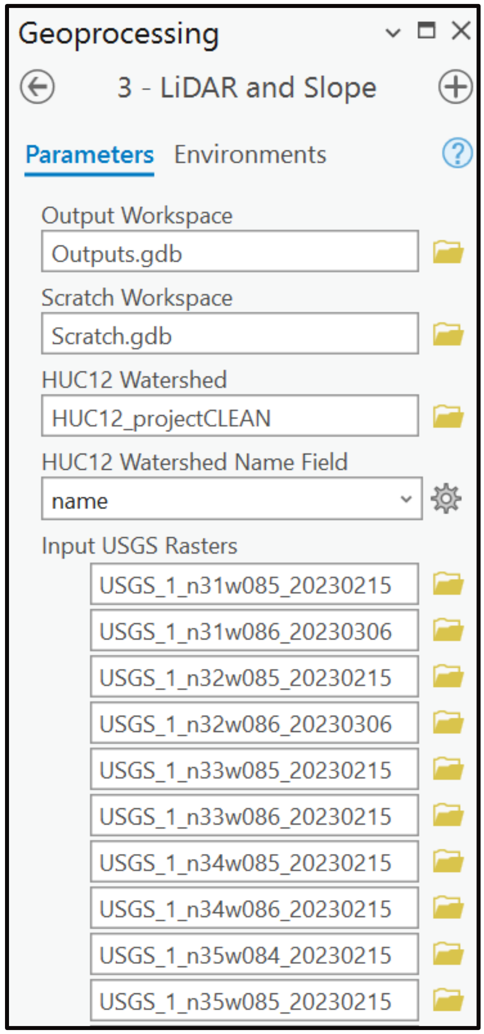


	ncontrib	noncontr_1	shape_Leng	ObjectID	Shape_Length	Shape_Area	LandCover	Impervious
1	0	0	0.473341	41	0.473341	0.007999	1.102304	0.396627
2	0	0	0.620992	42	0.620992	0.010697	1.190655	0.961724
3	0	0	0.68852	43	0.68852	0.011757	1.158188	0.684819
4	0	0	0.489823	44	0.489823	0.008344	1.161888	0.942342

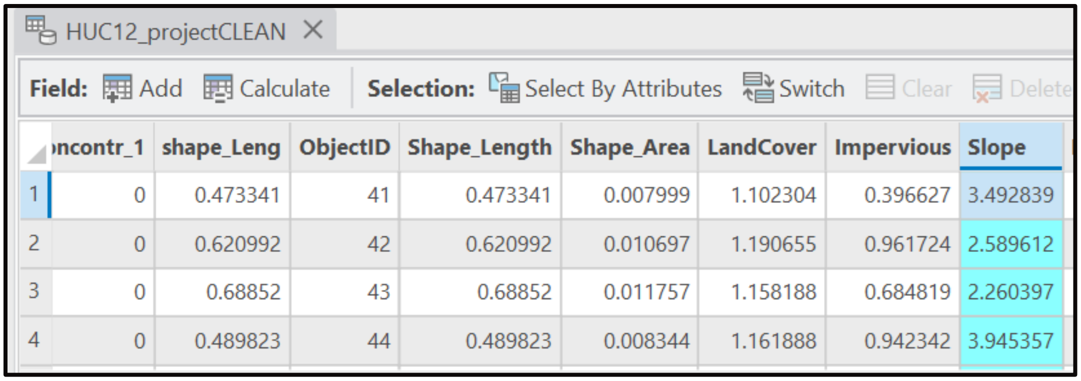
3.3 LiDAR and Slope Processing

Slope correlates to trash quantity because litter in watersheds with steeper slopes will flow downhill to streams, rather than settle in flat areas. Therefore, watersheds with a higher average slope will more easily transport litter to low elevations within the watershed.

This model can be run by opening the HUC12 toolset. Click on "3 - Slope" to launch the LiDAR and Slope model. This will open a geoprocessing pane. Input information to match the figure below. Note that the “Input USGS Rasters” may not have the same names as those below. The “HUC12 Watershed” and “Input USGS Rasters” will be stored in the Inputs geodatabase.



Press "Run" on the bottom right of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that intermediate data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 project feature class. From here, press “Open Table.” There should be a new column labeled "Slope" as seen below.



HUC12_projectCLEAN

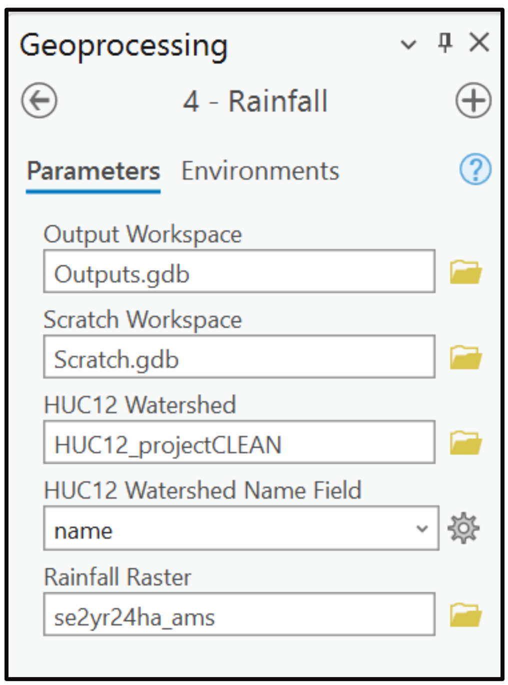
Field: Add Calculate Selection: Select By Attributes Switch Clear Delete

	ncontr_1	shape_Leng	ObjectID	Shape_Length	Shape_Area	LandCover	Impervious	Slope
1	0	0.473341	41	0.473341	0.007999	1.102304	0.396627	3.492839
2	0	0.620992	42	0.620992	0.010697	1.190655	0.961724	2.589612
3	0	0.68852	43	0.68852	0.011757	1.158188	0.684819	2.260397
4	0	0.489823	44	0.489823	0.008344	1.161888	0.942342	3.945357

3.4 Rainfall Processing

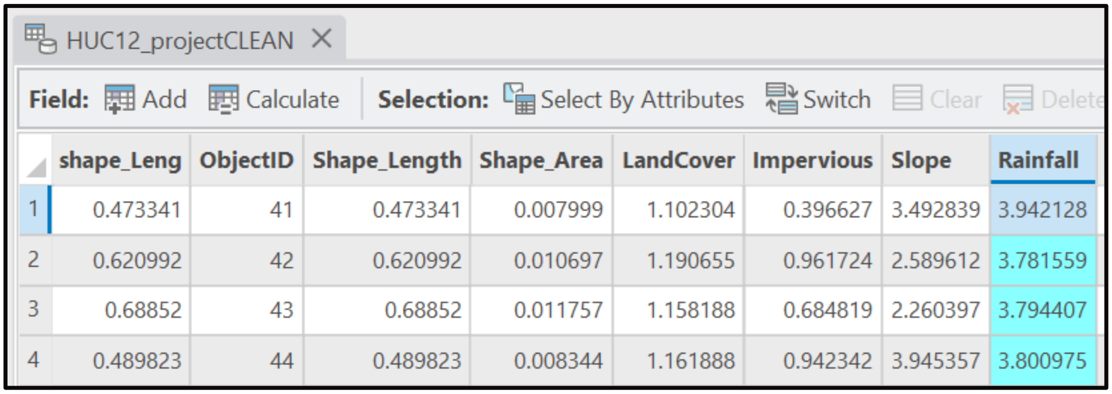
The intensity of rainfall indicates trash quantity because more intense rainfall correlates to higher runoff and more litter transport.

This model can be run by opening the HUC12 toolset. Click on "4 - Rainfall" to launch the rainfall model. This will open a geoprocessing pane. Input information to match the figure below. Note that the “Rainfall Raster” data may not have the same name as below. The “HUC12 Watershed” and “Rainfall Raster” files are stored in the Inputs geodatabase.



Press "Run" on the bottom right. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that intermediate data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening Inputs geodatabase and right clicking on the

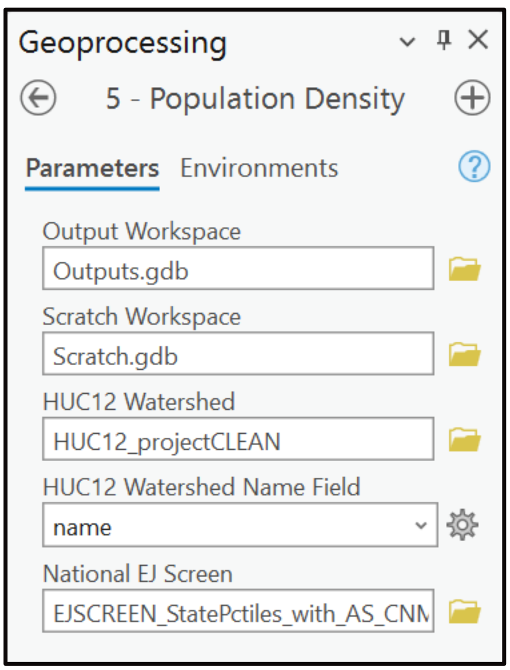
HUC12 project feature class. From here, press “Open Table.” There should be a new column labeled "Rainfall" as seen below.



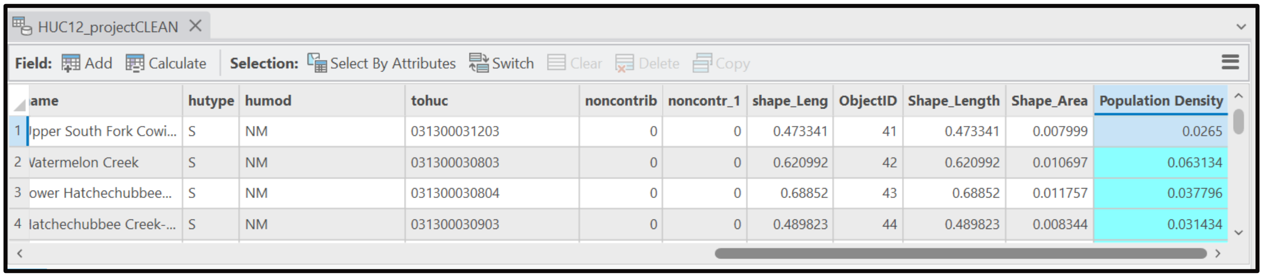
	shape_Leng	ObjectID	Shape_Length	Shape_Area	LandCover	Impervious	Slope	Rainfall
1	0.473341	41	0.473341	0.007999	1.102304	0.396627	3.492839	3.942128
2	0.620992	42	0.620992	0.010697	1.190655	0.961724	2.589612	3.781559
3	0.68852	43	0.68852	0.011757	1.158188	0.684819	2.260397	3.794407
4	0.489823	44	0.489823	0.008344	1.161888	0.942342	3.945357	3.800975

3.5 Population Density Processing

Population affects the quantity of trash because a higher population typically correlates to more litter in nearby waterways. This model can be run by opening the HUC12 toolset. Click on "5 – Population Density" to launch the population density processing model in the catalog pane. This will open a geoprocessing pane. Input information to match the figure below. Note that the data files may not have the same name as below. The “HUC12 Watershed” and “National EJ Screen” files are stored in the Inputs geodatabase.



Press "Run" in the bottom right corner of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 project feature class. From here, press “Open Table.” There should be a new column labeled "Population Density" as shown below.

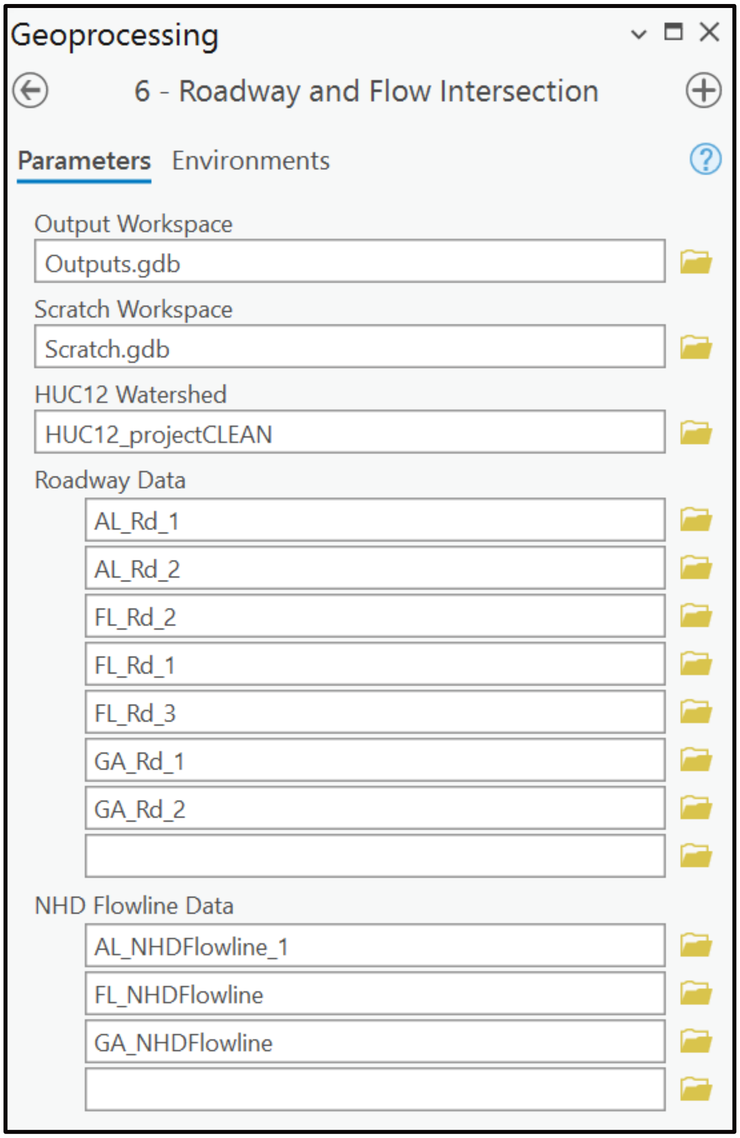


	ame	hutype	humod	tohuc	noncontrib	noncontr_1	shape_Leng	ObjectID	Shape_Length	Shape_Area	Population Density
1	Ipper South Fork Cowi...	S	NM	031300031203	0	0	0.473341	41	0.473341	0.007999	0.0265
2	Vatermelon Creek	S	NM	031300030803	0	0	0.620992	42	0.620992	0.010697	0.063134
3	ower Hatchechubbee...	S	NM	031300030804	0	0	0.68852	43	0.68852	0.011757	0.037796
4	latchechubbee Creek-...	S	NM	031300030903	0	0	0.489823	44	0.489823	0.008344	0.031434

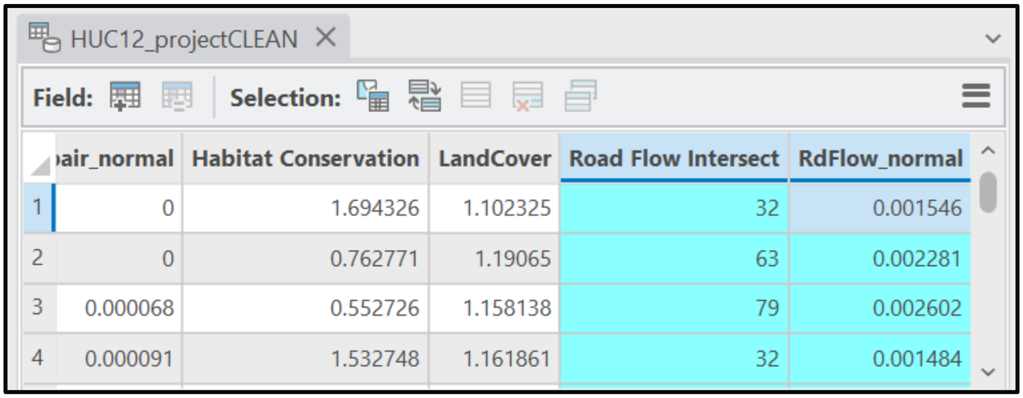
3.6 Roadway and Flow Intersection Processing

Intersections of roadways and flowlines are used as a part of this model because proximity to roads increases the amount of litter that ends up in nearby streams.

This model can be run by opening the HUC12 toolset. Click on "6 – Roadway and Flow Intersections" to launch the roadway/flow processing model. This will open a geoprocessing pane. Input information to match the figure below. The “HUC12 Watershed,” “Roadway Data,” and “NHD Flowline Data” are stored in the Inputs geodatabase.



Press "Run" in the bottom right corner of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 feature class. From here, press “Open Table.” There should be two new columns labeled "Road Flow Intersect" and “RdFlow_normal” as shown below.

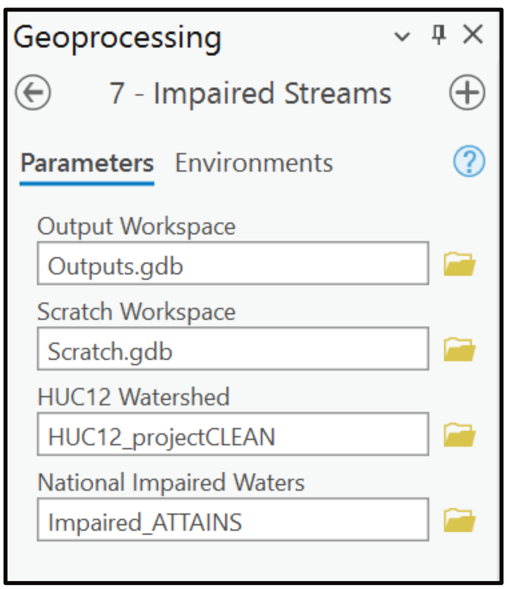


	air_normal	Habitat Conservation	LandCover	Road Flow Intersect	RdFlow_normal
1	0	1.694326	1.102325	32	0.001546
2	0	0.762771	1.19065	63	0.002281
3	0.000068	0.552726	1.158138	79	0.002602
4	0.000091	1.532748	1.161861	32	0.001484

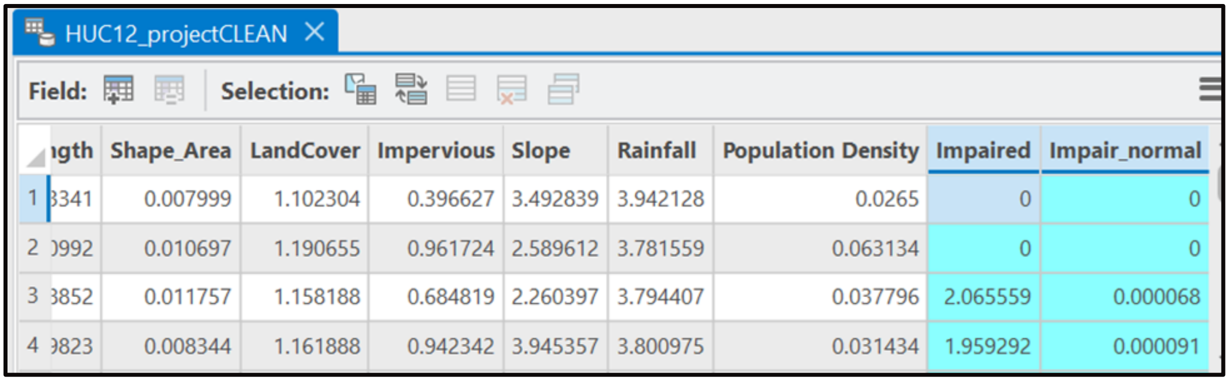
3.7 Impaired Streams Processing

Impaired streams are used as a part of this model to help prioritize areas that have types of pollution different from large trash. Impaired streams are typically located in areas that are underserved.

This model can be run by opening the HUC12 toolset. Click on "7 – Impaired Streams" to launch the impaired streams processing model. This will open a geoprocessing pane. Input information to match the figure below. The “HUC12 Watershed” and “National Impaired Waters” are stored in the Inputs geodatabase.



Press "Run" in the bottom right corner of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 feature class. From here, press “Open Table.” There should be two new columns labeled "Impaired" and “Impair_normal” as shown below.



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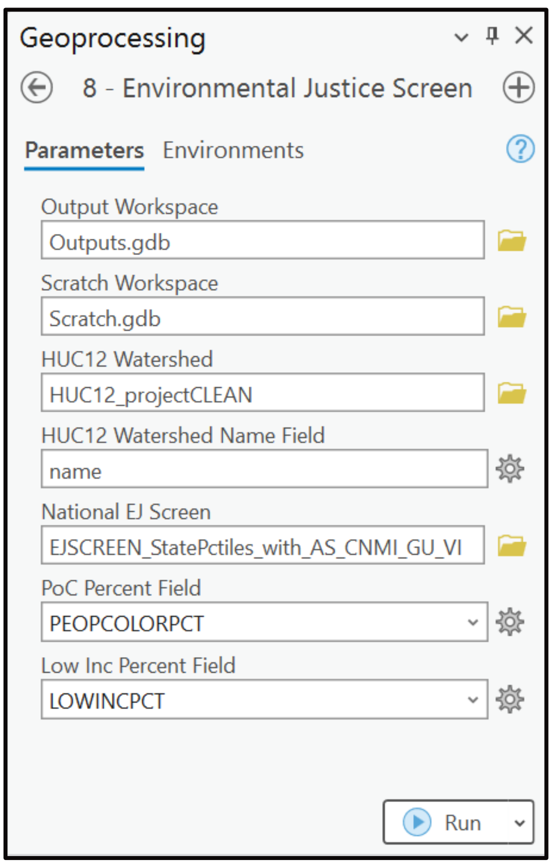
Field: Selection:

	ıgth	Shape_Area	LandCover	Impervious	Slope	Rainfall	Population Density	Impaired	Impair_normal
1	3341	0.007999	1.102304	0.396627	3.492839	3.942128	0.0265	0	0
2	)992	0.010697	1.190655	0.961724	2.589612	3.781559	0.063134	0	0
3	3852	0.011757	1.158188	0.684819	2.260397	3.794407	0.037796	2.065559	0.000068
4	)823	0.008344	1.161888	0.942342	3.945357	3.800975	0.031434	1.959292	0.000091

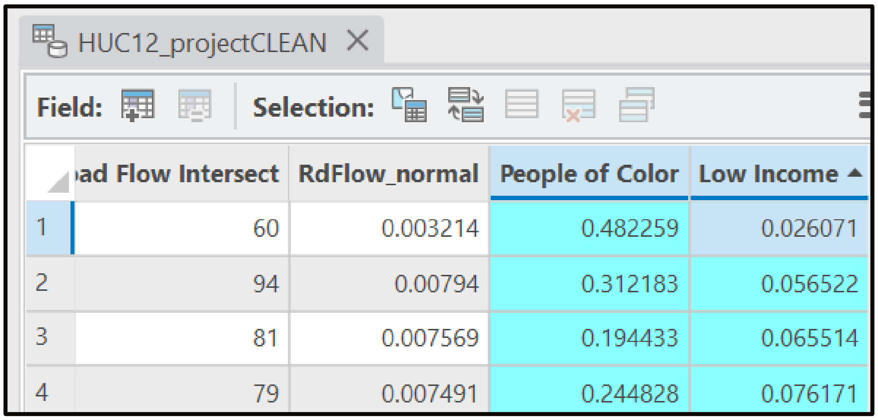
3.8 Environmental Justice Screen Processing

Environmental justice indicators are used as a part of this model to help prioritize environmental restoration in marginalized communities.

This model can be run by opening the HUC12 toolset. Click on "8 – Environmental Justice Screen" to launch the environmental justice processing model. This will open a geoprocessing pane. Input information to match the figure below. The “HUC12 Watershed” and “National EJ Screen” are stored in the Inputs geodatabase.



Press "Run" in the bottom right corner of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 feature class. From here, press “Open Table.” There should be two new columns labeled "People of Color" and “Low Income” as shown below.

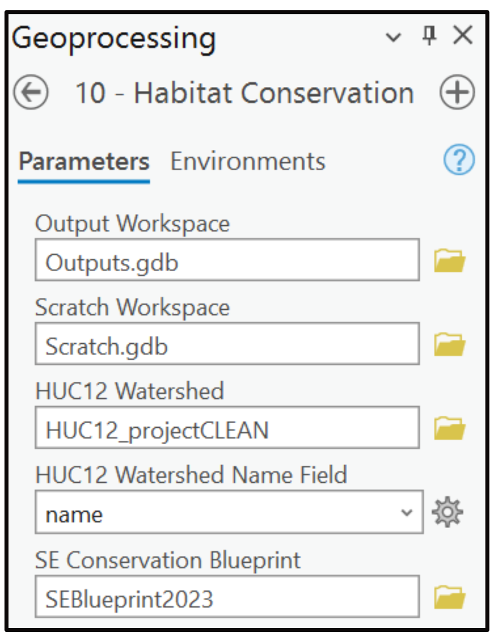


	ɪad Flow Intersect	RdFlow_normal	People of Color	Low Income
1	60	0.003214	0.482259	0.026071
2	94	0.00794	0.312183	0.056522
3	81	0.007569	0.194433	0.065514
4	79	0.007491	0.244828	0.076171

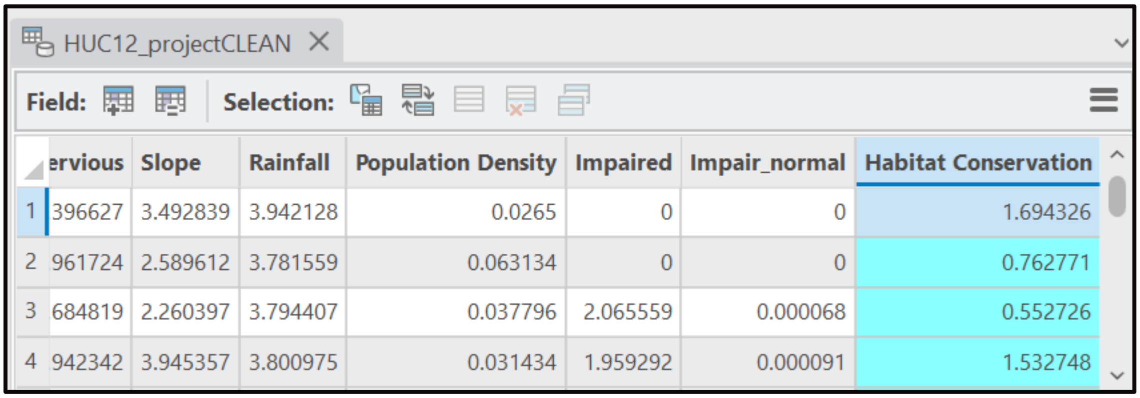
3.9 Habitat Conservation Processing

Habitat Conservation Indicators are used as a part of this model to help prioritize areas that need habitat conservation the most.

This model can be run by opening the HUC12 toolset. Click on "10-Habitat Conservation” to launch the habitat conservation processing model. This will open a geoprocessing pane. Input information to match the figure below. The “HUC12 Watershed” and “SE Conservation Blueprint” are stored in the Inputs geodatabase.



Press "Run" in the bottom right corner of the geoprocessing pane. To confirm that the model has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabases to ensure that data was added to those folders. The user may need to update the folder by right clicking on the overall model folder and pressing "Refresh". The user can also check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 feature class. From here, press “Open Table.” There should be a new column labeled "Habitat Conservation” as shown below.

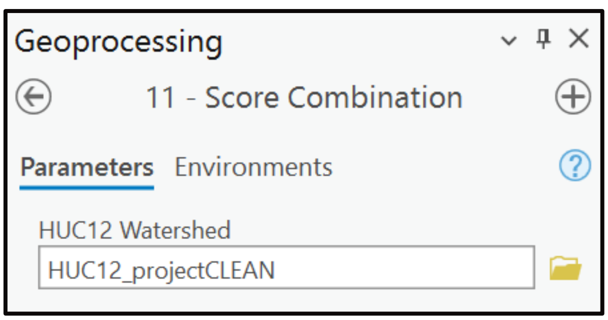


	ervious	Slope	Rainfall	Population Density	Impaired	Impair_normal	Habitat Conservation
1	396627	3.492839	3.942128	0.0265	0	0	1.694326
2	961724	2.589612	3.781559	0.063134	0	0	0.762771
3	684819	2.260397	3.794407	0.037796	2.065559	0.000068	0.552726
4	942342	3.945357	3.800975	0.031434	1.959292	0.000091	1.532748

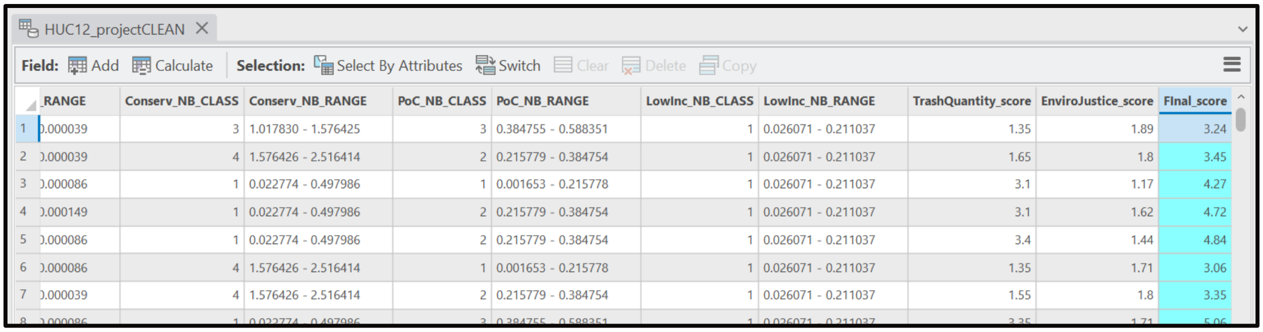
3.10 Score Combination

Once all other models within this toolset have been run successful, the last model can be launched. This model combines the outputs of the different models within the HUC12 Watershed Prioritization toolset.

This model can be run by opening the HUC12 toolset. Click on "11 - Score Combination" to launch the score combination processing model. This will open a geoprocessing pane. Input information to match the figure below. The “HUC12 Watershed” is stored in the Inputs geodatabase.



Press "Run" in the bottom right corner of the geoprocessing pane. To confirm that the model has worked properly, check that data is being added to the HUC12 project feature class by opening the Inputs geodatabase and right clicking on the HUC12 feature class. From here, press “Open Table.” There should be 23 new columns, the last of which being the “Final_score” as seen below.



HUC12_projectCLEAN

Field: Add Calculate Selection: Select By Attributes Switch Clear Delete Copy

	_RANGE	Conserv_NB_CLASS	Conserv_NB_RANGE	PoC_NB_CLASS	PoC_NB_RANGE	LowInc_NB_CLASS	LowInc_NB_RANGE	TrashQuantity_score	EnviroJustice_score	FInal_score
1	).000039	3	1.017830 - 1.576425	3	0.384755 - 0.588351	1	0.026071 - 0.211037	1.35	1.89	3.24
2	).000039	4	1.576426 - 2.516414	2	0.215779 - 0.384754	1	0.026071 - 0.211037	1.65	1.8	3.45
3	).000086	1	0.022774 - 0.497986	1	0.001653 - 0.215778	1	0.026071 - 0.211037	3.1	1.17	4.27
4	).000149	1	0.022774 - 0.497986	2	0.215779 - 0.384754	1	0.026071 - 0.211037	3.1	1.62	4.72
5	).000086	1	0.022774 - 0.497986	2	0.215779 - 0.384754	1	0.026071 - 0.211037	3.4	1.44	4.84
6	).000086	4	1.576426 - 2.516414	1	0.001653 - 0.215778	1	0.026071 - 0.211037	1.35	1.71	3.06
7	).000039	4	1.576426 - 2.516414	2	0.215779 - 0.384754	1	0.026071 - 0.211037	1.55	1.8	3.35
8	).000086	1	0.022774 - 0.497986	3	0.384755 - 0.588351	1	0.026071 - 0.211037	3.35	1.71	5.06

4 Model Weighting Analysis

The models within the HUC12 Watershed Prioritization toolset are associated with indicators that affect the amount of trash going into nearby rivers and streams. These indicators were compared to existing trash trap data to determine which have the highest correlation to the amount of trash that ends up in waterways.

This was done by analyzing data from several years of Chattahoochee River Basin trash trap operations. Each trash trap was matched to the HUC12 watershed within which it was located. In total the analysis assessed 16 existing trash traps in 11 different HUC12 watersheds. The average rate of trash collection in pounds per day was calculated for each trash trap. This data was plotted against the results of the Land Cover, Impervious, LiDAR and Slope, Rainfall, Population Density, and Roadway and Flow Intersection models. A linear regression was performed by plotting the HUC12 watershed indicator score against the average pounds of trash per day at the corresponding trash trap location. For example, the average pounds of trash per day collected at a trash trap located in the Proctor Creek watershed would be plotted against the Land Cover indicator score for the Proctor Creek watershed. The Land Cover indicator scores for other watersheds with existing traps would be plotted on the same graph and a linear relationship would be interpolated.

The coefficients of determination for each indicator were compared to determine the relative importance of each indicator. The Analytical Hierarchy Process (AHP) was used to assign relative scores to each indicator in the matrix. For example, in our analysis, Land Cover was determined to have four times as much importance as Rainfall. Therefore, the relative score assigned to Land Cover at the intersection of its row with the Rainfall column is set to “4.00” and the intersection of Rainfall with the Land Cover column is set to “0.25.” Intersections of rows and columns with the same indicator are always set to “1” because they are of equal importance.

The weight assigned to each indicator score is the sum of the relative scores in each row divided by the sum of all the relative scores in the column. The sum of the weights should add up to one, as shown in Table A-3.

Table A-3: AHP Matrix

	Roadway & Flow	Land Cover	Impervious Cover	Watershed Slope	Rainfall	Population	Weight
Roadway & Flow	1.00	0.50	0.40	0.50	2.00	0.50	0.10
Land Cover	2.00	1.00	0.80	1.00	4.00	1.00	0.20
Impervious Cover	2.50	1.25	1.00	1.25	5.00	1.25	0.25
Watershed Slope	2.00	1.00	0.80	1.00	4.00	1.00	0.20
Rainfall	0.50	0.25	0.20	0.25	1.00	0.25	0.05
Population	2.00	1.00	0.80	1.00	4.00	1.00	0.20
							1.00

If the indicator scores need to be changed to better fit user needs, the AHP process described above should be replicated for the new indicator scores. If users collect additional trash trap data, the linear regression analysis should be updated and the AHP matrix should be updated to reflect linear regression results.

Appendix B

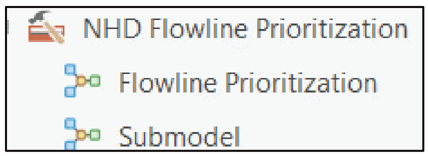
Appendix B: NHD Flowline Prioritization Model Execution

NHD Flowline Prioritization Model Execution

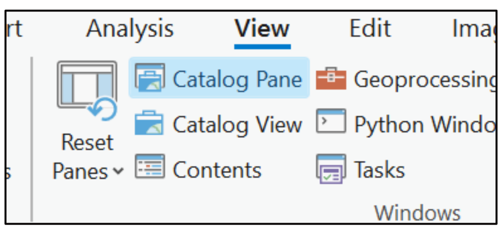
The first step to executing the National Hydrography Dataset (NHD) Flowline Prioritization toolset is collecting input data and downloading the toolbox from [Trash Trap Guide Download - Chattahoochee Riverkeeper](). Once the toolbox and input data have been downloaded, some data parameterization may be required.

The complete model (Model) includes two toolsets: HUC12 Watershed Prioritization and NHD Flowline Prioritization. The two toolsets are entirely independent of each other and can be run in unison or successively. This appendix focuses on the NHD Flowline Prioritization toolset.

The NHD Flowline Prioritization toolset contains one main model (Flowline Prioritization) and one sub model (Submodel), which will automatically run when the Flowline Prioritization model is run. **No user input is required for the Submodel.**



We recommend accessing the NHD Flowline Prioritization toolset, as well as the HUC12 toolset via the catalog pane in ArcGIS. Throughout this appendix, the catalog pane will be referenced. To access the catalog pane, navigate to the “View” toolbar and select “Catalog Pane.”



When the catalog pane opens, right click on “Folders” and select “Add a Folder Connection.” The user must add the folder within which they have stored the Model.

1 Data Collection

The Model references data from a user-generated geodatabase, referred to in this appendix as the Inputs geodatabase. A geodatabase is a collection of geographic datasets of various types held in a common file system folder ([What is a geodatabase?—ArcGIS Pro | Documentation).]() To populate the geodatabase, data will need to be collected from various sources. If the Model is rerun later, some data in the Inputs geodatabase may need to be updated. Information on how to combine the downloaded data into a geodatabase can be found here: [Create a file geodatabase—ArcGIS Pro | Documentation.]() See Table B-1 below for a summary of the data stored in the Inputs geodatabase that is relevant to the execution of the NHD Flowline Prioritization toolset. Please note that the 12-digit hydrologic unit code (HUC12) watershed data *is* the same data used in the HUC12 Prioritization model and only needs to be downloaded once. The National Hydrography Dataset Plus (NHDPlus) flowline data, however, *is not* the same as the flowline data in the HUC12 Prioritization toolset and will need to be downloaded by the user.

Table B-1: Input Geodatabase Files for Flowline Prioritization Toolset

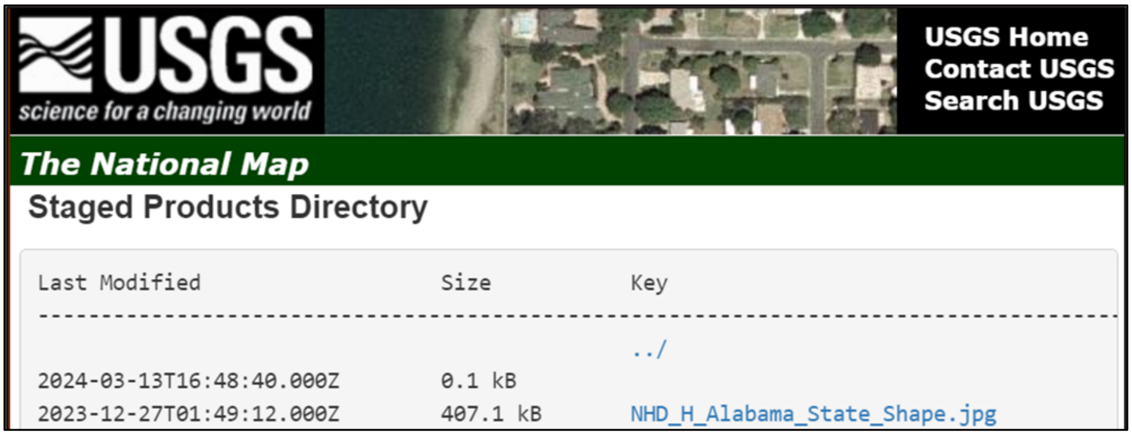
Files	Parameters	Included in Inputs.gdb*	Update Frequency
National Hydrography Dataset HUC12 Watersheds	Single polygon shapefile	☒	The USGS updates hydrography data annually.
NHDPlus Flowlines	Multiple line shapefiles	☒	The USGS updates NHDPlus National Data every few years.
NHDPlus EROMMA Tables	Tables	☒	
National Public Lands	Single polygon shapefile	☑	The Trust for Public Lands updates park data annually.
National Public Schools	Single point shapefile	☑	The National Center for Education Statistics updates school data annually.
National Public Libraries	Single point shapefile	☑	The Institute of Museum and Library Services updates library data annually.

*Note: Data included in the Inputs geodatabase folder may not be the most recent published data and should be updated as needed.

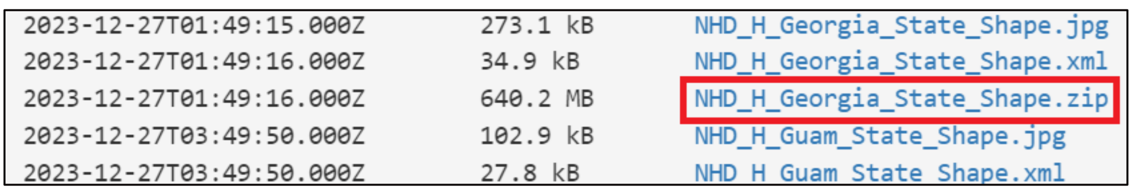
1.1 National Hydrography Dataset HUC12 Watersheds

Download location: The National Map (prd-tnm.s3.amazonaws.com)

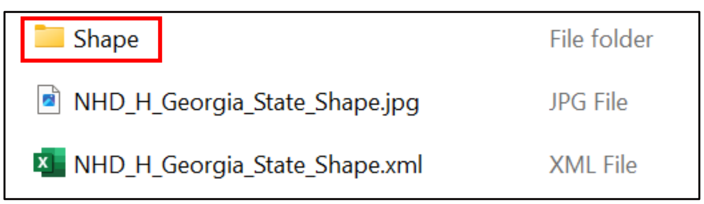
Note that this is the same data used in the HUC12 Prioritization toolset and only needs to be downloaded and processed once.



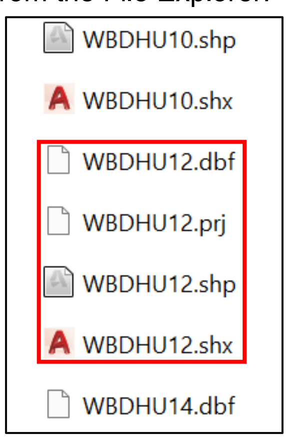
Click on the .zip file for the state(s) of interest.



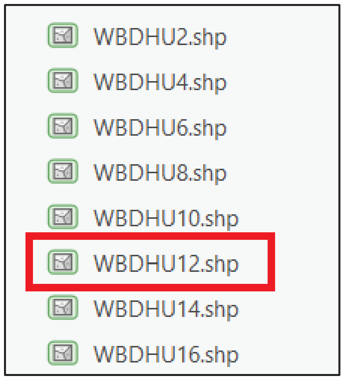
Once downloaded, navigate to the "Shape" folder within the .zip file and identify the WBDHU12 file.



The data will look something like this from the File Explorer:



From ArcGIS, the data should look more like this:

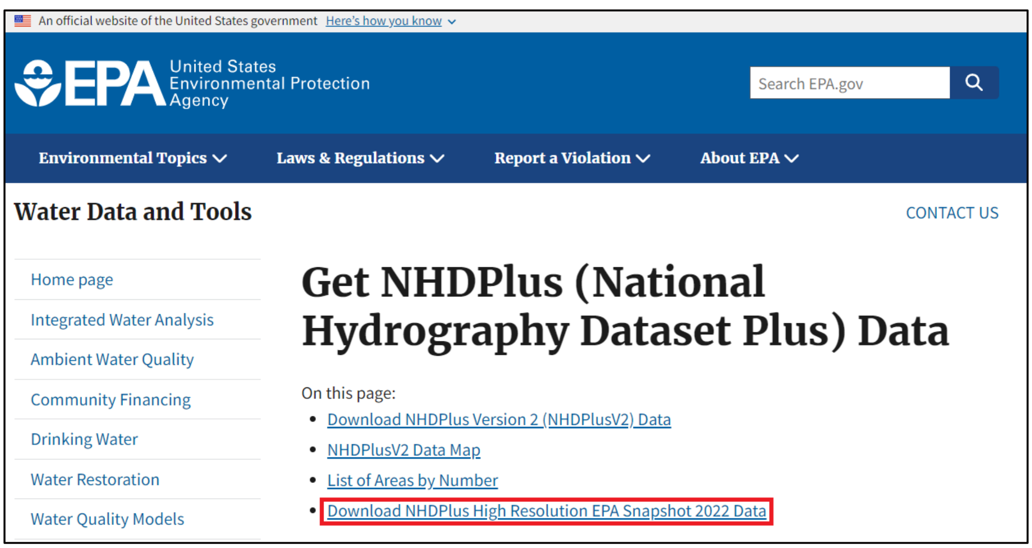


If the analysis uses multiple states' data, the user will need to rename the HUC12 file to include the state name, e.g. "HUC12_GA." The HUC12 watersheds which contribute to the broader watershed of interest will need to be identified and exported to a new "HUC12_project" shapefile. Detailed instructions for this process are provided in Section 1.1.1 of **Appendix A**.

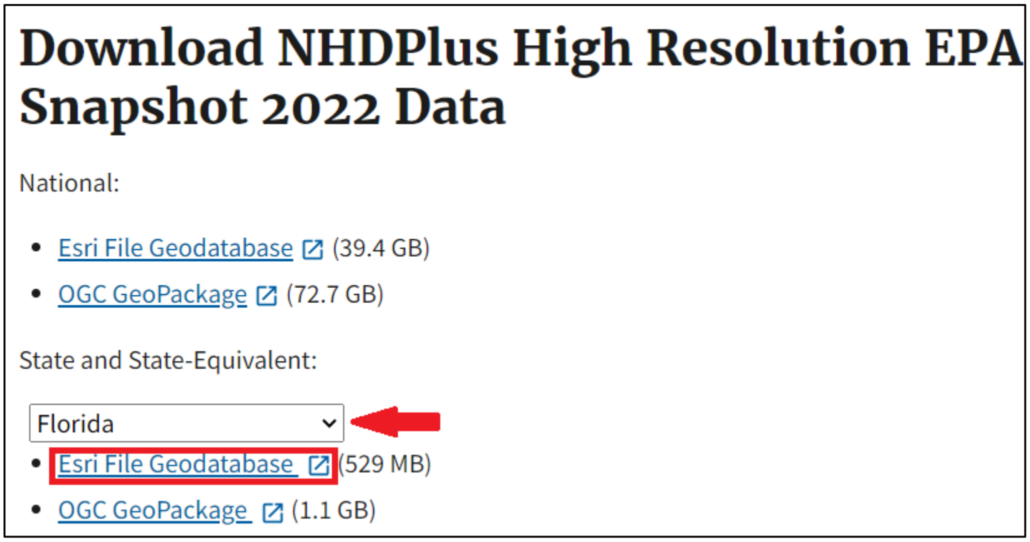
1.2 NHDPlus Flowlines and EROMMA Tables

Download location: https://www.epa.gov/waterdata/get-nhdplus-national-hydrography-dataset-plus-data

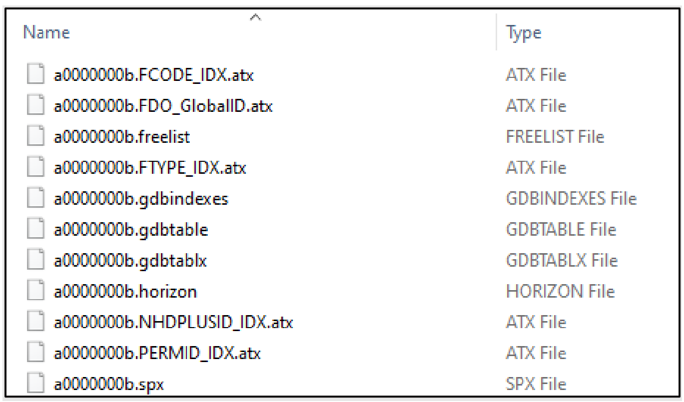
Click the link or scroll to the very bottom of the page where it says "Download NHDPlus High Resolution EPA Snapshot 20[XX] Data."



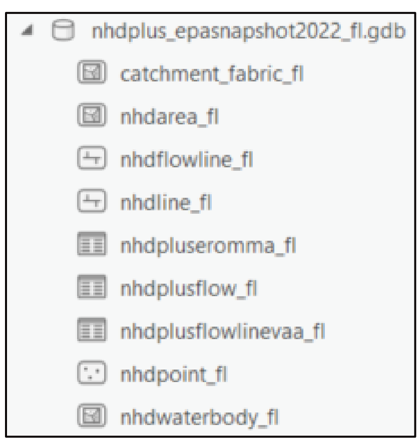
Under "State and State-Equivalent", find the state of interest, and download the Esri File Geodatabase (this example uses Florida).



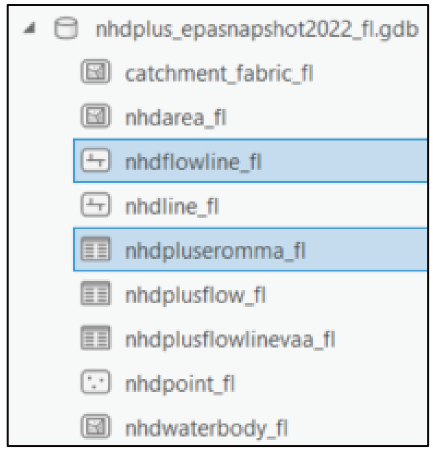
Extract the .zip file to the user's preferred location. The data will look something like this from the File Explorer:



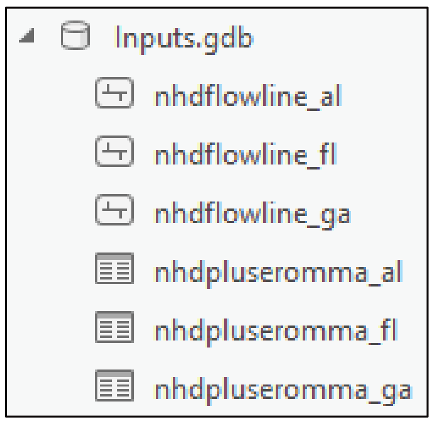
In ArcGIS, it should look more like this:



The flowlines and Enhanced Runoff Method Mean Annual (EROMMA) tables are the only relevant data here. Add these two datasets to the Inputs geodatabase by dragging and dropping them in the ArcGIS catalog, or by copying and pasting them (ctrl + select files → right click → copy → select Inputs geodatabase folder in the ArcGIS catalog → right click → paste).



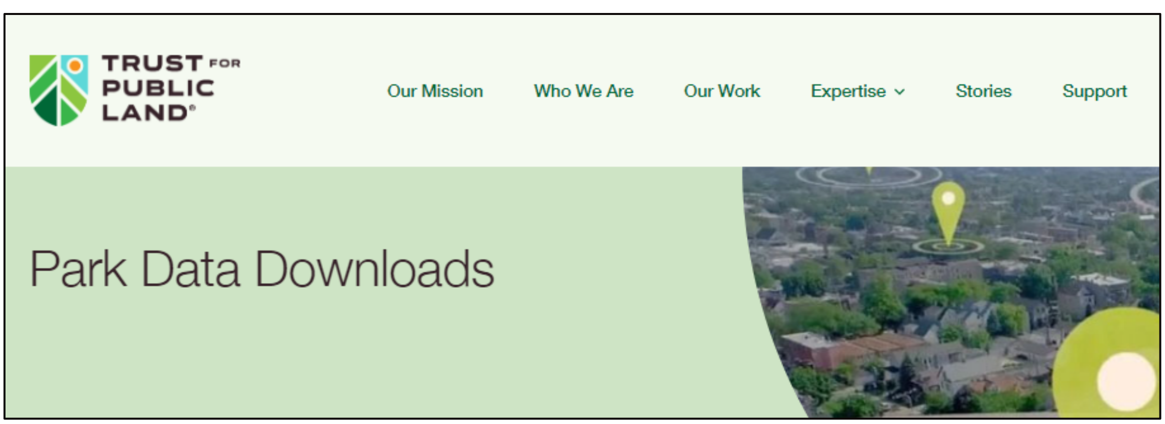
Repeat this process for any additional states until there is a flowline file and EROMMA table for each state of interest.



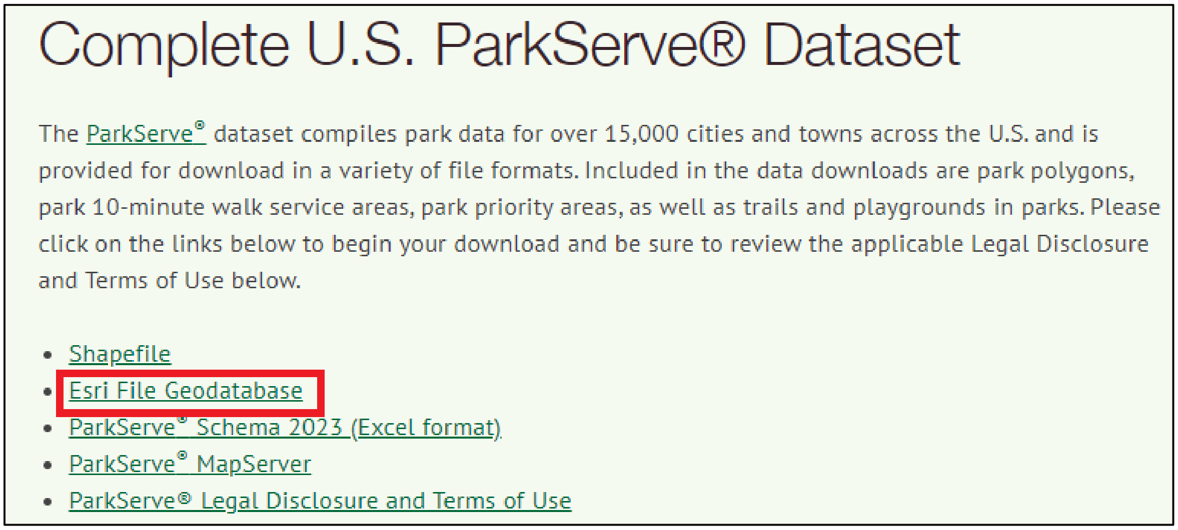
The flowlines will be in the format (using Georgia as an example) of “nhdflowline_ga,” and the EROMMA data will be in the format “nhdpluseromma_ga.”

1.3 National Public Lands

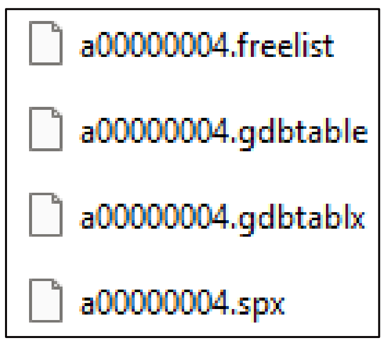
Download location: ParkServe® Data Downloads – Trust for Public Land (tpl.org)



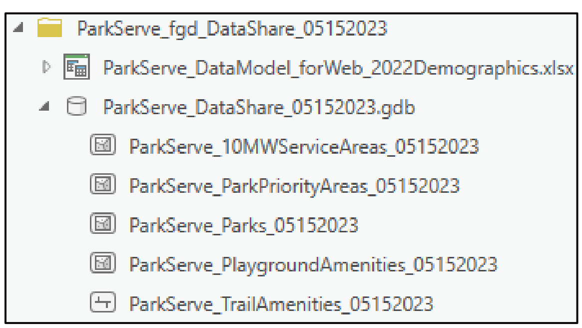
Click “Esri File Geodatabase” to download a .zip file. The format will be “ParkServe_fgd_DataShare_[MMDDYYYY].zip,” where the date indicates when the data was last updated.



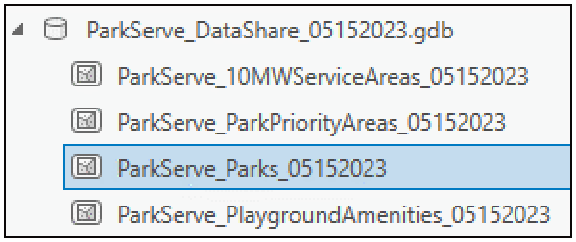
Extract the .zip file to the user’s preferred location. The data might look something like this from the File Explorer:



In ArcGIS, it should look more like this:



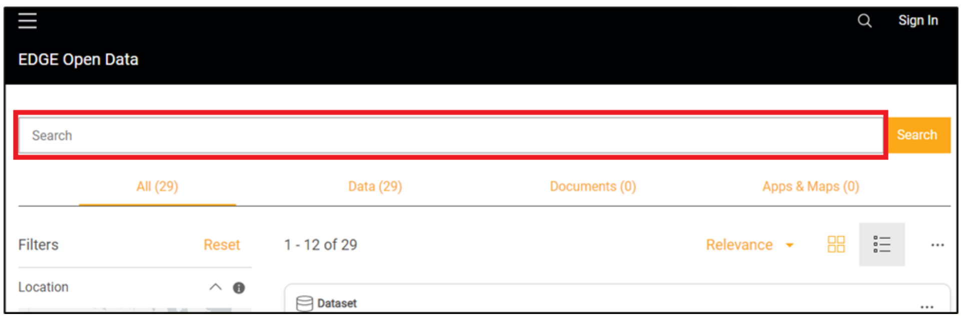
Add the “ParkServe_Parks_[MMDDYYYY]” dataset to the Inputs geodatabase folder by dragging and dropping in the ArcGIS catalog, or by copying and pasting it (select file → right click → copy → select Inputs geodatabase folder in the ArcGIS catalog → right click → paste).



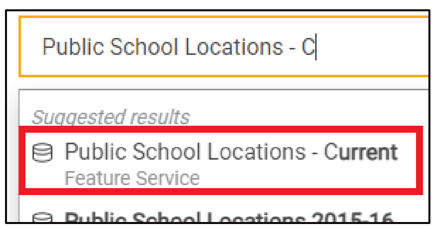
The user may also rename the file to “ParkServe_Parks,” if they prefer.

1.4 National Public Schools

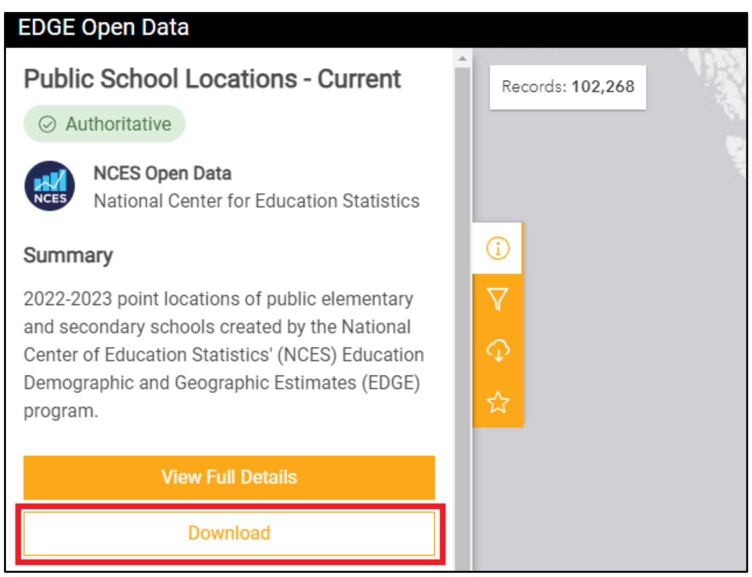
Download location: National Center for Education Statistics (arcgis.com).



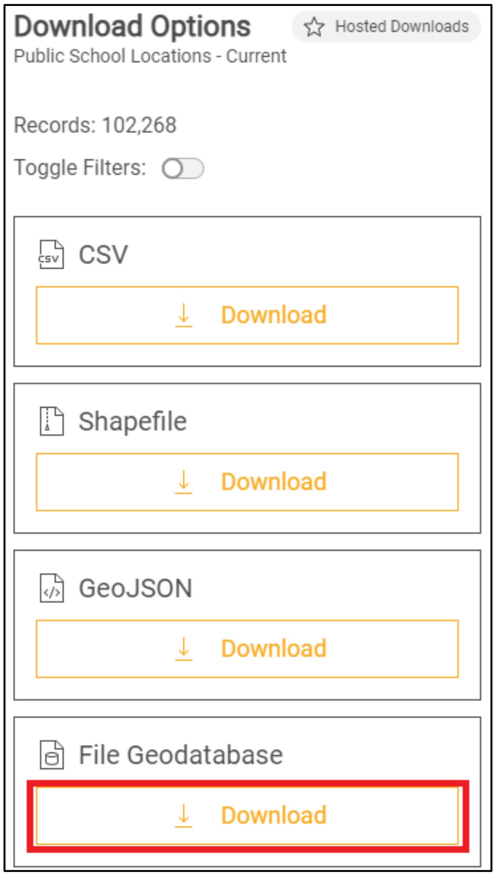
Search “Public School Locations – Current” and click on the result.



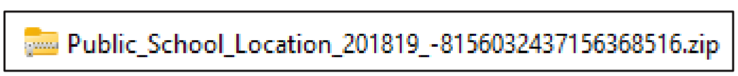
Doing so will open a mapping page.



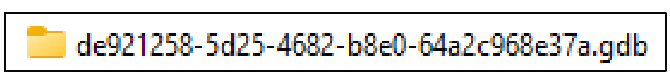
Download the data as a File Geodatabase.



The .zip file will be in the format "Public_School_Location_[…]" possibly followed by a long string of numbers.

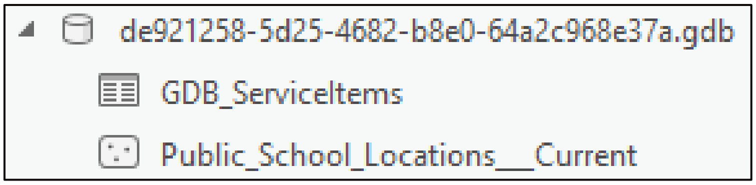


Extract the .zip file to the user's preferred location. When extracted, the resulting .gdb folder title will likely also be lengthy with seemingly random characters.



The data will look something like this from the File Explorer:

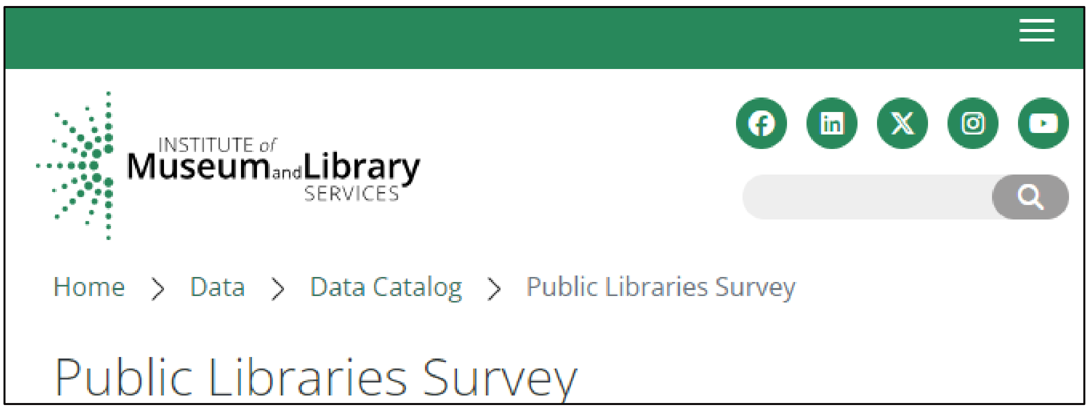
In ArcGIS, it should look more like this:



Add “Public_School_Locations__Current” to Inputs geodatabase by dragging and dropping in the ArcGIS catalog, or by copying and pasting it (select file → right click → copy → select Inputs geodatabase folder in the ArcGIS catalog → right click → paste).

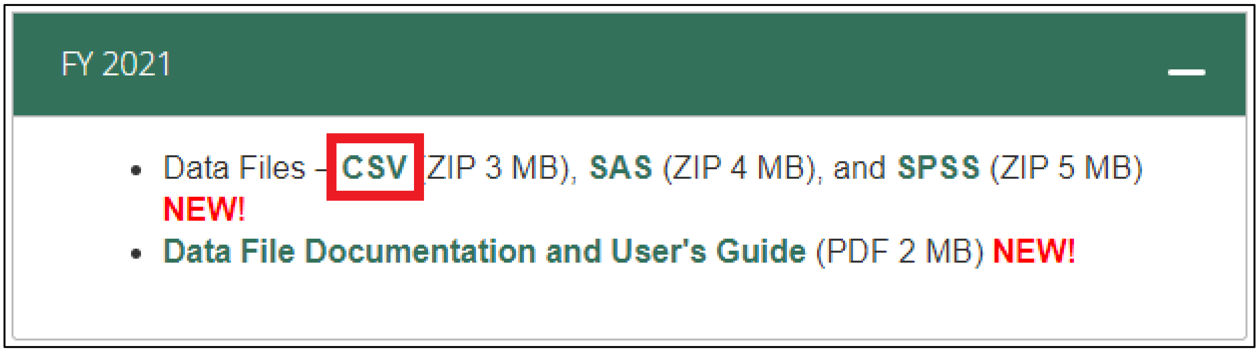
1.5 National Public Libraries

Download location: Public Libraries Survey | Institute of Museum and Library Services (imls.gov)

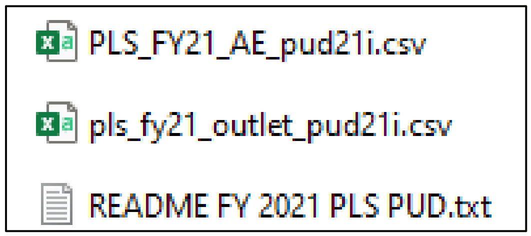


Scroll down until a list of the format “FY [20XX]” is seen.

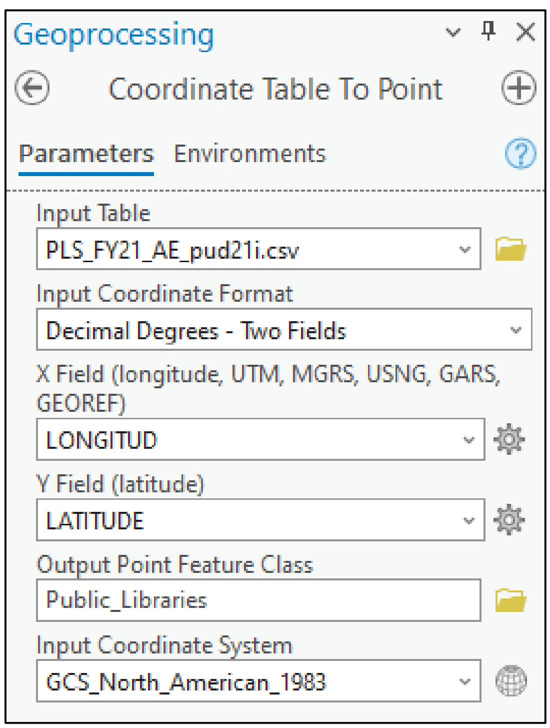
Click the “+” next to the most recent year and download the “CSV” format. This will download a .zip file with a title format of “pls_fy20[XX]_csv.zip.”



Extract the .zip file to the user's preferred location. The data might look something like this from the File Explorer:

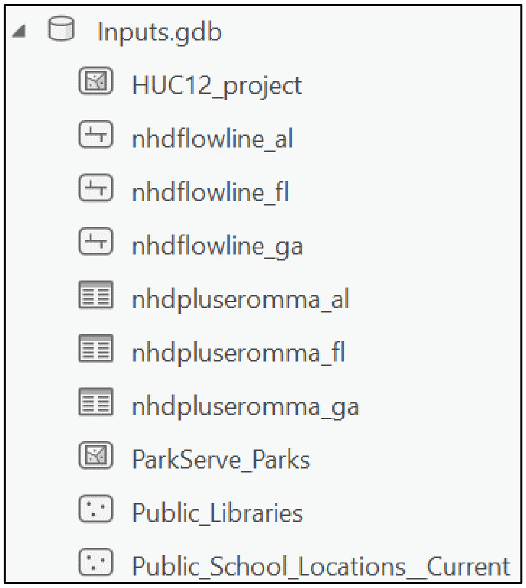


In ArcGIS Pro, run the "Coordinate Table to Point" tool on the PLS_FY[XX]_AE_pud[XX].csv file. Select "LONGITUD" column for "X Field" and "LATITUDE" for "Y Field." Set "Input Coordinate System" to "GCS_North_American_1983." Set the Output Point Feature Class to output to the Inputs geodatabase folder, if possible, or add the file manually. Set the Ouput Point Feature Class name to "Public_Libraries."



1.6 Completed Inputs Geodatabase Example

A completed Inputs geodatabase for the NHD Flowline Prioritization toolset should look something like the image below.



2 Data Quality Control and Parameterization

The models contained within the HUC12 and NHD Flowline Prioritization toolsets are hardcoded to certain field names. This means that if naming conventions for data sources change over time, the model and data may become incompatible. This issue can be avoided by ensuring that relevant data is stored in field names that match those in the model. Table B-2 shows each data source and the field names that are referenced in the models, as well as the field aliases. In ArcGIS, field names are the internal references used by the software, while field aliases are the usually more user-friendly names that are seen in attribute table headers. The table also provides the data type required for each referenced parameter in parentheses. Data types define how field values appear in the attribute table and whether they can be processed by certain tools.

Table B-2: Input Data Parameterization

<table>
<tr><th>Dataset</th><th>Referenced Parameter</th><th>Parameter Meaning</th></tr>
<tr><td>NHDPlus Flow Lines</td><td>Field Name: “nhdplusid” (Double)
Field Alias: “NHDPlus Identifier”</td><td rowspan="2">A 14-digit number identifying each flowline.
Example: 15001100057801
This parameter is hardcoded into the model. User must update naming in the input file before running the model. Field Alias does not need to match exactly.</td></tr>
<tr><td rowspan="2">NHDPlus EROMMA Tables</td><td>Field Name: “nhdplusid” (Double)
Field Alias: “NHDPlus Identifier”</td></tr>
<tr><td>Field Name: “qe” (Double)
Field Alias: “Flow from Gage Adjustment (cfs)”</td><td>Gage-adjusted flow values. This parameter is hardcoded into the model. User must update naming in the input file before running the model. Field Alias does not need to match exactly.</td></tr>
<tr><td>National Public Lands</td><td>Field Name: “Park_Statu” (Text)
Field Alias: “Park_Statu”</td><td>Parameter will have values of “Open,” “Restrict,” “UNK,” etc.

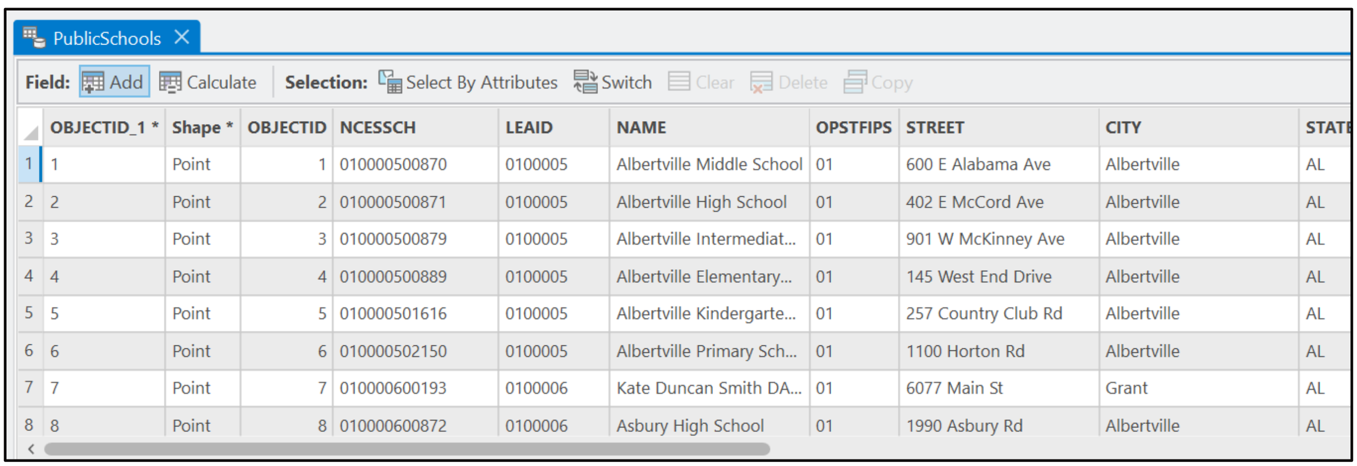
This parameter is entered into the model by the user so if the naming convention changes, the user must identify the new field name with the same meaning and enter it into the model in the Geoprocessing window.</td></tr>
<tr><td>National Public Schools</td><td>Field Name: “SCHOOLYEAR” (Text)
Field Alias: “SCHOOLYEAR”</td><td>This parameter is hardcoded into the model. User must update naming in the input file before running the model. Field Alias does not need to match exactly.</td></tr>
<tr><td>National Public Libraries</td><td>Field Name: “LIBID” (Text)
Field Alias: “LIBID”</td><td>This parameter is hardcoded into the model. User must update naming in the input file before running the model. Field Alias does not need to match exactly.</td></tr>
</table>

To confirm that the downloaded data fits within the parameters outlined above, open the attribute table for each dataset by dragging the data into the “Contents Pane” on the left side of the ArcGIS window. Right click on the data and select “Open Attribute Table.” Fields aliases will appear as the headers of each column in the attribute table. Navigate to the field names by right clicking on any field alias in the attribute table. Select “Fields.” In the pop-up window, identify the field names listed in Table B-2 and confirm that the column in the attribute table contains the required values or range of values.

2.1 Updating Field Names

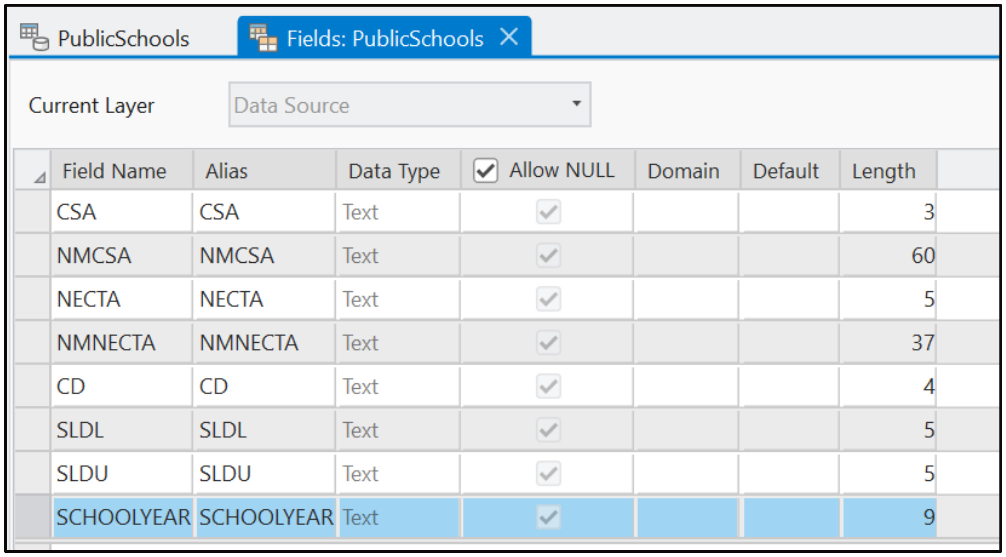
If the attribute table does not have the necessary field name, look for a field name in the attribute table that has the meaning described in the “Parameter Meaning” column of Table B-2. For example, if the national public school data is missing the “SCHOOLYEAR” field, but it does have a “school_yr” field, it is possible that the “SCHOOLYEAR” field was renamed to “school_yr” in a more recent data release. To ensure that new fields record the same data as the field originally used in this model, review the data documentation included on the data source websites.

When it is confirmed that the new field (“school_yr”) represents the same data, add a field by selecting “Add” in the top left-hand corner of the attribute table (see figure below).

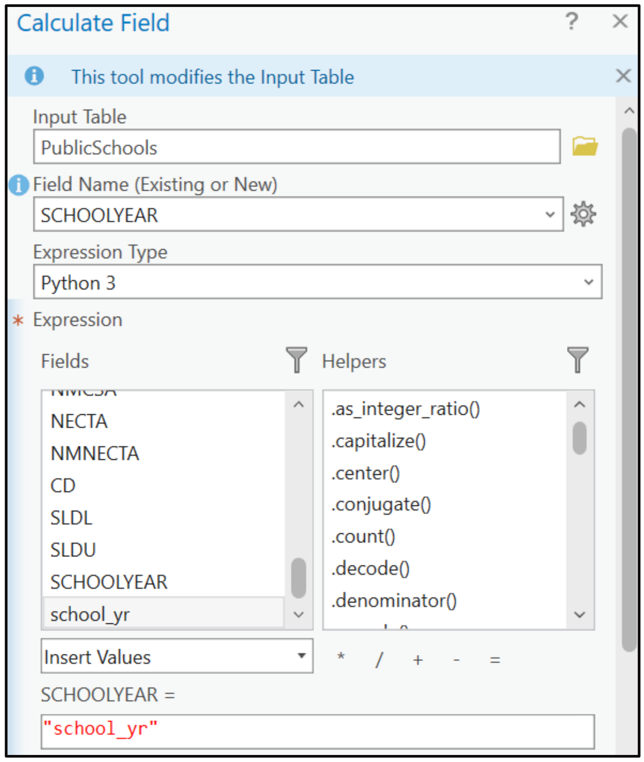


	OBJECTID_1 *	Shape *	OBJECTID	NCESSCH	LEAID	NAME	OPSTFIPS	STREET	CITY	STATE
1	1	Point	1	010000500870	0100005	Albertville Middle School	01	600 E Alabama Ave	Albertville	AL
2	2	Point	2	010000500871	0100005	Albertville High School	01	402 E McCord Ave	Albertville	AL
3	3	Point	3	010000500879	0100005	Albertville Intermediat...	01	901 W McKinney Ave	Albertville	AL
4	4	Point	4	010000500889	0100005	Albertville Elementary...	01	145 West End Drive	Albertville	AL
5	5	Point	5	010000501616	0100005	Albertville Kindergarte...	01	257 Country Club Rd	Albertville	AL
6	6	Point	6	010000502150	0100005	Albertville Primary Sch...	01	1100 Horton Rd	Albertville	AL
7	7	Point	7	010000600193	0100006	Kate Duncan Smith DA...	01	6077 Main St	Grant	AL
8	8	Point	8	010000600872	0100006	Asbury High School	01	1990 Asbury Rd	Albertville	AL

Name the added field to match the field in the “Referenced Parameters” column of Table B-2. In this example, the field should be named “SCHOOLYEAR.” Ensure that the field parameters of the “SCHOOLYEAR” field match the parameters described in Table B-2 as shown in the figure below.



Save the changes by clicking “Save” in the top of the window. Close the “Fields” window and return to the attribute table for the dataset that is being edited. Scroll through the columns of the attribute table until the “SCHOOLYEAR” field is visible. Right click on the heading of this field and select “Calculate Field.” As shown in the figure below, set the “SCHOOLYEAR” field equal to the “school_yr” field and click “Apply.”

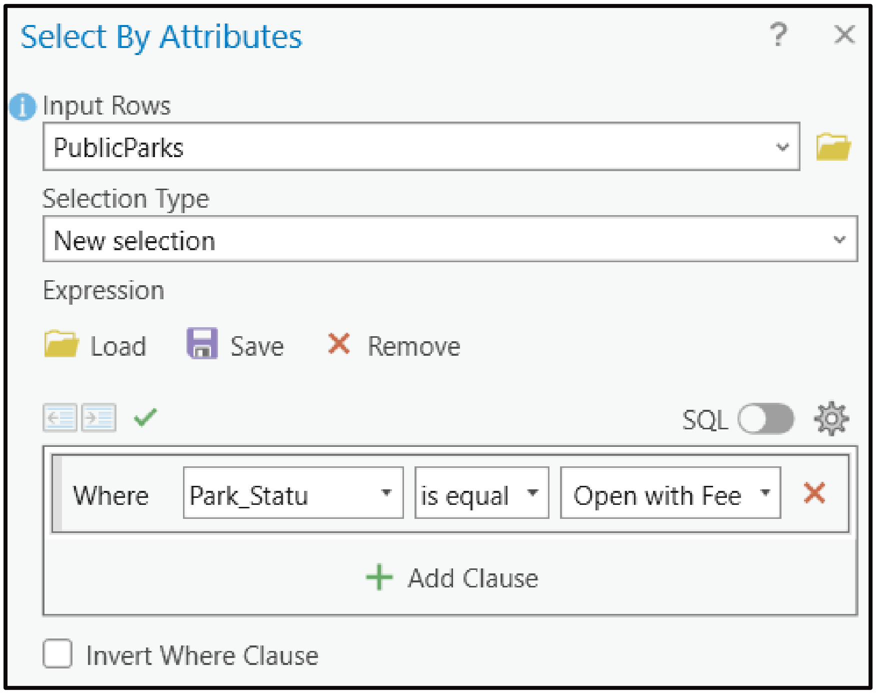


Confirm that the row values in the “SCHOOLYEAR” field match the values in the “school_yr” field. The data is ready for input into the Model.

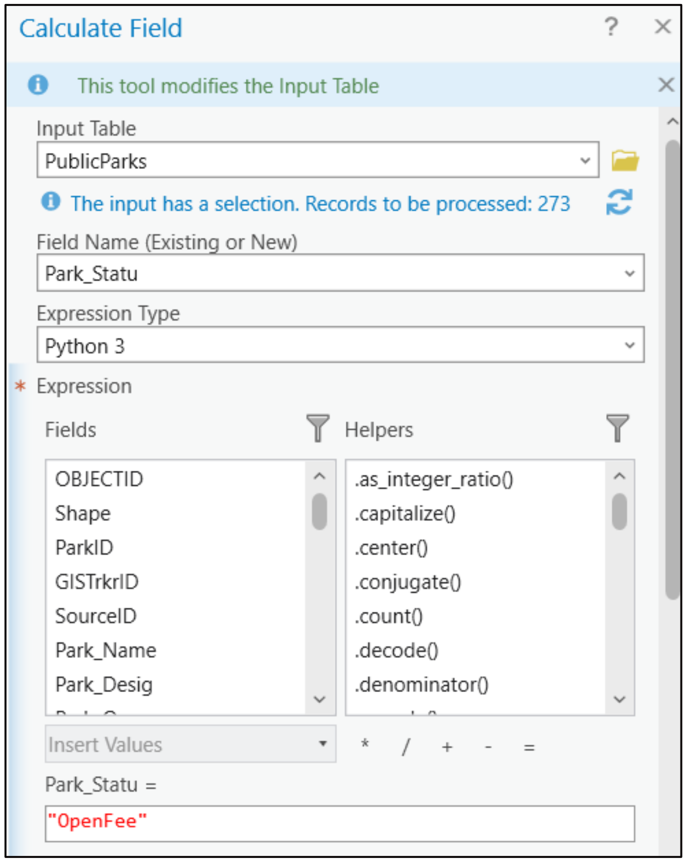
2.2 Updating Field Values

Alternatively, if the attribute table has the proper field name, but the values in the column do not match the values described in Table B-2, these values will need to be updated. First, identify the renamed value that corresponds to the description of the data used in the original model. For example, the value in the public lands data for the “Park_Statu” field may have changed from “OpenFee” to “Open with Fee.” Consult online documentation to confirm that the renamed values match the description of data used in the original model.

To update the values in the “Park_Statu” field so that the model will run, select “Select by Attributes” at the top of the attribute table window. Create a clause that selects rows with “Park_Statu” equal to “Open with Fee” and click apply (see figure below). This selects all rows with the attribute “Open with Fee.”



Click “Apply” and close the “Select by Attributes” window to confirm that the rows with “Open with Fee” values in the “Park_Statu” field are selected. These rows will appear in light blue. Right click on the field “Park_Statu.” Select “Calculate Field.” As shown in the figure below, set the “Park_Statu” field equal to “OpenFee.” Click “Apply” and the values “Open with Fee” will be updated to “OpenFee.” The data is ready for input into the Model.

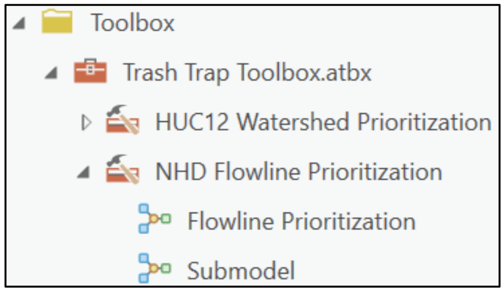


3 Running the NHD Flowline Prioritization Toolset

Section 1 of this appendix described what data should be pulled into the Inputs geodatabase. Once complete, and the data has been parameterized according to Section 2, the data can be used to run the Flowline Prioritization model contained within the NHD Flowline Prioritization toolset. This section describes how to use the data collected in Section 1 to run this model.

3.1 Flowline Prioritization Model

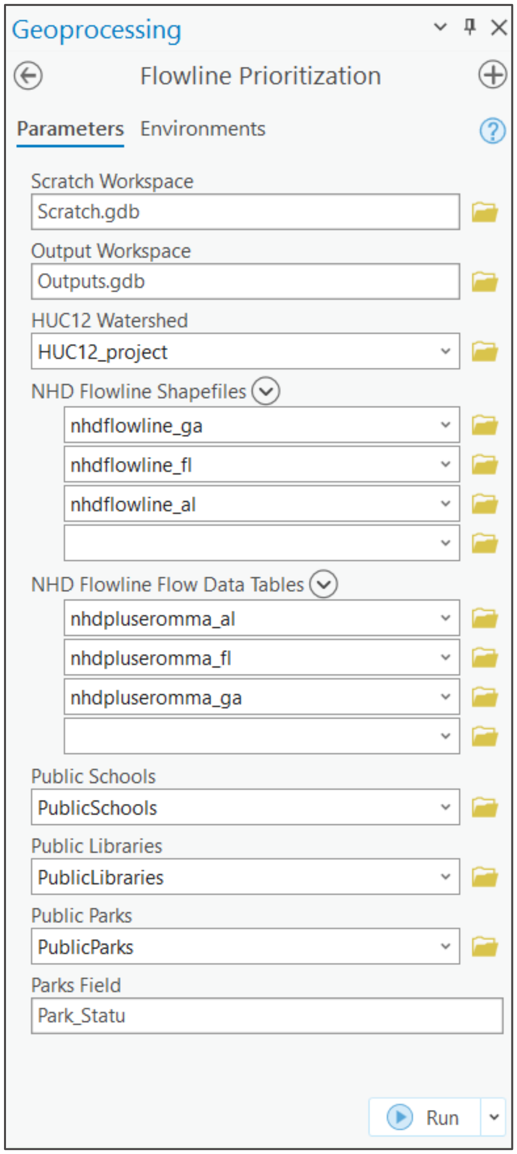
To access the NHD Flowline Prioritization toolset, expand the toolbox folder (shown as “Trash Trap Toolbox.atbx” in the figure) within the model folder (shown as “Toolbox” in the figure) in the ArcGIS catalog pane. Expand the NHD Flowline Prioritization toolset within that folder. The model folder should look like the figure below.



The folder names do not matter and may be different depending on the user's naming preferences. The toolset will run regardless of folder naming conventions if the data has been correctly parameterized. For example, if the user's model folder were named "Model Folder" instead of "Toolbox," the toolsets would not be affected.

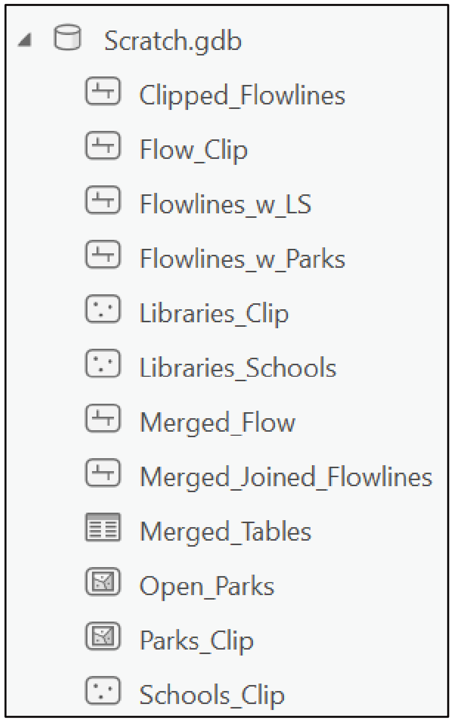
Once in the model folder within the catalog pane, double click on "Flowline Prioritization". This will open a geoprocessing pane. If the geoprocessing pane opens in the same pane as the catalog pane and covers the model folder, click and drag the geoprocessing pane out of the catalog pane. Situate the geoprocessing pane somewhere else within the ArcGIS window.

Input information to match the figure below by dragging data from the catalog pane into the correct location within the geoprocessing pane.

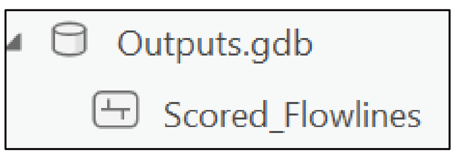


Press "Run" on the bottom right. To confirm that the tool has worked properly, navigate to the catalog pane and open the Scratch and Outputs geodatabase folders. Ensure that data was added to those folders. The user may need to update the folders by right clicking on the overall model folder and pressing "Refresh." As a note, if the user is using the same Scratch and Outputs geodatabases as were used to run the HUC12 toolset, there will already be data within these folders.

The Scratch geodatabase should contain the following:



The Outputs geodatabase should contain the following:



This output file Scored_Flowlines contains an attribute of “Score”, which will have a value representing the number of parks the flowline intersects with, and the number of libraries and schools within 500 feet of each flowline. Each park, school, or library adds one point to the score.

Appendix C

Appendix C: Model Editing and Additions

Model Editing and Additions

Users with more experience with ArcGIS Pro might feel comfortable making edits to the overall model (Model) to better fit their watershed and priorities. Edits to the Model should be made with caution. If the user is not experienced enough to troubleshoot a variety of ArcGIS errors, we recommend limiting edits to the Model. This appendix does not include details on editing the National Hydrography Dataset (NHD) Flowline Prioritization toolset because only the most experienced GIS users should make changes to this portion of the Model.

That said, the HUC12 Watershed Prioritization toolset (HUC12 toolset) is segmented such that datasets can be added and removed without requiring extensive changes to the model process. The following sections will discuss how to edit the HUC12 toolset and provide a crash course in ArcGIS ModelBuilder, the program used to generate the Model.

The model editing pane in ArcGIS can be accessed by right-clicking on a model in the catalog pane and selecting “Edit” rather than “Open.” Details on how to create new models are described later in this appendix.

1 Editing Indicator Scores

The HUC12 toolset is structured such that each indicator score is calculated in its own unique model. This design was intentional to allow for removal of indicators that may not be available for a given watershed. We will use the Southeast Conservation Adaptation Strategy (SECAS) Blueprint data to illustrate the best way to edit indicator score data in the HUC12 toolset. This data is used as an example because it is only available for the southeast region of the United States. Users conducting watershed analyses outside of the southeast region will need to address this issue.

The SECAS Blueprint is the primary input for the habitat conservation indicator score. This indicator contributes to the composite environmental justice score which is then combined with the composite trash quantity score to generate the final HUC12 prioritization score. If the Southeast Blueprint is not available for the study watershed, users can solve the issue through replacement of the indicator score’s input data or through the removal of the indicator score altogether.

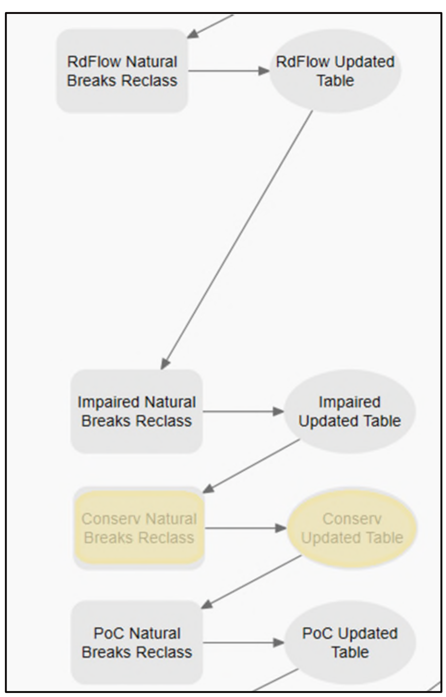
1.1 Replacing Indicator Score Data

First, the user could identify a dataset that represents similar information. For example, a watershed in Utah is not covered by the SECAS Blueprint data, but a state agency or local nonprofit may have developed a habitat conservation priority dataset that covers the study watershed. The user should use their best judgement to select a replacement dataset that represents the same type of data. After confirming that the replacement dataset is sufficient, the user must ensure that the data is in a raster format with the “Value” field ranging from zero to four. Please refer to Table 1 in **Appendix A** for more details on what each value should represent. For example, the values of four should correspond to the highest priority habitats. Regardless of the dataset that users are replacing, they must refer to this table to confirm that the replacement data is congruent with the parameters required by the model. Advanced users may also edit the reclassification steps in the Model if the replacement data does not match the priority rating of the SECAS Blueprint data.

After the replacement data has been reviewed for congruence with the SECAS Blueprint data and any updates to the reclassification step are complete, the Habitat Conservation model can be run. With the model open for execution, input the replacement dataset where the SECAS Blueprint data should go. No other edits are needed.

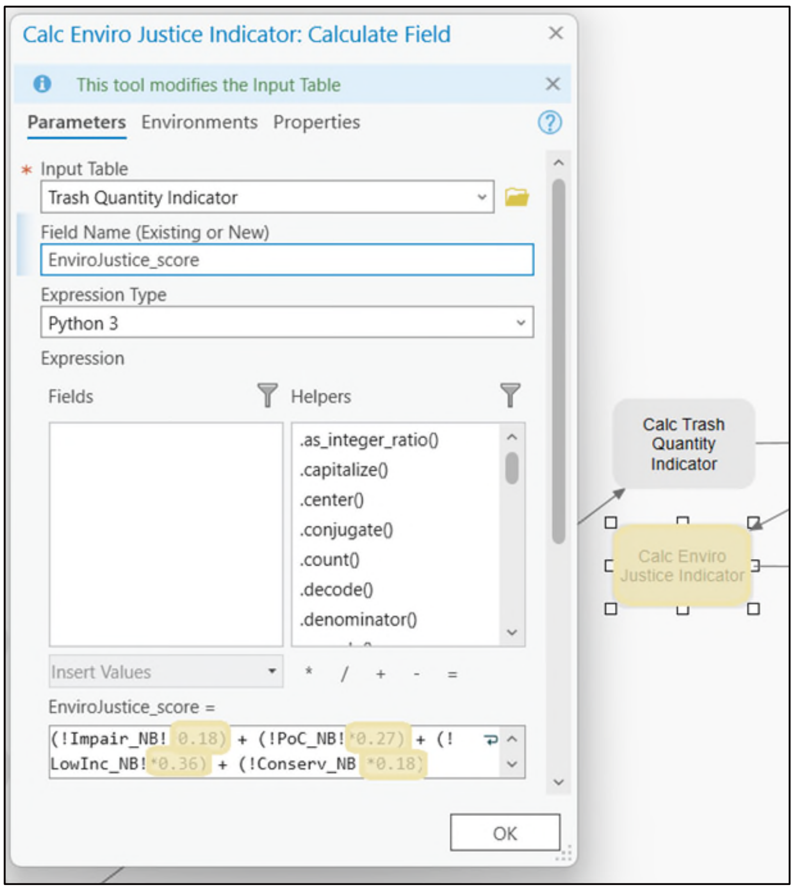
1.2 Removing Indicator Scores

The second option to resolve the issue of missing data is to remove the corresponding step from the Model altogether. In the case of the SECAS Blueprint, this means removing the Habitat Conservation model. Because the HUC12 toolset relies on composite, weighted scoring, edits must be made to the Score Combination model to account for missing data. The Score Combination model is a series of field creations and calculations. If the Habitat Conservation model is not run due to missing data, then the fields referenced in the Score Combination model will not be present and the model will error. Therefore, all references to the Habitat Conservation model outputs must be removed. The first step of the Score Combination model reclassifies the data for each indicator score into a Natural Breaks distribution from one to four. The calculation for conservation values, highlighted below, must be deleted for the model to run.



The second step in the Score Combination model and the final step needed to update the model based on missing data is the calculation of the environmental justice composite score. Each of the environmental justice indicator scores was assigned a percent weight as a decimal (e.g., 0.1 = 10%) and the sum of these weights totals 100 percent. If one of the indicator scores is missing, the totaled weights would not equal 100%, so new weights must be assigned.

Users should refer to Table 7 in the main report to determine new weights for the remaining scores. Users familiar with Analytical Hierarchy Process (AHP) may also reference Section 4 of **Appendix A** and perform their own multicriteria analysis to weight the remaining scores more accurately. When weights are determined, users must edit the calculation of the environmental justice composite score to reflect the changes in weights. The weight inputs for each indicator are highlighted below. In this example, the term for the habitat conservation score (!Conserv_NB!*0.18) must be deleted.



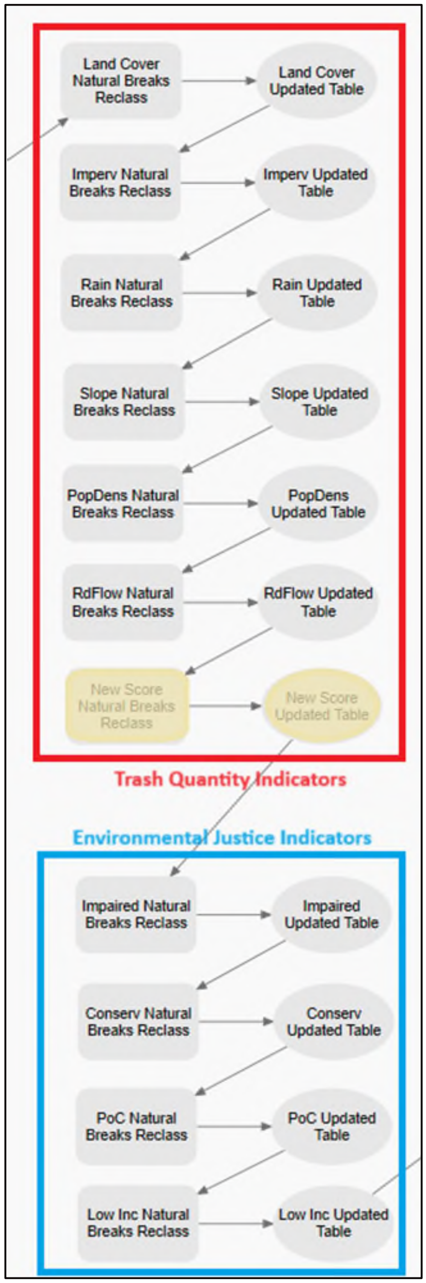
Removing or replacing data from the Model may be required due to data coverage constraints, but it also might be desired to reflect different watershed priorities. Section 6.1 of the main report discusses data that may be relevant to trash trap location prioritization but was not included in this model. The following section describes how to add data to the Model.

2 Adding Indicator Scores to the HUC12 Toolset

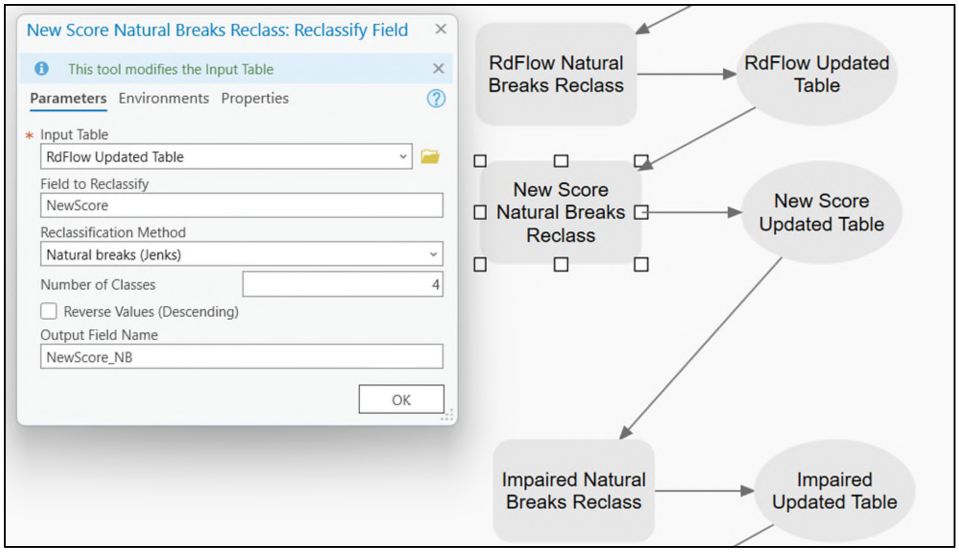
Adding data to the HUC12 toolset follows a similar process as removing and replacing data in the Model. To add data analysis to the HUC12 toolset, users must first create a new model within ModelBuilder. Section 3 describes model creation in more detail. After the user has created the model that is to be added into the HUC12 toolset, the user must review the Score Combination model. This section assumes that the user has set up their model such that an additional score is added as a field to the 12-digit hydrologic unit code (HUC12) watershed shapefile for their study area. This mimics the methodology used for all the HUC12 indicator models within the HUC12 toolset.

To add a new indicator score to the Score Combination model, determine whether the indicator being added should be normalized by watershed area. If the indicator is not an average of values across a watershed, it should be normalized by watershed area, and a watershed area normalization step should be included in the indicator score model that is being added. Indicator scores dependent on watershed area can be normalized by adding a “Calculate Field” tool to the model. Divide the indicator score by the ”areaacres” field that is built into the HUC12 study area feature class.

The user must then add a “Reclassify Field” step to the Score Combination model. Name the “Reclassify Field” step to reflect the indicator score that is being added to the model. Situate the tool in the flow of the model. We recommend adding the new indicator based on the composite score to which it will contribute. For example, a trash quantity indicator should be grouped with the existing trash quantity indicator scores as shown below. Note that the screenshot below shows the new reclassification step connected to the output of the previous step and the output of the new reclassification step connected to the reclassification step that follows.



Mimic the input parameters in the reclassification steps that are already in the Score Combination model. The "Field to Reclassify" will be the original field name that the user set to output to the project HUC12 feature. The tool should use the "Natural breaks (Jenks)" method and distribute the data into four classes. The output field name should be the original name of the field proceeded by "_NB. The screenshot below shows an example of the input parameters for an indicator score field, "NewScore."



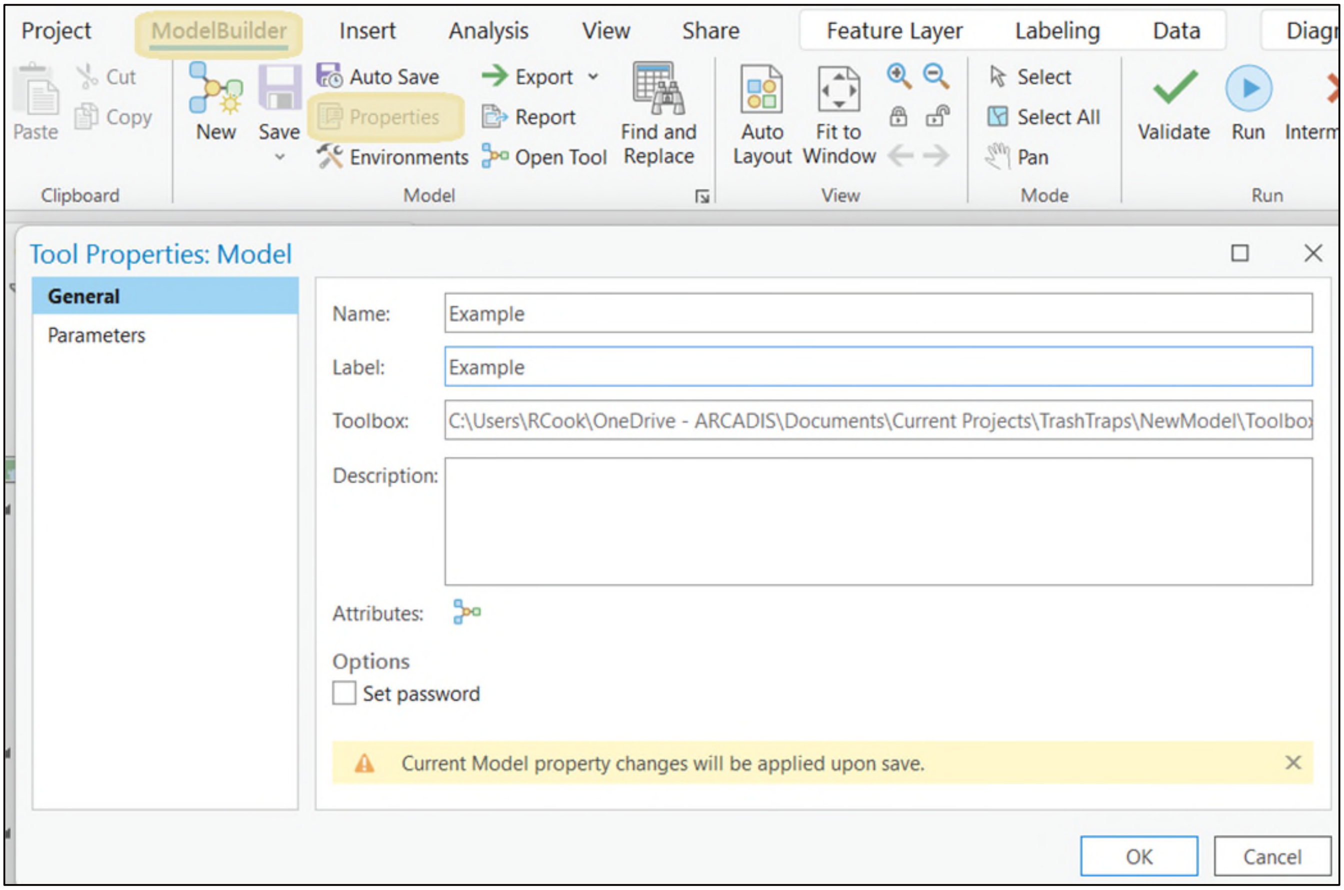
Lastly, the user must determine weights for the indicator scores and update the calculation of the corresponding composite score. Refer to Section 4 of **Appendix A** for more details on applying new weights to the HUC12 toolset.

3 ModelBuilder Crash Course

Users should refer to ArcGIS Pro's online ModelBuilder documentation for a comprehensive discussion of the functionality that ModelBuilder offers. The following section provides a brief overview of creating models in the context of the Model.

3.1 Creating a Model

ModelBuilder models are stored within ArcGIS toolboxes. The Model is downloaded with an existing toolbox that includes two toolsets: HUC12 Watershed and NHD Flowline Prioritization toolsets. Within these two toolsets are a series of models. The models within these toolsets were created in ModelBuilder. To create a new model, the user must right click on the toolset within which they would like to add a model. Select "New" and then "Model." A new model will be added within the toolset. Creating the new model will also open a window within GIS titled "Model." To name the model, select "Properties" in the ModelBuilder toolbar at the top of the screen and change the "Name" and "Label" to the name of the new model. Select "OK" and exit out of the properties window. The screenshot below shows this step. The new name should update in the tab name below the top toolbar.

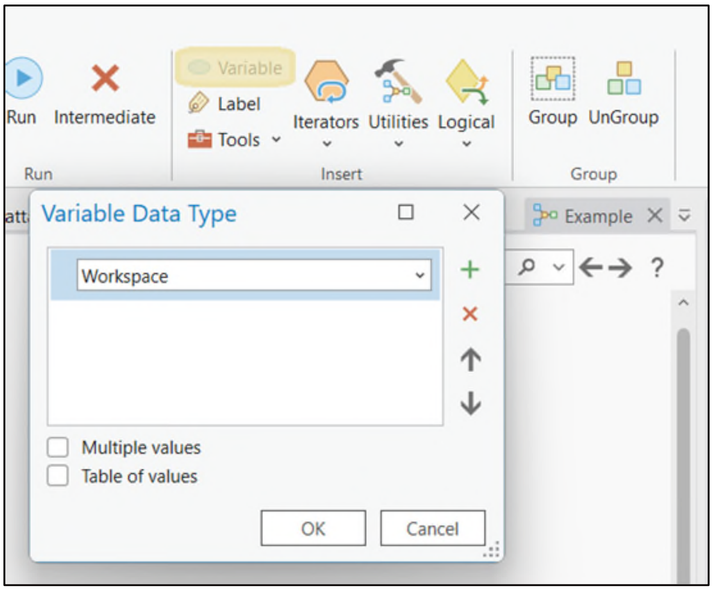


With the model created, the user may now begin laying out the model processes.

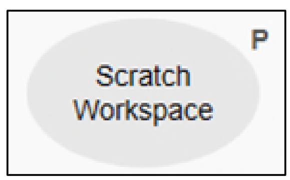
3.2 Model Setup

Models are composed of several elements. Variables are the inputs or outputs that are referenced throughout the model. Variables are connected by geoprocessing tools, iterators, logicals, and utilities. In this example, we will create a model that clips a dataset to a desired area, calculates statistics on smaller areas within the broader study area, and adds the output of the statistics to a field in the original study area shapefile. This processing mimics the processing required for most of the existing indicator score models.

Most models use an output and scratch workspace. Workspaces are a storage structure unique to ArcGIS that can consist of a folder or geodatabase that allows for the storage of potentially large, geospatially referenced data. An output workspace is a folder or database that stores the final model outputs, while a scratch workspace is a folder or database that stores intermediate data. Scratch workspaces allow for easy review of the intermediate output data for troubleshooting and quality control. First, create outputs and scratch workspaces from within ModelBuilder by selecting “Variable” in the top toolbar and searching for “Workspace” in the pop-up window. This step is shown in the screenshot below. When the user clicks “OK,” a variable will appear in the model. Right click and rename to “Output Workspace.” Repeat for the scratch workspace.

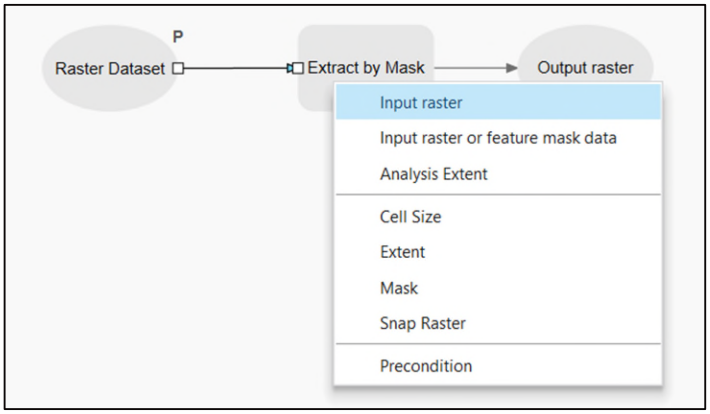


Both the scratch and output workspaces should be model parameters. This means that the location of these workspaces is dependent on a user input. To make the workspaces parameters, right click on them and select “Parameter.” A small gray “P” will appear in the top right corner of each oval.

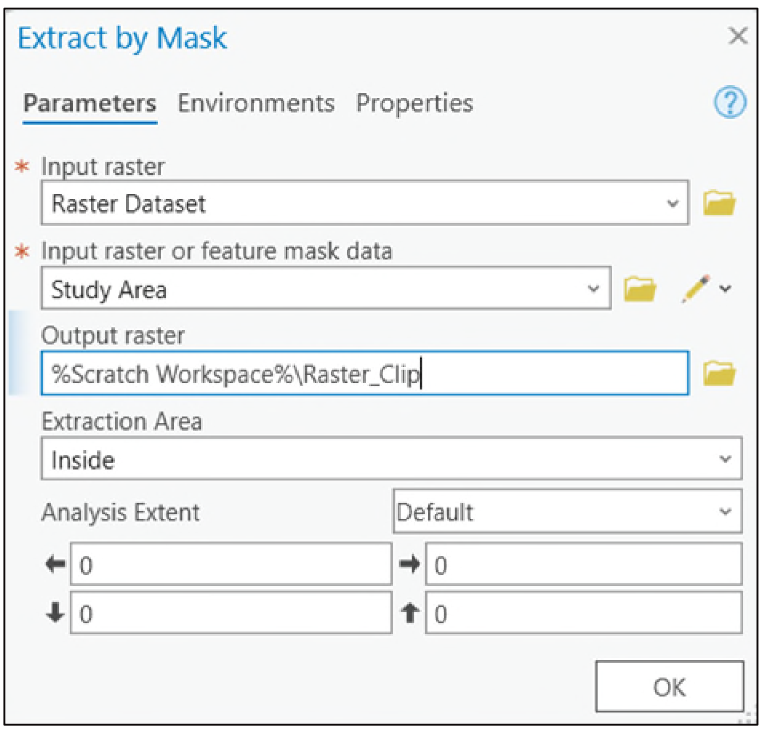


The next step in the model will clip a dataset to the study area clipping boundary. The dataset to be clipped, as well as the study area clipping boundary, will also be model parameters. In this example, the dataset to be clipped is a raster. Therefore, the user should create a model variable of type “Raster Dataset.” Next, create a variable of type “Feature Class” for the study area clipping boundary. Make both of these variables parameters by right clicking on them and selecting “Parameter.”

Tools can be added to the model from the ModelBuilder toolbar under the “Insert” tab. Any tool available with the user’s licensing for ArcGIS Pro can be added to the model through the tools drop down. In the tools drop down search “Extract by Mask.” Double click on “Extract by Mask” and it will be added to the model. Drag from the raster dataset to the “Extract by Mask” box and connect the raster dataset as the “Input raster.” This step is shown in the screenshot below. Do the same with the study area variable but connect it as the “Input raster or feature mask data.”

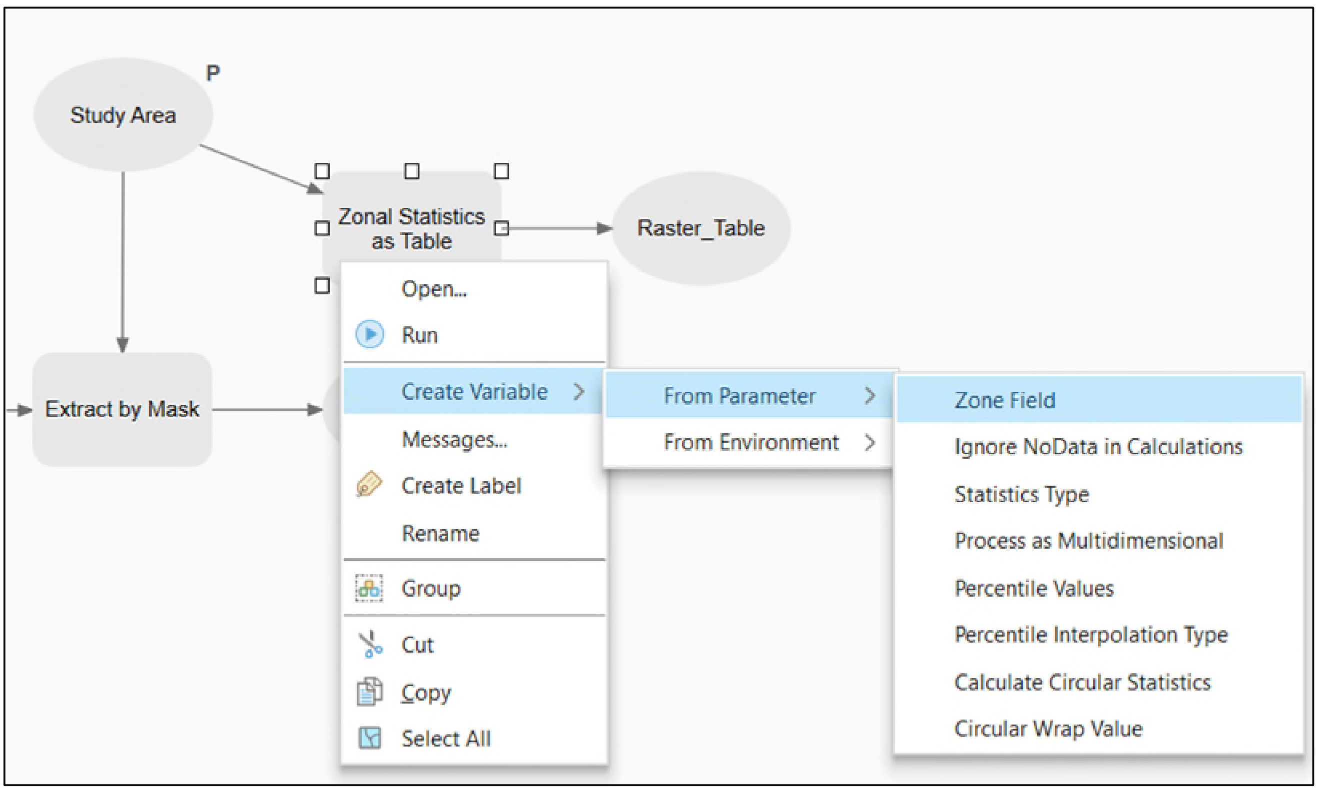


With the “Extract by Mask” step in place, the next step is to edit the tool parameters. Double click on the “Extract by Mask” tool. Notice that the “Input raster” is already set to “Raster Dataset” and “Input raster or feature mask data” is set to “Study Area.” The “Output raster” still needs to be specified. This parameter provides the output location and name of the output raster in the form of a file path. To output the clipped raster to the scratch workspace, type “%Scratch Workspace%\Raster_Clip” into the “Output raster” box. This outputs the clipped raster as a file named “Raster_Clip” in the Scratch Workspace. Note the syntax of the file path in the screenshot below. In ModelBuilder, variables can be coded into tools using a percent sign on either side of the variable name.

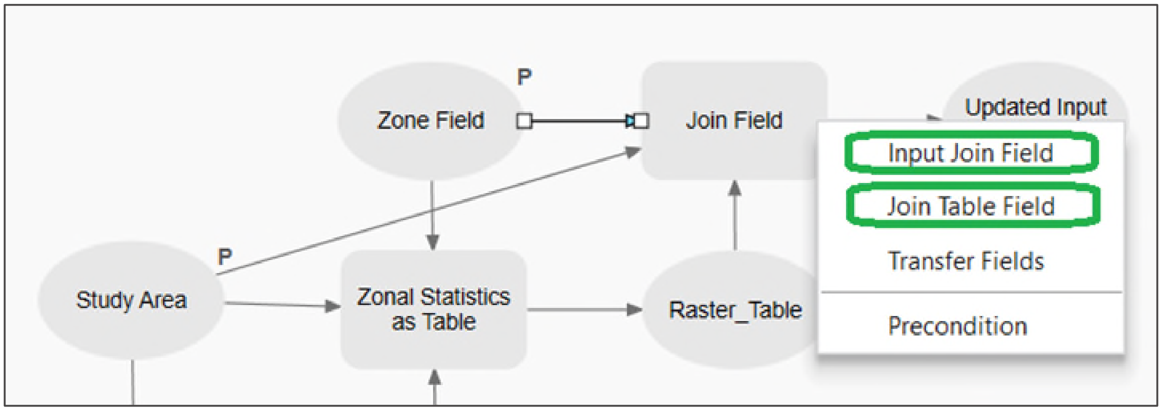


The next step is to calculate statistics on the smaller areas within the study area. For most existing indicator models, this step calculates the raw score that is later input into the Score Combination model for reclassification and combination. Select the “Zonal Statistics as Table” tool from the tool drop down.

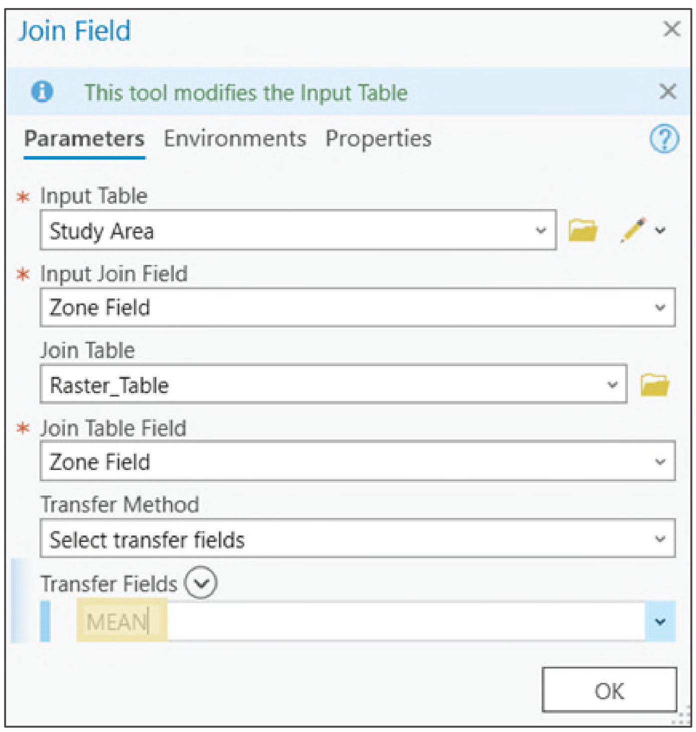
Connect the output “Raster_Clip” to the “Zonal Statistics as Table” tool as the “Input Value Raster.” Then connect the “Study Area” as the “Input Raster or Feature Zone Data.” In the “Zonal Statistics as Table” tool, set the output location to “%Outputs Workspace%\Raster_Table” and the “Statistics Type” to “Mean.” The remaining missing parameter, “Zone Field,” indicates the field that will differentiate the zones for which statistical analysis will occur. In the Model, zones are set based on the “Name” field in the HUC12 watershed (“Study Area”) file. The “Zone Field” can be set as a user-entered parameter. Right click on “Zonal Statistics” and select “Create Variable,” “From Parameter,” “Zone Field.” This step is shown in the screenshot below. When “Zone Field” is added to the model, right click on it and set it as a parameter.



Next, the user should join the desired field from the “Raster_Table” to the “Study Area” feature class. Select the “Join Field” tool from the tool drop down and connect “Raster_Table” to “Join Field” as the “Join Table.” Then connect the “Study Area” as the “Input Table.” In this case, both the “Input Join Field” and the “Join Table Field” are the Study Area “Name” field. Therefore, the parameterized “Zone Field” can be connected to the “Join Field” tool as both inputs.

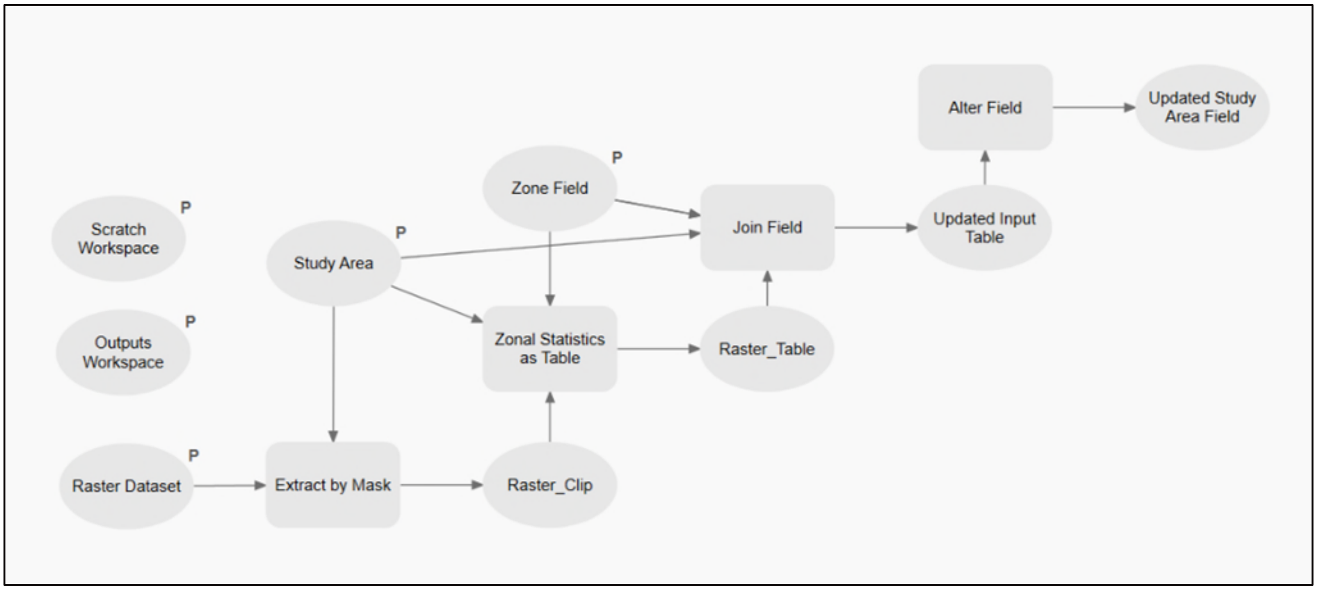


The remaining parameter is the "Transfer Fields." Type the field name in "Raster_Table" that corresponds to the mean value calculated by "Zonal Statistics as Table." In this example, "Transfer Fields" is set to "MEAN." This step joins the mean value calculated for each sub watershed to the feature class containing the sub watersheds. This allows the data to be represented spatially, rather than as a table.

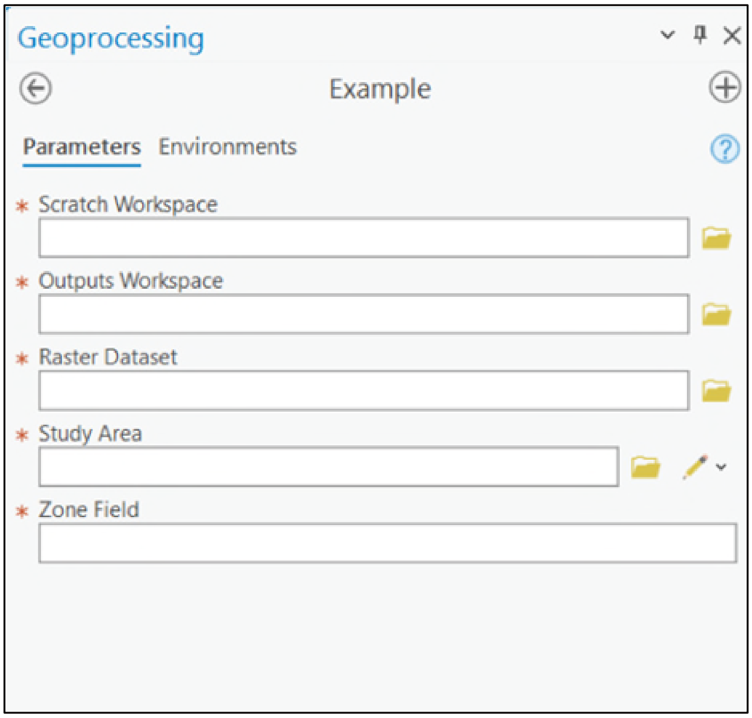


Lastly, the user must rename the joined field so that it will be distinct from other fields when the rest of the models in the Model are executed. Add an "Alter Field" tool from the tool drop down and connect the "Updated Input Table" as the "Input Table." Within "Alter Field" set "Field Name" to the field name that needs to be updated. This will be the same value as "Transfer Fields" in the last step. Set "New Field Name" to something distinct. For example, if this model was calculating average bank slope, the field name might be "BankSlope," and "New Field Alias" might be set to "Bank Slope."

Ultimately, the example model should look like the layout shown in the screenshot below when open in the ModelBuilder editing pane.

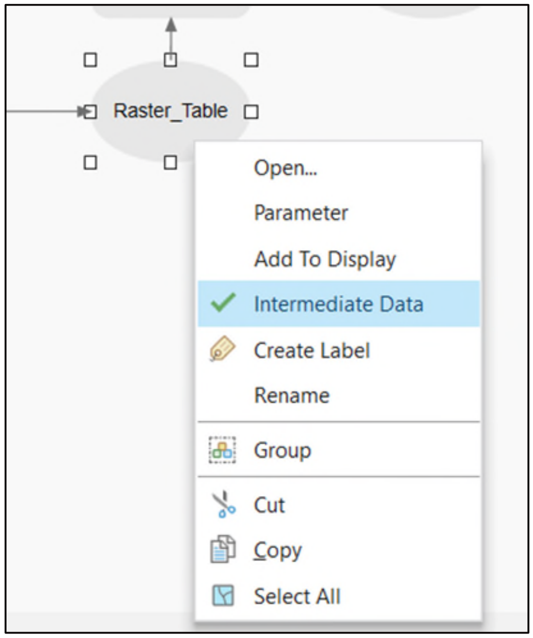


When the model is opened in the geoprocessing pane rather than in edit mode, the user should see the five parameterized variables as inputs. This view is shown in the screenshot below. The order of the input parameters can be edited by opening the model properties, navigating to the "Parameters" tab, and dragging the rows to the desired order. Input parameter names can be edited by renaming the corresponding blocks in the model editor.



3.3 Intermediate Data

Processes that occur as intermediate steps within the model have outputs that are considered "Intermediate Data" by default in ModelBuilder. Intermediate data do not automatically output to the file path specified in the model. For all outputs of intermediate steps in the model, right click on the output and uncheck "Intermediate Data."



3.4 Preconditions

Another valuable tool in ModelBuilder is setting preconditions. The example model follows a direct processing path in that outputs from one tool go directly into the next tool. Some models do not follow a direct processing path. Multiple outputs, sometimes from different processes, must be executed before the next step in the model can be performed. Setting these multiple outputs as preconditions to the next step in the model prevents the subsequent tool from executing until all of those outputs have been created. Using preconditions in more complex models is crucial to preventing errors. Connect the output data to the tool for which it is a precondition and select “Precondition.”

3.5 Additional Considerations

The example model process described above is typical of the Model. Additional indicators will likely follow a similar processing approach. Note that when processing feature classes instead of rasters, commands for geoprocessing are slightly different. The “Pairwise Clip” tool should be used rather than the “Extract by Mask” tool to clip the data to the study area and the “Summarize Within” tool should be used to calculate statistics rather than the “Zonal Statistics as Table” tool. User should familiarize themselves with the applicability of tools to different types of input datasets.

This example model does not cover logicals or iterators. Logicals allow the user to specify model processes that occur for a given true or false condition. Iterators allow the user to iterate through certain types of files within a folder or geodatabase, through fields in a table, and through many other data types. For more information on iterators and logicals, reference ArcGIS Pro’s online ModelBuilder documentation.

Appendix D

Appendix D: Troubleshooting Guide

Troubleshooting Guide

The following appendix details how to fix common errors that may occur when running the overall model (Model). Refer to section titles to navigate to specific ArcGIS Pro error codes and general model issues. ArcGIS error codes can be viewed by hovering over errors (shown as a red “X”) in the geoprocessing pane before running the model or by clicking on “View Details” in the error bar that appears at the bottom of the geoprocessing pane if the model fails.

1 ArcGIS Error Codes

1.1 Error 002598

This error message will show if a field in the attribute table already exists. Typically, this error occurs with the 12-digit hydrologic unit code (HUC12) watershed feature class and occurs if any of the models are run more than once. This is because each model within the HUC12 Watershed Prioritization toolset adds and renames a field in the HUC12 watershed feature class. When the field has already been added, the model does not know how to rename the field, so it throws an error. Even if the model is stopped partway through running and is not complete, these fields may still appear and prevent the models from being run again.

To fix this problem, open the attribute table of the HUC12 study area watershed feature class and delete the fields associated with the model that is erroring by right clicking on the field name and pressing “Delete.”

1.2 Error 00664

All input files must be stored in the Inputs geodatabase. If files are stored outside of a geodatabase, they are stored as different file types. For example, a shapefile is converted to a feature class when it is imported to a geodatabase. The models are very prescriptive about which types of files they process. Therefore, a model expecting a feature class input may error if a file stored outside of the Inputs geodatabase as a shapefile is input. Storing all files in the Inputs geodatabase ensures that files are the correct type (i.e. feature class rather than shapefile) for input into the model.

To fix this error check the file types of datasets used as inputs to the model. The user can do this by hovering over each input file in the catalog pane. Under “File Type,” the pop-up window should read “File Geodatabase Feature Class” or “Raster Dataset.” If any files do not fall under this category, review the save locations of each dataset and ensure that they are saved in the Inputs geodatabase.

1.3 Error 000271

This error occurs when the user edits input files. ArcGIS may throw an error even if the user did nothing wrong. If the user has edited the field names or values in an input file and a model produces this error, we recommend redownloading the inputs geodatabase and replacing the file that was edited with its original file. Close and reopen GIS. Ensure that any field or value edits are performed based on the methodology described throughout this manual.

1.4 Error 000820

This error will appear when the user adds input feature classes or raster data to the model. A red “X” will appear next to the input box. If the user hovers over this red “X,” the error message “000820: the parameters need repair” will open in the pop-up window. This error is caused by a bug in ArcGIS, possibly due to the download of the Model or due to discrepancies in the user’s ArcGIS version and the version in which the Model was created.

To fix this error, close the geoprocessing pane and navigate to the model of interest in the catalog pane. Right click on the model and select “Edit.” When the model window opens, right click on an input that is parameterized. Parameterized inputs have a small, grey “P” next to their input box. For example, for the Land Cover model, an example of a parameterized input is the “NLCD Land Cover Data.” After right clicking on the parameterized input, uncheck “Parameter.” When this is unchecked the grey “P” above the parameterized input will disappear. Next, right click on the parameterized input and re-check “Parameter.” Save the model by clicking “Save” in the top left corner of the ModelBuilder toolbar.

The model is the same as it was before the user opened the model and made edits. The only purpose of checking and unchecking the parameterized input is to make a change to the model such that the user can save the model. The act of saving the model repairs the parameters and allows the user to run the model.

1.5 Error 000870

This error means the model has already been run or run to partial completion and the corresponding table was generated in the Outputs geodatabase. Most models in the Model generate a table that is output to the Outputs geodatabase. Sometimes ArcGIS will not overwrite files that already exist in the output location with the same name. When the model is run more than once, and the output table already exists, the model will error.

To fix this, navigate to the Outputs geodatabase, right click on the table that corresponds to the model that is erroring, and select “Delete.” The user may also have to delete the corresponding data that was generated in the Scratch geodatabase.

1.6 Error 100032

This error will primarily occur when running the Roadway and Flow Intersection model. To address this error, the way the data is brought into the model must be changed. Rather than dragging data directly into the geoprocessing pane from the catalog pane, data should first be added to the contents pane. This will add it to the map view in the main frame of the ArcGIS window. From the catalog pane, right click on the roadway data and National Hydrography Dataset (NHD) flowlines in the Inputs geodatabase and select “Add to Current Map” or “Add to New Map” if there is not an existing map. Add the roadway, NHD flowline, and HUC12 watershed data to the map. Once the map is created, the user can also drag data directly from the catalog pane to the contents pane. Open the Roadway and Flow Intersection model geoprocessing pane and input the Outputs geodatabase and Scratch geodatabase by dragging them in from the catalog pane. Select the roadway data from the map contents pane rather than from the Inputs geodatabase in the catalog pane and drag the data from the map contents pane into the geoprocessing pane. Do the same for the flowline and HUC12 watershed data. Run the model by clicking on the “Run” button on the bottom right of the geoprocessing pane.

1.7 Error 999999

This is a generalized error message that occurs when something unidentifiable causes the model to fail.

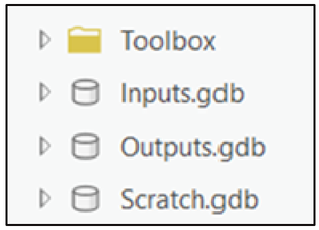
This error most commonly occurs when running the Slope and LiDAR model. To address this error, users will have to try a variety of fixes until the model runs.

First, users should simply try closing and reopening ArcGIS. Users may also try restarting their computer entirely. If these fixes do not work, users should add the USGS LiDAR tiles and any relevant input data into the map contents pane. This solution is similar to the one described for Error 100032. After dragging data into the map, the user should add the input data into the geoprocessing pane directly from the map contents pane.

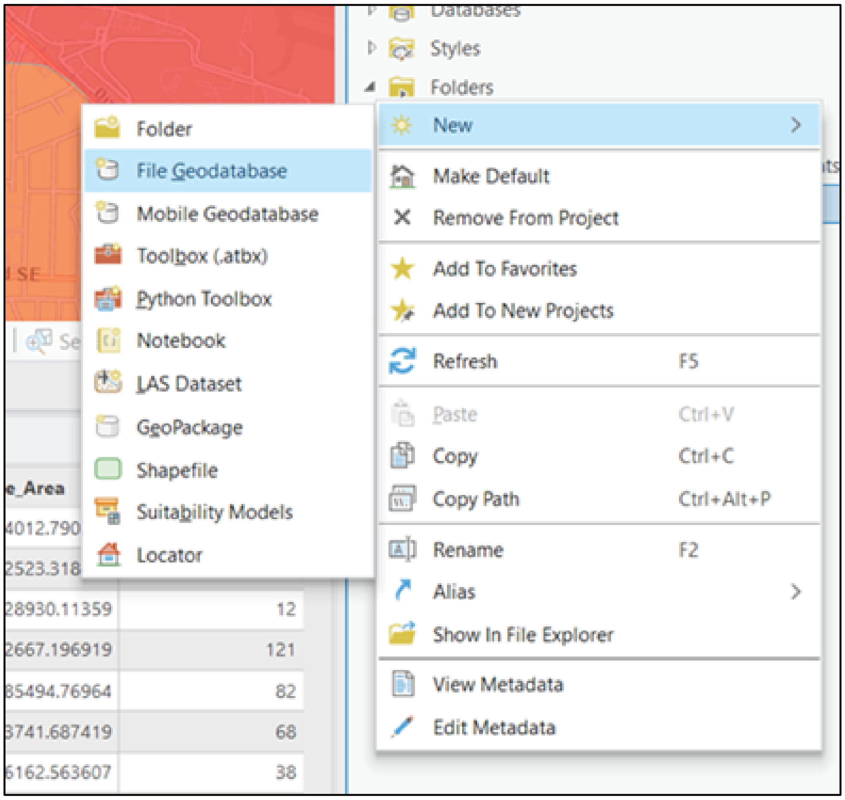
2 Model Download Errors

2.1 Scratch & Outputs Geodatabases

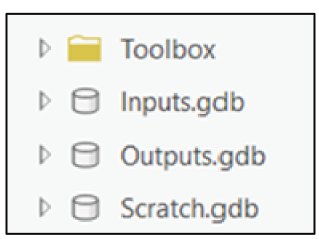
Along with the Inputs geodatabase folder, two other geodatabases should download from Trash Trap Guide Download - Chattahoochee Riverkeeper: the Scratch geodatabase and Outputs geodatabase. If the user’s folder in the ArcGIS catalog pane does not look like the figure below, the user will need to set up these geodatabases according to the following instructions.



Navigate to the catalog pane by going to “View” on the top ribbon. Under “Windows” click on “Catalog Pane”. From here, open the Model folder and right click to add a file geodatabase as seen below.



Name this file geodatabase “Scratch”. Repeat this process and name the second file geodatabase “Outputs”. Once this is finished the final model folder should look like the figure below.



2.2 Duplicate Download Folders

Sometimes the Model downloads with duplicate folders. This is likely caused by the size of the download. When the user unzips the downloaded .zip file, two folders might appear. For example, if the Model folder is “TrashTrapPrioritizationModel,” two folders may appear in the unzipped folder: “TrashTrapPrioritizationModel” and “_TrashTrapPrioritizationModel.” Confirm that the duplicate folder, “_TrashTrapPrioritizationModel,” is empty. The duplicate folder may have folders within it, but these folders should all be empty. If the duplicate folder is empty, delete it and proceed with execution of the Model. If the duplicate folder is not empty, confirm that the original folder (“TrashTrapPrioritizationModel”) has all relevant files in the ArcGIS catalog pane. If the original folder is complete, delete the duplicate folder. If the original folder is not complete, attempt to download the Model again. Ensure that your computer has sufficient storage for the download.

3 General Troubleshooting

Because ArcGIS is such a powerful software, it is easy to make changes to the models and input data that cause bugs in the execution of the model. These are especially common if the model runs once, unsuccessfully, and then subsequent attempts are made to run the model after changes to the inputs. If the specific troubleshooting above fails, we recommend redownloading the Model and making necessary changes with the original data. Visit the Trash Trap Guide Download - Chattahoochee Riverkeeper for information on training dates and troubleshooting contact information.

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