2019

GRAIP Lite Quick Start

Version 1.2 – August 6th, 2019

GRAIP Lite Quick Start

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GRAIP Lite Quick Start

1.0 Installation

1.1 ArcMap

- Prerequisite: ArcGIS 10.5.1 or later with Spatial Analyst and 3D Analyst extensions. Advanced license required for some of the tools in the toolset.
- Install Arc Hydro Tools:
    - 10.5.0.125 or later on a computer with ArcGIS 10.5.1.

1.2 ArcGIS Pro

- Prerequisite: ArcGIS Pro 2.x or later with Spatial Analyst and 3D Analyst extensions.
- Install Arc Hydro Tools for Pro 2.0.37 or later on a computer with ArcGIS Pro 2.x or later.

1.3 R Support for Calibration

This is an optional step required only if you want to create new calibration data for GRAIP Lite.

- Download and install R from http://cran.cnr.berkeley.edu/bin/windows/base. Accept all default in the installation wizard.
- Optional: download RStudio Desktop from https://www.rstudio.com/products/rstudio/download3. Accept all defaults in the installation wizard.
- Install the R-ArcGIS bridge. You need to install it only once either using ArcMap or ArcGIS Pro to have it working in both ArcMap and ArcGIS Pro.

Using ArcMap

- Go to https://github.com/R-ArcGIS/r-bridge-install. Click Clone or Download and then click Download ZIP to download the project repository as a zip file. You can also click the following link: https://github.com/R-ArcGIS/r-bridge-install/archive/master.zip.

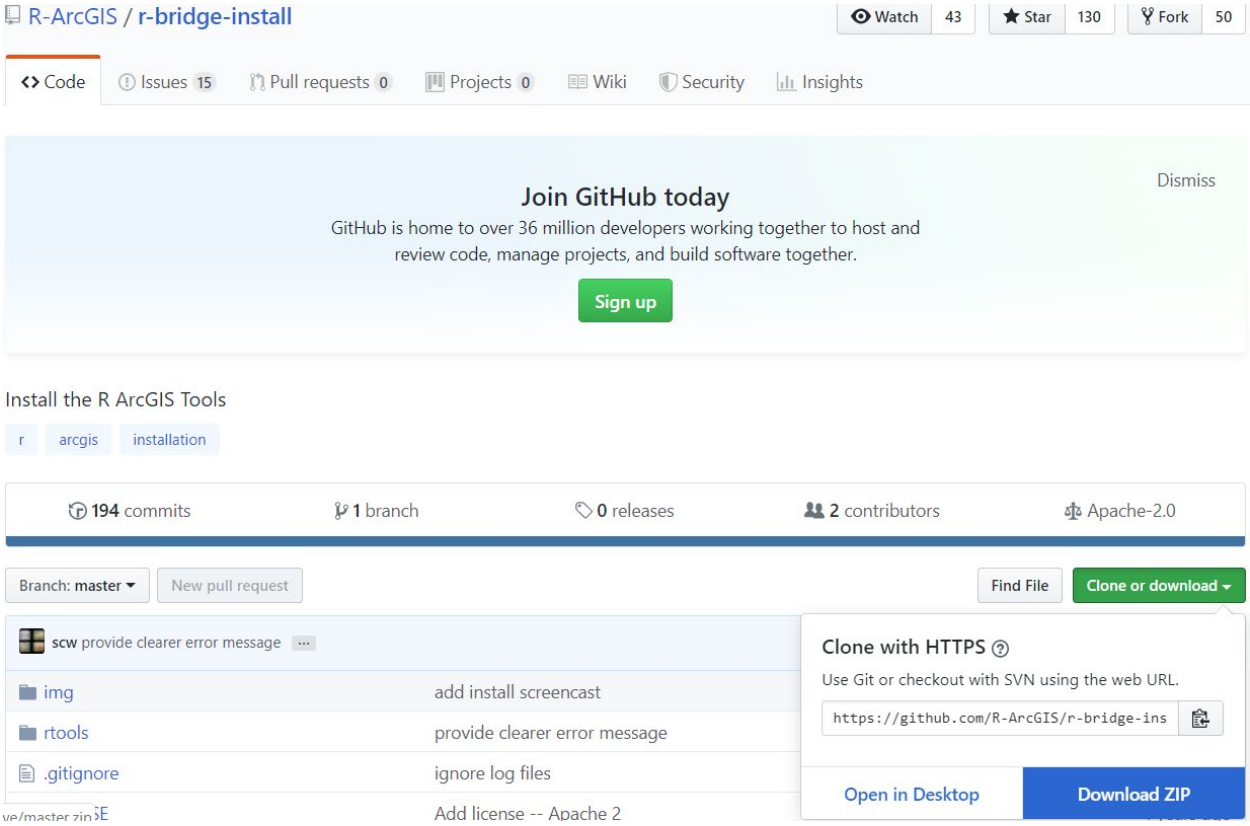


Figure 1 - Downloading r-bridge-install

- Extract the contents of the zip file.
- Download the latest version of the arcgisbinding package from https://github.com/R-ArcGIS/r-bridge/releases/latest.
- Place the arcgisbinding_x.zip in the same directory as the R integration Python toolbox.

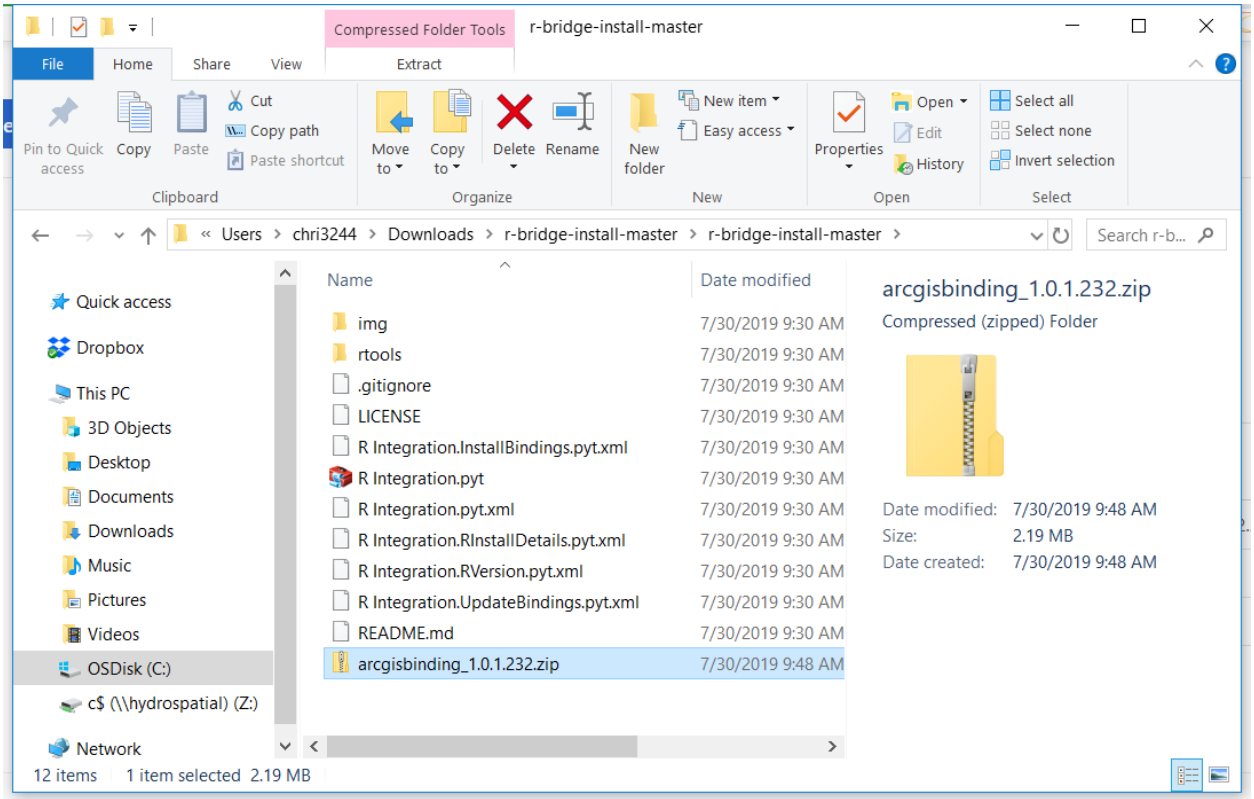


Figure 2 – R Integration Toolbox folder

- Open ArcMap and connect to the extracted location in the Catalog window.

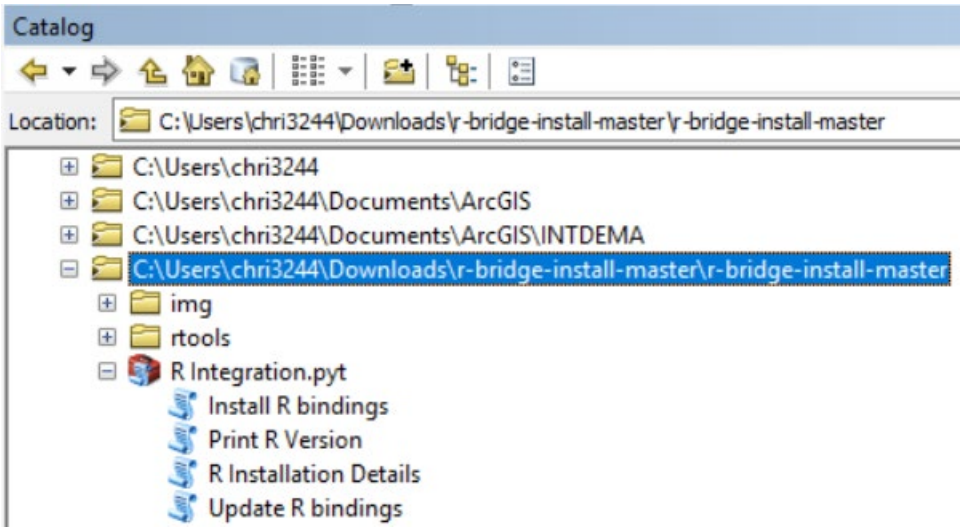


Figure 3 - r-bridge-install-master extracted folder

- Browse to the R Integration.pyt toolbox and double-click the tool Install R bindings.

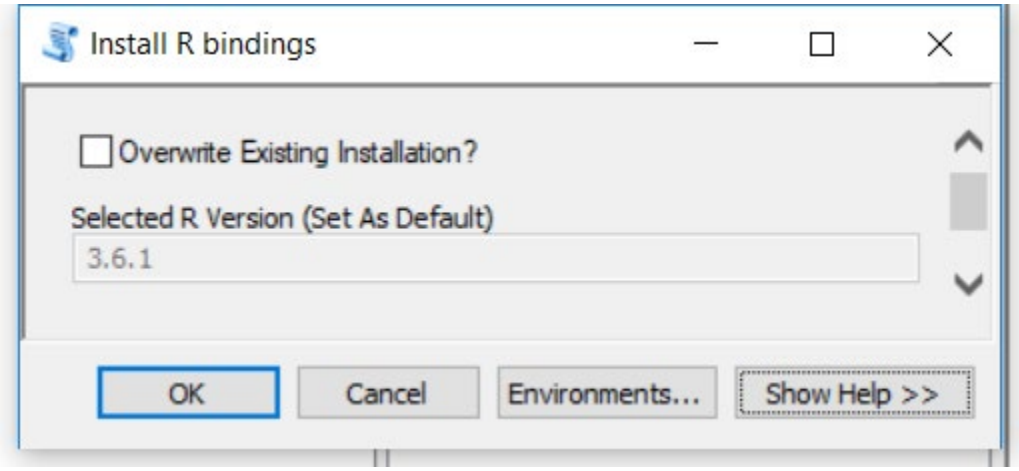


Figure 4 - Install R bindings Tool

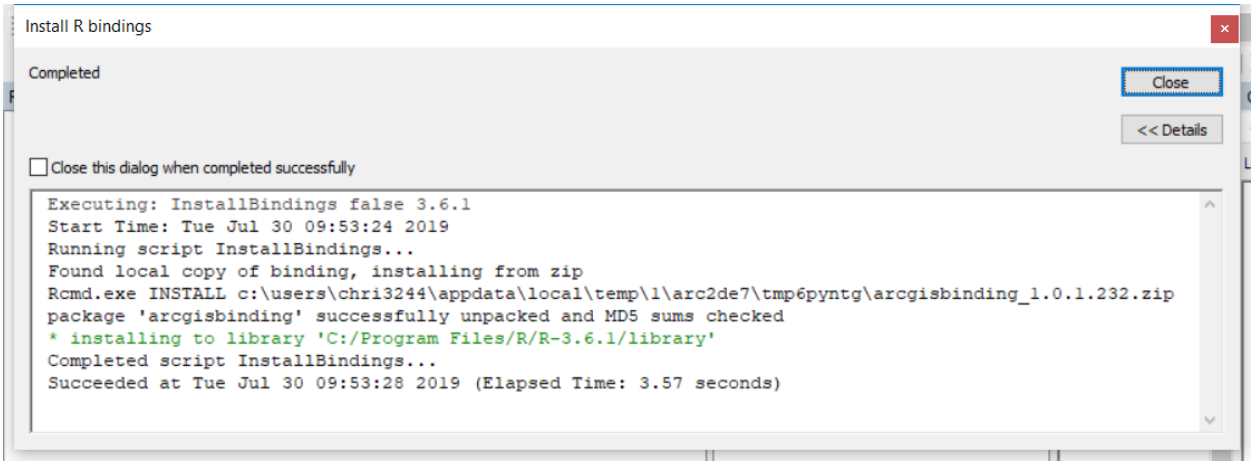


Figure 5 - Install R bindings Tool Execution Message

The installation is complete.

Using ArcGIS Pro

- Open a new project and on the ribbon click the **Project** tab.

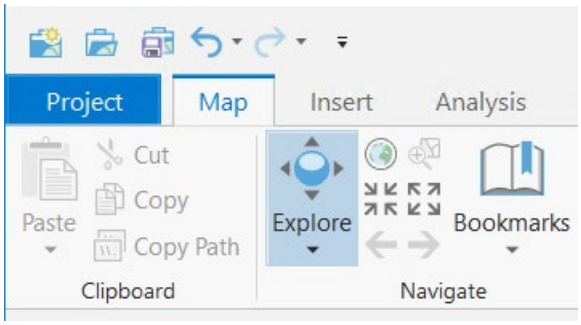


Figure 6 – Project tab in Pro

- Click Options. In the **Options** pane, in the Application list, click **Geoprocessing**.

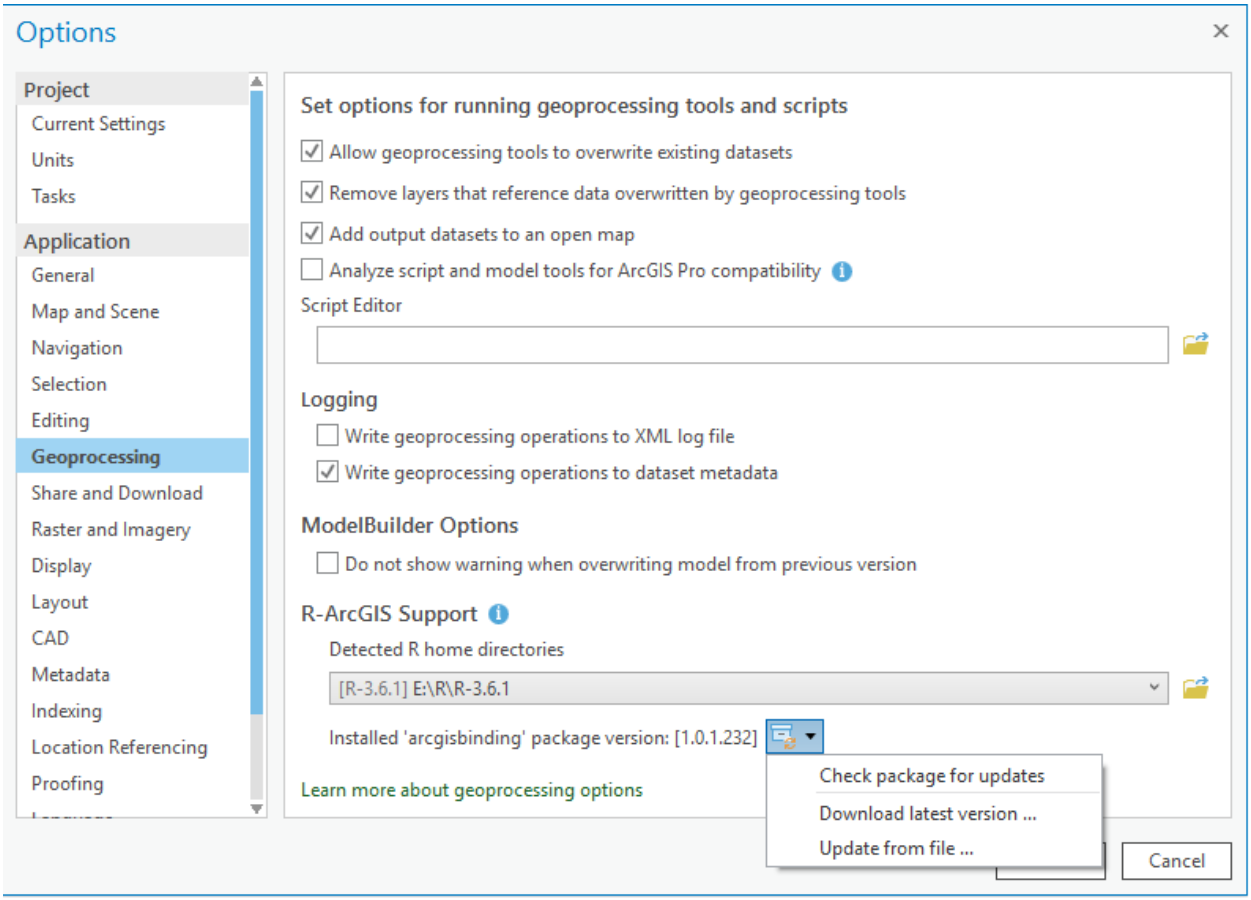


Figure 7 - Geoprocessing Options

- In the R-ArcGIS Support section, select your desired R home directory. All versions installed on your computer will appear in the list. Select a version later than R 3.2.2.

Note

If you have not already installed the R-ArcGIS bridge, a warning appears indicating that you need to install the `arcgisbinding` R package to connect R with ArcGIS. You can automatically download and install the `arcgisbinding` package, download the package separately, or install the package from a file. If you previously installed the R-ArcGIS bridge, an installed message appears indicating the version of your `arcgisbinding` package. You are presented with options to check for updates, download the latest version, or update from a file.

If applicable, click the icon next to the warning, and select the option to automatically download and install the `arcgisbinding` package. Otherwise, check for updates and ensure that you have the latest version of the package.

- In the **Options** window, click **OK**. Click the **Back** button to return to the open map.

The installation is complete.

2.0 Setting the Environment

2.1 ArcMap

- Open a new map document in ArcMap. Save the map in your project location (e.g. TestSeptember.mxd under folder TestSeptember.
- Open the Catalog window in ArcMap and dock the window to the right.

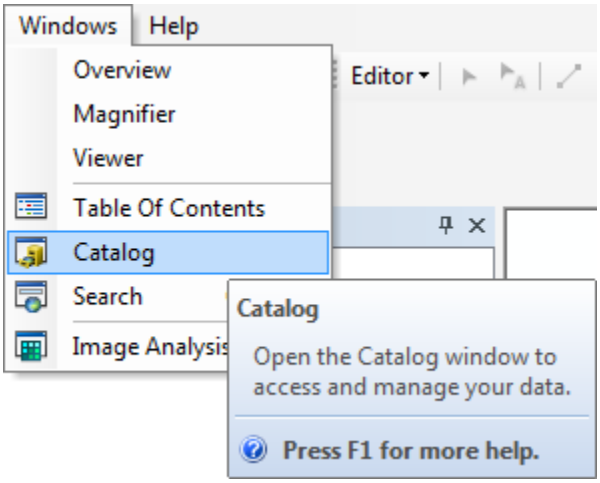


Figure 2-1 - Opening Catalog Window in ArcMap

The location of the map document becomes the Home location for the map and is displayed at the top of the Catalog window.

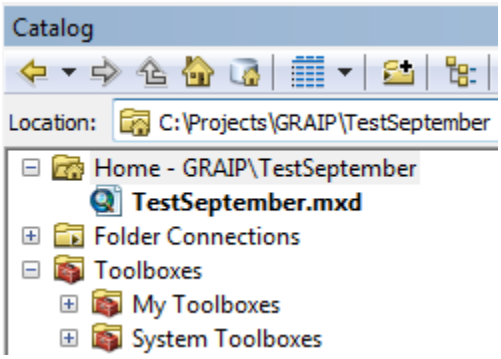


Figure 2-2 – Home Location in Catalog Window

- In the Catalog window, browse to Toolboxes > System Toolboxes and look for the GRAIP Lite toolbox.

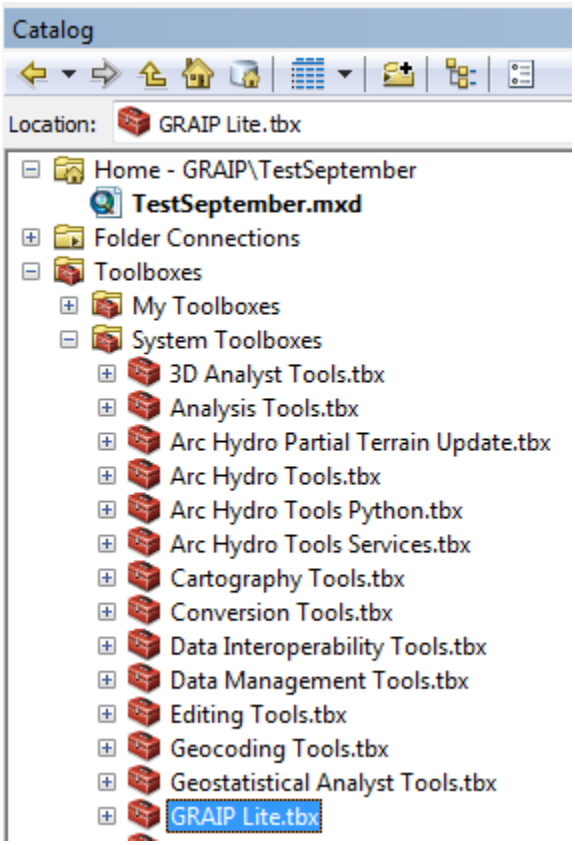


Figure 2-3 – GRAIP Lite Toolbox

Note

The GRAIP Lite toolbox uses tools from the Arc Hydro Tools Python toolbox. This toolbox must be loaded in memory, i.e. it must be visible in the ArcToolbox window. You may need to add the toolbox manually the first time you install the Arc Hydro Tools.

- On the standard toolbar click the ArcToolbox icon ( ) to open the ArcToolbox window.
- Look for the Arc Hydro Tools Python toolbox.

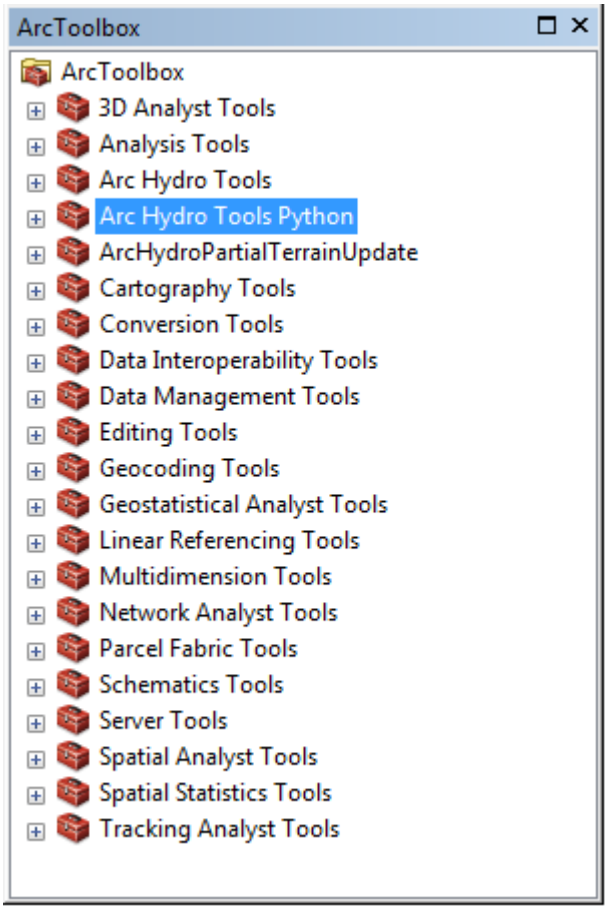


Figure 2-4 – Arc Hydro Tools Python toolbox

- If you do not see the Arc Hydro Tools Python toolbox, you need to add it manually to the ArcToolbox window:
    - Right-click the top ArcToolbox node and select Add Toolbox… in the context menu.

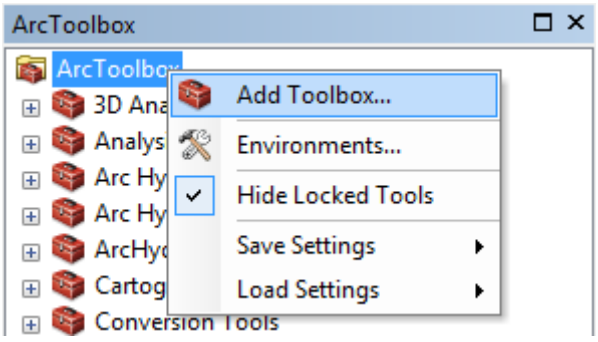


Figure 2-5 – Adding Toolbox in ArcToolbox window

    - Browse to the location where the ArcGIS toolboxes are installed (e.g. C:\Program Files (x86)\ArcGIS\Desktop10.3\ArcToolbox\Toolboxes), select Arc Hydro Tools Python.tbx and click Open to add the toolbox.

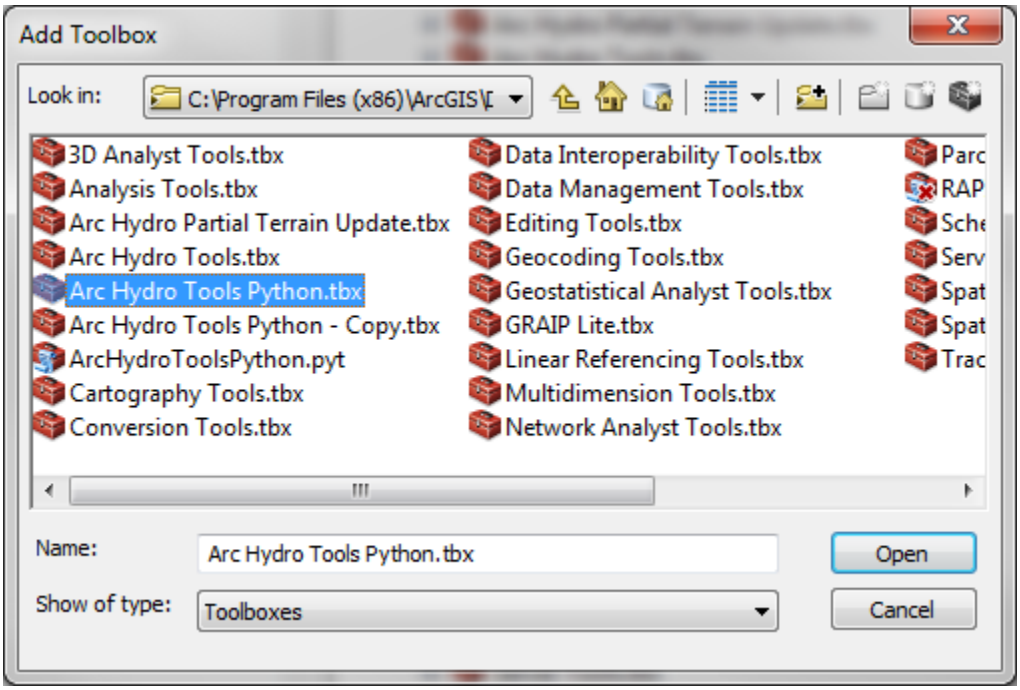


Figure 2-6 – Adding Arc Hydro Tools Python Toolbox

The toolbox should now be visible in the ArcToolbox window.

- Right-click the top ArcToolbox node and select Save Settings > To Default in the context menu.
- Close the ArcToolbox window.

Geoprocessing Settings

- Open the Geoprocessing menu in the main toolbar in ArcMap and select Geoprocessing Options….

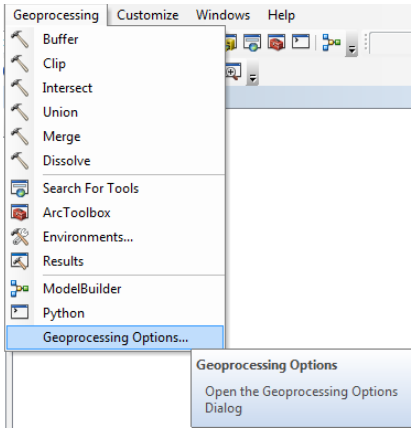


Figure 2-7 – Geoprocessing Options

- Check the options to overwrite the outputs and to add the results to the display. Turn off background processing.

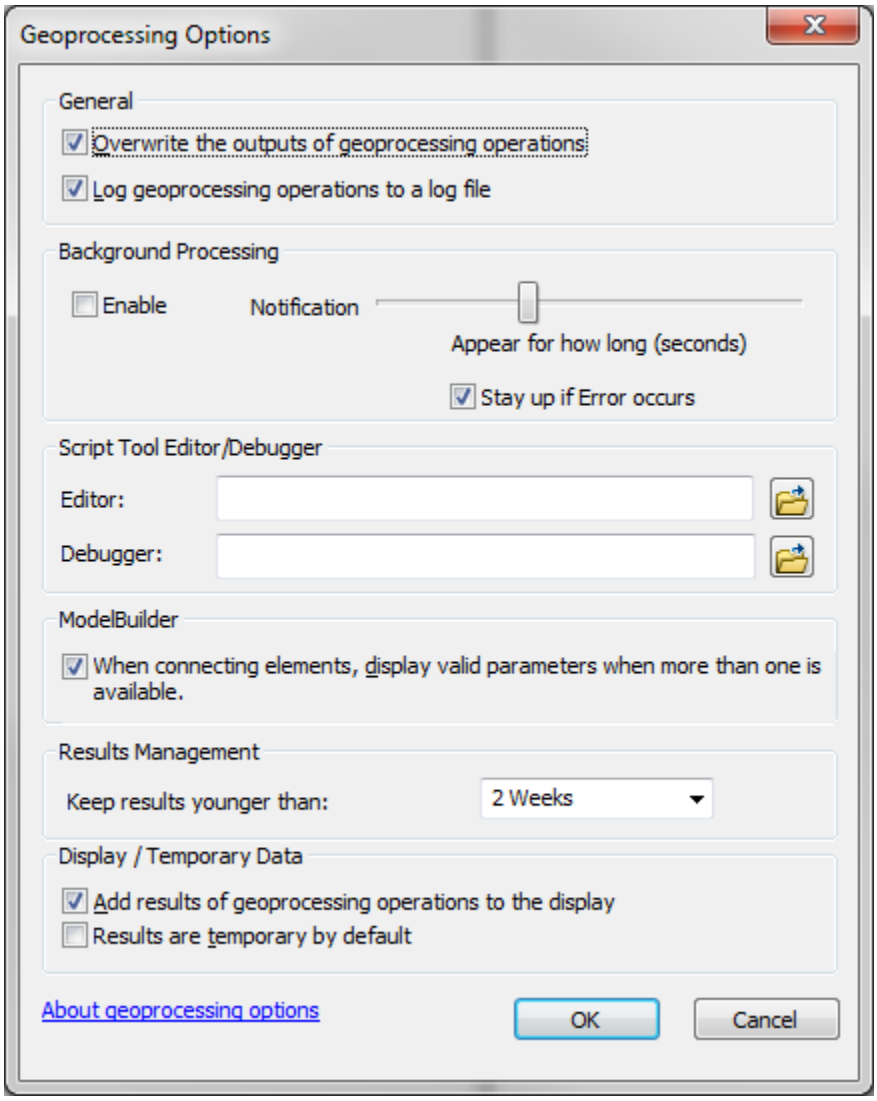
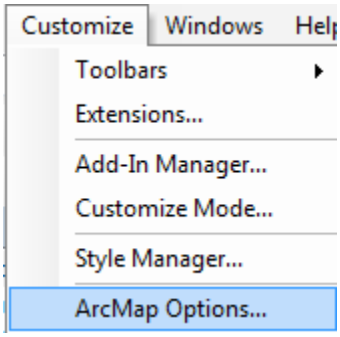


Figure 2-8 – Geoprocessing Options Window

ArcMap Settings

To improve performance, you should uncheck the option “Make newly added layers visible by default”.

- Select Customize > ArcMap Options…



- Uncheck “Make newly added layers visible by default” and click OK.

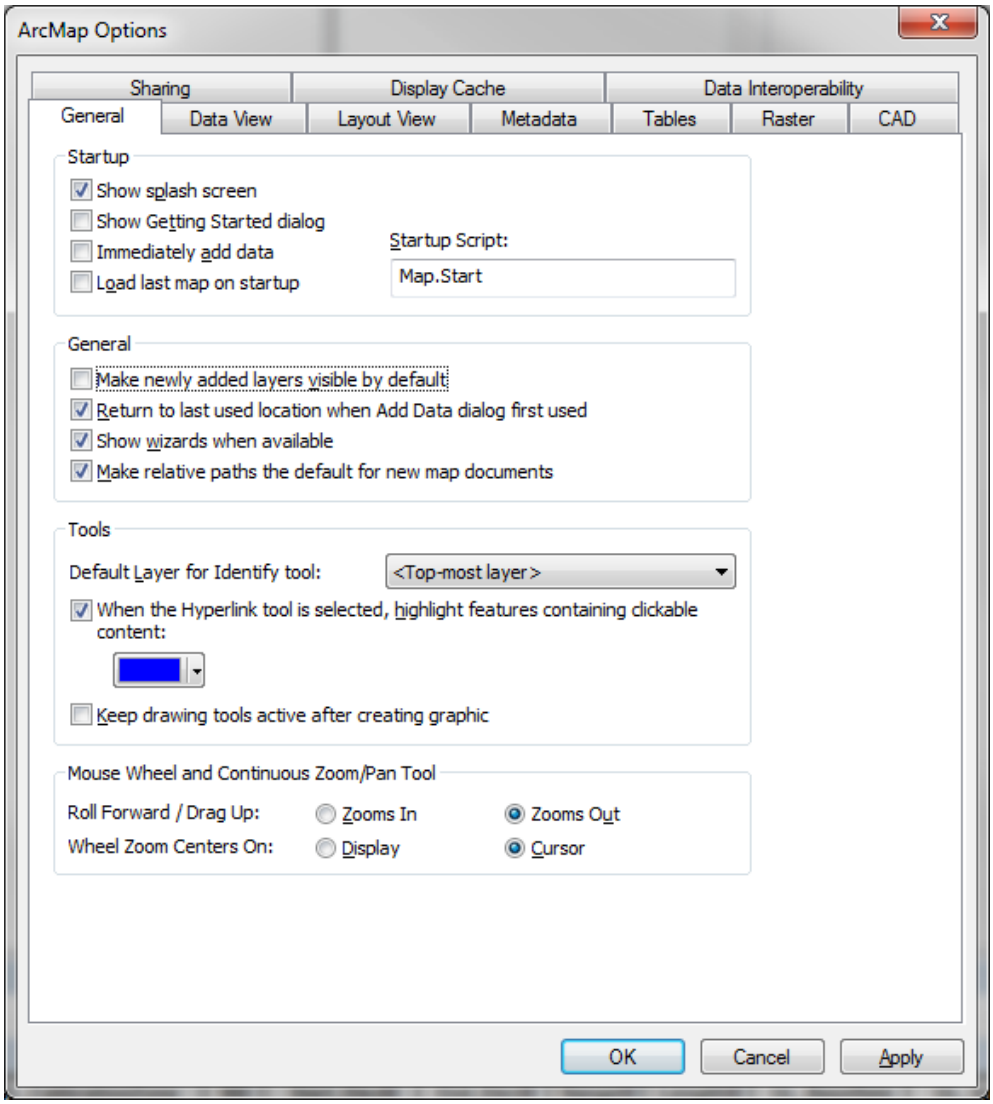


Figure 2-9 – ArcMap Options

3.0 Input Data

The GRAIP Lite toolset requires 2 inputs:

- Digital Elevation Model
- Road

3.1 Digital Elevation Model

The input DEM is used to set the spatial reference for the analysis. It should use a meaningful projection allowing performing length and area based analyses. The DEM is used to retrieve elevation and establish the overland flow of water as well as computing the distance to the streams.

3.2 Road

The input Road layer must have clean geometries to yield correct results even though the GRAIP Lite tools will run with "bad" geometries.

Geometry checks

- No zero length lines
- No multipart features
- No loop (from_node = to_node) ()
- No end loop ()
- No overlap – Need to decide which feature to keep (attributes)
- Connectivity issue
- Bad geometries – duplicate vertices and overlap

Attributes

No attributes are required in the input Road. However if the following INFRA attributes are present and populated, they will be used to populate some of the GRAIP Lite attributes instead of using default values.

- ROUTE_STAT
- OPER_MAINT
- SURFACE_TY

Optional input fields:

- NEWROAD
- TRAFFIC (used in previous version – not used currently)

QC Road

The input roads should be single part features with no overlaps or loops. You can use the GRAIP Lite tool QC Roads to look for multipart features, overlaps and loops if needed. Note that the other GRAIP Lite tools will run on roads having data issues but you may encounter unexpected results with some of the "bad" geometries.

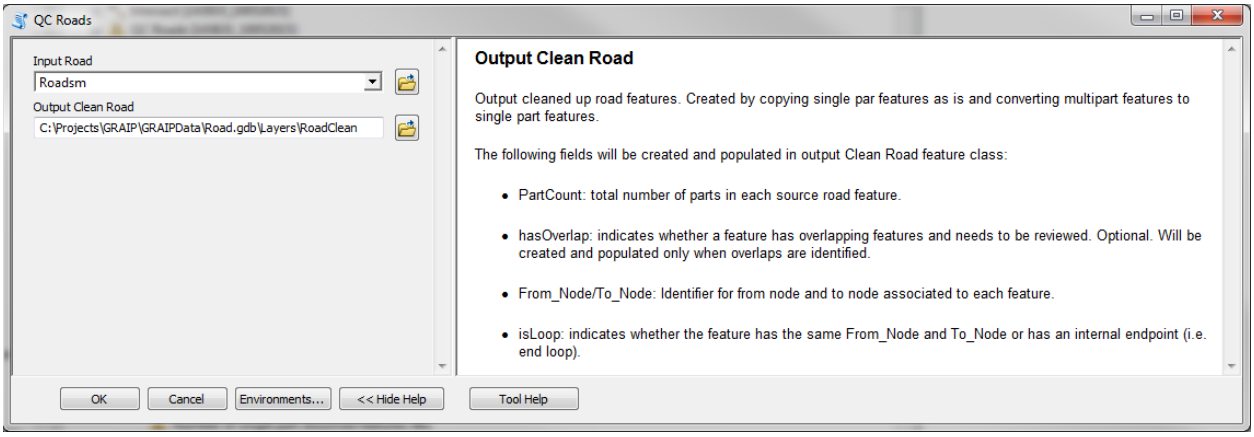


Figure 3-1 – QC Roads Tool

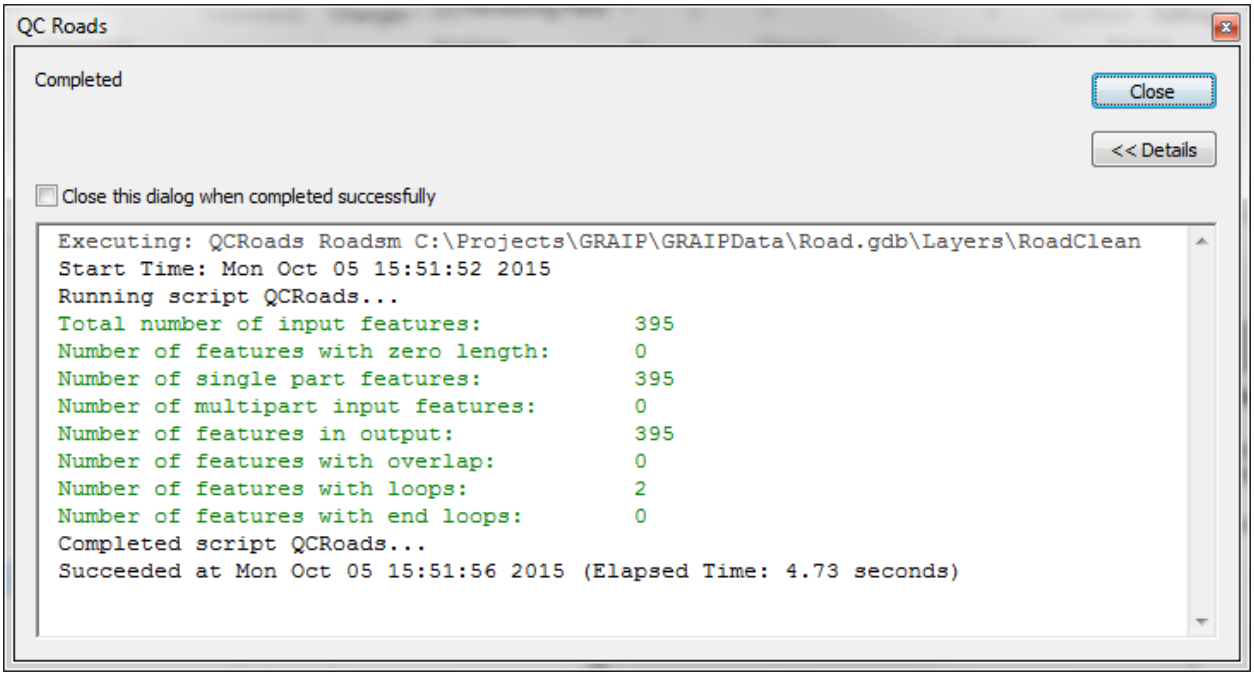


Figure 3-2 – QC Roads Log

The roads with loops or overlaps will be displayed in the map for review.

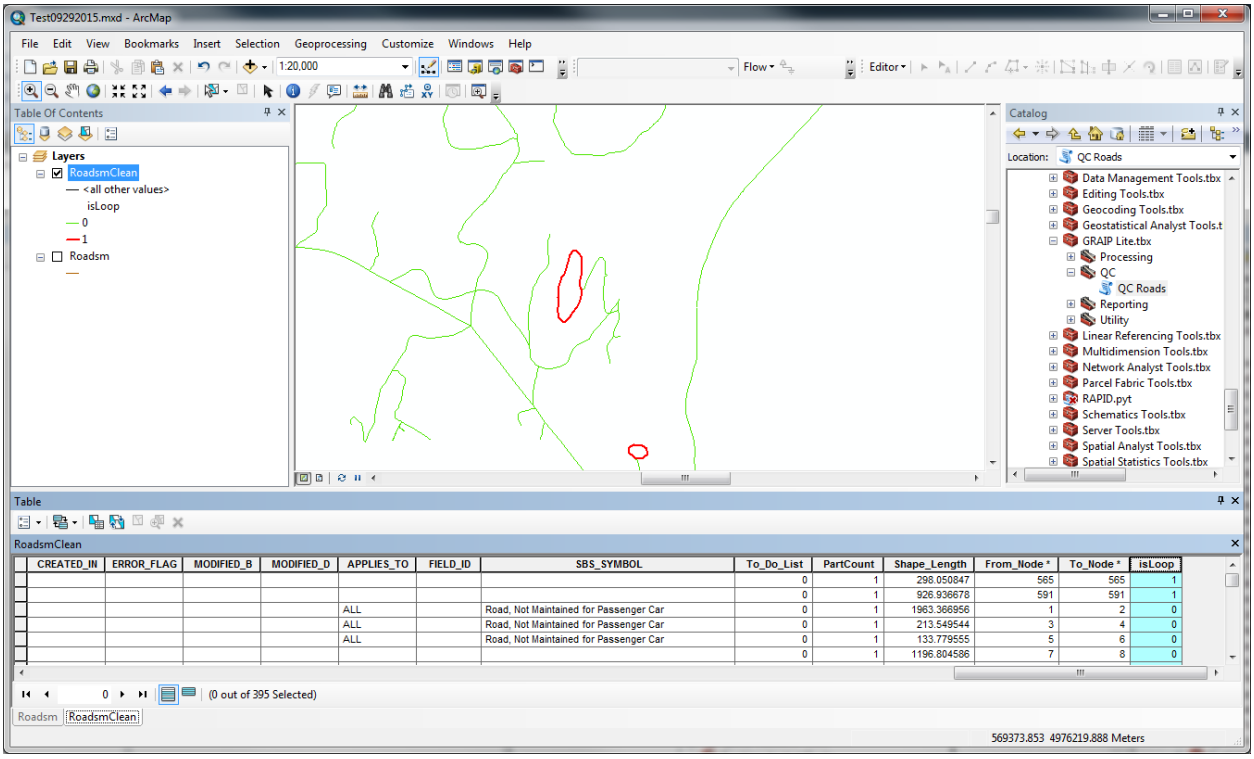


Figure 3-3 – QC Roads Results

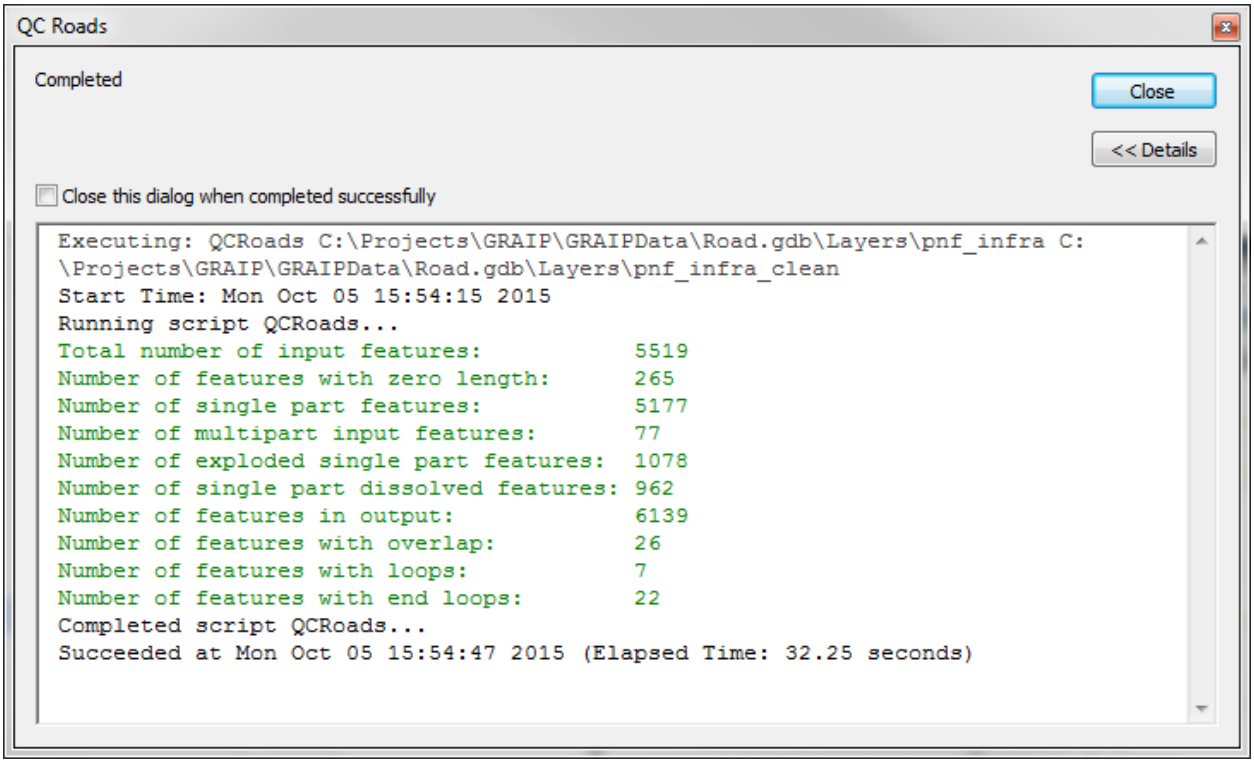


Figure 3-4 – QC Roads on pnf_infra

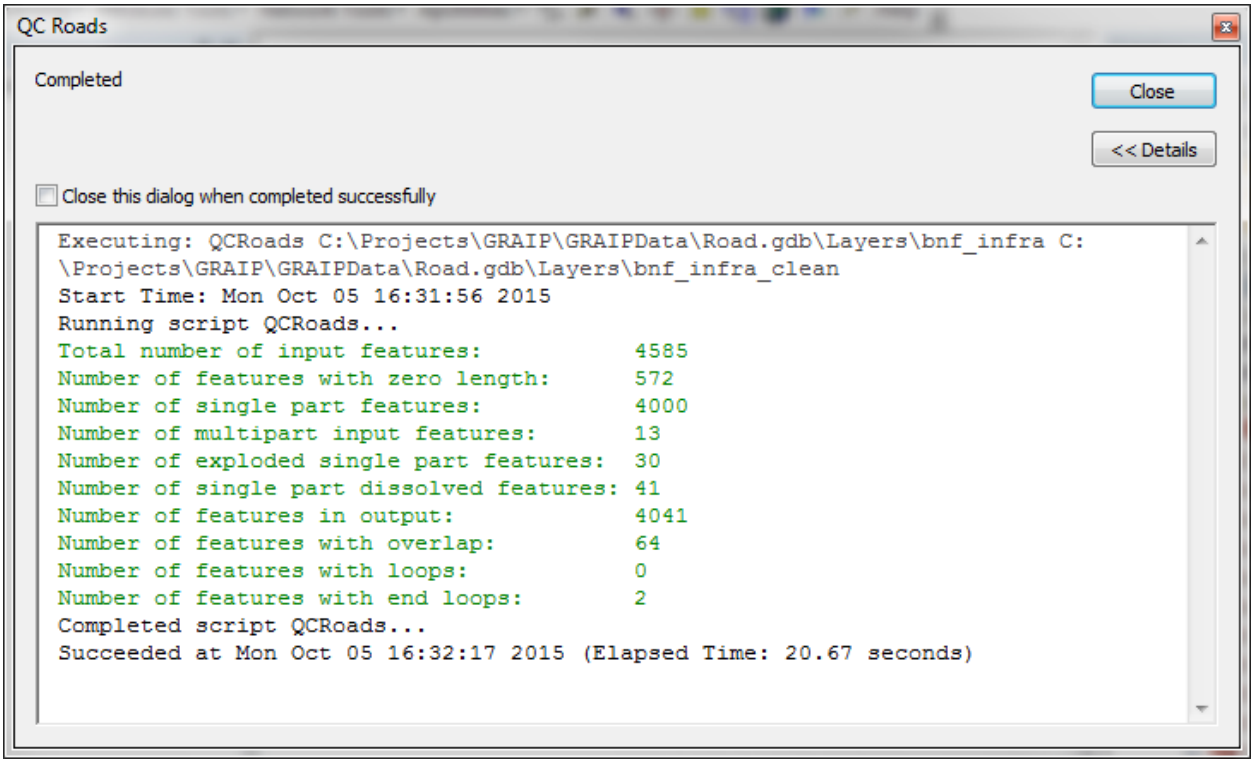


Figure 3-5 – QC Roads on bnf_infra

The associated Overlap layer showed the overlapping features.

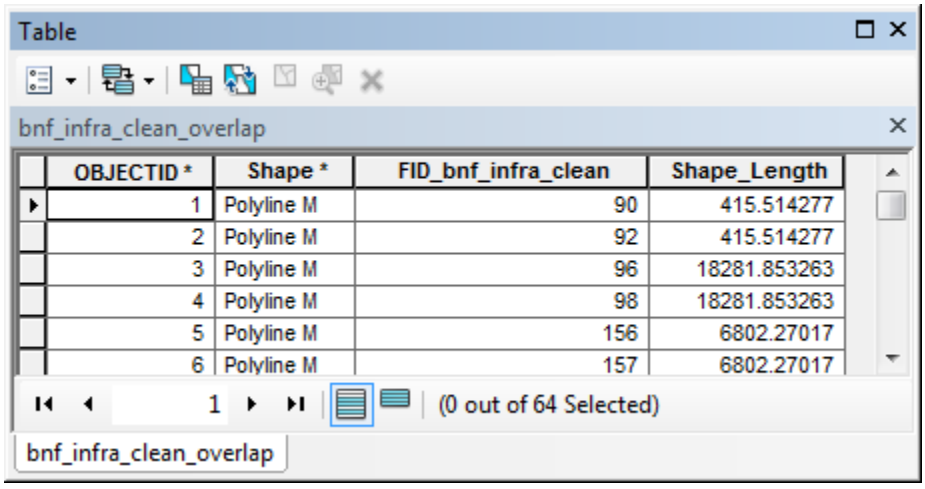


Figure 3-6 – Overlapping layer

Feature to Line

This tool may be used to cleanup bad geometry. It will also perform single part to multipart conversion and segment the lines at their intersection with other lines. For overlapping features, 2 lines will be returned.

Validate Input Road Attributes

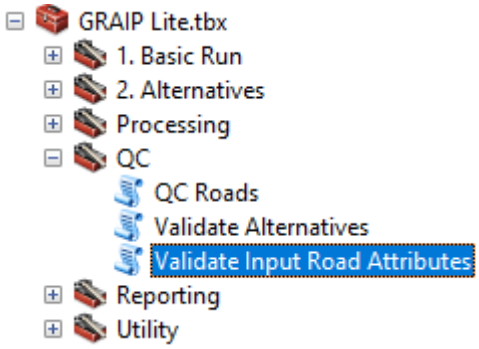


Figure 7 - Validate Input Road Attributes

This tool reports incorrect values in the INFRA fields in the input Road layer. It creates a copy of the input Road layer and a QC field for each input INFRA field. This field is populated with the value from the INFRA field only if this value is invalid.

The tool validates the following fields:

- SURFACE_TYPE or SURFACE_TY
- OPER_MAINT_LEVEL or OPER_MAINT
- ROUTE_STATUS or ROUTE_STAT

The tool creates the following QC fields if the associated input field exists:

- QC_SURFACE_TYPE or QC_SURFACE_TY
- QC_OPER_MAINT_LEVEL or QC_OPER_MAINT
- QC_ROUTE_STATUS or QC_ROUTE_STAT

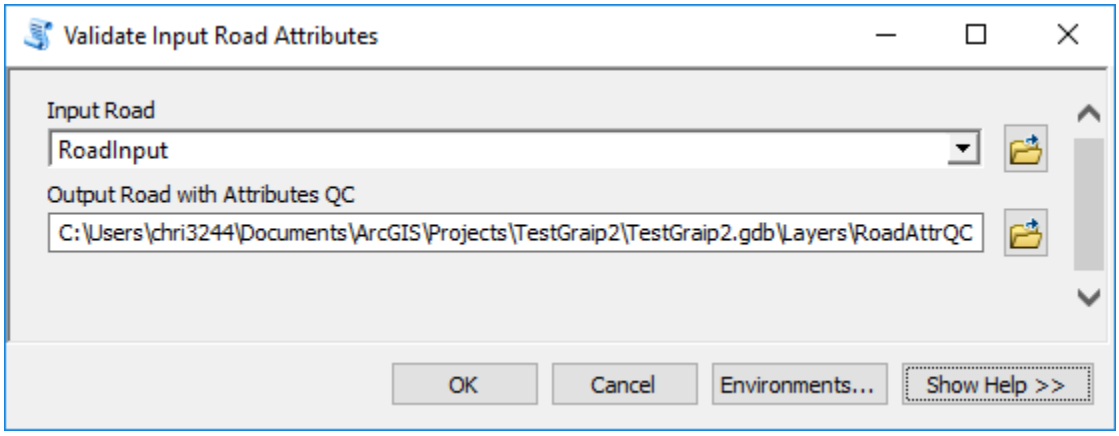
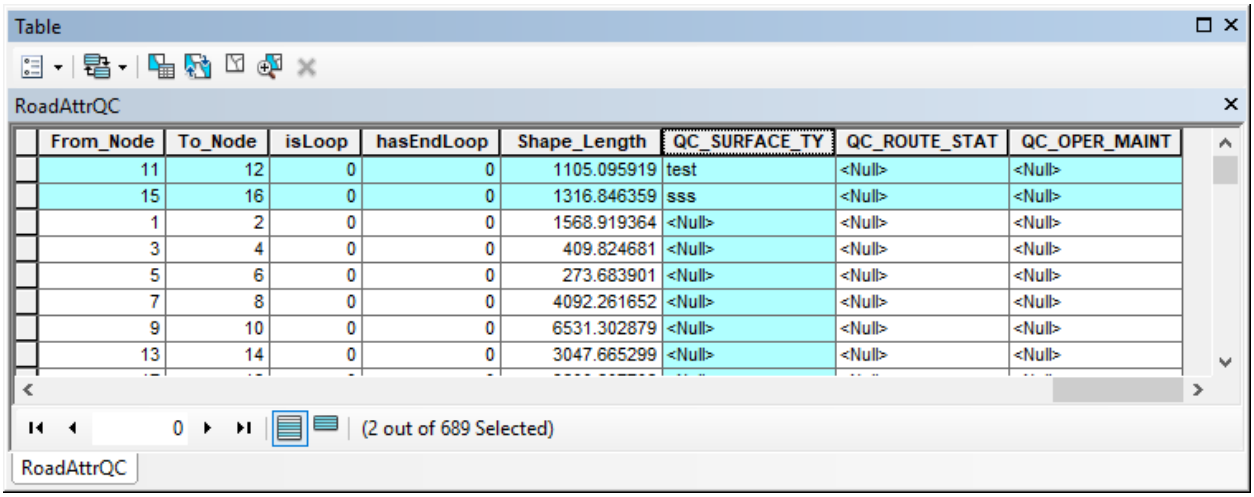


Figure 8 – Validate Input Road Attributes UI

Figure 9- Validate Input Road Attributes Message



From_Node	To_Node	isLoop	hasEndLoop	Shape_Length	QC_SURFACE_TY	QC_ROUTE_STAT	QC_OPER_MAINT
11	12	0	0	1105.095919	test	<Null>	<Null>
15	16	0	0	1316.846359	sss	<Null>	<Null>
1	2	0	0	1568.919364	<Null>	<Null>	<Null>
3	4	0	0	409.824681	<Null>	<Null>	<Null>
5	6	0	0	273.683901	<Null>	<Null>	<Null>
7	8	0	0	4092.261652	<Null>	<Null>	<Null>
9	10	0	0	6531.302879	<Null>	<Null>	<Null>
13	14	0	0	3047.665299	<Null>	<Null>	<Null>

Figure 10 - QC Fields added by Validation

Validate Alternatives

The Validate Alternatives tool may be used after selecting treatments to validate the combination of V,T, L,S specified for the roads. The tool takes as input an alternative road layer and creates a copy. It creates the fields GL_CalibrationZone, GL_VegFactor (0, 1 ,2), GL_SurfaceFactor (0, 1, 2) and GL_BaseRate (0, 1, 2).

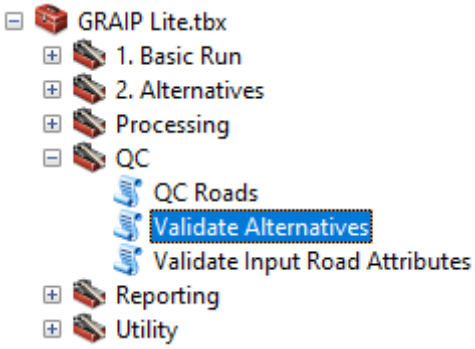


Figure 11 - Validate Alternatives Tool

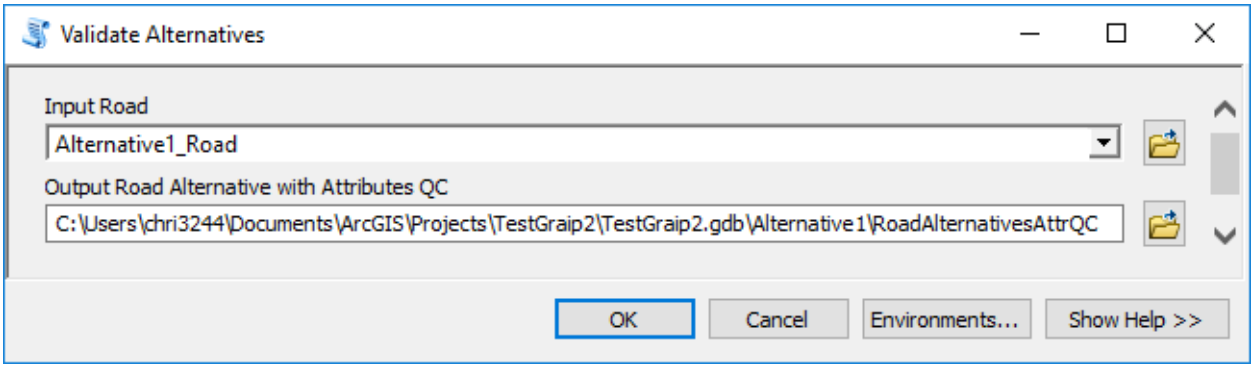


Figure 12 – Validate Alternatives QC

The tool reports the oid in the output layer of the records having V,T,L,S values not matching the combinations specified in the configuration tables.

```
Executing: ValidateAlternatives Alternative1_Road
C:\Users\chri3244\Documents\ArcGIS\Projects\TestGraip2\TestGraip2.gdb\Altern
ative1\RoadAlternativesAttrQC
Start Time: Thu Jul 11 14:58:07 2019
Running script ValidateAlternatives...
Accessing schema workspace c:\program files
(x86)\arcgis\desktop10.5\ArcToolbox\Scripts\GRAIP\GRAIPLiteSchema.gdb...
Processing alternative 0
GL_VegFactor not defined for oid 6: Default-Not a road-1. Setting
GL_VegFactor to 0.
Surface Factor not defined for oid 690: surface type None and traffic None.
Setting GL_SurfaceFactor to 0.
GL_VegFactor not defined for oid 690: Default-None-None. Setting
GL_VegFactor to 0.
Surface Factor not defined for oid 691: surface type None and traffic None.
Setting GL_SurfaceFactor to 0.
GL_VegFactor not defined for oid 691: Default-None-None. Setting
GL_VegFactor to 0.
Processing alternative 1
Surface Factor not defined for oid 690: surface type None and traffic None.
Setting GL_SurfaceFactor to 0.
GL_VegFactor not defined for oid 690: Default-None-None. Setting
GL_VegFactor to 0.
Surface Factor not defined for oid 691: surface type None and traffic None.
Setting GL_SurfaceFactor to 0.
GL_VegFactor not defined for oid 691: Default-None-None. Setting
GL_VegFactor to 0.
Processing alternative 2
Surface Factor not defined for oid 690: surface type None and traffic None.
Setting GL_SurfaceFactor to 0.
GL_VegFactor not defined for oid 690: Default-None-None. Setting
GL_VegFactor to 0.
Surface Factor not defined for oid 691: surface type None and traffic None.
Setting GL_SurfaceFactor to 0.
GL_VegFactor not defined for oid 691: Default-None-None. Setting
GL_VegFactor to 0.
Completed script ValidateAlternatives...
Succeeded at Thu Jul 11 14:58:14 2019 (Elapsed Time: 6.56 seconds)
```

For example, the tool set the values for GL_VegFactor0 and GL_SurfaceFactor0 to 0 as there were no values associated to the combination of fields set for alternative 0 for the highlighted record.

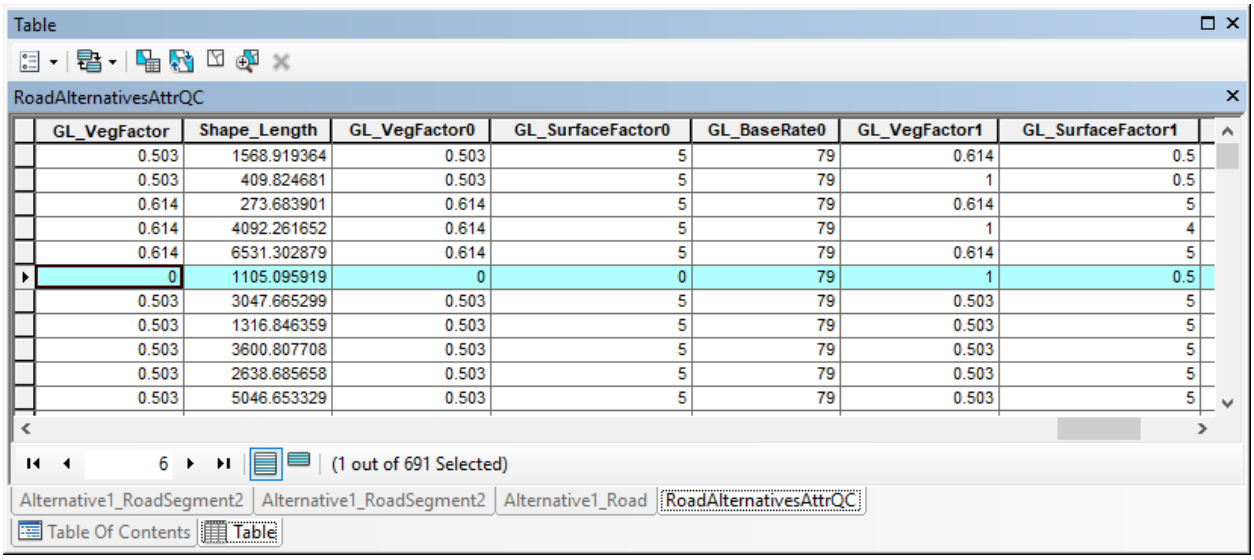


Figure 13 – QC Attributes

4.0 Basic Run and Report

The Basic Run toolset automates the processing steps and creates a default pdf file. This toolset requires the user to provide as input only a Road layer and a DEM in an adequate projection. The tool uses the default calibration.

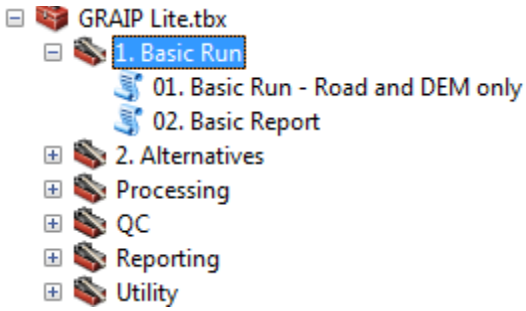


Figure 4-1 – Basic Run Toolset

4.1 Basic Run

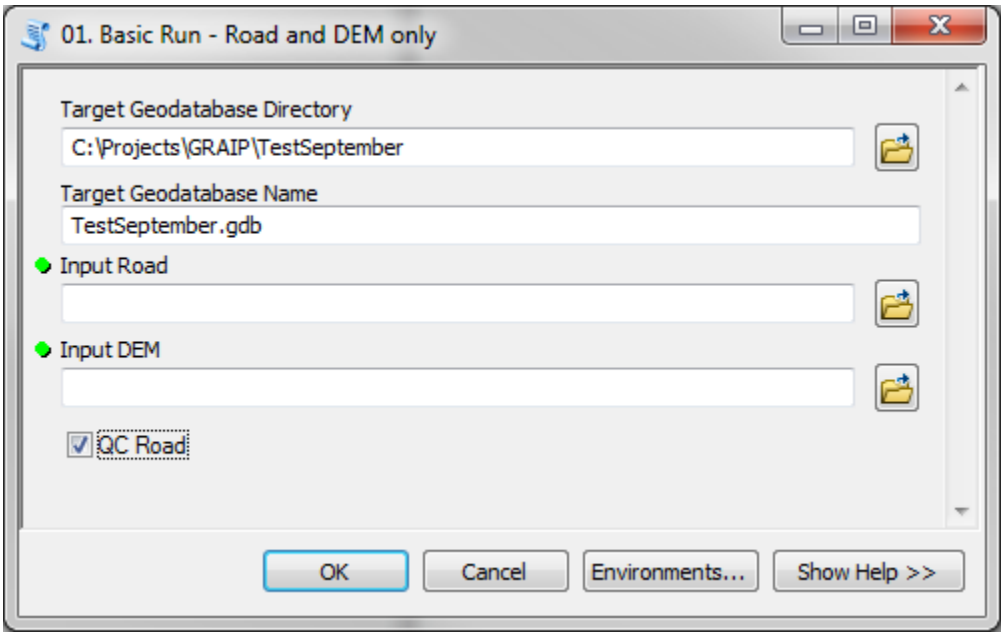


Figure 4-2 – Basic Run Tool User Interface

- Browse to the input Road and DEM or select them from the Table of Contents. Click OK.

The tool executes and adds the final data to the map. The output vector data is stored in a new file geodatabase named after the map and the raster datasets are stored in the Layers subdirectory.

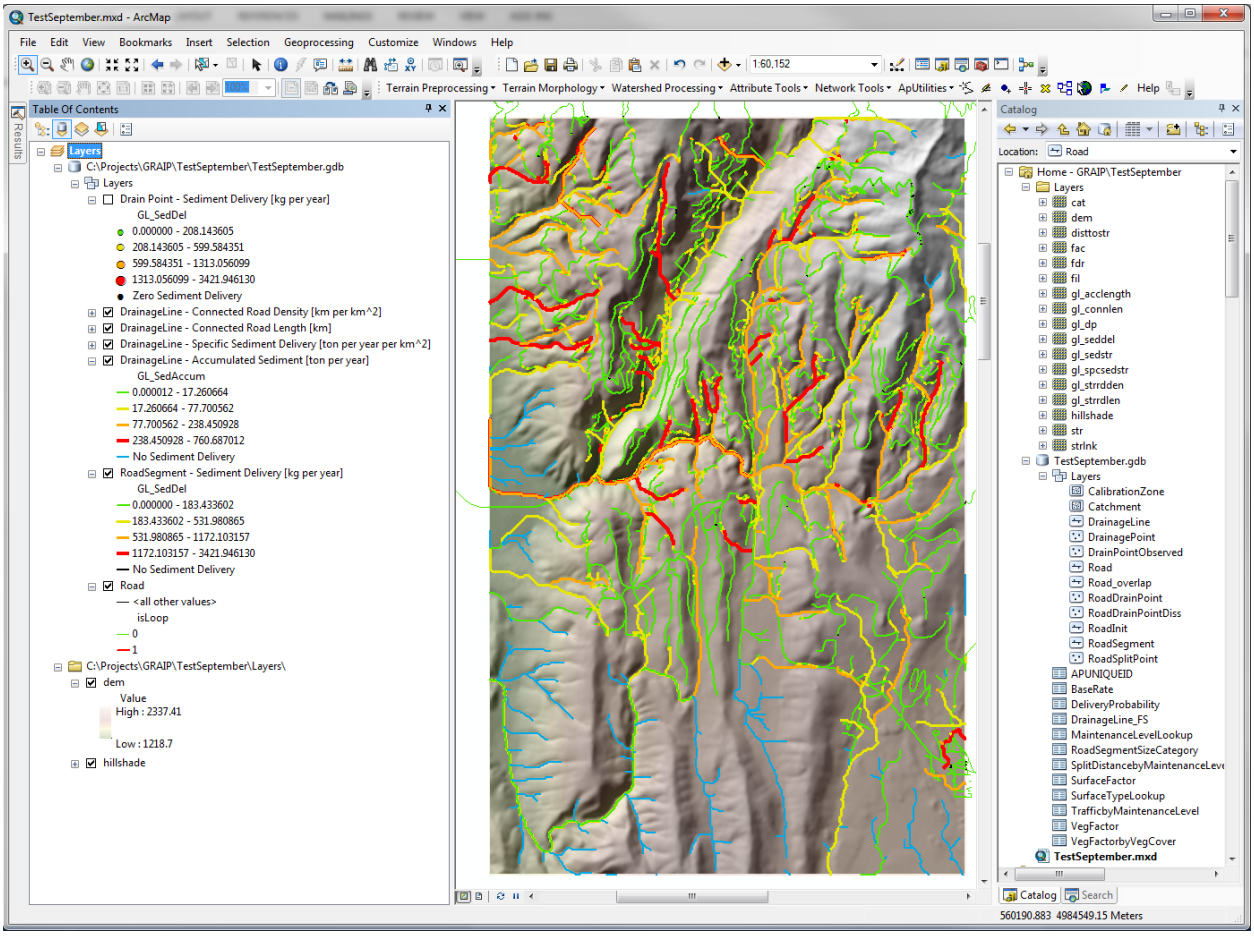


Figure 4-3 – Results from Basic Processing Tool

4.2 Basic Report

After running the basic run, the next step consists in creating the basic pdf report.

- Double-click the Basic Report tool.

The input GRAIP Lite Workspace is automatically populated with the GRAIP Lite database.

The input template directory is optional. The user can point to its own templates, By default, the templates associated with the Basic Report are used.

- Click OK.

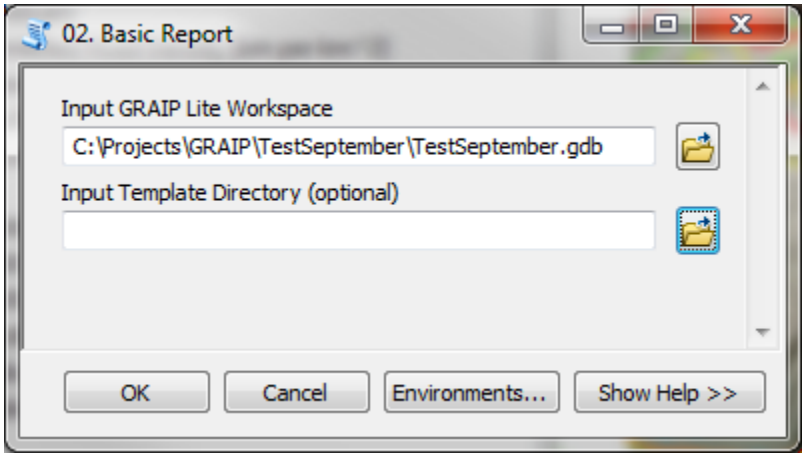


Figure 4-4 – Basic Report Tool User Interface

The output Report folder parameter shows the location where the basic report pdf and associated files are created.

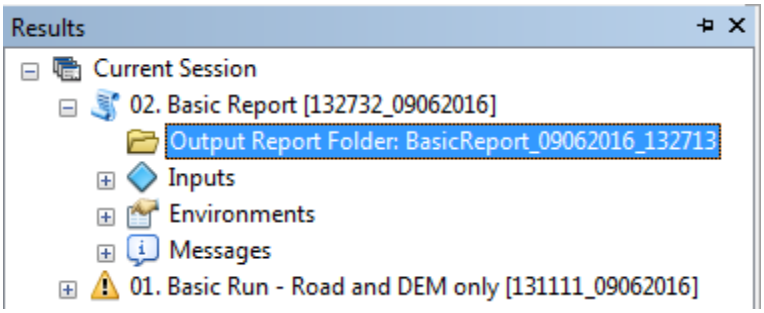


Figure 4-5 – Output Report Folder

- Right-click the parameter and select Copy Location in the context menu.
- Paste the value in Windows Explorer (e.g. C:\Projects\GRAIP\TestSeptember\Reports\BasicReport_09062016_132713).

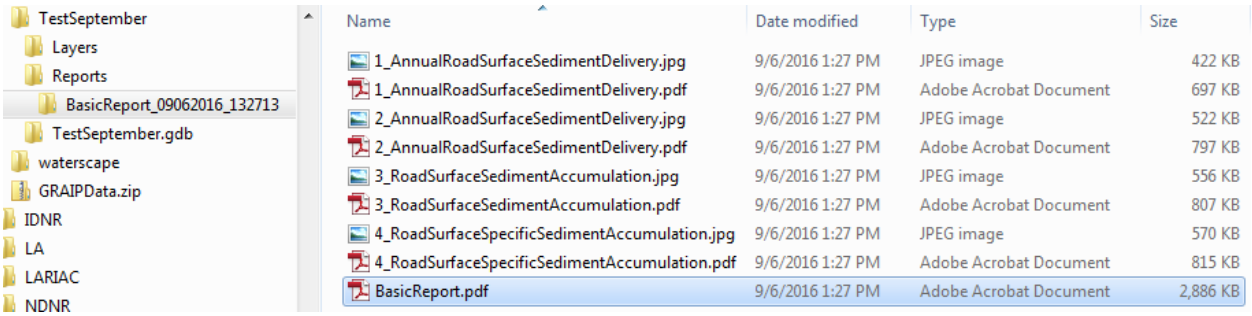


Figure 4-6 – Basic Report Folder

The tool creates one final pdf (BasicReport.pdf) as well as one jpg and pdf for each of the input map templates. The map templates are added to the final pdf in alphabetical order.

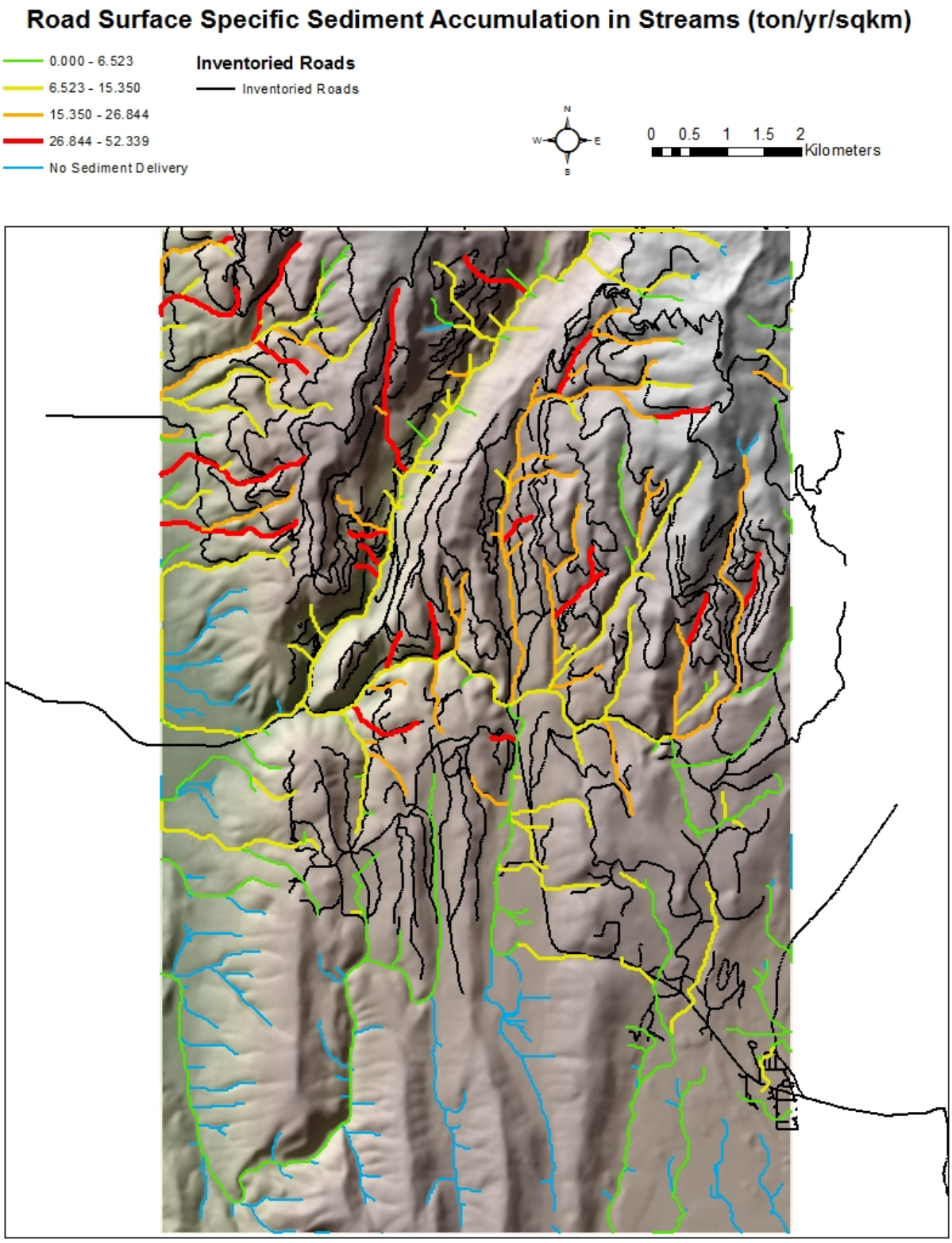


Figure 4-7 – Output jpg file in created by Basic Report tool

- Open the BasicReport.pdf. Note that you can turn the layers on and off in the pdf.

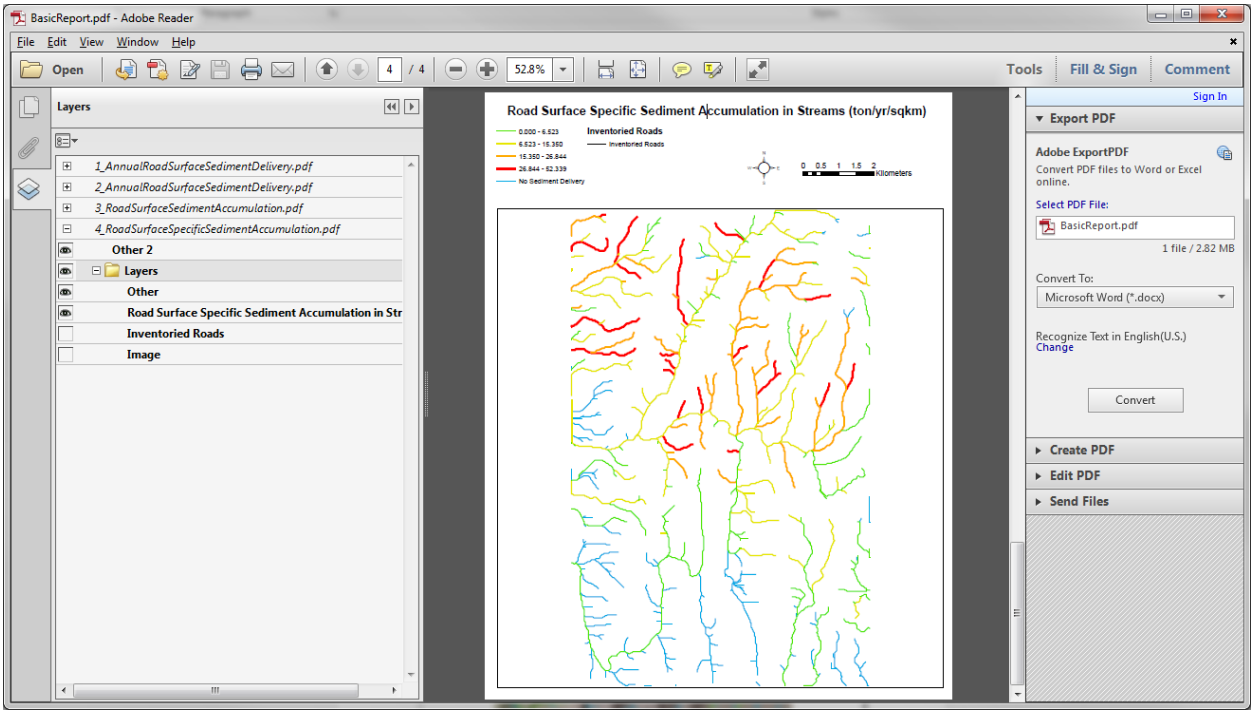


Figure 4-8 – Turning Layers on and off in pdf

5.0 Road Treatment Alternatives

After running the initial Basic Run, add the GRAIP Lite toolbar to ArcMap if it is not visible.

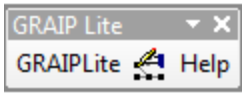


Figure 5-1 – GRAIP Lite Toolbar

- Click GRAIPLite.

The GRAIP Lite form opens in ArcMap in a dockable window and additional configuration tables are copied into the GRAIP Lite database:

  - GLAlternatives
  - GLRoadTreatment
  - GLDefaultVTLSbyML

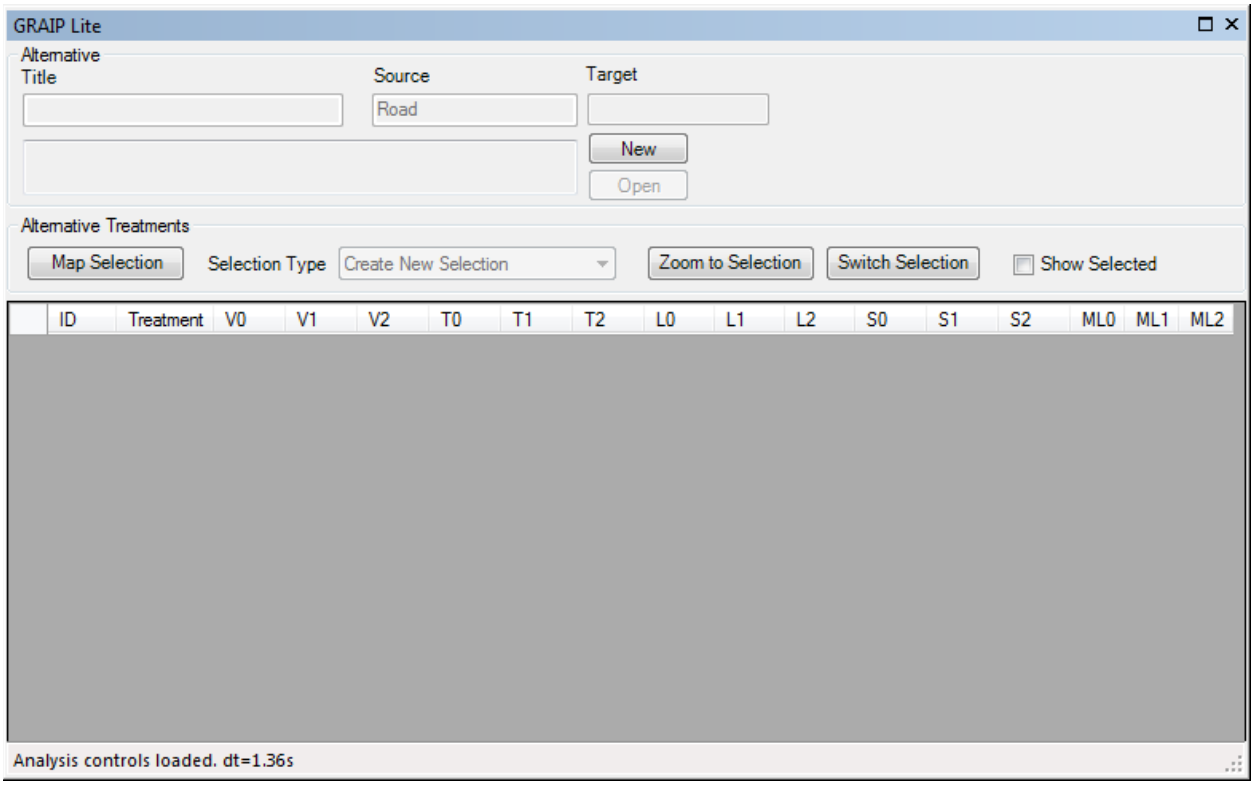


Figure 5-2 – GRAIP Lite Alternative Window

- Click New.

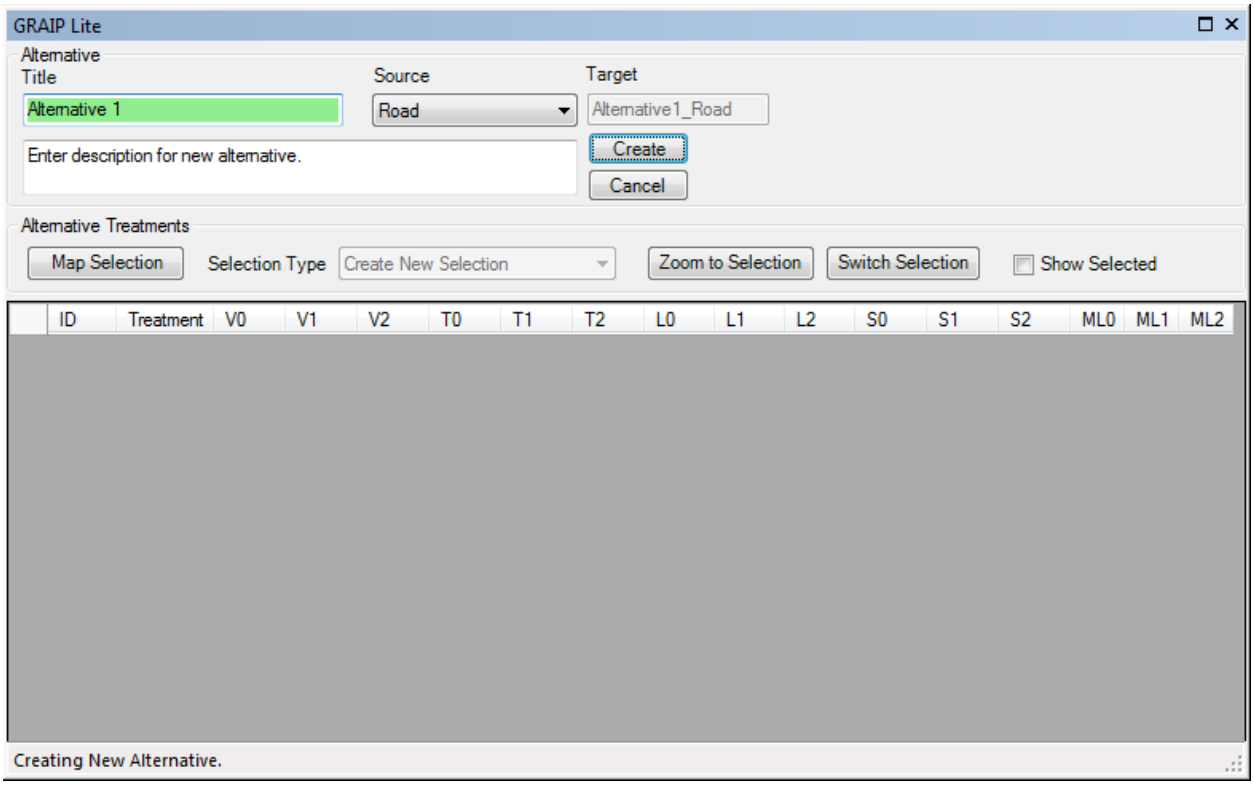


Figure 5-3 – Creating New Altervative

- Enter a name and description for the new alternative and click Create.

The tool creates a new feature dataset and copy the input Road feature class into it. It creates the associated dataframe in the map and adds the new road alternative layer into it.

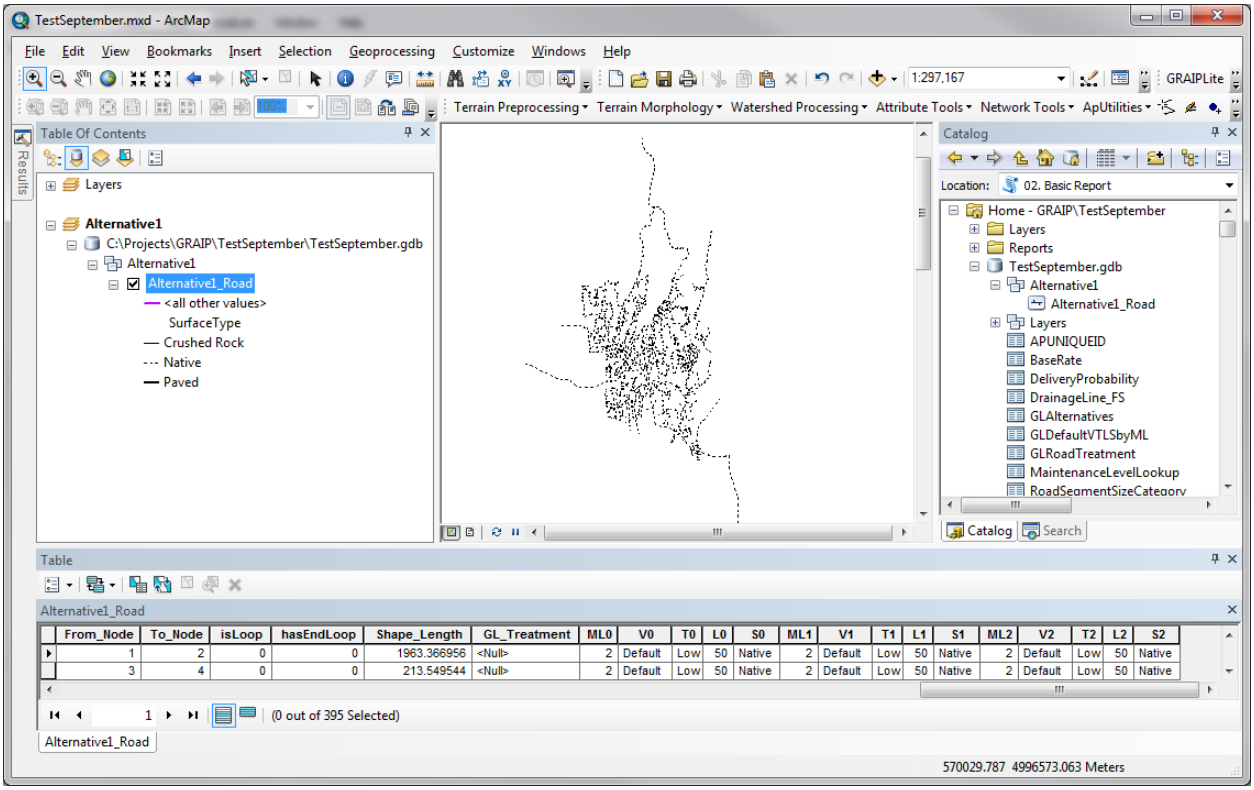
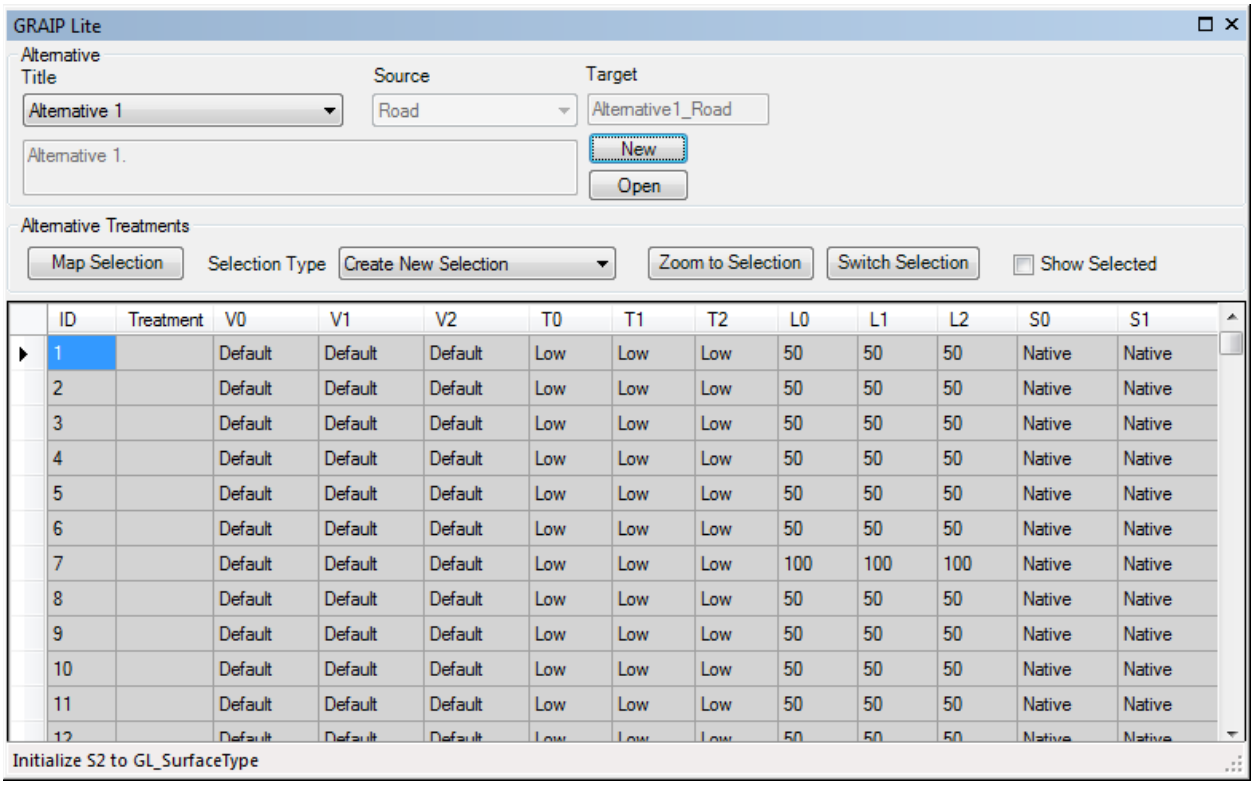


Figure 5-4 –New Alternative Added to Map

The tool adds the field GL_Treatment and M,V,T,L,S in the new alternative layer. The records are also displayed in the GRAIP Lite form.



ID	Treatment	V0	V1	V2	T0	T1	T2	L0	L1	L2	S0	S1
1		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
2		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
3		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
4		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
5		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
6		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
7		Default	Default	Default	Low	Low	Low	100	100	100	Native	Native
8		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
9		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
10		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
11		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native
12		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native

Figure 5-5 – New Alternative

- Click Open to edit the alternative. The fields M,V,T,L,S are populated either with the values from the input Source, or set to the defaults read from the input Source layer.

You can edit one record at the time or multiple records. Editing the Treatment field will set the M,V,T,L,S to the associated values defined for the treatment.

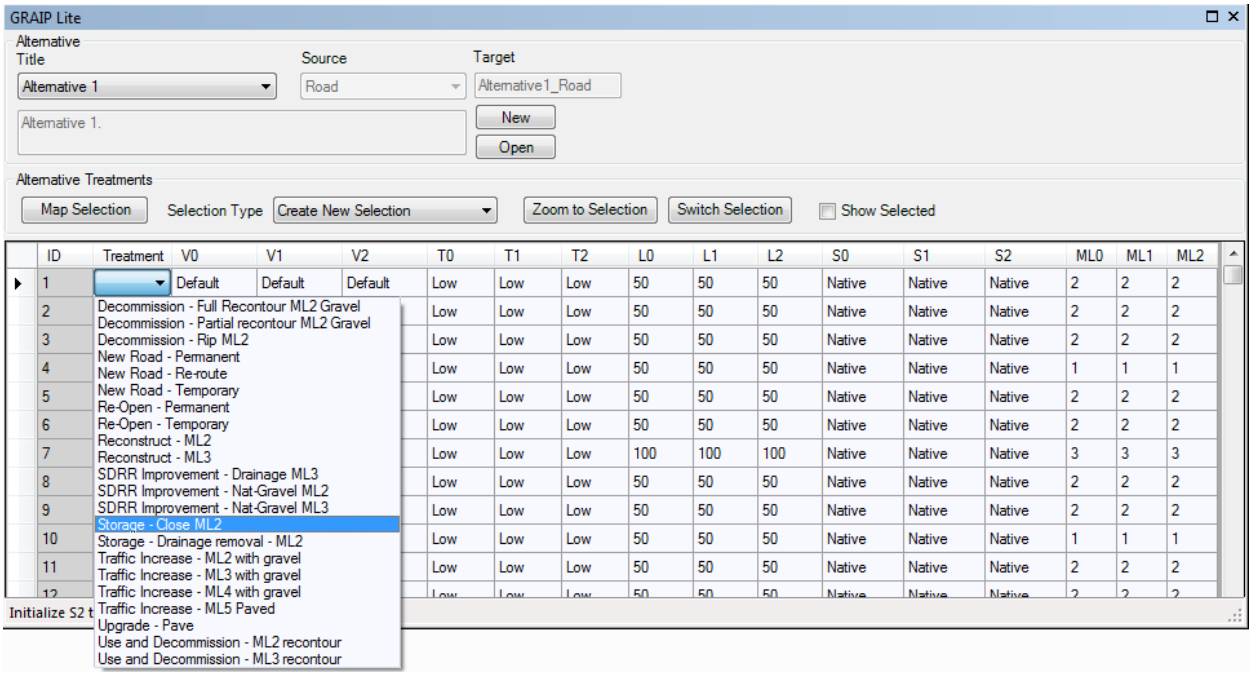


Figure 5-6 – Setting treatment for individual record

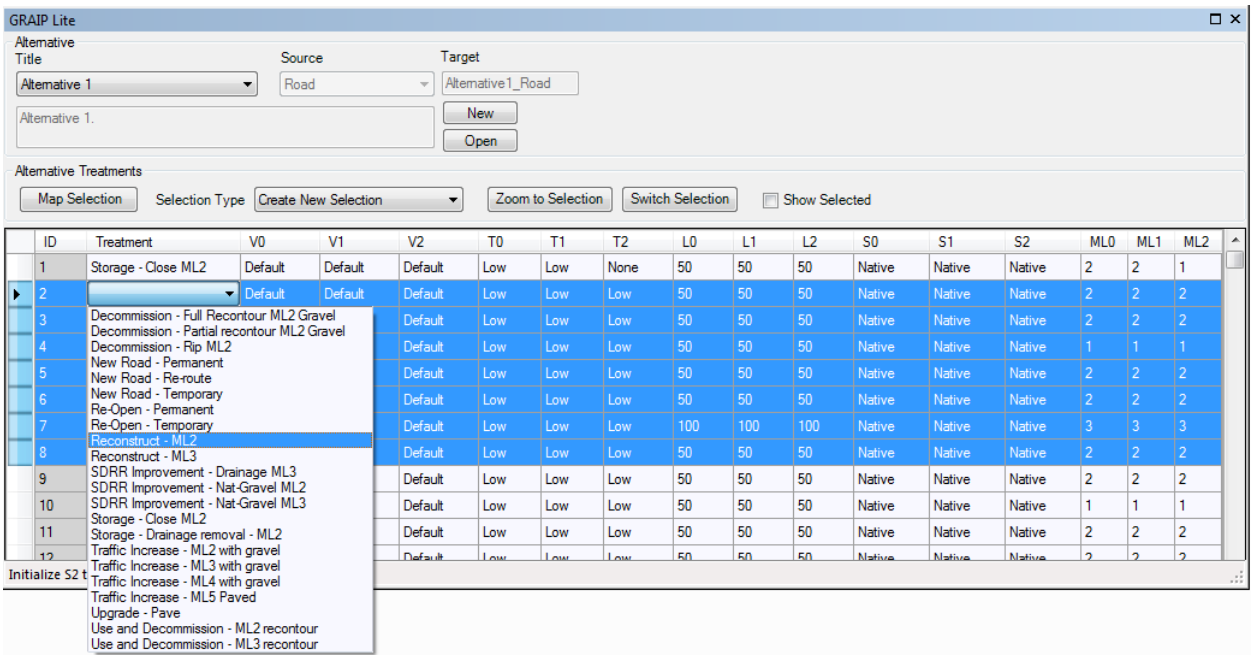


Figure 5-7 – Setting treatment for multiple records 1/2

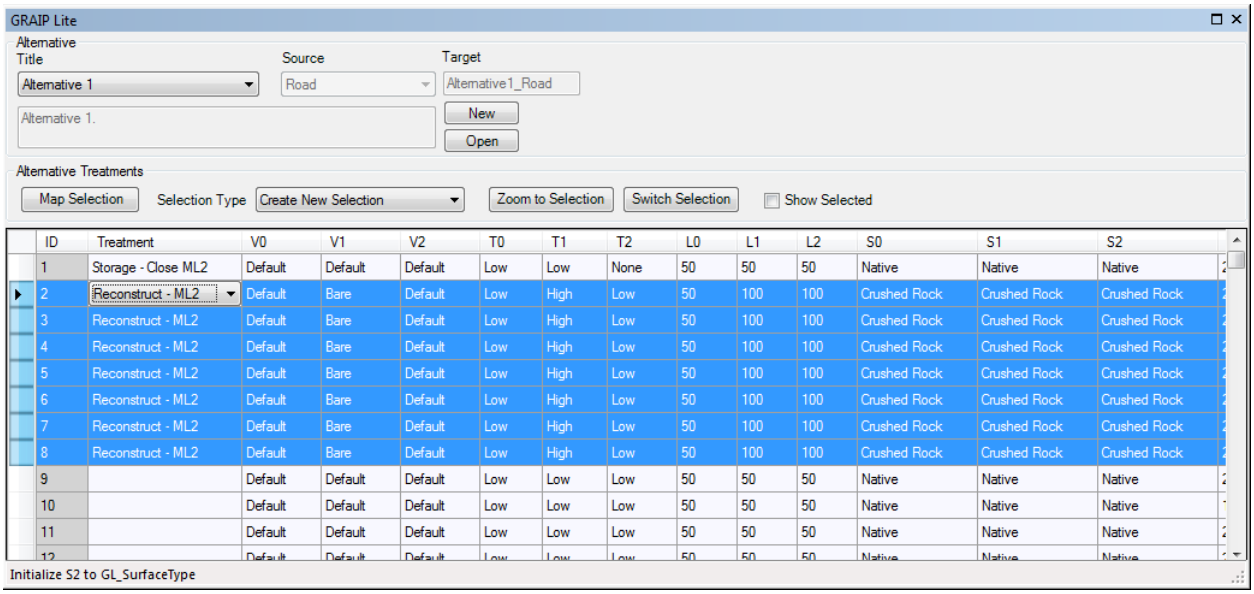


Figure 5-8 - Figure 5-9 – Setting treatment for multiple records 2/2

Selected features are also displayed in the map document.

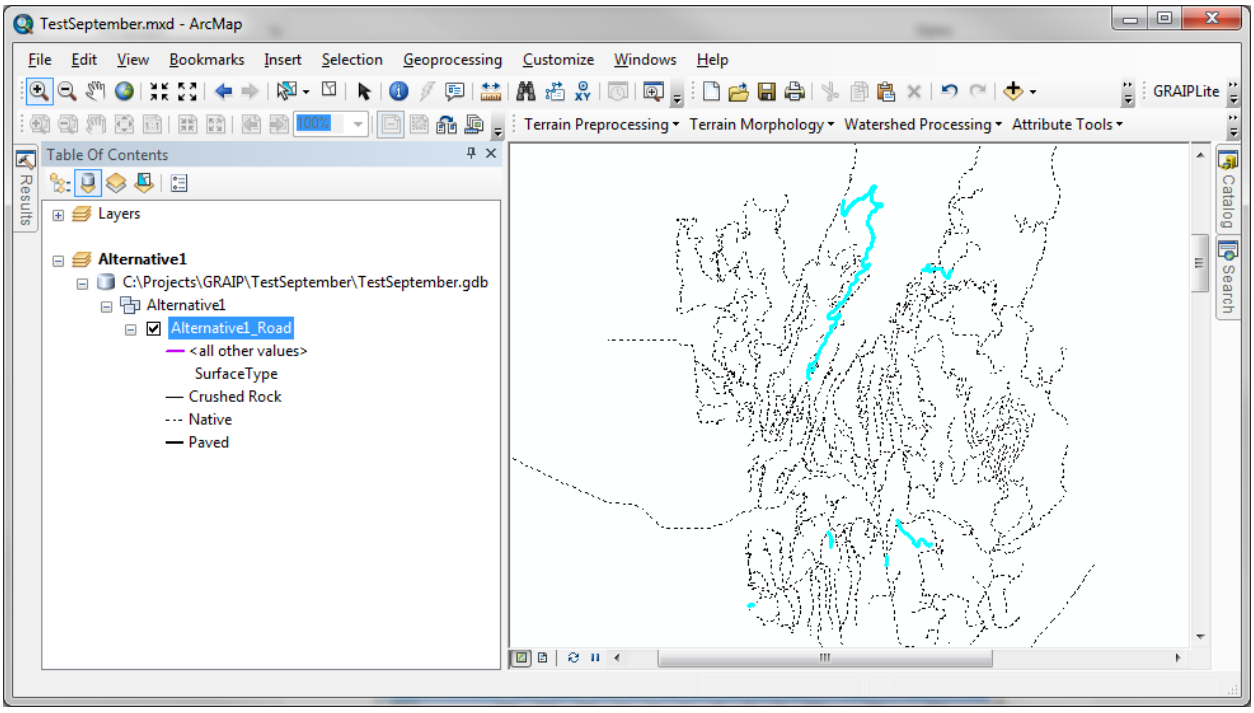


Figure 5-10 – Features selected in map

You can create a new map by using the Create Road tool from the GRAIP Lite toolbar.

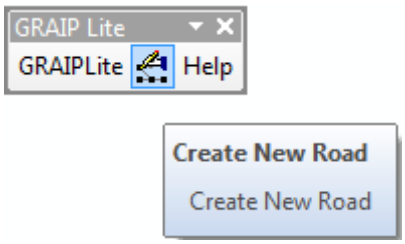


Figure 5-11 – Create New Road

- Click the tool and then digitize the new road features on the map.

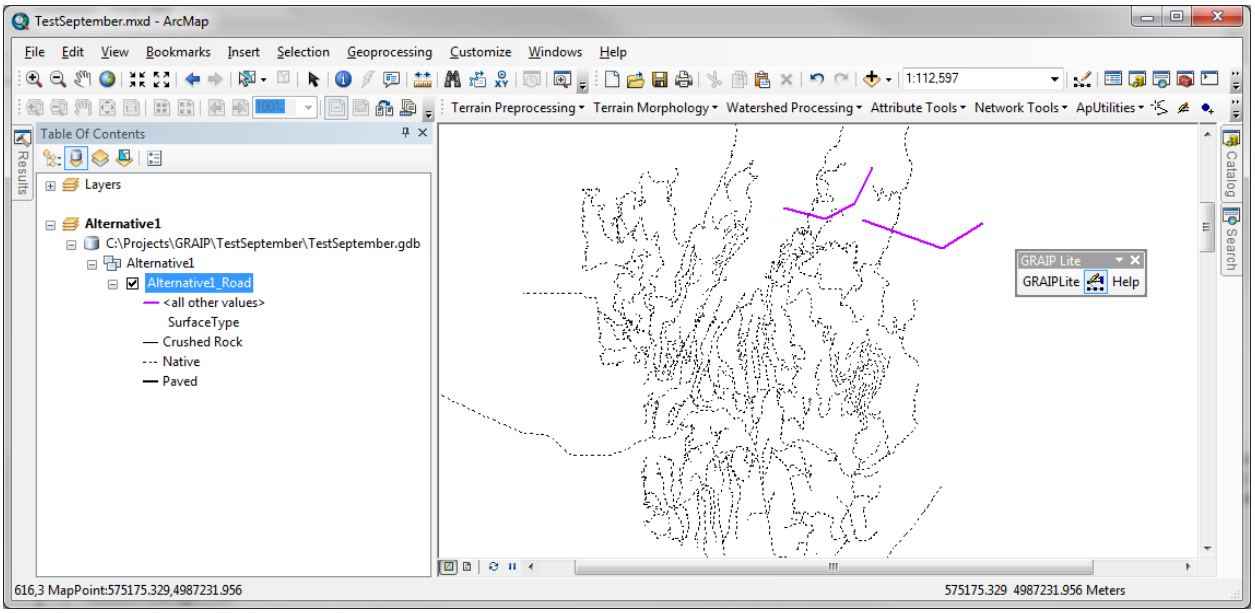
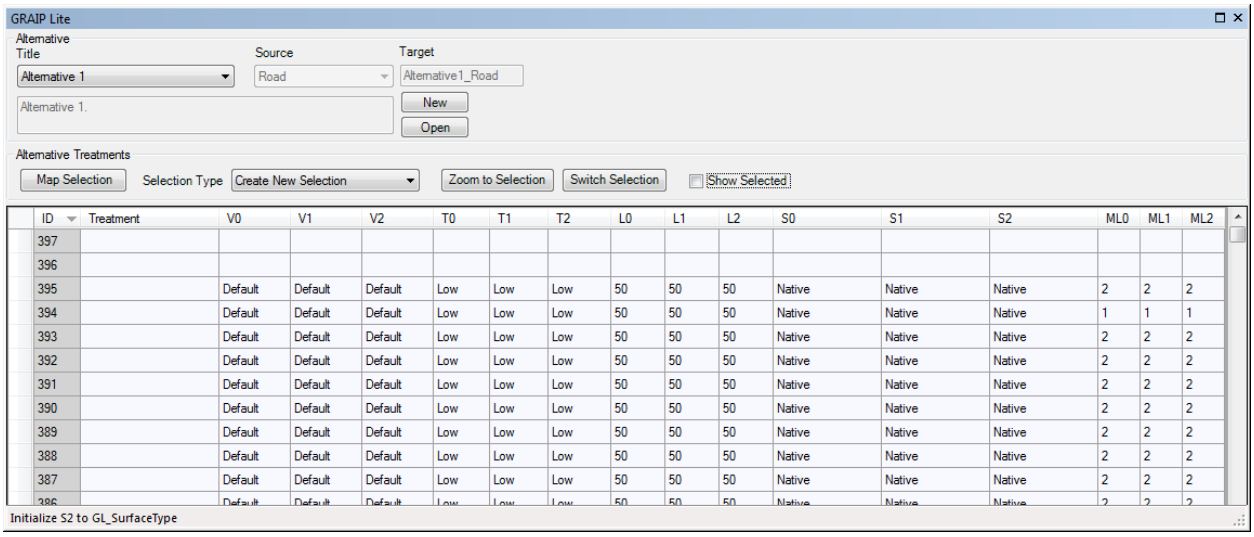


Figure 5-12 – New Road Features

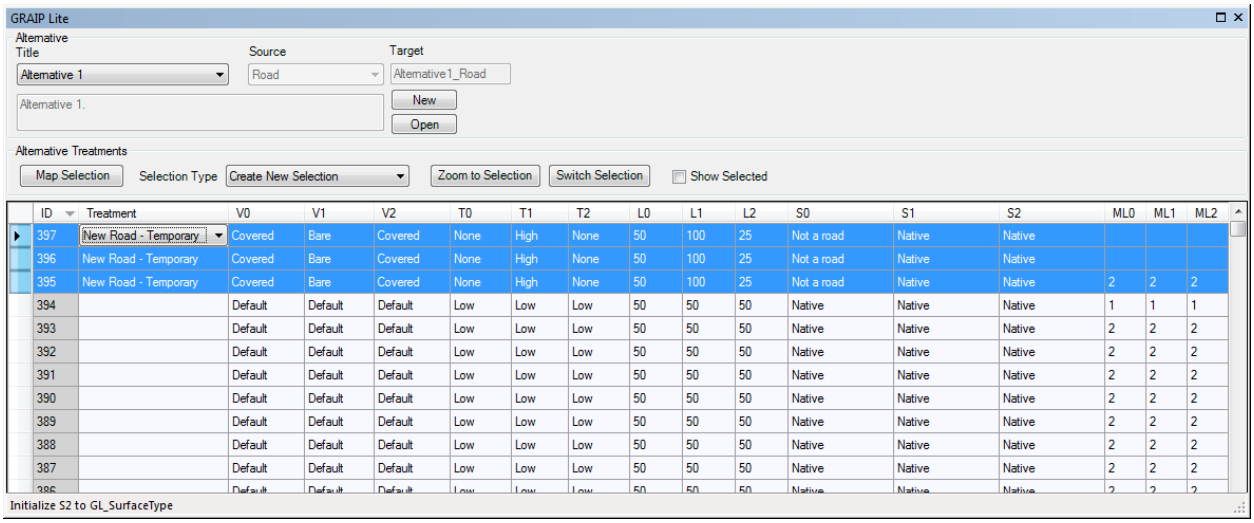
- In the form sort the records by descending IDs to view the new features.



ID	Treatment	V0	V1	V2	T0	T1	T2	L0	L1	L2	S0	S1	S2	ML0	ML1	ML2
397																
396																
395		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
394		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	1	1	1
393		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
392		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
391		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
390		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
389		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
388		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
387		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2

Figure 5-13 – New Features Records

- Set the appropriate treatment for the new roads.



ID	Treatment	V0	V1	V2	T0	T1	T2	L0	L1	L2	S0	S1	S2	ML0	ML1	ML2
397	New Road - Temporary	Covered	Bare	Covered	None	High	None	50	100	25	Not a road	Native	Native			
396	New Road - Temporary	Covered	Bare	Covered	None	High	None	50	100	25	Not a road	Native	Native			
395	New Road - Temporary	Covered	Bare	Covered	None	High	None	50	100	25	Not a road	Native	Native	2	2	2
394		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	1	1	1
393		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
392		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
391		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
390		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
389		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
388		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2
387		Default	Default	Default	Low	Low	Low	50	50	50	Native	Native	Native	2	2	2

Figure 5-14 – New Road Treatment Assignment

Note

The VTLS values may be reset to the original values read from the fields GL_Traffic, GL_SurfaceType, GL_MaintenanceLevel, GL_SplitDistance and Default vegetation by selecting the option “No Treatment”.

6.0 Run Alternatives

The Alternatives toolset allows generating the loads for current, disturbed and long term conditions specified for the roads and generating the associated reports.

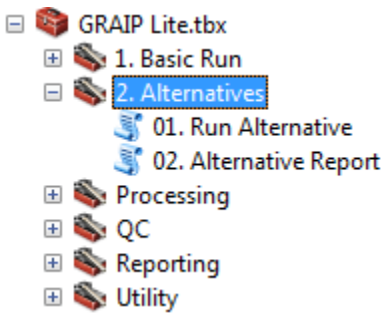


Figure 6-1 – Alternatives Toolset

6.1 Run Alternatives

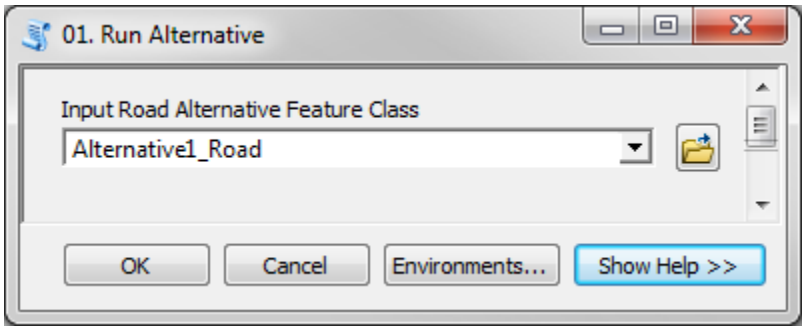


Figure 6-2 – Run Alternatives Tool User Interface

6.2 Alternative Report

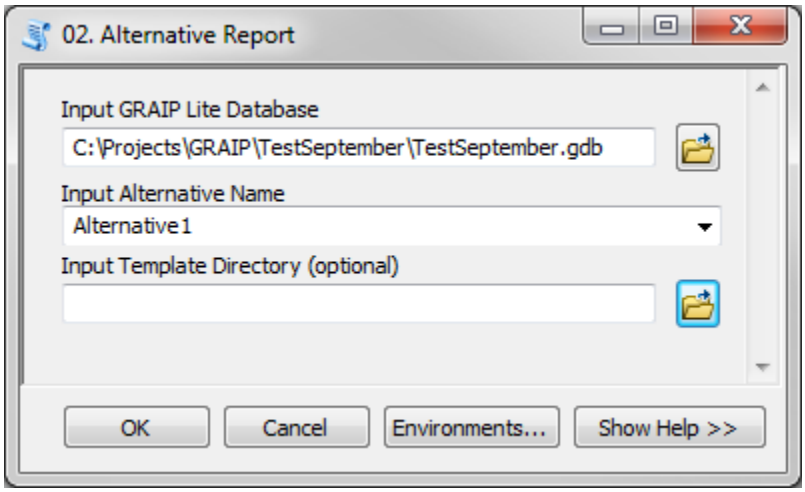


Figure 6-3 – Altenative Report User

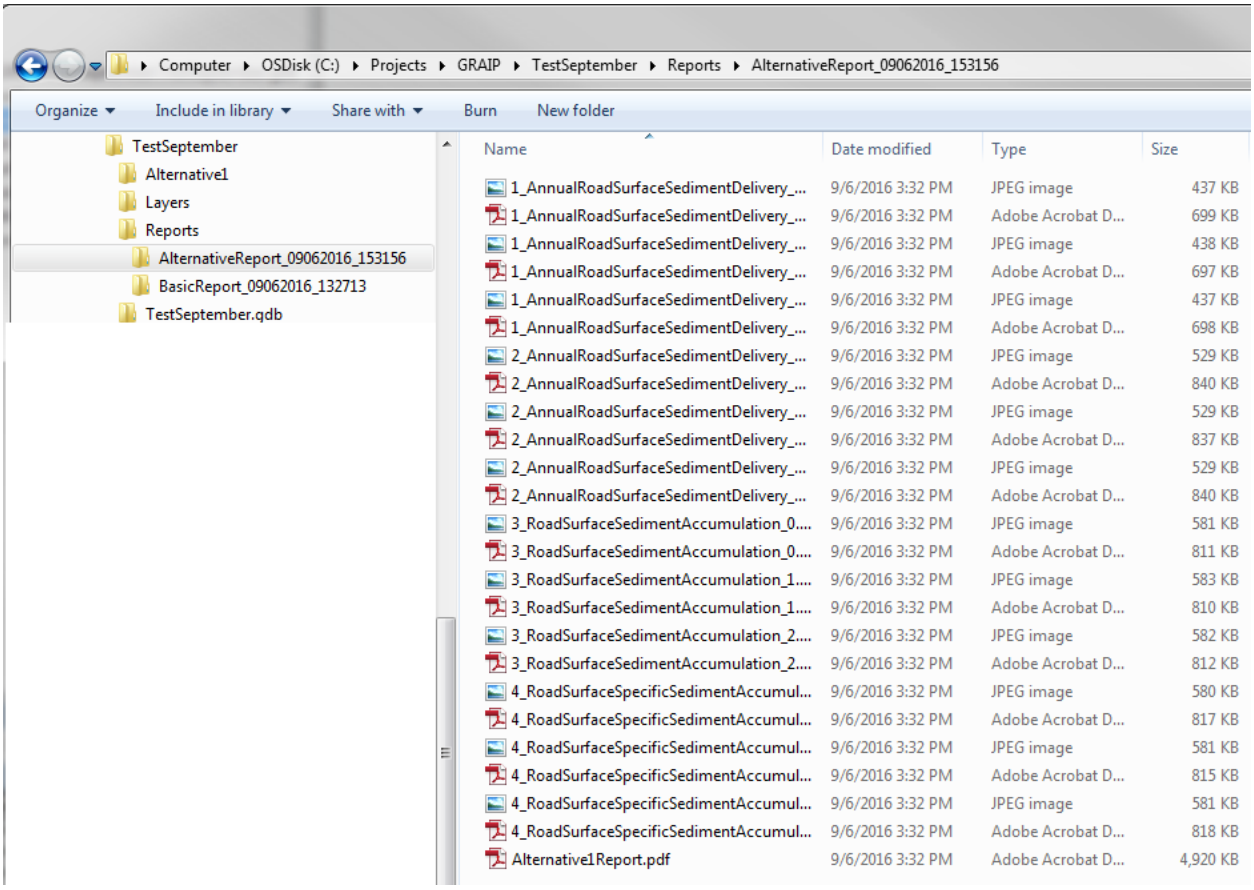


Figure 6-4 – Alternative Reports

7.0 Step by Step Processing Workflow

The processing steps listed in the Processing toolset must be run sequentially:

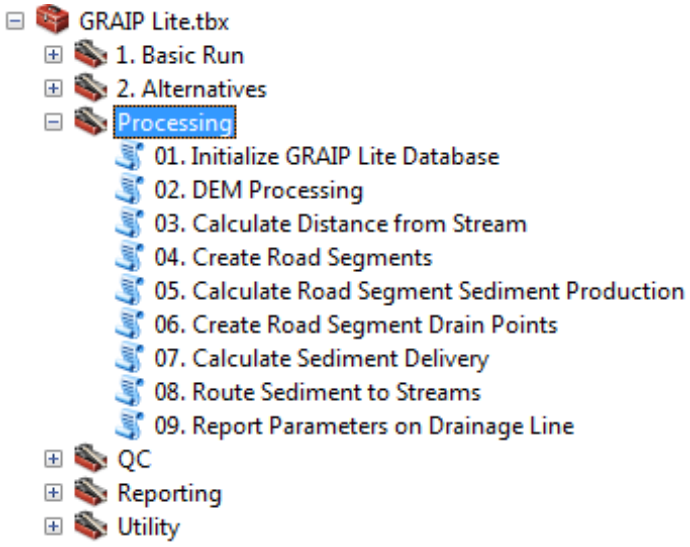


Figure 7-1 – GRAIP Lite Processing Steps

The following section illustrates the process using a small tutorial dataset (Roadsm, demsm) and a bigger one (pnf_infra, pbnf).

- Demsm: 283x450, 30m cell size, floating point, 497.46KB
- Pbnf: 9443x10591, 30m cell size, floating point, 381.51MB
- Roadsm: 395 features
- Pnf_infra: 5519 features → cleanup multipart and zero length segments Pnf_infra_clean → 6139 segments

Tool	Processing Time		Branching
01. Initialize GRAIP Lite Database.	27s	2mn27s	Run when dem or input roads change.
02. DEM Processing	19s	32mn45s	Dem changed or Stream threshold changed.
03. Calculate Distance from Stream	57s	50s	Dem changed or Stream Threshold changed.
04. Create Road Segments	1mn19s	17mn16s	Roads, DEM, Stream Threshold, ObservedDrainPoint, CalibrationZone have changed
05. Calculate Road Segment Sediment Production	18s	4mn49s	Dem or RoadSegment changed, configuration tables changed
06. Create Road Segment Drain Points	10s	2mn46s	

07.	**Calculate Sediment Delivery**	4s	1mn2s	Delivery Curve or Segmentation rules changed.
08.	**Route Sediment to Streams**	3s	15mn28s	

7.1 Initialize GRAIP Lite Database

This tool initializes the GRAIP Lite project database by creating the specified target geodatabase and importing the input Road, and if provided, the Observed Drain Point and Calibration Zone layers as well as predefined configuration tables.

The tool also copies the input DEM into the Layers directory located in the

- Double-click the 01. Initialize GRAIP Lite Database tool to open the user interface. Browse to the location of the input INFRA Road features and input DEM and click OK. The Target Geodatabase Directory and Name are populated with defaults based on the location and name of the saved map document.

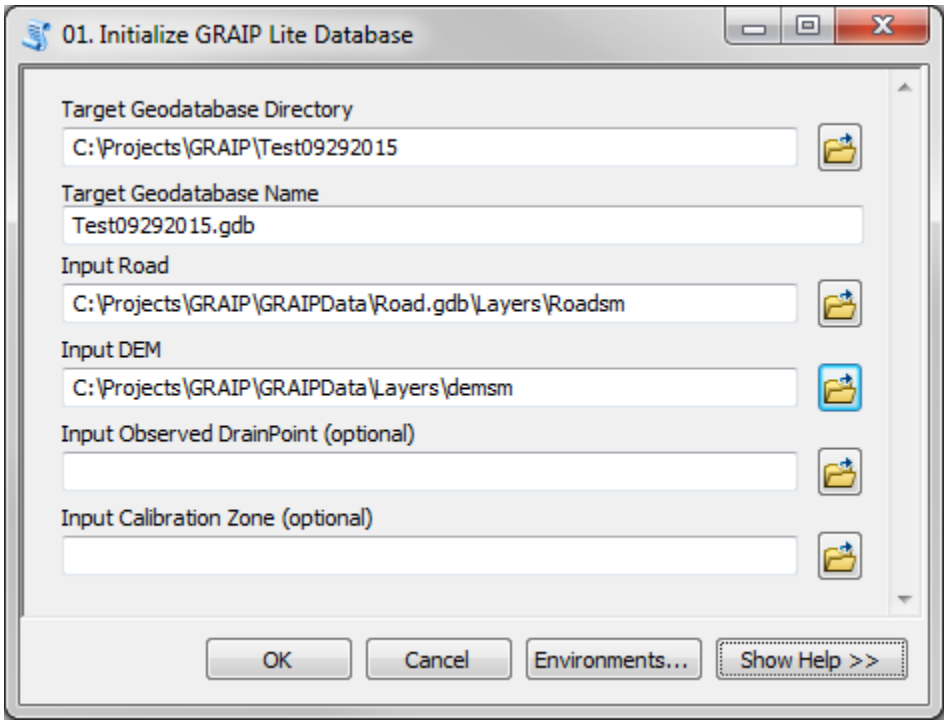


Figure 7-2 – Initialize GRAIP Lite Database

```
Executing: InitializeGRAIPLiteDatabase C:\Projects\GRAIP\Test09292015
Test09292015.gdb C:\Projects\GRAIP\GRAIPData\Road.gdb\Layers\Roadsm
C:\Projects\GRAIP\GRAIPData\Layers\demsm # #
Start Time: Tue Sep 29 09:10:58 2015
Running script InitializeGRAIPLiteDatabase...
Creating new database...
Accessing schema workspace c:\program files
(x86)\arcgis\desktop10.2\ArcToolbox\Scripts\GRAIP\GRAIPLiteSchema.gdb...
Copying table MaintenanceLevelLookup...
Copying table SurfaceTypeLookup...
Copying table GLDomains...
```

```
 Copying table SplitDistancebyMaintenanceLevel...
 Copying table BaseRate...
 Copying table SurfaceFactor...
 Copying table VegFactor...
 Copying table DeliveryProbability_Granite...
 Copying table RoadSegmentSizeCategory...
 Deleting copied table GLDomains...
 Importing road features...
 395 record(s) updated on
 C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\Road. The HydroID
 values ranged from 1 to 395.
 Initializing calibration zone...
 395 road(s) imported into new database.
 Joining road layer with surface type table to populate GL_SurfaceType...
 146 road(s) have null GL_SurfaceType that will be set to Native.
 227 road(s) have null or empty OPER_MAINT. GL_MaintenanceLevel will be set
 based on ROUTE_STAT.
 Joining road layer with SplitDistancebyMaintenanceLevel table to populate
 GL_SplitDistance...
 Creating directory C:\Projects\GRAIP\Test09292015\Layers...
 Copying input dem to C:\Projects\GRAIP\Test09292015\Layers\dem...
 Cleaning up...
 Completed script InitializeGRAIPLiteDatabase...
Succeeded at Tue Sep 29 09:11:25 2015 (Elapsed Time: 26.99 seconds)
```

The input Digital Elevation Model is copied as dem in the Layers directory located in the same location as the map document.

The input Roadsm features are imported as Road features under the Layers feature dataset in the target geodatabase. Since no CalibrationZone was passed as input, a default CalibrationZone matching the outline of the DEM is created. The output DrainPointObserved feature class is created empty as well.

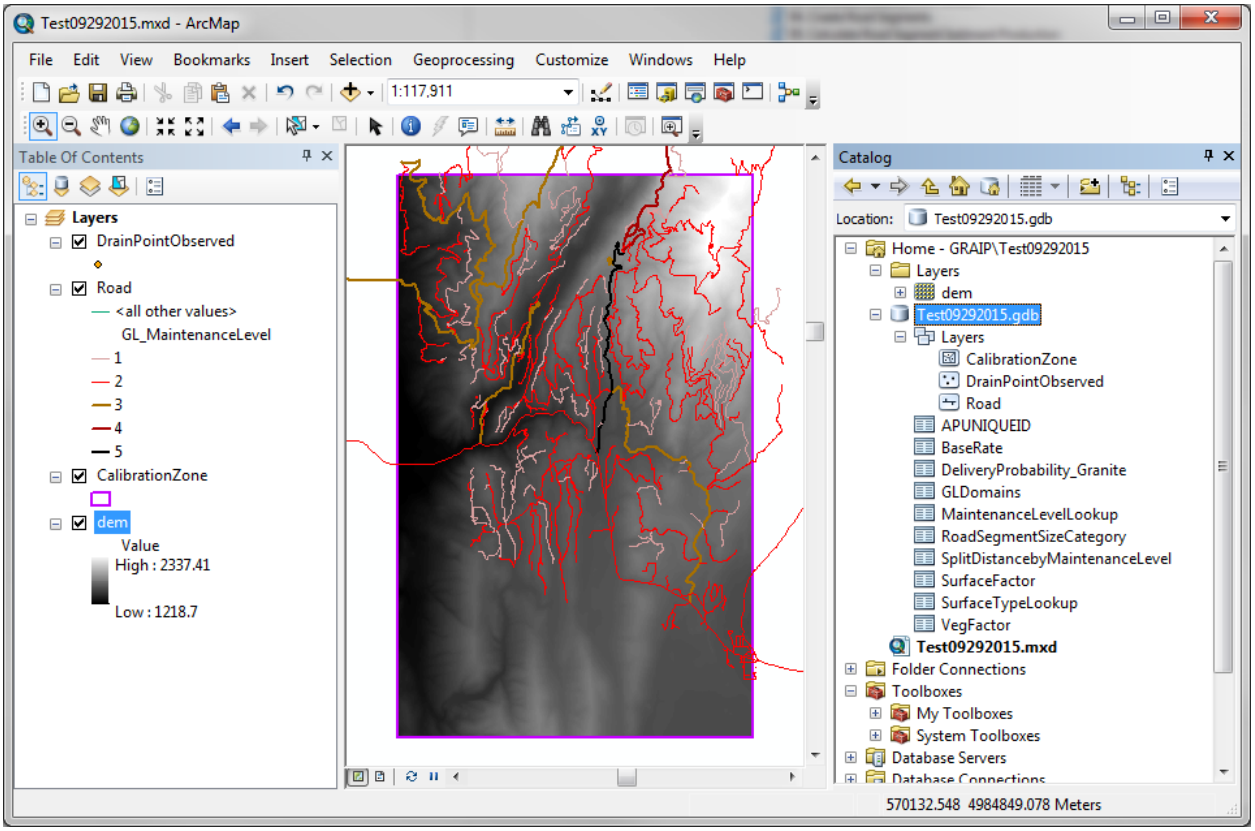


Figure 7-3 – Initialize GRAIP Lite Database Results

The following attributes are added to the imported Road features:

- HydroID: Unique identifier of the Road features in the geodatabase.
- GL_NewRoad: Default to '0 - Existing'. If the field NEWROAD exists in the source INFRA Road layer, any value <> 0 will be imported as '1 – New'.
- GL_Traffic: Level of traffic associated to the road. Default to 'low'. If the field TRAFFIC exists in the source INFRA Road, values that are in the list ('none', 'low', 'medium', 'high') will be imported as is.
- GL_SurfaceType: Type of surface. Populating by joining with configuration table SurfaceTypeLookup using input field SURFACE_TY. Null values after the join will be populated with 'Native'.
- GL_MaintenanceLevel: Type of maintenance associated with the road.
    - Populated with code stored in input OPER_MAINT field (e.g. 2 for '2 – HIGH CLEARANCE VEHICLES').
    - If OPER_MAINT is null or empty, populated by joining with configuration table MaintenanceLevelLookup using INFRA field ROUTE_STAT.
    - Populated with 2 if ROUTE_STAT and OPER_MAINT are not populated
- GL_SplitDistance: Maximum length for associated road segments. Populating by joining with configuration table SplitDistancebyMaintenanceLevel based on GL_MaintenanceLevel field.

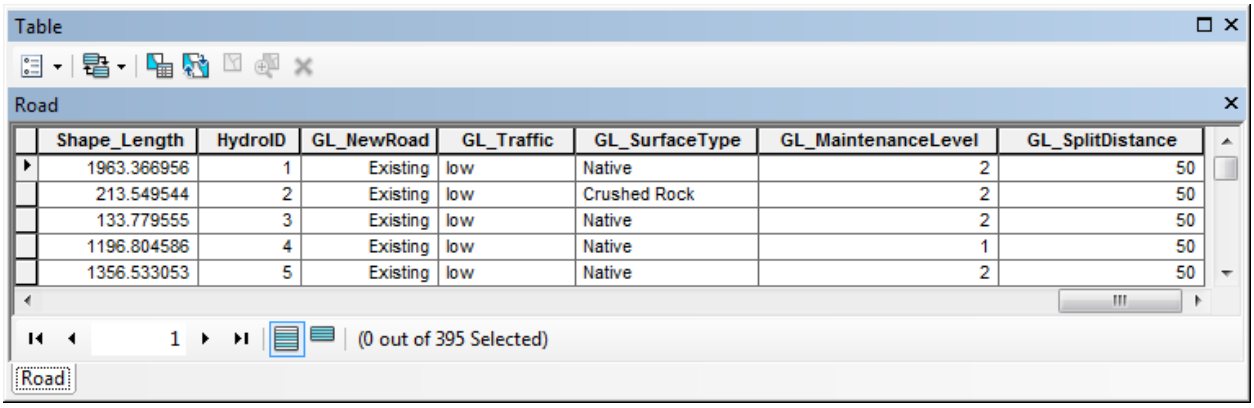


Figure 7-4 – Road Attribute Table

The CalibrationZone is created based on the outline of the input DEM. It contains the field GL_CalibrationZone that is populated with the default value 'Granite'. Each calibration zone name must have an associated delivery curve configuration table named DeliveryProbability_calibrationzonename (e.g. DeliveryProbability_Granite) and associated records in the configuration tables BaseRate and VegFactor.

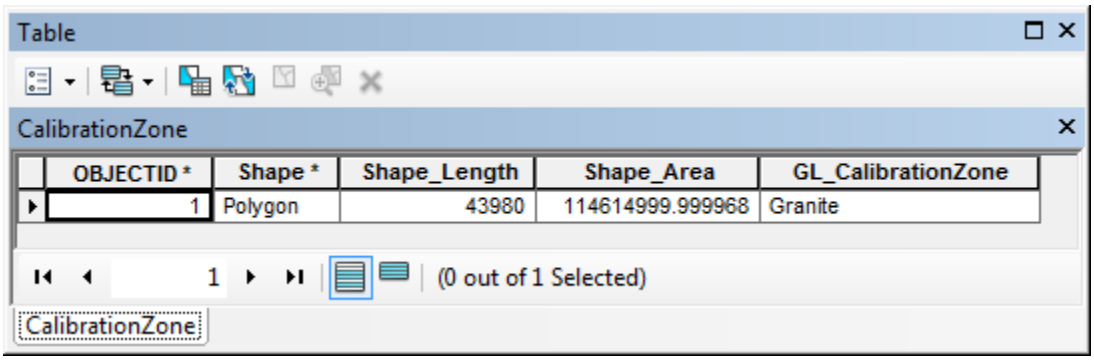


Figure 7-5 – CalibrationZone Attribute Table

If no input Observed Drain Point is provided, the output DrainPointObserved is created empty.

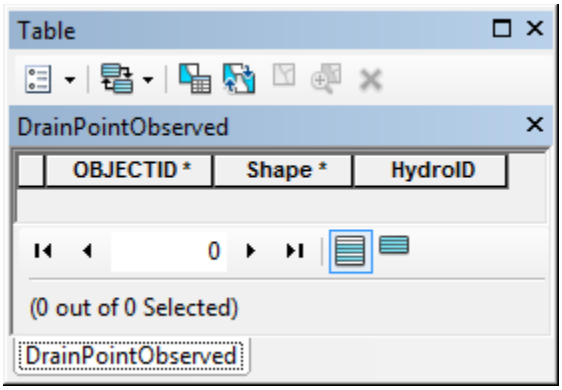


Figure 7-6 – DrainPointObserved Attributes Table

7.2 DEM Processing

This tool generates the data required to support the GRAIP Analyses. The input GRAIP Lite Road is used to identify the output location for the vector and table data. The output raster location is set to the location of the input DEM.

All parameters should be prepopulated with default values. The input Number of cells is used to specify the stream threshold, i.e. the minimum area a cell has to drain to be considered a stream cell.

- Modify the Number of cells if needed and click OK.

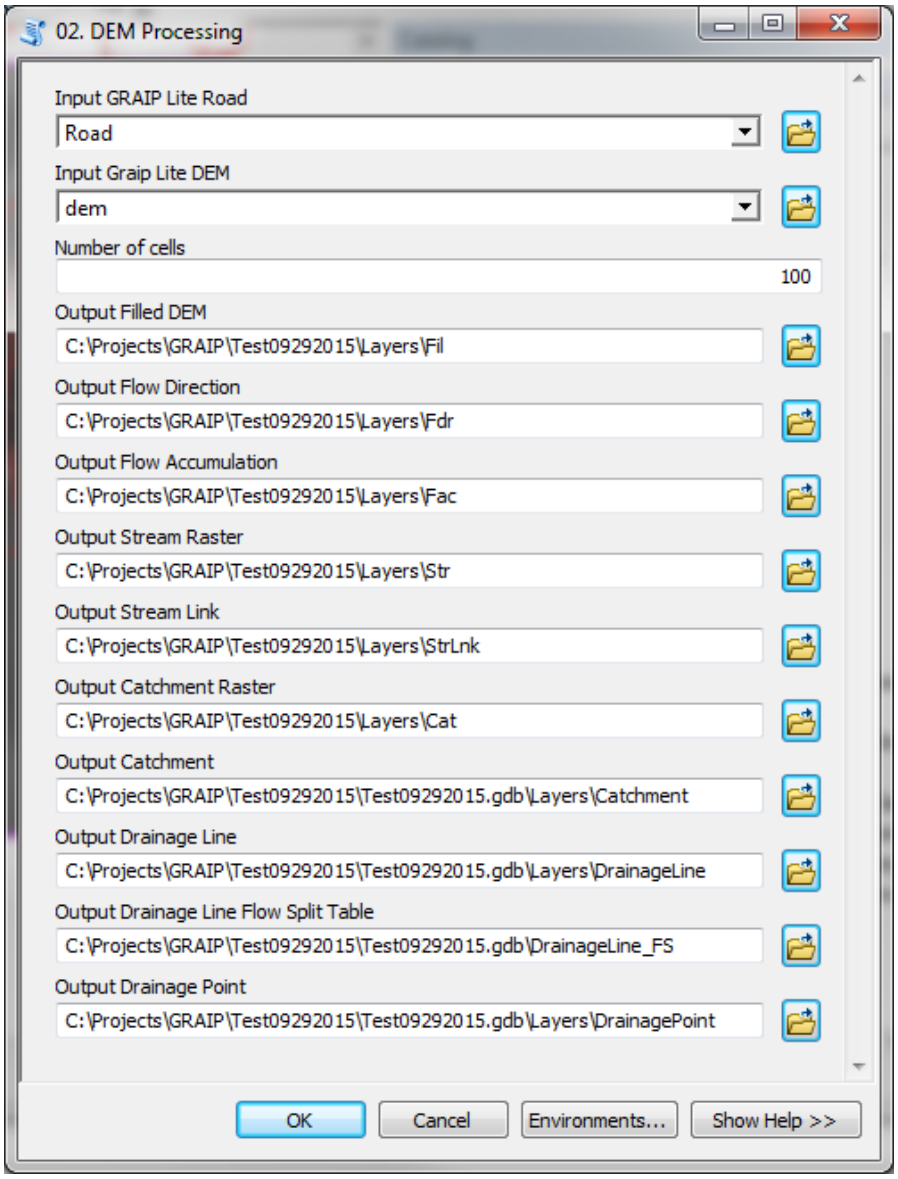


Figure 7-7 – DEM Processing

```
 Executing: DEMProcessing Road dem 100
 C:\Projects\GRAIP\Test09292015\Layers\Fil
 C:\Projects\GRAIP\Test09292015\Layers\Fdr
 C:\Projects\GRAIP\Test09292015\Layers\Fac
 C:\Projects\GRAIP\Test09292015\Layers\Str
 C:\Projects\GRAIP\Test09292015\Layers\StrLnk
 C:\Projects\GRAIP\Test09292015\Layers\Cat
 C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\Catchment
 C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\DrainageLine
 C:\Projects\GRAIP\Test09292015\Test09292015.gdb\DrainageLine_FS
 C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\DrainagePoint
 Start Time: Tue Sep 29 09:30:03 2015
 Running script DEMProcessing...
 Filling sinks...
       - Filling sinks completed in 0.5 seconds.
 Generating Flow Direction...
       - Generating Flow Direction completed in 0.5 seconds.
 Generating Flow Accumulation...
       - Generating Flow Accumulation completed in 0.7 seconds.
 Defining streams...
       - Defining streams completed in 1.1 seconds.
 Generating stream links...
       - Generating stream links completed in 0.6 seconds.
 Generating Catchment raster...
       - Generating Catchment raster completed in 0.7 seconds.
 Generating Catchment features...
        - Generating Catchment features completed in 3.4 seconds.
 Generating Drainage Lines...
        - Generating Drainage Lines completed in 6.1 seconds.
 Generating Drainage Point features...
        - Generating Drainage Point features completed in 3.7 seconds.
 Assigning Strahler River Order...
        - Assigning Strahler River Order completed in 1.1 seconds.
 DEM Processing completed...
 Completed script DEMProcessing...
Succeeded at Tue Sep 29 09:30:22 2015 (Elapsed Time: 18.67 seconds)

 Executing: DEMProcessing Road dem 100 C:\Projects\GRAIP\testa\Layers\Fil
 C:\Projects\GRAIP\testa\Layers\Fdr C:\Projects\GRAIP\testa\Layers\Fac
 C:\Projects\GRAIP\testa\Layers\Str C:\Projects\GRAIP\testa\Layers\StrLnk
 C:\Projects\GRAIP\testa\Layers\Cat
 C:\Projects\GRAIP\testa\testa.gdb\Layers\Catchment
 C:\Projects\GRAIP\testa\testa.gdb\Layers\DrainageLine
 C:\Projects\GRAIP\testa\testa.gdb\DrainageLine_FS
 C:\Projects\GRAIP\testa\testa.gdb\Layers\DrainagePoint
 Start Time: Wed Sep 30 10:51:11 2015
 Running script DEMProcessing...
 Filling sinks...
       - Filling sinks completed in 58.7 seconds.
 Generating Flow Direction...
       - Generating Flow Direction completed in 30.4 seconds.
 Generating Flow Accumulation...
       - Generating Flow Accumulation completed in 908.7 seconds.
 Defining streams...
       - Defining streams completed in 10.6 seconds.
 Generating stream links...
```

```
        - Generating stream links completed in 8.9 seconds.
  Generating Catchment raster...
        - Generating Catchment raster completed in 38.7 seconds.
  Generating Catchment features...
         - Generating Catchment features completed in 318.6 seconds.
  Generating Drainage Lines...
         - Generating Drainage Lines completed in 277.8 seconds.
  Generating Drainage Point features...
         - Generating Drainage Point features completed in 175.8 seconds.
  Assigning Strahler River Order...
         - Assigning Strahler River Order completed in 137.1 seconds.
  DEM Processing completed...
  Completed script DEMProcessing...
Succeeded at Wed Sep 30 11:23:57 2015 (Elapsed Time: 32 minutes 45 seconds)
```

All parameters

The resulting streams are displayed using the computed Strahler river order.

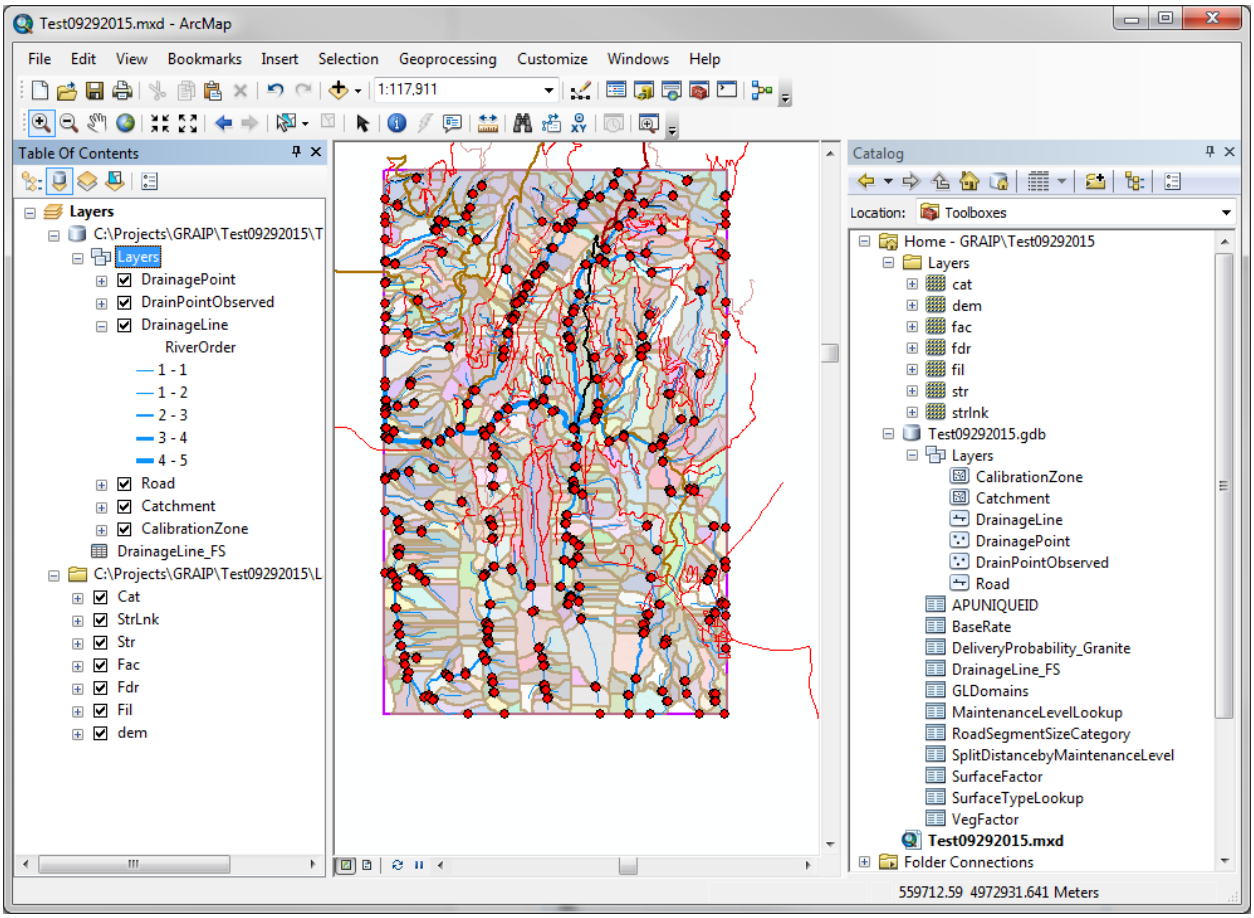


Figure 7-8- DEM Processing Results

7.3 Calculate Distance from Stream

This tool generates the raster DisttoStr that contains the distance from each cell to the closest stream cell based on overland flow. It uses as input the stream raster (Str) and flow direction raster (Fdr) generated by the DEM Processing tool. The tool is prepopulated with default values.

- Modify the inputs if needed and click OK.

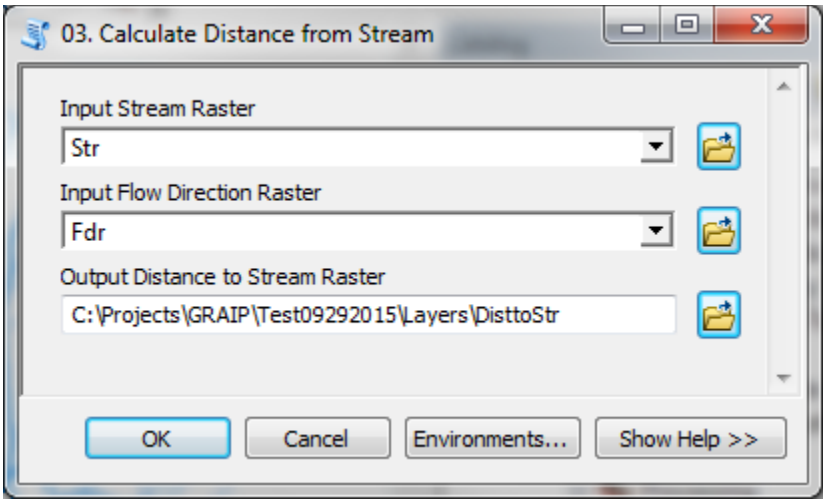


Figure 7-9 – Calculate Distance from Stream

```
Executing: CalculateDistancefromStream Str Fdr
C:\Projects\GRAIP\Test09292015\Layers\DisttoStr
Start Time: Tue Sep 29 09:38:15 2015
Running script CalculateDistancefromStream...
Identifying null stream cells...
Creating flow direction raster with nodata in streams...
Calculating flow length...
Setting flow length to 0 in streams...
Raster linear unit: Meter
Completed script CalculateDistancefromStream...
Succeeded at Tue Sep 29 09:38:16 2015 (Elapsed Time: 0.57 seconds)
```

The output DisttoStr raster stores in each cell the distance in meters to its closest stream cell based on the direction of overland flow.

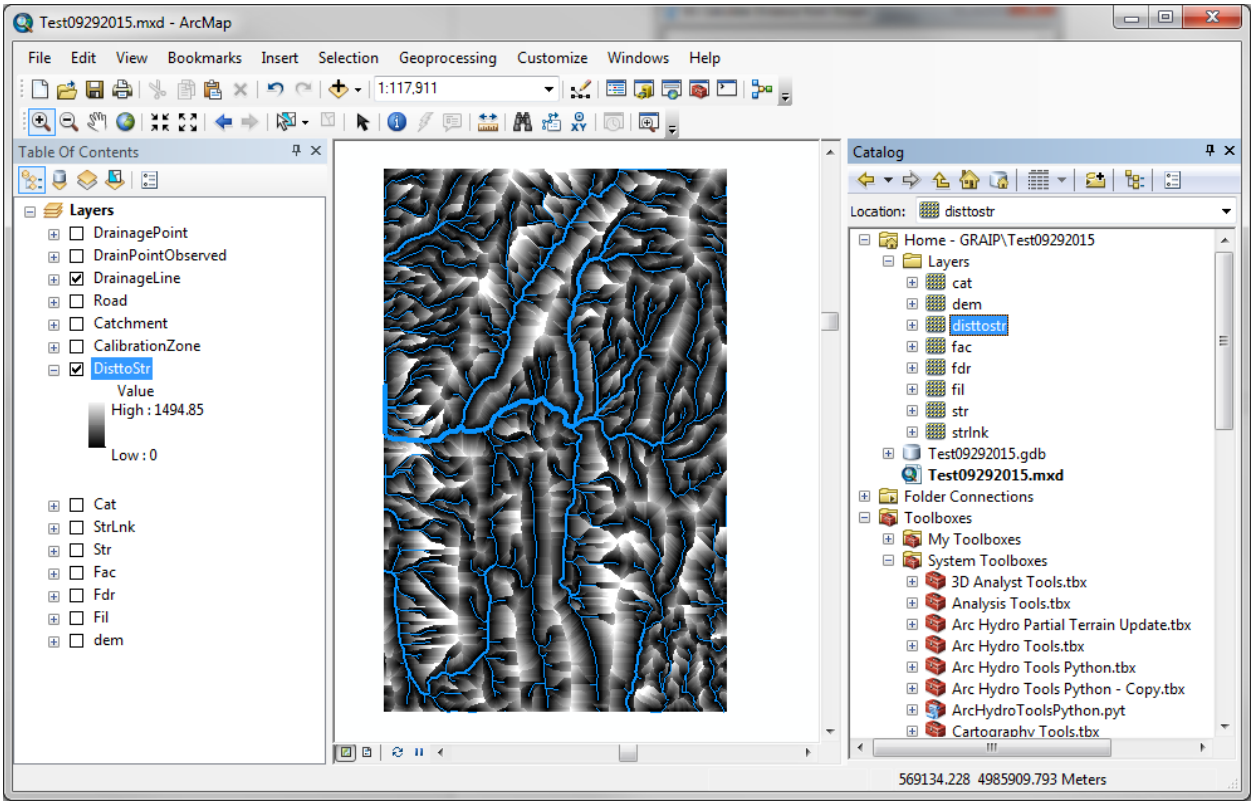


Figure 7-10 – Distance to Stream Result

7.4 Create Road Segments

This tool generates Road Segments using input CalibrationZone, Catchment, DrainageLine, DrainPointObserved and the field GL_SplitDistance that defines the maximum allowed length for each segment.

The tool populates the field GL_CalibrationZone in the resulting segment by retrieving the value from the field GL_CalibrationZone in the input CalibrationZone feature class.

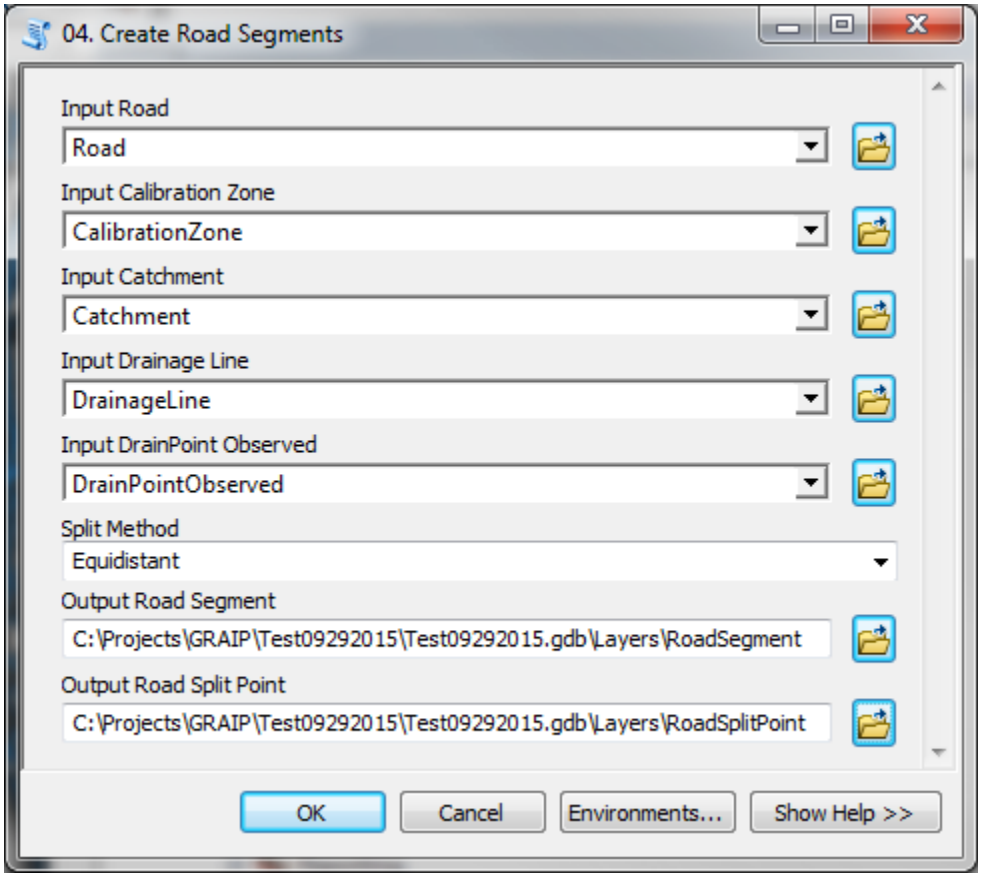


Figure 7-11 – Create Road Segments

```
Executing: CreateRoadSegments Road CalibrationZone Catchment DrainageLine
DrainPointObserved Equidistant
C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\RoadSegment
C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\RoadSplitPoint
Start Time: Tue Sep 29 10:25:36 2015
Running script CreateRoadSegments...
Processing Road/Calibration intersections...
Processing Road/Catchment intersections...
Processing Road/Stream intersections...
Processing Road/Junction intersections...
Merging intersecting points...
1896 record(s) updated on
C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\RoadSplitPoint. The
HydroID values ranged from 2007 to 3902.
0 observed drain point.
Splitting lines at points...
Number of Split Point features: 1896
Number of input lines: 395
Number of lines to split: 392
Number of lines not split: 3
Removing spatial index...
Adding spatial index...
Splitting lines using distance field GL_SplitDistance...
Split method specified: equidistant
```

```
Split method implemented: 1
Number of line(s) to process: 2148
Copying 851 original short line(s)...
Number of long line(s) to split: 1297
Appending 6763 split point(s) by distance...
6763 record(s) updated on
C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\RoadSplitPoint. The
HydroID values ranged from 3903 to 10665.
Cleaning up...
Completed script CreateRoadSegments...
Succeeded at Tue Sep 29 10:26:57 2015 (Elapsed Time: 1 minutes 19 seconds)
```

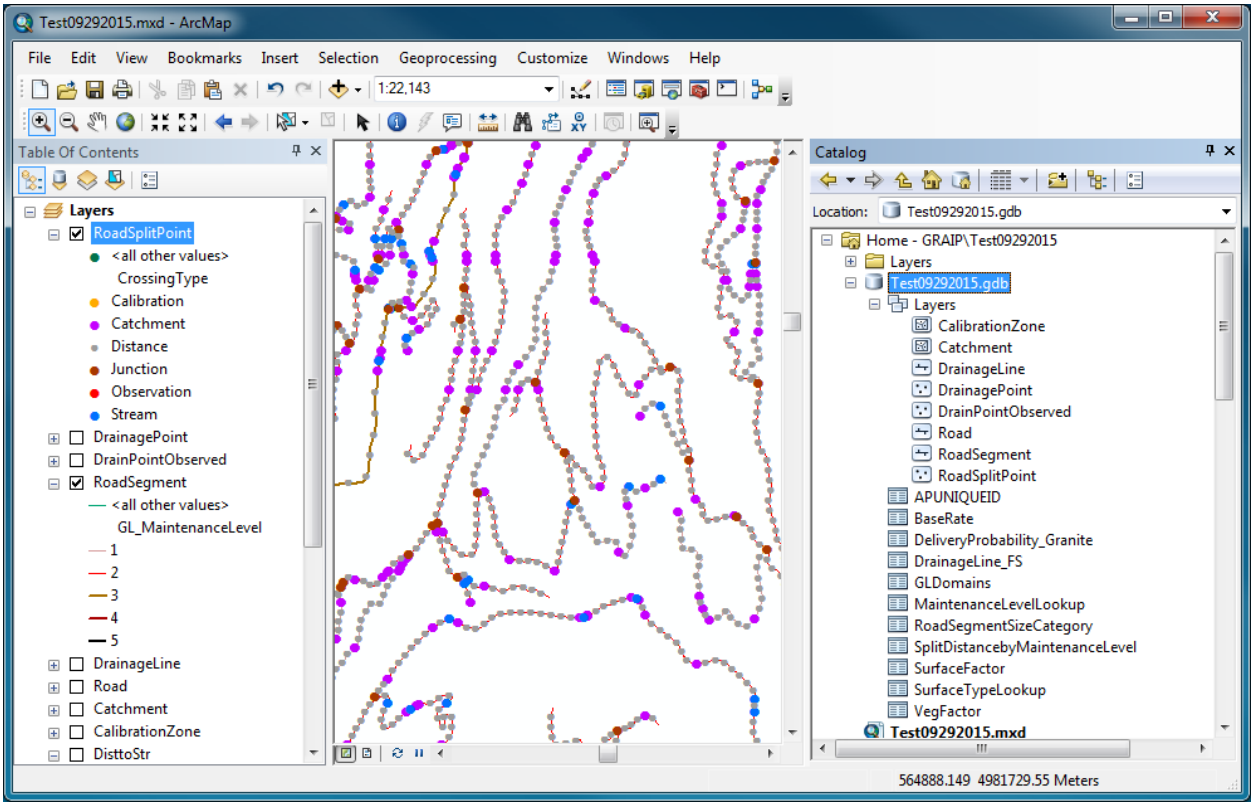


Figure 7-12 – Create Road Segments Result

Table

RoadSplitPoint

OBJECTID *	Shape *	GL_CrossingType	HydroID	GL_Observed	GL_SnapDist
1	Point	Calibration	2007	0	0
2	Point	Calibration	2008	0	0
3	Point	Calibration	2009	0	0
4	Point	Calibration	2010	0	0
5	Point	Calibration	2011	0	0
6	Point	Calibration	2012	0	0

1 (0 out of 8659 Selected)

RoadSplitPoint

Figure 7-13 – RoadSplitPoint Attributes Table

Table

RoadSegment

OBJECTID *	Shape *	SplitID	OrigLength	RTE_CN	ID	NAME	BMP
1	Polyline	317	167.494612	43377010602	MCC00	MCCALL	0
2	Polyline	317	167.494612	43377010602	MCC00	MCCALL	0
3	Polyline	317	167.494612	43377010602	MCC00	MCCALL	0
4	Polyline	317	167.494612	43377010602	MCC00	MCCALL	0
5	Polyline	8	7916.552093	725010444	50453	GOOSE CREE	2.26

1 (0 out of 8911 Selected)

RoadSegment

Figure 7-14 – Road Segment Attributes Table (1/2)

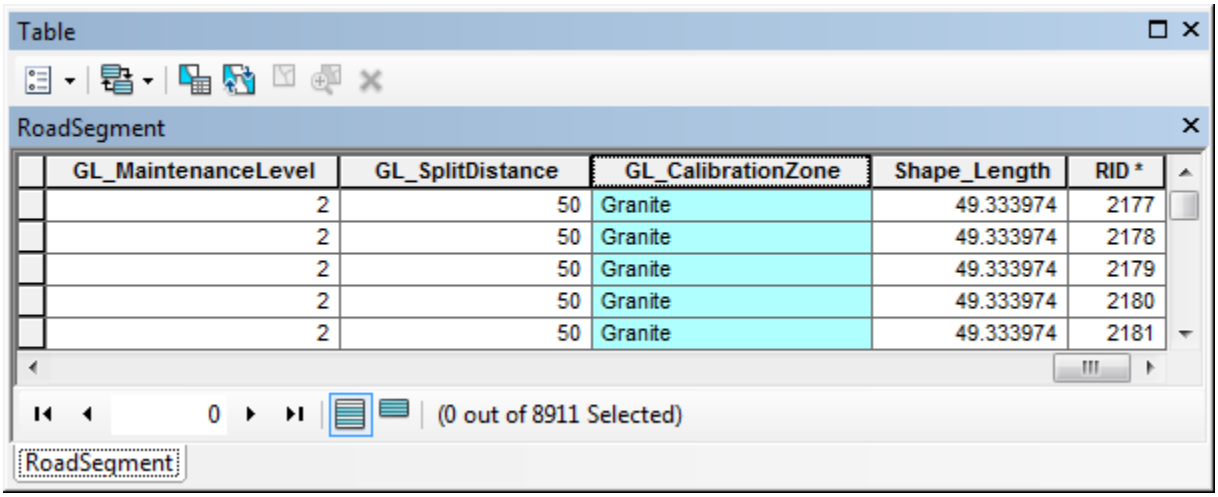


Figure 7-15 – Road Segment Attributes Table (2/2)

7.5 Calculate Road Segment Sediment Production

This tool calculates the sediment production and stores it in the field GL_SedProd.

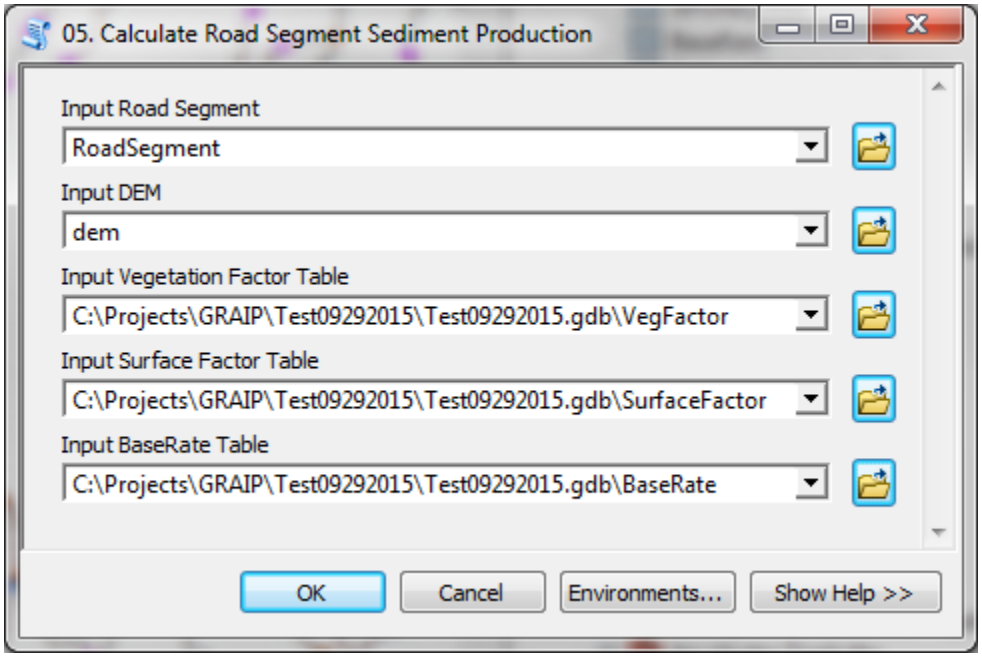


Figure 7-16 – Calculate Road Segment Sediment Production

```
Executing: CalculateRoadSegmentSedimentProduction RoadSegment dem
C:\Projects\GRAIP\Test09292015\Test09292015.gdb\VegFactor
C:\Projects\GRAIP\Test09292015\Test09292015.gdb\SurfaceFactor
C:\Projects\GRAIP\Test09292015\Test09292015.gdb\BaseRate
Start Time: Tue Sep 29 10:32:33 2015
Running script CalculateRoadSegmentSedimentProduction...
Processing 8911 road segments...
```

```
 DEM linear unit: Meter
 Unit conversion factor: 1
 Conversion factor: 1
 Identifying Start points...
        - completed in 1.3 seconds.
 Interpolating shapes for 8911 Start points...
        - completed in 1.7 seconds.
 Adding Z to 6759 points...
        - completed in 1.0 seconds.
 Adding attribute index to field RID...
        - completed in 0.3 seconds.
 Retrieving elevations Start_ElevM from 6759 points...
        - completed in 0.3 seconds.
 Storing elevations Start_ElevM in 8911 road segments...
        - completed in 0.6 seconds.
 Identifying End points...
        - completed in 1.2 seconds.
 Interpolating shapes for 8911 End points...
        - completed in 1.2 seconds.
 Adding Z to 6758 points...
        - completed in 0.8 seconds.
 Adding attribute index to field RID...
        - completed in 0.2 seconds.
 Retrieving elevations End_ElevM from 6758 points...
        - completed in 0.2 seconds.
 Storing elevations End_ElevM in 8911 road segments...
        - completed in 0.7 seconds.
 Populating attribute RangeM...
        - completed in 1.2 seconds.
 Populating attribute LengthM...
        - completed in 1.8 seconds.
 Populating attribute GL_VegFactor...
 GL_CalibrationZone field is not populated for all road segments.
        - completed in 1.5 seconds.
 Populating attribute GL_SedProd...
        - completed in 1.3 seconds.
 Cleaning up...
 Completed script CalculateRoadSegmentSedimentProduction...
Succeeded at Tue Sep 29 10:32:51 2015 (Elapsed Time: 17.98 seconds)
```

Table

RoadSegment

Start_ElevM	End_ElevM	RangeM	LengthM	GL_BaseRate	GL_SurfaceFactor	GL_VegFactor	GL_SedProd
1564.9197	1570.0971	5.1774	49.333974	21.7	5	0.779	437.601614
1570.0971	1572.8167	2.7196	49.333974	21.7	5	0.779	229.864671
1572.8167	1573.4853	0.6686	49.333974	21.7	5	0.779	56.511075
1573.4853	1573.727	0.2417	49.333974	21.7	5	0.779	20.428847
1573.727	1573.8539	0.1269	49.333974	21.7	5	0.779	10.725778

1 (0 out of 8911 Selected)

RoadSegment

Figure 7-17 – Road Segment with GL_SedProd and other computed fields

7.6 Create Road Segment Drain Points

This tool creates the Road Drain Point associated to each Road Segment at the end of the segment having the lowest elevation and retrieves the distance to the closes stream cell under the point from the DisttoStr raster. If the point is located on a Catchment boundary, it will be moved to the cellsize/1000 t oensure that they are located in the same Catchment where the associated Road Segment is located.

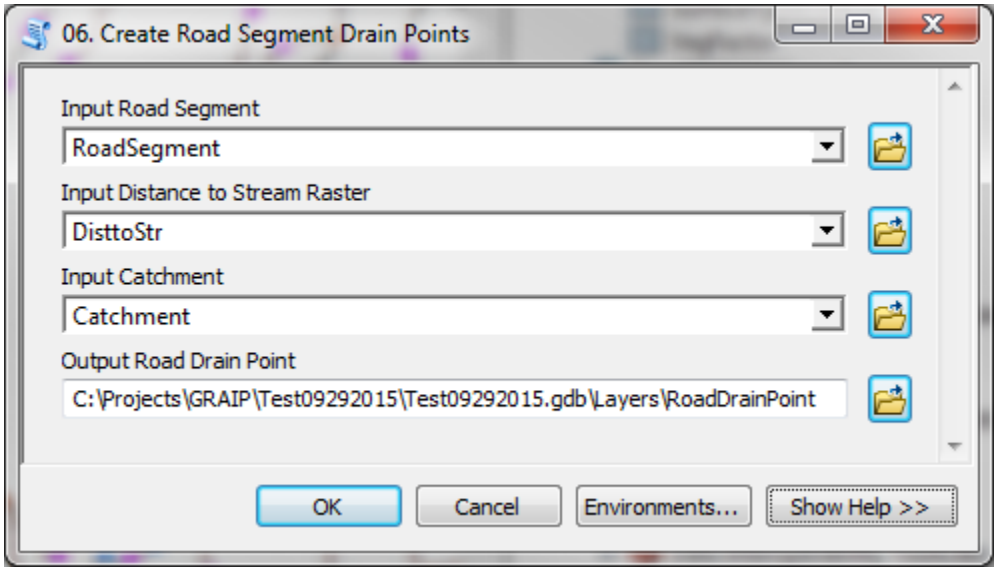


Figure 7-18 – Create Road Segment Drain Points

```
 Executing: createroadsegmentdrainpoints RoadSegment DisttoStr Catchment
 C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\RoadDrainPoint
 Start Time: Tue Sep 29 10:38:26 2015
 Running script createroadsegmentdrainpoints...
 Cleaning up...
 Completed script createroadsegmentdrainpoints...
Succeeded at Tue Sep 29 10:38:36 2015 (Elapsed Time: 9.85 seconds)
```

If there is no DisttoStr cell under a RoadDrainPoint, the field GL_StreamDist is populated with -9999.

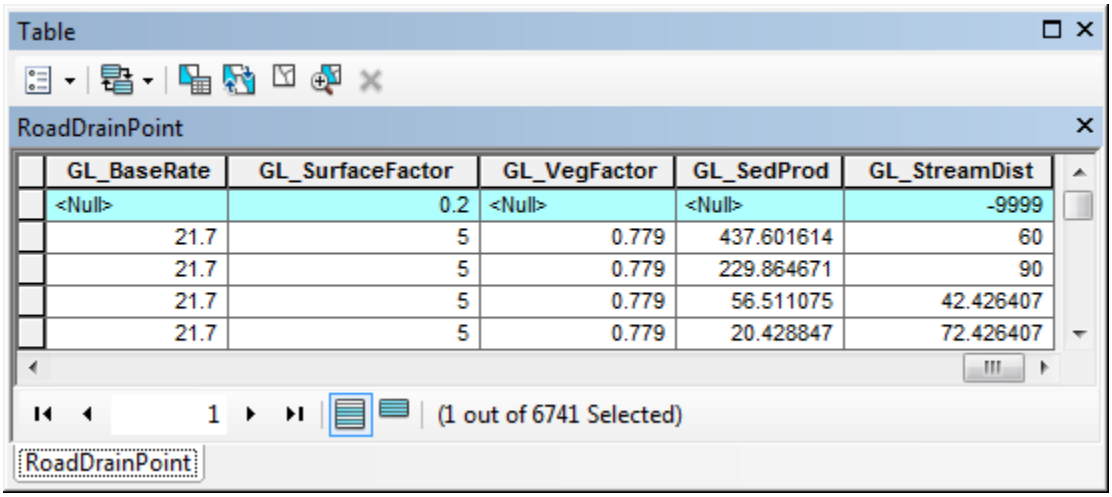


Figure 7-19 – RoadDrainPoint Attribute Table

7.7 Calculate Sediment Delivery

This tool calculates the sediment delivery probability and sediment delivery for each RoadDrainPoint. The tool first categorize the type of each segment (short ,medium, long) based on the segment length (LenghtM) and the configuration table RoadSegmentSizeCategory.

The tool then calculates the delivery probability by reading and interpolating the probabilities from the DeliveryProbability configuration tables associated to the calibration zone.

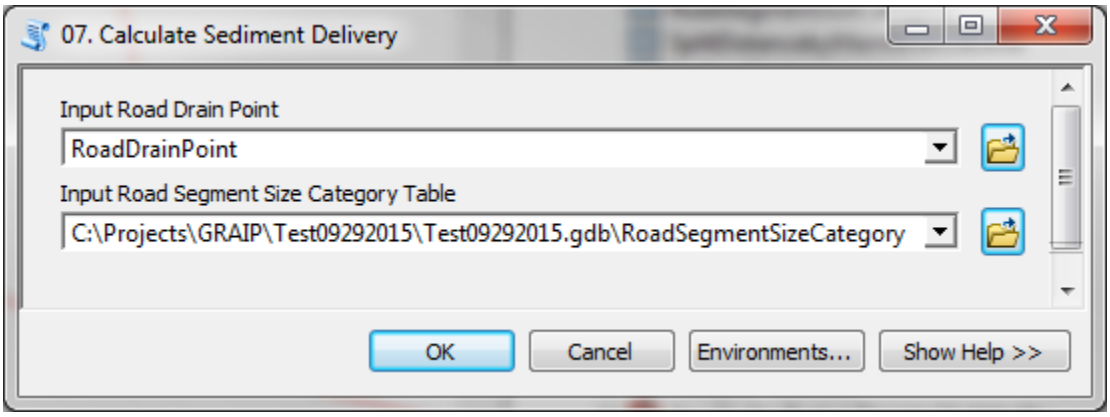


Figure 7-20 – Calculate Sediment Delivery

```
 Executing: CalculateSedimentDelivery RoadDrainPoint
 C:\Projects\GRAIP\Test09292015\Test09292015.gdb\RoadSegmentSizeCategory
 Start Time: Tue Sep 29 10:45:31 2015
 Running script CalculateSedimentDelivery...
 GL_CalibrationZone is not populated for 6 features.
 Populating field GL_SedDel...
 Completed script CalculateSedimentDelivery...
Succeeded at Tue Sep 29 10:45:35 2015 (Elapsed Time: 3.89 seconds)
```

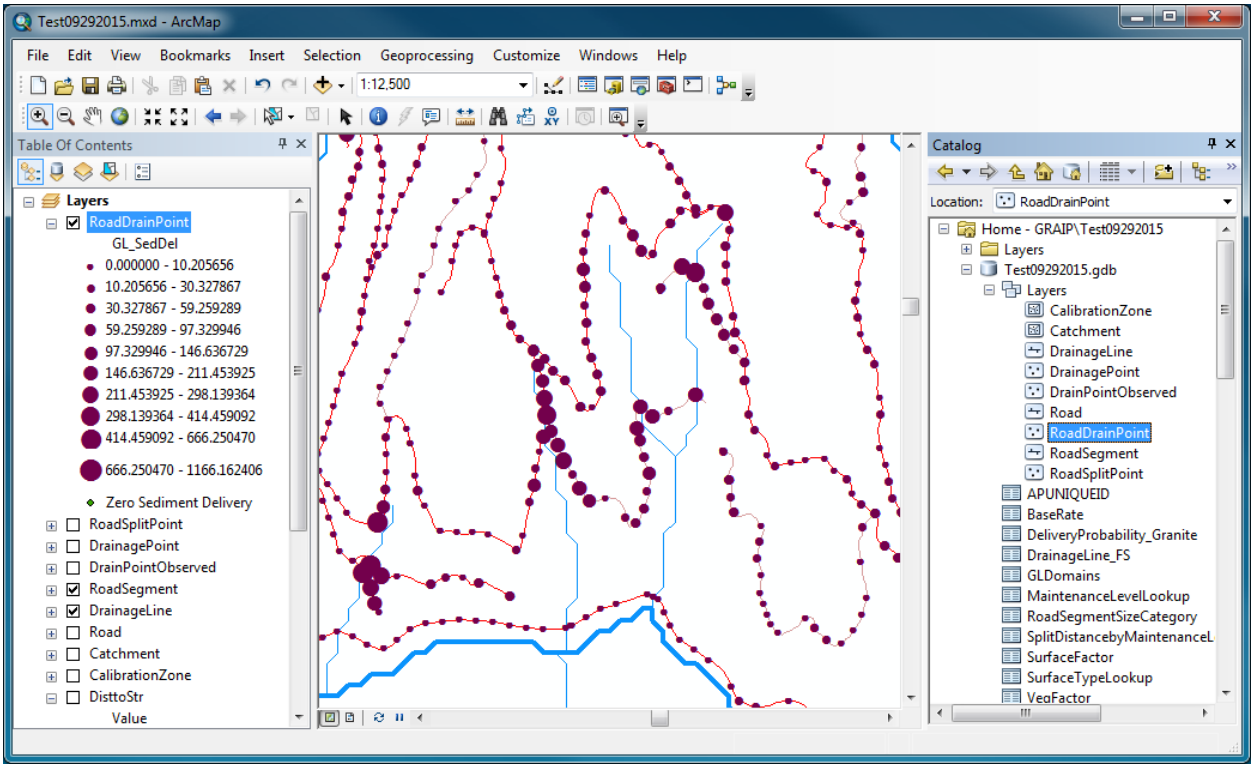


Figure 7-21 – Calculate Sediment Delivery Results

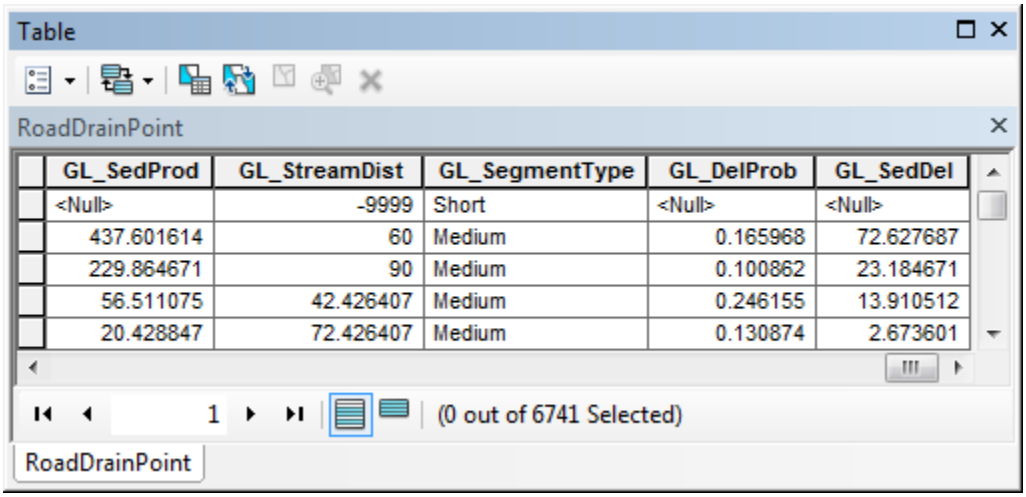


Figure 7-22 – RoadDrainPoint Attributes Table

7.8 Route Sediments to Streams

The tools calculates the Drain Point raster storing the cumulative sediment delivery in any cell.

It then tool routes the cumulative sediment deliveries to the streams by performing a weighted flow accumulation to generate the Sediment Delivery Raster (GL_SedDel).

The tool generates the Stream Sediment Load raster (GL_SedStr) by keeping only the cells from the Sediment Delivery raster that are located on a stream.

The tool generates the Stream Specific Sediment Load raster by dividing the previous raster by the input Flow Accumulation Raster.

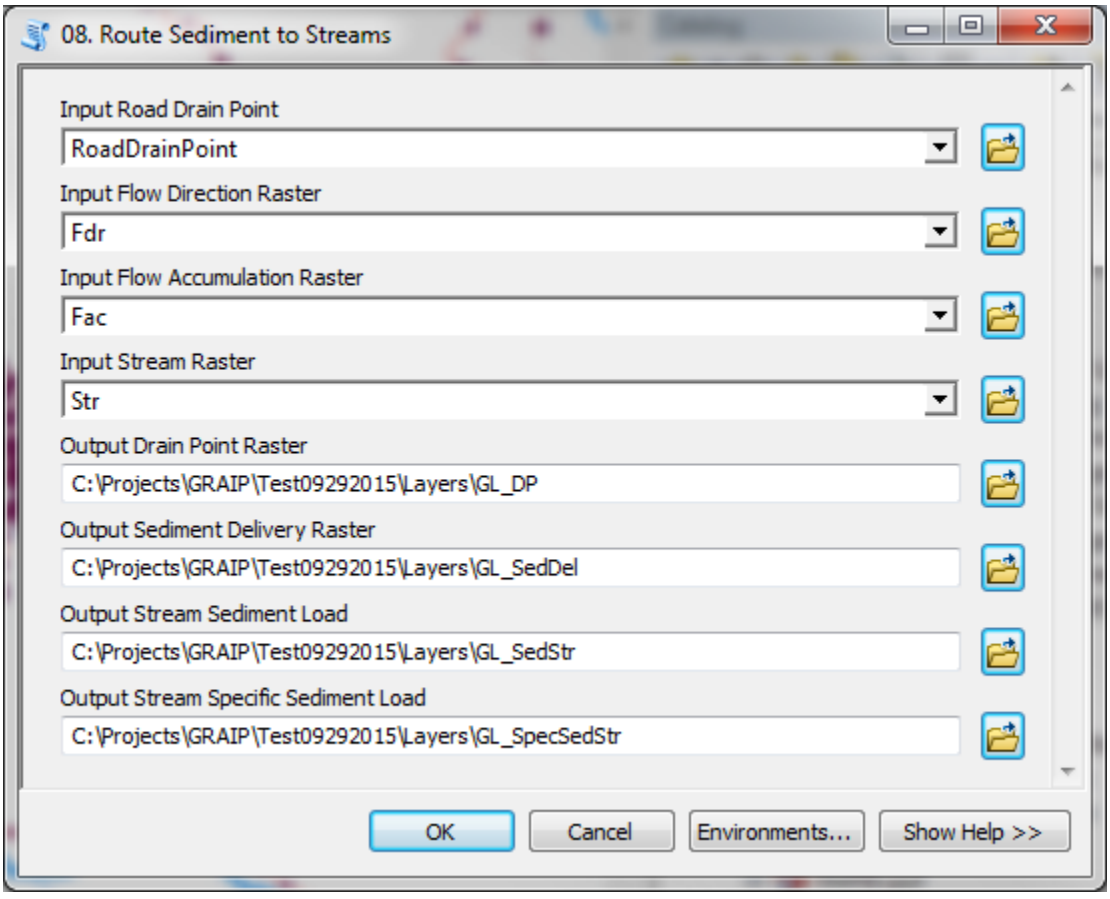


Figure 7-23 – Route Sediment to Streams

```
Executing: RouteSedimenttoStreams RoadDrainPoint Fdr Fac Str
C:\Projects\GRAIP\Test09292015\Layers\GL_DP
C:\Projects\GRAIP\Test09292015\Layers\GL_SedDel
C:\Projects\GRAIP\Test09292015\Layers\GL_SedStr
C:\Projects\GRAIP\Test09292015\Layers\GL_SpecSedStr
Start Time: Tue Sep 29 10:49:12 2015
Running script RouteSedimenttoStreams...
Converting DrainPoint to raster...
```

```
 Accumulating sediment: computing weighted flow accumulation...
 Completed script RouteSedimenttoStreams...
Succeeded at Tue Sep 29 10:49:14 2015 (Elapsed Time: 2.56 seconds)
```

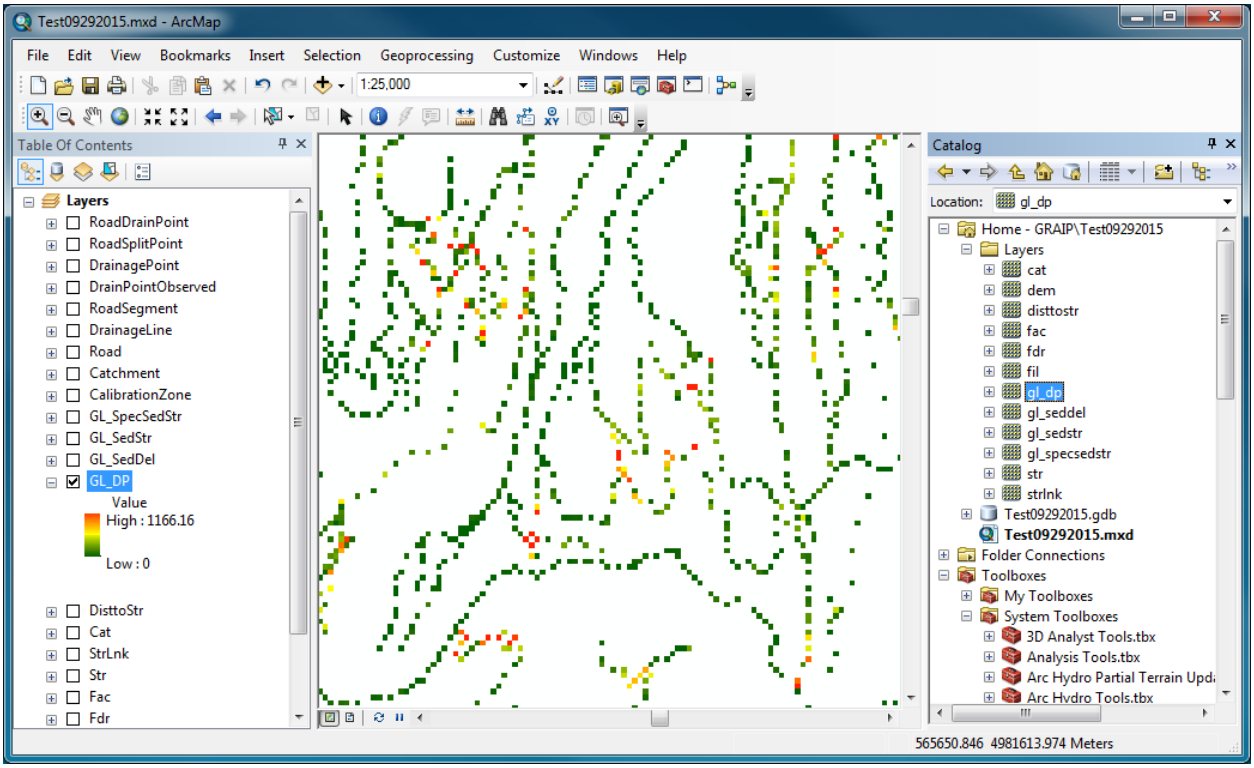


Figure 7-24-GL_DP Raster

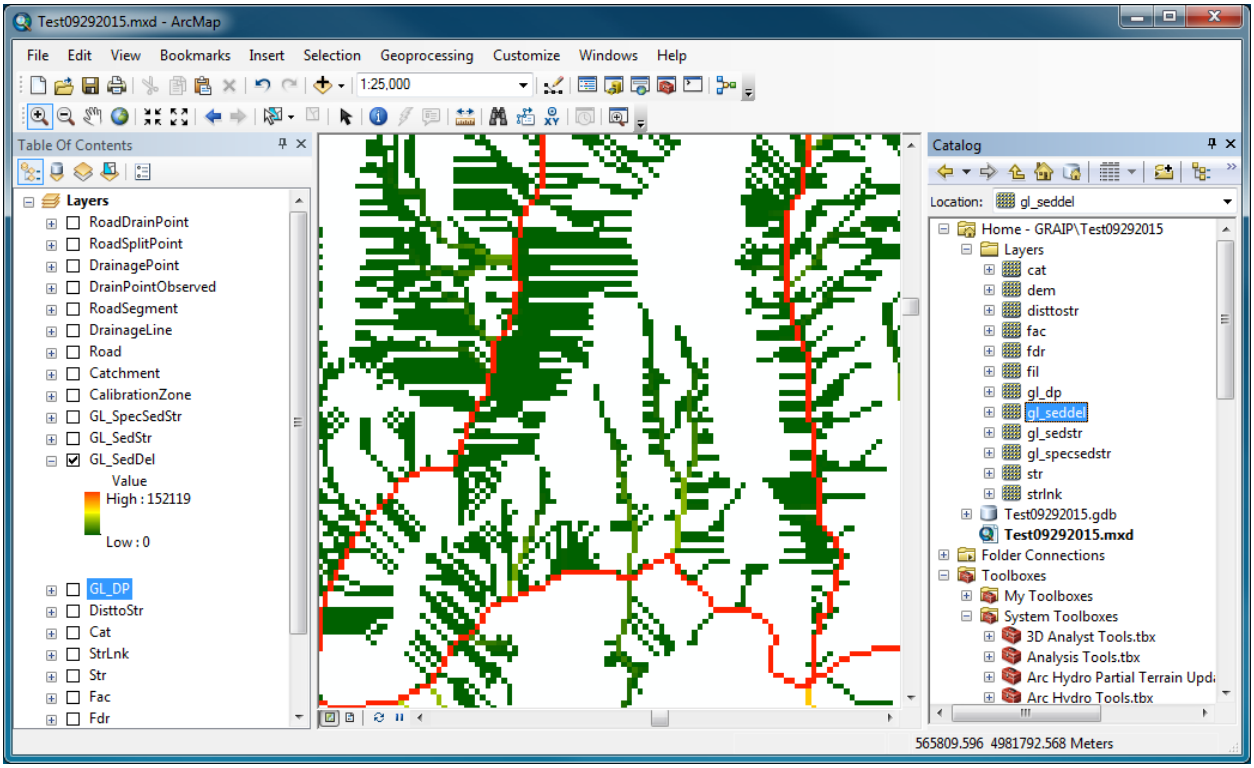


Figure 7-25 – GL_SedDel Raster

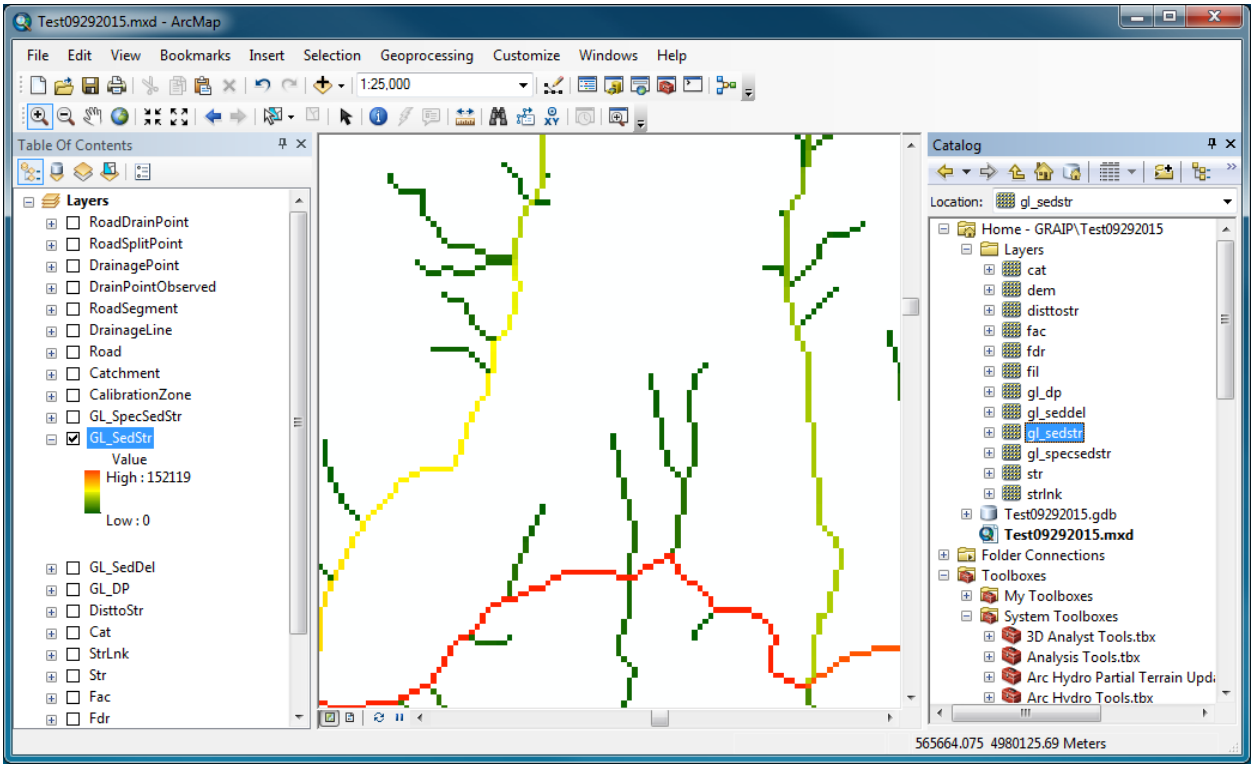


Figure 7-26 – GL_SedStr Raster

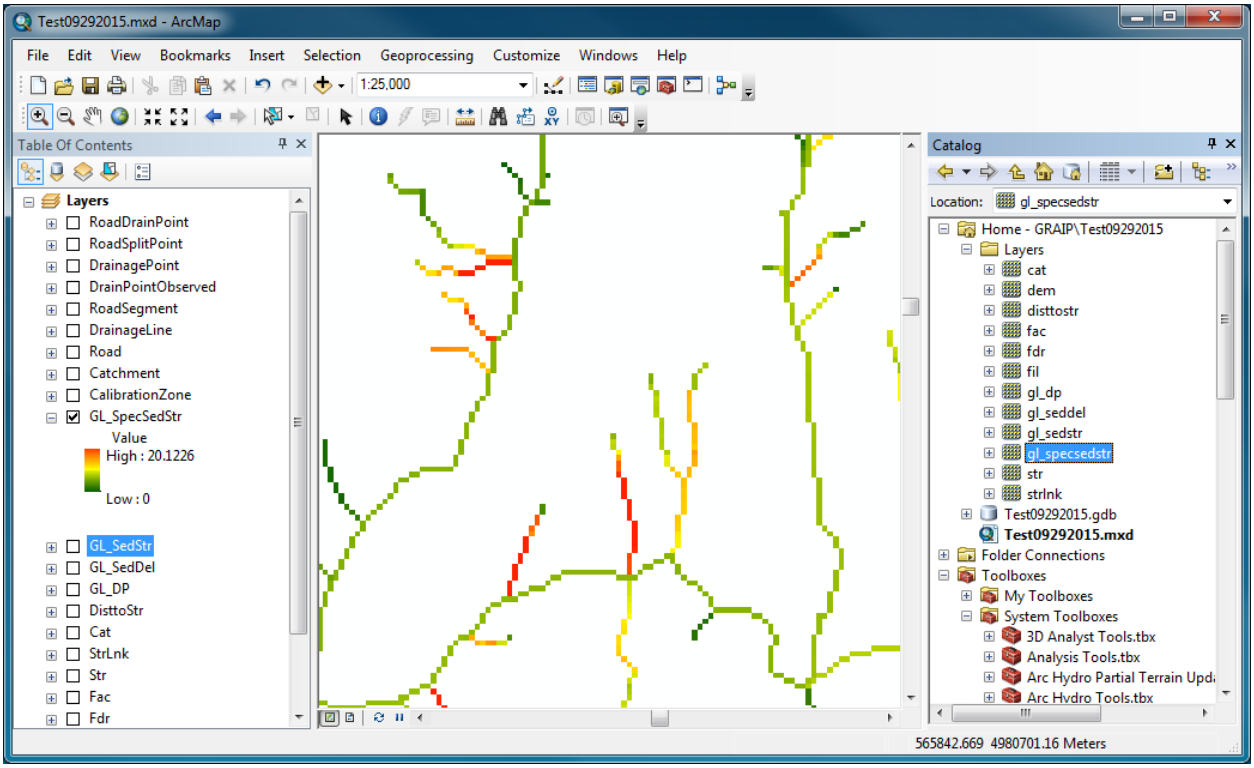


Figure 7-27 - GL_SpecSedStr Raster

8.0 Reporting

The Reporting toolset contains some tools that allow visualizing the results from the GRAIP Lite processing steps.

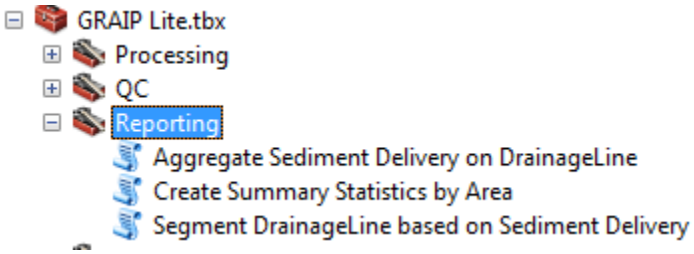


Figure 8-1 – Reporting Toolset

The following section illustrates the process using a small tutorial dataset (Roadsm, demsm).

Tool	Processing Time
01. Aggregate Sediment Delivery on DrainageLine	3s
02. DEM Processing	5s
03. Calculate Distance from Stream	2s

8.1 Aggregate Sediment Delivery on DrainageLine

This tools retrieves the value of the accumulated sediment delivery raster under each Drainage Point which represents the location of maximum flow accumulation for a given DrainageLine/Catchment and transfers this value into the field GL_SedAccum in the DrainageLine features.

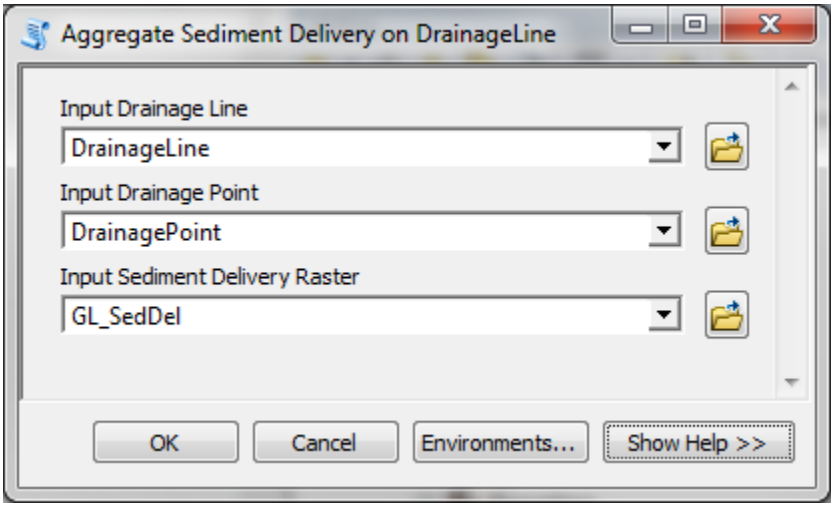


Figure 8-2 – Aggregate Sediment Delivery on DrainageLine

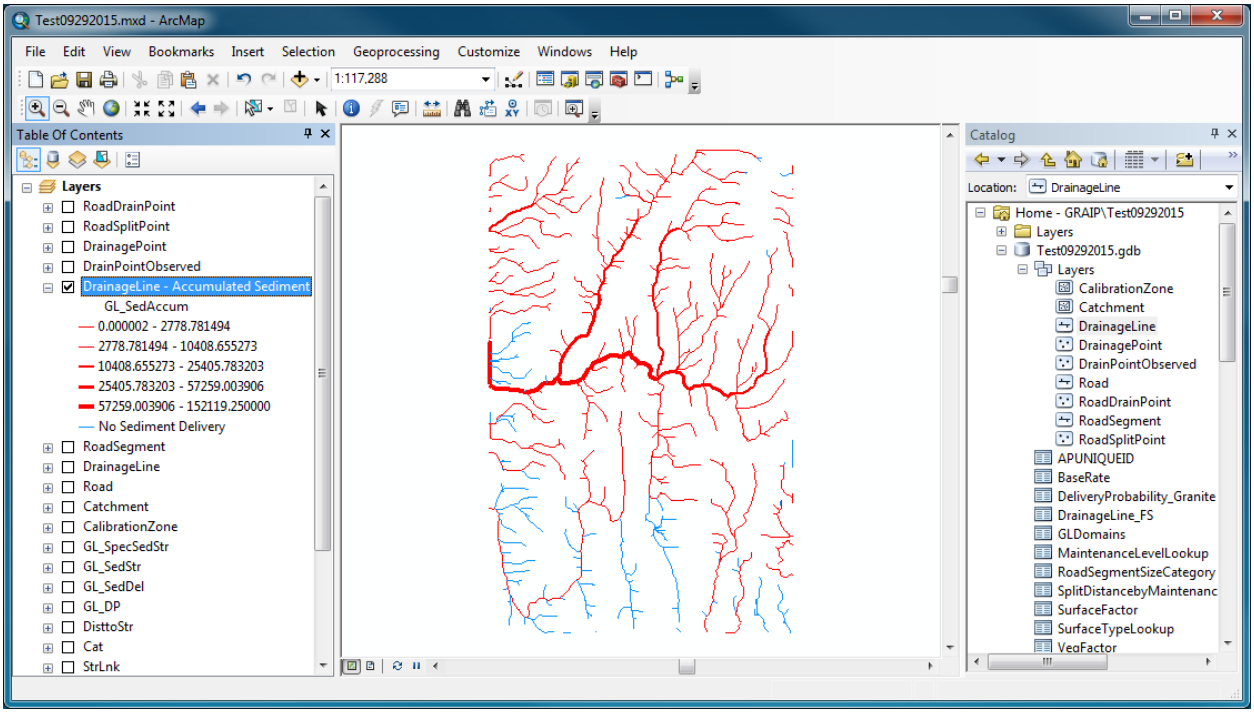
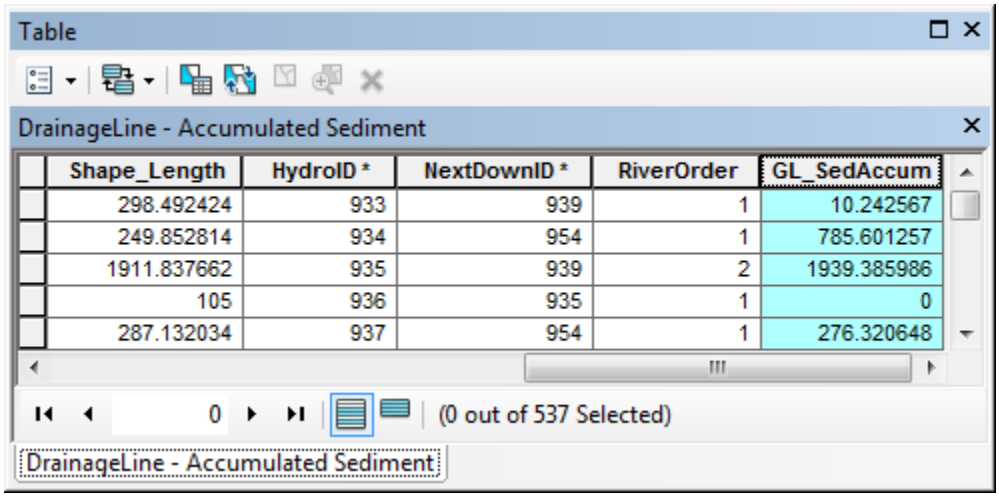


Figure 8-3 - Aggregate Sediment Delivery on DrainageLine Results




```
 Executing: AggregateSedimentDeliveryonDrainageLine DrainageLine
 DrainagePoint GL_SedDel
 Start Time: Tue Sep 29 11:01:46 2015
 Running script AggregateSedimentDeliveryonDrainageLine...
 Completed script AggregateSedimentDeliveryonDrainageLine...
Succeeded at Tue Sep 29 11:01:48 2015 (Elapsed Time: 2.89 seconds)
```

8.2 Create Summary Statistics by Area

This tool calculates the sum of the Drain Point raster cells (i.e. Cumulative Sediment Delivery) within each source polygon and stores it in the attribute GL_SedDel. It then divides this field by the polygons' area in square meters to populate the attribute GL_SpecSedDel.

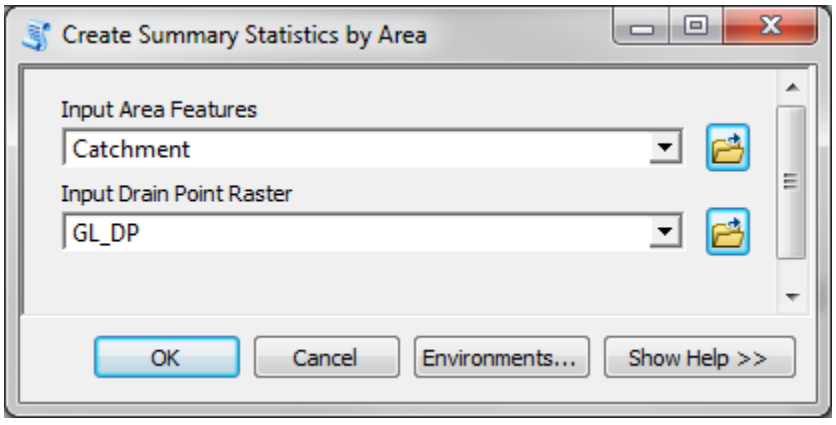


Figure 8-4 – Create Summary Statistics by Area

```
 Executing: CreateSummaryStatisticsbyArea Catchment GL_DP
 Start Time: Tue Sep 29 11:08:50 2015
```

```
  Running script CreateSummaryStatisticsbyArea...
  Completed script CreateSummaryStatisticsbyArea...
Succeeded at Tue Sep 29 11:08:56 2015 (Elapsed Time: 5.29 seconds)
```

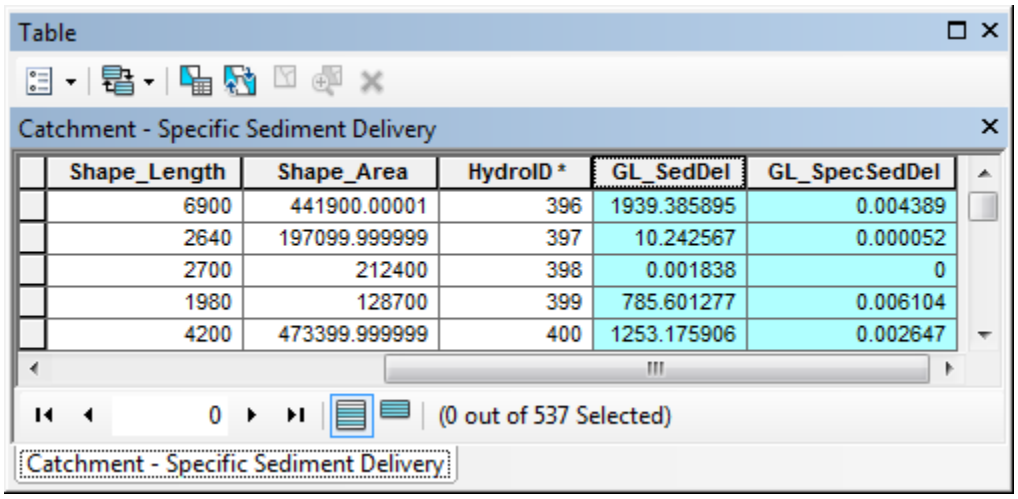


Figure 8-5 – Catchment Attributes Table

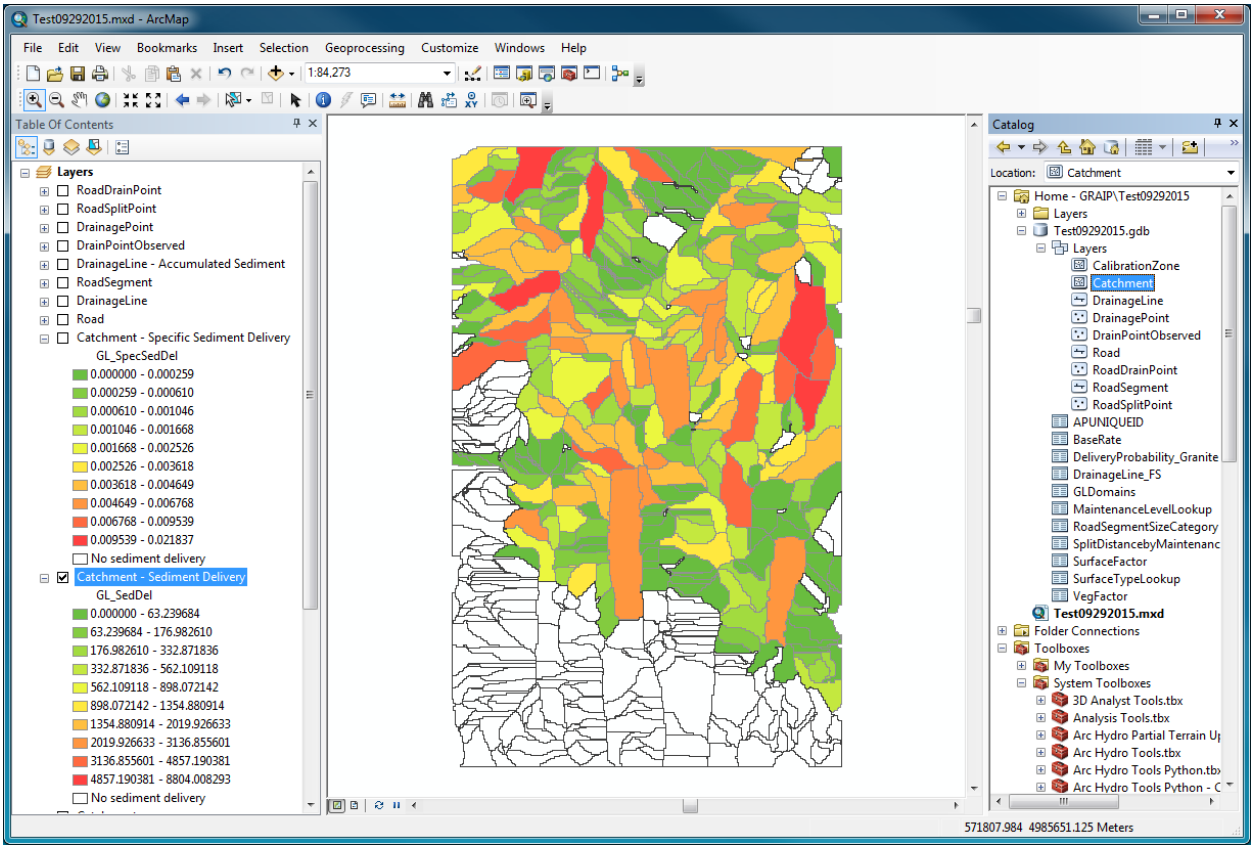


Figure 8-6 – Catchment – Sediment Delivery

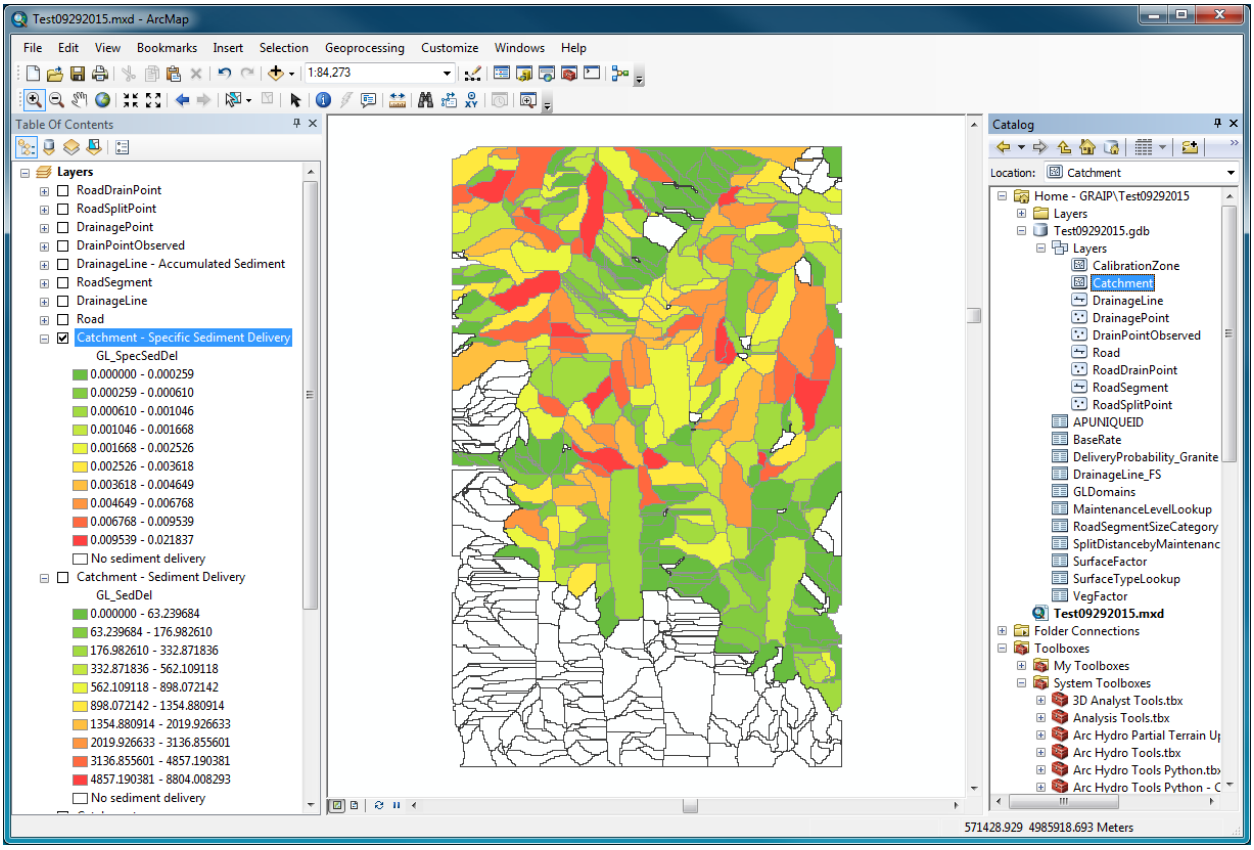


Figure 8-7 – Catchment – Specific Sediment Delivery

8.3 Aggregate Sediment Delivery on DrainageLine

This tool creates a Sediment Delivery Stream raster (SedStr) by keeping only the cells from the input Sediment Delivery Raster that are within a stream cell. Note that if the input Stream raster is Str, this raster will be identical to the raster GL_SedStr created by the tool 08. Route Sediment to Streams.

The tool then creates a vector representation of the raster (SedStream) whith one stream segment created for each unique sediment delivery value (GL_SedAccum).

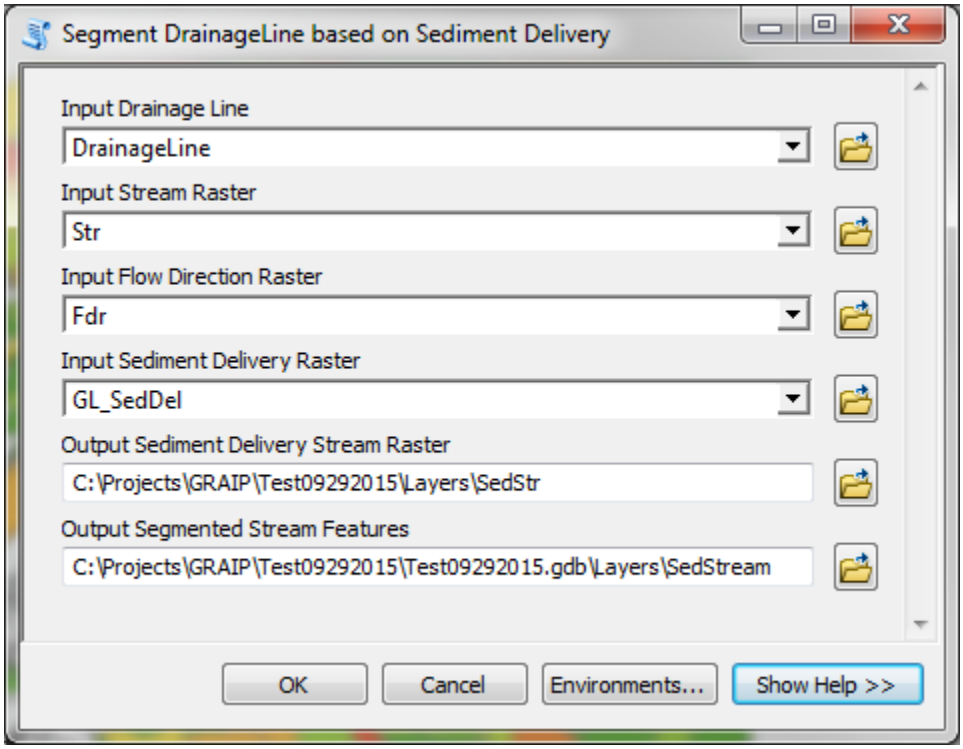


Figure 8-8 – Segment DrainageLine based on Sediment Delivery

```
  Executing: SegmentDrainageLinebasedonSedimentDelivery DrainageLine Str Fdr
  GL_SedDel C:\Projects\GRAIP\Test09292015\Layers\SedStr
  C:\Projects\GRAIP\Test09292015\Test09292015.gdb\Layers\SedStream
  Start Time: Tue Sep 29 11:18:47 2015
  Running script SegmentDrainageLinebasedonSedimentDelivery...
  Completed script SegmentDrainageLinebasedonSedimentDelivery...
Succeeded at Tue Sep 29 11:18:49 2015 (Elapsed Time: 1.49 seconds)
```

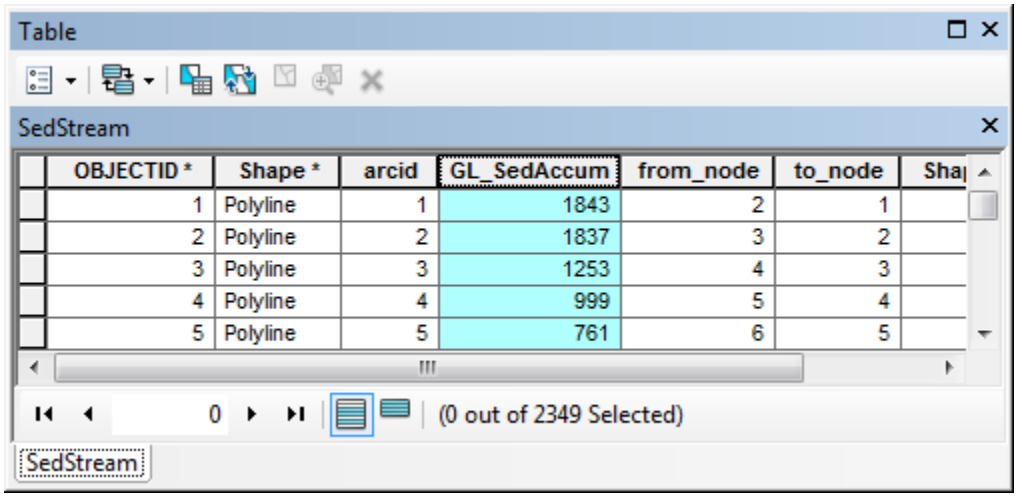


Figure 8-9 – SedStream Atributes Table

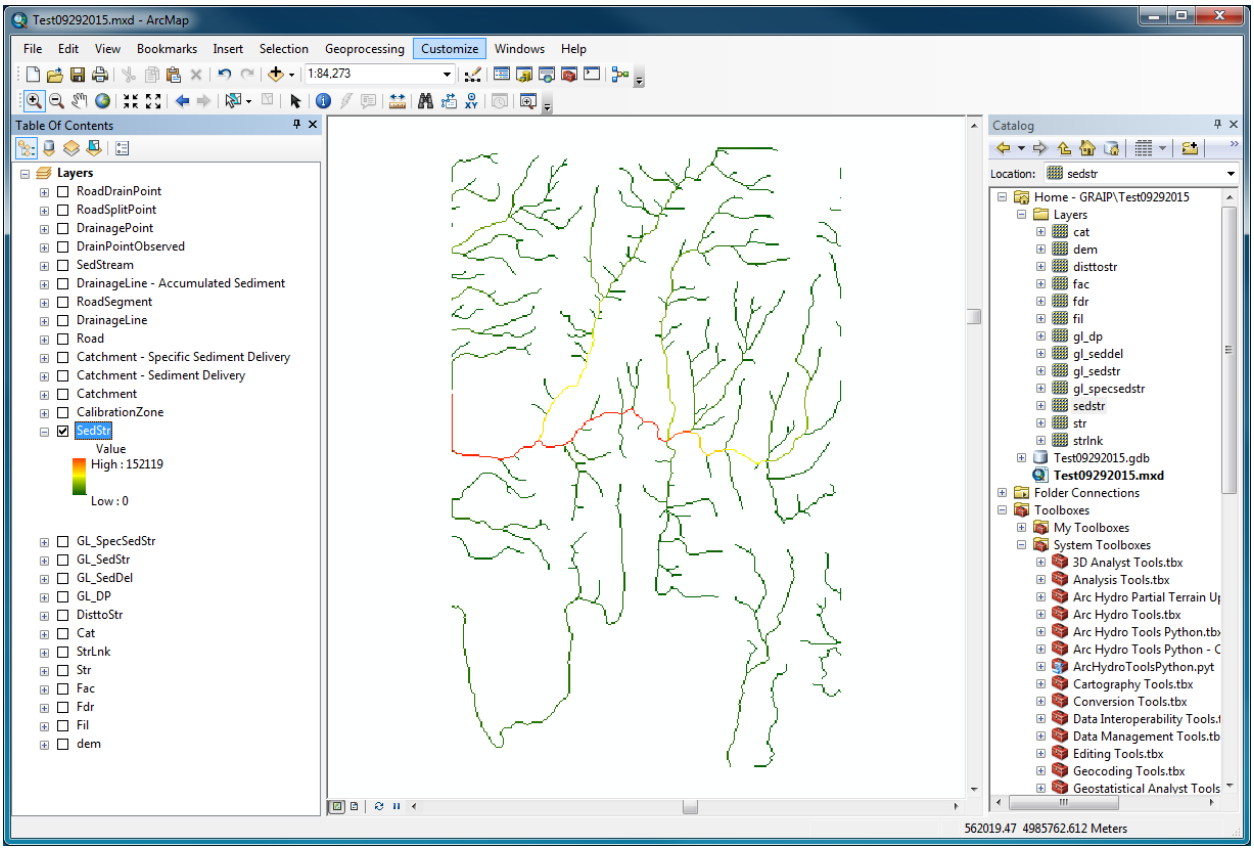


Figure 8-10 - – SedStr

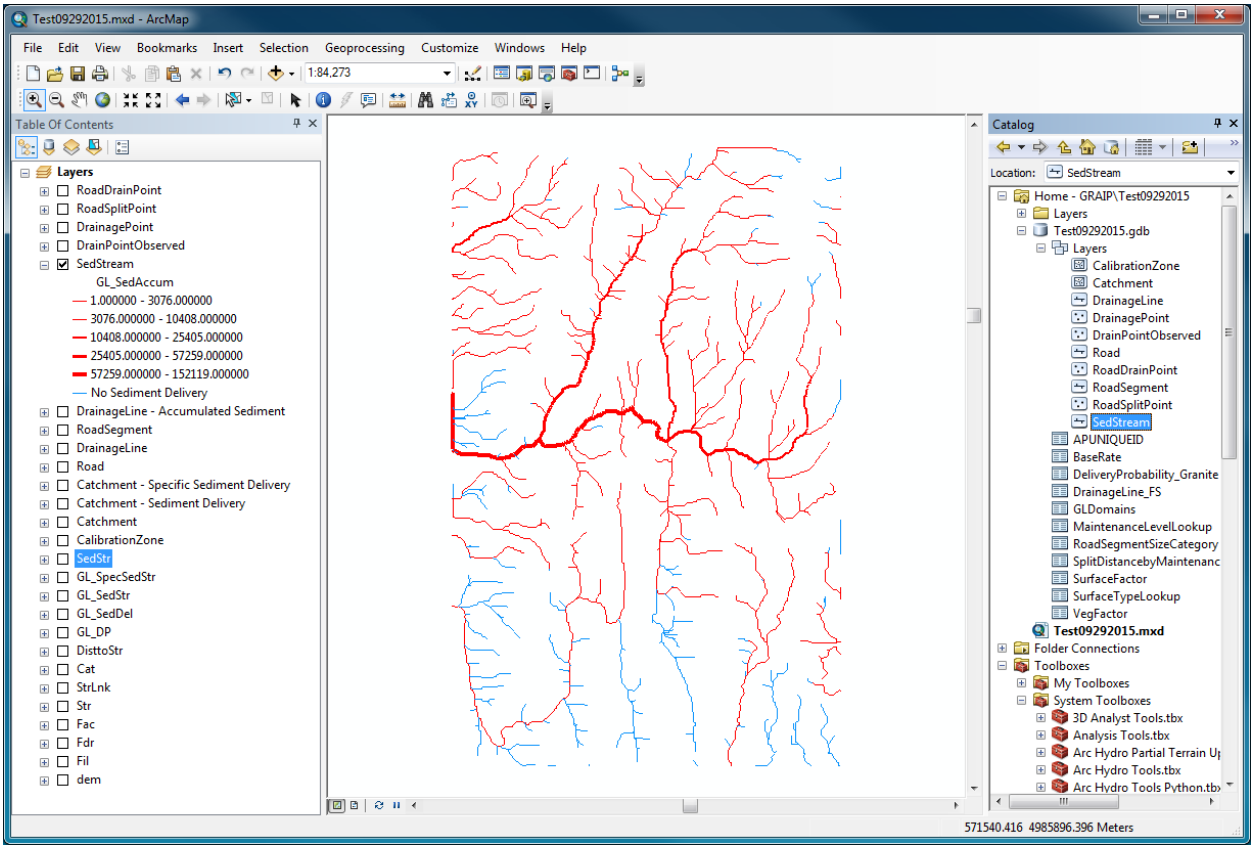


Figure 8-11 – SedStream

9.0 Calibration

9.1 Data Preparation

The following calibration data are used by the GRAIP Lite tools:

- Calibration Zone polygon feature class
- BaseRate table
- VegFactor table
- DeliveryProbability table

9.1.1 Calibration Zone Polygon Layer

The CalibrationZone layer defines the areas associated to each calibration. It is an optional input to the tool 01. Initialize GRAIP Lite Database. If the layer is not provided, a default CalibrationZone will be created that will correspond to the outline of the input DEM. The name of the default calibration zone is defined in the graipliteconfig.py configuration file and is set to 'Default'.

9.1.2 Calibration Point Layer

Each calibration must have an associated calibration point shapefile collected during field data collection. Field data collection for calibrating GRAIP_Lite uses a specific data dictionary and is based on our GRAIP inventory data collection. If you are familiar with collecting GRAIP data, collecting calibration data for GRAIP_Lite will be easy. The data dictionary consists of four types of features: drainpoint, gully point, landslide point, and photo point. The gully, landslide, and photo points are exactly the same as they are in the GRAIP data dictionary, which should be referred to for more detailed explanations of these points. The data used for the actual calibration is stored in the Drainpoint features. Within the DrainPoint feature type, there are several fields of information that is collected.

The first piece of information we collect is what type of drainpoint the feature is, and these types are based on the GRAIP INVENT6 data dictionary. Refer to the GRAIP data collection manual for more details and descriptions of these features.

Stream connection is next and is examined the same way as GRAIP does it. Stream connection is determined by observing evidence of water flow and sediment transport being continuous between the drainpoint and the stream.

Maintenance Level (Road_ML) is derived from the Forest Service INFRA layers. A map should be used to determine the maintenance level of the road on which you are collecting calibration data.

Surface refers to the material out of which the road is made; like GRAIP, the options are Native, Crushed Rock, or Paved.

Flowpath1Veg and Flowpath2Veg refer to the amount rooted vegetation in the flowpath where water flows down the road. There are two classes, >25% and <25%. This is usually estimated, though it can be measured by using a point intersection method. Using some measurements to calibrate your estimates in the field is a good idea.

Status is either Open or Closed. This is especially useful if collecting data on non-Forest Service System Roads that do not have maintenance level data.

Class is also intended to help with roads that do not have maintenance level data. The available options are Local, Collector, and Arterial. Local roads are smaller roads, often with less traffic, and they tend to be built to a lower standard and receive infrequent maintenance. Maintenance level 2 roads are a good example of local roads. Collector roads provide access to a number of local roads and are built to handle higher traffic volumes, often with some sort of improved surface; maintenance level 3 roads are a good example. Arterial roads are the main roads and highways through an area. They receive a high volume of traffic and are designed to provide a comfortable ride and higher travel speeds. County, state, and federal highways, as well as maintenance level 4 and 5 roads, are good examples.

9.1.3 BaseRate table

The default BaseRate table is located in the GRAIPLiteSchema.gdb database and is copied to the project's database when running the tool 01. Initialize GRAIP Lite Database.

If a Calibration Zone input is provided, the tool will check whether an input Calibration Folder is provided as well. If it is, the tool will look for the BaseRate.csv file in that folder.

If the input Calibration Folder is not specified, the tool will look in the same location as the input Calibration Zone layer for the BaseRate table.

The tool will overwrite the default BaseRate with this new BaseRate calibration table.

The custom table is created by running the tool Create Calibration Tables.

Store the baserates for your calibrations in Project_Baserates.csv. It should look like the example below and be saved in the Calibration folder with the associated calibration point shapefiles.

GL_CalibrationZone	GL_BaseRate
DryBasalt_UmatillaNF	1.5
WetBasalt_MalheurNF	27.2

The project's base rates are added to the default baserates used by GRAIP Lite.

9.1.4 VegFactor table

The default VegFactor table is located in the GRAIPLiteSchema.gdb database and is copied to the project's database when running the tool 01. Initialize GRAIP Lite Database.

If a Calibration Zone input is provided, the tool will check whether an input Calibration Folder is provided as well. If it is, the tool will look for the VegFactor.csv file in that folder.

If the input Calibration Folder is not specified, the tool will look in the same location as the input Calibration Zone layer for the VegFactor table.

The tool will overwrite the default VegFactor with this new VegFactor calibration table.

The custom table is created by running the tool Create Calibration Tables.

9.1.5 DeliveryProbability table

The default DeliveryProbability table is located in the GRAIPLiteSchema.gdb database and is copied to the project's database when running the tool 01. Initialize GRAIP Lite Database.

If a Calibration Zone input is provided, the tool will check whether an input Calibration Folder is provided as well. If it is, the tool will look for the DeliveryProbability_calibname.cvs table associated to each input calibration point shapefile.

If the input Calibration Folder is not specified, the tool will look in the same location as the input Calibration Zone layer for the DeliveryProbability_calibname tables.

The tool will append the records from the tables to the default DeliveryProbability table. It will also import each table as is into the project's database.

The custom tables are created by running the tool Create Calibration Tables.

9.2 Calibration Process

Once your calibration points are collected and can be brought in to GIS, start a GRAIP_Lite project. The Calibration Process is conducted by running the following tools:

- 01. Initialize GRAIP Lite Database
- 02.a DEM Processing to Str
- Optional - Evaluate the Str raster created. You can add the Fac raster and modify the symbology to view different threshold.
- Stream Definition (Arc Hydro Tools Python) to recreate Str for the desired threshold.
- 03. Calculate Distance from Stream

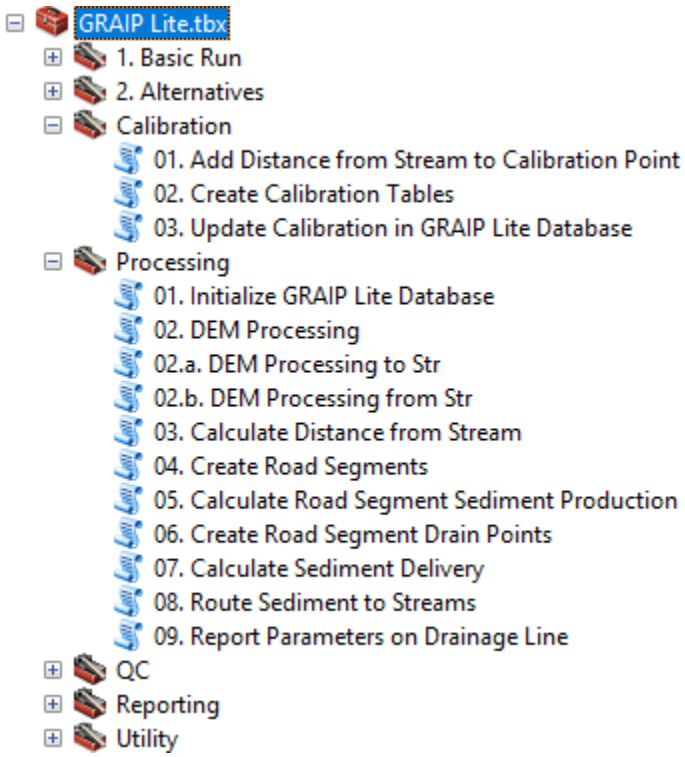


Figure 12- Tools for Calibration

9.2.1 Initialize GRAIP Lite Database

This step allows generating the standard GRAIP Lite project database. Specify the Roads and DEM associated to the project as input. Leave the other inputs blank as this time.

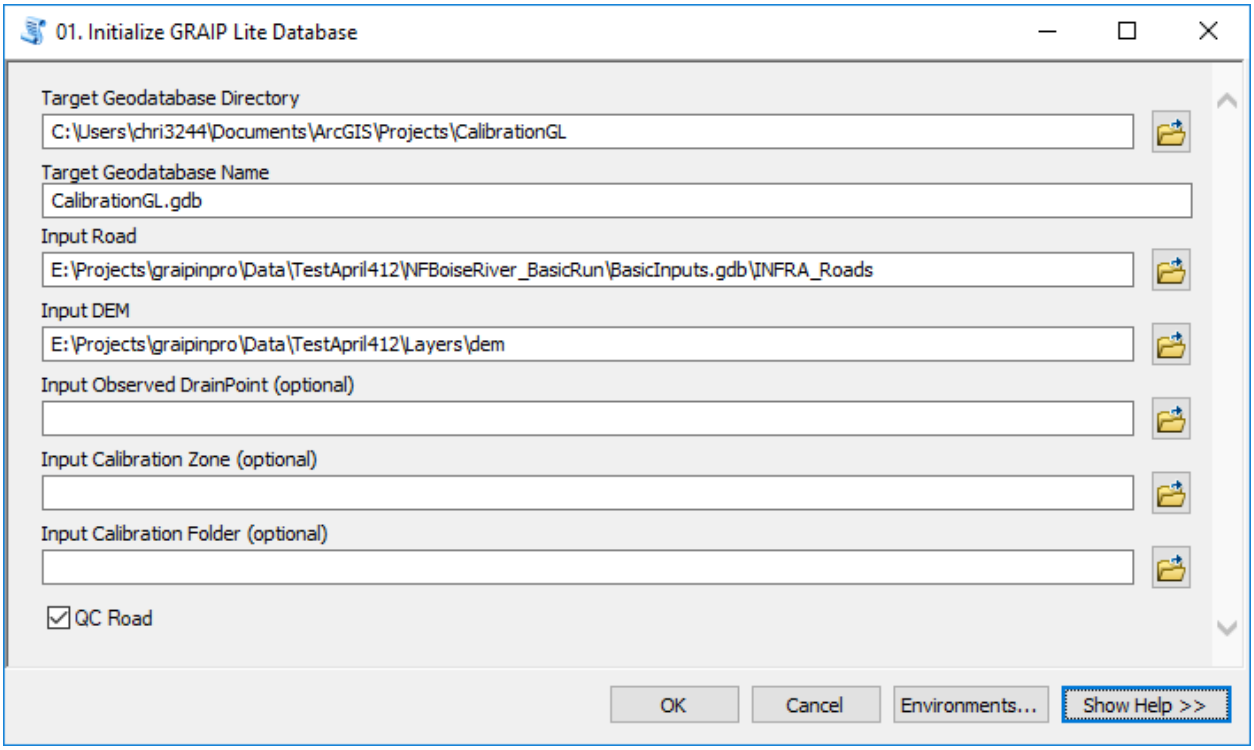


Figure 13 - Initialize GRAIP Lite Database for Calibration

This step generated a default CalibrationZone polygon feature class. You can edit the GL_CalibrationZone and geometry to match your calibration area. You can also bring you own CalibrationZone layer in a later step.

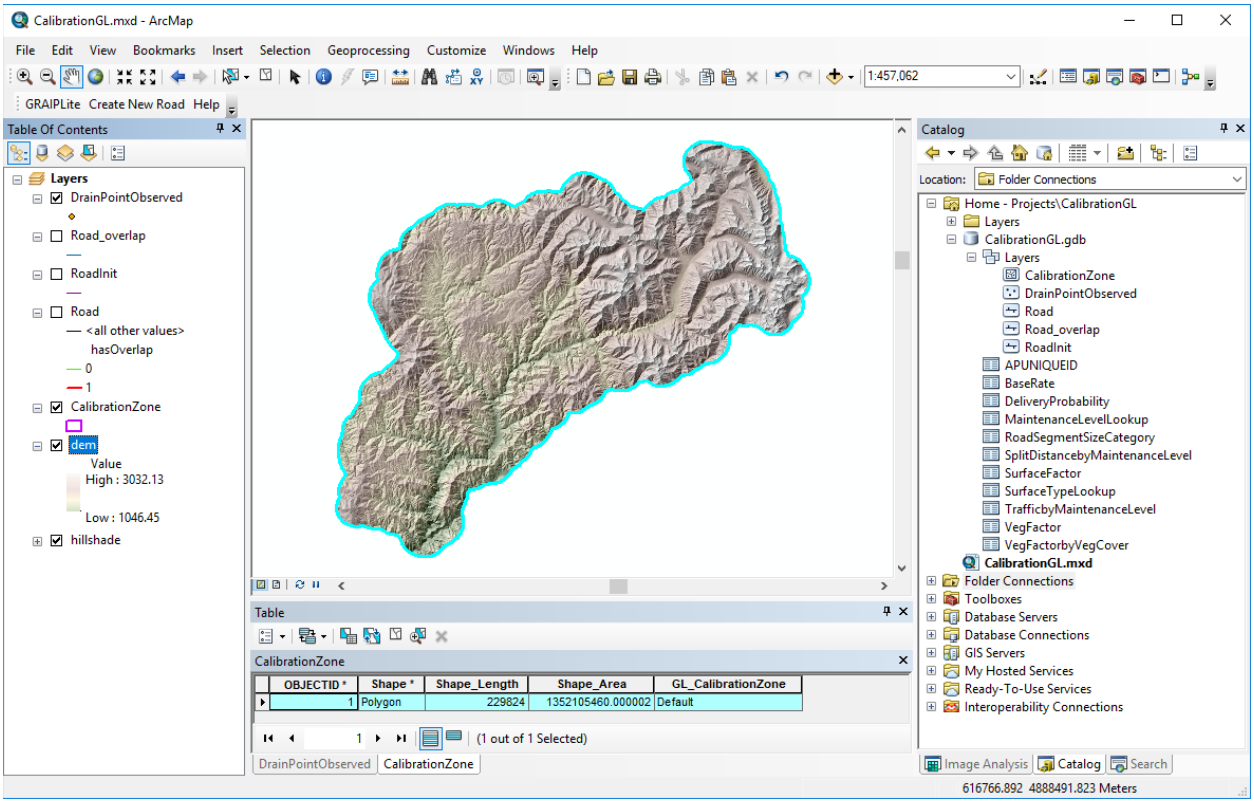


Figure 14 - Results from Initialization

9.2.2 DEM Processing to Str

The next step consists in creating supporting rasters, in particular the Stream raster Str corresponding to the specified threshold (e.g. 100 cells by default). The process stops after creating the Str raster.

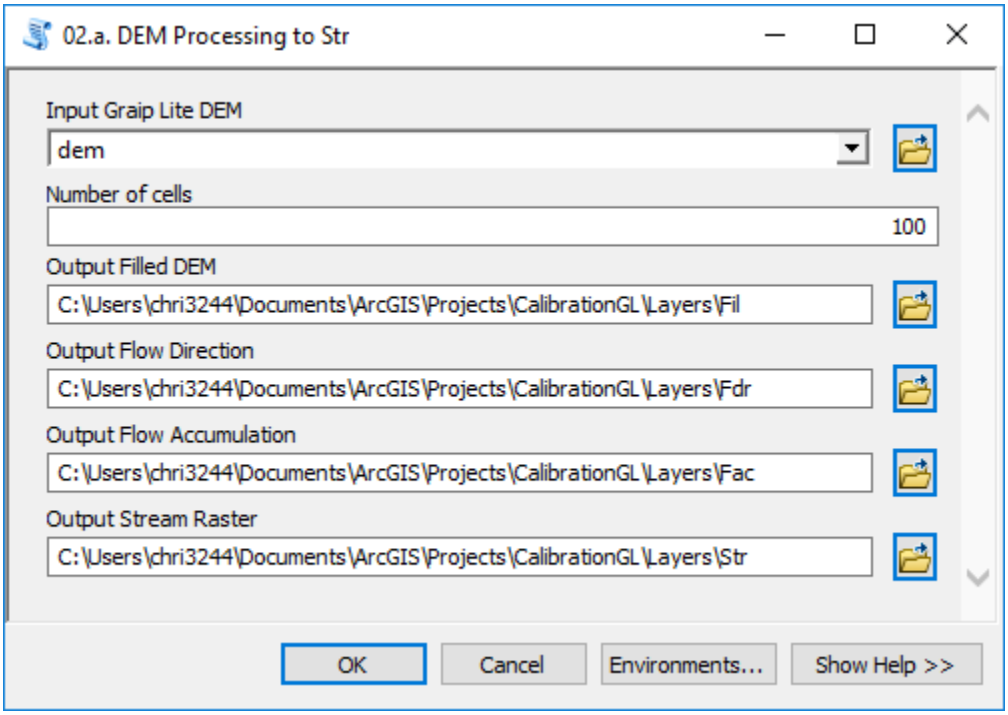


Figure 15 - DEM Processing to Str Tool

Note

You can review the Fac raster which displays the total number of cells upstream of any cell to decide whether you want to adjust the threshold for creating Str. The tool Stream Definition available in the Arc Hydro Tools Python toolbox in the Terrain Preprocessing toolset.

9.2.3 Calculate Distance from Stream

The tool Calculate Distance from Stream is run next to create the DisttoStr raster that will be used in the next step to populate the attribute DisttoStr in the input Calibration Point layer.

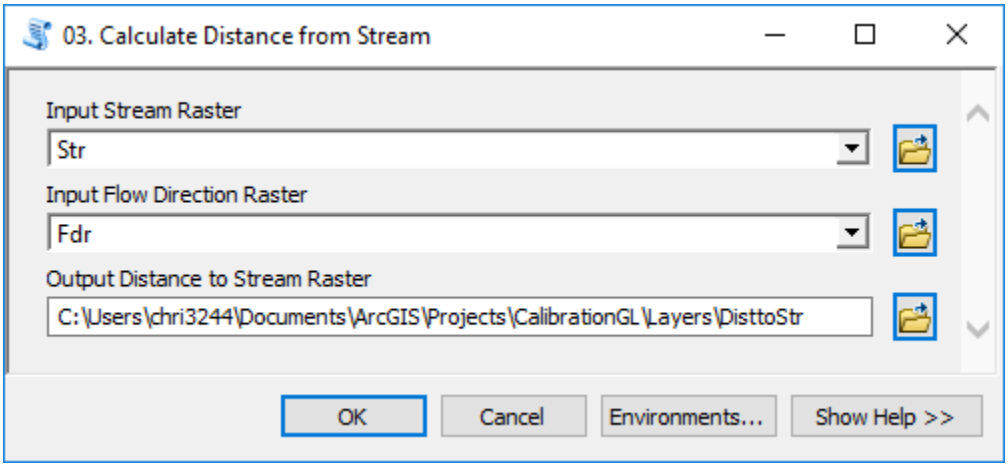


Figure 16 - Calculate Distance from Stream for Calibration

9.2.4 Add Distance from Stream to Calibration Point

The Add Distance from Stream to Calibration tool allows creating and populating the field DisttoStr in the input Calibration Point layer.

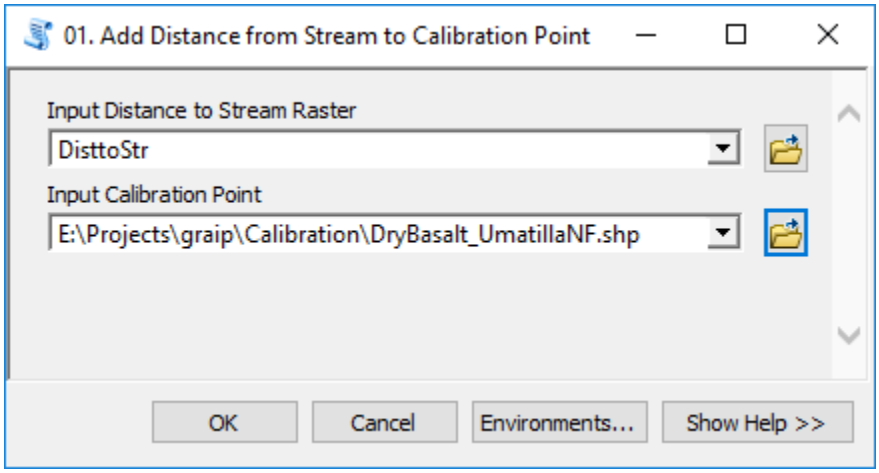


Figure 17 - Populating DisttoStr in Calibration Point Layer

9.2.5 Create Calibration Tables

The following steps need to be followed to define new calibration data:

- Define your calibration areas and store them in a polygon feature class. Define the name of each calibration zone in the field GL_CalibrationZone, GL_Calibra (for shapefiles) or Name.
- Define the calibration point shapefile associated to each calibration. The name of the file must match the name of the calibration zone (e.g. Rocktype_ForestNameNF). Make sure your names are descriptive, so you can tell what they are later.
- Put your calibration point shapefiles into a Calibration folder. The shapefile name sets all of the outputs and is the name of the calibration. These shapefiles are used to develop the vegetation factors and delivery probabilities for the calibration.
- Store the base rates for your calibrations in Project_Baserates.csv in the CalibrationFolder. It should look like the example below and be saved in the Calibration folder with the calibration point shapefiles.

GL_CalibrationZone	GL_BaseRate
DryBasalt_UmatillaNF	1.5
WetBasalt_MalheurNF	27.2

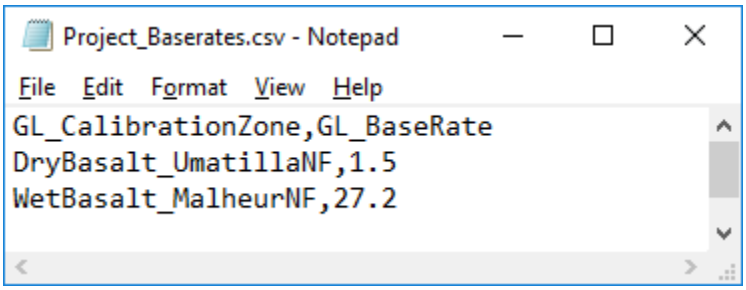


Figure 18 - Project_Baserates.csv

- Run the tool Create Calibration Tables. Specify the location of the input Calibration folder that should contain the following elements:
  - Calibration Point shapefile for each calibration zone
  - Project_Baserates.csv with base rate defined for each calibration zone.

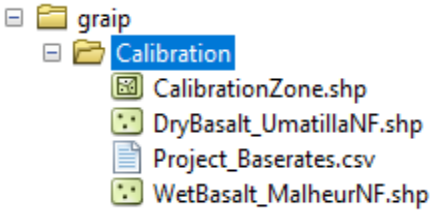


Figure 19 - Input Calibration Folder

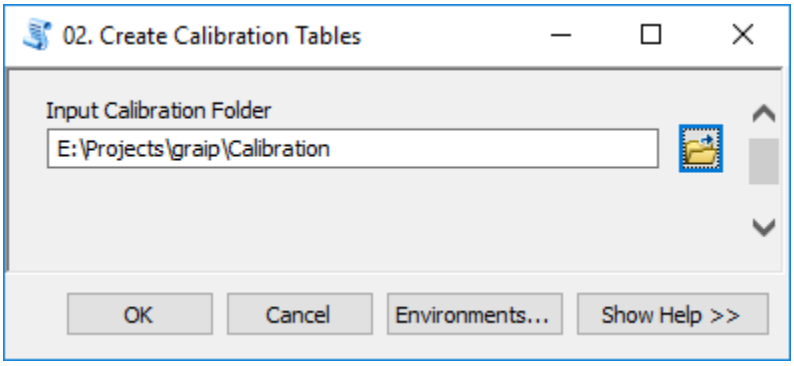


Figure 20 - Create Calibrations Tables Tool

The tool creates a DeliveryPropability table for each input Calibration Point. It creates as well one BaseRates and one VegFactor csv files.

```
Executing: CreateCalibrationTables E:\Projects\graip\Calibration
Start Time: Thu Aug 01 13:56:30 2019
Running script CreateCalibrationTables...
package 'locfit' is in use and will not be installed
Calibration Folder:E:\Projects\graip\Calibration
Processing 3 dbf files...
Processing dbf file: CalibrationZone.dbf
          Field DrainTypeI does not exist.
          Required calibration field Flowpath1V does not exit. Skipping dbf
file CalibrationZone.dbf
Processing dbf file: DryBasalt_UmatillaNF.dbf
          Field DrainTypeI exists.
Processing dbf file: WetBasalt_MalheurNF.dbf
          Field DrainTypeI does not exist.
          Field Flowpath1V exists.
          Field Flowpath2V exists.
          Field Road_ML exists.
          Required calibration field disttostr does not exit. Looking for
RASTERVALU instead WetBasalt_MalheurNF.dbf
          Field RASTERVALU exists.
          Field StreamConn exists.
Table VegFactor.csv successfully created.
Table DeliveryProbability_DryBasalt_UmatillaNF.csv successfully created.
Table DeliveryProbability_WetBasalt_MalheurNF.csv successfully created.
Table BaseRate.csv successfully created.
Completed script CreateCalibrationTables...
Succeeded at Thu Aug 01 13:56:32 2019 (Elapsed Time: 1.38 seconds)
```

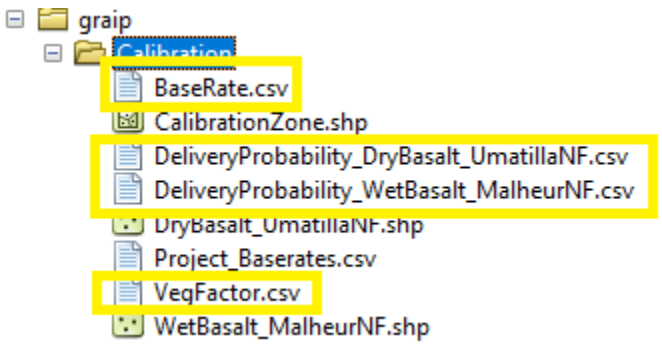


Figure 21 – Outputs from Create Calibration Tables

9.2.6 Update Calibration in GRAIP Lite Database

This tool allows updating an exiting GRAIP Lite Database with the custom configuration. The Input Calibration Zone provided will overwrite the existing layer. The existing BaseRate table will be overwritten as well. The new DeliveryProbability tables will be copied in to the database and their records will be appended to the existing DeliveryProbability table.

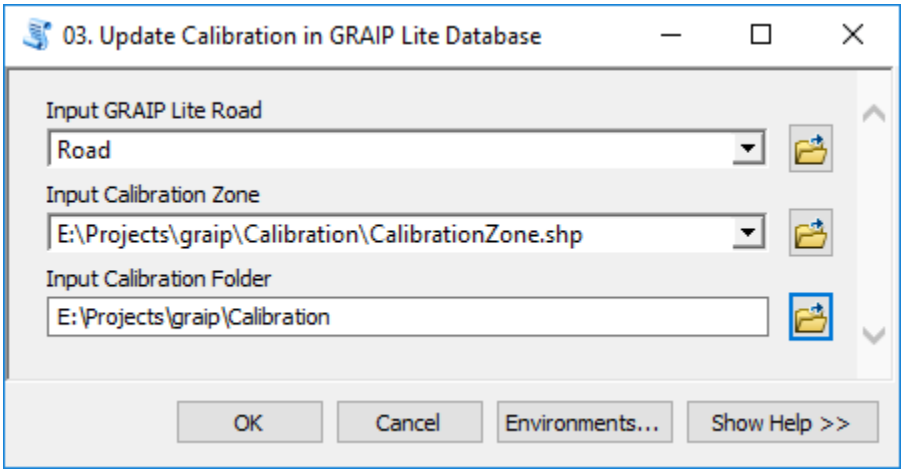


Figure 22 - Update Calibration in GRAIP Lite Database Tool

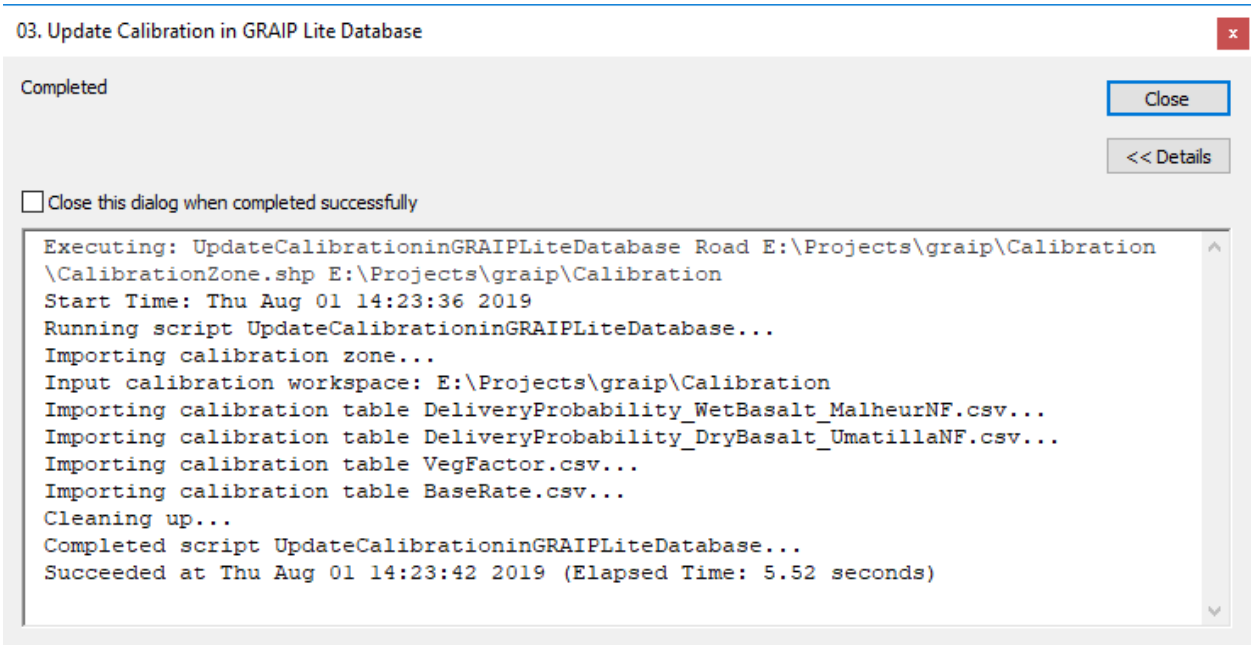
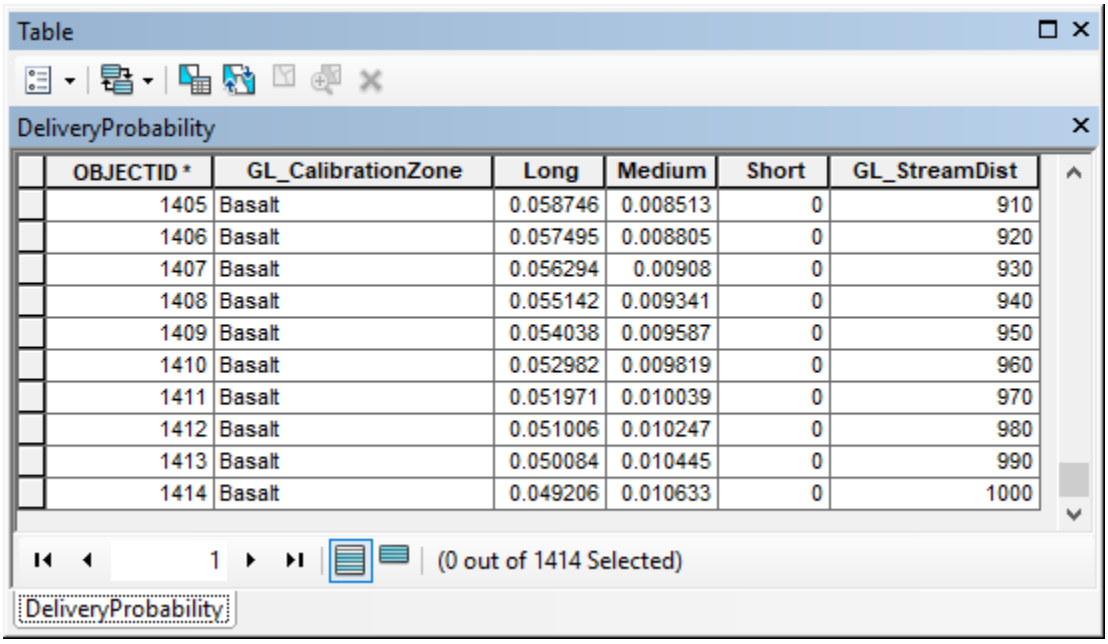


Figure 23 – Update Calibration in GRAIP Lite Database Results



Table

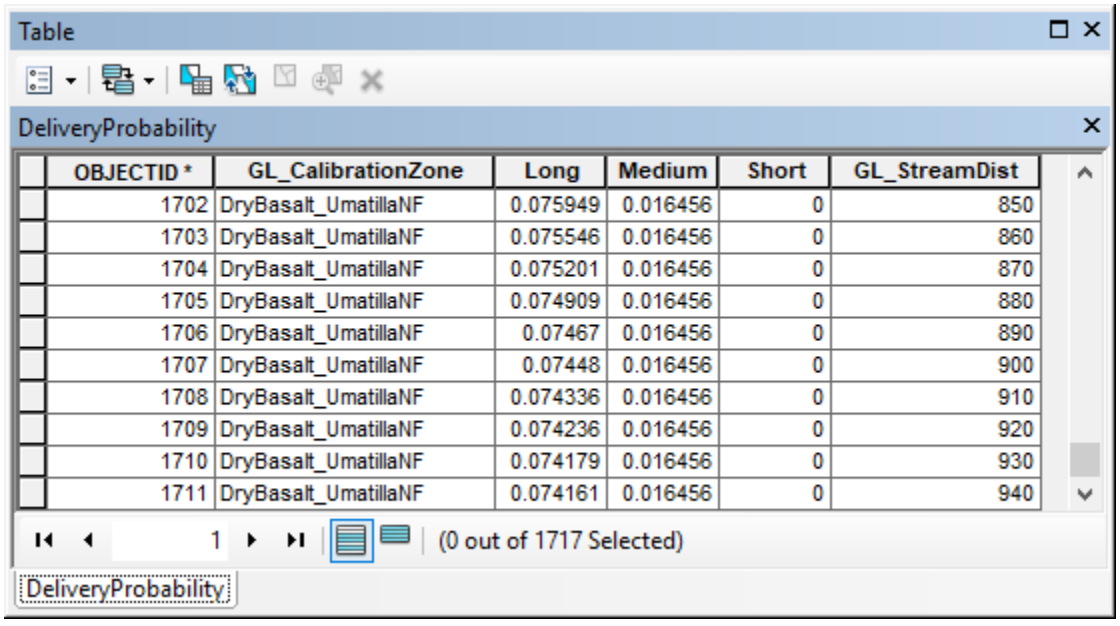
DeliveryProbability

OBJECTID *	GL_CalibrationZone	Long	Medium	Short	GL_StreamDist
1405	Basalt	0.058746	0.008513	0	910
1406	Basalt	0.057495	0.008805	0	920
1407	Basalt	0.056294	0.00908	0	930
1408	Basalt	0.055142	0.009341	0	940
1409	Basalt	0.054038	0.009587	0	950
1410	Basalt	0.052982	0.009819	0	960
1411	Basalt	0.051971	0.010039	0	970
1412	Basalt	0.051006	0.010247	0	980
1413	Basalt	0.050084	0.010445	0	990
1414	Basalt	0.049206	0.010633	0	1000

1 (0 out of 1414 Selected)

DeliveryProbability

Figure 24 - Initial DeliveryProbability Table



Table

DeliveryProbability

OBJECTID *	GL_CalibrationZone	Long	Medium	Short	GL_StreamDist
1702	DryBasalt_UmatillaNF	0.075949	0.016456	0	850
1703	DryBasalt_UmatillaNF	0.075546	0.016456	0	860
1704	DryBasalt_UmatillaNF	0.075201	0.016456	0	870
1705	DryBasalt_UmatillaNF	0.074909	0.016456	0	880
1706	DryBasalt_UmatillaNF	0.07467	0.016456	0	890
1707	DryBasalt_UmatillaNF	0.07448	0.016456	0	900
1708	DryBasalt_UmatillaNF	0.074336	0.016456	0	910
1709	DryBasalt_UmatillaNF	0.074236	0.016456	0	920
1710	DryBasalt_UmatillaNF	0.074179	0.016456	0	930
1711	DryBasalt_UmatillaNF	0.074161	0.016456	0	940

1 (0 out of 1717 Selected)

DeliveryProbability

Figure 25 - Updated DeliveryProbability Table with new Calibrations appended

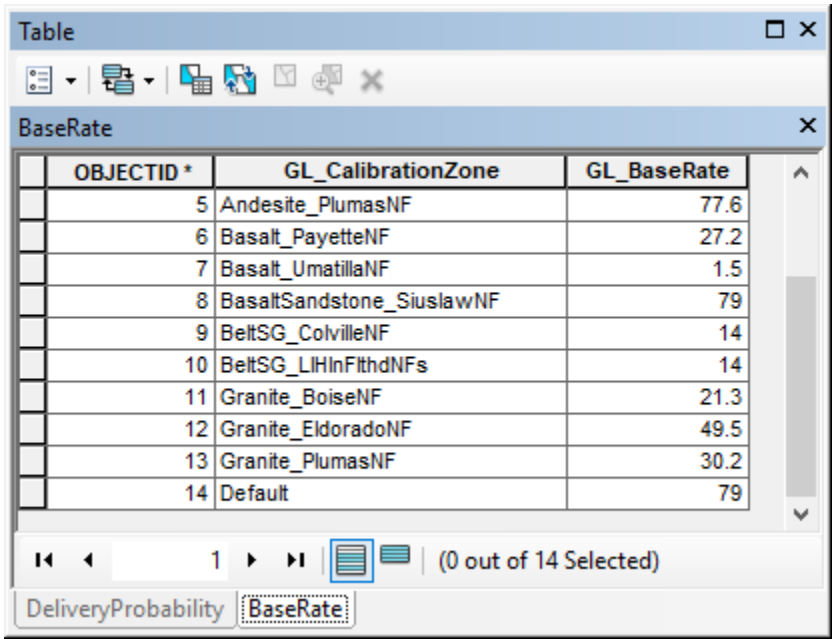


Figure 26 – Initial BaseRate Table

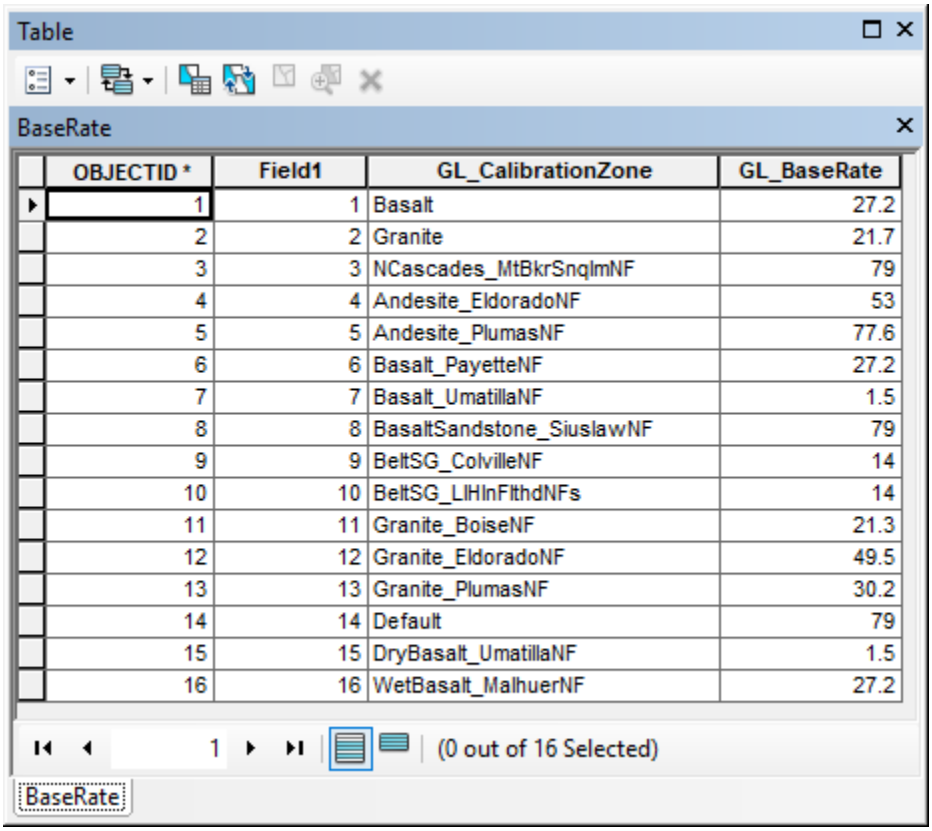
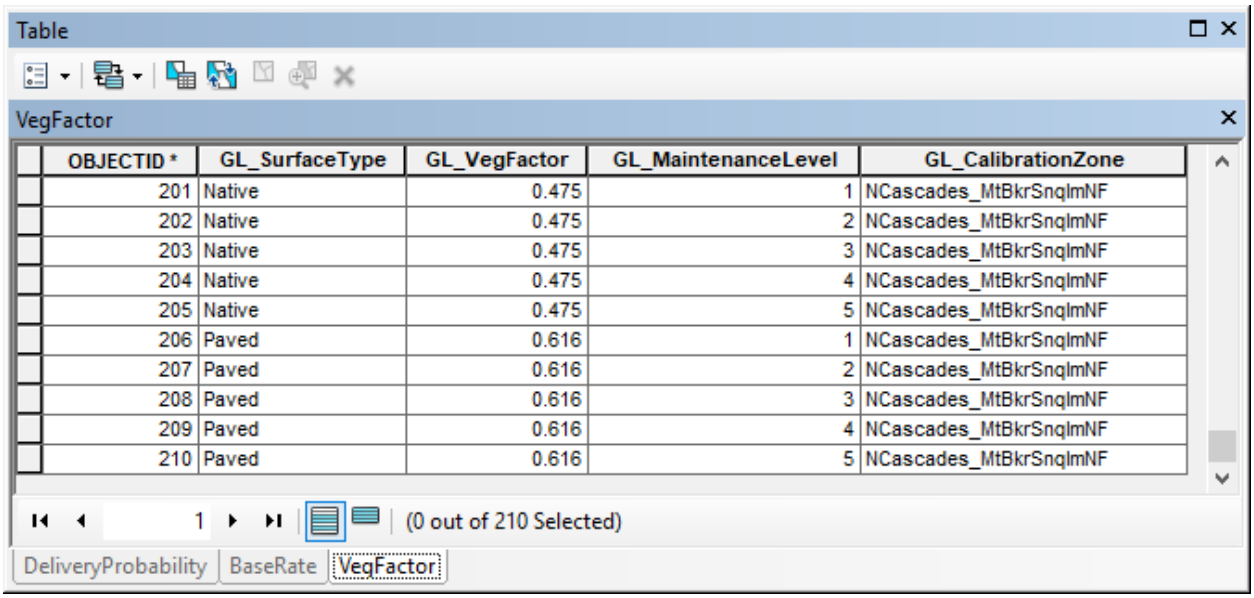


Figure 27- Updated BaseRate Table



Table

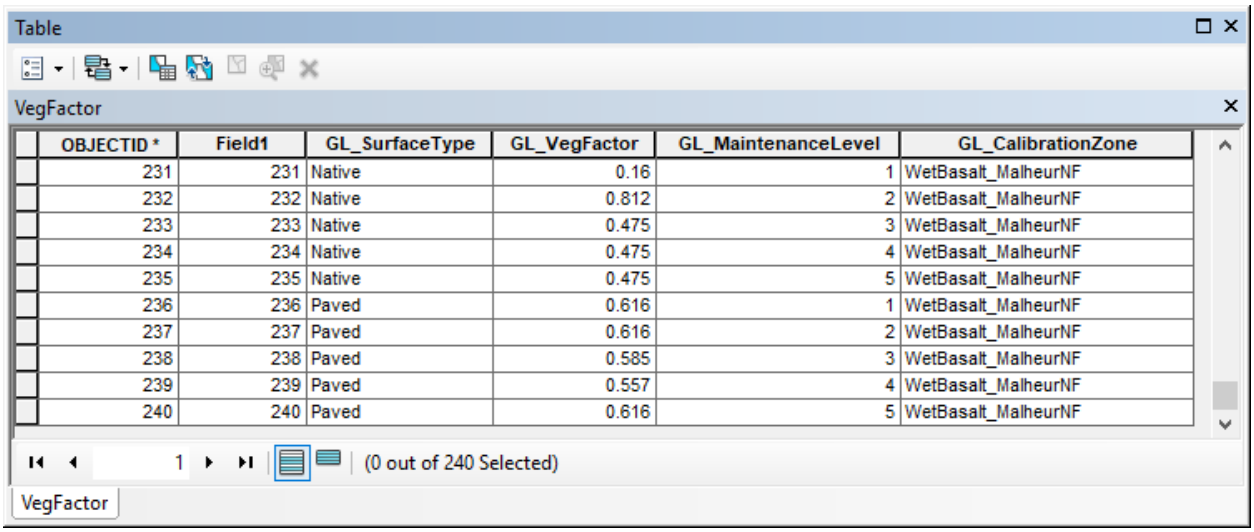
VegFactor

OBJECTID *	GL_SurfaceType	GL_VegFactor	GL_MaintenanceLevel	GL_CalibrationZone
201	Native	0.475	1	NCascades_MtBkrSnqlmNF
202	Native	0.475	2	NCascades_MtBkrSnqlmNF
203	Native	0.475	3	NCascades_MtBkrSnqlmNF
204	Native	0.475	4	NCascades_MtBkrSnqlmNF
205	Native	0.475	5	NCascades_MtBkrSnqlmNF
206	Paved	0.616	1	NCascades_MtBkrSnqlmNF
207	Paved	0.616	2	NCascades_MtBkrSnqlmNF
208	Paved	0.616	3	NCascades_MtBkrSnqlmNF
209	Paved	0.616	4	NCascades_MtBkrSnqlmNF
210	Paved	0.616	5	NCascades_MtBkrSnqlmNF

1 (0 out of 210 Selected)

DeliveryProbability | BaseRate | VegFactor

Figure 28 - Initial VegFactor Table



Table

VegFactor

OBJECTID *	Field1	GL_SurfaceType	GL_VegFactor	GL_MaintenanceLevel	GL_CalibrationZone
231	231	Native	0.16	1	WetBasalt_MalheurNF
232	232	Native	0.812	2	WetBasalt_MalheurNF
233	233	Native	0.475	3	WetBasalt_MalheurNF
234	234	Native	0.475	4	WetBasalt_MalheurNF
235	235	Native	0.475	5	WetBasalt_MalheurNF
236	236	Paved	0.616	1	WetBasalt_MalheurNF
237	237	Paved	0.616	2	WetBasalt_MalheurNF
238	238	Paved	0.585	3	WetBasalt_MalheurNF
239	239	Paved	0.557	4	WetBasalt_MalheurNF
240	240	Paved	0.616	5	WetBasalt_MalheurNF

1 (0 out of 240 Selected)

VegFactor

Figure 29 - Updated VegFactor Table

9.2.7 GRAIP Lite Processing using the Updated Calibration

The GRAIP Lite project may continue from this point on by running the tool 02.b DEM Processing from Str, followed by the 04. Create Road Segments and following tools.

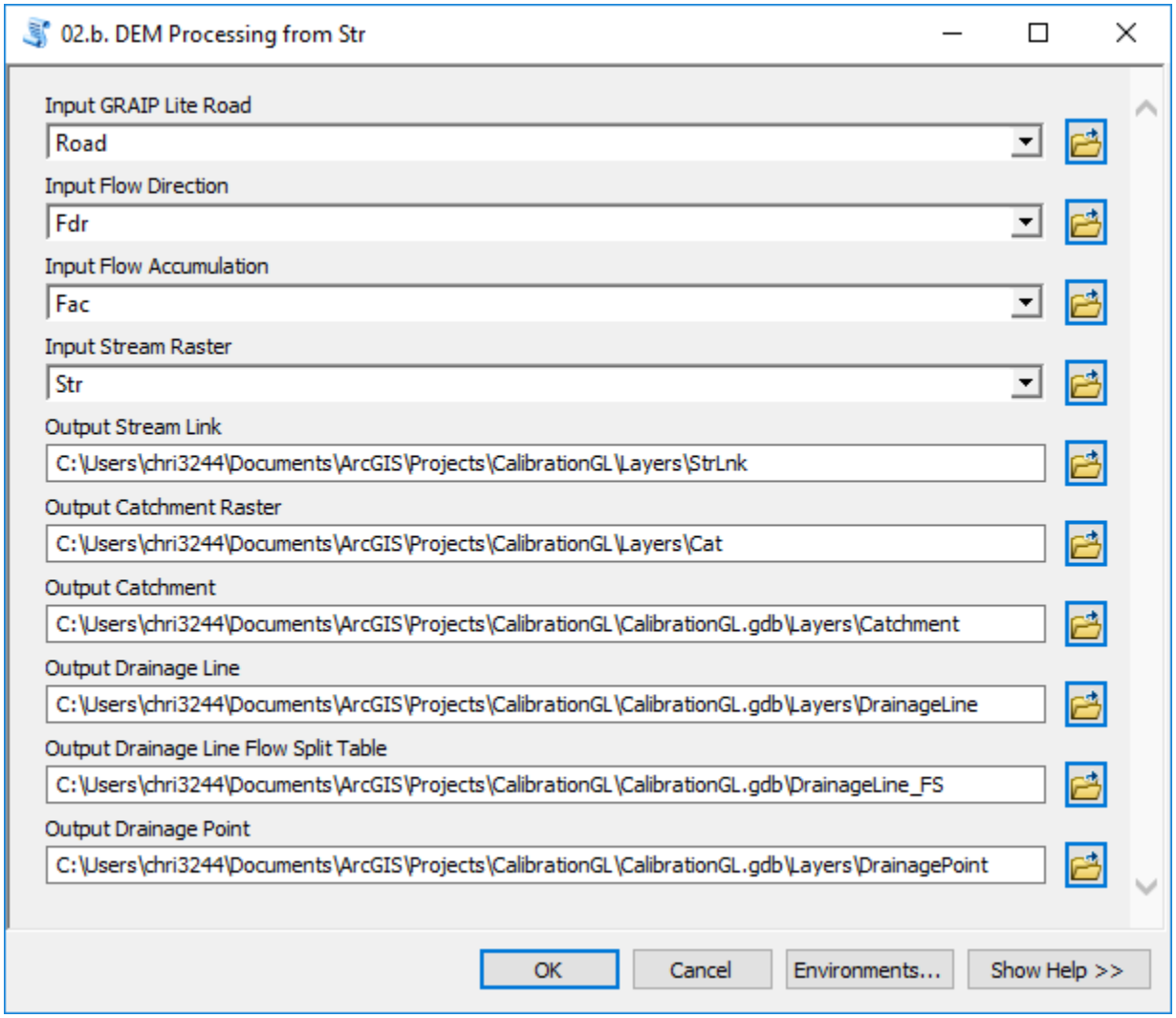


Figure 30 – DEM Processing from Str

You can also restart a brand-new project and analysis. Open a new map and save it. Then run the 01. Initial GRAIP Lite Database tool by providing the input Calibration Zone and Calibration Folder.

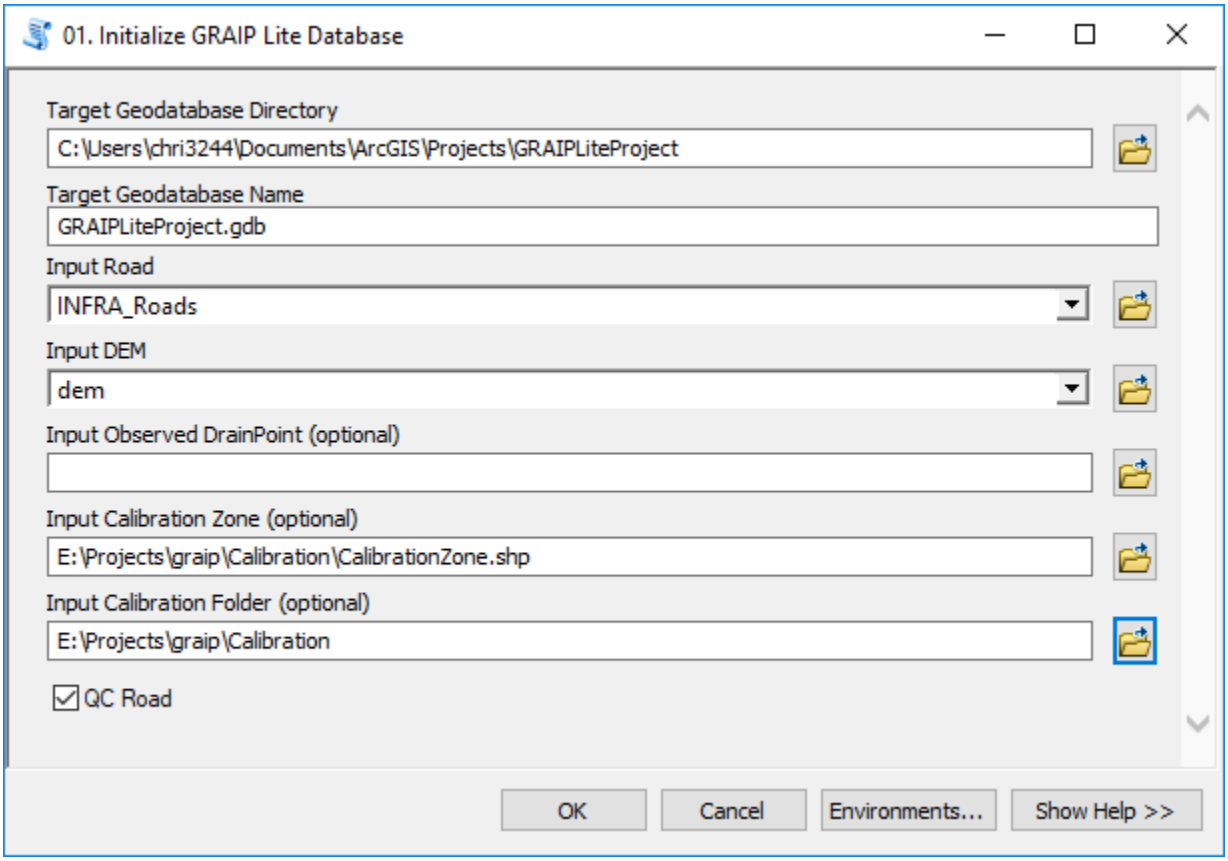


Figure 31 – Initialize GRAIP Lite Database with custom Calibration

10.0 Configuration

10.1 Template Database

The template database GRAIPLiteSchema.gdb is installed in the ArcGISInstall\Desktop10.x\Scripts\GRAIP.

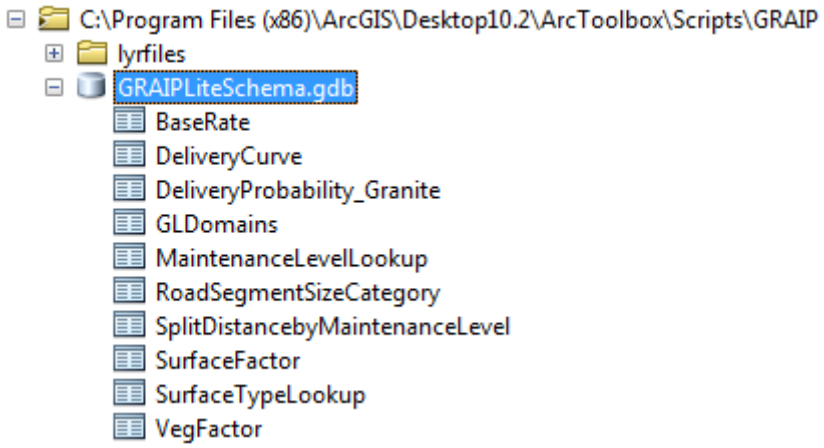


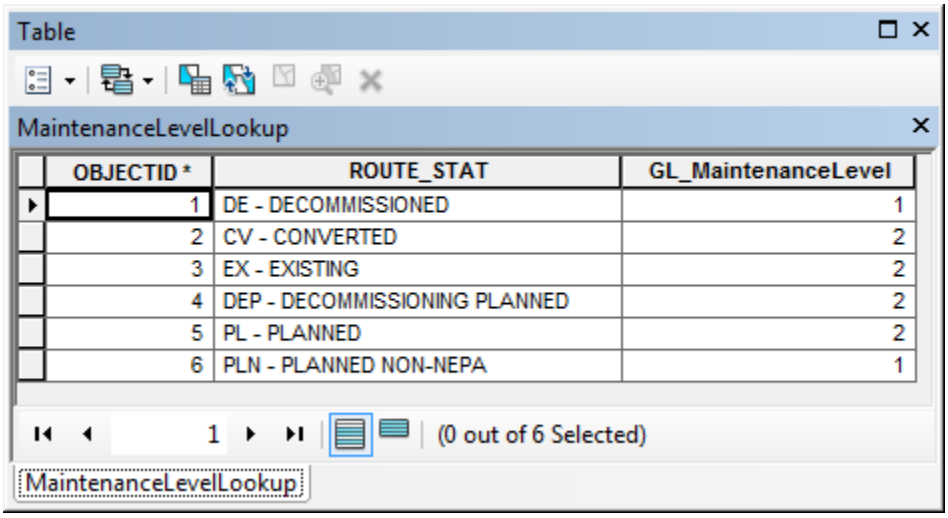
Figure 10-1 – GRAIPLiteSchema.gdb

Table Name	Used by Function
MaintenanceLevelLookup	01. Initialize GRAIP Lite Database
SplitDistancebyMaintenanceLevel	01. Initialize GRAIP Lite Database
SurfaceTypeLookup	01. Initialize GRAIP Lite Database
GLDomains	01. Initialize GRAIP Lite Database
BaseRate	05. Calculate Road Segment Sediment Production
SurfaceFactor	05. Calculate Road Segment Sediment Production
VegFactor	05. Calculate Road Segment Sediment Production
DeliveryProbability_Granite	07. Calculate Sediment Delivery
RoadSegmentSizeCategory	07. Calculate Sediment Delivery

10.1.1 Configuration Tables used to initialize GRAIP Lite Database

MaintenanceLevelLookup

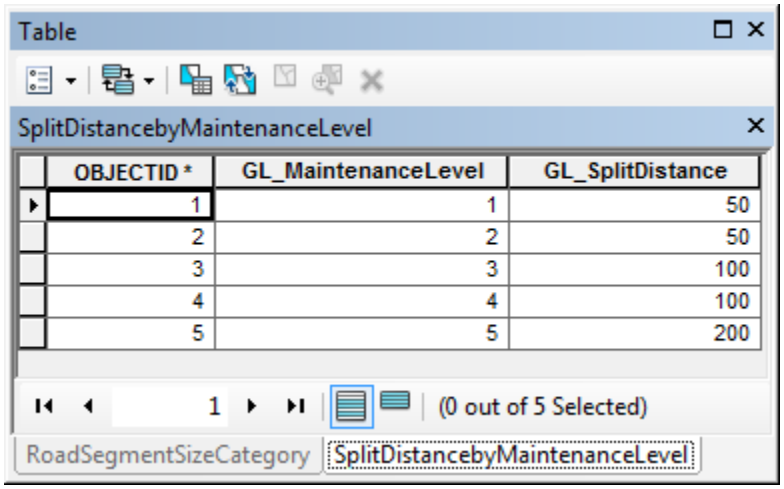
The MaintenanceLevelLookup table is used by the tool 01. Initialize GRAIP Lite Database to populate the new field GL_MaintenanceLevel based on the values in the field ROUTE_STAT in the source INFRA Road layer.



OBJECTID *	ROUTE_STAT	GL_MaintenanceLevel
1	DE - DECOMMISSIONED	1
2	CV - CONVERTED	2
3	EX - EXISTING	2
4	DEP - DECOMMISSIONING PLANNED	2
5	PL - PLANNED	2
6	PLN - PLANNED NON-NEPA	1

SplitDistancebyMaintenanceLevel

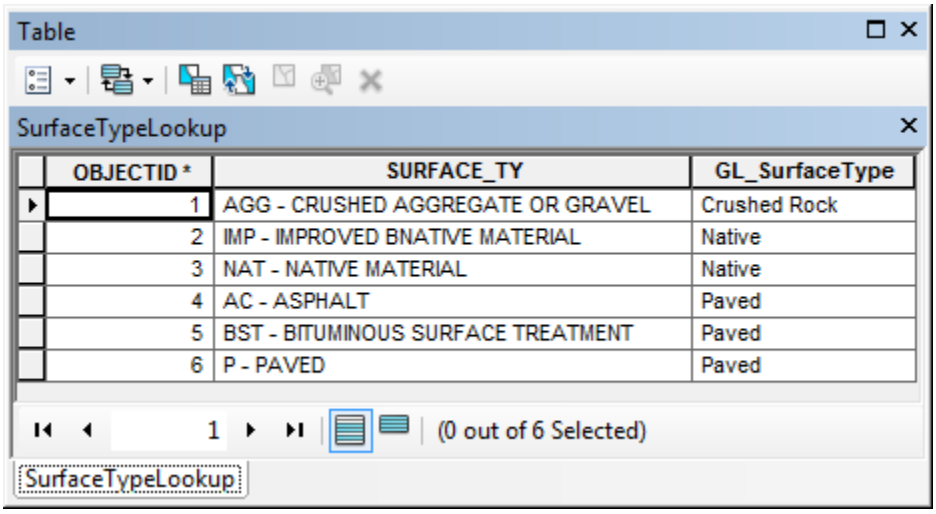
The SplitDistancebyMaintenanceLevel is used by the tool 01. Initialize GRAIP Lite Database to populate the new field GL_SplitDistance based on the values in the field GL_MaintenanceLevel. GL_SplitDistance is populated with distances in meters.



OBJECTID *	GL_MaintenanceLevel	GL_SplitDistance
1	1	50
2	2	50
3	3	100
4	4	100
5	5	200

SurfaceTypeLookup

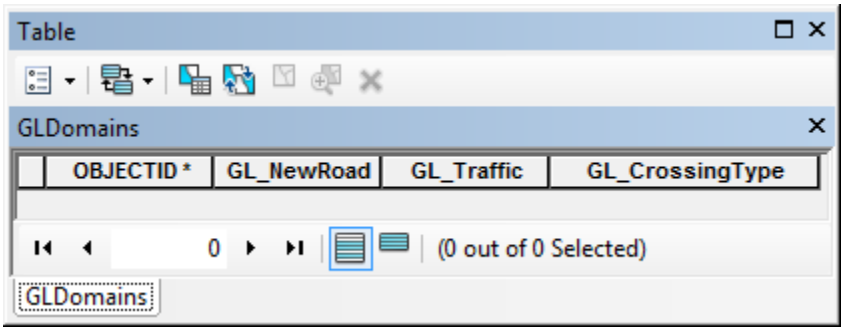
The SurfaceTypeLookup table is used by the tool 01. Initialize GRAIP Lite Database to populate the new field GL_SurfaceType based on the values in the field SURFACE_TY in the source INFRA Road layer.



GLDomains

The table GLDomains is used to import domains that are not assigned to any of the configuration tables' attributes but that will be applied to some fields created during the analyses. Domains assigned to a field in a table that is copied are copied with the table.

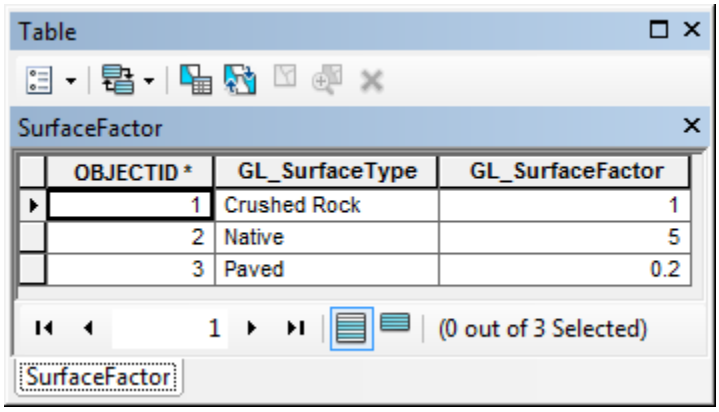
This table is copied during the initialization of the database so that the domains can be copied. It is then deleted from the target geodatabase.



10.1.2 Configuration Tables used to compute Sediment Production

SurfaceFactor

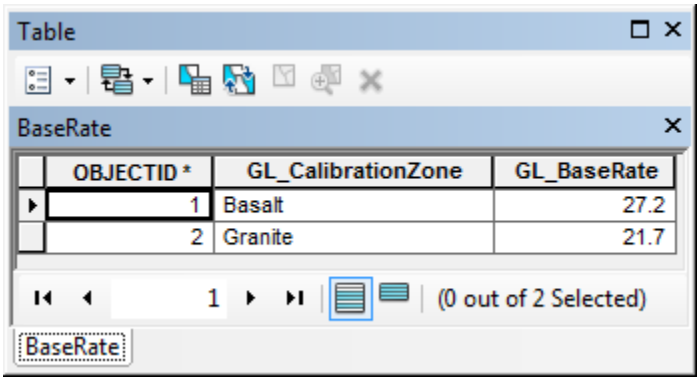
The SurfaceFactor table is used by the tool 05. Calculate Road Segment Sediment Production to populate the new field GL_SurfaceFactor based on the values in the field GL_SurfaceType.



BaseRate

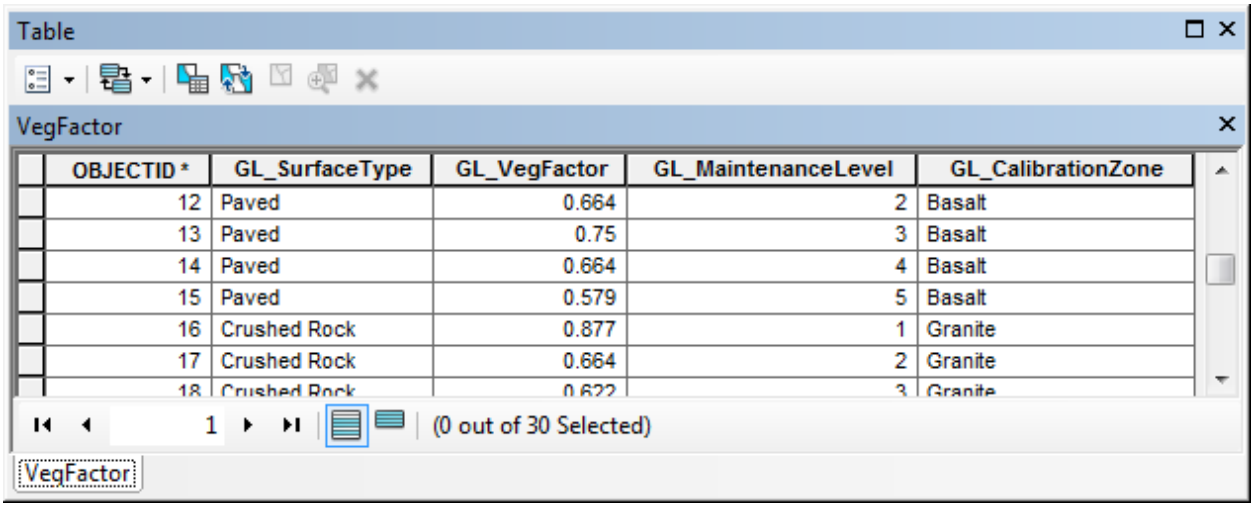
The BaseRate table is used by the tool 05. Calculate Road Segment Sediment Production to populate the new field GL_BaseRate based on the values in the field GL_CalibrationZone.

Each distinct GL_CalibrationZone in the RoadSegment and RoadDrainPoint layers must have an associated record defined in the BaseRate table.



VegFactor

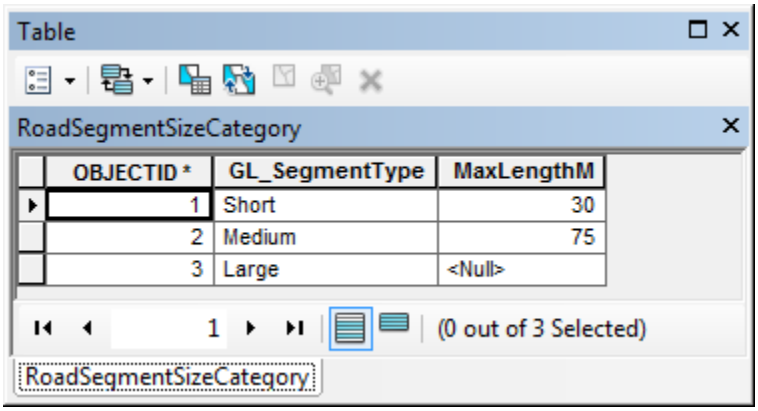
The VegFactor table is used by the tool 05. Calculate Road Segment Sediment Production to populate the field GL_VegFactor based on the values in the fields GL_CalibrationZone, GL_SurfaceType and GL_MaintenanceLevel. Each distinct GL_CalibrationZone in the RoadSegment and RoadDrainPoint must have associated records defined in the VegFactor table.



10.1.3 Configuration Tables used to compute Delivery Probability

RoadSegmentSizeCategory

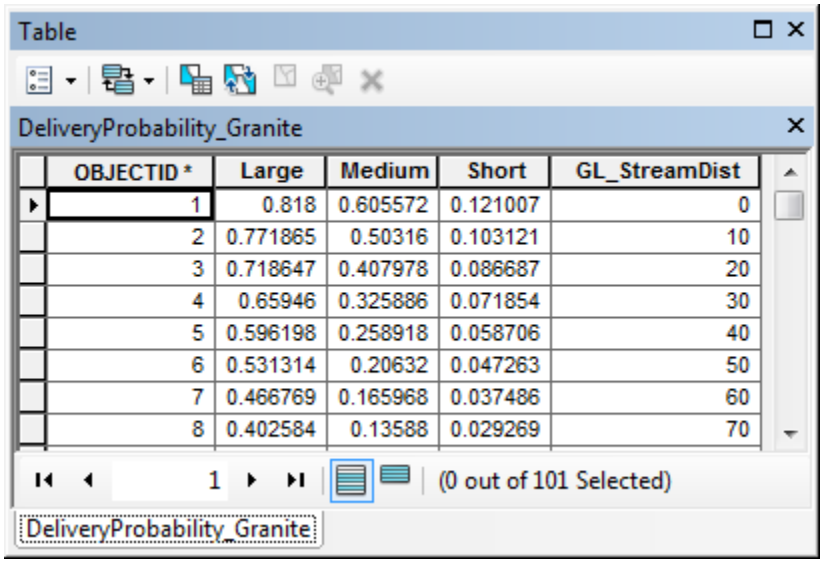
The RoadSegmentSizeCategory table is used by the tool 07. Calculate Sediment Delivery to populate the field GL_SegmentType based on the field LengthM and MaxLengthM. MaxLengthM defines the maximum length for a segment to be of the specific type. A null value indicates that there is no maximum length specified for the specific type.



DeliveryProbability_Granite

The DeliveryProbability_Granite is used by the tool 07. Calculate Sediment Delivery to populate the field GL_StreamDist based on the field GL_SegmentType (Large, Medium, Short) and GL_StreamDist.

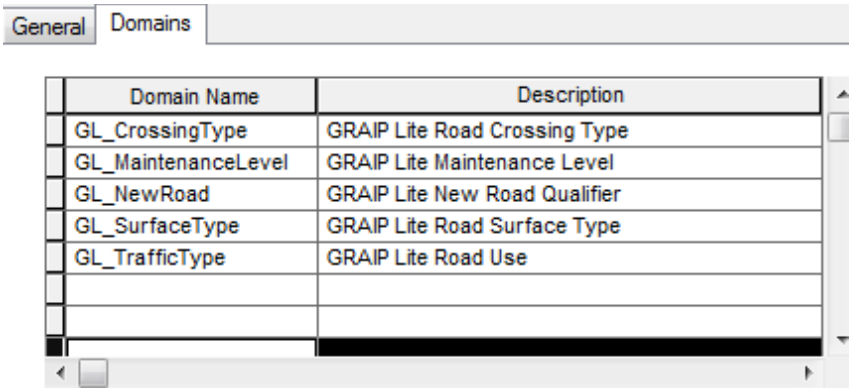
One DeliveryProbability_CalibrationZoneName table must be defined for each distinct GL_CalibrationZone value.



OBJECTID *	Large	Medium	Short	GL_StreamDist
1	0.818	0.605572	0.121007	0
2	0.771865	0.50316	0.103121	10
3	0.718647	0.407978	0.086687	20
4	0.65946	0.325886	0.071854	30
5	0.596198	0.258918	0.058706	40
6	0.531314	0.20632	0.047263	50
7	0.466769	0.165968	0.037486	60
8	0.402584	0.13588	0.029269	70

10.1.4 GeodatabaseDomains

The following domains are defined in the template geodatabase and will be copied into the target geodatabase:



Domain Name	Description
GL_CrossingType	GRAIP Lite Road Crossing Type
GL_MaintenanceLevel	GRAIP Lite Maintenance Level
GL_NewRoad	GRAIP Lite New Road Qualifier
GL_SurfaceType	GRAIP Lite Road Surface Type
GL_TrafficType	GRAIP Lite Road Use

GL_CrossingType

This domain (Coded Values, Text) is copied into the target database during the copy of the GLDomains table. The domain is assigned to the field GL_CrossingType in the GLDomains table. The domain will be assigned to the field GL_CrossingType in the RoadSplitPoint feature class created by the tool 04. Create Road Segments. Note that the values in the domain are used to render the RoadSplitPoint layer using the layer file RoadSplitPoint.lyr.

Code	Description
Catchment	Catchment
Calibration	Calibration

Stream	Stream
Junction	Junction
Distance	Distance
Observation	Observation

GL_MaintenanceLevel

This domain (Coded Values, Short Integer) is assigned to the field GL_MaintenanceLevel in the MaintenanceLevelLookup configuration table and will be copied with the table into the target database. This domain will be assigned to the field GL_MaintenanceLevel in the Road layer created by the tool 01. Initialize GRAIP Lite Database.

Code	Description
1	1
2	2
3	3
4	4
5	5

GL_NewRoad

This domain (Coded Values, Short Integer) is copied into the target database during the copy of the GLDomains table. The domain is assigned to the field GL_NewRoad in the GLDomains table. The domain will be assigned to the field GL_NewRoad in the Road feature class created by the tool 01. Initialize GRAIP Lite Database.

Code	Description
0	Existing
1	New

GL_SurfaceType

This domain (Coded Values, Text) is assigned to the field GL_SurfaceTypel in the SurfaceTypeLookup configuration table and will be copied with the table into the target database. This domain will be assigned to the field GL_SurfaceType in the Road layer created by the tool 01. Initialize GRAIP Lite Database.

Code	Description
Crushed Rock	Crushed Rock
Native	Native
Paved	Paved

GL_TrafficType

This domain (Coded Values, Text) is copied into the target database during the copy of the GLDomains table. The domain is assigned to the field GL_Traffic in the GLDomains table. The domain will be

assigned to the field GL_TrafficType in the Road feature class created by the tool 01. Initialize GRAIP Lite Database.

Code	Description
none	none
low	low
medium	medium
high	high

10.2 Python Configuration File

The file graipliteconfig.py installed under ArcGISDesktop\ArcToolbox\Scripts\GRAIP (e.g. C:\Program Files (x86)\ArcGIS\Desktop10.2\ArcToolbox\Scripts\GRAIP) controls the names of the layers, tables, fields, domains and default.

10.3 Layer Files

The layer files used to set the symbology for the output of the tools are stored in the lyrfile folder installed under ArcGISDesktop\ArcToolbox\Scripts\GRAIP (e.g. C:\Program Files (x86)\ArcGIS\Desktop10.2\ArcToolbox\Scripts\GRAIP).

The table below lists the layers files together with the tools and layers to which they apply.

Tool	Output	Layer File
01. Initialize GRAIP Lite Database	Road	Road.lyr
	CalibrationZone	CalibrationZone.lyr
	DrainPointObserved	DrainPointObserved.lyr
02. DEM Processing	Fil	HydroDEM.lyr
	Fdr	FlowDirGrid.lyr
	Fac	FlowAccGrid.lyr
	Str	StreamGrid.lyr
	StrLnk	
	Cat	CatchmentGrid.lyr
	Catchment	Catchment.lyr
	DrainageLine	LineRiverOrder.lyr
	DrainageLine_FS	N/A (Table)
	DrainagePoint	DrainagePoint.lyr
03. Calculate Distance to Stream	DisttoStr	
04. Create Road Segments	RoadSegment	RoadSegment.lyr
	RoadSplitPoint	RoadSplitPoint.lyr
05. Calculate Road Segment Sediment Production		

06. Create Road Segment Drain Points	RoadDrainPoint	
07. Calculate Sediment Delivery	RoadDrainPoint (Derived)	RoadDrainPointSedDel.lyr
08. Route Sediment to Streams	GL_DP	GL_DP.lyr
	GL_SedDel	Gl_SedDel.lyr
	GL_SedStr	Gl_SedDel.lyr
	GL_SpecSedStr	Gl_SedDel.lyr
QC Roads	RoadClean	RoadwithLoop.lyr
		RoadwithOverlap.lyr
		RoadwithLoopandOverlap.lyr
Aggregate Sediment Delivery on DrainageLine	DrainageLine – Accumulated Sediment	DrainageLine – Accumulated Sediment.lyr
Create Summary Statistics by Area	Catchment – Sediment Delivery	Catchment – Sediment Delivery.lyr
	Catchment – Specific Sediment Delivery	Catchment – Specific Sediment Delivery
Segment DrainageLine based on Sediment Delivery	SedStr	Gl_SedDel.lyr
	SedStream	Drainage Line – Accumulated Sediment.lyr

10.4 Map Templates

The map templates used by the reporting tools are located:

- ArcMap: in the ArcGIS install\ ArcToolbox\Scripts\GRAIP\Templates folder (e.g. C:\Program Files (x86)\ArcGIS\Desktop10.5\ArcToolbox\Scripts\GRAIP\Templates folder).
- ArcGIS Pro: in the ArcGIS Pro Install\ Resources\ArcToolBox\Scripts\GRAIP\Templates folder (e.g. C:\Program Files\ArcGIS\Pro\Resources\ArcToolBox\Scripts\GRAIP\Templates folder).

This folder contains 2 subfolders, one containing the map templates for the basic report and the other for the alternatives.

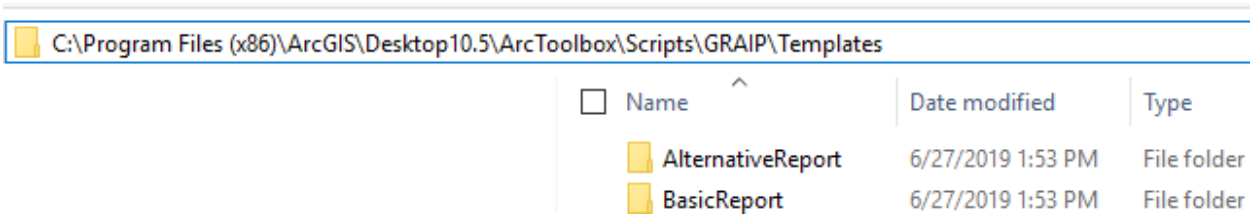


Figure 2 - Templates Folder for ArcMap

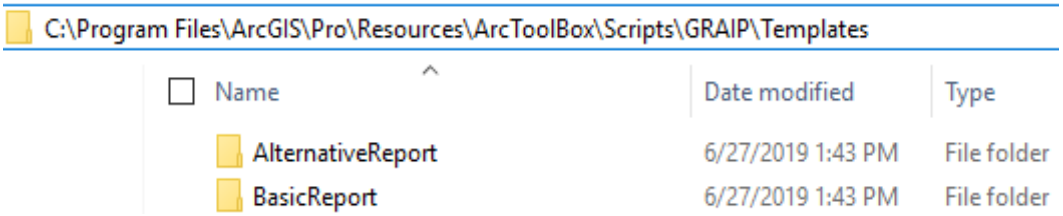


Figure 3 – Templates Folder for ArcGIS Pro

Each subfolder contains the map documents used to create the corresponding report.

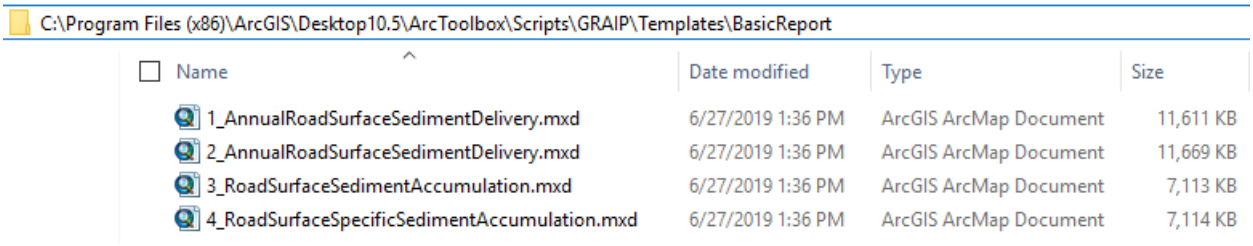


Figure 4- Basic Report Templates

The tool builds the report by using the templates in the subfolder based on the alphabetical order. 1_xxx will be used first, then 2_xxx, etc.

10.4.1 Table of Contents

For each layer in the table of contents of a map, the tool replaces its workspace with the one associated to the current project. The name of the layer in the Table of Contents does not matter (it can be renamed as needed), but the associated dataset name must match the one created in the project.

For example, in the map shown below, “Inventoried Roads” refers to the dataset RoadSegment. You can view the associated datasource by right-clicking the layer and selecting Properties…>Source.

The tool will identify the “DrainageLine” dataset (e.g. Streams) and zoom to the extent of that layer.

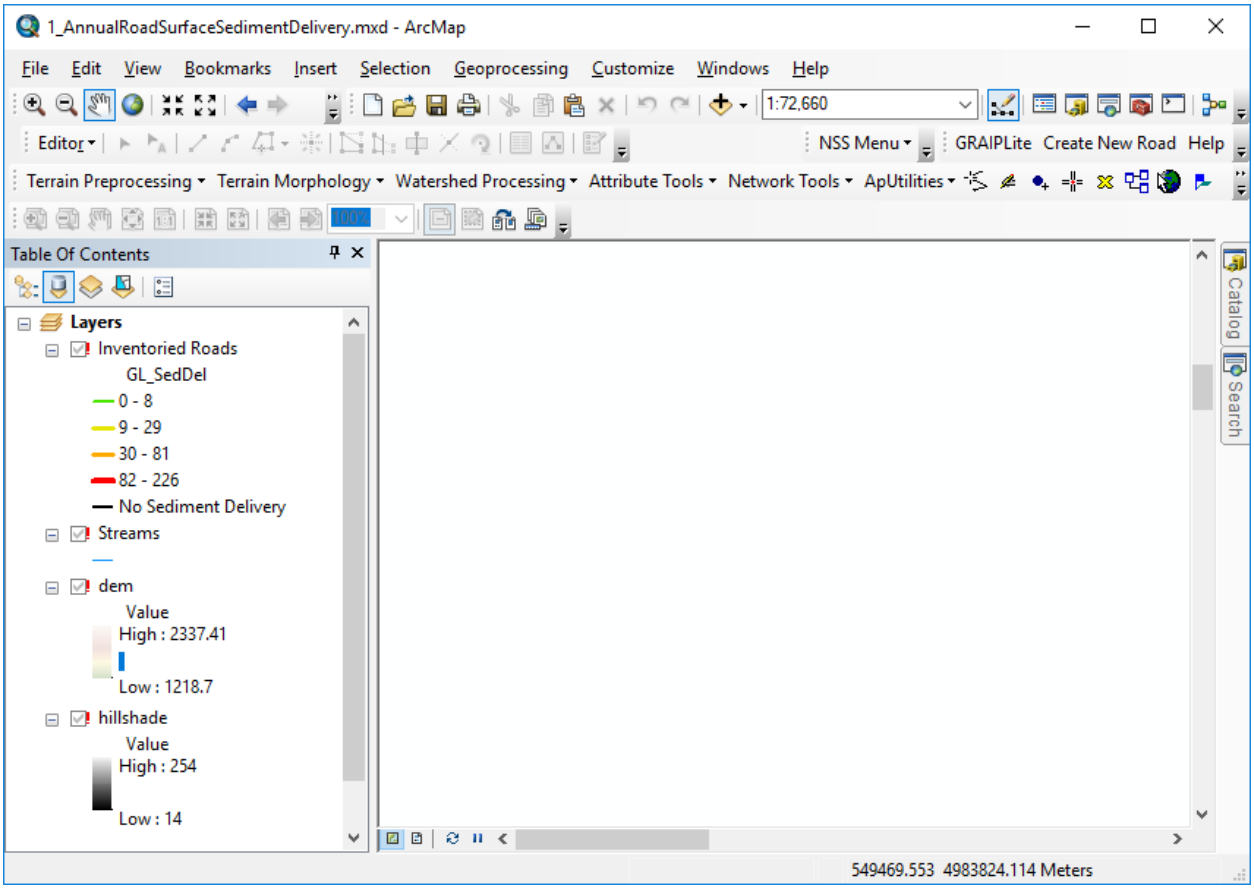


Figure 5 - Layers in Table of Contents

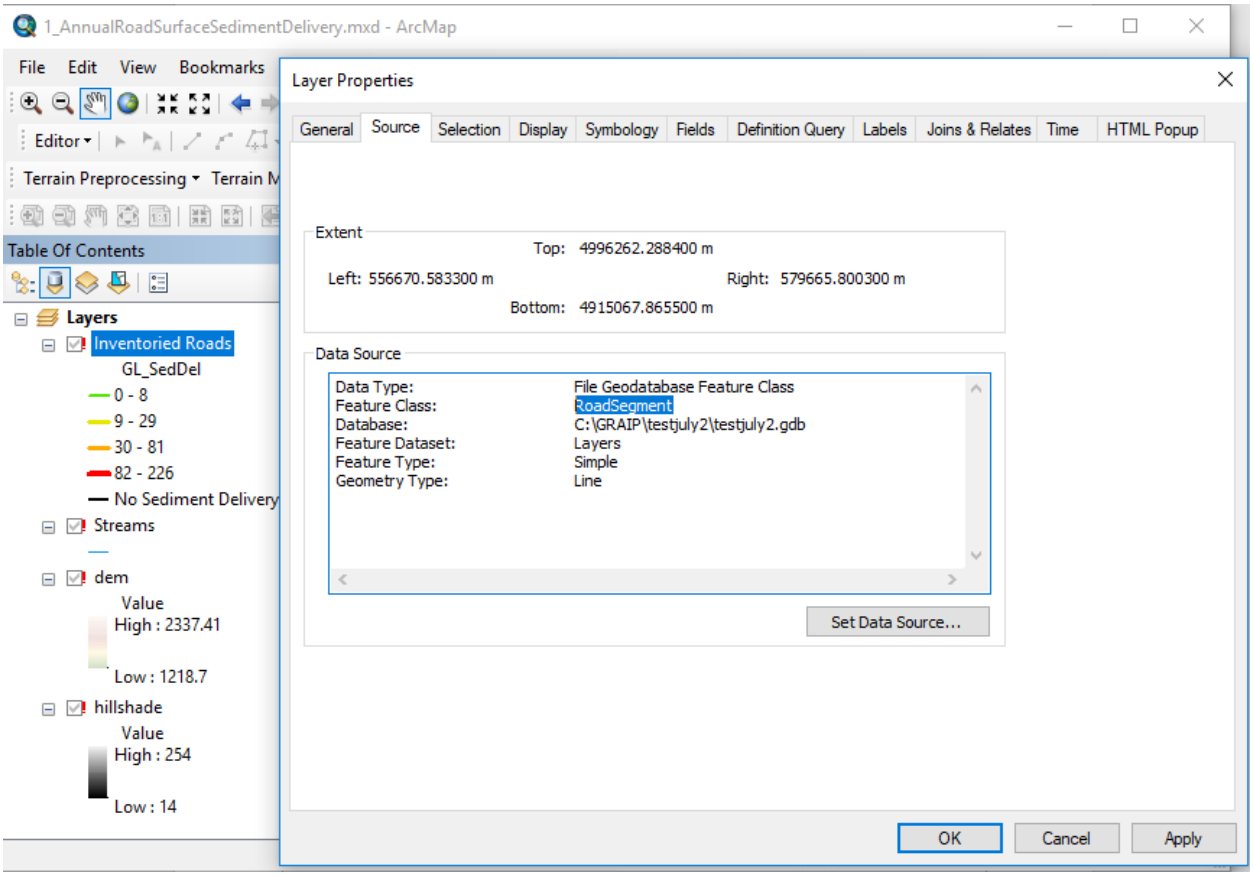


Figure 6 - Associated Datasource

The tool will update the symbology if it is of type graduated color or symbol to reflect the correct values range in the analysis.

10.4.2 Layout

- Click the Layout View button to switch to the Layout view.

The Layout View allows inserting elements in the template such as Legend, North Arrow, Scale, Dataframe containing the map (“Layers”) and Map Title. The elements may be edited by right-clicking them and selecting Properties…

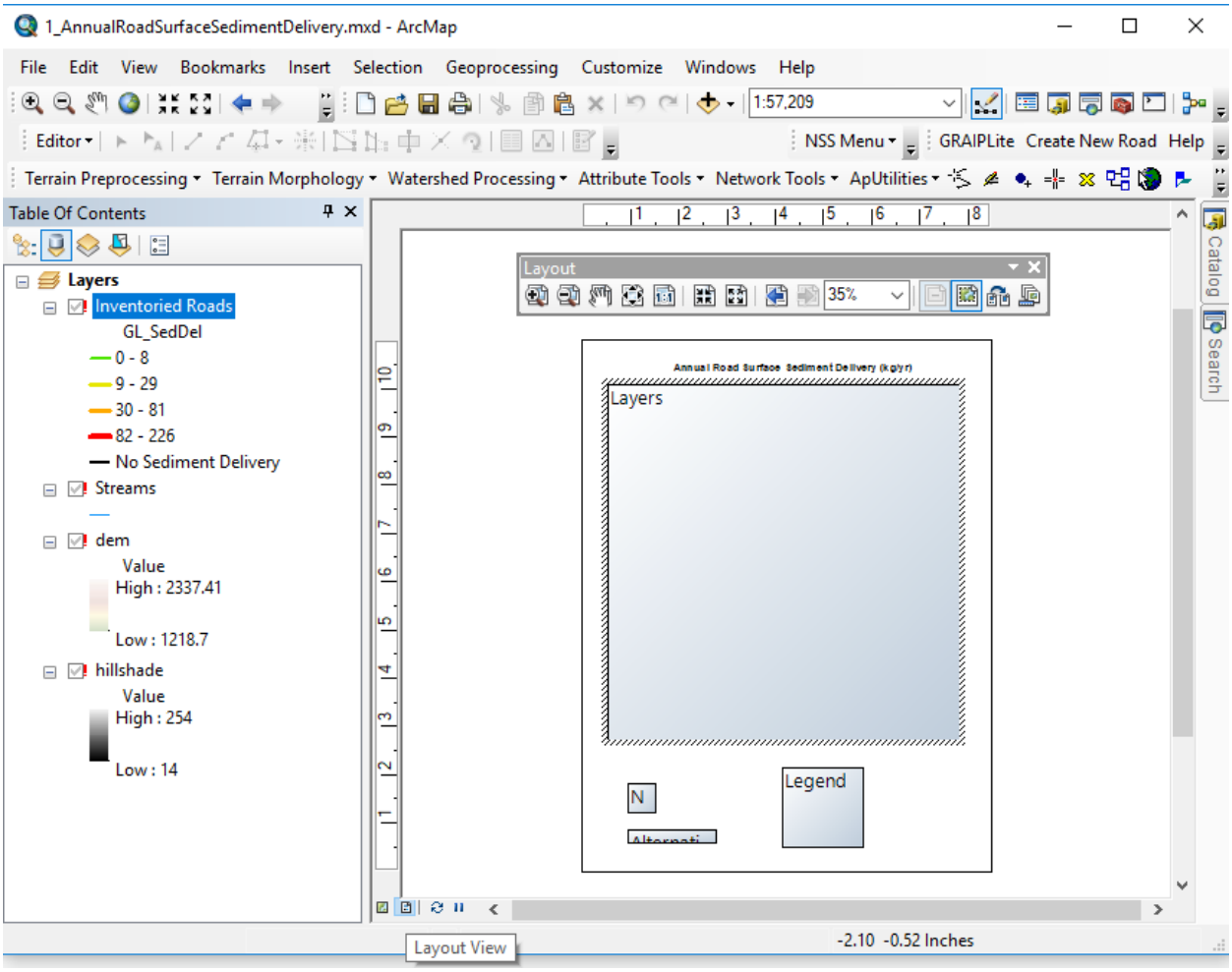


Figure 7 - Layout View

For example, the legend properties are set below so that only the Inventoried Roads layer and the Streams layer are displayed.

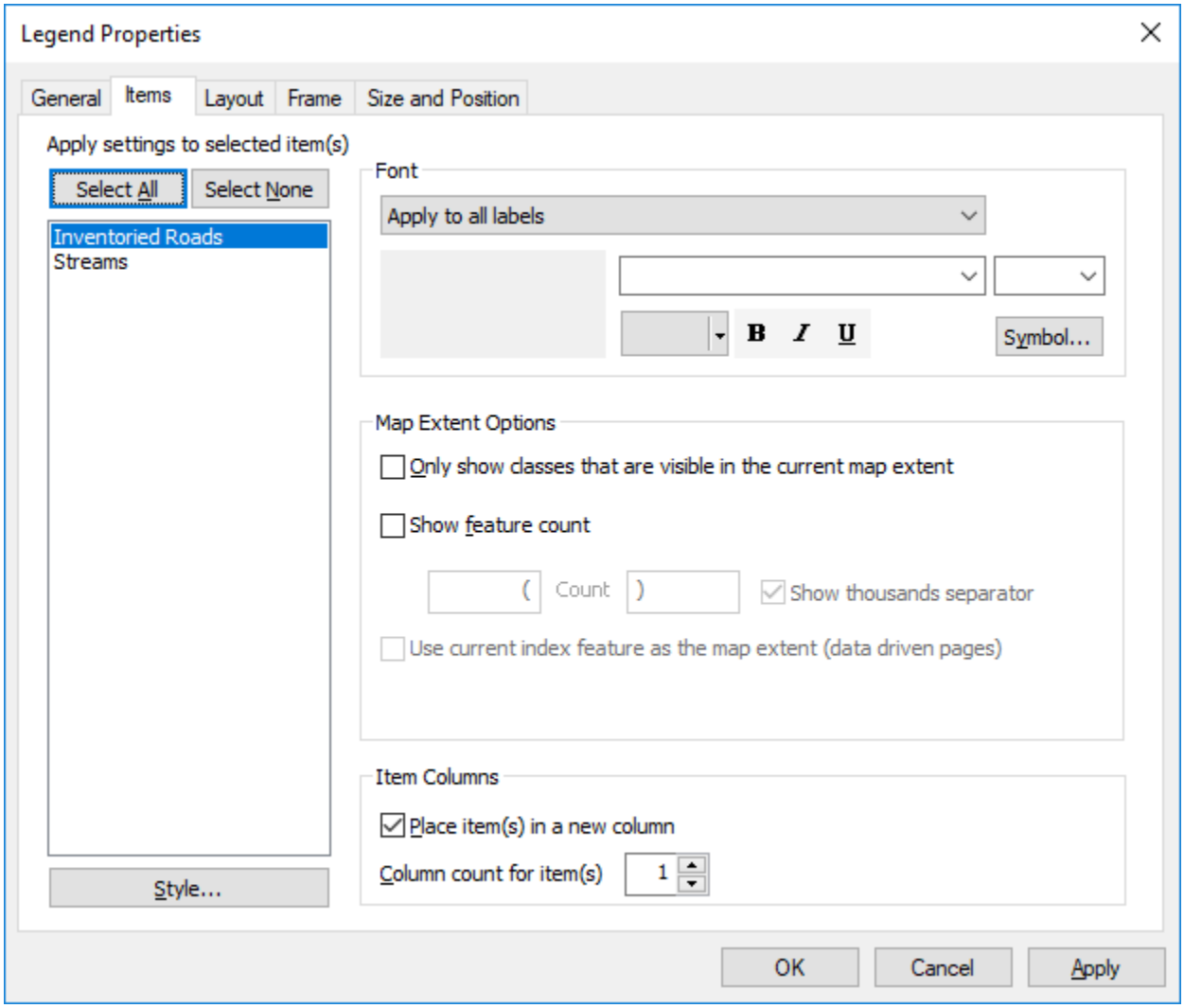


Figure 8 - Legend Properties

In addition to these elements, the templates used for the alternative report also update the subtitle with the alternative number and condition. The Subtitle must be set as: Alternative Name – Condition

Alternative Name will be replaced with Alternative1, etc.

Condition will be replaced with the associated condition: Current, Disturbed, Long Term.

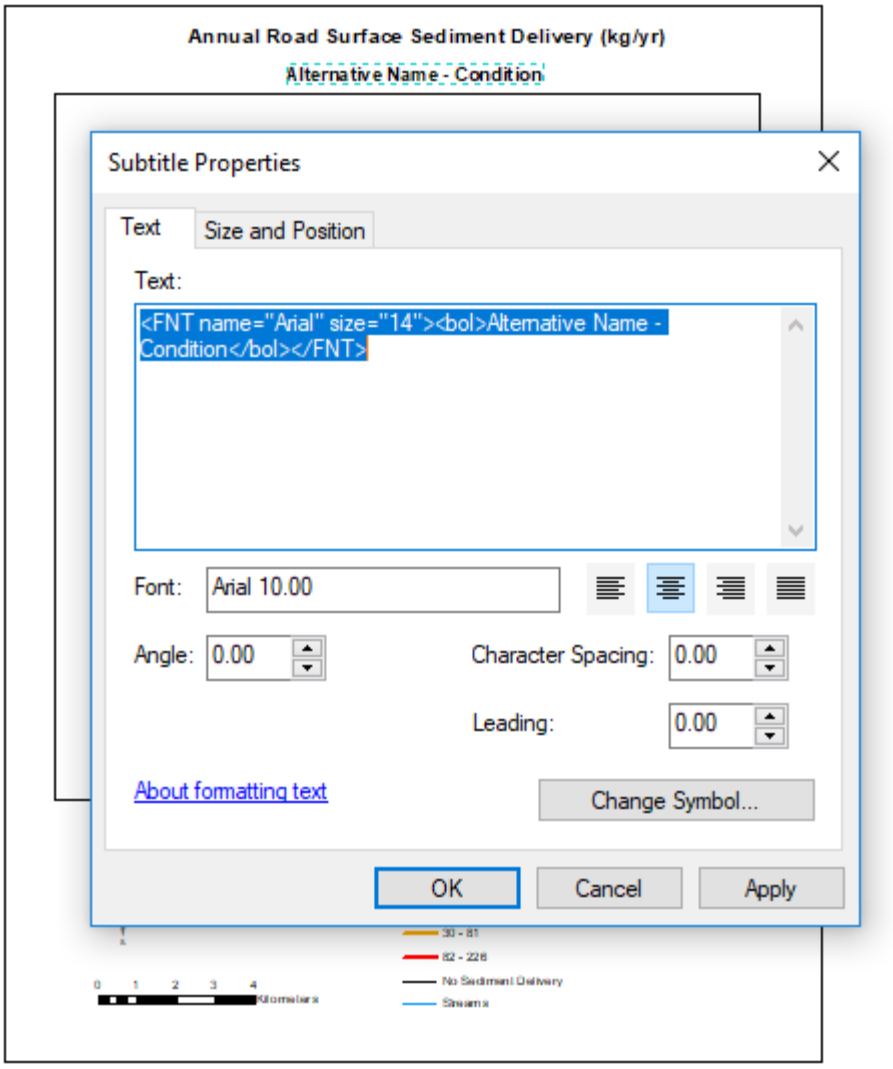


Figure 9 – Subtitle in Alternative Report

Any template having "Change" in its name will not be used when processing alternative 0 since this type of template shows changes between an alternative and alternative 0.

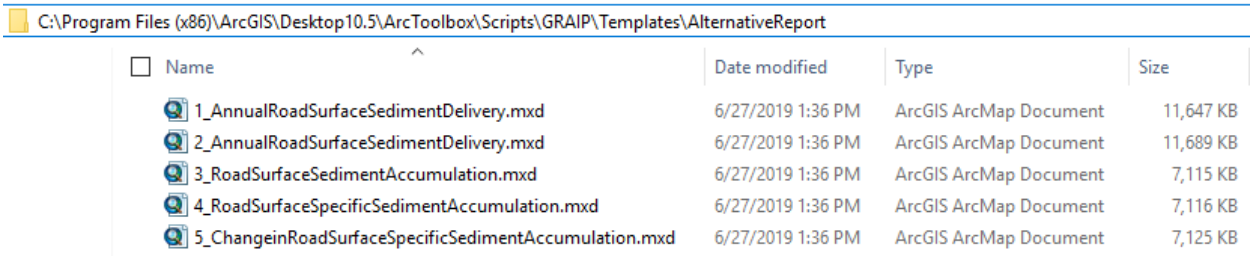
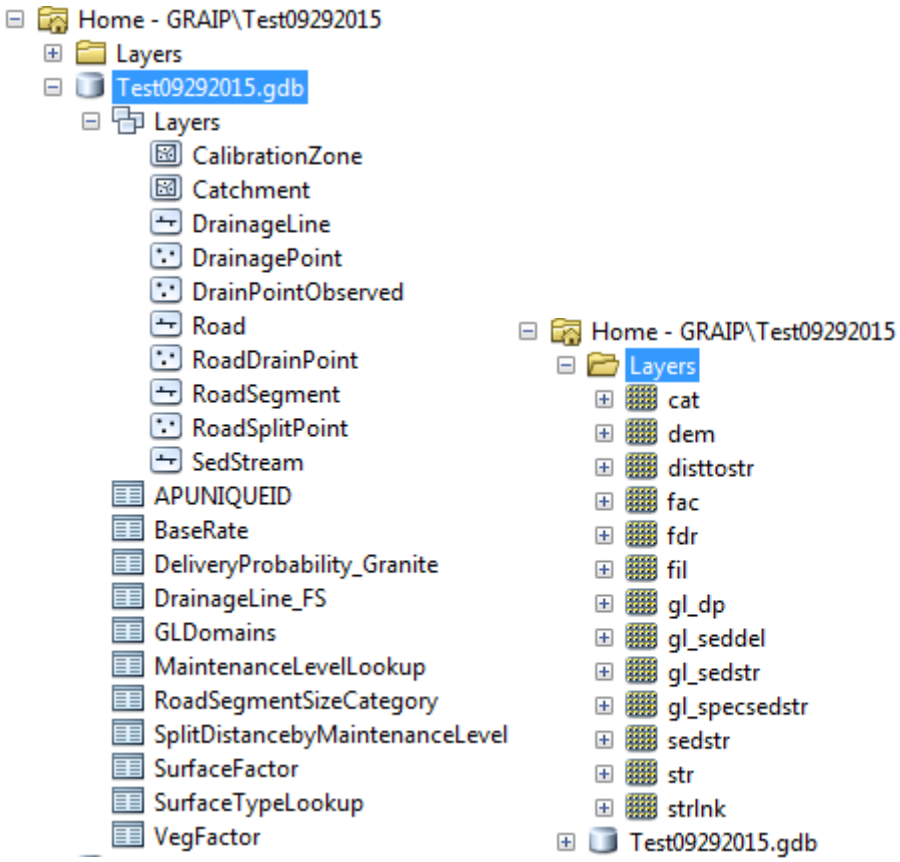


Figure 10 - Alternative Report Templates

11.0 Data Dictionary



Layer	Created by	Input to
CalibrationZone	01. Initialize GRAIP Lite Database	04. Create Road Segments
Catchment	02. DEM Processing	04. Create Road Segments
		Create Summary Statistics by Area
		06. Calculate Road Segment Drain Points
DrainageLine	02. DEM Processing	04. Create Road Segments
		Aggregate Sediment Delivery on DrainageLine
		Segment Drainage Line based on Sediment Delivery
DrainagePoint	02. DEM Processing	Aggregate Sediment Delivery on DrainageLine

DrainPointObserved	01. Initialize GRAIP Lite Database	04. Create Road Segments
Road	01. Initialize GRAIP Lite Database	04. Create Road Segments
RoadDrainPoint	06. Create Road Segment Drain Points	07. Calculate Road Segment Delivery
		08. Route Sediment to Streams
RoadSegment	04. Create Road Segments	05. Calculate Road Segment Sediment Production
		06. Calculate Road Segment Drain Points
RoadSplitPoint	04. Create Road Segments	
SedStream	Segment Drainage Line based on Sediment Delivery	
APUNIQUEID	01. Initialize GRAIP Lite Database	
BaseRate	01. Initialize GRAIP Lite Database	04. Calculate Road Segment Sediment Production
DeliveryProbability_Granite	01. Initialize GRAIP Lite Database	07. Calculate Road Segment Delivery
DrainageLine_FS	02. DEM Processing	
MaintenanceLevelLookup	01. Initialize GRAIP Lite Database	01. Initialize GRAIP Lite Database
RoadSegmentSizeCategory	01. Initialize GRAIP Lite Database	07. Calculate Road Segment Delivery
SplitDistancebyMaintenanceLevel	01. Initialize GRAIP Lite Database	01. Initialize GRAIP Lite Database
SurfaceFactor	01. Initialize GRAIP Lite Database	04. Calculate Road Segment Sediment Production
SurfaceTypeLookup	01. Initialize GRAIP Lite Database	01. Initialize GRAIP Lite Database
VegFactor	01. Initialize GRAIP Lite Database	05. Calculate Road Segment Sediment Production
cat	02. DEM Processing	
dem	01. Initialize GRAIP Lite Database	02. DEM Processing
		05. Calculate Road Segment Sediment Production
disttostr	03. Calculate Distance from Stream	06. Calculate Road Segment Drain Points

fac	02. DEM Processing	08. Route Sediment to Streams
fdr	02. DEM Processing	03. Calculate Distance from Stream
		08. Route Sediment to Streams
		Segment Drainage Line based on Sediment Delivery
fil	02. DEM Processing	
gl_dp	08. Route Sediment to Streams	Create Summary Statistics by Area
gl_seddel	08. Route Sediment to Streams	Aggregate Sediment Delivery on DrainageLine
		Segment Drainage Line based on Sediment Delivery
gl_sedstr	08. Route Sediment to Streams	
gl_specsedstr	08. Route Sediment to Streams	
sedstr	Segment Drainage Line based on Sediment Delivery	
str	02. DEM Processing	03. Calculate Distance from Stream
		Segment Drainage Line based on Sediment Delivery
		08. Route Sediment to Streams
strlnk	02. DEM Processing	

11.1 Geodatabase

11.1.1 Road

Attribute	Description	Comment
HydroID	Unique identifier of each road feature.	
GL_SurfaceType	Native, Crushed Roack, Paved	
GL_MaintenanceLevel	1-5	
GL_SplitDistance		
Gl_NewRoad	Not used. 0 – Existing, 1 - New	

GL_Traffic	Not used. low, medium, high, none

11.1.2 RoadSegment

Attribute	Description	Comment
SplitID	Unique identifier of source road feature.	
OrigLength	Original length of source road feature.	
GL_SurfaceType	Native, Crushed Roack, Paved	
GL_MaintenanceLevel	1-5	
GL_SplitDistance		
Gl_NewRoad	Not used. 0 – Existing, 1 – New	
GL_Traffic	Not used. low, medium, high, none	
GL_CalibrationZone	Calibration Zone associated to the segment.	
RID	Segment identifier.	

11.1.3 RoadSplitPoint

Attribute	Description
HydroID	Unique identifier of the feature.
FeatureID	Unique identifier of the associated input DrainPointObservedOrig for point of GL_CrossingType Observation.
GL_CrossingType	Type of road “crossing: Calibration, Catchment, Distance, Junction, Observation, Stream
GL_SplitDistance	Distance between observed drain point and split point.

11.1.4 RoadDrainPoint

Attribute	Description
SplitID	Unique identifier of source road feature.
OrigLength	Original length of source road feature.
GL_SurfaceType	Native, Crushed Roack, Paved
GL_MaintenanceLevel	1-5
GL_SplitDistance	
Gl_NewRoad	Not used. 0 – Existing, 1 – New
GL_Traffic	Not used. low, medium, high, none
GL_CalibrationZone	Calibration Zone associated to the segment.
RID	Segment identifier.
Start_ElevM	Segment start elevation in meters.
End_ElevM	Segment end elevation in meters.

RangeM	Elevation range in meters.
LengthM	Segment length in meters.
GL_BaseRate	Base rate associated to GL_CalibrationZone read from BaseRate table.
GL_SurfaceFactor	Surface factor associated to GL_SurfaceType read from SurfaceFactor table.
GL_VegFactor	Vegetation factor associated to GL_CalibrationZone, GL_MaintenanceLevel and GL_SurfaceType read from VegFactor table.
GL_SedProd	Sediment production. Calculated as GL_BaseRate * RangeM * GL_SurfaceFactor * GL_VegFactor.
GL_StreamDist	Distance from drain point to closest stream cell.
GL_SegmentType	Type of segment based on LengthM and RoadSegmentSizeCategory table.
GL_DelProb	Delivery probability based on GL_CalibrationZone, GL_StreamDist and DeliveryProbability_calibrationzone tables.
GL_SedDel	Sediment delivery calculated as GL_SedProd * GL_DelProb.