Illini Drainage Tools

Introduction to Illini Drainage Tools

By:

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Reminders

- Installed the recommended QGIS Version. Unzip “Instructions” at link:

https://publish.illinois.edu/illinoisdrainageguide/illini-drainage-tools/

- Installed the “Illini Drainage Tools”. Unzip “Instructions” at link:

https://publish.illinois.edu/illinoisdrainageguide/illini-drainage-tools/

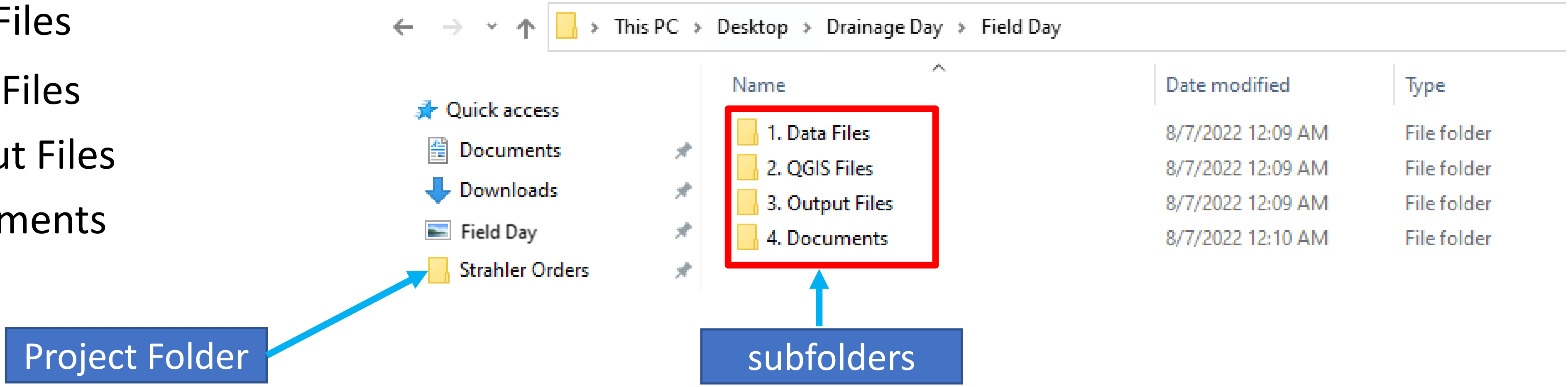
- Prepared Project Folder with the following subfolders:

a. Data Files

b. QGIS Files

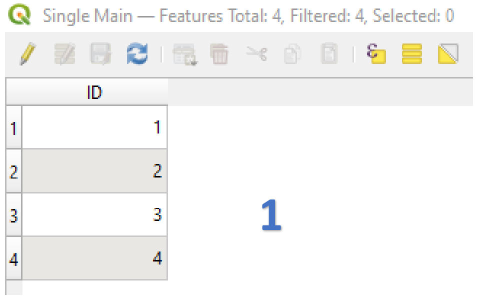
c. Output Files

d. Documents

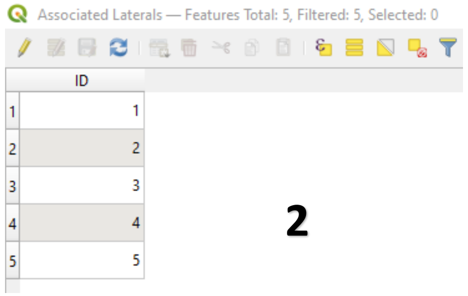


Data Check & Preparation

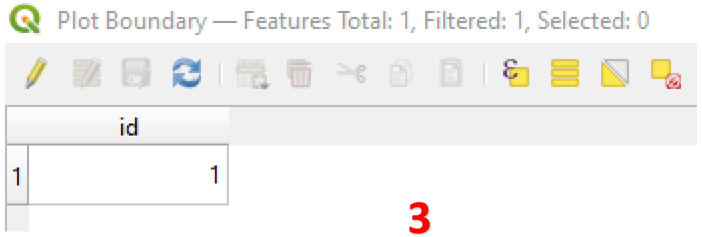
1. Main Layer
2. Lateral Layer
3. Boundary Layer
4. Raster DEM (LiDAR)



1



2



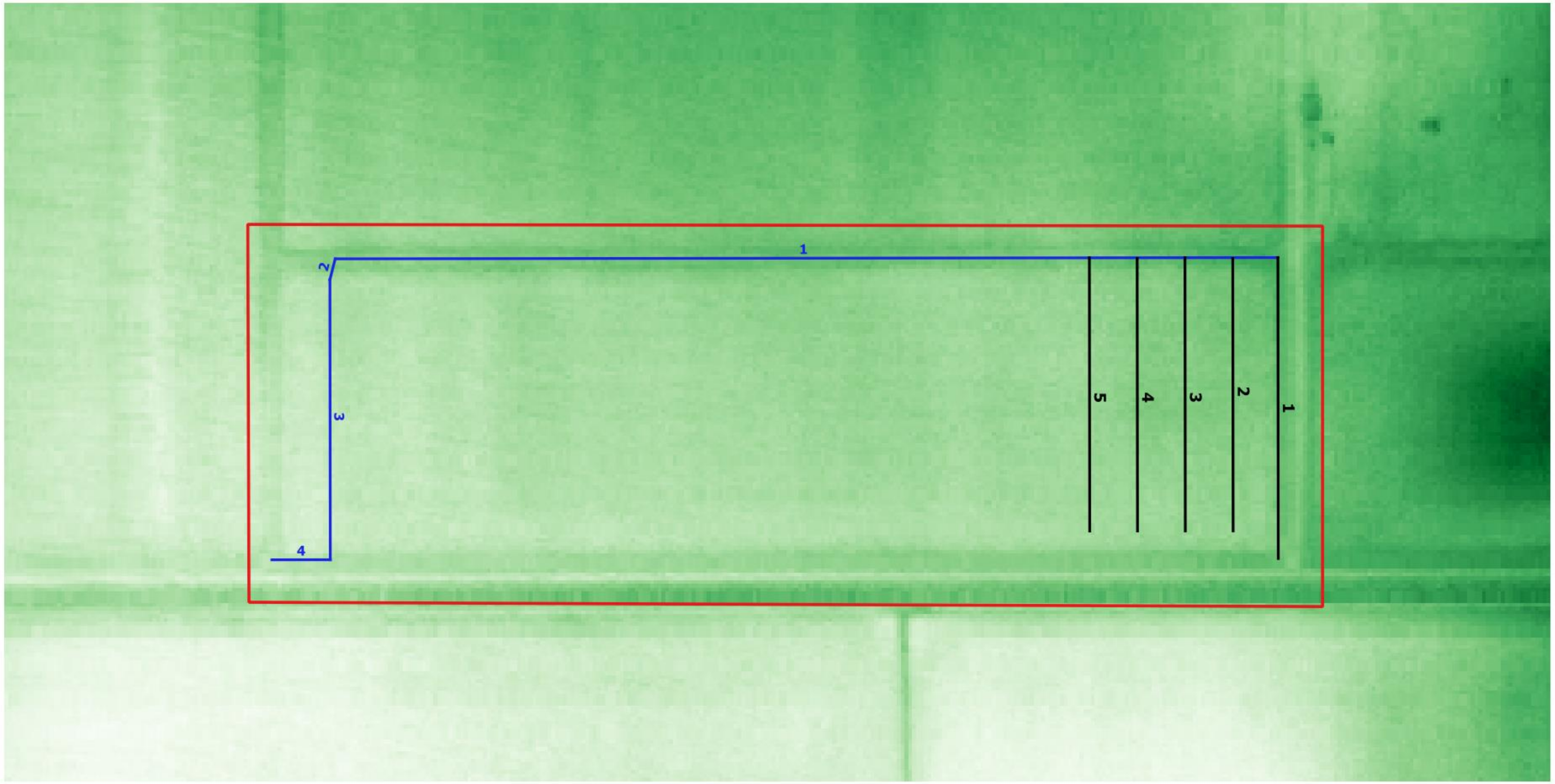
3

Main Layer

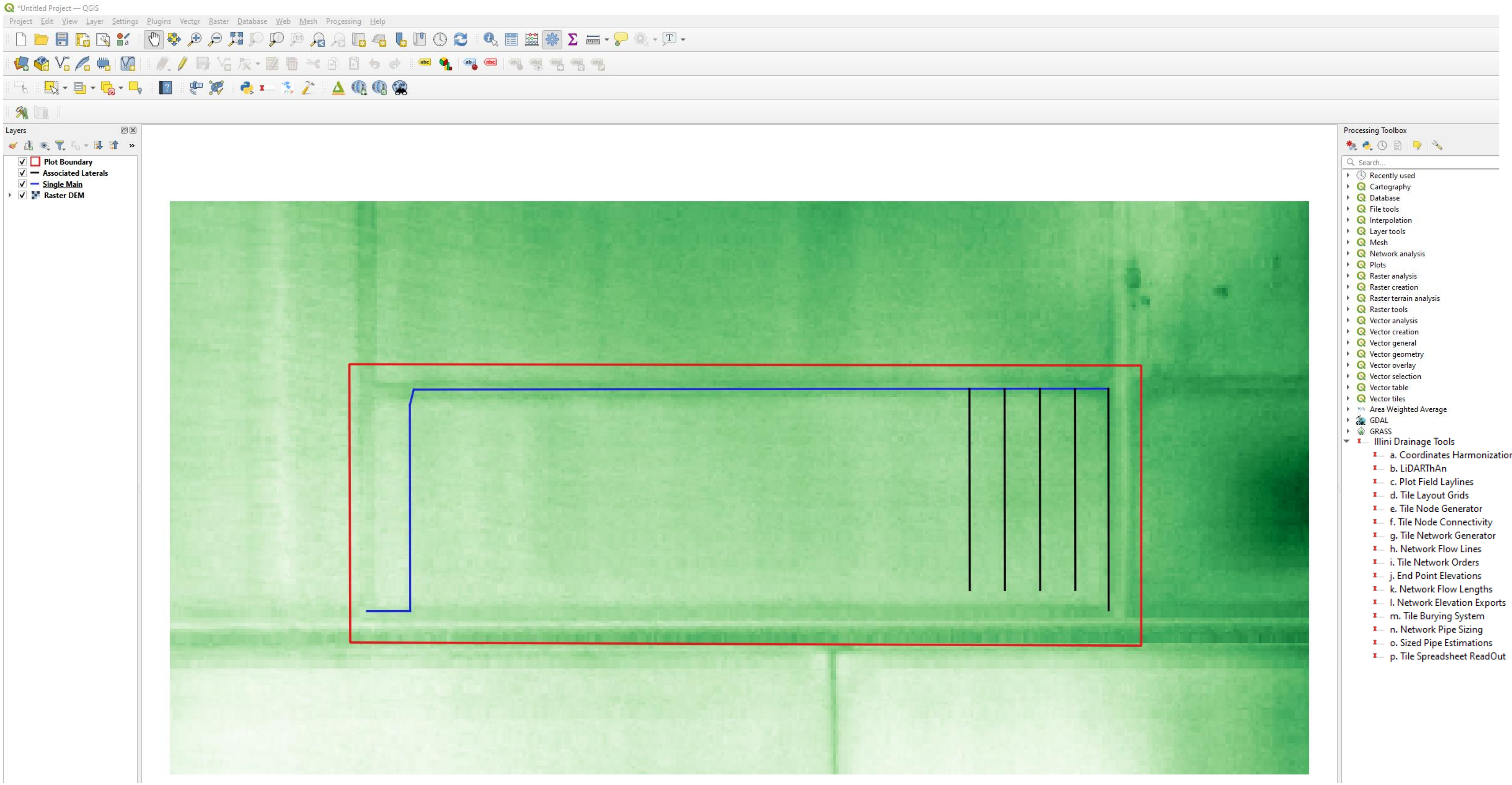
Lateral Layer

Boundary Layer

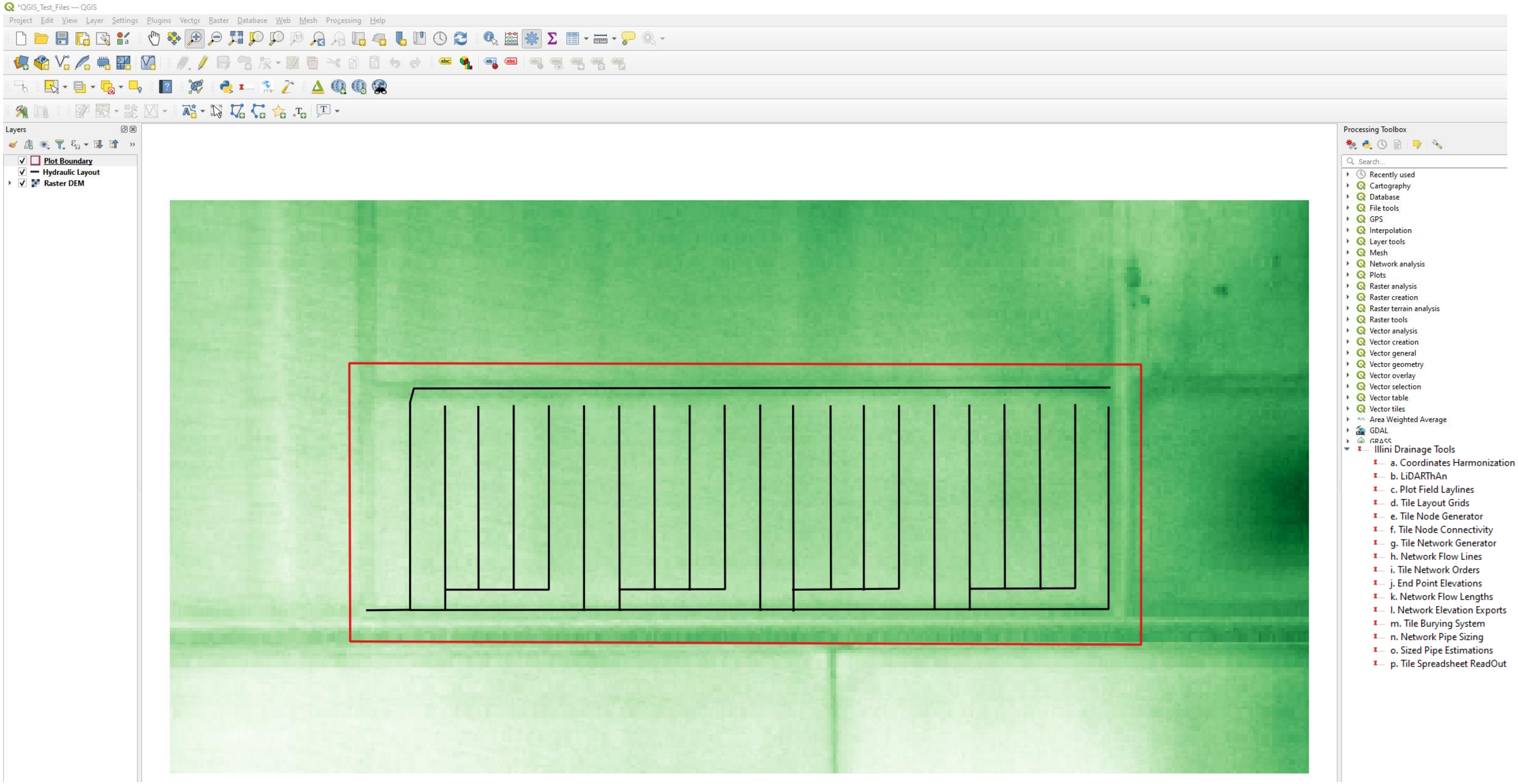
Raster DEM (LiDAR)



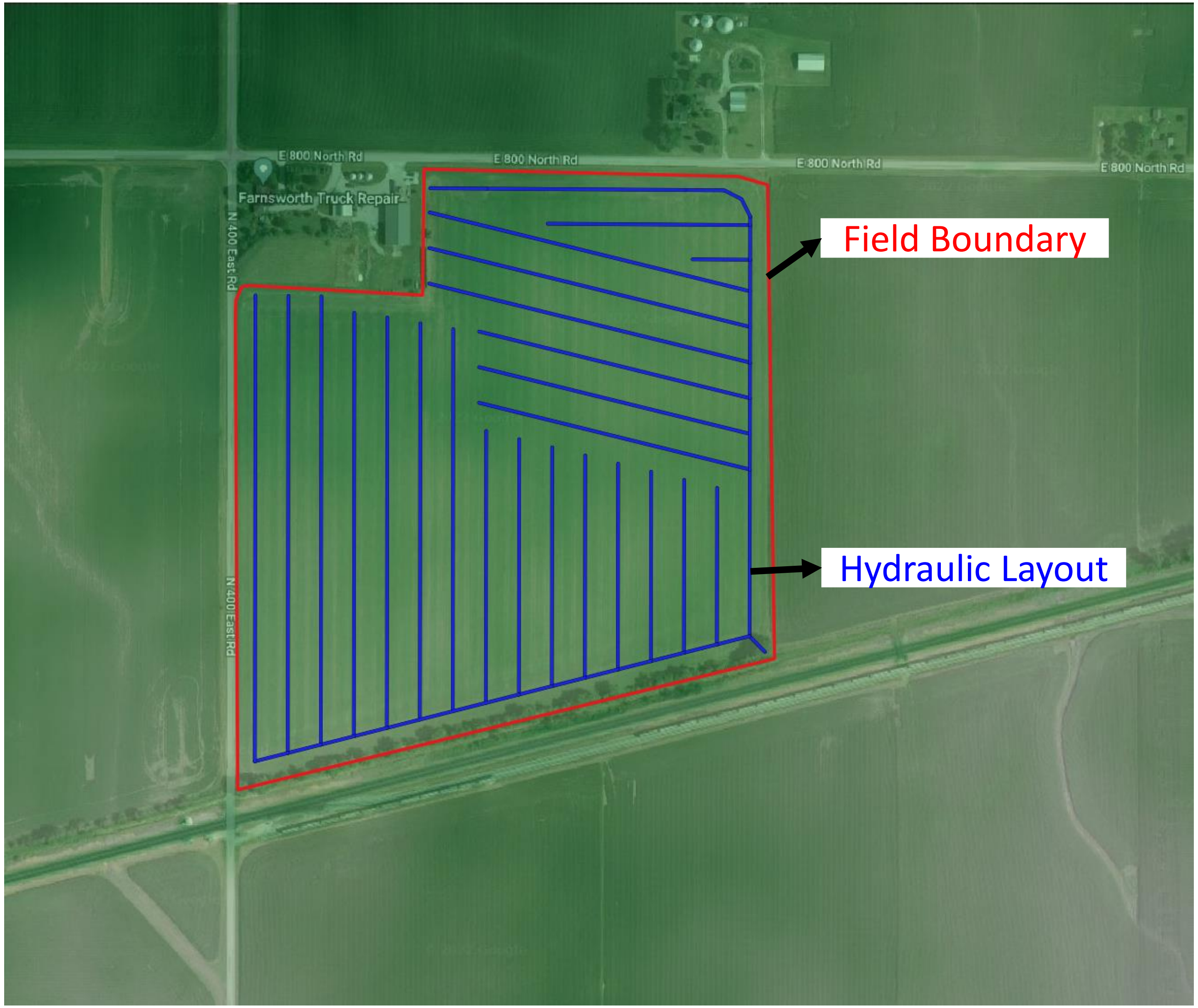
Ready Station: Simple Layout



Ready Station: Complex Layout



Demonstration Field



Site Name: **Farnsworth Field Plot**

a. Located near a Community called **Milmine**, in Piatt County, IL, United States
b. At a **Latitude:** 39.907954, **Longitude:** -88.666984 at an elevation of 713 feet

To get this practice field, use link:
https://publish.illinois.edu/illinoisdrainageguide/illini-drainage-tools/

Illini Drainage Tools

- Illini Drainage Tools
  - a. Coordinates Harmonization
  - b. LiDARThAn
  - c. Plot Field Laylines
  - d. Tile Layout Grids
  - e. Hydraulic Network Fixer
  - f. Network Flow-Path Generator
  - g. Tile Network Ordering
  - h. Network Elevation Exports
  - i. Network Flow Lengths
  - j. Tile Burying System
  - k. Network Pipe Sizing
  - l. Sized Pipe Estimations
  - m. Tile Spreadsheet ReadOut

Part One

✓ **Goal:** Facilitating the Layout of Drainage Systems

a. Coordinate Harmonization
b. Boundary Extraction and LiDAR Thinning
c. Plotting and Visualizing Drain Nets
d. Creating Tile Overlay Grids

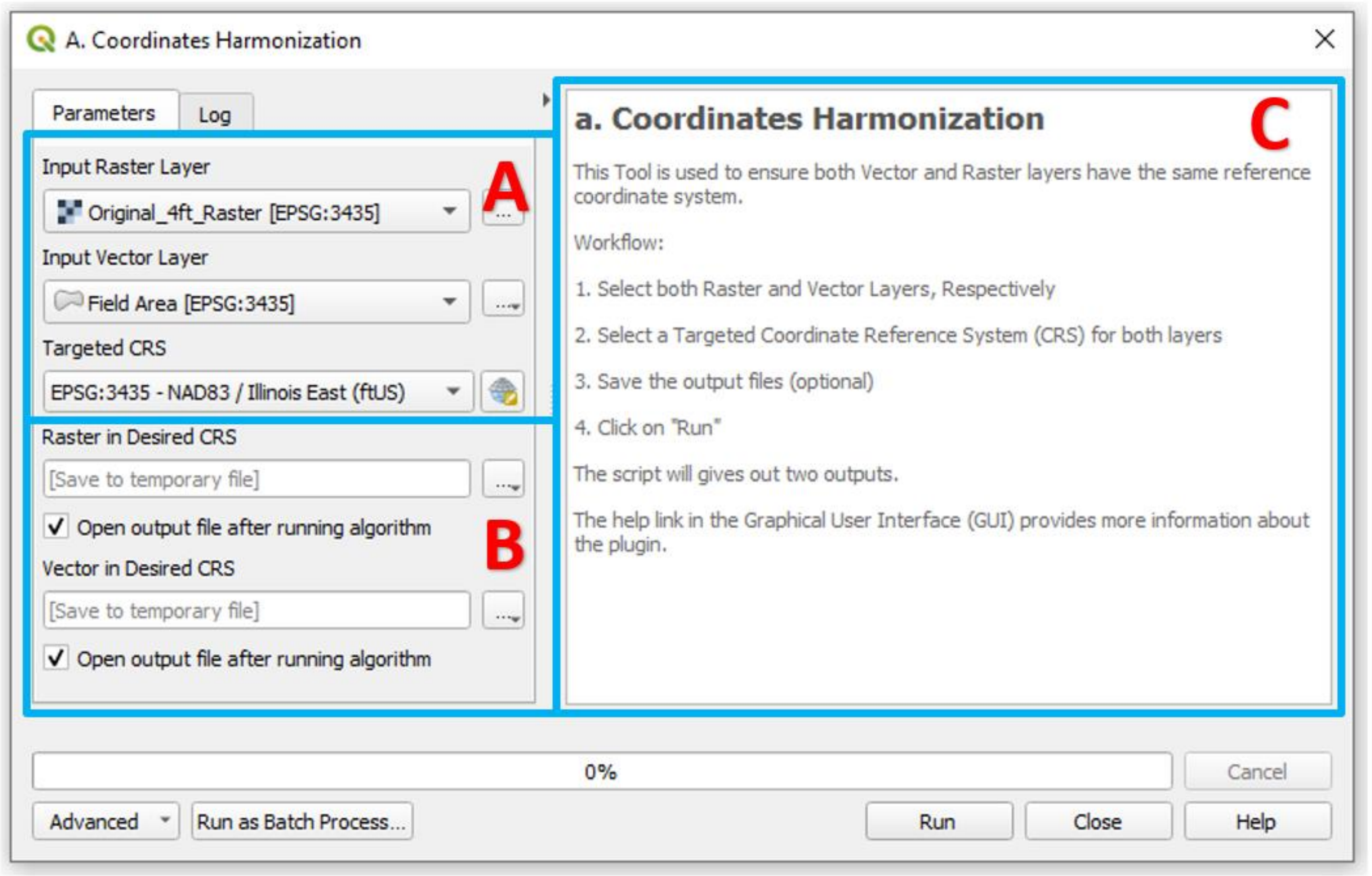
Coordinates Assignation and Harmonization:

This is Routine A.

a. Select the Raster DEM Layer
b. Select the Boundary Layer
c. Select the targeted Coordinate Reference System
d. Save File to “Output Folder” as *RasterDEM*
e. Save File to “Output Folder” as *BoundaryLine*

Note*: Do same for Vector Line Layer and save as *HydraulicLayout* and for any other working Layers accordingly.

This operation ensures that all layer datasets are in the same coordinate reference system, to avoid distortions resulting from using different projections.

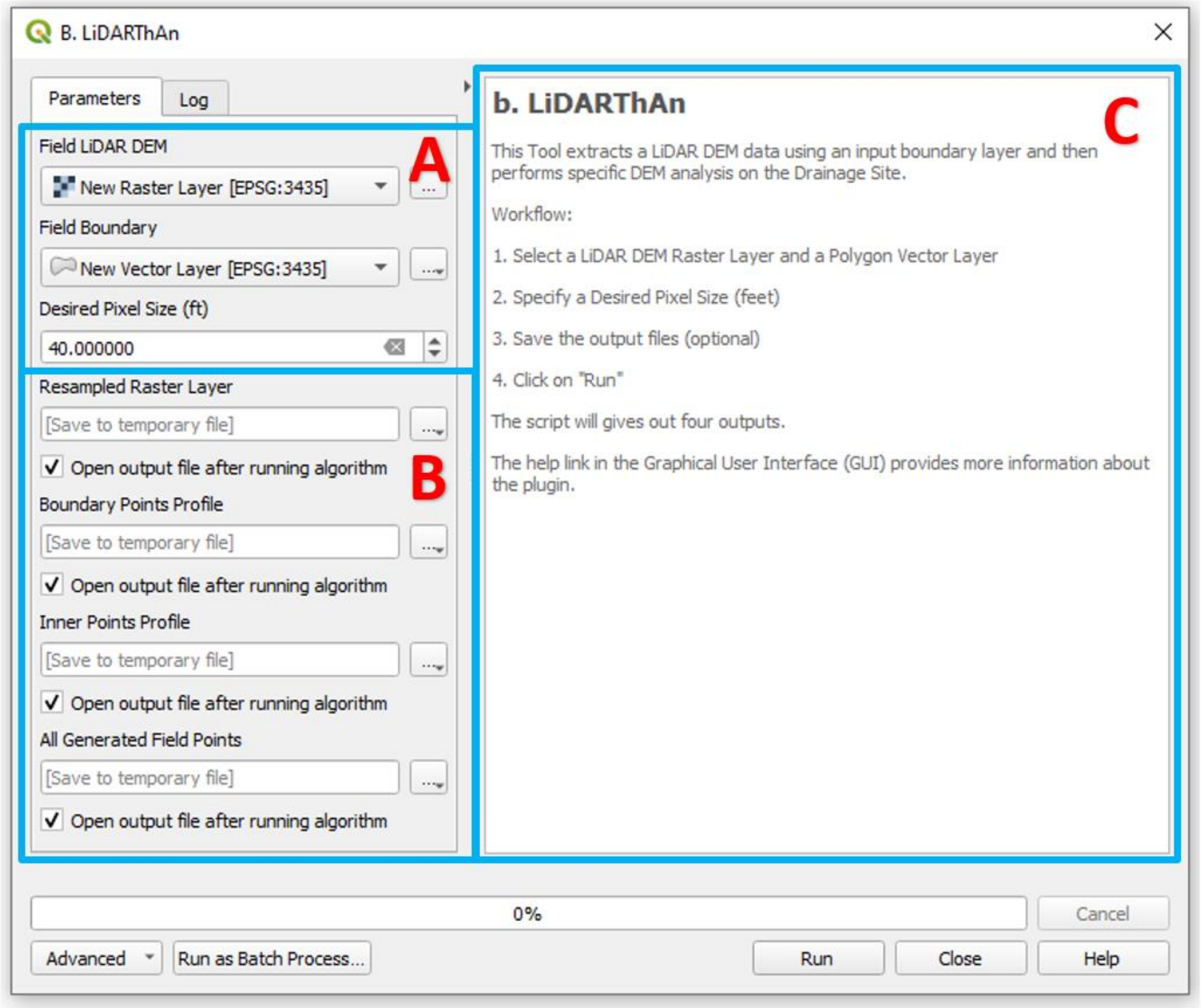


Boundary Extraction and LiDAR Thinning:

This is Routine B.

a. Select the new **RasterDEM** Layer
b. Select the new **PlotBoundary** Layer
c. Specify the desired pixel size for thinning
d. Save File to "Output Folder" as *ThinnedDEM*
e. Save File to "Output Folder" as *BoundaryPoints*
f. Save File to "Output Folder" as *InnerPoints*
g. Save File to "Output Folder" as *AllFieldPoints*

This operation reduces the density of point cloud data based on a specified threshold spacing. The resulting field dots of the grids represents a point feature with spatial reference in a point sampling design.

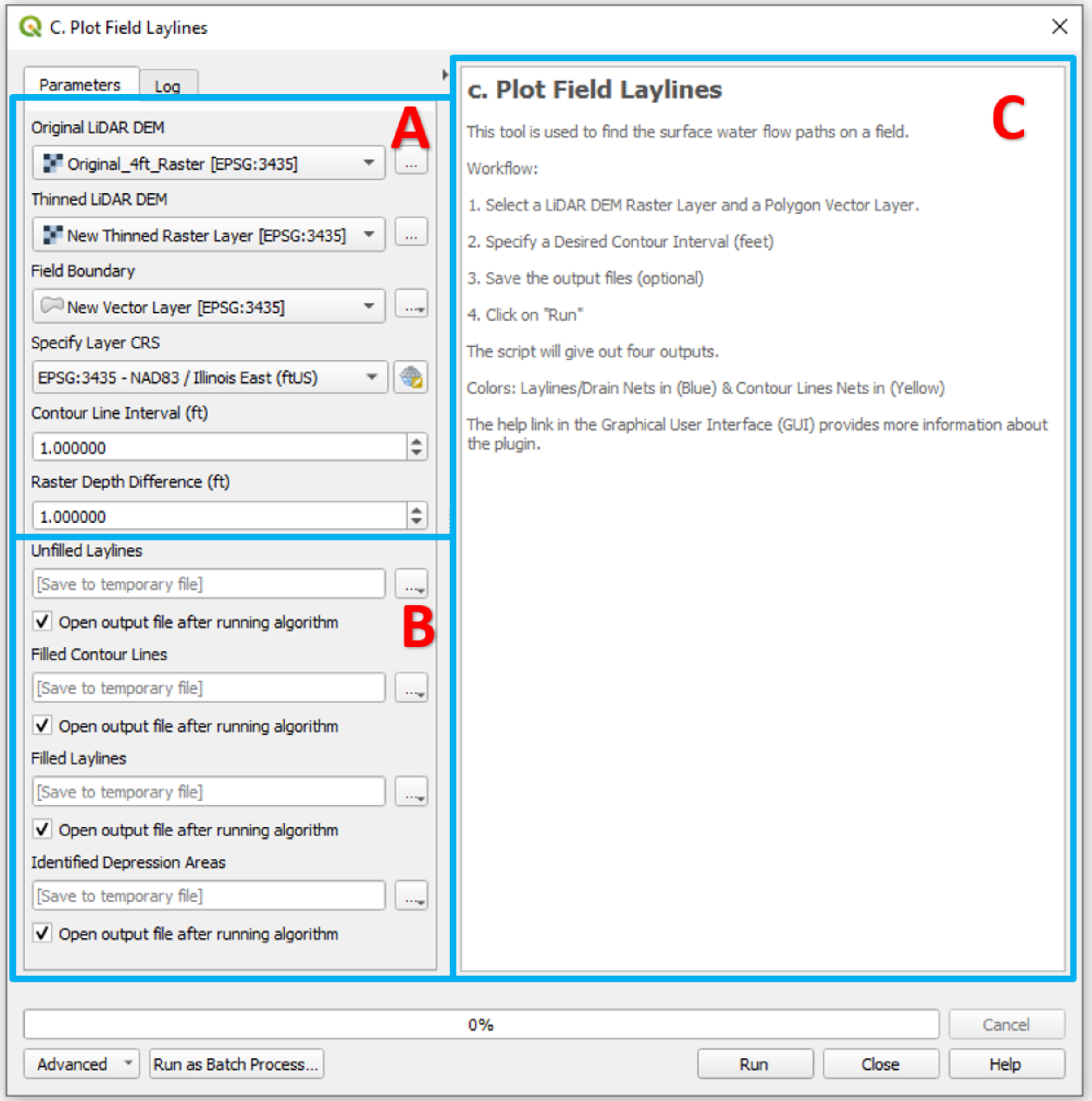


Plotting and Visualizing Drain Nets:

This is Routine C.

a. Select the new **RasterDEM** Layer
b. Select the new **ThinnedDEM** Layer
c. Select the **PlotBoundary** Layer
d. Specify the Contour Line Interval
e. Specify the Raster Depth Difference
f. Save File to "Output Folder" as *UnfilledLaylines*
g. Save File to "Output Folder" as *ContourLines*
h. Save File to "Output Folder" as *FilledLaylines*
i. Save File to "Output Folder" as *DepressionAreas*

This operation creates Drain Nets (LAYLINES) to show and visualize surface flow patterns. These Drain Nets can be used to optimized tile layout either perpendicular or parallel to the contours.

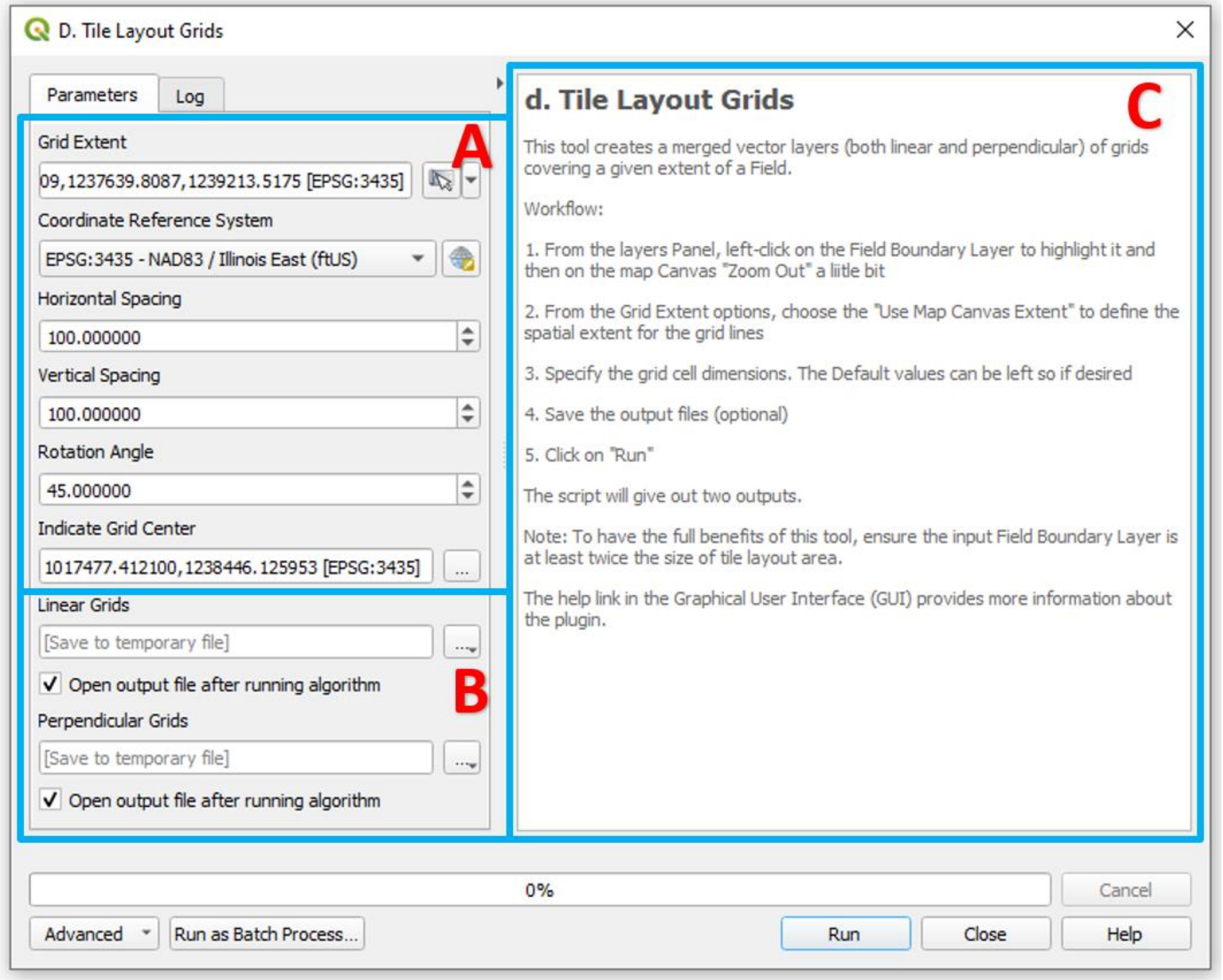


Creating Tile Overlay Grids:

This is Routine D.

a. On the Map Canvas, “Zoom Out” a little bit using the Boundary Layer
b. From the Grid Extent options, select the “Map Canvas Extent”
c. Select the targeted Coordinate Reference System
d. Specify the Horizontal Line Spacing
e. Specify the Vertical Line Spacing
f. Specify the Rotation Angle for the Perpendicular Grids
g. Indicate the Grid Center
h. Save File to “Output Folder” as *LinearGrids*
i. Save File to “Output Folder” as *PerpendicularGrids*

This operation produces guidelines, in form of overlay-grids to assist in drainage system layout.



INTERMISSION

Part Two

✓ **Goal:** Creating Topologically-sound Networks

a. Perform a Class Activity in QGIS
b. Fix Digitization Errors, Recreate and Connect the Tile Network
c. Reorient the Layout Network to create a Unilateral Flow System

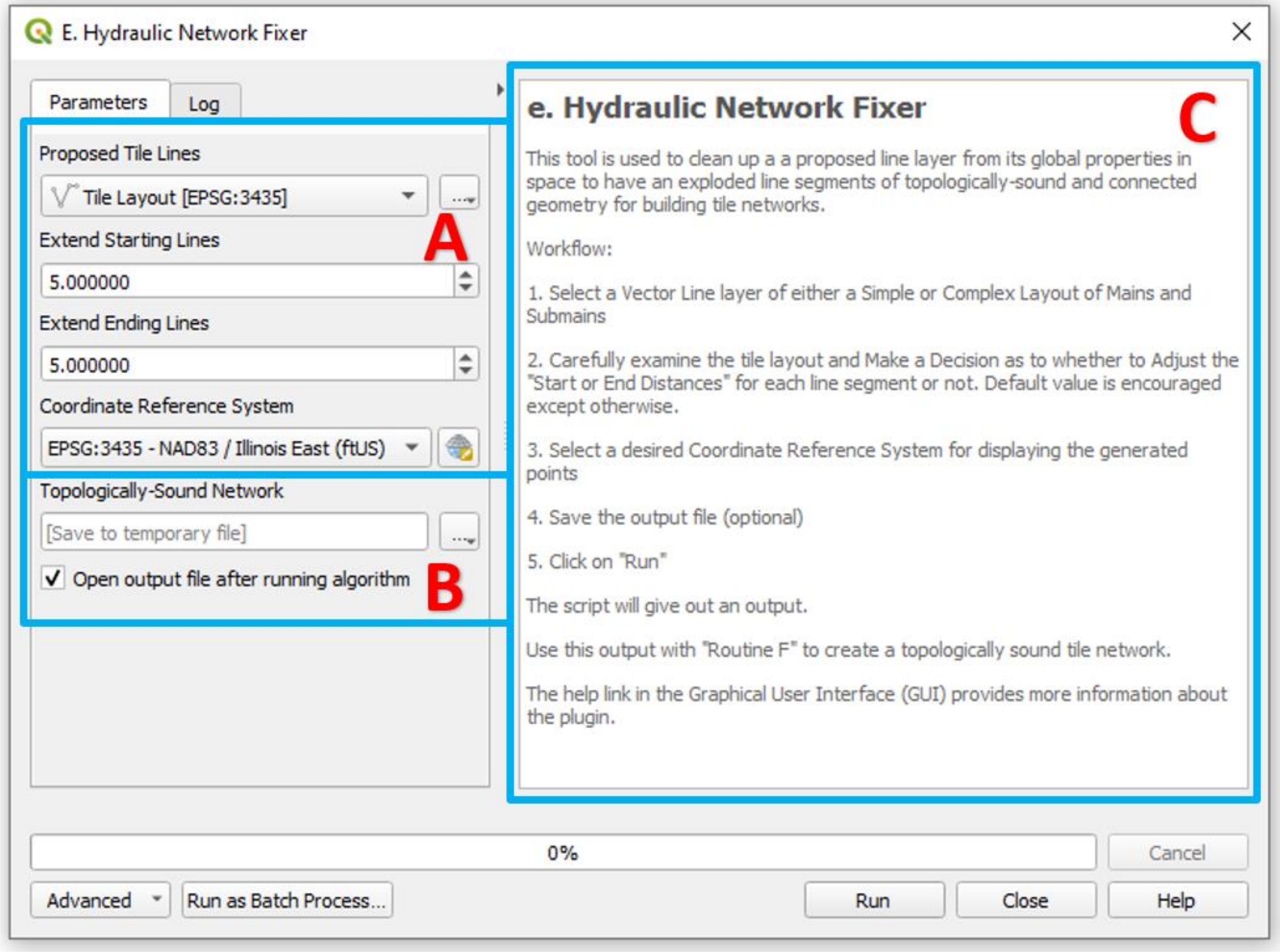
Class Activity

Use the Outputs from Routines C and D
to digitize a tile layout network

Fixe Digitization Errors on the New Tile Network

This is Routine E.

a. Select the new **Hydraulic Layout** Layer (or use the one created in the class activity)
b. Specify the Extended Distance to cover for Dangles in the system
c. Select the targeted Coordinate Reference System
d. Save File to "Output Folder" as *Topologically-Sound Network*



This operation ensures that the discontinuities (Dangles, Overshoots, Fractures) in the system layout are cleaned-up, recreates the layout, and thus exploding the system layout into connected line segments that are topologically-sound like the original tile layout.

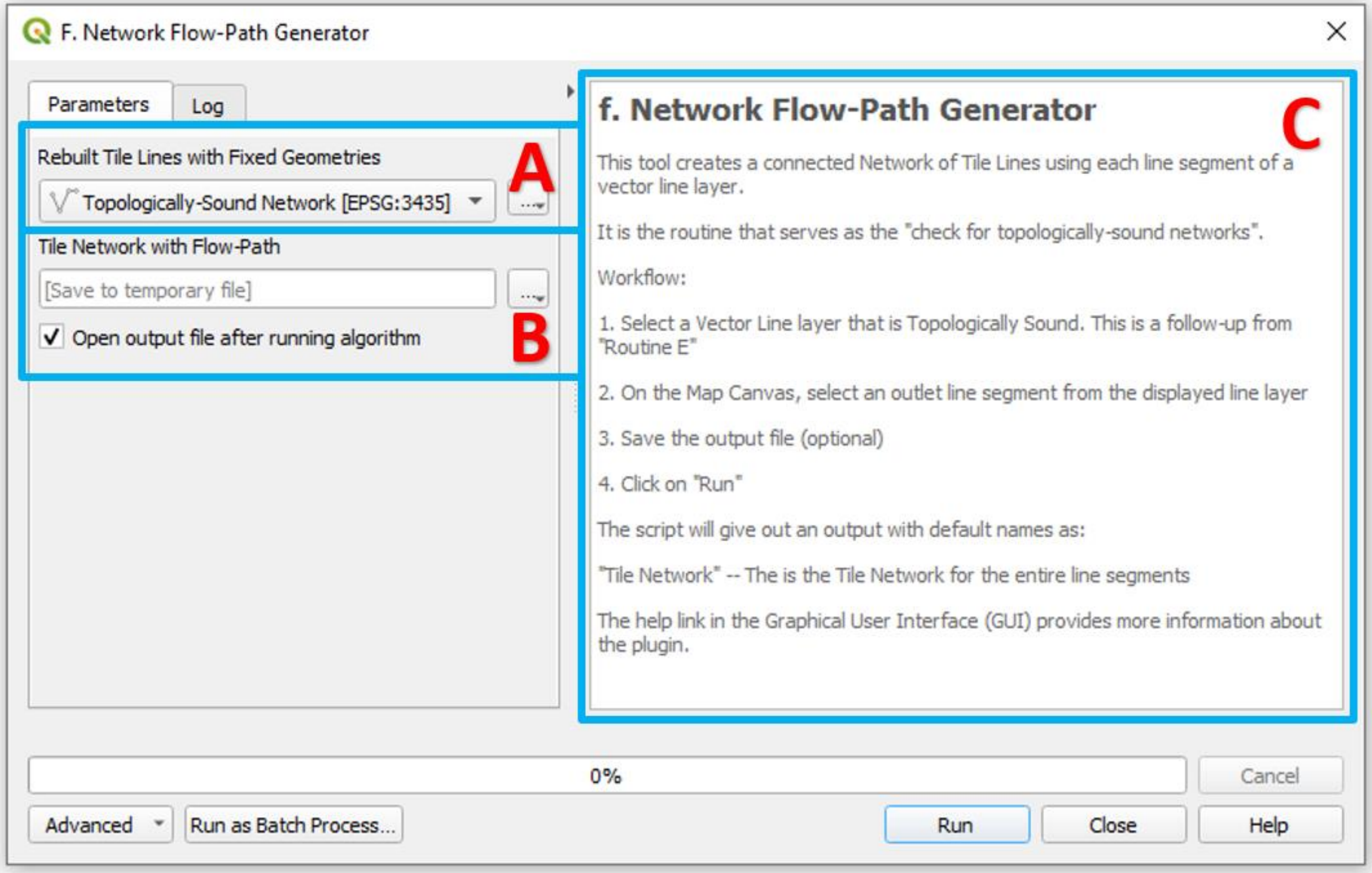
***Note:** * we use **"Routine E"** for either a simple or complex layout. For simple layout, first perform the "Union" operation to join the main and lateral layers into one layer. (e.g., Vector>geoprocessing>union)*

Reorient Tile Network to Create a Unilateral Flow System:

This is Routine F.

a. On the Map Canvas, select an Outlet line segment from the displayed ***Topologically-Sound Network*** Layer, using the "Select Feature by Area or Single Click" tool in QGIS.
b. Now, on the Routine G, select the ***Topologically-Sound Network*** Layer
c. Save File to "Output Folder" as *FlowPathNetworkLayout*

The routine uses the output from routine F to reorient the line segments so that the beginning and end nodes of each is consistently upstream and downstream respectively and identifies line segments immediately upstream and downstream of each line segment. This operation is used to validate the layout network and check as topologically-sound.



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Part Three

✓ **Goal:** Generating Network Geometric Attributes

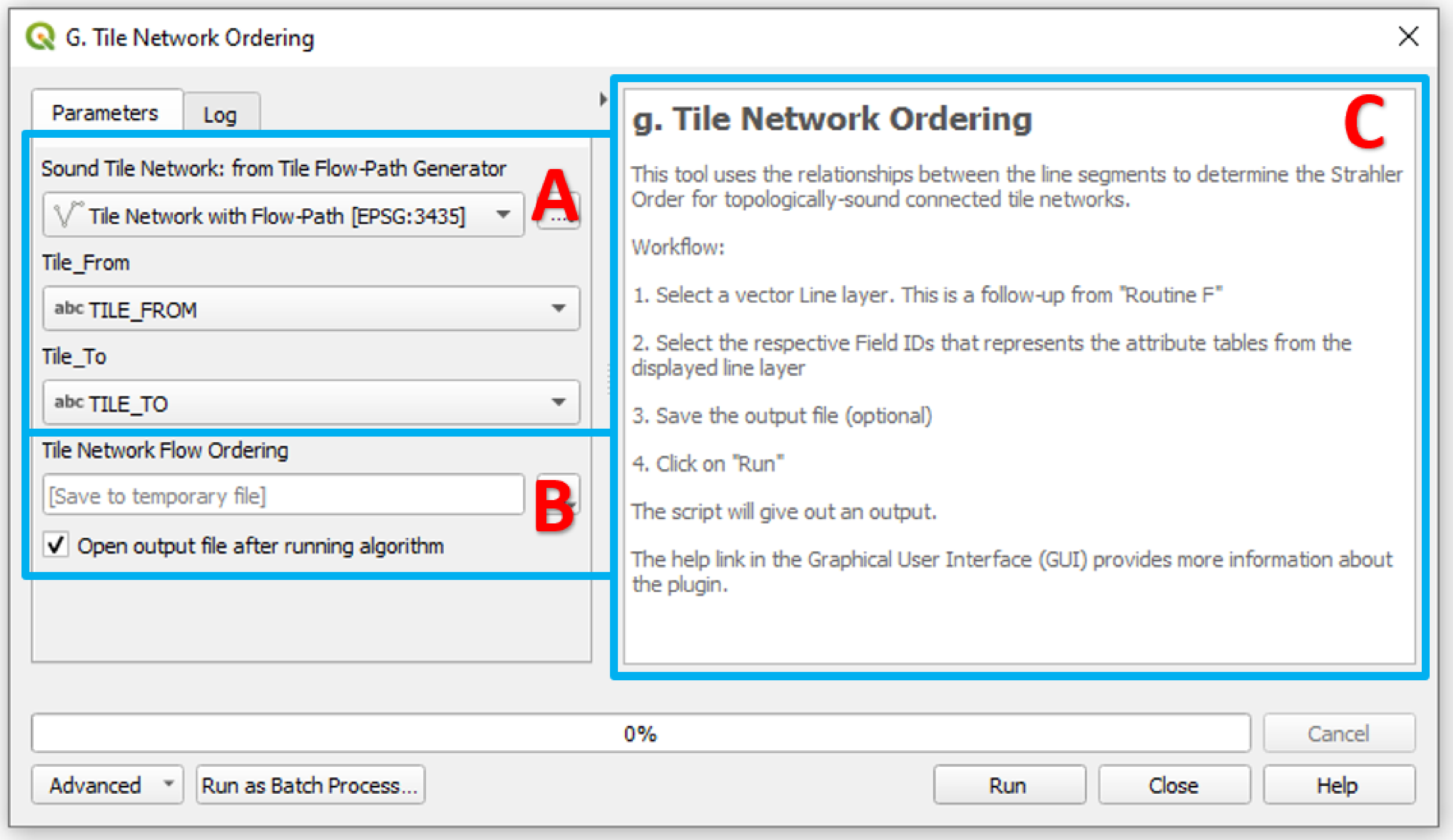
a. Determine and Generate Network Upstream Flow Line Orders
b. Generate Elevation Points and Geometric Attributes for Tile Network
c. Calculate Cumulative Flow Lengths on Tile Lines

Determining Network Upstream Flow Line Orders:

This is Routine G.

a. Select the new ***FlowPathNetworkLayout*** Layer
b. Select the fields “Tile_FROM” and “Tile_TO” respectively
c. Save File to “Output Folder” as *FlowLayoutOrderings*

This operation uses the line segments to determine the flow route in the tile network based on the connecting nodes in the layout and likewise the Flow Order for each line segment in the tile network. This ordering in the line segment reflects the flow strength in the drainage system.

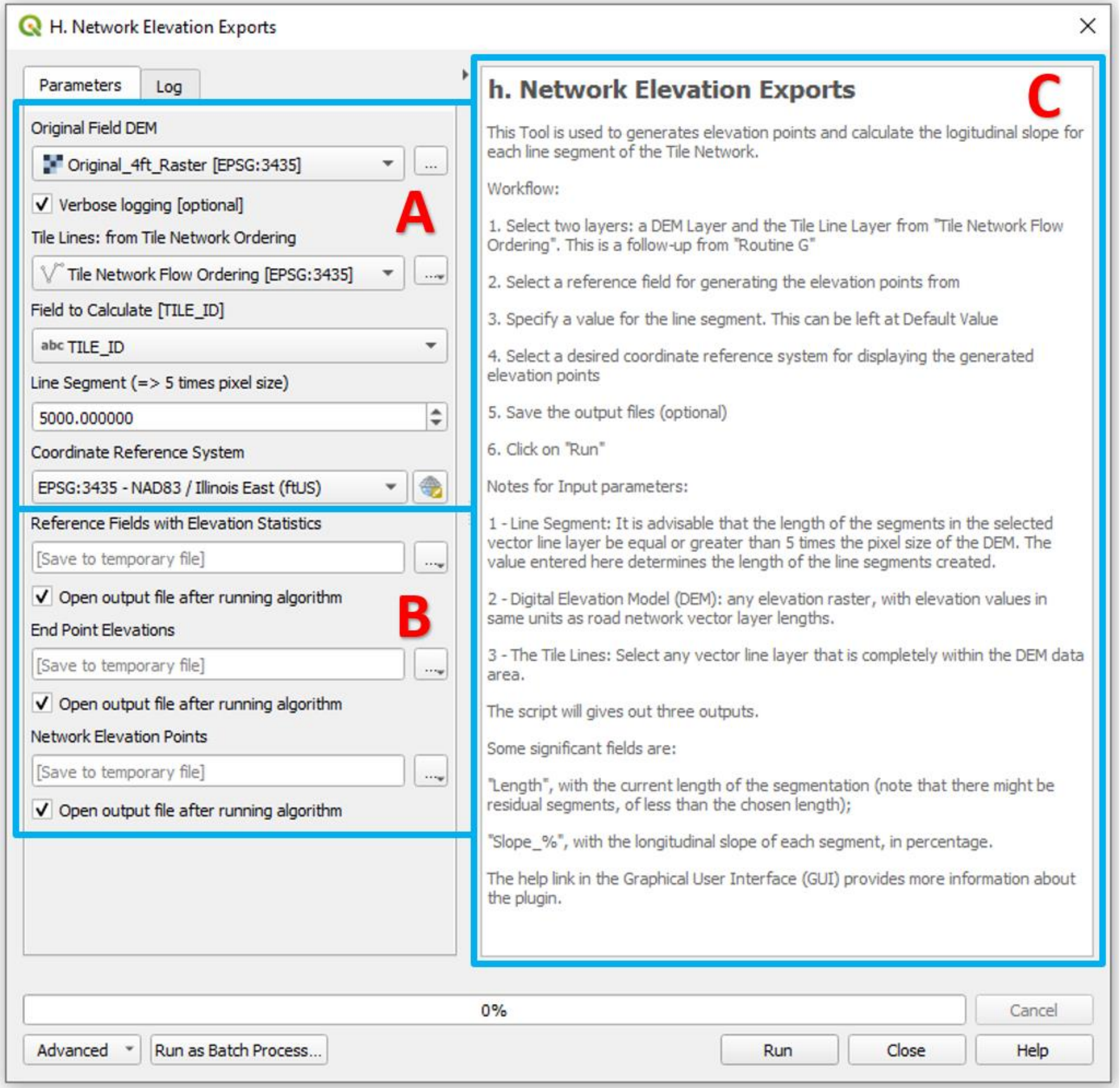


Generating Tile Network Elevation Points and Field Geometric Attributes:

This is Routine H.

a. Select the new **RasterDEM** Layer
b. Select the new ***FlowLayoutOrderings*** Layer
c. Select the field to calculate: “Tile_ID”
d. Specify a length value for the line segment
e. Save File to “Output Folder” as *ReferencedFields*
f. Save File to “Output Folder” as *ElevationPoints*
g. Save File to “Output Folder” as *NetworkPoints*

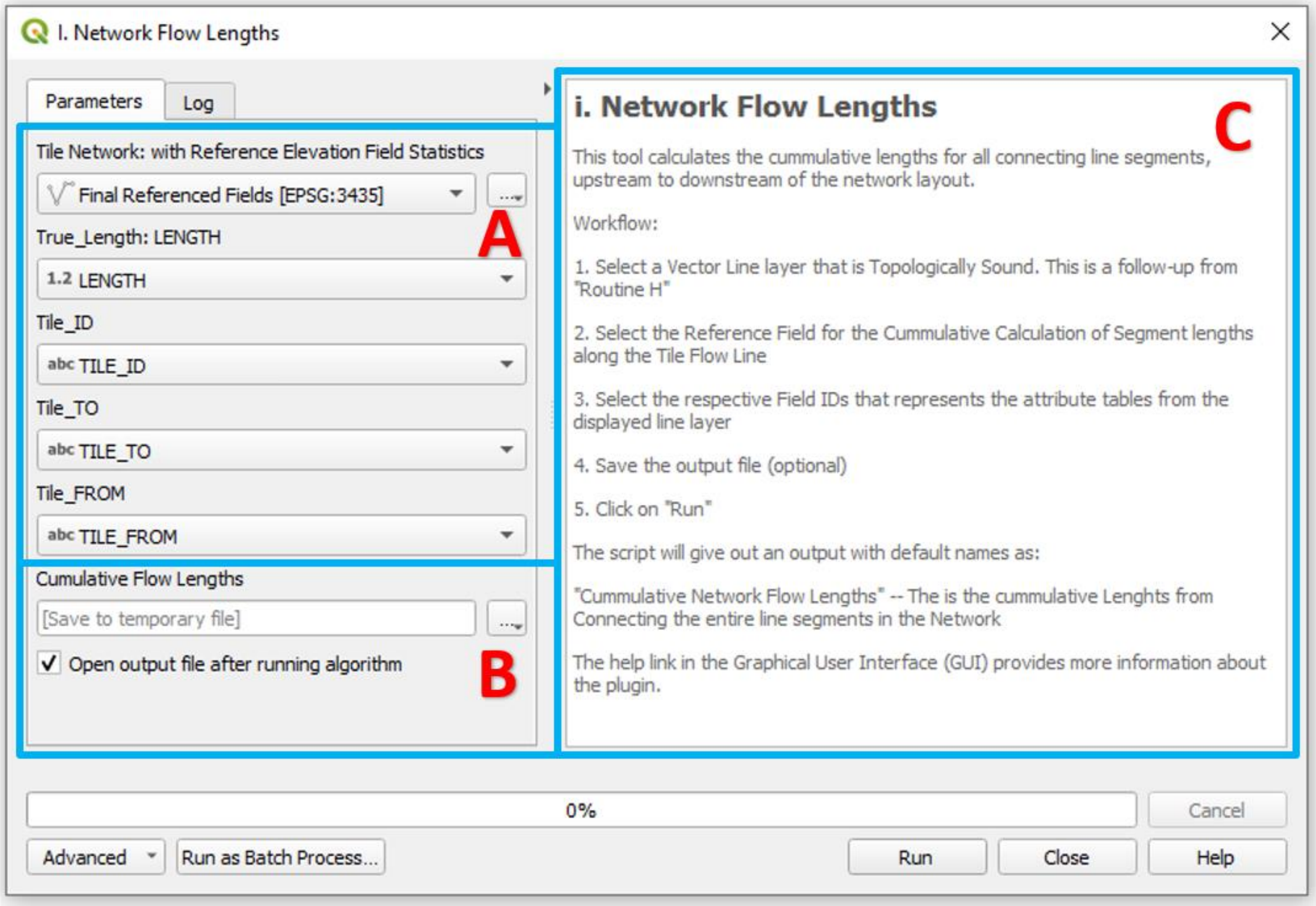
This operation is used to determine the endpoint elevations, true length, and absolute slope for each line segment in the tile network layout.



Determining Cumulative Flow Lengths for Adjoining Segments:

This is Routine I.

a. Select the new ***ReferencedFields*** Layer
b. Select the fields “Lengths”, “Tile_ID”, “Tile_TO” and “Tile_FROM” respectively
c. Save File to “Output Folder” as *CumFlows*



This operation is used to calculate the cumulative flow lengths for all connecting line segments, upstream to downstream in the tile network layout.


TIME FOR A
BREAK

Part Four

✓Goal: Burying and Sizing of Drainage Network

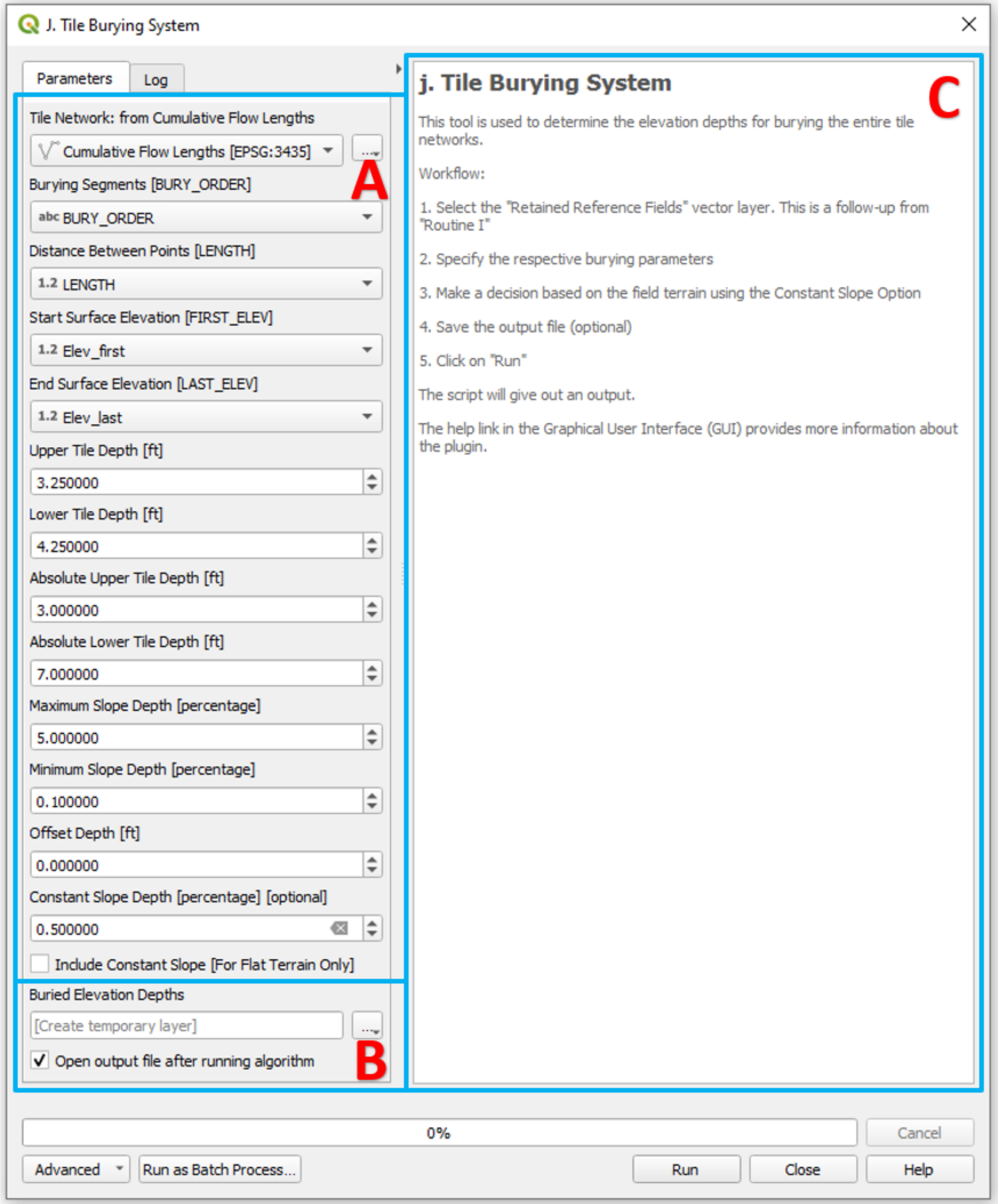
a. Calculate the Optimal Elevation Depth for Tile Placement
b. Telescoping Pipe Size Across Field Terrain
c. Cost Analysis for all Pipe Sizes in the Drainage Network
d. Export Output to Transferrable Formats

Calculate the Optimal Elevation Depths for Tile Placement:

This is Routine J.

a. Select the new ***CumFlows*** Layer
b. Select the fields "Bury_Order", "Length" and the End-point Elevations "First & Last", respectively.
c. Specify the Burying parameters
d. Decide on using the Constant Slope Option based on the field terrain
e. Save File to "Output Folder" as *BuriedDepths*

This operation is used to determine the minimum size of each section of the drainage main to carry the upstream design flow in the tile network layout.

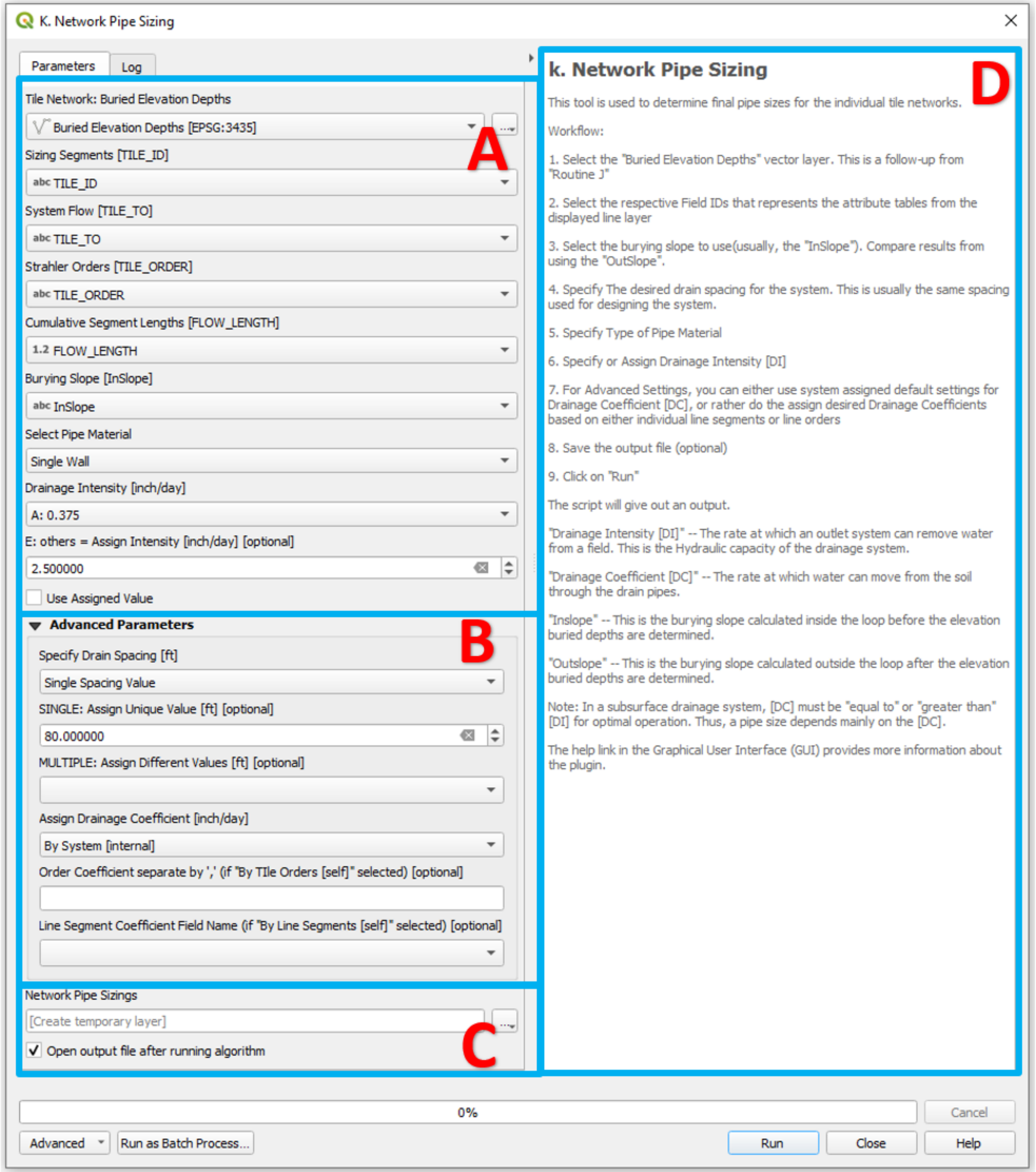


Telescoping Pipe Size Across Field Terrain:

This is Routine K.

a. Select the **BurriedDepths** Layer
b. Select the fields “Tile_ID”, “Tile_TO”, “TILE_ORDER”, “Flow_Length”, and “InSlope”
c. Specify Type of Pipe Material
d. Assign Value for Drainage Intensity
e. Decide How to Assign Value for Drain Spacing
   i. Use Single Spacing. Leave default settings
   ii. Assign Multiple Drain Spacing per line segments (more effort)
f. Decide How to Assign Value for Drainage Coefficient
   i. By System. Leave default settings
   ii. By Line Segments (more effort)
   iii. By Orders (more effort)
g. Save File to “Output Folder” as *PipeSizes*

This routine relies on the Tile Order, Length and Slope for determining the pipe size for each line segment. The output includes the actual and nominal pipe sizes for each line segment in the tile network layout.

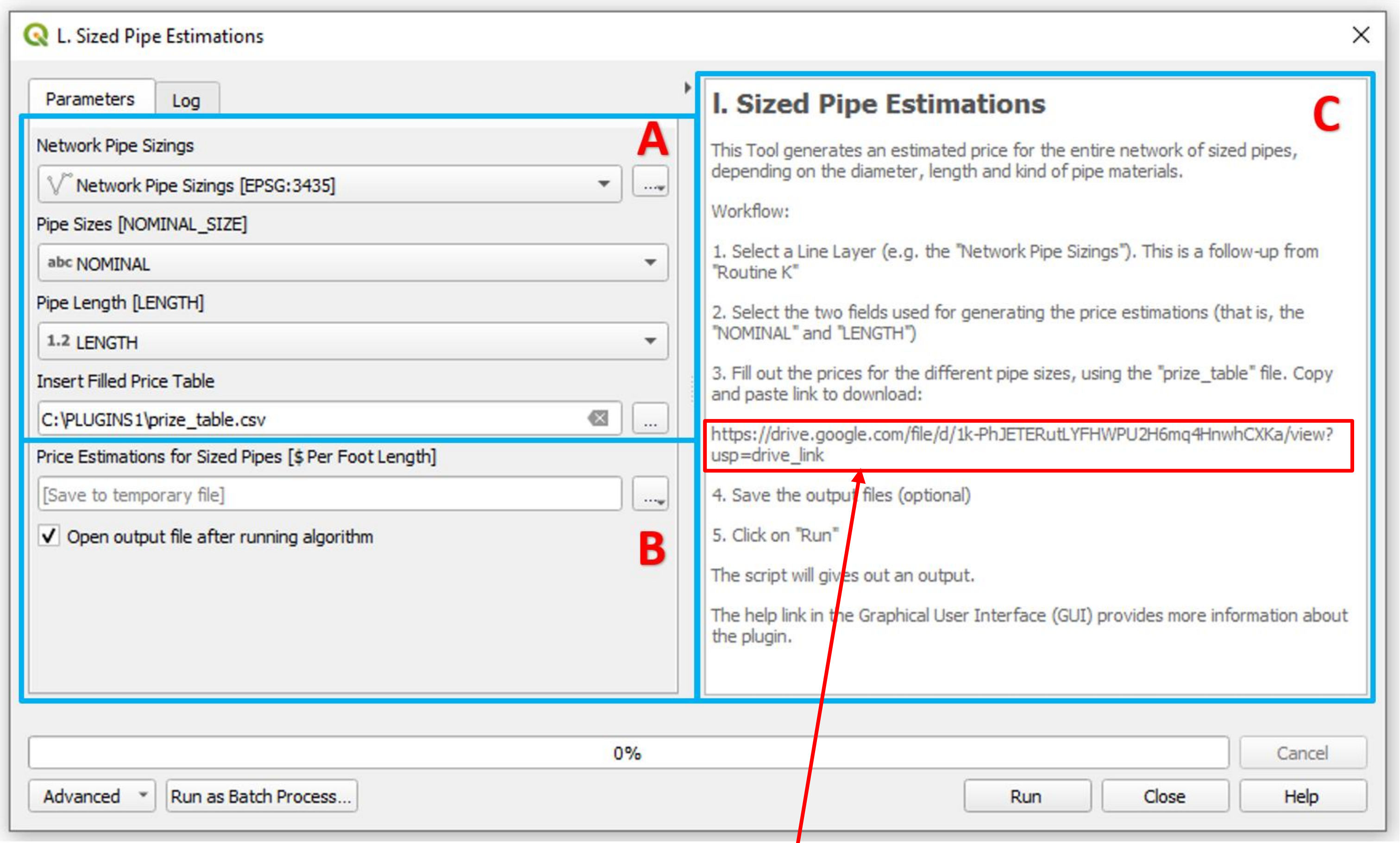


Cost Analysis for all Sized Pipes in the Drainage Network:

This is Routine L.

a. Select the new **PipeSizes** Layer
b. Select the fields “Nominal_Sizes” and “Length”
c. Download and fill the prices for all sized pipes in the network
d. Reload the filled “Prize_Table” file
e. Save File to “Output Folder” as *PriceEstimations*

This operation is used to estimate possible prices for all sized pipes in the network based on their total length. This estimation is done for all 4(four) types of pipe materials featured in Routine K.

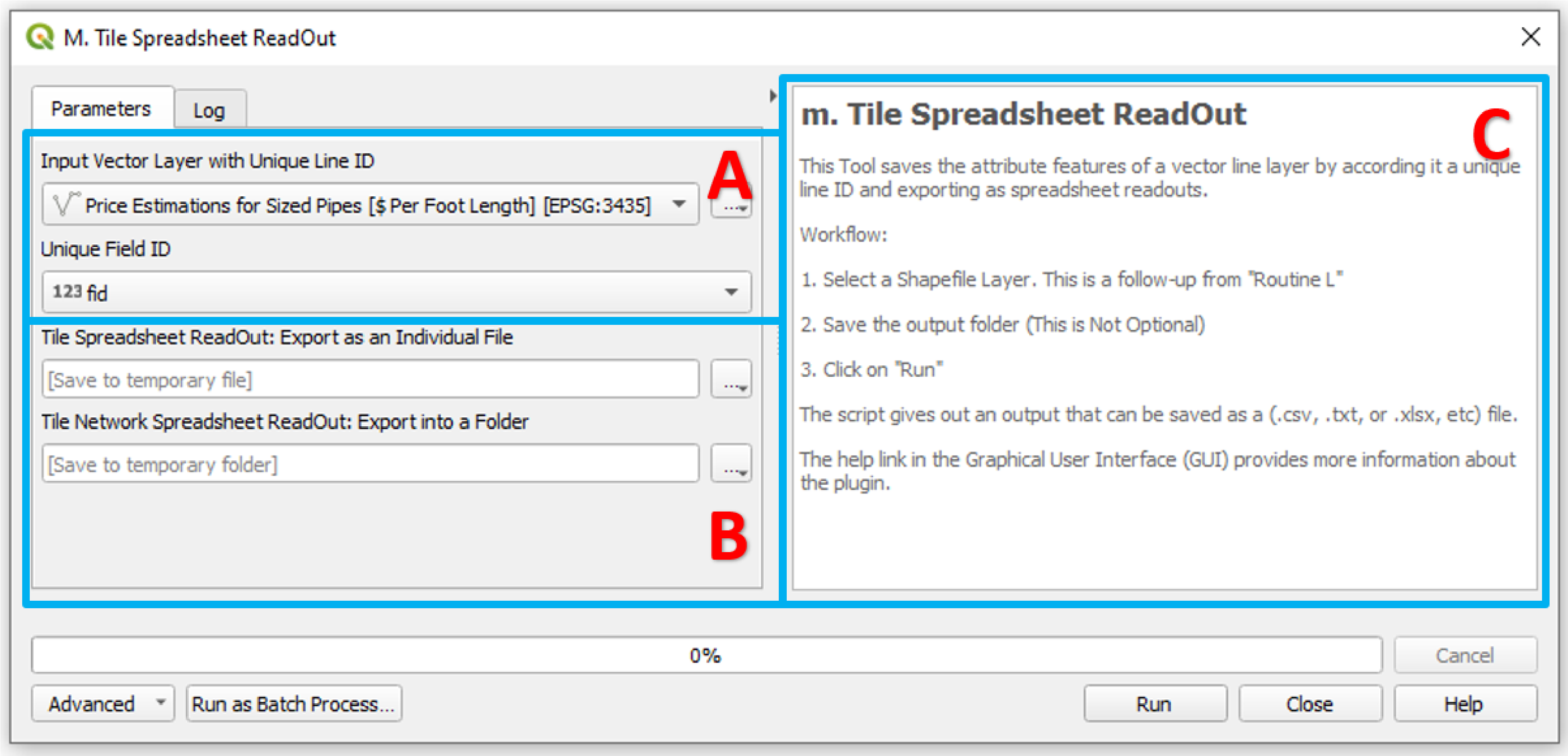


Click “Prize_Table” to download or copy and paste link on browser.

Export Output to Transferrable Formats (e.g., csv, xlsx, txt):

This is Routine M.

a. Select the **PriceEstimations** or **PipeSizes** Layer
b. Select the Unique field ID: "F_ID"
c. Save File to "Output Folder" as *PriceLists*
d. Select "Output Folder" to save files



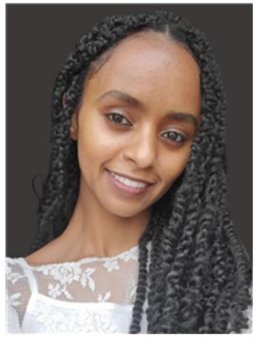
This operation is used for exporting a vector layer according to its unique ID into spreadsheet files. This routine is sequel to the routine L.

Thank You!!!

Illini Drainage Tools

Scan the Code for more Details






Special Thanks to Professor Richard Cooke's Team

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