Geomorphic layers used in very flat terrain

VERSION	DATE	CHANGE
2.0	3/12/21	Second draft

For lidar layer in SE TX

In flat terrain with little natural drainage network, the geomorphic index was changed to capture more subtle features in the terrain. We tested the layers used in Alaska and changed a number of the inputs to the index.

- Plan Curvature – not helpful
- Dinf – not helpful – too poor at the confluences
- TWI – not helpful – very much like the D8 and Dinfinity

LAYERS TO USE

1. Openness - with a medium filter
2. Curvature (not plan curvature) - with a feature preserving filter
3. Geomorphons – with a feature preserving filter
4. BotHat channels - also helpful for low relief channels

1. Positive Openness < 2 std from mean (84.6 for pilot area)

Positive openness uses a line-of-sight approach to measure the surrounding eight zenith angles viewed above the landscape surface to a specified distance. The central cells get an average of the eight angles. An angle of 90 degrees would indicate a flat surface, while angles less than 90 degrees indicate a concave surface.

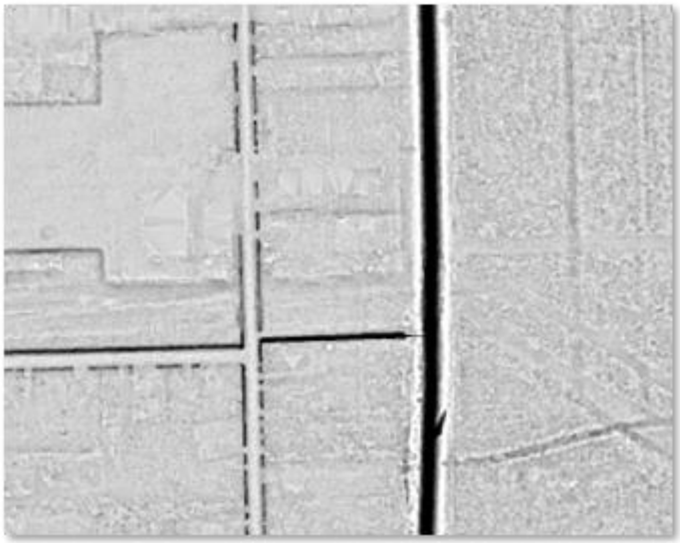
RVT is used to create the Openness layer. [Relief Visualization Toolbox (RVT) | Institute of Anthropological and Spatial Studies (zrc-sazu.si)]

Output from tool:

Openness - Positive --
Note: Parameters are taken from the Sky-View Factor method:
Number of search directions: 16
Search radius [pixels]: 10.0000
Level of noise removal: medium
>> Output file 1 (without results manipulation):
C:\Users\seterzio\Documents\D_Drive\5_SE_TX\PilotData\PreScreens\HE_dem_OPEN-POS_R10_D16_NRmedium.tif
>> Output file 2 (linear histogram stretch between 60° and 95° for 8-bit output):

C:\Users\seterzio\Documents\D_Drive\5_SE_TX\PilotData\PreScreens\HE_dem_OPEN-POS_R10_D16_NRmedium_8bit.tif

Extract the values 2 standard deviations below the mean to identify the open canals and waterways. Source and extracted values in pink:



2. White Box Arc Toolbox or stand alone GIS system has filters, multidirectional hillshades and many lidar and geomorphometric analysis tools. It also has some very good breaching algorithms.

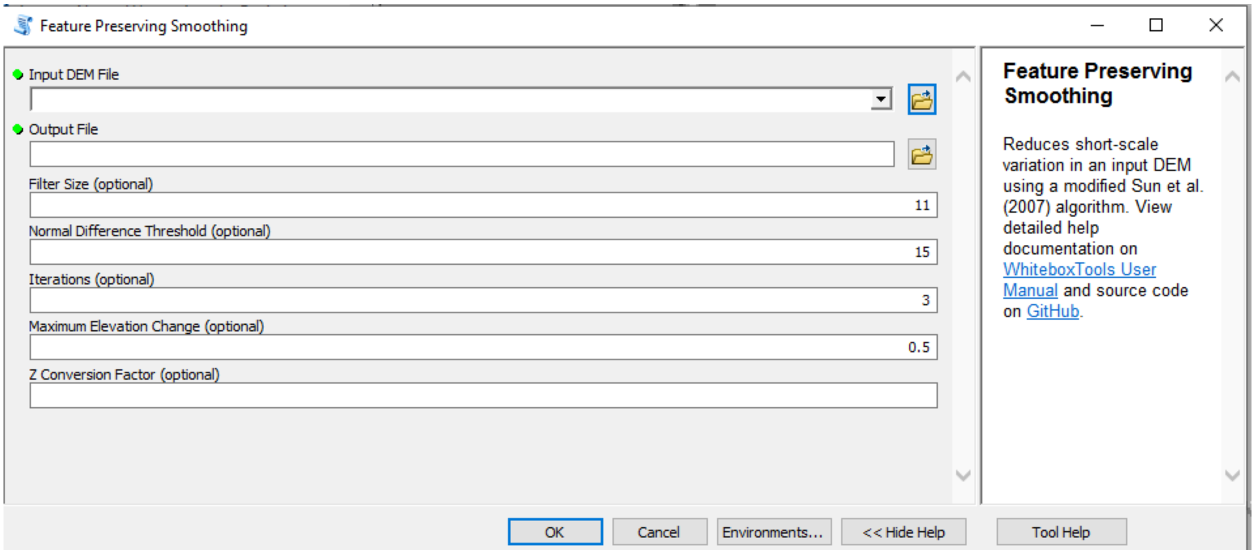
Links to both versions:

[WhiteboxTools | Home (jblindsay.github.io)]

[Preface - WhiteboxTools User Manual (jblindsay.github.io)]

ArcGIS Toolbox for WhiteboxTools : gis (reddit.com)

Use the Feature Preserving Smoothing from White Box to create a smoothed dataset to use for Geomorphons and Curvature

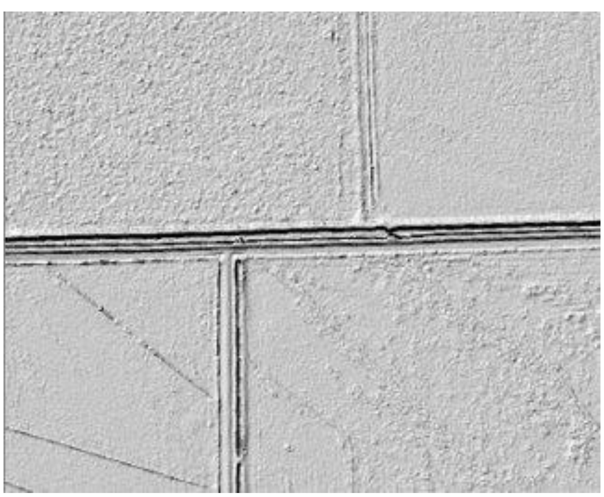


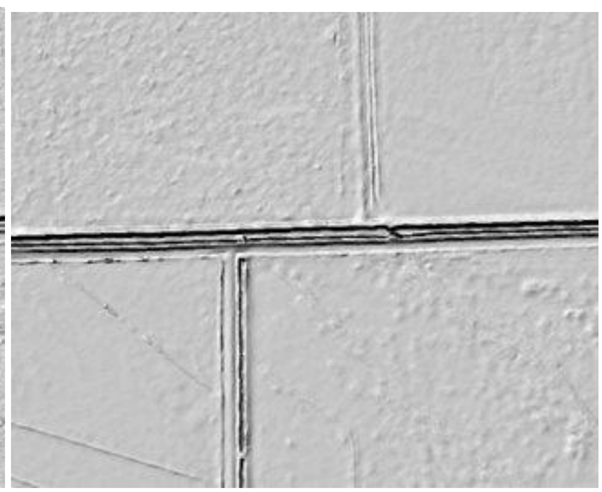
Filter size 11

Normal Difference Threshold 15

Iterations 3

And Maximum Elevation Change .5



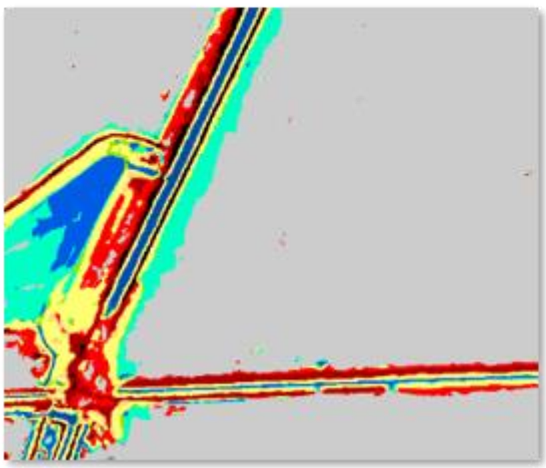


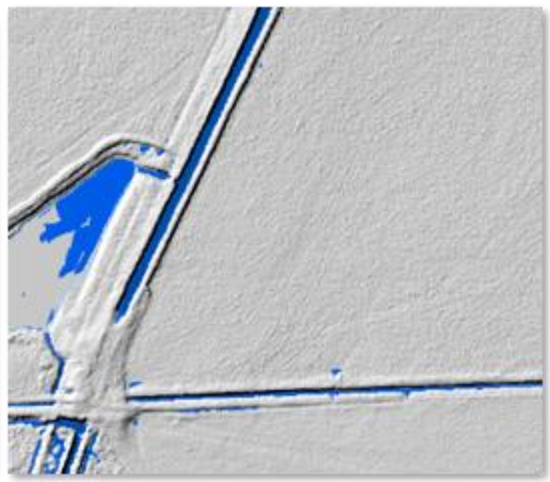
3. Use SAGA and run the Geomorphons on the FPS filtered surface using:

```
[2021-03-01/13:32:29] Executing tool: Geomorphons
Parameters
    Grid System: 1; 22380x 28645y; 377947.500122x 3306887.500122y
    Elevation: FPS_DEM11_15_3_pt5
    Geomorphons:
    Threshold Angle: 1.000000
    Radial Limit: 250.000000
    Method: line tracing
```

Angle 1, Radial limit 250 and Line tracing

Output Geomorphon layer as a tiff

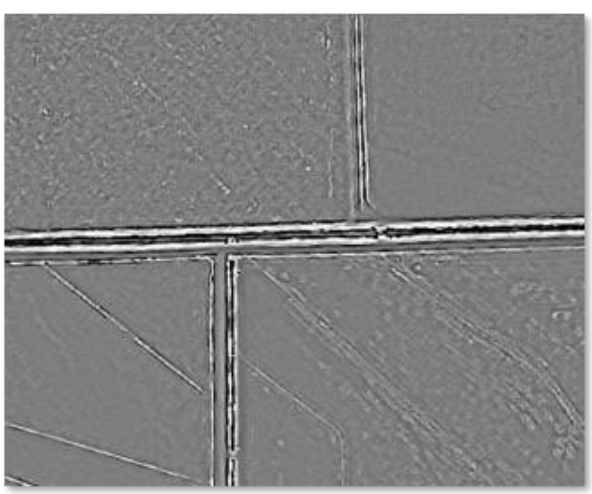


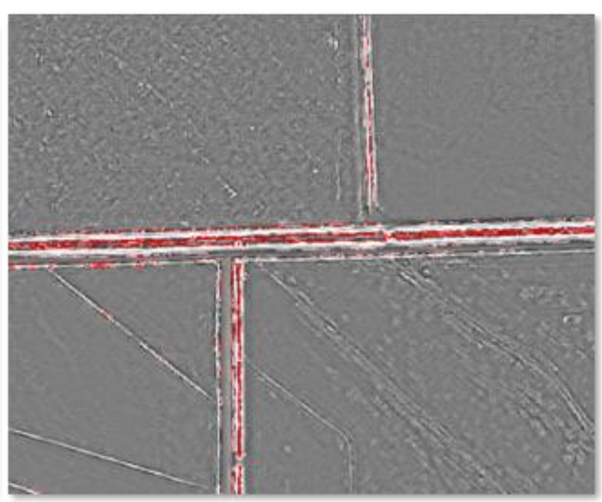


4. Run Curvature on the FPS filtered surface:

Curvature – FPS filter, this produces a smoother surface, so 1 standard dev is better.

Eg Mean is –3.8, Standard deviation 5.48. So break would be -9.28

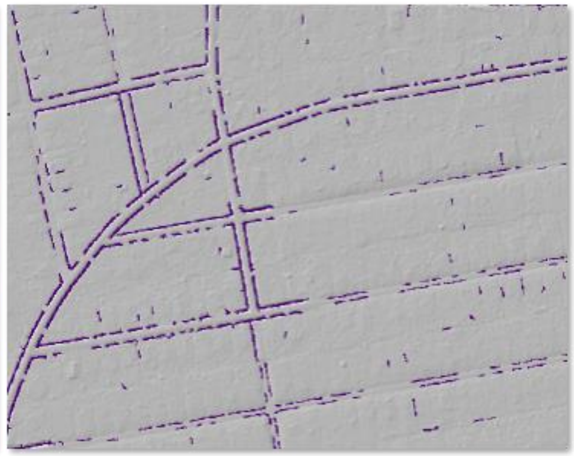




5. BotHat is a method that is used in New England (Neil Olson developed) that finds relative low points in the surface. This will help find hard to detect channels with little channelization.

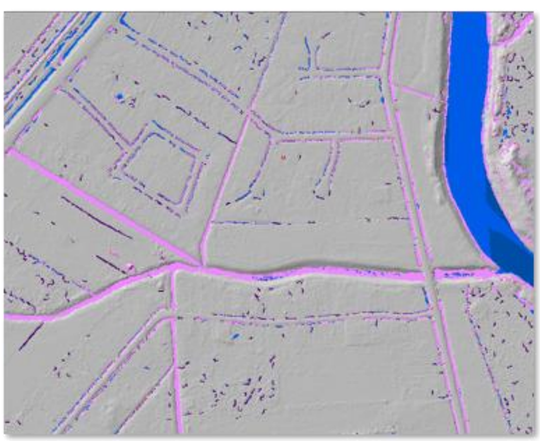
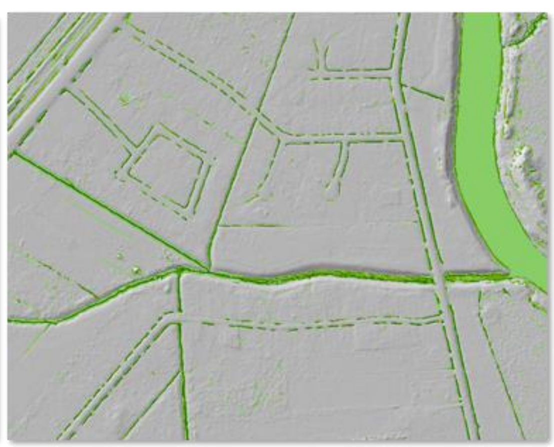
The BotHat method, used in New Hampshire to map streams, uses a small neighborhood of cells (3x3) to find the max – min value and compares it to a larger neighborhood (11x11) where the threshold max – min value.

Where the smaller neighborhood is also within the larger neighborhood, it indicates a more major elevation difference and probable channel.

6. GMI:

Combine the subsets of the Openness, Curvature, Geomorphons, and BotHat to create the GMI:

[The Black Top Hat function applied to a DEM: A tool to estimate recent incision in a mountainous watershed (Estibère Watershed, Central Pyrenees) - Rodriguez - 2002 - Geophysical Research Letters - Wiley Online Library]

Use the GMI layer to find the portions of lines that fall outside channels

Final datasets:

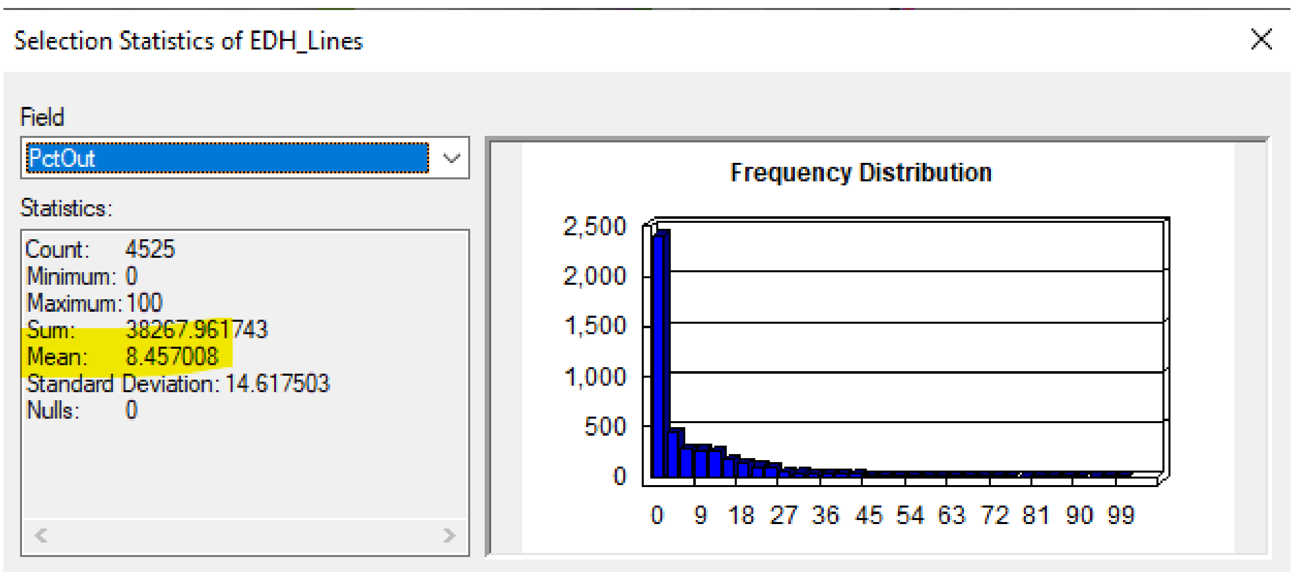
CombGMI.tif

SegmentsOutGMI

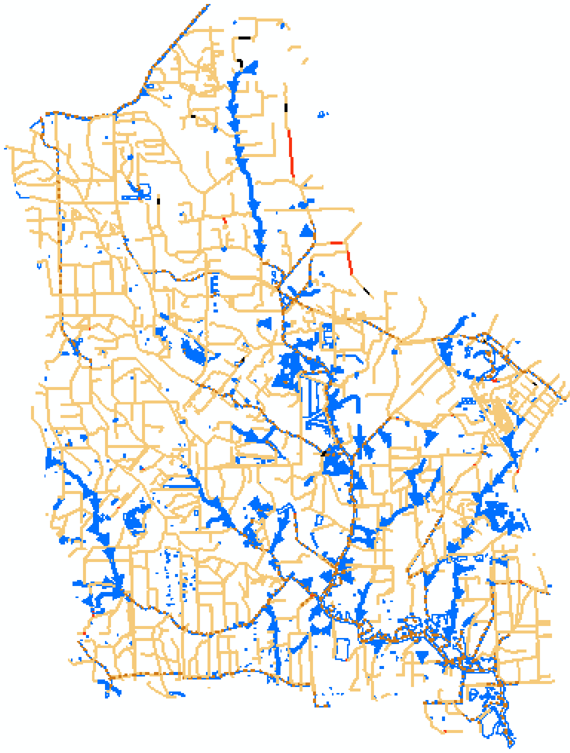
And selection of just Segments that aren't AP's, culverts and are greater than 10 meters long:

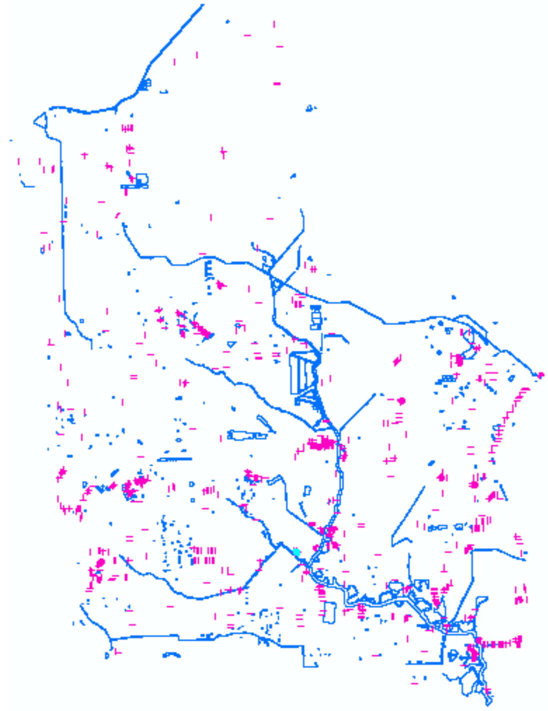
The mean PctOut is 8.5% - so below the 25%, mean segment length out (this does not include artificial paths, connectors, or pipelines)

Results for SE Texas pilot (including BotHat results):

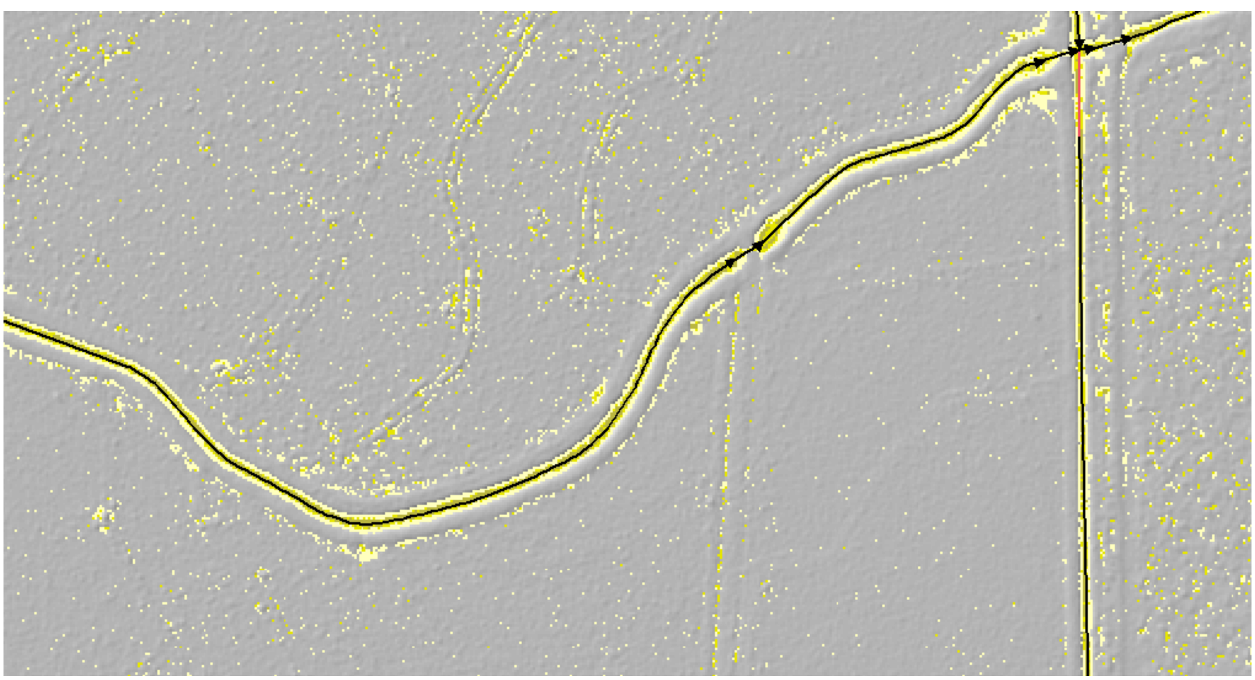


Stream and canal network and Errors where lines fall outside of GMI:

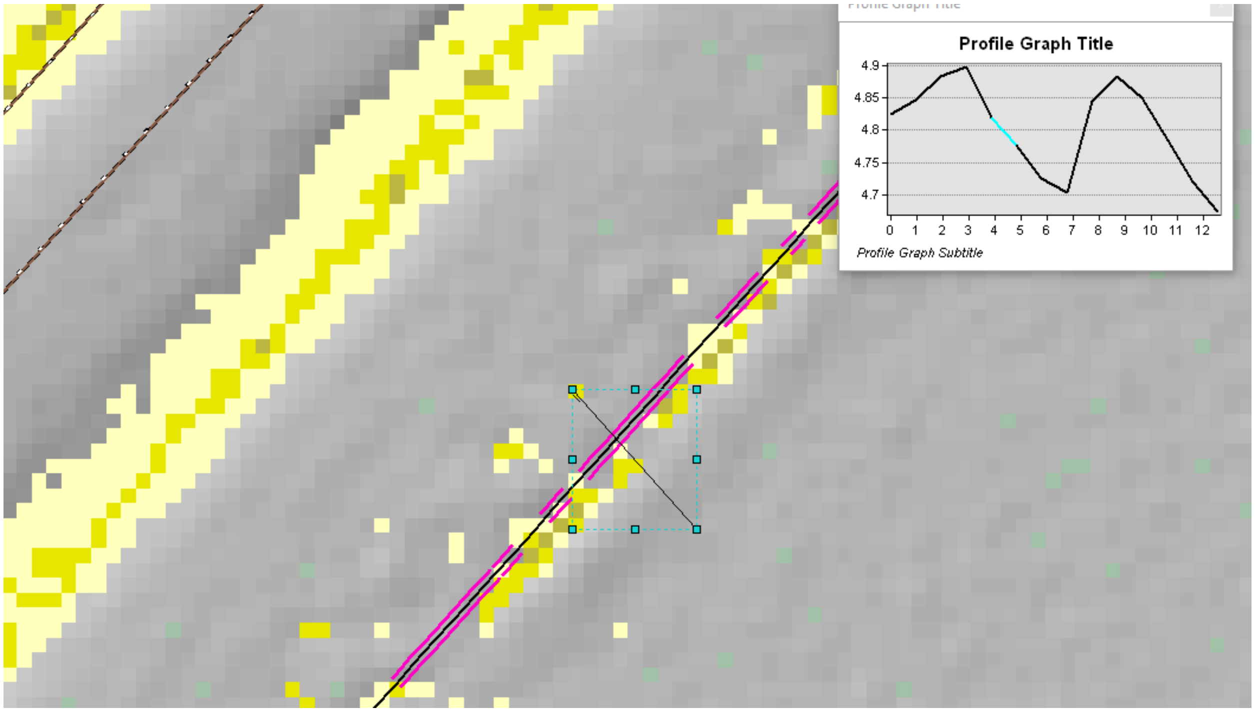




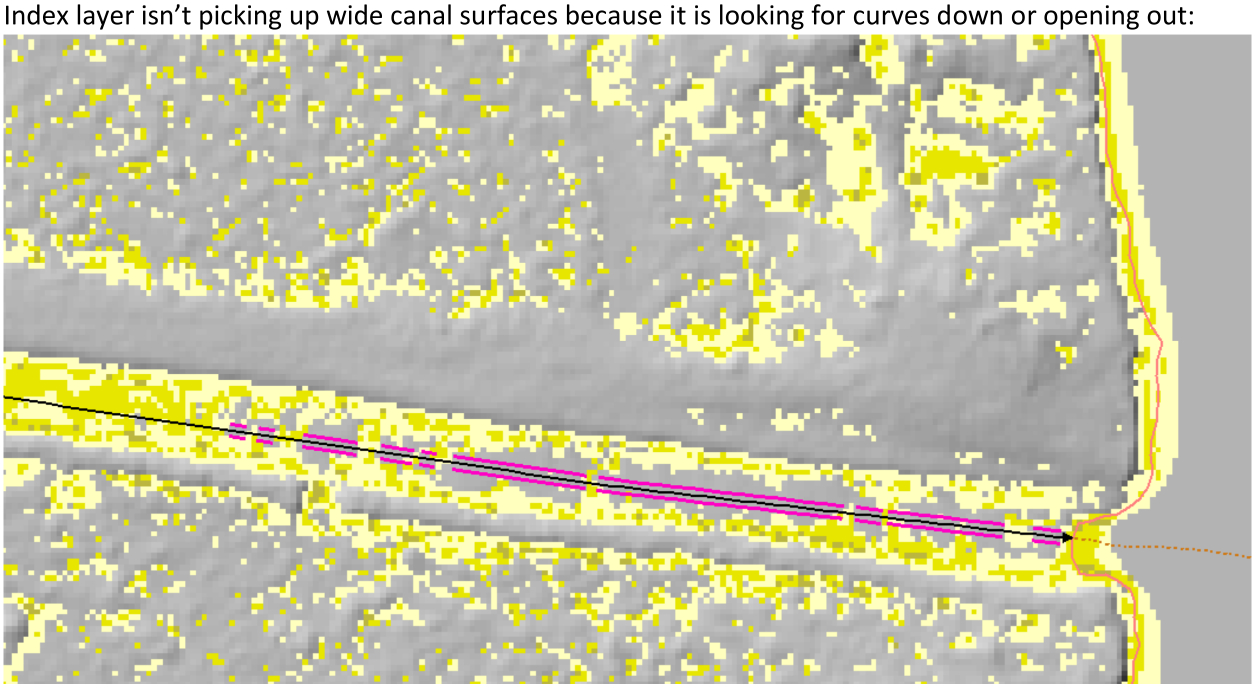
Generally looks good for canal and ditches



Sometimes slightly offset – still in channel. This should be acceptable according to the new guidelines.

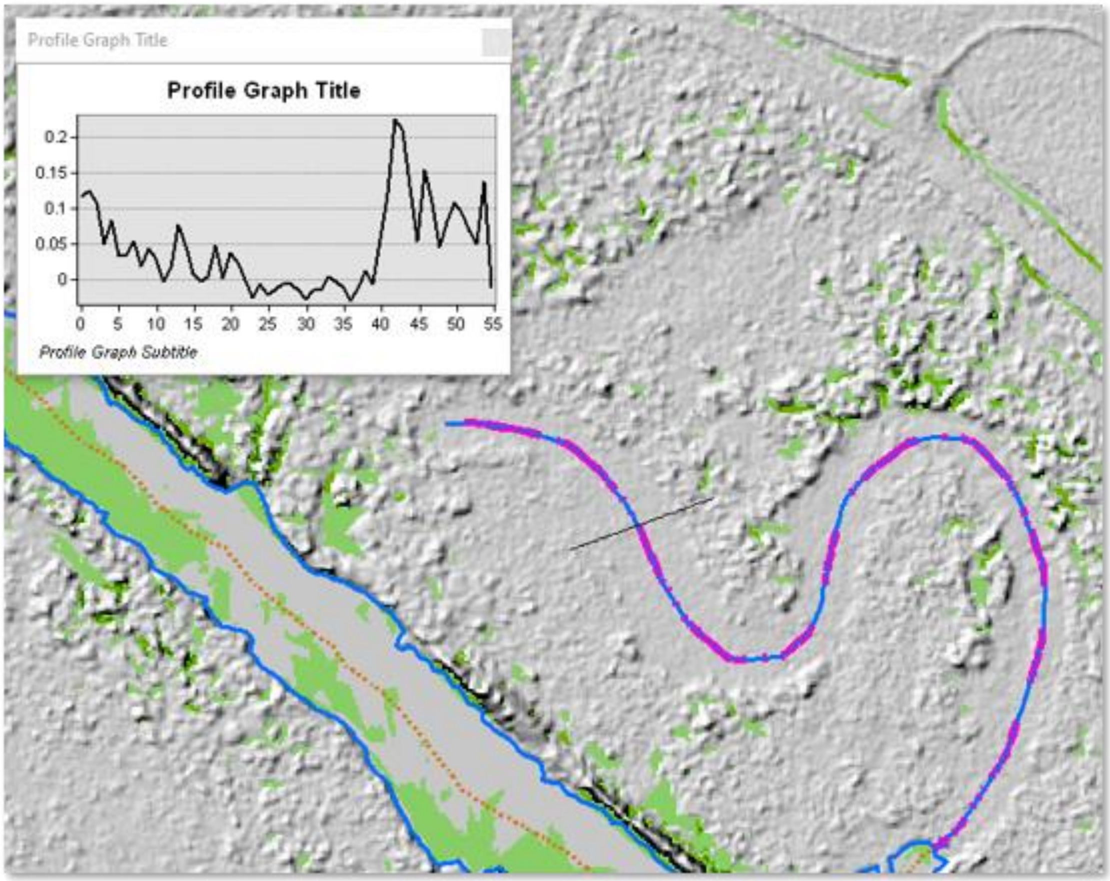


Index layer isn't picking up wide canal surfaces because it is looking for curves down or opening out:



Still difficult to identify very shallow channels. This example only has a .2 meters z-difference along 55 meters in length. The tools are not able to pick up channels in areas with less than about .25 to .5

meters of relief.

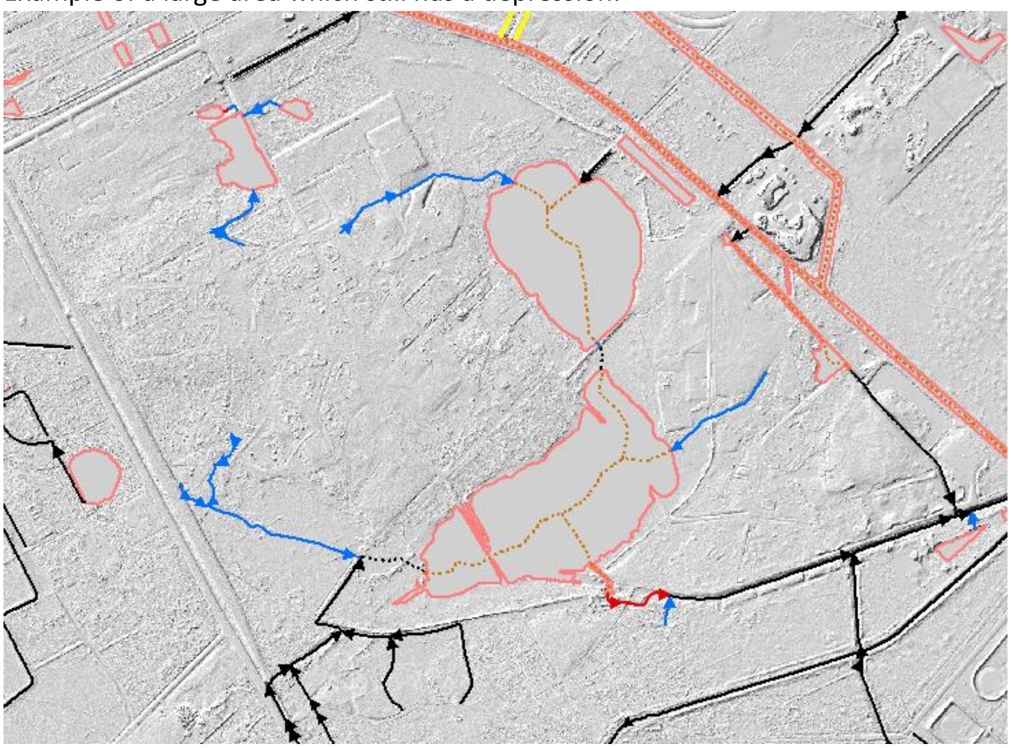


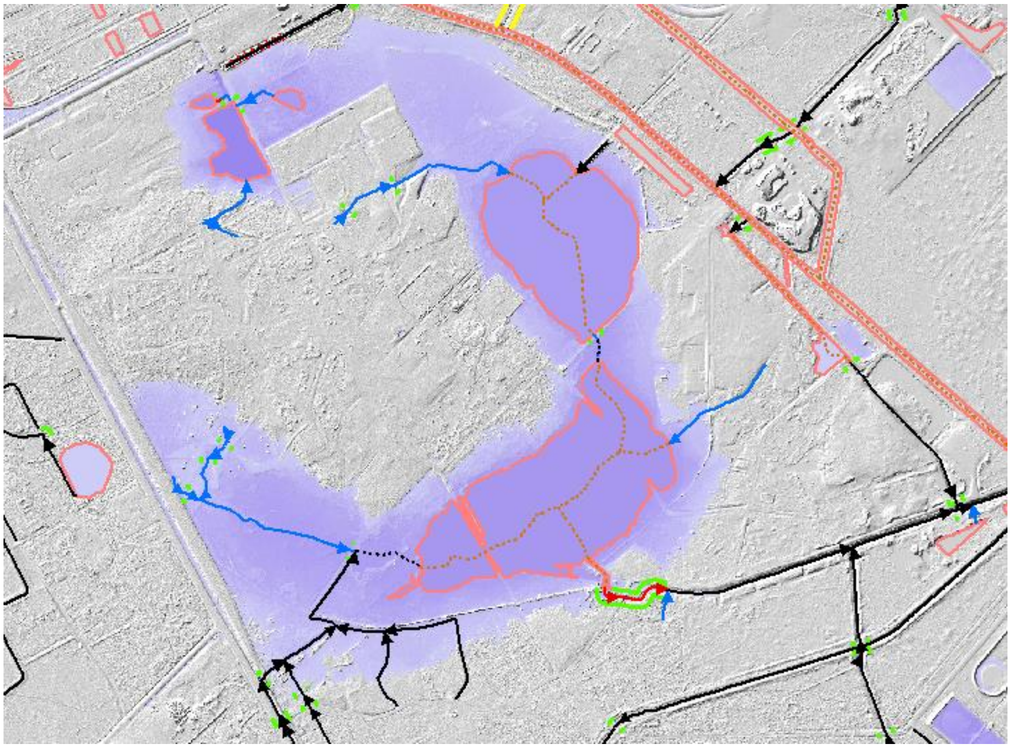
INSINK - New metric to test for missing culverts and missing polygons.

If a large area is not cleared by adding culverts, it is still a depression in the surface and gets filled. This may indicate that it was not properly treated with culverts.

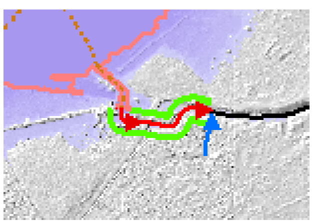
1. Apply all the culverts and connectors to hydroenforce the surface
2. Fill the new surface
3. Subtract the filled from the hydroenforced surface to get fill/sink areas not breached by culverts
4. Find EDH lines that are not artificial paths within large (greater than 1 acre) fill areas
5. New code InSink is added to EDHlines – if = 1, the line is within a sink area

Example of a large area which still has a depression:





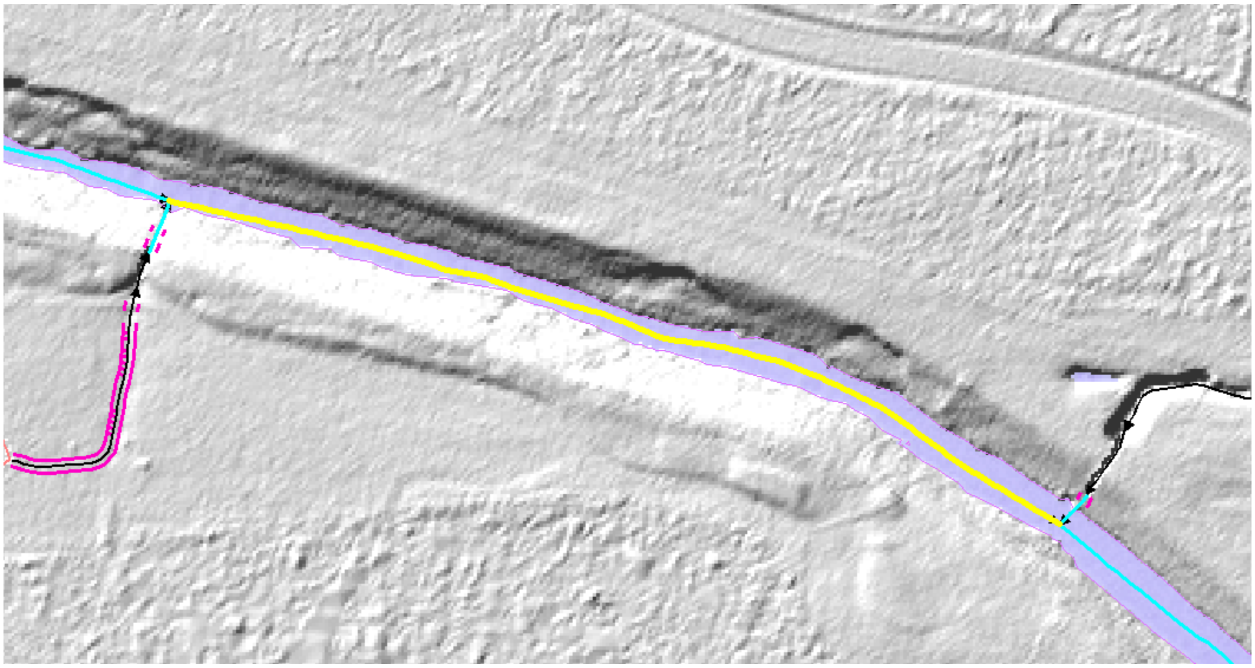
Should drain here:



The connector was added to the surface but the z-value of the end points (used to hydro-enforce the surface) was higher than the lake, so it didn't breach the roads.

These areas are necessary to check.

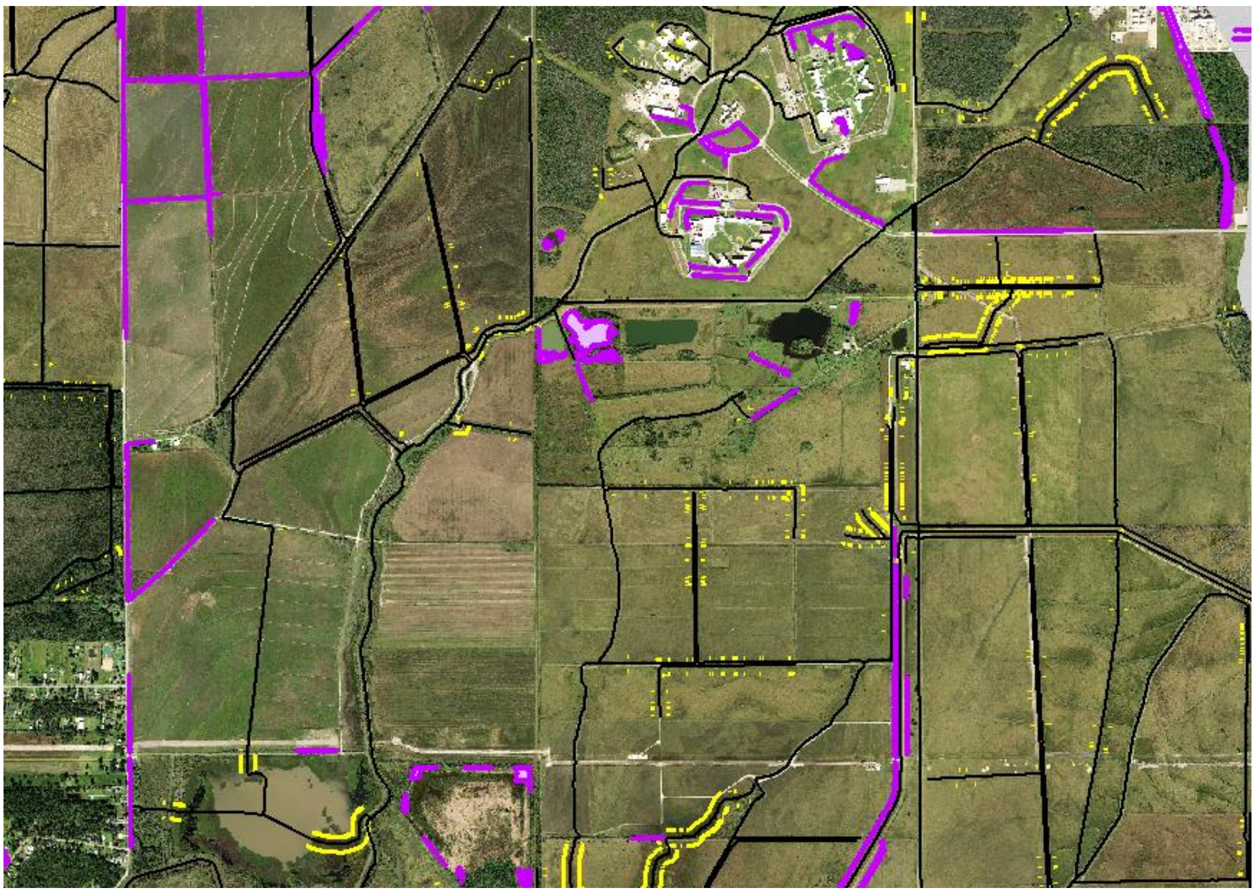
A fair number of 'InSink' lines are in narrow canal features. They could be double line streams, but most are below the width requirement. This canal is about 10 meters wide.



Finding features that should have been included in the canal/ditch network

The Geomorphic Index (GMI) can also be use to identify canal or stream features that are missing (omission errors). If a well defined channel is identified using the GMI, the area should be reviewed and if it is necessary to complete the hydrologic network, should be added as an EDH feature.

Purple lines are canal/ditch features that are potentially missed canals. Black is EDH network delivered.



Some waterbodies are also included. The GMI will not be a continuous feature in many areas, but it will identify the general area where an EDH line might be missing.

Overall – very good correspondence, but areas in red are where the canal network could potentially be densified: