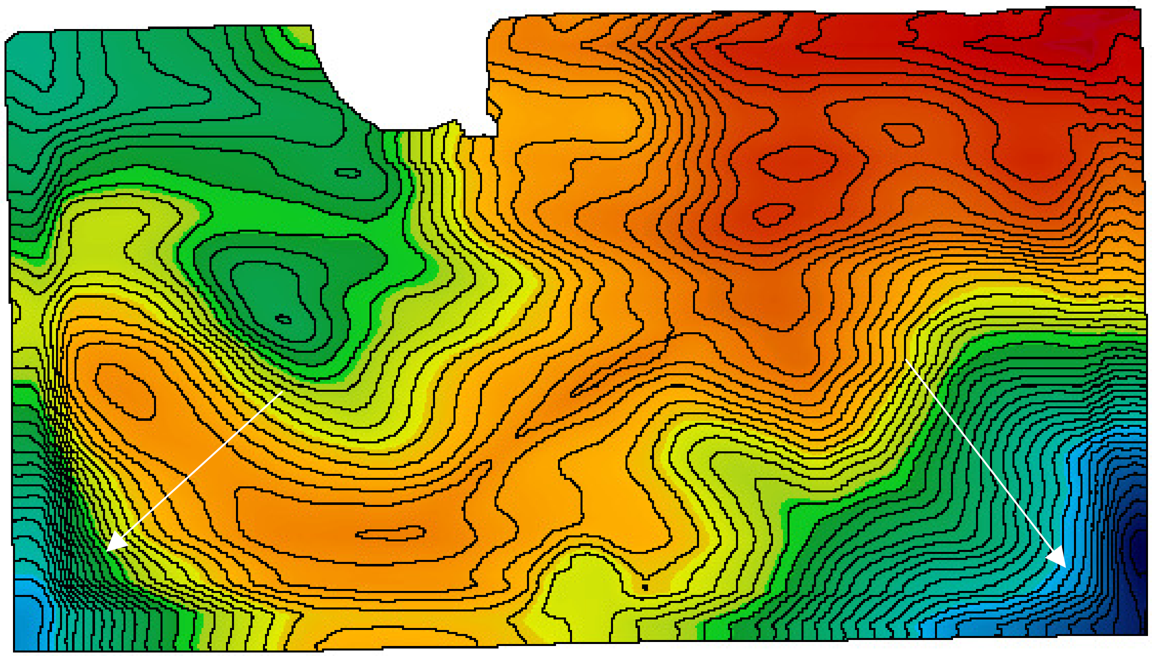
Water Management Processing Issues

A visual discussion based on GSII elevation collections

Terrain Processes - Modeling the physical surface.

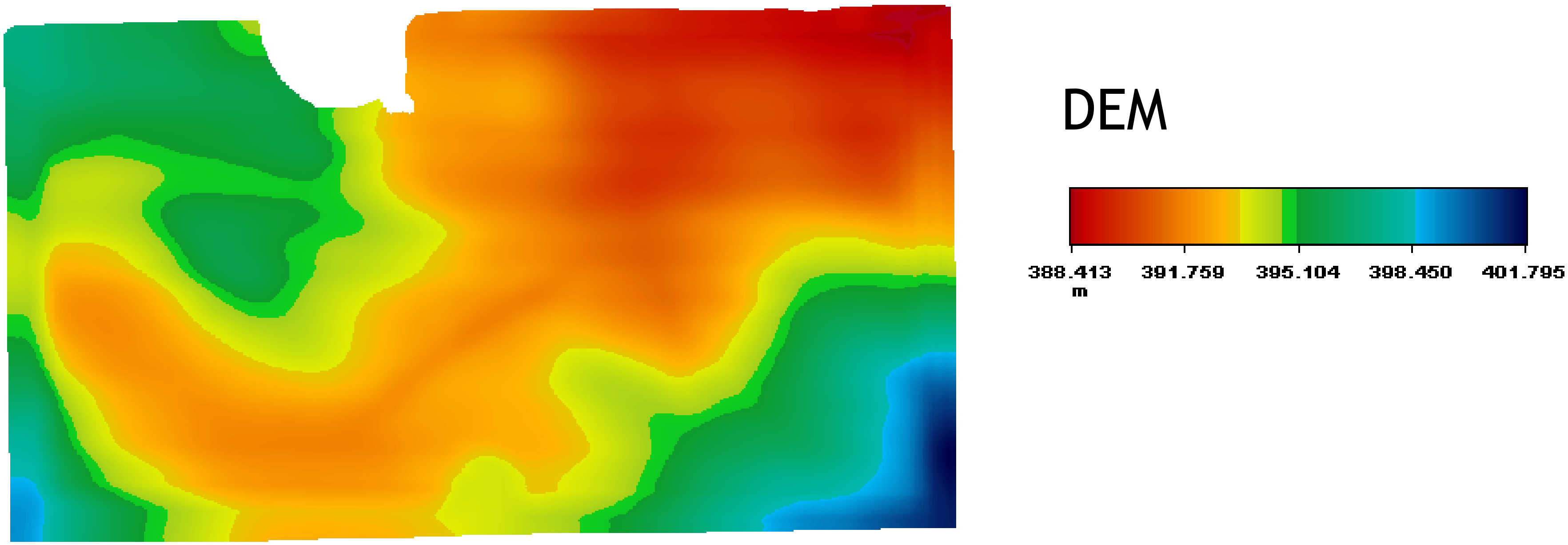


An elevation model ("DEM") created from GSII harvest operations. The field is 78 acres of pivot ground in Nebraska. Elevation range is 387.80m to 402.39m. This model is a weighted moving average with a decay constant of 2 (1/d2) and a radius of influence of 20m. Then, because there were "noise effects" in the data, a Mean Filter (radius of 66') was applied to reduce those effects by smoothing the model. Note the aliasing that persists (arrows). Noise is dampened but not eliminated.

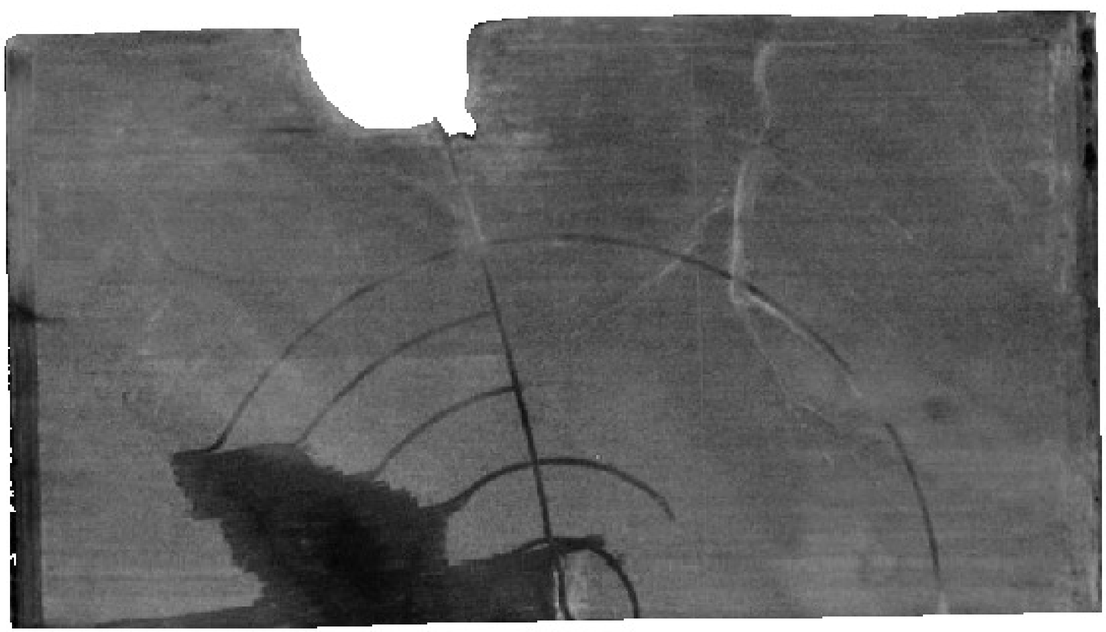
The Pearson correlation number as a measure of variation between the model outcome and the data points is .99414. A reasonably good fit and a reasonably good representation of the terrain is assumed to be better than "less bad". Contours (1' isolines) are presented for familiar reference.

Note that the estimation of a terrain surface is fatally dependent on the quality and density of the elevation data input (XYZ). Bad input = Bad Model = Bad Design.

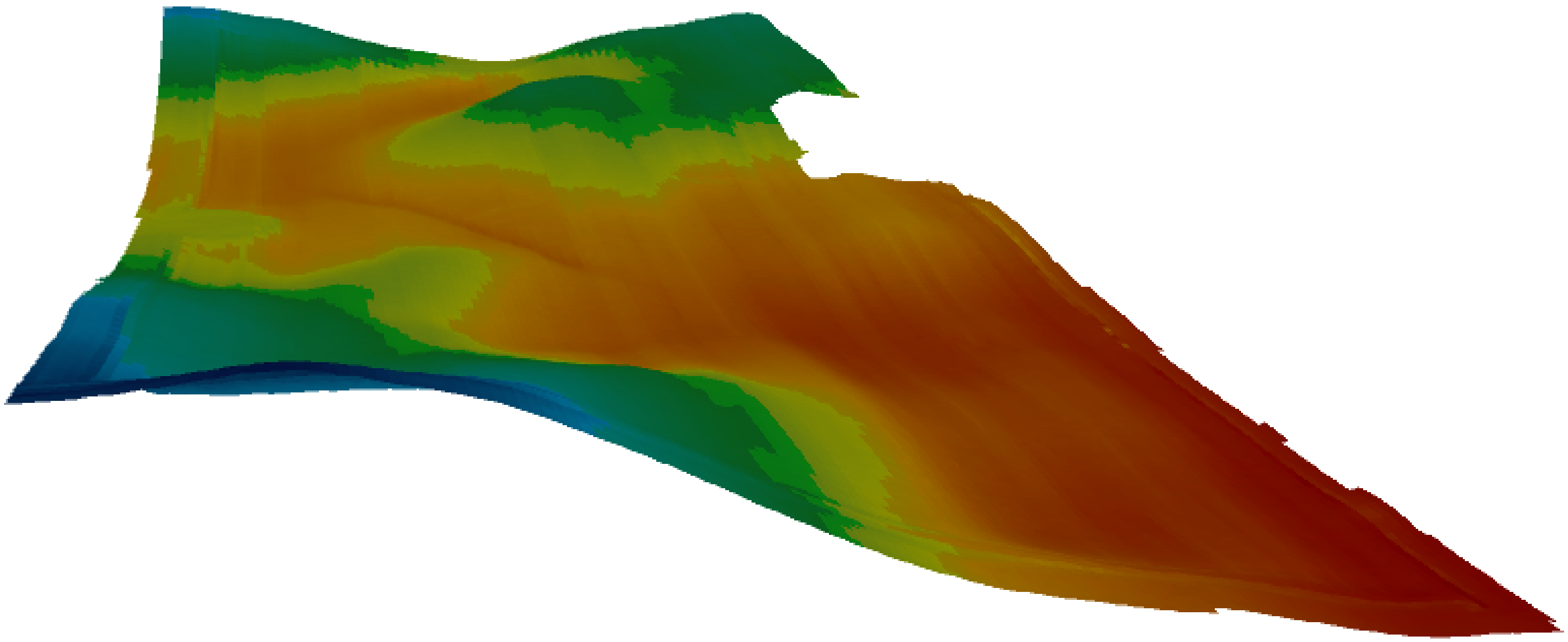
DEM



BW Aerial (TerraServer)



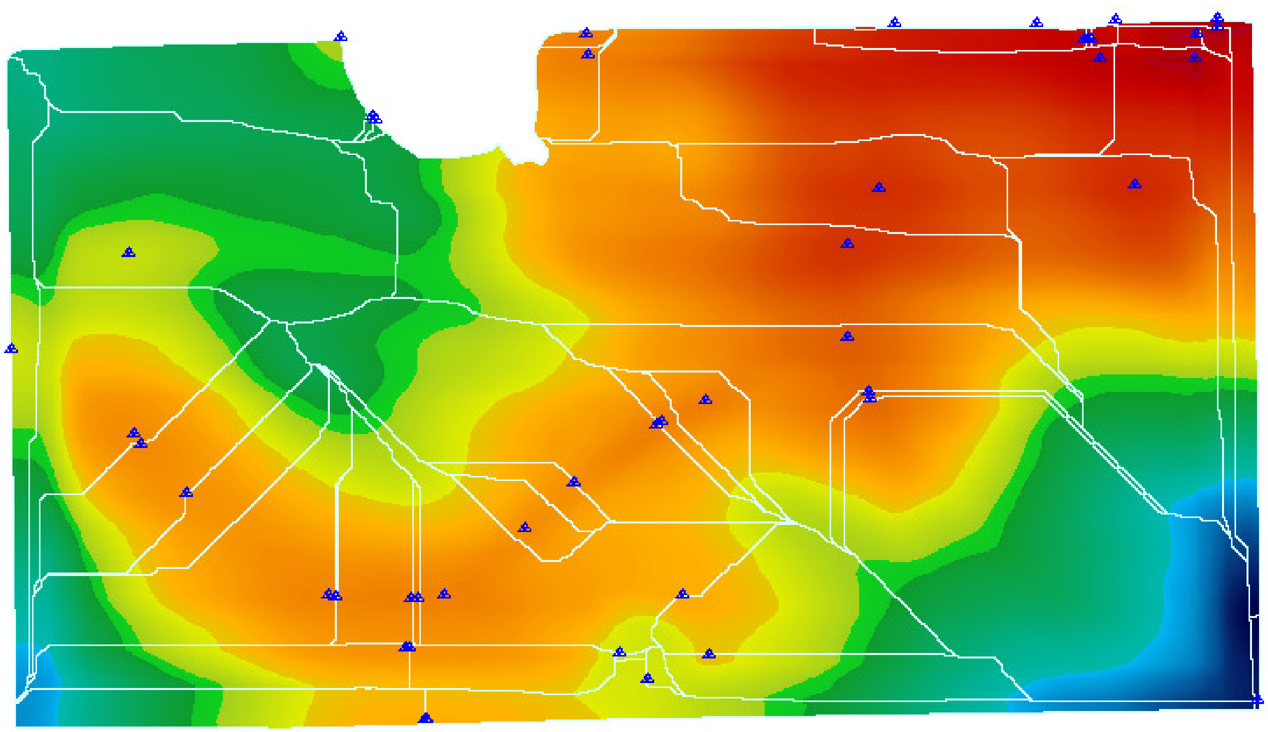
Vertically exaggerated 3D view of the field looking from east to west.

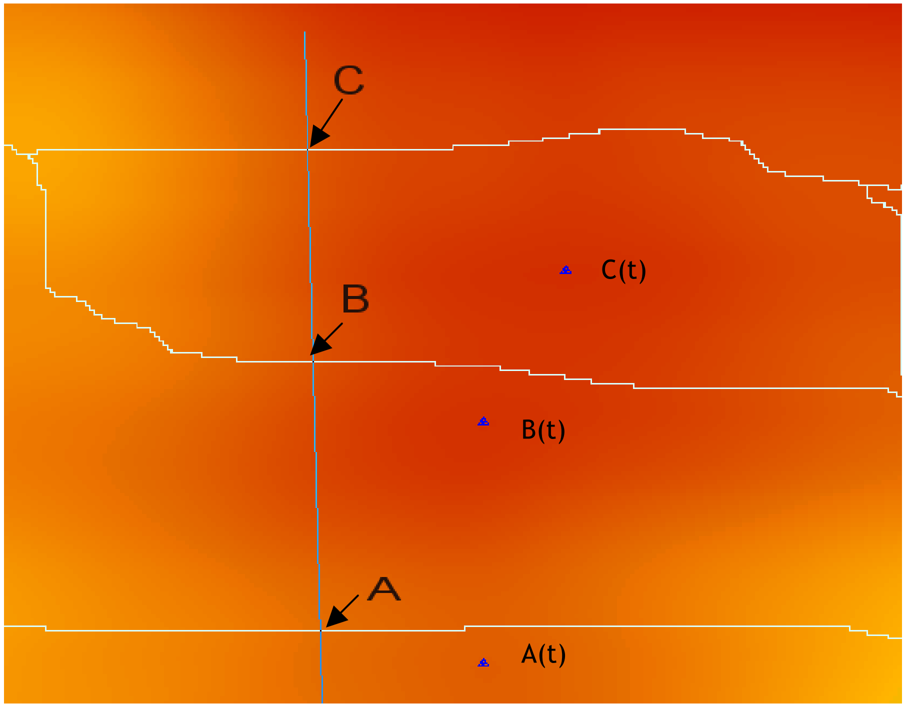


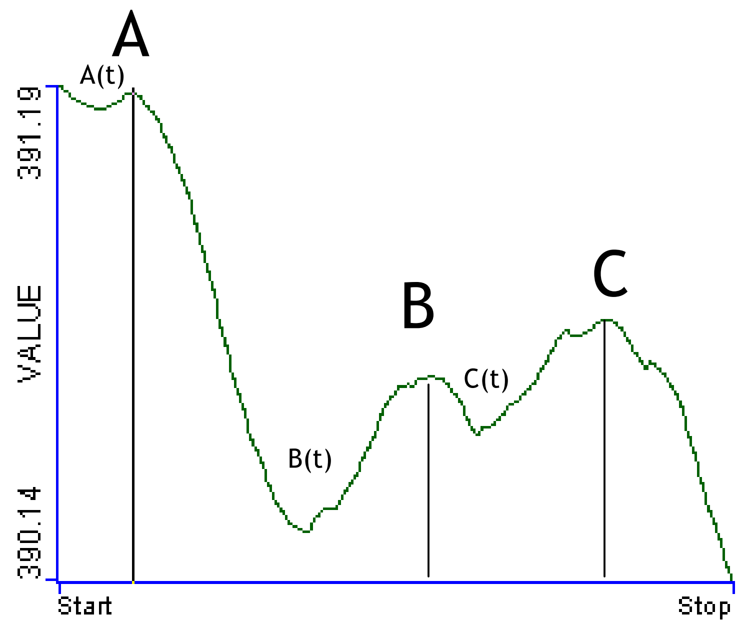
Terrain Processes - Watershed and ‘Collection Point’ Delineation

At the beginning of a rain event (T1 – the first drop) the terrain of this field divides into individual ‘micro-sheds’. At T1 a drop of water hitting an area will behave in a manner unique to that area. Each area has a ‘termination point’ – the point of termination for a drop of water falling anywhere in the micro-shed. This termination point is normally, but not necessarily always, the low point of the micro-shed. Note that a computer sees .003m as higher than .002m but we humans can’t perceive that difference. A low spot to a computer is noise to us. We don’t have a useful definition of noise.

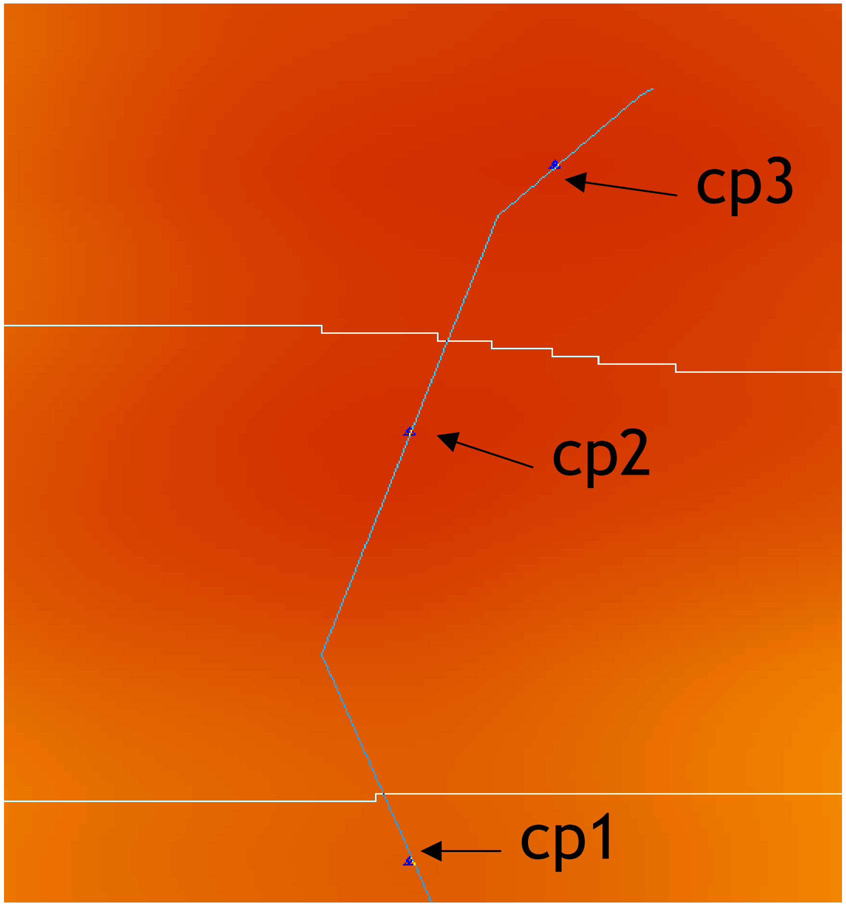
The micro-shed areas and their neutral points are unique to T1. This approach describes initial surface conditions and considers nothing about volume, pressure, intensity, infiltration, friction, saturation, etc., etc. This process has value as an educated guess about the location of collection potential in some rain event. Note that the “holding capacity” of the vicinity of a termination point could be exceeded almost immediately after T1. Termination points are not depressions (they can be ‘flats’ as opposed to ‘holes’). We think ‘depressions’ are difficult to define numerically.

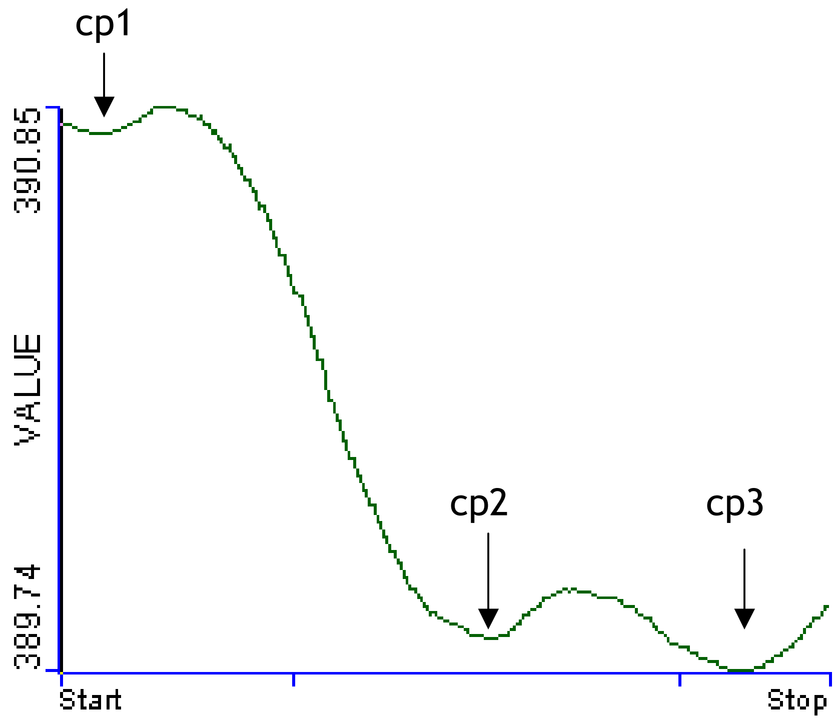






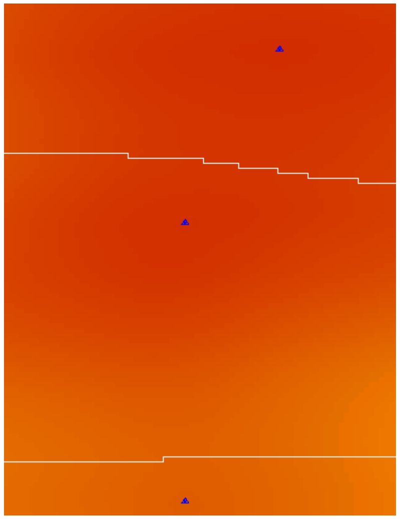
Micro-shed boundary points are those where the termination point (collection point) changes. Every elevation pixel in micro-shed A follows the maximum gradient and terminates at A(t). When an elevation pixel is reached whose path terminates at a location other than A(t), that pixel becomes a boundary point for micro-shed A and micro-shed (n). Every pixel in the DEM is related to some termination point.



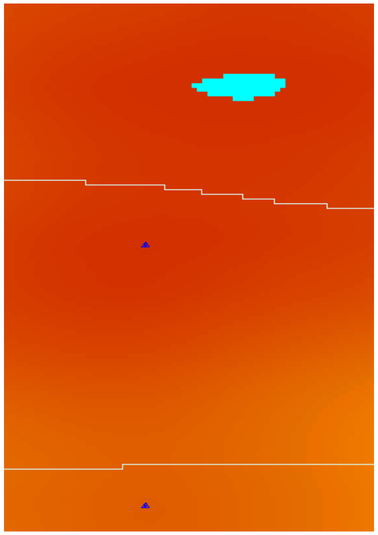


Collection points along the traverse line. In this case they are behaving as expected- defining a vicinity point (low) of collection.

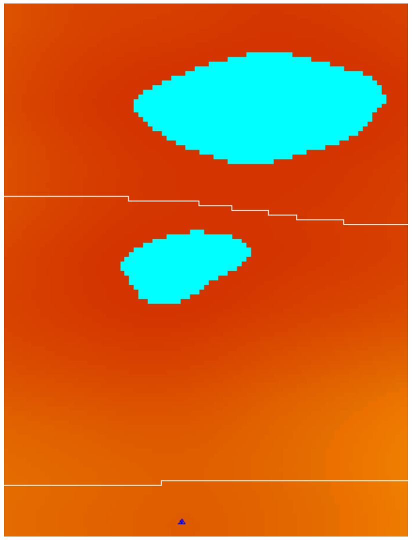
A goal is the discovery/definition of ‘depression areas’. We have shown how to define a point where water would have a tendency to collect- which could be the start of the mapping of ‘depression areas’ in a field. The ‘area’ part presents difficulties.



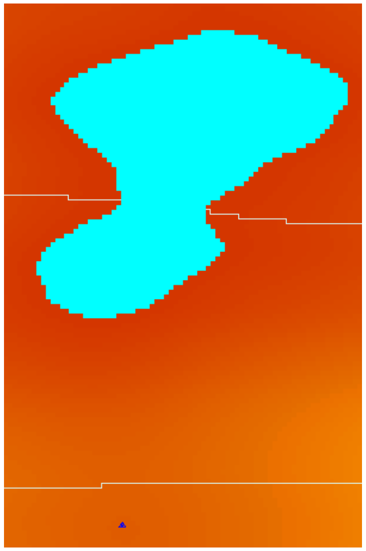
T1. Depression vicinities. Not filled.



T2 One filled depression area of .019 acres.



T3. Two filled depressions of .28 acres.

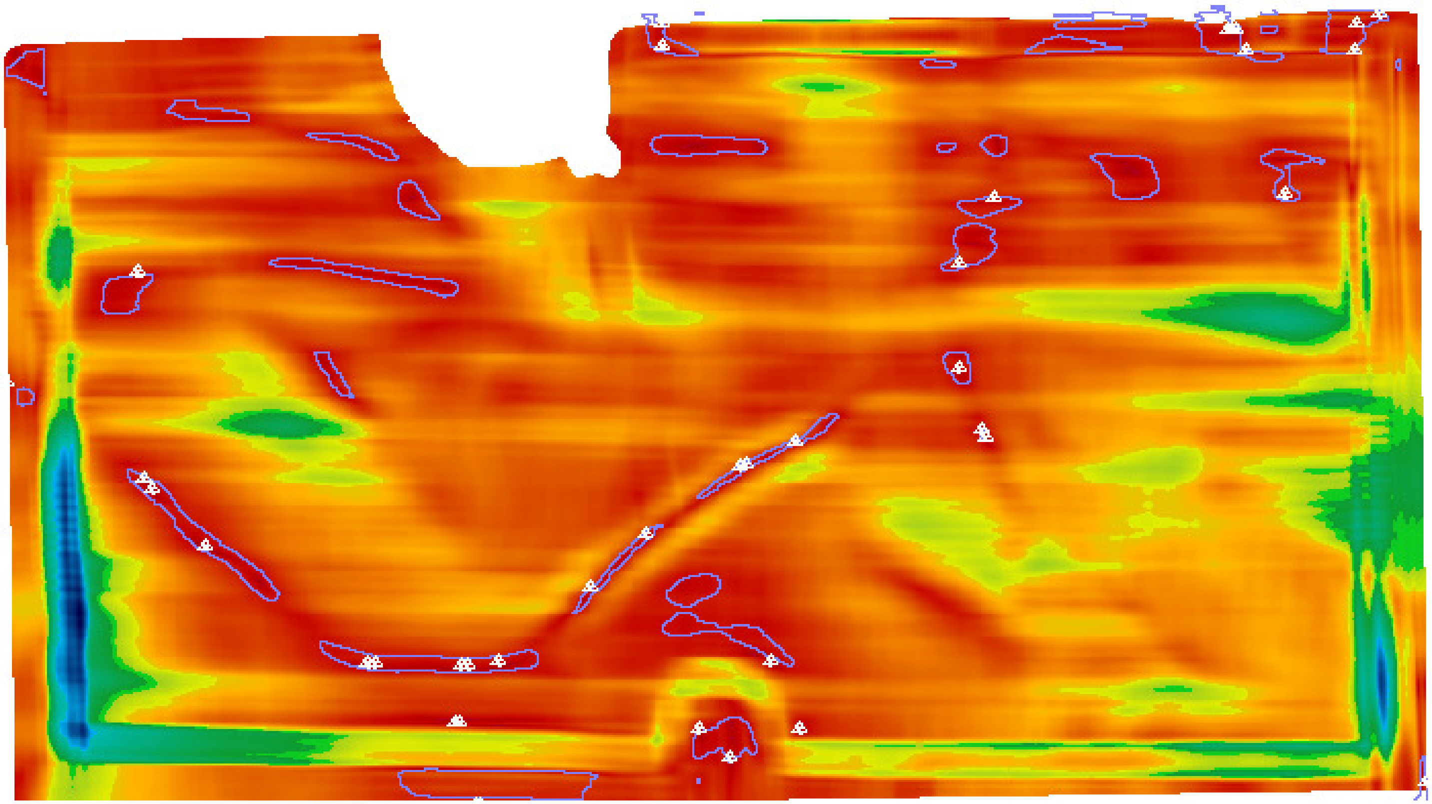


T4. One filled depression of .5 acres.

T(n) One filled depression of 3.6 acres. When is a depression a depression? At T2 or T(n)? What are the conditions? Rainfall amount, intensity, surface friction, soil saturation, etc.? Difficult problem. We suggest that linking the vicinity points could be a technique as effective as seeking to define ‘depression areas’.

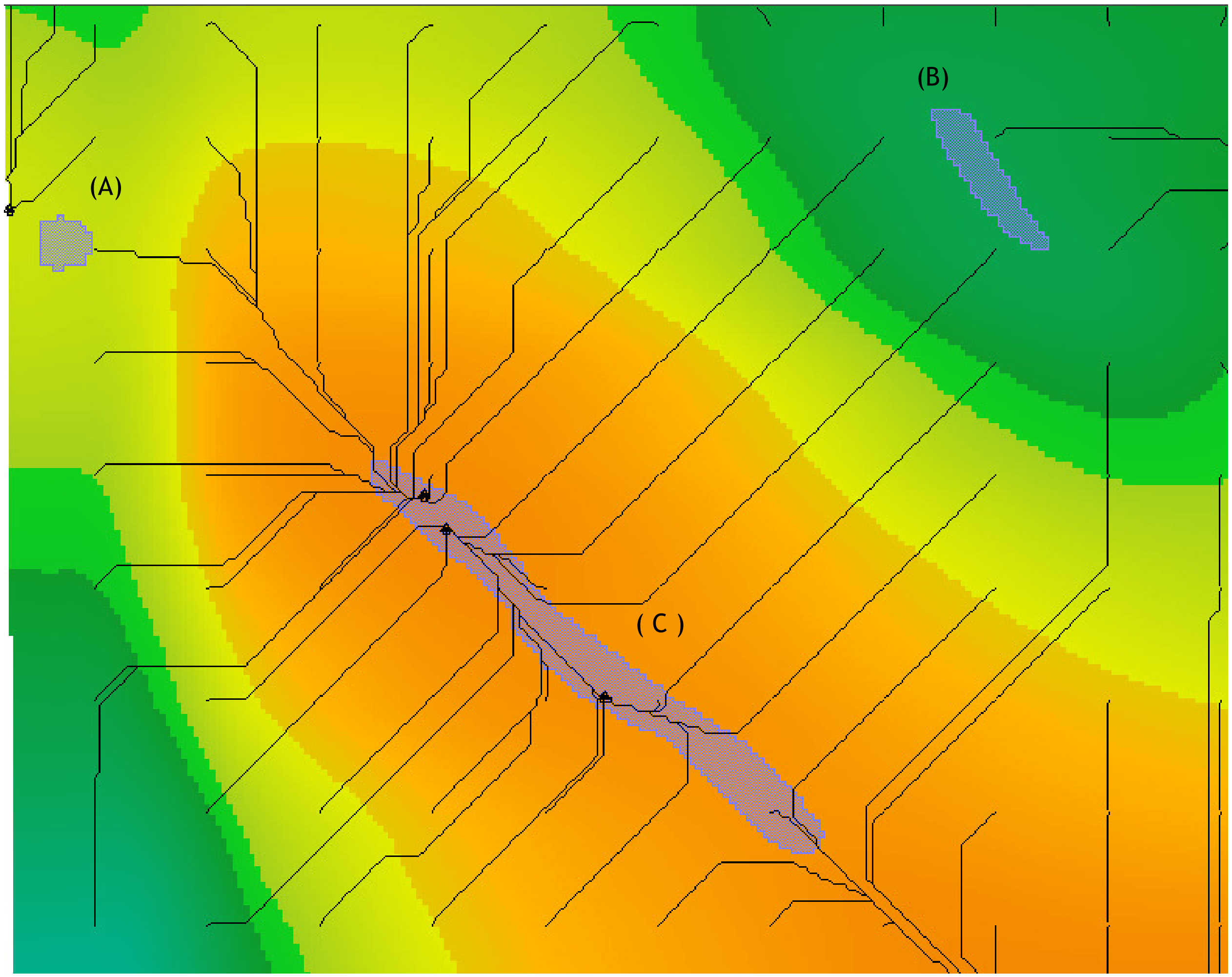
Could one use slope to refine estimates of “depression areas”?

If we accept a collection point as a point describing the vicinity of an area of potential water collection, can we get an idea of area involved?

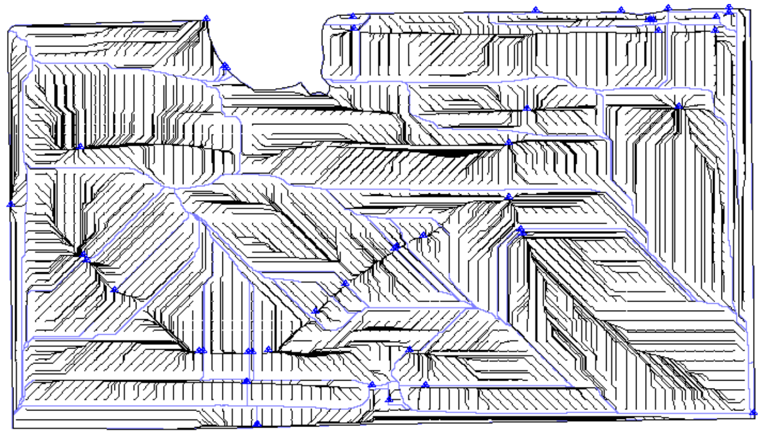


The polygon overlay defines areas with a slope of <= 0.33 deg. That’s an arbitrary number defining “flat”. The assumption is that water is likely to collect in the “flats”. The polygons containing a collection point (white symbols) are estimated to be area extents of depressions that would fill (at T1 + (n) in some rain event). The polygons not containing a collection point are flats where water would collect and rapidly shed toward a depression. But again, when is a depression a depression? In a 3 inch event? In a 6 inch event? What is the right slope number to define a “flat” where the potential for collection is effectively mapped ? Is that 0.33? 0.50?

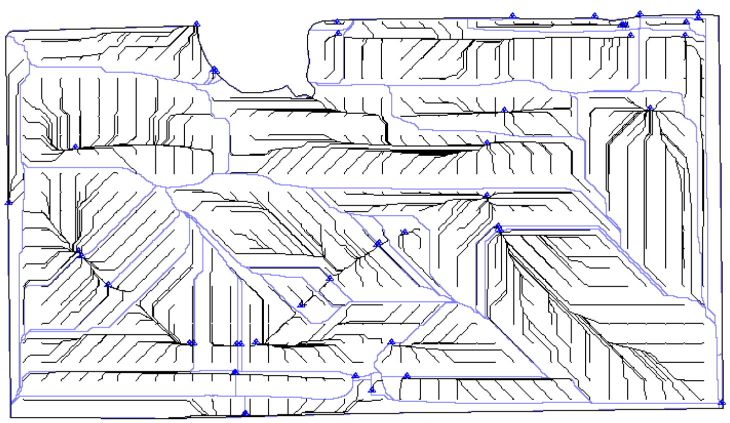
A little more detail. **A** and **B** are no-, low-slope areas (<= 0.33 deg.) that do not contain a collection point. **C** is a no-, low-slope area that contains 3 collection points. (Which implies that **C** is not necessarily a contiguous area at T1) The flow geometry implies that areas **A** and **B** would shed water to area **C** at some point in a rain event.



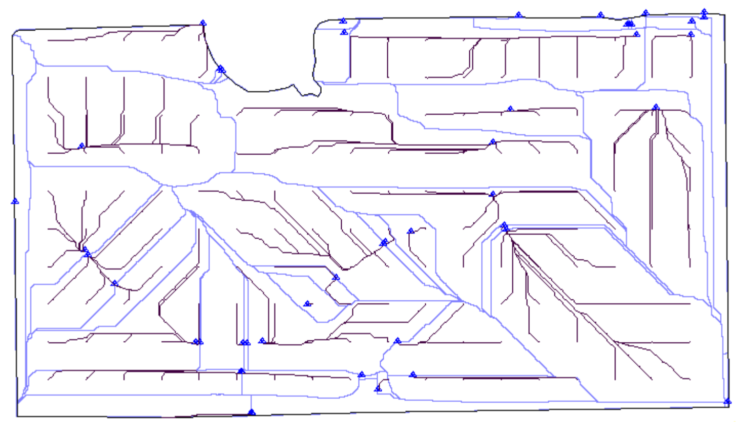
A goal is the discovery/definition of the geometry of flow on the terrain. If a drop of water falls anywhere on a completely saturated surface it is going to "move" in some direction. Direction is "downhill" along a line of maximum gradient. There is an issue of granularity- drop on how many locations? Note that regardless of granularity, the termination of paths at collection points is consistent.



Flow geometry at 33'. Follow a drop from a location on the terrain at 33' intervals (x,y).

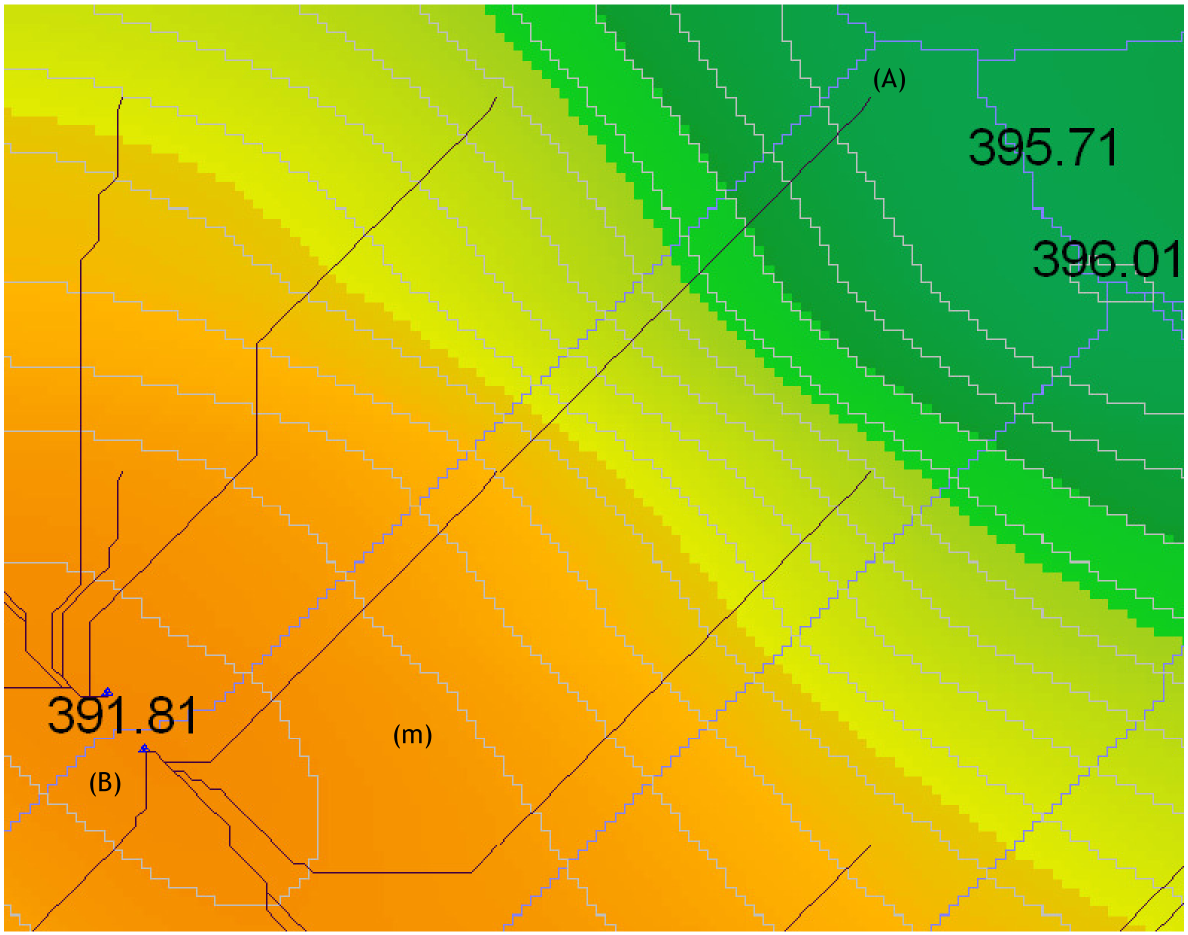


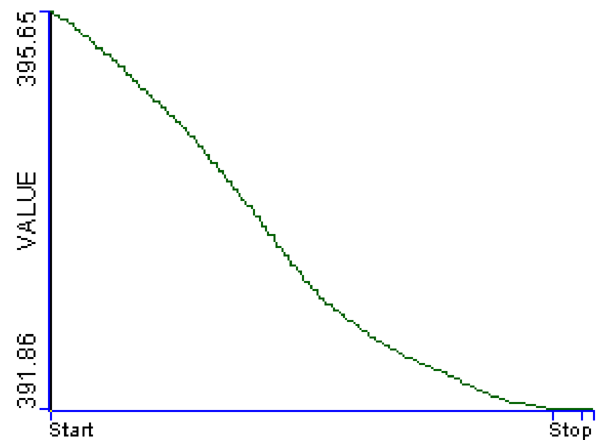
Flow geometry at 66' intervals.



Flow geometry at 132' intervals.

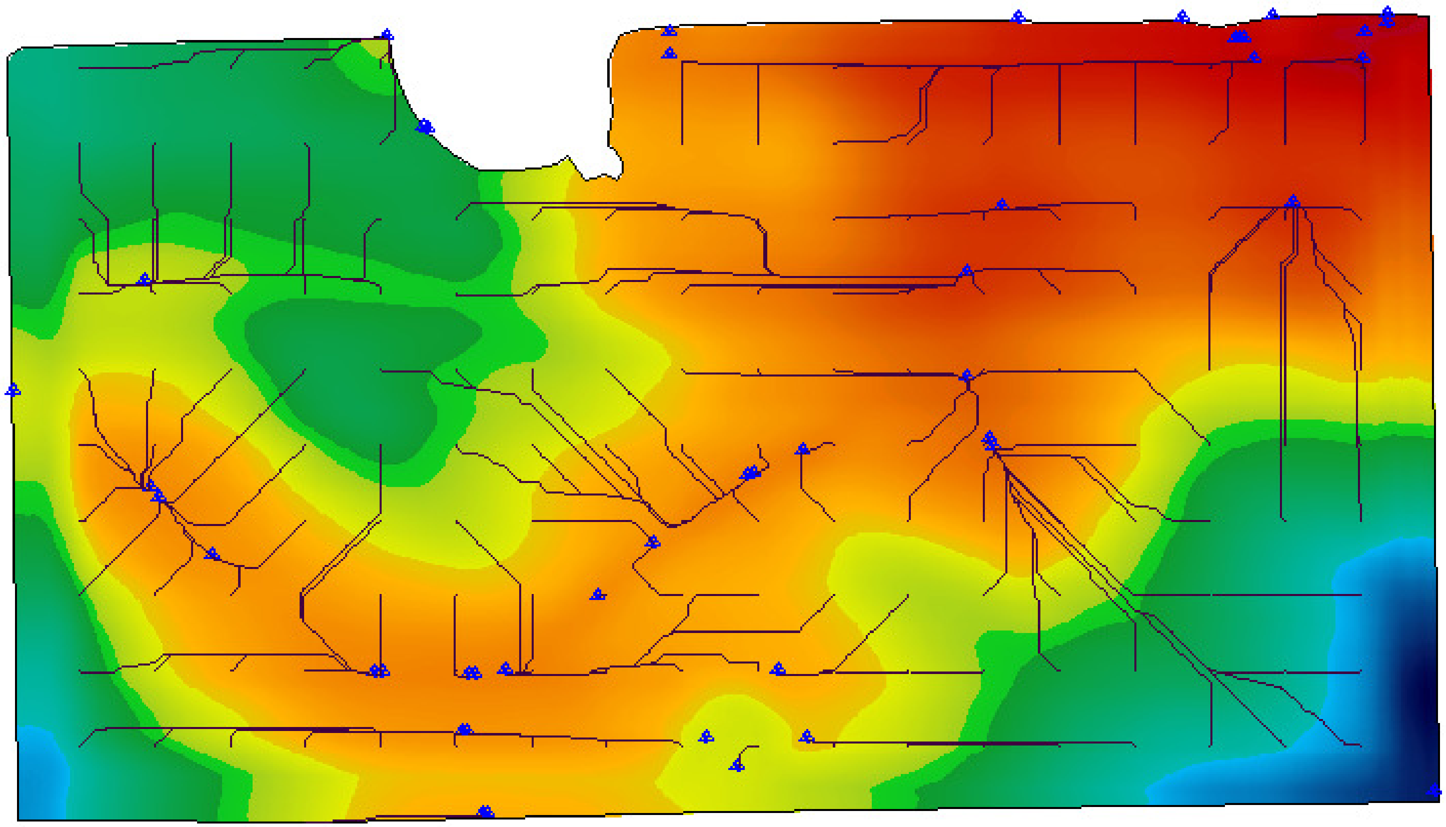
Close up of flow geometry. Origins of paths are a 132' intervals. Path (A) starts at an elevation of ~395.71m and terminates at a collection point (B) in micro-shed (m) at an elevation of ~ 391.81m. It terminates because it has reached a point on the surface where gradient zeros or reverses.



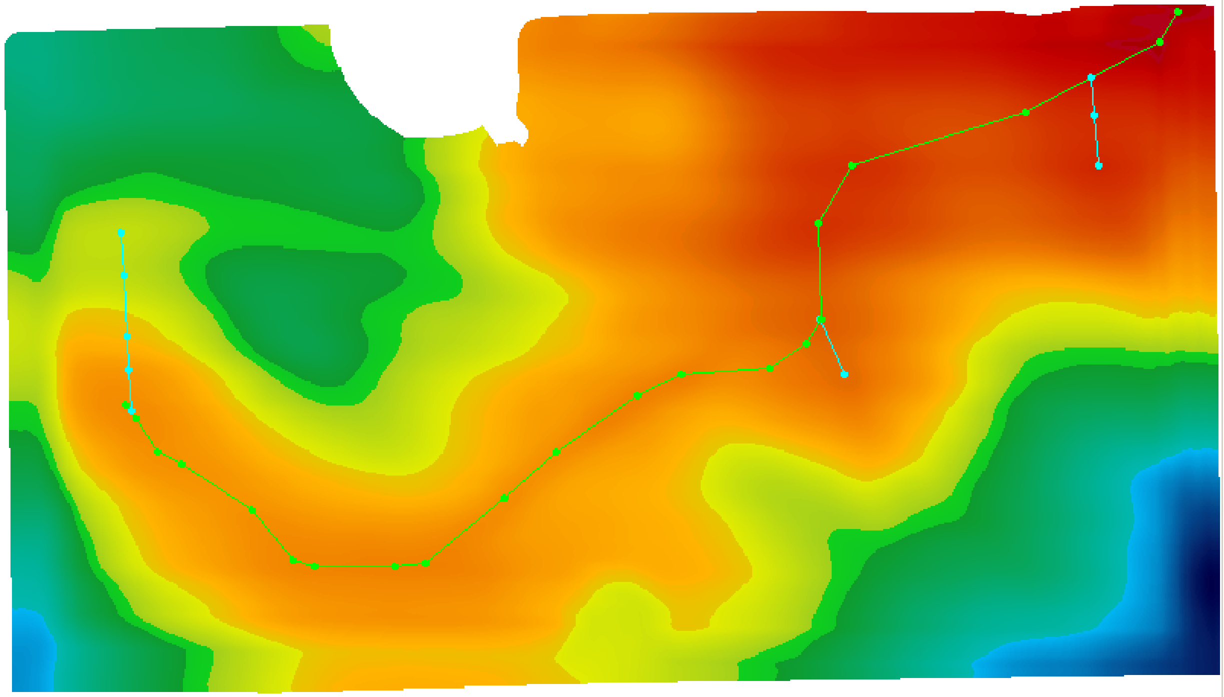


Profile of path (A)(B)

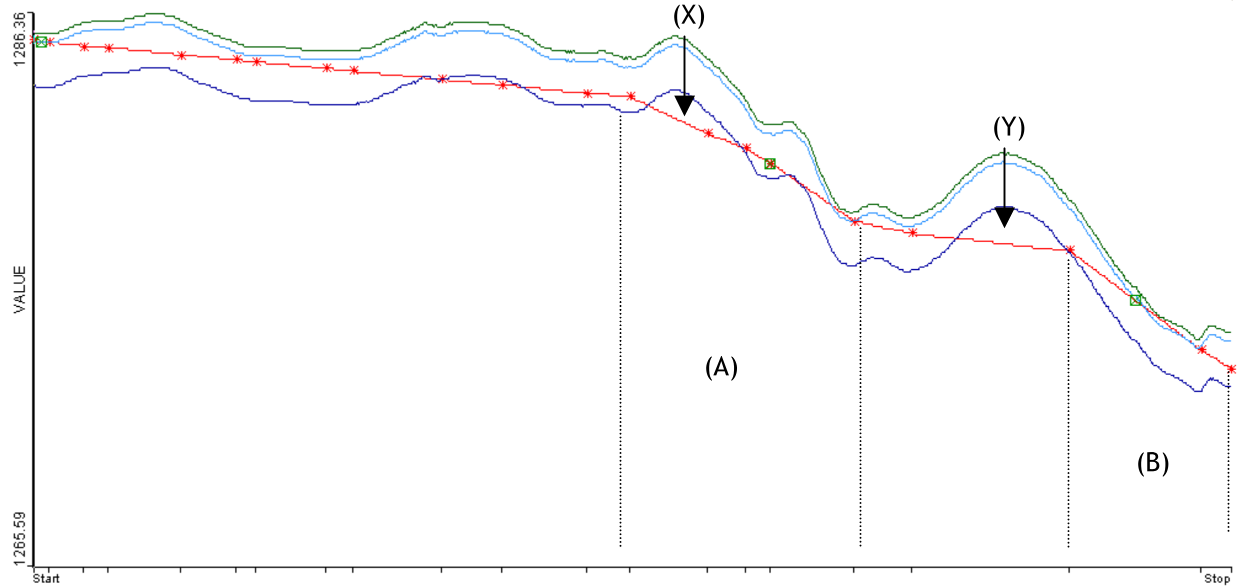
Primary value of DEM, collection points and path geometry is to provide an analyst with visual clues for the placement of a surface drainage way.



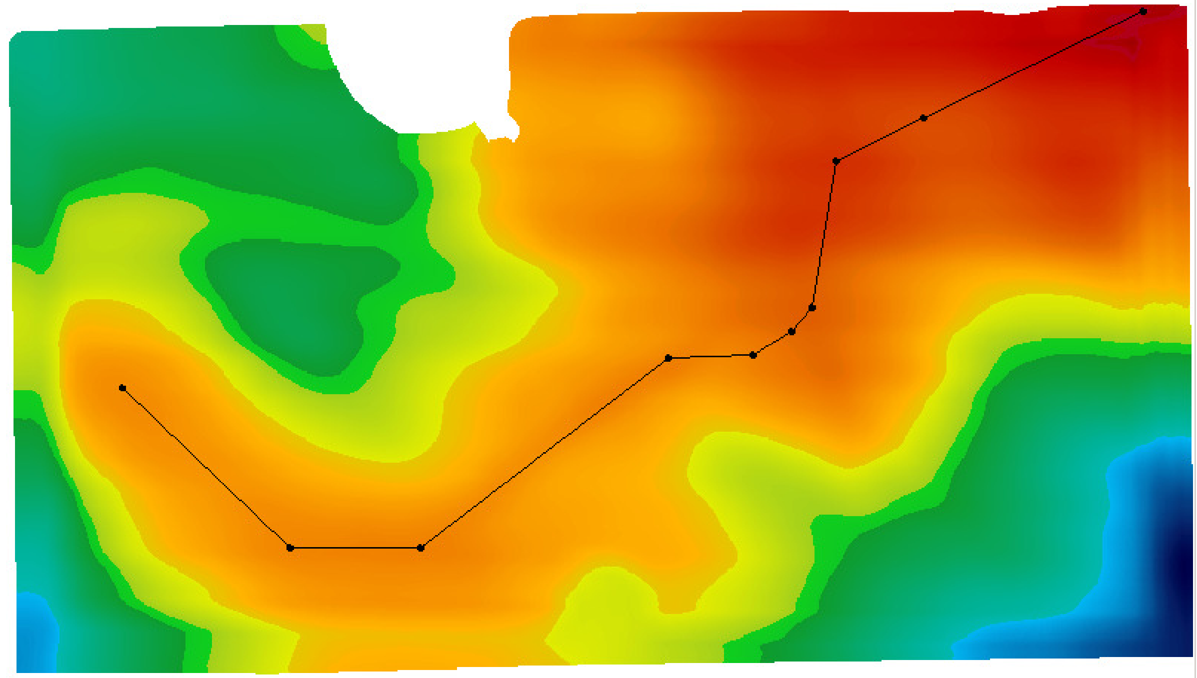
User-constructed run of a proposed surface drainage way ("water furrow"). Current setting is TilePro. Construction is a connect-the-dots exercise. The dots are termination points of various micro-sheds.



Graph of the run (red) showing position relative to model of terrain. In practice, this (surface) feature may not work. (A) and (B) sections propose slopes that exceed design specs of 0.15% (0.8% and 1.2% respectively) and present an erosion risk. (X) and (Y) propose depths that exceed equipment capacity (the dark blue line is 1.5' below grade and is the maximum cut).



User constructed run of a sub-surface drain (tile main).



Graph of the feature (red) showing position relative to model of terrain. Minimum depth is 2’ (cyan) and maximum depth is 6’ (blue). This drainage feature works within the envelope of allowed slope and machine capability.