# A GEOMORPHIC INTERPERATION OF THE SWARR RUN WATERSHED OF LANCASTER COUNTY, PENNSYLVANIA

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## INTRODUCTION

The Little Conestoga Waters drains directly into the Conestoga River which, in turn, drains into the Susquehanna River, the largest tributary of the Chesapeake Bay. This watershed is of particular concern because recent studies have shown that increased amounts of sediment in the Chesapeake Bay tributaries result in lower light levels in the shallow and sensitive Chesapeake Bay. This stems from areas such as the Little Conestoga, where current land practices encourage erosion through impervious land cover, poor livestock management, and the deterioration and confinement of riparian zones. In our watershed we looked at three different locations in order to examine how the river's physical parameters change in areas of different land use. We examined a small tributary of Swarr Run called Miller's Run which is representative of the upper reaches of the watershed. Miller's Run gives us a picture of how suburban sprawl can affect river geomorphology. We also studied a stretch of the Swarr Run along the Mann farm to see how the presence of cows can affect the channel's geomorphology. This area is also interesting because the channel was straightened between 1947 and 1958 in order to create more usable farmland(Carlson, 2001). Our final study location is immediately upstream in the Snavely Farm, which historically has had similar land use to the Mann Farm but stopped allowing cows in the river fifteen years ago. In each location we observed differences in channel geomorphology which reflects differences in land use, local geology, and temporal change in the river to maintain a state of equilibrium.

### Swarr Run Watershed

Swarr Run has a drainage area of 7.2 mi$^2$ which represents a significant portion of the Little Conestoga watershed. (Lopar, Davis, 1998) Historically, agriculture has been the primary land use and 68% of the land continues to be used by agriculture. Many farms continue to use poor livestock and farming practices such as allowing cows to graze freely in the stream channel, clearing of riparian vegetation, and straitening channels to maximize useable farmland. Within the last twenty years urban sprawl from the city of Lancaster has prompted significant development in the Swarr Run watershed. Currently, 19% of the land is characterized as urbanized. This development increases impervious cover that tends to make streams prone to flash floods. Development adjacent to the stream tends to confine and straighten the channel through the use of riprap. Also, many homeowners mow riparian vegetation that is important for maintaining stable banks. Presently, only 12% of the watershed remain forested resulting in a huge change in run-off from precolonial pristine conditions. As a result, the natural equilibrium the streams established is no longer balanced with this land use changes.

## METHODS

Our work revolved around gathering data that accurately reflects the channel morphology of our specific site locations. For both the Snavely and Mann Farm locations we used the total station to establish the water level width, depth, and elevation. The Total Station was necessary because a considerable degree of accuracy was needed to establish the subtle elevation changes over a long distance. A considerably more concentrated number of data points were taken in the Snavely stretch of Swarr Run because the stream was much more complicated. Generally, we tried to establish a set of data points at the beginning and end of each riffle and in the middle of most pools. In order to place this highly accurate, dense data in a larger context we constructed a stream profile for the entire length of Swarr Run using Pennsylvania State TOPO maps with five foot intervals. In addition to the total station, we constructed 18 cross sections over the Snavely and Mann Farms using a mounted level to determine elevation and a tape measure to establish distance. These cross sections give us a representation how the channel shape varies in the two farms. Finally, we analyzed soil samples from cut banks and a core sample we obtained using a vibracore. We analyzed the grain size distribution for each sample using a series of sieves in a Rototap for fourteen minutes. This gives us clues to establishing how the sediment record preserves major regional land use changes. When analyzing Miller’s run we used a hand level and hipchain to create fairly accurate longitudinal profile for an 800m stretch of the run. We were able to use this method because the elevation changes in Miller’s Run are far greater than in the Snavely and Mann Farms. We then fit this data into the context of the entire Miller’s Run longitudinal profile based on TOPO map.

## RESULTS AND DISCUSSION

Our data suggests there is a significant difference in channel morphology between the Snavely and Mann Farms. The Snavely section of Swarr Run exhibits a more natural stream pattern while the Mann Farm stretch shows a significant need for future stream restoration. The Snavely stretch shows a much tighter meandering pool riffle pattern as opposed to longer and deeper pools in the Mann property with a lower sinuosity. (See figures 1 and 2) The channel shape also changes from a confined "V" shape with a very well defined thalweg in the Snavely Farm to a broad "U" shape with a less defined thalweg in the Mann Farm. (See figure 3) Further comparison shows that the average stream width is nearly twice as wide in the Mann Farm as well as being deeper, which further suggests abnormally large pools

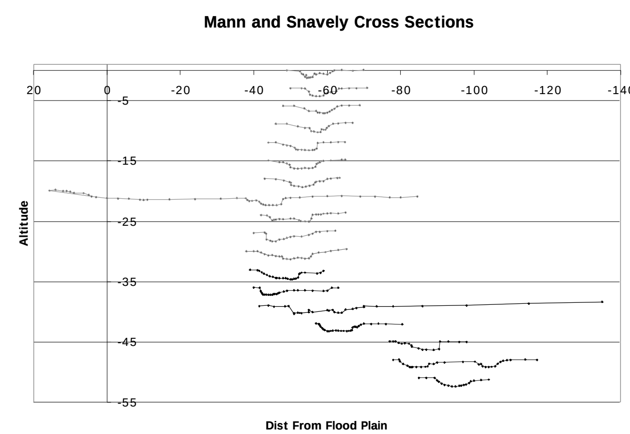


**Fig 1. Cross sections of the Mann and Snavely Farms, showing the change from v-shaped profiles to less healthy, u-shaped profiles.**

creating slow moving water. Slowing water down over large pools is problematic to water

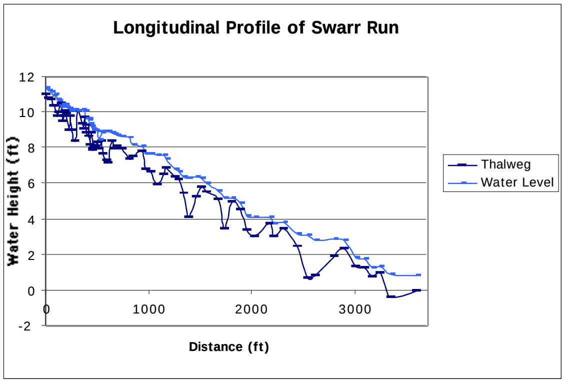


**Fig 2. Longitudinal profile of the larger area, including that of the Snavely farm.**

quality because it reduces the dissolved oxygen. Also, the large width of pools increases water temperature, particularly in this location because there are virtually no trees for shade. Finally, these large pools force the stream to deposit much of its suspended and bed load creating the mucky silty bottom we observed. These conditions do not promote a natural diverse stream ecosystem and suggest that the Mann Farm stretch of Swarr Run be not in a natural state of equilibrium. We believe that the presence of cows in the stream is the primary cause of this change in channel morphology. Cows exert a tremendous amount of pressure and cause considerable bank erosion that tends to widen the channel. (Trimble, 1993) Also, cows destroy riparian vegetation that is important for bank stabilization. This further illustrates the importance of simple livestock management practices such as fencing off cows from the stream. Over a period of 15 years the Snavely Farm stretch of Swarr Run appears to have recovered significantly from the presence of cows. However, there is a significant drop in channel slope from the Snavely Farm to the Mann Farm that could cause some of the observed difference. More work needs to be done to understand the cause and effect of this change in slope.

## MILLERS RUN

Miller's run is an excellent example of a small tributary that has been thrown out of equilibrium by excessive development. Our longitudinal data suggests upper reaches of the stream are degrading, while lower sections are aggrading. (See figure 4) A bedrock

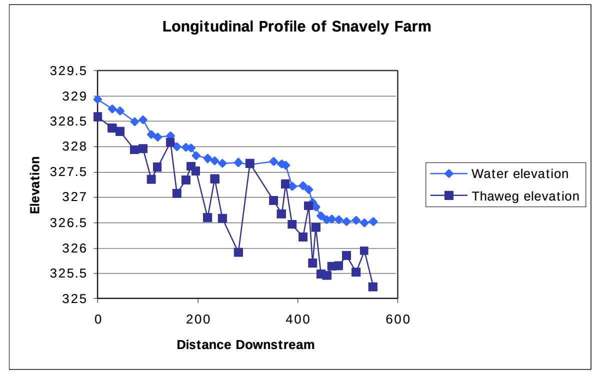


**Fig. 3. Longitudinal profile of Snavely farm, showing the more healthy, tighter pool-riffle system.**

outcropping marks the hinge point of this transition. We observed extensive, extreme cutbanks upstream of the bedrock were the stream incised into the ancient alluvial fan. The ideal alluvial fan plane is represented as the line on the figure four. (Knighton, 98) Below the outcrop we observed aggregating piles of gravel. This is consistent with increased discharge in the stream caused by greater impervious cover after development. (Trimble, 1997) The stream appears to be more sinuous in historical aerial photography, implying development resulted in straightening that could also be a major factor in the degradation. The upper stream appears to be reestablishing meanders to further reduce its slope because it is easier to cut away the softer side banks than continue to incise the

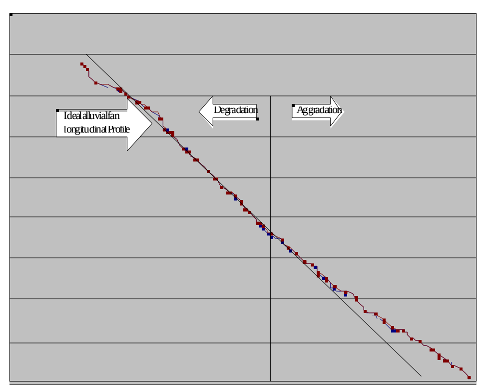


**Fig 4. Longitudinal Profile of Millers Run, Showing the Areas of agradation and degration.**

gravel bed.

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