Storm Water Management on the Hyde Park Irrigation Canal

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Introduction

In Cache Valley many of the canal systems are used to channel the storm water runoff to the river system. During a water season if a big storm event hits then canal companies have to be aware on an increase in discharge in their canals. In 2006 the Hyde Park Irrigation Canal had a mishap because of storm water runoff. It was before the irrigation season had begun and snow was still on the ground but due to warm temperatures and a rain storm the canal quickly filled up to its capacity. As the storm went on more and more water began to run into the canal from Logan, North Logan and Hyde Park cities. At a certain area in Hyde Park the canal overtopped its banks and began to flood a resident's basement. Because of this event the canal company had to switch insurance companies and has focused on better storm water management. Also Cache Valley is moving towards a solution to combat storm water runoff between the cities aforementioned and the canal companies affected by such cities. Hyde Park Irrigation canal is a major entity for managing storm water and being able to quantify how much water is being put into the canal during a storm event is a crucial part in coming up with an agreement with the cities.

Currently they are working with the three cities and need to work out a contracted budget of maintenance on the canals in order to sustain the storm water. The canal company will pay 50% of the maintenance bill and then needs to split it between the three cities. In order to do so fairly a total of storm water runoff needs to be analyzed to determine each city's contribution. Using Geographical Information System (GIS) data for elevations and using a DEM to quantify impervious areas to pervious layers will be crucial. The objective of this project is to find out how much storm water runoff from a storm event will each city contributes and then an agreement between the costs of each city can be contracted.

Discussion

In order to get accurate information for the canal it was mapped by Logan City and The Utah Conservation and Association District (UACD). In the section of the canal many things were mapped like headgates, flumes and storm drain inlets. We will focus on the storm drain inlets for this project and an aerial view of the map can be seen in Figure 1. The highlighted blue area is the irrigable area that the canal company has water rights to. Many of the other nodes along the canal are headgates but at the start of the canal which is in Logan and moves to the North to Hyde Park City.

Arcmap

Arcmap will first be used to find the area of the cities between the municipal boundaries and the Logan Northern Canal. The upper boundary is the canal because anything above it to the East would flow into it. After inputting the GPS coordinates of the different structures along the canal and the canal itself an aerial image base map was used to show where the boundaries are located. The measurement tool for in toolbar section was used to get the areas in acres for each city.

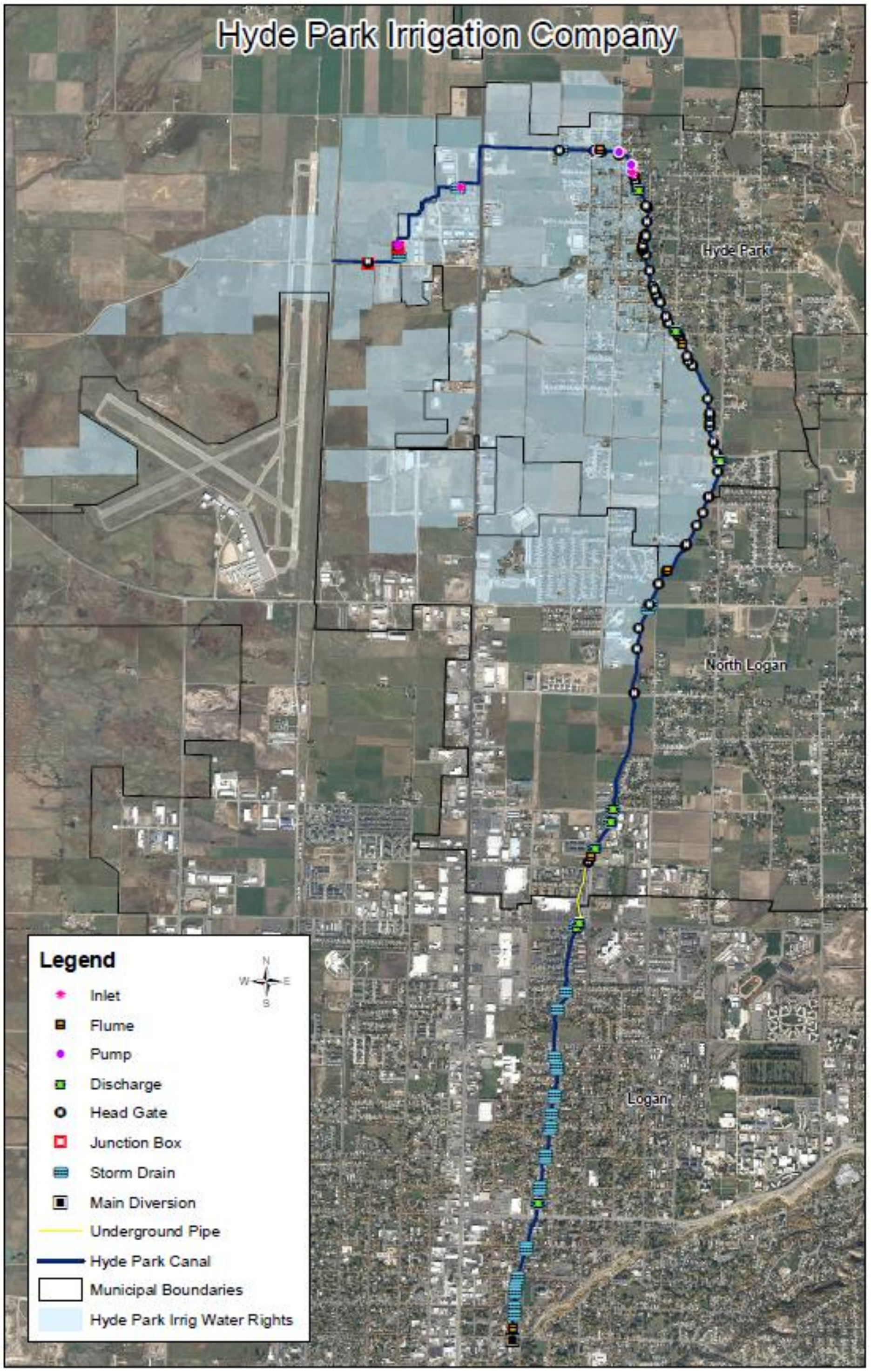

Figure 1. Map of canal and nodes

In order to find elevation data to figure the average slope of the area calculated a 10 meter DEM raster data from the GIS portal for Utah (Utah 2010). Figure 2 shows the two units that were needed in order to calculate slope. The colors can be seen in Figure 2 and shows that the greatest slope where the brown changes to a purple and the darker brown and purple area lie above the second canal so it is concluded that the slope of the storm water runoff is at a low range of 2.3% - 4.5% for the Hyde Park Irrigation canal (see Table 1).

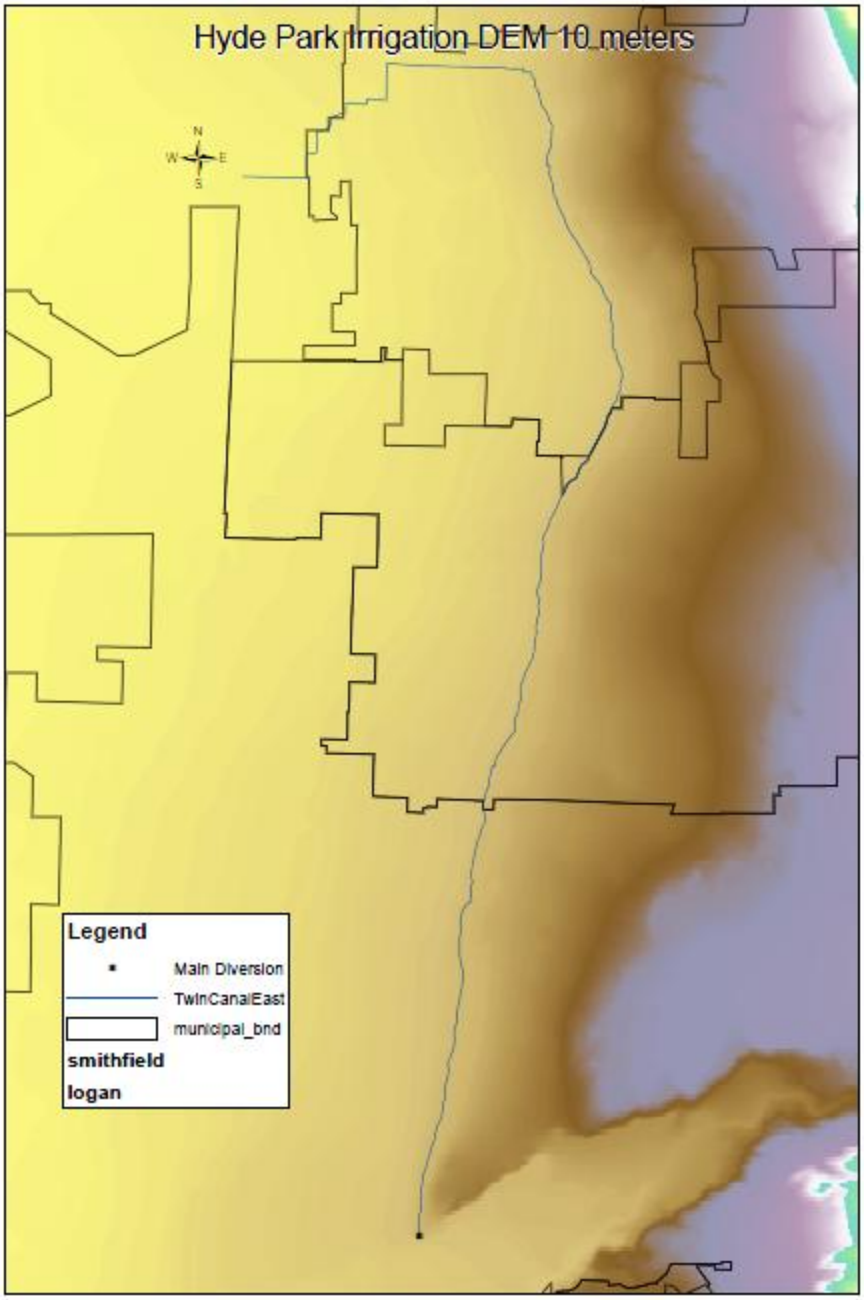

Figure 2. DEM Model of Canal

In order to project the raster data the input coordinate system and other inputs are shown in Figure 3. In order to know which zone would need to be selected a Google search was conducted to find what zone Utah lied in. The units were meters and converted to feet in excel in calculating slopes and widths of the area of the subcatchments.

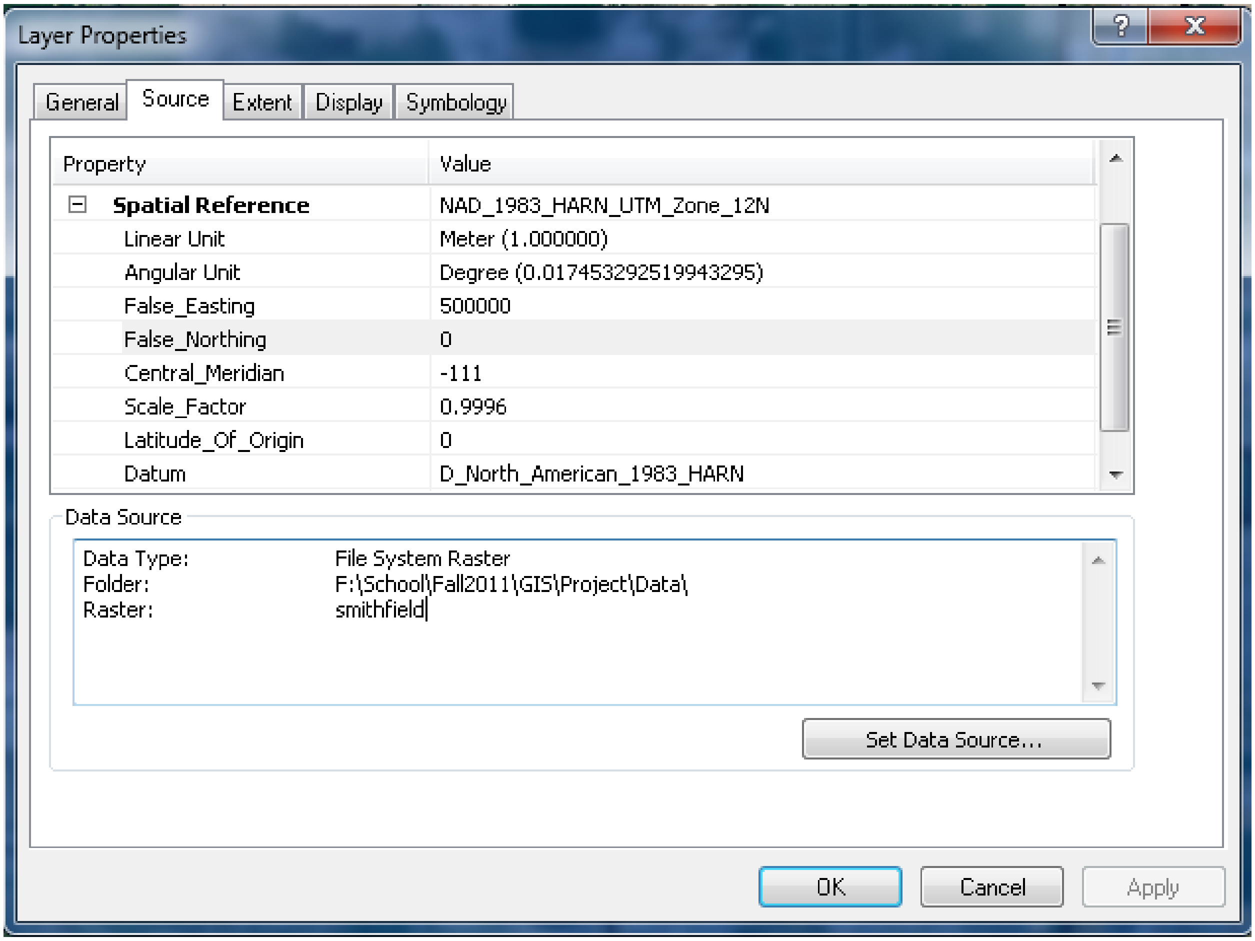

Figure 3. Layer Properties in Arcmap for DEM

When the areas, slopes and widths of the subcatchments were calculated, impervious land cover needed to be calculated. Using the USGS seemless website (USGS 2006) the data needed was imported to Arcmap and an estimate of the percentage of impervious area in the subcatchments was calculated by re classifying the symbology impervious layer (see Figure 4). An approximation was taken by looking and using a guess to calculate the percentage. The symbology was easy to see that the roads, sidewalks and parking lots were accounted for in each subcatchment (see Figure 5).

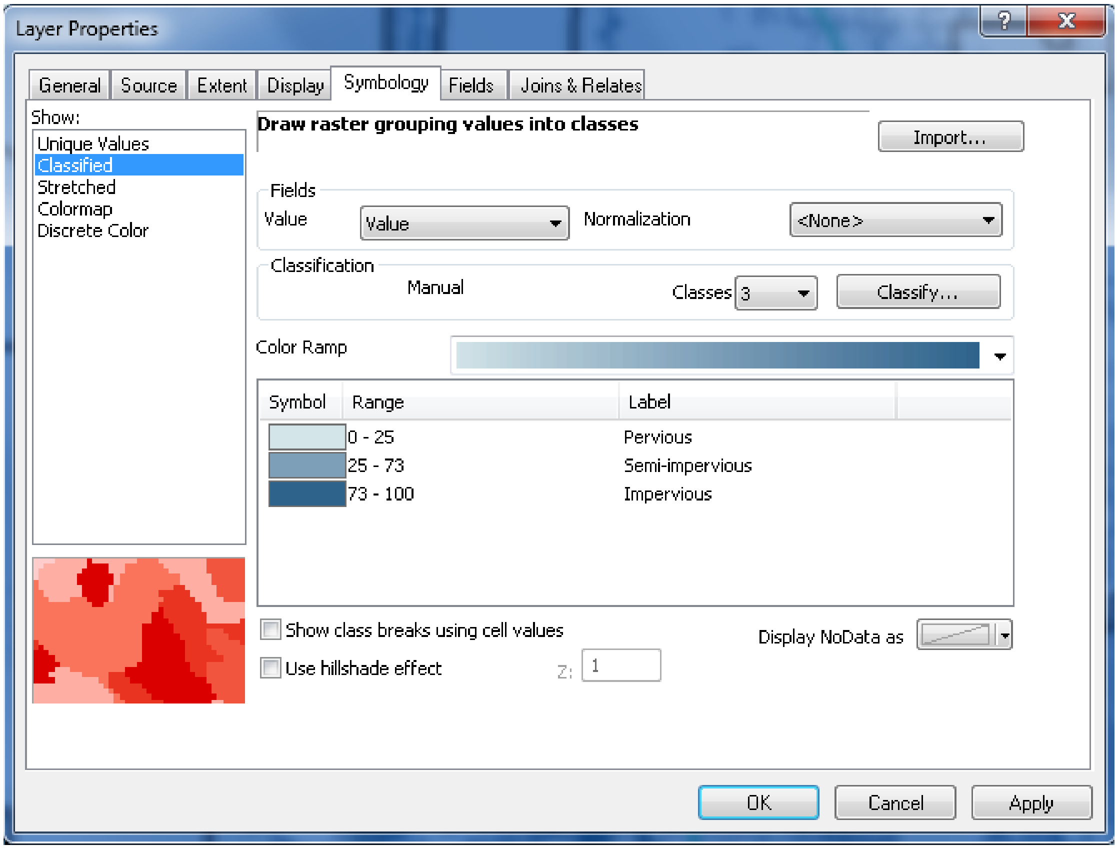

Figure 4. Symbology Classification for Impervious Layer

Looking at Figure 5 the impervious layer clearly shows that Logan City subcatchment for the canal has a great amount of impervious area. It also has the most storm drains that discharge into the canal. Although North Logan has the greatest area it is mostly fields so the runoff is not great but there a few large parking lots that contribute a great portion of runoff for North Logan. Hyde Park is mostly residential but is not as urbanized as Logan is and does not carry the infrastructure of storm water management that the other two cities have. There are no curb and gutters that drain directly into the canal in Hyde Park and the lots in the residential area are larger and have more lawns, gardens and pastures that exist. Hyde Park also has the smallest area of 340 acres which are almost doubled by the other two cities (see Table 1).

Table 1. Calculated Results

City	**High Elev. *(ft)***	**Low Elev. *(ft)***	**Length *(ft)***	**Slope *(ft/ft)***	**Area *(ac)***	**% Impervious**	**Runoff *(ft3)***	**% Runoff**
Logan	4636	4561	2300	0.033	540	70.00%	4613372	62.84%
N. Logan	4640	4550	3900	0.023	700	10.00%	1534654	20.90%
Hyde Park	4630	4540	2000	0.045	340	15.00%	1193457	16.26%
						Total Vol. =	7341482	

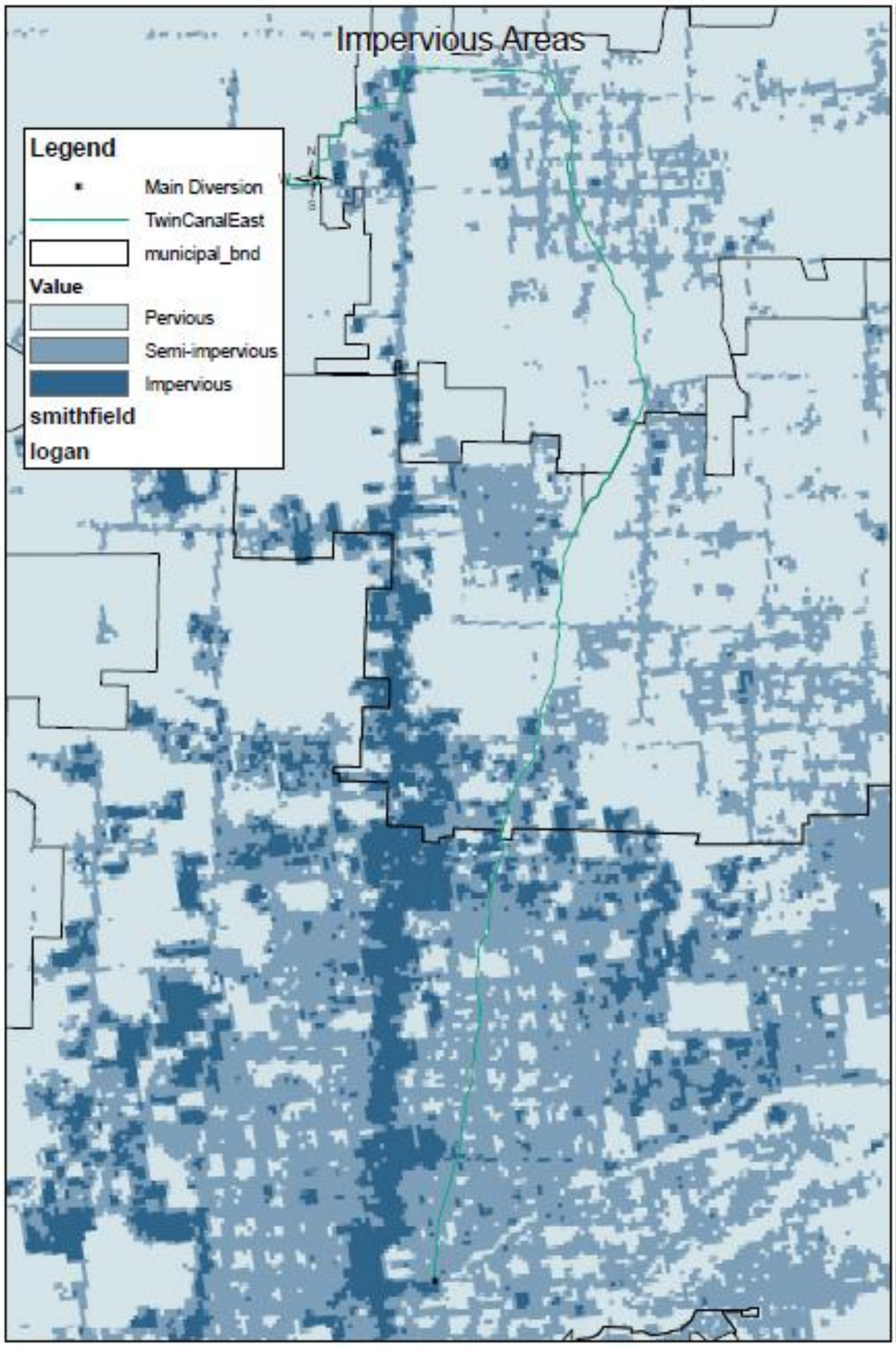

Figure 5. Impervious Layer

EPA SWMM 5.0 (EPA 2011)

In order to design a storm water management system Logan City has created a Code Design Manual (Logan City 2010) for these types of systems. Table 2 shows the methodologies and design requirements of the code for the design storm. After obtaining this design storm hyetograph (see Figure 6), computer software called Storm Water Management Model (SWMM) from the Environmental Protection Agency (EPA) was used t to create the scenarios and runoffs to design for the optimization of the developed sites. The SWMM model had many parameters that were obtained from the SWMM manual which was also provided by the EPA.

Table 2. Storm event requirements

Design Specifications	Requirement
Methodology	SCS Method
Hytegraph	SCS II Storm
Event Storm	100-year
Duration	24 hours

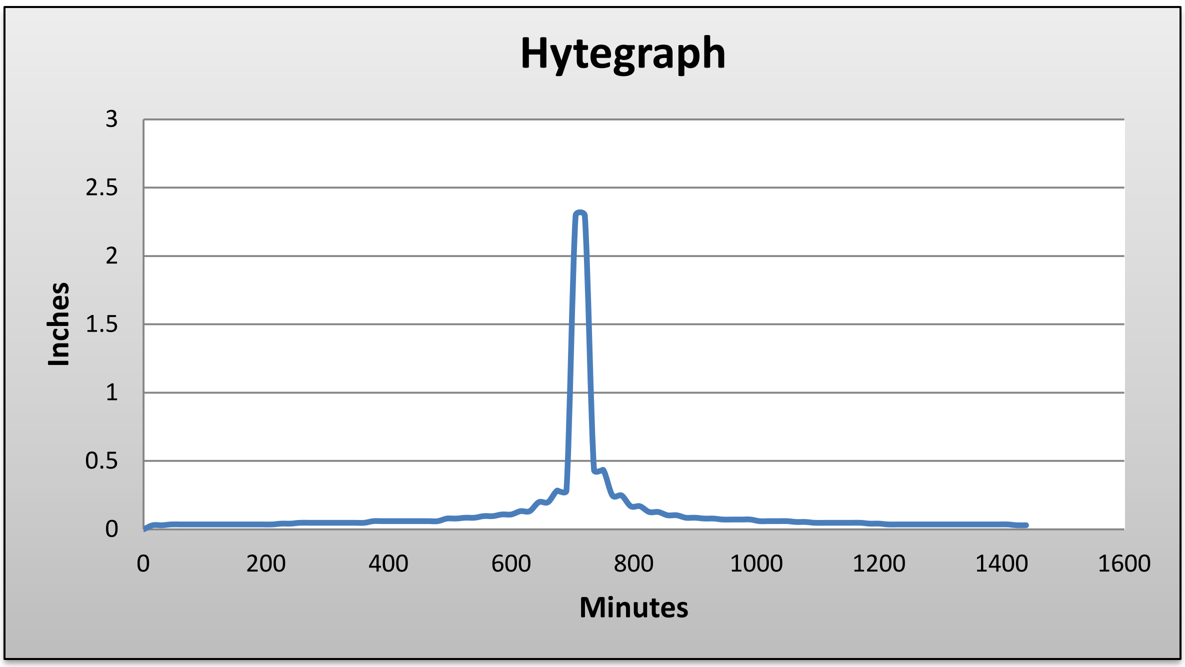

Figure 6. Design Hytegraph

With the design requirements input and the subcatchments could be drawn in the SWMM model and a DEM background was loaded to give a better visual of things (see Figure 7). Some of the calculated results in Table 2 were input in the each of the three subcatchments in order to get accurate runoffs. The run simulation was run for just over a day which the design storm calls for. After the simulations were complete the Total Volume of each subcatchment were computed and are shown in Table 2. The percentage of Total Volume is used to account for the percentage each city contributes after the storm would run its course. Logan has the greatest percentage which was a conclusion by just looking at the impervious layer. From experience of being the Water Master for the Hyde Park Irrigation Canal the numbers generated were very close the observation of storms over the three years experience.

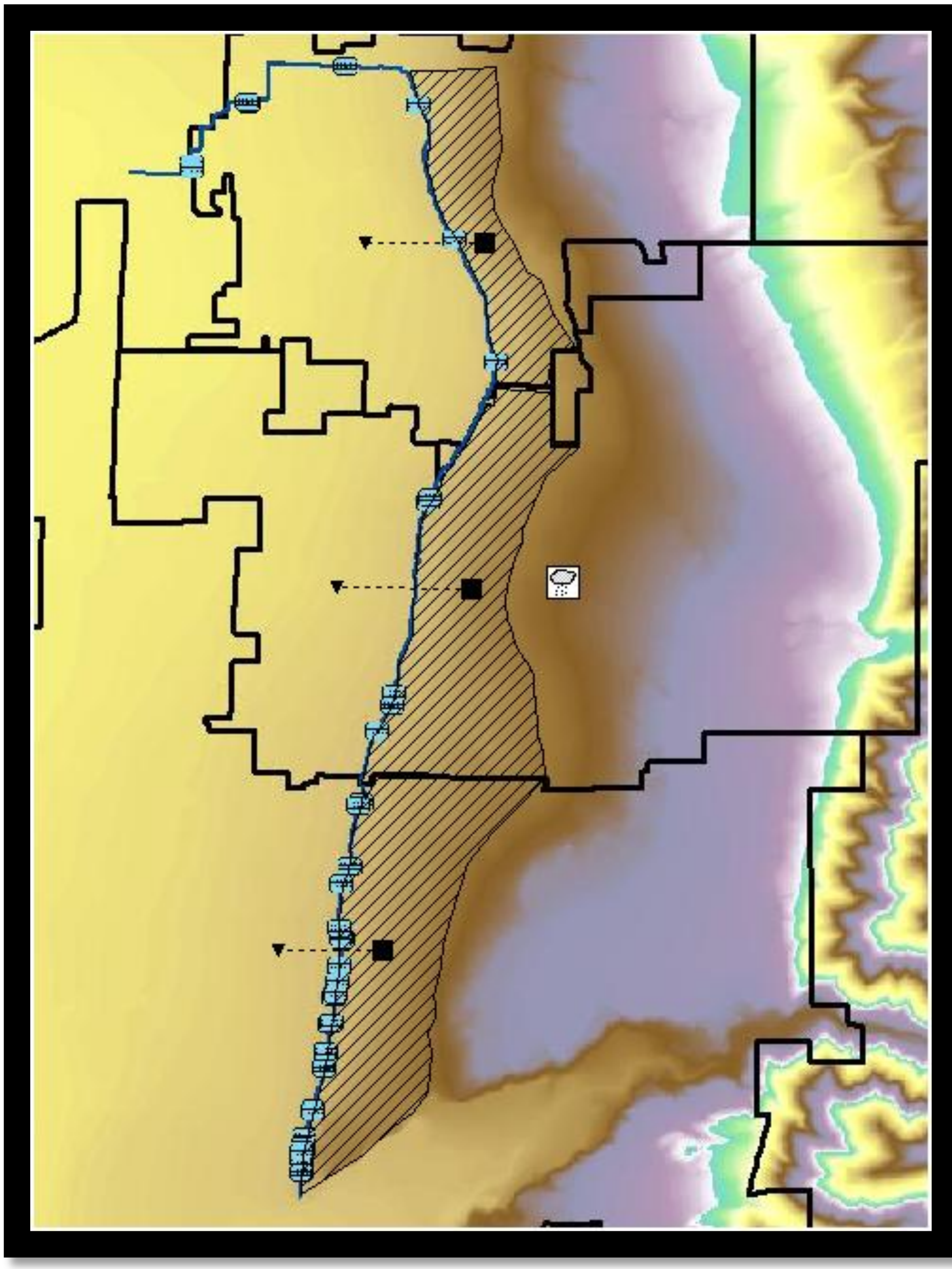

Figure 7. EPA SWMM Model

Summary/Conclusion

From the two software programs Arcmap and EPA SWMM the volumes of water that each city would potentially produce could be calculated in order to create a contract for the three cities. Logan would contribute around 60%, North Logan 20% and Hyde Park 16%. These costs are from the maintenance of the canal costs that are accumulated annually in order to manage the storm water runoff.

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