

**Flood Delineation of Dunawi Creek at Bruce Starker Arts Park Wetland,
using ArcGIS with HEC-RAS**



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1. Introduction

Flooding is one of the most catastrophic natural disasters and a huge problem that can cause damages and destroy infrastructures. In the United States, flood occurs almost annually and lead to economic damages of approximately \$2.9 billion (FEMA, 2013). Even with the advance of technology and scientific research, floods keep occurring leading to severe impacts in communities and in the environment. According to Schmitt et al (2004), the cost of drainage systems that would be able to deal with extreme storm conditions is usually very expensive to build and operate. Thus, the no availability of reliable infrastructure in local watershed can increase the danger for communities surrounding areas susceptible to flooding. Besides the absence of infrastructure, the excess of water in the land surface can lead to agricultural industry impacts. For example, in 2010, Saskatchewan, Canada reported that 12 million acres of agricultural lands drowned due to excessive soil moisture (Pattison-Williams et al, 2018).

The implementation of new sewage systems and drainage pipelines have been done by several local and regional governments to mitigate flood impacts and as part of flood risk programs. In China, to ensure community security, the number of flood control strategies as well as drainage systems built have increased exponentially over time (Figure 1; Li et al, 2016). However, solution that would lead to the prevention of these impacts would certainly be more effective as well as bring lasting benefits for the impacted area as well as to the surrounding communities and environment. Current studies have also focused on flooding analysis in regional or even global scale due to climate change assumptions (Lehner et al, 2006; Smith et al, 2015; Falter et al, 2016), but there is still necessary of investigating local watersheds and the effectiveness of new strategies in preventing flood occurrence.

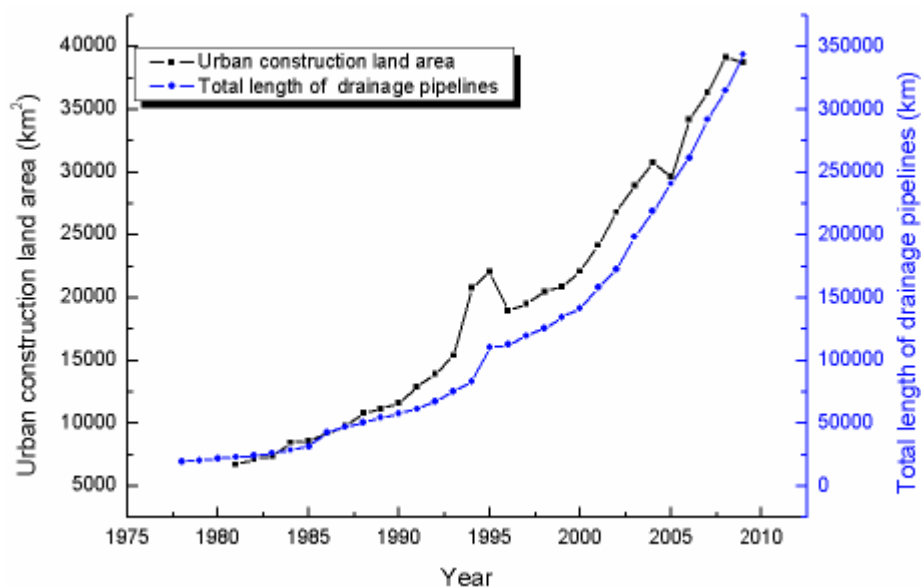


Figure 1 - China's number of urban constructions in relation to the implementation of drainage pipelines as a strategy for flooding mitigation (Figure by Li et al, 2016).

Even though infrastructure may reduce the impacts of flooding events principally more in urbanized regions than in rural areas, natural and more sustainable strategies could not only mitigate flooding impacts but also prevent them. Restored and/or new constructed wetlands is one of the ways to mitigate floods. Wetlands have been the focus of several research areas such as ecology, hydrology, geography and engineering, due to their multiple important roles in the environment. They can the potential of providing habitat for fish and wildlife, improving water quality, supporting food webs, protecting coastlines, but more importantly they can ameliorate flooding impacts (Barbier et al, 2011; Enwright et al, 2016). Therefore, it has become necessary to explore the effectiveness of wetlands to reduce the risk of flood occurrence (Javaheri & Babbar-Sebens, 2014).

Bruce Starker Arts Park at Dunawi Creek is an area in Corvallis, Oregon where residents have suffered with flood impacts. For instance, the park's bicycle lanes inundate during flood seasons as well as in heavy rain events blocking residents away. This project aims to develop a first-stage design of a wetland in Bruce Starker Arts Park to observe how effective a constructed wetland would be in alleviate the flooding impacts. With that said, the objective here is to delineate the floodplains and the areas the flood events are impacting in order to point out regions where a constructed wetland would be optimal. Peak discharge of 100 years recurrence interval of Dunawi creek watershed will be calculated by using TR-55 method, and HeC-Geo RAS, a tool designed in ArcGIS to process geospatial data for use with HEC-RAS (USACE), will be used to define the flow in the region as well as modeling this flow defined. This study focus in the evaluation of a 200 meters upstream and 200 meters downstream particular area that will be analyzed visually in ArcGIS.

2. Objectives

The main purpose of this project is to delineate the floodplains of the Dunawi Creek considering peak discharge. The software ArcGIS and HEC-RAS were used.

The main stages of the research are:

- Processing of Topographic and bathymetric data base in ArcGIS
- Preparation of data set to be ready to import from HEC RAS.
- Defining the Geometric and Flow dataset in HEC RAS.
- Flow modeling using the HEC-RAS.
- Exporting dataset from HEC-RAS to ArcGIS by using HEC-geoRAS tool.
- Analysis of results.
- Presentation of results on Tables and ArcGIS-maps.

3. Study area

Dunawi creek is located in Corvallis, Oregon. It starts from Bald Hill Natural Area and discharge to Marys River. The area of Dunawi creek watershed is about 2 square miles. Figure 2 illustrates the Dunawi Creek Watershed delineated as well as the river analyzed in this study. We can also observe in figure 2, that Dunawi Creek is somewhat populated with forest and agriculture lands. In fact, 50% of the watershed is low-density urban area, 20% is canopy forest, and the rest is crop land. Summers in n Corvallis are warm, dry, and mostly clear, while winters are very cold, wet,

and overcast. Over the course of the year, the temperature typically varies and is rarely below 25°F or above 97°F. The climate of the region (i.e. Corvallis) is shown in table 1.

Table 1. Corvallis weather averages

Annual high temperature	63.4°F
Annual low temperature	41.9°F
Average temperature	52.65°F
Average annual precipitation - rainfall	42.76 inch
Average annual snowfall	3 inches

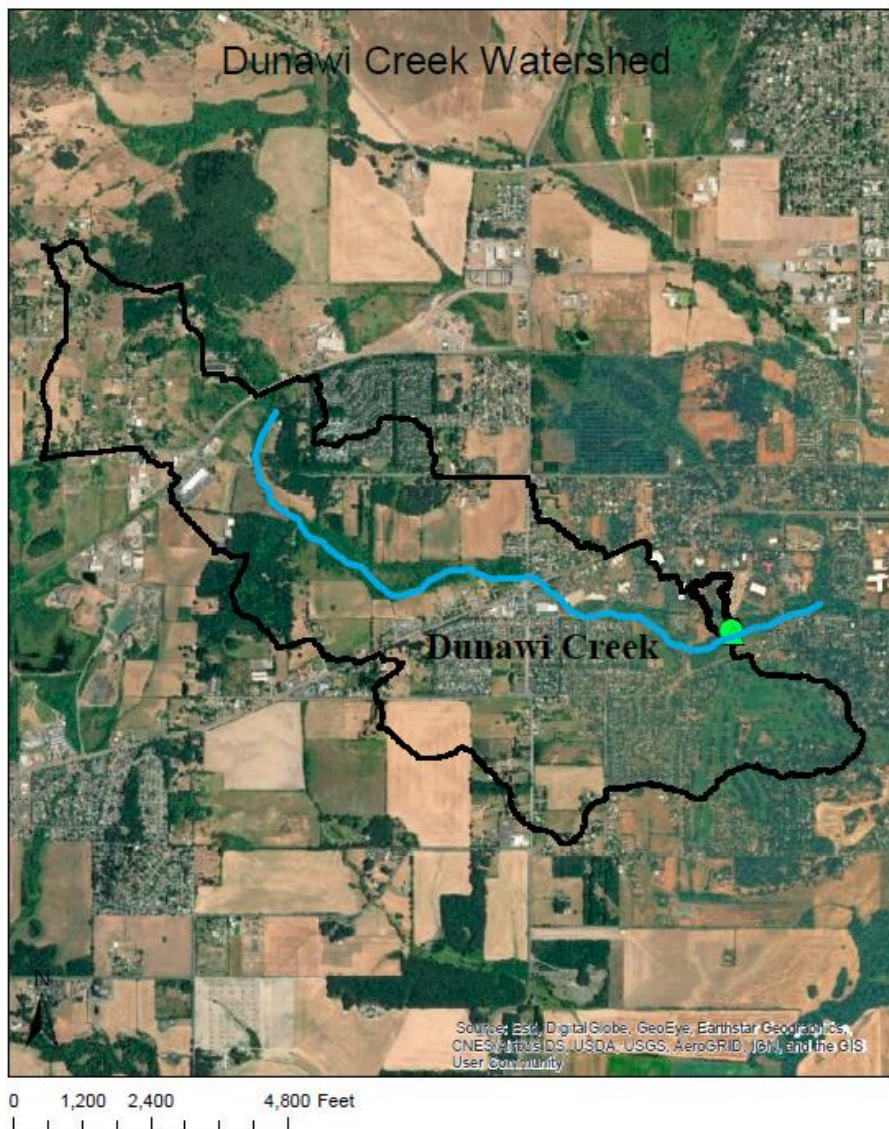


Figure 2. General view Dunawi Creek.

4 Data

4.1. Topography data

The original information of the Dunawi Creek is presented in DEM mode. From this, it will be prepared the information in vector mode to export to HEC RAS model, following some processes in ArcGIS. Figure 3 illustrates the Dunawi Creek river information, available in raster (a DEM – digital elevation model -form), has been downloaded from USDA- Unites States Department of Agriculture – Geospatial Data Gateway server. Table 2 shows the details of the DEM used in this study.

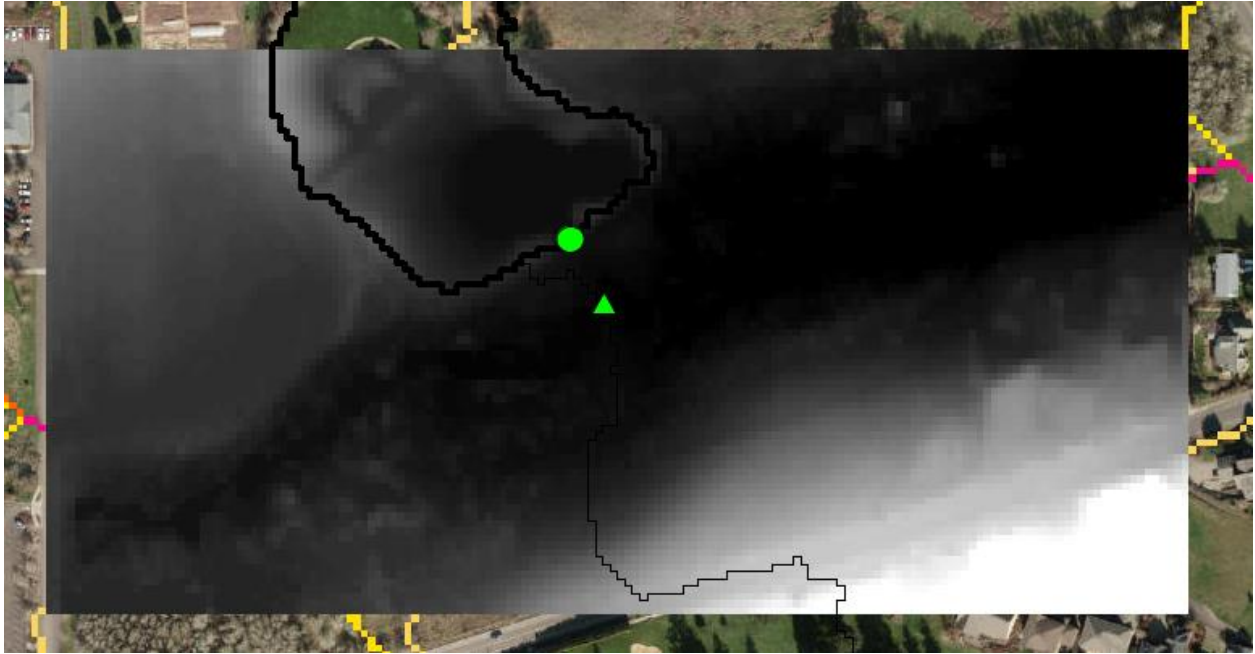


Figure 3. DEM illustration with both outlets necessary for the watershed delineation.

Table 2. Characteristics of the Digital Elevation Model (DEM) used.

Name	<i>Duwani Creek Raster</i>
Description	<i>Topographic information is available in DEM mode.</i>
Raster	<i>Cell size = 3m x 3 m</i>
Geographic Coordinate System	<i>GCS_North_American_1983</i>
Projected Coordinate System	<i>NAD_1983_UTM_Zone_10N</i>
Projection	<i>UTM</i>
Datum	<i>D_North_American_1983</i>
Angular Unit	<i>Degree (0.01745)</i>
Linear Unit	<i>Meter (1.000)</i>
Source	<i>USDA - Unites States Department of Agriculture – Geospatial Data Gateway. https://datagateway.nrcs.usda.gov/</i>
Scale Factor	<i>0.9996</i>

4.2 Soil Data

Figure 4 illustrates the data of soil obtained from SURRGO to calculate the curve number, which is needed for calculating the peak discharge.

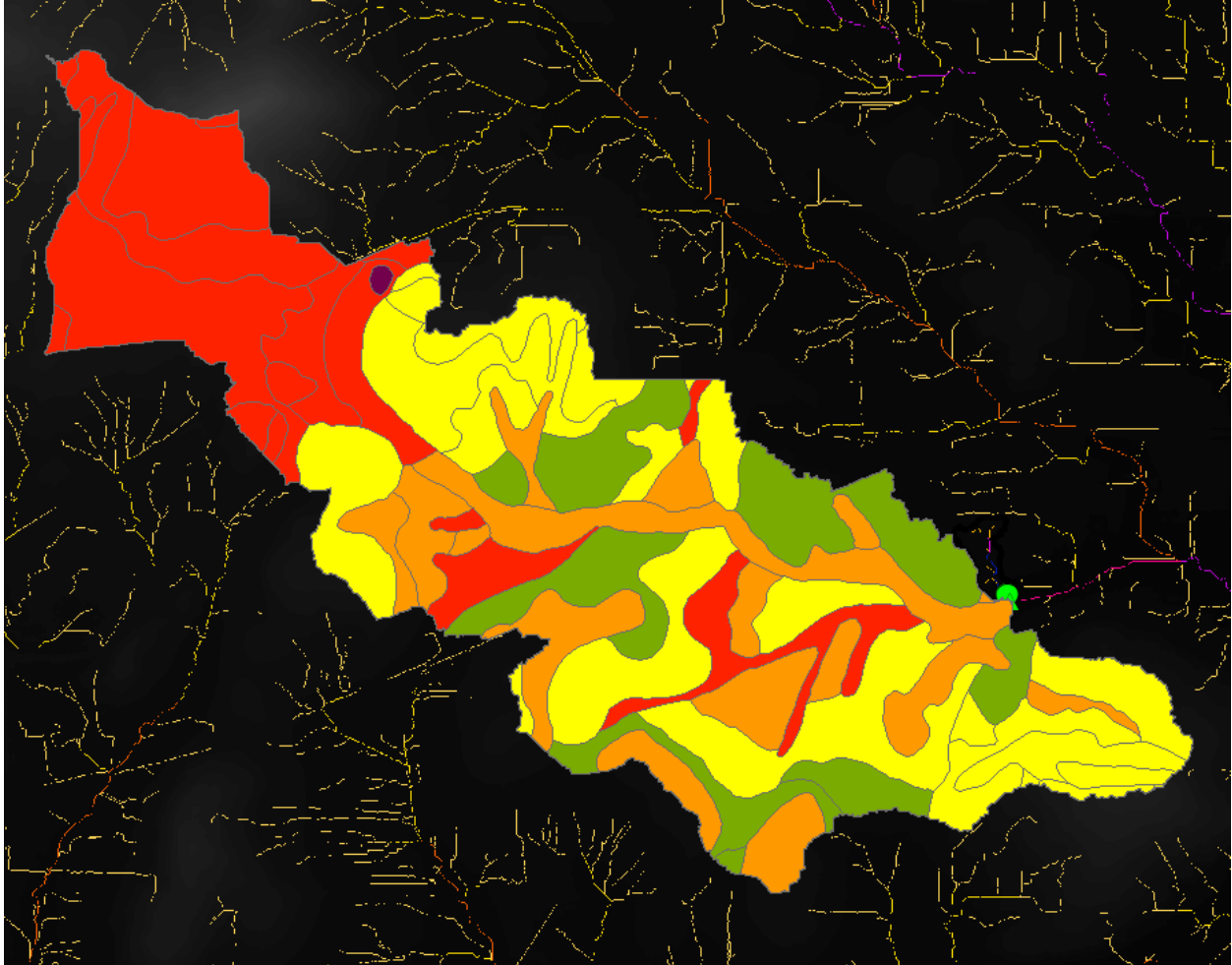


Figure4. Soil type data from SURRGO dataset.

4.3 Flow Data

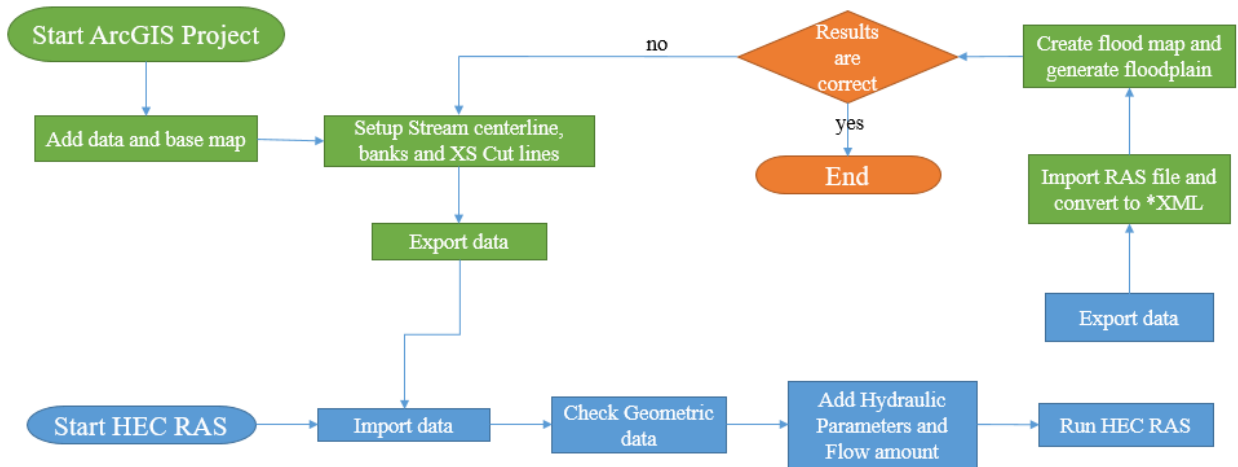
The peak discharge of Dunawi creek calculated by using TR-55 hydrology method. With some assumptions the peak discharge obtained was 250cfs.

5. Methodology

Two different software programs (Arc-GIS and HEC-RAS) are used in this project. The three main steps of this project are:

- 1) Preparing topographic information;
- 2) Run hydraulic modeling.
- 3) Get output maps to show delineation and results.

Arc-GIS and Arc-GeoRAS were used for the first step, HEC-RAS is used for step two, and Arc-GeoRAS used in the final step.



5.1 Geospatial analysis topographic data

Start an ArcGIS project and Add data and base map: Data and base map will be added to Arc-GIS after using Clip tool to clip the interested area then Arc-hydrology tools will be used for fill, flow direction and flow accumulation will be used. For the area, the watershed will be delineated, and the soil data will be added to obtain the hydraulic soil group areas.

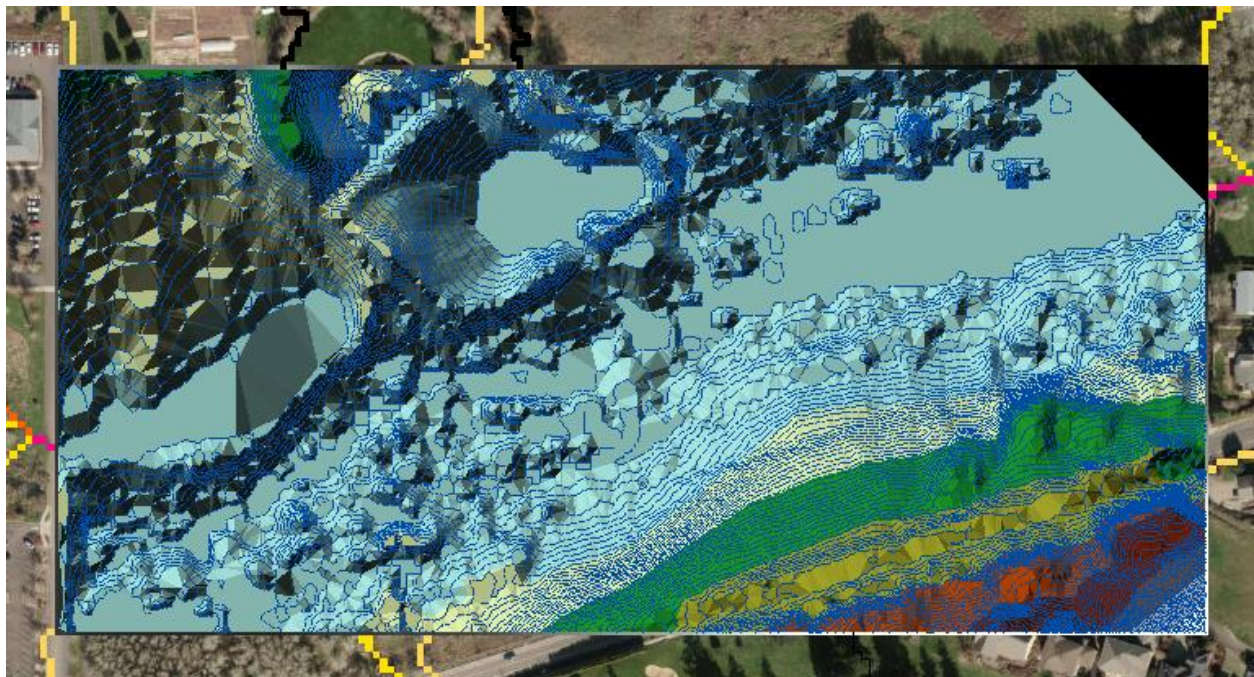


Figure 5. Created TIN file.

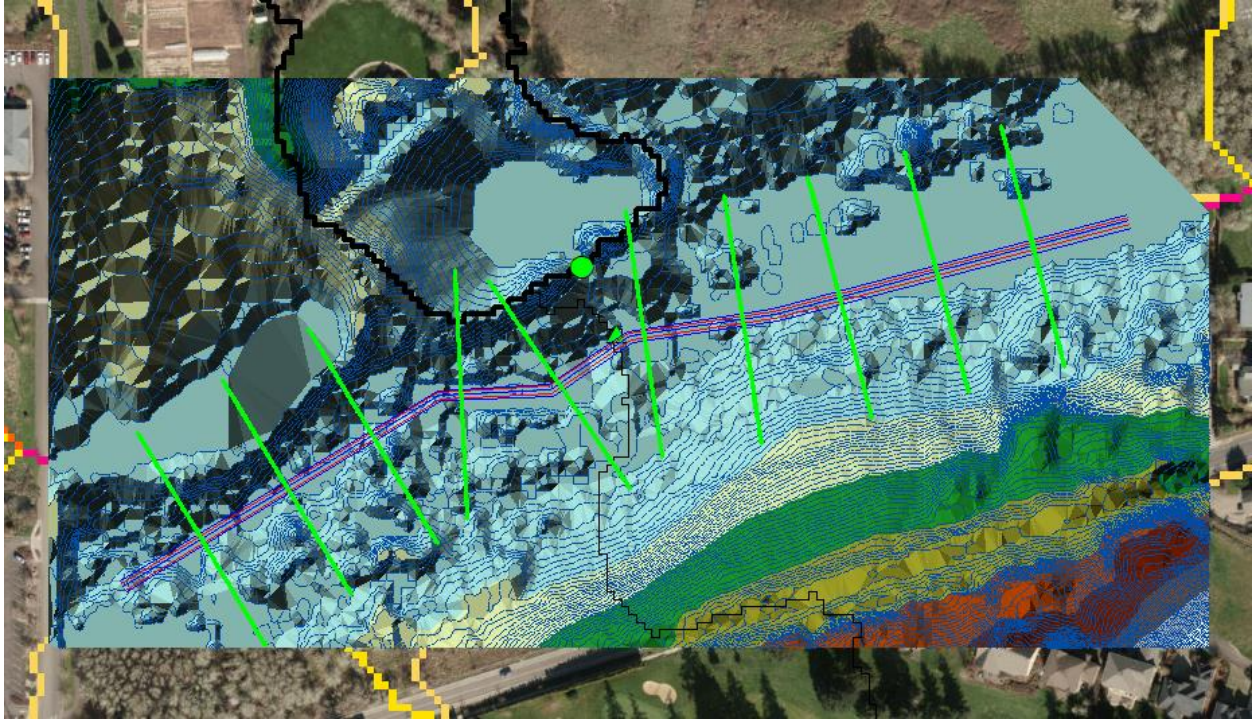


Figure 6. Setup centerline, banks, flow paths, and cross-sectional cut lines.

5.2 Geospatial analysis hydraulic modeling

Start HEC-RAS import GIS data to HEC-RAS geometric data. Entering flow data and boundary conditions. Run HEC-RAS. Export HEC-RAS output to HEC-GeoRAS.

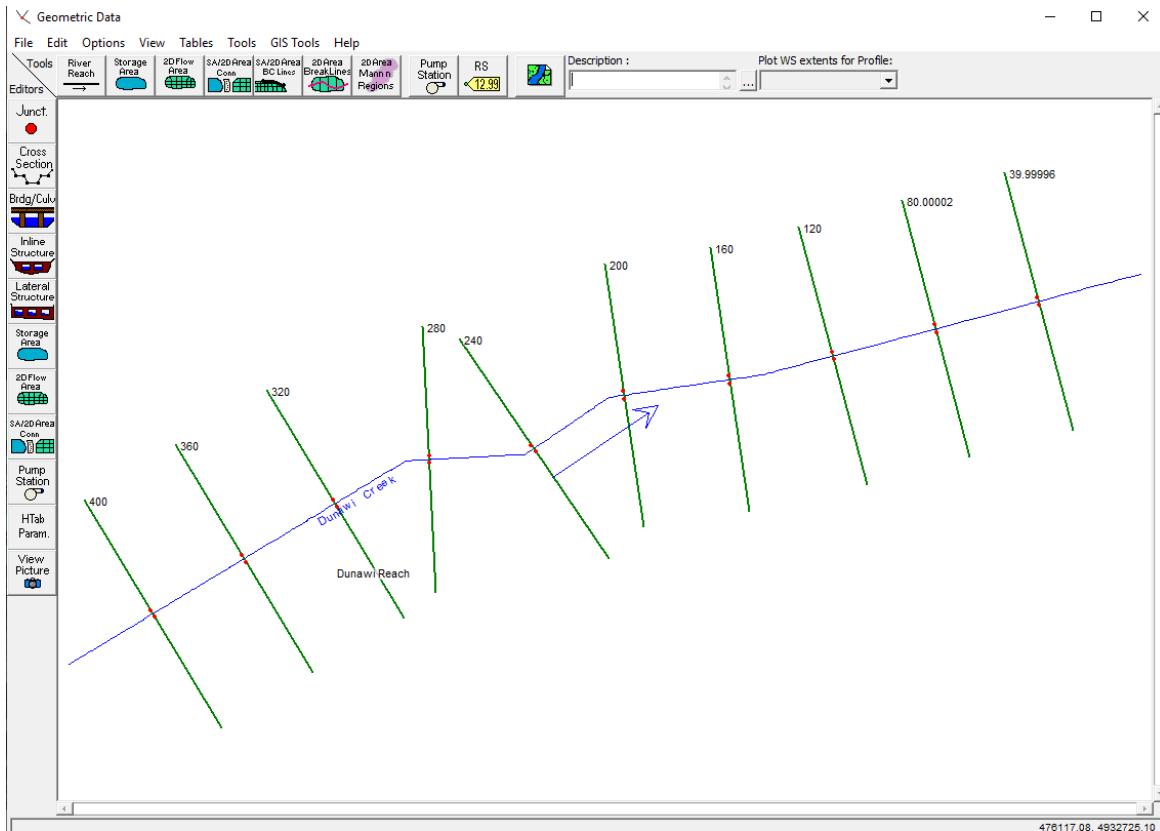


Figure 7. Geometric data in HEC-RAS.

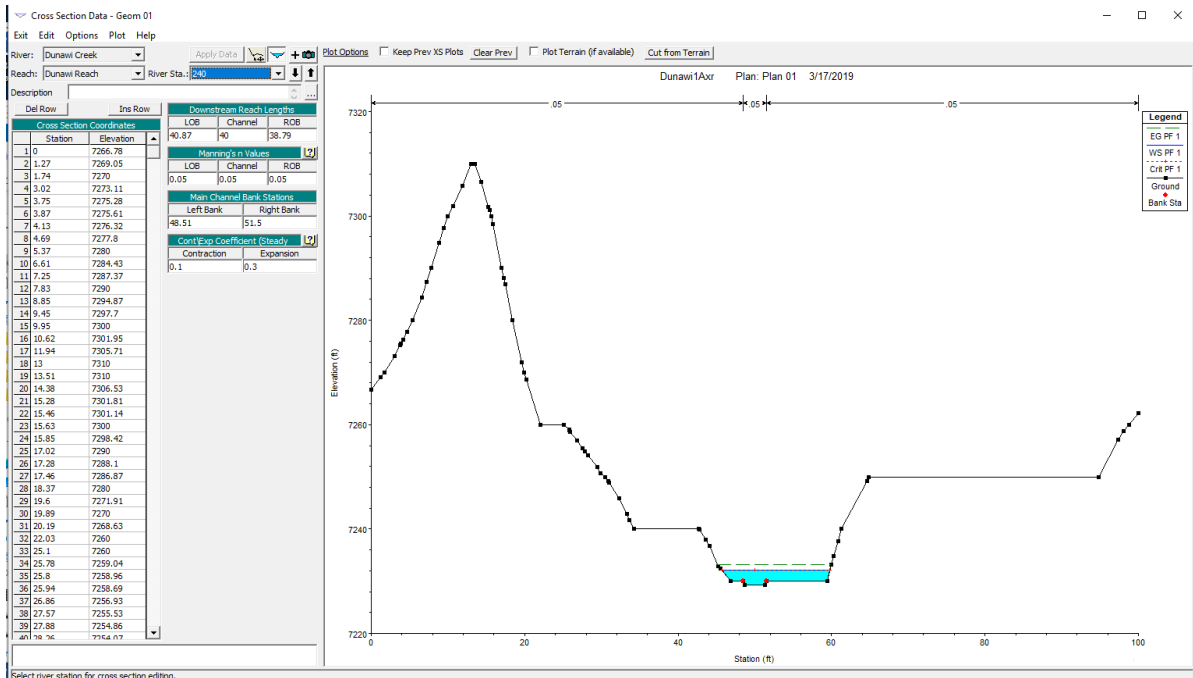


Figure 8. Cross-sectional data profile at wetland.

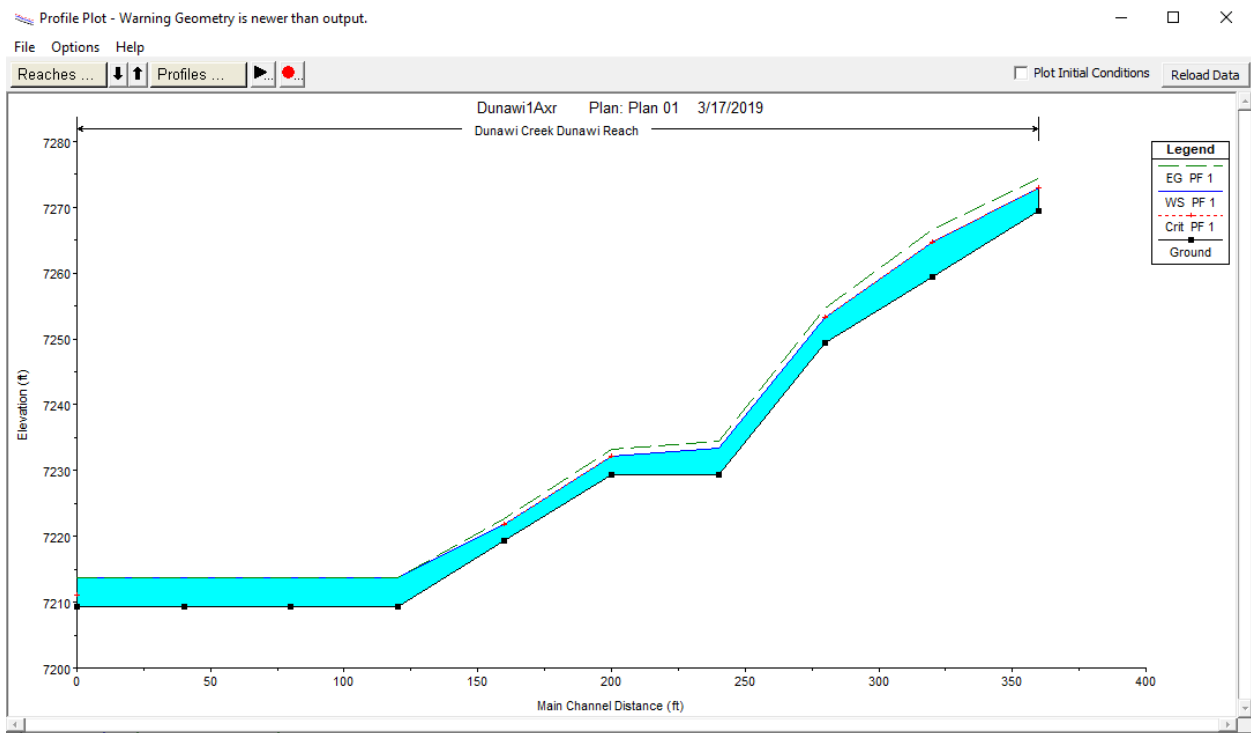


Figure 9. Profile plot of Dunawi Creek.

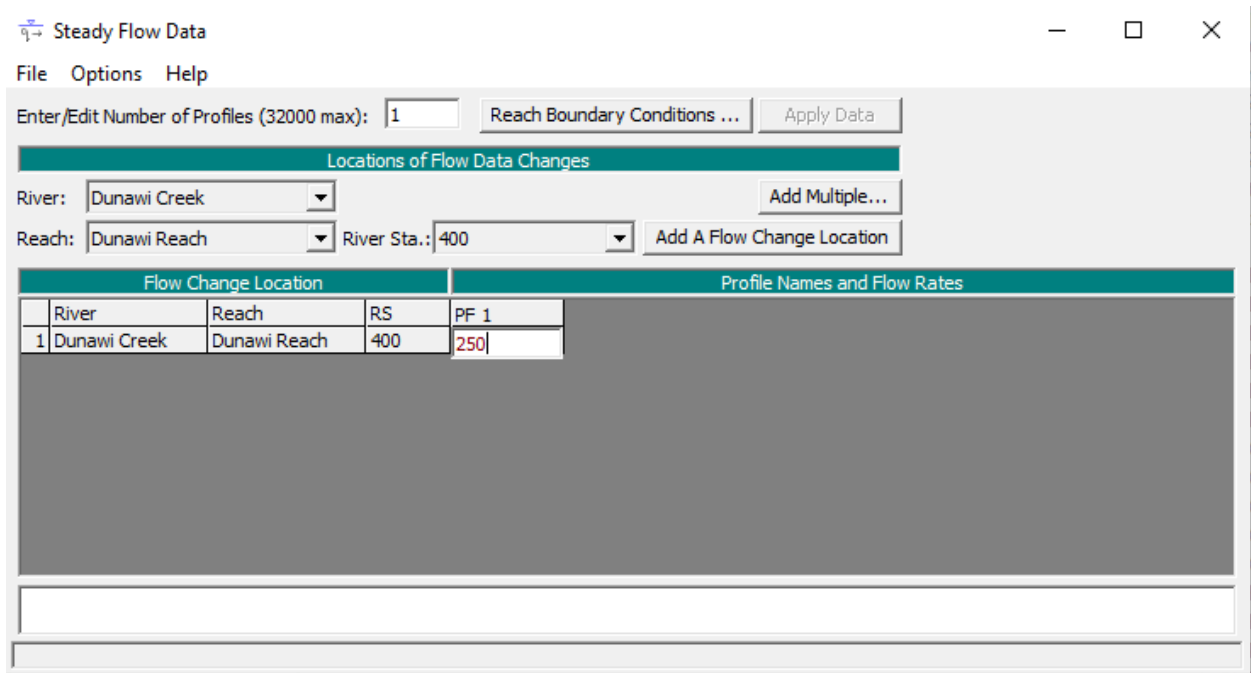


Figure 10. Peak discharge flow dataset.

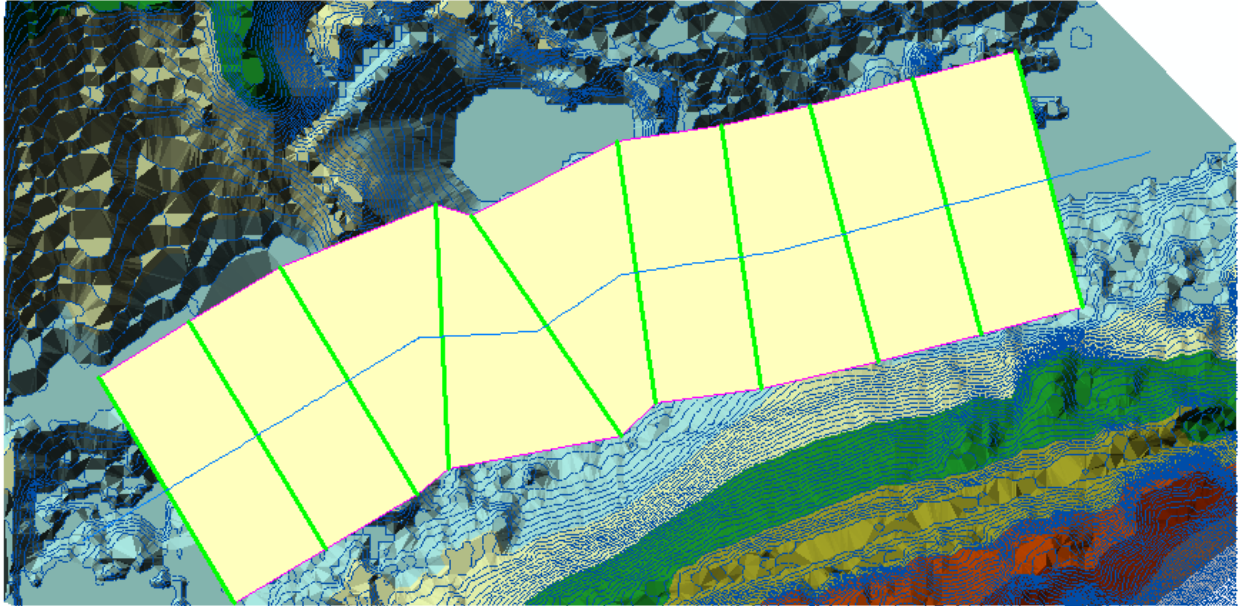


Figure 11. Water surface in HEC-geoRAS

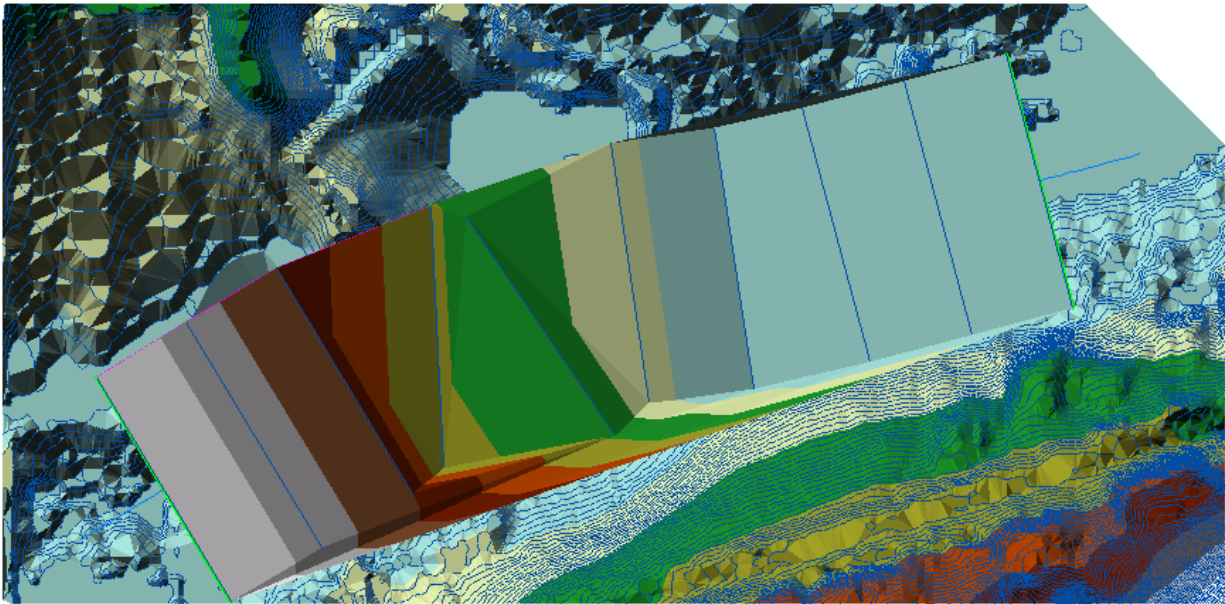


Figure 12. Water surface elevation.

6. Results

Creating tin from raster then setting up the stream centerline and all the boundaries for HEC_RAS making the procedure very simple and easy to run in HEC_RAS.

After importing RAS data to GIS the water surface created and converting it to Grid the area that have positive results it means water surface higher than terrain and the negative result are dry area.

After running HEC-GeoRAS, flood delineation was plotted. As shown in Figure xx, the flood delineation of Dunawi Creek covers the wetland, the polygon area at the wetland will give us the flooded volume. The peak discharge for Dunawi Creek was calculated by using TR-55 which was 250cfs. The volume will be calculated by the different of raster elevation of the water surface and

the elevation of ground elevation multiply by the area of polygon at the wetland.

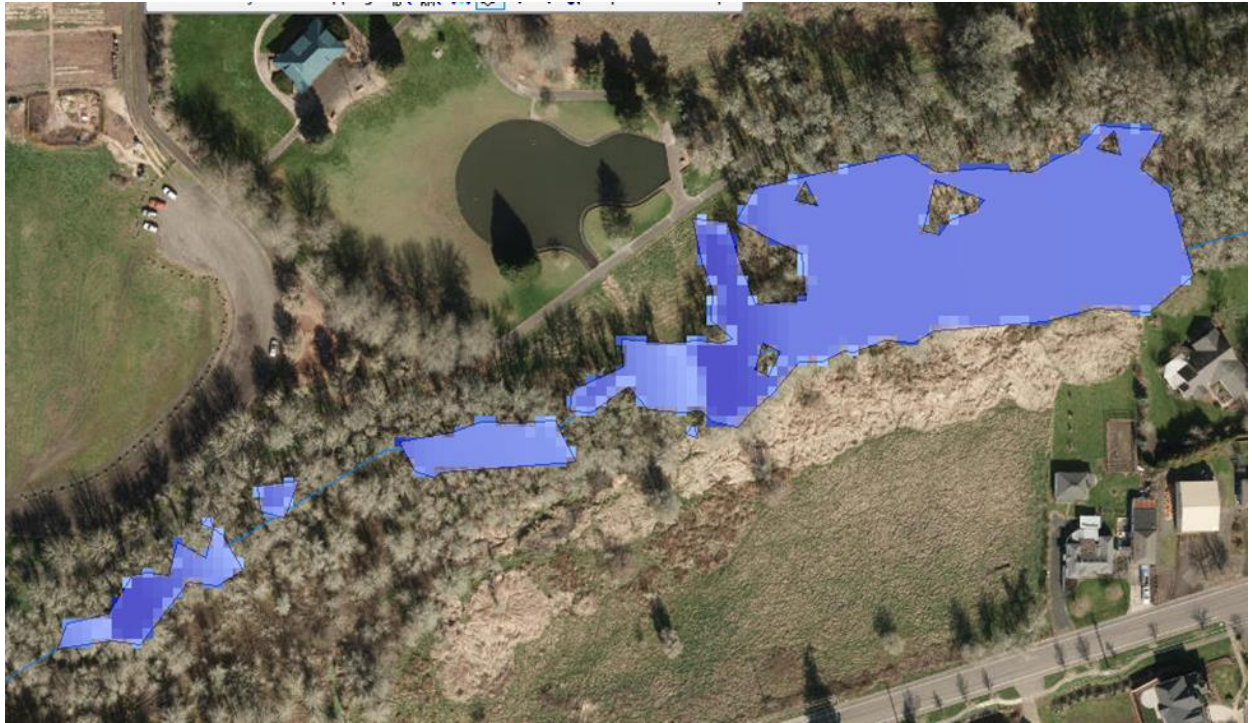


Figure 13. Flooding delineation on Lower Snake River.

7. Conclusion.

The use of GIS helped us to process large area of topographic and the needed information of the Dunawi Creek at the Bruce Starker Arts park Corvallis, Oregon. Then, HEC_RAS creates the profile of cross-section cut lines and the elevation of water surface. Thus, flood area delineation will be formed after importing the RAS data to HEC-GeoRAS.

Future Work:

From this output, we will be able to design the wetland according to the flood volume to prevent the flood in future.

8. References

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