CENE Capstone
Flagstaff Weighted Curve Number Research
Blue Wave Engineering

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Acknowledgements

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1.0 Project Introduction

Weighted curve numbers are used in estimating the amount of water that will not infiltrate during a storm event. The City of Flagstaff is experiencing higher than predicted amounts of flooding from runoff during smaller storm events. The Flagstaff Weighted Curve Number project aims to research how weighted curve number estimation can more accurately represent real-world runoff volumes from 2-yr, 10-yr and 100-yr storm events.

1.1 Project Location

The area chosen to be evaluated is near Fanning Dr. This neighborhood is located in East Flagstaff off of Route 66. This location was brought to the team as a possible study location by the City of Flagstaff due to the frequent flooding reported by citizens in the area. Current conditions are as described in Section 2.0 Site Investigation.

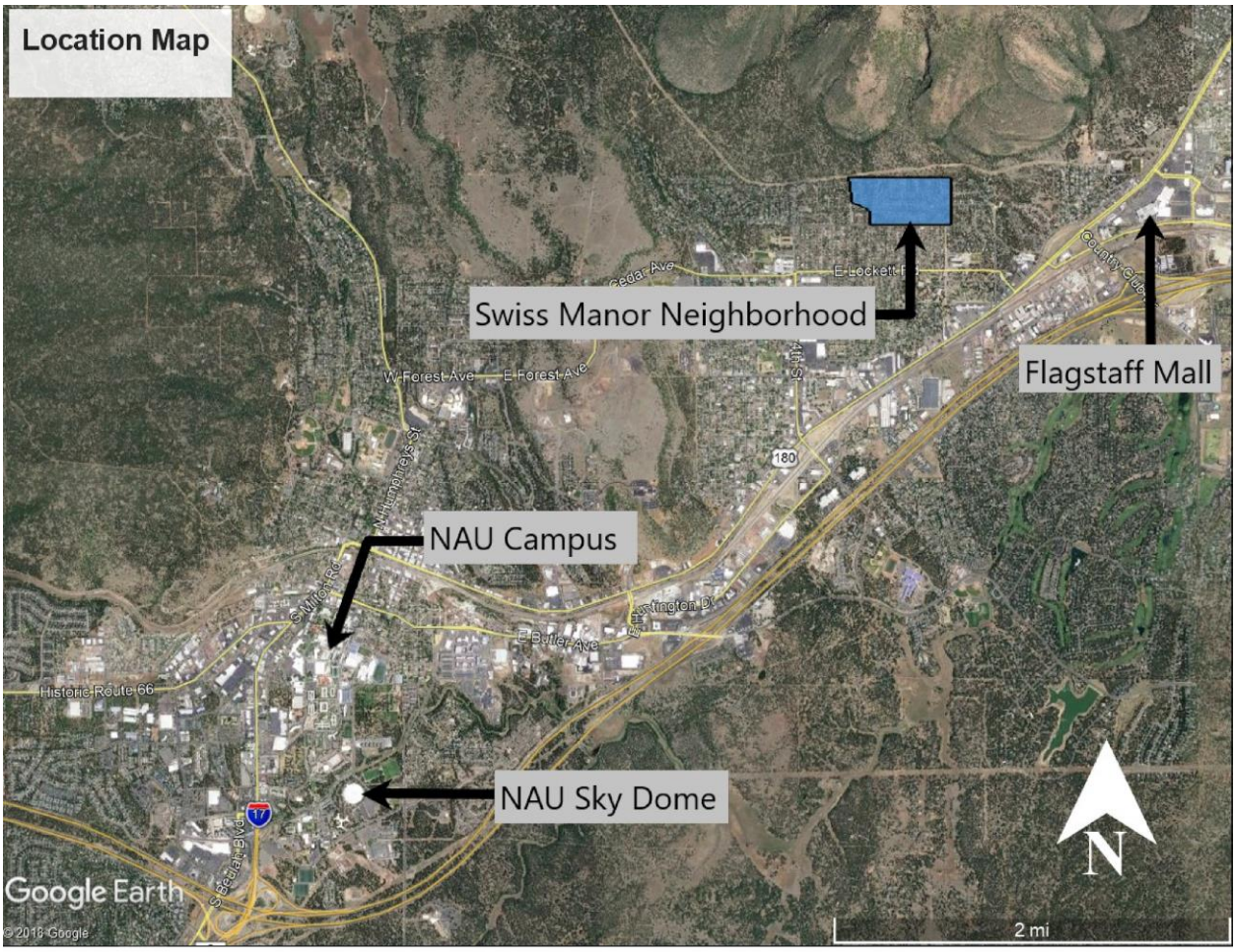


Figure A-1: Site Location Map

1.2 Constraints

The project constraints are dictated by the available data, site location, and the existing topography. Gathering the data is limited to only one gauge site located within the project watershed. This location collects stage elevation in a constructed channel, as well as precipitation depth. The gauge site is limited to data collected since May 2019 as the gauge site is extremely new. During the 2019 monsoon season, Flagstaff experienced a drier season than normal, limiting the amount of data recorded at the gauge site. Though this is not an abundance of data, this data is highly accurate and has a high degree of resolution. Supplemental historical data is only available for the Newman Canyon, Upper Lake Mary Gauge site, which the team determined was not representative enough of East Flagstaff to be beneficial to this project [1].

1.3 Objective

The main objective of this project is to determine whether the method used by the City of Flagstaff to calculate design flows is representative of what occurs during heavy rainfall events. HEC-HMS will be used to produce hydrographs of known storm events, to compare against the HEC-HMS hydrographs of the method the City of Flagstaff uses as well as assigning curve numbers to residential areas by land use. The curve numbers within the model will then be manipulated to produce a hydrograph that resembles the hydrograph of the known storm event.

2.0 Site Investigation

This phase of the project involved gathering and processing critical data used for further analysis. This phase started with the collection of topographic maps in the form of ArcGIS contours from the City of Flagstaff mapping portal. The contours were provided as a shape file with 2ft elevation intervals. An aerial image was collected from Google Earth to serve as a basemap. This was used heavily during all basin delineations, time of concentration delineation and the delineation of micro-basins based on surface type. This aerial map needed to be scaled to fit the contours and after some trial and error it was determined that the X-Y scale of the contours was in hundreds of miles.

The USGS Web Soil Survey was used as a guide to categorize the soil conditions within the area of the site. The mountainous region near our site is baldy rock outcrop with 16 to 60 percent slopes and the flat area at the base of the mountains is baldy stony loam with 2 to 15 percent slopes [2]. A full map from Web Soil Survey can be seen in Appendix A. Once the survey was obtained, the following step was to take a site visit. During this site visit, this is where the team confirmed the accuracy and understand the extents of what was obtained from the survey and what the soil is on the site.

The gauge station is located within the channel that intersects Linda Vista Dr. and goes south underneath the road. The gauge at this location was recently placed and has been producing data as of May 2019. During the 2019 summer monsoon season there was only one event significant enough to provide stage data at the gauge station. This stage data did not have a small enough resolution for the data to be used accurately in the modeling. The gauge station did however produce precipitation data that was used within the HEC-HMS model and can be seen in Appendix F.

3.0 Basin Delineation

Basin delineation graphically depicts the watershed area that drains to the concentration point and gauge site of the chosen location. The City of Flagstaff GIS division provided the necessary contours for the northeast side of the City of Flagstaff that covers the Swiss Manor neighborhood. These contours were placed into AutoCAD to delineate the major basin boundary by following the Coconino County Drainage Manual. Starting at the concentration point, perpendicular lines to the contours were drawn to show where water would run if it were to be dropped at any location. Ridges, rivers and channels were followed to delineate the watershed. This process was followed until the delineation returned to the concentration point. StreamStats was used to check the general shape and size of the delineation done by hand.

The sub-basin boundaries were determined and drawn by following the ridges, rivers, and channels from the contours. The purpose of the sub-basins were to split up the large area into more manageable areas where the time of concentration would not exceed 60 minutes as defined in the City of Flagstaff Stormwater Manual [3]. Along with the time of concentration the major basin was split up by surface type and slope to create eight separate sub-basins. Sub-bains 1 and 3 run the western side of Mt. Elden and join together in sub-basin 2 which ends at the natural channel to the northwest of the neighborhoods. Sub-basins 4 and 5 also run on the west side of Mt. Elden and join together in sub-basin 6. Sub-basin 6 also ends at the natural channel to the northwest of the neighborhoods. Sub-basin 7 runs off the central area of Mt. Elden and runs into sub-basin 8. Sub-basin 8 is the base of Mt. Elden including the neighborhood. Table 3-1 shows a summary of the area associated with each sub-basin and exhibits of all sub-basins can be seen in Appendix B.

Table 3-1: Sub-Basin Areas

Sub Basin	Area (mi^2)	Area (acres)	Percent of Total Area
1	0.393	251.3	15.0
2	0.109	69.6	4.2
3	0.045	28.7	1.7
4	0.187	119.5	7.1
5	0.233	149.0	8.9
6	0.055	34.9	2.1
7	1.118	715.4	42.8
8-Nat	-	223.3	13.3
8-Urban	-	81.1	4.8
8- Total	0.4757	304.4	18.2
SUM	2.614	1672.9	100.0

Surface type areas were defined in the basin region as houses, streets and driveways. The reason for delineating and identifying by surface type is to determine the curve number for urban regions based on the area weighted method instead of a standard number for developed land. The computation of the time of concentration was done as outlined in section 4.2 Time of Concentration. However, the process of delineating the surface type areas was entirely done in ArcMap - ArcGIS where the database map can be placed underneath the contours. This helped to determine the areas of houses, driveways, and streets.

4.0 Runoff Routing

4.1 Path Delineation

The time of concentration path was determined using AutoCAD showing a line that represents the water flow. The time of concentration path is the longest route a drop of water can take to reach the concentration point. When delineating the time of concentration, general practice is to cross elevation lines at a perpendicular angle in the shortest possible distance between elevations.

4.2 Time of Concentration

A combination of equations 1-3 were used to calculate the time of concentration for each sub-basin. To find the time of concentration, first, each path was broken into the various flow types that were present in each sub-basin. This was sheet flow, shallow concentrated, open channel flow and curb flow. Each of these flows have restrictions based on the City of Flagstaff Stormwater manual [3]. Manning's coefficients were selected from the Flagstaff Drainage Manual for use in equations 1 and 3. Slope was identified by using the contours to find elevations and length along the time of concentration line for [5] shallow concentrated flow and open channel flow. Using this information the time of concentration could be calculated for each sub-basin. The time of concentration was then used to calculate the lag time for HEC-HMS using equation 4. Table 4-1 shows the time of concentration and lag time for each sub-basin.

Table 4-1: Sub-Basin Time of Concentration

Time of Concentration and Lag Time Summary		
Sub-Basin	**Time of Concentration (min)**	**Lag Time (min)**
Sub-Basin 1	25	45
Sub-Basin 2	24	44
Sub-Basin 3	11	37
Sub-Basin 4	43	56
Sub-Basin 5	14	39
Sub-Basin 6	9	35
Sub-Basin 7	32	49
Sub-Basin 8	33	50

5.0 Centroid Analysis

The determination of the centroid analysis was done for the major basin and sub-basins. This process was completed to define the centroid of a specific region using the x and y coordinate system points of the selected region (basin or sub-basin) in AutoCAD. The purpose of defining the centroid point of each sub-basin and the major basin was to identify the shape and uniformity of the watershed without using external sources such as imagery maps or topographic maps. This also gives a general idea of how close the time of concentration path is to the center of the basin.

6.0 Curve Numbers

Curve numbers were assigned to each sub-basin based on the Web Soil Survey from USGS, and the land use type from the curve numbers identified in TR-55 [4] and The Oak Creek Flood Warning System Hydrology Report [5]. All the land within the area of interest is categorized as hydrological group B as stated within the USGS Soil Survey Report [2]. Sub-basins 1, 3, 5, and 7 were identified as Mixed Conifer, with poor drainage characteristics. Sub-basins 2, 4, and 6 were identified as Mixed Conifer with fair drainage characteristics. The method used to determine the weighted curve number for Sub-basin 8 was altered by changing the area of different components in the respect to the goal of that specific simulation. Further information on curve number generation and alteration can be found above the corresponding table.

For the TR-55 approach simulation the curve number was created by combining the curve numbers for the natural area defined as Mixed Conifer and the ¼ acre urban parcel based on area. The land use approach uses a weighted curve number generated based on curve numbers assigned for the natural area, the roads and the parcel area. The weighted curve number for the urban area was calculated by dividing up each parcel's area by land cover type and assign a weighted curve number to the individual parcel. These weighted curve numbers were then averaged to find the weighted curve number for the urban residential area. To find the weighted curve number for the urban area, the area of roofs, landscaping, lawn, driveways, and roadways were measured. The curve number for each type of surface was determined. The area weighted method was then used to determine the weighted curve number of the urban developed area based on actual land use type.

Table 6-1: Curve Numbers for TR-55 Approach

Curve Numbers for TR-55 Approach			
Sub Basin	**Area (acres)**	**Curve Number**	**Description**
1	251.3	71	B, Mixed Conifer, Poor
2	69.6	53	B, Mixed Conifer, Fair
3	28.7	71	B, Mixed Conifer, Poor
4	119.5	71	B, Mixed Conifer, Poor
5	149.0	71	B, Mixed Conifer, Poor
6	34.9	53	B, Mixed Conifer, Fair
7	715.4	71	B, Mixed Conifer, Poor
8-Nat	223.3	53	B, Mixed Conifer, Fair
8-Urban	81.1	75	B, 1/4 Acre Lots
8- Total	304.4	59	Basin 8 total weighted CN

Table 6-2: Curve Numbers Land Use Approach

Curve Numbers for Land Use Approach			
Sub Basin	**Area (acres)**	**Curve Number**	**Description**
1	251.3	71	B, Mixed Conifer, Poor
2	69.6	53	B, Mixed Conifer, Fair
3	28.7	71	B, Mixed Conifer, Poor
4	119.5	71	B, Mixed Conifer, Poor
5	149.0	71	B, Mixed Conifer, Poor
6	34.9	53	B, Mixed Conifer, Fair
7	715.4	71	B, Mixed Conifer, Poor
8-Natural	223.3	53	B, Mixed Conifer, Fair
8-Parcel	52.1	78	B, Based on Detailed Analysis
8- Road	29.0	98	B, Based on Detailed Analysis
8- Total	304.4	62	Basin 8 total weighted CN

The calculated curve numbers seen below were created for a simulation to see the effect of increasing the developed area on discharge. These values were generated by increasing the developed area within the basin from 81.1 acres to 200 Acres. For curve numbers developed based on surface type the ratio between parcels and streets were kept constant. This alteration shows a large in the final totaled curve number.

Table 6-3: TR-55 Increased Development Area Altered Curve Numbers

TR-55 Increased Development Area Altered Curve Numbers			
Sub Basin	**Area (acres)**	**Curve Number**	**Description**
8-Nat	104.448	53	B, Mixed Conifer, Fair
8-Urban	200	75	B, 1/4 Acre Lots
8- Total	**304.448**	**67**	**Basin 8 total weighted CN**

Table 6-4: Land Use Increased Development Area Altered Curve Numbers

Land Use Increased Development Area Altered Curve Numbers			
Sub Basin	**Area (acres)**	**Curve Number**	**Description**
8-Natural	104.4483	53	B, Mixed Conifer, Fair
8-Parcel	128.531	78	B, Based on Detailed Analysis
8- Road	71.4687	98	B, Based on Detailed Analysis
8- Total	**304.448**	**74**	**Basin 8 total weighted CN**

An additional set of curve numbers were created to investigate the effect of increasing impervious area within each individual parcel. This was done by increasing the area of each house by 25 percent thus increasing the impervious area by 25 percent. The resulting curve number was only altered by one, as seen in Table 6-5 below. The curve numbers in Table 6-5 were used for developed areas, as increasing the impervious area within the parcel has no effect on this method of curve number selection.

Table 6-5: Land Use Increased Development Area and Home Size Altered Curve Numbers

Land Use Increased Development Area and Home Size Altered Curve Numbers			
Sub Basin	**Area (acres)**	**Curve Number**	**Description**
8-Natural	104.4483	53	B, Mixed Conifer, Fair
8-Parcel	128.531	81	B, Based on Altered Detailed Analysis
8- Road	71.4687	98	B, Based on Detailed Analysis
8- Total	**304.448**	**75**	**Basin 8 total weighted CN**

7.0 HEC-HMS Model

To run the HEC-HMS model, the layout for the sub-basins and sub-basin information was input into HEC-HMS. Input information can be found in Appendix F. Using equation 4 the lag time was calculated and input into the software. The curve numbers and area for each sub-basin were assigned to each element in the basin model. A value of 0 for percent impervious was used for all sub-basins except sub-basin 8. For both models the urban area within sub-basin 8 used a percent impervious value of 12.49. This value was calculated by summing the area of the streets and the homes. The HEC-HMS model was then run for both the TR-55 approach and the Land Use approach to find the peak discharge at the gauge site. Results for both models can be found in Appendix G.

7.1 Increased developed area size and the impervious area

As described above, utilizing the same sub-basins and sub-basin information was inputted into HEC-HMS.Yet, this is when the development area size was increased to see how the curve numbers would affect the discharge values. In doing so, the percent impervious area was kept at standard value through each simulation that was done. These results can be found in Appendix G.

8.0 Runoff Volumes

Using HEC-HMS as outlined in section 7.0 HEC-HMS Model, the peak discharge rate for each model was found. HEC-HMS produced hydrographs of the flow rate throughout the storm. These flow rates represent the volume of water running off the entire watershed. The hydrograph can be found in Appendix G.

Table 8-1 shows the peak discharge associated with the first simulation that utilized the information attempting to model real world conditions found in the selected area of interest.

Table 8-1: Simulation Peak Discharge

Simulation Peak Discharge	
TR-55 Peak Discharge (cfs)	**Land Use Peak Discharge (cfs)**
413.2	417.9

The following table presents the resulting peak discharges from the simulation that increased developed area. This simulation utilized identical data to the simulation seen in Table 8-1 other than the curve numbers which were taken from Table 6-3 and Table 6-4. This allowed for the collection of evidence of a direct effect of developed area alteration when compared to Table 8-1.

Table 8-2: Increased Development Area Simulation Discharge

Increased Development Area Simulation Discharge	
TR-55 Peak Discharge (cfs)	**Land Use Peak Discharge (cfs)**
426.9	443.4

The results seen below represent an alteration to the house of size which effectively changes the impervious area within each parcel. These results should be compared to Table 8-2. This simulation used curve numbers found in Table 6-3 for the TR-55 method and Table 6-5 for the surface type based curve numbers.

Table 8-3: Increased Development and Home Size Area Simulation Discharge

Increased Development and Home Size Area Simulation Discharge	
TR-55 Peak Discharge (cfs)	**Land Use Peak Discharge (cfs)**
430.5	449.5

9.0 Results

The collected data from the first HEC-HMS simulation found in Table 8-1 shows very little variation between the two curve number selection methods. As seen in Table 8-1 the peak discharge created by the land use method is 4.7 cubic feet per second (cfs) higher than the TR-55 method. This variation serves as a comparison between the detailed curve number for Basin-8 seen in Table 6-2 and the TR-55 curve numbers for developments by lot size seen in Table 6-1. From this first simulation it was concluded that differences between methods were being drowned out by the large contributing watershed as there was a significant difference between sub basin-8 total curve numbers.

A second simulation was completed to attempt to reduce the effect of the larger upper basin. The results seen in table 8-2 represent a simulation where the developed area was increased to 200 acres. The variation between the methods for this simulation greatly increased from 4.7 cfs to 16.5 cfs. This simulation shows that the accuracy of TR-55 methods will decrease as the development size increases.

An additional simulation was conducted to analyze the effect of increasing the amount of impervious area within each parcel. To model this the area of the homes were increased by 25 percent effectively increasing the impervious area in the parcel. This changed the variation between the TR-55 method and

the Land use method from 16.5 cfs to 19 csf. This shows how sensitive the model is to small changes to impervious area within large developments. When this methodology was applied to the real world conditions used in the first simulation there was no change in discharge. This occurred because the area of the parcels was not large enough to have an effect on the total basin curve number.

The accuracy of the peak discharges produced by HEC-HMS are largely affected by the hydrologic soil group taken from the Soil Survey Report and the assumed ground cover. The accuracy of this evaluation could be increased by evaluating the soil conditions through soil testing. This evaluation would not affect the variation between the two simulations and would only have an effect on the accuracy of the peak discharge calculated from the entire watershed. A basin with a higher percent of urbanized area would provide a more accurate comparison between a detailed evaluation and the TR-55 method.

10.0 Impacts

10.1 Economic Impacts

The economic impacts due to the results of our project are changes in development regulation changes, flooding, property damage and the cost to carry out future simulations. In the studied watershed there is no significant change in outflow with changes in the curve number. This means that flooding will still continue to happen around the Fanning neighborhood of Flagstaff. Knowing that flooding will continue to happen, development regulations may become more restrictive to help mitigate the flooding problems, raising the cost of new development and redevelopment in the area. This can cause home prices to increase making it economically more difficult for families to purchase a house. The continued flooding will also cause property damage to homes in this area. The property damage will be a continue extra cost to families in this area as opposed to families that live in an area of Flagstaff that does not experience this type of flooding.

10.2 Social Impacts

The largest social impact of continued flooding is the possibility of these areas to become abandoned. As stated in the economical impacts the cost of housing could rise in Flagstaff because of the flooding. Families not wanting to move to the Fanning area either because of cost or because of the known flooding means this area may slowly lose population. This impacts the social aspect of the area because as more people move out of the area less and less people will move to the area. Most families will not desire to move to a location knowing that there is a high possibility of their house being damaged by flooding.

10.3 Environmental Impacts

The main environmental impact of the research is the continued flooding that will occur in the Fanning neighborhood. Flooding can cause erosion to the natural channels within the watershed. This can damage the natural landscape. Along with sediment from erosion, the water will carry contaminants off of impervious surfaces and eventually lead to the Rio de Flag. This contaminated water will negatively impact wildlife in the Rio de Flag and any wildlife that relies on the Rio de Flag. There will also be a negative environmental impact from the materials needed to continue protecting property from flooding and repairing property damage.

11.0 Summary of Engineering Work

11.1 Scope

One major modification to the scope of this project is the elimination of a site. Presidio in the Pines was removed from the project due to insufficient gauge data for this area. Without accurate gauge data for this location, the resulting analysis would have been highly extrapolated to fit the area. With the input from both the client and grading instructor, it was determined that focusing time on one site would provide better results and ensure the team would fully complete one site to the best of their abilities.

11.2 Schedule

Appendix J-1 shows the expanded proposed schedule with all milestones. Appendix J-2 shows the schedule of completed work to date. Actual time is shown by the green bars. The project was completed on time. While some tasks took longer than expected, the team was able to shorten other tasks to make up for this lost time.

12.0 Summary of Engineering Cost

12.1 Staffing

Appendix H-1 shows the original staffing table for all milestones. Appendix H-2 shows the hours completed. The team has not exceed the estimated hours due to the significant reduction in scope. Highlighted in yellow are the tasks where the actual hours worked exceeded the proposed hours. These tasks when over on hours because they were the four main tasks that made up our project. Table 12-1 shows a summary comparison of the hours.

Table 12-1: Hours Summary

	Proposed					Actual				
Tasks	**SENG**	**ENG**	**EIT**	**AA**	**Total**	**SENG**	**ENG**	**EIT**	**AA**	**Total**
Task 1: Site Investigation	1	8	35	0	**44**	2	0	31.5	0	**33.5**
Task 2: Basin Delineation	0	7	21	0	**28**	2	10	51.5	0	**63.5**
Task 3: Runoff Routing	0	14	13	0	**27**	3	10	24	0	**37**
Task 4: Centroid Analysis	0	2	6	0	**8**	0	3	4	0	**7**
Task 5: Curve Numbers	2	6	22	0	**30**	7	9	30.5	0	**46.5**
Task 6: Runoff Volumes	2	11	48	0	**61**	0	0	0	0	**0**
Task 7: HEC-HMS Model	1	7	21	0	**29**	3	10	17.5	0	**30.5**
Task 8: Bench Model Simulation	1	10	26	0	**37**	0	0	0	0	**0**
Task 9: Evaluation of Results	8	16	24	0	**48**	0	8	9	0	**17**
Task 10: Project Impacts	6	30	0	0	**36**	0	4	0	0	**4**
Task 11: Project Deliverables	30	33	91	11	**165**	6	11	68	2	**87**
Task 12: Project Management	118	179	0	26	**323**	8.5	6.5	62.5	7	**84.5**
Total Hours	**169**	**323**	**307**	**37**	**836**	**31.5**	**71.5**	**298.5**	**9**	**410.5**

12.2 Cost

Appendix I-1 shows the proposed total cost of engineering services. Appendix I-2 shows the cost of engineering services. The cost of engineering services is well under budget because of the reduction in scope and hours. The elimination of the bench model simulation removed the lab supply cost further ensuring the team is under budget.

13.0 Conclusion

The original objective of this project was to determine whether the method used by the City of Flagstaff to calculate design outflows for a large watershed is an accurate assessment of actual flows. This was completed by comparing the accuracy of TR-55 development curve numbers against land use curve numbers built based on surface type and land use. The simulations show that there is very little variation between the discharge generated by the two methods within the modeled swiss manor neighborhood. It was found that there is significant variation between the two methods of generated curve numbers, this could cause an underestimation of discharge in larger developments.

14.0 References

[1]"USGS WaterWatch -- Streamflow conditions", *Waterwatch.usgs.gov*, 2019. [Online]. Available: https://waterwatch.usgs.gov/?m=real&r=az. [Accessed: 24- Sep- 2019].
[2]"Web Soil Survey - Home", *Websoilsurvey.sc.egov.usda.gov*, 2019. [Online]. Available: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. [Accessed: 24- Sep- 2019].
[3]*City of Flagstaff Stormwater Management Design Manual*. Flagstaff: City of Flagstaff Stormwater Division, 2009.
[4]United States Department of Agriculture, Natural Resources Conservation Service, "Urban Hydrology for Small Watersheds Technical Release 55", 1986.
[5]Arizona Department of Water Resources Engineering Division, Flood Management Section, “Oak Creek Flood Warning System Hydrology Report”, 1990
[6]U.S. Army Corps of Engineers, "Hydrologic Modeling System HEC-HMS User's Manual", 2018.

15.0 Equations

Time of Concentration Estimation Equations

Equation 1: Overland or Sheet Flow [3]

$$T_t = [0.007(nL)^{0.8}/(2.0)^{0.5}S^{0.4}]$$

Where:
T_t = sheet flow travel time, hr
n = Manning's roughness coefficient
L = flow length, ft
s = land slope, ft/ft

Equation 2: Shallow Concentrated Flow [3]

Unpaved: $V = 16.1345(S)^{0.5}$

Paved: $V = 20.3282(S)^{0.5}$

Where:
V = average velocity, ft/s
S = slope of hydraulic grade line, ft/ft

Equation 3: Open Channel Flow [3]

$$V = (1.49r^{2/3}s^{1/2})/n$$

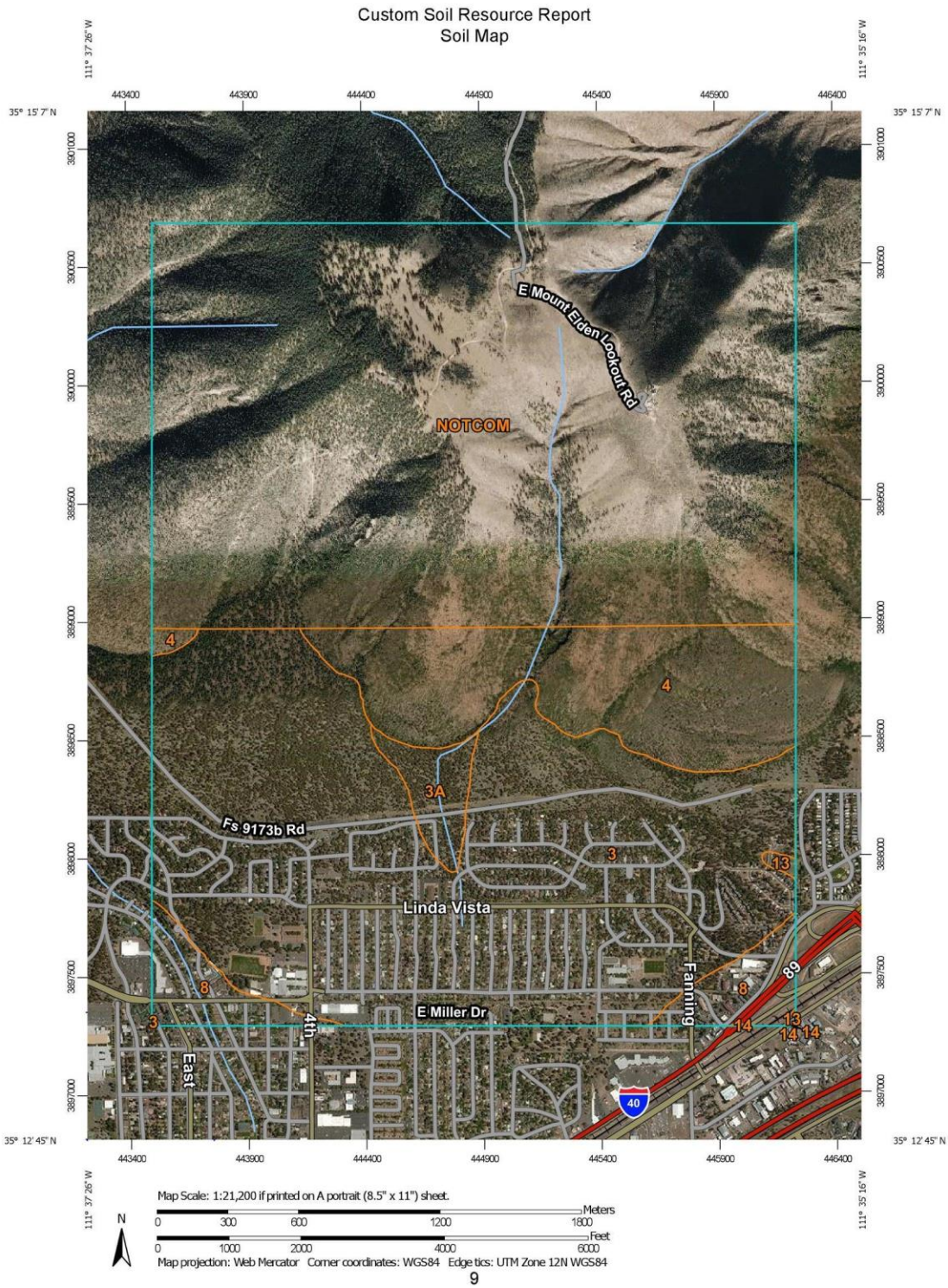
Where:
V = velocity, ft/s
R = hydraulic radius, ft
S = slope of hydraulic grade line, ft/ft
n= Manning's roughness coefficient

Equation 4: Lag Time [6]

$$L = \frac{D}{2} + T$$

Where:
L = lag time, min
D = storm duration, min
T = time of concentration, min

16.0 Appendices
Appendix A: USGS Soil Survey



Appendix A-1: Soil Report Map

Map Unit Symbol	Map Unit Name	Percent of Area of Interest
3	Baldy stony loam, 2 to 8 percent slopes	34.6
3A	Baldy stony loam, 8 to 15 percent slopes	1.4
4	Baldy rock outcrop association, 15 to 60 percent	10.2
8	Paymaster family fine sandy loam, 0 to 3 percent slopes	3.4
13	Lynx loam, 0 to 2 percent	0.1
14	Daze fine sandy loam, 0 to 8 percent slopes	0
NOTCOM	No digital data available	50.3

Appendix A-2: Soil Report Map Legend

Appendix B: Basin Delineation Exhibits

Appendix B-1: Basin Delineation

Appendix C: Time of Concentration Calculations

Appendix C-1: Time of Concentration Exhibit

Appendix C-2: Sub-Basin 1 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
299.87	9070	9056	0.047	Sheet	Natural	0.13		18.96
4186.36	9056	7724	0.050	Channelized	Natural	0.05	12.25	5.70
						Total Time (min)		24.65

Appendix C-3: Sub-Basin 2 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
6594.08	7724	7112	0.093	Channelized	natural	0.1	5.60	19.64
971.14	7112	7056	0.058	Concentrated	Natural	0.4	3.87	4.18
						Total Time (min)		23.81

Appendix C-4: Sub-Basin 3 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
286.45	8554	8440	0.398	Sheet	Natural	0.13		7.76
1837.07	8440	7692	0.407	Concentrated	Natural	0.13	10.30	2.97
639.78	7692	7554	0.216	Channelized	Natural	0.05	21.68	0.49
						Total Time (min)		11.22

Appendix C-5: Sub-Basin 4 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
295.88	9034	8984	0.169	Sheet	natural	0.13		11.21
9406.49	8984	7724	0.134	Concentrated	Natural	0.13	5.91	26.55
2994.02	7724	7418	0.102	Channelized	Natural	0.05	9.87	5.06
						Total Time (min)		42.81

Appendix C-6: Sub-Basin 5 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
288.01	8788	8692	0.333	Sheet	Natural	0.13		8.36
2066.91	8692	7876	0.395	Concentrated	Natural	0.13	10.14	3.40
1503.11	7876	7364	0.341	Channelized	Natural	0.05	9.87	2.54
						Total Time (min)		14.30

Appendix C-7: Sub-Basin 6 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
4151.89	7418	7062	0.086	Channelized	Natural	0.1	7.68	9.01
						Total Time (min)		9.01

Appendix C-8: Sub-Basin 7 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
275.50	9132	9120	0.044	Sheet	Natural	0.13		18.21
1652.42	9056	8994	0.038	Concentrated	Natural	0.13	3.13	8.81
7631.92	8994	7272	0.226	Channelized	Natural	0.05	26.85	4.74
						Total Time (min)		31.76

Appendix C-9: Sub-Basin 8 Time of Concentration

Distance (ft)	Elev 1	Elev 2	Slope (ft/ft)	Flow Type	Material	Mannings	v (ft/s)	T (min)
1631.88	7272	7146	0.077	Channelized	Natural	0.1	5.04	5.39
1773.00	7146	7062	0.047	Concentrated	Natural	0.4	3.51	8.41
3766.66	7062	6960	0.027	Concentrated	Urban	0.011	3.35	18.77
						Total Time (min)		32.57

Appendix D: Centroid Analysis Exhibit

Appendix D-1: Centroid Exhibit

Appendix E: Area and Weighted Curve Number

Appendix E-1: Sub-Basin Area and TR-55 Curve Number Calculations

Sub Basin	Area (ft^2)	Area (Hund. Mile. ^2)	Area (mi^2)	Area (acres)	Percent of Total Area	Curve Number	Description
1	10947848	0.00003927	0.393	251.3	15.0	71	B, Mixed Conifer, Poor
2	3033170	0.00001088	0.109	69.6	4.2	53	B, Mixed Conifer, Fair
3	1251740	0.00000449	0.045	28.7	1.7	71	B, Mixed Conifer, Poor
4	5204897	0.00001867	0.187	119.5	7.1	71	B, Mixed Conifer, Poor
5	6490092	0.00002328	0.233	149.0	8.9	71	B, Mixed Conifer, Poor
6	1519373	0.00000545	0.055	34.9	2.1	53	B, Mixed Conifer, Fair
7	31162476	0.00011178	1.118	715.4	42.8	71	B, Mixed Conifer, Poor
8-Nat	-	-	-	223.3	13.3	53	B, Mixed Conifer, Fair
8-Urban	-	-	-	81.1	4.8	75	B, 1/4 Acre Lots
8- Total	13261755	0.00004757	0.4757	304.4	18.2	59	
SUM	72871350	0.00026139	2.614	1672.9	100.0		

Appendix E-2: Sub-Basin Area and Curve Number Calculation

Sub Basin	Area (ft^2)	Area (Hund. Mile. ^2)	Area (mi^2)	Area (acres)	Percent of Total Area	Curve Number	Description
1	10947848	0.00003927	0.393	251.3	15.0	71	B, Mixed Conifer, Poor
2	3033170	0.00001088	0.109	69.6	4.2	53	B, Mixed Conifer, Fair
3	1251740	0.00000449	0.045	28.7	1.7	71	B, Mixed Conifer, Poor

4	5204897	0.00001867	0.187	119.5	7.1	71	B, Mixed Conifer, Poor
5	6490092	0.00002328	0.233	149.0	8.9	71	B, Mixed Conifer, Poor
6	1519373	0.00000545	0.055	34.9	2.1	53	B, Mixed Conifer, Fair
7	31162476	0.00011178	1.118	715.4	42.8	71	B, Mixed Conifer, Poor
8-Nat	-	-	-	223.3	13.3	53	B, Mixed Conifer, Fair
8-Parcel	-	-	-	52.1	3.1	78	B, Based on Detailed Analysis
8- Road	-	-	-	29.0	1.7	98	B, Based on Detailed Analysis
8- Total	13261755	0.00004757	0.4757	304.4	18.2	62	B, Based on Detailed Analysis
SUM	72871350	0.00026139	2.614	1672.9	100.0		

Appendix E-3:Properties Area and Detailed Curve Number Calculations

Parcel ID	House Area (acs)	Parcel Area (acs)	Percent of Area	Curve Number	Landscape Area (acs)	Percent of Area	Landscape Type (Soil Type B)	Curve Number	Weighted Curve Number
2655	0.045	0.21	0.214	98	0.17	0.786	Grass Cover < 50%	79	83
2675	0.047	0.21	0.226	98	0.16	0.774	Grass Cover < 50%	79	83
2685	0.061	0.21	0.291	98	0.15	0.709	Grass Cover < 50%	79	85
2695	0.063	0.21	0.301	98	0.15	0.699	Grass Cover < 50%	79	85
2715	0.054	0.21	0.258	98	0.16	0.742	Grass Cover < 50%	79	84
2735	0.053	0.21	0.252	98	0.16	0.748	Grass Cover < 50%	79	84
2755	0.055	0.21	0.264	98	0.15	0.736	Grass Cover < 50%	79	84
2775	0.042	0.21	0.199	98	0.17	0.801	Grass Cover < 50%	79	83
3880	0.078	0.30	0.259	98	0.22	0.741	Grass Cover < 50%	79	84
3884	0.069	0.25	0.275	98	0.18	0.725	Grass Cover < 50%	79	84
3890	0.052	0.28	0.186	98	0.23	0.814	Grass Cover < 50%	79	83

3900	0.057	0.22	0.261	98	0.16	0.739	Grass Cover < 50%	79	84
3891	0.062	0.24	0.259	98	0.18	0.741	Grass Cover < 50%	79	84
3887	0.044	0.23	0.193	98	0.19	0.807	Grass Cover < 50%	79	83
3883	0.048	0.23	0.210	98	0.18	0.790	Grass Cover < 50%	79	83
3879	0.044	0.23	0.193	98	0.19	0.807	Grass Cover < 50%	79	83
2909	0.070	0.21	0.336	98	0.14	0.664	Grass Cover < 50%	79	85
2929	0.045	0.22	0.206	98	0.17	0.794	Grass Cover < 50%	79	83
2939	0.034	0.27	0.125	98	0.24	0.875	Grass Cover < 50%	79	81
2810	0.085	0.27	0.313	98	0.19	0.687	Grass Cover < 50%	79	85
2690	0.053	0.18	0.293	98	0.13	0.707	Grass Cover < 50%	79	85
2680	0.069	0.18	0.382	98	0.11	0.618	Grass Cover < 50%	79	86
2540	0.063	0.17	0.369	98	0.11	0.631	Grass Cover < 50%	79	86
3800	0.055	0.20	0.277	98	0.14	0.723	Grass Cover < 50%	79	84
3824	0.060	0.18	0.332	98	0.12	0.668	Grass Cover < 50%	79	85
3852	0.047	0.18	0.259	98	0.13	0.741	Grass Cover < 50%	79	84
3856	0.069	0.18	0.384	98	0.11	0.616	Grass Cover < 50%	79	86
3860	0.057	0.19	0.299	98	0.13	0.701	Grass Cover < 50%	79	85
3864	0.066	0.18	0.369	98	0.11	0.631	Grass Cover < 50%	79	86
3875	0.077	0.21	0.368	98	0.13	0.632	Grass Cover < 50%	79	86
3871	0.060	0.18	0.336	98	0.12	0.664	Grass Cover < 50%	79	85
3869	0.055	0.18	0.306	98	0.12	0.694	Grass Cover < 50%	79	85
3865	0.038	0.19	0.200	98	0.15	0.800	Grass Cover < 50%	79	83
3837	0.041	0.18	0.230	98	0.14	0.770	Grass Cover < 50%	79	83
3833	0.047	0.18	0.263	98	0.13	0.737	Grass Cover < 50%	79	84

3829	0.049	0.18	0.273	98	0.13	0.727	Grass Cover < 50%	79	84
3805	0.058	0.18	0.320	98	0.12	0.680	Grass Cover < 50%	79	85
3801	0.040	0.20	0.200	98	0.16	0.800	Grass Cover < 50%	79	83
2637	0.054	0.22	0.245	98	0.17	0.755	Grass Cover < 50%	79	84
2807	0.056	0.22	0.258	98	0.16	0.742	Grass Cover < 50%	79	84
2811	0.037	0.22	0.170	98	0.18	0.830	Grass Cover < 50%	79	82
2800	0.052	0.21	0.251	98	0.15	0.749	Grass Cover < 50%	79	84
4045	0.071	0.33	0.213	98	0.26	0.787	Grass Cover < 50%	79	83
4005	0.050	0.24	0.209	98	0.19	0.791	Grass Cover < 50%	79	83
4000	0.048	0.22	0.221	98	0.17	0.779	Grass Cover < 50%	79	83
4075	0.084	0.33	0.255	98	0.25	0.745	Grass Cover < 50%	79	84
4055	0.051	0.21	0.243	98	0.16	0.757	Grass Cover < 50%	79	84
4035	0.053	0.24	0.222	98	0.19	0.778	Grass Cover < 50%	79	83
4015	0.055	0.21	0.260	98	0.16	0.740	Grass Cover < 50%	79	84
2640	0.038	0.21	0.181	98	0.17	0.819	Grass Cover < 50%	79	82
3940	0.066	0.31	0.212	98	0.24	0.788	Grass Cover < 50%	79	83
3950	0.053	0.21	0.255	98	0.16	0.745	Grass Cover < 50%	79	84
Total	2.883	11.32	0.255	98	8.44	0.745		79	84
3860	0.046	0.18	0.254	98	0.13	0.746	Grass Cover 50% to 75%	69	76
3850	0.044	0.18	0.242	98	0.14	0.758	Grass Cover 50% to 75%	69	76
3840	0.048	0.18	0.265	98	0.13	0.735	Grass Cover 50% to 75%	69	77
3832	0.076	0.18	0.423	98	0.10	0.577	Grass Cover 50% to 75%	69	81
3822	0.069	0.19	0.365	98	0.12	0.635	Grass Cover 50% to 75%	69	80
3812	0.051	0.21	0.243	98	0.16	0.757	Grass Cover 50% to 75%	69	76
2302	0.043	0.18	0.240	98	0.14	0.760	Grass Cover 50% to 75%	69	76

2324	0.066	0.18	0.367	98	0.11	0.633	Grass Cover 50% to 75%	69	80
2330	0.051	0.19	0.271	98	0.14	0.729	Grass Cover 50% to 75%	69	77
2823	0.066	0.21	0.315	98	0.14	0.685	Grass Cover 50% to 75%	69	78
2835	0.045	0.21	0.212	98	0.17	0.788	Grass Cover 50% to 75%	69	75
3847	0.063	0.20	0.313	98	0.14	0.687	Grass Cover 50% to 75%	69	78
3851	0.061	0.18	0.341	98	0.12	0.659	Grass Cover 50% to 75%	69	79
3861	0.072	0.18	0.398	98	0.11	0.602	Grass Cover 50% to 75%	69	81
2225	0.061	0.18	0.341	98	0.12	0.659	Grass Cover 50% to 75%	69	79
2200	0.053	0.27	0.195	98	0.22	0.805	Grass Cover 50% to 75%	69	75
2212	0.061	0.25	0.245	98	0.19	0.755	Grass Cover 50% to 75%	69	76
2222	0.046	0.23	0.200	98	0.18	0.800	Grass Cover 50% to 75%	69	75
2232	0.052	0.23	0.226	98	0.18	0.774	Grass Cover 50% to 75%	69	76
2242	0.090	0.32	0.281	98	0.23	0.719	Grass Cover 50% to 75%	69	77
3888	0.057	0.45	0.127	98	0.39	0.873	Grass Cover 50% to 75%	69	73
3876	0.070	0.52	0.134	98	0.45	0.866	Grass Cover 50% to 75%	69	73
3864	0.082	0.55	0.150	98	0.47	0.850	Grass Cover 50% to 75%	69	73
3852	0.106	0.52	0.205	98	0.41	0.795	Grass Cover 50% to 75%	69	75
3840	0.000	0.49	0.000	98	0.49	1.000	Grass Cover 50% to 75%	69	69
3836	0.068	0.47	0.144	98	0.40	0.856	Grass Cover 50% to 75%	69	73
3826	0.066	0.46	0.144	98	0.39	0.856	Grass Cover 50% to 75%	69	73
3814	0.072	0.40	0.179	98	0.33	0.821	Grass Cover 50% to 75%	69	74
3802	0.068	0.49	0.139	98	0.42	0.861	Grass Cover 50% to 75%	69	73
2351	0.063	0.48	0.130	98	0.42	0.870	Grass Cover 50% to 75%	69	73
2347	0.045	0.20	0.223	98	0.16	0.777	Grass Cover 50% to 75%	69	75

2335	0.062	0.21	0.296	98	0.15	0.704	Grass Cover 50% to 75%	69	78
2323	0.046	0.21	0.218	98	0.16	0.782	Grass Cover 50% to 75%	69	75
2301	0.054	0.20	0.270	98	0.15	0.730	Grass Cover 50% to 75%	69	77
2345	0.045	0.30	0.149	98	0.26	0.851	Grass Cover 50% to 75%	69	73
2365	0.050	0.26	0.193	98	0.21	0.807	Grass Cover 50% to 75%	69	75
2405	0.058	0.22	0.265	98	0.16	0.735	Grass Cover 50% to 75%	69	77
2465	0.057	0.30	0.189	98	0.24	0.811	Grass Cover 50% to 75%	69	74
2515	0.047	0.28	0.168	98	0.23	0.832	Grass Cover 50% to 75%	69	74
2605	0.054	0.25	0.217	98	0.20	0.783	Grass Cover 50% to 75%	69	75
2615	0.060	0.21	0.285	98	0.15	0.715	Grass Cover 50% to 75%	69	77
2635	0.039	0.21	0.187	98	0.17	0.813	Grass Cover 50% to 75%	69	74
2785	0.068	0.23	0.294	98	0.16	0.706	Grass Cover 50% to 75%	69	78
2795	0.052	0.20	0.261	98	0.15	0.739	Grass Cover 50% to 75%	69	77
2805	0.065	0.19	0.344	98	0.12	0.656	Grass Cover 50% to 75%	69	79
2815	0.056	0.19	0.295	98	0.13	0.705	Grass Cover 50% to 75%	69	78
2821	0.070	0.25	0.280	98	0.18	0.720	Grass Cover 50% to 75%	69	77
2825	0.046	0.29	0.160	98	0.24	0.840	Grass Cover 50% to 75%	69	74
2827	0.046	0.18	0.255	98	0.13	0.745	Grass Cover 50% to 75%	69	76
3876	0.057	0.26	0.220	98	0.20	0.780	Grass Cover 50% to 75%	69	75
3868	0.050	0.29	0.173	98	0.24	0.827	Grass Cover 50% to 75%	69	74
2800	0.066	0.18	0.366	98	0.11	0.634	Grass Cover 50% to 75%	69	80
2780	0.050	0.18	0.278	98	0.13	0.722	Grass Cover 50% to 75%	69	77
2760	0.044	0.18	0.245	98	0.14	0.755	Grass Cover 50% to 75%	69	76
2740	0.041	0.18	0.226	98	0.14	0.774	Grass Cover 50% to 75%	69	76

2720	0.066	0.18	0.364	98	0.11	0.636	Grass Cover 50% to 75%	69	80
2700	0.058	0.18	0.323	98	0.12	0.677	Grass Cover 50% to 75%	69	78
2660	0.050	0.18	0.278	98	0.13	0.722	Grass Cover 50% to 75%	69	77
2640	0.068	0.18	0.380	98	0.11	0.620	Grass Cover 50% to 75%	69	80
2620	0.056	0.18	0.311	98	0.12	0.689	Grass Cover 50% to 75%	69	78
2600	0.049	0.18	0.269	98	0.13	0.731	Grass Cover 50% to 75%	69	77
2460	0.034	0.19	0.177	98	0.16	0.823	Grass Cover 50% to 75%	69	74
3804	0.056	0.18	0.311	98	0.12	0.689	Grass Cover 50% to 75%	69	78
3808	0.035	0.18	0.192	98	0.15	0.808	Grass Cover 50% to 75%	69	75
3812	0.057	0.18	0.315	98	0.12	0.685	Grass Cover 50% to 75%	69	78
3816	0.041	0.18	0.228	98	0.14	0.772	Grass Cover 50% to 75%	69	76
3820	0.065	0.18	0.363	98	0.11	0.637	Grass Cover 50% to 75%	69	80
3828	0.043	0.18	0.237	98	0.14	0.763	Grass Cover 50% to 75%	69	76
3832	0.061	0.18	0.337	98	0.12	0.663	Grass Cover 50% to 75%	69	79
3836	0.048	0.18	0.268	98	0.13	0.732	Grass Cover 50% to 75%	69	77
3840	0.052	0.18	0.291	98	0.13	0.709	Grass Cover 50% to 75%	69	77
3844	0.059	0.18	0.329	98	0.12	0.671	Grass Cover 50% to 75%	69	79
3848	0.060	0.18	0.331	98	0.12	0.669	Grass Cover 50% to 75%	69	79
3861	0.046	0.22	0.211	98	0.17	0.789	Grass Cover 50% to 75%	69	75
3857	0.044	0.18	0.244	98	0.14	0.756	Grass Cover 50% to 75%	69	76
3853	0.048	0.18	0.265	98	0.13	0.735	Grass Cover 50% to 75%	69	77
3849	0.055	0.18	0.303	98	0.13	0.697	Grass Cover 50% to 75%	69	78
3845	0.049	0.18	0.274	98	0.13	0.726	Grass Cover 50% to 75%	69	77
3841	0.067	0.18	0.374	98	0.11	0.626	Grass Cover 50% to 75%	69	80

3825	0.044	0.18	0.245	98	0.14	0.755	Grass Cover 50% to 75%	69	76
3821	0.058	0.18	0.322	98	0.12	0.678	Grass Cover 50% to 75%	69	78
3817	0.063	0.18	0.350	98	0.12	0.650	Grass Cover 50% to 75%	69	79
3813	0.039	0.18	0.219	98	0.14	0.781	Grass Cover 50% to 75%	69	75
3809	0.045	0.18	0.249	98	0.14	0.751	Grass Cover 50% to 75%	69	76
2300	0.063	0.27	0.234	98	0.21	0.766	Grass Cover 50% to 75%	69	76
2501	0.073	0.23	0.318	98	0.16	0.682	Grass Cover 50% to 75%	69	78
2515	0.077	0.21	0.366	98	0.13	0.634	Grass Cover 50% to 75%	69	80
2545	0.036	0.22	0.165	98	0.18	0.835	Grass Cover 50% to 75%	69	74
2565	0.067	0.22	0.303	98	0.15	0.697	Grass Cover 50% to 75%	69	78
2601	0.065	0.22	0.297	98	0.15	0.703	Grass Cover 50% to 75%	69	78
2607	0.038	0.22	0.172	98	0.18	0.828	Grass Cover 50% to 75%	69	74
2617	0.039	0.22	0.179	98	0.18	0.821	Grass Cover 50% to 75%	69	74
2645	0.050	0.22	0.228	98	0.17	0.772	Grass Cover 50% to 75%	69	76
2655	0.061	0.22	0.279	98	0.16	0.721	Grass Cover 50% to 75%	69	77
2667	0.038	0.22	0.174	98	0.18	0.826	Grass Cover 50% to 75%	69	74
2677	0.042	0.22	0.192	98	0.18	0.808	Grass Cover 50% to 75%	69	75
2701	0.038	0.22	0.172	98	0.19	0.828	Grass Cover 50% to 75%	69	74
2757	0.048	0.22	0.215	98	0.18	0.785	Grass Cover 50% to 75%	69	75
2777	0.058	0.22	0.266	98	0.16	0.734	Grass Cover 50% to 75%	69	77
2795	0.043	0.25	0.172	98	0.21	0.828	Grass Cover 50% to 75%	69	74
2801	0.063	0.22	0.295	98	0.15	0.705	Grass Cover 50% to 75%	69	78
2848	0.046	0.21	0.214	98	0.17	0.786	Grass Cover 50% to 75%	69	75
2810	0.060	0.21	0.282	98	0.15	0.718	Grass Cover 50% to 75%	69	77

4010	0.036	0.28	0.129	98	0.24	0.871	Grass Cover 50% to 75%	69	73
4020	0.042	0.26	0.166	98	0.21	0.834	Grass Cover 50% to 75%	69	74
4030	0.071	0.26	0.278	98	0.18	0.722	Grass Cover 50% to 75%	69	77
4040	0.057	0.23	0.244	98	0.18	0.756	Grass Cover 50% to 75%	69	76
4050	0.067	0.34	0.195	98	0.27	0.805	Grass Cover 50% to 75%	69	75
4060	0.068	0.24	0.286	98	0.17	0.714	Grass Cover 50% to 75%	69	77
4035	0.048	0.24	0.201	98	0.19	0.799	Grass Cover 50% to 75%	69	75
4025	0.051	0.26	0.201	98	0.20	0.799	Grass Cover 50% to 75%	69	75
4015	0.080	0.26	0.315	98	0.17	0.685	Grass Cover 50% to 75%	69	78
4010	0.037	0.22	0.170	98	0.18	0.830	Grass Cover 50% to 75%	69	74
4020	0.062	0.25	0.253	98	0.18	0.747	Grass Cover 50% to 75%	69	76
4030	0.044	0.22	0.197	98	0.18	0.803	Grass Cover 50% to 75%	69	75
4040	0.033	0.33	0.100	98	0.30	0.900	Grass Cover 50% to 75%	69	72
4050	0.036	0.23	0.157	98	0.19	0.843	Grass Cover 50% to 75%	69	74
4045	0.090	0.33	0.270	98	0.24	0.730	Grass Cover 50% to 75%	69	77
4035	0.053	0.22	0.244	98	0.16	0.756	Grass Cover 50% to 75%	69	76
4025	0.060	0.25	0.244	98	0.19	0.756	Grass Cover 50% to 75%	69	76
4015	0.061	0.22	0.283	98	0.15	0.717	Grass Cover 50% to 75%	69	77
4005	0.040	0.21	0.190	98	0.17	0.810	Grass Cover 50% to 75%	69	74
2660	0.030	0.21	0.145	98	0.18	0.855	Grass Cover 50% to 75%	69	73
4020	0.075	0.21	0.358	98	0.13	0.642	Grass Cover 50% to 75%	69	79
4040	0.061	0.24	0.252	98	0.18	0.748	Grass Cover 50% to 75%	69	76
4050	0.068	0.21	0.323	98	0.14	0.677	Grass Cover 50% to 75%	69	78
4060	0.043	0.33	0.130	98	0.29	0.870	Grass Cover 50% to 75%	69	73

4070	0.061	0.22	0.277	98	0.16	0.723	Grass Cover 50% to 75%	69	77
3900	0.047	0.29	0.161	98	0.24	0.839	Grass Cover 50% to 75%	69	74
3920	0.067	0.29	0.232	98	0.22	0.768	Grass Cover 50% to 75%	69	76
3960	0.056	0.33	0.170	98	0.27	0.830	Grass Cover 50% to 75%	69	74
3965	0.057	0.23	0.249	98	0.17	0.751	Grass Cover 50% to 75%	69	76
3955	0.056	0.29	0.192	98	0.23	0.808	Grass Cover 50% to 75%	69	75
3945	0.051	0.23	0.222	98	0.18	0.778	Grass Cover 50% to 75%	69	75
3935	0.066	0.24	0.274	98	0.17	0.726	Grass Cover 50% to 75%	69	77
3915	0.054	0.22	0.244	98	0.17	0.756	Grass Cover 50% to 75%	69	76
2540	0.059	0.24	0.248	98	0.18	0.752	Grass Cover 50% to 75%	69	76
2500	0.061	0.23	0.265	98	0.17	0.735	Grass Cover 50% to 75%	69	77
2238	0.049	0.25	0.195	98	0.20	0.805	Grass Cover 50% to 75%	69	75
2230	0.055	0.26	0.212	98	0.20	0.788	Grass Cover 50% to 75%	69	75
2220	0.029	0.19	0.151	98	0.16	0.849	Grass Cover 50% to 75%	69	73
2212	0.050	0.36	0.138	98	0.31	0.862	Grass Cover 50% to 75%	69	73
2203	0.067	0.25	0.267	98	0.18	0.733	Grass Cover 50% to 75%	69	77
2211	0.000	0.50	0.000	98	0.50	1.000	Grass Cover 50% to 75%	69	69
2219	0.109	0.41	0.267	98	0.30	0.733	Grass Cover 50% to 75%	69	77
2225	0.037	0.32	0.116	98	0.28	0.884	Grass Cover 50% to 75%	69	72
2233	0.052	0.30	0.173	98	0.25	0.827	Grass Cover 50% to 75%	69	74
2243	0.038	0.27	0.139	98	0.23	0.861	Grass Cover 50% to 75%	69	73
2253	0.048	0.27	0.178	98	0.22	0.822	Grass Cover 50% to 75%	69	74
2265	0.086	0.26	0.329	98	0.17	0.671	Grass Cover 50% to 75%	69	79
2275	0.092	0.26	0.355	98	0.17	0.645	Grass Cover 50% to 75%	69	79

2285	0.085	0.28	0.302	98	0.20	0.698	Grass Cover 50% to 75%	69	78
3799	0.080	0.34	0.234	98	0.26	0.766	Grass Cover 50% to 75%	69	76
2860	0.064	0.36	0.177	98	0.30	0.823	Grass Cover 50% to 75%	69	74
4001	0.039	0.25	0.157	98	0.21	0.843	Grass Cover 50% to 75%	69	74
4089	0.042	0.29	0.143	98	0.25	0.857	Grass Cover 50% to 75%	69	73
4115	0.030	0.26	0.115	98	0.23	0.885	Grass Cover 50% to 75%	69	72
4131	0.000	0.25	0.000	98	0.25	1.000	Grass Cover 50% to 75%	69	69
4157	0.074	0.43	0.170	98	0.36	0.830	Grass Cover 50% to 75%	69	74
4160	0.053	0.33	0.157	98	0.28	0.843	Grass Cover 50% to 75%	69	74
4140	0.052	0.33	0.159	98	0.28	0.841	Grass Cover 50% to 75%	69	74
4120	0.057	0.32	0.179	98	0.26	0.821	Grass Cover 50% to 75%	69	74
4100	0.057	0.26	0.220	98	0.20	0.780	Grass Cover 50% to 75%	69	75
4080	0.072	0.24	0.299	98	0.17	0.701	Grass Cover 50% to 75%	69	78

Parcel ID	House Area (acs)	Parcel Area (acs)	Percent of Area	Curve Number	Landscape Area (acs)	Percent of Area	Landscape Type (Soil Type B)	Curve Number	Weighted Curve Number
2655	0.045	0.21	0.214	98	0.17	0.786	Grass Cover < 50%	79	83
2675	0.047	0.21	0.226	98	0.16	0.774	Grass Cover < 50%	79	83
2685	0.061	0.21	0.291	98	0.15	0.709	Grass Cover < 50%	79	85
2695	0.063	0.21	0.301	98	0.15	0.699	Grass Cover < 50%	79	85
2715	0.054	0.21	0.258	98	0.16	0.742	Grass Cover < 50%	79	84
2735	0.053	0.21	0.252	98	0.16	0.748	Grass Cover < 50%	79	84
2755	0.055	0.21	0.264	98	0.15	0.736	Grass Cover < 50%	79	84
2775	0.042	0.21	0.199	98	0.17	0.801	Grass Cover < 50%	79	83
3880	0.078	0.30	0.259	98	0.22	0.741	Grass Cover < 50%	79	84

3884	0.069	0.25	0.275	98	0.18	0.725	Grass Cover < 50%	79	84
3890	0.052	0.28	0.186	98	0.23	0.814	Grass Cover < 50%	79	83
3900	0.057	0.22	0.261	98	0.16	0.739	Grass Cover < 50%	79	84
3891	0.062	0.24	0.259	98	0.18	0.741	Grass Cover < 50%	79	84
3887	0.044	0.23	0.193	98	0.19	0.807	Grass Cover < 50%	79	83
3883	0.048	0.23	0.210	98	0.18	0.790	Grass Cover < 50%	79	83
3879	0.044	0.23	0.193	98	0.19	0.807	Grass Cover < 50%	79	83
2909	0.070	0.21	0.336	98	0.14	0.664	Grass Cover < 50%	79	85
2929	0.045	0.22	0.206	98	0.17	0.794	Grass Cover < 50%	79	83
2939	0.034	0.27	0.125	98	0.24	0.875	Grass Cover < 50%	79	81
2810	0.085	0.27	0.313	98	0.19	0.687	Grass Cover < 50%	79	85
2690	0.053	0.18	0.293	98	0.13	0.707	Grass Cover < 50%	79	85
2680	0.069	0.18	0.382	98	0.11	0.618	Grass Cover < 50%	79	86
2540	0.063	0.17	0.369	98	0.11	0.631	Grass Cover < 50%	79	86
3800	0.055	0.20	0.277	98	0.14	0.723	Grass Cover < 50%	79	84
3824	0.060	0.18	0.332	98	0.12	0.668	Grass Cover < 50%	79	85
3852	0.047	0.18	0.259	98	0.13	0.741	Grass Cover < 50%	79	84
3856	0.069	0.18	0.384	98	0.11	0.616	Grass Cover < 50%	79	86
3860	0.057	0.19	0.299	98	0.13	0.701	Grass Cover < 50%	79	85
3864	0.066	0.18	0.369	98	0.11	0.631	Grass Cover < 50%	79	86
3875	0.077	0.21	0.368	98	0.13	0.632	Grass Cover < 50%	79	86
3871	0.060	0.18	0.336	98	0.12	0.664	Grass Cover < 50%	79	85
3869	0.055	0.18	0.306	98	0.12	0.694	Grass Cover < 50%	79	85
3865	0.038	0.19	0.200	98	0.15	0.800	Grass Cover < 50%	79	83

3837	0.041	0.18	0.230	98	0.14	0.770	Grass Cover < 50%	79	83
3833	0.047	0.18	0.263	98	0.13	0.737	Grass Cover < 50%	79	84
3829	0.049	0.18	0.273	98	0.13	0.727	Grass Cover < 50%	79	84
3805	0.058	0.18	0.320	98	0.12	0.680	Grass Cover < 50%	79	85
3801	0.040	0.20	0.200	98	0.16	0.800	Grass Cover < 50%	79	83
2637	0.054	0.22	0.245	98	0.17	0.755	Grass Cover < 50%	79	84
2807	0.056	0.22	0.258	98	0.16	0.742	Grass Cover < 50%	79	84
2811	0.037	0.22	0.170	98	0.18	0.830	Grass Cover < 50%	79	82
2800	0.052	0.21	0.251	98	0.15	0.749	Grass Cover < 50%	79	84
4045	0.071	0.33	0.213	98	0.26	0.787	Grass Cover < 50%	79	83
4005	0.050	0.24	0.209	98	0.19	0.791	Grass Cover < 50%	79	83
4000	0.048	0.22	0.221	98	0.17	0.779	Grass Cover < 50%	79	83
4075	0.084	0.33	0.255	98	0.25	0.745	Grass Cover < 50%	79	84
4055	0.051	0.21	0.243	98	0.16	0.757	Grass Cover < 50%	79	84
4035	0.053	0.24	0.222	98	0.19	0.778	Grass Cover < 50%	79	83
4015	0.055	0.21	0.260	98	0.16	0.740	Grass Cover < 50%	79	84
2640	0.038	0.21	0.181	98	0.17	0.819	Grass Cover < 50%	79	82
3940	0.066	0.31	0.212	98	0.24	0.788	Grass Cover < 50%	79	83
3950	0.053	0.21	0.255	98	0.16	0.745	Grass Cover < 50%	79	84
Total	2.883	11.32	0.255	98	8.44	0.745		79	84
3860	0.046	0.18	0.254	98	0.13	0.746	Grass Cover 50% to 75%	69	76
3850	0.044	0.18	0.242	98	0.14	0.758	Grass Cover 50% to 75%	69	76
3840	0.048	0.18	0.265	98	0.13	0.735	Grass Cover 50% to 75%	69	77
3832	0.076	0.18	0.423	98	0.10	0.577	Grass Cover 50% to 75%	69	81
3822	0.069	0.19	0.365	98	0.12	0.635	Grass Cover 50% to 75%	69	80

3812	0.051	0.21	0.243	98	0.16	0.757	Grass Cover 50% to 75%	69	76
2302	0.043	0.18	0.240	98	0.14	0.760	Grass Cover 50% to 75%	69	76
2324	0.066	0.18	0.367	98	0.11	0.633	Grass Cover 50% to 75%	69	80
2330	0.051	0.19	0.271	98	0.14	0.729	Grass Cover 50% to 75%	69	77
2823	0.066	0.21	0.315	98	0.14	0.685	Grass Cover 50% to 75%	69	78
2835	0.045	0.21	0.212	98	0.17	0.788	Grass Cover 50% to 75%	69	75
3847	0.063	0.20	0.313	98	0.14	0.687	Grass Cover 50% to 75%	69	78
3851	0.061	0.18	0.341	98	0.12	0.659	Grass Cover 50% to 75%	69	79
3861	0.072	0.18	0.398	98	0.11	0.602	Grass Cover 50% to 75%	69	81
2225	0.061	0.18	0.341	98	0.12	0.659	Grass Cover 50% to 75%	69	79
2200	0.053	0.27	0.195	98	0.22	0.805	Grass Cover 50% to 75%	69	75
2212	0.061	0.25	0.245	98	0.19	0.755	Grass Cover 50% to 75%	69	76
2222	0.046	0.23	0.200	98	0.18	0.800	Grass Cover 50% to 75%	69	75
2232	0.052	0.23	0.226	98	0.18	0.774	Grass Cover 50% to 75%	69	76
2242	0.090	0.32	0.281	98	0.23	0.719	Grass Cover 50% to 75%	69	77
3888	0.057	0.45	0.127	98	0.39	0.873	Grass Cover 50% to 75%	69	73
3876	0.070	0.52	0.134	98	0.45	0.866	Grass Cover 50% to 75%	69	73
3864	0.082	0.55	0.150	98	0.47	0.850	Grass Cover 50% to 75%	69	73
3852	0.106	0.52	0.205	98	0.41	0.795	Grass Cover 50% to 75%	69	75
3840	0.000	0.49	0.000	98	0.49	1.000	Grass Cover 50% to 75%	69	69
3836	0.068	0.47	0.144	98	0.40	0.856	Grass Cover 50% to 75%	69	73
3826	0.066	0.46	0.144	98	0.39	0.856	Grass Cover 50% to 75%	69	73
3814	0.072	0.40	0.179	98	0.33	0.821	Grass Cover 50% to 75%	69	74
3802	0.068	0.49	0.139	98	0.42	0.861	Grass Cover 50% to 75%	69	73

2351	0.063	0.48	0.130	98	0.42	0.870	Grass Cover 50% to 75%	69	73
2347	0.045	0.20	0.223	98	0.16	0.777	Grass Cover 50% to 75%	69	75
2335	0.062	0.21	0.296	98	0.15	0.704	Grass Cover 50% to 75%	69	78
2323	0.046	0.21	0.218	98	0.16	0.782	Grass Cover 50% to 75%	69	75
2301	0.054	0.20	0.270	98	0.15	0.730	Grass Cover 50% to 75%	69	77
2345	0.045	0.30	0.149	98	0.26	0.851	Grass Cover 50% to 75%	69	73
2365	0.050	0.26	0.193	98	0.21	0.807	Grass Cover 50% to 75%	69	75
2405	0.058	0.22	0.265	98	0.16	0.735	Grass Cover 50% to 75%	69	77
2465	0.057	0.30	0.189	98	0.24	0.811	Grass Cover 50% to 75%	69	74
2515	0.047	0.28	0.168	98	0.23	0.832	Grass Cover 50% to 75%	69	74
2605	0.054	0.25	0.217	98	0.20	0.783	Grass Cover 50% to 75%	69	75
2615	0.060	0.21	0.285	98	0.15	0.715	Grass Cover 50% to 75%	69	77
2635	0.039	0.21	0.187	98	0.17	0.813	Grass Cover 50% to 75%	69	74
2785	0.068	0.23	0.294	98	0.16	0.706	Grass Cover 50% to 75%	69	78
2795	0.052	0.20	0.261	98	0.15	0.739	Grass Cover 50% to 75%	69	77
2805	0.065	0.19	0.344	98	0.12	0.656	Grass Cover 50% to 75%	69	79
2815	0.056	0.19	0.295	98	0.13	0.705	Grass Cover 50% to 75%	69	78
2821	0.070	0.25	0.280	98	0.18	0.720	Grass Cover 50% to 75%	69	77
2825	0.046	0.29	0.160	98	0.24	0.840	Grass Cover 50% to 75%	69	74
2827	0.046	0.18	0.255	98	0.13	0.745	Grass Cover 50% to 75%	69	76
3876	0.057	0.26	0.220	98	0.20	0.780	Grass Cover 50% to 75%	69	75
3868	0.050	0.29	0.173	98	0.24	0.827	Grass Cover 50% to 75%	69	74
2800	0.066	0.18	0.366	98	0.11	0.634	Grass Cover 50% to 75%	69	80
2780	0.050	0.18	0.278	98	0.13	0.722	Grass Cover 50% to 75%	69	77

2760	0.044	0.18	0.245	98	0.14	0.755	Grass Cover 50% to 75%	69	76
2740	0.041	0.18	0.226	98	0.14	0.774	Grass Cover 50% to 75%	69	76
2720	0.066	0.18	0.364	98	0.11	0.636	Grass Cover 50% to 75%	69	80
2700	0.058	0.18	0.323	98	0.12	0.677	Grass Cover 50% to 75%	69	78
2660	0.050	0.18	0.278	98	0.13	0.722	Grass Cover 50% to 75%	69	77
2640	0.068	0.18	0.380	98	0.11	0.620	Grass Cover 50% to 75%	69	80
2620	0.056	0.18	0.311	98	0.12	0.689	Grass Cover 50% to 75%	69	78
2600	0.049	0.18	0.269	98	0.13	0.731	Grass Cover 50% to 75%	69	77
2460	0.034	0.19	0.177	98	0.16	0.823	Grass Cover 50% to 75%	69	74
3804	0.056	0.18	0.311	98	0.12	0.689	Grass Cover 50% to 75%	69	78
3808	0.035	0.18	0.192	98	0.15	0.808	Grass Cover 50% to 75%	69	75
3812	0.057	0.18	0.315	98	0.12	0.685	Grass Cover 50% to 75%	69	78
3816	0.041	0.18	0.228	98	0.14	0.772	Grass Cover 50% to 75%	69	76
3820	0.065	0.18	0.363	98	0.11	0.637	Grass Cover 50% to 75%	69	80
3828	0.043	0.18	0.237	98	0.14	0.763	Grass Cover 50% to 75%	69	76
3832	0.061	0.18	0.337	98	0.12	0.663	Grass Cover 50% to 75%	69	79
3836	0.048	0.18	0.268	98	0.13	0.732	Grass Cover 50% to 75%	69	77
3840	0.052	0.18	0.291	98	0.13	0.709	Grass Cover 50% to 75%	69	77
3844	0.059	0.18	0.329	98	0.12	0.671	Grass Cover 50% to 75%	69	79
3848	0.060	0.18	0.331	98	0.12	0.669	Grass Cover 50% to 75%	69	79
3861	0.046	0.22	0.211	98	0.17	0.789	Grass Cover 50% to 75%	69	75
3857	0.044	0.18	0.244	98	0.14	0.756	Grass Cover 50% to 75%	69	76
3853	0.048	0.18	0.265	98	0.13	0.735	Grass Cover 50% to 75%	69	77
3849	0.055	0.18	0.303	98	0.13	0.697	Grass Cover 50% to 75%	69	78

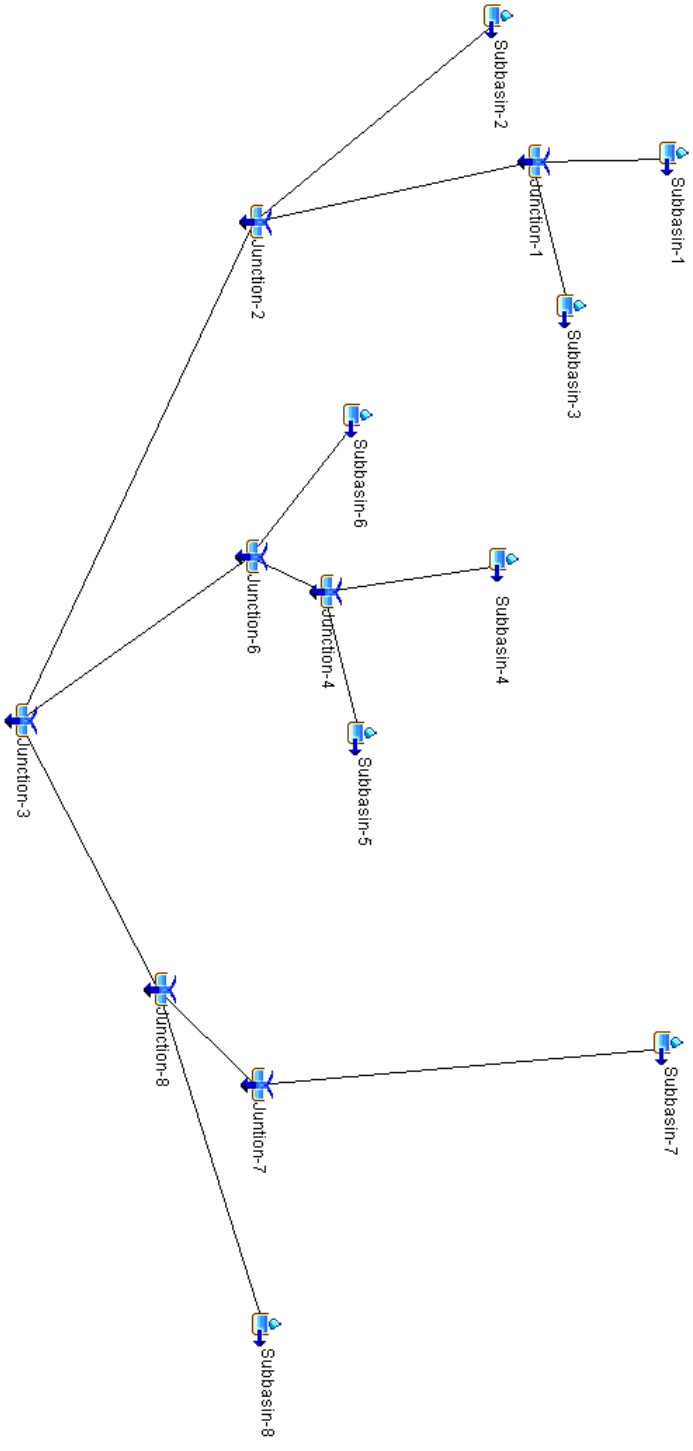
3845	0.049	0.18	0.274	98	0.13	0.726	Grass Cover 50% to 75%	69	77
3841	0.067	0.18	0.374	98	0.11	0.626	Grass Cover 50% to 75%	69	80
3825	0.044	0.18	0.245	98	0.14	0.755	Grass Cover 50% to 75%	69	76
3821	0.058	0.18	0.322	98	0.12	0.678	Grass Cover 50% to 75%	69	78
3817	0.063	0.18	0.350	98	0.12	0.650	Grass Cover 50% to 75%	69	79
3813	0.039	0.18	0.219	98	0.14	0.781	Grass Cover 50% to 75%	69	75
3809	0.045	0.18	0.249	98	0.14	0.751	Grass Cover 50% to 75%	69	76
2300	0.063	0.27	0.234	98	0.21	0.766	Grass Cover 50% to 75%	69	76
2501	0.073	0.23	0.318	98	0.16	0.682	Grass Cover 50% to 75%	69	78
2515	0.077	0.21	0.366	98	0.13	0.634	Grass Cover 50% to 75%	69	80
2545	0.036	0.22	0.165	98	0.18	0.835	Grass Cover 50% to 75%	69	74
2565	0.067	0.22	0.303	98	0.15	0.697	Grass Cover 50% to 75%	69	78
2601	0.065	0.22	0.297	98	0.15	0.703	Grass Cover 50% to 75%	69	78
2607	0.038	0.22	0.172	98	0.18	0.828	Grass Cover 50% to 75%	69	74
2617	0.039	0.22	0.179	98	0.18	0.821	Grass Cover 50% to 75%	69	74
2645	0.050	0.22	0.228	98	0.17	0.772	Grass Cover 50% to 75%	69	76
2655	0.061	0.22	0.279	98	0.16	0.721	Grass Cover 50% to 75%	69	77
2667	0.038	0.22	0.174	98	0.18	0.826	Grass Cover 50% to 75%	69	74
2677	0.042	0.22	0.192	98	0.18	0.808	Grass Cover 50% to 75%	69	75
2701	0.038	0.22	0.172	98	0.19	0.828	Grass Cover 50% to 75%	69	74
2757	0.048	0.22	0.215	98	0.18	0.785	Grass Cover 50% to 75%	69	75
2777	0.058	0.22	0.266	98	0.16	0.734	Grass Cover 50% to 75%	69	77
2795	0.043	0.25	0.172	98	0.21	0.828	Grass Cover 50% to 75%	69	74
2801	0.063	0.22	0.295	98	0.15	0.705	Grass Cover 50% to 75%	69	78

2848	0.046	0.21	0.214	98	0.17	0.786	Grass Cover 50% to 75%	69	75
2810	0.060	0.21	0.282	98	0.15	0.718	Grass Cover 50% to 75%	69	77
4010	0.036	0.28	0.129	98	0.24	0.871	Grass Cover 50% to 75%	69	73
4020	0.042	0.26	0.166	98	0.21	0.834	Grass Cover 50% to 75%	69	74
4030	0.071	0.26	0.278	98	0.18	0.722	Grass Cover 50% to 75%	69	77
4040	0.057	0.23	0.244	98	0.18	0.756	Grass Cover 50% to 75%	69	76
4050	0.067	0.34	0.195	98	0.27	0.805	Grass Cover 50% to 75%	69	75
4060	0.068	0.24	0.286	98	0.17	0.714	Grass Cover 50% to 75%	69	77
4035	0.048	0.24	0.201	98	0.19	0.799	Grass Cover 50% to 75%	69	75
4025	0.051	0.26	0.201	98	0.20	0.799	Grass Cover 50% to 75%	69	75
4015	0.080	0.26	0.315	98	0.17	0.685	Grass Cover 50% to 75%	69	78
4010	0.037	0.22	0.170	98	0.18	0.830	Grass Cover 50% to 75%	69	74
4020	0.062	0.25	0.253	98	0.18	0.747	Grass Cover 50% to 75%	69	76
4030	0.044	0.22	0.197	98	0.18	0.803	Grass Cover 50% to 75%	69	75
4040	0.033	0.33	0.100	98	0.30	0.900	Grass Cover 50% to 75%	69	72
4050	0.036	0.23	0.157	98	0.19	0.843	Grass Cover 50% to 75%	69	74
4045	0.090	0.33	0.270	98	0.24	0.730	Grass Cover 50% to 75%	69	77
4035	0.053	0.22	0.244	98	0.16	0.756	Grass Cover 50% to 75%	69	76
4025	0.060	0.25	0.244	98	0.19	0.756	Grass Cover 50% to 75%	69	76
4015	0.061	0.22	0.283	98	0.15	0.717	Grass Cover 50% to 75%	69	77
4005	0.040	0.21	0.190	98	0.17	0.810	Grass Cover 50% to 75%	69	74
2660	0.030	0.21	0.145	98	0.18	0.855	Grass Cover 50% to 75%	69	73
4020	0.075	0.21	0.358	98	0.13	0.642	Grass Cover 50% to 75%	69	79
4040	0.061	0.24	0.252	98	0.18	0.748	Grass Cover 50% to 75%	69	76

4050	0.068	0.21	0.323	98	0.14	0.677	Grass Cover 50% to 75%	69	78
4060	0.043	0.33	0.130	98	0.29	0.870	Grass Cover 50% to 75%	69	73
4070	0.061	0.22	0.277	98	0.16	0.723	Grass Cover 50% to 75%	69	77
3900	0.047	0.29	0.161	98	0.24	0.839	Grass Cover 50% to 75%	69	74
3920	0.067	0.29	0.232	98	0.22	0.768	Grass Cover 50% to 75%	69	76
3960	0.056	0.33	0.170	98	0.27	0.830	Grass Cover 50% to 75%	69	74
3965	0.057	0.23	0.249	98	0.17	0.751	Grass Cover 50% to 75%	69	76
3955	0.056	0.29	0.192	98	0.23	0.808	Grass Cover 50% to 75%	69	75
3945	0.051	0.23	0.222	98	0.18	0.778	Grass Cover 50% to 75%	69	75
3935	0.066	0.24	0.274	98	0.17	0.726	Grass Cover 50% to 75%	69	77
3915	0.054	0.22	0.244	98	0.17	0.756	Grass Cover 50% to 75%	69	76
2540	0.059	0.24	0.248	98	0.18	0.752	Grass Cover 50% to 75%	69	76
2500	0.061	0.23	0.265	98	0.17	0.735	Grass Cover 50% to 75%	69	77
2238	0.049	0.25	0.195	98	0.20	0.805	Grass Cover 50% to 75%	69	75
2230	0.055	0.26	0.212	98	0.20	0.788	Grass Cover 50% to 75%	69	75
2220	0.029	0.19	0.151	98	0.16	0.849	Grass Cover 50% to 75%	69	73
2212	0.050	0.36	0.138	98	0.31	0.862	Grass Cover 50% to 75%	69	73
2203	0.067	0.25	0.267	98	0.18	0.733	Grass Cover 50% to 75%	69	77
2211	0.000	0.50	0.000	98	0.50	1.000	Grass Cover 50% to 75%	69	69
2219	0.109	0.41	0.267	98	0.30	0.733	Grass Cover 50% to 75%	69	77
2225	0.037	0.32	0.116	98	0.28	0.884	Grass Cover 50% to 75%	69	72
2233	0.052	0.30	0.173	98	0.25	0.827	Grass Cover 50% to 75%	69	74
2243	0.038	0.27	0.139	98	0.23	0.861	Grass Cover 50% to 75%	69	73
2253	0.048	0.27	0.178	98	0.22	0.822	Grass Cover 50% to 75%	69	74

2265	0.086	0.26	0.329	98	0.17	0.671	Grass Cover 50% to 75%	69	79
2275	0.092	0.26	0.355	98	0.17	0.645	Grass Cover 50% to 75%	69	79
2285	0.085	0.28	0.302	98	0.20	0.698	Grass Cover 50% to 75%	69	78
3799	0.080	0.34	0.234	98	0.26	0.766	Grass Cover 50% to 75%	69	76
2860	0.064	0.36	0.177	98	0.30	0.823	Grass Cover 50% to 75%	69	74
4001	0.039	0.25	0.157	98	0.21	0.843	Grass Cover 50% to 75%	69	74
4089	0.042	0.29	0.143	98	0.25	0.857	Grass Cover 50% to 75%	69	73
4115	0.030	0.26	0.115	98	0.23	0.885	Grass Cover 50% to 75%	69	72
4131	0.000	0.25	0.000	98	0.25	1.000	Grass Cover 50% to 75%	69	69
4157	0.074	0.43	0.170	98	0.36	0.830	Grass Cover 50% to 75%	69	74
4160	0.053	0.33	0.157	98	0.28	0.843	Grass Cover 50% to 75%	69	74
4140	0.052	0.33	0.159	98	0.28	0.841	Grass Cover 50% to 75%	69	74
4120	0.057	0.32	0.179	98	0.26	0.821	Grass Cover 50% to 75%	69	74
4100	0.057	0.26	0.220	98	0.20	0.780	Grass Cover 50% to 75%	69	75
4080	0.072	0.24	0.299	98	0.17	0.701	Grass Cover 50% to 75%	69	78

Appendix F: HEC-HMS Input Values


Subbasin-2
Junction-1
Subbasin-1
Junction-2
Subbasin-3
Subbasin-6
Junction-6
Junction-4
Subbasin-4
Junction-3
Subbasin-5
Junction-8
Junction-7
Subbasin-7
Subbasin-8

Appendix F-1: Sub-Basin Layout

Appendix F-2: TR-55 Method Curve Number Summary

Curve Numbers for The TR-55 Approach			
Sub Basin	Area (acres)	Curve Number	Description
1	251.3	71	B, Mixed Conifer, Poor
2	69.6	53	B, Mixed Conifer, Fair
3	28.7	71	B, Mixed Conifer, Poor
4	119.5	71	B, Mixed Conifer, Poor
5	149.0	71	B, Mixed Conifer, Poor
6	34.9	53	B, Mixed Conifer, Fair
7	715.4	71	B, Mixed Conifer, Poor
8-Nat	223.3	53	B, Mixed Conifer, Fair
8-Urban	81.1	75	B, 1/4 Acre Lots
8- Total	304.4	59	Basin 8 total weighted CN

Appendix F-3: Land Use Method Curve Number Summary

Curve Numbers for The Detailed Analysis Approach			
Sub Basin	Area (acres)	Curve Number	Description
1	251.3	71	B, Mixed Conifer, Poor
2	69.6	53	B, Mixed Conifer, Fair
3	28.7	71	B, Mixed Conifer, Poor
4	119.5	71	B, Mixed Conifer, Poor
5	149.0	71	B, Mixed Conifer, Poor
6	34.9	53	B, Mixed Conifer, Fair
7	715.4	71	B, Mixed Conifer, Poor
8-Natural	223.3	53	B, Mixed Conifer, Fair
8-Parcel	52.1	78	B, Based on Detailed Analysis

8- Road	29.0	98	B, Based on Detailed Analysis
8- Total	304.4	62	Basin 8 total weighted CN

Appendix F-4: Sub-Basin 8 Percent Impervious Value

Percent Impervious Calculation	
Total Streets	28.992
Area of houses	9.03
Impervious Area	38.022
Basin Area	304.448
Percent Impervious	12.49%

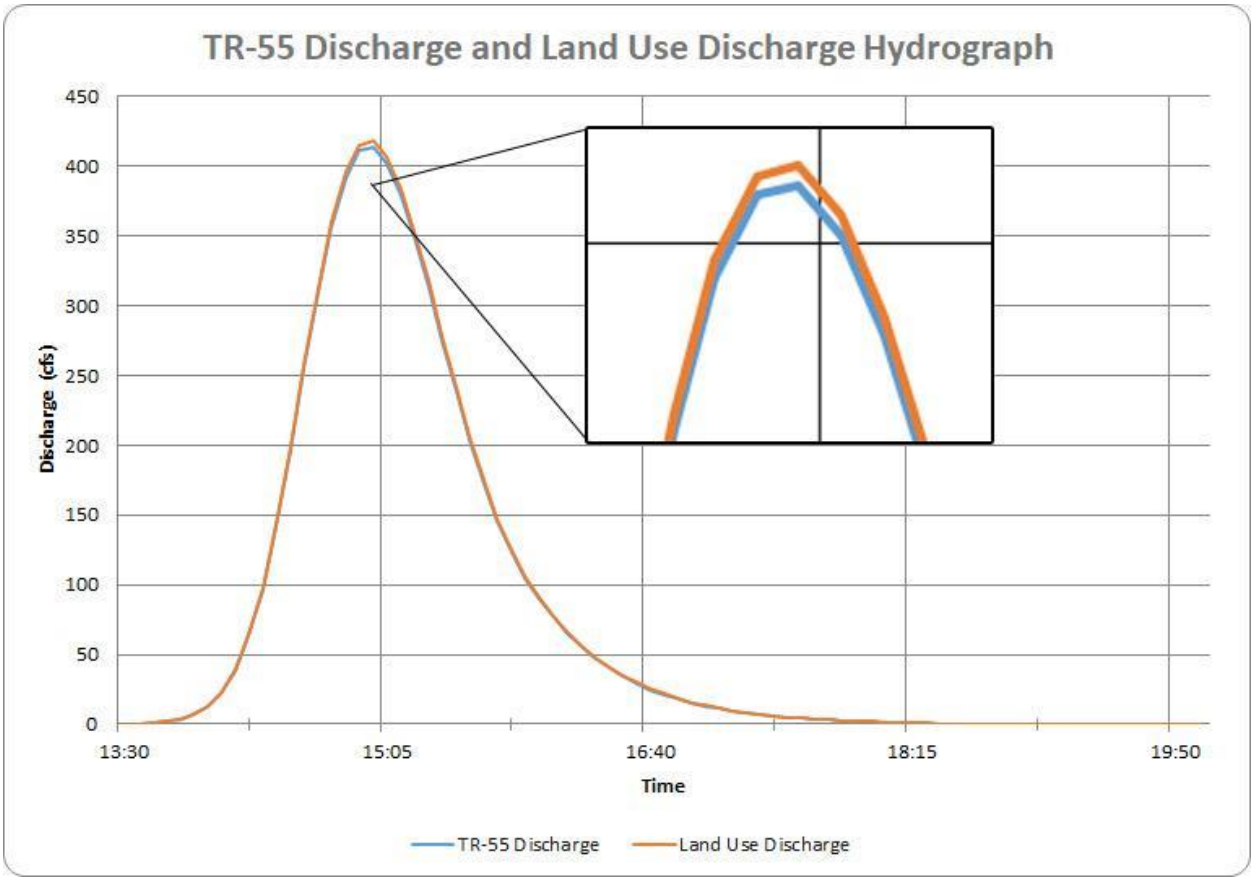
Appendix F-5: Precipitation Data

Time	Elevation
13:28:30	0.98 in
13:30:47	1.02 in
13:34:04	1.06 in
13:35:02	1.1 in
13:37:01	1.18 in
13:38:01	1.22 in
13:39:01	1.26 in
13:40:18	1.3 in
13:45:07	1.34 in
13:55:11	1.42 in
13:58:03	1.46 in
13:59:03	1.5 in
13:59:49	1.57 in
14:00:49	1.61 in
14:03:45	1.77 in
14:04:45	1.81 in
14:06:38	1.93 in
14:07:38	1.97 in
14:09:38	2.05 in
14:11:38	2.13 in
14:17:47	2.2 in
14:20:27	2.24 in
14:21:25	2.28 in
14:22:18	2.36 in
14:25:56	2.44 in

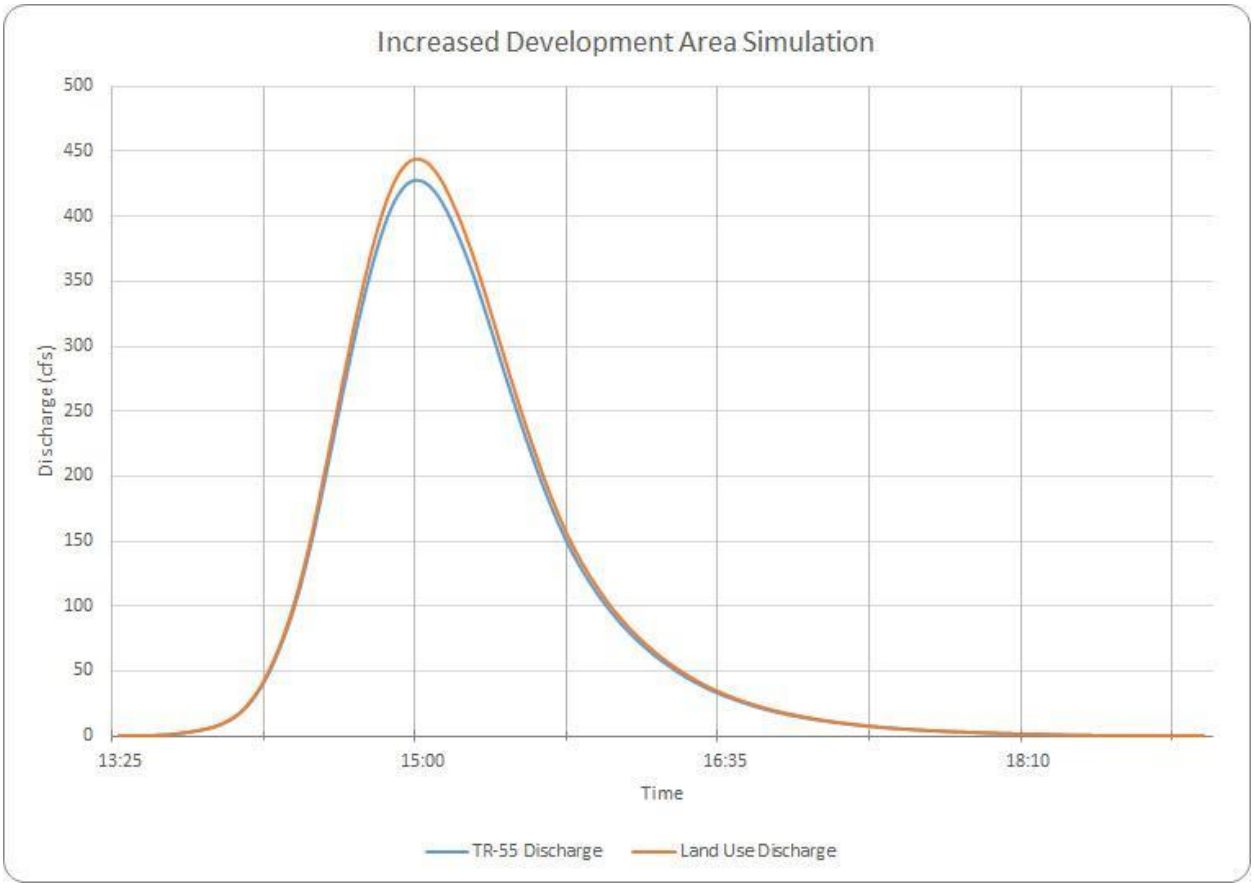
Appendix F-6: Lag Time

Lag Time	
Sub Basin	Lag Time
1	45
2	45
3	37
4	56
5	39
6	35
7	49
8	50

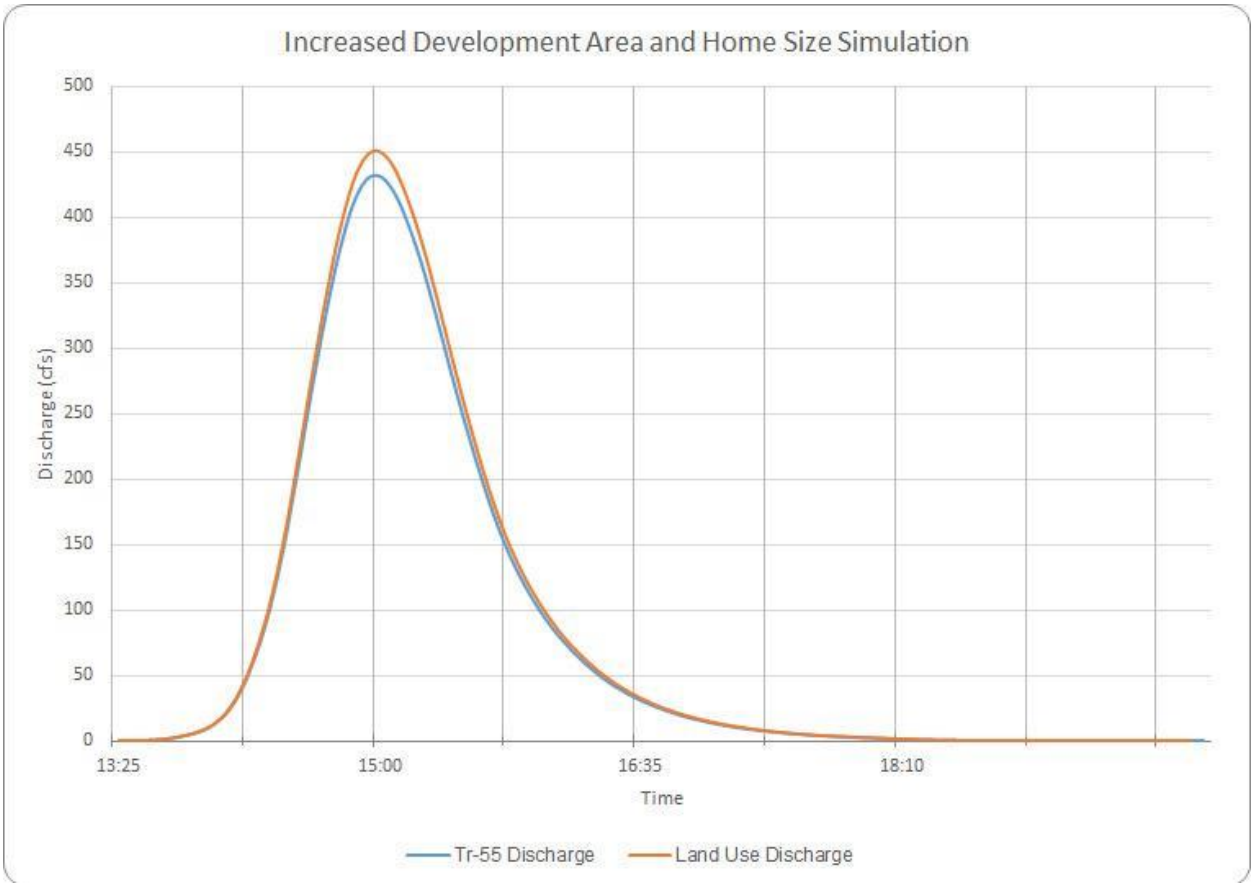
Appendix G: HEC-HMS Output Values



Appendix G-1: Comparison Hydrograph



Appendix G-2: Increased Development Simulation Hydrograph



Appendix G-3: Increased Development and House Area Simulation Hydrograph

Project: City of Flag Approach Simulation Run: Existing 1.0

Start of Run: 28Aug2019, 13:25
End of Run: 28Aug2019, 20:00
Compute Time: 24Nov2019, 15:24:05

Basin Model: Existing
Meteorologic Model: Met 1
Control Specifications: Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-2	0.5464	84.4	28Aug2019, 14:55	0.27
Subbasin-7	1.1178	176.1	28Aug2019, 15:00	0.30
Subbasin-8	0.4757	82.0	28Aug2019, 15:00	0.35
Juntion-7	1.1178	176.1	28Aug2019, 15:00	0.30
Junction-8	1.5935	258.2	28Aug2019, 15:00	0.31
Subbasin-6	0.0545	5.9	28Aug2019, 14:50	0.16
Junction-1	0.4376	74.8	28Aug2019, 14:55	0.30
Subbasin-1	0.3927	66.2	28Aug2019, 14:55	0.30
Subbasin-2	0.1088	9.7	28Aug2019, 14:55	0.16
Subbasin-3	0.0449	8.9	28Aug2019, 14:50	0.30
Subbasin-4	0.1867	26.2	28Aug2019, 15:10	0.30
Subbasin-5	0.2328	44.0	28Aug2019, 14:50	0.30
Junction-4	0.4195	67.4	28Aug2019, 14:55	0.30
Junction-6	0.4740	73.0	28Aug2019, 14:55	0.28
Junction-3	2.6139	413.2	28Aug2019, 15:00	0.30

Appendix G-4: TR-55 Method Simulation Summary

Project: City of Flag Approach Simulation Run: Proposed 1.0

Start of Run: 28Aug2019, 13:25
End of Run: 28Aug2019, 20:00
Compute Time: 24Nov2019, 14:59:56

Basin Model: Proposed
Meteorologic Model: Met 1
Control Specifications: Control 1

Show Elements: All Elements Volume Units: (•) IN ( ) AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-2	0.5464	84.4	28Aug2019, 14:55	0.27
Subbasin-7	1.1178	176.1	28Aug2019, 15:00	0.30
Subbasin-8	0.4757	86.7	28Aug2019, 15:00	0.37
Juntion-7	1.1178	176.1	28Aug2019, 15:00	0.30
Junction-8	1.5935	262.8	28Aug2019, 15:00	0.32
Subbasin-6	0.0545	5.9	28Aug2019, 14:50	0.16
Junction-1	0.4376	74.8	28Aug2019, 14:55	0.30
Subbasin-1	0.3927	66.2	28Aug2019, 14:55	0.30
Subbasin-2	0.1088	9.7	28Aug2019, 14:55	0.16
Subbasin-3	0.0449	8.9	28Aug2019, 14:50	0.30
Subbasin-4	0.1867	26.2	28Aug2019, 15:10	0.30
Subbasin-5	0.2328	44.0	28Aug2019, 14:50	0.30
Junction-4	0.4195	67.4	28Aug2019, 14:55	0.30
Junction-6	0.4740	73.0	28Aug2019, 14:55	0.28
Junction-3	2.6139	417.9	28Aug2019, 15:00	0.30

Appendix G-5: Land Use Method Simulation Summary

Appendix G-6: TR-55 and Land Use Total Outflow

Date	Time	TR-55 Outflow	Land Use Outflow
28-Aug-19	13:25	0	0
28-Aug-19	13:30	0	0
28-Aug-19	13:35	0.2	0.2
28-Aug-19	13:40	0.8	0.8
28-Aug-19	13:45	2.1	2.1
28-Aug-19	13:50	4	4
28-Aug-19	13:55	7	7
28-Aug-19	14:00	12.3	12.4
28-Aug-19	14:05	22.1	22.3
28-Aug-19	14:10	38.8	39.1
28-Aug-19	14:15	63.7	64.3
28-Aug-19	14:20	97.2	98.1
28-Aug-19	14:25	142.3	143.7
28-Aug-19	14:30	197.4	199.4
28-Aug-19	14:35	255.2	257.7
28-Aug-19	14:40	309.8	312.9
28-Aug-19	14:45	356.8	360.6
28-Aug-19	14:50	392.1	396.4
28-Aug-19	14:55	410.9	415.4

28-Aug-19	15:00	413.2	417.9
28-Aug-19	15:05	401.8	406.4
28-Aug-19	15:10	379	383.5
28-Aug-19	15:15	349.4	353.6
28-Aug-19	15:20	313.8	317.6
28-Aug-19	15:25	275.5	278.9
28-Aug-19	15:30	238.5	241.5
28-Aug-19	15:35	204	206.6
28-Aug-19	15:40	172.6	174.8
28-Aug-19	15:45	145.5	147.4
28-Aug-19	15:50	123.4	125
28-Aug-19	15:55	105.2	106.5
28-Aug-19	16:00	89.6	90.7
28-Aug-19	16:05	76.4	77.4
28-Aug-19	16:10	65.2	66.1
28-Aug-19	16:15	55.7	56.4
28-Aug-19	16:20	47.4	48
28-Aug-19	16:25	40.3	40.9
28-Aug-19	16:30	34.4	34.8
28-Aug-19	16:35	29.3	29.7
28-Aug-19	16:40	25	25.3

28-Aug-19	16:45	21.3	21.6
28-Aug-19	16:50	18.2	18.4
28-Aug-19	16:55	15.5	15.7
28-Aug-19	17:00	13.2	13.4
28-Aug-19	17:05	11.3	11.5
28-Aug-19	17:10	9.7	9.8
28-Aug-19	17:15	8.2	8.4
28-Aug-19	17:20	7	7.1
28-Aug-19	17:25	6	6.1
28-Aug-19	17:30	5.1	5.2
28-Aug-19	17:35	4.4	4.4
28-Aug-19	17:40	3.7	3.8
28-Aug-19	17:45	3.2	3.2
28-Aug-19	17:50	2.7	2.7
28-Aug-19	17:55	2.2	2.3
28-Aug-19	18:00	1.8	1.9
28-Aug-19	18:05	1.5	1.5
28-Aug-19	18:10	1.2	1.2
28-Aug-19	18:15	0.9	0.9
28-Aug-19	18:20	0.6	0.6
28-Aug-19	18:25	0.4	0.4

28-Aug-19	18:30	0.3	0.3
28-Aug-19	18:35	0.2	0.2
28-Aug-19	18:40	0.1	0.1
28-Aug-19	18:45	0.1	0.1
28-Aug-19	18:50	0.1	0.1
28-Aug-19	18:55	0	0
28-Aug-19	19:00	0	0
28-Aug-19	19:05	0	0
28-Aug-19	19:10	0	0
28-Aug-19	19:15	0	0
28-Aug-19	19:20	0	0
28-Aug-19	19:25	0	0
28-Aug-19	19:30	0	0
28-Aug-19	19:35	0	0
28-Aug-19	19:40	0	0
28-Aug-19	19:45	0	0
28-Aug-19	19:50	0	0
28-Aug-19	19:55	0	0
28-Aug-19	20:00	0	0

Appendix H: Project Hours

Appendix H-1: Proposed Staffing Hours

Tasks	SENG	ENG	EIT	AA	Total
Task 1: Site Investigation	1	8	35	0	44
Task 1.1: Field Visit and Preliminary Assessment	0	7	17	0	24
Task 1.1.1: Topographic Maps	0	2	4	0	6
Task 1.1.2: Aerial Maps	0	2	5	0	7
Task 1.1.3: Precipitation Data	0	3	8	0	11
Task 1.2: Soil Assessment	1	1	6	0	8
Task 1.3: Flow Measurement	0	0	12	0	12
Task 2: Basin Delineation	0	7	21	0	28
Task 2.1: Major Basin	0	3	3	0	6
Task 2.2: Sub-Basins for Weighted Curve Number	0	1	4	0	5
Task 2.3: Micro-Basins Based on Surface Type	0	3	14	0	17
Task 3: Runoff Routing	0	14	13	0	27
Task 3.1: Time of Concentration Path Delineation	0	6	5	0	11
Task 3.2: Time of Concentration	0	8	8	0	16
Task 4: Centroid Analysis	0	2	6	0	8
	0	2	6	0	8
Task 5: Curve Numbers	2	6	22	0	30
Task 5.1: Weighted Curve Number Calculation for Sub-Basin	1	4	18	0	23
Task 5.2: Curve Numbers for Micro-Basins	1	2	4	0	7
Task 6: Runoff Volumes	2	11	48	0	61
Task: 6.1: Runoff Calculations Using Weighted Curve Numbers	1	3	12	0	16
Task: 6.2: Runoff Calculations Using Micro-Basin Curve Numbers	1	8	36	0	45

Task 7: HEC-HMS Model	1	7	21	0	29
Task 7.1: Data Input	0	3	11	0	14
Task 7.1.1: Soil Assessment Input	0	1	3	0	4
Task 7.1.2: Runoff Routing	0	1	4	0	5
Task 7.1.3: Topographic Map	0	1	4	0	5
Task 7.2: Running HEC-HMS Model	1	1	4	0	6
Task 7.3: Create Hydrographs	0	3	6	0	9
Task 7.3.1: 2-yr Storm Hydrograph	0	1	2	0	3
Task 7.3.2: 10-yr Storm Hydrograph	0	1	2	0	3
Task 7.3.3: 100-yr Storm Hydrograph	0	1	2	0	3
Task 8: Bench Model Simulation	1	10	26	0	37
Task 8.1: Creation of Physical Model	0	4	10	0	14
Task 8.2: Physical Model Storm Simulation	0	4	10	0	14
Task 8.3: Generate Hydrographs from Results	1	2	6	0	9
Task 9: Evaluation of Results	8	16	24	0	48
Task 9.3: Compare HEC-HMS Results to Known Storm Events	4	8	12	0	24
Task 9.2: Compare Simulation to Runoff Volume Results	4	8	12	0	24
Task 10: Project Impacts	6	30	0	0	36
Task 10.1: Economic Impacts	2	10	0	0	12
Task 10.2: Social Impacts	2	10	0	0	12
Task 10.3: Environmental Impacts	2	10	0	0	12
Task 11: Project Deliverables	30	33	91	11	165
Task 11.1 30% Submittal	5	6	22	3	36
Task 11.1.1: 30% Report	3	4	15	2	24
Task 11.1.2: 30% Presentation	2	2	7	1	12
Task 11.2: 60% Submittal	5	6	22	3	36

Task 11.2.1: 60% Report	3	4	15	2	24
Task 11.2.2: 60% Presentation	2	2	7	1	12
Task 11.3: 90% Submittal	7	6	39	3	55
Task 11.3.1: 90% Report	5	4	15	2	26
Task 11.3.2: 90% Website	2	2	24	1	29
Task 11.4: Final Submittal	13	15	8	2	38
Task 11.4.1: Final Report	8	8	1	1	18
Task 11.4.2: Final Presentation	4	4	0	1	9
Task 11.4.3: Final Website	1	3	7	1	12
Task 12: Project Management	118	179	0	26	323
Task 12.1: Meetings	58	174	0	26	258
Task 12.1.1: Client Meetings	2	6	0	2	10
Task 12.1.2: Technical Advisor Meetings	4	12	0	4	20
Task 12.1.3: Grading Instructor Meetings	4	12	0	4	20
Task 12.1.4: Team Meetings	48	144	0	16	208
Task 12.2: Coordination	20	5	0	0	25
Task 12.3: Schedule Management	20	0	0	0	20
Task 12.4: Resource Management	20	0	0	0	20
Total Hours	**169**	**323**	**307**	**37**	**836**

Appendix H-2: Actual Staffing Hours

Tasks	SENG	ENG	EIT	AA	Total
Task 1: Site Investigation	2	0	31.5	0	33.5
Task 1.1: Field Visit and Preliminary Assessment	0	0	25.5	0	25.5
Task 1.1.1: Topographic Maps	0	0	10	0	10

Task 1.1.2: Aerial Maps	0	0	12	0	12
Task 1.1.3: Precipitation Data	0	0	3.5	0	3.5
Task 1.2: Soil Assessment	0	0	4	0	4
Task 1.3: Flow Measurement	2	0	2	0	4
Task 2: Basin Delineation	2	10	51.5	0	63.5
Task 2.1: Major Basin	0	3	20	0	23
Task 2.2: Sub-Basins for Weighted Curve Number	1	4	16.5	0	21.5
Task 2.3: Micro-Basins Based on Surface Type	1	3	15	0	19
Task 3: Runoff Routing	3	10	24	0	37
Task 3.1: Time of Concentration Path Delineation	1	6	15	0	22
Task 3.2: Time of Concentration	2	4	9	0	15
Task 4: Centroid Analysis	0	3	4	0	7
	0	3	4	0	7
Task 5: Curve Numbers	7	9	30.5	0	46.5
Task 5.1: Weighted Curve Number Calculation for Sub-Basin	2	4	10.5	0	16.5
Task 5.2: Curve Numbers for Micro-Basins	5	5	20	0	30
Task 6: Runoff Volumes	0	0	0	0	0
Task: 6.1: Runoff Calculations Using Weighted Curve Numbers	0	0	0	0	0
Task: 6.2: Runoff Calculations Using Micro-Basin Curve Numbers	0	0	0	0	0

Task 7: HEC-HMS Model	3	10	17.5	0	30.5
Task 7.1: Data Input	0	7	8.5	0	15.5
Task 7.1.1: Soil Assessment Input	0	4	2.5	0	6.5
Task 7.1.2: Runoff Routing	0	2	3	0	5
Task 7.1.3: Topographic Map	0	1	3	0	4
Task 7.2: Running HEC-HMS Model	3	3	9	0	15
Task 7.3: Create Hydrographs	0	0	0	0	0
Task 7.3.1: 2-yr Storm Hydrograph	0	0	0	0	0
Task 7.3.2: 10-yr Storm Hydrograph	0	0	0	0	0
Task 7.3.3: 100-yr Storm Hydrograph	0	0	0	0	0
Task 8: Bench Model Simulation	0	0	0	0	0
Task 8.1: Creation of Physical Model	0	0	0	0	0
Task 8.2: Physical Model Storm Simulation	0	0	0	0	0
Task 8.3: Generate Hydrographs from Results	0	0	0	0	0
Task 9: Evaluation of Results	0	8	9	0	17
Task 9.3: Compare HEC-HMS Results to Known Storm Events	0	4	5	0	9
Task 9.2: Compare Simulation to Runoff Volume Results	0	4	4	0	8
Task 10: Project Impacts	0	4	0	0	4
Task 10.1: Economic Impacts	0	1	0	0	1
Task 10.2: Social Impacts	0	2	0	0	2
Task 10.3: Environmental Impacts	0	1	0	0	1

Task 11: Project Deliverables	6	11	68	2	87
Task 11.1 30% Submittal	1	0	16	0	17
Task 11.1.1: 30% Report	1	0	11	0	12
Task 11.1.2: 30% Presentation	0	0	5	0	5
Task 11.2: 60% Submittal	3	2	22	0	27
Task 11.2.1: 60% Report	2	1	15	0	18
Task 11.2.2: 60% Presentation	1	1	7	0	9
Task 11.3: 90% Submittal	2	8	16	0	26
Task 11.3.1: 90% Report	2	8	8	0	18
Task 11.3.2: 90% Website	0	0	8	0	8
Task 11.4: Final Submittal	0	1	14	2	17
Task 11.4.1: Final Report	0	0	0	0	0
Task 11.4.2: Final Presentation	0	1	14	0	15
Task 11.4.3: Final Website	0	0	0	0	0
Task 12: Project Management	8.5	6.5	62.5	7	84.5
Task 12.1: Meetings	3	6.5	51.5	7	68
Task 12.1.1: Client Meetings	2	0.5	1.5	0.5	4.5
Task 12.1.2: Technical Advisor Meetings	0	3	9	1.5	13.5
Task 12.1.3: Grading Instructor Meetings	0	3	17	2	22
Task 12.1.4: Team Meetings	1	0	24	3	28
Task 12.2: Coordination	2.5	0	3	0	5.5
Task 12.3: Schedule Management	2	0	6	0	8

Task 12.4: Resource Management	1	0	2	0	3
Total Hours	**31.5**	**71.5**	**298.5**	**9**	**410.5**

Appendix I: Cost Estimations

Appendix I-1: Proposed Cost Estimate

Cost Estimate of Engineering Services

Description	Unit	Quantity	Unit Cost	Cost
SENG	HR	169	$160	$27,040
ENG	HR	323	$110	$35,530
EIT	HR	307	$60	$18,420
AA	HR	37	$50	$1,850
Bench Model Supplies	LS	1	$1,000	$1,000
TOTAL				**$83,840**

Appendix I-2: Cost of Services to Date

Cost Estimate of Engineering Services

Description	Unit	Quantity	Unit Cost	Cost
SENG	HR	31.5	$160	$5,040
ENG	HR	71.5	$110	$7,865
EIT	HR	298.5	$60	$17,910
AA	HR	9	$50	$450
Bench Model Supplies	LS	0	$1,000	$0
TOTAL				**$31,265**

Appendix J: Schedule

Appendix J-1: Proposed Schedule

Appendix J-2: Actual Schedule