



Woodland Drive Drainage Improvement Study

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1.0 Project Summary

1.1 Background

This project included services to prepare a drainage improvement study for potential upgrades to a portion of the existing drainage system in the City of Harrisonburg, VA. The watershed draining to the existing conveyance channel along Woodland Drive was analyzed to evaluate feasible drainage improvement alternatives. A site map has been provided in Figure 1 below.

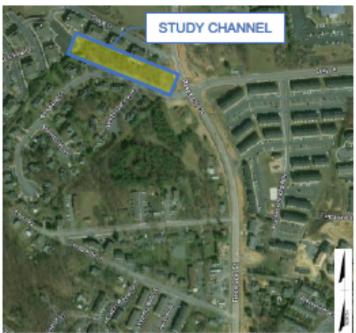


Figure 1: Woodland Drive Drainage Improvement Site Map

The completed study summarizes the analysis process, findings, and suggestions for potential design improvements to the site, including channel improvements and the configuration of proposed detention basins. The hydrologic and hydraulic analyses described below were performed using PCSWMM (v7.4.3202) utilizing the SWMM 5.1.015 calculation engine.

1.2 Description of Project Limits

The Woodland Drive Drainage Improvement study area sits west of Reservoir Street and north of White Oak Circle, primarily along Woodland Drive in a residential neighborhood in the City of Harrisonburg, VA.



The primary stormwater conveyance system is a riprap-lined channel that extends from east to west, north of Woodland Drive. The channel outfalls to a 10'x6' concrete box culvert under the Sunchase parking lot. The study area is the headwaters of Tributary No. 3 to Blacks Run. Multiple drainage pipes outfall to this channel, as does surface drainage from the Woodland neighborhood and Sunchase Apartment complex.

The conveyance channel is approximately 560 linear feet and is fed by four piped systems, ranging from 24" to 60" in diameter. There are two stormwater detention basins located directly upstream of the channel, southwest and southeast of the Reservoir Street intersection. For reporting purposes, portions of the existing drainage network have been labeled as indicated in Appendix A, EXBT-1, and are described below. EXBT-2 displays the contributing drainage areas that feed each trunkline.

Surface runoff from the Woodland neighborhood is served by curb and gutter, which feeds Trunklines B and C. Drainage discharges into the riprap channel via 36" reinforced concrete pipe (RCP). There is a grass-lined, v-shaped ditch that drains into the Woodland system through a grate inlet at 652 White Oak Circle.

Drainage from the northern development of Sunchase Apartments discharges to the channel via Trunkline D (24" RCP). This trunkline also collects runoff from the area bounded by Neff Avenue, Reservoir Street, and Chase Court.

Surface drainage from Reservoir Street is routed to BMP 1 (southwest of the intersection of Reservoir Street and Lucy Drive) and enters the channel via a 36" steel pipe (Trunkline E). A 60" RCP also discharges to the channel (Trunkline F), which collects drainage from two piped systems. Trunkline F serves as the junction for both a 54" system that runs south to north along Reservoir Street (Trunkline G) and a 36" system that runs east to west along Lucy Drive (Trunkline H). A second BMP (BMP 2) located southeast of the intersection drains into the Lucy Drive system. It should be noted that two additional BMPs exist upstream of Trunkline H, outside of the study limits and were therefore excluded from the analysis.

1.3 Site Visit and Survey

Timmons Group conducted a site visit on March 17th, 2021 to collect site photos and analyze existing conditions in the field. These photos are included in Appendix A. Overall, the existing natural channel was found to be in good operating condition, though woody vegetation was well-established within the channel and portions of the banks displayed signs of scour near the downstream outfall (see Figures 1-14, Appendix A). The grate inlet between 652 and 654 White Oak Circle has been observed to become inundated, causing flooding to occur in this area (Figures 15-18). This information was used to help develop existing hydrologic and hydraulic conditions, summarized below.



2.0 Hydrologic Study Summary

Frequency discharges for the 2-, 10-, 25- and 100-year storm events along the study reach were independently calculated. For this study, hydrology was developed using the SCS Curve Number method. The drainage areas developed for this study were delineated based on 1-ft topography generated from a composite Digital Elevation Model (DEM). The DEM was developed by combining 1-ft contour data from James Madison University and 2-ft contour data from the City of Harrisonburg. Aerial photography streamed from VGIN was also referenced as part of the drainage area delineation. Refer to Appendix B for a map illustrating the drainage areas used to develop the hydrological model evaluated in this study.

2.1 SCS Methodology

Land cover information taken from the VGIN data server was used as the basis for establishing land use classifications within each drainage area. VGIN land cover data was translated into SCS TR-55 land cover types. Soils data defining Hydrologic Soils Groups (HSG) within each drainage area was downloaded from the NRCS Soils Survey website. Based on the Runoff Curve Number tables provided in the NRCS TR-55, a curve number shapefile was generated using each land cover and soils classification, as summarized in Table 1 below. It was assumed that all ground cover types were in "good" hydrologic condition when using the TR-55 tables to estimate curve numbers. Time of concentration was developed for each drainage area using the NRCS methodology for sheet flow, shallow concentrated flow, and channel/pipe reaches, see Section 2.2.1.

Table 1: Runoff Curve Numbers (from NRCS TR-55 Table 2-2)

Cover Type	Н	lydrolog	ic Soil G	iroup
Cover Type	Α	В	С	D
Urban				
Open Space - Good	39	61	74	80
Impervious Area - Paved parking	98	98	98	98
Cultivated Agricultural				
Row crops - SR - Good	67	78	85	89
Other Agricultural				
Pasture - Good	39	61	74	80
Woods - Good	30	55	70	77
Arid/Semiarid				
Desert shrub - Good	49	68	79	84



2.2 SWMM Model Parameter Inputs

2.2.1 ARM Subcatchments

Hydrologic data was input into PCSWMM using alternative runoff method (ARM) subcatchments. GIS data and tools were used to develop many of the hydrologic input parameters for the SWMM model. Drainage areas were delineated and directly imported into the model from the supporting GIS layer. Area calculations were performed in ArcMap. As mentioned in Section 2.1, a curve number shapefile was generated in GIS based on land cover and soils classification. This file was imported into PCSWMM and a curve number was calculated for each subcatchment using the Spatial Weighting tool. A slope file was generated from the DEM using the Slope from DEM tool in PCSWMM, which was used to calculate average percent slope for each subcatchment. The percent impervious parameter was set to zero for all subcatchments because SCS methodology accounts for imperviousness in the curve number calculation.

Flow lengths and time of concentrations were calculated outside of PCSWMM. These were developed based on the TR-55 spreadsheet, see Appendix C. Topography data and aerial photography were used to evaluate the longest flow path from the most remote point to the ultimate discharge point for each subcatchment. Time of concentration was taken as the sum of sheet flow, shallow concentrated flow, and pipe and channel flow travel times. For smaller, majority impervious areas with small time of concentrations, an assumed time of 5 minutes was used to provide a more conservative runoff estimate.

2.2.2 Rainfall Distribution

Rain gages were created for each design storm in PCSWMM using the *Design Storm Creator* tool. The hydrographs for each of the design storms were calculated using an SCS Type II, 24-hr storm. Cumulative rainfall depths were determined in accordance with the NOAA Atlas 14 Precipitation Frequency Data Server for Harrisonburg, Virginia and can be found in Table 2.

Table 2: Frequency and Depth of Analyzed Storm Events

Storm Frequency	24-Hour Rainfall Depth (in.)
2-Year	2.63
10-Year	3.87
25-Year	4.69
100-Year	6.13



2.3 Hydrologic Summary

The site has a contributing drainage area of 371.5 acres. Timmons Group developed flows for subcatchments in accordance with SCS methodology. A drainage area map and hydrology characteristics are presented in EXBT-1, Appendix B. A summary table of the hydrology model has also been included in the exhibit. The channel may experience peak flows of approximately 898 cfs during a 100-yr event and up to 413 cfs during a 10-yr event. Subcatchment 1E was the largest contributing area to the site, and it yielded the largest peak flows for all four design storms.

In Table 3 below, model peak flows are compared to USGS StreamStats flows generated at the influent invert the 10'x6' box culvert, as well as FEMA FIS data. Model flows were similar to USGS data, but greater than FEMA data for the area. Each of the three sources derives flow values using different hydrologic methods, contributing to some of the difference in values.

Table 3: Summary of Hydrologic Parameters and Peak Discharge Rates

Source	Area (Ac.)	100-Yr Peak Flow (cfs)
Model	371.5	898
FEMA FIS (downstream)	640	661
UGS StreamStats (47.52% Developed, 2006 NLCD)	364.8	880
UGS StreamStats (72.5% Developed, 2011 NLCD)	364.8	1090

The flow values reported in the FIS were derived from a larger drainage area. The FEMA model profiles do not account for changes to the floodway immediately downstream of the study area, including the removal of a pond and the installation of the box culvert under the Sunchase Apartments parking lot. These changes may also contribute to the difference in reported peak flows. It should be noted that two FEMA Letter of Map Revisions (LOMRs) exist for Tributary No. 3 to Blacks Run. LOMRs 20-03-1670P and 09-03-0277P for panel 510076 were referenced in this analysis.

3.0 Existing Conditions SWMM Model

3.1 SWMM Model Development

A one-dimensional (1D) unsteady flow hydraulic analysis was completed for the study area in SWMM. In a 1D model, piped system and surface flows interact together and are routed to the outfall. The system consists of nodes representing pipe inlets, outlets, and manholes, and conduits representing pipes, drainage ditches, conveyance channels, and overland flows. Elevation data on the existing drainage infrastructure was



obtained from city GIS data and plan sets. To supplement this, city contour data was processed to obtain approximate ground surface elevations for unknown rim elevations.

Entrance and exit loss coefficients were developed to account for bends, pipe diameter changes, pipe confluences, etc. The following table generally details how entrance and exit losses were developed for the model.

Table 4: Entrance and Exit Loss Coefficients Used for Pipe Conduits

ENTRANCE LOSS DESCRIPTION	LOSS COEFFICIENT
	Kentrance
Straight thorough manhole	0.25
junction	
EXIT LOSS DESCRIPTION	LOSS
	COEFFICIENT
Junctions	KE
No bends	0.35
Bend Angle (degrees)	K _B
15	0.10
20	0.16
25	0.22
30	0.28
40	0.38
50	0.47
60	0.55
70	0.61
80	0.66
90	0.70
K _{Exit} =	K _E + K _B
Open Pipe End	1.0

Manning's n roughness coefficients were based on pipe material and channel characteristics. The following values were used for the various conduit materials:

Table 5: Summary Manning's n-Values Used for Conduits

Material	Manning's n
Concrete	0.013
HDPE	0.011
Steel Casing	0.011
Corrugated Metal	0.024
Riprap Channel with Stones and Weeds	0.04 - 0.045
Surface Flow over Impervious Areas	0.020
Surface Flow over Grassy Areas	0.03 - 0.035
Surface Flow over Heavily Vegetated/ Forested Areas	0.06 - 0.09

The hydraulic model incorporates open channel reaches and surface flows caused by flooding drainage structures. The DEM developed for this model (see Section 2.0) was used to digitize surface flow paths and cross sections at key locations along the flow



path alignment. Cross sections were cut from the DEM in PCSWMM using the *Transect Creator* tool. Manning's n-values for surface flow and open channel flow were established based on land cover conditions depicted in aerial photography, site photos, and StreetView in Google Maps. For roadway sections not modeled by irregular conduits, rectangular open channels with widths ranging 10 to 20 ft were used to convey surface flow surcharging from drainage structures.

The presence of two existing BMPs within the study area issued the need to include storage nodes in the model. Stage-storage curves were estimated based on existing topographic data. Plans provided by the City were referenced to obtain information on the outlet structures for the BMPs. For each BMP, a series of orifices was used to model the outlets in PCSWMM. Two weirs also were used for each BMP. One weir simulated an emergency spillway, with an assumed elevation two feet below the BMP crest. A second weir was used to simulate flows overtopping the crest of the BMP berm. Existing topographic data was used to approximate weir lengths and heights.

According to existing plans, both BMPs were designed to contain the 100-yr storm without overtopping. However, the model indicates that BMP 1 overtops in the 100-yr event, and that BMP 2 overtops in the 2-yr event. This error may be partially attributed to the use of SCS methodology to produce more conservative peak flows, as well as the omission of two BMPs upstream of Trunkline H. As mentioned in Section 1.2, these BMPs were located outside of the initial study limits and were therefore not included as storage nodes in the model. Plans were not available for these facilities at the time of model development, but some storage volume was accounted for in this area by modeling an irregular conduit with a transect pulled across the basin footprint.

The model's outfall node was set downstream of the system, west of Neff Avenue, to ensure that backwater effects from the 10'x6' box culvert were modeled. The outfall condition was set to normal depth. A 24-hour simulation was created using the Dynamic Wave routing method. The Curve Number method was selected for the infiltration model. A three second routing time step was used, and the reporting time step was set to one minute.

3.2 Findings / Summary of Existing Conditions

The model described above established base flooding along the studied area for existing conditions. Inundation maps and profiles of the existing system were generated for each storm event in PCSWMM. These results are included in Appendix D. This information was used to identify critical flood locations and determine which components of the system would provide the most benefit from upgrades. See Appendix F for detailed SWMM output data for the existing 10-yr model.

As summarized in Section 2.3, the channel outfall north of Woodland Drive collects 371.51 acres of drainage. Model results indicate that the channel passes a peak flow of 413.04 cfs in the 10-yr storm event. Subcatchment 1E contributes most of this drainage,



which is collected by Trunkline G along Reservoir Street. In the modeled 10-yr storm event, this subcatchment yields a peak flow of 265.35 cfs. Trunkline G collects a total of 198.05 acres of drainage from five subcatchments. These subcatchments represent drainage east and west of Reservoir Street, as well as the intersection of Reservoir Street and Foley Road (See Appendix A, EXBT-2). Surface runoff from Reservoir Street is primarily collected by Trunkline E and routed to BMP 1.

As seen in the Existing Conditions inundation map in Appendix D.2, roadway flooding occurs in the study area for all events, including the 2-yr storm. This flood mapping, along with a hydraulic grade line (HGL) analysis of the studied trunklines (see Appendices D.2 and D.3), indicates that the existing riprap channel is not the primary source of roadway flooding in the Woodland neighborhood. The inundation exhibit highlights two flood-prone areas: 1) the ditch between 652 and 654 White Oak Circle, and 2) the inlets associated with Trunklines H, F, and BMP 2 at the intersection of Reservoir Street and Lucy Drive.

As seen in the storm profiles in Appendix D.3, in Trunkline F, the HGL spikes in Conduits 78214 and 34066 under all storm events, indicating that these pipes are undersized. This causes Trunkline H to surcharge and flood at the intersection of Reservoir Street and Lucy Drive. As flow backs up Trunkline G, the system demonstrates capacity for the 2-yr event until Structure 3170, at which point surcharging occurs. It should be noted that routed drainage from subcatchments 1D_1 and 1D_3 merge at this structure before entering Trunkline G via Conduit 29039. Figure 2 below displays the configuration of existing drainage infrastructure at Ridgeville Lane and Reservoir Street



Figure 2: Structure 3170 at Ridgeville Lane and Reservoir Street



Overflow from Structure 3170 then flows north towards Foley Rd, through three cityowned parcels and two residential lots. At 2210 Reservoir Street, a swale runs through the yard that likely conveys this flow (Figure 25, Appendix A,). Drainage is then routed under Foley Road via a concrete pipe and enters a paved channel east of 709 Foley Road. This channel was inaccessible at the time of the site visit due to overgrown vegetation (Figure 26, Appendix A). Channel flow then drains to the Woodland neighborhood through a private, undeveloped parcel before entering the v-ditch on 652 White Oak Circle (Figure 16, Appendix A).

Trunkline E exhibits adequate capacity for the 2-yr event, but portions of Reservoir Street east of the BMP begin to surcharge in the 10-yr event. This was initially causing flood loss in the model because flows were exiting the drainage system and were not accounted for at the end of the simulation. For this reason, the model directs overflow from Reservoir Street to escape the roadway via a driveway entrance, as displayed in Figure 3 below. This flow then merges with surface flows from Foley Road on an undeveloped private parcel and drains to 652 White Oak Circle.



Figure 3: Structure 51639 Surcharge Routing

Findings were presented to city staff on April 28th and June 21st, 2021 and were validated based on prior storm events and complaints received by residents. Potential alternative solutions were discussed and are presented in Section 4.0 below. As described in Section 3.1, flow simulations indicate BMP1 overtopping during the 100-yr event and BMP2 overtopping in the 2-yr event, which indirectly routes additional flow to the v-ditch and grate inlet via surcharging inlets along Reservoir Street. This is a noted inaccuracy in the model, likely due to the omission of upstream detention facilities along Lucy Drive. Results of the Existing Conditions model may be considered more conservative because the arrival time and volume of peak flows would be dampened by modeling this additional detention.



4.0 Alternatives Analysis

The Existing Conditions model serves as the basis of analysis for each of the proposed alternatives. Five alternatives were analyzed to determine the effectiveness of various flood improvements strategies. Effectiveness was determined by reduction in the existing floodplain and reported peak flow at the outfall for various storm events. Flood improvement strategies considered in this study include:

- A. Construction of a BMP on city-owned property.
- B. Construction of a BMP on an undeveloped private parcel.
- C. Combination of public property and private property BMP footprints in series.
- D. Drainage channel improvements.
- E. Construction of a BMP on an undeveloped private parcel in addition to channel improvements.

Conceptual layouts of Alternatives A, B, C, and E are presented in Appendix E.1.

4.1 Alternative A: BMP on City-Owned Property

The Existing Conditions hydraulic analysis indicates that flooding in the Woodland neighborhood is caused by flows bypassing the existing drainage infrastructure along Reservoir Street. Flows from two major components of the study basin merge in Trunkline F, creating a spike in the HGL that backs up through Trunkline G and prohibits additional flows from entering the system.

Alternative A seeks to slow down the timing and volume of flows traveling through Trunkline G by redirecting all drainage from subcatchment 1D to a BMP located on city property between Ridgeville Lane and Foley Road. The BMP footprint encompasses a 0.4 ac area and has approximately a 60,000 ft³ volume. Subcatchment 1D runoff is redirected to the BMP by removal of an existing 27" RCP (Pipe ID 29039 in city GIS database) and replacement with a 27" pipe that routes drainage to the BMP. All drainage from subcatchment 1E is still routed through Trunkline G. Drainage from the BMP is primarily routed into Trunkline E via 24" RCP. Overflow from the BMP in larger events still bypasses the Reservoir Street trunklines and travels north towards Foley Road.

4.2 Alternative B: BMP on Undeveloped Private Parcel

A large BMP is proposed in Alternative B on a privately-owned parcel located between Reservoir Street and the Woodland neighborhood. This BMP footprint encompasses approximately 1.53 ac and has a 495,000 ft³ volume. Implementation of this alternative may be cost-prohibitive because it requires the City to purchase this parcel prior to BMP construction. Only surface flow from the Foley Road channel (see Section 3.2) and



overflow from the Reservoir Street trunklines feed the BMP; there is no piped component to reroute flows from the existing trunklines as presented in Alternative A.

The placement of this BMP impacts the feasibility of rerouting Trunkline G. To redirect the most impactful subcatchments (DA 1D_1, 1D_2, 1D_3), an additional trunkline would need to be installed from the intersection of Ridgeville Lane and Reservoir Street, and outfall at the mouth of the BMP footprint. This would require either: 1) spanning multiple private residential properties, or 2) placing the proposed system within the existing right-of-way and managing spatial conflicts with the two existing trunklines below Reservoir Street. Additionally, the HGL through existing infrastructure along Trunkline E indicates adequate capacity and is already routed to an existing BMP. It is for this reason that Trunklines E and G are not rerouted in this alternative.

The Existing Conditions analysis indicates that excess flows draining to the v-ditch at 652 White Oak Circle are a primary area of flood concern. The BMP placement in this alternative analyzes the effect of detaining flow immediately upstream of this flood-prone area. Though only drainage from the Foley Road channel and overflow from Reservoir Street is detained in this BMP, the model shows that this footprint detains up to the 25-yr event and improves the corresponding floodplains for these storms.

4.3 Alternative C: Combination of City Property BMP and Private Property BMP in Series

The effect of incorporating two BMPs into the drainage system is modeled in Alternative C. Descriptions of the city-owned parcel and private-owned parcel footprints are described in Sections 4.1 and 4.2 above, respectively. The method of flow routing to these BMPs varies slightly from those presented in Alternatives A and B. In this alternative, only drainage from Subcatchment 1D_2 is routed to the city parcel BMP. Subcatchments 1D_1 and 1D_3 are routed to the private parcel BMP via a 24" piped trunkline. Multiple routing combinations were analyzed to direct flow from these subcatchments to the BMPs, and the presented configuration displayed the most effective floodplain reduction. As noted in Alternative B, directing flow to the private parcel footprint through a closed system presents potential design conflicts. Additionally, the feasibility of this alternative is limited because it requires acquisition of a large parcel zoned for future development, in addition to potential easements for a proposed trunkline that directs the most influential flows to the large BMP.

4.4 Alternative D: Drainage channel improvements

Alternative D focuses drainage improvement efforts on the existing conveyance channel only. This alternative represents maintenance of and/or minor upgrades to the existing channel by clearing existing trees and established vegetation. Maintenance would limit disturbance solely to the headwaters of Tributary No. 3 to Blacks Run. Three subalternatives were analyzed for this concept, including clearing only the channel,



clearing the channel and overbank areas, and upgrading the channel to a concrete-lined drainage ditch.

The model indicated that channel and overbank clearing does little to improve flooding in the area. Inundation maps for these two subalternatives exhibited negligible differences between the existing and proposed floodplains. However, upgrading the channel to a concrete-lined system and re-grading the channel to establish a more uniform slope produces noticeable effects on the floodplain. For this reason, only this subalternative was pursued and reported upon in the analysis herein.

In this alternative, the channel is regraded to achieve a more uniform longitudinal slope. Ditch geometry is widened to achieve 2:1 side slopes, a 5-ft bottom width, and 6-ft depth. The channel roughness coefficient is changed from 0.045 to 0.013 to simulate a concrete lining. As seen in Figure 4 below, when compared to Existing Conditions, this alternative produces a floodplain increase in the 10-yr storm. Additionally, Alternative D3 increases peak flow at the outfall in the 2-yr event, see Table 7. For these reasons, this alternative was not considered for further evaluation.



Figure 4: Alternative D vs. Existing Conditions, 10-Year Floodplain

4.5 Alternative E: Construction of a BMP on an undeveloped private parcel and channel improvements

This alternative was included in the analysis to evaluate the effect of combined maintenance and mitigation measures on the floodplain. As was observed in the Alternative D results, this alternative also produces a floodplain rise in the 100-yr event. Figure 4 displays an inset of the 100-yr hydrograph for a section of the conveyance channel. Even though overall peak flow is reduced, the timing of the peak is affected, and portions of storm event show a larger volume flowing through the system than under the Existing Conditions model (approximately 30 cfs in some places). As seen in



EXBT-7 and EXBT-8 (Appendix E.2-2), there is no significant floodplain improvement in this alternative over Alternative B in the 10-yr event. In fact, the 25-yr floodplain is slightly higher in Alternative E than in B, and 100-yr floodplain is higher than the Existing Conditions model.

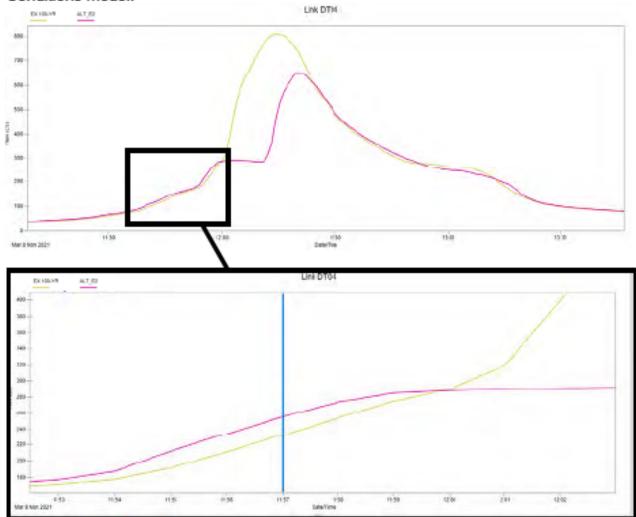


Figure 5: Alternative E Hydrograph

5.0 Summary and Recommendations

5.1 Summary

The 10-yr floodplain was mapped for each alternative and compared to the Existing Conditions results. Of the five presented alternatives, three were selected for detailed analysis. Alternative D exacerbates flooding along Woodland Drive in the 10-yr event and was therefore omitted from further analysis. Alternative C was also removed from the analysis despite providing significant peak flow and floodplain reduction. This



alternative provides little benefit over Alternative B for flood attenuation and requires the construction of two basins instead of one. Alternatives A, B, and E have been analyzed under the 2-, 10-, 25-, and 100-yr events. Detailed results and SWMM outputs are presented Appendices E and F. Table 7 below summarizes peak flow reductions by alternative.

Table 7: Comparison of Peak Flows at Outfall by Alternative

	2-Y	R	10-	YR	25	-YR	100-	-YR
	Q (cfs)	Δ	Q (cfs)	Δ	Q (cfs)	Δ	Q (cfs)	Δ
Ex. Cond.	183.34	-	413.04	-	603.24	-	898.58	-
Α		-5.85		-47.09		-21.19		-16.70
В		-4.95		-90.13		-238.74		-58.94
С		-0.96		-90.70		-237.56		-89.00
D		+1.46		-33.49		-72.27		-39.96
E		-3.08		-96.94		-254.03		-136.9

No structures are removed from the 100-yr floodplain under the presented alternatives (see Table 8 below). Alternative E exacerbates flooding and adds an additional structure to the 100-yr floodplain. Both Alternatives B and E remove five structures from the 25-yr floodplain. Alternative A provides relief for three structures in smaller storm events but offers no removal in the 25-yr storm.

Table 8: Comparison of Peak Flows at Outfall by Alternative

Storm Event	No. of Structures in Floodplain	Number	of Structures F	Removed
	Existing	Α	В	E
2-YR	10	3	*	*
10-YR	15	3	3	3
25-YR	19	0	5	5
100-YR*	26	0	0	-1**

^{* 2-}yr inundation was mapped only for Alternative A to determine if the proposed BMP demonstrated capacity for small storm events.

Alternative B demonstrates that even large detention volumes are unable to fully relieve the Woodland neighborhood of flooding issues in large storm events. Further, comparison of Alternatives A, B, and E underscore a key finding of the Existing Conditions analysis: the main conveyance channel is not the primary cause of flooding in this area. Drainage issues first arise further upstream in the existing drainage network and can be attributed to insufficient pipe capacity at key junctions, as well as peak flow augmentation caused by hydrograph overlap.



^{**} Alternative E 100-yr floodplain inundates an additional structure rather than removal.

The construction of a BMP on city-owned property (Alternative A) exhibits the most potential for design, despite its limited effectiveness at flood attenuation. This alternative does not require additional land acquisition by the City. The size of the BMP footprint is much less than that of the private parcel BMP proposed in Alternative B, meaning a smaller footprint of disturbance and few associated construction material quantities.

This analysis demonstrates that the installation of a BMP on the city-owned parcel slightly improves flooding conditions in the Woodland neighborhood. Under this scenario, flows entering the vegetated v-ditch at 652 White Oak Circle are contained within the channel and less flow is allowed to bypass the existing drainage network at the intersection. Though this BMP design only achieves a 2-yr level of service for water quantity benefits in the model, it has the potential to earn credit as water quality BMP as well

Hydrologic inputs were processed in the Virginia Runoff Reduction Method (VRRM) Re-Development Spreadsheet to determine the feasibility of implementing a constructed wetland per VA BMP Clearinghouse Specifications. The VRRM spreadsheet indicated that a volume of 111,120 ft³ would be required to treat the contributing drainage area. Though the proposed footprint under Alternative A attempted to maximize treatment volume based on existing spatial constraints, it was only able to achieve a volume of 60,000 ft³. For this reason, the Chesapeake Bay Program retrofit curves and loading rates were used to calculate estimated load reductions for Total Nitrogen (TN), Phosphorus (TP), and Suspended Solids (TSS). Using Table 3b from the Chesapeake Bay TMDL Special Condition Guidance Memo, loading rates were calculated for each pollutant, see Appendix G. Reduction percentages were calculated using the retrofit equations and load reductions are presented in Table 9 below.

Table 9: Estimated Reduction by Pollutant

Pollutant	Load (lb/yr)	% Reduction	Est. Reduction (lb/yr)
TN	720	29	210
TP	55	45	25
TSS	37,000	58	22,000

It should be noted that the studied reach is sensitive to fluctuations in the arrival times of peak flows from different subcatchments within the study basin. As seen in Alternative E, upgrading the channel from riprap to concrete causes an increase in the 100-yr floodplain due to compounding hydrographs. Drainage design for future developments in the area should ensure that flooding is not exacerbated by allowing the hydrograph of post-developed peak flows to coincide with major peaks in the existing system.

5.2 Recommendations

The alternatives presented in this report analyze designs that seek to mitigate residential flooding impacts in the Woodland neighborhood. Flood inundation maps,



hydrographs, and system hydraulics were analyzed using PCSWMM for each alternative.

It is recommended that further studies be conducted upstream of the study area to better inform the design of a stormwater detention system between Ridgeville Lane and Foley Road. Existing infrastructure that outfalls to the conveyance channel should also be further analyzed to demonstrate adequate capacity under small storm events, such as the 2-yr and 10-yr storms.

Future work may include improving and validating the Existing Conditions model developed for this study. Extending the model further south to encompass more of the drainage infrastructure along Reservoir Street would provide a more realistic simulation of true drainage network conditions. Additionally, subdividing the larger subcatchments and routing them through the expanded drainage network would better inform the hydraulic model on the timing of peak flows through the system. Extension of the model eastward along Lucy Drive to encompass upstream BMPs would also improve the model results by accounting for the detention provided by these facilities, especially for smaller storm events.

Inundation mapping may also be improved through the use of a higher resolution DEM, in which curb elevations, inlet sumps, and updated road and channel geometries are included. Mapping may also be improved by utilizing irregular conduits in place of open rectangular conduits to simulate sheet flow on roadways.

Further design and analysis of the proposed BMP outlet control structures would improve the proposed scenarios. The Alternatives Analysis models these structures as pipes with the same geometry as the downstream system. The purpose of this analysis was to provide proof of concept for multiple storm scenarios for these alternatives, rather than fully designed basins. However, detailed information on the outlet control devices in these BMPs would enhance model results, especially for smaller storm events which the small BMP would be capable of detaining.

It is important to note that future changes within the studied area as a result of development, redevelopment, or infrastructure changes may cause or contribute to flooding not represented in this report. Hydrologic discharge rates and corresponding base flood elevations may be impacted by further urbanization of the study area. Because of sensitivity to peak flow timing in the existing channel, it is recommended that drainage design for future developments in the area ensure that flooding is not exacerbated by allowing post-developed peak flows to coincide with major peaks in the existing system.



APPENDIX A

Site Map and Photos





SITE PHOTOS



EXISTING CONVEYANCE CHANNEL



FIG 1: Trunkline E Outfall (36" SS)



FIG 2: Trunkline F Outfall (60" RCP)



FIG 3: Upstream Terminus of Existing Channel



FIG 4: Existing Conveyance Channel (Facing Upstream)



FIG 5: Existing Conveyance Channel (Facing Upstream)



FIG 6: Existing Conveyance Channel (Facing Downstream)

TIMMONS GROUP



FIG 7: Trunkline B Outfall



FIG 8: Trunkline B Outfall



FIG 9: Trunkline D Outfall and Riprap



FIG 10: Trunkline D Outfall



FIG 11: Existing Conveyance Channel, Upstream of Outfall (Facing Downstream)



FIG 12: Erosion of Left Bank (Downstream Terminus of Existing Conveyance Channel, Upstream of Outfall)





FIG 13: Observed Bank Erosion Upstream of Outfall (Facing Upstream)



FIG 14: Ultimate Outfall of Project Limits (10'x6' Box Culvert Under Sunchase Parking)

WOODLAND DRIVE



FIG 15: Intersection of Woodland Drive and White Oak Circle



FIG 16: Yard Inlet and v-ditch at 652 White Oak Circle



FIG 17: Curb Opening to Conveyance Channel at Woodland Drive (Facing West)



FIG 18: Woodland Drive and White Oak Circle (Facing Northeast)



RESERVOIR STREET AND EXISTING BMPs



FIG 19: BMP 1 (Facing South)



FIG 20: Trunkline E2 Outfall into BMP 1



FIG 21: Intersection of Reservoir Street and Woodland Drive (Facing North)



FIG 22: BMP 2 From Top of Berm (Facing East)



FIG 23: BMP 2 at Outlet Structure (Facing South)



FIG 24: BMP 2 Basin and Outlet Structure, Facing Reservoir Street (Facing West)





FIG 25: Drainage Ditch on 2210 Reservoir Street (Facing South)



FIG 26: Overgrown Channel at Foley (Unable to Locate Defined Channel)



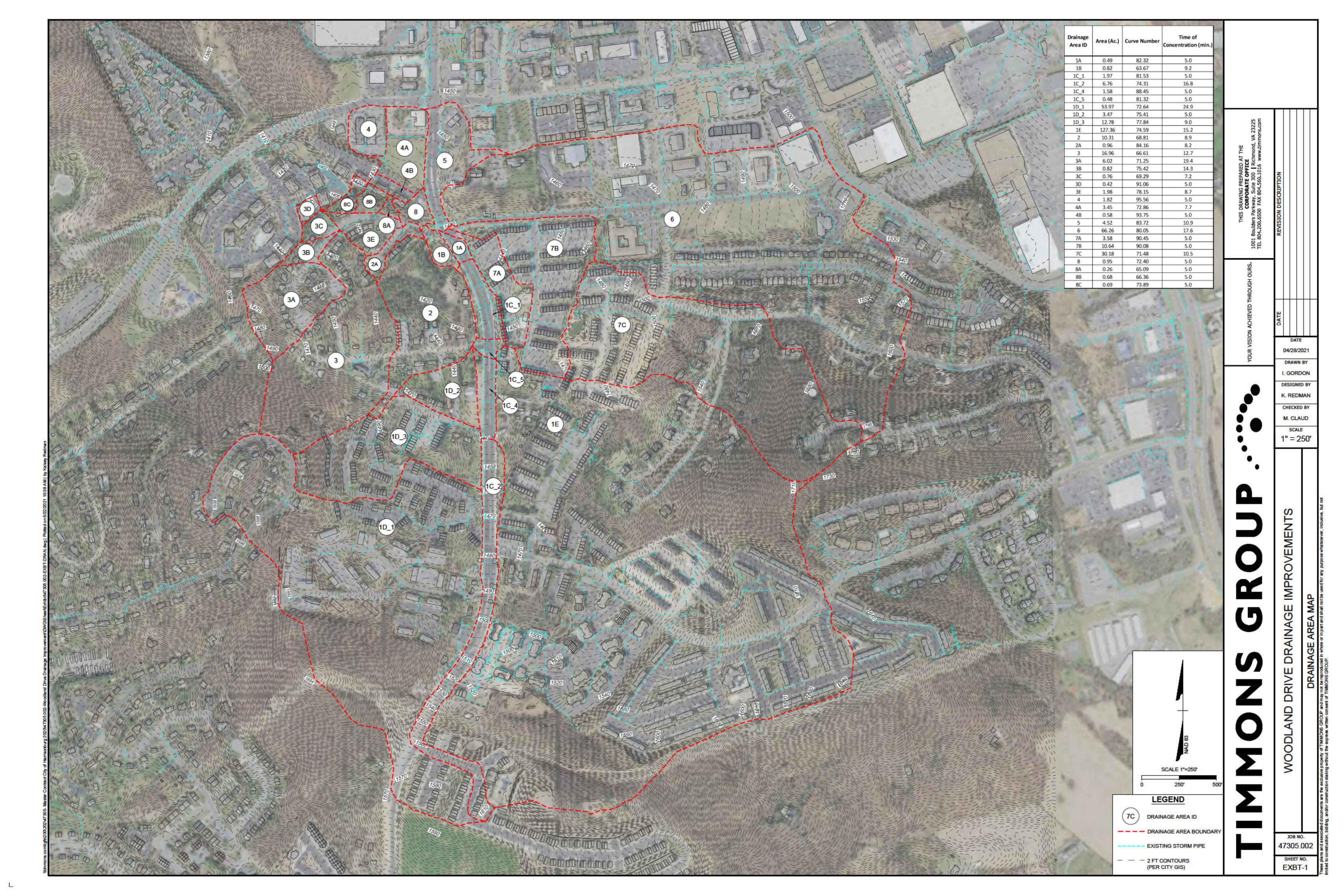
FIG 27: Intersection of Foley Road and Reservoir Street (Facing East)



FIG 28: Reservoir Street at Foley Road (Facing South)

APPENDIX B

Drainage Areas



APPENDIX C

Hydrologic Support Data



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA]											
	land Harr	X	fairting	Project:	Woodland	Orive Oraina	ge improvement			1											
	Land Use:		Proposed	Oralinge Area Number:	1A					1											
OHIO	Site Land Use:	X	twinting	By:	K. REDIMA	N				1											
UII-S	site Land Use:		Proposed	Date:	6/17/3021					1											
									TIME OF	CONCENTRATION	(VELOCITY METHO	D)									
		2-Year 2	8-Hour Percipitation Reinfell Amount [in] •																		
lacksquare			County/City	City of Harrisonibu	rg.					Sheet F											
								Aug. Mope		Sheet P								Western			
		Type of Hou			US flex.	DS Elex.	Length (ft.)	(h/h)				Ti	avel Time Equa	tion				(Py/4)	T,(bes)	T _r (mins)	Notes
1		Grass - Dense Gr	-	0.240				epev/or					0.007 (nE)	0.8							
⊢								_	ł			$\tau_{\rm e}$	$=\frac{0.007 (\pi L)}{(P_{a})^{1/2} g^{1/2}}$					NA.		-	I
lacksquare										Shallow Concer	metad films										
-								Aug Slene		SHARW CORE	Dated Fow							Makedon			
10	1	How Type			US Elex.	DS Elev.	Length (ft.)	Aug. Slope (ft/ft)	l			,	Velocity figuration	on .				(Ps/4)	Tr(bes)	N(mins)	Notes
2		Pewement and Small Up	fand Guilles	0.005	1439.0	1427.8	29.67	800.0					V + 20.325(s)*0	3				1.790	0.005	0.276	
																					I
⊢										Quantil											
-										Classed			_	E C	PT-000	1.	Average				
10	Channel Shape	Channel Type	Channel Description	•	US Elev.	DS Eller.	(ength (t.)	Aug. Slope (ft/ft)	Avg. Normal Depth (R)	Avg. Bottom Width (ft)	Avg. Side Slopes (N/Ts)	Avg. Top Width (t)	Area	Wetted Perimeter	Valority	Average How Area (th')	Wetter	Velocity (TV4)	T,(box)	T _r (mine)	Notes
13	Circular Pipe	Lined or Built-Up Channel	Clean, straight, full, no riffs or deep pools w/ more stones and weeds	6.040	1427.77	\$419.57	15892	0.058	125	NA	NA.	NA.	A = 10[4/2]*2	P = 2x(4/2)	V = (1.49()/)*2/30(s/*0.5()/s	1.23	1-7	1.96	0.011	0.65	
																			0.015		



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS														
$\overline{}$		X	tairting	Project:	Woodland	Orive Oraina	ge improvement			1										
	and Use:		Proposed	Drainage Area Number:	18					1										
		X	fairting	livs	K. REDMA	N				1										
Off-S	ite Land Use:			Date:	Q'17/3001					1										
									TIME OF	CONCENTRATION	N (VELOCITY METHO	0)								
		3-76673	S-Hour Perceptation Karotal Account [10]																	
lee			County/City	City of Harrisonius	org.					Sheet R										
-								Aug. Mope		and P							Vesicity			
		Type of Flow			US files.	Di Elex.	Length (ft.)	(11/11)				11	need Time Equa	tion			(79/4)	T, (brs)	T _r (mins)	Notes
1		Grass - Dense Gr	-	0.340	1490.0	1420.0	501.08	0.099		0007 (~1708										
									l			T _e	$=\frac{0.007 (\pi L)}{(P_3)^{1/2} g^{1/2}}$	_			NA.	lacksquare		
													12 2							
										Shallow Concer	trated Flow								_	
10		Flow Type			US Elex.	DS Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity Squarts	on.			Velocity (TV4)	Tr(box)	%(mind)	Notes
2		Pewement and Small Up	land Guillies	0.025	1430.0	1416.0	139.64	0.029					V + 20.828(s)*0	5			3.440	8.811	0.676	
$ldsymbol{ldsymbol{eta}}$																				
\vdash		_				_	_			Cleanel	Now.		_		973-203	-		_		
	Channel Shape	Channel Type	Channel Description	•	US Elex.	DS Elex.	(angth (%.)	Aug. Slope (ft/ft)	Aug. Hormal Depth (ft)	Avg. Buttom Width (ft)	Avg. Side Slopes (ft/ft)	Aug. Top Width (%)	Area	Wetted Perimeter	Valodity	Amerage How Area (h) (h)	Velocity (TV4)	T _r (lum)	T _i (mind)	Notes
	Circular Pipe	Lined or Bulb-Up Clarinel	Concrete	6.013	\$496.00	1413.00	194.48	0.022	3.00	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(d/2)	V = (5.49([/)*2/3)((s)*0.5)((/s	7.07 9.42	14.13		0.16	Assumed Diameter
																	Total T, e	0.050	9.211 5.527	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PAR	AMETE	RS				1											
		X	fairting	Project	Wooden	d Orive Oraina	ge improvement		•	1											
	and Use:		Proposed	Drainage Area Number:	_					1											
0#1	to Lond House	X	tolering	By:	K. REDIMA	N.				1											
Office	ite Land Use:		Proposed	Date:	6/17/202	1				1											
									TIMEO	F CONCENTRATIO	N (VELOCITY METHO	D)									
		3-Year	8-Hour Perceptation Raintal Amount [10] County/City																		
-			CountyCop	City of Harmonia	ol.					Sheet F	low .										
10		Type of Flow			US Elex.	DS Elec.	Length (ft.)	Avg. 300pe (ft/ft)				Ti	evel Time Equa	tion				(TV/s)	T,(hes)	T _i (min)	Notes
1		Grass - Dense Gr	-	0.240	1616.1	1685.0	87.71	0.052					0.007 (-1)					1044	0.286	17.545	
									1			T _e	$=\frac{0.007 (\pi L)}{(P_{a})^{1/2} S^{1/2}}$	(1.0				NA.			
\vdash	<u> </u>									Shallow Concer			12 4								
\vdash					_	_		Aug. Slope		Shallow Concer	titled Pow							Velocity			
10		Flow Type			US files.		Length (ft.)	(11/11)					Velocity figural					(19/4)		N(mins)	Notes
2		Pevernent and Small Up	land Guilles	0.025	1635.0	1599.8	1171.12	0.085					V = 20.123(c)*0	15				3.311	0.065	5.121	
\vdash					+	⊢		_										_		-	
-					_					Cleanel											
										Channel	Row										
					П					Clannel	Pice T			Top	urbon.	Average	Average				
10	Clamel Shape	Channel Type	Channel Description		US Elex.	CS Elex.	(augit (t.)	Aug. Slope (ft/ft)	Aug. Normal Depth (%)	Avg. Bottom Width (ft)		Avg. Top Width (%)	Area	Noticed Perimeter	Valority	Flow Area	Average Wetted Perimeter	Velocity (TV/s)	T,(hrs)	T,(mind)	Notes
	Channel Shape	Clamel Type	Channel Description		US Elex.	DS Elex.	Length (ft.)	Aug. Slope (h/M)	Aug. Normal Depth (10)			Aug. Top Width (%)	Area			How Area (h ¹)	Wetted Perturber (%)	(9/4)			
	Clarnel Shape Circular Pipe	Classel Type Used or Bulk-Up Classel	Clannel Description Concrete	6.003		05 flex. 1580.83			Aug. Normal Depth (Pd)			Avg. Top Width (%)	Area A = 10(4/2)*2			(h) 0.79	Wetted	(9/4)			Notes Assumed Diameter
	Circular Pipe Trapsoldal Channel	Lined or Bulk-Up Channel Lined or Bulk-Up Channel	Concrete Gean, straight, full, no rifts or deep pools	6.000	1582.58 1580.89	1580.83 1514.41	18074 236.46	0.065 0.187	1.00 4.90	Avg. Bottom Width (ft) NA 10.00	Avg. Side Slopes (N/Ti) NA 1.00	NA 59.80	A = 164/2)*2 A = (b + 26)h	Wetted Perimeter P = 2x(d/2) P = b + (2h)x()x1(1 + (x)^2()	Valodby V = (2.49()/*2/30(s/*0.5())/n V = (2.49()/*2/30(s/*0.5())/n	(h ²) 0.79 73.01	Wetted Pertoster (%) 3.14 23.86	11.60 46.51	0.004	0.26	
	Circular Pipe Trapezoldal Channel Circular Pipe	Used or Bulk-Up Channel Used or Bulk-Up Channel Used or Bulk-Up Channel	Concrete Clean, straight, full, no ritte or deep pools Concrete		1592.58 1590.89 1504.45	1580.83 1514.41 1518.06	\$80.74 896.46 \$94.69	0.065	100	Avg. Buttom Width [ft]	Avg. Side Skopes (ft/ft)	NA.	A = 16(4/2)*2	Wetted Perimeter P = 2x(4/2) P = b + (2x(4/2)(4/2) P = 2x(4/2)	Valodby V = (2.49()/*2/3()()/*0.5()(/n V = (2.49()/*2/3()()/*0.5()(/n V = (2.49()/*2/3()()/*0.5()(/n	(h) 0.79	Wetned Perturber (%) 3.14	11.60	0.004	0.26	
3	Circular Pipe Trapsoldal Channel	Lined or Bulk-Up Channel Lined or Bulk-Up Channel Lined or Bulk-Up Channel Lined or Bulk-Up Channel	Concrete Geon, straight, full, no rifts or deep pools	6.000	1582.58 1580.89	1580.83 1514.41	18074 236.46	0.065 0.187	1.00 4.90	Avg. Bottom Width (ft) NA 10.00	Avg. Side Slopes (N/Ti) NA 1.00	NA 59.80	A = x(4/2)^2 A = (b + x)(A A = x(4/2)^2 A = (b + x)(A	Wetted Perimeter P = 2x(4/2) P = b + (2x)(4/2) P = 2x(4/2) P = b + (2x)(4/2)(1 + (4/2))	Valodby V = (2.44()/*2/3(0)/*0.5(0)/* V = (2.44()/*2/3(0)/*0.5(0)/* V = (2.44()/*2/3(0)/*0.5(0)/* V = (2.44()/*2/3(0)/*0.5(0)/*	Row Area (M ²) 0.79 73.01 1.23 74.76	Wether (n') 3.14 23.86 3.93 48.55	(P/4) 11.60 46.51 4.40 26.33	0.004 0.002 0.012 0.001	0.36 0.12 0.74	
4 5	Circular Pipe Trapezoldal Channel Circular Pipe	Used or Bulk-Up Channel Used or Bulk-Up Channel Used or Bulk-Up Channel	Concrete Clean, straight, full, no ritte or deep pools Concrete	ESSO ESS	1592.58 1590.89 1504.45	1580.83 1514.41 1518.06 1496.18	\$80.74 896.46 \$94.69	0.065 0.197 0.007	100 490 125	Avg. Burnom Wildth (ft.) NA 10:00	Avg. Side Slopes (PL/Pt) NA 1.00 NA	NA S9.80 NA	A = 104/20*2 A = (0 + 104) A = 104/20*2	Wetted Perimeter P = 2x(4/2) P = b + (2x(4/2)+(4/4)) P = 2x(4/2)	Valodby V = (2.49()/*2/3()()/*0.5()(/n V = (2.49()/*2/3()()/*0.5()(/n V = (2.49()/*2/3()()/*0.5()(/n	Row Area (M ²) 0.79 73.01 1.23 74.76	Wetted Perimeter (n°) 3.14 23.86 3.93	(P/4) 11.60 46.51 4.40 26.33	0.004 0.002 0.012 0.001	0.26 0.12 0.74	
4	Circular Pipe Trapecoldal Channel Circular Pipe Trapecoldal Channel	Lined or Bulk-Up Channel Lined or Bulk-Up Channel Lined or Bulk-Up Channel Lined or Bulk-Up Channel	Concrete Clean, straight, full,no offis or deep pools Concrete Clean, straight, full,no offis or deep pools	ESIO ESIA ESIO	190.9 190.8 1504.4 1513.0	1580.83 1514.41 1518.06 1496.18	\$80.74 \$86.46 \$94.69 \$06.79	0.065 0.187 0.007 0.158	100 490 125 210	NA 10:00 NA 20:00	Avg. Side Slopes (A/R) NA 1.00 NA 6.00	NA 39.80 NA 48.20	A = x(4/2)^2 A = (b + x)(A A = x(4/2)^2 A = (b + x)(A	Wetted Perimeter P = 2x(4/2) P = b + (2x)(4/2) P = 2x(4/2) P = b + (2x)(4/2)(1 + (4/2))	Valodby V = (2.44()/*2/3(0)/*0.5(0)/* V = (2.44()/*2/3(0)/*0.5(0)/* V = (2.44()/*2/3(0)/*0.5(0)/* V = (2.44()/*2/3(0)/*0.5(0)/*	Row Area (M ²) 0.79 73.01 1.23 74.76	Wether (n') 3.14 23.86 3.93 48.55	(P/4) 11.60 46.51 4.40 26.33	0.004 0.002 0.012 0.001 0.004	0.26 0.12 0.34 0.07 0.22 0.46	
3 4 5 6 7	Orcular Pipe Trapecoldal Channel Groular Pipe Trapecoldal Channel Circular Pipe	Lined or Bulk-Up Channel Lined or Bulk-Up Channel	Concrete Clean, straight, full,no offis or deep pools Concrete Clean, straight, full,no offis or deep pools Concrete	£500 £513 £500	1592.58 1590.89 1554.41 1518.06	1580.83 1514.41 1518.06 1496.18	180.74 896.46 194.69 106.79 184.87	0.065 0.197 0.007 0.158 0.055	100 490 125 210 150	Avg. Burtom Width (%) NA. 10.00 NA. 23.00 NA.	Avg. Side Slopes (A/R) NA 1.00 NA 6.00 NA	NA 28.80 NA 48.30	A = 104/2)*2 A = (0 + 10)A A = 104/2)*2 A = (0 + 10)A A = 104/2)*2	Wetted Perimeter P = 2x(4/2) P = b + (3x)(4/2) P = 2x(4/2) P = b + (3x)(4/2) P = b + (3x)(4/2) P = 2x(4/2)	Valodby V = (1.44()/*2/30()/*0.5()/*0	70.79 73.01 1.23 74.76 1.77 16.00	Wetned Purineter (b) 3.14 23.86 3.93 48.55 4.71 16.49 6.28	(PV4) 11.60 46.51 4.40 26.33 13.99 11.33	0.004 0.002 0.012 0.001 0.004	0.26 0.12 0.34 0.07 0.22 0.46	
3 4 5 6 7	Orcular Pipe Trapecoldal Channel Groular Pipe Trapecoldal Channel Groular Pipe Triangular Channel	titled or bulk-tip Channel titled or bulk-tip Channel	Concrete Clean, straight, full, no offix or deep pools Concrete Clean, straight, full, no offix or deep pools Concrete Clean, straight, full, no offix or deep pools Clean, straight, full, no offix or deep pools	£ 580 £ 553 £ 550 £ 550	1592.58 1590.88 1504.41 1513.06 1496.18	1580.83 1514.41 1518.06 1496.18 1486.00	\$86,74 896,46 \$94,69 \$06,79 \$84,87	0.065 0.187 0.007 0.158 0.055	100 490 125 210 150 200	Avg. Bortom Width (%) NA. 10.00 NA. 23.00 NA. NA.	Avg. Side Slopes (A/R) NA 1.00 NA 6.00 NA	NA 19.80 NA 48.20 NA 16.00	A = x(d/2)^2 A = (2 + x)(A A = x(d/2)^2 A = (2 + x)(A A = x(d/2)^2 A = x(d/2)^2	Wetted Perimeter P = 2x(d/2) P = b + (3x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2) P = (2x)(4(2)+(x)*2) P = (2x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2)	Valodby V = (1.44()/*2/3()()/*0.5()/*0	74.76 1.77 16.00	Wetned Purineter (b) 3.14 23.86 3.93 48.55 4.71 16.49 6.28	(PV4) 11.60 46.51 4.40 26.33 13.99 11.33	0.004 0.002 0.012 0.001 0.004	0.26 0.12 0.34 0.07 0.22 0.46	
3 4 5 6 7 8	Orcular Pipe Trapecoldal Channel Circular Pipe Trapecoldal Channel Circular Pipe Triangular Channel Circular Pipe	titled or bulk-tip Channel titled or bulk-tip Channel	Concrete Clean, straight, full, no rifes or deep pools Concrete Clean, straight, full, no rifes or deep pools Concrete Clean, straight, full, no rifes or deep pools Concrete Clean, straight, full, no rifes or deep pools Concrete Clean, straight, full, no rifes or deep pools Concrete	£.000 £.003 £.000 £.000 £.003 £.000	1592.58 1590.89 1504.41 1513.06 1696.18 1496.00	1580.83 1514.41 1518.06 1496.18 1486.00 1468.00	280.74 286.46 294.69 206.79 284.87 213.87 441.76	(%/%) 0.065 0.187 0.067 0.158 0.055 0.054	100 490 125 210 130 200	Avg. Burtom Width (%) NA. 10:00 NA. 20:00 NA. NA. NA.	Avg. Side Slopes (PL/Pt) NA. 1.00 NA. 6.00 NA. 4.00 NA.	NA 19.80 NA 48.20 NA 16.00	A = x 4/2)*2 A = (0 + x)4/4 A = x 4/2)*2 A = (0 + x)4/4 A = x 4/2)*2 A = x 4/2)*2 A = x 4/2)*2	Wetted Perimeter P = 2x(4/2) P = b + (3x)(4/2) P = 2x(4/2) P = (2x)(4/2) P = (2x)(4/2)	Valodby V = (2.44()/*2/30()/*0.5()/*0	70.79 73.01 1.23 74.76 1.77 16.00	Wetned Purineter (b) 3.14 23.86 3.93 48.55 4.71 16.49 6.28	(P/4) 11.60 46.51 4.40 26.33 13.90 11.33	0.004 0.002 0.012 0.001 0.004 0.008	0.26 0.12 0.34 0.07 0.22 0.46	
3 4 5 6 7 2 9	Orcular Pipe Trapecoldal Channel Circular Pipe Trapecoldal Channel Circular Pipe Triangular Channel Circular Pipe Trapecoldal Channel	Liked or Bulk-Up Channel Liked or Bulk-Up Channel	Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools w/ more stones and weeds	£.000 £.000 £.000 £.000 £.000 £.000 £.000	1592.58 1590.89 1554.41 1513.06 1496.18 1496.00 1469.00	1580.83 1514.41 1518.06 1496.18 1486.00 1468.00 1458.15	180.74 286.46 194.69 106.79 184.87 441.76 80.28	0.065 0.187 0.007 0.158 0.055 0.054 0.025	100 490 125 210 130 200 200 400	Avg. Burtom Width (%) NA. 10.00 NA. 23.00 NA. NA. NA. 65.00	Avg. Side Slopes (A/R) NA 1.00 NA 6.00 NA 4.00 NA	NA. 19.80 NA. 48.70 NA. 16.00 NA.	A = x 4/2 *2 A = (0 + x)4/2 *2 A = (0 + x)4/2 *2 A = x 4/2 *2	Wetted Perimeter P = 2x(d/2) P = b + (3x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2) P = (2x)(4(2)+(x)*2) P = (2x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2) P = b + (3x)(4(2)+(x)*2)	Valodby V = (1.44()/*2/3()()/*0.5()/*0	Row Area (h ²) 0.79 73.01 1.23 74.76 1.77 16.00 3.14 356.00	Wented Parkinster (n ²) 3.14 23.96 3.93 48.55 4.71 16.49 6.28 113.66	(P/4) 11.60 46.51 4.40 26.13 13.99 11.13 11.12 22.36	0.004 0.002 0.012 0.001 0.004 0.008 0.011	0.26 0.12 0.34 0.07 0.22 0.46 0.65	
2 4 5 6 7 2 8 9	Orcular Pipe Trapezoldal Channel Circular Pipe Trapezoldal Channel Circular Pipe Triangular Channel Circular Pipe Trapezoldal Channel Circular Pipe	thed or bulk-Up Channel	Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Clean, straight, full, no oths or deep pools Clean, straight, full, no oths or deep pools Concrete Clean, straight, full, no oths or deep pools Clean, straight, full, no oths or deep pools Clean, straight, full, no oths or deep pools	£.000 £.000 £.000 £.000 £.000 £.000 £.000	1592.58 1590.89 1524.41 1523.06 1496.18 1496.00 1458.15	1581.83 1514.41 1518.06 1496.18 1486.00 1468.00 1458.15 1458.59	180.74 286.46 194.59 106.79 184.87 441.76 80.33 64.77	(n/n) 0.065 0.187 0.067 0.158 0.055 0.054 0.025	100 490 125 210 130 200 200 400	NA 10.00 NA 23.00 NA	Avg. Side Slopes (A/R) NA 1.00 NA 6.00 NA 4.00 NA	NA. 19.80 NA. 48.20 NA. 16.00 NA. 118.00	A = x64/2)*2 A = (b + x64)* A = x64/2)*2 A = (b + x64)* A = x64/2)*2 A = (b + x64)*	Wetted Perimeter P = 2x(d/2) P = b + (2b)50(kT(1 + (x)^2)) P = b + (2b)50(kT(1 + (x)^2)) P = b + (2b)50(kT(1 + (x)^2)) P = (2x(d)50(kT(1 + (x)^2)) P = 2x(d/2) P = 2x(d/2)	Valodby V = (1.44()/*2/4())/*0.5()/* V = (1.44()/*2/4()/*0.5()/* V = (1.44()/*2/4()/*0.5()/* V = (1.44()/*2/4()/*0.5()/* V = (1.44()/*2/4()/*0.5()/*	Row Area (n°) 0.79 73.01 1.23 74.76 1.77 16.00 3.14 356.00	Wensel Partnerser (e ¹) 3.14 21.86 3.93 48.55 4.71 16.49 6.28 113.66 7.07	(PV4) 11.60 46.51 4.40 26.33 13.99 11.33 11.32 22.38	0.004 0.002 0.012 0.001 0.004 0.008 0.011 0.001	0.36 0.12 0.34 0.07 0.22 0.46 0.65 0.06	
3 4 5 6 7 8 9 10 11	Circular Pipe Trapecoldal Channel Circular Pipe Trapecoldal Channel Circular Pipe Triangular Channel Circular Pipe Trapecoldal Channel Circular Pipe Trapecoldal Channel	titled or Bullt-Up Channel	Concrete Clean, straight, full, no rifts or deep pools Concrete Clean, straight, full, no rifts or deep pools Concrete Clean, straight, full, no rifts or deep pools Concrete Clean, straight, full, no rifts or deep pools Concrete Clean, straight, full, no rifts or deep pools uf more stones and weeds Clean, straight, full, no rifts or deep pools uf more stones and weeds Clean, straight, full, no rifts or deep pools Clean, straight, full, no rifts or deep pools	£.000 £.013 £.000 £.013 £.000 £.013 £.000	1592.58 1590.89 1504.41 1518.06 1496.18 1496.00 1458.15 1458.15	1580.88 1514-61 1512.06 1696.18 1686.00 1668.00 1668.00 1668.00 1668.00 1668.00	180.74 286.45 194.69 106.79 184.87 441.76 80.88 64.77	0.065 0.187 0.067 0.158 0.065 0.064 0.005 0.004	1.00 4.90 1.25 2.10 1.50 2.00 2.00 4.00 2.25 2.00	NA 10:00 NA 20:00 NA	Avg. Side Slopes (M/M) NA 1.00 NA 6.00 NA 4.00 NA 4.00 NA 6.00 NA	NA. 19.80 NA. 48.20 NA. 16.00 NA. 118.00 NA.	A = x(d/2)*2 A = (b + x)d/b A = x(d/2)*2 A = (b + x)d/b A = x(d/2)*2 A = x(d/2)*2	Wetted Perimeter P = 3x(4/2) P = b + (3h)40(7) 1 + (4)*2) P = 3x(4/2) P = b + (3h)40(7) 1 + (4)*2) P = 2x(4/2) P = (3h)40(7) 1 + (4)*2) P = b + (3h)40(7) 1 + (4)*2) P = b + (3h)40(7) 1 + (4)*2) P = b + (3h)40(7) 1 + (4)*2)	Valodby V = (1.44()/*2/4()()/*0.5()(/n	Row Area (h ²) 0.79 73.01 1.23 74.76 1.77 16.00 3.14 356.00 21.00	Wested Perhanter (b ⁴) 3.14 23.86 3.93 48.55 4.71 16.49 6.28 113.66 7.07	(PV4) 11.60 46.51 4.40 26.33 13.90 11.33 11.12 22.38 20.84 7.15	0.004 0.002 0.012 0.001 0.008 0.011 0.001 0.001 0.010	0.36 0.12 0.34 0.07 0.22 0.46 0.65 0.06	



		w	ORKSHEET FOR SCS HYD																		
										4											
ı	Land Use:	×	fairting	Project:		Orive Oraina	ge improvement			1											
	came one.		Proposed	Orainage Area Number:	1D_1					4											
- 044	Site Land Use:	X	fairting	Bys	E. REDMAN					1											
Om-	site Land Use:		Proposed	Date:	Q/17/3025					1											
TIME OF CONCENTRATION (VELOCITY METHOD)																					
		3-Tear	St-Hour Perceptation Keintel Amount [10]																		
County/City. City of Harriworkung																					
$\overline{}$	Sheet Flow																				
10	Type of Flow a US Elex. Ct Elex. Length (ft.) Avg. Stope (ft/ft)											7	nvel Time Equa	tion				(Py/4)	T,(hm)	T _i (mins)	Notes
1		Grass - Dense Gr		0.240	1616.1	1685.0	87.71	0.012					0.007 (-1)	0.0					0.286	17.145	
									ı			T ₀	= 0.007 (RL)	-				NA.			1
		$T_i = \frac{0.007 (\pi L) 0.8}{\rho_2 d^2 J^{2d}}$																			
	Shallow Concentrated Flow																				
10		How Type			US Clex.	Di Elev.	Length (ft.)	Aug. Slope (ft/ft)		Velodity Equation								Velocity (TV4)	Tr(box)	N(mins)	Notes
—		loud.								u. D. WALLEY											
2		Personant and Small Up	paris Guiller	6.005	3845.0	1396.8	1171.12	0.085		V = 10.128(4)*C.5 A.811 0.085 5.131										1	
\vdash	 				 			_	-									 	\vdash	_	1
	•			•					•	Classel	Flow										
														Tip.	ar Sories	America	Average				
10	Channel Shape	Channel Type	Channel Description	•	US Elex.	DS Elex.	Length (t.)	Aug. Slope (ft/ft)	Aug. Normal Depth (11)	Aug. Buttom Width (ft)	Avg. Side Slopes (N/N)	Avg. Top Width (t)	Area	Wetted Perlineter	Valority	How Area (h)	Wetted Perimeter (%)	(TV4)	T,(lum)	T _r (mind)	Notes
	Circular Pipe	Lined or Built-Up Channel	Concrete	0.013	1592.58	1580.83	180.74	0.065	1.00	NA.	NA.	NA.	A = 10[4/2]*2	P = 2x(d/2)	V = (1.49(1)/*2/30(6)*0.5(1)/6	0.79	3.14	11.60	0.004	0.26	Assumed Diameter
4	Trapezoidal Channel	Lined or Bulk-Up Channel	Clean, straight, full, no rifts or deep pools	0.000	1580.88	151441	336.46	0.197	4.90	10.00	1.00	19.80	A = (b + ship)	P+b+(2h)3QRT(1+(s)*2)	V = (1.49()()*2/30()s)*0.5()(/s	73.01	23.86	46.51	0.002	0.12	
5	Circular Pipe	Lined or Bulb-Up Charmel	Concrete	6.013	2504.40	2513.06	294.69	0.007	125	NA.	NA.	NA.	A = x64/25*2	P = 2x(4/2)	V = (5.49(F)**2/30(6)*0.5(E)/6	1.23	3.93	4.40	0.012	0.74	
6	Trapezoidal Channel	Lined or Built-Up Classed	Clean, straight, full, no rifts or deep pools	0.000	1513.06	1496.18	106.79	0.158	2.10	29.00	6.00	48.20	A+(b+sh)h		V = (1.49()·)*2/30(»)*0.5()(»	74.76	48.55	26.33	0.001	0.07	
7	Circular Pipe	thed or hulb-tip Clannel	Concrete	688	5495.18	\$496.00	184.87	0.055	150	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(4/2)	V = (1.49()·(*2/3)(s)*0.5()(/s	1.77	4.71	13.99	0.004	0.22	
																_	16.49				
	Triangular Channel	Lined or Built-Up Classed	Clean, straight, full, no offix or deep pools	6.000	5486.00	5469.00	818.87	0.054	2.00	NA.	4.00	16.00	A=1[0]*2	P = [20(84QRT[1 + (1)*2)	V= (1.49()/*2/4)()-(*0.5()/*	16.00		11.33	0.008	0.46	
	Circular Pipe	Lined or Bulk-Up Channel	Concrete	CELL	\$469.00	1458.15	461.76	0.025	2.00	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(4/2)	V = (1.49())*2/30(s)*0.5()/s	_	6.28		0.011		
10	Trapezoidal Channel	Lined or Built-Up Clannel	Clean, straight, full, no riffs or deep pools	0.000	1458.15	\$454.59	80.33	0.044	4.00	65.00	6.00	113.00	A+(b+ship		V = (1.49()()*2/30((s)*0.5()()*s		113.66		0.001	0.06	
11	Circular Pipe	Used or Bulb-Up Channel	Concrete	COL	1454.58	1669.98	64.77	0.071	225	NA.	NA.	NA.	A = 104/21/12	P = 2x(4/2)	V = (1.49([/)*2/3)([s]*0.5([)/s	3.98	7.07	20.84	0.001	0.05	



		w	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS														
	X fairting Project:					Orive Oraina	ge improvement			1										
۱ ۱			Orainage Area Number:	1D_2					1											
	Det Con Local Many By: C. REDMAN								1											
Off-S	ite Land Use:			Date:	\$17/302					1										
lacksquare		_		CONCENTRATIO	N (VELOCITY METHO	D)														
			8-Rour Perceptiation Katolan Amount [10] •						TIME OF	CONCENTRATION	N (VELOCITY METHO	וט								
lacksquare		21887	County/City			1														
\vdash	Sheet How																			
		Type of Flor	Di Elex.	Length (%.)	Aug. Mope					awi Tine Equa	tion			Vencing	T,(bes)	T _i (mins)	Notes			
_								(11/11)									(9/4)			1000
1		Smooth Surface (concrete, asph	att, graves, bare sott)	6.011	1676.7	1479.7	21.28	0.045		0.007 (=170.8										
⊢					_	_				$\tau_i = \frac{0.007 (\pi L)0.0}{(P_d)^{1/2} S^{1/2}}$									-	
⊢						_				Shallow Concer	trated Row						Velocity	_	_	
		Row Type		•	US Elex.	DS Elex.	Length (ft.)	Aug. Slope (ft/ft)		Amoral affeative								Tr(brs)	T(mind)	Notes
2		Grassed Waters		0.050		1447.3	290.28	0.091		V=16.129()*0.5 4.270 0.217 0.998										
		Pevernent and Small Up	fand Gullies	0.025	1647.3	1446.0	78.00	0.048		V = 20.828(-)*0.5										
						_				Channel	Row		_		(a) 5.00					
	Channel Shape	Classel Type	Channel Description	•	US Elev.	DS Eller.	(angth (t.)	Aug. Slope (ft/ft)	Aug. Normal Depth (11)	Avg. Buttom Width (ft)	Avg. Side Slopes (N/N)	Avg. Top Width (%)	Area	Wetted Perkinster	Valodty	Average Wested Flow Area (n') (n')	Velocity (PV4)	T _r (box)	T _r (mind)	Notes
	Triangular Channel	Natural Stream	Vegetal Libing	0.000	1463.98	1429.79	298.09	0.048	1.00	NA.	5.00	50.00	A+a(N/*2	P = [28(84)RT(1 + (4)*2)	V = (1.49()/)*2/30(s)*0.5()/s	5.00 10.20	6.74	0.012	0.74	Assumed Diameter
		·													·		Total T, e		2.011	
												7,4	0.029	1.206						



		W	ORKSHEET FOR SCS HYE	ROLOGIC PARA	METE	RS]											
	X fairting			Project:	Woodland	Orive Oraina	ge improvement			1											
	Land Use:		Proposed	Orainage Area Number:	amber: 1D_il																
	V 144									1											
Off-S	ite Land Use:		Proposed	Date:	6/17/2021					1											
$\overline{}$		•		•					N (VELOCITY METHOD	0)											
		3-Tea/ 2	S-room Perceptiation Retotal Association	2.63																	
	County/City. City of Hardsonkurg																				
	Sheet Flow																				
10		Type of How	•		US files.	DS Elex.	Length (ft.)	(n/n)				Ti	ovel Time Equa	tion				(P/4)	T,(bes)	T _i (mind)	Notes
1		Grass - Dense Gr		0.240	1600.0	1599.0	84.78	0.301		2.65											
										$T_k = \frac{0.007 (\pi L) 0.0}{(P_s)^{0.0} g^{0.0}}$											
	Shallow Concentrated Flow																				
10		Flow Type			US Elex.	DS Elex.	Longth (ft.)	Aug. Slope (ft/ft)		Velocity Squardon										T(min)	Notes
2		Forest w/ Heavy Ground Utte	r & Hay Mandows	0.202	1599.0	1544.0	224.00	0.259		V + 2.510(x)*0.5										8.178	
		Povement and Small Up	fand Guilles	0.025	1544.0	1594.9	61.17	0.149		V = 20.828(s/Pd.5										0.130	
		Forest w/ Heavy Ground Utte	r & Hay Maadows	0.202	1534.9	1513.4	96.59	0.228			V = 2.514(s)*0.5										
	Provement and Small Upland Guilles 0.025 1513.4 1696.9 166.94 0.152									6.818	0.006	0.358									
										Channel	Now										
	Channel Shape	Classed Type	Channel Description		US Elex.	DS Eller.	Length (%.)	Avg. Slope (ft/ft)	Aug. Normal Depth (P)	Avg. Buttom Width (ft)	Avg. Side Slopes (PL/Ts)	Aug. Top Width (1)	Area	Netted Perimeter	Valodty	Average Flow Area (tr')	Average Wested Perturber (%)	Velocity (TV4)	T,(hm)	T/(mind)	Notes
8	Circular Pipe	Lined or Built-Up Cleanel	Concrete	0.013	1499.90	1472.85	175.24	0.128	1.25	NA.	NA.	NA.	A = 10 4/2 *2	P = 2x(4/2)	V = (1.49()-(*2/3)(s)*0.5()/n	1.23	3.93	18.51	0.003	0.36	Assumed Diameter

A = (b + ship) P = b + (2h)sQRT(1 + (s)*2)

V = (1.49()/)*2/30(s)*0.5()/s

147.00 58.97 22.60 0.001 0.07



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS]											
_	and Here	X	fairting	Project	Woodland	Orive Oraina	ge improvement			1											
	Land Use:		Proposed	Drainage Area Number:	15					1											
OH	Site Land Use:	X	Existing	Bys	C. REDMA	N				j											
Office	site Land Use:		Proposed	Date:	6/17/2021																
									TIMEO	F CONCENTRATION	N (VELOCITY METHO	D)									
		3-Year 3	S-Hour Fercipitation Kainfall Amount [10] +																		
_			County/City	City of Harrisonia	ug					Sheet Fi											
—						_		Aug. Mope		Sheet H								Vestrally		_	
		Type of How						(11/11)				Te	red Time Equa	tion				(79/4)	T,(hm)	T _i (mins)	Notes
1		Grass - Short Grass	Prarie	0.550	1727.3	1715.5	101.71	0.116					0.007 (=0)	0.0					0.090	5.425	
⊢—					\vdash	—			I			T _e	0.007 (nL)	-				NA.			ı
⊢				L																	
						_				Shallow Concer	trated How							H-b-d-			
		Row Type			US Elec.	Di Elex.	Length (ft.)	Aug. Slope (ft/ft)					lelocity figural					Velocity (TV4)	Tr(hrs)	T(mind)	Notes
-		Forest w/ Heavy Ground Utte		0.302	1715.5	1682.2	548.47	0.225					V = 2.516(c)*0					1.293	988.0		
		Short-Grass Per		6.071	1682.2	1964.0	60.03	0.308					V = 6.962(x)*0	5				3.834	0.004	0.265	l .
+		Forest w/ Heavy Ground Utte Povement and Small Up		0.302	1964.0	1590.0 1596.5	258.55 89.04	0.292										1.360	0.052	8.102 0.831	
_		-			4070-0	1300.0	8348	6.044		Cleanel	New							4.000		9.554	
-														figs	untions		Average				
10	Channel Shape	Channel Type	Channel Description	•	US Elex.	DS Elex.	Length (%.)	Aug. Slope (ft/ft)	Aug. Normal Depth (R)	Avg. Bottom Width (ft)	Avg. Side Slopes (N/R)	Avg. Top Width (1)	Area	Wetted Perlineter	Velocity	American Flow Area (Pr ²)	Wetted Pertreter (%)	(PV4)	,	T _r (mine)	Notes
	Circular Pipe	Lined or Built-Up Channel	Concrete	6.013	1586.47	1530.63	955.04	0.069	125			NA	A = 10[4/2]*2	P = 2x(4/2)	V = (1.49()-)*2/30(s)*0.5()(n	1.23	3.93	13.86	0.019	1.15	
4	Trapezoldal Channel	Lined or Built-Up Channel	Clean, straight, full, no rifes or deep pools w/ more closes and weeds	0.040	1520.68	1510.00	124.78	0.085	5.00	12.00	4.00	\$2.00	A+(b+sh)h	$P = b + (2b) SQRT(1 + (4)^{-2})$	V = (1.49()·)*2/40(s)*0.5()/s	160.00	53.23	22.64	0.002	0.09	ı
5	Circular Pipe	Lined or Built-Up Channel	Concrete	6.003	1500.00	\$477.48	863.38	880.0	1.50			NA.	A = 10[4/2]*2	P = 2x(d/2)	V = (1.49())*2/30(s)*0.5()/s	1.77	4.71	11.58	0.021	1.24	
•	Trapezoldal Channel	Lined or Built-Up Channel	Clean, straight, full, no rifts or deep pools w/ more stones and weeds	0.040	107.48	1472.56	60.79	0.080	4.00	8.50	8.00	27.50	A = (b + ship)	$P = b + (2b) SQRT(1 + (4)^42)$	V = (1.49())*2/40(s)*0.5()/s	62.00	28.80	17.58	0.001	0.06	ı
7	Circular Pipe	Lined or Built-Up Clannel	Concrete	6.013	1672.56	\$467.99	659.51	0.007	2.00			NA.	A+x 4/2 *2	P = 2x(4/2)	V = (1.49())*2/30(s)*0.5()/s	3.14	6.28	6.01		1.83	
																			0.254 0.152		



		w	ORKSHEET FOR SCS HYD	ROLOGIC PAR	AMETE	RS				1											
\vdash					_		ge improvement	_		╡											
	and Use:		fairting	Project		Drive Drains	ige in provenient.			-											
			Proposed	Orainage Area Number:		_		_		•											
Off-S	ite Land Use:	X	fairting	Bys	K. REDIMA					1											
-	ne came ose.		Proposed	Date:	6/17/302	1															
									TIMEO	F CONCENTRATION	(VELOCITY METHOD	D)									
		2-Year 2	18-Hour Percipitation Kainfall Amount [10]																		
			County/City	City of Harrisons	wg																
					_	_				Sheet R	010									_	
10		Type of Flow	•		US files.	DS Elex.	Longth (ft.)	(h/h)				Ti	avel Time Equa	tion				(TV4)	T _r (bes)	T _i (mins)	Notes
1		Grass - Dense Gr	100	0.340	1494.6	1489.4	45.98	0.118					00000						0.071	4.295	
]			T _k	$=\frac{0.007 (\pi L)}{(P_3)^{1/2} S^{1/2}}$	0.0				NA.			1
													(PS) m Sm	•							
										Shallow Concern	rated Flow										
		How Type			US files.	DS Elex.	Length (ft.)	Avg. Slope (ft/ft)					Velocity figural					Velocity (PV4)	Tr(bm)	Tr(mins)	Notes
2		Short-Grass Par	Bure	0.073	1489.4	1476.0	541.04	0.095					V = 6.962(c)*0	5				2.548	0.012	1.095	
		Pevement and Small Up	sland Guillies		1476.0	1471.4	99.87	0.049					V = 20.828(s)*	5				4.517	8.006	0.345	
										Classel	ew .										
													lacksquare	liqu	25000	Average	Average				
В	Channel Shape	Clamal Type	Channel Description	•	US Elex.	DS Elex.	Length (ft.)	Aug. Slope (h/h)	Aug. Normal Depth (R)	Avg. Buttom Width (ft)	Avg. Side Slopes (M/M)	Avg. Top Width (1)	Area	Wetted Perimeter	Valority	Flow Area (th ²)	Perference (NC)	(R/4)	T _r (lunc)	T _i (mind)	Notes
4	Triangular Channel	Used or Bulk-Up Channel	Vegetal Living	0.000		1669.68		0.080	650	NA.	4.00	4.00		P = [25 SQRT[3 + (1]^2]	V = (2.49()·)*2/30(s)*0.5()/n		4.12				Assumed Diameter
5	Triangular Channel	Lined or Bulk-Up Channel	Vegetal Living	0.080	1469.68	\$490.90	323.58	0.060	1.00	NA.	3.00	6.00	A+x[N/*2	P = [25(5)QRT[1 + (1)*2]	V = (1.49()/)*2/3((s)*0.5()/n		6.32		0.012		
6	Circular Pipe	Lined or Built-Up Channel	Corrugated Metal	0.025		\$490.00	56.34	0.005	1.00	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(4/2)	V = (1.49([r)*2/3)([s)*0.5[(]/n		3.14		0.009		
7	Trapezoidal Channel	Used or Bulk-Up Channel	Vegetal Libing	0.000	\$490.00	1412.21	827.47	0.021	7.64	79:00	25.00	461.00		P+b+(2h)sQRT(1+(s)*2)	V = (2.49()-)*2/30(s)*0.5()/s		461.31		0.012		
	Triangular Channel	Used or Bulk-Up Channel	Vegetal Living	0.000	1412.21	1411.98	94.46	0.009	150	NA	k.00	9.00	A+s[N/*2	P = [2N(HQRT[1 + (1)^2])	V = (1.49(1)**1/3)(1)*0.5(1)/n	6.75	9.49	1.71	0.007		
																			0.548		



Land Use: X			w	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS]										
Proposed			X	Salesting	Project	Woodland	Orive Oraina	ge improvement			1										
Off-Site Land Use: Proposed Date: V17/2015 TIME OF CONCENTRATION (VELOCITY METHOD)	L	and Use:		Proposed	Orainage Area Number:	2A					1										
Off-Site Land Use: Proposed State \$\frac{1}{2}\text{Figs of Flow State \$\frac{1}{2}Figs of Flow Sta			X	fairtire	by:	C. REDMA	N				1										
Start 28-Hour Faulty/Station Kathful (In) 2.68 Case (In) 1.28 Shart How	Off-Si	ite Land Use:			Date:	6/17/2001					1										
County City			•		•					TIME OF	CONCENTRATION	N (VELOCITY METHO	D)								
D Type of Flow n US Elex. DS Elex.			3-Tear	R-Hour Percipitation Kennal Amount (In)	2.63																
Type of Row n US files Di Siles Langth (t.) Reg. Slope (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.) (t.)						ug	1														
Type of Now 1											Sheet Fi	OW .									
1 Grass - Dense Grasses 6.240 1618.8 1628.1 92.18 0.128	10		Type of Hou	•		US files.	Di Elex.	Length (ft.)					71	nvel Time Equal	tion				T,(hm)	T _i (mind)	Notes
Shallow Concentrated Flow	1		Grass - Dense Gr	100	0.340	1639.8	1429.1	92.13						0000 (-1)					0.517	7.016	
Shallow Concentrated Flow										1			T _e	= 0007 (HE)				NA.			
D Flow Type n US Elex. Large (t.) Arg. Slope (t.)														baller an							
Power Powe											Shallow Concern	trated Flow									
2 Provement and Small Upland Guilles 8.025 14.28.1 1410.0 205.89 0.059 V+20.228(s)*0.5 V+20.228(s)*0.5 0.059			Flow Type			US files.	Di Elev.	Length (%.)						Velocity fourtie				Velocity	T-Down)	Model	Notes
	2		Perement and Small Up	stand Guilles	0.025	1428.1	1410.0	905.88	0.059					V = 20.828(c)*0	5			4.941	0.017	1.032	
	\vdash					_	—											_	\vdash	-	
	-										Channel	San and American Control of the Cont									
	-			1			_						1		E .	(FT-55T)	Average				
Annual Western Constitution Con	ю.	Channel Shape	Channel Type	Channel Description		US flex.	Di Elev.	Length (ft.)	Aug. Slope	Avg. Normal Depth (R)	Avg. Buttom Width (ft)	Avg. Side Slopes (19/70)	Avg. Top Width (1)				Store Area		T _r (bes)	Tilmbel	Notes
Committee State Committee					1				(10/10)					Area	Wetted Perimeter	Valodity	Personal	(75/4)			
4 Clouder Pipe Lined or Built-Lip Channel Concrete SEE SEC 120 SEC 125	4	Circular Pipe	Lined or Built-Up Channel	Concrete	0.013	1401.29	\$405.05	17.85	0.005	2.50	NA.	4.00	NA.	A = x(4/2)*2	P = 2x(d/2)	V = (1.49()-(*2/3)(s-(*0.5))/s	4.91 7.85	5.82	0.002	0.11	Assumed Diameter
Total T, 4 8.386 8.385																			0.136	8.155	
T ₁ 0.002 4.000																		3.4	0.002	4.898	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	AMETE	RS]											
		×	fairting	Project:	Woodland	Orive Drains	ge Improvement			1											
u	and Use:		Proposed	Oralnage Area Number:						1											
OH C	ite Land Use:	X	tainting	Bys	E REDIMA					i											
Om-Si	ite Land Use:		Proposed	Date:	6/17/3001																
									TIMEO	F CONCENTRATION	(VELOCITY METHO	D)									
		3-Year	SHOOT FREE PRODUCTION RECEIVED ACCOUNT [10] IN	2.68																	
			County/City.	City of Harrisonb	org.																
					_					Sheet R	•									_	
10		Type of Hou			US files.		Length (%.)	Aug. 300pe (ft/ft)				T	avel Time Equa	tion				(Ty/4)	T,(hm)	T _i (mind)	Notes
1		Grass - Dense Gr	-	0.340	1500.4	1591.3	35.19	0.260					0.007 (=0)	0.0					0.045	2.447	
					-							T _e	$=\frac{0.007 (nL)}{(P_3)^{0.8} S^6}$	_				NA	\vdash		
													12 -								
					_	_				Shallow Concen	rated Flow										
10		Flow Type			US files.	DS Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity Squat	on				Velodity (TV/4)	Tr(hos)	%(mind)	Notes
2		Forest w/ Heavy Ground Utte		6.302	1591.3	1462.2	692.58	0.394					V = 2.516(c)*0					1.136	0.155		
		Personent and Small Up	fand Gullies	0.025	1462.2	1461.0	10.50	0.042					V = 20.828(s)*	15				4.548	0.002	0.128	
				<u> </u>																	
					_					Cleanel	low				2000				_		
				l				Aug. Slope					_	-		American	Average	Velocity			
10	Channel Shape	Channel Type	Channel Description		US files.	DS Elex.	Length (ft.)	(11/11)	Avg. Normal Depth (11)	Avg. Buttom Width (ft)	Avg. Side Slopes (ft/ft)	Avg. Top Width (1)	Area	Wetted Perimeter	Valority	Flow Area	Perkeeter	(9/4)	T, (box)	T _e (mins)	Notes
																8	(m²)				
	Circular Pipe	Lined or Built-Up Channel	Concrete	6.003	\$460.97	5494.65	389.65	890.0	125	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(4/2)	V= (1.49()-(*2/3)(s)*0.5()/s	1.23	3.93	13.72	0.008	0.47	Assumed Diameter
5	Trapezoidal Channel	Lined or Built-Up Classed	Clean, straight, full,no rifts or deep pools	0.000	104.65	1411.96	603.49	880.0	8.00	50.00	5.00	130.00	A = (b + ship)	$P = b + (2b)SQRT(1 + (1)^{n}2)$	V = (1.49())**2/40()+(**0.5)()/n	720.00	131.58	29.90	0.006	0.34	
6	Circular Pipe	Used or Bulk-Up Channel	Concrete	6.013	\$407.00	1409.00	49.55	0.081	2.50	NA	NA.	NA.	A+x(4/2)*2	P= 2x(4/2)	V = (1.49()-(*2/3)(s)*0.5()(/s	4.91	7.85	23.81	0.001	0.03	
																			8.212		
																		1.0	0.527	7.615	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS															
-	and Use:	×	fairting			Orive Draina	ge improvement]											
	ind Ose.		Proposed	Oralinge Area Number:	MA.]											
OHE	te Land Use:	X	fairting	Byc	C. REDIMA	N				1											
Uni-si	te Land Use:		Proposed	Date:	6/17/3003					1											
									TIME OF	F CONCENTRATION	(VELOCITY METHO	0)									
		2-Year 2	S-Hour Perceptation Rational Amount [10] •																		
			County/City	City of Harrisonb	org.																
—					_					Sheet Fi	04										
10		Type of Flow			US files.	DS Elev.	Length (ft.)	Aug. 300pe (11/11)				Ti Ti	med Time Equ	ation				(7y/4)	T,(hm)	T _i (mins)	Notes
1		Woods - Light Und	etrush	0.400	1500.1	1489.7	71.59	0.145					0.007 (=/	vos.					0.137	8.212	
igsquare									l			T _i	$=\frac{0.007 (\pi L)}{(P_{3})^{1/2} S^{1}}$	4				NA.	\Box		
ш													Pa a								
										Shallow Concent	trated Flow										
10		Flow Type			US Elex.	DS Elex.	Longth (ft.)	Aug. Slope (ft/ft)					Velocity figure	ion				Velocity (TV4)	Tr(box)	N(mins)	Notes
2		Short-Grass Par	ture .	0.073	1489.7	1462.0	225.31	0.128					V+6.962(c)*	15				2.443	0.036	1.537	
										Channel	Now										
		l		l	1 1							1	⊢	- 10	purtions	Average	Average		 	- 1	
10	Channel Shape	Channel Type	Channel Description		US files.	DS Elev.	Longth (ft.)	Aug. Slope (ft/ft)	Avg. Normal Depth (P)	Avg. Button Width (ft)	Avg. Side Slopes (ft/ft)	Avg. Top Width (1)	Area	Wetted Perimeter	Valority	Flow Area	Wetted	(P/4)	T, (box)	T _e (mins)	Notes
oxdot								1444							1200	(Pri)	(19.)				
4	Getter	tined or Bulk-Up Channel	Concrete	6.003	1462.0	1425.5	445.78	0.082	6.50	1.00	0.08	1.00	A = 0.5bb	P+h+SQRT[0/2]+(0/2))	V = [0.56/(Ac[)[[5]*1.67)[[5]*2.67][[4]*0.5)	0.25	1.00	0.77	0.160	9.621	vdot 9.4.4.3
																		Total T, e		18.870	
																		7.0	0.594	11.622	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS]											
	and there	X	Existing	Project	Woodland	Orive Drains	ge improvement			1											
_	and Use:		Proposed	Orainage Area Number:	*]											
0# 0	to Lond Hou	X	Existing	By:	K. REDIMA	N				1											
Om-Si	te Land Use:		Proposed	Clate:	6/17/2001					1											
									TIMEO	F CONCENTRATION	(VELOCITY METHO)	D)									
		3-Year 2	Broom Perception to Resident Amount (10)																		
			County/City	City of Harrisonia	wg.																
—					_	_		Aug. Mope		Sheet R								Vencenty			
10		Type of Hou	•		US files.	DS Elex.	Length (ft.)	(11/11)				Ti	avel Time Equ	ation				(7/4)	T _r (hes)	T _r (mins)	Notes
1		Grass - Short Grass	Prorie	0.150	1663.1	1438.1	84.74	0.058					0.007 (-7	van.					0.508	6.186	
$ldsymbol{\sqcup}$									l			74	$=\frac{0.007 (\pi L)}{(P_3)^{4.8} g^4}$	4				NA.			
$oldsymbol{oldsymbol{eta}}$													Pa -								
										Shallow Concer	trated Flow										
10		Flow Type			US Elex.	Di Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity figure	ion				Velocity (TV4)	Tr(hm)	Trimba)	Notes
2		Short-Grass Par	ture .	0.079	1698.1	1417.0	228.54	0.095					V = 6.962(c)*0	1.5				2.541	0.029	1.717	
$ldsymbol{eta}$																					
—					_	_				Channel	Now.				witers	_					
ı l				I	1 1			Aug. Slope	I			I	\vdash	19		Average Flow Area	Average	Velocity			
10	Channel Shape	Channel Type	Channel Description		US files.	DS Elex.	Length (ft.)	(11/11)	Aug. Normal Depth (11)	Avg. Buttom Width (ft)	Avg. Side Slopes (ft/ft)	Avg. Top Width (t)	Area	Wetted Perimeter	Valodity		Perimeter	(75/4)	T _r (hm)	T _i (mins)	Notes
l I			l		1 1				l			l				(Pr.)	(m²)				
3	Getter	Lined or Built-Up Channel	Concrete	0.003	1617.0	1410.2	193.34	0.085	0.50	1.00	9.08	1.00	A=0.5bb	P+h+sqrr((h/2)+(h/2))	V = [0.56/(Ac[)[[h]^1.67][[h]^2.67][h]^0.5]	0.25	1.00	0.51	0.106	6.348	vdot 9.4.4.3
ш																					
																		Total T, e	0.238		
																		7,4	0.549	8.568	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS]										
	Land Use:	X	tairting	Projecti	Woodland	Orive Oraina	ge improvement			i										
	Land Ose.		Proposed	Drainage Area Number:	×]										
Office	Site Land Use:	X	tairting		K. REDIMAN]										
Olive	Site Land Ose.		Proposed	Date:	6/17/3025															
									TIME OF	F CONCENTRATION	N (VELOCITY METHO	0)								
	·	3-Year 3	t-Hour Percipitation Rainfall Amount [In]			1			·	·		·		·	·					
\vdash			County/City	City of Harrisonia						Sheet F	OW									
		Type of Flow			US Ber	Di flex.	Length (%.)	Aug. Stope					avel Time Equ	ation			Vesticity	T,(hrs.)	T.(mins)	Notes
-	+	Grass - Short Grass		6.150			25.19	0.721									(9/4)	0.000		
_	+	W 200 - 2 0001 W 0001		-	4525-6	*****	****	0.221	1				= 0.007 (nL (p _y kl gi	yo.s			NA.		2.752	I
-									1			*	(P) fel of	-			_	-	-	I
										Shallow Concer	trated Flow									
10		Flow Type			US Elex.	DS Elex.	(ength (t.)	Aug. Slope (ft/ft)					Velocity figure	ion			Velocity (T/4)	T,(bes)	T_((mind)	Notes
2		Short-Grass Past	Mare .	0.071	1432.0	1411.9	165.90	0.061					V+6.962(c)*	15			1.716	8.827	1.611	
⊢										Cleanel	il ner									
\vdash										California				fe	unione	Average				
10	Channel Shape	Channel Type	Channel Description	•	US Elex.	DS Elex.	Length (ft.)	Aug. Slope (ft/ft)	Aug. Normal Depth (7)	Avg. Buttom Width (ft)	Avg. Side Slopes (N/Ts)	Avg. Top Width (t)	Area	Wetted Perimeter		How Area (tr') (tr')	Velocity (P/4)	T _r (box)	T _r (mind)	Notes
4	Getter	Lined or Built-Up Channel	Concrete	6.013	1611.9	1410.2	86.66	0.000	6.50	1.00	0.08	1.00	A = 0.5bb	P+h+sqrt([M2)+[M2))	V = [0.56/(Au[[[]):/*1.67)[]3/*2.67][[c]*0.5]	0.25 1.00	0.38			vdot 9.4.4.3
																		0.072		1



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS]											
-	and Use:	X	fairting	Project	Woodland	Orive Oraina	ge improvement]											
			Proposed	Orainage Area Number:]											
0#10		X	tolering	Bys	K. REDMA	N				1											
Off-Si	te Land Use:		Proposed	Cete:	6/17/2021					1											
									TIME O	F CONCENTRATION	(VELOCITY METHO	D)									
		3-Tear 2	4-Hour Perceptation Rainfall Amount [10]																		
			County/City	City of Harrisonia	urg.																
			•							Sheet R	**				•						
10		Type of How			US Elex.	DS Elev.	Length (ft.)	(n/n)				1	avel Time Equa	tion				(TV4)	T, (box)	T _r (mins)	Notes
1		Smooth Surface (concrete, asph	alt, gravel, bare soil)	0.011	3438.5	1421.0	89.93	0.088					0.007 (-1)	0.0					0.012	0.694	
									1			T _i	$=\frac{0.007 (\pi L)}{(P_{a})^{1/2} S^{1/2}}$	0.0				NA.			
													(b) by See	•							
										Shallow Concent	rated Flow										
10		Flow Type			US Elex.	DS Elex.	(ength (ft.)	Aug. Slope (ft/ft)					Velocity Equation	on.				Velocity (TV4)	Tr(has)	T(min)	Notes
2		Pevement and Small Up	land Guilles	0.025	1631.0	1417.3	90.99	0.046					V + 20.325(c)*0	3				4.880	0.006	0.808	
-																					
										Clannel	ow.										
$\overline{}$															quetore		Average			-	
10	Channel Shape	Channel Type	Channel Description	•	US Elex.	Di Elex.	Length (ft.)	Aug. Slope (ft/ft)	Aug. Normal Depth (R)	Avg. Bottom Width (ft)	Avg. Side Slopes (N/Tt)	Avg. Top Width (%)	Area	Wetted Perimeter	Valority	Average Flow Area (tr')	Wetted Pertonter (%)	(RV4)	T,(hm)	T _r (mine)	Notes
4	Circular Pipe	Lined or Built-Up Channel	Concrete	6.013	PREFI	1494.65	389.65	PROF	1.25	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(4/2)	V = (1.49(1)**2/30(1)**0.5(1)/n	1.23	3.93			A	ssumed Diameter
																		Total T, e	0.017	1.002	
																		7.4	0.010	0.605	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS														
	and Use:	X	fairting	Project:	Woodland	Orive Oraina	ge improvement			1										
	and Use:		Proposed	Orainage Area Number:	×]										
Office	ite Land Use:	X	fairting	Bys	K. REDIMA	N				1										
ŭi-s	ite Land Use:		Proposed	Date:	6/17/3025															
									TIME OF	F CONCENTRATION	N (VELOCITY METHO	0)								
		3-Year 2	8-Hour Percipitation Kainfall Amount [10]																	
			County/City	City of Harrisonia	wg.					Sheet F										
		Type of Flow			US files	Di Elev.	Length (%.)	Aug. Stope		-	_	•	nvel Time Equa	tion			Vesicity	T,(bes)	T(mind)	Notes
-		Grass - Short Grass						(11/11)									(75/4)	-		no an
- 1		Grand - Smort Grand	rune	0.150	1438.0	1424.9	82.99	0.087	ł				$=\frac{0.007 (\pi L)}{(P_3)^{1/2} g^{1/2}}$	0.8				0.525	7.242	
						-			1				lb light de	_			_	-		
_				•						Shallow Concer	trated Flow									
		Flow Type			US Elex.	Di Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity figural	on.			Velocity (TV4)	Tr(brs)	T(mins)	Notes
2		Short-Grass Pag	ture	0.073	1434.9	1409.3	\$65.70	0.095					V = 6.962(x)*0.	s .			2.542	0.025	1.290	
					_					Channel	Now									
	I		I	l		l		Aur Shore	l			I	$\vdash \vdash$	- N	purtors	Average Wetted	Velocity	 		
10	Channel Shape	Clamel Type	Channel Description	•	US files.	DS Elex.	Longth (%.)	Aug. Slope (N/N)	Aug. Normal Depth (10)	Avg. Buttom Width (ft)	Avg. Side Slopes (ft/ft)	Avg. Top Width (%)	Area	Wetted Perimeter	Valority	Flow Area Perforater	(75/4)	T,(bm)	T _i (mine)	Notes
4	Circular Pipe	Lined or Built-Up Channel	Concrete	0.013	1401.5	1399.4	180.81	0.006	3.00	NA.	0.08	NA.	A = x(4/2)*2	P = 2x(4/2)	V = (1.49()/)*2/30(s)*0.5()/s	7.07 9.42	11.95	0.003	0.18	vdot 9.4.4.3
																		0.146	8.718	
																	**	0.087	5.228	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS															
		×	fairting	Project:	Woodland	Orive Oraina	ge improvement			1											
u	and Use:		Proposed	Orainage Area Number:	4					1											
- **		X	tairting	liv:	K. REDMA	v				1											
Off-Si	ite Land Use:	-	Proposed	Date:	Q/17/2021					1											
-									TIME OF	CONCENTRATION	(VELOCITY METHO	DI									
-		3-7667	Second Participation Resident Association (1)	2.63																	
			County/City		ung.																
										Sheet Fi	046										
10		Type of Flor			US Elex.	DS Elev.	Longth (ft.)	(n/n)				71	avel Time Equa	tion				(7y/4)	T,(bes)	T _i (mins)	Notes
1		Smooth Surface (concrete, asph	alt, gravel, bare soil)	6.011	1454.0	1453.5	79.29	0.006					0.007 (-1)	0.8					0.029	1.761	
									1			T _e	= 0.007 (nL)	U.B				NA			
													(PS) 3								
										Shallow Concent	trated Row										
10		Flow Type			US Elec.	DS Elex.	(angth (ft.)	Aug. Slope (ft/ft)					Velocity Equation					Velocity (TV4)	Tr(box)	T(mins)	Notes
2		Povement and Small U	fand Guilles	0.025	1459.5	1466.0	336.23	0.028					V = 20.828(s)*0	5				3.417	0.027	1.640	
										Channel	Now										
													\vdash	Bq.	article.	Average	Average				
10	Channel Shape	Clamel Type	Channel Description	•	US Elex.	DS Elex.	Length (ft.)	(h/h)	Aug. Normal Depth (P)	Avg. Buttom Width (ft)	Avg. Side Slopes (N/N)	Aug. Top Width (t)	Area	Wetted Perimeter	Valority	Flow Area (th')		(TV4)	T,(hm)	T _r (mine)	Notes
	Triangular Channel	Lined or Built-Up Channel	Vegetal Libing	0.080	5666.00	\$443.50	15.78	0.082	2.00	NA.	8.00	12.00	A+s[N/*2	P = [25(SQRT(1+(s)^2))	V = (1.49()/)*2/30(s)*0.5()/s	12.00	12.65	8.54	0.001	0.03	Assumed Diameter
			<u> </u>															Total T, 4		3.432	
																		7,0	0.014	2.059	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS														
	and there	X	fairting	Project:	Woodland	Orive Oraina	ge improvement			1										
	Land Use:		Proposed	Drainage Area Number:	44.					1										
Office	Site Land Use:	X	tainting	Bys	K. REDIMA	N														
On-s	site Land Use:		Proposed	Date:	6/17/3005															
									TIME OF	CONCENTRATION	N (VELOCITY METHO	D)								
		3-Year 2	6-Hour Fercipitation Kainfall Amount [in]																	
\vdash			County/City	City of Harrisonius	4					Sheet R										
10		Type of Flow	,		US Elev.	Di Elex.	Length (ft.)	Aug. 300pa (ft/ft)		-	-	Ti	ned Time Equa	tion			(PV4)	T,(hm)	T _i (mins)	Notes
1		Grass - Short Grass	Prarie	0.550	1450.0	1447.0	\$7.07	0.058					0.007 (-1)	0.0			104-0	0.076	4.688	
									l			T _i	$=\frac{0.007 (\pi L)}{(P_{a})^{1/2} g^{1/2}}$	<u></u>			NA.			
$ldsymbol{eta}$													PM 4							
					_					Shallow Concer	trated Flow									
10		Row Type		•	US files.	Di Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity figural				Velocity (TV4)	Tr(brs)	T(mins)	Notes
2		Short-Grass Pas	ture	0.071	1647.0	1494.0	265.27	0.049					V = 6.962(c)*0.	s .			1.541	8.048	2.869	
⊢—																			-	
\vdash										Quanti	Rew .									
\vdash												Т		16	sar Sona	Average				
10	Channel Shape	Chemel Type	Chennel Description	•	US Elev.	DS Eller.	(ength (t.)	Avg. Slope (ft/ft)	Aug. Normal Depth (P)	Avg. Buttom Width (ft)	Avg. Side Slopes (N/N)	Avg. Top Width (%)	Area	Wetted Perkneter	Valority	American How Area (b) (b)	(TV4)	T _r (box)	T _r (mine)	Notes
	Triangular Channel	Lined or Built-Up Classel	Vegetal Liking	0.000	1494.00	1429.92	88.80	0.046	2.00	NA.	8.00	12.00	A+s[N/*2	P = [25(35QRT[1+(1]^2)	V = (1.49()/)*2/30(s)*0.5()/s	12.00 12.65	10.28			Assumed Diameter
																	Total T, e			
																	3,4	0.077	4.620	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS														
		x	Soluting	Project:	Woodland	Orive Oraina	ge improvement			1										
	Land Use:			Orainage Area Number:						1										
		v	fairing		K. REDMA					1										
Off-	Site Land Use:			Date:	\$/17/2003					1										
-					d avlance				TIMEO	CONCENTRATION	(VELOCITY METHO	01								
—			8-Rour Perceptiation Katolan Amount [10] •						TIME OF	CONCENTRATION	I (VELUCITY METHO	u)								
-		21687	County/City																	
\vdash			County Con							Sheet Fi	0 W									
		Type of Flow			DS Clar	DS Elev.	Length (ft.)	Aug. Stope					avel Time Equal	los.			Vesicity	T,(hm)	T _i (mins)	Notes
_								(11/11)									(9/4)		-	
1		Smooth Surface (concrete, asph	att, graves, bare sott)	6.011	1435.9	1494.7	55.88	0.022				_	0.007 (nE)	1.8				0.013	0.805	
-					-	_						T ₆	$=\frac{0.007 (\pi L)}{(P_2)^{1/2} S^{1/2}}$				NA.	-	lacksquare	
—																				
⊢										Shallow Concent	trated Row								$\overline{}$	
10		Row Type		•	US Elev.	Di Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity figuration				Velocity (TV4)	Tr(hos)	%(mind)	Notes
2		Pewement and Small Up	land Guilles	6.035	1494.70	5490.59	259.63	0.006					V = 20.828(c)*0.	5			2.558	0.038	1.692	
\vdash						_		_		Channel	WW				(F)-327					
10	Channel Shape	Channel Type	Channel Description	•	US Elex.	DS Elec.	(angth (%)	Aug. Slope (ft/ft)	Aug. Normal Depth (11)	Avg. Bottom Width (ft)	Avg. Side Slopes (PL/PI)	Avg. Top Width (%)	Area	Wetted Perimeter	Valodty	Average Wested Flow Area (tr') (tr')	Velocity (TV4)	T _r (box)	T _i (mins)	Notes
4	Circular Pipe	Lined or Bulb-Up Channel	Concrete	6.013	160.59	1436.18	47.89	0.098	2.00	NA.	NA	NA	A = x(4/2)*2	P = 2x(4/2)	V = (1.49()/)*2/30(s)*0.5()/s	3.14 6.28	22.00	0.001	0.04	Assumed Diameter
							·									·	Total T, +	0.00	2.529 1.517	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS														
		x	Soluting	Project:	Woodland	Orive Oraina	ge improvement			1										
ļ ,	Land Use:			Orainage Area Number:	5					1										
		v	talering		K. REDMA	_				1										
Off-S	ite Land Use:	-		Date:	Q'17/3005					1										
-					400,000				TIMEO	CONCENTRATION	(VELOCITY METHO	D)								
-		Man	Charles American Control American (II)	140					TIME OF	CONCENTION	(AETOCILL METHO	9								
-			County/City			ı														
										Sheet R	OW COM									
10		Type of Ros		DS Elex.	Length (ft.)	Aug. 380pe (ft/ft)				Ti	avel Time Equal	ion			(PV4)	T,(brs)	T _r (mind)	Notes		
1		Grass - Short Grass	Prarie	0.550	1864.0	1463.3	\$7.59	0.052					0.007 (-1)					0.545	8.482	<i></i>
												T _e	$=\frac{0.007 (\pi L)}{(P_2)^{1/2} S^{1/2}}$	1.00			NA.		\Box	ı
													le Sur Sur							
										Shallow Concert	trated Flow									
10		Flow Type			US Elev.	DS Elex.	Longth (ft.)	Aug. Slope (ft/ft)					Velocity Squarto	-			Velocity (TV4)	Tr(box)	T(min)	Notes
2		Payement and Small Up	land Guilles	0.025	1469.3	1446.4	391.50	0.048					V = 20.828(4)*0.	5			4.226	0.036	1.543	
																				ı
								_		Channel	low								$\overline{}$	
ю	Channel Shape	Classel Type	Channel Description	•	US Clex.	DS Elex.	Langth (%.)	Aug. Slope (ft/ft)	Aug. Normal Depth (R)	Avg. Bottom Width (ft)	Avg. Side Slopes (ft/ft)	Avg. Top Width (%)	Area	Wetted Perkneter	Valodty	Average Wested Flow Area (tr') (tr')	Velocity (TV4)	T _r (box)	T _i (mine)	Notes
	Circular Pipe	Lined or Built-Up Channel	Concrete	6.013	1465.40	1421.68	696.15	0.086	2.00	NA.	NA	NA	A = 10[4/2]*2	P = 2x(d/2)	V = (1.49[]·)*2/3([s)*0.5[]]/s	3.14 6.28			0.85	Assumed Diameter
															·	Total T, e	0.585	18.87E 6.527		



WORKSHEET FOR SCS HYDROLOGIC PARAMETERS

_	-						‡														
	land Use:	X	fairting		Woodland	Orive Drains	ge improvement			1											
	dania data.		Proposed	Orainage Area Number:	6					4											
0#1	State and then	X	fairting	Bys	C. REDMA	N			•	1											
Om-s	ite Land Use:		Proposed	Date:	6/17/3003					1											
-				•					TIMEO	F CONCENTRATION	(VELOCITY METHO	D)									
lacksquare		3-7447	CONTRACTOR	141	_						. (-,									
-			County/City	City of Harrisonia	wg.	l															
										Sheet Fi	04										
10		Type of Flor			US files.	DS Elex.	Length (ft.)	(h/h)				1	nvel Time Equa	tion				(tV4)	T,(bes)	100	Notes
1		Grass - Dense Gr		0.240	1768.0	1747.8	109.87	0.184					0.007 (-17	0.0					0.516	6.989	
									1			T _e	$=\frac{0.007 (\pi L)}{(P_2)^{0.0} g^{0.0}}$	0.0				NA			
													(Paper Se	•							
										Shallow Concer	trated Flow										
_		Row Type			US files.	Di Elev.	Length (ft.)	Aug. Slope					Velocity figure	-				Velocity	Tr(bes)	Northe	Notes
				•	us me.		resilies (e.)	(11/11)										(9/4)	ninei	spend	-
1		Pevernent and Small U		0.025	1747.8		15.27	0.042					V = 20.828(s)*0					4364	8.002		
		Forest w/ Heavy Ground Utte		0.202	1746.3	1649.6	311.90	0.829					V = 2.516(s)*0.					1.466	0.060	3.600	
4		Short-Grass Par		0.073	1543.6	1598.8	218.90	0.394					V = 6.962(c)*0.					3.541	0.019	1.167	
5		Pevernent and Small Up	pland Guilles	0.025	1598.8	1555.7	498.63	0.087					V = 20.828(s)*0	.5				5.879	0.023	1.890	
lacksquare						_				Channel	Now.				artore	_		_	_	_	
I	1		I	I	1			Aver Mone	I			ı	$\vdash \vdash$	liq.	and the second	Average	Average	Velocity			
10	Channel Shape	Clamel Type	Chennel Description		US Elex.	DS Elev.	Length (%.)	Avg. Slope (N/N)	Avg. Normal Depth (1)	Avg. Buttom Width (ft)	Avg. Side Slopes (ft/ft)	Aug. Top Width (%)	Area	Wetted Perimeter	Valodty	Flow Area (Pr ²)	Pertmeter	(7/4)	T _r (bes)	T _i (mind)	Notes
6	Circular Pipe	Lined or Built-Up Channel	Concrete	683	1555.67	1504.87	701.00	0.078	125	NA.	NA.	NA.	A = x(4/2)*2	P= 2x(4/2)	V = (1.49()/)*2/30(s)*0.5()/s	1.23	3.93	14.28	0.014	0.82	Assumed Diameter
7	Trapezoidal Channel	Lined or Built-Up Channel	Vegetal Living	0.000	1504.87	5479.40	871.71	0.029	2.00	20.00	50.00	60.00		P+b+(25)SQRT(1+())*0)	V = (1.49()/)*2/30(s)*0.5()/s		60.20				
	Circular Pipe	Used or Built-Up Channel	Concrete	0.013	1479.40	1648.33	950.94	650.0	3.00	NA.	NA.	NA	A = x(4/2)*2	P = 2x(4/2)	V = (1.49()/)*2/30(s)*0.5()/s	7.07			0.015		
	Fond/Lake/Reservoir	Pond/Lake/Reservoir	Fond/Lake/Reservoir	NA	1448.33	1664.00	262.92	0.006	6.00	NA.	NA.	NA	NA.	NA.	V = SQRT(g0)	NA.	NA.	13.90	0.005	0.32	
10	Circular Pipe	Lined or Built-Up Channel	Concrete	6.013	\$444.00	\$436.94	727.27	0.024	8.00	NA.	NA.	NA.	A = x(4/2)*2	P = 2m(d/2)	V = (1.49()/)*2/30(s)*0.5()/n	7.07	9.42	14.74	0.014	0.82	
																		Total Co.			



		w	ORKSHEET FOR SCS HYD	ROLOGIC PARA	AMETE	RS				1											
	and Use:	X	fairting	Project		Orive Oraina	ge improvement			1											
			Proposed	Drainage Area Number:																	
Off-Si	te Land Use:	X	fairting Proposed	ity: Date:	K. REDMAI 6/17/3021					1											
			Propused	ORIGINAL TOTAL CONTRACTOR OF THE PERSON OF T	of a shapes				THE	CONCENTRATIO	A PLOCITY METHOD	n)									
			R-Hour Perceptiation Katolan Amount [10] -	141	_				TIME O	FCUNCENTRATIO	(VELOCITY METHO	미									
\vdash		21887	County/City.		wy.	ı															
										Sheet R	OW COM										
		Type of Hou			US flex.	DS Elex.	Length (ft.)	Avg. 300pe (11/10)				Ti	avel Time Equa	tion				(P/4)	T,(hm)	T _i (mind)	Notes
1		Grass - Dense Gr		0.340	1768.0	1766.0	112.90	0.218					0.007 (-1)	0.0					0.512	6.788	
		·										T _e	$=\frac{0.007 (\pi L)}{(P_2)^{51} S^5}$	-				NA			
lacksquare													Py a								
_					_	_				Shallow Concer	trated Row									_	
10		Flow Type			US files.	DS Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity Squat	on .				Velocity (TV4)	Tr(has)	%(mind)	Notes
2		Pevement and Small Up		0.025	1744.0	1716.5	257.21	0.077					V = 20.828k)*					5.635	0.018		
5		Pevernent and Small Up	fand Guilles	0.005	1556.0	1552.6	84.16	0.099					V = 20.828(s)*	1.5				6.394	0.005	0.089	
-										Classel	lan.										
-										Claime	***			Ige	9-327	-	Average				
10	Channel Shape	Clamel Type	Channel Description		US Elex.	DS Elex.	Length (%.)	Aug. Slope (N/N)	Aug. Normal Depth (10)	Avg. Buttom Width (ft)	Avg. Side Slopes (N/N)	Avg. Top Width (1)	Area	Wetted Perimeter	Valority	American Flow Area (Pr.)	Wester	Velocity (TV4)	T,(hm)	T _e (mind)	Notes
8	Circular Pipe	Lined or Built-Up Channel	Concrete	0.013	1715.29	1699.78	52.22	0.297	125	NA.	NA.	NA.	A = 10[4/2]*2	P = 2x(4/2)	V = (1.49()/)*2/30(s)*0.5()/s		3.93				Assumed Diameter
4	Triangular Channel	Used or Bulb-Up Channel	Vegetal Libing	0.000	2699.78	1555.97	680.29	0.228	2.00	NA.	8.00	82.00		P = [28(8QRT[3+(6]*2)	V = (1.49()/)*2/30(s)*0.5()/s		32.25			0.45	
6	Trapezoidal Channel	Natural Stream	Vegetal Libing	0.000		1538.00	157.88	0.092	0.75	8.00	6.00			P+b+(2h)sQRT(1+(s)*2)	V = (1.49()-(*2/3)(s)*0.5()/s		12.12				
7	Circular Pipe	Lined or Bulb-Up Channel	Concrete	6.003	1538.00	1512.87	202.48	0.124	125	NA.	NA.	NA.	A = 10[4/2]*2	P= 2x(4/2)	V = (L49())*2/30()+*0.5()/n	1.23	3.93	18.59	0.003	0.18	
	Triangular Channel	Natural Stream	Clean, straight, full, no riffs or deep pools w/ more stones and weeds	6.040	1512.87	1500.00	343.61	0.087	150	NA.	5.00	15.00	A+1[N/*2	P = (25)39QRT(1 + (1)*2)	V = (1.49()/)*2/30(s/*0.5()/s	11.25		5.87	0.016	0.97	
	Circular Pipe	Lined or Built-Up Channel	Concrete	0.013	1500.00	1443.09	1212.45	0.047	2.00	NA.	NA.	NA.	A = 10[4/2]*2	P = 2x(4/2)	V = (1.49())**2/30(s)**0.5()/s	3.14	6.28	15.64	0.022		
																			0.185		



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS]										
	and Use:	X	Salerling	Project:	Woodland	Orive Draina	ge improvement			1										
			Proposed	Orainage Area Number:]										
	te Land Use:	X	fairting	Bys	K. REDMA					1										
Uni-si	te Lina Use:		Proposed	Dete:	6/17/3003															
									TIME O	F CONCENTRATION	(VELOCITY METHO	D)								
		3-Year 2	8-Hour Percipitation Retrial Amount [in]																	
			County/City	City of Harrisonia	urg.															
—					_			Aug. Mope		Sheet Pi	010							Vencen	_	
ID		Type of Flow	•		US files.	DS Elev.	Length (ft.)	(11/11)				T	neel Time Equa	tion				(7/4)	T, (brs)	T _i (mins) Notes
1		Grass - Short Grass	Prorie	0.150	1476.8	1463.0	46.26	0.288					0.007 (~()	0.0					0.000	2.008
$ldsymbol{\sqcup}$									l			T _e	$=\frac{0.007 (\pi L)}{(p_g h)^2 g^{2d}}$	-				NA.	\rightarrow	
$oldsymbol{ol}}}}}}}}}}}}}}}}}}$													12 2							
										Shallow Concent	trated Flow									
10		Flow Type			US Elex.	DS Elex.	Length (ft.)	Aug. Slope (11/11)					Velocity Squarb	on.				(PV4)	Tr(hos)	Notes Notes
2		Pevement and Small Up	fand Guillies	0.025	1463.0	1450.2	218.40	0.059					V = 20.328(c)*0	5				4.821	0.012	0.740
					_					Channel	Now.					_				
	Clamel Shape	Channel Type	Channel Description		US Elex.	DS Elex.	Length (%.)	Aug. Slope (ft/ft)	Aug. Normal Depth (11)	Avg. Buttom Width (ft)	Avg. Side Slopes (PL/P)	Avg. Top Width (t)	Area	Wetted Perkneter	Questions	Amerage Flow Area (tr')	Average Wetted Perioder	Velocity (TV4)	T _r (bes)	T _i (mind) Notes
	Circular Pipe	Lined or Built-Up Clannel	Concrete	6.013	1450.20	1425.61	747.82	0.088	125	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(4/2)	V = (1.49())*2/3((s)*0.5()/s	1.23	3.93	9.57	0.022	1.30 Assumed Diameter
																		Total T, e	8.068	4.050
															76.0	0.045	2.430			



		w	ORKSHEET FOR SCS HYD	ROLOGIC PARA	AMETE	RS				1											
		X	tolerting	Project	Woodland	Orive Oraina	ge improvement			1											
L	and Use:	-	Proposed	Oralinage Area Number:						1											
		v	fairting	_	K. REDMA					1											
Off-Si	te Land Use:	-	Proposed	Date:	6/17/2003					1											
-									TIMEO	E CONCENTRATION	N (VELOCITY METHO	11									
lacksquare		Plant	Charles and the control of the contr	2.63	_				THE C	Concention	· (verociti metino	-1									
-			County/City.		wg.	I															
										Sheet Fi	046										
		Type of Flow			US files.	DS Elex.	Length (ft.)	Aug. 300pe (ft/ft)			_	Ti	evel Time Equa	tion			_	(TV/4)	T,(hm)	100	Notes
1		Grass - Dense Gr		0.340	1768.0	1766.0	112:90	0.258					0.007 (-17	0.0					0.512	6.738	
												T _k	= 0.007 (nL) (P ₃ ^(s) 5 ^(s)					NA.			
													legta								
										Shallow Concer	trated Row										
10		Flow Type			US files.	DS Elex.	Length (ft.)	Aug. Slope (ft/ft)				,	Velocity Equati	on				Velocity (TV4)	%(has)	T(mind)	Notes
2		Pewement and Small Up	land Guilles	0.025	1744.0	1716.5	257.21	0.077					V = 20.328(c)*	15				5.685	0.018	1.056	
5		Pevement and Small Up	land Guilles	0.025	1556.0	1552.6	84.16	0.099				1	V = 30.328(s)*0	1.5				6.394	0.000	0.089	
					_					Channel	Now				2-32	_			_	_	
			l	I	1 1			Aug. Slope				I		liqu		Average		Velocity			
10	Channel Shape	Channel Type	Channel Description	•	US Elev.	DS Elev.	Length (ft.)	(11/11)	Aug. Normal Depth (70)	Avg. Buttom Width (ft)	Avg. Side Slopes (ft/ft)	Aug. Top Width (%)	Area	Wetted Perimeter	Valodby	Flow Area (Pt ²)	Pertoneter	(75/4)	T,(hm)	T _r (mins)	Notes
3	Circular Pipe	Lined or Built-Up Channel	Concrete	6.013	1715.29	1699.78	52.22	0.297	1.25	NA.	NA.	NA.	A = x(4/2)*2	P = 2x(d/2)	V = (5.49()/P2/30(s)P0.5()/s	1.23	3.93	29.76	0.001	0.00	Assumed Diameter
4	Triangular Channel	Lined or Built-Up Channel	Vegetal Liking	0.080	2599.78	1555.97	690.29	0.228	2.00	NA.	8.00	82.00		P = [29(SQRT(1+(s)^2))	V = (1.49()/)*2/30((s)*0.5()/s		32.25		0.007	0.45	
6	Trapezoidal Channel	Natural Stream	Vegetal Libring	0.080	1552.50	1538.00	157.98	0.092	0.75	8.00	6.00	12.00	A + (b + zh)h	P+b+(2b)SQRT(1+(x)*0)	V = (5.49()/)*2/30((s)*0.5())/s		12.12			0.29	
7	Circular Pipe	Lined or Bulb-Up Channel	Concrete	683	1538.00	1512.87	202.48	0.124	1.25	NA.	NA.	NA	A = 10[4/2]*2	P = 2x(d/2)	V = (1.49()/)*2/30(s)*0.5()/s	1.23	3.93	18.59	0.003	0.38	
	Triangular Channel	Natural Stream	Clean, straight, full, no riffs or deep pools w/ more stones and weeds	6.040	1512.87	1500.00	34861	0.087	150	NA.	5.00	25.00	A+s[N/*2	P = (28/34QRT(1 + (x)^2)	V = (1.49([1)*2/3)([1)*0.5[[]/n	11.25	15.30	5.87	0.016	0.97	
	Circular Pipe	Lined or Built-Up Channel	Concrete	0.013	1500.00	1453.21	798.29	0.065	2.00	NA.	NA.	NA.	A+x 4/2 *2	P = 2x(d/2)	V = (1.49()/)*2/30(s)*0.5()/s	3.14	6.28		0.011		
																			0.175 0.105		



		w	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS				1											
	and Use:	x	fairting	Project:	Woodland	Orive Oraina	ge improvement]											
	and use.		Proposed	Drainage Area Number:	8]											
OM C	De Land Heer	X	tairting	Bys	K. REDMAN	N				1											
Om-Si	ite Land Use:		Proposed	Date:	Q'17/3031																
									TIMEO	F CONCENTRATION	(VELOCITY METHO	D)									
		3-7667	18-Hour Percipitation Keinfall Amount [In] •	2.63																	•
			County/City	City of Harrisonb	wg .																
-					_	_		Aug. Mope		Sheet R	•							Velocity		$\overline{}$	
10		Type of Flor	•		US files.	DS Elex.	Length (ft.)	(10/10)				T	avel Time Equ	ation				(7/4)	T _r (bes)	T _r (mins)	Notes
1		Grass - Dense Gr		0.240	1641.0	1487.0	43.91	0.091					0.007.6-7	va e					0.074	6.662	<i>-</i>
									l			T _k	= 0.007 (nL (P ₃) ^{(cl} gi	/// /				NA.			ı
													le3t a								
										Shallow Concern	rated Flow										
10		Flow Type			US Elex.	Di Elex.	Length (ft.)	Aug. Slope (ft/ft)					Velocity figure	ion				Velocity (TV4)	Tr(hos)	'S(mind)	Notes
2		Payement and Small U	pland Guillies	0.005	1637.0	1494.9	56.80	0.038					V = 20.328(c)*	1.5				3.946	8.004	0.240	
					\Box														\Box		ı
$ldsymbol{eta}$				<u> </u>																	
├──					_					Cleanel	-			E C	7-22	_	Average			$\overline{}$	
	Channel Shape	Clamel Type	Channel Description	•	US Elex.	DS Elex.	Length (ft.)	Aug. Slope (N/N)	Aug. Normal Depth (11)	Avg. Bottom Width (ft)	Avg. Side Slopes (N/N)	Aug. Top Width (%)	Area	Wetted Perimeter		Average Flow Area (th')	Watted	Velocity (PV4)	T _r (box)	T _e (mins)	Notes
	Triangular Channel	Lined or Built-Up Channel	Vegetal Links	0.000	1494.87	\$406.70	124.09	0.327	1.00	NA.	\$0.00	20.00	A+1[N/*2	P = [25(5)QRT[1+(1)^2]	V = (1.49()/)*2/30(s)*0.5()/s	10.00	20.10	14.86	0.002	0.34	Assumed Diameter
4	Trapezoidal Channel	Natural Stream	Clean, straight, full, no riffs or deep pools w/ more stones and weeds	6.040	1406.70	1405.97	34.02	0.000	2.00	5.00	4.00	21.00	A = (b + ab)b	$P = b + (2h)sQRT(1 + (s)^{2})$	V = (2.49([)/*2/30(k)*0.5[()/k	26.00	21.49	7.37	0.001	0.05	
														<u> </u>				Total T, 4	0.065	4.885	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	AMETE	RS				1											
	and Use:	X	tuirting	Project	_	Orive Drains	ge improvement			1											
			Proposed	Drainage Area Number:	SA.	_				4											
Office	ite Land Use:	X	fairting	Bys	E. REDIMA]											
011-3	tte Line ose.		Proposed	Clate:	Q'57/3025	1															
									TIME O	F CONCENTRATION	(VELOCITY METHO	D)									
		3-746/	SPROOF PROGRESSION CONTACT AND CO.																		
			County/City	City of Harrisonia	of.																
					_					Sheet R	OM/										
10		Type of Ho			US Elex.	DS Elex.	Length (ft.)	(h/h)				Ti	nvel Time Equ	ation				(TV/4)	T,(hm)	T _r (mins)	Notes
1		Grass - Dense G	186	0.340	1661.0	1497.0	43.91	0.091					0.007 (-7	voe.					0.074	4.442	
									l			T _k	$=\frac{0.007 (\pi L)}{(P_3)^{4.8} g^4}$	4				NA			
													le3ta								
										Shallow Concern	rated Row										
		Flow Type			US files.	DS Elex.	Length (%.)	Aug. Slope (ft/ft)					Velocity figure	ion				(TVA)	Tr(box)	N(mins)	Notes
2		Payement and Small U	stand Guilles	0.005	1637.0	1494.9	56.80	0.008					V = 20.828(s)*	1.5				3.946	0.004	0.240	
										Classel	low .					_					
	Channel Shape	Classel Type	Channel Description	•	US Clex.	DS Eller.	Langth (ft.)	Aug. Slope (ft/ft)	Aug. Normal Depth (T)	Avg. Buttom Width (ft)	Avg. Side Slopes (N/Ts)	Avg. Top Width (%)	Area	Wetted Perimeter	Valodty	Amerage Flow Amer (tr ²)		Velocity (PV4)	T,(hes)	T _i (mind)	Notes
	Triangular Channel	Lined or Built-Up Channel	Vegetal Liking	0.000	164.87	\$406.70	124.09	0.227	1.00	NA.	50.00	20.00	A+1[N/*2	P = [29(8QRT[1 + (s]^2)]	V = (1.49())*2/30(s)*0.5()/s	10.00	20.10	14.86	0.002	0.34	Assumed Diameter
4	Trapezoidal Channel	Heturel Stream	Clean, straight, full, no riffs or deep pools w/ more stones and weeds	6.040	\$406.70	1998.00	400.40	0.022	4.00	5.00	2.50	25.00	A = (b + ab)b	P+b+(26)5Q87(1+(s)*0)	V = (2.49([s/r-2/30(s)/r0.5[()/s	60.00	26.54	9.46	0.012	0.71	
																		Total T, -	0.092	5.582 8.819	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS															
	and the co	×	fairting	Project:	Woodland	Orive Oraina	ge improvement			1											
u	and Use:		Proposed	Oralnage Area Number:	100					1											
		X	birting	llys:	K. REDMA	N				1											
Off-Si	te Land Use:		Proposed	Date:	Q/17/3001					1											
									TIME O	CONCENTRATION	N (VELOCITY METHO	D)									
		3-Year	S-roor Perceptation Rental Amount [10] -	2.63																	
			County/City	City of Harrisonia	No.																
										Sheet R	OW .										
10		Type of Flor			US Elex.	DS Elev.	Length (ft.)	Aug. 300pe (11/11)				7	need Time Equa	tion				(11/4)	T _r (hm)	T _i (mind)	Notes
1		Grass - Short Gras	Prorie	0.150	1408.0	1402.0	51.85	0.116					0.007 (-1)	0.0					0.053	3.160	
									l			T _e	$=\frac{0.007 (nL)}{(P_3)^{0.8} S^0}$					NA.			
													(PS)3-								
										Shallow Concern	trated Row										
10		Row Type			US Elec.	DS Elex.	Length (%.)	Aug. Slope (ft/ft)					Velocity figure	on				Velocity (TV4)	Tr(bes)	200	Notes
										Cleanel	Pow										
														fq	uetione	American	Average				
	Channel Shape	Channel Type	Channel Description	•	US Elex.	DS Elex.	Length (ft.)	Aug. Slope (ft/ft)	Aug. Normal Depth (ft)	Avg. Buttom Width (ft)	Avg. Side Slopes (N/N)	Aug. Top Width (%)	Area	Wetted Perimeter	Valority	American Flow Area (Pr ²)	Wetted Pertreter (%)	(PV4)	T,(hm)	T _e (mind)	Notes
a	Trapezoidal Channel	Lined or Bulk-Up Channel	Clean, straight, full, no riffs or deep pools w/ more stones and weeds	0.040	1401.98	1399.94	124.09	0.056	2.00	5.00	4.00	21.00	A = (b + ship)	$P = b + (2h) \log RT(1 + (1)^{-2})$	V = (1.49()/P2/30()/P0.5()(/n	26.00	21.49	5.42	0.006	0.38	Assumed Diameter
			·												·			Total T, e		3.542	
																		7,4	0.015	2.125	



		W	ORKSHEET FOR SCS HYD	ROLOGIC PARA	METE	RS														
		x	Existing	Project:	Woodland	Orive Oraina	ge improvement													
	Land Use:			Orainage Area Number:	ac:															
		v	fairting		K. REDMA	_														
Off-S	ite Land Use:			Date:	\$/17/2005															
-					4 11/11/11				TIMEO	CONCENTRATION	(VELOCITY METHO	D)								
			S-Pour Perceptation Kenter Amount (m) -	140					TIME OF	CONCENTRATION	(AETOCILL WELLO	ויי								
-		2100	County/City			ı														
										Sheet Fi										
		Type of Flow			US flex.	Di Elev.	Length (ft.)	Aug. Stope				1	awi Tine Equa	tion			Vesicity	T,(hrs)	T _i (mind)	Notes
_		Grass - Short Grass			1617.3			(11/11)				-					(79/4)			
- 1		GERM - SHAFT GERM	riana	0.150	1410.0	54.19	0.184				_	0.007 (nL)	0.8				0.052	3.090	ı	
-										14	$=\frac{0.007 (\pi L)}{(P_2)^{1/2} S^{1/2}}$	_				—	-	ı		
-										Shallow Concert	tested floor									
-								Aug. Slope		SERVICE CORNE	CARRO PARK						Malacha		$\overline{}$	
		Flow Type			US Elex.	DS Elex.	Length (ft.)	(11/11)					Velocity figuration				Velocity (TV4)	Tr(box)	Tr(mins)	Notes
2		Short-Grass Par	lure .	0.073	3410.0	1406.0	126.45	0.082					V+6.962(c)*0.	5			1,238	0.028	1.702	
																			$oldsymbol{oldsymbol{\sqcup}}$	ı
⊢—								_		Cleanel	WW				P1.02					
10	Channel Shape	Classed Type	Channel Description	•	US Elex.	Di Elex.	Langth (%.)	Aug. Slope (ft/ft)	Aug. Normal Depth (11)	Aug. Bottom Width (ft)	Avg. Side Slopes (ft/ft)	Avg. Top Width (%)	Area	Wetted Perimeter	Valodty	Average How Area (n') (n')	Velocity (TV4)	T _r (box)	T _i (mind)	Notes
	Triangular Channel	Lined or Built-Up Channel	Vegetal Libring	0.000	\$406.00	1998.00	56.48	0.142	1.00	NA.	8.00	6.00	A+1[N]*2	P = [25(5)QRT[1+(1)*2]	V = (1.49()/)*2/30((s)*0.5())/n	1.00 6.32	11.37	0.001	0.08	Assumed Diameter
			·												-		Total T, +	0.065	4.875	
														3.4	0.049	2.925	1			

APPENDIX D

Modeled Existing Conditions

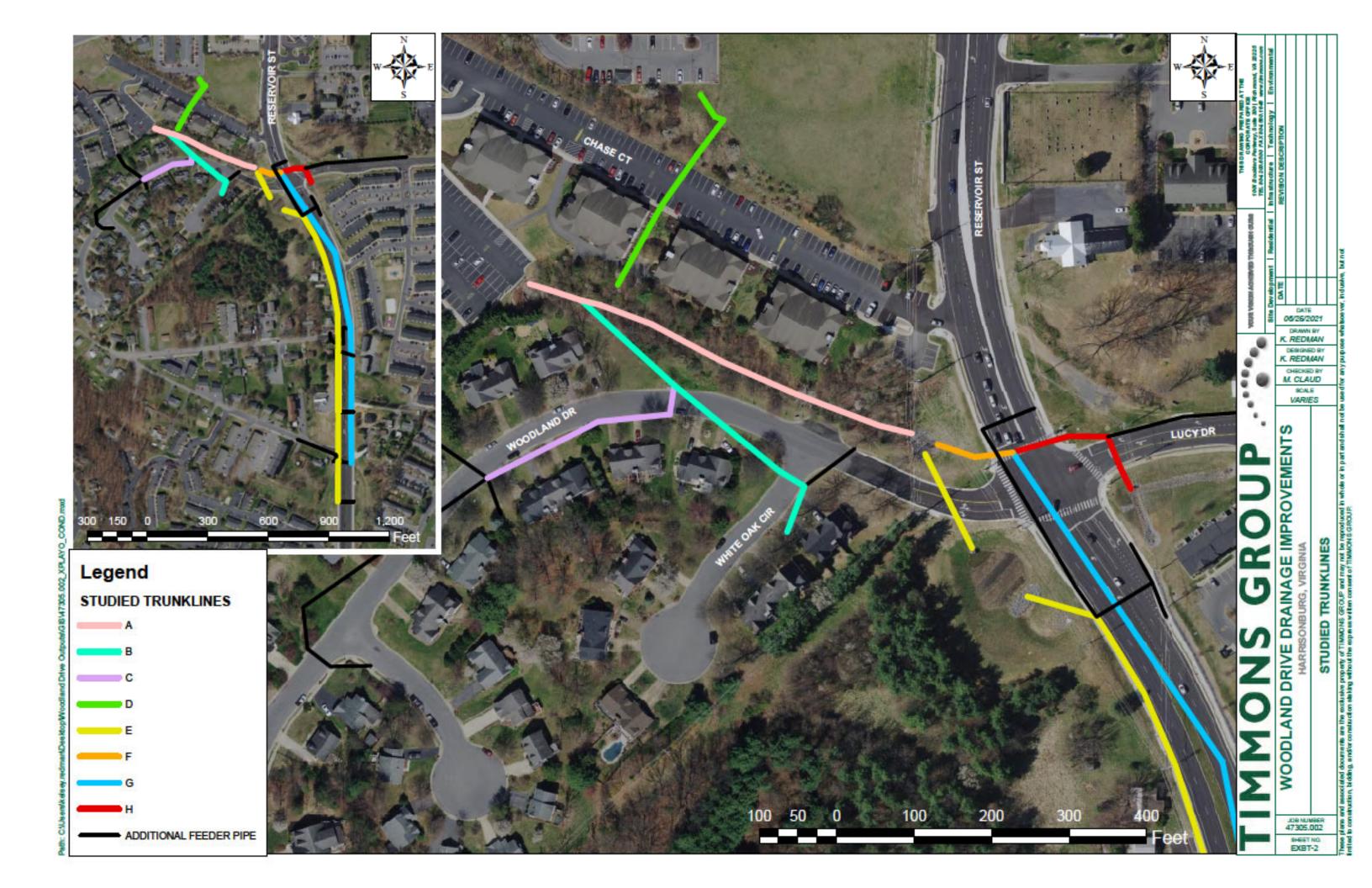
APPENDIX D.1

Flood Inundation Maps – Existing Storm Events



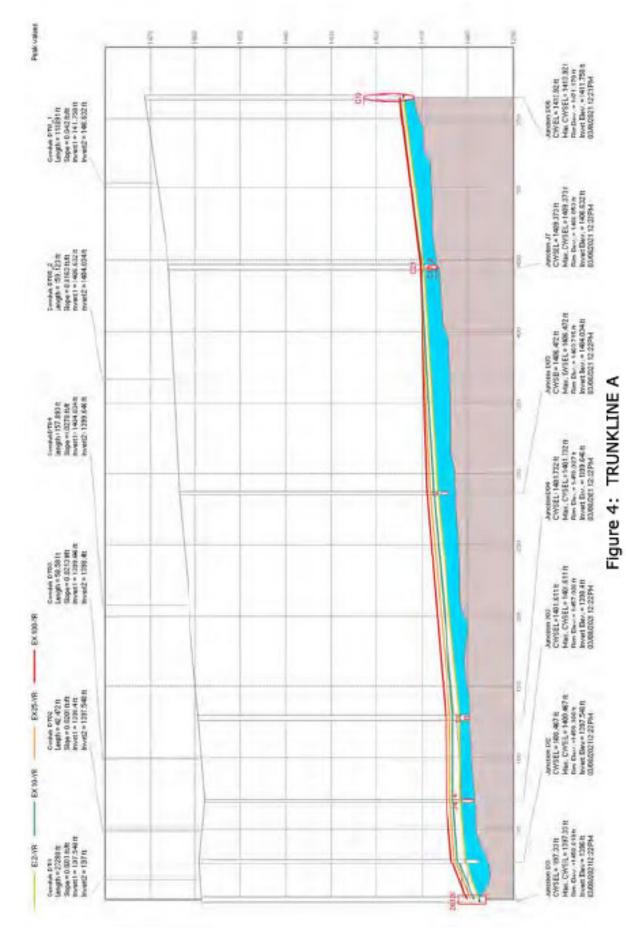
APPENDIX D.2

Plan View - Trunklines

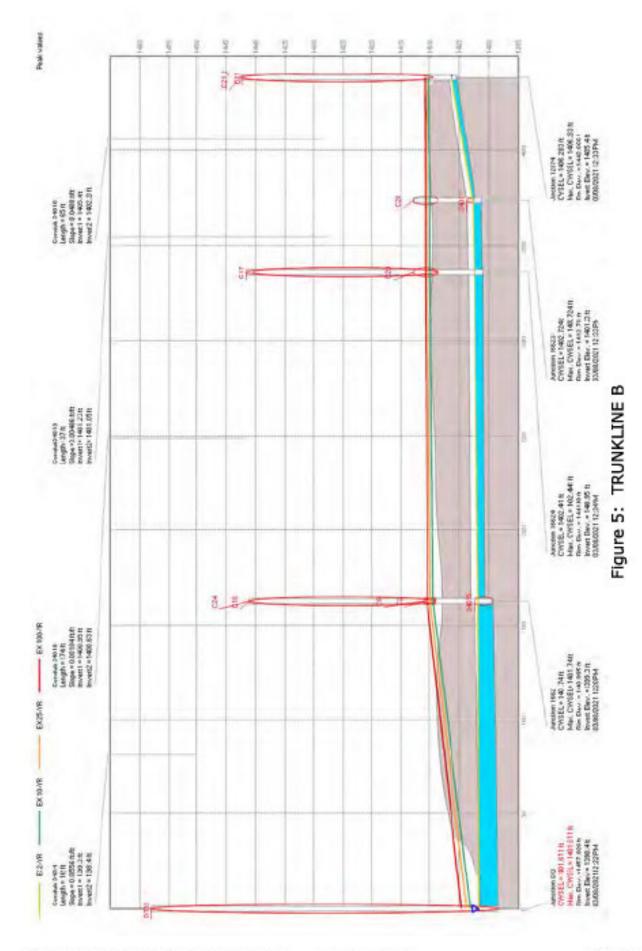


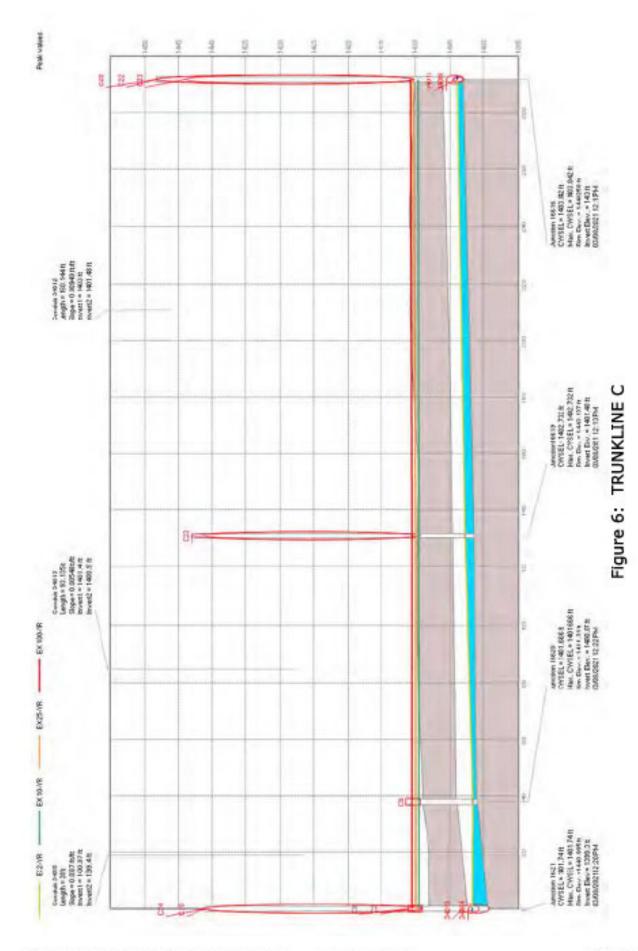
APPENDIX D.3

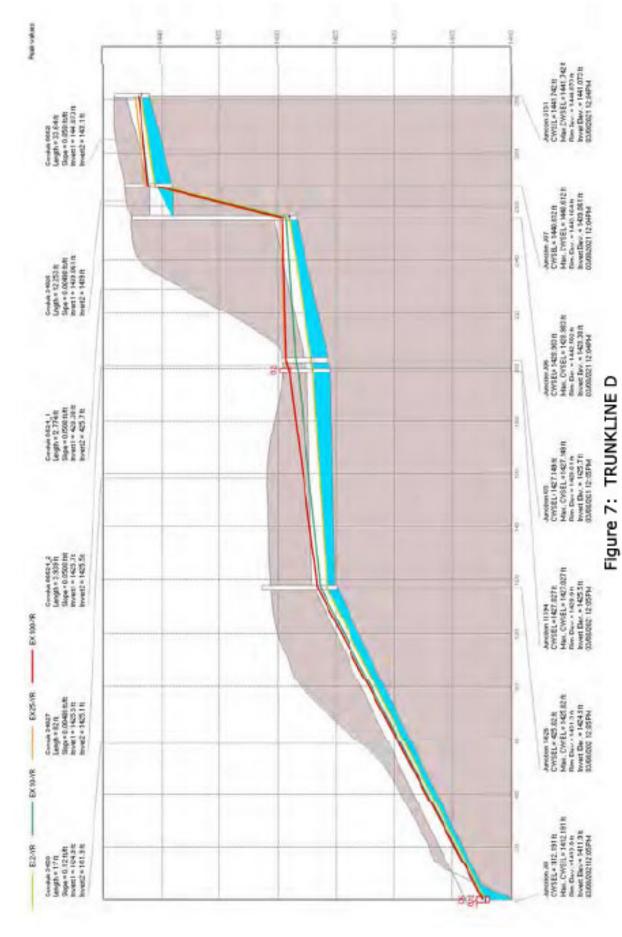
Profiles – Existing Storm Events



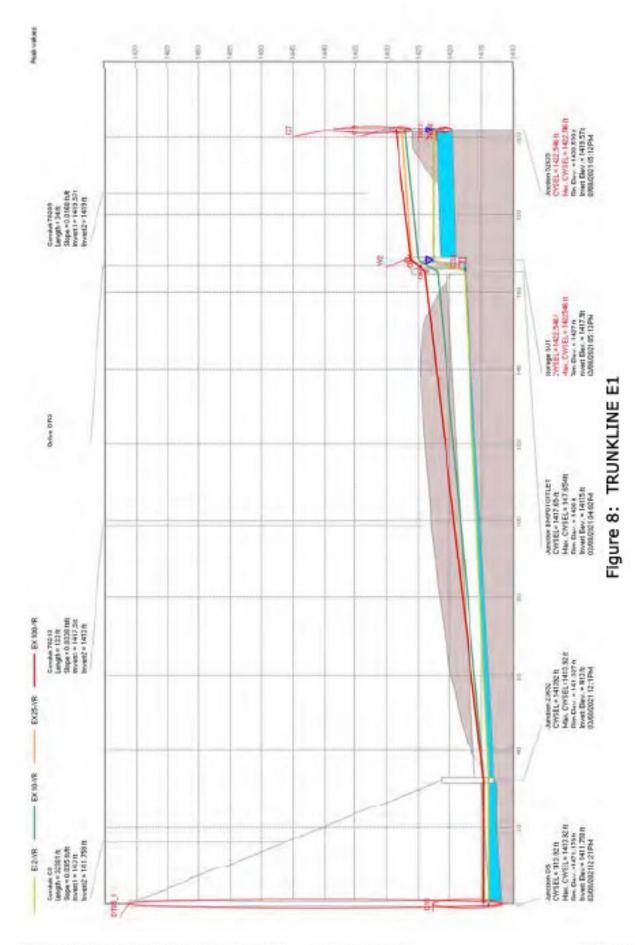
47305.002_Woodland_Drive_plandata_ex2 June 22, 2021

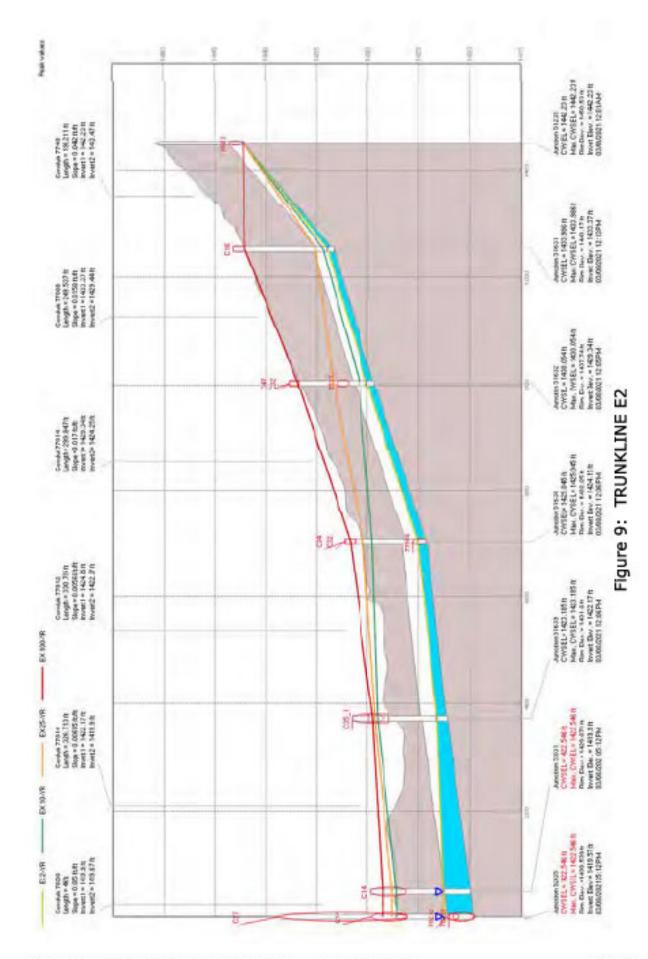


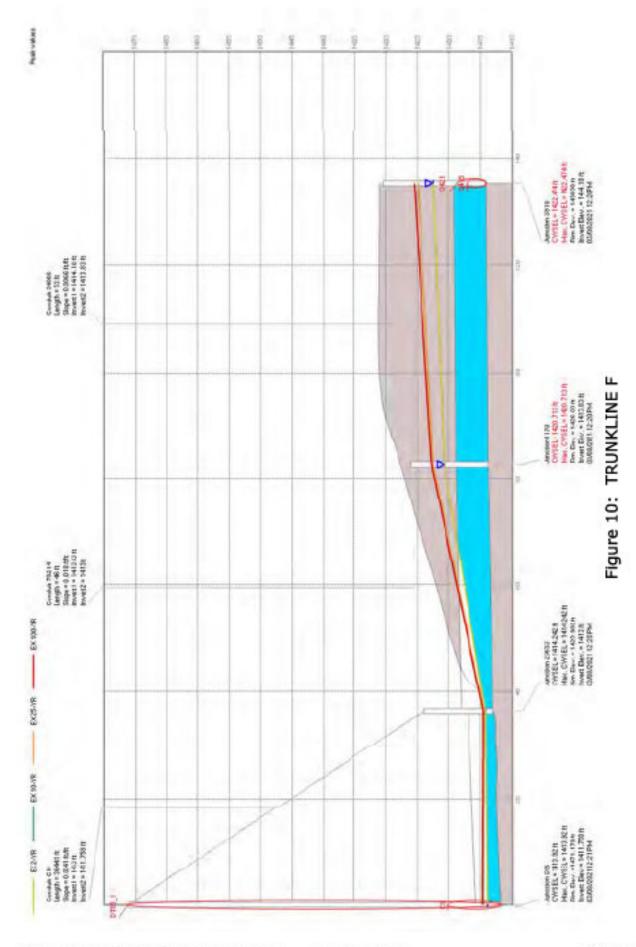


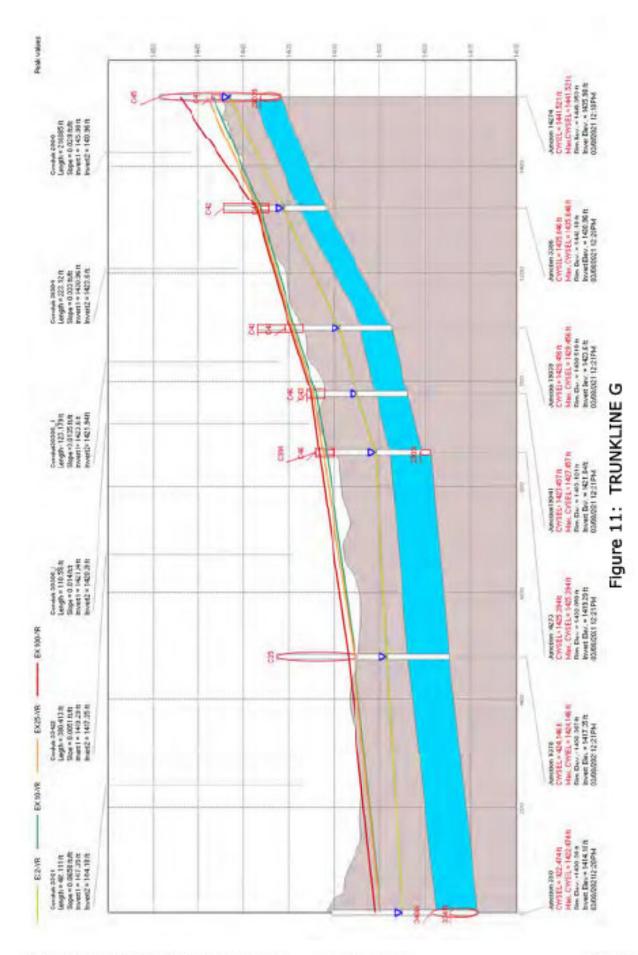


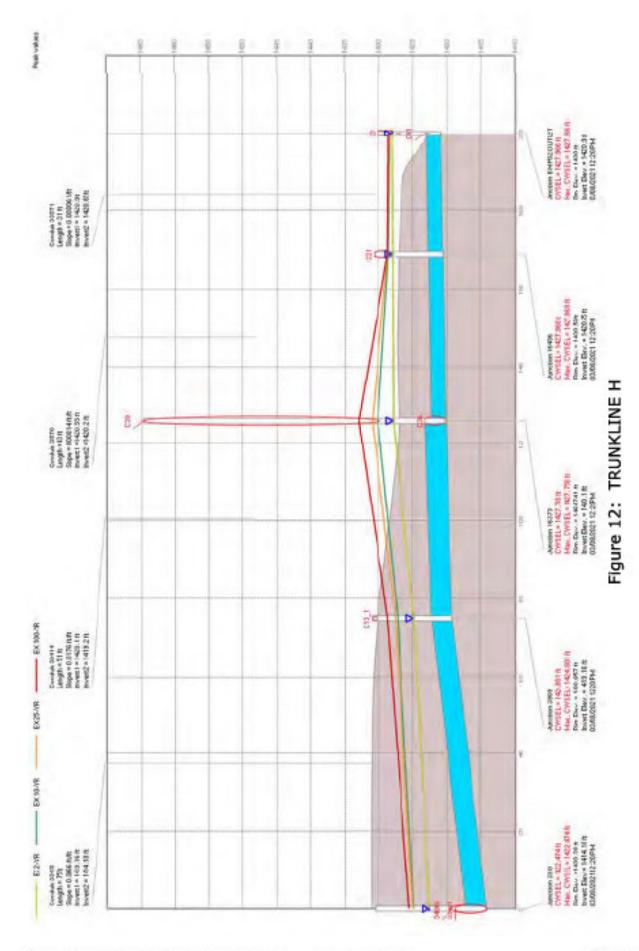
47305.002_Woodland_Drive_plandata_ex2 June 22, 2021







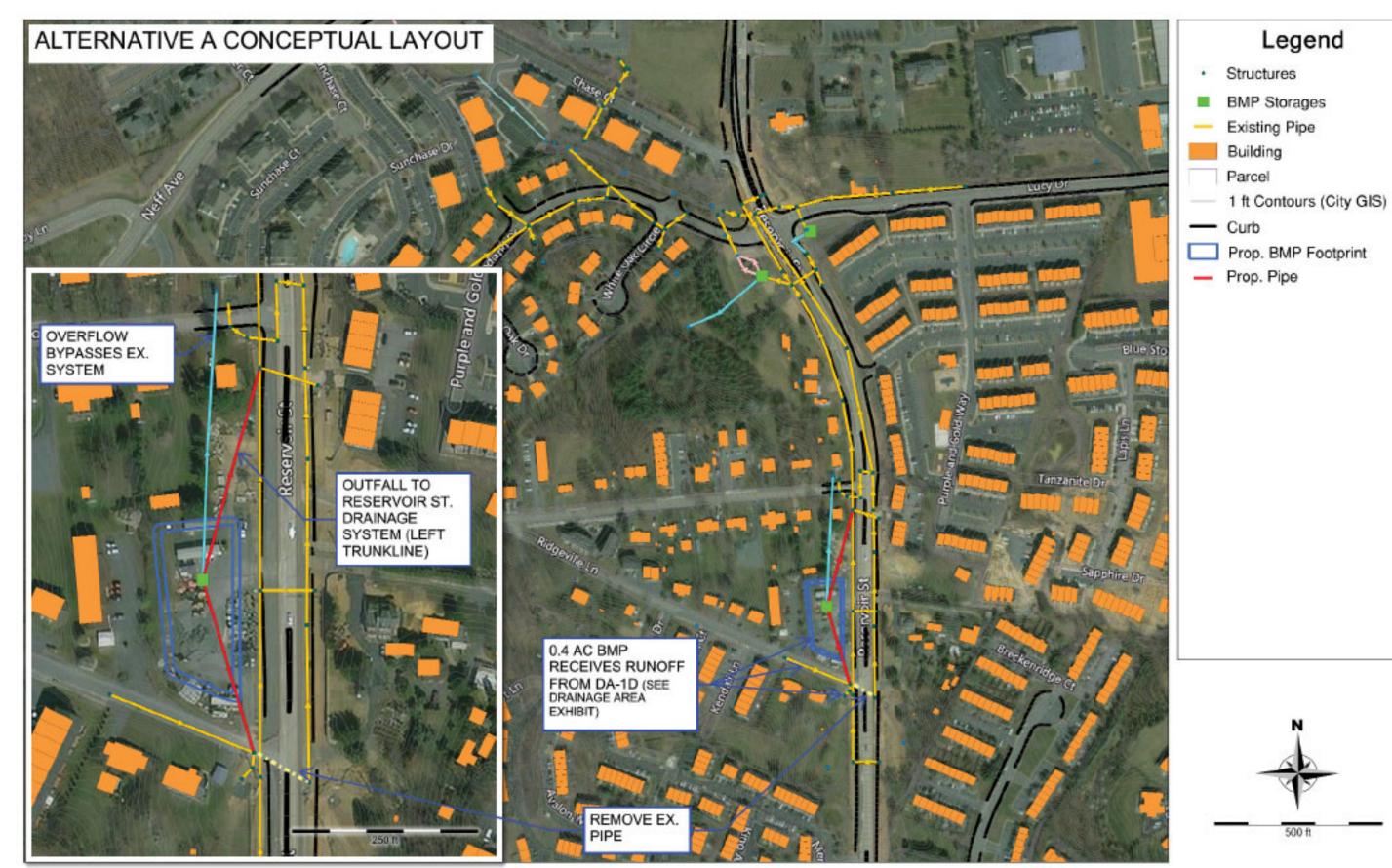




APPENDIX E

Modeled SWMM Alternatives

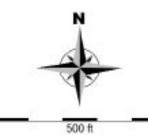
Conceptual Exhibits – Modeled Storm Drainage System

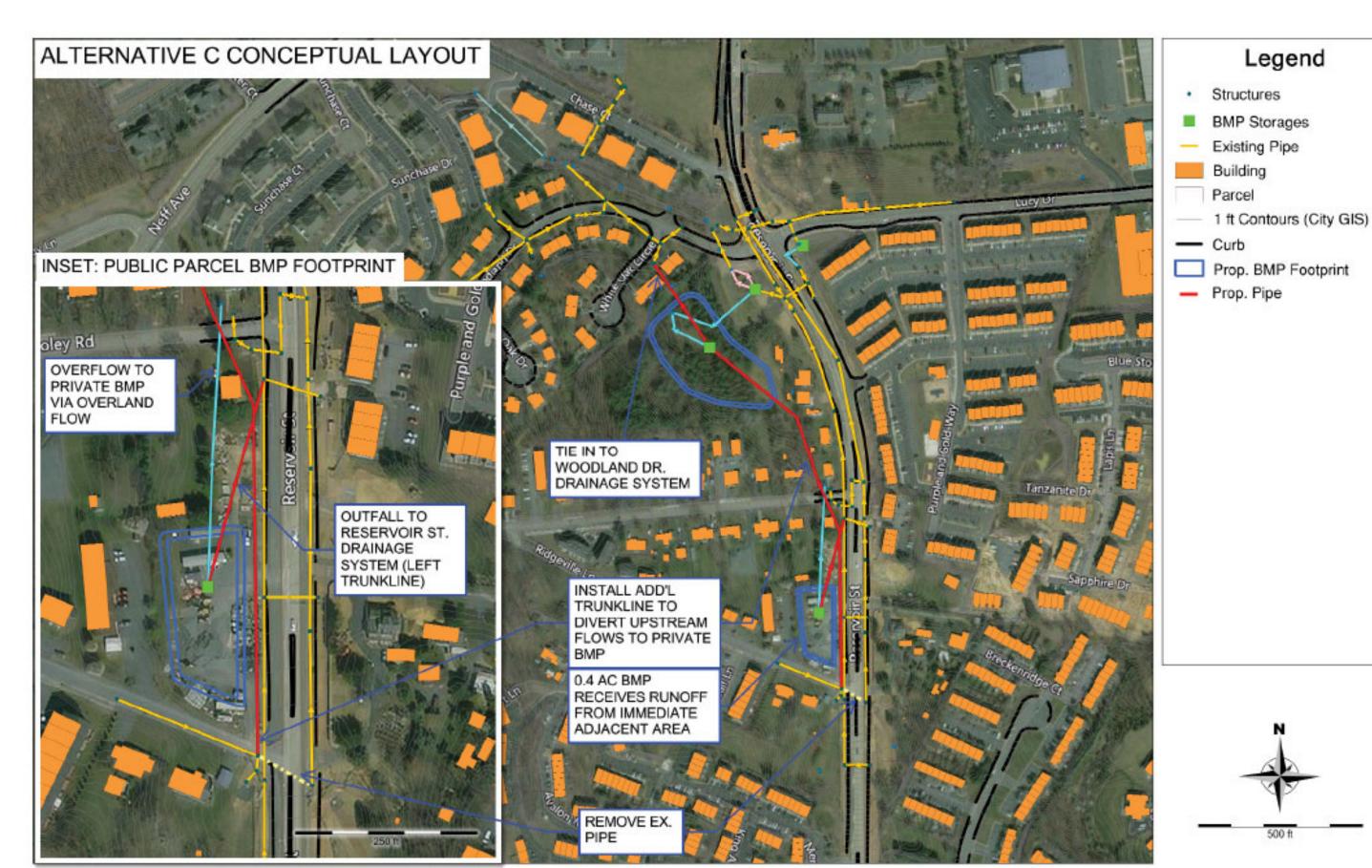


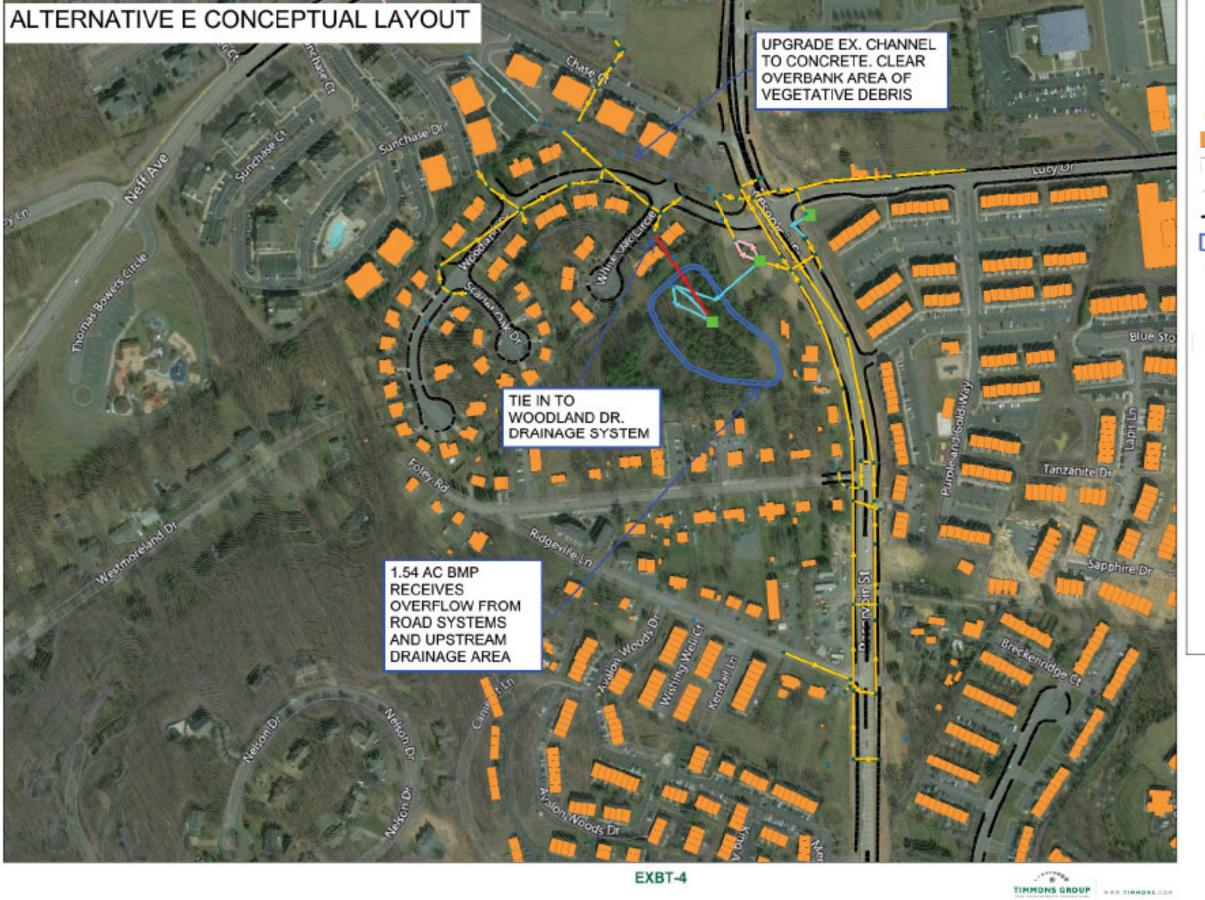


Legend

- Structures
- BMP Storages
- Existing Pipe
- Building
- Parcel
- 1 ft Contours (City GIS)
- Curb
- Prop. BMP Footprint
- Prop. Pipe

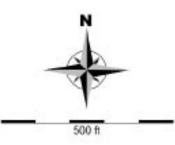






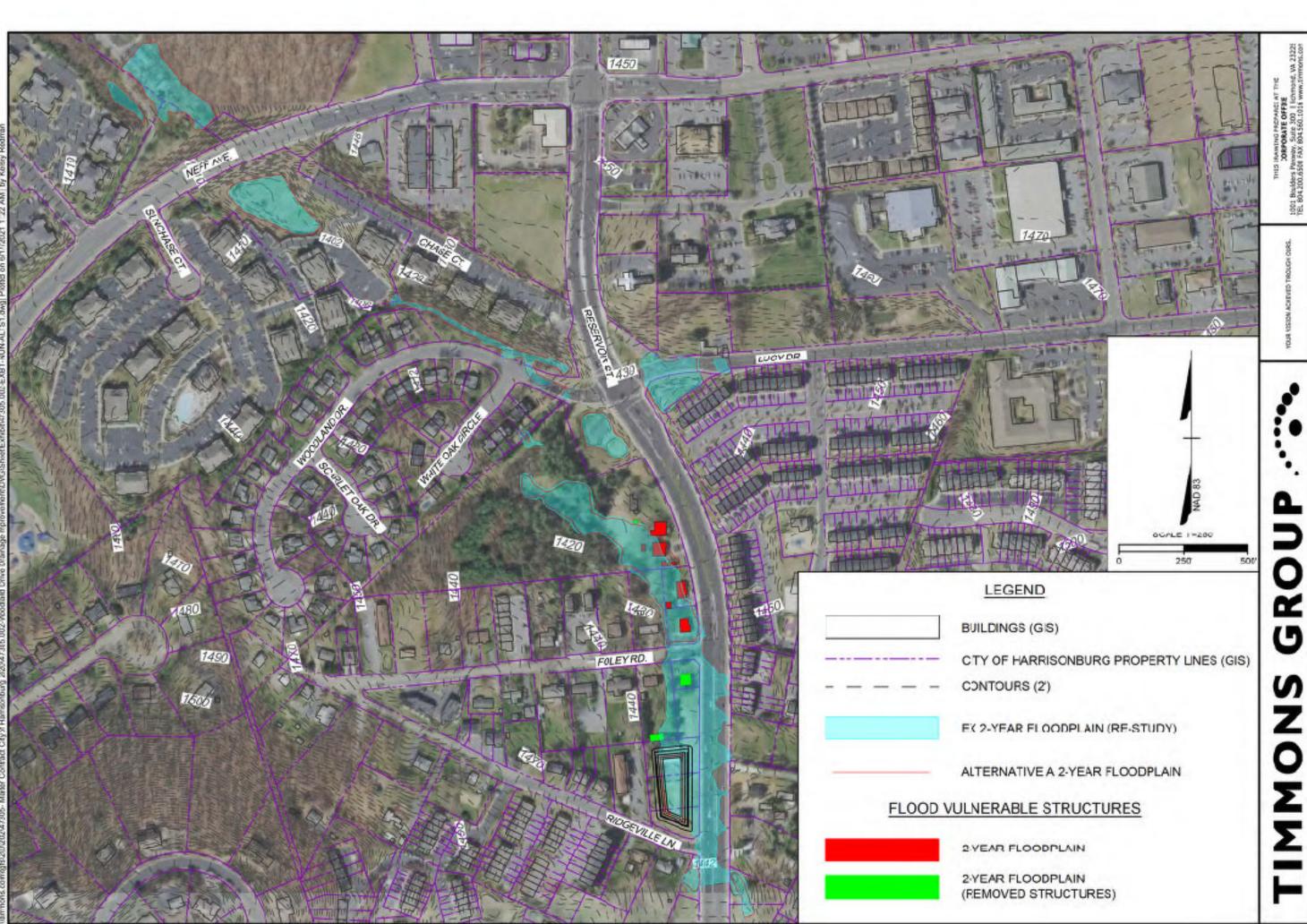
Legend

- Structures
- BMP Storages
- Existing Pipe
- Building
- Parcel
- 1 ft Contours (City GIS)
- Curb
- Prop. BMP Footprint
- Prop. Pipe



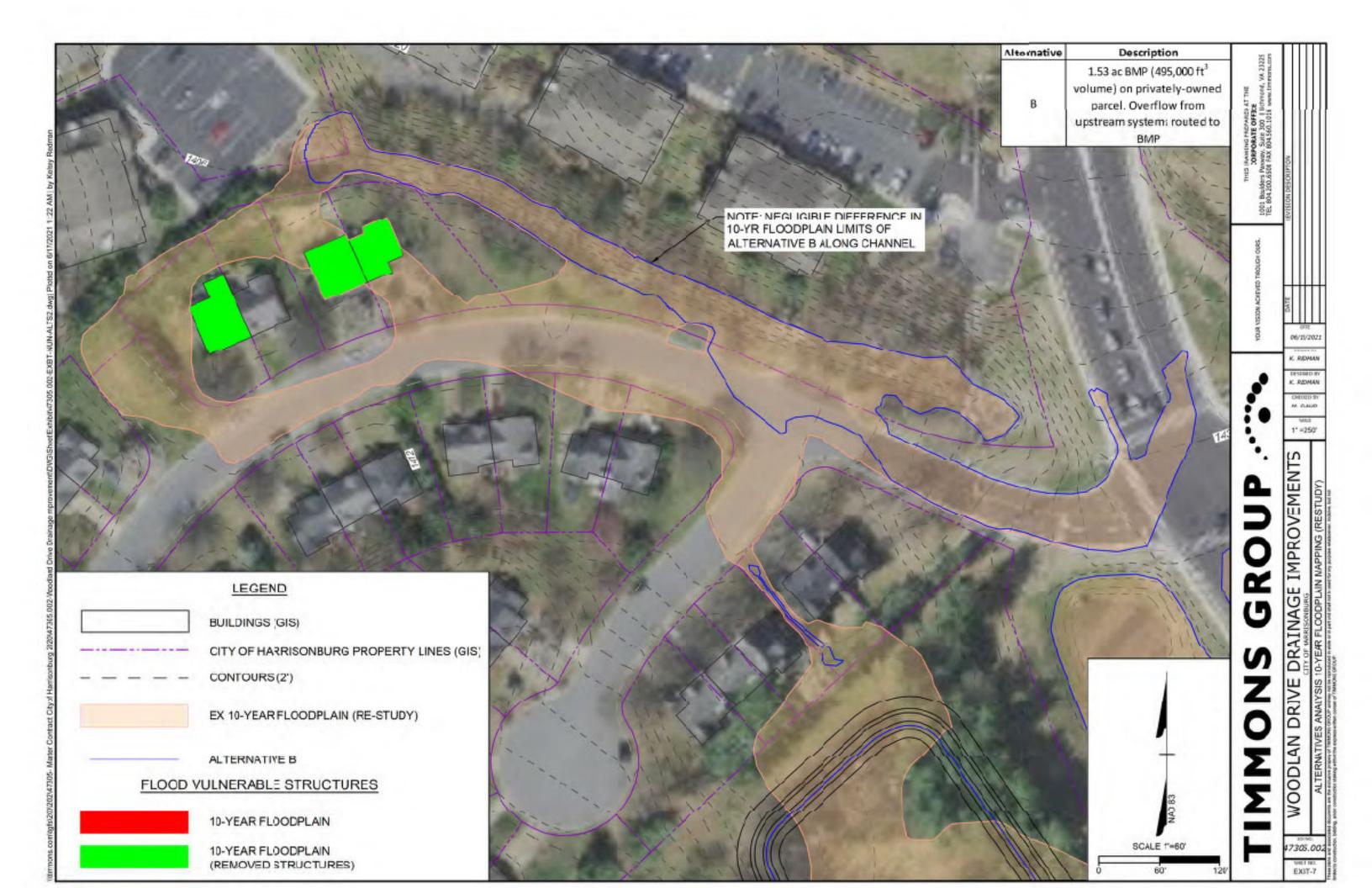
Flood Inundation Maps – Modeled Storm Drainage System

2-Year Flood Inundation Map



10-Year Flood Inundation Maps

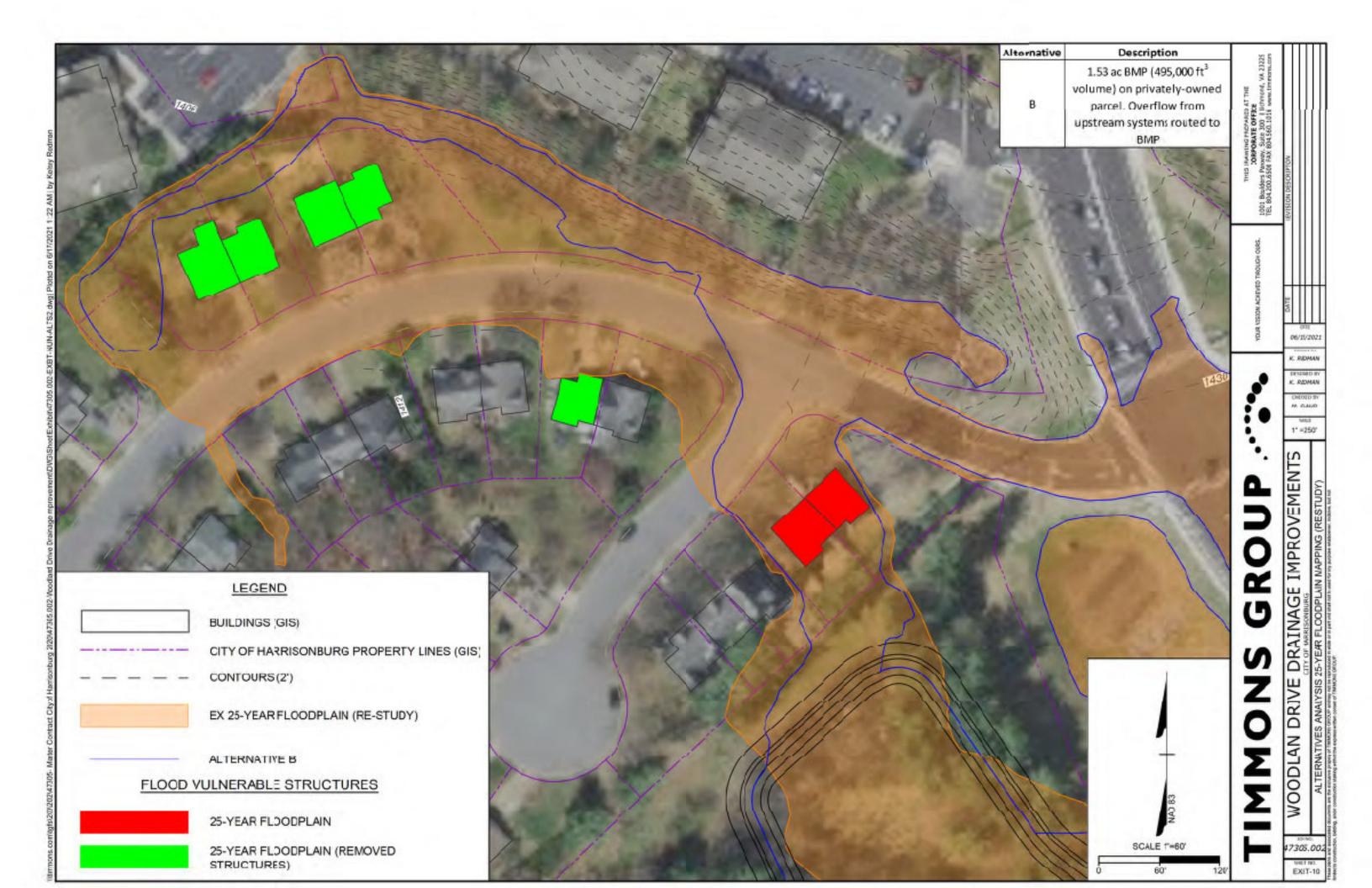


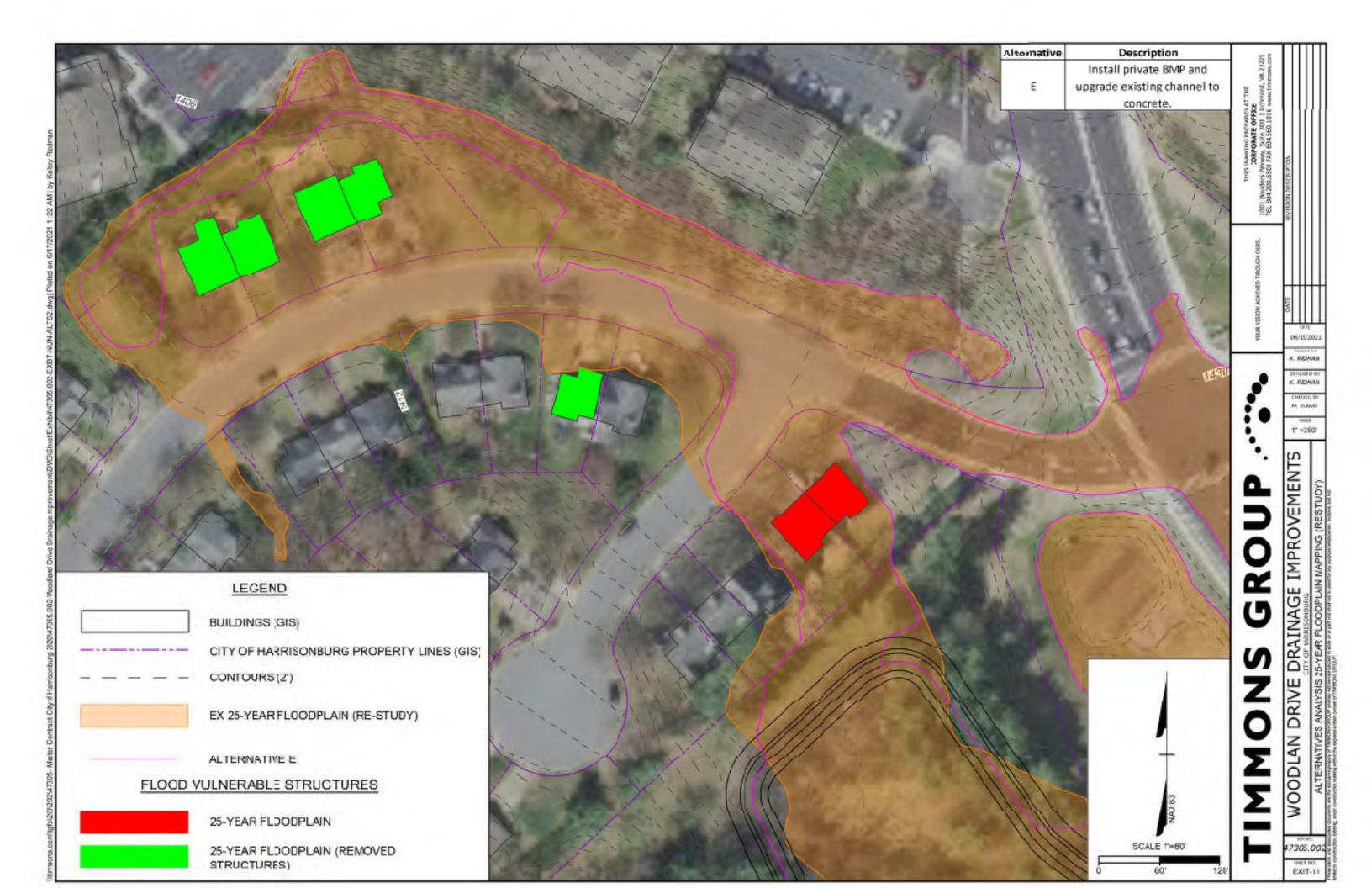




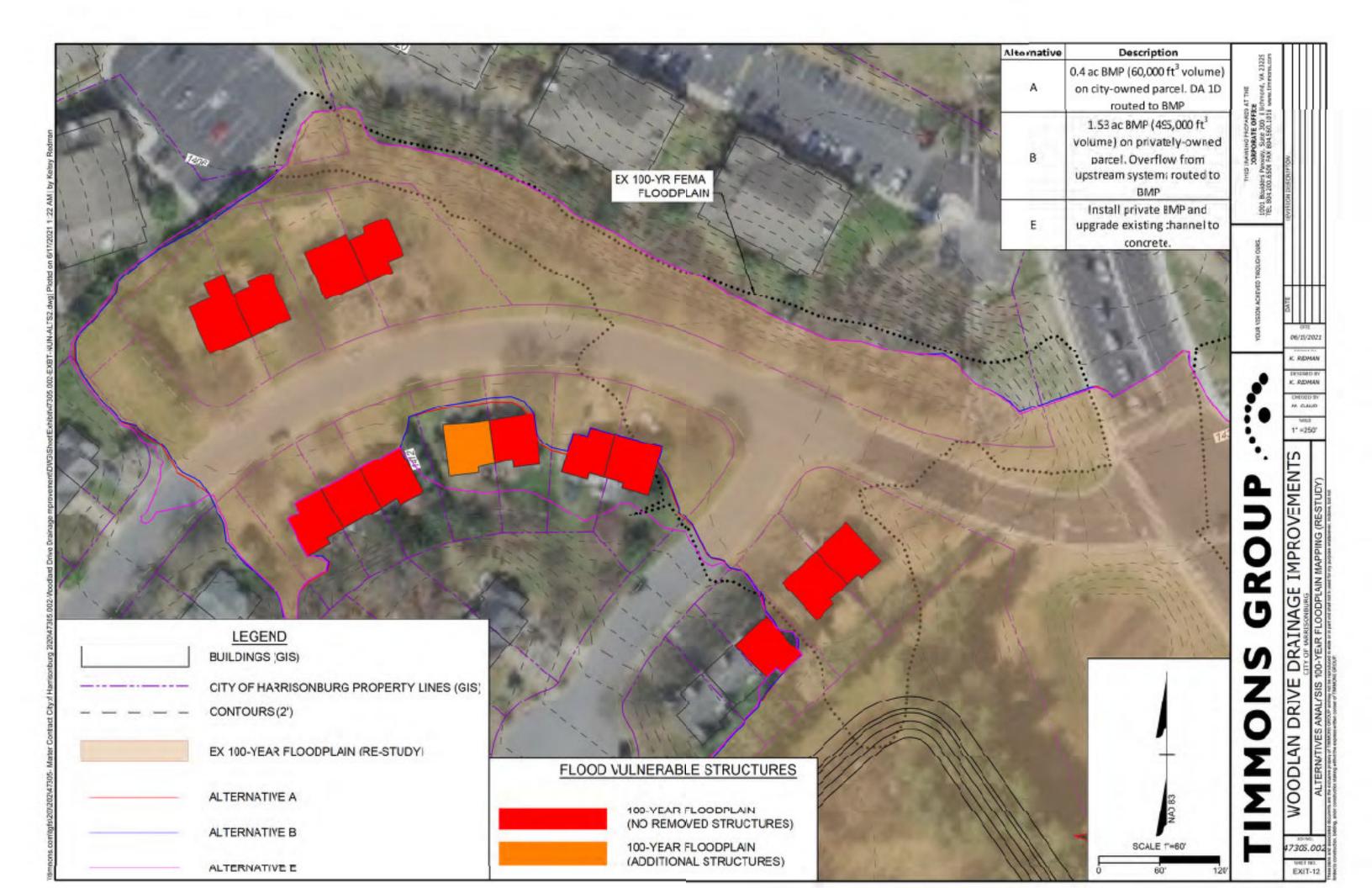
25-Year Flood Inundation Maps







100-Year Flood Inundation Map



Profiles - Modeled Storm Drainage System

SWMM 2 Year Storm Profiles

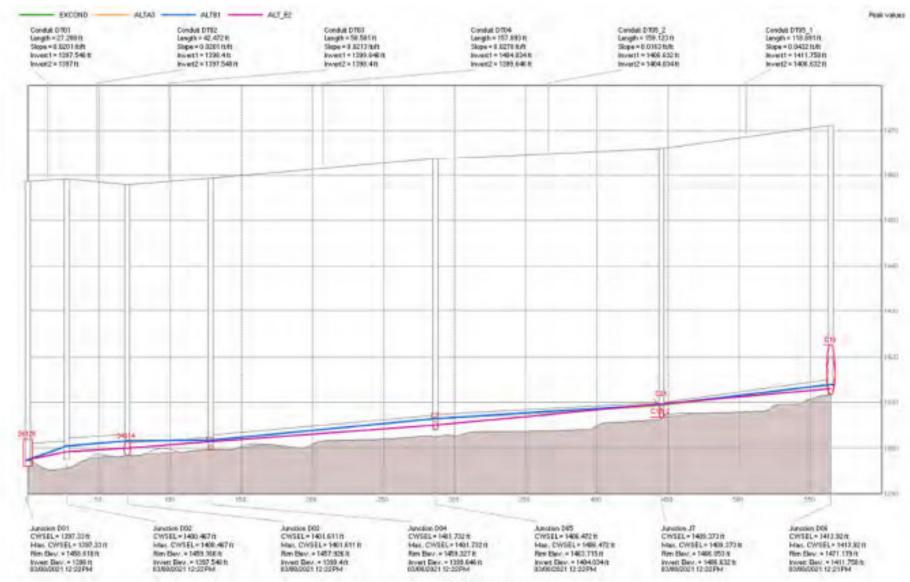


Figure 4: TRUNKLINE A

2-YEAR STORM PROFILES

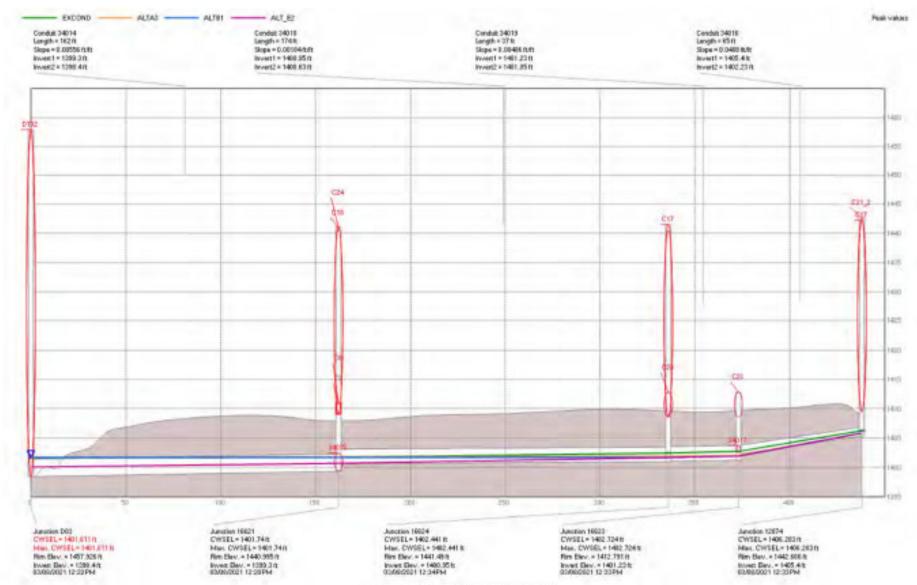


Figure 5: TRUNKLINE B

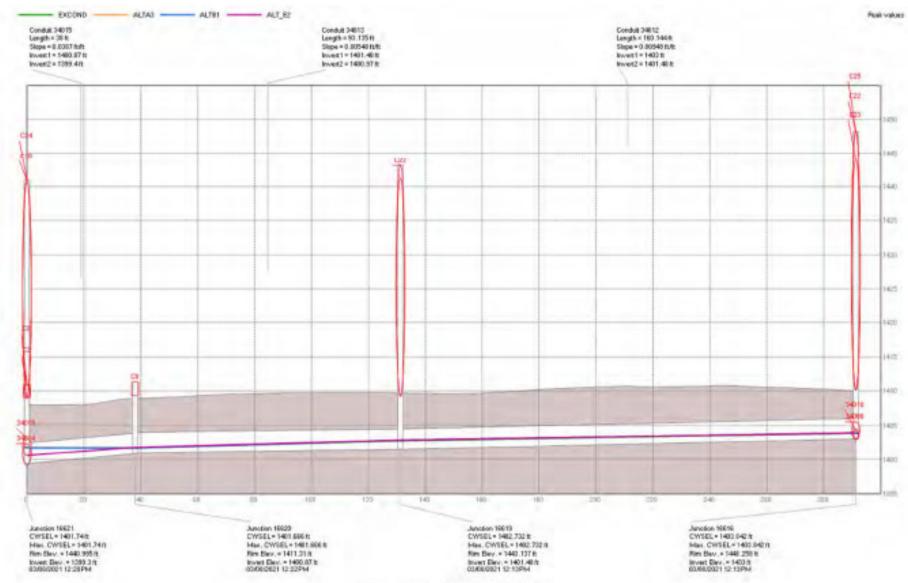


Figure 6: TRUNKLINE C

2-YEAR STORM PROFILES

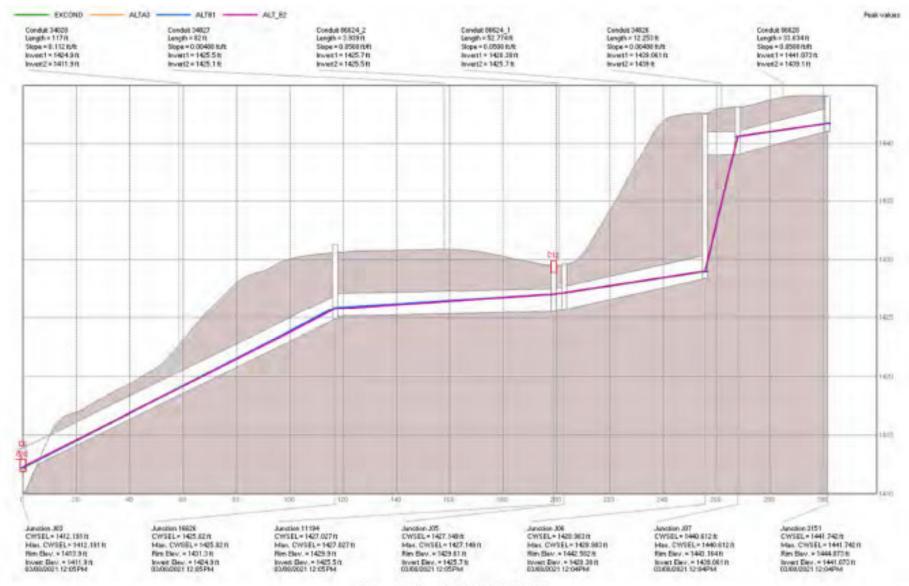


Figure 7: TRUNKLINE D

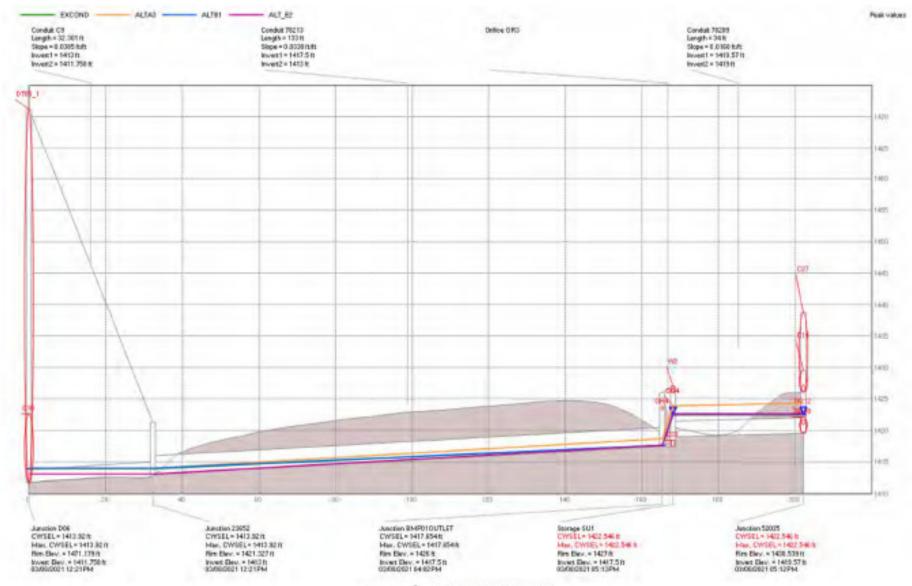


Figure 8: TRUNKLINE E1

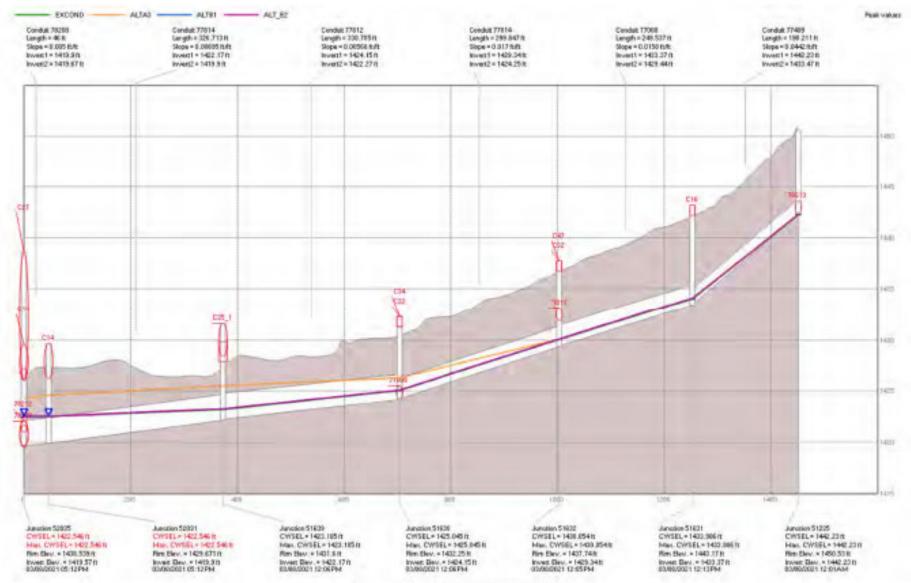


Figure 9: TRUNKLINE E2

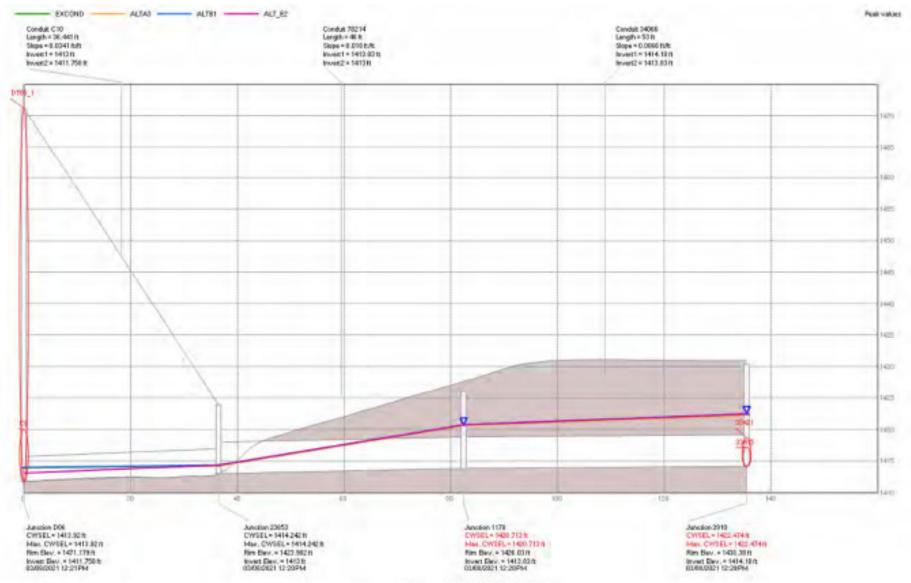


Figure 10: TRUNKLINE F

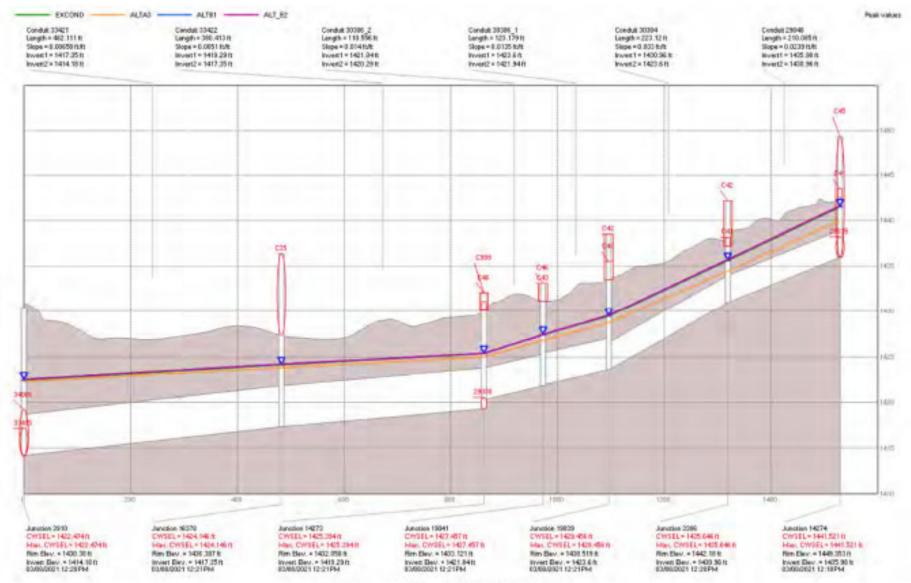


Figure 11: TRUNKLINE G

2-YEAR STORM PROFILES

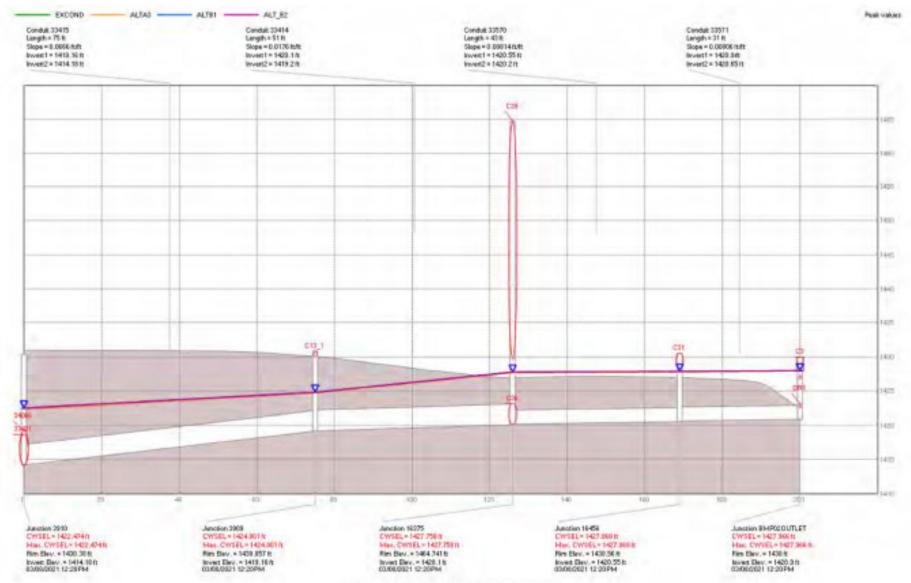


Figure 12: TRUNKLINE H