



Atlantic Development

Lake Mary Housing

III.3 Drainage Impact Analysis

Zoning Group

Nick Wood, Esq
Attorney

Noel J. Griemsmann, AICP
Sr. Urban Planner

Ryan McCann, AICP
Urban Planner

Taylor N. Moran
Urban Planner

Ty Utton
Assistant Planner

**DRAINAGE IMPACT STATEMENT
LAKE MARY HOUSING PROJECT
LOCATED IN PORTIONS OF SECTION 3
T20N, R07E, G&SRM
COCONINO COUNTY, ARIZONA
APN: 115-03-001A**

**Date:
June 15th, 2022**

**Applicant:
Atlantic Developments
Mark Breen, Managing Partner
Email: mbreen@atlanticdev.com**

**FOR AGENCY
REVIEW ONLY**

Prepared by:



618 E. Route 66 • Flagstaff, Arizona 86001 • Telephone (928) 522-9287

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Lake Mary Housing Project
Located in a Portion of Section 3
T20N, R07E, G&SRM
Coconino County, Arizona
APN: 115-03-001A

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3. INTRODUCTION

The Lake Mary Housing Project is a proposed residential apartment complex. The project is proposing 202 dwelling units mixed between townhome style and traditional flats. The 14 acre parent parcel (Coconino County APN 115-03-001A) is located in a portion of Section 3, T20N, R07E, G&SRM. The parcel address is 4631 S. Lake Mary Road in Flagstaff, Arizona.

The site is currently a vacant meadow. The parcel is currently heavily vegetated with grass and weeds.

In the existing condition, all on-site drainage runs towards Lake Mary Road along the northeast property line. There is a swale that carries water northward until it flattens enough for the water to spill into the curb and gutter along Lake Mary Road. This is the ultimate discharge point for on-site flows.

In the developed condition, site drainage patterns will generally remain unaltered. The proposed buildings, sidewalks, parking areas, and drives will all flow generally northeast until a stormsewer system under the main drive directs water towards a detention pond located as close to the historical discharge point as possible. This pond will meter the post-developed flows to the pre-developed flowrate before the water is allowed into stilling basin which will mimic the pre-developed condition of water flowing over the curb into the gutter along Lake Mary Road.

The project site is located in a FEMA Flood Zone 'X,' or an area of low risk to inundation in the 100-year event.

4. OBJECTIVES AND PROCEDURES

The objective of this Drainage Impact Statement is to prove that the development will mitigate the peak flows and duration to pre-developed conditions.

This site contributes flow to a wash that is located along SJ Diamond Road. This wash eventually becomes Skunk Canyon and flows to a FEMA designated Zone 'A' approximately 3,500 feet northeast of the intersection of SJ Diamond Road and Lake Mary Road.

To mitigate the flow rate, the developed condition will utilize a detention pond to meter the post-development flow rates to pre-development conditions. To mitigate total runoff volume, the site will use retention to keep the difference between the pre-development hydrograph and the post-development hydrograph on site for 24-36 hours.

5. HYDROLOGY

The On-Site Watershed Delineations (**Appendix A & B**) show contributing areas and T^c paths for the existing and proposed conditions of the Lake Mary Housing Project. The site has a ridge running up the middle that divides the flows into a West Catchment and an East Catchment. They are shown on the exhibit in **Appendix 'A'**. For the purposes of proving feasibility in the preliminary drainage report, runoff curve numbers were derived from the TR-55 manual. Table

No. 1 below shows the curve numbers, times of concentration, and peak flows for each catchment that contributes water to the Lake Mary Road curb and gutter.

Please refer to **Table No. 1** for a complete tabulation of how runoff coefficients were input.

Table 1: Pre-Developed On-Site Catchment Information

Pre-Developed On-Site Catchment Information				
Basin ID	Total Area	CN	T ^c	Peak Flow (Q)
West Catchment	8.266 Acres	85 (Arid and Herbaceous, Type 'D' Soil)	0.675 Hrs	16.99 cfs
East Catchment	4.688 Acres	85 (Arid and Herbaceous, Type 'D' Soil)	0.616 Hrs	10.36 cfs

Due to the different T^c values the total peak flow is 27.35 cfs during the 100-year 24-hour rainfall event. This event has a total hydrograph volume of 138,235 cu.ft.

In the developed condition, the site has two catchments. One is the majority of the impervious surfaces which will flow to the previously mentioned stormsewer system which is directed to the detention pond. The second catchment is the area along the frontage which flows unmitigated to the curb and gutter in Lake Mary Road. Both of the catchments are shown on the exhibit in **Appendix 'B'**. For the purposes of proving feasibility in the preliminary drainage report, runoff curve numbers were derived from the TR-55 manual. Table No. 2 below shows the curve numbers, times of concentration, and peak flows for each catchment that contributes water to the Lake Mary Road curb and gutter.

Please refer to **Table No. 2** for a complete tabulation of how runoff coefficients were input.

Table 2: Post-Developed On-Site Catchment Information

Post-Developed On-Site Catchment Information				
Basin ID	Total Area	CN	T ^c	Peak Flow (Q)
Frontage Catchment	5.234 Acres	89.09 (Composite with Impervious and Landscaped Areas)	0.257 Hrs	4.83 cfs
East Catchment	11.780 Acres	92.60 (Composite with Impervious and Landscaped Areas)	0.178 Hrs	55.66 cfs

Due to the different T^c values the total peak flow is 60.17 cfs during the 100-year 24-hour rainfall event. This event has a total hydrograph volume of 173,945 cu.ft.

6. RUNOFF VOLUME MITIGATION

The peak flow mitigation is discussed in the Preliminary Drainage Report that accompanies this submittal. The site will also comply with the rest of the City of Flagstaff Stormwater Management Design Manual. This includes LID or Low Impact Development. Per the LID Standards, the developed condition must provide retention for 1" over all of the impervious surfaces. The total

area of impervious surfaces is 341,918 sf. Therefore, the required retention volume for the site is 28,493 cu.ft.

The difference between total runoff volume for the pre-developed condition and the post-developed condition is 35,715 cu.ft. By increasing the retention on site to a minimum of 35,715 cu.ft., the site mitigates the increase in runoff volume and complies with the LID Standards.

The current preliminary design for the site includes approximately 36,616 cu.ft. of retention volume on-site. This is done with underground polyethylene chambers that will be located under the detention pond.

7. SUMMARY AND CONCLUSIONS

The Lake Mary Housing Project will use on-site detention and retention to reduce the flowrate and runoff volume for the 100-yr 24-hr storm event to the pre-developed condition.

The detention necessary to reduce the flowrate to the pre-developed condition is discussed in the Preliminary Drainage Report included with this report.

The retention necessary to reduce the runoff volume is 35,715 cu.ft. The retention designed on-site will reduce the runoff volume by 36,616 cu.ft.

This negates the impact of the development to downstream stormwater appurtenances.

8. REFERENCES

Publications

On-Site Topographic Survey Provided by Arizona Surveying, Inc., 2021

Geotechnical Evaluation Report Provided by Western Technologies, Inc., 2022

City of Flagstaff Stormwater Management Design Manual. 03-2009

Software

Bentley Pondpack V8i

APPENDIX A



WEST CATCHMENT:

AREA: 360,062 SF = 8.266 ACRES
 CURVE NUMBER: 85 (HERBACEOUS - GOOD COVER - 'D' SOILS)
 T_c : 0.675 hrs = 40.5 min

SHEET FLOW
 $T_t = (0.007(nL)^{0.8}) / (2^{0.5}S^{0.4})$
 $n = 0.24$ (DENSE GRASS)
 $L = 300'$
 $S = 3.1\%$
 $T_t = 0.608$ hrs

SHALLOW CONCENTRATED FLOW
 $V = 16.1345(S^{0.5})$
 $S = 3.1\%$
 $V = 2.84$ ft/s
 $T_t = 688' / 2.84 \text{ ft/s}$
 $T_t = 0.067$ hrs

EAST CATCHMENT:

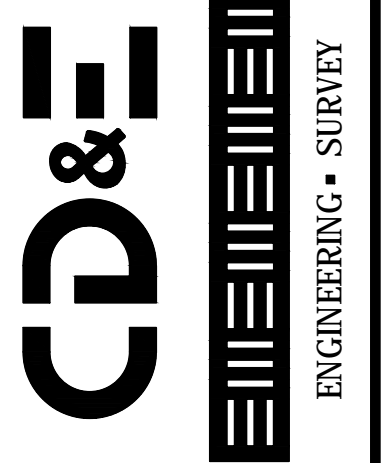
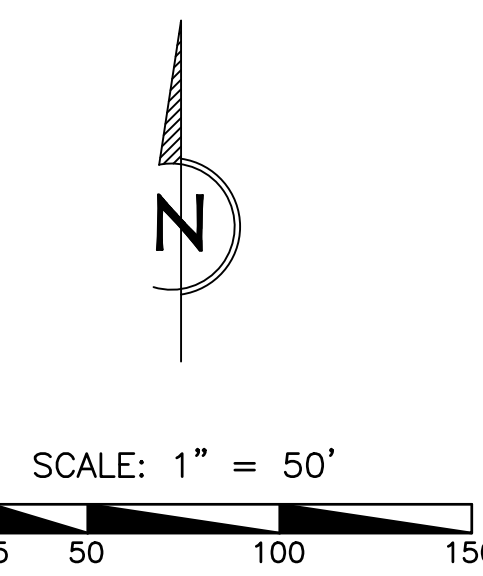
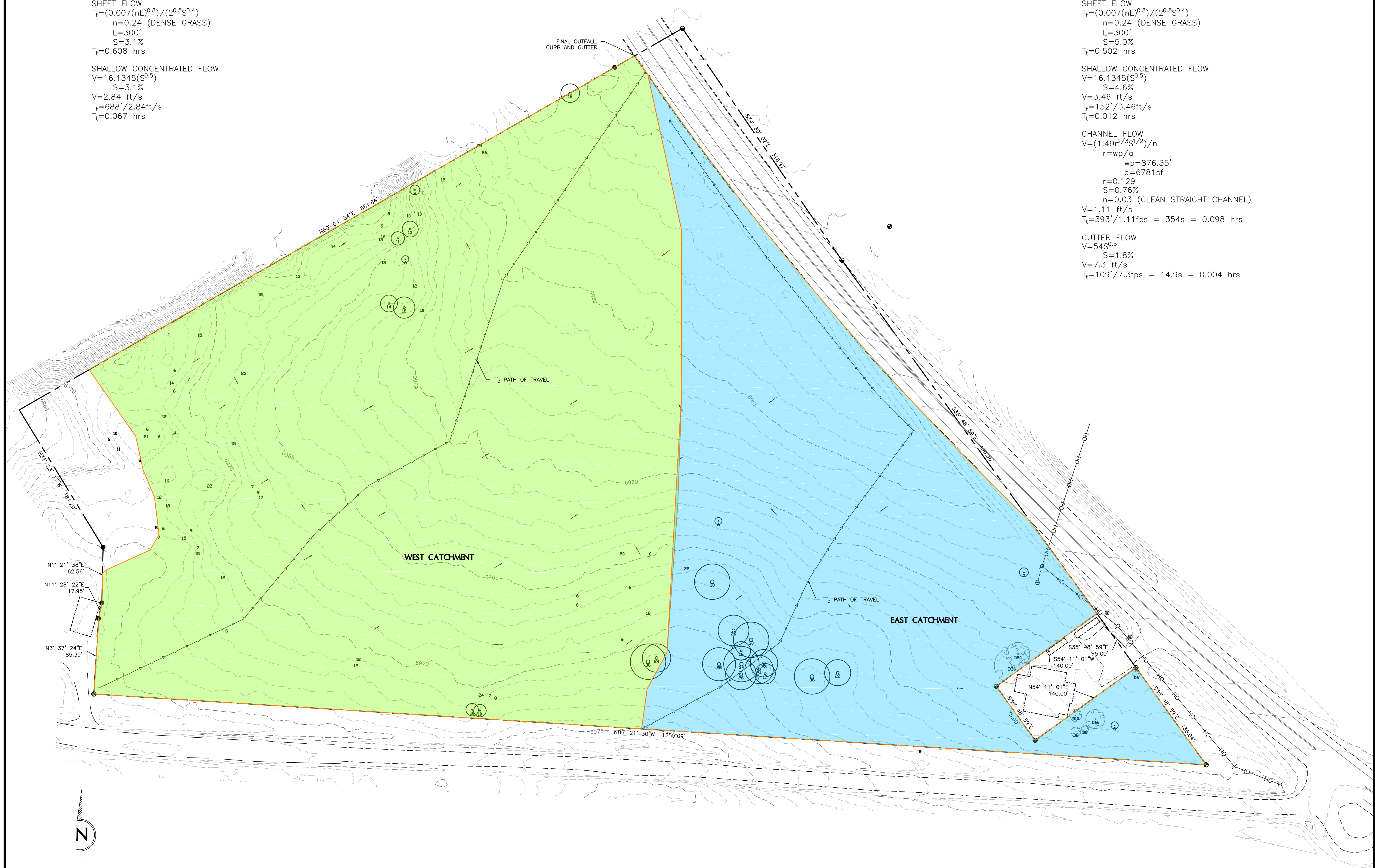
AREA: 204,224 SF = 4.688 ACRES
 CURVE NUMBER: 85 (HERBACEOUS - GOOD COVER - 'D' SOILS)
 T_c : 0.616 hrs = 37.0 min

SHEET FLOW
 $T_t = (0.007(nL)^{0.8}) / (2^{0.5}S^{0.4})$
 $n = 0.24$ (DENSE GRASS)
 $L = 300'$
 $S = 5.0\%$
 $T_t = 0.502$ hrs

SHALLOW CONCENTRATED FLOW
 $V = 16.1345(S^{0.5})$
 $S = 4.6\%$
 $V = 3.46$ ft/s
 $T_t = 152' / 3.46 \text{ ft/s}$
 $T_t = 0.012$ hrs

CHANNEL FLOW
 $V = (1.49 / 2^{0.5} S^{1/2}) / n$
 $r = wp / a$
 $wp = 876.35'$
 $a = 6781 \text{ sf}$
 $r = 0.129$
 $S = 0.76\%$
 $n = 0.03$ (CLEAN STRAIGHT CHANNEL)
 $V = 1.11$ ft/s
 $T_t = 393' / 1.11 \text{ ft/s} = 354 \text{ s} = 0.098$ hrs

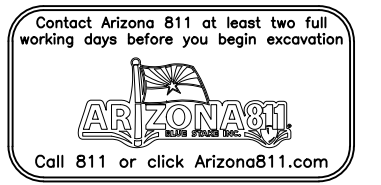
GUTTER FLOW
 $V = 54 S^{0.5}$
 $S = 1.8\%$
 $V = 7.3$ ft/s
 $T_t = 109' / 7.3 \text{ ft/s} = 14.9 \text{ s} = 0.004$ hrs



CIVIL DESIGN & ENGINEERING, INC.
 PHONE (602) 439-2700
 PHOENIX, ARIZONA 85022
 14001 N. 7th St. Suite C-106
 P.O. BOX 30836
 PHOENIX (928) 522-9287
 FLAGSTAFF, ARIZONA 86001-0810

PRE-DEVELOPMENT ON-SITE DRAINAGE MAP
 ATLANTIC DEVELOPMENT & INVESTMENTS, LLC.
 ASSESSOR'S PARCEL NUMBER 115-03-001A
 4631 S. LAKE MARY ROAD
 FLAGSTAFF, AZ 86005

PRELIMINARY
 NOT FOR
 CONSTRUCTION
 OR
 RECORDING



project: LAKE MARY Mac
 proj #: 21-037
 drawing name:
 SITE PLAN.dwg
 drawn by: RM
 reviewed by: RM
 date: 6/14/22
 review #:

revisions:

APPENDIX B



LARGE CATCHMENT:

AREA: 513,135 SF = 11.780 ACRES

CURVE NUMBER: 92.597
 IMPERVIOUS AREAS (CN=98): 315,094 sf
 LANDSCAPED AREAS (CN=84): 198,041 sf

T_c: 0.178 hrs = 10.68 min
 SHEET FLOW
 $T_t = (0.007(nL)^{0.8}) / (2^{0.5}S^{0.4})$
 n=0.17 (CULTIVATED SOILS - LANDSCAPING)
 L=100'
 S=4.6%
 T_t=0.163 hrs

SHALLOW CONCENTRATED FLOW
 $V = 16.1345(S^{0.5})$
 S=4.6%
 V=3.46 ft/s
 T_t=89'/3.46ft/s
 T_t=0.007 hrs

CHANNEL FLOW
 $V = (1.49r^{2/3}S^{1/2})/n$
 r=WP/A
 WP=200.04'
 A=200 sf
 r=1.0002
 S=1.5%
 n=0.011 (CONCRETE VALLEY GUTTER)
 V=16.59 ft/s
 T_t=454'/16.59ft/s = 27.36 s = 0.008 hrs

FRONTAGE CATCHMENT:

AREA: 53,770 SF = 1.234 ACRES
 CURVE NUMBER: 89.093
 IMPERVIOUS AREAS (98): 19,559 sf
 LANDSCAPED AREAS (84): 34,211 sf
 T_c: 0.226 hrs = 13.56 min

SHEET FLOW
 $T_t = (0.007(nL)^{0.8}) / (2^{0.5}S^{0.4})$
 n=0.17 (CULTIVATED SOILS, LANDSCAPED)
 L=100'
 S=3.0%
 T_t=0.194 hrs

CHANNEL FLOW
 $V = (1.49 r^{2/3} S^{1/2}) / n$
 r=0.488 ft
 s=0.77%
 n=0.03
 V=2.7 fps
 T_t=477'/2.7fps = 177s = 0.049 hrs

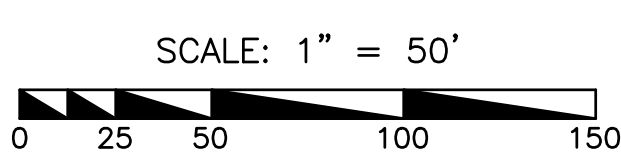
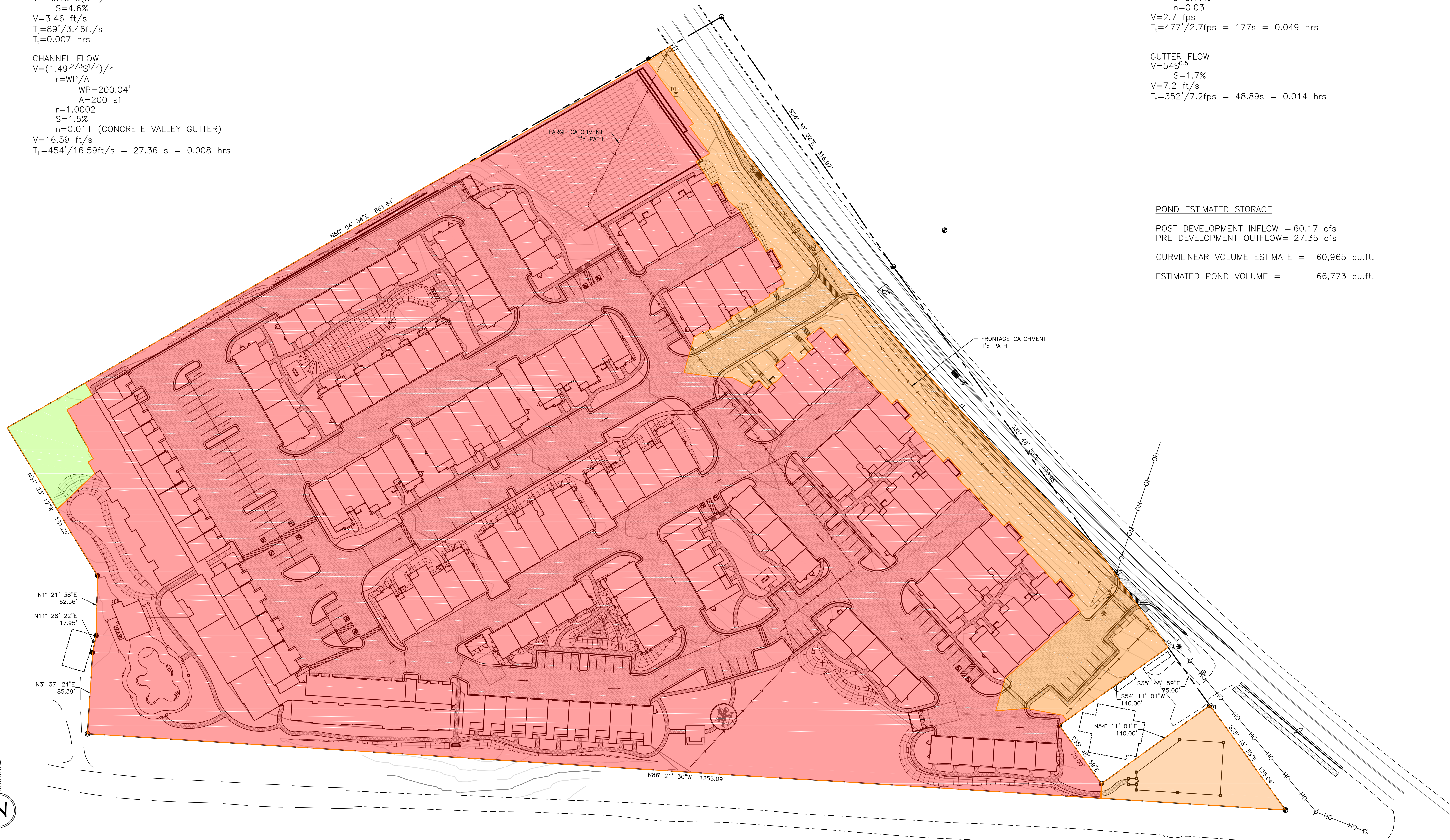
GUTTER FLOW
 $V = 54S^{0.5}$
 S=1.7%
 V=7.2 ft/s
 T_t=352'/7.2fps = 48.89s = 0.014 hrs

POND ESTIMATED STORAGE

POST DEVELOPMENT INFLOW = 60.17 cfs
 PRE DEVELOPMENT OUTFLOW = 27.35 cfs

CURVILINEAR VOLUME ESTIMATE = 60,965 cu.ft.

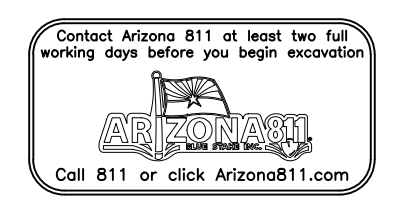
ESTIMATED POND VOLUME = 66,773 cu.ft.



CIVIL DESIGN & ENGINEERING, INC.
 PHONE (602) 438-2700
 PHOENIX, ARIZONA 85022
 14001 N. 7th St. Suite C-106
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 PHOENIX (928) 522-9287
 FLAGSTAFF, ARIZONA 86001-0810

POST-DEVELOPMENT ON-SITE DRAINAGE MAP
 ATLANTIC DEVELOPMENT & INVESTMENTS, LLC.
 ASSESSOR'S PARCEL NUMBER 115-03-001A
 4631 S. LAKE MARY ROAD
 FLAGSTAFF, AZ 86005

**PRELIMINARY
 NOT FOR
 CONSTRUCTION
 OR
 RECORDING**



project: LAKE MARY 14ac
 proj. #: 21-037
 drawing name: SITE PLAN.dwg
 drawn by: RM
 reviewed by: RM
 date: 6/14/22
 review #:

revisions:

APPENDIX C



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Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft ³)	Time to Peak (hours)	Peak Flow (ft ³ /s)
WEST CATCHMENT	Pre-Development 2-YEAR	2	21,868.000	12.330	4.08
WEST CATCHMENT	Pre-Development 10-YEAR	10	44,218.000	12.330	8.50
WEST CATCHMENT	Pre-Development 100-YEAR	100	88,184.000	12.240	16.99
EAST CATCHMENT	Pre-Development 2-YEAR	2	12,415.000	12.240	2.46
EAST CATCHMENT	Pre-Development 10-YEAR	10	25,100.000	12.240	5.17
EAST CATCHMENT	Pre-Development 100-YEAR	100	50,051.000	12.240	10.36

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft ³)	Time to Peak (hours)	Peak Flow (ft ³ /s)
LAKE MARY C&G	Pre-Development 2-YEAR	2	34,282.000	12.320	6.49
LAKE MARY C&G	Pre-Development 10-YEAR	10	69,317.000	12.240	13.59
LAKE MARY C&G	Pre-Development 100-YEAR	100	138,235.000	12.240	27.35

Subsection: Runoff CN-Area
Label: EAST CATCHMENT

Return Event: 100 years
Storm Event: 100-YR-NOAA

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Runoff CN-Area
Label: WEST CATCHMENT

Return Event: 100 years
Storm Event: 100-YR-NOAA

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Unit Hydrograph Summary
 Label: EAST CATCHMENT

Return Event: 2 years
 Storm Event: 2-YR-NOAA

Storm Event	2-YR-NOAA
Return Event	2 years
Duration	24.000 hours
Depth	1.9 in
Time of Concentration (Composite)	0.616 hours
Area (User Defined)	4.688 acres

Computational Time Increment	0.082 hours
Time to Peak (Computed)	12.238 hours
Flow (Peak, Computed)	2.46 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.240 hours
Flow (Peak Interpolated Output)	2.46 ft ³ /s

Drainage Area	
SCS CN (Composite)	85.00000
Area (User Defined)	4.688 acres
Maximum Retention (Pervious)	1.8 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.7 in
Runoff Volume (Pervious)	12,542.685 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	12,415.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.616 hours
Computational Time Increment	0.082 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	8.62 ft ³ /s
Unit peak time, Tp	0.411 hours

Subsection: Unit Hydrograph Summary
Label: EAST CATCHMENT

Return Event: 2 years
Storm Event: 2-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.643 hours
Total unit time, Tb	2.053 hours

Subsection: Unit Hydrograph Summary
 Label: EAST CATCHMENT

Return Event: 10 years
 Storm Event: 10-YR-NOAA

Storm Event	10-YR-NOAA
Return Event	10 years
Duration	24.000 hours
Depth	2.9 in
Time of Concentration (Composite)	0.616 hours
Area (User Defined)	4.688 acres

Computational Time Increment	0.082 hours
Time to Peak (Computed)	12.238 hours
Flow (Peak, Computed)	5.17 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.240 hours
Flow (Peak Interpolated Output)	5.17 ft ³ /s

Drainage Area	
SCS CN (Composite)	85.00000
Area (User Defined)	4.688 acres
Maximum Retention (Pervious)	1.8 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.5 in
Runoff Volume (Pervious)	25,321.464 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	25,100.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.616 hours
Computational Time Increment	0.082 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	8.62 ft ³ /s
Unit peak time, Tp	0.411 hours

Subsection: Unit Hydrograph Summary
Label: EAST CATCHMENT

Return Event: 10 years
Storm Event: 10-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.643 hours
Total unit time, Tb	2.053 hours

Subsection: Unit Hydrograph Summary
 Label: EAST CATCHMENT

Return Event: 100 years
 Storm Event: 100-YR-NOAA

Storm Event	100-YR-NOAA
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.616 hours
Area (User Defined)	4.688 acres

Computational Time Increment	0.082 hours
Time to Peak (Computed)	12.238 hours
Flow (Peak, Computed)	10.37 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.240 hours
Flow (Peak Interpolated Output)	10.36 ft ³ /s

Drainage Area	
SCS CN (Composite)	85.00000
Area (User Defined)	4.688 acres
Maximum Retention (Pervious)	1.8 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.0 in
Runoff Volume (Pervious)	50,436.938 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	50,051.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.616 hours
Computational Time Increment	0.082 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	8.62 ft ³ /s
Unit peak time, Tp	0.411 hours

Subsection: Unit Hydrograph Summary
Label: EAST CATCHMENT

Return Event: 100 years
Storm Event: 100-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.643 hours
Total unit time, Tb	2.053 hours

Subsection: Unit Hydrograph Summary
 Label: WEST CATCHMENT

Return Event: 2 years
 Storm Event: 2-YR-NOAA

Storm Event	2-YR-NOAA
Return Event	2 years
Duration	24.000 hours
Depth	1.9 in
Time of Concentration (Composite)	0.675 hours
Area (User Defined)	8.266 acres

Computational Time Increment	0.090 hours
Time to Peak (Computed)	12.330 hours
Flow (Peak, Computed)	4.08 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.330 hours
Flow (Peak Interpolated Output)	4.08 ft ³ /s

Drainage Area	
SCS CN (Composite)	85.00000
Area (User Defined)	8.266 acres
Maximum Retention (Pervious)	1.8 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	0.7 in
Runoff Volume (Pervious)	22,115.565 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	21,868.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.675 hours
Computational Time Increment	0.090 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	13.88 ft ³ /s
Unit peak time, Tp	0.450 hours

Subsection: Unit Hydrograph Summary
Label: WEST CATCHMENT

Return Event: 2 years
Storm Event: 2-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.800 hours
Total unit time, Tb	2.250 hours

Subsection: Unit Hydrograph Summary
 Label: WEST CATCHMENT

Return Event: 10 years
 Storm Event: 10-YR-NOAA

Storm Event	10-YR-NOAA
Return Event	10 years
Duration	24.000 hours
Depth	2.9 in
Time of Concentration (Composite)	0.675 hours
Area (User Defined)	8.266 acres

Computational Time Increment	0.090 hours
Time to Peak (Computed)	12.330 hours
Flow (Peak, Computed)	8.50 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.330 hours
Flow (Peak Interpolated Output)	8.50 ft ³ /s

Drainage Area	
SCS CN (Composite)	85.00000
Area (User Defined)	8.266 acres
Maximum Retention (Pervious)	1.8 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.5 in
Runoff Volume (Pervious)	44,647.467 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	44,218.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.675 hours
Computational Time Increment	0.090 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	13.88 ft ³ /s
Unit peak time, Tp	0.450 hours

Subsection: Unit Hydrograph Summary
Label: WEST CATCHMENT

Return Event: 10 years
Storm Event: 10-YR-NOAA

SCS Unit Hydrograph Parameters

Unit receding limb, Tr	1.800 hours
Total unit time, Tb	2.250 hours

Subsection: Unit Hydrograph Summary
 Label: WEST CATCHMENT

Return Event: 100 years
 Storm Event: 100-YR-NOAA

Storm Event	100-YR-NOAA
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.675 hours
Area (User Defined)	8.266 acres

Computational Time Increment	0.090 hours
Time to Peak (Computed)	12.240 hours
Flow (Peak, Computed)	16.99 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.240 hours
Flow (Peak Interpolated Output)	16.99 ft ³ /s

Drainage Area	
SCS CN (Composite)	85.00000
Area (User Defined)	8.266 acres
Maximum Retention (Pervious)	1.8 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.0 in
Runoff Volume (Pervious)	88,931.682 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	88,184.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.675 hours
Computational Time Increment	0.090 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	13.88 ft ³ /s
Unit peak time, Tp	0.450 hours

Subsection: Unit Hydrograph Summary
Label: WEST CATCHMENT

Return Event: 100 years
Storm Event: 100-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.800 hours
Total unit time, Tb	2.250 hours

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Post Development Pondpack Report

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft ³)	Time to Peak (hours)	Peak Flow (ft ³ /s)
FRONTAGE CATCHMENT	Post-Development 2-YEAR	2	4,321.000	12.060	1.43
FRONTAGE CATCHMENT	Post-Development 10-YEAR	10	8,036.000	12.030	2.64
FRONTAGE CATCHMENT	Post-Development 100-YEAR	100	15,018.000	12.030	4.83
LARGE CATCHMENT	Post-Development 2-YEAR	2	51,640.000	11.985	19.01
LARGE CATCHMENT	Post-Development 10-YEAR	10	89,711.000	11.985	32.38
LARGE CATCHMENT	Post-Development 100-YEAR	100	158,926.000	11.985	55.66

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft ³)	Time to Peak (hours)	Peak Flow (ft ³ /s)
LAKE MARY C&G	Post-Development 2-YEAR	2	55,960.000	11.995	20.32
LAKE MARY C&G	Post-Development 10-YEAR	10	97,747.000	11.985	34.81
LAKE MARY C&G	Post-Development 100-YEAR	100	173,945.000	11.985	60.17

Post Development Pondpack Report

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method (Computational Notes)

Definition of Terms

At	Total area (acres): $A_t = A_i + A_p$
Ai	Impervious area (acres)
Ap	Pervious area (acres)
CNi	Runoff curve number for impervious area
CNp	Runoff curve number for pervious area
fLoss	f loss constant infiltration (depth/time)
gKs	Saturated Hydraulic Conductivity (depth/time)
Md	Volumetric Moisture Deficit
Psi	Capillary Suction (length)
hK	Horton Infiltration Decay Rate (time^{-1})
fo	Initial Infiltration Rate (depth/time)
fc	Ultimate(capacity)Infiltration Rate (depth/time)
Ia	Initial Abstraction (length)
dt	Computational increment (duration of unit excess rainfall) Default dt is smallest value of $0.1333T_c$, r_{tm} , and t_h (Smallest dt is then adjusted to match up with T_p)
UDdt	User specified override computational main time increment (only used if UDdt is $\Rightarrow .1333T_c$)
D(t)	Point on distribution curve (fraction of P) for time step t
K	$2 / (1 + (T_r/T_p))$: default K = 0.75: (for $T_r/T_p = 1.67$)
Ks	Hydrograph shape factor = Unit Conversions * K: = $((1\text{hr}/3600\text{sec}) * (1\text{ft}/12\text{in}) * ((5280\text{ft})^2/\text{sq.mi})) * K$ Default Ks = $645.333 * 0.75 = 484$
Lag	Lag time from center of excess runoff (dt) to T_p : Lag = $0.6T_c$
P	Total precipitation depth, inches
Pa(t)	Accumulated rainfall at time step t
Pi(t)	Incremental rainfall at time step t
qp	Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi. = $(K_s * A * Q) / T_p$ (where Q = 1in. runoff, A=sq.mi.)
Qu(t)	Unit hydrograph ordinate (cfs) at time step t
Q(t)	Final hydrograph ordinate (cfs) at time step t
Rai(t)	Accumulated runoff (inches) at time step t for impervious area
Rap(t)	Accumulated runoff (inches) at time step t for pervious area
Rii(t)	Incremental runoff (inches) at time step t for impervious area
Rip(t)	Incremental runoff (inches) at time step t for pervious area
R(t)	Incremental weighted total runoff (inches)
Rtm	Time increment for rainfall table
Si	S for impervious area: $S_i = (1000/CN_i) - 10$
Sp	S for pervious area: $S_p = (1000/CN_p) - 10$
t	Time step (row) number
Tc	Time of concentration
Tb	Time (hrs) of entire unit hydrograph: $T_b = T_p + T_r$
Tp	Time (hrs) to peak of a unit hydrograph: $T_p = (dt/2) + \text{Lag}$
Tr	Time (hrs) of receding limb of unit hydrograph: $T_r = \text{ratio of } T_p$

Post Development Pondpack Report

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method

Computational Notes

Precipitation

Column (1) Time for time step t
Column (2) $D(t)$ = Point on distribution curve for time step t
Column (3) $P_i(t) = P_a(t) - P_a(t-1)$: Col.(4) - Preceding Col.(4)
Column (4) $P_a(t) = D(t) \times P$: Col.(2) x P

Pervious Area Runoff (using SCS Runoff CN Method)

Column (5) $Rap(t)$ = Accumulated pervious runoff for time step t
If $(P_a(t) \leq 0.2Sp)$ then use: $Rap(t) = 0.0$
If $(P_a(t) > 0.2Sp)$ then use:
 $Rap(t) = (Col.(4) - 0.2Sp) \times 2 / (Col.(4) + 0.8Sp)$
Column (6) $Rip(t)$ = Incremental pervious runoff for time step t
 $Rip(t) = Rap(t) - Rap(t-1)$
 $Rip(t) = Col.(5)$ for current row - $Col.(5)$ for preceding row.

Impervious Area Runoff

Column (7 & 8)... Did not specify to use impervious areas.

Incremental Weighted Runoff

Column (9) $R(t) = (A_p/A_t) \times Rip(t) + (A_i/A_t) \times Rii(t)$
 $R(t) = (A_p/A_t) \times Col.(6) + (A_i/A_t) \times Col.(8)$

SCS Unit Hydrograph Method

Column (10) $Q(t)$ is computed with the SCS unit hydrograph method using $R(t)$ and $Qu(t)$.

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary
 Label: FRONTAGE CATCHMENT

Return Event: 2 years
 Storm Event: 2-YR-NOAA

Storm Event	2-YR-NOAA
Return Event	2 years
Duration	24.000 hours
Depth	1.9 in
Time of Concentration (Composite)	0.257 hours
Area (User Defined)	53,770.000 ft ²

Computational Time Increment	0.034 hours
Time to Peak (Computed)	12.062 hours
Flow (Peak, Computed)	1.43 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.060 hours
Flow (Peak Interpolated Output)	1.43 ft ³ /s

Drainage Area	
SCS CN (Composite)	89.09254
Area (User Defined)	53,770.000 ft ²
Maximum Retention (Pervious)	1.2 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.0 in
Runoff Volume (Pervious)	4,336.610 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	4,321.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.257 hours
Computational Time Increment	0.034 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary

Label: FRONTAGE CATCHMENT

Return Event: 2 years

Storm Event: 2-YR-NOAA

SCS Unit Hydrograph Parameters

Unit peak, qp	5.44 ft ³ /s
Unit peak time, Tp	0.171 hours
Unit receding limb, Tr	0.685 hours
Total unit time, Tb	0.857 hours

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary
 Label: FRONTAGE CATCHMENT

Return Event: 10 years
 Storm Event: 10-YR-NOAA

Storm Event	10-YR-NOAA
Return Event	10 years
Duration	24.000 hours
Depth	2.9 in
Time of Concentration (Composite)	0.257 hours
Area (User Defined)	53,770.000 ft ²

Computational Time Increment	0.034 hours
Time to Peak (Computed)	12.028 hours
Flow (Peak, Computed)	2.64 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.030 hours
Flow (Peak Interpolated Output)	2.64 ft ³ /s

Drainage Area	
SCS CN (Composite)	89.09254
Area (User Defined)	53,770.000 ft ²
Maximum Retention (Pervious)	1.2 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.8 in
Runoff Volume (Pervious)	8,062.029 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	8,036.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.257 hours
Computational Time Increment	0.034 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary

Label: FRONTAGE CATCHMENT

Return Event: 10 years

Storm Event: 10-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit peak, qp	5.44 ft ³ /s
Unit peak time, Tp	0.171 hours
Unit receding limb, Tr	0.685 hours
Total unit time, Tb	0.857 hours

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary
 Label: FRONTAGE CATCHMENT

Return Event: 100 years
 Storm Event: 100-YR-NOAA

Storm Event	100-YR-NOAA
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.257 hours
Area (User Defined)	53,770.000 ft ²

Computational Time Increment	0.034 hours
Time to Peak (Computed)	12.028 hours
Flow (Peak, Computed)	4.83 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	12.030 hours
Flow (Peak Interpolated Output)	4.83 ft ³ /s

Drainage Area	
SCS CN (Composite)	89.09254
Area (User Defined)	53,770.000 ft ²
Maximum Retention (Pervious)	1.2 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.4 in
Runoff Volume (Pervious)	15,062.059 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	15,018.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.257 hours
Computational Time Increment	0.034 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary

Label: FRONTAGE CATCHMENT

Return Event: 100 years

Storm Event: 100-YR-NOAA

SCS Unit Hydrograph Parameters

Unit peak, qp	5.44 ft ³ /s
Unit peak time, Tp	0.171 hours
Unit receding limb, Tr	0.685 hours
Total unit time, Tb	0.857 hours

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary
 Label: LARGE CATCHMENT

Return Event: 2 years
 Storm Event: 2-YR-NOAA

Storm Event	2-YR-NOAA
Return Event	2 years
Duration	24.000 hours
Depth	1.9 in
Time of Concentration (Composite)	0.178 hours
Area (User Defined)	513,135.000 ft ²

Computational Time Increment	0.024 hours
Time to Peak (Computed)	11.985 hours
Flow (Peak, Computed)	19.02 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	11.985 hours
Flow (Peak Interpolated Output)	19.01 ft ³ /s

Drainage Area	
SCS CN (Composite)	92.59679
Area (User Defined)	513,135.000 ft ²
Maximum Retention (Pervious)	0.8 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.2 in
Runoff Volume (Pervious)	51,754.792 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	51,640.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.178 hours
Computational Time Increment	0.024 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary

Label: LARGE CATCHMENT

Return Event: 2 years

Storm Event: 2-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit peak, qp	74.98 ft ³ /s
Unit peak time, Tp	0.119 hours
Unit receding limb, Tr	0.475 hours
Total unit time, Tb	0.593 hours

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary
 Label: LARGE CATCHMENT

Return Event: 10 years
 Storm Event: 10-YR-NOAA

Storm Event	10-YR-NOAA
Return Event	10 years
Duration	24.000 hours
Depth	2.9 in
Time of Concentration (Composite)	0.178 hours
Area (User Defined)	513,135.000 ft ²

Computational Time Increment	0.024 hours
Time to Peak (Computed)	11.985 hours
Flow (Peak, Computed)	32.39 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	11.985 hours
Flow (Peak Interpolated Output)	32.38 ft ³ /s

Drainage Area	
SCS CN (Composite)	92.59679
Area (User Defined)	513,135.000 ft ²
Maximum Retention (Pervious)	0.8 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.1 in
Runoff Volume (Pervious)	89,892.828 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	89,711.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.178 hours
Computational Time Increment	0.024 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary

Label: LARGE CATCHMENT

Return Event: 10 years

Storm Event: 10-YR-NOAA

SCS Unit Hydrograph Parameters

Unit peak, qp	74.98 ft ³ /s
Unit peak time, Tp	0.119 hours
Unit receding limb, Tr	0.475 hours
Total unit time, Tb	0.593 hours

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary
 Label: LARGE CATCHMENT

Return Event: 100 years
 Storm Event: 100-YR-NOAA

Storm Event	100-YR-NOAA
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.178 hours
Area (User Defined)	513,135.000 ft ²

Computational Time Increment	0.024 hours
Time to Peak (Computed)	11.985 hours
Flow (Peak, Computed)	55.67 ft ³ /s
Output Increment	0.005 hours
Time to Flow (Peak Interpolated Output)	11.985 hours
Flow (Peak Interpolated Output)	55.66 ft ³ /s

Drainage Area	
SCS CN (Composite)	92.59679
Area (User Defined)	513,135.000 ft ²
Maximum Retention (Pervious)	0.8 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.7 in
Runoff Volume (Pervious)	159,222.520 ft ³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	158,926.000 ft ³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.178 hours
Computational Time Increment	0.024 hours
Unit Hydrograph Shape Factor	483.43172
K Factor	0.74912
Receding/Rising, Tr/Tp	1.670

Post Development Pondpack Report

Subsection: Unit Hydrograph Summary
Label: LARGE CATCHMENT

Return Event: 100 years
Storm Event: 100-YR-NOAA

SCS Unit Hydrograph Parameters	
Unit peak, qp	74.98 ft ³ /s
Unit peak time, Tp	0.119 hours
Unit receding limb, Tr	0.475 hours
Total unit time, Tb	0.593 hours

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APPENDIX E



Pond Builder

Prepared by Microsoft

HydroCAD® 10.10-5a s/n 11752 © 2020 HydroCAD Software Solutions LLC

Rainfall file not specified

Printed 6/15/2022

Pond 1P: (new Pond) - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)

Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf

Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

19 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 136.90' Row Length +12.0" End Stone x 2 =
138.90' Base Length

23 Rows x 51.0" Wide + 6.0" Spacing x 22 + 12.0" Side Stone x 2 = 110.75' Base Width

6.0" Stone Base + 30.0" Chamber Height + 12.0" Stone Cover = 4.00' Field Height

437 Chambers x 45.9 cf = 20,075.8 cf Chamber Storage

61,531.2 cf Field - 20,075.8 cf Chambers = 41,455.4 cf Stone x 40.0% Voids = 16,582.2 cf Stone Storage

Chamber Storage + Stone Storage = 36,658.0 cf = 0.842 af

Overall Storage Efficiency = 59.6%

Overall System Size = 138.90' x 110.75' x 4.00'

437 Chambers

2,278.9 cy Field

1,535.4 cy Stone

