June 24, 2021

Nick Williams, P.E., CFM
Director of Public Works
City of Stephenville
298 W. Washington
Stephenville, TX 76401

Stephenville Townhomes Drainage
Technical Memorandum

The purpose of this drainage study is to show the impact of the proposed Stephenville Townhome development on the downstream property. This study was done by comparing pre-development conditions to post-development conditions and demonstrates that there are no adverse impacts to the immediate downstream property and detention will not be necessary.

Existing Conditions

In existing conditions, both lots generally outfall to the south to three design points at a swale along the railroad. Both lots accept upstream flow from the properties to the north and there is no existing storm water drainage infrastructure. Refer to the Pre-Development Drainage Area Map, Exhibit A, for the existing drainage area delineations. A more detailed description of each drainage area outfall can be seen below:

- Existing drainage area A drains to the south end of the smaller lot of the proposed development.
    - The discharge drains across West Swan Street and through a grassed area to the swale along the railroad.
- Existing drainage area B drains to the south end of the larger lot of the proposed development.
    - The discharge drains to the swale along the railroad.
- Existing drainage area C drains to the south east corner of the larger lot of the proposed development.
    - The discharge drains south along South Lillian Street then to the east to the swale along the railroad.

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Table 1 is a summary of the discharge going to each design point in the existing conditions.

Junction	Existing Discharge (cfs)						
	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1	17.8	20.9	32.5	41.7	54.3	64.3	74.9
2	25.2	29.7	46.4	59.6	77.9	92.3	107.7
3	10.2	12.2	19.7	25.7	34.0	40.6	47.6

Table 1- Design Point Existing Conditions Summary

Proposed Conditions

In the proposed conditions both lots will continue to drain to the south to the swale along the railroad. The drainage areas have been adjusted to demonstrate the allowable fully developed flow that can go to each design point without causing an adverse impact. The actual percent impervious value for the proposed development has been calculated and was used in determining post-development discharge. Refer to the Post-Development Drainage Area Map, Exhibit B, for the proposed drainage area delineations.

Table 2 is a summary of the discharge going to each design point in the proposed conditions.

Junction	Proposed Discharge (cfs)						
	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1	17.8	20.9	32.6	41.7	54.4	64.3	75.0
2	23.4	27.6	43.4	55.9	73.2	86.8	101.5
3	9.7	11.6	18.8	24.5	32.5	38.9	45.7

Table 2- Design Point Proposed Conditions Summary

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Pre vs. Post Development Conditions

Table 3 compares the pre and post development discharges at each design point. We can see that the proposed design does not cause an increase in discharge at design points 2 and 3. Design point 1 has a max increase of 0.1 cfs. This increase does not cause an increase in water surface elevation or water velocity in the swale and is therefore considered negligible.

Junction	Existing Discharge (cfs)							Proposed Discharge (cfs)						
	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1	17.8	20.9	32.5	41.7	54.3	64.3	74.9	17.8	20.9	32.6	41.7	54.4	64.3	75.0
2	25.2	29.7	46.4	59.6	77.9	92.3	107.7	23.4	27.6	43.4	55.9	73.2	86.8	101.5
3	10.2	12.2	19.7	25.7	34.0	40.6	47.6	9.7	11.6	18.8	24.5	32.5	38.9	45.7

Junction	Difference						
	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	-1.8	-2.1	-3.1	-3.8	-4.7	-5.5	-6.2
3	-0.5	-0.6	-1.0	-1.2	-1.5	-1.7	-1.9

Table 3- Design Point Comparison

Conclusion

While the proposed development will have an increase in discharge it does not create adverse impacts to the immediate downstream property and this increase is considered negligible. There will not be in increase in water surface elevation or velocity in the swale that is immediately downstream from the proposed development and detention will not be necessary.

I, Reece Flanagan, a Professional Engineer registered in the State of Texas and in good standing, have prepared the enclosed drainage study in compliance with the latest published requirements and criteria of the City of Stephenville, Texas, and have verified that the topographic information used in this study is in compliance with said requirements and is otherwise suitable for developing this workable Plan of Drainage which can be implemented through proper subsequent detailed construction planning.

Signature MRFlanagan, P.E., Date 6/25/2021

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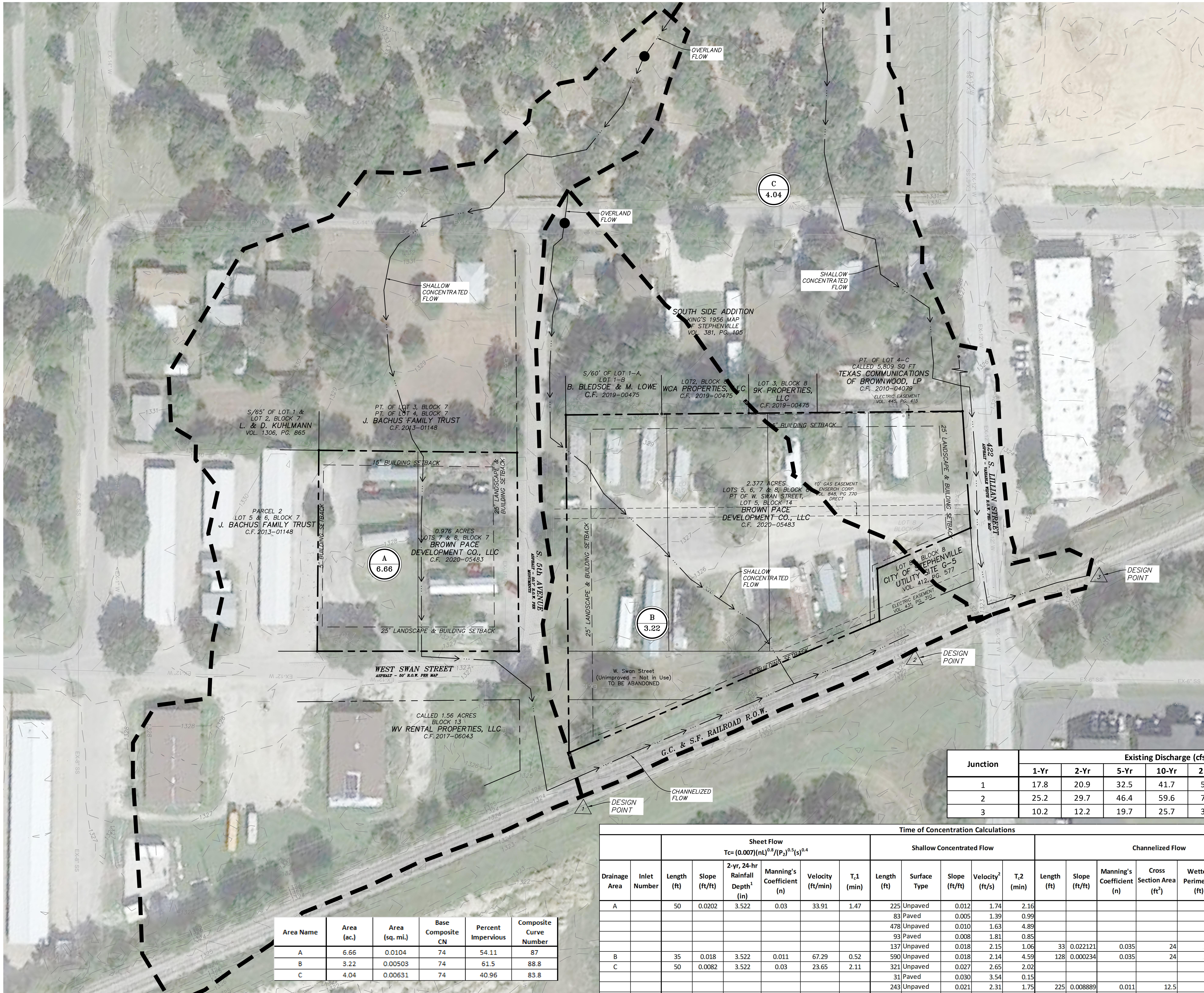

Junction	Existing Discharge (cfs)						
	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1	17.8	20.9	32.5	41.7	54.3	64.3	74.9
2	25.2	29.7	46.4	59.6	77.9	92.3	107.7
3	10.2	12.2	19.7	25.7	34.0	40.6	47.6

Area Name	Area (ac.)	Area (sq. mi.)	Base Composite CN	Percent Impervious	Composite Curve Number
A	6.66	0.0104	74	54.11	87
B	3.22	0.00503	74	61.5	88.8
C	4.04	0.00631	74	40.96	83.8

Time of Concentration Calculations

		Sheet Flow $Tc=(0.007)(nL)^{0.8}/(P_2)^{0.5}(s)^{0.4}$						Shallow Concentrated Flow					Channelized Flow							
Drainage Area	Inlet Number	Length (ft)	Slope (ft/ft)	2-yr, 24-hr Rainfall Depth[1] (in)	Manning's Coefficient (n)	Velocity (ft/min)	T_c1 (min)	Length (ft)	Surface Type	Slope (ft/ft)	Velocity[2] (ft/s)	T_c2 (min)	Length (ft)	Slope (ft/ft)	Manning's Coefficient (n)	Cross Section Area (ft²)	Wetted Perimeter (ft)	Velocity (ft/s)	T_c3 (min)	Total Travel Time (min)
A		50	0.0202	3.522	0.03	33.91	1.47	225	Unpaved	0.012	1.74	2.16								
								83	Paved	0.005	1.39	0.99								
								478	Unpaved	0.010	1.63	4.89								
								93	Paved	0.008	1.81	0.85								
								137	Unpaved	0.018	2.15	1.06	33	0.022121	0.035	24	24.33	6.27	0.09	11.52
B		35	0.018	3.522	0.011	67.29	0.52	590	Unpaved	0.018	2.14	4.59	128	0.000234	0.035	24	24.33	0.65	3.30	8.41
C		50	0.0082	3.522	0.03	23.65	2.11	321	Unpaved	0.027	2.65	2.02								
								31	Paved	0.030	3.54	0.15								
								243	Unpaved	0.021	2.31	1.75	225	0.008889	0.011	12.5	50	5.07	0.74	
								108	Unpaved	0.014	1.93	0.93								7.70

VICINITY MAP

NO SCALE

LEGEND:

- DRAINAGE AREA BOUNDARY
- DRAINAGE AREA LABEL
  - NAME — A1
  - AREA (ACRES) — 2.6
- FLOW ARROW
- EXISTING CONTOUR — 640
- LONGEST FLOW PATH
- ANALYSIS POINT DESIGNATION — 1

NOTE:

1. DRAINAGE AREAS ARE BASED ON 2016 TNRIS LIDAR CONTOURS.
2. SCS METHOD WAS USED FOR THE DRAINAGE ANALYSIS.

OWNER/DEVELOPER:

BROWN PACE DEVELOPMENT COMPANY, LLC
819 OLD ANNETTE ROAD
ALEDO, TEXAS 76008
EMAIL: MPACE37@YAHOO.COM
CONTACT: MARC PACE

STEPHENVILLE TOWNHOMES PRE-DEVELOPMENT DRAINAGE AREA MAP

EXHIBIT A

APRIL 2021

ENGINEER/SURVEYOR:

mma
civil engineering surveying landscape architecture planning
tbpels registration number: f – 2759
tbpels registration/license number: 10088000
519 east border
arlington, texas 76010
817-469-1671
fax: 817-274-8757
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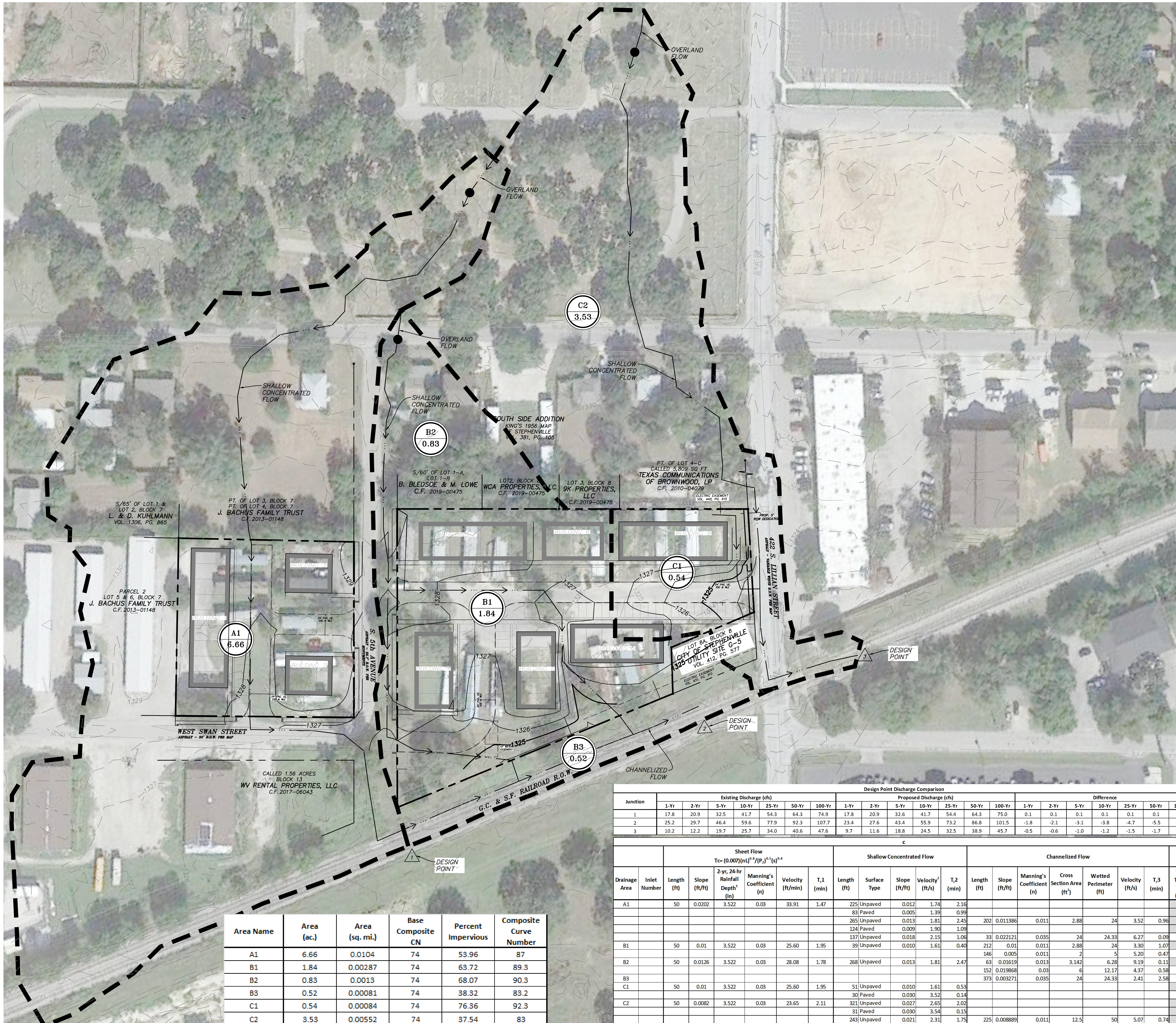
04/14/2021 SHEET 1 OF 1



Area Name	Area (ac.)	Area (sq. mi.)	Base Composite CN	Percent Impervious	Composite Curve Number
A1	6.66	0.0104	74	53.96	87
B1	1.84	0.00287	74	63.72	89.3
B2	0.83	0.0013	74	68.07	90.3
B3	0.52	0.00081	74	38.32	83.2
C1	0.54	0.00084	74	76.36	92.3
C2	3.53	0.00552	74	37.54	83

Design Point Discharge Comparison

Junction	Existing Discharge (cfs)							Proposed Discharge (cfs)							Difference						
	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1	17.8	20.9	32.5	41.7	54.3	64.3	74.9	17.8	20.9	32.6	41.7	54.4	64.3	75.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	25.2	29.7	46.4	59.6	77.9	92.3	107.7	23.4	27.6	43.4	55.9	73.2	86.8	101.5	-1.8	-2.1	-3.1	-3.8	-4.7	-5.5	-6.2
3	10.2	12.2	19.7	25.7	34.0	40.6	47.6	9.7	11.6	18.8	24.5	32.5	38.9	45.7	-0.5	-0.6	-1.0	-1.2	-1.5	-1.7	-1.9

c

		Sheet Flow $Tc=(0.007)(nL)^{0.8}/(P_2)^{0.5}(s)^{0.4}$						Shallow Concentrated Flow					Channelized Flow							
Drainage Area	Inlet Number	Length (ft)	Slope (ft/ft)	2-yr, 24-hr Rainfall Depth[1] (in)	Manning's Coefficient (n)	Velocity (ft/min)	T_c1 (min)	Length (ft)	Surface Type	Slope (ft/ft)	Velocity[2] (ft/s)	T_c2 (min)	Length (ft)	Slope (ft/ft)	Manning's Coefficient (n)	Cross Section Area (ft^2)	Wetted Perimeter (ft)	Velocity (ft/s)	T_c3 (min)	Total Travel Time (min)
A1		50	0.0202	3.522	0.03	33.91	1.47	225	Unpaved	0.012	1.74	2.16								
								83	Paved	0.005	1.39	0.99								
								265	Unpaved	0.013	1.81	2.45	202	0.011386	0.011	2.88	24	3.52	0.96	
								124	Paved	0.009	1.90	1.09								
								137	Unpaved	0.018	2.15	1.06	33	0.022121	0.035	24	24.33	6.27	0.09	10.27
B1		50	0.01	3.522	0.03	25.60	1.95	39	Unpaved	0.010	1.61	0.40	212	0.01	0.011	2.88	24	3.30	1.07	
													146	0.005	0.011	2	5	5.20	0.47	3.90
B2		50	0.0126	3.522	0.03	28.08	1.78	268	Unpaved	0.013	1.81	2.47	63	0.01619	0.013	3.142	6.28	9.19	0.11	
													152	0.019868	0.03	6	12.17	4.37	0.58	4.94
B3													373	0.003271	0.035	24	24.33	2.41	2.58	2.58
C1		50	0.01	3.522	0.03	25.60	1.95	51	Unpaved	0.010	1.61	0.53								
								30	Paved	0.030	3.52	0.14								2.62
C2		50	0.0082	3.522	0.03	23.65	2.11	321	Unpaved	0.027	2.65	2.02								
								31	Paved	0.030	3.54	0.15								
								243	Unpaved	0.021	2.31	1.75	225	0.008889	0.011	12.5	50	5.07	0.74	
								108	Unpaved	0.014	1.93	0.93								7.70

LEGEND:

- DRAINAGE AREA BOUNDARY
- DRAINAGE AREA LABEL
  - NAME (A1)
  - AREA (ACRES) (2.6)
- FLOW ARROW
- EXISTING CONTOUR (640)
- LONGEST FLOW PATH
- ANALYSIS POINT DESIGNATION (1)

NOTES:

1. EXISTING CONTOURS ARE BASED ON TOPOGRAPHIC SURVEY PREPARED BY **TEXAS SURVEYING INC,** DATED **JUNE 21, 2021.**

   CONTACT TRAVIS ZINN FOR ANY QUESTIONS.
   MINERAL WELLS BRANCH:
   112 S.E. 1ST STREET
   MINERAL WELLS, TX 76067
   TEL: 940–325–2155
   EMAIL: MINERALWELLS@TXSURVEYING.COM

GENERAL UTILITY NOTES:

ALL EXISTING UTILITY DATA IS PROVIDED FOR INFORMATION ONLY. ALTHOUGH THIS DATA IS SHOWN AS ACCURATELY AS POSSIBLE, THE CONTRACTOR IS CAUTIONED THAT THE OWNER AND THE ENGINEER NEITHER ASSUME NOR IMPLY ANY RESPONSIBILITY FOR THE ACCURACY OF THIS DATA. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO CONTACT THE UTILITY AFFECTED AND VERIFY THESE LOCATIONS AND ELEVATIONS PRIOR TO CONSTRUCTION.

CALL TEXAS 811 OR OTHER UTILITY LOCATING SERVICES 48 HOURS PRIOR TO CONSTRUCTION ACTIVITY. MMA INC. IS NOT RESPONSIBLE FOR KNOWING ALL EXISTING UTILITIES OR DEPICTING EXACT LOCATIONS OF UTILITIES ON DRAWINGS.

BENCHMARKS:

ELEVATION DATA SHOWN HEREON REPRESENTS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88), AS COMPUTED USING THE CURRENT NATIONAL GEODETIC SURVEY GEOID MODEL (12B).

ORIGINAL SURVEY: M20159 – JUNE 29, 2020
TOPOGRAPHY UPDATED: M20159–R1 – JANUARY 18, 2021
BOUNDARY ADDED: M20159–R2 – FEBRUARY 5, 2021

SMALL PORCHES, EVES, AND/OR STEPS NOT SHOWN FOR CLARITY.

C.I.R.S. – CAPPED IRON ROD SET

SURVEYING COMPLETED BY:
TEXAS SURVEYING INC.

CONTACT: TRAVIS ZINN
MINERAL WELLS BRANCH:
112 S.E. 1ST STREET
MINERAL WELLS, TX 76067
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422 LILLIAN TOWN HOMES STEPHENVILLE, TEXAS

DRAINAGE AREA MAP

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PROJECT NUMBER:	3448–00–01
PROJECT MANAGER:	R. FLANAGAN
DRAWN BY:	D.FRASCELLA
CHECKED BY:	R.FLANAGAN
ISSUE DATE:	06/25/2021

REV.	DATE	DESCRIP.	BY

SHEET CONTENT:

DRAINAGE AREA MAP

SHEET NO: **C8.1**