TO: Ms. Monica Stegall
City of Williams
P.O. Box 310/810 E. Street
Williams, California 95987

FROM: Brian Delemos, P.E., CA C66421
Laugenour and Meikle

DATE: September 22, 2021

SUBJECT: Preliminary Drainage Study - Valley Ranch Unit 3 Tentative Map Application

INTRODUCTION:

This preliminary drainage study (Drainage Study) was prepared in support of a tentative map application for the Valley Ranch, Unit 3, development project (Project); the TM sheets are contained in **Attachment 1, Tentative Map for the Project**. The focus of the Drainage Study is whether the existing city drainage system has adequate capacity to accept the additional rainfall runoff that would be generated by the Project (as compared to existing conditions of the Project area). In particular, the capacity of the existing detention basin at the intersection of Highway 20 and Husted Road (referred to as HLDET7) is in question. The capacity was analyzed in accordance with the methods and assumptions in the citywide storm drainage master plan (Master Plan)[a]. The topics discussed in the following sections include:

- Citywide Drainage Master Plan
- Analysis Approach
- Scenarios
- Results
- Conclusions

CITYWIDE DRAINAGE MASTERPLAN:

The citywide Master Plan referenced above included an evaluation of the city's existing drainage system to handle the runoff from the ultimate buildout of the city's planned land uses. The results of the evaluation are shown on **Exhibit 1, Storm Drainage Infrastructure Plan** from the Master Plan. The exhibit shows existing drainage system and any improvements that would be needed to accommodate development in the city.

The Project location is shown on **Exhibit 1**, as is detention basin HLDET7. Also shown on the exhibit are the areas that are tributary to detention basin HLDET7. The tributary areas are NE16, NE17, HL13,

[a] City of Williams Storm Drainage Master Plan, November 2007. Stormwater Consulting Inc., and Civil Engineering Solutions, Inc.

and HL14, which are sub-basins in the hydrologic model (discussed below).

These areas are mostly undeveloped, with NE16, NE17, and HL14 planned for industrial land uses. The Project area lies within subbasin HL13. The remainder of subbasin HL13 is already developed with multi-family housing. It should be noted that, for the Master Plan, sub-basin HL13 was not planned to be tributary to detention basin HLDET7, but sub-basin HL13 has been physically plumbed to detention basin HLDET7 after the Master Plan had been completed.

Exhibit 1, Storm Drainage Infrastructure Plan shows the estimated size for detention basin HLDET7 to have the capacity to accommodate buildout of the tributary areas. The required size is 101 acre-feet of storage volume, with a foot print of approximately 29 acres. Additional storage may be needed to accommodate runoff from sub-basin HL13, for the reason discussed above. Since the completion of the Master Plan, HLDET7 has been constructed, but not to the full storage volume specified in the Master Plan. Based on topographic survey data collected by L&M in 2008[b], the existing detention basin HLDET7 has a storage volume of approximately 65 acre-feet of storage volume, and a foot print of approximately 13 acres (not including ancillary facilities such as patrol roads).

ANALYSIS APPROACH:

The Master Plan included development and use of an HEC-1 hydrologic model for evaluation of the drainage system capacity. This model was not available electronically, so the relevant portion of the model was recreated based on information contained in the Master Plan.

HEC-HMS (version 4.8, successor to HEC-1 software) hydrologic models were developed for detention basin HLDET7 and the sub-basin areas tributary to the HLDET7—the electronic model files are attached separately for review. The associated model schematic is shown on **Exhibit 2, Hydrologic Model Schematic**. The model sub-basin inputs from the Master Plan are highlighted in **Attachment 2, Model Input from the Master Plan**. The connectivity of the model elements (sub-basins and detention basins) was determined from the HEC-1 model code from the Draft Master Plan[c]; relevant excerpts of the model code are contained in **Attachment 3, Model Code from the Master Plan**. Model input for detention basin HLDET7 was developed from the topographic survey discussed above. The existing detention basin has a total of approximately 65 acre-feet of storage space, and a 24-inch diameter culvert outlet (which is different than what was assumed for the Master Plan) with a flap gate. The water surface elevation in the detention basin for the model runs was started at elevation 62 feet (National Geodetic Vertical Datum of 1929, or NGVD29) to reflect apparent groundwater infiltration observed on aerial photography taken over several years. It should be noted that the vertical datum referenced above may be a different vertical datum than was used for the Master Plan.

[b] LM, 2008, file 3021-3-D.
[c] City of Williams Storm Drainage Master Plan, Draft, August 2007. Stormwater Consulting Inc., and Civil Engineering Solutions, Inc.

Exhibit 1, Storm Drainage Infrastructure Plan shows the allowable outflow from detention basin HLDET7, which is 30 cubic feet per second (cfs). With this outflow (or lower), it was deemed in the Master Plan that the existing drainage system would not be impacted by land development that occurs in the sub-basin areas that are tributary to detention basin HLDET7.

The adequacy of the storage space in detention basin HLDET7 was evaluated for the analysis herein using the following criteria:

- Outflow from HLDET7 < 30 cfs
- Minimum freeboard = 1 foot (since the detention basin is below ground, and not leveed, this freeboard is acceptable). The top of the existing detention basin HLDET7 is approximately 66 feet (NGVD29). So, the maximum allowable water elevation in HLDET7 is 65 feet.

SCENARIOS:

The scenarios in **Table 1, Scenarios Analyzed** were analyzed. A model was created for each scenario.

Table 1, Scenarios Analyzed

Scenario Name	Development Level	Detention Basin Size (acre-feet)	Detention Basin Foot Print (acres)
Base	Ultimate	65, existing	13
Design-Ultimate	Ultimate	TBD	TBD
Design-Interim	Current + Project	TBD	TBD

For the last two scenarios (Design-Ultimate and Design-Interim), the size of detention basin HLDET7 was adjusted in the model until the criteria listed above could be met. For the last scenario (Design-Interim), the model parameters for the sub-basins were recalculated as shown in **Attachment 4, Calculations for Model Input for the Design-Interim Scenario**. The input reflects the current level of development in the model sub-basin areas, as shown on **Exhibit 3, Current Level of Development (2021)**, plus the Project.

RESULTS:

The model results are summarized in **Table 2, Model Results**. The results indicate that the existing detention basin HLDET7 is not large enough to accommodate the Project. An additional 35 acre-feet (100 -65 acre-feet) of storage space would be needed to accommodate ultimate buildout of all areas tributary to detention basin HLDET7. An additional 7 acre-feet (72 -65 acre-feet) of storage space would be needed to accommodate the current level of development plus the Project.

It should be noted that the estimated foot print of the enlarged detention basin is based on the discharge resulting from the existing gravity outlet culvert. The foot print of the enlarged detention basin may be

able to be decreased (compared to what is in **Table 2**) if a pump station is installed to help evacuate the detention basin. A pump-station scenario was not evaluated at this time.

Table 2, Model Results

Scenario Name	Development Level	Detention Basin Size (acre-feet)	Detention Basin Foot Print (acres)[1,2]	Contains Storm-Event Runoff?
Base	Ultimate	65, existing	13	No
Design-Ultimate	Ultimate	100	30	Yes
Design-Interim	Current + Project	72	18	Yes

(1) Does not include ancillary areas, such as for patrol roads.
(2) The foot print of the enlarged detention basin may be able to be decreased if a pump station is installed to help evacuate the detention basin.

CONCLUSIONS:

Detention basin HLDET7 needs to be enlarged to accommodate the Project. An additional 35 acre-feet (56,500 cubic yards) is needed for ultimate buildout of the tributary area. An additional 7 acre-feet (11,300 cubic yards) is needed to accommodate only the Project (with the current level of development in the remainder of the tributary area).

If you have any questions, please feel free to call me at (530) 662-1755, or e-mail me at bdelemos@lmce.net.

Enclosures

EXHIBITS

PLANNED DETENTION BASIN SIZE

PROPOSED DETENTION BASINS

DETENTION BASIN NO.	STORAGE VOLUME	SURFACE AREA	INFLOW (Q_{100})	OUTFLOW (Q_{100})	OUTLET STRUCTURE TYPE
NWDET1	41 AF	12.0 Ac.	99 cfs	18 cfs	②
NWDET2	23 AF	7.6 Ac.	44 cfs	12 cfs	①
NWDET3	53 AF	18.0 Ac.	82 cfs	15 cfs	②
NWDET4	7 AF	2.3 Ac.	14 cfs	2 cfs	④
NWDET5	18 AF	5.0 Ac.	33 cfs	2 cfs	④
NDET1	56 AF	15.7 Ac.	106 cfs	2 cfs	④
NEDET1	5 AF	2.6 Ac.	120 cfs	110 cfs	⑤
HLDET1	81 AF	23.1 Ac.	169 cfs	33 cfs	①
HLDET2	37 AF	9.8 Ac.	67 cfs	2 cfs	④
HLDET3	5 AF	2.5 Ac.	23 cfs	5 cfs	①
HLDET4	10 AF	3.0 Ac.	21 cfs	2 cfs	④
HLDET5	15 AF	4.2 Ac.	27 cfs	2 cfs	④
HLDET6	31 AF	8.3 Ac.	48 cfs	2 cfs	④
HLDET7	101 AF	29.2 Ac.	165 cfs	30 cfs	①
SDDET1	52 AF	15.9 Ac.	88 cfs	20 cfs	①
SDDET2	99 AF	29.2 Ac.	169 cfs	25 cfs	①
SDDET3	32 AF	10.0 Ac.	75 cfs	16 cfs	①
SDDET4	8 AF	2.3 Ac.	21 cfs	2 cfs	④
SDDET5	32 AF	10.7 Ac.	97 cfs	61 cfs	③
SDDET6	8 AF	2.3 Ac.	22 cfs	2 cfs	④
SDDET7	55 AF	16.9 Ac.	119 cfs	19 cfs	①
SDDET8	65 AF	19.5 Ac.	134 cfs	22 cfs	①
SDDET9	49 AF	15.0 Ac.	78 cfs	23 cfs	①
SDDET10	55 AF	16.9 Ac.	90 cfs	19 cfs	①
EDDET1	64 AF	19.5 Ac.	118 cfs	21 cfs	①
EDDET2	31 AF	10.0 Ac.	63 cfs	12 cfs	①
EDDET3	12 AF	4.2 Ac.	29 cfs	7 cfs	①
EDDET4	31 AF	10.0 Ac.	57 cfs	15 cfs	①
EDDET5	65 AF	19.5 Ac.	86 cfs	23 cfs	①

DETENTION BASIN OUTLET TYPES

① 12" PIPE PRIMARY OUTLET; 20' WEIR AT 3' DEPTH.

② GRADUATING DISCHARGE 0 cfs TO 20 cfs BASED ON DEPTH.

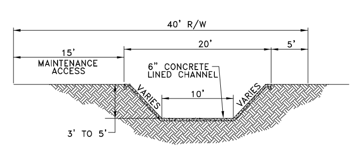
③ GRADUATING DISCHARGE 0 cfs TO 80 cfs BASED ON DEPTH.

④ PUMP DISCHARGE AT 2 cfs.

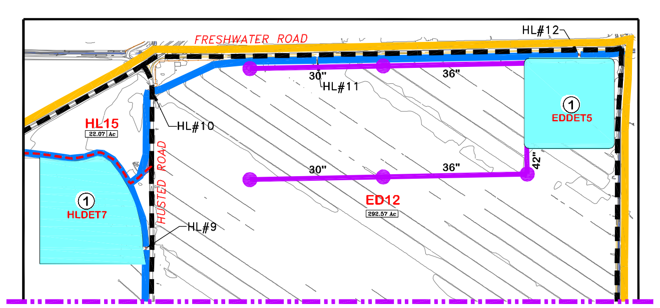
⑤ DISCHARGE BASED ON EXISTING 2–5'x2' CBC CAPACITY.

CULVERT INFORMATION

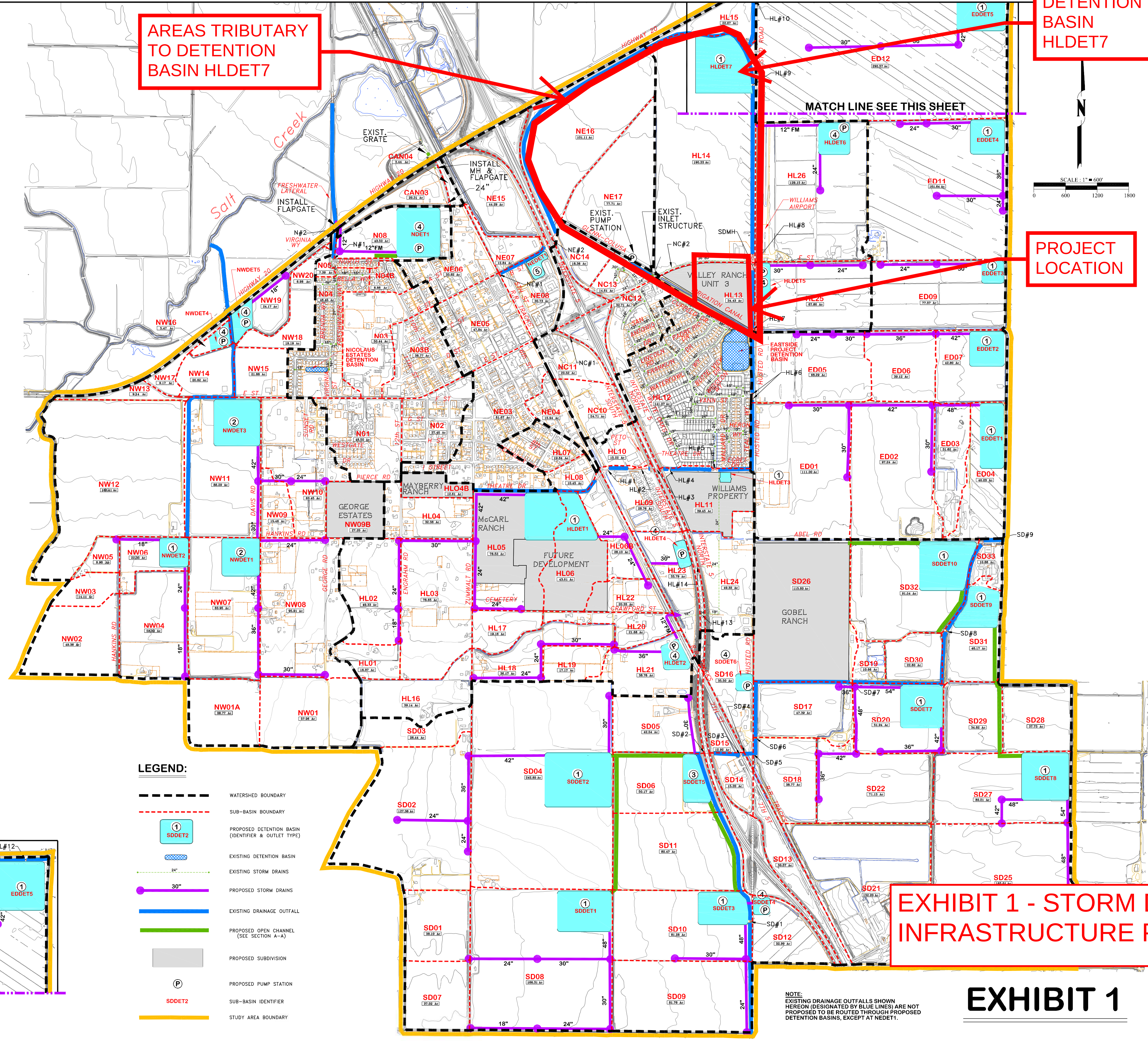
ID NO.	CULVERT SIZE	APPROXIMATE CAPACITY (cfs)	100-YR (cfs)	10-YR (cfs)	PROPOSED UPGRADE
N#1	36"PIPE	55	23	14	N/A
N#2	1 – 6'x3'RCB	132	36	23	N/A
NE#1	42"CMP	80	81	54	N/A
NE#2	2 – 5'x2'RCB	130	54	41	N/A
NC#1	24"RCP	20	29	20	N/A
NC#2	36"SD	35	55	37	N/A
HL#1	24"CMP	20	33	6	30"CMP
HL#2	36"PIPE	55	33	6	N/A
HL#3	3'x3'RCB	72	36	19	N/A
HL#4	48"RCP	115	36	19	N/A
HL#5	2–36"CMP	110	36	19	N/A
HL#6	2–36"CMP	110	64	43	N/A
HL#7	BOX CULVERT	UNKNOWN	118	76	N/A
HL#8	36"PIPE	55	118	76	N/A
HL#9	UNKNOWN	UNKNOWN	163	104	N/A
HL#10	UNKNOWN	UNKNOWN	220	148	N/A
HL#11	UNKNOWN	UNKNOWN	220	148	N/A
HL#12	36"PIPE	55	220	148	N/A
HL#13	24"RCP	20	12	12	N/A
HL#14	24"RCP	20	2	1	N/A
SD#1	5'x4'RCB	185	75	48	N/A
SD#2	5'x5'RCB	255	60	29	N/A
SD#3	36"RCP	55	63	34	48"RCP
SD#4	36"RCP	55	63	34	48"RCP
SD#5	48"CMP	115	63	34	N/A
SD#6	48"CULVERT	115	63	34	N/A
SD#7	48"CULVERT	115	65	34	N/A
SD#8	48"CULVERT	115	81	41	N/A
SD#9	UNKNOWN	UNKNOWN	125	53	N/A



SECTION A-A
TYPICAL OPEN CHANNEL
N.T.S.



MATCH LINE SEE THIS SHEET



NOTE:
EXISTING DRAINAGE OUTFALLS SHOWN HEREON (DESIGNATED BY BLUE LINES) ARE NOT PROPOSED TO BE ROUTED THROUGH PROPOSED DETENTION BASINS, EXCEPT AT NEDET1.

EXHIBIT 1 - STORM DRAINAGE INFRASTRUCTURE PLAN

EXHIBIT 1

DRAWN BY: R.L.T.	DESIGN BY: S.A.
CHECKED BY: J.H.N.	DWG:
Dwg.	

REVISION	DATE	DESCRIPTION	APPROVED	DATE

CIVIL ENGINEERING SOLUTIONS, INC.
1325 Howe Avenue, Suite 202
Sacramento CA. 95825
(916) 563 - 7300 fax (916) 563 - 7362

Storm Water Consulting Inc.
1899 Sapphire Way
El Dorado Hills, CA 95762
ph (916) 801-3962

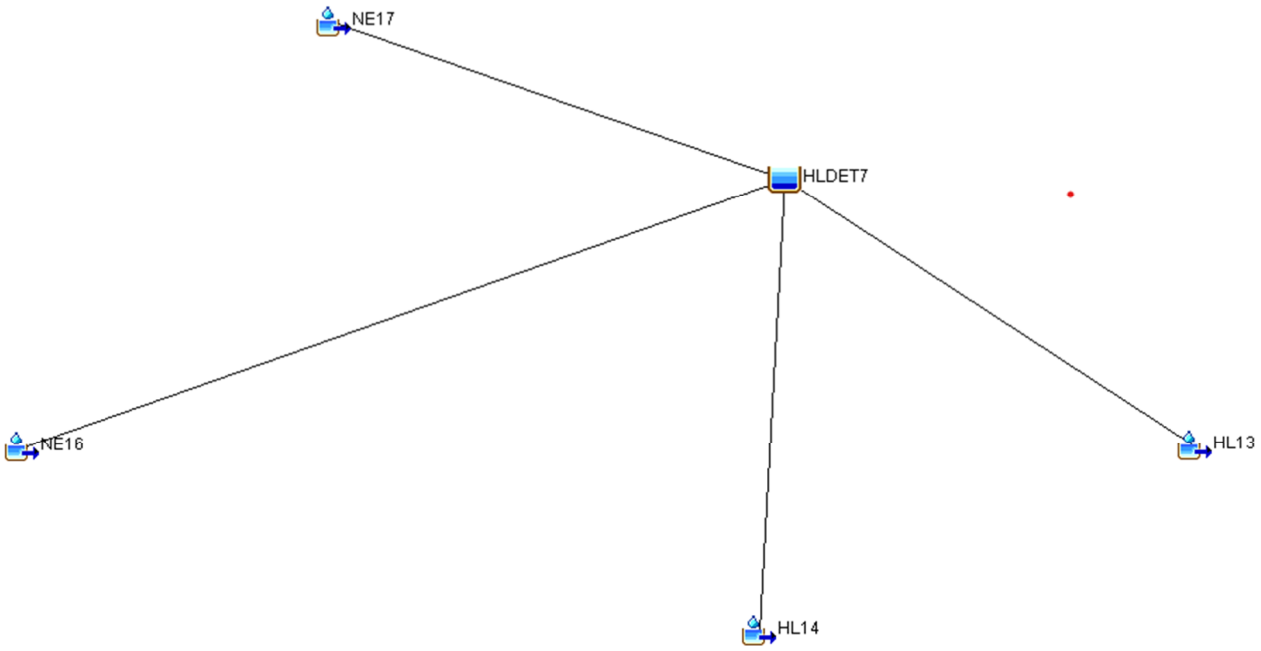
CITY OF WILLIAMS
STORM DRAINAGE MASTER PLAN
STORM DRAINAGE INFRASTRUCTURE PLAN

CITY OF WILLIAMS — COUNTY OF COLUSA — CALIFORNIA

DATE: NOVEMBER 2007
SCALE: 1"=600'
W.O. NO. 2007.51

SHEET EXH–1 OF 3

P:\PROJECTS\2007.27\EXHIBITS\EXH-1_SD_INFRA.DWG Oct 30, 2007



.EXHIBIT 2, HYDROLOGIC MODEL SCHEMATIC.

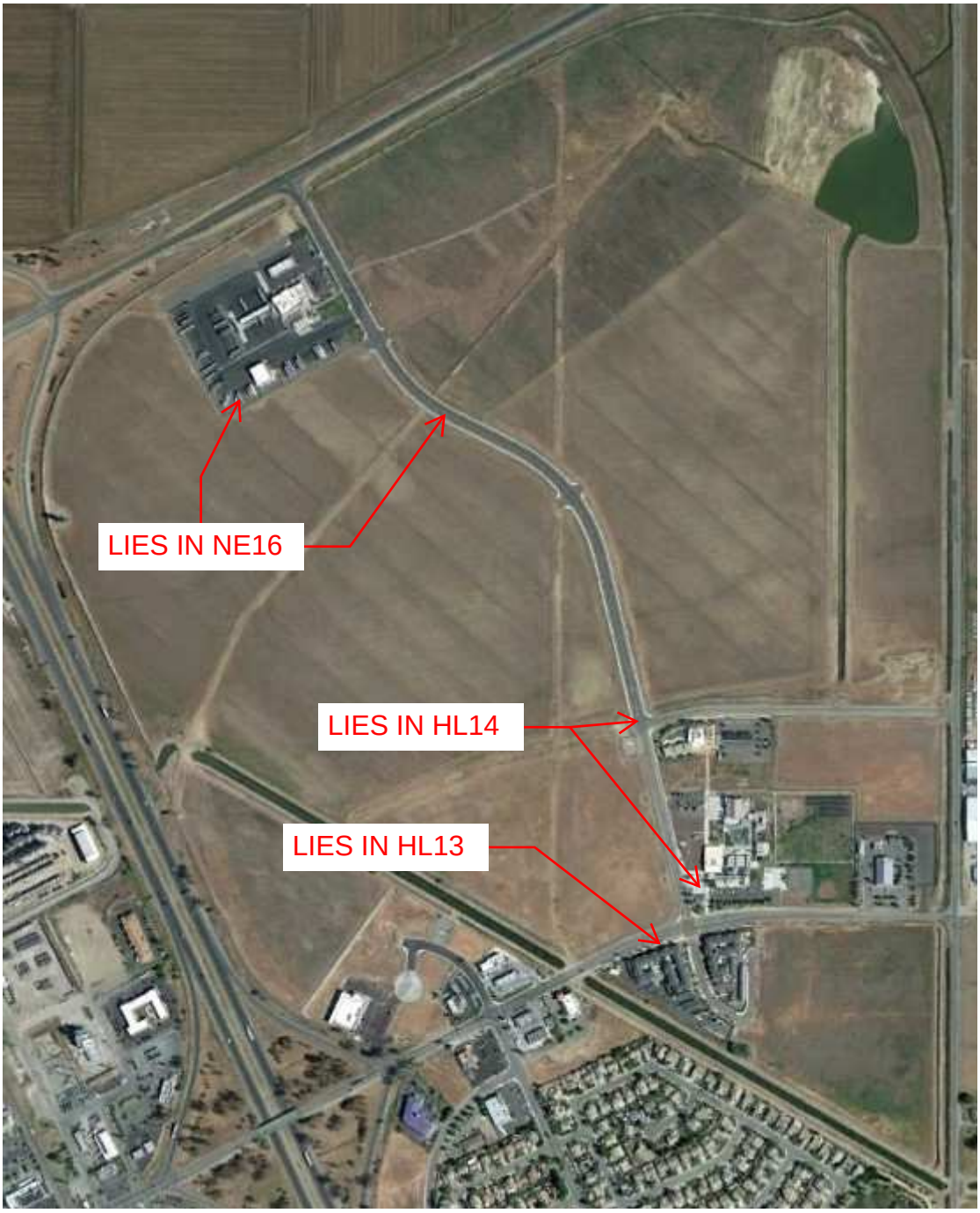
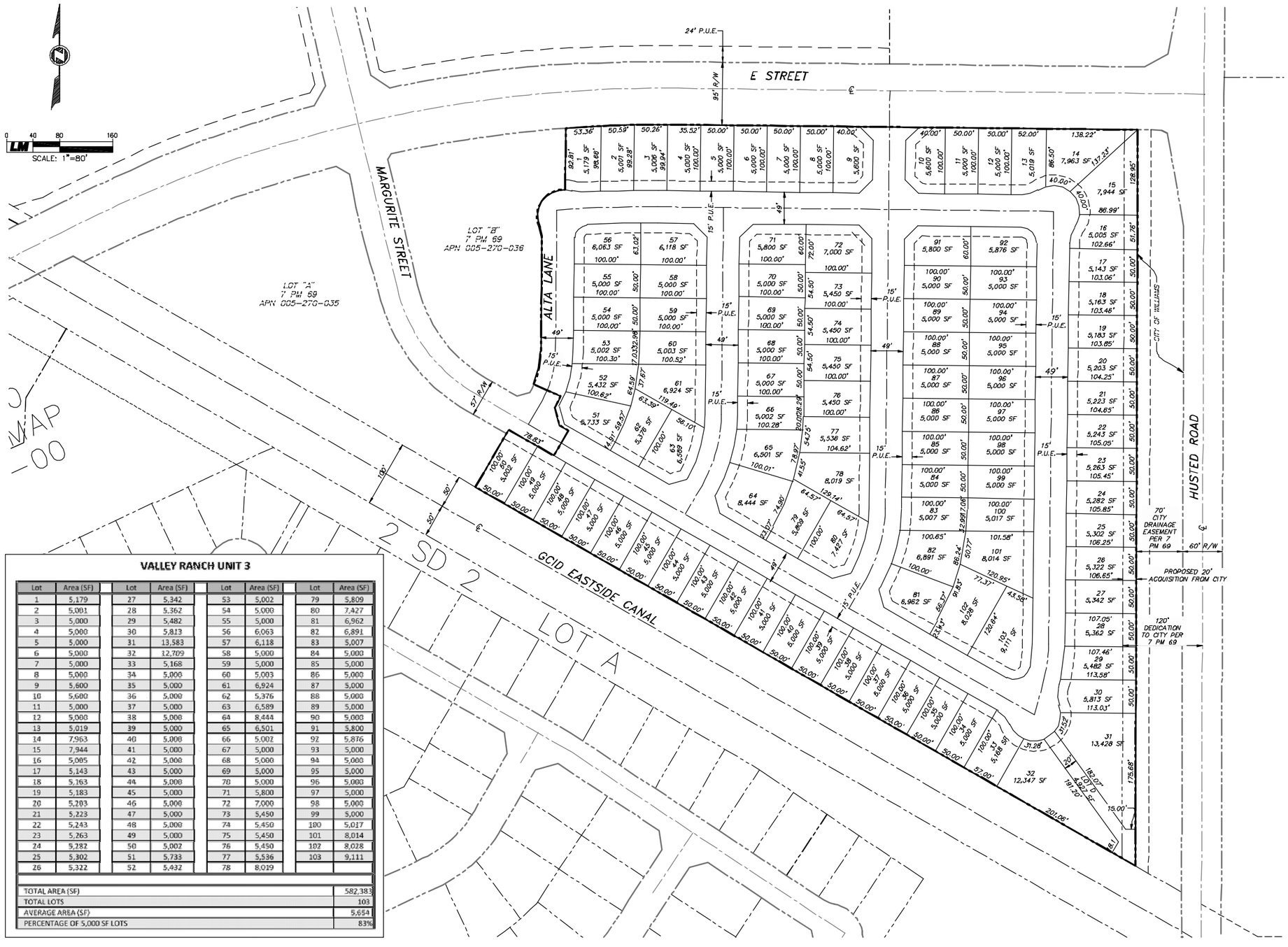


EXHIBIT 3 - CURRENT LAND USES (2021)

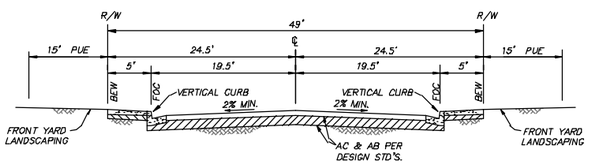
ATTACHMENT 1
TENTATIEVE MAP FOR THE PROJECT



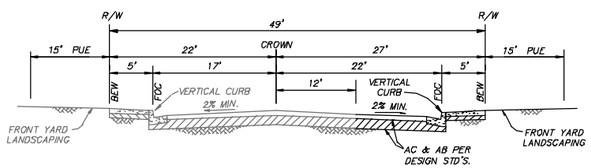
VALLEY RANCH UNIT 3

Lot	Area (SF)	Lot	Area (SF)	Lot	Area (SF)	Lot	Area (SF)
1	5,179	27	5,342	53	5,002	79	5,809
2	5,001	28	5,362	54	5,000	80	7,427
3	5,000	29	5,482	55	5,000	81	6,962
4	5,000	30	5,813	56	6,063	82	6,891
5	5,000	31	13,583	57	6,118	83	5,007
6	5,000	32	12,709	58	5,000	84	5,000
7	5,000	33	5,168	59	5,000	85	5,000
8	5,000	34	5,000	60	5,003	86	5,000
9	5,600	35	5,000	61	6,924	87	5,000
10	5,600	36	5,000	62	5,376	88	5,000
11	5,000	37	5,000	63	6,589	89	5,000
12	5,000	38	5,000	64	8,444	90	5,000
13	5,019	39	5,000	65	6,501	91	5,800
14	7,963	40	5,000	66	5,002	92	5,876
15	7,944	41	5,000	67	5,000	93	5,000
16	5,005	42	5,000	68	5,000	94	5,000
17	5,143	43	5,000	69	5,000	95	5,000
18	5,163	44	5,000	70	5,000	96	5,000
19	5,183	45	5,000	71	5,800	97	5,000
20	5,203	46	5,000	72	7,000	98	5,000
21	5,223	47	5,000	73	5,450	99	5,000
22	5,243	48	5,000	74	5,450	100	5,017
23	5,263	49	5,000	75	5,450	101	8,014
24	5,282	50	5,002	76	5,450	102	8,028
25	5,302	51	5,733	77	5,536	103	9,111
26	5,322	52	5,432	78	8,019		

TOTAL AREA (SF)	582,383
TOTAL LOTS	103
AVERAGE AREA (SF)	5,654
PERCENTAGE OF 5,000 SF LOTS	83%

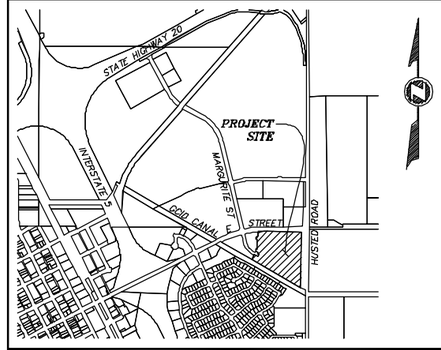


1 49' STREET TYPICAL SECTION
NTS



2 49' ALTA LANE SECTION
NTS

VICINITY MAP



NOTES

OWNERS	FRANK & VADA RUGGIERI PO BOX 837 WILLIAMS, CA 95987 GARNETT VANN 365 RUGGIERI WAY WILLIAMS, CA 95987 WILLIAM VANN 365 RUGGIERI WAY WILLIAMS, CA 95987
ENGINEER & SURVEYOR	LAUGENOUR AND MEIKLE CIVIL ENGINEERS 608 COURT STREET WOODLAND, CA 95695 PHONE: (530) 662-1755
ASSESSOR'S PARCEL NUMBER	005-270-037
EXISTING USE	VACANT
PROPOSED USE	SINGLE FAMILY RESIDENTIAL
GENERAL PLAN DESIGNATION	URBAN RESIDENTIAL
EXISTING ZONING	R-U (URBAN RESIDENTIAL) 6,000 SF AVERAGE
PROPOSED ZONING	R-U (URBAN RESIDENTIAL) 5,500 SF AVERAGE
WATER SERVICE	CITY OF WILLIAMS
SEWER SERVICE	CITY OF WILLIAMS
STORM DRAINAGE	CITY OF WILLIAMS, OFF-SITE DRAINAGE DETENTION
FIRE PROTECTION	CITY OF WILLIAMS
ELECTRICAL SERVICE	PG&E
GAS SERVICE	PG&E
TELEPHONE SERVICE	FRONTIER COMMUNICATIONS
CABLE TV	COMCAST
SCHOOL DISTRICT	WILLIAMS UNIFIED SCHOOL DISTRICT
FLOOD DESIGNATION	ZONE "X," AREA OUTSIDE THE 0.2% CHANCE (500-YEAR) FLOODPLAIN, PER FEMA FIRM 06011C0517F, DATED MAY 15, 2003
STREET NAMES	TO BE DETERMINED DURING FINAL MAP REVIEW WITH CITY
ACREAGE	17.266± (PRE-ACQUISITION) 17.774± (POST ACQUISITION)
LOTS	103 SINGLE-FAMILY LOT D (DEDICATION TO CITY FOR PEDESTRIAN/BIKE PATH ACCESS)
PUEs	15' ALONG EACH LOT FRONTAGE
MAXIMUM DENSITY	4.17 DWELLING UNITS/ACRE (PER EXISTING ZONING)

REQUESTED VARIANCES

1. REDUCING MINIMUM STREET RIGHT-OF-WAY WIDTH TO 49 FEET.
2. REDUCING AVERAGE LOT AREA TO 5,600 SF.
3. INCREASING PERCENTAGE OF SMALL LOTS (5,000 SF MIN.) ALLOWED TO 85%.
4. INCREASING MAXIMUM DENSITY 5.97 DWELLING UNITS/ACRE.

BY	APP'D	DESCRIPTION	REV.	DATE

REDUCED PLOT

LAUGENOUR AND MEIKLE
CIVIL ENGINEERING · LAND SURVEYING · PLANNING
608 COURT STREET, WOODLAND, CALIFORNIA 95695 PHONE: (530) 662-1755
P.O. BOX 1285, WOODLAND, CALIFORNIA 95776 FAX: (530) 662-4822

BY _____ BRYAN P. BONINO
DATE _____ L.S. 7521

TENTATIVE MAP FOR VALLEY RANCH UNIT 3
COLUSA COUNTY, CALIFORNIA
CITY OF WILLIAMS

JOB NO.	3201-2-C
DESIGNED BY	PF
DRAWN BY	JB
CHECKED BY	BPB
DATE	09-23-21
SCALE	1"=80'

TM-1

SHEET 1 OF 3

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LEGEND

PROPOSED	EXISTING	
12"SD	12"SD	STORM DRAIN AND MANHOLE
6"SS	6"SS	SANITARY SEWER AND MANHOLE
		FIRE HYDRANT AND VALVE ASSEMBLY
		STREET LIGHT AND POLE
		VERTICAL CURB, GUTTER & SIDEWALK WITH DRIVEWAY
		CATCH BASIN OR DRAINAGE INLET
		FLOWLINE OF DITCH OR SWALE
		DIRECTION OF SURFACE DRAINAGE FLOW
		CUT OR FILL SLOPE
		RIGHT OF WAY OR PROPERTY LINE
		STREET CENTERLINE OR BASELINE
		EDGE OF PAVEMENT

REV.	DATE	DESCRIPTION	BY	APP'D
		REDUCED PLOT		

LM LAUGENOUR AND MEIKLE
CIVIL ENGINEERING · LAND SURVEYING · PLANNING
608 COURT STREET, WOODLAND, CALIFORNIA 95695 PHONE: (530) 662-7755
P.O. BOX 928, WOODLAND, CALIFORNIA 95776 FAX: (530) 662-7822

BY _____ BRYAN P. BONINO

DATE _____ L.S. 7521

PRELIMINARY UTILITY PLAN
FOR
VALLEY RANCH UNIT 3

COLUSA COUNTY, CALIFORNIA

CITY OF WILLIAMS

JOB NO.	3201-2-C
DESIGNED BY	PF
DRAWN BY	JB
CHECKED BY	BPB
DATE	09-23-21
SCALE	1"=60'

TM-2

SHEET 2 OF 3

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EARTHWORK ESTIMATE

CUT: 980 CY
FILL: 64,681 CY

NET: 63,701 CY FILL

E STREET

OVERLAND RELEASE

MARGURITE STREET

ALTA LANE

HUSTED ROAD

GCID EASTSIDE CANAL

LOT "B" 7 PM 69

LOT "A" 7 PM 69

36" SD

24" SD

SCALE: 1"=60'

REDUCED PLOT

REV.	DATE	DESCRIPTION	BY	APP'D

LAUGENOUR AND MEIKLE
CIVIL ENGINEERING · LAND SURVEYING · PLANNING
608 COURT STREET, WOODLAND, CALIFORNIA 95695 PHONE: (530) 662-7553
P.O. BOX 5281, WOODLAND, CALIFORNIA 95776 FAX: (530) 662-7652
BY _____ DATE _____
BRYAN P. BONINO
L.S. 7521

PRELIMINARY GRADING PLAN
FOR
VALLEY RANCH UNIT 3
COLUSA COUNTY, CALIFORNIA
CITY OF WILLIAMS

JOB NO.	3201-2-C
DESIGNED BY	PF
DRAWN BY	JB
CHECKED BY	BPB
DATE	09-23-21
SCALE	1"=60'

TM-3

SHEET 3 OF 3

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ATTACHMENT 2
MODEL INPUT FROM THE MASTER PLAN

TABLE 1
CITY OF WILLIAMS
Storm Drainage Master Plan
Weighted % Impervious Cover Values for Sub-basins
(Based on Future Land Uses Assumptions)

			Future Land Uses and % Impervious Cover Values							
Watershed I.D.	**Sub-basin I.D.**	**Total Area (ac)**	**Comm 90% (ac)**	**Ind 90% (ac)**	**M/HDR 65% (ac)**	**SFR 50% (ac)**	**LDR 15% (ac)**	**PF 50% (ac)**	**OS 2% (ac)**	**Weighted % Impervious**
Northwest (NW)	NW01	57.96				57.04	0.92			49
	NW01A	38.77				38.34			0.43	49
	NW02	49.38					0.47		48.91	2
	NW03	14.11					0.10		14.01	2
	NW04	58.32					57.46		0.86	15
	NW05	9.96					0.16		9.80	2
	NW06	22.35					22.20		0.15	15
	NW07	83.95				0.87	82.95		0.13	15
	NW08	95.91				0.05	95.85		0.01	15
	NW09	15.46				0.09	15.37			15
	NW09B	27.20		0.02		27.18				50
	NW10	63.45	0.07			10.14	53.17		0.07	21
	NW11	88.29				83.06	0.75		4.48	47
	NW12	163.41					0.02		163.39	2
	NW13	9.14				0.01			9.13	2
	NW14	20.62	0.21		0.07	20.24			0.09	50
	NW15	21.88	21.65		0.04	0.18				90
	NW16	5.47				5.47				50
	NW17	9.17				7.98			1.19	44
	NW18	19.19	0.56		18.63					66
	NW19	24.17			7.62	11.70			4.86	45
	NW20	6.98			5.46				1.52	51
North (N)	N01	48.50			25.52	16.53	0.03	6.43		58
	N02	37.45	5.98		10.86	20.60				61
	N03	50.44			2.35	5.29		42.80		51
	N03B	38.77	0.13		18.19	13.37		7.09		57
	N04	46.45	0.52		0.17	43.87		1.89		51
	N04B	8.86				8.86				50
	N05	7.39			2.44	3.30			1.66	44
	N08	43.50	0.04						43.46	2
Northeast (NE)	NE03	81.67	25.33		12.87	37.77	2.15	2.84	0.71	63
	NE04	15.94	13.03		0.82				2.09	77
	NE05	47.84	34.23		10.06	1.95			1.60	80
	NE06	33.82	20.75		4.39	4.30			1.70	70
	NE07	12.84		9.93					2.91	70
	NE08	30.73	5.18	19.54					6.01	73
	NE15	44.29		33.99					10.30	70
	NE16	101.11		86.02					15.09	77
	NE17	77.71	0.5	73.24					3.96	86

Land Use Categories
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Last Modified: 10-29-07

TABLE 1
CITY OF WILLIAMS
Storm Drainage Master Plan
Weighted % Impervious Cover Values for Sub-basins
(Based on Future Land Uses Assumptions)

			Future Land Uses and % Impervious Cover Values							
Watershed I.D.	**Sub-basin I.D.**	**Total Area (ac)**	**Comm 90% (ac)**	**Ind 90% (ac)**	**M/HDR 65% (ac)**	**SFR 50% (ac)**	**LDR 15% (ac)**	**PF 50% (ac)**	**OS 2% (ac)**	**Weighted % Impervious**
North Central (NC)	NC10	24.71	0.34	21.45					2.93	80
	NC11	20.52	14.24	2.66					3.62	74
	NC12	32.56	17.54			12.03			3.00	67
	NC13	12.79	9.39						3.40	67
	NC14	16.36	13.64						2.72	75
Husted Lateral (HL)	HL01	16.37				0.25	16.12			16
	HL02	49.33				0.05	49.28			15
	HL03	78.65				0.31	78.34			15
	HL04	32.38				2.10	30.05		0.23	17
	HL04B	12.61				0.04	12.57			15
	HL05	78.53			1.16	76.70	0.67			50
	HL06	43.01	0.51		0.2	42.30				51
	HL06B	28.10	10.53		0.09	10.39			7.00	53
	HL07	19.64			5.07	14.57				54
	HL08	10.45	0.02		10.42	0.01				65
	HL09	28.76		1.47	24.32				2.97	60
	HL10	15.22		13.28					1.94	79
	HL11	39.45	2.32			37.13				52
	HL12	141.07	12.38			115.35			13.34	49
	HL13	34.43			3.65	22.75			8.04	40
	HL14	190.33		181.44					8.89	86
	HL15	22.07	3.09						18.98	14
	HL16	39.14				34.42	4.72			46
	HL17	19.16				19.08	0.08			50
	HL18	36.17				36.08	0.09			50
	HL19	17.17				17.17				50
	HL20	21.68				20.25			1.43	47
	HL21	38.76				35.44			3.32	46
	HL22	20.33				17.65			2.68	44
	HL23	33.79		27.66	0.07				6.06	74
	HL24	49.33	40.76			0.54			8.03	75
	HL25	67.80				66.65			1.15	49
	HL26	129.15				126.87			2.28	49
South Drain (SD)	SD01	38.10				38.10				50
	SD02	127.38				127.38				50
	SD03	26.44				26.44				50
	SD04	242.85				242.85				50
	SD05	42.54				36.25			6.29	43

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TABLE 1
CITY OF WILLIAMS
Storm Drainage Master Plan
Weighted % Impervious Cover Values for Sub-basins
(Based on Future Land Uses Assumptions)

			Future Land Uses and % Impervious Cover Values							
Watershed I.D.	**Sub-basin I.D.**	**Total Area (ac)**	**Comm 90% (ac)**	**Ind 90% (ac)**	**M/HDR 65% (ac)**	**SFR 50% (ac)**	**LDR 15% (ac)**	**PF 50% (ac)**	**OS 2% (ac)**	**Weighted % Impervious**
South Drain (SD)	SD06	50.17	5.51			42.37			2.29	52
	SD07	37.02				36.62			0.40	49
	SD08	166.31				166.31				50
	SD09	81.76	0.44			81.32				50
	SD10	81.28	32.22			48.92			0.14	66
	SD11	80.47	24.91			53.65			1.91	61
	SD12	32.99	30.06						2.93	82
	SD13	30.57	30.57							90
	SD14	15.20	12.86						2.34	76
	SD15	12.92	7.09						5.83	50
	SD16	35.50	31.82						3.68	81
	SD17	47.39	1.12	45.66		0.58			0.03	89
	SD18	38.77	0.56	38.01					0.20	90
	SD19	10.66		10.66						90
	SD20	51.94		51.94						90
	SD21	132.20		129.52					2.68	88
	SD22	71.13		71.13						90
	SD25	165.01		165.01						90
	SD26	115.80	1.24	3.33		108.05			3.18	50
	SD27	80.21		80.21						90
	SD28	37.73		37.73						90
	SD29	34.82		34.82						90
	SD30	22.60		22.6						90
	SD31	40.17		40.17						90
	SD32	91.54		87.44		4.10				88
	SD33	10.86		9.78		1.08				86
East Drain (ED)	ED01	111.00				106.84			4.16	48
	ED02	97.24				97.24				50
	ED03	31.62				31.62				50
	ED04	40.23				40.32				50
	ED05	68.29				65.22			3.07	48
	ED06	39.12				39.12				50
	ED07	42.80				41.66			1.14	49
	ED09	77.57				77.57				50
	ED11	161.64				160.85			0.79	50
	ED12	292.57				280.70			11.87	48
Canal (CAN)	CAN03	20.31	4.59			0.06			15.66	22
	CAN04	3.44							3.44	2
Total of Areas		6090.43	435.93	1298.7	164	3081.54	523.52	61.05	522.56	

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PF = Public Facility
OS = Open Space

TABLE 2
CITY OF WILLIAMS
Storm Drainage Master Plan
Sub-basin Lag Times (hr)

Watershed I.D.	Sub-basin I.D.	Length (ft)	Slope (%)	Percent Impervious	Composite CN	Surface Retention	Lag Time (hr)
Northwest (NW)	NW01	2050	0.32	49	89	1.24	0.73
	NW01A	1700	0.32	49	91	0.99	0.58
	NW02	2300	0.17	2	84	1.90	1.32
	NW03	1400	0.21	2	84	1.90	0.80
	NW04	2500	0.14	15	86	1.63	1.45
	NW05	1100	0.30	2	84	1.90	0.55
	NW06	1700	0.20	15	86	1.63	0.89
	NW07	3000	0.26	15	86	1.63	1.23
	NW08	3200	0.34	15	86	1.63	1.13
	NW09	1850	0.26	15	86	1.63	0.83
	NW09B	1500	0.27	50	91	0.99	0.57
	NW10	3200	0.37	21	88	1.36	1.01
	NW11	2800	0.24	47	91	0.99	1.00
	NW12	4400	0.23	2	84	1.90	1.90
	NW13	2400	0.17	2	84	1.90	1.36
	NW14	1200	0.06	50	91	0.99	1.01
	NW15	1300	0.19	90	97	0.31	0.45
	NW16	900	0.02	50	91	0.99	1.39
	NW17	2100	0.22	44	90	1.11	0.86
	NW18	1100	0.08	66	94	0.64	0.71
	NW19	2400	0.10	45	90	1.11	1.42
	NW20	1100	0.15	51	91	0.99	0.60
North (N)	N01	1800	0.47	58	93	0.75	0.46
	N02	1850	0.20	61	93	0.75	0.72
	N03	2200	0.40	51	91	0.99	0.64
	N03B	1900	0.21	57	93	0.75	0.71
	N04	3500	0.33	51	91	0.99	1.01
	N04B	1400	0.15	50	91	0.99	0.72
	N05	500	0.18	44	90	1.11	0.30
	N08	2200	0.22	2	84	1.90	1.12
Northeast (NE)	NE03	4000	0.22	63	93	0.75	1.27
	NE04	1600	0.30	77	95	0.53	0.47
	NE05	2400	0.24	80	95	0.53	0.73
	NE06	2800	0.12	70	94	0.64	1.23
	NE07	1900	0.15	70	94	0.64	0.81
	NE08	1400	0.21	73	94	0.64	0.53
	NE15	2700	0.26	70	94	0.64	0.81
	NE16	3700	0.22	77	95	0.53	1.08
	NE17	3200	0.09	86	96	0.42	1.43

TABLE 2
CITY OF WILLIAMS
Storm Drainage Master Plan
Sub-basin Lag Times (hr)

Watershed I.D.	Sub-basin I.D.	Length (ft)	Slope (%)	Percent Impervious	Composite CN	Surface Retention	Lag Time (hr)
North Central (NC)	NC10	1200	0.28	80	95	0.53	0.39
	NC11	1700	0.30	74	95	0.53	0.50
	NC12	1400	0.46	67	94	0.64	0.36
	NC13	1300	0.19	67	94	0.64	0.53
	NC14	900	0.31	75	95	0.53	0.29
Husted Lateral (HL)	HL01	1200	0.43	16	87	1.49	0.44
	HL02	2100	0.47	15	87	1.49	0.66
	HL03	3400	0.43	15	87	1.49	1.02
	HL04	1500	0.45	17	87	1.49	0.52
	HL04B	1500	0.49	15	87	1.49	0.50
	HL05	2600	0.37	50	91	0.99	0.76
	HL06	2700	0.47	51	92	0.87	0.66
	HL06B	1800	0.40	53	92	0.87	0.52
	HL07	800	0.30	54	92	0.87	0.31
	HL08	900	0.31	65	93	0.75	0.32
	HL09	1400	0.18	60	93	0.75	0.60
	HL10	900	0.38	79	95	0.53	0.27
	HL11	1500	0.42	52	92	0.87	0.44
	HL12	2300	0.34	49	91	0.99	0.71
	HL13	1500	0.11	40	90	1.11	0.93
	HL14	4400	0.16	86	96	0.42	1.38
	HL15	2000	0.30	14	84	1.90	0.89
	HL16	2000	0.24	46	90	1.11	0.79
	HL17	1300	0.35	50	91	0.99	0.45
	HL18	2800	0.29	50	91	0.99	0.91
	HL19	1400	0.19	50	91	0.99	0.64
	HL20	2400	0.28	47	90	1.11	0.85
	HL21	1700	0.12	46	90	1.11	0.98
	HL22	1500	0.64	44	90	1.11	0.39
	HL23	1600	0.28	74	93	0.75	0.54
	HL24	1900	0.32	75	95	0.53	0.53
	HL25	2400	0.13	49	91	0.99	1.20
	HL26	3100	0.14	49	91	0.99	1.41
South Drain (SD)	SD01	1700	0.45	50	91	0.99	0.49
	SD02	3200	0.33	50	91	0.99	0.94
	SD03	1800	0.31	50	91	0.99	0.61
	SD04	3600	0.34	50	91	0.99	1.02
	SD05	1900	0.21	43	90	1.11	0.81
	SD06	1600	0.25	52	92	0.87	0.60
	SD07	1750	0.27	49	91	0.99	0.64

TABLE 2
CITY OF WILLIAMS
Storm Drainage Master Plan
Sub-basin Lag Times (hr)

Watershed I.D.	Sub-basin I.D.	Length (ft)	Slope (%)	Percent Impervious	Composite CN	Surface Retention	Lag Time (hr)
South Drain (SD)	SD08	3600	0.16	50	91	0.99	1.49
	SD09	2700	0.25	50	91	0.99	0.95
	SD10	2700	0.28	66	93	0.75	0.82
	SD11	2400	0.36	61	93	0.75	0.66
	SD12	1800	0.26	82	96	0.42	0.53
	SD13	3550	0.39	90	97	0.31	0.70
	SD14	1050	0.14	76	95	0.53	0.49
	SD15	1050	0.19	50	91	0.99	0.51
	SD16	1500	0.23	81	95	0.53	0.51
	SD17	1600	0.19	89	97	0.31	0.53
	SD18	1400	0.14	90	97	0.31	0.56
	SD19	900	0.33	90	97	0.31	0.26
	SD20	2000	0.10	90	97	0.31	0.88
	SD21	2200	0.58	88	97	0.31	0.39
	SD22	2300	0.15	90	97	0.31	0.80
	SD25	3600	0.26	90	97	0.31	0.87
	SD26	3150	0.11	50	91	0.99	1.62
	SD27	2850	0.23	90	97	0.31	0.77
	SD28	1700	0.24	90	97	0.31	0.50
	SD29	1550	0.23	90	97	0.31	0.47
	SD30	1100	0.18	90	97	0.31	0.41
	SD31	1600	0.23	90	97	0.31	0.48
	SD32	2700	0.23	88	97	0.31	0.74
	SD33	900	0.10	86	96	0.42	0.49
East Drain (ED)	ED01	2400	0.28	48	91	0.99	0.81
	ED02	2900	0.17	50	91	0.99	1.22
	ED03	2600	0.41	50	91	0.99	0.72
	ED04	2800	0.27	50	91	0.99	0.94
	ED05	2200	0.15	48	91	0.99	1.04
	ED06	1700	0.31	50	91	0.99	0.59
	ED07	1800	0.14	49	91	0.99	0.92
	ED09	2750	0.12	50	91	0.99	1.39
	ED11	3600	0.14	50	91	0.99	1.59
	ED12	5400	0.12	48	91	0.99	2.38
Canal (CAN)	CAN03	1600	0.21	22	87	1.49	0.80
	CAN04	800	0.13	2	84	1.90	0.65

ATTACHMENT 3
MODEL CODE FROM THE DRAFT MASTER PLAN

```
* *                TOP AREA (AC)                    7.964
* *                VOLUME (AC-FT)                    94.0
* *                DISCHARGE (Gravity)           2-24"RCP
* *                BOTTOM ELEVATION(FT)                71
* *                TOP ELEVATION (FT)                  75
* ************************************************************************
*
RS     1    STOR      -1
SA  7.33   7.409   7.489   7.568   7.647   7.806
SE    71    71.5      72    72.5      73      74
* SQ     0       9      25      45      67     130     130
* use 2-24" RCP AS OUTLET
SL  71.0    6.28    0.67     0.5
SS 73.99      20    2.75     1.5
*
KK RR306
KMROUTE  FLOW FROM B ST & RR TO EAST UNDER I-5
KM2-5'X 2' BOX CULVERTS
RD   350   0.003   0.015            TRAP      10       3
*
KK RR307
KMROUTE  FLOW FROM I-5 TO NORTHEAST TO JOIN WITH HUSTED LATERAL
RD  4800   0.003   0.035            TRAP       5       3
*
KK  NE16
KMNORTHEAST WATERSHED
KMAREA = 101.11 AC =0.1580 SQ MI
BA0.1580
LS            84      77
UD  1.08
*
KK  NE17
KMNORTHEAST WATERSHED
KMAREA = 77.71 AC = 0.1214 SQ MI
BA0.1214
LS            84      86
UD  1.43
*
* ###################### HUSTED LATERAL WATERSHED ########################
*
KK  HL14
KMHUSTED LATERAL WATERSHED
KMAREA = 190.33 AC = 0.2974 SQ MI
BA0.2974
LS            84      86
UD  1.38
*
KK  C305
KO     3                              21
KMCOMBINE FLOW FROM NE16 &NE17 WITH FLOW FROM I-5 CULVERTS
HC     3
*
* ************  ADD A DETENTION BASIN ***************
* ********   EAST OF HUSTED ROAD & SOUTH OF HIGHWAY 20 *********
*
KKHLDET7
KO     3                              21
KMDETENTION BASIN NORTHEAST
KMASSUMES THE FOLLOWING PARAMETERS:
*
* ************************************************************************
* *                BOTTOM WIDTH(FT)                  1104
* *                BOTTOM LENGTH (FT)                1104
* *                BOTTOM AREA (AC)                  28.0
* *                SIDE SLOPES (H:V)                  3:1
* *                DEPTH (FT)                           4
* *                TOP WIDTH (FT)                    1128
* *                TOP LENGTH (FT)                   1128
* *                TOP AREA (AC)                    29.20
* *                VOLUME (AC-FT)                     112
* *                DISCHARGE (GRAVITY)          1-12" PIPE
```

```
* *                BOTTOM ELEVATION(FT)                63
* *                TOP ELEVATION (FT)                  67
* ************************************************************************
*
RS     1    STOR      -1
SA  28.0   29.20
SE    63      67
* ******* USE 1-12" AS OUTLET *********
SL  63.5    0.79    0.67     0.5
SS 66.00      20    2.75     1.5
*
*
KK CHL14
KMCOMBINE OUTFLOW FROM DETENTION WITH FLOW FROM NORTHEAST
HC     2
*
* ##################### NORTH CENTRAL WATERSHED ##############################
*
KK  NC10
KMNORTH CENTRAL WATERSHED
KMAREA = 24.71 AC = 0.0386 SQ MI
BA0.0386
LS            84      80
UD  0.39
*
KK RR308
KMROUTE  FLOW FROM BASIN NC10 TO I-5 SOUTH BOUND RAMP CULVERT
RD  1200   0.003   0.035            TRAP       5       3
*
KK  NC11
KMNORTH CENTRAL WATERSHED
KMAREA = 20.52 AC = 0.0321 SQ MI
BA0.0321
LS            84      74
UD  0.50
*
KK  C306
KMCOMBINE FLOW FORM NC10 & NC11
HC     2
*
KK RR309
KMROUTE  FLOW ACROSS I-5 TO THE EAST
RD   950   0.003   0.035            TRAP       5       3
*
KK  NC12
KMNORTH CENTRAL WATERSHED
KMAREA = 13.54 AC = 0.0212 SQ MI
BA0.0212
LS            84      73
UD  0.34
*
KK  NC14
KO     3                                21
KMNORTH CENTRAL WATERSHED
KMAREA = 16.36 AC = 0.0256 SQ MI
BA0.0256
LS            84      75
UD  0.29
*
* KKNCDET1
* KO     3                               21
* KM DETENTION BASIN NORTH CENTRAL
* KM ASSUMES THE FOLLOWING PARAMETERS:
*
* ************************************************************
* *                BOTTOM WIDTH(FT)                  185
* *                BOTTOM LENGTH (FT)                185
* *                BOTTOM AREA (AC)                 0.79
* *                SIDE SLOPES (H:V)                 3:1
* *                DEPTH (FT)                          4
* *                TOP WIDTH (FT)                    209
```

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*
KK  C408
KMCOMBINE FLOW AT CALTRANS 24" RCP
HC     2
*
KK RR413
KMROUTE  FLOW TO THE NORTH TO HUSTED LATERAL DRAINAGE VIA 24" RCP
RD  1800   0.003   0.015            CIRC       2
*
KK  HL11
KO     3                                21
KMHUSTED LATERAL WATERSHED (Williams Property)
KMAREA = 39.45 AC = 0.0616 SQ MI
BA0.0616
LS            84      52
UD  0.46
*
KKHLDET3
KO     3                                21
KMWILLIAMS PROPERTY (S OF HUSTED LATERAL RD & W OF I-5)
KMDETENTION BASIN HUSTED LATERAL
KMASSUMES THE FOLLOWING PARAMETERS:
*
* ************************************************************
* *                BOTTOM WIDTH(FT)                      300
* *                BOTTOM LENGTH (FT)                    300
* *                BOTTOM AREA (AC)                     2.07
* *                SIDE SLOPES (H:V)                     3:1
* *                DEPTH (FT)                              4
* *                TOP WIDTH (FT)                        330
* *                TOP LENGTH (FT)                       330
* *                TOP AREA (AC)                        2.50
* *                VOLUME (AC-FT)                       10.0
* *                DISCHARGE (GRAVITY)           1-12" pipe
* *                BOTTOM ELEVATION(FT)                   85
* *                TOP ELEVATION (FT)                     89
* ************************************************************
*
RS     1    STOR      -1
SA  2.07     2.5
SE    85      89
* ******* USE 1-12" AS OUTLET *********
SL  85.5    0.79    0.67     0.5
SS 88.00      20    2.75     1.5
*
KK  C409
KMCOMBINE FLOW AT CALTRANS 24" RCP HUSTED LATERAL AT SUBDIVISION ENTRANCE
HC     3
*
KK RR414
KMROUTE  FLOW TO THE NORTH IN HUSTED LATERAL DRAINAGE ALONG HUSTED RD
RD  3200   0.003   0.045            TRAP       5       3
*
KK  HL12
KMEXISTING SUBDIVISIONS
KMHUSTED LATERAL WATERSHED
KMAREA = 160.10 AC = 0.2502 SQ MI
BA0.2502
LS            84      51
UD  0.68
*
KK  C410
KMCOMBINE FLOW AT HUSTED LATERAL WITH FLOW FROM SUBDIVISION
HC     2
*
KK RR415
KMROUTE FLOW TO THE NORTH IN HUSTED LATERAL DRAINAGE TO E ST
RD  1350   0.003   0.045            TRAP       5       3
*
KK  HL13
KMHUSTED LATERAL WATERSHED
```

```
KMAREA = 34.43 AC = 0.0538 SQ MI
BA0.0538
LS            84       40
UD  0.93
*
KK  HL25
KO     3                                21
KMHUSTED LATERAL DRAINAGE WATERSHED
KMAREA = 67.80 AC = 0.1059 SQ MI
BA0.1059
LS            84       49
UD  1.20
*
KKHLDET5
KO     3                                21
KMSOUTH OF "E" sTREET  AND EAST OF HUSTED rOAD
KMDETENTION BASIN  FOR HL25
KMASSUMES THE FOLLOWING PARAMETERS:
*
* ********************************************************************
* *                 BOTTOM WIDTH(FT)                    401
* *                 BOTTOM LENGTH (FT)                  401
* *                 BOTTOM AREA (AC)                   3.69
* *                 SIDE SLOPES (H:V)                   3:1
* *                 DEPTH (FT)                            4
* *                 TOP WIDTH (FT)                      425
* *                 TOP LENGTH (FT)                     425
* *                 TOP AREA (AC)                      4.15
* *                 VOLUME (AC-FT)                     17.0
* *                 DISCHARGE (PUMP)                    2.0
* *                 BOTTOM ELEVATION(FT)                 85
* *                 TOP ELEVATION (FT)                   89
* ********************************************************************
*
RS     1    STOR      -1
SA  3.69    4.15
SE    85      89
SQ     0       2
SS 88.00      20    2.75     1.5
*
KK  C413
KMCOMBINE FLOW AT HUSTED LATERAL W FLOW FROM HL13& NORTHEAST DRAIN
HC     4
*
KK RR416
KMROUTE FLOW TO THE NORTH IN HUSTED LATERAL DRAINAGE TO HL26
RD  2700   0.003   0.045            TRAP       5       3
*
KK  HL26
KO     3                                21
KMHUSTED LATERAL DRAINAGE WATERSHED
KMAREA = 129.15 AC = 0.2018 SQ MI
BA0.2018
LS            84       49
UD  1.41
*
KKHLDET6
KO     3                                21
KM2600' NORTH OF "E" STREET  AND EAST OF HUSTED ROAD
KMDETENTION BASIN  FOR HL26
KMASSUMES THE FOLLOWING PARAMETERS:
*
* ********************************************************************
* *                 BOTTOM WIDTH(FT)                    576
* *                 BOTTOM LENGTH (FT)                  576
* *                 BOTTOM AREA (AC)                   7.62
* *                 SIDE SLOPES (H:V)                   3:1
* *                 DEPTH (FT)                            4
* *                 TOP WIDTH (FT)                      600
* *                 TOP LENGTH (FT)                     600
* *                 TOP AREA (AC)                      8.26
```

ATTACHMENT 4
CALCULATIONS FOR MODEL INPUT FOR THE DESIGN-INTERIM SCENARIO

LAUGENOUR & MEIKLE
CALCULATIONS
SEPTEMBER 20, 2021

WEIGHTED CN VALUES

NE16: $CN = (1-i)84 + (i)(98)$

$= (1-.12)84 + (.12)(98)$

$= 73.92 + 11.76 \rightarrow CN_{weighted} = 86$

$L = 3700$ ft

$S = (1000/CN) - 10 \rightarrow (1000/86) - 10 \rightarrow S = 1.63$

$CN = 86$

$Y = .22$

$LAG = (L)^{0.8}(S+1)^{0.7}/1900(Y)^{0.5}$

$= (3700)^{0.8}(1.63+1)^{0.7}/1900(.22)^{0.5}$

$= 1.58 \rightarrow \boxed{LAG_{NE16} = 1.58}$ 94.8 minute

HL14: $CN = (1-i)84 + (i)(98)$

$= (1-.15)84 + (.15)(98)$

$= 71.4 + 14.7 \rightarrow CN_{weighted} = 86$

$L = 4400$ ft

$S = (1000/CN) - 10 \rightarrow (1000/86) - 10 \rightarrow S = 1.63$

$CN = 86$

$Y = .16$

$LAG = (L)^{0.8}(S+1)^{0.7}/1900(Y)^{0.5}$

$= (4400)^{0.8}(1.63+1)^{0.7}/1900(.16)^{0.5}$

$= 2.13 \rightarrow \boxed{LAG_{HL14} = 2.13}$ 127.8 minutes

NE17: $L = 3200$ ft

$S = (1000/CN) - 10 \rightarrow (1000/84) - 10 \rightarrow S = 1.90$

$CN = 84$

$Y = 0.9$

$$LAG = (3200)^{0.8}(1.90+1)^{0.7}/1900(.09)^{0.5} \rightarrow \boxed{LAG_{NE17} = 2.36}$$

141.6 minute

HL13: $L = 1500$ ft

$S = (1000/CN) - 10 \rightarrow (1000/90) - 10 \rightarrow S = 1.11$

$CN = 90$

$Y = .11$

$$LAG = (1500)^{0.8}(1.11+1)^{0.7}/1900(.11)^{0.5} \rightarrow \boxed{LAG_{HL13} = .93}$$

55.8 minutes