

(Amendment Letter)
**MASTER DEVELOPMENT DRAINAGE
PLAN AND FINAL DRAINAGE REPORT**
for SHILOH MESA & SHILOH MESA
FILING NO. 1 and FINAL DRAINAGE
REPORT for SHILOH MESA
FILINGS NO. 2 AND NO. 3

April 2016

Prepared for:

COLA, LLC
1710 Jet Stream Drive
Colorado Springs, CO 80921
Mike DeGrant

Prepared by:



20 Boulder Crescent, Suite 110
Colorado Springs, CO
80903 (719) 955-5485

Project #08-026

(Amendment Letter)

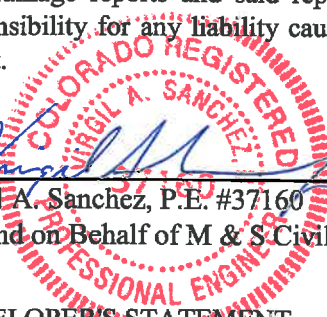
To the MASTER DEVELOPMENT DRAINAGE PLAN AND FINAL DRAINAGE REPORT for SHILOH MESA FILING NO. 1 & FINAL DRAINAGE LETTER FOR SHILOH MESA FILING NO. 2 & 3

DRAINAGE PLAN STATEMENTS

ENGINEER'S STATEMENT

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the established criteria for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Virgil A. Sanchez, P.E. #37160
For and on Behalf of M & S Civil Consultants, Inc.



DEVELOPER'S STATEMENT

I, the developer, have read and will comply with all the requirements specified in this drainage report and plan.

COLA, LLC

BY: Mike DeGrant DATE: 4-19-16

TITLE: Owner & Manager

ADDRESS: COLA, LLC
1710 Jet Stream Drive
Colorado Springs, CO 80921

CITY OF COLORADO SPRINGS

Filed in accordance with Section 7-7-906 of the Code of the City of Colorado Springs, 2001, as amended.

BY: For the City Engineer DATE: 4/22/16

CONDITIONS:

(Amendment Letter)

To the MASTER DEVELOPMENT DRAINAGE PLAN AND FINAL DRAINAGE REPORT for SHILOH MESA FILING NO. 1 & FINAL DRAINAGE LETTER FOR SHILOH MESA FILING NO. 2 & 3

CERTIFICATION STATEMENT

"This report and plan for the final drainage design of Shiloh Mesa Filing No. 1 was prepared by me (or under my direct supervision) in accordance with the provisions of City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2, Drainage Design and Technical Criteria for the owners thereof. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others."

SIGNATURE:

Virgil A. Sanchez, P.E. #37160 For and on Behalf of M & S Civil Consultants, Inc.

"COLA, LLC hereby certifies that the drainage facilities for of Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. 1 & Shiloh Mesa Filing No. 2 & 3 shall be constructed according to the design presented in this report. COLA, LLC understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that the City of Colorado Springs reviews drainage plans pursuant to Colorado Revised Statutes, Title 30, Article 28 (verify reference to CRS); but cannot, on behalf of Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. 1 & Shiloh Mesa Filing No. 2 & 3, guarantee that final drainage design review will absolve COLA, LLC and/or their successors and /or assigns of future liability for improper design. COLA, LLC further understand that approval of the final plat does not imply approval of my engineer's drainage design."

COLA, LLC

BY: Mike DeGrant

DATE: 4-19-16

April 18, 2016

City of Colorado Springs
Subdivision Engineering Review Team
30 South Nevada Avenue, Suite 401
Colorado Springs, Colorado 80903
Attn: Elizabeth Nijkamp

RE: Amendment Letter to the Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa Filing No. 1 & Final Drainage Letter for Shiloh Mesa Filing No. 2 & 3.

Dear Elizabeth,

The following is the Final Drainage Letter for Shiloh Mesa Filing No. 2 & 3 to amend the "Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. 1", prepared by M&S Civil Consultants, Inc., dated December 2015. The amendment letter will address the grading changes incurred and drainage fees for Shiloh Mesa Filing No. 2 & 3. The * before a basin callout denotes previously studied in the "Master Development Drainage Plan for Woodmen Heights Master Plan", by Classic Consulting Engineers, & Surveyors, LLC., dated June 2004.

This letter is being prepared to accompany the proposed Final Plat for Shiloh Mesa Filing No. 2 (20.310 acres) & Filing No. 3 (14.554 acres). Grading changes will result in Drainage Basin G2 being divided into two basins (Basin G2 and Basin G2A, see Exhibit 1 Drainage Basin Revision). Basin G2A is located in the southeast corner of Filing No. 2, and contains 0.75 acres of backyards of single family residential lots. Runoff from roof drains shall drain to the front of the lot and will flow, via side lot swales, to the curb and gutter to Design Point G2. Basin G2A has proposed design flows of $Q_5=1.0$ cfs and $Q_{100}=2.9$ cfs (see Exhibit 2 Area Drainage Summary). Runoff from Basin G2A will sheet flow to the existing swale parallel to Mustang Road (Basin OSM). Basin OSM is located off-site and parallels the east edge of Shiloh Mesa Filing No. 2 & 3, and contains 1.03 acres of paved street and vegetated road swale. Basin OSM has design flows of $Q_5=1.2$ cfs and $Q_{100}=3.6$ cfs. The cumulative flows at Design Point M are $Q_5=2.2$ cfs, $Q_{100}=6.5$ cfs (see Exhibit 3 Basin Routing Summary) and are conveyed south to Design Point G2A. The roadside swale has the capacity to carry 21 cfs at a one foot depth (see Exhibit 4 Open Channel Calculation). The road side swale has an approximate depth of four and a half feet at Design Point G2A. The flows are combined with flows from Basin *OS5 ($Q_5=72$ cfs, $Q_{100}=340$ cfs). The cumulative flows at Design Point G2A are $Q_5=72.7$ cfs, $Q_{100}=341.4$ cfs. The modified CDOT inlet at Design Point G2A has been sized to accept flows in the developed condition (see Exhibit 5 Weir and Orifice Calculation and Exhibit 6 Pipe Flow Calculation). Basin G2 is located in the southeast area of Filing No. 2, and contains 1.83 acres of single family residential lots and streets. Basin G2 has proposed design flows of $Q_5=3.7$ cfs and $Q_{100}=8.0$ cfs (see Exhibit 2 Area Drainage Summary). Runoff from Basin G2 will flow via curb and gutter to the existing Design Point G2. The proposed flows to Design Point G2 are less than the flows from the "Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. 1", prepared by M&S Civil Consultants, Inc., Design Point G2 ($Q_5=5.3$ cfs, $Q_{100}=11.2$ cfs). There is no change to Basin G1, shown only as reference. The overall grading changes will not adversely affect downstream inlets and storm infrastructure.

CONSTRUCTION COST OPINION

Public Drainage Facilities Reimbursable- 72" Storm Conveyance System (Filing No. 1)

Submitted with Shiloh Mesa Filing No. 1 Improvements. Use as reference only.

Item	Description	Quantity	Unit Cost	Cost
* 1.	72" RCP	1119 LF	\$350/LF	\$ 391,650.00
2.	22.7x3.0' CDOT Inlet	1 EA	\$25,000/LF	\$ 25,000.00
3.	Type 1 MH	2 EA	\$10,000/EA	\$ 20,000.00
				Total= \$ 436,650.00

Public Drainage Facilities Reimbursable- Sand Creek Improvements (Filing No. 2 & 3)

Item	Description	Quantity	Unit Cost	Cost
1.	Channel Selective Lining	2200 LF	\$150/LF	\$ 330,000.00
2.	Channel 10-yr Riprap	300 LF	\$150/LF	\$ 45,000.00
3.	Channel Grade Control	3 EA	\$150,000/EA	\$ 450,000.00
* 4.	72" RCP	94 LF	\$350/LF	\$ 32,900.00
				Total= \$ 857,900.00

* Temp 72" pipe will NOT BE CONSIDERED REIMB. (1-3A')

Pvt / Public Drainage Facilities NON-Reimbursable-Shiloh Mesa-Residential (Filing No. 2)

Item	Description	Quantity	Unit Cost	Cost
1.	18" RCP	16 LF	\$40/LF	\$ 640.00
2.	24" RCP	463 LF	\$50/LF	\$ 23,150.00
3.	30" RCP	281 LF	\$65/LF	\$ 18,265.00
4.	36" RCP	467 LF	\$75/LF	\$ 35,025.00
5.	42" RCP	262 LF	\$85/LF	\$ 22,270.00
6.	Type 1 MH	5 EA	\$6,500/EA	\$ 32,500.00
7.	Type 2 MH	3 EA	\$4,500/EA	\$ 13,500.00
8.	4' Sump Inlet	3 EA	\$3,000/EA	\$ 9,000.00
9.	6' Sump Inlet	1 EA	\$4,000/EA	\$ 4,000.00
10.	8' Sump Inlet	2 EA	\$5,000/EA	\$ 10,000.00
11.	Central WQ Pond Pvt*	1 EA	\$15,000/EA	\$ 15,000.00
12.	Type VL Riprap Pvt	60 CY	\$40/CY	\$ 2,400.00
				Total= \$ 185,750.00

* Includes outlet box, grate, and outlet and spillway riprap protection private (Pvt) facilities to be maintained by the HOA.

**Pvt / Public Drainage Facilities NON-Reimbursable-Shiloh Mesa-Residential (Filing No. 3)
No NON-Reimbursable Improvements**

Public Drainage Facilities NON-Reimbursable-Shiloh Mesa-Residential (Future Filing No.4)

Item	Description	Quantity	Unit Cost	Cost
1.	24" RCP	275 LF	\$50/LF	\$ 13,750.00
2.	Type 1 MH	1 EA	\$6,500/EA	\$ 6,500.00
3.	6' Sump Inlet	1 EA	\$4,000/EA	\$ 4,000.00
4.	North WQ Pond Pvt*	1 EA	\$15,000/EA	\$ 15,000.00
				Total= \$ 39,250.00

* Includes outlet box, grate, and outlet and spillway riprap protection private (Pvt) facilities to be maintained by the HOA.

DRAINAGE, BRIDGE AND POND FEES

The Shiloh Mesa-Residential site is located within the Sand Creek Drainage Basin. The site as defined above consists of 68.88 acres. Shiloh Mesa Filing No.1 consists of 19.956 acres, the remaining future filings total 48.924 acres. The 2015 Drainage, Bridge and Pond Fees per the City of Colorado Springs for these sites are listed below:

Shiloh Mesa Residential Filing No. 1 (19.956 ac)

Submitted with Shiloh Mesa Filing No. 1 Improvements. Use as reference only.

Drainage Fee:	\$10,247/acre x 19.499*acres	\$199,806.25
Bridge Fee:	\$ 622/acre x 19.499* acres	\$ 12,128.38
Pond Fee (Land):	\$ 1,070/acre x 19.499* acres	\$ 20,863.93
Pond Fee (Facilities):	\$ 3,005/acre x 19.499* acres	\$ 58,594.50
	Total fees:	\$291,393.06

***100-year flood plain subtracted out from developed acreage (0.457 ac).**

Shiloh Mesa Residential Filing No. 2 (20.310 ac)

Drainage Fee:	\$10,247/acre x 18.954*acres	\$194,221.64
Bridge Fee:	\$ 622/acre x 18.954* acres	\$ 11,789.39
Pond Fee (Land):	\$ 1,070/acre x 18.954* acres	\$ 20,280.78
Pond Fee (Facilities):	\$ 3,005/acre x 18.954* acres	\$ 56,956.77
	Total fees:	\$283,248.58

***100-year flood plain subtracted out from developed acreage (1.356 ac).**

Shiloh Mesa Residential Filing No. 3 (14.554 ac)

Drainage Fee:	\$10,247/acre x 13.955*acres	\$142,996.89
Bridge Fee:	\$ 622/acre x 13.955* acres	\$ 8,680.01
Pond Fee (Land):	\$ 1,070/acre x 13.955* acres	\$ 14,931.85
Pond Fee (Facilities):	\$ 3,005/acre x 13.955* acres	\$ 41,934.78
	Total fees:	\$208,543.53

***100-year flood plain subtracted out from developed acreage (0.599 ac).**

Shiloh Mesa Future Residential Filings No. 4 (14.060 ac)

Drainage Fee:	\$10,247/acre x 12.845* acres	\$131,622.72
Bridge Fee:	\$ 622/acre x 12.845* acres	\$ 7,989.59
Pond Fee (Land):	\$ 1,070/acre x 12.845* acres	\$ 13,744.15
Pond Fee (Facilities):	\$ 3,005/acre x 12.845* acres	\$ 38,599.23
	Total fees:	\$191,955.69

***100-year flood plain subtracted out from developed acreage (1.215 ac).**

DRAINAGE COST COMPARISON AND CREDIT SUMMARY

Sand Creek Drainage Basin Planning Study Assumed Costs (Filing No. 1)

Description	DBPS Cost	Inflation Multiplier	Today's Dollars-Reimbursable
Mustang Road 2-60" CMP	\$14,400	x 1.79	\$0*
<i>*Not to be installed with this Development</i>			
Reach 150-2 Riprap lined channel	\$480,000	x 1.79	\$859,200.00
			Total= \$859,200.00

Sand Creek Drainage Basin Planning Study Assumed Costs (Filing No. 2 & 3)

Sand Creek 160 Selective Lining	\$279,400	x 1.79	\$500,126.00
Sand Creek 160 Grade Control	\$64,800	x 1.79	\$115,992.00
Sand Creek 160 10-yr Riprap	\$71,400	x 1.79	\$127,806.00
			Total= \$743,924.00

Public Facilities:

Submitted with Shiloh Mesa Filing No. 1 Improvements. Use as reference only.

Total Public <u>Reimbursable</u> Estimated Cost-Shiloh Mesa Residential (Filing No. 1)	\$ 436,650.00
Total Estimated Drainage Facility Fees Filing No. 1 (19.499 ac)	\$ -199,806.25
Total Difference/Credit	\$ 236,843.75

***Because Public Reimbursable facility costs do exceed the fees due for drainage fees, \$236,843.75 is an excess cost at this time. Payment of Bridge and Pond Land is still required.**

Public Facilities:

Total Public <u>Reimbursable</u> Estimated Cost-Shiloh Mesa Residential (Filing 2&3)	\$ 857,900.00
Total Public <u>Reimbursable</u> Estimated Cost-Shiloh Mesa Filing 1 **Credit	\$ 236,843.75
Total Estimated Drainage Facility Fees Filing No. 2 (18.954 ac)	\$ -194,221.64
Total Estimated Drainage Facility Fees Filing No. 3 (13.955 ac)	\$ -142,996.89
Total Estimated Drainage Facility Fees Future Filing No. 4 (12.845 ac)	\$ -131,622.72
Total Difference/Credit	\$ 625,902.50

***Because Public Reimbursable facility costs do exceed the fees due for drainage fees, \$625,902.50 is a credit at this time. Payment of Bridge and Pond Land will still be required.**

****The "Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. 1", does not include the credit in the overall calculation. The credit will be accounted for in this report.**

AND POND FACILITIES.

Refer to the "Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. 1", prepared by M&S Civil Consultants, Inc., dated December 2015 for information regarding the "Sand Creek Drainage Basin Planning Study", prepared by Kiowa Engineering, CORP., dated Rev. March 1996, estimated storm infrastructure and Sand Creek improvement costs associated with Shiloh Mesa Residential Subdivision.

M & S Civil Consultants, Inc. (M & S) cannot and does not guarantee the construction cost will not vary from these opinions of probable costs. These opinions represent our best judgment as design professionals

familiar with the construction industry and this development in particular. The above is only an estimate of the facility cost and drainage basin fee amounts in 2016. Upon completion of the aforementioned improvements, M & S shall submit the actual construction costs to the City of Colorado Springs/City Drainage Board for reimbursement.

The amendment drainage letter for Shiloh Mesa Filing No. 2 & 3 and development of the Shiloh Mesa Filing No. 2 & 3 subdivisions shall not adversely affect adjacent or downstream property and is in accordance with the Master Development Drainage Plan and Final Drainage Report for Shiloh Mesa & Shiloh Mesa Filing No. 1.

Respectfully,

A handwritten signature in blue ink, appearing to read "Virgil A. Sanchez".

Virgil A. Sanchez, P.E.
M&S Civil Consultants, Inc.

Attachments:

- Exhibit 1-Basin Revision
- Exhibit 2-Area Drainage Summary
- Exhibit 3-Basin Routing Summary
- Exhibit 4-Open Channel Flow Calculation
- Exhibit 5-Weir VS Orifice Calculation
- Exhibit 6-Pipe Flow Calculation

**AMENDMENT TO THE MASTER DEVELOPMENT DRAINAGE PLAN SHILOH MESA
AND FINAL DRAINAGE REPORT FOR SHILOH MESA FILING NO. 1 &
FINAL DRAINAGE LETTER FOR SHILOH MESA FILING NO. 2 & 3
(Area Drainage Summary)**

From Area Runoff Coefficient Summary				OVERLAND				STREET / CHANNEL FLOW				Time of Travel (T _t)	INTENSITY *		TOTAL FLOWS	
BASIN	AREA TOTAL (Acres)	C _s	C ₁₀₀	C _s	Length (ft)	Height (ft)	T _c (min)	Length (ft)	Slope (%)	Velocity (fps)	T _t (min)	TOTAL (min)	I ₅ (in/hr)	I ₁₀₀ (in/hr)	Q ₅ (c.f.s.)	Q ₁₀₀ (c.f.s.)
	323											55.7			72.0	340.0
*OS5	1.03	0.27	0.45	0.27	18	0.4	5.1	1202	2.6%	5.6	3.6	8.6	4.3	7.7	1.2	3.6
OSM	1.83	0.50	0.80	0.50	160	4	10.5	408	2.0%	4.9	1.4	10.1	4.1	7.3	3.7	8.0
G2	0.75	0.30	0.50	0.30	77	6	6.7	440	1.7%	4.6	1.6	8.3	4.4	7.8	1.0	2.9

#REF!	CA ₅	Basin	CA ₁₀₀
	43.28	*OS5	114.67
	0.28	OSM	0.46
	0.92	G2	1.10
	0.23	G2A	0.38

* Intensity equations assume a minimum travel time of 5 minutes.

* "Master Development Drainage Plan for Woodmen Heights Master Plan" by Classic Consulting Engineers and Surveyors, LLC., dated June 2004

Calculated by: ET
Date: 2/16/2016
Checked by: VAS

EXHIBIT 2

**AMENDMENT TO THE MASTER DEVELOPMENT DRAINAGE PLAN SHILOH MESA
AND FINAL DRAINAGE REPORT FOR SHILOH MESA FILING NO. 1 &
FINAL DRAINAGE LETTER FOR SHILOH MESA FILING NO. 2 & 3
(Basin Routing Summary)**

From Area Runoff Coefficient Summary				OVERLAND				PIPE / CHANNEL FLOW				Time of Travel (T _c)	INTENSITY *		TOTAL FLOWS		COMMENTS
DESIGN POINT	CONTRIBUTING BASINS	CA ₅	CA ₁₀₀	C _s	Length (ft)	Height (ft)	T _c (min)	Length (ft)	Slope (%)	Velocity (fps)	T _c (min)	TOTAL (min)	I ₅ (in/hr)	I ₁₀₀ (in/hr)	Q ₅ (c.f.s.)	Q ₁₀₀ (c.f.s.)	
M	G2A + OSM	0.50	0.84								8.6		4.3	7.7	2.2	6.5	FLOW AT MUSTAND RD. WESTSIDE SWALE
G2A	G2A + OSM + *OS5	43.78	115.51								55.7		1.7	3.0	72.7	341.4	FLows AT MOD CDOT TYPE D INLET INCL. BASIN G2A

* Intensity equations assume a minimum travel time of 5 minutes.

* "Master Development Drainage Plan for Woodmen Heights Master Plan" by Classic Consulting Engineers and Surveyors, LLC., dated June 2004

Calculated by: ET
Date: 2/16/2016
Checked by: VAS

EXHIBIT 3

The open channel flow calculator

Select Channel Type:
Trapezoid ▾

Rectangle Trapezoid Triangle Circle

Velocity(V)&Discharge(Q) ▾ Select unit system: Feet(ft) ▾

Channel slope: <input type="text" value="0.0256"/> <small>ft/ft</small>	Water depth(y): <input type="text" value="1"/> <small>ft</small>	Bottom width(b): <input type="text" value="1"/> <small>ft</small>
Flow velocity <input type="text" value="5.295"/> <small>ft/s</small>	LeftSlope (Z1): <input type="text" value="3"/> to 1 (H:V)	RightSlope (Z2): <input type="text" value="3"/> to 1 (H:V)
Flow discharge <input type="text" value="21.1802"/> <small>ft³/s</small>	Input n value <input type="text" value="0.03"/> or select r	
Calculate!	Status: <input type="text" value="Calculation finished"/>	Reset
Wetted perimeter <input type="text" value="7.32"/> <small>ft</small>	Flow area <input type="text" value="4"/> <small>ft²</small>	Top width(T) <input type="text" value="7"/> <small>ft</small>
Specific energy <input type="text" value="1.44"/> <small>ft</small>	Froude number <input type="text" value="1.23"/>	Flow status <input type="text" value="Supercritical flow"/>
Critical depth <input type="text" value="1.1"/> <small>ft</small>	Critical slope <input type="text" value="0.0162"/> <small>ft/ft</small>	Velocity head <input type="text" value="0.44"/> <small>ft</small>

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EXHIBIT 4

WEIR VS ORIFICE CALCULATION

width	2.916667	area	66.11111	open area	33.05556
length	22.66667	blockage	0.5		
perimeter	51.16667	blockage	4	avail perm.	47.16667
				Orifice	Weir
39.19	0			0	0
39.315	0.125			56.27217	6.461925
39.44	0.25			79.58086	18.27708
39.565	0.375			97.46625	33.57715
39.69	0.5			112.5443	51.6954
39.815	0.625			125.8284	72.24652
39.94	0.75			137.8381	94.97051
40.065	0.875			148.8822	119.6765
40.19	1			159.1617	146.2167
40.315	1.125			168.8165	174.472
40.44	1.25			177.9482	204.344
40.565	1.375			186.6337	235.7496
40.69	1.5			194.9325	268.6172
40.815	1.625			202.8922	302.8844
40.94	1.75			210.5512	338.4963
41.065	1.875			217.9412	375.4039
41.19	2			225.0887	413.5632
41.315	2.125			232.0161	452.9344
41.44	2.25			238.7426	493.4813
41.565	2.375			245.2847	535.1707
41.69	2.5			251.6568	577.9721
41.815	2.625			257.8715	621.8574
41.94	2.75			263.9399	666.8005
42.065	2.875			269.8718	712.777
42.19	3			275.6762	759.7641
42.315	3.125			281.3608	807.7406
42.44	3.25			286.9329	856.6865
42.565	3.375			292.3988	906.5829
42.69	3.5			297.7643	957.4122
42.815	3.625			303.0349	1009.157
42.94	3.75			308.2154	1061.803
43.065	3.875			313.3102	1115.333
43.19	4			318.3235	1169.733
43.315	4.125			323.259	1224.991
43.44	4.25			328.1203	1281.092
43.565	4.375			332.9106	1338.024
43.69	4.5			337.633	1395.776
HP 43.75 → 43.815	4.625		340± →	342.2902	1454.335
43.94	4.75			346.8849	1513.691
44.065	4.875			351.4196	1573.834



Ultimate - GD&T Wall Chart
ASME Y14.5-2009 Standard
Laminated, 24" x 36" - Awesome!



Partially Full Pipe Flow Calculator and Equations

Fluid Flow Table of Contents | Hydraulic and Pneumatic Knowledge
Fluid Power Equipment

This engineering calculator determines the Flow within a partially full pipe using the Manning equation. This calculator can also be used for uniform flow in a pipe, but the Manning roughness coefficient needs to be considered to be variable, dependent upon the depth of flow.

Partially Full Pipe Flow Calculations - U.S. Units

II. Calculation of Discharge, Q, and average velocity, V
for pipes more than half full

Instructions: Enter values in blue boxes. Calculations in yellow

Inputs

Pipe Diameter, D = 72 in
Depth of flow, y = 70 in

(must have $y \geq D/2$)

Full Pipe Manning roughness, n_{full} = 0.013
Channel bottom slope, S = 0.006 ft/ft

Calculations
 n/n_{full} = 1.0138888
Partially Full Manning roughness, n = 0.013

Calculations

Pipe Diameter, D = 6 ft
Pipe Radius, r = 3 ft

Circ. Segment Height, h = 0.167 ft

Central Angle, θ = 0.67 radians
Cross-Sect. Area, A = 28.05 ft^2

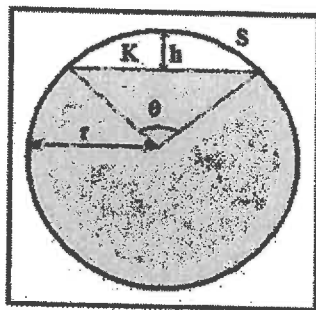
Wetted Perimeter, P = 16.8 ft
Hydraulic Radius, R = 1.67 ft
Discharge, Q = 345.21 cfs
Ave. Velocity, V = 12.31 ft/sec

pipe % full $[(A/A_{full}) * 100\%]$ = 99.2%



Fabrico is the leader in manufacturing engineered flexible materials for medical applications

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Partially Full Pipe Flow Parameters (More Than Half Full)

$r = D/2$

$h = 2r - y$

(hydraulic radius)

$R = A/P$

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

$V = Q/A$

$\theta = 2 \arccos \left(\frac{r-h}{r} \right)$

$A = \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2}$

$P = 2\pi r - r * \theta$

Equation used for n/n_{full} : $n/n_{full} = 1.25 - (y/D - 0.5) * 0.5$ (for $0.5 \leq y/D \leq 1$)

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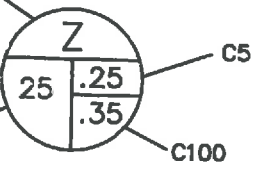




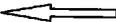
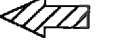









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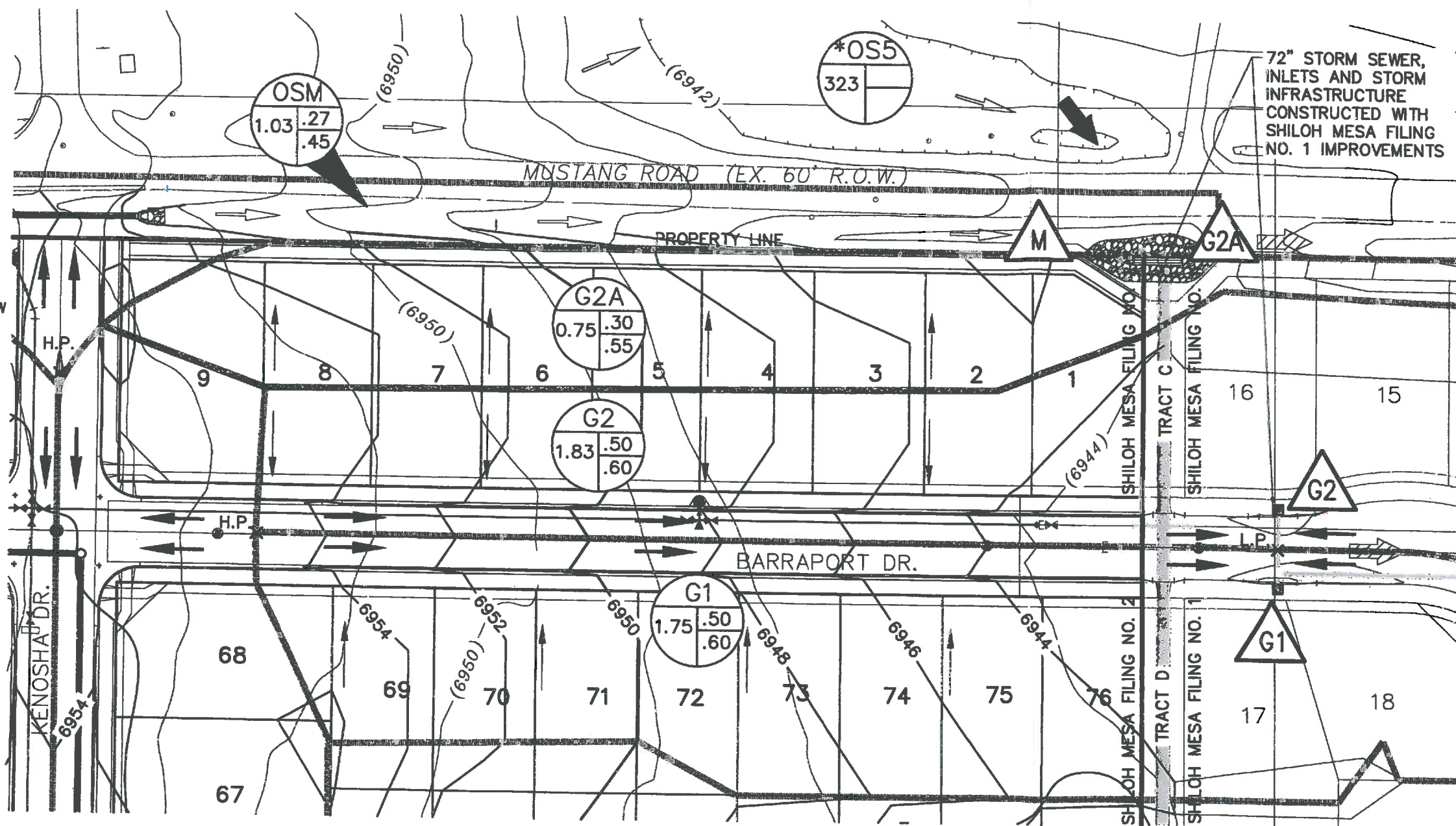
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EXHIBIT 6

LEGEND

- BASIN DESIGNATION 
- ACRES
-  SURFACE DESIGN POINT
-  BASIN BOUNDARY
-  PROPOSED LOT DRAINAGE FLOW
-  PROPOSED FLOW DIRECTION ARROW
-  EXISTING FLOW DIRECTION ARROW
-  EMERGENCY OVERFLOW DIRECTION
- LOT 11  LOT NUMBER
- H.P.  HIGH POINT
- L.P.  LOW POINT
-  STORM SEWER PIPE
-  INLET
-  EXISTING MAJOR CONTOUR
-  EXISTING MINOR CONTOUR
-  PROPOSED MAJOR CONTOUR
-  PROPOSED MINOR CONTOUR



CIVIL CONSULTANTS, INC.
 20 BOULDER CRESCENT, SUITE 110
 COLORADO SPRINGS, CO 80903
 PHONE: 719.955.5485

BASIN SUMMARY			
BASIN	AREA (ACRES)	Q5	Q100
*OS5	323	72	340
G1	1.75	3.3	7.1
G2	1.83	3.7	8.0
G2A	0.75	1.0	2.9

*"MASTER DEVELOPMENT DRAINAGE PLAN FOR WOODMEN HEIGHTS MASTER PLAN" BY CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC., DATED JUNE 2004

DESIGN POINT SUMMARY			
DESIGN POINT	Q5	Q100	BASIN
M	2.2	6.5	G2A, OSM
G2A	72.7	341.4	G2A, OSM, *OS5
G2	3.7	8.0	G2

EXHIBIT 1 DRAINAGE BASIN REVISION FOR MASTER DEVELOPMENT DRAINAGE PLAN AND FINAL DRAINAGE REPORT FOR SHILOH MESA FILING NO. 1 & FINAL DRAINAGE LETTER FOR SHILOH MESA FILING NO. 2 & 3

