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CE 5338

Hydrologic Engineering,

Professor Martin Pierson

HW 4, Sep. 21, 2022

```python
In [1]: from wand.image import Image as WImage
        img = WImage(filename='5338 HW 4 Gutter Flow.pdf')
        img
```

Out[1]:

CE 5338

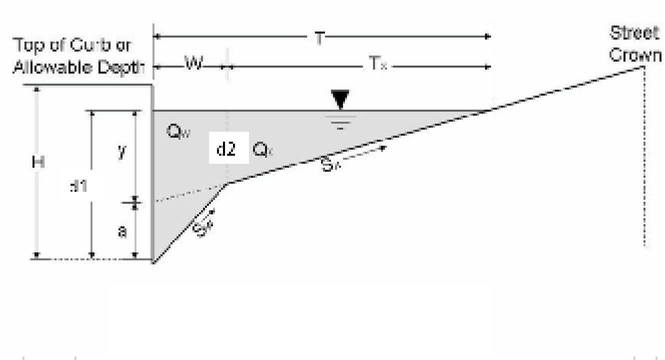
Pierson **HYDROLOGIC ENGINEERING**

Assignment #4

Street Drainage (10 points)

1. Use the provided screen shot and the equations from the presentation in class (6 2 Street Drainage.pdf) as a guide, create your own spread sheet that solves the gutter flow equations. (note: the "Pass" is an option to check the depth d1 is less than H)

Inundation Calculations			
[illegible]			
Long Street Slope	SL	[illegible]	ft/ft
Transverse Street Slope	SX	[illegible]	ft/ft
Transverse Gutter Slope	SW	[illegible]	ft/ft
Manning n	n	[illegible]	
GEOMETRY			
Spread	T	[illegible]	ft
Curb Width	W	2	ft
Tx	Tx	[illegible]	ft
a	a	[illegible]	[illegible]
d2	d2	[illegible]	ft
d1 or y	d1	[illegible]	
Max Depth Criteria	H	[illegible]	ft
d1 < H		PASS	
FLOW			
Street Flow	Qx	[illegible]	cfs
Gutter Flow	Qw	[illegible]	cfs
Total Flow	Q	[illegible]	cfs



2. Using your spreadsheet, determine the depth of flow (d1) and the street spread (T) using the following inputs: Q= 7.5cfs, SL = 0.025 ft/ft, Sx = 0.021 ft/ft, Sw = 0.0833 ft/ft, n = 0.015, and W = 3 ft. Use a screen shot to record your solution.

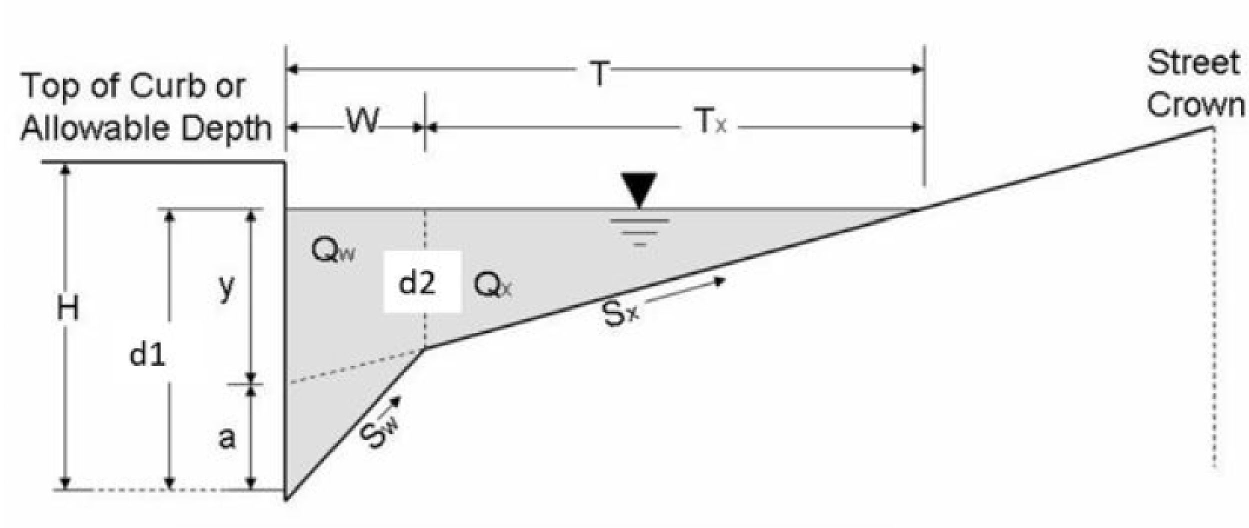
3. Determine the intercepted flow and bypass flow for a street inlet that is 7' wide (L), with Q= 7.5cfs, SL = 0.025 ft/ft, Sx = 0.021 ft/ft, Sw = 0.0833 ft/ft, n = 0.015, and W = 3 ft and a clog reduction of 10%.

4. Determine the inlet flow rate (Qi) for an inlet of type SS-3 with L = 7', h = 10" with the following depths: 4", 1', and 2'.

5. A long rectangular property that drains to the street will be developed as a park with an average C of 0.5. The width of the park is 200 feet and the street is 30 feet wide. Determine where to place the first inlet such that the flow for the two year storm is 5cfs at the inlet.

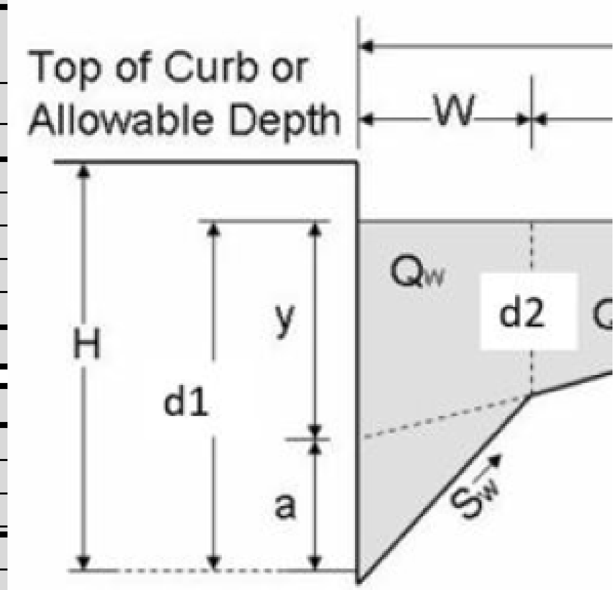
6. Let's combine problem 5 and 2 to determine the location of the second inlet from problem 5. Using the inlet and street properties from 3 determine the location of the second inlet from problem 5.

1. Use the provided screen shot and the equations from the presentation in class (6 2 Street Drainage.pdf) as a guide, create your own spread sheet that solves the gutter flow equations. (note: the "Pass" is an option to check the depth d1 is less than H)



Note corrected derivation for "a" height.

	Inundation Calculations		Eng or SI
Flow	Street Flow (Qs)	1.269	cfs
	Gutter Flow (Qw)	4.736994	cfs
	Total Flow (Q)	**6.006**	cfs
Slope	Long street (S_L)	0.02	ft /ft
	Transverse street (Sx)	0.021	ft /ft
	Transverse gutter (Sw)	0.0833	ft /ft
	Manning n: (n)	0.015	
Geometry	Flow: d1<H	Sufficient	
	H: max depth criteria	0.500	ft
	d1 = y+a | d2 + W*Sw	0.388	ft
	a = d1 - W*Sx	0.20	ft
	d2	0.13797	ft
	Tx	6.57	ft
	W: Curb Width	3	ft
	T: Spread	9.57	ft



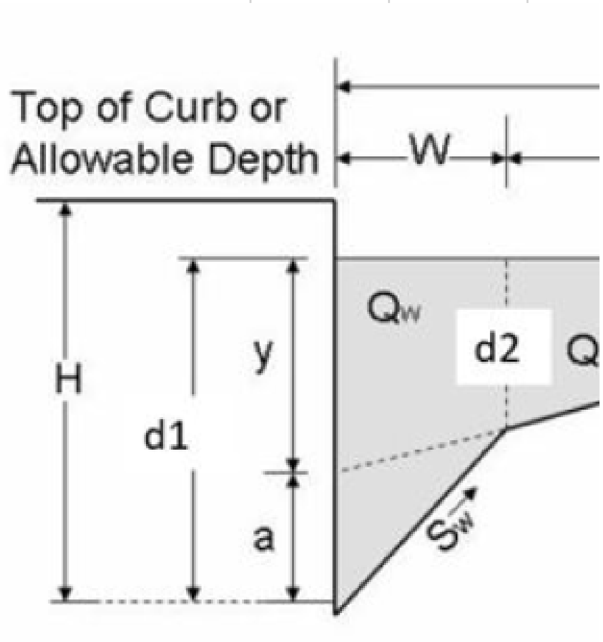
Inlet Efficiency	Inlet E% Above + L_inlet = 6ft, Clog 10% reduce		
Input			
Length (Design)	**6.000**	**ft**	L
Efficiency	0.46		E
Length for E=100%	20.96	ft	Lt
Slope Equivalent X	0.088612	ft/ ft	Se
Ratio of flow gutter	0.788		E0
Clog Factor	0.10		
Intercepted Flow Qr*E	2.460112	cfs	Qi = E*Q(1-Clog)
Bypass flow Q-Qi	3.55	cfs	Qb

2. Using your spreadsheet, determine the depth of flow (d1) and the street spread (T) using the following inputs: Q = 7.5cfs, SL = 0.025 ft/ft, Sx = 0.021 ft/ft, Sw = 0.0833 ft/ft, n = 0.015, and W = 3 ft. Use a screen shot to record your solution.

d1 = 0.4 ft

T = 10.17 ft

	Inundation Calculations		Eng or SI
Flow	Street Flow (Qs)	1.793	cfs
	Gutter Flow (Qw)	5.706756	cfs
	Total Flow (Q)	**7.500**	cfs
Slope	Long street (SL)	0.025	ft /ft
	Transverse street (Sx)	0.021	ft /ft
	Transverse gutter (Sw)	0.0833	ft /ft
	Manning n: (n)	0.015	
Geometry	Flow: d1<H	Sufficient	
	H: max depth criteria	0.500	ft
	d1 = y+a | d2 + W*Sw	0.401	ft
	a = d1 - W*Sx	0.21	ft
	d2	0.1506	ft
	Tx	7.17	ft
	W: Curb Width	3	ft
	T: Spread	10.17	ft



Inlet Efficiency	Inlet E% Above + L_inlet = 6ft, Clog 10% reduce		
Input			
Length (Design)	**6.000**	**ft**	L
Efficiency	0.40		E
Length for E=100%	24.58	ft	Lt
Slope Equivalent X	0.088746	ft/ ft	Se
Ratio of flow gutter	0.760		E0
Clog Factor	0.10		
Intercepted Flow Qr*E	2.671512	cfs	Qi = E*Q(1-Clog)
Bypass flow Q-Qi	4.83	cfs	Qb

3. Determine the intercepted flow and bypass flow for a street inlet that is 7' wide (L), with Q = 7.5cfs, SL = 0.025 ft/ft, Sx = 0.021 ft/ft, Sw = 0.0833 ft/ft, n = 0.015, and W = 3 ft and a clog reduction of 10%.

$Qi = 5.19cfs$

4. Determine the inlet flow rate (Qi) for an inlet of type SS-3 with L = 7’, h = 10” with the following depths: 4”, 1’, and 2’.

$$Qi = 5.95cfs : 4inches$$

$$Qi = 36.97cfs : 1ft.$$

$$Qi = 5.19cfs : 2ft.$$

It grows drastically with increasing depth.

5. A long rectangular property that drains to the street will be developed as a park with an average C of 0.5. The width of the park is 200 feet and the street is 30 feet wide. Determine where to place the first inlet such that the flow for the two year storm is 5cfs at the inlet.

Q =C*i*L*W

1 ft/s = 43200 in/hour

L = Q/(C*i*W)

assume 5.45in/hr for 2 year storm

L = 5/(0.5*5.45/43200*(200+30))

L = 344.64 ft

6. Let’s combine problem 5 and 2 to determine the location of the second inlet from problem 5. Using the inlet and street properties from 3 determine the location of the second inlet from problem 5.

This makes sense for terrain, rain fall rate, and conditions changing downstream (non-uniform).

$Q_i = Q - Q_b$ $L_{out} = Q_i/(c * i * W)$

$$L_{out} = 184.14ft$$

In [ ]:

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