CEEn-2016CPST-002

Soil Data Percolation App Development

SWL Engineers

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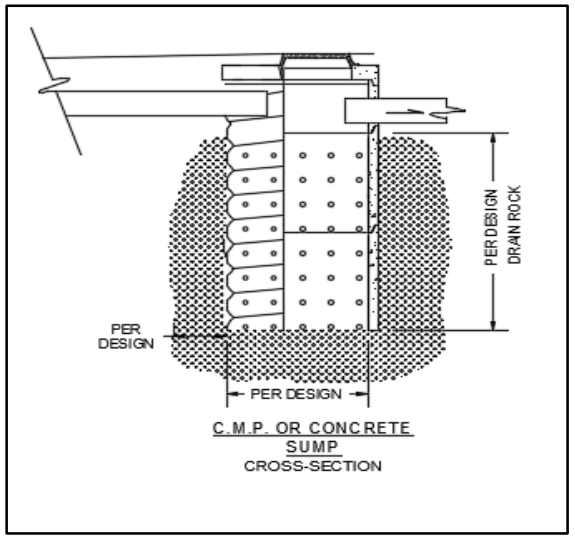
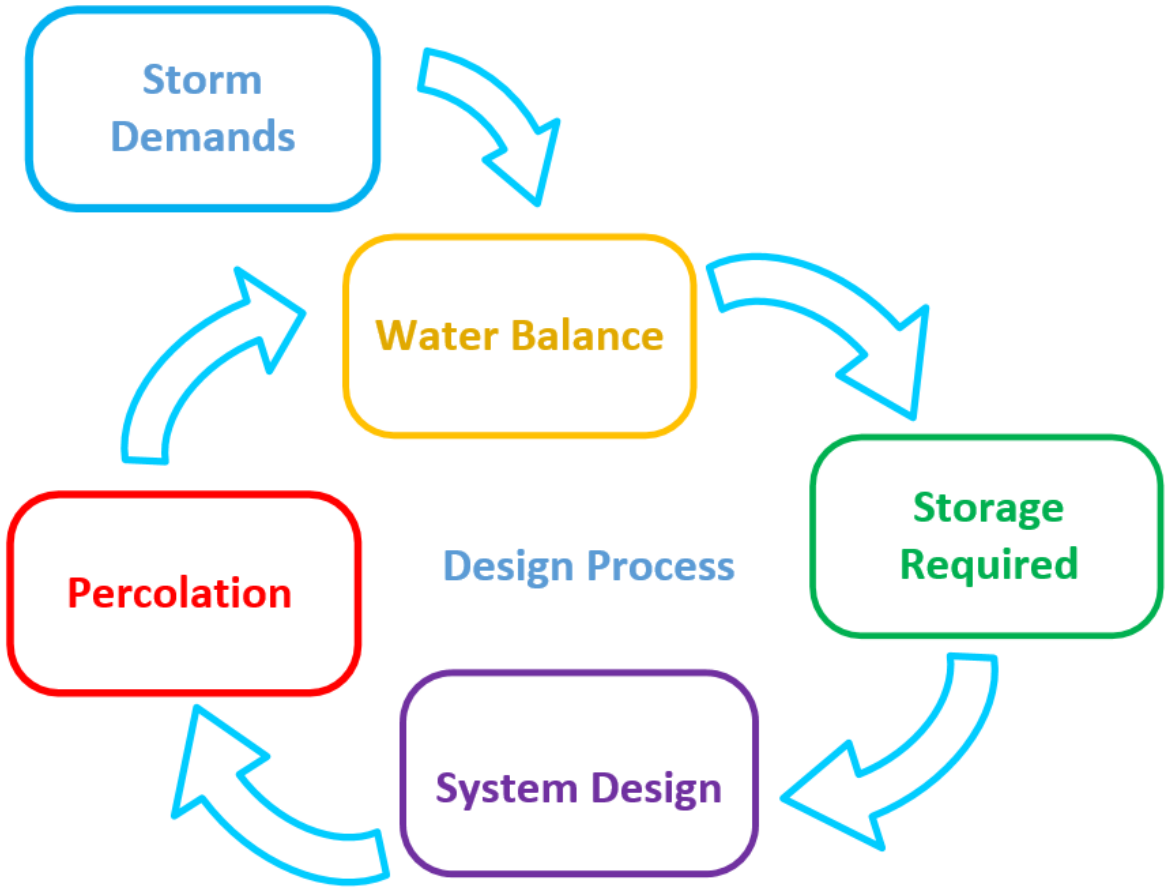
Introduction

- **Project Requirements:**
  - **Develop an application to design multiple types of storm water management systems while taking into account percolation.**



Design, Analysis & Results



Spreadsheet Sample

System of Interest	Sump	Select the system of Interest or NONE for preliminary design
Calculated Percolation	Active: Yes	The Percolation Rate is System Dependent and can be turned ON/OFF with the Active selection of Yes/No. The allowable release rate must be consistent with your system. If you need to change it then please revesit the HOME page.
Percolation Rate	0.52725215 [cfs]	
Allowable Release Rate:	0 [cfs]	
Storm of Interest		Select a storm event and input a storm duration of interest. If interested in just the maximum storage required for the particular storm event then simply insert 999 for the storm duration.
Storm Duration	999 Hours	
Storm Event	5 Year Storm	
Input Value	Active: No	If you wish to observe the critical inflow (Qp) for inlet design then either input a value or use a calculated value for the time of concentration.
Time of Concentration:	20 (min)	
Calculated Value	Active: Yes	
Time of Concentration:	4 (min)	

Water Balance Table for Given Storm

Duration		Rainfall			Surface			Percolation		Outflow (Release)		Storage
		Depth	Intensity	Volume	Runoff	R Volume	Q Peak	Q	Q Volume	Q	Q Volume	Volume
[days]	[min]	[in]	[in/hr]	[ft^3]	[cfs]	[ft^3]	[cfs]	[cfs]	[ft^3]	[cfs]	[ft^3]	[ft^3]
0.003	5	0.22	2.64	7986	15.58	4673	15.58	0.53	158.18	0	0	4515
0.007	10	0.34	2.01	12342	11.86	7115	11.86	0.53	316.35	0	0	6799
0.010	15	0.41	1.66	14883	9.79	8815	9.79	0.53	474.53	0	0	8340
0.021	30	0.56	1.12	20328	6.61	11894	6.61	0.53	949.05	0	0	10945
0.042	60	0.69	0.69	25047	4.07	14656	4.07	0.53	1898.11	0	0	12757
0.083	120	0.80	0.40	29040	2.36	16992	2.36	0.53	3796.22	0	0	13196
0.125	180	0.90	0.30	32670	1.77	19116	1.77	0.53	5694.32	0	0	13422
0.250	360	1.11	0.19	40293	1.12	24214	1.12	0.53	11388.65	0	0	12825
0.500	720	1.41	0.12	51183	0.71	30586	0.71	0.53	22777.29	0	0	7808
1.000	1440	1.67	0.07	60621	0.41	35683	0.41	0.53	45554.59	0	0	0
2.000	2880	1.96	0.04	71148	0.24	40781	0.24	0.53	91109.17	0	0	0
3.000	4320	2.18	0.03	79134	0.18	45878	0.18	0.53	136663.76	0	0	0
4.000	5760	2.40	0.03	87120	0.18	61171	0.18	0.53	182218.34	0	0	0
7.000	10080	2.79	0.02	101277	0.12	71366	0.12	0.53	318882.10	0	0	0
10.000	14400	3.14	0.01	113982	0.06	50976	0.06	0.53	455545.86	0	0	0

Storage Required: 13422 [ft^3]

R-Tank Design

R-Tank storm water systems are efficient underground storage devices. R-Tanks are made up of modular units that allow for 95% of their volume to be used as storage. This design sheet allows the user to specify the layout of the modular units and determine a volume capable of meeting the maximum storage required from the storm criteria on the HOME and Water Balance Pages.

Project Description:

Project Name:	R-Tank at Target Parking Lot
Street Address:	57 N 82 E
City, State:	Orem, Utah
Zip Code:	84057
Latitude:	40.2
Longitude:	-111.63
Date:	3/16/2017

The project description refrences the HOME Page. If you desire to change anything then please revist the HOME Page.

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Dimensions & Details

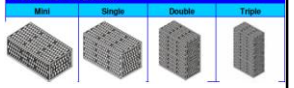
Module	Width	Length	Height	Tank Volume	Storage Volume	Weight
[Units]	[in]	[in]	[in]	[ft^3]	[ft^3]	[lbs]
Mini	15.75	28.15	9.45	2.42	2.3	10.19
Single (1)	15.75	28.15	17.32	4.44	4.22	15.73
Single + Mini (1.5)	15.75	28.15	25.98	6.67	6.33	23.61
Double (2)	15.75	28.15	33.86	8.69	8.25	27.15
Double + Mini (2.5)	15.75	28.15	42.52	10.91	10.36	37.02
Triple (3)	15.75	28.15	50.39	12.93	12.28	42.56
Triple + Mini (3.5)	15.75	28.15	59.06	15.15	14.39	50.43
Quad (4)	15.75	28.15	66.93	17.17	16.31	55.97
Quad + Mini (4.5)	15.75	28.15	75.59	19.39	18.42	63.85
Pent (5)	15.75	28.15	83.46	21.41	20.34	69.38
None	0	0	0	0	0	0

Specifications

Item	Description
Void Area	Area available for water storage vs. that made up of plastic
Surface Area Void	Open area where water may percolate into or out of the unit
Rib Thickness	Thickness of load-bearing members
Unit Weight	Weight of plastic per cubic foot of tank
Service Temperature	Operating temperatures where unit can be expected to perform
Uncontined Crush Strength*	Using a 5" x 5" load plate placed centrally over the unit will det at which the top plate with bend to the point of failure
Unconfined Crush Strength*	Using a full-size load plate that completely covers the top of th the pressure required to crush the entire unit
Recycled Content	Percentage of product made from Recycled Polypropylene
180 Day Creep Testing	Used to determine the long-term performance of the system: Load Applied, Creep Sustained, Creep Sustained, Projected Creep

*All crush eras performed on units with two internal plates.

Product Pictures



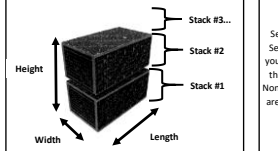
Unit Stack

Stack #	Module Type	Height [in]	Tank Volume [ft^3]	Storage Volume [ft^3]	Weight [lbs]
1	Pent (5)	83.46	21.41	20.34	69.38
2	None	0	0	0	0
3	None	0	0	0	0
4	None	0	0	0	0
5	None	0	0	0	0
6	None	0	0	0	0
7	None	0	0	0	0
8	None	0	0	0	0
9	None	0	0	0	0
10	None	0	0	0	0

Per Unit Stack Totals

Width	1.31	[ft]
Length	2.35	[ft]
Height	6.96	[ft]
Tank Volume	21.41	[ft^3]
Storage Volume	20.34	[ft^3]
Weight	69.38	[lbs]

Unit Stack Layout



Select a Module from the Unit Stack Section and add as many modules as you want up to 10. If you do not desire that many then just leave the rest as None. The dimensions of one unit stack are automatically calculated using the table above.

Stack Layout

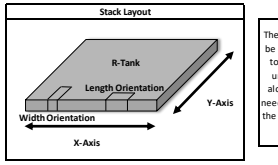
	Width Orientation #	Length Orientation #	Measurement Along Axis	
# of Unit Stacks Along the X-Axis	33		43.31	[ft]
# of Unit Stacks Along the Y-Axis		30	70.38	[ft]

Tank Dimensions

Area of Tank	3048.1	[ft^2]
Volume of Tank	21199.7	[ft^3]
Storage of Tank	20139.7	[ft^3]
Surface Area of Tank	7677.6	[ft^2]

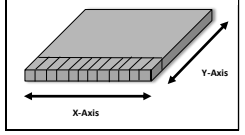
Choose a stack layout that you think will work. The width orientation is the short side oriented on the axis and the length orientation is the long side. The tank dimensions are automatically calculated.

Stack Layout



The width and length orientations may be confusing at first but use the figure to the left to aid you. If you place all unit stacks in the width orientation along the X-Axis, that means you will need at least 1 Length Orientation along the Y -Axis. Similar to a layout shown to the right.

12 stacks width oriented along the X-Axis and 1+ stacks length oriented along the Y-Axis

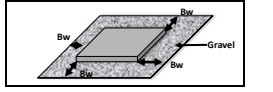


Gravel Distribution

Void Ratio of Gravel	0.33	
Buffer Width (Bw)	2	[ft]
Gravel Above Tank	2	[ft]
Gravel Below Tank	2	[ft]
Volume of Gravel	5157.07	[ft^3]
Storage Volume in Gravel	1701.83	[ft^3]

Type in the void ratio of the gravel you will be using along with the buffer width around your tank and the gravel above and below the tank. Gravel will provide additional storm water storage.

Gravel Distribution



System Dimensions

Height of System Including Gravel	10.96	[ft]
Depth of System From Ground Surface	15.00	[ft]
Width of System Including Gravel	47.31	[ft]
Length of System Including Gravel	74.38	[ft]
Footprint Area of System	3518.87	[ft^2]
Surface Area of System	9703.91	[ft^2]

Based on the parameters and inputs, the sytem dimensions and storage capacity are automatically calculated. Make sure to select R-Tank as the system of interest on the Water Balance Page. Based off of the criteria on that page, the volume of storage required is calculated and shown below. Adjust your system design until the capacity meets the demands set forth on the Water Balance Page.

Storage Capacity of System	21842	[ft^3]

Volume Required Based off Water Balance	
13422	[ft^3]
Sump Selected on Water Balance Page	

Does your system meet the demands?
YES

Percolation

Surface Area of Percolation	1161.23	[ft^2]
Depth of Ground Water Table	50	[ft]
L	35	[ft]
Ke	0.07529	[ft/s]
iav	0.214285714	
Percolation Rate	1.6128	[cfs]

The percolation rate is automatically calculated based off the HOME Page inputs for Percolation. If you wish to neglect percolation you can deactivate it on the Water Balance Page.

Based on Option 2 on HOME Page

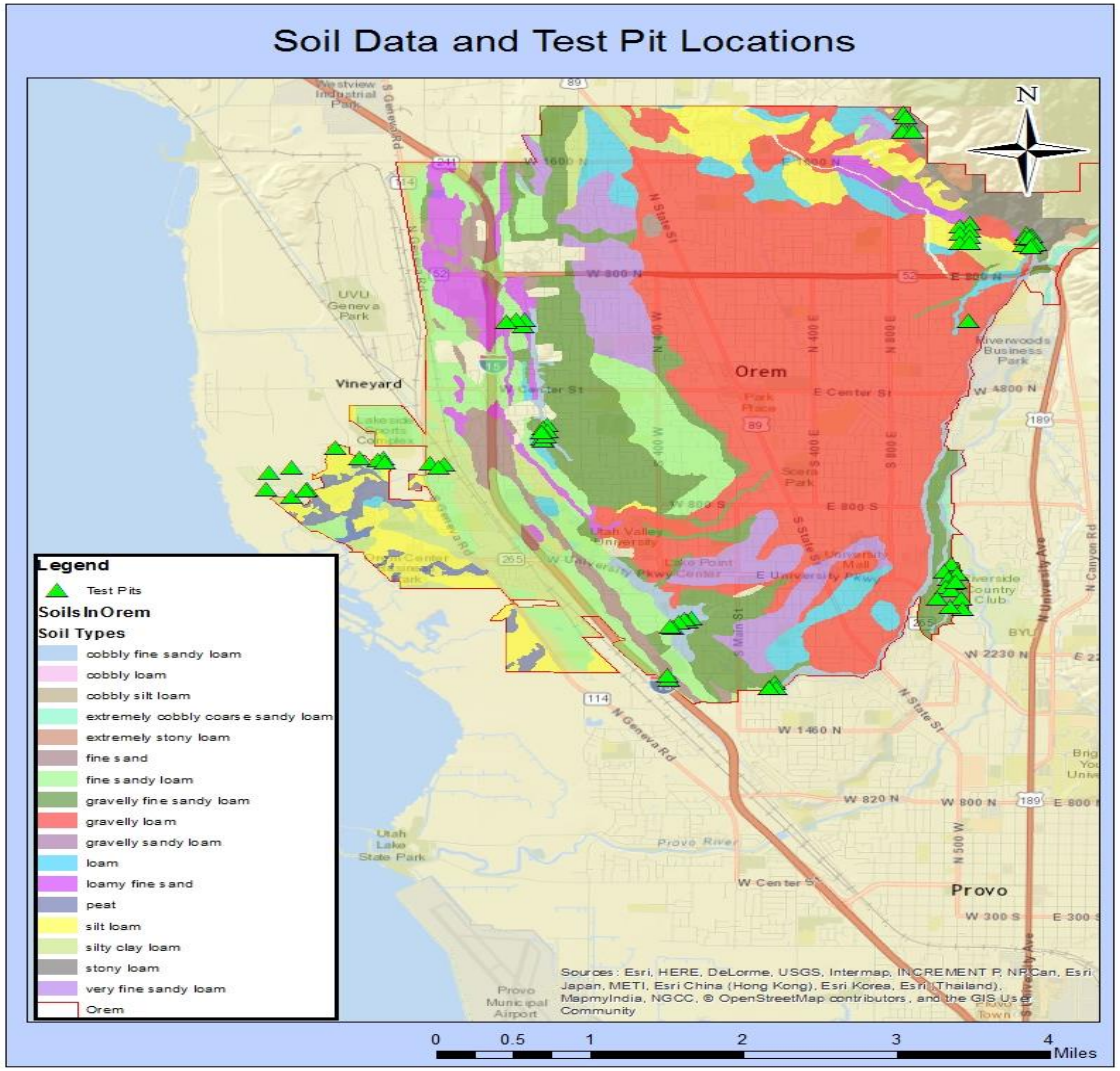
$$Percolation = k_e * A_e * i_{av}$$

Based on Option 1 on HOME Page

$$Percolation = Percolation$$

Conclusions & Recommendations

- Percolation's impact on the required storage volume depends on the system being used and soil type.
- Soil types even on the gravel bar in Orem vary from location to location. For accurate percolation values, a percolation test must be done for a specific site.
- The application is powerful enough to design for a variety of storms and soil types.



Picture References

- http://www.acfenvironmental.com (R-Tank)
- http://spel.com.au/products/stormchamber/ (Storm Chamber)
- Orem City Engineering Department (Sump)