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Job: Lot A (#19) Staniford St., Newton, MA
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COMMONWEALTH OF MASSACHUSETTS
TSUNG TING CHIANG
No. 23891
REGISTERED PROFESSIONAL ENGINEER

Storm Water Analysis & Control Facility Design

I. Project Description

The proposed project is to construct a residential building includes driveway, parking, and utilities on lot with total land area of 10,070 ft^2 or 0.231 acre. All existing structures shall be razed. On site soil test, performed by Bibbo Brothers, indicates the soil is sandy gravel with percolation rate under 2 MPI. No sign of ground water can be found in the 8' deep test pits.

II. Storm Water Analysis

Based on City of Newton requirement, any runoff increased, at 24 hours duration, 100-year storm with total rainfall of 8.78 inches, due to development shall be controlled on site. The increase of runoff due to addition of impervious area is the difference of runoff from an impervious area and landscaped area. It is difficult to seperated the runoff from addition, therefore, it is better to completely control the total runoff from the addition impervious area.

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Job: Lot 14 A (#19) Stanford St, Newton, MA
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A. Land Use Analysis: Total Land Area = 10,070 Ft^2, 0.231 Ac.

1. Pre-Development Land Use

Building Area	2013	Ft^2
Pavement Area	2772	Ft^2
Other Impervious Area	–	Ft^2
Total Impervious Area	4785	Ft^2

Runoff Coefficient $= \frac{0.3 \times 5285 + 0.9 \times 4785}{10070} = 0.585$

2. Post-Development Land Use

Building Area:	1,814	Ft^2	
Pavement Area:	1,000	Ft^2	
Other Impervious Area:	406	Ft^2	Patio & Walkway
Total Impervious Area:	3220	Ft^2	

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Runoff Coefficient $= \frac{0.3 \times 6850 + 0.9 \times 3220}{10070} = 0.492$

B. Method Used To Analyze Storm Runoff

Due to small site area (much less than 5g. mile)
Rational Formula shall be used for runoff analysis.

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Rational Formula: $Q = CiA$, where

Q = Runoff peak rate, cfs

i = Rainfall Intensity, in/hr

A = Site Area, Acre

For Compute runoff volume, $V_R = CiAt$, where t is rainfall duration time, Hr. Also, A is changed to sq. ft (FT^2), i, rainfall intensity, in ft/hr, and V_R is total runoff volume of the storm from area A, in cu. Ft (FT^3).

C is runoff coefficient, $C = 0.9$ for impervious Area, $C = 0.3$ for wooded/grass, pervious area.

In general, peak runoff rate occurs at short duration high intensity storm, but runoff volume is larger at long duration storm. For small project site, it is difficult to control runoff rate. The easy way is to control the runoff from impervious area, so to reduce runoff volume.

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C. Storm Peak Runoff Rate & Total Runoff Volume @ 8.78"/24 Hr

Storm Duration Hr	Rainfall Intensity In/Hr	Peak Runoff Rate, cfs			Total Runoff Volume, Cu. Ft.		
		Pre-Devel. Condition C=0.585	Post-Devel. Condition C=0.492	Increase (Decrease)	Pre-Develop. Condition C=0.585	Post-Develop Condition C=0.492	Increase (Decrease)
24	0.37	0.05	0.042	(0.008)	4359.3	3666.3	(693.0)
0.5	4.6	0.622	0.523	(0.099)	1129.1	949.6	(179.5)

Minimum Total Runoff Volume Need To Be Controlled

24 Hr, 100-y storm : V_R = 0 Ft^3

0.5 Hr, 100-y storm: V_R = 0 Ft^3

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Total Runoff Volume From New Impervious, It is recommended that runoff from all impervious area, new/old, shall be controlled.

24 Hr, 100-y storm, $V_R = \frac{8.78}{12} \times 0.9 \times 3220 = 2120.4$ Ft^3

0.5 Hr, 100-y storm, $V_R = \frac{4.6}{12} \times 0.5 \times 0.9 \times 3220 = 555.5$ Ft^3

There shall be much less runoff at post-condition than at pre-development condition from the site.

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III. Runoff Control Facility Design

For small watershed area, control of the increased runoff rate is very difficult, therefore control runoff from selected impervious area is a better way to control the runoff increased due to development.

A. Minimum Required Control Volume – At 100-y Storm

0.5 Hour Duration, V_R =

24 Hour Duration, V_R =

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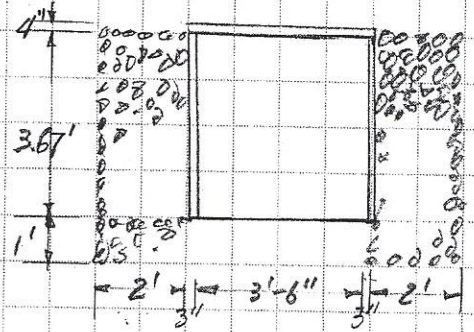
B. Control Facility

1. Leaching Galley: 4'x4'x4' with 2 ft thickness crushed stone around it and 1.0 ft thickness crushed stone under it



Storage Volume = $3.5 \times 3.5 \times 3.67 = 45\ ft^3$

Stone Void = $0.35[4\times4\times2\times2(2\text{-sides}) + 4\times8\times2\times2(2\text{-Ends}) + 8\times8\times1(\text{bottom})]$
$= 0.35 \times 256 = 89.6\ ft^3/Ea$

Total Storage Capacity = $89.6 + 45 = 134.6\ ft^3/Ea$

Exfiltration Volume (Use Bottom Area Only) = $64 \times \frac{1}{12} \times \frac{60}{2} \times \frac{1}{2}$ (Safety Factor)
$= 80\ ft^3/Hr/Ea.$

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Total Capacity of Galley

At 0.5 Hr Storm = $134.6 + 0.5 \times 80 = 174.6$ Ft^3/Ea

At 24 Hr Storm = $134.6 \times 6 = 807.6$ Ft^3/Ea

or

$= 134.6 + 80 \times 24 = 2054.6$ Ft^3/Ea Use the lower.

C. Control Area Analysis & Control System Design

1. Front System - Control Area

Front Part of House 944 Ft^2

Walk & Pavement 1070 Ft^2

Total Impervious: 2014 Ft^2

100-year storm runoff Volume:

At 0.5 Hr Storm = $0.9 \times 2014 \times \frac{4.6}{12} \times 0.5 = 347.4$ Ft^3

At 24 Hr storm = $.9 \times 2014 \times \frac{0.37}{12} \times 24 = 1341.3$ Ft^3

Number of Galley Need = $\frac{347.4}{174.6} = 1.99$ Say 2

$= \frac{1341.3}{807.6} = 1.66$ Say 2

Use Trench Grate to collect runoff from Paved Area and use a manhole with Sump and oil/Gas Seperator

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for control water quality before discharge to leaching galleys.

2. Rear System - Control Area

Rear Part of House: 870 ft^2

Patio 336 ft^2

Total Impervious Area 1206 ft^2

100-year storm runoff volume

At 0.5 Hr Storm = $0.9 \times 1206 \times \frac{4.6}{12} \times 0.5 = 208.0\ ft^3$

At 24 Hr Storm = $0.9 \times 1206 \times \frac{0.37}{12} \times 24 = 803.2\ ft^3$

Number of Galley Need = $\frac{208}{174.6} = 1.19$
At 0.5 Hr, 100y storm

At 24 Hr, 100-y storm = $\frac{803.2}{807.6} = 0.99$.

Use One galley with 3' thickness crushed around it and 1' thickness crushed stone under it. to increase the storage capacity and the exfiltration capacity

Bottom Area increased = $8 \times 2 + 10 \times 2 = 36\ ft^2$

Exfiltration Capacity increased = $\frac{36}{12} \times \frac{60}{2} \times \frac{1}{2} = 45\ ft^3/Hr$

Storage Capacity Increased = $0.35[4.67(2 \times 8 + 2 \times 10)] = 58.8\ ft^3/Ea.$

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Total Capacity of Galley:

At 0.5 Hr Storm = $174.6 + 58.8 + \frac{45}{2} = 255.9$ Ft³/Ea
> 208 Ft³/Ea.

D. Control Facilities Arrangement

As shown on Plan.

Notes: All PVC pipe under paved area shall be Sch. 40.

All downspouts shall have an overflow Y-section in case of strange storm, or suddenly weather changes.

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E. Runoff Reduction Due to Development

1. Controlled Impervious Area Runoff.

At 100-y, 24 Hr Storm = 803.2 + 1341.3 = 2144.5 Ft³

2. Change Impervious Area to landscaping Area

Area = 4785 - 3220 = 1565 Ft²

At 100-y - 24 Hr Storm = $1565 \times (0.9-0.3) \times \frac{0.37}{12} \times 24$
= 694.9 Ft³

3. Total Runoff Volume Reduction at 100-y, 24 Hr Storm = 2839.4 Ft³

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Storm Water Analysis & Control Facility Design

I. Project Description

The proposed project is to construct a residential house including driveway, and utilities on lot with total area of 15,297 ft^2 or 0.351 Ac. On site soil test, performed by Bibbo Brothers, indicates the soil is sandy-gravel with percolation rate of less than 2 MPI. No sign of ground water can be found in the 8 ft deep test pits. It is recommended that runoff from all impervious area shall be controlled.

II. Storm Water Analysis

Based on City of Newton requirement, any runoff increased, at 24 hours duration, 100-year storm with total rainfall of 8.78 inches, due to development shall be controlled on site. The increase of runoff due to addition of impervious area is the difference of runoff from an impervious area and landscaped area. It is difficult to seperated the runoff from addition, therefore, it is better to completely control the total runoff from the addition impervious area.

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Job: Lot B (#19) Stanford St, Newton, MA
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A. Land Use Analysis: Total Land Area = 15297 Ft², 0.351 Ac.

1. Pre-Development Land Use

Building Area - Ft²

Pavement Area - Ft²

Other Impervious Area - Ft²

Total Impervious Area - Ft²

$$\text{Runoff Coefficient} = \frac{0.3 \times 15297 + 0.9 \times 0}{15297} = 0.30$$

2. Post-Development Land Use

Building Area: 1,832 Ft²

Pavement Area: 2500 Ft²

Other Impervious Area: Patio 160, Walk 300 Ft²

Total Impervious Area: 4792 Ft²

$$\text{Runoff Coefficient} = \frac{0.3 \times 10505 + 0.9 \times 4792}{15297} = 0.488$$

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B. Method Used To Analyze Storm Runoff

Due to small site area (much less than sq. mile)
Rational Formula shall be used for runoff analysis.

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Rational Formula: $Q = CiA$, where

Q = Runoff peak rate, cfs

i = Rainfall Intensity, in/hr

A = Site Area, Acre

For Compute runoff volume, $V_R = CiAt$, where t is rainfall duration time, Hr. Also, A is changed to sq. ft (FT^2), i, rainfall intensity, in ft/hr, and V_R is total runoff volume of the storm from area A, in cu. Ft (FT^3).

C is runoff coefficient, $C = 0.9$ for impervious Area, $C = 0.3$ for wooded/grass, pervious area.

In general, peak runoff rate occurs at short duration high intensity storm, but runoff volume is larger at long duration storm. For small project site, it is difficult to control runoff rate. The easy way is to control the runoff from impervious area, so to reduce runoff volume.

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C. Storm Peak Runoff Rate & Total Runoff Volume @ 8.78"/24 Hr

Storm Duration Hr	Rainfall Intensity In/Hr	Peak Runoff Rate, cfs			Total Runoff Volume, Cu. Ft.		
		Pre-Devel. Condition C=0.30	Post-Devel. Condition C=0.488	Increase (Decrease)	Pre-Develop. Condition C=0.30	Post-Develop Condition C=0.488	Increase (Decrease)
24	0.37	0.039	0.063	0.024	3395.9	5524.1	2128.2
0.5	4.6	0.484	0.788	0.304	879.6	1430.8	551.2

Project Site = 0.351 Ac = 15,297 Ft²

Minimum Total Runoff Volume Need To Be Controlled

24 Hr, 100-y storm : V_R = 2128.2 Ft³

0.5 Hr, 100-y storm: V_R = 551.2 Ft³

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Total Runoff Volume From New Paved Area, It is recommended that runoff from impervious, should it be new, shall be controlled. Total Impervious Area = 4792 Ft²

24 Hr, 100-y storm, $V_R = \frac{8.78}{12} \times 0.9 \times 4792 = 3155.5$ Ft³

0.5 Hr, 100-y Storm, $V_R = \frac{4.6}{12} \times 0.5 \times 0.9 \times 4792 = 826.6$ Ft³

There shall be no increased runoff at post-condition than at pre-development condition from the site. Should the total runoff volume from new paved area is less than the minimum required control volume, addition impervious area need to be added to control area.

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III. Runoff Control Facility Design

For small watershed area, control of the increased runoff rate is very difficult, therefore control runoff from selected impervious area is a better way to control the runoff increased due to development.

A. Minimum Required Control Volume – At 100-y Storm

0.5 Hour Duration, $V_R = 551.2$

24 Hour Duration, $V_R = 2128.2$

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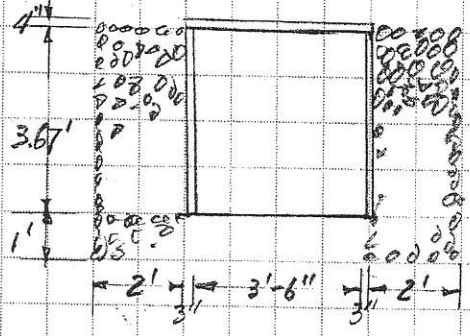
B. Control Facility

1. Leaching Galley: 4'x4'x4' with 2 ft thickness crushed stone around it and 1.0 ft thickness crushed stone under it.



Storage Volume $= 3.5 \times 3.5 \times 3.67 = 45\ ft^3$

Stone Void $= 0.35[4\times4\times2\times2\text{(2-sides)} + 4\times8\times2\times2\text{(2-Ends)} + 8\times8\times1\text{(bottom)}]$
$= 0.35 \times 256 = 89.6\ ft^3/Ea$

Total Storage Capacity $= 89.6 + 45 = 134.6\ ft^3/Ea$

Exfiltration Volume (Use Bottom Area Only) $= 64 \times \frac{1}{12} \times \frac{60}{2} \times \frac{1}{2}$ (Safety Factor)
$= 80\ ft^3/Hr/Ea.$

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Total Capacity of Galley

At 0.5 Hr Storm = 134.6 + 0.5×80 = 174.6 Ft^3/Ea

At 24 Hr Storm = 134.6×6 = 807.6 Ft^3/Ea use the small one

or

= 134.6 + 24×80 = 2054.6 Ft^3/Ea

C. Control Area Analysis & Control System Design

1. Front System - Control Area

Part of Driveway, 1000 Ft^2

100-y storm runoff volume

at 0.5 Hr Duration Storm = $0.9 \times 1000 \times \frac{4.6}{12} \times 0.5 = 172.5\ Ft^3$

at 24 Hr Duration Storm = $0.9 \times 1000 \times \frac{0.37}{12} \times 24 = 666\ Ft^3$

One galley is adequate to control the 100-y storm runoff from the 1000 ± Ft^2 Impervious area.

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2. REAR System - Control Area

Part of driveway, walk (Pavement)	1800 Ft^2
House	1832 Ft^2
Patio	160 Ft^2
Total Impervious Area	3792 Ft^2

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Runoff Volume :

At 100-year, 24 Hr Storm $= 0.9 \times 3792 \times \frac{0.37}{12} \times 24$

$= 2525.5 \text{ Ft}^3$

At 100-year, 0.5 Hr Storm $= 0.9 \times 3792 \times \frac{4.6}{12} \times 0.5$

$= 654.1 \text{ Ft}^3$

No. of Galley Need At 100-y 0.5 Hr Storm $= \frac{654.1}{174.6} = 3.7$ Say 4 galleys.

No. of Galley Need at 100-year, 24 Hr Storm $= \frac{2525.5}{807.6} = 3.1$ Say 4 galleys

D. Control Facilities Arrangement

Refer to Plan

1. Use two catchbasins, one for Front System, one for Rear System, to collect runoff from paved area then discharge to leaching facilities. The C.B shall have 4' deep sump and oil/gas seperator.
2. All PVC pipe under paved area shall be Sch. 40.

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3. All downspouts shall have an overflow Y-sec in case of strange storm, or suddenly wealth changes.

E. Runoff Reduction Due to Development

The controlled impervious area was wooded or landscaping area. After control the 100-year storm, its runoff is reduced.

Runoff Volume Reduced at 24 hour, 100-year storm $= 0.3 \times 4792 \times \frac{0.37}{12} \times 24$

$= 1063.8\ ft^3$