CIVIL DESIGN CONSULTANTS, INC

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April 24, 2024

Denise M. Gaffey
Director & City Planner
562 Main Street
Melrose, MA 02176

CDCI File #: 20-10201
22 Montvale Street
Melrose, MA 02176

Civil Design Consultants, Inc. (CDCI) has prepared this information to address a Memorandum from the Department of Public Works, dated April 17, 2024, regarding the current design of the stormwater management system for the proposed dwelling located at 22 Montvale Street. In the Memorandum, Comment 2 states that '*while the draft Stormwater Handbook allows for a reduction in effective impervious cover if a rain barrell or cistern is sized to capture the 1-inch water quality volume, this only allows for the impervious areas to be deducted from Standard 3 (groundwater recharge) and Standard 4 (Pollutant Removal). It does not allow for removal from Standard 2 (peak flow attenuation). DPW therefore, will not approve this method as a way to attenuate peak flows. An alternative method to attenuate peak flows should be explored.*'

According to Section 235-73.2D.(1)(a)(10) of the Zoning Ordinance of the City of Melrose, projects applying for the Slope Protection Special Permit are required to demonstrate that post-development run-off does not exceed pre-development run-off. The project proposes a minor increase of 1,238-SF of impervious area, associated with the rooftop, and stairs required to access the driveway. The additional proposed impervious area increases peak flows towards Montvale Street by 0.02-CFS in post-development for the 2-year, 10-year, and 25-year, and 0.01-CFS for the 100-year storm[1]. Although the increase peak flows are considered de minimis, the Applicant proposes to install two (2) 550-gallon above-ground rain barrels, designed to capture and store runoff from the entire 1,360-SF rooftop area, while slowly releasing overflows, directed towards surrounding vegetation. The Drainage Memo submitted to the City, dated April 9, 2024, included one (1) rain barrel to mitigate peak flows to the tenth decimal place. The attached updated Drainage Memo, dated April 24, 2024, has been revised to expand the peak flow units to the hundredth decimal place, and as a result, an additional rain barrel has been added in order to attenuate peak flows to the hundredth decimal place.

According to the DRAFT Massachusetts Stormwater Handbook, MassDEP recognizes rain barrels as an Environmentally Sensitive Site Design (ESSD) and a Structural Low Impact Development (LID) technique. Also, according to Chapter 235-16.1.E(12)(b) of the City of Melrose Zoning Ordinance, the City encourages the use of rain barrels as a Low Impact Design methodology to mitigate drainage impacts and promote the reuse of runoff (Exhibit 2). The proposed rain barrel is an environmentally-friendly solution that will not only help mitigate the de minimis increase in peak flows, but it also aligns with the goals of the City of Melrose's Slope Protection Ordinance, by eliminating additional disturbance to the natural slopes that would be otherwise required for other Best Management Practice techniques, such as stormwater basins or subsurface systems. Due to the large quantity of existing on-site rock outcroppings and shallow bedrock within a depth of ±24" from the surface, high excavation costs makes constructing basins and subsurface systems infeasible.

According to the current Massachusetts Stormwater Handbook, Volume 2 Chapter 2, rain barrel provides peak flow attenuation for small storms (Exhibit 3). Additionally, the DRAFT Massachusetts Stormwater Handbook states that rain barrels can provide benefits by reducing peak discharge rates depending on the amount of storage available at the beginning of each (Exhibit 4). The Applicant is aware of the

[1] See attached Exhibit 1 illustrating the pre- and post-development HydroCAD modeling peak flows (rounded to the hundredth decimal place) without any stormwater management systems to provide context of the de minimis increase in post-development peak flows.

importance and responsibility of completely draining the rain barrel within 72-hours after a storm so that there is always storage available for retention for the next storm.

To summarize, the Applicant understands the importance of mitigating any potential adverse effects as a result of the proposed development and is willing to take steps to minimize the impact of what we believe to be a de minimis increase in peak flows by installing rain barrels to capture and store rooftop runoff. As illustrated in Exhibits 3 and 4, the current and DRAFT Massachusetts Stormwater Handbook states that rain barrels can be used to attenuate peak flows and is recognized and encouraged by MassDEP and the City of Melrose as a Low Impact Development technique that provides the least amount of disturbance to the existing natural slopes.

If you have any questions or comments or would like to discuss this information in further detail, please do not hesitate to contact this office.

Very Truly Yours,

CIVIL DESIGN CONSULTANTS, INC.

Meera A. Cousens
Project Manager

EXHIBIT 1

*Pre- and Post-Development HydroCAD modeling analysis without any stormwater management systems

Subcat Reach Pond Link

Routing Diagram for Exhibit 1
Prepared by Civil Design Consultants, Inc, Printed 4/24/2024

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWP-1 Runoff Area=7,750 sf 10.99% Impervious Runoff Depth=1.92"
Tc=6.0 min CN=86 Runoff=0.39 cfs 1,242 cf

Subcatchment PWA-1: PWP-1 Runoff Area=7,750 sf 27.48% Impervious Runoff Depth=2.00"
Tc=6.0 min UI Adjusted CN=87 Runoff=0.41 cfs 1,294 cf

Total Runoff Area = 15,500 sf Runoff Volume = 2,535 cf Average Runoff Depth = 1.96"
80.76% Pervious = 12,518 sf 19.24% Impervious = 2,982 sf

Summary for Subcatchment EWA-1: EWP-1

Runoff = 0.39 cfs @ 12.09 hrs, Volume= 1,242 cf, Depth= 1.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

	Area (sf)	CN	Description
*	852	98	Rock Outcrop, HSG D
*	6,898	85	Woods, Good, HSG D
	7,750	86	Weighted Average
	6,898		89.01% Pervious Area
	852		10.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment PWA-1: PWP-1

Runoff = 0.41 cfs @ 12.09 hrs, Volume= 1,294 cf, Depth= 2.00"
Routed to nonexistent node DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

	Area (sf)	CN	Adj	Description
*	684	98		Rock Outcrop, HSG D
*	5,570	85		Woods, Good, HSG D
	86	98		Unconnected pavement, HSG D
*	50	80		Permeable Paver, HSG D
	1,360	98		Unconnected roofs, HSG A
	7,750	89	87	Weighted Average, UI Adjusted
	5,620			72.52% Pervious Area
	2,130			27.48% Impervious Area
	1,446			67.89% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWP-1 Runoff Area=7,750 sf 10.99% Impervious Runoff Depth=3.63"
Tc=6.0 min CN=86 Runoff=0.73 cfs 2,342 cf

Subcatchment PWA-1: PWP-1 Runoff Area=7,750 sf 27.48% Impervious Runoff Depth=3.73"
Tc=6.0 min UI Adjusted CN=87 Runoff=0.75 cfs 2,407 cf

Total Runoff Area = 15,500 sf Runoff Volume = 4,749 cf Average Runoff Depth = 3.68"
80.76% Pervious = 12,518 sf 19.24% Impervious = 2,982 sf

Summary for Subcatchment EWA-1: EWP-1

Runoff = 0.73 cfs @ 12.09 hrs, Volume= 2,342 cf, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.17"

	Area (sf)	CN	Description
*	852	98	Rock Outcrop, HSG D
*	6,898	85	Woods, Good, HSG D
	7,750	86	Weighted Average
	6,898		89.01% Pervious Area
	852		10.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment PWA-1: PWP-1

Runoff = 0.75 cfs @ 12.09 hrs, Volume= 2,407 cf, Depth= 3.73"
Routed to nonexistent node DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.17"

	Area (sf)	CN	Adj	Description
*	684	98		Rock Outcrop, HSG D
*	5,570	85		Woods, Good, HSG D
	86	98		Unconnected pavement, HSG D
*	50	80		Permeable Paver, HSG D
	1,360	98		Unconnected roofs, HSG A
	7,750	89	87	Weighted Average, UI Adjusted
	5,620			72.52% Pervious Area
	2,130			27.48% Impervious Area
	1,446			67.89% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWP-1 Runoff Area=7,750 sf 10.99% Impervious Runoff Depth=4.73"
Tc=6.0 min CN=86 Runoff=0.94 cfs 3,057 cf

Subcatchment PWA-1: PWP-1 Runoff Area=7,750 sf 27.48% Impervious Runoff Depth=4.84"
Tc=6.0 min UI Adjusted CN=87 Runoff=0.96 cfs 3,128 cf

Total Runoff Area = 15,500 sf Runoff Volume = 6,185 cf Average Runoff Depth = 4.79"
80.76% Pervious = 12,518 sf 19.24% Impervious = 2,982 sf

Summary for Subcatchment EWA-1: EWP-1

Runoff = 0.94 cfs @ 12.09 hrs, Volume= 3,057 cf, Depth= 4.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.34"

	Area (sf)	CN	Description
*	852	98	Rock Outcrop, HSG D
*	6,898	85	Woods, Good, HSG D
	7,750	86	Weighted Average
	6,898		89.01% Pervious Area
	852		10.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment PWA-1: PWP-1

Runoff = 0.96 cfs @ 12.09 hrs, Volume= 3,128 cf, Depth= 4.84"
Routed to nonexistent node DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.34"

	Area (sf)	CN	Adj	Description
*	684	98		Rock Outcrop, HSG D
*	5,570	85		Woods, Good, HSG D
	86	98		Unconnected pavement, HSG D
*	50	80		Permeable Paver, HSG D
	1,360	98		Unconnected roofs, HSG A
	7,750	89	87	Weighted Average, UI Adjusted
	5,620			72.52% Pervious Area
	2,130			27.48% Impervious Area
	1,446			67.89% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EWA-1: EWP-1 Runoff Area=7,750 sf 10.99% Impervious Runoff Depth=6.49"
Tc=6.0 min CN=86 Runoff=1.27 cfs 4,189 cf

Subcatchment PWA-1: PWP-1 Runoff Area=7,750 sf 27.48% Impervious Runoff Depth=6.61"
Tc=6.0 min UI Adjusted CN=87 Runoff=1.28 cfs 4,266 cf

Total Runoff Area = 15,500 sf Runoff Volume = 8,455 cf Average Runoff Depth = 6.55"
80.76% Pervious = 12,518 sf 19.24% Impervious = 2,982 sf

Summary for Subcatchment EWA-1: EWP-1

Runoff = 1.27 cfs @ 12.09 hrs, Volume= 4,189 cf, Depth= 6.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.16"

	Area (sf)	CN	Description
*	852	98	Rock Outcrop, HSG D
*	6,898	85	Woods, Good, HSG D
	7,750	86	Weighted Average
	6,898		89.01% Pervious Area
	852		10.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment PWA-1: PWP-1

Runoff = 1.28 cfs @ 12.09 hrs, Volume= 4,266 cf, Depth= 6.61"
Routed to nonexistent node DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.16"

	Area (sf)	CN	Adj	Description
*	684	98		Rock Outcrop, HSG D
*	5,570	85		Woods, Good, HSG D
	86	98		Unconnected pavement, HSG D
*	50	80		Permeable Paver, HSG D
	1,360	98		Unconnected roofs, HSG A
	7,750	89	87	Weighted Average, UI Adjusted
	5,620			72.52% Pervious Area
	2,130			27.48% Impervious Area
	1,446			67.89% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

EXHIBIT 2

(c) If any of the standards in Subsection **E(7)(a)** and **(b)** above are violated, the applicant shall provide alternative proposals to meet the standards, including but not limited to reduction in the size of the development, change in the proposed uses on the site, contributions to off-site street and intersection improvements or construction of off-site street and intersection improvements.

(8) Adequacy of sewerage and water supply systems within the site to serve the proposed use without overloading the municipal systems to an extent that the health, safety or general welfare of residents of the City is put at risk.

(9) Adequacy of proposed methods of refuse disposal and storage.

(10) Adequacy of snow management, including removal or on-site storage.

(11) Adequacy of soil erosion plan and the plan for protection of steep slopes, both during and after construction.

(12) Stormwater management.

(a) Stormwater systems shall be designed to protect the public and environment from flooding, siltation, pollutants and related drainage impacts and shall conform to the applicable performance standards included in the Massachusetts Department of Environmental Protection Stormwater Management Policy or any successor legislation.

(b) Stormwater systems shall be designed to use low-impact design (LID) methodologies to mitigate drainage impact. Low-impact design (LID) methodologies may include porous pavements, bioretention cells, infiltration trenches, rainwater collection cisterns and other design methods that maximize the use of landscaped areas for stormwater control and promote the reuse of runoff.

(c) Stormwater flood mitigation shall be provided through the use of best management practices (BMPs) to further reduce the frequency and intensity of flooding otherwise generated at the proposed site. To the extent practicable, BMPs shall be sized to capture, retain, and percolate to ground all runoff from impermeable surfaces generated by the five-year, twenty-four-hour storm event. Preferred BMPs shall include, but not be limited to, constructed wetlands, pocket wetlands, rain gardens, vegetated swales, retention/detention ponds, and subsurface leaching systems.

(13) Adequacy of landscaping, including the screening of adjacent residential uses, street trees, landscape islands in any parking lots and landscape buffers along the street frontage.

(14) Adequacy of screening for storage areas, loading docks, dumpsters, rooftop equipment, utility buildings and similar features.

F. Site Plan Review Committee; composition. The Site Plan Review Committee (SPRC) shall be the Melrose Planning Board.

G. Review schedule. The SPRC shall open a public hearing on the application no later than 65 days after the application materials have been filed with the City Clerk. Notice of such public hearing shall be provided as required by MGL c. 40A, § 11. The decision of the SPRC shall be made within 35 days of the close of the public hearing. The required time limits for a public hearing and decision may be extended by written agreement between the applicant and the SPRC. For new renewable and alternative energy research and development establishments permitted in the industrial districts, the decision of the SPRC shall be made within one year from the date of filing the site plan review application with the City Clerk. The decision of the Site Plan Review Committee shall be upon a concurring vote of the majority of SPRC members and shall be in writing. The SPRC may approve the application as submitted, approve subject to modifications or conditions, or deny the application. A written decision setting forth the record of the proceedings, the vote of each member and the reasons for the decision shall be filed in the office of the City Clerk within 14 days. In the event of a denial, the application and site plan may be resubmitted if the reasons for the denial are remedied. Failure by the SPRC to take action within 35 days of the close of the public hearing or

Rain Barrels & Cisterns

EXHIBIT 3

Description: Cisterns and rain barrels are structures that store rooftop runoff and reuse it for landscaping and other non-potable uses. Instead of a nuisance to get rid of, consider rooftop runoff as a resource that can be reused or infiltrated. In contrast, conventional stormwater management strategies take rooftop runoff, which is often relatively free of pollutants, and direct it into the stormwater treatment system along with runoff from paved areas.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides peak flow attenuation for small storms.
3 - Recharge	Provides no groundwater recharge.
4 - TSS Removal	The roof surface can be deducted from the impervious area used to calculate the Required Water Quality Volume for sizing other structural treatment BMPs, a) when rain barrel or cistern is sized to store the Required Water Quality Volume for the roof surface (0.5 inch or 1.0 inch), b) stored water is used within 72-hours or discharged to an infiltration BMP, and c) the system is designed to operate year round.
5 - Higher Pollutant Loading	Not applicable.
6 - Discharges near or to Critical Areas	Not applicable.
7 - Redevelopment	Suitable.

Pollutant Removal Efficiencies

- Offers no primary pollutant removal benefits
- Rooftop Runoff presumed to be clean[1]

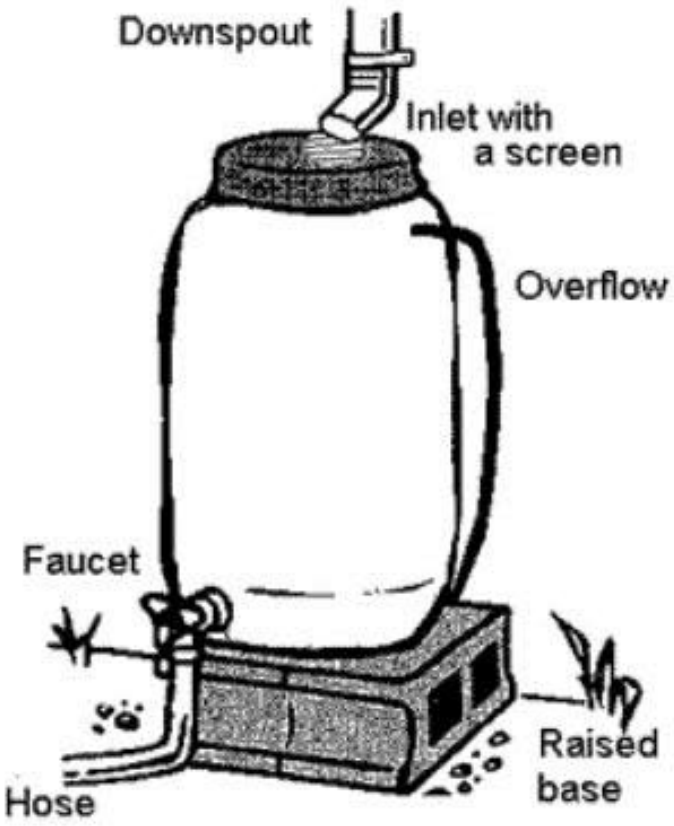
Advantages/Benefits:

- Can reduce water demand for irrigation or other non-potable uses.
- Property owners save money on water bills by using stored water for landscape purposes.
- Public water systems may experience lower peak demand in summer.
- When properly installed, rain barrels and cisterns reduce stormwater runoff volume for small storms.

Disadvantages/Limitations:

- Provides mosquito-breeding habitat unless properly sealed.
- May need to be disconnected and drained in winter to avoid cracking of storage structure

[1]*Although MassDEP presumes rooftop runoff to be clean for purposes of the Stormwater Management Standards, research indicates higher PAHs in runoff from asphalt shingled roofs and zinc from metal roofs. USGS research in Texas indicates rooftop runoff contains mercury. Before using rooftop runoff for vegetable gardens, investigate the quality of the runoff, especially when using larvicides in rain barrels or cisterns for mosquito control.*



Maintenance

Activity	Frequency
Maintenance requirements for cisterns and rain barrels are minimal. These requirements include the following: Inspecting the unit twice a year, larviciding for mosquito control, disconnecting and draining the system prior to winter to prevent cracking, and replacing or repairing any worn-out pieces.	

Special Features

Direct overflow from rain barrels and cisterns to a dry well, infiltration trench, rain garden, bioretention area, or other infiltration BMP sized to recharge the overflow volume.

Rain Barrels & Cisterns

Applications and Design Principles

The most common approach to roof runoff storage involves directing each downspout to a 55-gallon rain barrel. A hose is attached to a faucet at the bottom of the barrel and water is distributed by gravity pressure. A more sophisticated and effective technique is to route multiple downspouts to a partially or fully buried cistern with an electric pump for distribution. Where site designs permit, cisterns may be quite large, and shared by multiple households, achieving economies of scale. Stored rainwater can be used for lawn irrigation, vegetable and flower gardens, houseplants, car washing, and cleaning windows.

The roof surface can be deducted from the impervious surfaces used to determine the Required Water Quality Volume for sizing other structural treatment practices, only when a) the cistern or barrel can store the required water quality volume for the roof surface, b) the stored water is used or discharged to an infiltration BMP within 72-hours, and c) the system is designed to operate 365 days a year.

Cisterns and rain barrels can provide benefits by reducing the required water quality volume and peak discharge rates depending on the amount of storage available at the beginning of each storm. One rain barrel may provide a useful amount of water for garden irrigation, but it will have little effect on overall runoff volumes, especially if the entire tank is not drained between storms. Improve effectiveness by having more storage volume and by designing the system with a continuous discharge to an infiltration structure, so that there is always storage available for retention. To operate the system year-round, bury or insulate the unit. State Plumbing Code requirements apply to cisterns and rain barrels located within 10 feet of a building. All applicable requirements of the Massachusetts State Plumbing or State Building Codes must be met.

Cisterns and rain barrels are applicable to most commercial and residential properties where there is a gutter and downspout system to direct roof runoff to the storage tank. They take up little room and can be used in dense urban areas. Rain barrels and cisterns are excellent retrofit techniques for almost any circumstance. Rain barrels are covered plastic tanks that can hold from 50 to 100 gallons with a hole in the top for downspout discharge, an overflow outlet, and a valve and hose adapter at the bottom. They are used almost exclusively on residential properties. Plastic rain barrels are typically installed above ground. They must be disconnected prior to the winter, and the barrel drained completely to prevent the barrel from cracking.

Because rain barrels rely on gravity flow, place them near, and slightly higher than, the point of use (whether a garden, flower bed, or lawn). Route the overflow outlet to a dry well, bioretention area, rain garden or other infiltration BMP. It is important for property owners to use the water in rain barrels on a regular basis, otherwise the barrels can fill up and prevent additional roof runoff from being stored. Each house should have the appropriate number of rain barrels or an appropriately sized cistern. A one-inch storm produces over 620 gallons of water from a 1,000 square foot roof. Assuming a rain barrel capacity of 55 gallons, it would take 11 rain barrels to store one inch of runoff from 1,000 square feet of roof.

Cisterns are partially or fully buried tanks with a secure cover and a discharge pump; they provide considerably more storage than barrels, as well as pressurized distribution. They are less susceptible to cracking induced by expansion of freezing water when buried below grade. Cisterns can collect water from multiple downspouts or even multiple roofs, and then distribute this water wherever it needs to go via an electric pump. Property owners may use one large tank or multiple tanks in series. Either way, direct the overflow for the systems to a dry well or other infiltration mechanism so that if the cistern is full, excess roof runoff is infiltrated, and not discharged to the stormwater treatment system. Some cisterns are designed to continuously discharge water into infiltration units at very slow rates, so that the tank slowly empties after a storm, providing more storage for the next storm. The cisterns must also be designed to dewater in 72 hours or less.

Design

Because of the low pressure of the discharge, rain barrels are most effectively used with a drip irrigation system. Secure rain barrels against disturbance by children or animals. Seal any openings with mosquito netting. If present, place the cistern's continuous discharge outlet so that the tank does not empty completely. This ensures water availability at all times, and provides some storage capacity for every storm. A diverter at the cistern inlet can redirect

Rain Barrels & Cisterns

EXHIBIT 4

Other Structural

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Does not provides peak flow attenuation.
3 - Recharge	If sized to retain the required 1-inch Water Quality Volume, consists of a reduction in Effective Impervious Cover (EIC) from the roof which may be deducted from the total area of impervious surface that must be managed as required by Standard 3 (Groundwater Recharge).
4 - TSS/TP Removal	If sized to retain the required 1-inch Water Quality Volume, consists of a reduction in Effective Impervious Cover (EIC) from the roof which may be deducted from the total area of impervious surface that must be managed as required by Standard 4 (Pollutant Removal).
5 – Higher Pollutant Loading	Not suitable.
6 – Discharges near or to Critical Areas	Not suitable.
7 - Redevelopment	Suitable.
11 – Total Maximum Daily Loads	Does not meet any TMDL requirements as a stand-alone treatment practice.
ESSD / LID?	Yes, this practice is a MassDEP recognized ESSD / LID technique.

Note: *Although MassDEP presumes rooftop runoff from non-metal, non-industrial roofs to be 'clean" for purposes of the Stormwater Management Standards, research indicates higher PAHs in runoff from asphalt shingled roofs and zinc from metal roofs. USGS research in Texas indicates rooftop runoff contains mercury. Before using rooftop runoff for vegetable gardens, investigate the quality of the runoff, especially when using larvicides in rain barrels or cisterns for mosquito control.*

Description

Cisterns and rain barrels are structures that store rooftop runoff and reuse it for landscaping and other non-potable uses. Instead of a nuisance to get rid of, consider rooftop runoff as a resource that can be reused or infiltrated. In contrast, conventional stormwater management strategies take rooftop runoff, which is often relatively free of pollutants, and direct it into the stormwater treatment system along with runoff from paved areas.

Advantages/Benefits

- Can reduce water demand for irrigation or other non-potable uses.
- Property owners save money on water bills by using stored water for landscape purposes.
- Public water systems may experience lower peak demand in summer.
- When properly installed, rain barrels and cisterns reduce stormwater runoff volume for small storms.

Disadvantages/Limitations

- Provides mosquito-breeding habitat unless properly sealed.
- May need to be disconnected and drained in winter to avoid cracking of storage structure

ESSD / LID Alternatives

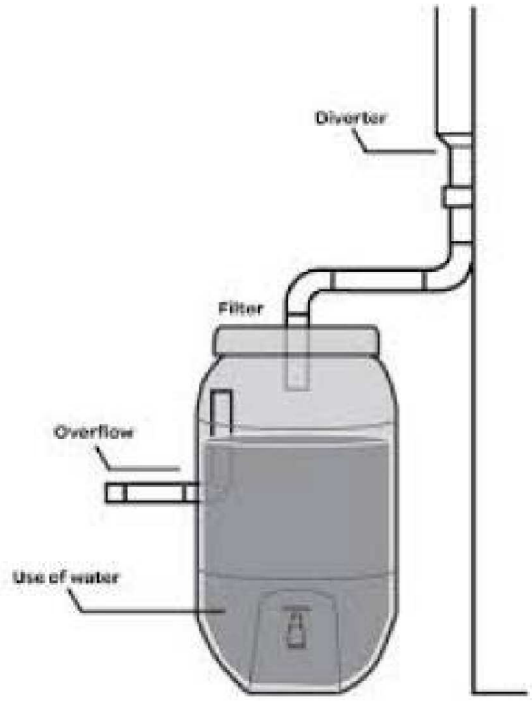
This practice is a MassDEP recognized ESSD / LID technique.

Suitability to Treat TMDL Pollutants

Pollutant	Suitable to Treat?
TSS	N
Total Nitrogen	N
Total Phosphorous	N
Pathogens	N
Metals	N

Notes:

1. *Pathogens category includes: fecal coliform, E. coli, and enterococcus.*
2. *Metals category includes Zinc, Cadmium, Lead, Aluminum, and Iron*



Special Features

Direct overflow from rain barrels and cisterns to a dry well, infiltration trench, rain garden, bioretention area, or other infiltration SCM sized to recharge the overflow volume.

Applications and Design Principles

The most common approach to roof runoff storage involves directing each downspout to a 55- gallon rain barrel. A hose is attached to a faucet at the bottom of the barrel and water is distributed by gravity pressure. A more sophisticated and effective technique is to route multiple downspouts to a partially or fully buried cistern with an electric pump for distribution. Where site designs permit, cisterns may be quite large, and shared by multiple households, achieving economies of scale. Stored rainwater can be used for lawn irrigation, vegetable and flower gardens, houseplants, car washing, and cleaning windows.

The roof surface can be deducted from the impervious surfaces used to determine the Required Water Quality Volume for sizing other structural treatment practices, only when: 1) the cistern or barrel can store the required water quality volume for the roof surface; 2) the stored water is used or discharged to an infiltration SCM within 72-hours, and 3) the system is designed to operate 365 days a year.

Cisterns and rain barrels can provide benefits by reducing the required water quality volume and peak discharge rates depending on the amount of storage available at the beginning of each storm. One rain barrel may provide a useful amount of water for garden irrigation, but it will have little effect on overall runoff volumes, especially if the entire tank is not drained between storms. Improve effectiveness by having more storage volume and by designing the system with a continuous discharge to an infiltration structure, so that there is always storage available for retention. To operate the system year-round, bury or insulate the unit. State Plumbing Code requirements apply to cisterns and rain barrels located within 10 feet of a building. All applicable requirements of the Massachusetts State Plumbing or State Building Codes must be met.

Cisterns and rain barrels are applicable to most commercial and residential properties where there is a gutter and downspout system to direct roof runoff to the storage tank. They take up little room and can be used in dense urban areas. Rain barrels and cisterns are excellent retrofit techniques for almost any circumstance. Rain barrels are covered plastic tanks that can hold from 50 to 100 gallons with a hole in the top for downspout discharge, an overflow outlet, and a valve and hose adapter at the bottom. They are used almost exclusively on residential properties. Plastic rain barrels are typically installed above ground. They must be disconnected prior to the winter, and the barrel drained completely to prevent the barrel from cracking.

Because rain barrels rely on gravity flow, place them near, and slightly higher than, the point of use (whether a garden, flower bed, or lawn). Route the overflow outlet to a dry well, bioretention area, rain garden or other infiltration SCM. It is important for property owners to use the water in rain barrels on a regular basis, otherwise the barrels can fill up and prevent additional roof runoff from being stored. Each house should have the appropriate number of rain barrels or an appropriately sized cistern. A one-inch storm produces over 620 gallons of water from a 1,000 square foot roof. Assuming a rain barrel capacity of 55 gallons, it would take 11 rain barrels to store one inch of runoff from 1,000 square feet of roof.

Cisterns are partially or fully buried tanks with a secure cover and a discharge pump; they provide considerably more storage than barrels, as well as pressurized distribution. They are less susceptible to cracking induced by expansion of freezing water when buried below grade. Cisterns can collect water from multiple downspouts or even multiple roofs, and then distribute this water wherever it needs to go via an electric pump. Property owners may use one large tank or multiple tanks in series. Either way, direct the overflow for the systems to a dry well or other infiltration mechanism so that if the cistern is full, excess roof runoff is infiltrated, and not discharged to the stormwater treatment system. Some cisterns are designed to continuously discharge water into infiltration units at very slow rates, so that the tank slowly empties after a storm, providing more storage for the next storm. The cisterns must also be designed to dewater in 72 hours or less.

Setback Requirements

Stormwater Control Measures (SCMs) and other components of the Stormwater Management System must be setback from wetlands, building foundations, and other features in accordance with 310 CMR 10.05(6)(q). SCMs must also include vertical separation between certain features, such as the depth to seasonally high groundwater. Refer to **Section 2.5** of the Stormwater Handbook for horizontal setback and vertical separation distance requirements. Horizontal setbacks also include maintenance access requirements around the perimeter of certain SCMs.

Design Considerations

Because of the low pressure of the discharge, rain barrels are most effectively used with a drip irrigation system. Secure rain barrels against disturbance by children or animals. Seal any openings with mosquito netting. If present, place the cistern's continuous discharge outlet so that the tank does not empty completely. This ensures water availability at all times, and provides some storage capacity for every storm. A diverter at the cistern inlet can redirect the "first flush" of runoff, which is more likely to have particulates, leaves, and air-deposited contaminants washed off the roof. Keep leaves and debris out of the storage tank by placing a screen at the top of the downspout. Hide rain barrels and cisterns with shrubs or other landscaped features. Direct overflow from rain barrels and cisterns to a dry well, infiltration trench, rain garden, bioretention area, or other infiltration SCM sized to recharge the overflow volume. Use pond routing methods to design cisterns or rain barrels to account for retention of early runoff in the storage tank. Include access ports for any subsurface cisterns. Confined space entry training may be needed to enter large cisterns. MassDEP does not require treatment of runoff from non-metal roofs prior to infiltration. winter, unless the runoff is directed to a qualifying stormwater infiltration practice.

Maintenance

Activity
Maintenance requirements for cisterns and rain barrels are minimal. These requirements include the following: Inspect the unit twice a year, use larvicide for mosquito control, disconnect and drain the system prior to winter to prevent cracking, and replace or repair any worn-out pieces.

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- *Roof catchment,* to ensure that trash and particulate matter are not entering the gutter and downspout to the rain barrel.
- *Gutters,* to ensure that no leaks or obstructions are occurring.
- *Downspouts,* to assure that no leaks or obstructions are occurring.
- *Entrance at rain barrel,* to ensure that there are no obstructions and/or leaks occurring.
- *Rain barrel,* to check for potential leaks, including barrel top and seal.
- *Runoff / overflow pipe,* to check that overflow is draining in non-erosive manner.
- *Spigot,* to ensure that it is functioning correctly.
- *Any accessories,* such as rain diverter, soaker hose, linking kit, and additional guttering.
- Apply larvicides in strict accordance with all Mass.
- Department of Agricultural Resources Pesticide
- *Bureau regulations* to prevent mosquitoes from reaching adulthood.

- Add bleach or other chemicals annually to kill bacteria present in the system. A qualified professional should determine appropriate treatment.
- *Drain the system before winter* if it is located above ground or partially exposed, to prevent cracking.
- Disconnect the system from roof leaders in the fall, if it is not intended to be used during the winter.
- When the cistern or barrel is connected to a stormwater recharge system, remove particulates trapped in the cistern or rain barrel annually to limit clogging of the stormwater infiltration system.

References

Adapted from: MAPC Low Impact Development Toolkit. For more information, go to www.mapc.org/lid and www.arc-of-innovation.org .

Other Resources:

http://www.rainwaterrecovery.com/about.html

Charles River Watershed Association: www.crwa.org

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Additional Information
http://www.rainwaterrecovery.com/about.html
www.crwa.org (Charles River Watershed Association)