PHRC Webinar Series | Tuesday, January 17 @ 1pm

Design & Construction of Dry Wells

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Description

Sumping of gutter downspouts is a common stormwater management technique to allow the rainwater that falls on a roof to infiltrate and one of the most frequently used BMPs by builders of single homes that aren't part of a larger subdivision plan. The DEP has provided design guidance in the BMP manual on the sizing of these dry wells, but the material can be difficult to find and is targeted to an engineering audience. The PHRC developed a Builder Brief that summarizes the details on the sizing and construction of downspout sumps for into an easy-to-use guide for homebuilders. This webinar will present design details, sizing explanation and equations, and example calculations of dry wells. Maintenance information that needs to be shared with the homeowner will also be covered.

Learning Objectives

- Calculate the necessary dry well volume to manage roof runoff
- Determine if the dry well drains quickly enough to prevent a mosquito problem
- Identify different design options of gravel pit versus pre-fabricated
- Describe maintenance needs to a homeowner

New Builder Brief

- New Builder Brief published December 2016
- Design and Construction of Dry Well in Pennsylvania

http://www.phrc.psu.edu/assets/docs/Publications/Dry-Well-Design.pdf

Disclaimer

- This Dry Well Builder Brief and webinar should only be used as a guide.
- Special soil or geologic conditions may require design calculations by an engineer.
- Your county conservation district or municipal engineer can confirm if this approach meets local requirements.

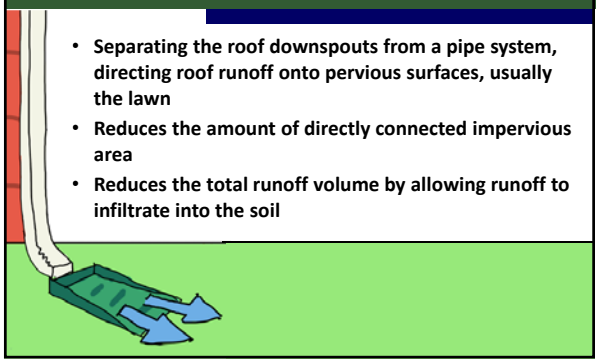
Outline

- Downspout disconnection
- What is a Dry Well
- Types of projects that can use Builder Brief guidance
- Design considerations for Dry Wells
- Key construction steps
- Maintenance issues for education to homebuyers
- Example calculation of Dry Well sizing

Downspout Disconnection

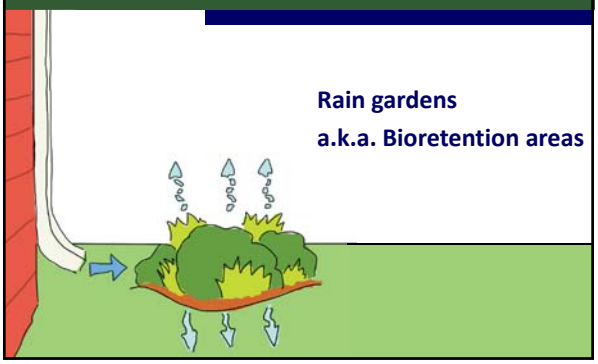
Downspout Disconnection

- Separating the roof downspouts from a pipe system, directing roof runoff onto pervious surfaces, usually the lawn
- Reduces the amount of directly connected impervious area
- Reduces the total runoff volume by allowing runoff to infiltrate into the soil



Downspout Disconnection: Options

Rain gardens
a.k.a. Bioretention areas

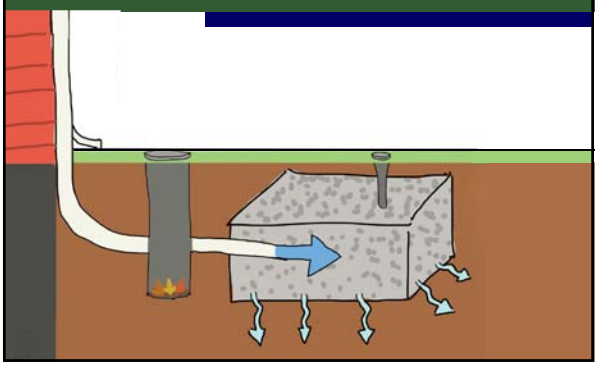


Downspout Disconnection: Options

Rain barrels

What is a Dry Well?

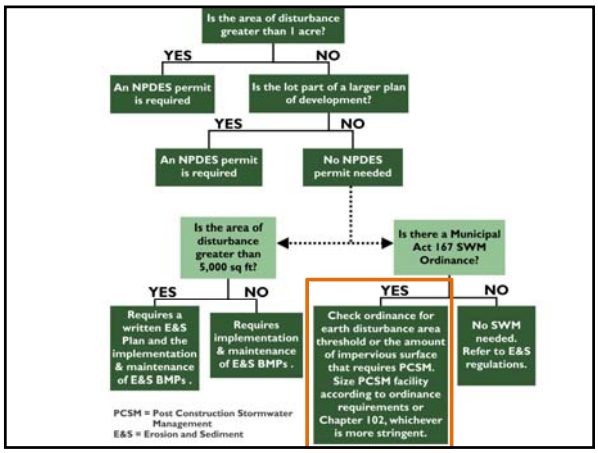
Downspout Disconnection: Dry Wells



Dry Wells

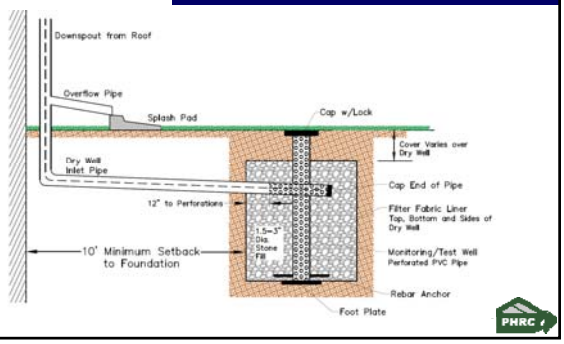
- A dry well is an underground storage facility that temporarily holds stormwater runoff from roofs
- Runoff drains from the gutter into either a gravel filled pit, or a prefabricated plastic or concrete tank
- Runoff slowly drains out of the dry well into the surrounding soil
- Dry wells reduce the volume of stormwater runoff by allowing the water to be infiltrated into the soil
- There may be a sump, or smaller chamber, located before the gravel pit or tank.
  - Sumo collects leaves and other debris to prevent clogging of the dry well

Types of Projects that can use Builder Brief guidance



Design Considerations for Dry Wells

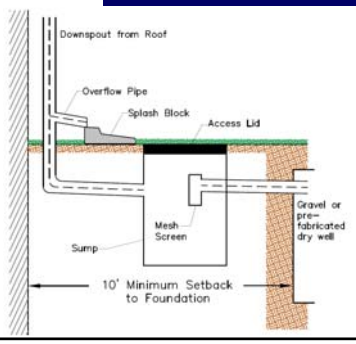
Dry Well without a Pre-treatment Sump



Dry Well Construction

- If the dry well is filled with gravel, the rock typically consists of clean washed, uniformly graded aggregate with 40% void capacity (AASHTO No. 3, or similar)
- Dry well aggregate is wrapped in a nonwoven geotextile, which keeps the surrounding soil out of the rock of the dry well but still lets the water pass through
- Prefabricated chamber made of concrete or plastic can be used instead of a gravel pit

Dry Well with a Pre-treatment Sump



Dry Well Construction w/Sump

- A dry well may also be designed with a pre-treatment sump that collects leaf, sediment, and other debris, reducing the risk of clogging the dry well
- Sump has a cleanout access hatch to allow for the periodic removal of accumulated material
- The only way to clean out a clogged gravel pit dry well is through removal and replacement of the gravel, so a pre-treatment sump is particularly important for this type of construction

Design Criteria & Considerations

- **Dry wells should empty within 72 hours of a rain event**
- **The bottom of the dry well should be 2 feet above the seasonally high water table or bedrock**
- **The top of a dry well should have approximately 1 foot of cover.**
- **Ten feet of separation is recommended between dry wells and building foundations to reduce risk for basement seepage**
  - This distance may be shortened at the discretion of a design professional
  - An impermeable liner may need to be installed on the building side of the dry well if the separation distance is less than 10'

Design Criteria & Considerations

- **A filtering screen should be installed in the bottom of the gutter below the surcharge pipe to keep out leaves and other debris**
- **An access pipe for inspection and maintenance should be provided**
- **Roof gutter guards can prevent leaves, sediment and other debris from clogging the dry well**
- **Consider what is near the overflow pipe to ensure that additional runoff is safely conveyed during an intense storm event that overflows the dry well**

Key Construction Steps

Key Construction Steps

- **Mark off the area where the dry wells will be located, and do not allow equipment to travel over this area which would compact the soil.**
- **Install dry wells after site construction has occurred and the site has been stabilized to prevent sedimentation and/or damage from construction activity.**
  - If construction of the dry well cannot be delayed, the dry well location must be protected with a berm, silt fence, or compost sock to prevent sediment from collecting in the area.
- **The dry well bottom must be uniform, level, and uncompacted. The bottom must be free from rocks and debris. Do NOT compact subgrade. Excavation should be performed with the lightest practical equipment, and the equipment should be located outside the limits of the dry well.**

See Builder Brief or PA Stormwater BMP Manual for more details.
http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-67994/6.4.6%20BMP%20Dry%20Well%20Seepage%20Pit.pdf

Maintenance Issues for Education of Homebuyers

Maintenance Info to Provide to Homebuyer

- **The builder needs to provide the homebuyer with information about any BMPs on their property.**
- **Maintenance plan needs to include:**
  - Location of BMPs
  - A long-term operation and maintenance schedule

Maintenance Info to Provide to Homebuyer:
After storms with more than 1 inch of rain

- There is typically a screen where the downspout enters the dry well. Clean the screen by removing any leaves that could block the flow of water into the dry well.
- Inspect the sump for accumulation of sediment, trash, or any other material. Remove any material that is in the sump to prevent it from clogging the dry well.

Maintenance Info to Provide to Homebuyer:
Quarterly

- There should be an above ground cap that allows access to the dry well. Four times a year, view down the access pipe to make sure that the dry well is not accumulating sediment, trash or other material. Overtime the accumulation of sediment or trash may be vacuumed or may require excavation.
- Contact your county conservation district for guidance on cleaning out your dry well.

Maintenance Info to Provide to Homebuyer:
Annually

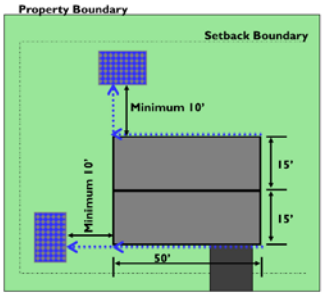
- Clean gutters to keep leave debris out of the sump and dry well.

Maintenance Info to Provide to Homebuyer:
Additional Information

- After large rain events, check the access pipe to ensure that the dry well is draining within 72 hours.
- If the drain times are more than 72 hours, the dry well may need to be cleaned out or replaced.
- Contact your county conservation district for guidance on fixing or replacing your dry well.

Example Calculation of Dry Well Sizing

Dry Well Sizing Example



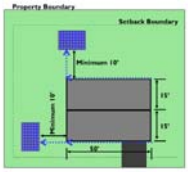
Step 1: Calculate the Runoff Volume

- The volume of runoff that must be managed is:

the area of the roof surface that is contributing runoff ✖ *depth of rainfall*

- Many ordinances are requiring the permanent removal of the first 1 inch of runoff, based on Control Guidance 2 (CG2) from the PA Stormwater Best Practices Manual (2006)
- If your ordinance requires control of a different depth, substitute that depth in for 1 inch in the runoff volume equation

Step 1: Calculate the Runoff Volume



$$\text{Runoff Volume}(\text{cu ft}) = \text{Roof area}(\text{sq ft}) \times \text{Rainfall depth (in)} \times \frac{1\text{ ft}}{12\text{ in}}$$

$$\text{Runoff Volume} = 50\text{ ft} \times 15\text{ ft} \times 1\text{ in} \times \frac{1\text{ ft}}{12\text{ in}} = 62.5\text{ cu ft}$$

Step 2: Calculate Required Volume of Dry Well

- In a gravel-filled dry well, about 60% of the space will be occupied by the rock, so there is less room for water storage. About 40% of gravel is air or void space, which means that in a dry well filled with gravel, only about 40% of the volume can store water. Divide the runoff volume by the 40% void space to find the volume of the dry well
- If you are using a prefabricated tank that doesn't use gravel, the required volume of the dry well is the same as the runoff volume.

Step 2: Calculate Required Volume of Dry Well

Gravel box type dry well:

$$\text{Dry Well Volume}(\text{cu ft}) = \frac{\text{Runoff Volume}(\text{cu ft})}{0.40}$$

$$\text{Dry Well Volume}(\text{cu ft}) = \frac{62.5 \text{ cu ft}}{0.40} = 156.25 \text{ cu ft}$$

Prefabricated dry well w/no gravel:

$$\text{Dry Well Volume}(\text{cu ft}) = \text{Runoff Volume}(\text{cu ft})$$

Step 3: Calculate the Dimensions of the Dry Well

- **The total volume of the dry well will be used to determine the dimensions of the dry well box**
- **The height of the box is limited by the depth to seasonally high ground water or bedrock, combined with providing approximately 1 foot of cover over the dry well.**
  - Even if ground water or bedrock aren't an issue, a dry well for a residential home typically doesn't have a height of more than 48 inches
- **Volume = height x length x width**
  - Height is known.
  - Plug numbers for the length and width to find a box volume that is larger than or equal to the required dry well volume calculated in Step 2.

Step 3: Calculate the Dimensions of the Dry Well

Height (ft) = Depth to SHWT or bedrock - 3 ft
(3 ft → 2 ft for separation to seasonally high water table (SHWT) or bedrock + 1 ft for cover on top)

For this example, the depth to the seasonally high water table is 7 ft.

Height (ft) = 7 ft - 3 ft = 4 ft

Height = 4 ft
Length = ?
Width = ?

Step 3: Calculate the Dimensions of the Dry Well

Dimensional Volume (cu ft) = Height (ft) × Length (ft) × Width (ft)

Dimensional Volume ≥ Dry Well Volume
Dimensional Volume ≥ 156.25 cu ft

Dimensional Volume (cu ft) = 4 ft × 5 ft × 7 ft = 140 cu ft ✗

Dimensional Volume (cu ft) = 4 ft × 5.75 ft × 7 ft = 161 cu ft ✓

Height = 4 ft
Length = 5.75 ft
Width = 7 ft

Step 4: Calculate the Drain Time of the Dry Well

- **Must drain in less than 72 hours to prevent mosquito problems**
- **Drain rate is a function of:**
  1. Soil permeability rate, and
  2. Surface area of the dry well through which the water will drain
     - 2006 PA SW BMP Manual allows for the bottom and side areas of the dry well to all be counted as surfaces that will drain or allow for infiltration. More recent design guides tend to only allow for infiltration through the bottom of the dry well
- **Drain time is a function of:**
  1. Drain rate
  2. Volume of runoff
- **If the drain time is longer than 72 hours, the bottom area of the dry well must be increased to provide additional area for the water to drain into the soil.**

Step 4: Calculate the Drain Time of the Dry Well

$$\text{Drain Rate}\left(\frac{\text{cu ft}}{\text{hr}}\right) = \text{Soil Permeability Rate}\left(\frac{\text{in}}{\text{hr}}\right) \times \frac{1\,\text{ft}}{12\,\text{in}} \times \text{Bottom Area (sq ft)}$$

Soil Permeability Rate → use 0.5 in/hr if you don't have measured data

Height = 4 ft
Length = 5.75 ft → **Bottom area = length x width** → **5.75 x 7 = 40.25 sq ft**
Width = 7 ft

$$\text{Drain Rate}\left(\frac{\text{cu ft}}{\text{hr}}\right) = 0.5\frac{\text{in}}{\text{hr}} \times \frac{1\,\text{ft}}{12\,\text{in}} \times 40.25\,\text{sq ft} = 1.68\,\frac{\text{cu ft}}{\text{hr}}$$

Step 4: Calculate the Drain Time of the Dry Well

Drain Time < 72 hours

$$\text{Drain Time (hr)} = \frac{\text{Runoff Volume (cu ft)}}{\text{Drain Rate}\left(\frac{\text{cu ft}}{\text{hr}}\right)}$$

From Step 2

From first part of Step 4

$$\text{Drain Time (hr)} = \frac{62.5 \text{ cu ft}}{1.68 \frac{\text{cu ft}}{\text{hr}}} = 37.27 \text{ hr} \checkmark$$

Summary

- Dry wells are an effective way to meet local stormwater regulations for single-family homes.
- Dry wells are sized based on soil conditions
  - You can make some assumptions, but will be more accurate with measured values
- Including a pre-treatment sump will include the longevity of the dry well
- The builder needs to provide maintenance information to the homeowner

Resources

- PA Department of Environmental Protection. (2016) 2022 Model Stormwater Management Ordinance. Available online at: http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-112616/3800-PM-BCW0100j%20Model%20Ordinance%20(Final).pdf
- PA Department of Environmental Protection. (2006) Pennsylvania Stormwater Best Management Practices Manual. Available online at: http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-8305
- New Jersey Department of Environmental Protection. (2016) New Jersey Stormwater Best Management Practices Manual. Available online at http://www.njstormwater.org/bmp_manual2.htm

Evaluations / Certificate / Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

Join us next month on Tuesday, February 14th at 1pm for the webinar titled
"Frost-Protected Shallow Foundations in Pennsylvania"
Presenter: Brian Wolfgang