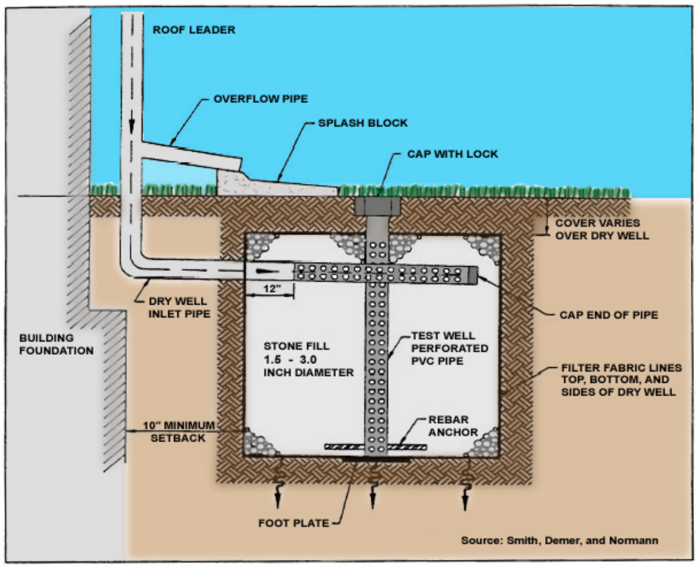
BMP #: Dry Wells / French Drains



A Dry Well, or French Drain, is a variation on an Infiltration Trench that is designed to temporarily stores and infiltrate rooftop runoff.

Key Design Elements

- Maintain minimum distance from building foundation (typically 10 feet)
- Provide adequate overflow outlet for large storms
- Size to retain and infiltrate the difference in runoff volume for the 2-year storm, pre- to post- development
- Depth of Dry Well aggregate should be between 18 and 48 inches deep
- At least one observation well; clean out is recommended
- Wrap aggregate with non-woven geotextile
- Maximum drain-down time is 48 hours
- Provide pre-treatment for some situations

Potential Applications

Residential Subdivision:	**YES**
Commercial:	**YES**
Ultra Urban:	**YES**
Industrial:	**LIMITED**
Retrofit:	**YES**
Highway/Road:	**NO**

Stormwater Functions

Volume Reduction:	**Medium**
Recharge:	**Medium**
Peak Rate Control:	**Medium**
Water Quality:	**Medium**

Pollutant Removal

Total Suspended Solids:	**x**
Nutrients:	**x**
Metals:	**x**
Pathogens:	**x**

Other Considerations:

- Infiltration criteria and required testing applies

Description

A Dry Well, sometimes called a French Drain, is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roofs of structures. Roof leaders connect directly into the Dry Well, which may be either an excavated pit filled with uniformly graded aggregate wrapped in geotextile or a pre-fabricated storage chamber. Dry Wells discharge the stored runoff via infiltration into the surrounding soils. In the event that the Dry Well is overwhelmed in an intense storm event, an overflow mechanism (surcharge pipe, connection to larger infiltration area, etc.) will ensure that additional runoff is safely and efficiently conveyed downstream.

By treating runoff at the source, Dry Wells can dramatically reduce the increased volume of stormwater generated by the roofs of structures. Though roofs are generally not a significant source of runoff pollution, they are still one of the most important sources of new or increased runoff volume from developed areas. By decreasing the volume of stormwater runoff, Dry Wells can also reduce runoff rate and improve water quality. As with other infiltration practices though, Dry Wells are not appropriate for "hot spots" or other areas where high pollutant or sediment loading is expected. Furthermore, Dry Wells are not recommended within a specified distance to structures (for fear of basement seepage or flooding) or where they might interfere with the operation of subsurface sewage disposal systems.

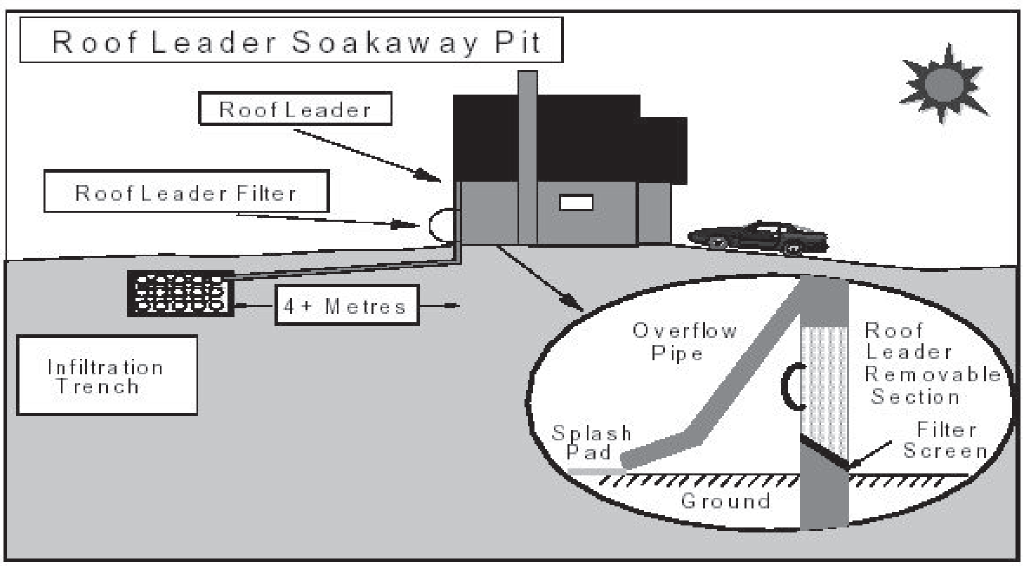


Figure 1. Roof Leader / Dry Well Schematic (Ontario Manual)

Variations

Intermediate "Sump" Box – Water can flow through an intermediate box with an outflow higher to allow the sediments to settle out. Water would then flow through a mesh screen and into the infiltration trench.

Drain Without Gutters – For structures without gutters or downspouts, runoff is designed to sheetflow off a pitched roof surface and onto a stabilized ground cover (surface aggregate, concrete, or other means). Runoff is then directed toward a Dry Well via stormwater pipes or swales.

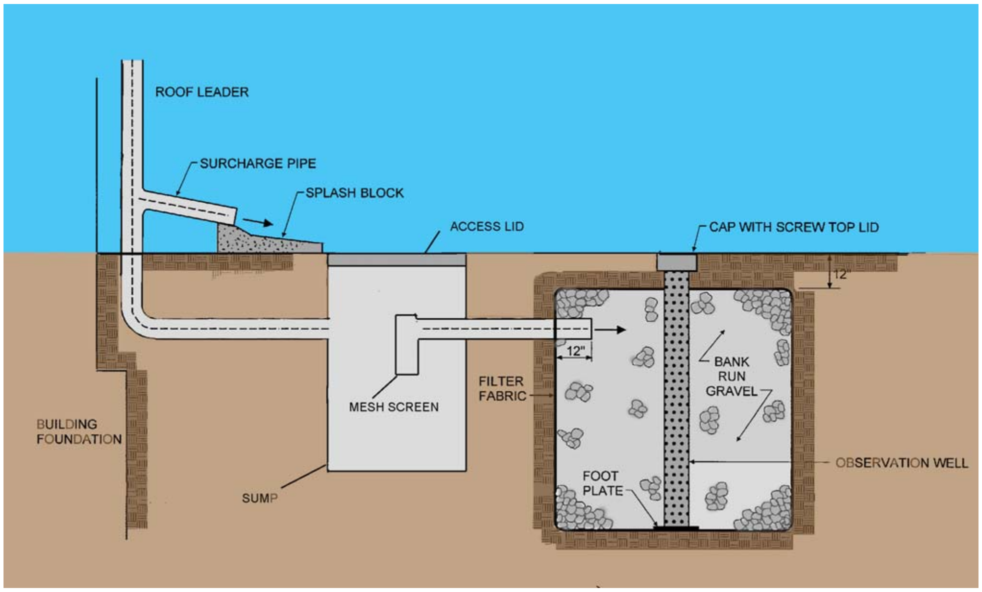


Figure 2. Intermediate Sump Box (New York Manual)

Pre-fabricated Dry Well – There are a variety of pre-fabricated, predominantly plastic subsurface storage chambers on the market today that can replace aggregate Dry Wells. Since these systems have significantly greater storage capacity than aggregate, space requirements are reduced and associated costs may be defrayed. Provided the following design guidelines are followed and infiltration is still encouraged, pre-fabricated chambers can prove just as effective as standard aggregate Dry Wells.

Figure 3. Example of pre-fabricated chamber (Infiltrator Systems, Inc.)

Applications

Any roof or impervious area with relatively low sediment loading

Design Considerations

1. Dry Wells are sized to temporarily retain and infiltrate stormwater runoff from roofs of structures, but if possible, Dry Wells should be designed to accommodate increased runoff volumes for up to the 2-year storm.

2. Dry Wells should drain-down within 48 hours. Longer drain-down times reduce Dry Well efficiency and can lead to anaerobic conditions, odor, and water quality problems.

3. Dry Wells typically consist of 18 to 48 inches of clean washed, uniformly graded aggregate with 40% void capacity (AASHTO No. 3, or similar). Dry Well aggregate is wrapped in a non-woven geotextile, which provides separation between the aggregate and the surrounding soil. At least 12 inches of soil is then placed over the Dry Well. An alternative form of Dry Well is a subsurface, pre-fabricated chamber. A variety of pre-fabricated Dry Wells are currently available on the market.

4. Dry Wells are not recommended when their installation would create a significant risk for basement seepage or flooding. In general, 10 feet of separation is recommended between Dry Wells and building foundations. However, this distance may be shortened at the discretion of a geotechnical or structural engineer. Shorter separation distances may warrant an impermeable liner to be installed on the building side of the Dry Well.

5. Continuously perforated pipe(s) can be installed along the length of an aggregate Dry Well to evenly distribute runoff, promoting more widespread infiltration.

6. All Dry Wells must be able to convey system overflows to downstream drainage systems. System overflows can be incorporated either as surcharge (or overflow) pipes extending from roof leaders or via connections to more substantial infiltration areas. In the case of the latter, the Dry Well bottom should have the minimally sufficient slope needed to direct runoff towards the infiltration bed area. (In general, the minimum slope of a Dry Well bottom should be ½” per foot.)

7. The design depth of a Dry Well should take into account frost depth to prevent frost heave.

8. Though it may vary according to design, the maximum drainage area to a Dry Well is typically on the order of 1 acre; most roof top areas are substantially smaller.

9. A removable filter with a screened bottom should be installed in the roof leader below the surcharge pipe in order to screen out leaves and other debris.

10. As the water level in a Dry Well is the primary means of measuring infiltration rates and drain-down times, adequate inspection and maintenance access to the Well should be provided. Observation wells not only provide the necessary access to the Well, but they also provide a conduit through which pumping of stored runoff can be accomplished in a failed system.

11. Though roofs are generally not a significant source of runoff pollution, they can still be a source of particulates and organic matter, as well as sediment and debris during construction. Measures such as roof gutter guards, roof leader clean-out with sump, or an intermediate sump box can provide pretreatment for Dry Wells by minimizing the amount of sediment and other particulates that may enter it.

Detailed Stormwater Functions

Volume Reduction Calculations: The storage volume of a Dry Well is defined as the volume beneath the discharge invert. The following equation can be used to determine the approximate storage volume of an aggregate Dry Well:

Dry Well Storage Volume = Length of Dry Well x Width of Dry Well x Depth of Dry Well x Void Capacity (40% for AASHTO No. 3)

If perforated pipes are incorporated in aggregate Dry Wells, additional storage volume can be provided. For prefabricated chambers, see manufacturers' specifications for storage volumes. Dimensions and volume capacity will vary.

Peak Rate Mitigation Calculations: See Section 8 for corresponding peak rate reduction.

Water Quality Improvement: If sized to treat the WQ storm, removal rates above can be applied to that volume of water.

Construction Sequence

1. Protect infiltration area from compaction prior to installation.

2. If possible, install Dry Wells during later phases of site construction to prevent sedimentation and/or damage from construction activity.

3. Install and maintain proper Erosion and Sediment Control Measures during construction as per the Pennsylvania Erosion and Sediment Pollution Control Program Manual (March 2000, or latest edition).

4. Excavate Dry Well bottom to a uniform, level uncompacted subgrade free from rocks and debris. Do NOT compact subgrade. To the greatest extent possible, excavation should be performed with the lightest practical equipment. Excavation equipment should be placed outside the limits of the Dry Well whenever possible.

5. Completely wrap Dry Well with non-woven geotextile. (If sediment and/or debris have accumulated in Dry Well bottom, remove prior to geotextile placement.) Geotextile rolls should overlap by a minimum of 24 inches within the trench. Fold back and secure excess geotextile during stone placement.

6. Install continuously perforated pipe, observation wells, and all other Dry Well structures. Connect roof leaders to structures as indicated on plans.

7. Place uniformly graded, clean-washed aggregate in 6-inch lifts, lightly compacting between lifts.

8. Fold and secure non-woven geotextile over trench, with minimum overlap of 12-inches.

Figure 4. Construction of a French drain. (www.gardenadvice.co.uk/howto/garden-build/frenchdrain/index.html)

9. Place 12-inch lift of approved Topsoil over trench, as indicated on plans.

10. Seed and stabilize topsoil.

11. Connect surcharge pipe to roof leader and position over splashboard.

12. Do not remove Erosion and Sediment Control measures until site is fully stabilized.

Maintenance Issues

As with all infiltration practices, Dry Wells require regular and effective maintenance to ensure prolonged functioning. The following represent minimum maintenance requirements for Dry Wells:

- Inspect Dry Wells at least four times a year, as well as after every storm exceeding 1 inch.
- Dispose of sediment, debris/trash, and any other waste material removed from a Dry Well at suitable disposal/recycling sites and in compliance with local, state, and federal waste regulations.
- Routinely evaluate the drain-down time of the Dry Well to ensure the maximum time of 48 hours is not being exceeded. If drain-down times are exceeding the maximum, drain the Dry Well via pumping and clean out perforated piping, if included. If slow drainage persists, the system may need replacing.
- Regularly clean out gutters and ensure proper connections to facilitate the effectiveness of the dry well.
- Replace filter in roof leaders as necessary.
- If an intermediate sump box exists, clean it out at least once per year.

Cost Issues

The construction cost of a Dry Well/French Drain can vary greatly depending on design variability, configuration, location, site-specific conditions, etc. Typical construction costs in 2003 dollars range from $4 - $9 per cubic foot of storage volume provided (SWRPC, 1991; Brown and Schueler, 1997). Annual maintenance costs have been reported to be approximately 5 to 10 percent of the capital costs (Schueler, 1987). The cost of gutters is typically included in the total structure cost, as opposed to the site work cost. However, the overflow connection and splash block may increase costs.

Specifications:

The following specifications are provided for information purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

1. Stone for infiltration trenches shall be 2-inch to 1-inch uniformly graded coarse aggregate, with a wash loss of no more than 0.5%, AASHTO size No. 3 per AASHTO Specifications, Part I, 19th Ed., 1998, or later and shall have voids ≥ 35% as measured by ASTM-C29.

2. Non-Woven Geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:

a. Grab Tensile Strength (ASTM-D4632) ≥ 120 lbs
b. Mullen Burst Strength (ASTM-D3786) ≥ 225 psi
c. Flow Rate (ASTM-D4491) ≥ 95 gal/min/ft^2
d. UV Resistance after 500 hrs (ASTM-D4355) ≥ 70%
e. Heat-set or heat-calendared fabrics are not permitted

Acceptable types include Mirafi 140N, Amoco 4547, and Geotex 451.

3. Topsoil

4. Pipe shall be continuously perforated, smooth interior, with a minimum inside diameter of 4-inches. High-density polyethylene (HDPE) pipe shall meet AASHTO M252, Type S or AASHTO M294, Type S.

5. Gutters and splashboards shall follow Manufacturer’s specifications.

References and Additional Sources

New Jersey Department of Environmental Protection. *New Jersey Stormwater Best Management Practices Manual*. 2004.

New York State Stormwater Management Design Manual

http://www.unexco.com/french.html