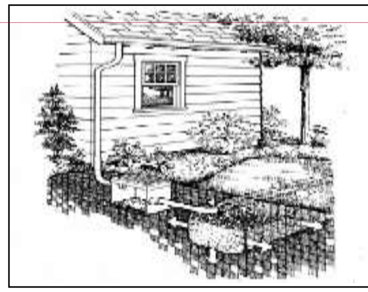
4.7~~8~~ Dry Wells

Description

Dry wells are low impact development practices that are located below the surface of development sites. They consist of shallow excavations, typically filled with stone, that are designed to intercept and temporarily store post-construction stormwater runoff until it infiltrates into the underlying and surrounding soils. ~~If properly designed, they can provide significant reductions in post-construction stormwater runoff rates, volumes and pollutant loads on development sites. Consequently, dry wells can be used to help satisfy the SWM Criteria presented in this CSS~~.

LID/GI Considerations: Use of a dry well decreases the post construction runoff volume from a site, decreasing the pollutant load as well as thermal and erosive impacts to receiving waters. Dry wells are installed underground, which allows for multiple uses of development space.



(Source: City of Portland, OR, 2008)

KEY CONSIDERATIONS

DESIGN CRITERIA:

- Dry wells should be designed to completely drain within 24 hours of the end of a rainfall event
- The distance from the bottom of a dry well to the top of the water table should be least 2 feet
- Dry wells should be designed with slopes that are as close to flat as possible to help ensure that stormwater runoff is evenly distributed throughout the stone reservoir

ADVANTAGES / BENEFITS:

- Helps restore pre-development hydrology on development sites and reduces post-construction stormwater runoff rates, volumes and pollutant loads
- W~~Particularly w~~ell suited for use on urban development sites

DISADVANTAGES / LIMITATIONS:

- Can only be used to "receive" runoff from small drainage areas of 2,500 square feet or less
- Should not be used on development sites that have soils with infiltration rates of less than 0.5 inches per hour

ROUTINE MAINTENANCE REQUIREMENTS:

- Dry wells should be inspected and cleaned annually, including pipes, gutters, downspouts, and all filters
- If water ponds for more than 48 hours after a major storm or more than six inches of sediment has accumulated, the gravel media should be

STORMWATER MANAGEMENT ~~"CREDITS"~~SUITABILITY

☑ Runoff Reduction

☑ Water Quality ~~Protection~~

☐~~☑~~ ~~Aquatic Resource~~Channel Protection

☐~~☑~~ Overbank Flood Protection

☐~~☑~~ Extreme Flood Protection

☑ = suitable for this practice

☐ = may provide partial benefits

~~☑ = practice has been assigned quantifiable stormwater management "credits" that can be used to address this SWM Criteria~~

IMPLEMENTATION CONSIDERATIONS

L Land Requirement

M Capital Cost

M Maintenance Burden

Residential Subdivision Use: *Yes*

High Density/Ultra-Urban: Yes

Roadway Projects: Not Recommended

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POLLUTANT REMOVAL

100%	**Total Suspended Solids**
100%100%	**Nutrients** - Total Phosphorus / Total Nitrogen removal
100%	**Metals** - Cadmium, Copper, Lead, and Zinc removal
100%	**Pathogens** – Fecal Coliform

Soils: *Dry wells should be considered for use on development sites where fine sediment (e.g., clay, silt) loads will be relatively low, as high sediment loads will cause them to clog and fail. Permeable soils with a water table low enough to provide for the infiltration of stormwater runoff are recommended.*

Other Considerations: *Dry wells should not be located beneath a driveway, parking lot or other impervious surface.*

L=Low **M**=Moderate **H**=High

Runoff Reduction Credit:
100% of the runoff reduction volume provided (HSG A and B Soils)

SITE APPLICABILITY

☑ Rural Use	M Construction Cost
☑ Suburban Use	M Maintenance
☑ Urban Use	L Area Required

STORMWATER MANAGEMENT PRACTICE PERFORMANCE

Runoff Reduction
80% - Annual Runoff Volume
Varies[1] - Runoff Reduction Volume

Pollutant Removal[2]
80% - Total Suspended Solids
80% - Total Phosphorus
80% - Total Nitrogen
80% - Metals
80% - Pathogens

1 = varies according to storage capacity of the dry well
2 = expected annual pollutant load removal

Discussion4.7.1 General Description

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Dry wells (also known as *seepage pits* and *french drains*) are low impact development practices that are located below the surface of development sites. They consist of shallow excavations, typically filled with stone, that are designed to intercept and temporarily store post-construction stormwater runoff until it infiltrates into the underlying and surrounding soils (Figure 4.7-.140). If properly designed, they can provide significant reductions in post-construction stormwater runoff rates, volumes and pollutant loads on development sites.

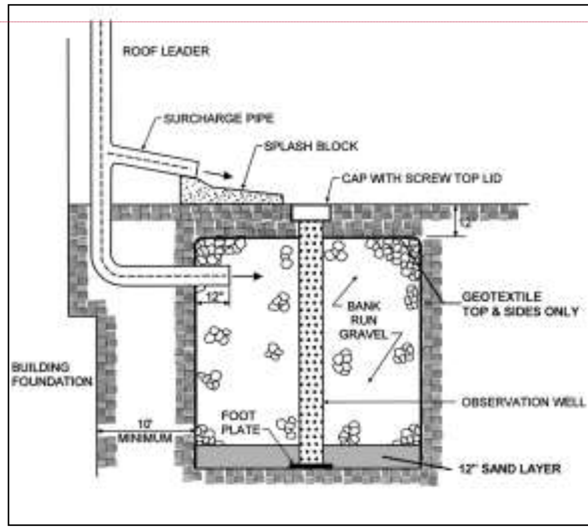

Figure 47.7-140: Dry Well
(Source: Maryland Department of the Environment, 2000)

As infiltration-based low impact development practices, dry wells are limited to use in areas where the soils are permeable enough and the water table is low enough to provide for the infiltration of stormwater runoff. They should only be considered for use on development sites where fine sediment (e.g., clay, silt) loads will be relatively low, as high sediment loads will cause them to clog and fail. In addition, dry wells should be carefully sited to avoid the potential contamination of water supply aquifers.

The primary concern associated with the design of a dry well is its storage capacity, which directly influences its ability to reduce stormwater runoff rates, volumes and pollutant loads. Site planning and design teams should strive to design dry wells that can accommodate the stormwater runoff volume generated by the target runoff reduction rainfall event (e.g., 85th percentile rainfall event). If this cannot be accomplished, due to site characteristics or constraints, site planning and design teams should consider using dry wells in combination with other runoff reducing low impact development practices, such as rain gardensbioretention areas (Section 4.27.8.9) and rainwater harvesting (Section 7.8.124.19), to supplement the stormwater management benefits provided by the dry wells.

4.7.2 Stormwater Management SuitabilityStormwater Management "Credits"

The Center for Watershed Protection (Hirschman et al., 2008) recently documented the ability of dry wells to reduce annual stormwater runoff volumes and pollutant loads on development sites, as follows:. Consequently, this low impact development practice has been assigned quantifiable stormwater management "credits" that can be used to help satisfy the SWM Criteria presented in this CSS:

- Stormwater Runoff Reduction

  : Subtract 100% of the storage volume provided by a dry well from the runoff reduction volume (RR_v) conveyed through the dry well.

- Water Quality Protection

  : If installed as per the recommended design criteria and properly maintained, 100% total suspended solids removal will be applied to the water quality volume (WQv) flowing to the dry well.Subtract 100% of the storage volume provided by a *dry well* from the runoff reduction volume (RR_v) conveyed through the *dry well*.

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- Channel~~Aquatic Resource~~ Protection

~~:~~ Proportionally adjust the post-development runoff curve number (CN) to account for the runoff reduction provided by a dry well when calculating the ~~aquatic resource~~channel protection volume ($C\sout{AR}P_v$) on a development site (See section 4.1.6.4).

- Overbank Flood Protection

~~:~~ Proportionally adjust the post-development runoff ~~curve number (~~CN~~)~~ to account for the runoff reduction provided by a dry well when calculating the overbank peak discharge (Q_{p25}) on a development site (See section 4.1.6.4).

- Extreme Flood Protection

~~:~~ Proportionally adjust the post-development runoff ~~curve number (~~CN~~)~~ to account for the runoff reduction provided by a dry well when calculating the extreme peak discharge (Q_{p100}) on a development site (See section 4.1.6.4).

~~The storage volume provided by a dry well can be determined using the following equation:~~

~~Storage Volume = Surface Area x Depth x Void Ratio~~

~~A void ratio (i.e., void space/total volume) of 0.32 should be used in all storage volume calculations, unless more specific planting bed void ratio data are available.~~

~~In order to "receive" stormwater runoff and be eligible for these "credits," it is *recommended* that dry wells satisfy the planning and design criteria outlined below.~~

4.7.3 Pollutant Removal Capabilities

Dry wells are presumed to remove 100% of the total suspended solids (TSS) load in typical urban post-development runoff when sized, designed, constructed, and maintained in accordance with the recommended specifications. Dry wells also remove 100% of the Phosphorus, Nitrogen, metals (such as Cadmium, Copper, Lead, and Zinc), and fecal coliform in contributing runoff.

In order to provide the most efficient pollutant removal, dry wells should be constructed in permeable soils of hydrologic soil group A or B. The maximum drainage area and site surface slope should not be exceeded to ensure proper pollutant removal.

For additional information and data on pollutant removal capabilities for dry wells, see the National Pollutant Removal Performance Database (Version 3) available at www.cwp.org and the National Stormwater Best Management Practices (BMP) Database at www.bmpdatabase.org.

4.7.4 Application and Site Feasibility Criteria

Dry wells can be used to treat stormwater runoff on a wide variety of development sites, including residential, commercial and institutional development sites in rural, suburban and urban areas. Although they are particularly well suited to receive rooftop runoff, they can also be used to receive stormwater runoff from other small drainage areas, such as local streets and roadways, driveways, small parking areas and disturbed pervious areas (e.g., lawns, parks, community open spaces). When compared with other low impact development practices, dry wells have a moderate construction cost, a moderate maintenance burden and require only a small amount of surface area.

General Feasibility

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- Suitable for Residential Subdivision Usage – YES
- Suitable for High Density/Ultra Urban Areas – YES
- Regional Stormwater Control – NO

Physical Feasibility – Physical Constraints at Project Site

Overall Feasibility

The criteria listed in Table 7.32 should be evaluated to determine whether or not a dry well is appropriate for use on a development site.

- Drainage Area – The size of the contributing drainage area should be 2,500 square feet or less.
- Space Required – Dry well surface area requirements vary according to the size of the contributing drainage area and the infiltration rate of the soils on which the dry well will be located. In general, dry wells require about 5-10% of the size of their contributing drainage areas.
- Flow Path - The length of flow path in contributing drainage areas should be 150 feet or less in pervious drainage areas and 75 feet or less in impervious drainage areas.
- Site Slope – Although dry wells may be used on development sites with slopes of up to 6%, they should be designed with slopes that are as close to flat as possible to help ensure that stormwater runoff is evenly distributed throughout the stone reservoir.
- Minimum Depth to Water Table – 2 feet
- Minimum Head – 2 feet
- Soils – Dry wells should be designed to completely drain within 24 hours of the end of a rainfall event. Consequently, dry wells generally should not be used on development sites that have soils with infiltration rates of less than 0.50 inches per hour (i.e., hydrologic soil group C and D soils).

Table 7.32: Factors to Consider When Evaluating the Overall Feasibility of Using a Dry Well on a Development Site

Site Characteristic	Criteria
Drainage Area	The size of the contributing drainage area should be 2,500 square feet or less. The length of flow path in contributing drainage areas should be 150 feet or less in pervious drainage areas and 75 feet or less in impervious drainage areas.
Area Required	Dry well surface area requirements vary according to the size of the contributing drainage area and the infiltration rate of the soils on which the dry well will be located. In general, dry wells require about 5-10% of the size of their contributing drainage areas.
Slope	Although dry wells may be used on development sites with slopes of up to 6%, they should be designed with slopes that are as close to flat as possible to help ensure that stormwater runoff is evenly distributed evenly distributed throughout the stone reservoir.
Minimum Head	2 feet
Minimum Depth to Water Table	2 feet
Soils	Dry wells should be designed to completely drain within 24 hours of the end of a rainfall event. Consequently, dry wells generally should not be used on development sites that have soils with infiltration rates of less than 0.50 inches per hour (i.e., hydrologic soil group C and D soils).

Other Constraints / Considerations

- Hot spots – May be used for hot spot runoff
- Damage to existing structures and facilities –
- Dry wells should not be used in areas where their operation may create a risk for basement

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- Dry wells should be designed so that overflow drains away from buildings to prevent damage to building foundations.
- Proximity – Dry wells may be used without restriction near:
  - 10 feet from building foundations
  - 10 feet from property lines
  - 100 feet from private water supply wells
  - 1,200 feet from public water supply wells
  - 100 feet from septic systems
  - 100 feet from surface waters
  - 400 feet from public water supply surface waters
- Trout Stream – Use of a dry well reduces a site's runoff pollutant load, as well as volume and velocity of stormwater runoff. Therefore, dry wells are an effective BMP for use where trout streams or other protected waters may receive stormwater runoff.

Coastal Areas

- Poorly Drained Soils, such as hydrologic soil groups C and D - reduces the ability of dry wells to reduce stormwater runoff rates, volumes and pollutant loads. Dry wells should not be used on development sites that have soils with infiltration rates of less than 0.5 inches per hour (i.e., hydrologic soil group C and D soils). Use other low impact development practices, such as rainwater harvesting (Section 4.19) and underdrained dry wells (Section 4.7), to "receive" stormwater runoff in these areas.
- Well drained soils, such as hydrologic soil group A and B - Enhances the ability of dry wells to reduce stormwater runoff rates, volumes and pollutant loads, but may allow stormwater pollutants to reach groundwater aquifers with greater ease. Rooftop runoff is relatively clean, so this should not prevent the use of dry wells, even at stormwater hotspots and in areas known to provide groundwater recharge to water supply aquifers. However, rooftop runoff should not be allowed to comingle with runoff from other impervious surfaces in these areas if it will be "received" by a dry well.
- Flat Terrain - Does not influence the use of dry wells. In fact, dry wells should be designed with slopes that are as close to flat as possible.
- Shallow Water Table - May be difficult to provide 2 feet of clearance between the bottom of the dry well and the top of the water table. May occasionally cause stormwater runoff to pond in the bottom of the dry well. Ensure that the distance from the bottom of the dry well to the top of the water table is at least 2 feet. Reduce the depth of the stone reservoir in dry wells to 18 inches.
- Tidally-influenced drainage system - Does not influence the use of dry wells.

Feasibility in Coastal Georgia

Several site characteristics commonly encountered in coastal Georgia may present challenges to site planning and design teams that are interested in using dry wells to "receive" post-construction stormwater runoff on a development site. Table 7.33 identifies these common site characteristics and describes how they influence the use of dry wells on development sites. The table also provides site planning and design teams with some ideas about how they can work around these potential constraints.

Table 7.33: Challenges Associated with Using Dry Wells in Coastal Georgia		
Site Characteristic	How it Influences the Use of Dry Wells	Potential Solutions

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Table 7.33: Challenges Associated with Using Dry Wells in Coastal Georgia		
Site Characteristic	**How it Influences the Use of Dry Wells**	**Potential Solutions**
• *Poorly drained soils, such as hydrologic soil group C and D soils*	• Reduces the ability of dry wells to reduce stormwater runoff rates, volumes and pollutant loads.	• Dry wells should not be used on development sites that have soils with infiltration rates of less than 0.5 inches per hour (i.e., hydrologic soil group C and D soils). • Use other low impact development practices, such as rainwater harvesting (Section 7.8.12) and underdrained bioretention area dry wells (Section 7.8.13), to "receive" stormwater runoff in these areas.
• *Well drained soils, such as hydrologic soil group A and B soils*	• Enhances the ability of dry wells to reduce stormwater runoff rates, volumes and pollutant loads, but may allow stormwater pollutants to reach groundwater aquifers with greater ease.	• Rooftop runoff is relatively clean, so this should not prevent the use of dry wells, even at stormwater hotspots and in areas known to provide groundwater recharge to water supply aquifers. However, rooftop runoff should not be allowed to comingle with runoff from other impervious surfaces in these areas if it will be "received" by a dry well. • Use bioretention area dry wells (Section 7.8.13) and dry swales (Section 7.8.15) with liners and underdrains to intercept and treat non-rooftop runoff at stormwater hotspots and in areas known to provide groundwater recharge to water supply aquifers.
• *Flat terrain*	• Does not influence the use of dry wells. In fact, dry wells should be designed with slopes that are as close to flat as possible.	

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Table 7.33: Challenges Associated with Using Dry Wells in Coastal Georgia

Site Characteristic	How it Influences the Use of Dry Wells	Potential Solutions
• *Shallow water table*	• May be difficult to provide 2 feet of clearance between the bottom of the dry well and the top of the water table. • May occasionally cause stormwater runoff to pond in the bottom of the dry well.	• Ensure that the distance from the bottom of the dry well to the top of the water table is at least 2 feet. • Reduce the depth of the stone reservoir in dry wells to 18 inches. • Use rainwater harvesting (Section 7.8.12), small stormwater wetlands (i.e., pocket wetlands) (Section 8.6.2) or wet swales (Section 8.6.6), instead of dry wells to intercept and treat stormwater runoff in these areas.
• *Tidally-influenced drainage system*	• Does not influence the use of dry wells.	

Site Applicability

Dry wells can be used to "receive" stormwater runoff on a wide variety of development sites, including residential, commercial and institutional development sites in rural, suburban and urban areas. Although they are particularly well suited to "receive" rooftop runoff, they can also be used to "receive" stormwater runoff from other small drainage areas, such as local streets and roadways, driveways, small parking areas and disturbed pervious areas (e.g., lawns, parks, community open spaces). When compared with other low impact development practices, dry wells have a moderate construction cost, a moderate maintenance burden and require only a small amount of surface area.

4.7.5 Planning and Design Criteria

Before designing the dry well, the following data is necessary:

- Existing and proposed site, topographic and location maps, and field reviews.
- The proposed site design, including, buildings, parking lots, sidewalks, stairs and handicapped ramps, and landscaped areas
- Architectural roof plan for rooftop pitches and downspout locations
- Roadway and drainage profiles, cross sections, utility plans, and soil report for the site.
- Information about downstream BMPs and receiving waters
- Design data from nearby storm sewer structure
- Water surface elevation of nearby water systems as well as the depth to seasonally high groundwater

*The following criteria are to be considered **minimum** standards for the design of a dry well. Consult with the local review authority to determine if there are any variations to these criteria or additional standards that must be followed.*It is recommended that dry wells meet all of the following criteria to be eligible for the stormwater management "credits" described above:

4.7.5.1. Location and Layout

- Dry wells should be located in a lawn or other disturbed pervious area and should be designed so that the top of the dry well is located as close to the surface as possible. Dry wells should not be located beneath a driveway, parking lot or other impervious surface.

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- Although dry wells may be installed on development sites with slopes of up to 6%, they should be designed with slopes that are as close to flat as possible to help ensure that stormwater runoff is evenly distributed throughout the stone reservoir.
- Dry wells should be used on development sites that have underlying soils with an infiltration rate of 0.50 inches per hour (in/hr) or greater, as determined by NRCS soil survey data and subsequent field testing.
- Although the number of infiltration tests needed on a development site will ultimately be determined by the local development review authority, at least one infiltration test is recommended for each dry well that will be used on the development site.
- Since clay lenses or any other restrictive layers located below the bottom of a dry well will reduce soil infiltration rates, infiltration testing should be conducted within any confining layers that are found within 4 feet of the bottom of a proposed dry well.
- The depth from the bottom of a dry well to the top of the water table should be at least 2 feet to prevent nuisance ponding and ensure proper operation of the dry well.
- If used to receive rooftop runoff, dry wells should be preceded by a leaf screen installed in the gutter or downspout. This will prevent leaves and other large debris from clogging the dry well.
- If used to receive non rooftop runoff, dry wells should be preceded by a pea gravel diaphragm or equivalent level spreader device (e.g., concrete sills, curb stops, curbs with sawteeth cut into them) and a vegetated filter strip that is designed according to the planning and design criteria provided in Section 4.28.
- Consideration should be given to the stormwater runoff rates and volumes generated by larger storm events (e.g., 25-year, 24-hour storm event) to help ensure that these larger storm events are able to safely bypass the dry well. An overflow, such as a vegetated filter strip (Section 4.28) or grass channel (Section 4.9), should be designed to convey the stormwater runoff generated by these larger storm events safely out of the dry well.

4.7.5.2.General Design

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General Planning and Design

- Dry wells should be used to "receive" stormwater runoff from small drainage areas of 2,500 square feet or less. The stormwater runoff rates and volumes from larger contributing drainage areas typically become too large to be properly "received"treated by a dry well.
- The length of the flow path within the contributing drainage area should be 150 feet or less for pervious drainage areas and 75 feet or less for impervious drainage areas. In contributing drainage areas with longer flow paths, stormwater runoff tends to becomes shallow, concentrated flow (Claytor and Schueler, 1996), which can significantly reduce the stormwater management benefits that dry wells can provide. In these situations, bioretention areas (Section 7.8.134.2) and infiltration practices (Section 7.8.144.12) should be used to "receive" post-construction stormwater runoff.
- Although dry wells may be installed on development sites with slopes of up to 6%, they should be designed with slopes that are as close to flat as possible to help ensure that stormwater runoff is evenly distributed throughout the stone reservoir.
- Dry wells should be located in a lawn or other disturbed pervious area and should be designed so that the top of the dry well is located as close to the surface as possible. Dry wells should not be located beneath a driveway, parking lot or other impervious surface.
- Dry wells should be used on development sites that have underlying soils with an infiltration rate of 0.50 inches per hour (in/hr) or greater, as determined by NRCS soil survey data and subsequent field testing. Field infiltration test protocol, such as that provided by the City of Portland, OR (Portland, OR, 2008) on the following website: http://www.portlandonline.com/shared/cfm/image.cfm?id= 202911, can be used to conduct field testing, but should be approved by the local development review authority prior to use.

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- Although the number of infiltration tests needed on a development site will ultimately be determined by the local development review authority, at least one infiltration test is recommended for each dry well that will be used on the development site.
- Since clay lenses or any other restrictive layers located below the bottom of a dry well will reduce soil infiltration rates, infiltration testing should be conducted within any confining layers that are found within 4 feet of the bottom of a proposed dry well.

- Dry wells should be designed to provide enough storage for the stormwater runoff volume generated by the target runoff reduction rainfall event (e.g., 85th percentile rainfall event). Since they are essentially infiltration practices, the required dimensions of a dry well can be determined using the design procedures provided in Section 8.6.5 of this CSS.
- Dry wells should be designed to completely drain within 24 hours of the end of a rainfall event. Where site characteristics allow, it is preferable to design dry wells to drain within 12 hours of the end of a rainfall event to help prevent the formation of nuisance ponding conditions.
- Broader, shallower dry wells perform more effectively by distributing stormwater runoff over a larger surface area. However, a minimum depth of 18 inches is recommended for all dry well designs to prevent them from consuming a large amount of surface area on development sites. Whenever practical, the depth of dry wells should be kept to 36 inches or less.
- Dry wells should be filled with clean, washed stone. The stone used in the dry well should be 1.5 to 2.5 inches in diameter, with a void space of approximately 40% (e.g., GA DOT No. 3 Stone). Unwashed aggregate contaminated with soil or other fines may not be used in the dry well.
- Underlying native soils should be separated from the dry well stone by a thin, 2 to 4 inch layer of choker stone (i.e., ASTM D 448 size No. 8, 3/8" to 1/8" or ASTM D 448 size No. 89, 3/8" to 1/16"). The choker stone should be placed between the dry well stone and the underlying native soils.
- The top and sides of the dry well should be lined with a layer of appropriate permeable filter fabric. The filter fabric should be a non-woven geotextile with a permeability that is greater than or equal to the infiltration rate of the surrounding native soils. The top layer of the filter fabric should be located 6 inches from the top of the excavation, with the remaining space filled with appropriate landscaping. This top layer serves as a sediment barrier and, consequently, will need to be replaced over time. Site planning and design teams should ensure that the top layer of filter fabric can be readily separated from the filter fabric used to line the sides of the dry well.

- The depth from the bottom of a dry well to the top of the water table should be at least 2 feet to prevent nuisance ponding and ensure proper operation of the dry well.
- To prevent damage to building foundations and contamination of groundwater aquifers, dry wells should be located at least:
  - 10 feet from building foundations
  - 10 feet from property lines
  - 100 feet from private water supply wells
  - 1,200 feet from public water supply wells
  - 100 feet from septic systems
  - 100 feet from surface waters
  - 400 feet from public water supply surface waters
- An observation well should be installed in every dry well. An observation well consists of a 4 to 6 inch perforated PVC (AASHTO M 252) pipe that extends to the bottom of the dry well. The observation well can be used to observe the rate of drawdown within the dry well following a storm event. It should be installed along the centerline of the dry well, flush with the elevation of the surface of the dry well. A visible floating marker should be provided within the observation well and the top of the well should be capped and locked to prevent tampering and vandalism. Appendix B in Volume 2 of the Georgia Stormwater Management Manual provides additional information about observation wells.
- If used to "receive" rooftop runoff, dry wells should be preceded by a leaf screen installed in the gutter or downspout. This will prevent leaves and other large debris from clogging the dry well.
- If used to "receive" non rooftop runoff, dry wells should be preceded by a pea gravel diaphragm or equivalent level spreader device (e.g., concrete sills, curb stops, curbs with

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"sawteeth" cut into them) and a vegetated filter strip that is designed according to the planning and design criteria provided in Section 7.8.6 of this CSS.

Consideration should be given to the stormwater runoff rates and volumes generated by larger storm events (e.g., 25-year, 24-hour storm event) to help ensure that these larger storm events are able to safely bypass the dry well. An overflow, such as a vegetated filter strip (Section 7.8.6) or grass channel (Section 7.8.7), should be designed to convey the stormwater runoff generated by these larger storm events safely out of the dry well.

4.7.5.3 Pretreatment \ Inlets

Pretreatment and inlet protection needs to be designed to reduce the velocity and energy of the stormwater entering the practice and prevent scour of the mulch and plantings. Pretreatment and inlet protection may include splash blocks, stone diaphragm, level spreader or similar device.

4.7.5.4 Outlet Structures

Outlet structures should be included in the design of a dry well to ensure that larger storms can be bypassed without damaging the practice. See Section 3.4 *Outlet Structures* for more guidance regarding the proper deisign and installation of an outlet structure.

4.7.7.6 Safety Features

Dry wells generally do not require any special safety features, provided side slopes are maintained at 3:1 or flatter. Fencing of dry wells is not generally desirable.

4.7.5.7 Landscaping

- The landscaped area above the surface of a dry well may be covered with pea gravel (i.e., ASTM D 448 size No. 8, 3/8" to 1/8"). This pea gravel layer provides sediment removal and additional pretreatment upstream of the dry well and can be easily removed and replaced when it becomes clogged.
- Alternatively, a dry well may be covered with an engineered soil mix, such as that prescribed in Section 7.8.9 of this CSSAppendix D, and planted with managed turf or other herbaceous vegetation. This may be an attractive option when dry wells are placed in disturbed pervious areas (e.g., lawns, parks, community open spaces).

4.7.5.8 Construction Considerations

To help ensure that dry wells are successfully installed on a development site, site planning and design teams should consider the following recommendations:

- If dry wells will be used to "receive" non rooftop runoff, they should only be installed after their contributing drainage areas have been completely stabilized. To help prevent dry well failure, stormwater runoff may be diverted around the dry well until the contributing drainage area has been stabilized.
- To help prevent soil compaction, heavy vehicular and foot traffic should be kept out of dry wells before, during and immediately after construction. This can typically be accomplished by clearly delineating dry wells on all development plans and, if necessary, protecting them with temporary construction fencing.
- Excavation for dry wells should be limited to the width and depth specified in the development plans. Excavated material should be placed away from the excavation so as not to jeopardize the stability of the side walls.
- The native soils along the bottom of the dry well should be scarified or tilled to a depth of 3 to 4 inches prior to the placement of the choker stone and dry well stone.

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- The sides of all excavations should be trimmed of all large roots that will hamper the installation of the permeable filter fabric used to line the sides and top of the dry well.

4.7.5.5 Construction and Maintenance Costs

- Cost varies with the size of the facility, but in general, both construction and maintenance of small residential facilities costs between $1,200 and$1,500.
- The construction cost of larger concrete facilities is similar to the cost associated with installing a standard, deep manhole—around$10,000 to $15,000.
- Costs for downstream infiltration trenches or regional BMPs can be found in their respective sections in this manual.

4.7.6 Design Procedures

Step 1. Determine the goals and primary function of the dry well

Consider whether the dry well is intended to:

- Meet a runoff reduction* target or water quality (treatment) target. ***Note that minimum infiltration rates of the surrounding native soils must be acceptable and suitable when used in runoff reduction applications.**
- Provide a possible solution to a drainage problem
- Enhance landscape and provide aesthetic qualities

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply. In addition, consider if the dry well has any special site-specific design conditions or criteria. List any restrictions or other requirements that may apply or affect the design.

Step 2. Determine if the development site and conditions are appropriate for the use of a dry well

Consider the application and site feasibility criteria in this chapter. In addition, determine if site conditions are suitable for a dry well. Create a rough layout of the dry well dimensions taking into consideration existing trees, utility lines, and other obstructions.

Complete Steps 3A & 3B for a runoff reduction approach, or skip 'Step 3' and complete Steps 4A & 4B for a water quality (treatment) approach. Refer to your local community's guidelines for any additional information or specific requirements regarding either method. In cases where RR_v can be partially met, the remaining amount of WQ_v must be traditionally treated, refer to 'Step 5' for an additional discussion.

Step 3A. Calculate the Stormwater Runoff Reduction Target Volume

Calculate the Runoff Reduction Volume using the following formula:

$RR_v = (P)(R_v)(A) / 12$

Where:

RR_v = Runoff Reduction Target Volume (cubic feet)

P = Target runoff reduction rainfall (inches)

R_v = Volumetric runoff coefficient which can be found by:

  $R_v = 0.05+0.009(I)$

  Where:

  I = new impervious area of the contributing drainage area (%)

A = Site area (square feet)

12 = Unit conversion factor (in/ft)

Using Table 4.1.3-2 - *BMP Runoff Reduction Credits*, lookup the appropriate runoff reduction percentage (or credit) provided by the practice:

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Calculate the Runoff Reduction Volume provided by the selected practice
RR_v (provided) = (RR%) (RRv)
Where:
RR_v (provided) = Runoff Reduction Volume provided (cubic feet) by a specific BMP
RR% = Runoff Reduction percentage, or credit, assigned to the specific practice
RR_v = Runoff Reduction Target Volume (square feet), as calculated at the beginning of Step 3A

When RR_v (provided) = Target RR_v, Water Quality requirements are met. If RR_v (provided) is less than the Target RR_v, then continue to Step 5.

To size the BMP based on RRv (provided), proceed to step 3B to calculate VP.

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Step 3B. If using the practice for Runoff Reduction, determine the storage volume of the practice and the Pretreatment Volume

To determine the actual volume provided in the dry well, use the following equation:

VP = (PV + VR (N))

Where:
VP = Volume provided (temporary storage)
PV = Ponding Volume
VR = Volume of Rocks
N = Porosity

Provide pretreatment by using a grass filter strip or pea gravel diaphragm, as needed, (sheet flow). Where filter strips are used, 100% of the runoff should flow across the filter strip. Pretreatment may also be desired to reduce flow velocities or assist in sediment removal and maintenance.

Step 4A. Calculate the Target Water Quality Volume

Calculate the Water Quality Volume using the following formula:
$WQ_V = (1.2) (R_V) (A) / 12$
Where:
WQ_V = Water Quality Volume (cubic feet)
1.2 = Target rainfall amount to be treated (inches)
R_V = Volumetric runoff coefficient which can be found by:
$R_V = 0.05+0.009(I)$
Where:
I = new impervious area of the contributing drainage area (%)
A = Site area (square feet)
12 = Unit conversion factor (in/ft)

Step 4B. If using the practice for Water Quality treatment, determine the footprint of the dry well practice

The peak rate of discharge for the water quality design storm is needed for sizing of off-line diversion structures (see subsection 2.1.7). If designing off-line, follow steps (a) through (d) below:
.
(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

To determine the minimum surface area of the dry well, use the following formula

$$A_f = (WQv)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:

A_f = surface area of ponding area (ft^2)
WQ_v = water quality volume (ft^3)
d_f = rock depth (ft)
k = coefficient of permeability of rock (ft/day)
h_f = average height of water above dry well bed (ft)
t_f = design rock drain time (days) (1 day is recommended maximum)

Step 5. For a hybrid approach that would provide partial runoff reduction and the remaining amount of volume through traditional water quality treatment, calculate the following parameters:

Calculate Target RR_v (refer to step 3A)

Calculate % Achieved Ratio (% of Overall Reduction provided by RR_v):
[RR_v (provided by practice) / Target RR_v] (100) = RR % Achieved

Where:
RR_v provided = Volume of Runoff Reduction that the practice actually provides
Target RR_v = Volume of Runoff Reduction that is required per local requirements
RR % Achieved = The portion of overall water quality requirement volume provided by RR_v

Calculate WQ_v (refer to step 4A)

Calculate % Remaining to treat for WQ (% of Overall Treatment provided by WQ_v):
100 - (RR % Achieved) = Remaining WQ to treat, as a percentage

Where:
WQ % Remaining = The remaining portion of volume that must be treated to reach the overall water quality goal.

Calculate the remaining volume to be traditionally treated by WQ_v
(WQ_v) [(WQ % Remaining) / 100] = WQ_v remaining

Step 6. Size flow diversion structure, if needed

If the contributing drainage area to dry well exceeds the water quality treatment and/or storage capacity, flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v (or RR_v) to the dry well.

Size low flow orifice, weir, or other device to pass Q_{wq}.

Step 7. Design emergency overflow

An overflow must be provided to bypass and/or convey larger flows to the downstream drainage system or stabilized watercourse. Non-erosive velocities need to be ensured at the outlet point. The overflow should be sized to safely pass the peak flows anticipated to reach the practice, up to a 100-year, 24-hour storm event.

Step 9. Prepare Vegetation and Landscaping Plan

A landscaping plan for the dry well should be prepared to indicate how it will be established with vegetation.

See section 4.7.5.7 (Landscaping) and Appendix D for more details.

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4.7.6 Inspection and Maintenance Requirements

Maintenance is important for dry wells, particularly in terms of ensuring that they continue to provide measurable stormwater management benefits over time. Consequently, a legally-binding inspection and maintenance agreement and plan should be put in place to ensure that dry wells are regularly maintained after occupancy. Table 7.344.7-1 provides a list of the routine maintenance activities typically associated with dry wells.

Table 7.344.7-1: Routine Maintenance Activities Typically Associated with Dry Wells

Activity	Schedule
• If used to "receive" non rooftop runoff, ensure that the contributing drainage area is stabilized prior to installation of the dry well. • If applicable, water to promote plant growth and survival within landscaped area over the top of the dry well. • If applicable, inspect vegetative cover on the surface of the dry well following rainfall events. Plant replacement vegetation in any eroded areas.	As Needed (During Construction)
• If applicable, inspect gutters and downspouts. Remove any accumulated leaves or debris. • Inspect dry well following rainfall events. Check observation well to ensure that complete drawdown has occurred within 72 hours after the end of a rainfall event. Failure to drawdown within this timeframe may indicate dry well failure. • If applicable, inspect pretreatment devices for sediment accumulation. Remove accumulated trash and debris. • Inspect top layer of filter fabric for sediment accumulation. Remove and replace if clogged.	Annually (Semi-Annually During First Year)
• Perform total rehabilitation of the dry well, removing dry well stone and excavating to expose clean soil on the sides and bottom of the well.	Upon Failure

Additional Resources

City of Portland, OR. 2008. "Soakage Trench." *Portland Stormwater Management Manual*. Section 2.3.3. City of Portland, OR. Bureau of Environmental Services. Available Online: http://www.portlandonline.com/bes/index.cfm?c=47952.

City of Portland, OR. 2008. "Dry Well." *Portland Stormwater Management Manual*. Section 2.3.3. City of Portland, OR. Bureau of Environmental Services. Available Online: http://www.portlandonline.com/bes/index.cfm?c=47952.

Atlanta Regional Commission (ARC). 2001. "Infiltration Trench." *Georgia Stormwater Management Manual*. Volume 2. Technical Handbook. Section 3.2.5. Atlanta Regional Commission. Atlanta, GA. Available Online: http://www.georgia stormwater.com/.

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