What is a Quality Gallon?

TO: Watershed Stakeholder Participants

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Introduction to Quality Gallons

The "additional" benefits or impacts to the ecosystem that may result from a stormwater BMP are taken into account through a concept termed *Quality Gallons*. The environmental impacts of the BMPs, whether they are positive or negative, are taken into account by the use of multipliers that modify the BMP volume into a "quality"-based volume. The water volume stored or infiltrated by a BMP is a measure of the BMP's contribution to the flow restoration target. The stormwater BMP volume is then converted into a "quality" volume by the use of three multipliers that account for the BMP environmental impacts. These multipliers include the following:

- **BMP Type.** This multiplier quantifies the impact, either positive or negative, that a specific stormwater BMP (Table 2-1) has on different ecosystem parameters (Table 2-2). Tables are found at the end of this document.
- **BMP Location.** This multiplier quantifies the benefit associated with constructing a stormwater BMP at a location that will have the greatest benefit on the receiving stream and downstream aquatic resources.
- **Watershed Priority.** This multiplier quantifies the benefit achieved by locating a stormwater BMP in an area and for a purpose that is identified as a restoration priority by watershed stakeholders.

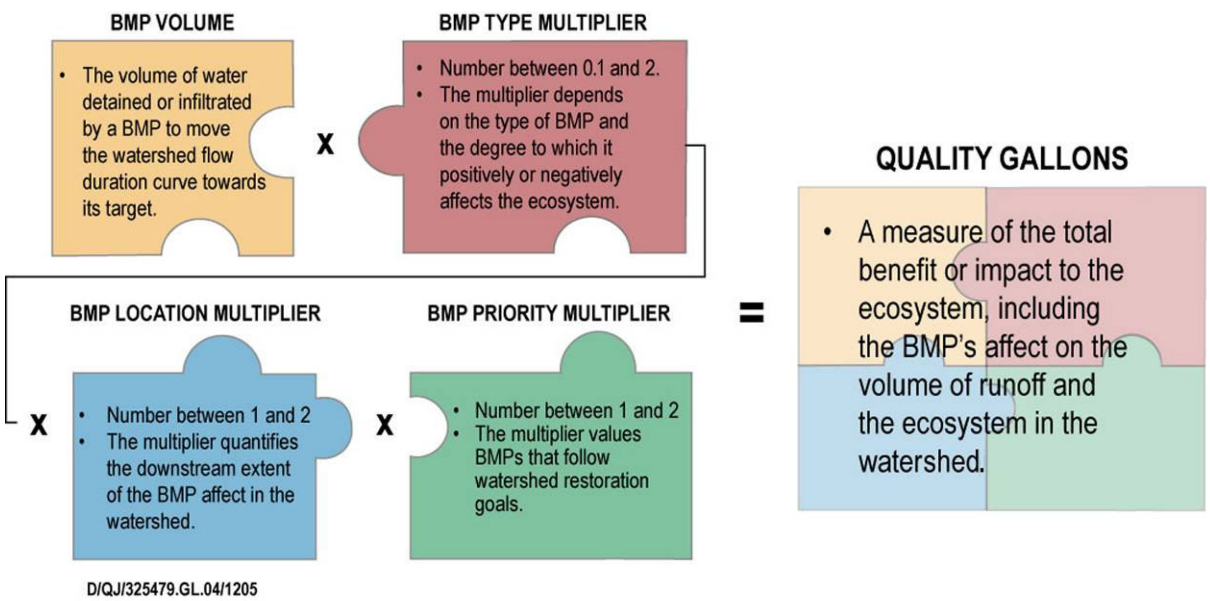
The combination of these three multipliers is used to convert the stormwater BMP storage or infiltration volume from gallons to *Quality Gallons*, which recognizes the impacts of specific BMPs on the ecosystem both in terms of flow restoration and other critical factors. The multipliers value the relative amount of improvement provided to the environment with respect to BMP type, and its location and relationship to watershed priorities. It is important to note that while the *gallons* metric provides a quantitative measure towards restoring the flow regime (meeting the flow regime target condition), the *Quality Gallons* metric will only measure the relative impact on the ecosystem (positive or negative) of the BMPs selected as compared with other BMPs.

To convert gallons to *Quality Gallons*, the multipliers identified above are incorporated in the equation below, which is graphically illustrated in Figure 2-1. The *Quality Gallons* equation takes into account the positive and negative impacts on the ecosystem that selected BMPs can have by adjusting the BMP volume with multipliers that place a value on the design and location of the stormwater BMP as well as the watershed restoration priorities. The *Quality Gallon* approach accounts for the fact that not all BMPs have the same value to the ecosystem.

$$QG_{BMP} = V_{BMP}\,T_{BMP}\,L_{BMP}\,P_{BMP}$$

where V_{BMP} is the stormwater control volume, storage or infiltration, provided by the BMP, in gallons; T_{BMP} is the BMP type multiplier; L_{BMP} is the BMP location multiplier; and P_{BMP} is the BMP watershed priority multiplier.

FIGURE 2-1
Equation to Calculate Quality Gallons



Because its primary focus is individual BMPs, the *Quality Gallon* concept does not account for system-wide impairments such as fish passage barriers, toxics, or invasive species that would affect fish populations and cannot be addressed through stormwater management controls. Nevertheless, it is possible to use the location or watershed priority multipliers to consider these effects. For example, a watershed that has significant barriers could be given a low priority until the barriers are removed.

BMP Type Multiplier

The stormwater BMPs identified in Table 2-1 will affect the ecosystem parameters identified in Table 2-2 in different ways. A BMP may improve some ecosystem parameters while negatively impacting others as a result of how the BMP manages the stormwater. For example, a detention pond can provide beneficial nutrient, solids and erosive energy control, but may negatively affect water temperature. The degree to which a BMP affects the ecosystem is scaled with a numerical factor between 1 and 20, with 10 being a neutral value. If a BMP has negative impacts on an ecosystem parameter, a factor between 1 and 9 would be assigned. A BMP that has a significant negative impact may be assigned a numerical factor of 1, while a BMP with a slightly negative impact on the ecosystem may receive a numerical factor of 9. Positive effects on the ecosystem are accounted for with a numerical factor between 11 and 20. A BMP with a significant beneficial impact on the ecosystem may receive a value of 20, while a BMP that provides a small improvement to the ecosystem may receive a factor of 11. Figure 2-2 illustrates the factor scale and the range of the positive and negative ecosystem impacts.

FIGURE 2-2
Range of Positive and Negative Impacts on the Ecosystem that Result from Different BMPs

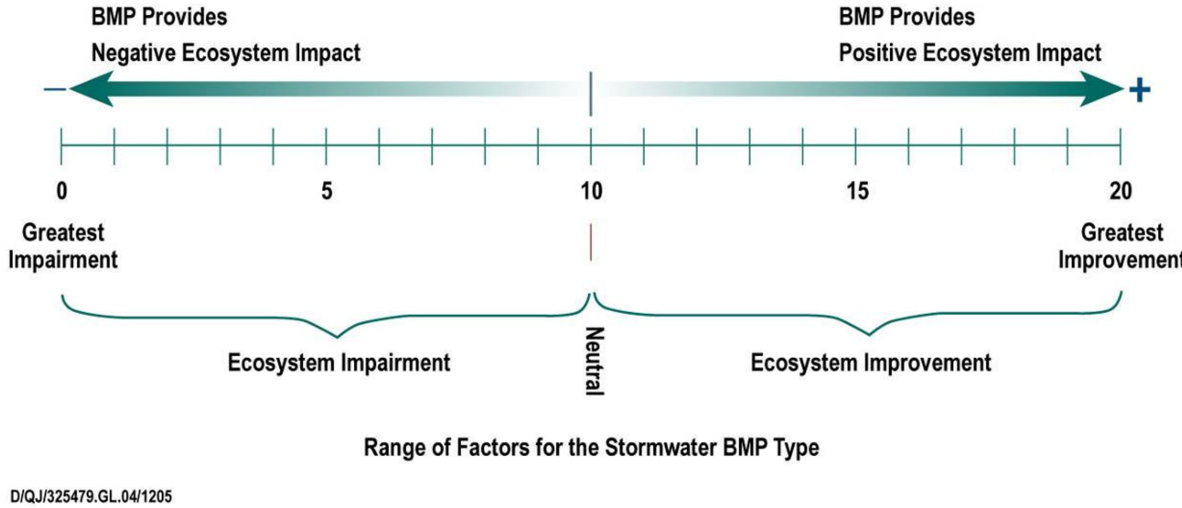


TABLE 2-1
Categories and Examples of Stormwater BMPs

BMP Categories	Example BMPs
Stormwater Wetlands	Constructed wetlands used to treat stormwater.
Bioretention	Decentralized stormwater controls, primarily based on engineered soils, that use plants, microbes, and soil filtration to remove pollutants from runoff. Implementations include bioretention swales, rain gardens, and median storage and detention.
Grassed Swale	Broad and shallow earthen channel vegetated with erosion resistant and flood-tolerant grasses. Check dams or engineered soil mixtures may be used to encourage infiltration and sedimentation.
Sand Filter	Device to filter runoff through a sand layer (with or without underdrain) prior to the ultimate point of discharge. Typical systems may consist of an inlet structure, sedimentation chamber, sand bed, and underdrain piping.
Riparian Buffer	Forested or grassed areas along the sides of a stream. Level spreaders may be used to distribute flow from pipes and ditches across the buffer and prevent short-circuiting.
Offline Wet Detention Basin	Traditional detention basin with a permanent pool of water to trap sediments and provide peak flow attenuation. The facility is located in an upland area and does not obstruct stream flow.

TABLE 2-1
Categories and Examples of Stormwater BMPs

BMP Categories	Example BMPs
Inline Wet Detention Basin	A storage facility constructed by damming a stream.
Dry Detention Basin	A detention basin without a permanent pool that drains completely after a storm.
Rooftop Runoff Management	A BMP to manage runoff generated by rooftops, for example a green roof or a cistern or rain barrel for rain water capture and reuse.
Underground storage	A detention facility located underground to maximize usability of surface space. Underground storage can take multiple forms including concrete vaults, corrugated steel pipe systems, or commercially manufactured systems.
Permeable Pavement and Infiltration Devices	Nonvegetated infiltration systems, such as infiltration trenches, dry wells and permeable paving materials including porous asphalt, porous concrete, and permeable pavers.
Land Use Conversion	Changing land use to reduce runoff generation, improve water quality, and enhance aquatic and terrestrial habitat. For example, conversion of an impervious area, such as a parking lot or building, to a forest or prairie.
Floodplain Enhancement	Projects that restore or create floodplains to provide temporary storage for floodwaters and sediment produced by the watershed.
Direct Discharge/Baseflow Augmentation	Augmentation of stream baseflow in a watershed with discharge sources such as treated effluent from a municipal wastewater treatment plant, industrial plant, or power plant.

TABLE 2-2
Summary of BMP Effects on the Ecosystem

Ecosystem Parameters	Examples
Temperature Moderation	If the overall water body temperature of a system is altered, an aquatic community shift can be expected. Cold water fish, such as trout and salmon, may disappear and be replaced by warm water fish, such as sunfish and carp. Higher temperatures also exacerbate low dissolved oxygen level problems in lakes and reservoirs. The increased storage time and surface area in detention ponds contributes to temperature increases, while infiltration-based BMPs contribute to maintaining or decreasing temperature.
Physical Aquatic Habitat Improvement	Aquatic organisms require adequate channel substrate, pool frequency, and available cover (for example, large woody debris) to feed, reproduce, and hide from predators. An underground storage device would have a lower habitat value than a treatment wetland.
Nutrient Control	The increase of nutrients in stormwater runoff such as phosphorus and nitrogen accelerates eutrophication of receiving waters. As eutrophication progresses, water bodies can experience algal blooms, decreased dissolved oxygen levels, and fish kills. A bioretention facility would be expected to remove more nutrients than a dry detention pond.

TABLE 2-2
Summary of BMP Effects on the Ecosystem

Ecosystem Parameters	Examples
Bacteria Control	In urban developed areas, high levels of bacteria can be found in stormwater. Receiving waters can be contaminated with bacteria to the point where recreation and public water supplies are impaired. BMPs that promote filtration can be effective at removing bacteria.
Solids Control	Sediment deposition can cover plants and animals and fill in rivers and lakes. Very fine suspended sediment causes the water to become cloudy, reducing the distance that light can penetrate into the water body. BMPs that encourage settling or filtration can be effective at controlling solids.
Improved Dissolved Oxygen	Both aquatic plants and animals depend on dissolved oxygen for survival. Different aquatic organisms have different oxygen needs. Trout, for example require more dissolved oxygen than other aquatic organisms. Dissolved oxygen levels are affected by temperature, rate of photosynthesis, the degree of turbulence, and the amount of organic matter. BMPs that promote cooler temperatures provide dissolved oxygen benefits.
Erosive Energy Control	Increased velocities can cause scouring, channel widening, stream incisement, and increased sedimentation. BMPs that slow stream velocity, such as a floodplain enhancement, provide more erosion control than BMPs that do not directly affect stream velocity. BMPs that reduce runoff volume through infiltration also help control erosion.
Baseflow Enhancement	Lower stream flows are more susceptible to seasonal temperature extremes in both winter and summer. The dewatering of reaches can block fish passage. BMPs that add water through infiltration enhance baseflows. Direct discharges can also be considered as baseflow enhancements.
Terrestrial Habitat Improvement	Restoration of native vegetation communities fosters diverse plant and animal populations in addition to the in-stream ecosystem. For example, a stormwater wetland BMP provides more habitat than an underground detention facility.