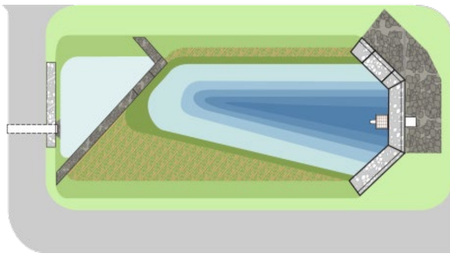
10.5 Wet Ponds (GI)



Wet ponds designed with a reuse component and a native vegetation perimeter are used to address the stormwater runoff quantity impacts of land development. This type of stormwater facility has an elevated outlet structure that creates a permanent pool where stormwater runoff is detained and attenuated. Wet ponds can be designed as multi-stage, multi-function systems; extended detention in the permanent pool provides pollutant treatment for runoff from the Water Quality Design Storm through sedimentation and biological processing; detention and attenuation are also provided for larger storm event through the higher elevation outlets. When designed in accordance with this chapter, the total suspended solids (TSS) removal rate is 50 - 90%, depending upon the storage volume in the permanent pool and the duration of detention time, if extended detention is provided.

N.J.A.C. 7:8 Stormwater Management Rules – Applicable Design and Performance Standards		
	Green Infrastructure	Yes, provided the system is designed to maintain at least a 10-foot wide area of native vegetation along at least 50 percent of the shoreline and to include a stormwater runoff retention component designed to capture stormwater runoff for beneficial reuse. See Page 4.
	Stormwater Runoff Quantity	When designed to receive runoff from all storm events as an on-line system
	Groundwater Recharge	Not Allowed
	Stormwater Runoff Quality	Only with a waiver or variance from N.J.A.C. 7:8-5.3, 50% TSS removal with 1:1 pool volume ratio; up to 90% TSS removal if extended detention is also provided

Stormwater Runoff Quality Mechanisms and Corresponding Criteria	
Settling	
Minimum Ratio of Permanent Pool Volume to WQ Design Storm Runoff Volume	1:1
12 to 24-Hour Extended Detention	Optional
Recommended Minimum Pool Length to Width Ratio	3:1
Presence of a Permanent Pool	Required
Surface Area of Permanent Pool	Minimum of 0.25 acre

Introduction

Green infrastructure wet ponds are used to address the stormwater runoff quantity impacts of land development. They may also be referred to as retention basins. Pursuant to N.J.A.C. 7:8-5.2(f), certain additional requirements must be included in the design of a wet pond in order for it be used to also address stormwater runoff water quality impacts. This type of stormwater facility has an elevated outlet structure that creates a permanent pool where stormwater runoff is detained and attenuated. As stated in footnote (d) of Table 5-2, the design of such a system must also be designed to maintain at least a 10-foot wide area of native vegetation along at least 50 percent of the shoreline and to include a stormwater runoff retention component designed to capture stormwater runoff for beneficial reuse. Wet ponds can be designed as multi-stage, multi-function systems; extended detention in the permanent pool provides pollutant treatment for runoff from the Water Quality Design Storm (WQDS) through sedimentation and biological processing; detention and attenuation is also provided for larger storm event through the higher elevation outlets.

Wet ponds can also be used to provide wildlife habitat, recreational benefits and water supply for fire protection; they can also be used to enhance the aesthetics of a site. However, these systems are designed primarily for stormwater treatment, so they should not be located within natural areas because they will not have the same range of ecological function.

GI wet ponds designed in accordance with this chapter can only be used to satisfy the standards for stormwater runoff quantity, unless a waiver from the green infrastructure requirements of N.J.A.C. 7:8-5.3 is obtained.

GI wet ponds must have a maintenance plan and must be reflected in a deed notice recorded in the county clerk's office to prevent alteration or removal.

Applications

Pursuant to N.J.A.C. 7:8-5.2(a)(2), the minimum design and performance standards for groundwater recharge, stormwater runoff quality and stormwater runoff quantity at N.J.A.C. 7:8- 5.4, 5.5 and 5.6 shall be met by incorporating green infrastructure in accordance with N.J.A.C. 7:8-5.3. Pursuant to N.J.A.C. 7:8-5.3(c), large-scale green infrastructure BMPs may only be used to satisfy the stormwater runoff quantity standards. Additionally, in order to meet the definition of green infrastructure at N.J.A.C. 7:8-1.2, the design must also include the specified vegetated perimeter and provide beneficial reuse of the stormwater runoff captured, both of which are discussed under the Design Criteria section.

GI wet ponds may be designed to reduce peak runoff rates when designed as an on-line system which provides storage volume to accommodate runoff from larger design storms. Regardless of the design storm chosen, wet ponds must be designed for stability in accordance with the *Standards for Soil Erosion and Sediment Control in New Jersey,* as required by N.J.A.C. 7:8.

Only if a waiver or variance form the green infrastructure requirements of N.J.A.C. 7:8-5.3 is obtained may GI wet ponds be used to meet the stormwater runoff quality requirement. If a variance or waiver is granted, refer to the section titled *TSS Removal Rates for Wet Ponds* on Page 10 for the design parameters associated with the desired TSS removal rate.

Design Criteria

Basic Requirements

The following design criteria apply to all GI wet ponds and must be met in order to receive the 50 - 90% TSS removal rate for this BMP. It is critical that all GI wet ponds are designed in accordance with these criteria in order to ensure proper operation, to maximize the functional life of the system, and to ensure public safety. Additional considerations are presented in the section beginning on Page 13.

Minimum Inflow Drainage Area

- To function properly, GI wet ponds must have a minimum inflow drainage area of 20 acres. Smaller drainage areas may be permissible if detailed analysis indicates that sufficient base or groundwater flow is available to maintain the permanent pool depth. A water budget must be included in this analysis. A wet pond water budget consists of calculations, on a daily basis, that are intended to show the depth of water in the wet pond is maintained throughout the year. This is done for a wet year, a dry year and an average year. A successful analysis must show that the permanent pool of the GI wet pond meets the requirements of this chapter for all of the days in each of the three analyses. All of the inputs to and outputs from the wet pond must be considered; this includes precipitation, surface water inflow, groundwater inflow, evaporation/evapotranspiration, surface water outflow and groundwater outflow. For more information on water budgets, see the *Regionalized Water Budget Manual for Compensatory Wetland Mitigation Sites in New Jersey*, which is available online at http://www.nj.gov/dep/landuse/download/mit_011.pdf. However, note that this source is intended for wetland mitigation design, and the above demonstration does not have the same goal. The concepts of the calculation are the same, but the calculations must be modified to make the required demonstration rather than show it will meet the definition of a “freshwater wetland” at N.J.A.C. 7:7A-1.3. Beneficial reuse must be included as an output. For irrigation, there is an example in this chapter of the manual, and other uses may be found in *Chapter 9.1: Cisterns*.

- Pumping of groundwater to maintain the permanent pool is not permitted.

Native Vegetation Perimeter

- The design must maintain at least a 10-foot-wide perimeter consisting of native vegetation.

- The native vegetation perimeter must be maintained along at least 50% of the shoreline.

- Perimeter vegetation should consist of species that are water-tolerant and adapted to similar soil and weather conditions. Take note that as the distance from the water’s edge increases, the vegetation may become more suited to that of an upland environment, depending on the site conditions. For more information on plant selection, see *Chapter 7: Landscaping*.

- In addition, species that are tolerant to periodic inundation and increased contact with pollutants tend to fare best in these systems.
- Adequate depth of suitable wetlands substrate should also be provided; a minimum soil thickness of 6 inches is recommended. The wetland substrate is also an ideal environment for bacteria, which further aids in pollutant treatment by metabolizing organic matter and nutrients.

Minimum Geometry

- The minimum permanent pool surface area is 0.25 acres.
- The minimum required ratio of the permanent pool volume to the WQDS volume is 1:1.

Detention Time

- In systems providing extended detention, the minimum detention time that can be used to calculate the TSS removal rate is 12 hours, and the maximum detention time that can be used to calculate the TSS removal rate is 24 hours.

Permanent Pool

- It is crucial for a wet pond to maintain its permanent pool level; if the soil at the site is not sufficiently impermeable to prevent excessive seepage, construction of an impermeable liner or other soil modifications will be necessary.
- Be aware that discharges of stormwater from areas of high pollutant loading to GI wet ponds that contain or interact with ground water may require a NJPDES permit pursuant to N.J.A.C. 7:14A-7.4(a)5ii. The review agency should not grant an approval for a GI wet pond unless this permit is obtained, or the Department determines no such permit is required. See N.J.A.C. 7:8-5.4(b)3i for a description of high pollutant loading areas.

Beneficial Reuse Component

- The minimum volume of stormwater runoff to be captured for beneficial reuse is equal to the runoff from 1.25 inches of rain falling over the drainage area of the GI wet pond. Additionally, the beneficial reuse volume of the development cannot include any water quality design storm volume infiltrated by infiltration type basins upstream the GI wet pond.
- One such reuse is irrigation:
  - There are three methods of irrigation: subsurface, surface or spray.
  - The irrigation system must adhere to State and local requirements for long-term storage, including any treatment required.
  - See Page 13 for example irrigation calculations in the section labeled "Designing for Pollutant Removal."
- Capture of stormwater may include the following:

- □ Increasing the area occupied by the pool, subject to the permanent pool depth standards discussed on Page 9.
- □ Discharge of treated runoff to an adjacent temporary holding structure, such as, but not limited to, a vault or tank or geocellular system.

1. The demand for stormwater reuse will vary depending on the day or time of year. In order to ensure that the captured volume will be available for storm events, the stormwater reuse demand must be calculated based upon the lowest volume need that would occur over any three (3) consecutive days during the year.

2. The temporary storage tank must be sized sufficiently to hold water from each rain event until it is reused.

3. Storage systems that require the installation of one or more pumps, valves or other controls to automate or regulate flow must include alarms, or other measures to detect flows, as well as failure conditions, an emergency shutoff and backup power where required. Pump systems and alarms must be maintained regularly to ensure long-term operation.

4. The hydraulic head required to distribute the water to the receiving area must be calculated so that the minimum required elevation of the storage system can be determined. A pump may be necessary.

5. Subsurface storage systems should be placed above the seasonal high water table. If this is not feasible, proper buoyancy calculations, the installation of hold-down fasteners or other methods to counter uplift must be included in the system design.

Structural Considerations

- When beneficial reuse storage systems are placed at or below grade, the weight bearing capacity of the soil must be considered with the weight of the system at full capacity.

- In some instances, a base or foundation may be necessary. A support base may consist of aggregate, concrete or block, depending on the location and type of system, and must be designed to support the weight of the system at full capacity. Failure to adequately design the foundation may lead to settling and create conditions for potential structural failure.

Construction Requirements

- Pursuant to N.J.A.C. 7:8-5.2(i)3, stormwater management measures shall be designed, constructed and installed to be strong, durable and corrosion resistant. Measures that are consistent with the relevant portions of the Residential Site Improvement Standards at N.J.A.C. 5:21-7.3, 7.4, and 7.5 shall be deemed to meet this requirement.

Mosquitoes

- Poorly designed storage and reuse systems may create habitat suitable for mosquito breeding. All designs must include screens or other measures to prevent mosquitoes and other insects from entering the system. If screens are not sufficient, dunks or pellets to control mosquito larvae must be added. Refer to the local or county mosquito commission for assistance on controlling mosquitoes.

Cold Weather

- In order to be credited toward compliance with the Stormwater Management rule, temporary storage systems and reuse components must be able to function year-round. Therefore, a storage system may need to be located 3 feet or more below grade, indoors, or otherwise winterized to prevent collected runoff from freezing. Piping and overflow components must be checked periodically for ice blockages particularly after storm events and during snowmelt.

Safety

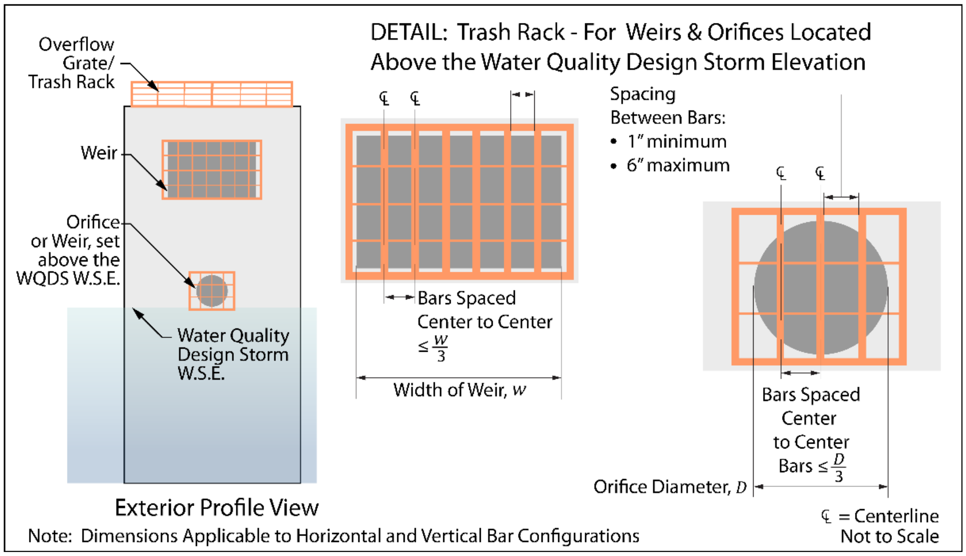
- Safety ledges must be constructed on the slopes of all wet ponds with a permanent pool deeper than 2.5 feet. Safety ledges shall be comprised of two steps. Each step shall be 4 to 6 feet in width. One step shall be located approximately 2.5 feet below the permanent water surface, and the second step shall be located 1 to 1.5 feet above the permanent water surface.

Outlet Structure

- Any flow control device, such as an orifice, weir, grate or perforated pipe, at the outlet of the stormwater management measures shall be designed to prevent the clogging of the flow control device while achieving the design and performance standards at N.J.A.C. 7:8-5.4, 5.5 and 5.6; additional information regarding outlet structures can be found in the Residential Site Improvement Standards at N.J.A.C. 5:21-7.

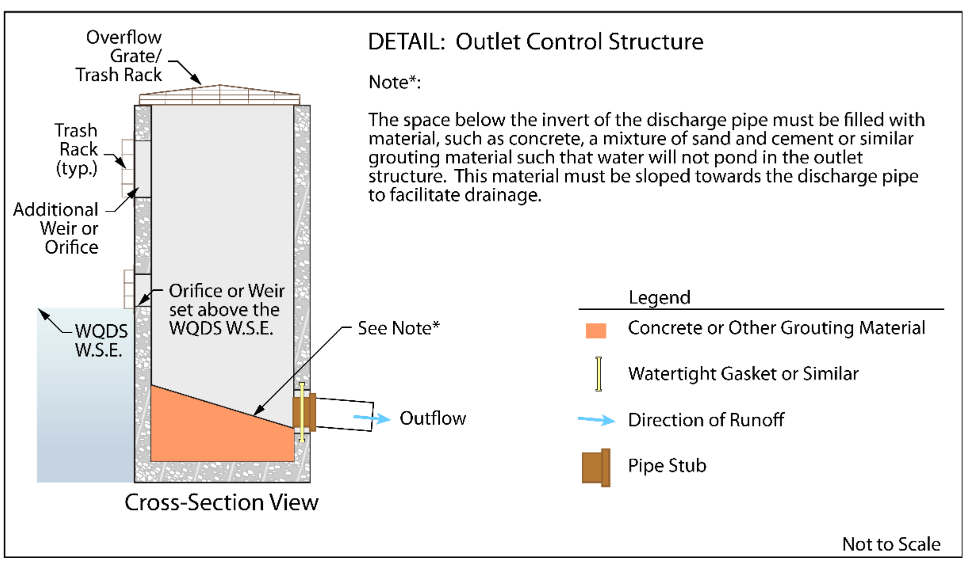
- Trash racks must be installed at the intake to the outlet structure. They must also be designed to avoid acting as the hydraulic control for the system, and they must meet the following criteria, as required by N.J.A.C. 7:8-5.2(i)2 and 6.2(a), and the detail on the following page illustrates these requirements:

    - Parallel bars spaced at 1-inch intervals, up to the elevation of the WQDS;
    - Minimum bar spacing: 1 inch, for elevations in excess of the WQDS;
    - Maximum bar spacing: 1/3 the diameter of the orifice or 1/3 the width of weir, with a maximum spacing of 6 inches, for elevations in excess of the WQDS;
    - Maximum average velocity of flow through clean rack: 2.5 feet/second, under full range of stage and discharge, computed on the basis of the net area of opening through rack;
    - Constructed of rigid, durable and corrosion-resistant material; and
    - Designed to withstand a perpendicular live loading of 300 lbs./sf.



- An overflow grate is designed to prevent obstruction of the overflow structure. If an outlet structure has an overflow grate, the grate must comply with the following requirements:
  - □ The overflow grate must be secured to the outlet structure but removable for emergencies and maintenance;
  - □ The overflow grate spacing must be no greater than 2 inches across the smallest dimension; and
  - □ The overflow grate must be constructed of rigid, durable and corrosion resistant material and designed to withstand a perpendicular live loading of 300 lbs./sf.

- The space below the invert of the discharge pipe must be filled with material, such as concrete, a mixture of sand and cement, or similar grouting material, such that water will not pond in the outlet structure. This material must be sloped towards the discharge pipe to facilitate drainage, as shown in the detail below.



- All GI wet ponds must be designed to safely convey overflows to downstream drainage systems. The design of the overflow structure must be sufficient to provide safe, stable discharge of stormwater in the event of an overflow. Safe and stable discharge minimizes the possibility of erosion and flooding in down-gradient areas. Therefore, discharge in the event of an overflow must be consistent with the current version of *Standard for Off-Site Stability* found in the *Standards for Soil Erosion and Sediment Control in New Jersey*, as required by N.J.A.C. 7:8. Wet ponds classified as dams under the NJDEP Dam Safety Standards at N.J.A.C. 7:20 must also meet the overflow requirements of these Standards, including safe conveyance of the wet pond's spillway design storm.

- Blind connections to down-gradient facilities are prohibited. Any connection to downstream stormwater management facilities must include access points such as inspection ports and manholes, for visual inspection and maintenance, as appropriate, to prevent blockage of flow and ensure operation as intended. All entrance points must adhere to all Federal, State, County and municipal safety standards such as those for both working in and entering confined spaces.

- In instances where the lowest invert in the outlet or overflow structure is below the flood hazard area design flood or tide elevation in a down-gradient waterway or stormwater collection system, the effects of tailwater on the hydraulic design of the overflow systems, as well as any stormwater quantity control outlets must be analyzed. Two methods to analyze tailwater are:

    - A simple method entails inputting flood elevations for the 2-, 10- and 100-year events as static tailwater during routing calculations for each storm event. These flood elevations are either obtained from a Department flood hazard area delineation or a FEMA flood hazard area delineation that includes the 100-year flood elevation or derived using a combination of NRCS hydrologic methodology and a standard step backwater analysis or level pool routing, where applicable. In areas where the 2-year or 10-year flood elevation does not exist in a FEMA or Department delineation, it may be interpolated or extrapolated from the existing data. If this method demonstrates that the requirements of the regulations are met with the tailwater effect, then the design is acceptable. If the analysis shows that the requirements are not met with the tailwater effects, the detailed method below can be used or the BMP must be redesigned.
    - A detailed method entails the calculation of hydrographs for the watercourse during the 2-, 10-, and 100-year events using NRCS hydrologic methodology. These hydrographs are input into a computer program to calculate rating curves for each event. Those rating curves are then input as a dynamic tailwater during the routing calculations for each of the 2-, 10- and 100-year events. This method may be used in all circumstances; however, it may require more advanced computer programs. If this method demonstrates that the requirements of the regulations are met with the tailwater effect, then the design is acceptable. If the analysis shows that the requirements are not met with the tailwater effects, the BMP must be redesigned.

GI Wet Pond Essentials of Pollutant Removal

Pollutants in runoff are treated in GI wet pond systems by both chemical reactions and the physical processes of dispersion and settling. These processes work most efficiently under ideal plug-flow conditions; under these conditions, a pulse of runoff enters the wet pond and is treated as it moves through the system. In order to simulate these conditions, GI wet ponds must be designed to maximize the length-to-width ratio.

In addition to plug-flow conditions, pollutant removal is also directly affected by the surface area of the permanent pool; the settling rate of particulate solids increases with increasing surface area. The surface area of the permanent pool is dependent on site topography, minimum and maximum pool depths, and the desired settling rate; however, as previously mentioned, the minimum required permanent pool surface area is 0.25 acres.

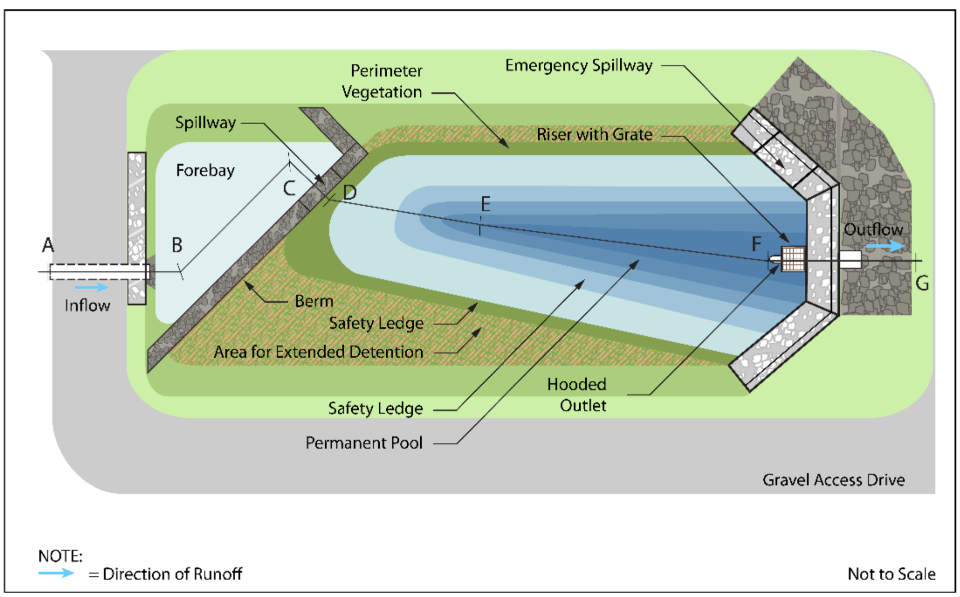
The depth of the permanent pool is another important design parameter. The permanent pool must be shallow enough to avoid thermal stratification, which can cause short-circuiting and anaerobic conditions in bottom waters; however, it must also be deep enough to minimize algal blooms and resuspension of previously deposited materials by subsequent storms and strong winds. The mean depth of the permanent pool is calculated by dividing the storage volume of the permanent pool by the pool surface area. A mean depth of 3 to 6 feet is normally sufficient to maintain a healthy environment within the permanent pool.

The outlet structure or riser must be located in a deep area of the permanent pool to facilitate withdrawal of cold bottom water; this will help mitigate any downstream thermal impacts. Additional information regarding outlet structures can be found in the *Standards for Soil Erosion and Sediment Control in New Jersey.*

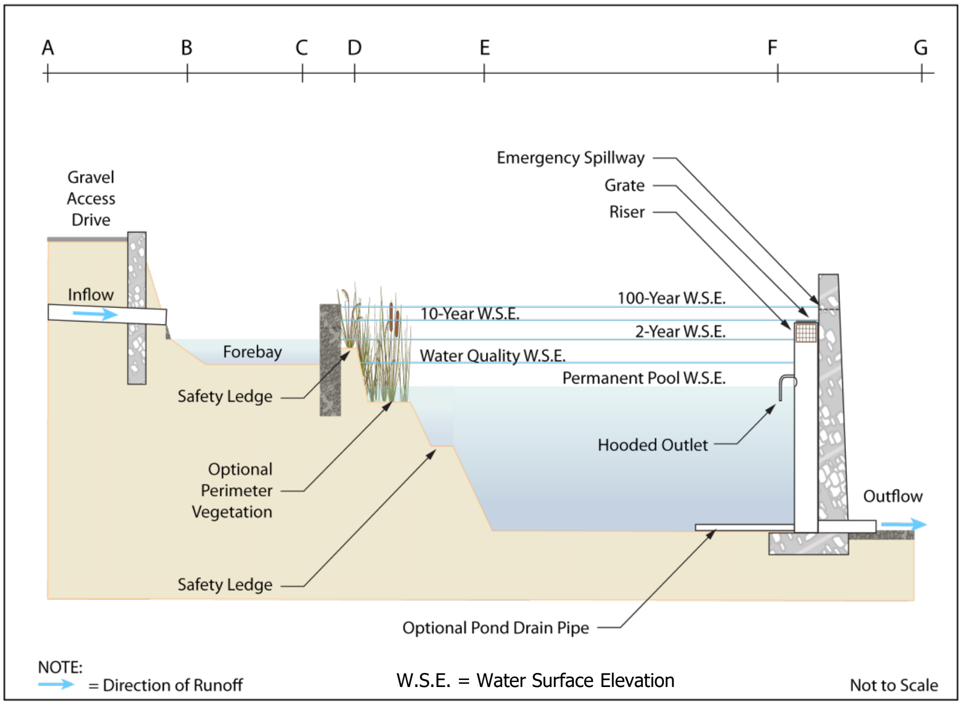
The hydraulic design of the outlet structure, outlet pipe, and emergency spillway in a GI wet pond must consider any significant tailwater effects of down-gradient waterways or facilities, including instances where the permanent pool level is below the flood hazard area design flood elevation of the receiving stream.

The following two illustrations depict the various components comprising a GI wet pond in both plan and profile view. The lettered path shown in the plan view represents the alignment along which an imaginary slice was made to prepare the corresponding profile view. The re-use component is not shown.

GI Wet Pond - Plan View



GI Wet Pond - Profile View



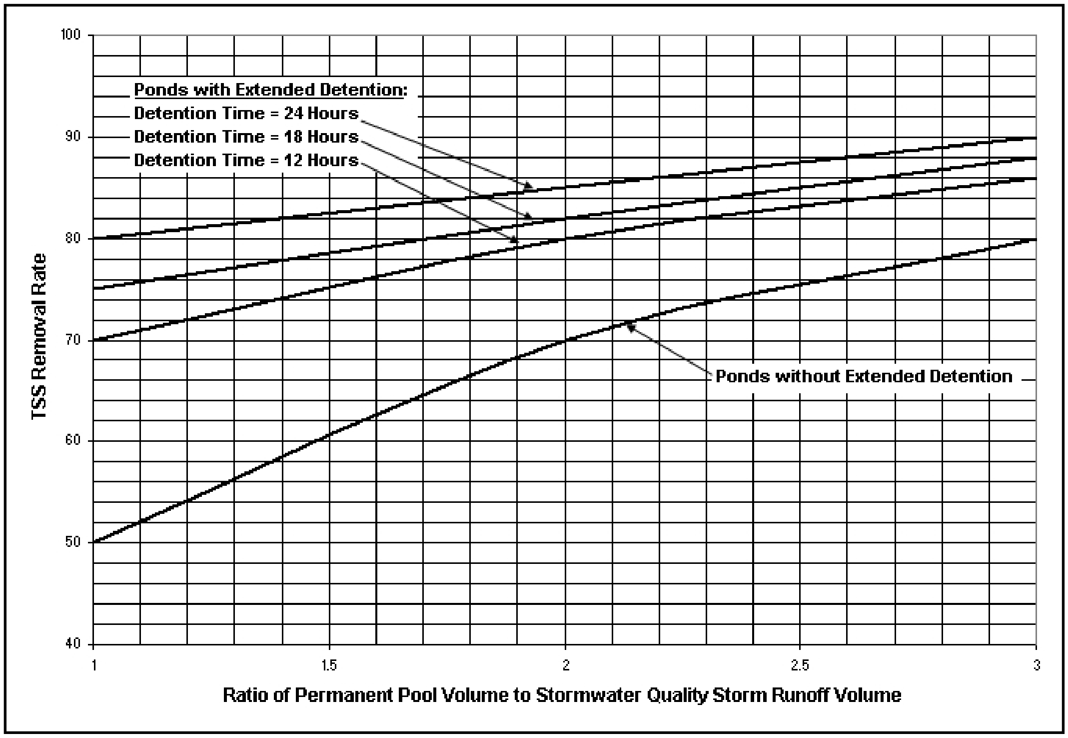
TSS Removal Rates for GI Wet Ponds

GI wet ponds may receive credit for pollutant removal only if a waiver or variance form the green infrastructure requirements of N.J.A.C. 7:8-5.3 is obtained. GI wet ponds must be designed to treat the volume generated by the WQDS to merit the approved TSS removal rate specified in Table 5-3 at N.J.A.C. 7:8-5.2(f). Techniques to compute this volume are discussed in *Chapter 5: Stormwater Management Quantity and Quality Standards and Computations*. The TSS removal rate for a GI wet pond is determined by the ratio of its permanent pool volume to the volume of stormwater generated by the WQDS. The minimum required ratio is 1:1; at this minimum ratio, the GI wet pond would have a TSS removal rate of 50%. TSS removal rates will increase as the ratio increases; the maximum TSS removal rate for a GI wet pond designed without extended detention is 80% at a 3:1 ratio.

In systems that provide extended detention above the permanent pool water surface elevation, TSS removal rates are also determined by detention time. Definitions and details of extended detention are presented in *Chapter 11.2: Extended Detention Basins*.

The following chart shows the TSS removal rate of a GI wet pond systems based on the ratio of the permanent pool volume to the volume of stormwater generated by the WQDS and detention time. The maximum TSS removal rate for a GI wet pond is 90%; to achieve this TSS removal rate, the system must be designed with 24-hours of extended detention and a 3:1 ratio of permanent pool volume to the volume of stormwater generated by the WQDS

TSS Removal Rates for GI Wet Ponds



The following example illustrates how to use the chart to determine the TSS removal rate provided:

Example: A number of GI wet pond designs are to be evaluated for TSS removal rates.

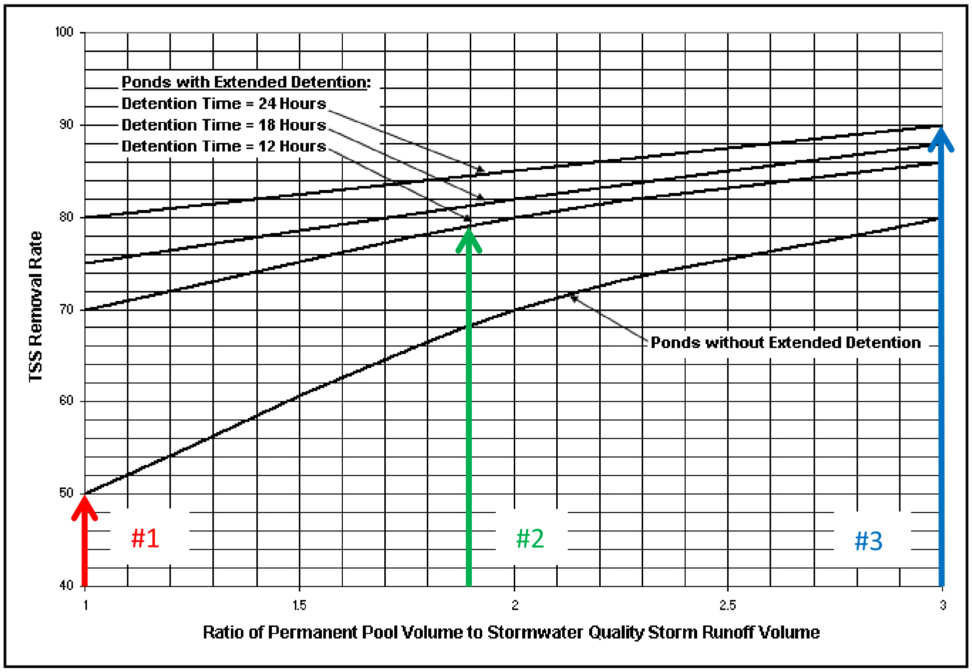
Design Number	Permanent Pool Volume (ac-ft)	WQ Runoff Volume	Extended Detention Period			Ratio of Permanent Pool to WQ Runoff	% TSS Removal
			12 Hr	18 Hr	24 Hr		
1	1.246	1.246	-	-	-		
2	2.764	1.481	X	-	-		
3	0.704	0.058	-	-	X		

Step 1: For each row of the designs, determine the ratio of the Permanent Pool Volume to the to the volume of stormwater generated by the WQDS. The result is located in the column below the red arrow symbol.

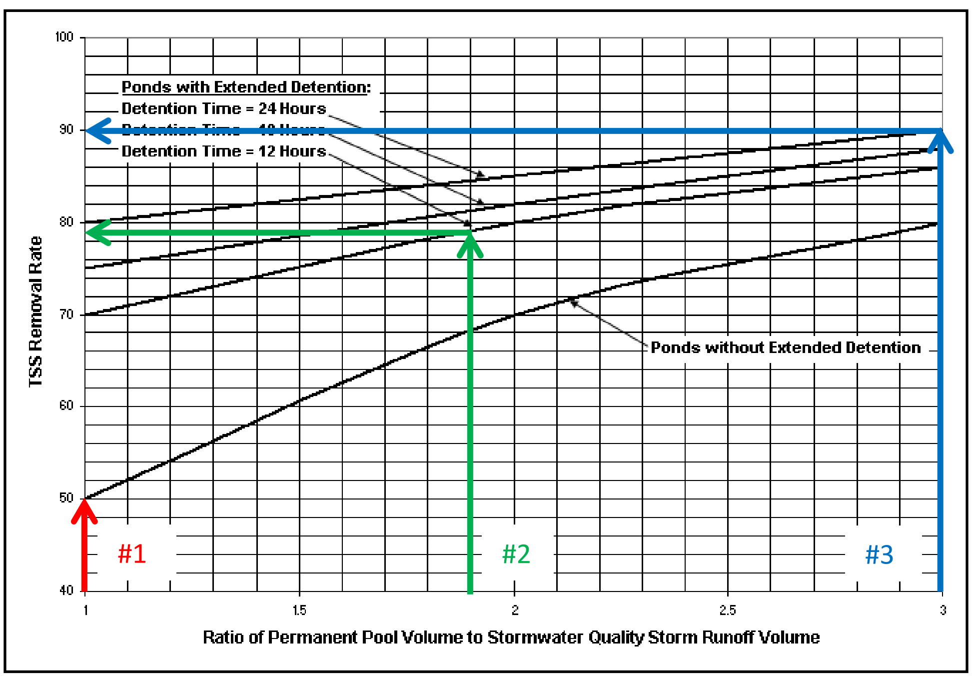
Design Number	Permanent Pool Volume (ac-ft)	WQ Runoff Volume	Extended Detention Period			Ratio of Permanent Pool to WQ Runoff	% TSS Removal
			12 Hr	18 Hr	24 Hr		
1	1.246	1.246	-	-	-	1.0	
2	2.764	1.481	X	-	-	1.9	
3	0.704	0.058	-	-	X	12.1	

Step 2: For each of the designs, find the ratio along the x-axis and project a vertical line up towards the curves. <u>If the ratio is greater than 3.0, use 3.0</u>. Stop at the curve that matches the period of

extended detention the GI wet pond provides. Design #1 provides no extended detention; therefore, the lowest curve is used to determine the TSS removal rate. Designs #2 and 3 provide extended detention and therefore, use the upper set of curves.



Step 3: For each of the designs, at the intersection of the vertical line from Step 2 with the respective curve, draw a horizontal line from right to left over to the y-axis to get the TSS removal rate.



The resulting percent TSS Removal Rates appear in the last column of this table.

Design Number	Permanent Pool Volume (ac-ft)	WQ Runoff Volume	Extended Detention Period			Ratio of Permanent Pool to WQ Runoff	% TSS Removal
			12 Hr	18 Hr	24 Hr		
1	1.246	1.246	-	-	-	1.0	50%
2	2.764	1.481	X	-	-	1.9	79%
3	0.704	0.058	-	-	X	12.1	90%

Considerations

A number of factors should be considered when utilizing a GI wet pond to treat stormwater runoff.

Pretreatment

Pretreatment can extend the functional life of a GI wet pond by reducing incoming velocities and capturing coarser sediments. Pretreatment can also increase the pollutant removal capability of the system.

- Pretreatment may consist of a forebay or any of the structural BMPs found in *Chapters 9* or *11.*
- There is no adopted TSS removal rate associated with forebays; therefore, their inclusion in any design should be solely for the purpose of facilitating maintenance. Forebays can be earthen, constructed of riprap, or made of concrete, and must comply with the following requirements:
  - □ The forebay must be designed to prevent scour of the receiving basin by outflow from the forebay.
  - □ The forebay should provide a minimum storage volume of 10% of the WQDS and be sized to hold the sediment volume expected between clean-outs.
  - □ It should fully drain within nine hours in order to facilitate maintenance and to prevent mosquito issues. Under no circumstances should there be any standing water in the forebay 72 hours after a precipitation event.
  - □ Surface forebays must meet or exceed the sizing for preformed scour holes in the *Standard for Conduit Outlet Protection* in the *Standards for Soil Erosion and Sediment Control in New Jersey* for a surface forebay.
- If a concrete forebay is utilized, it must have at least two weep holes to facilitate low level drainage.
- When using a structural BMP for pretreatment, it must be designed in accordance with the design requirements outlined in the respective chapter. For additional information on the design requirements of each structural BMP, refer to the appropriate chapter in this manual.

Designing for Pollutant Removal

When designing a GI wet pond for pollutant removal, there are two different strategies that can be utilized: sedimentation and controlled eutrophication. While both strategies relate pollutant removal efficiencies to hydraulic residence time, the choice of one strategy over the other will largely depend on the target pollutants and both site and economic constraints.

Sedimentation GI wet ponds treat pollutants entirely through settling; therefore pollutant removal can be maximized by increasing the hydraulic residence time. The recommended minimum length to width ratio of these types of systems is 3:1; in cases where this cannot be achieved, baffles or berms may be added within the pond to increase the travel length and residence time. The design criteria in this chapter are for GI wet pond systems that rely on the sedimentation strategy; these types of systems are particularly useful where there is a wide range of pollutants adsorbed to suspended solids.

The controlled eutrophication strategy relies on the biological, chemical and physical processes that occur in natural lake systems to treat the pollutants in stormwater runoff. When utilizing this strategy, the designer is creating a GI wet pond with conditions conducive to eutrophication, specifically longer residence times and larger storage volumes. This type of strategy is particularly useful in cases where nutrients are the concern.

Permanent Pool

There are a number of factors to consider when deciding if a GI wet pond is suitable for a specific site, particularly the inflow drainage area. As mentioned previously, sufficient dry weather or base flow is necessary to maintain both stormwater quality and dissolved oxygen levels and to control mosquito breeding. An adequate and regular inflow of surface or groundwater will allow for aeration of the permanent pool. In addition to increased dissolved oxygen levels, the regular inflow of water will result in a certain amount of agitation of the water surface; without this agitation, a wet pond can quickly become suitable mosquito breeding habitat. Where sufficient oxygen levels and mixing will be difficult to achieve, a fountain or aerator may be included. If a GI wet pond is designed for exchange with groundwater, consideration must be given to the types and amount of pollutants expected to be treated by the wet pond; all efforts must be made to ensure that wet ponds designed in this manner do not contribute to groundwater contamination. Finally, consideration must be given to safety around the permanent pool; local safety requirements in excess of those required by this chapter must be addressed in the design of any GI wet pond.

Thermal Effects

In addition to the above considerations, the selection of a GI wet pond for a specific site may be limited by the discharge of heated water from the permanent pool during the summer months. Because the permanent pool can act as a heat sink between storm events, runoff discharged from a GI wet pond may be as much as 10°F warmer than the naturally occurring baseflow in the downstream waterway; additionally, runoff to wet ponds from large impervious surfaces can also significantly raise the temperature of runoff in the system. These elevated temperatures may have adverse impacts, not only on the wildlife utilizing the permanent pool, but also on down-gradient waterbodies that have temperature-dependent designated uses, such as trout production. Therefore, GI wet pond designers should pay special attention to the potential of thermal effects on downstream water bodies supporting cold water fisheries. For more information on surface water quality designations, including designated uses, see N.J.A.C. 7:9(A) or http://www.state.nj.us/dep/wms/bwqsa/swqs.htm#1

Thermal impacts of GI wet ponds may be mitigated in a number of ways. For example, the use of a deep permanent pool with the outlet structure positioned near the lowest elevation allows for discharge of colder bottom water. The planting of shade trees around the perimeter of a GI wet pond can also help reduce the discharge of heated water by reducing the solar warming of the pool. Finally, designing a GI wet pond to consist of a series of pools, as opposed to a single pool, can allow cooling to occur prior to discharge into a down-gradient waterway.

Sediment Accumulation

A properly designed GI wet pond may accumulate considerable amounts of sediment over time, leading to the loss of the permanent pool volume, which leads to a loss in both runoff quality and quantity control effectiveness. Therefore, depending on the clean-out intervals, an increase in the GI wet pond's permanent pool volume should be considered to compensate for this expected loss of storage volume. Additionally, when designing a GI wet pond, consideration should be given to the frequency of sediment inspection and removal.

Plumbing Code

This chapter does not directly address indoor or outdoor plumbing codes. Designers and reviewers should consult with the New Jersey Plumbing Code N.J.A.C. 5:23-3.15 as well as with any applicable municipal plumbing codes. In cases where stormwater is being harvested for indoor use, storage systems and reuse components should have backflow preventers or air gaps to keep collected stormwater separate from the potable water supply. Any pipes or spigots that use harvested stormwater should be clearly labeled as non-potable. All stormwater harvesting design plans should be signed and sealed by a certified professional.

Disposal of Vehicle Wash Water

If stormwater runoff collected in a storage system will be reused for vehicle washing, it is important to keep in mind that any wastewater from vehicle washing is not permitted to enter into any storm sewer inlets or be discharged into any waters of the State. This wastewater can either be discharged into a sanitary sewer or it may be temporarily contained in a holding tank to be pumped and hauled to an appropriate wastewater treatment facility.

Maintenance

Regular and effective maintenance is crucial to ensure effective GI wet pond performance; in addition, maintenance plans are required for all stormwater management facilities associated with a major development, pursuant to N.J.A.C. 7:8-5.8. There are a number of required elements in all maintenance plans; these are discussed in more detail in *Chapter 8: Maintenance of Stormwater Management Measures*. Furthermore, maintenance activities are required through various regulations, including the New Jersey Pollutant Discharge Elimination System (NJPDES) Rules, N.J.A.C. 7:14A. Specific maintenance requirements for GI wet ponds are presented below; these requirements must be included in the GI wet pond's maintenance plan. In addition, the frequency of a clean out cycle for a GI wet pond should be considered in the maintenance plan since GI wet ponds are intended to accumulate sediment. The cleanout cycle for a GI wet pond in a stabilized watershed can vary, with an average cycle of approximately 10 years.

General Maintenance

- All GI wet pond components expected to receive and/or trap debris and sediment must be inspected for clogging and excessive accumulation at least twice annually, or as needed; these components may include forebays, bottoms, trash racks, outlet structures, and riprap or gabion aprons. Additional inspections are required after every storm exceeding 1 inch of rainfall

- The forebay must be cleaned when it accumulates either 6 inches of sediment, there is a 10% loss of forebay volume, or if it remains wet 9 hours after the end of a storm event.

- Disposal of debris, trash, sediment and other waste material must be done at suitable disposal/recycling sites and in compliance with all applicable local, state and federal waste regulations.

- All structural components must be inspected, at least once annually, for cracking, subsidence, spalling, erosion and deterioration.

- Access points for maintenance are required on all storage systems and reuse components; these access points must be clearly identified in the maintenance plan. In addition, any special training required for maintenance personnel to perform specific tasks must be included in the plan.

- All pumps, controls and alarms must be inspected at least annually and maintained in accordance with the manufacturer's requirements. Should a component fail, corrective action must be taken immediately. The maintenance logbook must include a section to record all maintenance information regarding pumps, controls and alarms.

- A detailed, written log of all preventative and corrective maintenance performed on the storage system and reuse component must be kept, including a record of all inspections and copies of maintenance-related work orders. Additional maintenance guidance can be found at https://dep.nj.gov/stormwater/maintenance-guidance/.

Vegetated Areas

- When establishing or restoring vegetation, inspections should be performed biweekly.

- Once established, inspections of health, density and diversity should be performed at least twice annually during both the growing and non-growing seasons.

- The vegetative cover must be maintained at 85%; if vegetation has damage, the area must be reestablished in accordance with the original specifications and the inspection requirement above.

- Mowing/trimming of vegetation must be performed on a regular schedule based on specific site conditions; only turf grass should be mowed at least once a month during growing season. Native vegetation may be harmed by inappropriate mowing or trimming. The maintenance plan must indicate areas that should not be mowed or trimmed and personnel trained.

- Vegetated areas must be inspected at least once annually for erosion, scour and unwanted growth; any unwanted growth should be removed with minimum disruption to the remaining vegetation.

- All use of fertilizers, pesticides, mechanical treatments and other means to ensure optimum vegetation health must not compromise the intended purpose of the GI wet pond.

Anti-Seepage Component(s)

- Where a liner or soil modifications are required to ensure the impermeability of the wet pond, testing, repair and replacement tasks, tools and costs must be indicated in the maintenance manual.

Drain Time

- The approximate time it would normally take to completely drain the volume of stormwater runoff generated by the Water Quality Design Storm, e.g., discharge the excess accumulated stormwater runoff so that the water surface elevation returns to that of the permanent pool, must be indicated in the maintenance manual.
- If the actual drain time is significantly different from the design drain time, the components that could provide hydraulic control must be evaluated and appropriate measures taken to return the wet pond to minimum and maximum drain time requirements.
- If the actual drain time is significantly different than the design drain time, the outlet structure and both groundwater and tailwater levels must be evaluated and appropriate measures taken to comply with the maximum drain time requirements.

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