4.3.1 Water Quality Basins

General Application Water Quality BMP

Description: A constructed water quality basin that has a permanent pool (or micropool). Runoff from each rain event is detained and treated in the pool primarily through settling and biological uptake mechanisms.

KEY CONSIDERATIONS

FEASIBILITY GUIDELINES:

- Minimum contributing drainage area of 25 acres; 10 acres for micropool ED basin.
- Requires approximately 2 to 3% of the contributing drainage area.
- Underlying soils of hydrologic groups C or D are typically adequate to maintain a permanent pool. Hydrologic soil groups A and B, or areas with karst topography require a basin liner.
- Shall not be located on unstable slopes or slopes greater than 15%.
- Six to eight feet of elevation difference is needed from inflow to outflow.
- There are additional design requirements for areas with underlying aquifers or hotspot areas.

ADVANTAGES / BENEFITS:

- Moderate to high removal rate of urban pollutants.
- High community acceptance if aesthetics are maintained.
- Opportunity for wildlife habitat.

DISADVANTAGES / LIMITATIONS:

- Potential for thermal impacts/downstream warming.
- Dam height restrictions for high relief areas.
- Basin drainage can be problematic for low relief terrain.

MAINTENANCE REQUIREMENTS:

- Remove debris from inlet and outlet structures.
- Maintain side slopes / remove invasive vegetation.
- Monitor sediment accumulation and remove periodically.

STORMWATER MANAGEMENT APPLICABILITY

Stormwater Quality:	**Yes**
Channel Protection:	**Yes**
Detention/Retention:	**Yes**

Accepts hotspot runoff: *Yes, but two feet of separation distance required to water table when used in hotspot areas*

COST CONSIDERATIONS

Land Requirement:	**Med - High**
Capital Cost:	**Low**
Maintenance Burden:	**Low**

LAND USE APPLICABILITY

Residential/Subdivision Use:	**Yes**
High Density/Ultra Urban Use:	**Yes**
Commercial/Industrial Use:	**Yes**

POLLUTANT REMOVAL

Total Suspended Solids:	**80%**

4.3.1.1 General Description

Water quality basins (also referred to as retention basins, wet basins, or wet extended detention basins) are constructed stormwater retention basins that have a permanent (dead storage) pool of water throughout the year. They can be created by excavating an already existing natural depression or through the construction of embankments.

In a water quality basin, runoff from each rain event is detained and the water quality volume (WQv) is treated in the pool through gravitational settling and biological uptake until it is displaced by runoff from the next storm. The permanent pool also serves to protect deposited sediments from resuspension. Above the permanent pool level, additional temporary storage (live storage) is provided for runoff quantity (i.e., peak discharge and/or volume) control if required by local regulations. The upper stages of a water quality basin can be designed to provide extended detention for downstream channel protection volume, as well as conventional detention for peak discharge control.

Water quality basins are among the most cost-effective and widely used stormwater practices. Water quality basins are generally applicable to most types of new development and redevelopment, and can be used in both residential and nonresidential areas. Basins can also be used for regional applications (i.e., controlling runoff from more than one developed site). A well-designed and landscaped basin can be an aesthetic feature on a development site when planned and located properly. However, limitations on available land may preclude their use for retrofit applications or high-density/ultra urban sites.

There are several variations of water quality basin design, the most common of which include the wet basin, the wet extended detention basin, and the micropool extended detention basin. In addition, multiple water quality basins can be placed in series or parallel to increase total suspended solids (TSS) removal efficiency or meet site design constraints. Figure 4-10 shows a number of examples of water quality basins. Descriptions of each basin type are provided below the figure.

Figure 4-10. Water Quality Basin Examples

Wet Basin

Wet Extended Detention Basin

Micropool Extended Detention Basin

Multiple Basin System

- **Wet Basin** – Wet basins are water quality basins constructed with a permanent (dead storage) pool of water equal to the WQv. Stormwater runoff displaces the water already present in the pool. Temporary storage (live storage) can be provided above the permanent pool elevation for larger flows.

- **Wet Extended Detention (ED) Basin** – A wet extended detention basin is a wet basin where the WQv is split evenly between the permanent pool and extended detention (ED) storage provided above the permanent pool. During storm events, water is detained above the permanent pool and released over 24 hours. This design has similar pollutant removal to a traditional wet basin, but consumes less space.
- **Micropool Extended Detention (ED) Basin** – The micropool extended detention basin is a variation of the wet ED basin where only a small "micropool" is maintained at the outlet to the basin. The outlet structure is sized to detain the WQv for 24 hours. The micropool prevents resuspension of previously settled sediments and also prevents clogging of the low flow orifice.
- **Multiple Basin System** – A multiple basin system consists of constructed facilities that provide water quality and quantity volume storage in two or more cells. The additional cells can create longer pollutant removal pathways and improved downstream protection.

4.3.1.2 Pollutant Removal Capabilities

Basins treat incoming stormwater runoff through physical, biological, and chemical processes. The primary removal mechanism is gravitational settling of particulates, organic matter, metals, bacteria and organics as stormwater runoff resides in the basin. Another mechanism for pollutant removal is uptake by algae and wetland plants in the permanent pool, particularly of nutrients. Volatilization and chemical activity also work to break down and eliminate a number of other stormwater contaminants such as hydrocarbons.

All of the water quality basin design variations are presumed capable of removing at least 80% of the total suspended solids load in typical urban post-development runoff when sized, designed, constructed and maintained in accordance with the specifications provided in this manual. The TSS removal performance can be reduced by poor design, construction or maintenance.

Additionally, research has shown that use of water quality basins will have benefits beyond the removal of TSS, such as the removal of other pollutants (i.e. phosphorous, nitrogen, fecal coliform and heavy metals) as well, which is useful information should the pollutant removal criteria change in the future.

For additional information and data on pollutant removal capabilities for water quality basins, see the National Pollutant Removal Performance Database (2nd Edition) available at www.stormwatercenter.net and the International Stormwater Best Management Practices Database at www.bmpdatabase.org.

4.3.1.3 Planning and Design Standards

The following standards shall be considered **minimum** design standards for the design of a water quality basin facility. Water quality basins that are not designed to these standards will not be approved. Consult with the local engineering department to determine if there are any variations to these criteria or additional standards that must be followed.

A. LOCATION AND SITING

- Water quality basins must have a minimum contributing drainage area of 25 acres or more for a wet basin or wet ED basin to maintain a permanent pool. For a micropool ED basin, the minimum drainage area is 10 acres. The use of a water quality basin for a smaller drainage area may be considered when water availability can be confirmed (such as from a groundwater source or areas that typically have a high water table). In such situations, calculation of a water balance for the basin may be required. Water balance calculations are presented in Chapter 3 of this manual. It is important that basins that serve smaller drainage areas have an adequate anti-clogging device provided for the basin outlet.
- It is strongly recommended that water quality basins be located where the topography allows for maximum runoff storage at minimum excavation or embankment construction costs. When locating a water quality basin, the site designers should also consider the location and use of other site features,

such as buffers and undisturbed natural areas, and should attempt to aesthetically blend the facility into the adjacent landscape.

- Water quality basins shall not be located on unstable slopes or slopes greater than 15%.
- Water quality basins shall not be located in a stream or any other navigable waters of the United States, including natural (i.e., not constructed) wetlands. Where an appeal or variance of this policy is desired, the property owner must obtain coverage under a Section 404 permit under the Clean Water Act and/or an Aquatic Resource Alteration Permit (ARAP) and provide proof of such coverage with the site development plans on which the basin design is presented.
- Each water quality basin shall be placed in an easement that is recorded with the deed. The easement shall be defined at the outer edge of the safety bench, or a minimum of 15 feet from the normal water pool elevation (measured perpendicular from the pool elevation boundary) if a safety bench is not included in the basin design. Minimum setback requirements for the easement shall be as follows unless otherwise specified by local regulations:
  - ➢ From a public water system well – TDEC specified distance per designated well category
  - ➢ From a private well – 50 feet; if the well is down gradient from a hotspot land use, as defined in this manual, then the minimum setback is 250 feet
  - ➢ From a septic system tank/leach field – 50 feet
- The minimum setback for habitable structures from the easement shall be 15 feet. The first floor elevation (FFE) for any structure adjacent to the basin shall have an elevation no lower than 1 foot above the top of the berm.
- All utilities shall be located outside of the easement.

B. GENERAL DESIGN

- A water quality basin shall consist of the following elements, designed in accordance with the specifications provided in this section.
  (1) Permanent pool of water;
  (2) A sediment forebay at each basin inlet (unless the inlet provides less than 10% of the total inflow to the basin);
  (3) Overlying zone in which runoff control volumes are stored;
  (4) Shallow littoral zone (aquatic bench) along the edge of the permanent pool that acts as a biological filter;
  (5) An emergency spillway;
  (6) Maintenance access;
  (7) Safety bench (if basin side slopes are greater than 3:1); and,
  (8) Appropriate native landscaping.

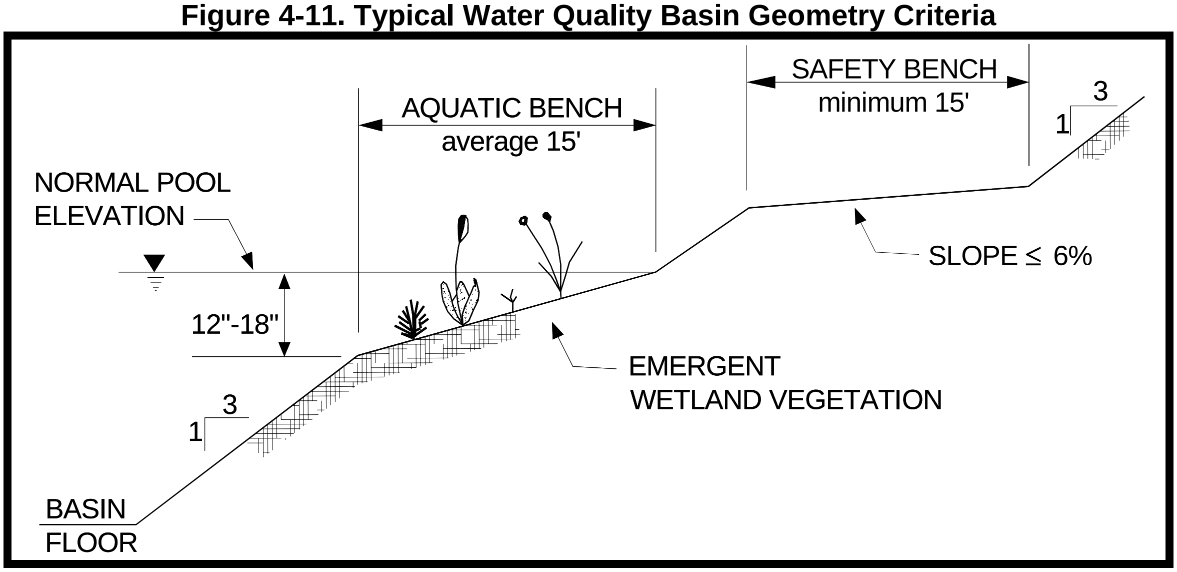
C. PHYSICAL SPECIFICATIONS / GEOMETRY

In general, basin designs are unique for each site and application. However, there are a number of geometric ratios and limiting depths for basin design that must be observed for adequate pollutant removal, ease of maintenance, and improved safety.

- Permanent pool volume shall be sized as follows:
  - ➢ Standard wet basins: 100% of the water quality treatment volume (1.0 X WQv);
  - ➢ Wet ED basins: 50% of the water quality treatment volume (0.5 X WQv);
  - ➢ Micropool ED basins: Approximately 0.1 foot per impervious acre (4356 ft^3).

- The pretreatment storage volume is part of the total WQv design requirement and may be subtracted from the WQv for permanent pool sizing. See Part D below for more information.
- Proper geometric design is essential to prevent hydraulic short-circuiting (unequal distribution of inflow), which results in the failure of the basin to achieve adequate levels of pollutant removal. The minimum length-to-width ratio permitted for the permanent pool shape is 1.5:1, and should ideally be greater than 3:1 to avoid short-circuiting. In addition, basins should be wedge-shaped when possible so that flow enters the basin and gradually spreads out, improving the sedimentation process. Baffles, basin shaping or islands can be added within the permanent pool to increase the flow path.
- The maximum depth of the permanent pool shall not exceed 8 feet to avoid stratification and anoxic conditions. Greater depths may be approved in the event that measures are taken that will eliminate the possibility of such conditions and safety precautions are adequately considered. The minimum depth for the permanent pool should be 3 to 4 feet. Deeper depths near the outlet will result in cooler bottom water discharges from the basin, which may mitigate downstream thermal effects caused by discharges of warm stormwater runoff.
- Side slopes shall not exceed 3:1 (horizontal to vertical) on one side of the basin to facilitate access for maintenance and repair. The remainder of the basin shall have side slopes no steeper than 2:1 although 3:1 is preferred. Benching of the slope (see safety bench in Figure 4-11) is required for embankments greater than 10 feet in height and having greater than a 3:1 side slope. Riprap-protected embankments shall be no steeper than 2:1.
- The perimeter of all deep pool areas (4 feet or greater in depth) shall be surrounded by two benches: safety and aquatic. For large basins, the safety bench shall extend no less than 15 feet outward from the normal water edge to the toe of the basin side slope. The slope of the safety bench shall not exceed 6%. The requirements for a safety bench may be waived if basin side slopes are 3:1 or gentler. The aquatic bench shall have an average width of 15 feet, and shall extend inward from the normal pool edge and shall have a maximum depth of 18 inches below the normal pool water surface elevation (see Figure 4-11).
- The contours and shape of the permanent pool should be irregular to provide a more natural landscaping effect.

Figure 4-11. Typical Water Quality Basin Geometry Criteria



D. PRETREATMENT / INLETS

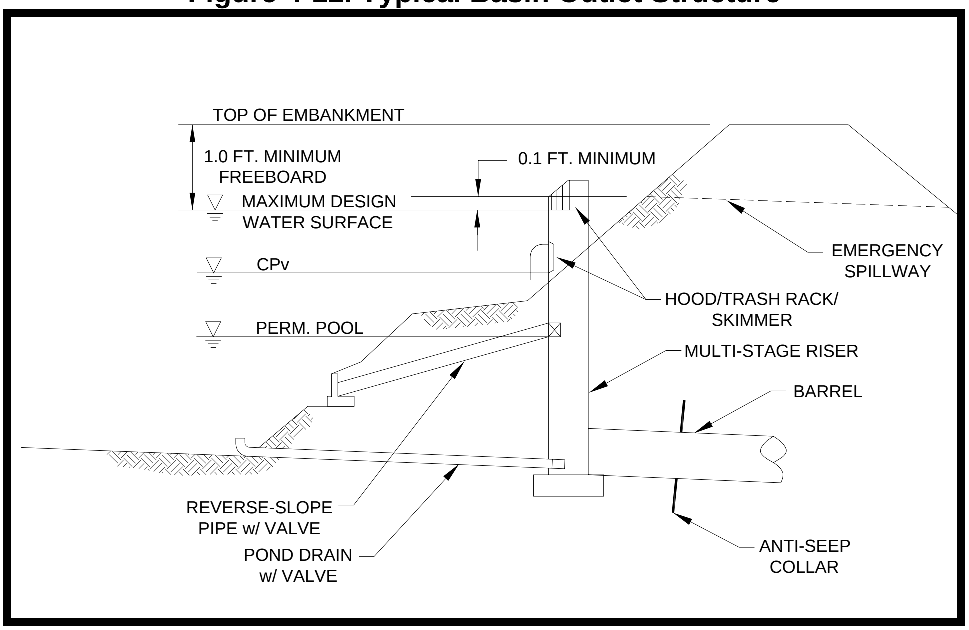
- Each basin shall have a sediment forebay or equivalent upstream pretreatment. A sediment forebay is designed to remove incoming sediment from the stormwater flow prior to dispersal in a larger permanent pool. The forebay shall consist of a separate cell, formed by an acceptable barrier. A forebay must be provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the basin. In some design configurations, the pretreatment volume may be located within the permanent pool.

- The sediment forebay shall be sized to contain 0.1 inch per impervious acre (363 ft^3) of contributing drainage and shall be no more than 4 to 6 feet deep. The pretreatment storage volume is part of the total WQv design requirement and may be subtracted from the WQv for permanent pool sizing.
- A fixed vertical sediment depth marker shall be installed in the forebay to measure sediment deposition over time. The bottom of the forebay may be hardened (e.g., using concrete, paver blocks, etc.) to make sediment removal easier.
- Inflow channels shall be stabilized with flared riprap aprons, or the equivalent. Inlet pipes to the basin can be partially submerged. Exit velocities of discharges from the forebay to the basin must be non-erosive.

E. OUTLET STRUCTURES

- Flow control from a water quality basin is typically accomplished with the use of a riser and barrel. The riser is a vertical pipe or inlet structure that is attached to the base of the basin with a watertight connection. The outlet barrel is a horizontal pipe attached to the riser that conveys flow under the embankment (see Figure 4-12). The riser shall be located within the basin embankment for maintenance access, safety and aesthetics.

Figure 4-12. Typical Basin Outlet Structure



- A number of outlets at varying depths in the riser provide internal flow control for routing of the WQv and CPv, and for peak discharge control (i.e., detention). The number of orifices can vary and is usually a function of the basin design.

  For example, a wet basin riser configuration is typically comprised of a channel protection (CPv) outlet (usually an orifice) and one or more outlets (often slots or weirs) for peak discharge control to comply with local detention requirements (e.g., control of the post-development 10-year peak discharge to pre-development conditions). The channel protection orifice is sized to release the channel protection storage volume over a 24-hour period, centroid to centroid. Since the water quality volume is fully contained in the permanent pool, no orifice sizing is necessary for this volume. As runoff from a water quality event enters the wet basin, it simply displaces that same volume through the channel protection orifice. Thus an off-line wet basin providing ***only*** water quality treatment can use a simple overflow weir as the outlet structure.

In the case of a wet ED basin or micropool ED basin, there is generally a need for an additional outlet (usually an orifice) that is sized to pass the extended detention water quality volume that is surcharged on top of the permanent pool. Flow will first pass through this orifice, which is sized to release the water quality ED volume in 24 hours. The preferred design is a reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool to prevent floatables from clogging the pipe and to avoid discharging warmer water at the surface of the basin. The next outlet is sized for the release of the channel protection storage volume. The outlet (often an orifice) invert is located at the maximum elevation associated with the extended detention water quality volume and is sized to release the channel protection storage volume over a 24-hour period. The final orifice invert is located at the extreme flood elevation.

Alternative hydraulic control methods to an orifice can be used and include the use of a broad-crested, rectangular, V-notch, or proportional weir, or an outlet pipe protected by a hood that extends at least 12 inches below the normal pool.

- Higher flows that must be controlled as part of the local jurisdiction's detention requirements pass through openings or slots protected by trash racks further up on the riser.
- After entering the riser, flow is conveyed through the barrel and is discharged downstream. Anti-seep collars shall be installed on the outlet barrel to reduce the potential for pipe or embankment failure.
- Riprap, plunge pads or pools, or other energy dissipators shall be placed at the outlet of the barrel to prevent scouring and erosion. If a basin outlet discharges immediately to a channel that carries dry weather flow (i.e., a stream), care shall be taken to minimize disturbance along the downstream channel, and to reestablish streamside vegetation in the shortest possible distance.
- Each basin shall have a bottom drain pipe with an adjustable slide gate that can completely or partially drain the basin within 24 hours.
- The basin drain shall be sized one pipe size greater than the calculated design diameter. The drain valve is typically a slide gate. Valve controls shall be located inside of the riser at a point where they: (a) will not normally be inundated; and (b) can be operated in a safe manner.
- Consult your local jurisdiction for materials specification for the outlet structure.

F. EMERGENCY SPILLWAY

- An emergency spillway shall be included per regulations of the local jurisdiction.

G. MAINTENANCE ACCESS

- A minimum 20' wide maintenance right-of-way or easement shall be provided to the basin from a driveway, public road or private road. The maintenance access easement shall have a maximum slope of no more than 15% and shall have a minimum unobstructed drive path having a width of 12 feet, appropriately stabilized to withstand maintenance equipment and vehicles.
- The maintenance access shall extend to the forebay, safety bench, riser, and outlet, and, to the extent feasible, be designed to allow vehicles to turn around.
- Access to the riser shall be provided by lockable manhole covers, and manhole steps within easy reach of valves and other controls.

H. SAFETY FEATURES

- A safety bench shall be provided for embankments greater than 10 feet in height and having greater than a 3:1 side slope. For large basins, the safety bench shall extend no less than 15 feet outward from the normal water edge to the toe of the basin side slope. The slope of the safety bench shall not exceed 6%.
- All embankments and spillways shall be designed to TDEC rules and regulations as applied to the Safe Dams Act of 1973 (see Appendix H), where applicable.

- The property owner may consider fencing the basin for the purpose of safety management.
- All outlet structures shall be designed so as not to permit access by children. Property owners are encouraged to post warning signs near the basin to prohibit swimming and fishing in the facility.

I. LANDSCAPING

- Aquatic vegetation can play an important role in pollutant removal in a water quality basin. In addition, vegetation can enhance the appearance of the basin, stabilize side slopes, serve as wildlife habitat, and can temporarily conceal unsightly trash and debris. Therefore, wetland plants should be encouraged in a basin design, along the aquatic bench (fringe wetlands), the safety bench and side slopes (ED basins), and within shallow areas of the pool itself. The best elevations for establishing wetland plants, either through transplantation or volunteer colonization, are within 6 inches (plus or minus) of the normal pool elevation. More information on wetland plants can be found at the following websites:
    - http://wetlands.fws.gov/
    - http://www.npwrc.usgs.gov/resource/plants/floraso/species.htm
- Woody vegetation shall not be planted on the embankment or allowed to grow within 15 feet of the toe of the embankment and 25 feet from the principal spillway structure.
- Fish such as *Gambusia* can be stocked in a basin to aid in mosquito prevention.
- A fountain or aerator may be used for oxygenation of water in the permanent pool and to aid in mosquito breeding prevention.
- Vegetated buffers, as defined and described in Chapter 6 of this manual, are not required for water quality basins that are constructed for the purpose of stormwater quality or quantity control. However, it should be noted that vegetated buffers can be utilized for water quality treatment and can result in a volume reduction that decreased the WQv. The criteria for the vegetated buffer reduction are presented in Chapter 5 of this manual.

J. ADDITIONAL SITE-SPECIFIC DESIGN CRITERIA AND ISSUES

There are a number of additional site specific design criteria and issues (listed below) that must be considered in the design of a water quality basin.

Physiographic Factors - Local terrain design constraints:

- Low Relief – Maximum normal pool depth is limited; providing the basin drain can be problematic.
- Karst – Requires poly or clay liner to sustain a permanent pool of water and protect aquifers; limits on ponding depth; geotechnical tests may be required.
- Soils - Hydrologic group “A” soils generally require a basin liner; group “B” soils may require infiltration testing.

Wellhead Protection Areas

- Reduce potential groundwater contamination in wellhead protection areas by preventing infiltration of runoff from hotspot areas, or provide pretreatment of this runoff for the target pollutants that may discharge from the land use.
- Wellhead protection may require liner for type “A” and “B” soils.
- A minimum of two (2) to four (4) feet separation distance of the basin from water table shall be provided.

4.3.1.4 Design Procedures

In general, site designers should perform the following design procedures when designing a water quality basin.

Step 1. Compute runoff control volumes

Calculate WQv CPv, and pre- and post-development peak discharges and runoff volumes. The calculation of WQv and CPv is presented in Chapter 3 of this manual. Consult local regulations for peak discharge control (i.e., detention) requirements.

Step 2. Determine if the development site and conditions are appropriate for a water quality basin

Consider the planning and design standards in sections 4.3.1.3.

Step 3. Confirm additional design criteria and applicability

Consider any special site-specific design conditions/criteria from subsection 4.3.1.3-J. Check with the local engineering department, TDEC, or other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply to the site.

Step 4. Determine pretreatment volume

A sediment forebay is provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the basin. The forebay should be sized to contain 0.1 inch per impervious acre (363 ft^3) of contributing drainage and should be 4 to 6 feet deep. The forebay storage volume counts toward the total WQv requirement and may be subtracted from the WQv for subsequent calculations.

Step 5. Determine permanent pool volume (and water quality ED volume)

Wet Basin: Size permanent pool volume to 1.0 WQv less any forebay storage volume.

Wet ED Basin: Size permanent pool volume to 0.5 WQv less any forebay storage volume. Size extended detention volume to 0.5 WQv less any forebay storage volume.

Micropool ED Basin: Size permanent pool volume at 0.1 foot per impervious acre (4356 ft^3) less any forebay storage volume. Size extended detention volume to remainder of WQv.

Step 6. Determine basin location and preliminary geometry. Conduct basin grading design and determine storage available for permanent pool (and water quality extended detention if needed)

This step involves initially designing the grading of the basin (establishing contours) and determining the elevation-storage relationship for the basin. See subsection 4.3.1.3 for more details.

- Include safety and aquatic benches, if required.
- Set WQv permanent pool elevation (and WQv-ED elevation for wet ED and micropool ED basin) based on volumes calculated earlier.

Step 7. Compute extended detention orifice release rate(s) and size(s), and establish CPv elevation

Wet Basin: The CPv elevation is determined from the stage-storage relationship and the orifice is then sized to release the channel protection storage volume over a 24-hour period. The channel protection orifice should be adequately protected from clogging by an acceptable external trash rack. A reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool, is a recommended design. Orifice diameters less than three inches must employ internal orifice protection (i.e., an over-perforated vertical stand pipe with ½-inch orifices or slots that are protected by wirecloth and a stone filtering jacket).

Wet ED Basin and Micropool ED Basin: Based on the elevations established in Step 6 for the extended detention portion of the water quality volume, the water quality orifice is sized to release this extended detention volume in 24 hours. The water quality orifice should be adequately protected from clogging by an acceptable external trash rack. A reverse slope pipe attached to the riser, with its inlet submerged 1 foot below the elevation of the permanent pool, is a recommended design. Orifice diameters less than three inches must employ internal orifice protection (i.e., an over-perforated vertical stand pipe with ½-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). The CPv elevation is then determined from the stage-storage relationship. The invert of the channel protection orifice is located at the water quality extended detention elevation, and the orifice is sized to release the channel protection storage volume over a 24-hour period, centroid to centroid.

Step 8. Calculate peak discharge release rates and water surface elevations for flood control (i.e., detention)

Set up a stage-storage-discharge relationship for the control structure for the extended detention (CPv) requirement and peak discharge control storm orifices.

Step 9. Design embankment(s) and spillway(s)

Using the peak event water surface elevation, set the top of the embankment elevation, and size the emergency spillway per the regulations of the local jurisdiction.

Step 10. Investigate potential basin hazard classification

The design and construction of water quality management basins are required to follow the latest version of the TDEC Rules and Regulations Application to the Safe Dams Act of 1973.

Step 11. Design inlets, sediment forebay(s), outlet structures, maintenance access, and safety features.

See subsection 4.3.1.3-D through H for more details.

Step 12. Design vegetation

A vegetation scheme for a water quality basin and its buffer should be prepared to indicate how aquatic and terrestrial areas will be stabilized and established with vegetation. See subsection 4.3.1.3-I for more details.

4.3.1.5 Maintenance Requirements and Inspection Checklist

Note: Section 4.3.1.5 must be included in the Operations and Maintenance Plan that is recorded with the deed.

Regular inspection and maintenance is critical to the effective operation of water quality basins as designed. It is the responsibility of the property owner to maintain all water quality facilities in accordance with the minimum design standards and other guidance provided in this manual. Consult with the local jurisdiction engineering department to determine if there are additional maintenance requirements.

This page provides guidance on maintenance activities that are typically required for water quality basins, along with a suggested frequency for each activity. Individual water quality basins may have more, or less, frequent maintenance needs, depending upon a variety of factors including the occurrence of large storm events, overly wet or dry (i.e., drought) regional hydrologic conditions, and any changes or redevelopment in the upstream land use. Each property owner shall perform the activities identified below at the frequency needed to maintain the basin in proper operating condition at all times.

Inspection Activities	Suggested Schedule
• After several storm events or an extreme storm event, inspect for: bank stability; signs of erosion; and damage to, or clogging of, the inlet/outlet structures and pilot channels.	As needed
• Inspect for: trash and debris; clogging of the inlet/outlet structures and any pilot channels; excessive erosion; sediment accumulation in the basin, forebay and inlet/outlet structures; tree growth on dam or embankment; the presence of burrowing animals; standing water where there should be none; vigor and density of the grass turf on the basin side slopes and floor; differential settlement; cracking; leakage; and slope stability.	Semi-annually
• Inspect that the inlet/outlet structures, pipes, sediment forebays, and upstream, downstream, and pilot channels are free of debris and are operational. • Check for signs of unhealthy or overpopulation of plants and/or fish (if utilized). • Note signs of algal growth or pollution, such as oil sheens, discolored water, or unpleasant odors. • Check sediment marker(s) for sediment accumulation in the facility and forebay. • Check for proper operation of control gates, valves or other mechanical devices. • Note changes to the wet basin or contributing drainage area as such changes may affect basin performance.	Annually
Maintenance Activities	**Suggested Schedule**
• Clean and remove debris from inlet and outlet structures. • Mow side slopes (embankment) and maintenance access. Periodic mowing is only required along maintenance rights-of-way and the embankment. The remaining basin buffer can be managed as a meadow (mowing every other year) or forest.	Monthly
• If wetland vegetation is included, remove invasive vegetation.	Semi-annually
• Repair damage to basin, outlet structures, embankments, control gates, valves, or other mechanical devices; repair undercut or eroded areas. • Remove pollutants or algal overgrowth as appropriate.	As Needed
• Perform wetland plant management and harvesting.	Annually (if needed)
• Remove sediment from the forebay. Sediments excavated from water quality basins that do not receive runoff from land uses that require a Special Pollution Abatement Permit (SPAP) are not considered toxic or hazardous material and can be safely disposed of by either land application or landfilling. Sediment testing may be required prior to sediment disposal when the basin receives discharge from a land use that requires a SPAP.	5 to 7 years or after 50% of the total forebay capacity has been lost
• Monitor sediment accumulations, and remove sediment when the basin volume has become reduced significantly or the basin is not providing a healthy habitat for vegetation and fish (if used). Discharges of basin water may be considered an illegal discharge, as per the local jurisdiction's requirements. Care should be exercised during basin drawdowns to prevent downstream discharge of sediments, anoxic water, or high flows with erosive velocities. The local jurisdiction should be notified before draining a water quality basin.	10 to 20 years or after 25% of the permanent pool volume has been lost

The property owner is encouraged to use the inspection checklist that is presented on the next page as a guide in the inspection and maintenance of water quality basins. Local authorities can require the use of this checklist or other form(s) of maintenance documentation when and where deemed necessary in order to ensure the long-term proper operation of the water quality basin. Questions regarding water quality facility inspection and maintenance should be referred to the local engineering department.

INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE (continued)
WATER QUALITY BASIN INSPECTION CHECKLIST

Location: ____ Owner Change since last inspection? Y N
Owner Name, Address, Phone: ____
Date: ___________ Time: ______________ Site conditions:______________________________________

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/Corrective Action
Embankment and Emergency Spillway		
Healthy vegetation?		
Growth of Woody Vegetation?		
Erosion on embankment?		
Animal burrows in embankment?		
Cracking, sliding, bulging of dam?		
Blocked or malfunctioning drains?		
Leaks or seeps on embankment?		
Obstructions of spillway(s)?		
Erosion in/around emergency spillway?		
Other (describe)?		
Inlet/Outlet Structures and Channels		
Clear of debris and functional?		
Trash rack clear of debris and functional?		
Sediment accumulation?		
Condition of concrete/masonry?		
Metal pipes in good condition?		
Control valve operation?		
Basin drain valve operation?		
Outfall channels function, not eroding?		
Other (describe)?		
Sediment Forebays		
Evidence of sediment accumulation?		
Permanent Pool Areas (if applicable)		
Undesirable vegetation growth?		
Visible pollution?		
Shoreline erosion?		
Erosion at outfalls into basin?		
Headwalls and endwalls in good condition?		
Encroachment by other activities?		
Evidence of sediment accumulation?		
Dry Basin Areas (if applicable)		
Vegetation adequate?		
Undesirable vegetation growth?		
Excessive sedimentation?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

If any of the above inspection items are **UNSATISFACTORY**, list corrective actions and the corresponding completion dates below:

Corrective Action Needed	Due Date

Inspector Signature:________________________________ Inspector Name (printed)____________________________

4.3.1.6 Example Schematics

The example schematics for water quality wet basins presented in Figures 4-13 through 4-16 can be used to assist in the design of such BMPs.

Figure 4-13. Schematic of a Standard Wet Basin

(Source: modified from a graphic by the Center for Watershed Protection)

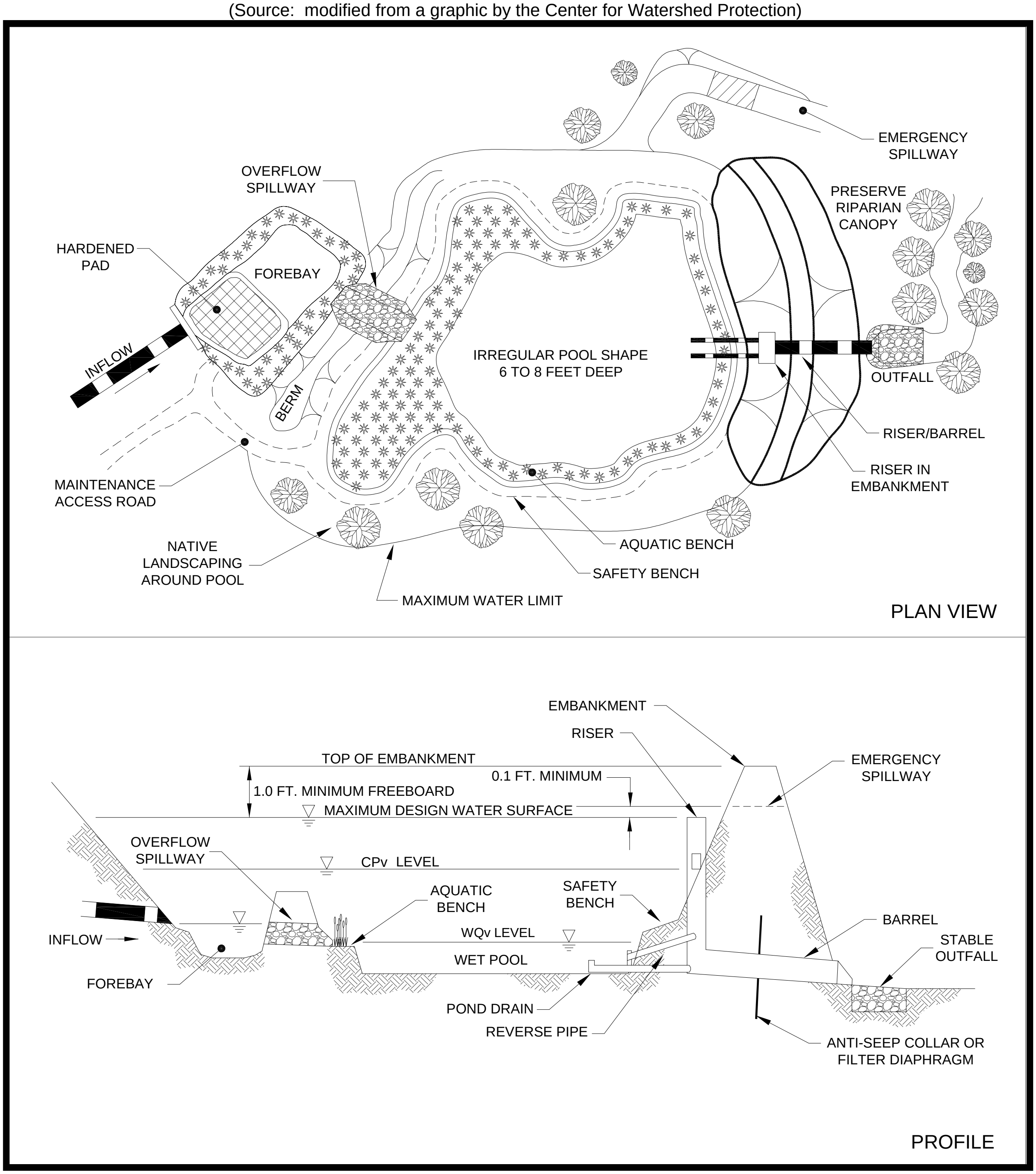


Figure 4-14. Schematic of a Wet Extended Detention Basin
(Source: modified from a graphic by the Center for Watershed Protection)

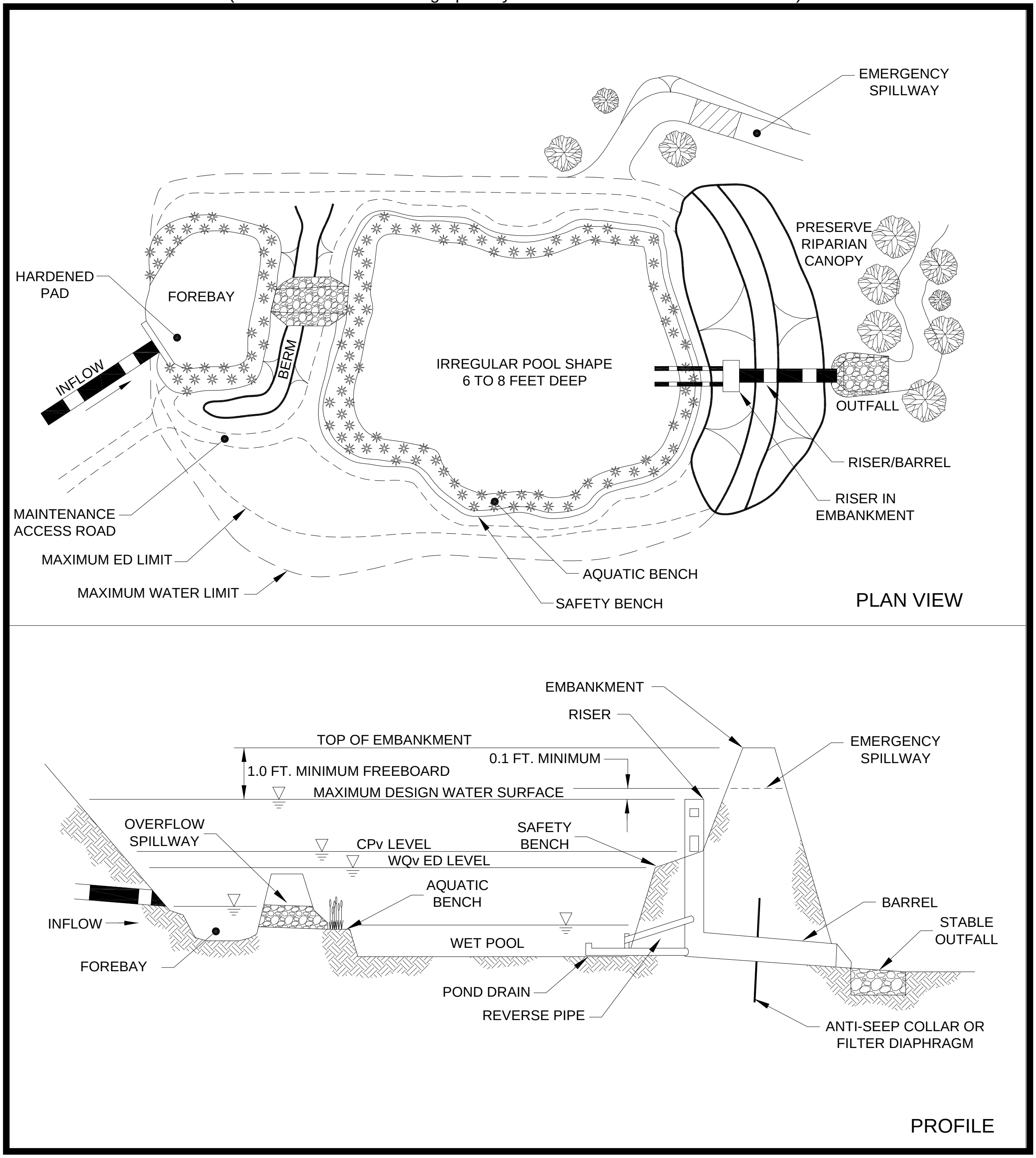


Figure 4-15. Schematic of a Micropool Extended Detention Basin
(Source: modified from a graphic by the Center for Watershed Protection)

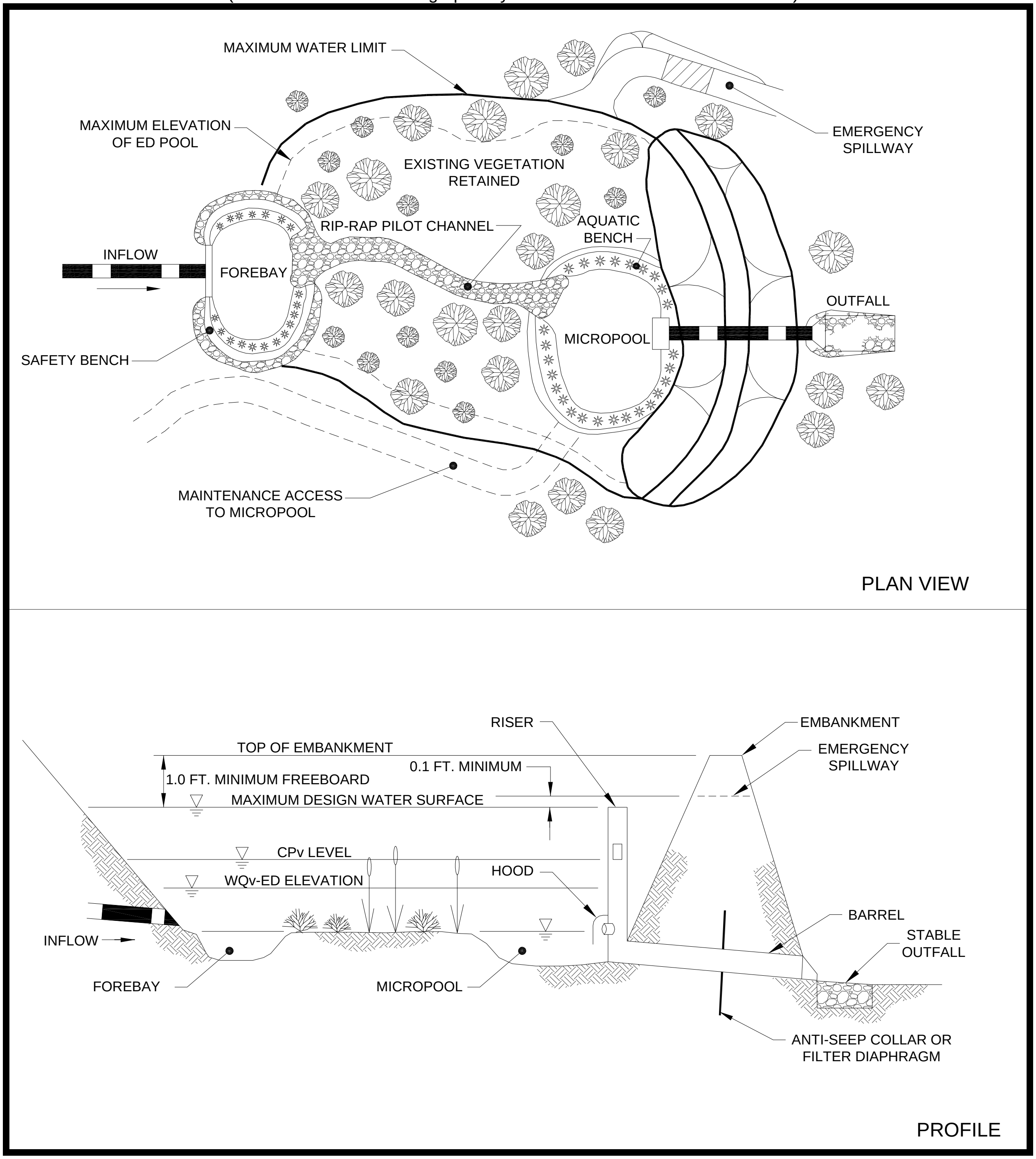
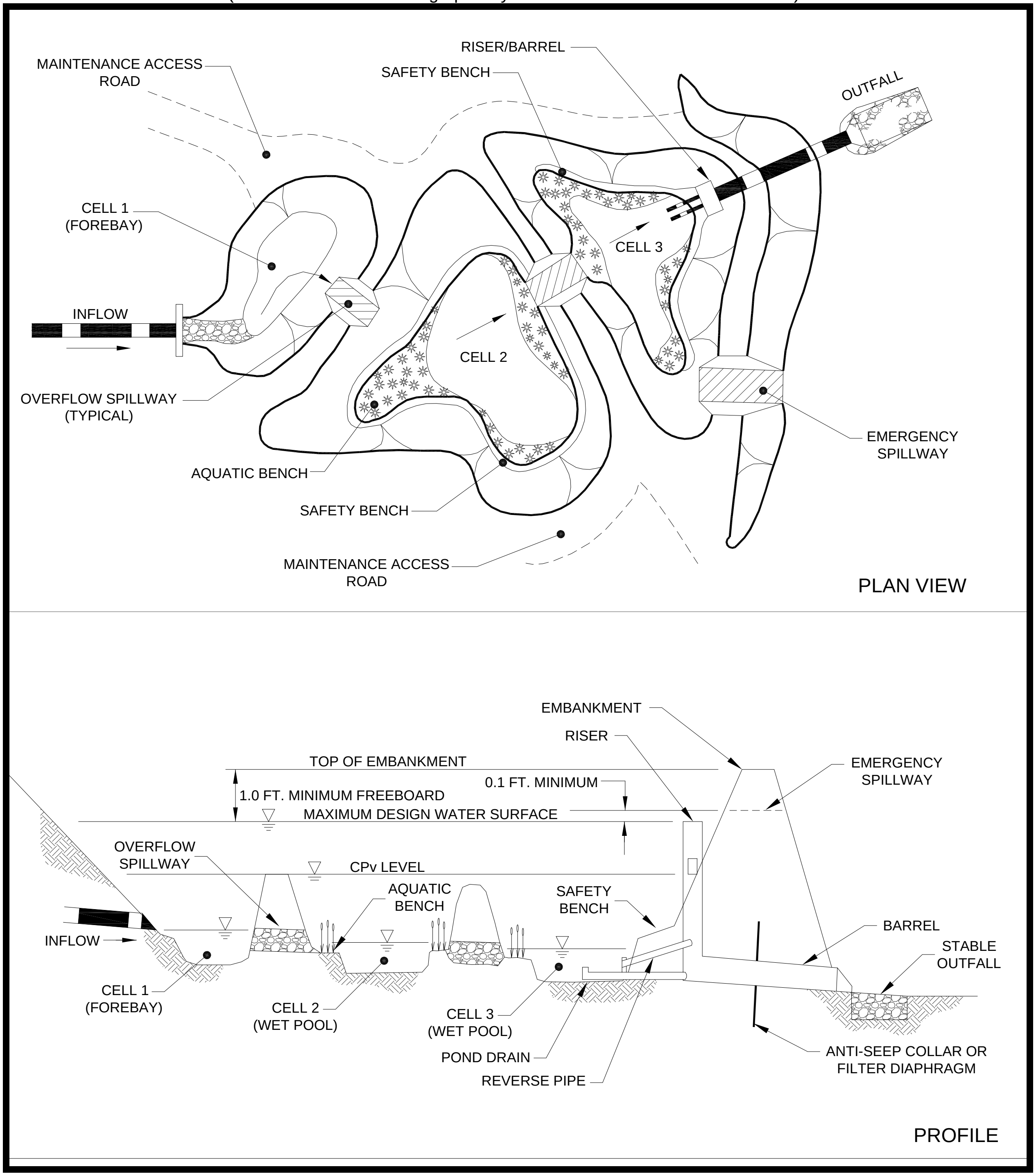


Figure 4-16. Schematic of a Multiple Basin System
(Source: modified from a graphic by the Center for Watershed Protection)



4.3.1.7 Design Form

Use of the following design procedure forms when designing a water quality wet basin is recommended. Proper use and completion of the form may allow a faster review of the basin design by the local engineering department.

Design Procedure Form: Water Quality Basins

PRELIMINARY HYDROLOGIC CALCULATIONS

1a. Compute WQv volume requirements
Compute Runoff Coefficient, Rv — Rv = ________
Compute WQv — WQv = ________ acre-ft

1b. Compute CPv — CPv = ________ acre-ft

STORMWATER BASIN DESIGN

2. Is the use of a stormwater basin appropriate? — ***See subsection 4.3.1.3***

3. Confirm additional design criteria and applicability. — ***See subsection 4.3.1.3 - J***

4. Pretreatment Volume (Forebay)
V_{pre} =(I)(.1")(1'/12") — V_{pre} = ________ acre-ft

5. Allocation of Permanent Pool Volume and ED Volume

Wet Basin — V_{pool}=1.0(WQv)-Vol_{pre} — V_{pool}= ________ acre-ft

Wet ED Basin — V_{pool}=0.5(WQv)-Vol_{pre} — V_{pool}= ________ acre-ft
V_{ED}=0.5(WQv)-Vol_{pre} — V_{ED}= ________ acre-ft

Micropool ED Basin — V_{pool}=(I)(.1")(1'/12") — V_{pool}= ________ acre-ft

6. Conduct grading design and determine storage available for permanent pool (and WQv-ED volume if applicable) — Prepare an elevation-storage table and curve using the average area method for computing volumes.

Elevation MSL	Area ft²	Ave. Area ft²	Depth ft	Volume ft³	Cumulative Volume ft³	Volume above Permanent Pool acre-ft

Design Procedure Form: Water Quality Basins (continued)

7. WQv Orifice Computations
   Average ED release rate (if applicable) — release rate= ______ cfs
   Average head, h= (ED elev.- Permanent Pool elev.) /2 — head= ______ ft
   Area of orifice from orifice equation — Area= ______ ft^2
   $Q=CA(2gh)^{0.5}$ — diameter ______ inches
   (C varies with orifice condition.)

   Establish CPv top elevation using stage-storage curve — CPv WSEL= ______ ft-NGVD
   Estimate orifice size — CPv orifice diameter = ______ inches
   Perform hydrograph routing to check detention time — centroid-centroid det. = ______ hours
   Iterate to final orifice size — Final CPv orifice diameter = ______ inches

8. Calculate required local peak discharge release rates and WSELs — Set up a stage-storage-discharge relationship

Elevation	Storage	Low Flow	Riser			Barrel		Emergency	Total
		WQv-ED	CPv_ED	High Storage		Inlet	Pipe	Spillway	Outflow
				Orif.	Weir				
MSL	acre-ft	H(ft) Q(cfs)	H(ft) Q(cfs)	H Q	H Q	H(ft) Q(cfs)	H(ft) Q(cfs)	H(ft) Q(cfs)	Q(cfs)

   Check inlet condition
   Check outlet conditions — **Use culvert design guidance from local municipality**

9. Size emergency spillway using the local jurisdiction peak discharge and set top of embankment elevation and emergency spillway elevation based on $WSEL_{peak}$
   $Q_{ES}=Qp_{eak}$ ______ cfs
   $WSEL_{peak}=$ ______ ft
   El_{embank} ______ ft
   $El_{ES}=$ ______ ft

10. Investigate potential basin hazard classification — **See TN Safe Dams Act of 1973**

11. Design inlets, sediment forebays, outlet structures, maintenance access, and safety features — **See subsection 4.3.1.3 - D through H**

12. Design basin vegetation according to guidance provided in TVA Riparian Restoration webpage www.tva.com/river/landandshore/stabilization/index.htm

13. Verify peak flow control, water quality drawdown time and channel protection detention time

4.3.1.8 References

Atlanta Regional Council (ARC). *Georgia Stormwater Management Manual Volume 2 Technical Handbook.* 2001.

City of Nashville, Tennessee. *Metropolitan Nashville and Davidson County Stormwater Management Manual, Volume 4 Best Management Practices.* 2006.

Center for Watershed Protection. *Manual Builder.* Stormwater Manager's Resource Center, Accessed July 2005. *www.stormwatercenter.net*

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4.3.1.9 Suggested Reading

California Storm Water Quality Task Force. *California Storm Water Best Management Practice Handbooks.* 1993.

City of Austin, TX. *Water Quality Management.* Environmental Criteria Manual, Environmental and Conservation Services, 1988.

City of Sacramento, CA. *Guidance Manual for On-Site Stormwater Quality Control Measures.* Department of Utilities, 2000.

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Maryland Department of the Environment. *Maryland Stormwater Design Manual, Volumes I and II.* Prepared by Center for Watershed Protection (CWP), 2000.

Metropolitan Washington Council of Governments (MWCOG). *A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone.* March, 1992.

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Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual – Volume 3 – Best Management Practices – Stormwater Quality.* Denver, Colorado, September 1992.

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