Chapter 14. Stormwater Quality

14.0 Introduction

This chapter addresses requirements and design criteria related to post-construction stormwater quality (requirements for construction erosion and sediment control are addressed in SEMSWA's Grading, Erosion, and Sediment Control (GESC) Manual). As described in Chapter 13, Storage, SEMSWA requires that Water Quality Capture Volume be provided for all new development, redevelopment, or expansion of a site, unless specifically exempted per Section 14.4. In addition, other Best Management Practices are required to reduce runoff volume, stabilize drainageways, and control pollutants at their source (the four-step approach). Criteria presented in Volume 3 of the UDFCD Manual shall govern except as modified or added to herein.

14.0.1 How to Use this Chapter. This chapter addresses stormwater quality planning and design. The foundation for this chapter is Volume 3 of the UDFCD Manual and reference is made to the UDFCD Manual for determining general Best Management Practice requirements, design features, and sizing.

In addition to referring designers to the UDFCD Manual, the goal of this chapter is to provide additional criteria and guidance to improve the design and implementation of water quality Best Management Practices in the City. To this end, the chapter provides the following information:

1. <u>Four-Step Approach.</u> Section 14.1 includes an expanded discussion of UDFCD's four-step approach to water quality planning. Unless specifically exempted, this is the approach that shall be used by every development project in the City. The four steps aim for a comprehensive approach to water quality by reducing the amount of site runoff, providing effective Water Quality Capture Volume and flood control detention, undertaking drainageway improvements to create stable, healthy streams, and implementing source controls to prevent pollutants from entering the stormwater system.

2. <u>Regional, Sub-regional, and Onsite Approaches.</u> Section 14.2 references Chapter 13, Storage, and states that SEMSWA requires that Water Quality Capture Volume facilities be implemented via regional or sub-regional facilities serving multiple lots when available, as opposed to onsite facilities for each individual lot. The section also identifies specific criteria for reducing directly connected impervious area in developments that discharge runoff into drainageways upstream of regional water quality facilities.

3. <u>Selection Guidance.</u> Section 14.3 offers selection guidance for Water Quality Capture Volume facilities based on the regional, sub-regional, or onsite approach used, the character of the upstream drainageways and watershed, and the type of upstream land use. The guidance is provided to help ensure that water quality facilities are effective and designed with consideration of the characteristics of the upstream tributary area.

4. <u>Exemptions from Post-Construction Best Management Practice Requirements.</u> Section 14.4 clarifies what kinds of projects are exempt from

Water Quality Capture Volume or from post-construction Best Management Practices in general.

5. Design Criteria, Example Drawings, and Checklists for SEMSWA-Standard Best Management Practices. Section 14.5 provides design criteria for five types of Best Management Practices that are most commonly used in the City. These consist of grass buffers and swales, extended detention basins, sand-filter basins, and porous landscape detention. Detailed example drawings and design checklists for these Best Management Practices are provided on SEMSWA's website at www.semswa.org. The engineer is responsible for preparing a complete, site-specific set of design plans that provide all the construction information and detailing that is shown in the example plans. The design checklists shall be marked off and included in the Phase III Drainage Report, with any departures explained, to help ensure that the design submittal is thorough and complete.

6. Design Criteria for Other Best Management Practices. Section 14.6 provides design criteria for Best Management Practices that are not as commonly used in the City. These Best Management Practices include various types of porous pavement and porous pavement detention, constructed wetland basins, and retention basins. At present, no example drawings or design checklists have been prepared for these Best Management Practices. Rather, a site-specific design shall be prepared by the engineer based on information provided in Volume 3 of the UDFCD Manual, typically in concert with appropriate specialists (in geotechnical engineering, pavement design, and structural design for porous pavement and in landscape architecture, wetlands treatment, and pond water quality for constructed wetlands and retention ponds).

7. Source Control Best Management Practices. Section 14.8 elaborates on the implementation of source controls on sites to reduce the likelihood that pollutants will enter the stormwater system.

14.0.2 Integrated Approach to Stormwater Quality. Stormwater runoff quality management is a critical component of a land development plan. The design of water quality Best Management Practices must start in the early stages of the land development process and be integrated into the site and the upstream and downstream drainage network. Collaboration with professionals in fields such as site planning, landscape architecture, and geotechnical and structural engineering is recommended to create stormwater Best Management Practices that function well and are safe, maintainable, and aesthetically pleasing.

14.1 Stormwater Quality Design Process

14.1.1 Four Step Process. Volume 3 of the UDFCD Manual defines a four-step process that has become the cornerstone of the Urban Drainage and Flood Control District's approach to selecting and implementing post-construction Best Management Practices. Specific SEMSWA criteria related to the four-step process are identified below.

1. Step 1: Reduce Runoff Volume to the Maximum Extent Practicable. Reducing runoff volume is accomplished by reducing the amount of pavement and roof area that is directly connected to inlets and storm sewer, while maximizing the pervious area that receives runoff from unconnected pavement or roofs. Pervious areas receiving runoff from unconnected impervious areas consist of grass buffers and swales, porous pavement, upland treatment swales, or some combination of these approaches. As long as these receiving pervious areas are stable and properly designed in accordance with Volume 3 of the UDFCD Manual, as modified herein, they provide stormwater runoff volume reduction by dissipating the energy of the runoff, filtering the runoff through vegetation, and infiltrating stormwater runoff into the soil.

   Figure ND-1 in Volume 3 of the UDFCD Manual can be used to estimate an effective imperviousness value based on reducing directly connected impervious area. This reduced imperviousness can result in a smaller Water Quality Capture Volume, Excess Urban Runoff Volume, and 100-year volume as described in Chapter 13, Storage. Reduced imperviousness can also result in smaller Rational Method peak flows for the 5-year and smaller storms.

   Reducing directly connected impervious area (DCIA) is strongly encouraged on all new development and redevelopment projects within the City. Site designers shall routinely look for and take advantage of opportunities to reduce directly connected impervious areas. The drainage report should contain a discussion of the efforts made to reduce DCIA. Where it can be demonstrated that additional reductions in DCIA can be achieved with minimal site revisions, SEMSWA will recommend that the Engineer provide DCIA reductions as a part of SEMSWA's review and recommendation for approval. For sites which are upstream of, and utilize regional water quality basins to provide their Water Quality Capture Volume requirements, reducing DCIA is required. This is described further in Section 14.2.2.

2. Step 2: Provide Water Quality Capture Volume and Flood Control Detention Via Full-Spectrum Detention. After reducing runoff volume, the remaining runoff is to be controlled through Best Management Practices that have the necessary Water Quality Capture Volume and flood detention volume. Appropriate reductions in required detention volumes may be applied for any reduction in runoff volume from Step 1, as discussed in Chapter 13, Storage. Runoff reduction reduces the land area and costs associated with detention facilities.

   Stormwater runoff from all development areas in the City (see Section 14.3.2 for exceptions) shall pass through a Water Quality Capture Volume facility in combination with full-spectrum detention (see Chapter 13, Storage). Water quality and flood control may be combined into a single detention facility or configured in separate facilities, as shown in Figure 13-5. Regional, sub-regional, or, in limited cases, onsite detention facilities may be used, as described in Chapter 13, Storage.

The purpose of full-spectrum detention is to control the increase in runoff rates from developed areas during frequent storm events that exacerbate stream degradation. Runoff reduction (Step 1) and full-spectrum detention (Step 2) are intended to reduce the extent and severity of degradation in drainageways downstream of developing areas. Reducing degradation helps to protect stream health and water quality while cutting down on costly stream stabilization efforts.

3. Step 3: Utilize Stream Channel Stabilization Techniques. The stream channel stabilization techniques described in Chapter 12, Open Channel Design, shall be applied to any drainageways that exist on or adjacent to the site or are constructed as part of the development. In some cases, as determined by SEMSWA, some stabilization may be required in off-site drainageways that receive runoff from the site.

   Where regional or sub-regional detention is implemented, drainageways shall be stabilized based on approved flow rates. In general, drainageways upstream of the facilities shall be stabilized based on the increased, undetained runoff that will flow in the channels. Drainageways downstream of the facility shall be stabilized based on the fully developed design flow rates for the channel. If a regional or sub-regional facility is located within land controlled by a single development, the developer is responsible for stabilizing the drainageways within its property boundaries.

   The concept of natural stream stabilization is discussed in Chapter 12, Open Channel Design. Natural stream stabilization goes beyond just stabilizing a channel against erosion (which technically could be accomplished by lining the channel with concrete), and has the goal of creating streams and floodplains that are stable, well vegetated, and physically and biologically healthy. This goal is just as important as improving the water quality of runoff flowing off a development site and into a receiving stream.

4. Step 4: Undertake Source Control. The last step in the four step process for implementing Best Management Practices on a site is to control the potential for illicit discharges from the site. If the site has the potential for chemicals, oils, fertilizers, or other pollutants to enter the stormwater system, additional measures shall be provided. These measures may include covering of storage/handling areas, spill containment and control, and other best available technologies. In addition to structural source controls, non-structural practices applicable to site activities shall be considered. Section 14.7 addresses requirements for source control Best Management Practices to reduce the potential for illicit discharges.

14.2 Sub-regional, Regional, and Onsite Approaches

14.2.1 General. Water Quality Capture Volume facilities, whether combined with flood control detention or standing-alone, may be implemented regionally (located on a major drainageway with a drainage area between 130 acres and one square mile), sub-regionally (serving two or more development parcels with a total drainage area less than 130 acres), or onsite (within an individual development parcel). As described in Section 13.2, SEMSWA encourages new development to consider implementing regional or sub-regional Water Quality Capture Volume facilities and flood control detention at a subdivision level in lieu of onsite facilities at the time each lot is developed.

14.2.2 Onsite Requirements for Developments Tributary to Regional Water Quality Facilities. Regionalization of water quality facilities is an effective means of addressing Step 2 (WQCV) for sites that are tributary and can take advantage of a regional facility to provide the required Water Quality Capture Volume for the site. However, the water quality of the major drainageway between the site and the regional pond cannot be ignored. Therefore, additional steps must be taken to address potential water quality impacts onsite, and prior to conveyance into the major drainageway system. The following water quality BMPs are required on all individual development sites upstream of the regional facility.

1. <u>Reducing Directly Connected Impervious Area (Step 1 of 4 Step Approach).</u> For each tributary or outfall draining to a major drainageway upstream of a regional water quality facility, at least 20-percent of the upstream imperviousness shall be disconnected and drain through a receiving pervious area comprising at least 10-percent of the upstream disconnected impervious area. The receiving pervious area shall consist of some combination of grass buffers and swales designed in accordance with Section 14.5.3 and porous pavement, designed in accordance with Section 14.6.3.

   Most traditional single-family detached residential developments will meet these requirements without providing additional BMPs, as long as roof downspouts are routed across adequate pervious areas. Denser multi-family and commercial developments may consider routing roof downspouts to pervious areas, using wheel stops or curb openings to route runoff from pavement areas to grass buffers or swales, or using porous pavement to achieve these goals. Where possible, attempts shall be made to disconnect the impervious areas where there is a greater potential for storm pollutants; such as parking lots, loading docks, areas that receive runoff from trash receptacles, etc.

2. <u>Stream Stabilization (Step 3).</u> The major drainageway reaches and all minor drainageways upstream of the regional water quality facility shall be fully stabilized in accordance with Chapter 12, Open Channel Design, as discussed in Section 14.1.1.

3. Source Control (Step 4). Source control measures are required in the individual lots upstream of the regional or sub-regional facility.

14.3 Selecting Type of Water Quality Capture Volume Facility

The selection of the type of water quality capture volume facility for a project depends on a number of factors, including the following:

1. Sub-Regional, Regional, or Onsite Water Quality Detention Approach. Sub-regional and regional Best Management Practices are generally larger facilities such as extended detention basins or, if hydrology is adequate to support wetlands or permanent pools, constructed wetlands basins or retention ponds. Infiltration-type Best Management Practices are not to be used for sub-regional and regional facilities, but may be considered for onsite Best Management Practices.

2. Drainage Area. Drainage area is a factor in the selection of certain Best Management Practices. For instance, infiltration-type Best Management Practices are suited for relatively small drainage areas. Also, a modified version of an extended detention basin may be considered for drainage areas less than 10 acres. Drainage area defines major and minor drainageways, which in turn dictates the dividing line between sub-regional and regional facilities.

3. Type of Development. Type of development determines certain Best Management Practice choices. Infiltration-type Best Management Practices are not allowed in single-family residential land uses in the City because ongoing construction of homes and landscaping on individual lots increases the likelihood of plugging of these facilities. Industrial and commercial land uses require source control Best Management Practices to be employed to keep chemicals and other potential pollutants out of the stormwater system.

4. Upstream Land Cover. Upstream land cover influences the selection of Best Management Practices. Infiltration-type Best Management Practices generally are only allowed if the upstream drainage area consists of pavement, roof, or fully-stabilized landscaping.

5. Hydrology. Hydrology affects the selection of Best Management Practices. Constructed wetlands basins and retention ponds shall only be used if adequate hydrology exists to support the wetlands or permanent pool.

Table 14-1, located at the end of this chapter, comprises a selection matrix for Water Quality Capture Volume facilities based on the factors described above.

14.4 Thresholds for Post-Construction Best Management Practice Requirements

14.4.1 Project Requirements. Post Construction BMPs are required for development, redevelopment, or expansion, as defined in these Criteria and as provided in the SEMSWA Water Quality Matrix, available on SEMSWA's website at www.semswa.org. No exemptions to these Criteria will be allowed that would result in a non-compliance with the SEMSWA CDPS MS4 Permit.

14.4.2 Water Quality Methodologies. Post-construction Best Management Practices shall generally consist of practicing minimizing directly connected impervious area (disconnecting impervious areas and passing runoff over vegetated areas) (Step 1 of the 4 step process described in Section 14.1.1), providing Water Quality Enhancements (disconnecting impervious area and passing runoff over a designed BMP), and/or Water Quality Capture Volume. In addition, any drainage conveyance elements, including roadside swales or rural ditches, drainageways, or existing stream channels on or adjacent to the site, shall be stabilized according to the criteria provided herein (Step 3), and any pollutant sources controlled onsite (Step 4).

14.5 Design Criteria for Commonly Implemented Best Management Practices

The following sections refer to base criteria in Volume 3 of the UDFCD Manual and provide supplementary design information, criteria, and example drawings. Detailed example drawings, design checklists, and material specifications can be found on SEMSWA's website at www.semswa.org. The checklists guide the engineer through all aspects of the design and are required to be used when developing the construction drawings.

14.5.1 Example Drawings. The example drawings provide guidance on how plan views, sections, and details are to look in the construction drawing set. The engineer is responsible for a complete, site-specific set of design plans that provide all the construction information and detailing that is shown in the example plans. The example drawings are not intended to serve as standard details and shall not be copied and reproduced in lieu of the engineer's own design.

14.5.2 Design Checklists. The design checklists identify all items that are required to be shown on the construction drawings and are intended to ensure that design issues are addressed and that adequate information is provided for proper construction and maintenance of Best Management Practices. The checklists are expected to produce more complete construction drawings that will reduce the time and effort expended on revisions during SEMSWA's review and approval process. The checklists shall be submitted with the Phase III Drainage Report.

14.5.3 Design Criteria for Grass Buffers and Swales.

1. Base Criteria. Grass buffers and grass swales shall be designed in accordance with information provided in Volume 3 of the UDFCD Manual, as supplemented by the following criteria. These criteria pertain to shallow urban roadside swales described in Section 7.7 and to grass buffers and swales not associated with a roadway.

2. Definition of Terms. Figure 14-1 illustrates four variables that are associated with the principle of reducing directly connected impervious area. These are defined in Appendix A of the Runoff chapter of the UDFCD Manual. The pavement and roof area that is directly connected to a curb and gutter or storm sewer is termed the directly connected impervious area (DCIA). The rest of the impervious area on the site, draining to landscape or porous pavement, is termed the unconnected impervious area (UIA). The directly connected impervious area and the unconnected impervious area add up to the total impervious area. The portion of the landscape area that receives runoff from the unconnected impervious area and is wetted during the 2-year storm is called the receiving pervious area (RPA). The remaining landscape area is called the separate pervious area (SPA).

3. Sizing and Design Criteria. As stated in Section 14.1.1, the objective on any urban site is to minimize directly connected impervious area and maximize receiving pervious area and to achieve the onsite requirements associated with regional and sub-regional water quality facilities on jurisdictional streams identified in Section 14.2.2. This is accomplished by laying out grass buffers and swales in proximity to roofs and pavement to receive as much impervious runoff as possible and convey it through the site.

   It is desirable to lay out grass buffers and swales with ample flow width and relatively flat slopes to slow down flow velocities and increase contact time with the soil and vegetation, but not so flat as to create standing water. Maximum slopes shall be dictated by the criteria shown in Table 14-2. Swales exceeding the maximum slope criteria may be allowed if lined with soil riprap, subject to approval by SEMSWA.

   Figure 14-2 illustrates concepts for grass swales, including an urban roadside grass swale and details for an underdrain and soil riprap lining.

TABLE 14-2
GRASS BUFFER AND SWALE DESIGN CRITERIA

	Grass Buffer	**Grass Swale**[2]	
	Max. Slope	Max. Slope	Max. 2-Year Velocity (fps)
Irrigated Bluegrass Sod[1]	25%	4.0%	4.0
Irrigated Native Turf Grass[1]	10%	2.5%	3.0
Non-Irrigated Native Turf Grass	4%	0.5%	1.0

[1] If swale slope is less than 2.0%, an underdrain is required
[2] Minimum swale slope is 0.2%

4. Determination of Receiving Pervious Area. The receiving pervious area is the wetted area of the buffers, swales, porous pavement, or upland treatment swales in the 2-year storm. A quick approximation of the wetted area may be obtained by summing the buffer areas, the bottom of any trapezoidal swales,

and the side slopes of swales assuming an average flow depth of a few inches. As the overall size of the receiving pervious area is finalized, a refined estimate of area may be determined by calculating average 2-year flow rates for each buffer, swale, or other component, computing flow depths and top widths, and summing the wetted area of the components.

The following guidelines apply when estimating the size of the receiving pervious area for purposes of achieving the requirements associated with regional or sub-regional water quality identified in Section 14.2.2.

a. The size of the unconnected impervious area needs to be estimated as a percentage of upstream directly connected impervious area for each tributary or outfall draining to a jurisdictional drainageway upstream of the regional or sub-regional water quality facility.

b. The size of the receiving pervious area needs to be estimated as a percentage of upstream unconnected impervious area for each tributary or outfall.

c. Areas that, in the judgment of the designer, may not be fully wetted in the 2-year event due to short-circuiting or other reasons, should not be included in the receiving pervious area.

d. The unconnected impervious area and receiving pervious area shall be clearly indicated on the drainage plan and construction drawings, as well as the percentages described in a. and b. above.

5. Pavement Edge Treatment. A concrete edger is recommended in urban areas for asphalt streets and parking areas adjacent to grass buffers and swales. The formed concrete provides a neat edge adjacent to the grassed area that can be constructed at a controlled grade. The concrete edger, a concept for which is shown in Figure 14-3, can also serve to cut off the flow of water from the buffer or swale toward the pavement subgrade.

6. Reducing Wheel Rut Impacts. Because standard curb and gutter is typically not used at the edge of pavement adjoining grass buffers or swales, inadvertent tracking of vehicles onto the grassed area can be an issue. One of several options may be considered for reducing the impact of wheel rutting on grass buffers and swales adjacent to access and parking areas.

   a. *Wheel stops.* Concrete wheel stops can be used in parking lots adjacent to grass buffers or swales to keep vehicles off the grass area.

   b. *Intermittent curb*. Curb and gutter with frequent openings in the curb may be used to direct runoff to a grass buffer or swale, while still impeding inadvertent tracking off the pavement. The unit runoff rates shown for grass buffers in Volume 3 of the UDFCD Manual shall not be exceeded through the openings in the curb. Curb ends shall be shaped or sloped to reduce impacts on snow removal equipment.

c. *Cobble strip*. A layer of exposed rock several feet wide can reduce wheel rutting impacts to grass buffers and swales. The rock shall be large enough to resist movement during the design runoff event.

d. *Reinforced turf*. Several feet of reinforced turf, one of the porous pavement options described in Volume 3 of the UDFCD Manual, may be considered to reduce wheel rutting impacts to grass buffers and swales adjacent to pavement.

7. Landscaping Considerations. Dense turf grass, either bluegrass or sod-forming native grasses, shall be used for grass buffers and swales. An irrigation system is required for grass buffers and grass swales; if sod-forming native grasses are used, the irrigation system will help to establish a dense stand of turf grass and maintain it in periods of low precipitation. Erosion control blankets in accordance with the SEMSWA GESC Manual shall be used during grass establishment in buffers and swales if native grasses are used. Shrub and tree plantings may be considered within grass buffers and swales, although their effect on capacity must be taken into account. .

8. Underdrain Piping. Underdrain piping shall be consistent with SEMSWA standards (see design checklists on the SEMSWA website).

9. Required Drawings. Construction drawings for grass buffers and grass swales shall include design drawings and detailed information, consistent with the example drawings and as required on the design checklist available on the SEMSWA website.

14.5.4 Design Criteria for Extended Detention Basins.

1. Base Design Information. Extended detention basins are to be designed in accordance with the two-stage layout shown in Volume 3 of the UDFCD Manual, as supplemented by the following criteria. This section also describes modified extended detention basin criteria for small sites (see Item 11, below).

2. Combining with Flood Detention. An extended detention basin is typically combined with Excess Urban Runoff Volume and 100-year detention, although any of the three design options shown in Figure 13-5 may be used. Criteria for Excess Urban Runoff Volume and 100-year detention are described in Chapter 13, Storage

3. Selection Criteria. Extended detention basins may be used as a sub-regional or regional water quality detention facility or as an on-site water quality facility for those cases where a sub-regional or regional approach is not possible (see Section 13.2). Extended detention basins shall comply with the

selection criteria shown in Table 14-1.

4. Basin Storage Volume. Provide extended detention storage volume equal to the applicable Water Quality Capture Volume, plus any combined volume of the Excess Urban Runoff and 100-year events computed according to Volume 3 of the Storage Chapter of the UDFCD Manual. The elevation difference between the invert of the pipe outlet at the centerline of the basin embankment and the crest of the emergency spillway shall be less than 10-feet.

5. Outlet Structure. Figures 14-4 and 14-5 show conceptual layouts of several types of outlet structures with integral micropools. Figures 14-6 and 14-7 show similar outlet structures with external micropools. External micropools shall only be used if a constant baseflow exists, and only with the approval of SEMSWA. Outlet structures include a column of orifices to control releases from the Water Quality Capture Volume and Excess Urban Runoff Volume (sized based on the Storage Chapter of the UDFCD Manual), a trash rack to protect the orifices, and a drop box for flood flows with a grate and control orifice. Orifice spacing may be adjusted based on the discussion in Section 13.3.12, if approved by SEMSWA.

   The flood-flow orifice shall be sized to provide the allowable 100-year release rate when the 100-year detention volume is completely full. The weir crest at the top of the Excess Urban Runoff Volume shall pass the allowable 100-year release rate at a head that is at least 0.5-feet below the completely-full 100-year volume, maintaining control at the 100-year orifice in the design event.

6. Trash Rack. Trash racks shall comply with the criteria described in Section 13.3.13 of Chapter 13, Storage

7. Scour Protection at Inflow Points. Stable protection against scour at all inflow points is required. This may consist of stable, irrigated grasses if runoff enters via sheet flow, or as described in Section 13.3.11 of Chapter 13, Storage.

8. Sediment Forebay. Forebays provide locations for debris and coarse sediment to drop out and accumulate, extending the functionality of the main portion of an extended detention basin. Forebays shall be sized based on Volume 3 of the UDFCD Manual and designed in a similar manner as shown in the example design drawings shown on the SEMSWA website. Figures 14-8 and 14-9 show concepts for sediment forebays that are integrated into the downstream outfall of storm sewer systems, one at a pipe end and one at a flared end section. The use and sizing of integral forebays at pipe outfalls shall be as approved by SEMSWA.

9. Low Flow Channel. See Section 13.3.9 for criteria pertaining to low flow channels.

10. Micropool. Micropools are an essential part of EDB function, as they are designed in conjunction with the trashrack protecting the control orifices to reduce the potential for trashrack and orifice plugging. The trashrack is designed to extend down to the bottom of the micropool. The micropool functions to keep a midrange portion of the trashrack clear between sediment accumulating on the bottom of the pool and floatable debris accumulating on the top. Experience has shown that extended detention basins that have been constructed without micropools tend to clog at the orifices or trashrack and result in shallow flooding and boggy conditions in the bottom of the pond. Micropools may be integrated into the outlet structure or, if approved by SEMSWA, extend upstream of the outlet structure (while maintaining a connection to the trashrack). Provisions for safety and maintenance access such as steps, ramps or a sloped perimeter bench shall be provided

11. Retaining Walls. All retaining walls shall be designed in accordance with the criteria specified in Chapter 13, Storage.

12. Modified Extended Detention Basin for Small Sites For sites that are smaller than 10 acres, the size requirements for the UDFCD standard forebay and micropool may become excessive in relationship to the overall pond configuration, and the two stage design is not practical. For these cases, SEMSWA will accept modified extended detention basins, as shown in Figure 14-1. Modified extended detention basins shall utilize sediment forebays integrated into pipe outfalls, as shown in Figures 14-8 and 14-9, and outlet structures with integral micropools, as shown in Figures 14-4 and 14-5. The sediment forebays may be sized according to the dimensions shown in Figures 14-8 or 14-9, or as approved by SEMSWA. The invert of the low flow channel shall be at an elevation at least 4-inches above the surface of the micropool, as specified for the two-stage design in the Storage Chapter of the UDFCD Manual.

    Figures 14-10 and 14-11 show representative layouts of a modified extended detention basin for a small site, if approved.

13. Designing for Maintenance. Design recommendations for maintenance operations are specified in Section 13.7 of Chapter 13, Storage.

14. Landscaping Considerations. Design recommendations for vegetation in extended detention basins and for shaping and making the most of recreation opportunities are discussed in Section 13.6 of Chapter 13, Storage.

15. Design Drawings and Checklist. Construction drawings for extended detention basins shall include design drawings and detailed information, consistent with the example drawings and as required on the design checklist available on the SEMSWA website.

14.5.5 Design Criteria for Sand Filter Basins.

1. Base Design Information. Sand filter basins are to be designed in accordance with information provided in Volume 3 of the UDFCD Manual, as supplemented by the following criteria.

2. Combining with Flood Detention. A sand filter basin may be used as a stand-alone Water Quality Capture Volume basin, may be combined with Excess Urban Runoff Volume, or may be combined with Excess Urban Runoff Volume and 100-year detention, in accordance with Figure 13-5. Criteria for Excess Urban Runoff Volume and 100-year detention are described in Chapter 13, Storage.

3. Selection Criteria. Sand filter basins may be used as a sub-regional facility or as an onsite water quality facility for those cases where a sub-regional approach to water quality detention is not possible (see Section 13.2). Sand filter basins shall comply with the selection criteria shown in Table 14-1. Although sand filter basins with sediment forebays can handle a small amount of inflowing sediment, sand filter basins in general are not well suited for high sediment loads.

4. Basin Storage Volume. The minimum area of the sand bed of the sand filter basin shall be actual area required to contain the Volume 3 Water Quality Capture Volume assuming a depth of 3.0-feet extending vertically upward from the bed (although the actual basin will normally provide 4 to 1 slopes or flatter around the sand bed). The bottom of the basin shall be flat for the entire area of the sand bed. If the Excess Urban Runoff Volume and 100-year volume is included, the aerial extent of the sand bed is to stay the same and the overflow drop-inlet is to be designed to control the Excess Urban Runoff Volume and 100-year outflows. The sand filter comprises the flat bottom of the basin, with stable landscaped slopes required all around.

5. Outlet Structure. Figure 14-16 shows the layout of a typical outlet structure for the three outflow conditions illustrated in Figure 13-5.

6. Underdrain Piping. Underdrain piping shall be consistent with the SEMSWA standards (see design checklists on the SEMSWA website).

7. Scour Protection at Inflow Points. Stable protection against scour at all inflow points is required. This may consist of stable, irrigated grasses if runoff enters via sheet flow, or as described in Section 13.3.14 of Chapter 13, Storage.

8. Sediment Forebay. Based on Table 14-1, sand filter basins serving more than an acre or that accept runoff from drainage areas that may have some non-irrigated native grasses require a sediment forebay at each inflow point. Forebays provide locations for debris and coarse sediment to drop out, extending the functionality of the main portion of a sand filter basin. Forebays shall be as shown in Figures 14-8 and 14-9 or as approved by SEMSWA.

9. Perimeter Separation Walls. Proper construction and maintenance of sand filter basins require that the sand filter material be separated from the native material surrounding the filter. A permanent barrier must be provided for the perimeter of the sand filter material. Barrier walls may consist of concrete, plastic sheet piling, stacked block, or other methods approved by SEMSWA. Barrier walls shall be designed by the engineer and detailed on the construction plans. The plans shall include methods for attaching or wrapping the geotextile fabric or liner, and for the surface treatment above the wall.

10. Liners. An impermeable liner may be required when the sand filter basin is within close proximity to a structure and expansive soils are a concern, or when there is a potential for chemicals or petroleum runoff from the tributary catchment. Whether or not an impermeable liner is provided for the sand filter basin shall be based on the recommendation of a licensed geotechnical engineer. Sections 14.5.7 and 14.5.8 provide additional information and design considerations when an impermeable liner is required.

11. Retaining Walls. All above ground retaining walls shall be designed in accordance with the criteria specified in Chapter 13, Storage. In addition, Section 14.5.9 provides design information regarding retaining walls and sand filter basins.

12. Designing for Maintenance. Design recommendations for maintenance operations are specified in Section 13.7 of Chapter 13, Storage.

13. Landscaping Considerations. Detailed information regarding landscaping of sand filter basins and porous landscape detention basins is presented in Section 14.5.10.

14. Design Drawings and Checklist. Construction drawings for sand filter basins shall include design drawings and detailed information, consistent with the example drawings and as required on the design checklist available on the SEMSWA website.

15. Construction of Sand Filter Basins. Because of their high potential for clogging during the construction of the development, sand filter basins shall not be installed until the site has been stabilized with pavement and permanent landscaping. Construction Best Management Practices should remain in place until the site is permanently stabilized.

14.5.6 Design Criteria for Porous Landscape Detention.

1. Base Design Information. Porous landscape detention facilities are to be designed in accordance with information provided in Volume 3 of the UDFCD Manual, as supplemented by the following criteria.

2. Combining with Flood Detention. Porous landscape detention may be used as a stand-alone Water Quality Capture Volume basin, may be combined

with the Excess Urban Runoff Volume, or may be combined with the Excess Urban Runoff Volume and 100-year detention volume, in accordance with Figure 13-5. Criteria for Excess Urban Runoff Volume and 100-year detention are described in Chapter 13, Storage.

3. Selection Criteria. Porous landscape detention shall only be used as an onsite water quality facility. Onsite facilities shall only be used for those cases where a sub-regional or regional approach to water quality detention is not possible (see Section 13.2). Porous landscape detention shall comply with the selection criteria shown in Figure 14-1. Porous landscape detention shall only be used in locations that receive runoff from upstream pavement, roofs, or fully stabilized landscape areas (irrigated sod or planting beds with stable mulch layer).

4. Basin Storage Volume. The minimum area of the filter area of the porous landscape detention basin shall be actual area required to contain the Volume 3 Water Quality Capture Volume assuming a maximum depth of 12-inches extending vertically upward above the bed, or to contain the Excess Urban Runoff Volume assuming a maximum depth of 2-feet extending vertically above the bed. In each case the side slopes will normally be 6 to 1 or flatter, so the actual depths will be less than assumed. For porous landscape detention basins located adjacent to paved areas, like those shown in Figures 14-12 through 14-14, the surface of the filter media shall be no more than 18-inches below the elevation of the adjacent pavement, unless otherwise approved. The bottom of the basin shall be flat for the entire area of the filter media. If the Excess Urban Runoff Volume and 100-year volumes are included, the aerial extent of the filter media stays the same and the overflow drop-inlet is designed to control the Excess Urban Runoff Volume and 100-year outflows as shown in Figure 14-13.

5. Outlet Structure. Figure 14-16 shows the layout of a typical outlet structure for the three outflow conditions illustrated in Figure 13-5. The structure receives the underdrain collection piping from the porous landscape detention and includes a drop box for flood flows with a grate and one or more control orifices.

6. Underdrain Piping. Underdrain piping shall be consistent with the SEMSWA standards (see design checklists on the SEMSWA website).

7. Scour Protection at Inflow Points. Stable protection against scour at all inflow points is required. This may consist of stable, irrigated grasses if runoff enters via sheet flow or other methods depicted in Figure 14-14.

8. Perimeter Separation Walls. Proper construction and maintenance of porous landscape detention facilities require that the sand filter material be separated from the native material surrounding the filter. A permanent barrier must be provided for the perimeter of the sand filter material. Barrier walls may consist of concrete, plastic sheet piling, stacked block, or other methods approved by SEMSWA. Barrier walls shall be designed by the engineer and

detailed on the construction plans. The plans shall include methods for attaching or wrapping the geotextile fabric or liner, and for the surface treatment above the wall.

In limited cases where porous landscape detention facilities are incorporated into unconstrained, open landscape areas located away from pavement, the perimeter separation walls may be eliminated as shown in Figure 14-15, if approved by SEMSWA.

9. Liners. An impermeable liner may be required when the porous landscape detention is within close proximity to a structure and expansive soils are a concern, or when there is a potential for chemicals or petroleum runoff from the tributary catchment. Whether or not an impermeable liner is provided for the porous landscape detention shall be based on the recommendation of a licensed geotechnical engineer. Sections 14.5.7 and 14.5.8 provide additional information and design considerations when an impermeable liner is required.

10. Retaining Walls. All above ground retaining walls shall be designed in accordance with the criteria specified in Section 13.3.15 of Chapter 13, Storage. No retaining walls shall be used within the area of any liners, except for the buried separation walls between the sand media and the earth. In addition, Section 14.5.9 provides design information regarding retaining walls and porous landscape detention.

11. Designing for Maintenance. Design recommendations for maintenance operations are specified in Section 13.7 of Chapter 13, Storage.

12. Landscaping Considerations. Detailed information regarding landscaping of sand filter basins and porous landscape detention basins is presented in Section 14.5.10.

13. Design Drawings and Checklist. Construction drawings for porous landscape detention shall include design drawings and detailed information consistent with the example drawings and as required on the design checklist available on the SEMSWA website.

14. Construction of Porous Landscape Detention. Because of their high potential for clogging during the construction of the development, porous landscape detention shall not be installed until the site has been stabilized with pavement and permanent landscaping. Construction Best Management Practices should remain in place until the site is permanently stabilized.

14.5.7 Geotextile Fabric Design Considerations. Proper specification and installation of the geotextile fabrics are significant elements in ensuring that sand filter and porous landscape detention basins function properly over an extended time period. In typical installations, a bottom layer geotextile fabric is required to provide a barrier between the underdrain gravel and the native subgrade material and a top layer geotextile is required to provide a barrier between the gravel underdrain layer and the filter media. In those cases where a geomembrane liner is required, the geomembrane liner provides the barrier between the gravel layer and the native material subgrade, but an additional geotextile fabric layer is required on each side of the liner to protect the liner. In typical installations (without a geomembrane liner) the top geotextile fabric layer must be wrapped over the buried perimeter wall and attached with a batten strip to the outlet or other structures. When a geomembrane liner is required, the geotextile fabric must be attached with the liner to perimeter walls and outlet structures with the batten strip.

The final design and specification and attachment of geotextile fabrics shall be based on the information and requirements presented on the SEMSWA example drawings and checklists, and in consultations with SEMSWA.

14.5.8 Geomembrane Liner Design Considerations. In some cases, developing sites or parcels may have expansive soils or sensitive environmental resources that must be protected. SEMSWA, the design engineer, or the project geotechnical engineer may require that a geomembrane liner be specified to protect structures or sensitive resources in the vicinity of proposed sand filter and porous landscape detention basins. There are a number of important design, construction, and inspection requirements and considerations that must be addressed to ensure that the geomembrane liner is properly installed and that the liner functions as intended. Some of the considerations include, but are not limited to, proper material specifications, liner pre-assembly, proper welding and testing of seams, provisions for pipe penetrations, careful subgrade preparation, liner attachment to trench walls and outlet structures, handling and protection of the liner during construction, anchoring of the liner, and the design of an underdrain system, if needed to mitigate potential impacts from a high groundwater table.

The final design of the geomembrane liner shall be based on the information and requirements presented on the SEMSWA example drawings and checklists, and in consultations with SEMSWA and the manufacturer of the specified liner.

14.5.9 Retaining Wall Use in Sand Filter Basins and Porous Landscape Detention. In general, the use of above grade retaining walls in the design of sand filter and porous landscape detention basins is discouraged. In most cases, the buried perimeter wall is needed to separate the filter media from the adjacent native soils during construction, but the use of above grade retaining walls shall be limited. A goal of the overall site design and layout should be to minimize the depth of sand filter and porous landscape detention basins and to allow for a smooth transition into adjacent impervious or landscaped areas. Utilizing sheet or shallow channel flow to convey runoff to the facilities rather than using underground storm sewer can also help reduce the depth between the filter media and the grade adjacent to the facility. The use of retaining walls adjacent to a sand filter or porous landscape detention basins limits the ability to easily access the filter media and other components for maintenance. In no case shall dry stack retaining walls be used below the top of the filter media or the design water surface when a geomembrane liner is required.

14.5.10 Sand Filter Basin and Porous Landscape Detention Landscaping Requirements. There are specific considerations and landscaping requirements for sand filter and porous landscape detention basins. In general, porous landscape detention basins offer more options than sand filter basins for vegetative treatments to compliment and enhance the overall site landscaping.

In the design of a sand filter basin, no vegetation or mulch shall be specified in the filter media of a sand filter basin. If the design includes a forebay or sediment chamber, vegetative treatment for the forebay or sediment chamber shall be irrigated sod turf grass. Irrigated turf grass sod or shrubs maybe used on the slopes above the Water Quality Capture Volume water surface, if a geomembrane liner is not required. Irrigation systems provided to supply water to the slopes shall be located outside of the filter media.

In the design of a porous landscape detention basin, potential vegetative treatments within the filter media include a full cover of native grasses established by seeding, or “clump-type” vegetation comprised of ornamental clump grasses or small native shrubs. Spacing of plants shall be specified such that hand raking can take place between plants to remove accumulated sediment. Shredded red cedar mulch shall be specified, if mulch is desired. Rock mulch shall not be used. Shrubs with mulch or irrigated turf grass may be used on the slopes of the basin, outside of the filter media. An irrigation system shall be provided to supply adequate water to all vegetated areas within and adjacent to the porous landscape detention basin. Irrigation heads and laterals shall be located outside of the filter media.

Tree plantings adjacent to porous landscape or sand filter basin installations shall be isolated from the basin using concrete or sheet pile barriers to ensure that the root structure does not impact the filter media or underdrain system. The barriers shall be placed adjacent to the basin, outside the Water Quality Capture Volume elevation, if a geomembrane liner is required. For either type of basin, the layout of landscaping on the adjacent slopes shall allow for necessary maintenance access.

14.6 Design Criteria for Other Best Management Practices

The following sections refer to base criteria in Volume 3 of the UDFCD Manual and provide supplementary design information and criteria for Best Management Practices that are not as commonly used in the City. These Best Management Practices include constructed wetland basins, retention basins, and various types of porous pavement and porous pavement detention. At present, no example drawings or design checklists have been prepared for these Best Management Practices. Rather, a site-specific design shall be prepared by the engineer, typically in concert with appropriate specialists (in geotechnical engineering, pavement design, and structural design for porous pavement and in landscape architecture, wetlands treatment, and pond water quality for constructed wetlands and retention ponds).

14.6.1 Design Criteria for Constructed Wetlands Basins.

1. Base Design Information. Constructed wetlands basins are to be designed in accordance with information provided in Volume 3 of the UDFCD Manual, as supplemented by the following criteria.

2. Combining with Flood Detention. A constructed wetlands basin is typically combined with the Excess Urban Runoff Volume and 100-year detention volume in accordance with Figure 13-5. Criteria for Excess Urban Runoff Volume and 100-year detention are described in Chapter 13, Storage.

3. Selection Criteria. Constructed wetlands basins may be used as a sub-regional or regional water quality detention facility where hydrology is adequate to support the wetlands and where any water rights issues have been addressed. Constructed wetlands basins are typically not used for small onsite facilities due to their requirement for adequate hydrology. Constructed wetlands basins shall comply with the selection criteria shown in Table 14-1.

4. Basin Storage Volume. Provide extended detention storage volume above the permanent wetlands water surface equal to the applicable Water Quality Capture Volume computed according to Volume 3. For combined facilities, the basin shall include the Excess Urban Runoff Volume and 100-year detention volumes based on the methods in Chapter 13, Storage.

5. Outlet Structure. The layout and sizing of the outlet structure for a constructed wetlands basin is the same as specified in Section 14.5.4 for an extended detention basin, with the wetlands water surface corresponding to the micropool water surface.

6. Scour Protection at Inflow Points. Stable protection against scour at all inflow points is required. This may consist of stable, irrigated grasses if runoff enters via sheet flow, or as described in Section 13.3.9 of Chapter 13, Storage.

7. Sediment Forebay. Forebays provide locations for debris and coarse sediment to drop out and accumulate, extending the functionality of the constructed wetlands basin. Forebays may be located upstream of the constructed wetlands basin, as long as all runoff entering the constructed wetlands basin flows through a forebay. Figures 14-8 and 14-9 show concepts for sediment forebays that are integrated into the downstream outfall of storm sewer systems, one at a pipe end and one at a flared end section. The use and sizing of integral forebays at pipe outfalls shall be as approved by SEMSWA.

8. Retaining Walls. All retaining walls shall be designed in accordance with the criteria specified in Section 13.3.15 of Chapter 13, Storage.

9. Designing for Maintenance. Design requirements for maintenance operations are the same as specified in Section 13.7 of Chapter 13, Storage.

10. Landscaping Considerations. If there is an adequate base flow to support the wetland vegetation and provide circulation in the pools, a constructed wetlands basin can be a very attractive natural feature. Establishing proper species of emergent and riparian vegetation is key to the basin's success. A detailed landscaping plan shall be developed by the appropriate specialists and included in the construction drawing set. Recommendations for shaping and making the most of recreation opportunities are discussed in Section 13.6 of Chapter 13, Storage.

11. Design Drawings. Site-specific construction drawings for constructed wetlands basins shall be prepared in accordance with the UDFCD Manual, the information above, and consultation with SEMSWA Staff.

14.6.2 Design Criteria for Retention Ponds.

1. Base Design Information. Retention ponds are to be designed in accordance with information provided in Volume 3 of the UDFCD Manual, as supplemented by the following criteria.

2. Combining with Flood Detention. A retention pond is typically combined with Excess Urban Runoff Volume and 100-year detention volumes in accordance with Figure 13-5. Criteria for Excess Urban Runoff Volume and 100-year detention are described in Chapter 13, Storage.

3. Selection Criteria. Retention ponds may be used as a sub-regional or regional water quality detention facility where hydrology is adequate to support the permanent pool and where any water rights issues have been addressed. Retention ponds are typically not used for small onsite facilities due to their requirement for adequate hydrology. Retention ponds shall comply with the selection criteria shown in Table 14-1.

4. Basin Storage Volume. Provide extended detention storage volume above the permanent water surface equal to the applicable Water Quality Capture Volume computed according to Volume 3 of the UDFCD Manual and Chapter 13, Storage. Additional sediment storage volume above the water surface is not necessary, since sediment storage will occur under the water surface. If the Excess Urban Runoff Volume is included above the permanent pool, no specific volume requirements are necessary for the pool other than providing the littoral zone shaping and pool depths specified in Volume 3 of the UDFCD Manual.

5. Outlet Structure. The layout and sizing of the outlet structure for a retention pond is the same as specified in Section 14.5.4 for an extended detention basin, with the permanent water surface corresponding to the micropool water surface.

6. Retaining Walls. All retaining walls shall be designed in accordance with the criteria specified in Section 13.3.15 of Chapter 13, Storage.

7. Designing for Maintenance. Design recommendations for maintenance operations are the same as specified in Section 13.7 of Chapter 13, Storage.

8. Landscaping Considerations. If there is an adequate base flow to maintain the permanent pool and provide circulation, a retention pond can be an attractive natural feature. Establishing proper species of emergent and riparian vegetation along the shoreline is essential for the pond's success. A detailed landscaping plan shall be developed by the appropriate specialists and included in the construction drawing set.

9. Design Drawings. Construction drawings for retention ponds shall be prepared in accordance with the UDFCD Manual, the information above, and consultation with SEMSWA Staff.

14.6.3 Design Criteria for Porous Pavement

1. Base Design Information. Porous pavement facilities shall be designed in accordance with information provided in Volume 3 of the UDFCD Manual, as supplemented by the following criteria.

2. Selection Criteria. Porous pavement shall only be used in locations that receive runoff from upstream pavement, roofs, or fully stabilized landscape areas (irrigated sod or planting beds with stable mulch layer).

4. Typical Drawings. Refer to Volume 3 of the UDFCD Manual for typical layouts of porous pavement.

5. Sizing Criteria. Sizing criteria for porous pavement used as a runoff reduction technique is shown in Volume 3 of the UDFCD Manual.

6. Underdrain Piping. Underdrain piping requirements shall be based on information provided in Volume 3 of the UDFCD Manual and consultation with SEMSWA Staff.

7. Liners. The determination whether or not an impermeable liner is required for the porous pavement shall be based on the recommendation of a licensed geotechnical engineer. Additional design requirements and material specifications shall be based on information provided in Volume 3 of the UDFCD Manual and consultation with SEMSWA Staff.

8. Designing for Maintenance. Access for maintenance is generally not a problem, since this Best Management Practice is located within an area of pavement.

9. Construction Phasing. Porous pavement shall not be installed until all upstream areas are fully stabilized, or barriers or filters shall be set up to

protect the porous pavement from sedimentation, as approved by SEMSWA. Site drainage shall be considered for the period of construction prior to site stabilization and installation of the porous pavement.

10. Design Drawings. Construction drawings for porous pavement shall be prepared in accordance with the UDFCD Manual, the information above, and consultation with SEMSWA Staff.

14.6.4 Design Criteria for Porous Pavement Detention.

1. Base Design Information. Porous pavement detention facilities are to be designed in accordance with information provided in Volume 3 of the UDFCD Manual, as supplemented by the following criteria.

2. Combining with Flood Detention. Porous pavement detention may be used as a stand-alone Water Quality Capture Volume basin, may be combined with the Excess Urban Runoff Volume, or may be combined with the Excess Urban Runoff Volume and 100-year detention volume, in accordance with Figure 13-5. If the Excess Urban Runoff Volume and 100-year volumes are not combined with the porous pavement detention, they shall be provided elsewhere on or downstream of the site.

3. Selection Criteria. Porous pavement detention shall only be used as an onsite water quality detention facility for those cases where a sub-regional or regional approach to water quality detention is not possible (see Section 13.2). Porous pavement detention shall comply with the selection criteria shown in Table 14-1. Porous pavement detention shall only be used in locations that receive runoff from upstream pavement, roofs, or fully stabilized landscape areas (irrigated sod or planting beds with stable mulch layer).

4. Typical Drawings. Refer to Volume 3 of the UDFCD Manual for typical layouts of porous pavement detention.

5. Sizing Criteria. Porous pavement detention facilities shall be flat, with no cross slope or longitudinal slope. Sizing criteria for porous pavement that is used as a stand-alone Water Quality Capture Volume facility is shown in Volume 3 of the UDFCD Manual. If the Excess Urban Runoff Volume and 100-year volume is included, the aerial extent of the porous pavement detention facility stays the same and the overflow drop-inlet is designed to control the Excess Urban Runoff Volume and 100-year outflows.

6. Outlet Structure. Figure 14-16 shows the layout of a typical outlet structure for the three outflow conditions illustrated in Figure 13-5. The structure receives the underdrain collection piping from the porous pavement and includes a drop box for flood flows with a grate and one or more control orifices.

7. Underdrain Piping. Underdrain piping requirements shall be based on information provided in Volume 3 of the UDFCD Manual and consultation with SEMSWA Staff.

8. Liners. The determination whether or not an impermeable liner is provided for the porous pavement detention shall be based on the recommendation of a licensed geotechnical engineer. Additional design requirements and material specifications shall be based on information provided in Volume 3 of the UDFCD Manual and consultation with SEMSWA Staff.

9. Designing for Maintenance. Access for maintenance is generally not a problem, since this Best Management Practice is located within an area of pavement.

10. Construction Phasing. Porous pavement detention shall not be installed until all upstream areas are fully stabilized, or barriers or filters shall be set up to protect the porous pavement from sedimentation, as approved by SEMSWA. Site drainage shall be considered for the period of construction prior to site stabilization and installation of the porous pavement.

11. Design Drawings. Construction drawings for porous pavement detention shall be prepared in accordance with the UDFCD Manual, the information above, and consultation with SEMSWA Staff.

14.7 Operation & Maintenance Manual

An Operation and Maintenance Manual (O&M) shall be required for all permanent stormwater facilities. The purpose of the O&M Manual is to provide information and guidance for those entities that will be responsible for the long-term inspection and maintenance of the facility. The SEMSWA standard template shall be used as the basis for the O&M Manual. For more information refer to Section 4.8.

14.8 Source Control BMPs

14.8.1 General. All new development and redevelopment in the City shall be required to provide onsite structural and/or non-structural source controls to reduce the potential for illicit discharges from their site into the stormwater management system. The term “illicit discharge” is defined in the Phase II stormwater regulations as “any discharge to a municipal separate storm sewer that is not composed entirely of stormwater, except discharges pursuant to the Colorado Discharge Permit System permit and discharges resulting from fire-fighting activities.”

Illicit discharges often include wastes and wastewater which enter the stormwater system through either direct connections (e.g., non-stormwater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the storm sewer from cracked sanitary systems, contaminants or spills carried by stormwater runoff into the stormwater system).

The result is untreated discharges that contribute high levels of pollutants, including heavy metals, toxics, oil and grease, solvents, nutrients, viruses, and bacteria to waters of the state. Pollutant levels from these illicit discharges have been shown in EPA studies to be high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health.

SEMSWA requires that adequate provisions be included during the site plan development process to reduce the potential for illicit discharges from the property. Volume 3 provides information on structural and nonstructural Best Management Practices and should be used as a basis for determining the appropriate source controls for the intended activities associated with the site.

14.8.2 Direct Connections. Direct connections into the public storm sewer system are prohibited, except for those storm sewer systems that are reviewed and approved by SEMSWA as a part of the development's Phase III Drainage Report. Exceptions may be made for special cases, in which SEMSWA may approve other flows that are acceptable to be permitted into the storm drainage system. Such cases shall be approved by a variance request, with adequate analysis and justification. A Direct Connection License Agreement, which addresses the terms and conditions for the connection is required with all direct storm sewer connections.

14.8.3 Indirect Connections. Illicit discharges can occur with "indirect" connections. These types of discharges occur from stormwater runoff which flows on and over the impervious area of a site. The runoff has the potential to pick-up and carry pollutants from the site into the storm drainage system. These illicit discharges occur as a result of site activities which have the potential to expose pollutants to stormwater runoff.

Examples of site activities which have the potential for pollutants to be discharged and carried off in stormwater runoff include:

- Outside material storage
- Vehicle washing
- Vehicle maintenance
- Outside manufacturing
- Painting operations
- Above ground storage tanks
- Loading and unloading areas
- Fueling
- Power washing

14.8.4 Structural Source Controls. Development projects which propose outdoor uses and activities which are deemed by SEMSWA to have the potential to create illicit discharges shall be required to provide special source control Best Management Practices. The source control Best Management Practices shall be designed to prevent the contamination of stormwater runoff from the site. Source control Best Management Practices can include, but are not limited to:

- Permanent covering of outdoor storage areas
- Spill containment and control (secondary containment, curbing, diking, etc.)
- Proper sanitary sewer connections
- Provision of designated storage and material handling areas
- Provision of proper waste receptacles

14.8.5 Non-structural Controls. Non-structural Best Management Practices reduce or prevent contamination of stormwater runoff by reducing pollutant generation through changes in behavior. Non-structural controls are extremely effective, as they typically prevent or eliminate the entry of pollutants into stormwater at their source. SEMSWA encourages that all development and redevelopment require and implement non-structural controls throughout their site and within their facility operational practices. Non-structural Best Management Practices which may provide a significant benefit to water quality include:

- General good housekeeping practices (proper material storage, clean and orderly work areas)
- Preventative maintenance
- Recycling programs
- Spill prevention and response
- Employee "awareness" education and training

14.8.6 SEMSWA Requirements for Illicit Discharge. The Phase III Drainage Report shall include a discussion of the uses and activities proposed for the site that may have the potential for illicit discharges. In particular, sites with a potential for the activities listed in Section 14.8.3 shall be identified. The Phase III Drainage Report shall discuss and include design information for appropriate source controls to mitigate the potential for illicit discharges from the identified activities. The source controls designated in the Phase III Drainage Report shall be required to be shown on the Site Improvement Plan, Phase III Drainage Plan and the Construction Drawings as applicable. The source controls shall be included in the Public Improvement Agreement, and shall be required to be constructed as a condition of acceptance of the project.

14.8.7 Operation and Maintenance. Source Control facilities require periodic maintenance to ensure that they are functioning properly and serving the intended purpose of reducing the potential for illicit discharges into the stormwater system. Inspection and maintenance requirements shall be incorporated into the Site Improvement Plan and addressed in the Operation and Maintenance Manual, as discussed in Section 14.8 for all source control Best Management Practices to ensure the controls function as intended.

TABLE 14-1
SELECTION MATRIX FOR WATER QUALITY CAPTURE VOLUME FACILITIES

Type of WQCV Facility	County Standard?	Regional, Sub-Regional or Onsite	Drainage Area	Development Type	Upstream Land Cover	Hydrology
Extended Detention Basin	Yes - Example drawings and design checklist shall be used	Regional or sub-regional	Generally 10 to 640 acres	Single-family residential or commercial/ office/ multi-family/ industrial	Can accept native, non-irrigated grass areas or upstream natural channels	Can handle baseflows, but baseflows are not needed
Constructed Wetlands Basin	No - specialized design requried	Regional or sub-regional	Generally 20 to 640 acres	Single-family residential or commercial/ office/ multi-family/ industrial	Can accept native, non-irrigated grass areas or upstream natural channels	Baseflows are required; adequate water must be available for evapotranspiration
Retention Pond	No - specialized design requried	Regional or sub-regional	Generally 20 to 640 acres	Single-family residential or commercial/ office/ multi-family/ industrial	Can accept native, non-irrigated grass areas or upstream natural channels	Baseflows are required; adequate water must be available for evapotranspiration
Modified Extended Detention Basin	Yes - Example drawings and design checklist shall be used	Sub-regional or onsite	Generally 1 to 10 acres	Single-family residential or commercial/ office/ multi-family/ industrial	Can accept limited* native, non-irrigated grass areas or upstream natural channels	No baseflows are expected
Sand Filter Basin with Sedimentation Basin	Yes - Example drawings and design checklist shall be used	Sub-regional or onsite	Generally 1 to 20 acres	Commercial/ office/ multi-family/ industrial	Can accept limited* native, non-irrigated grass areas	No baseflows are expected
Sand Filter Basin	Yes - Example drawings and design checklist shall be used	Sub-regional or onsite	Generally Less Than 10 acres	Commercial/ office/ multi-family/ industrial	Requires 100% stable land cover (pavement, irrigated turfgrass, or stable mulches)	No baseflows are expected
Porous Landscape Detention	Yes - Example drawings and design checklist shall be used	Onsite	Generally less than 1 acre	Commercial/ office/ multi-family/ industrial	Requires 100% stable land cover (pavement, irrigated turfgrass, or stable mulches)	No baseflows are expected
Porous Pavement Detention	No - specialized design requried	Onsite	Generally less than 1 acre	Commercial/ office/ multi-family/ industrial	Requires 100% stable land cover (pavement, irrigated turfgrass, or stable mulches)	No baseflows are expected

* For upstream land cover defined as "limited native non-irrigated grass", total land cover cannot consist of more than 20% native non-irrigated grass.

FIGURE 14-1
TERMS FOR MINIMIZING DIRECTLY CONNECTED IMPERVIOUS AREA

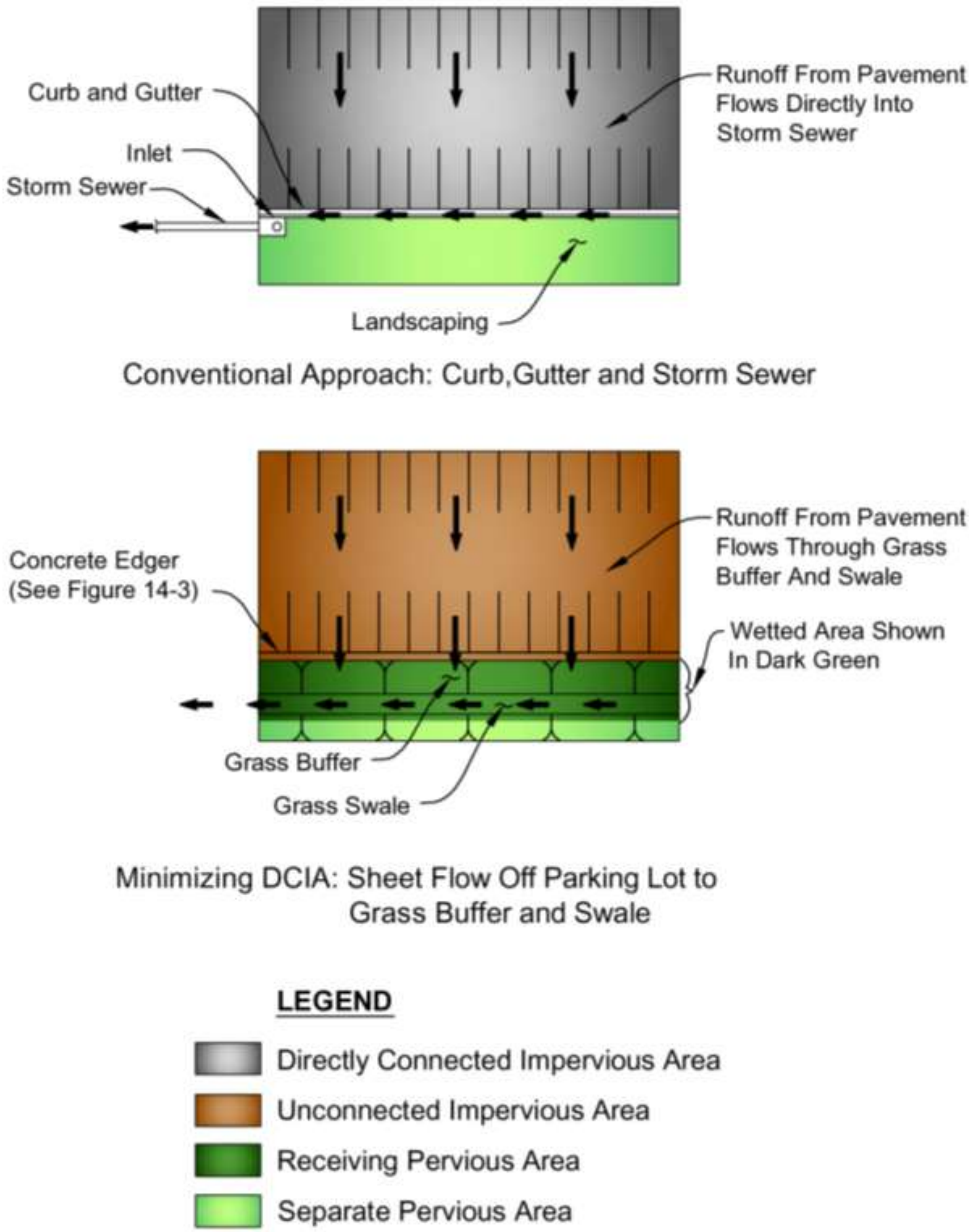


FIGURE 14-2
CONCEPTS FOR GRASS SWALES

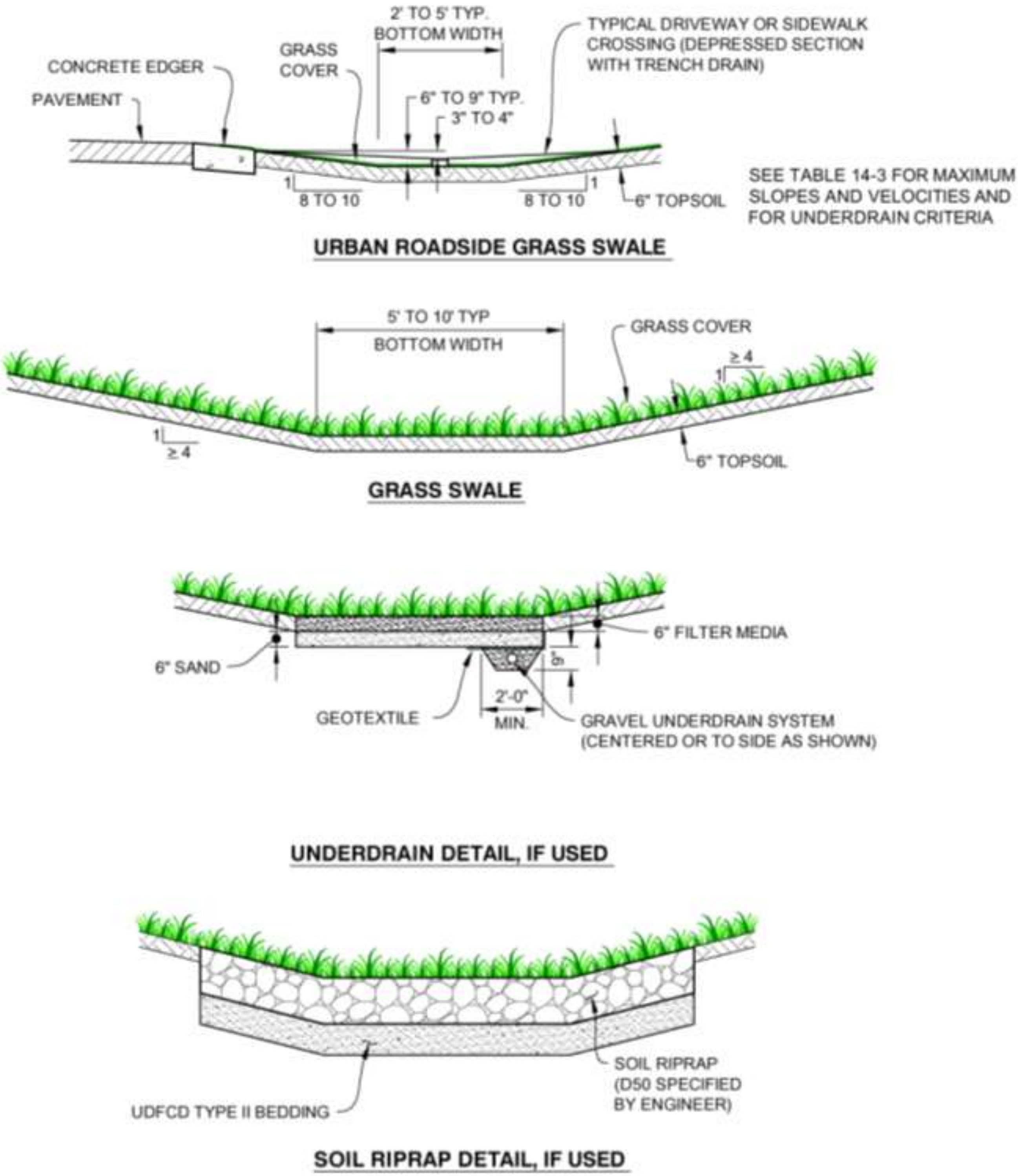


FIGURE 14-3
CONCEPT FOR CONCRETE EDGER

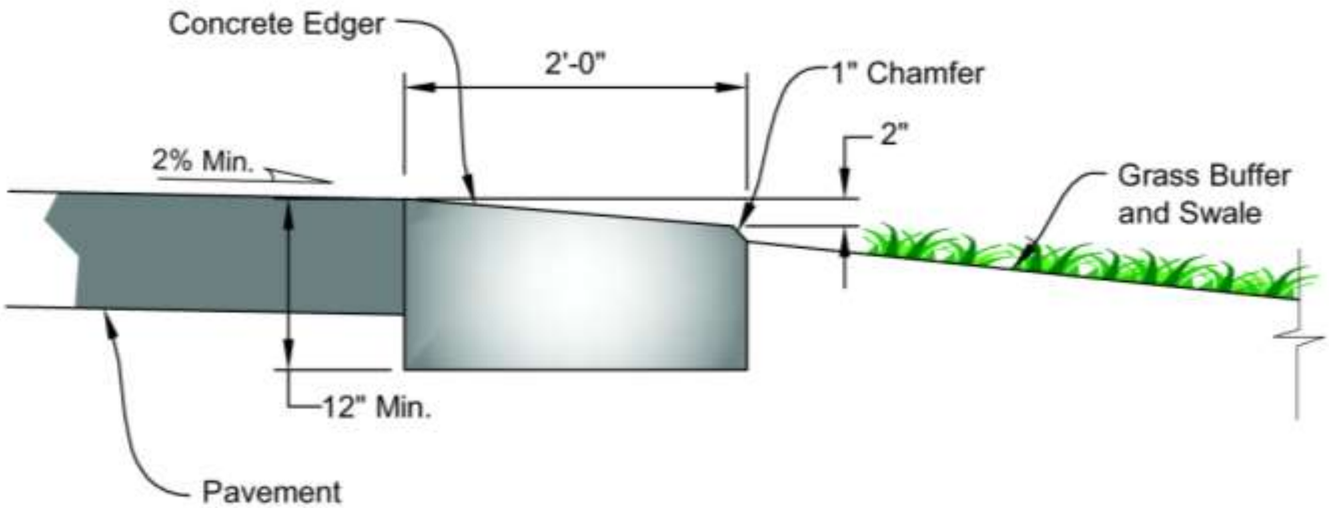
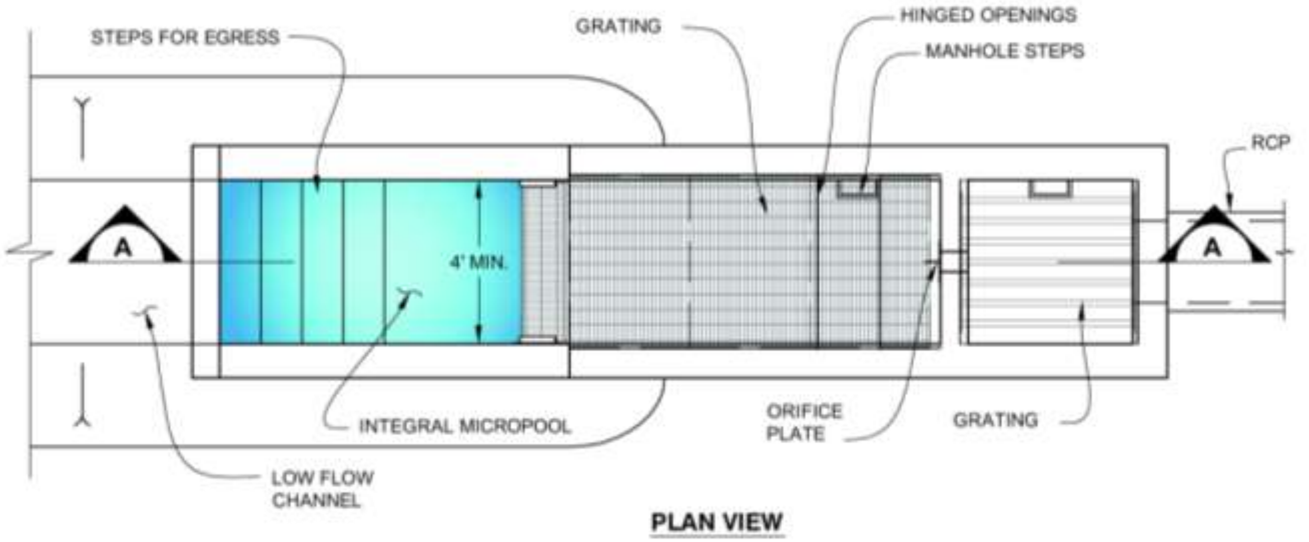


FIGURE 14-4
CONCEPT FOR OUTLET STRUCTURE WITH PARALLEL WINGWALLS AND FLUSH BAR GRATING (INTEGRAL MICROPOOL SHOWN)



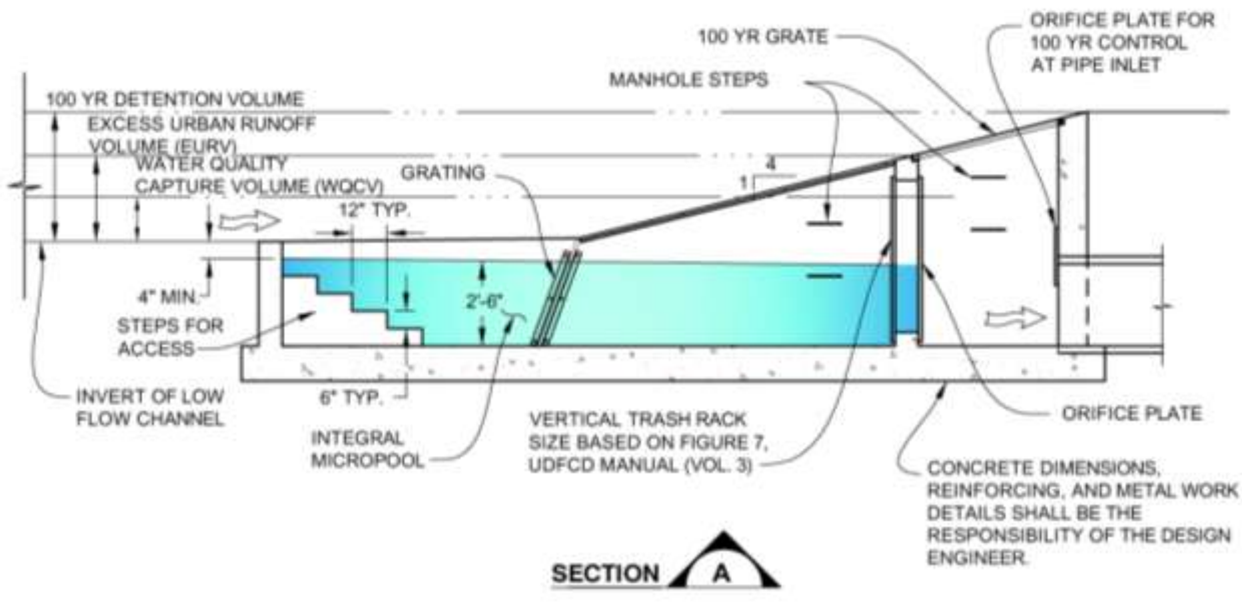
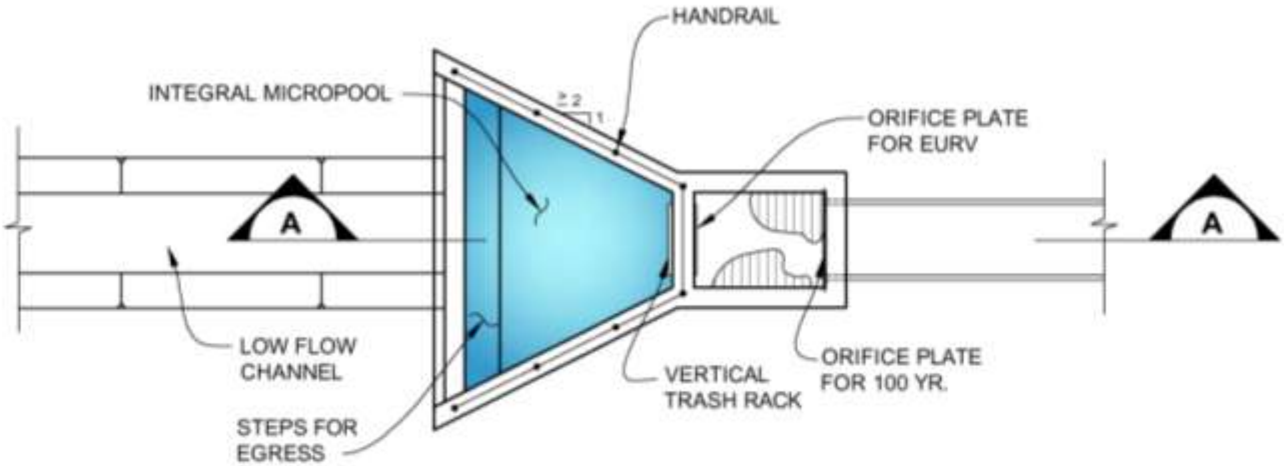
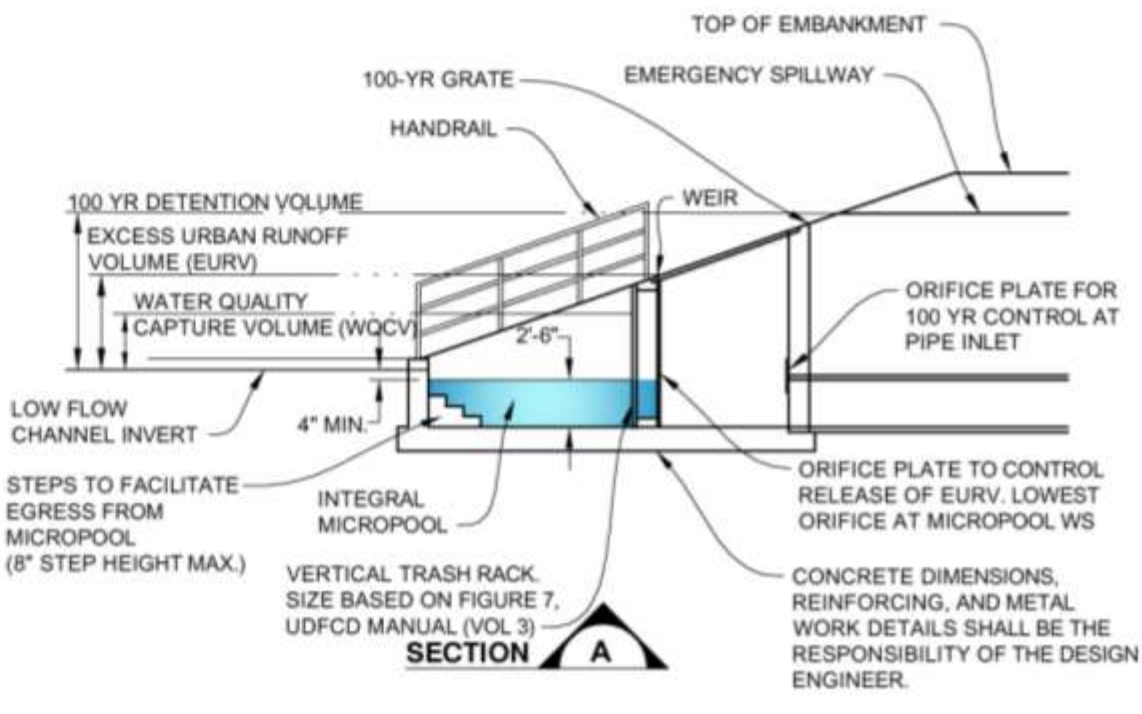


FIGURE 14-5
CONCEPT FOR OUTLET STRUCTURE WITH FLARED WINGWALLS AND HANDRAIL (INTEGRAL MICROPOOL SHOWN)



PLAN VIEW



SECTION A

FIGURE 14-6
CONCEPT FOR OUTLET STRUCTURE WITH PARALLEL WINGWALLS AND FLUSH BAR GRATING (EXTERNAL MICROPOOL SHOWN)

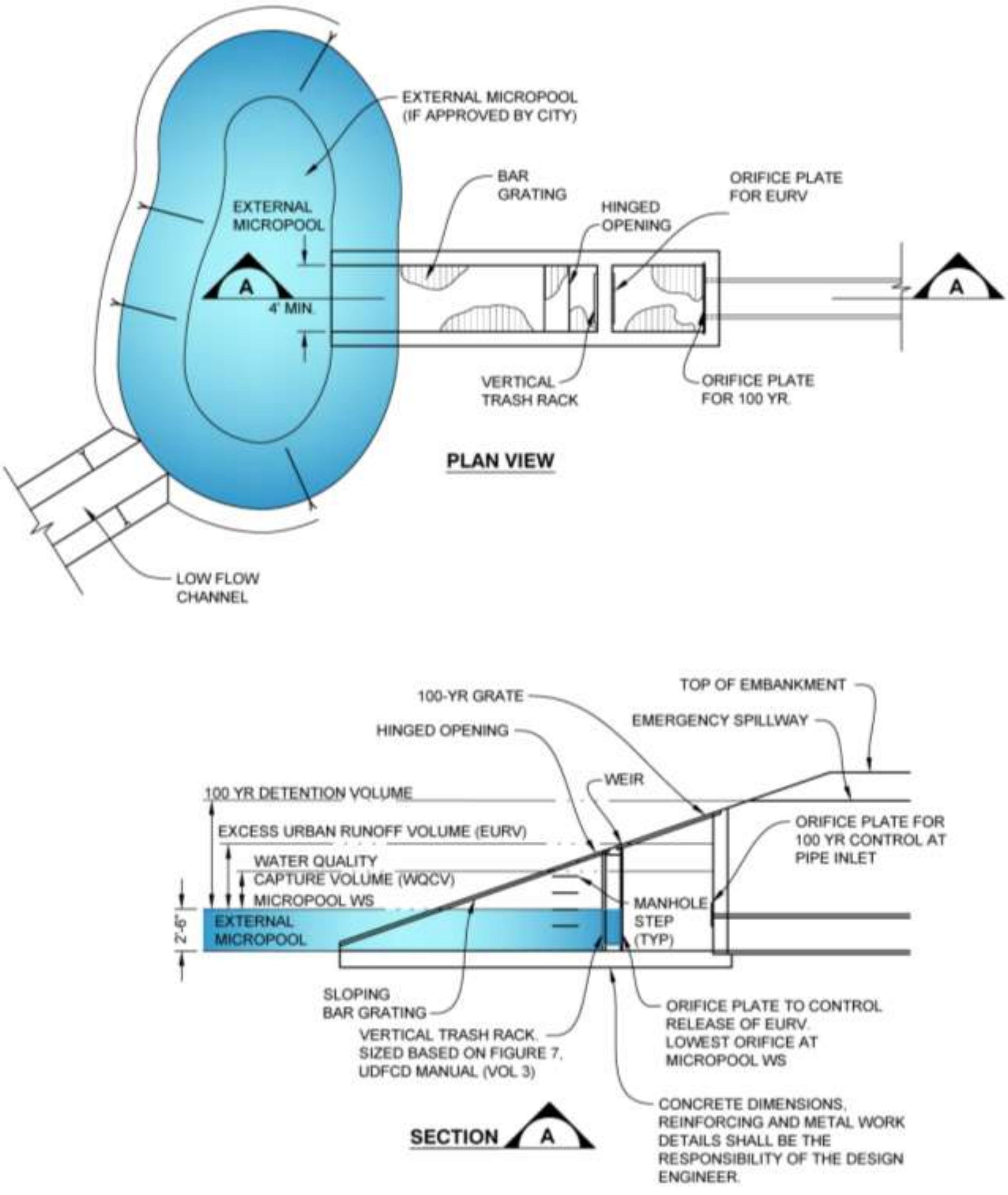
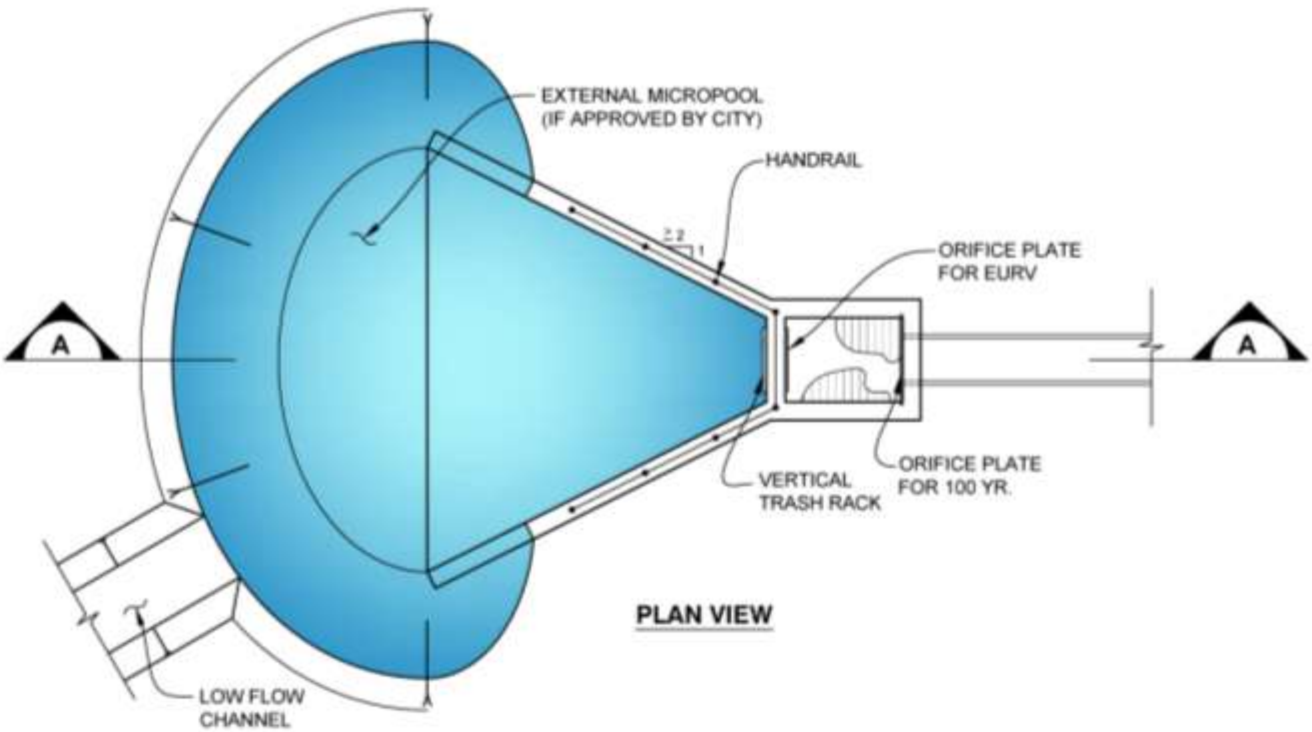


FIGURE 14-7
CONCEPT FOR OUTLET STRUCTURE WITH FLARED WINGWALLS AND HANDRAIL (EXTERNAL MICROPOOL SHOWN)



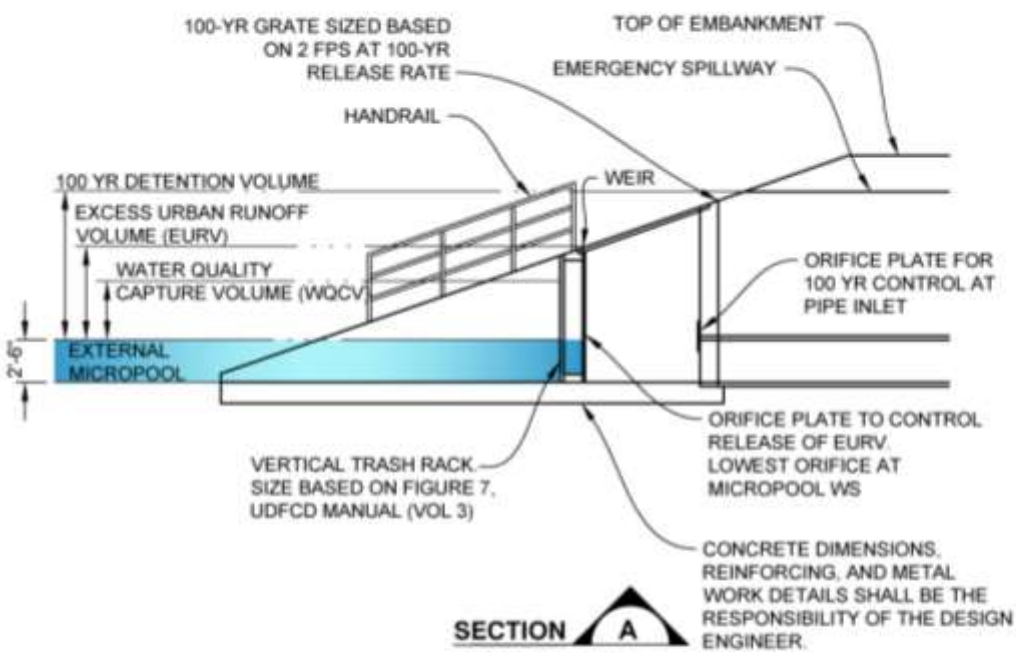


FIGURE 14-8
CONCEPT FOR INTEGRAL FOREBAY AT PIPE OUTFALL

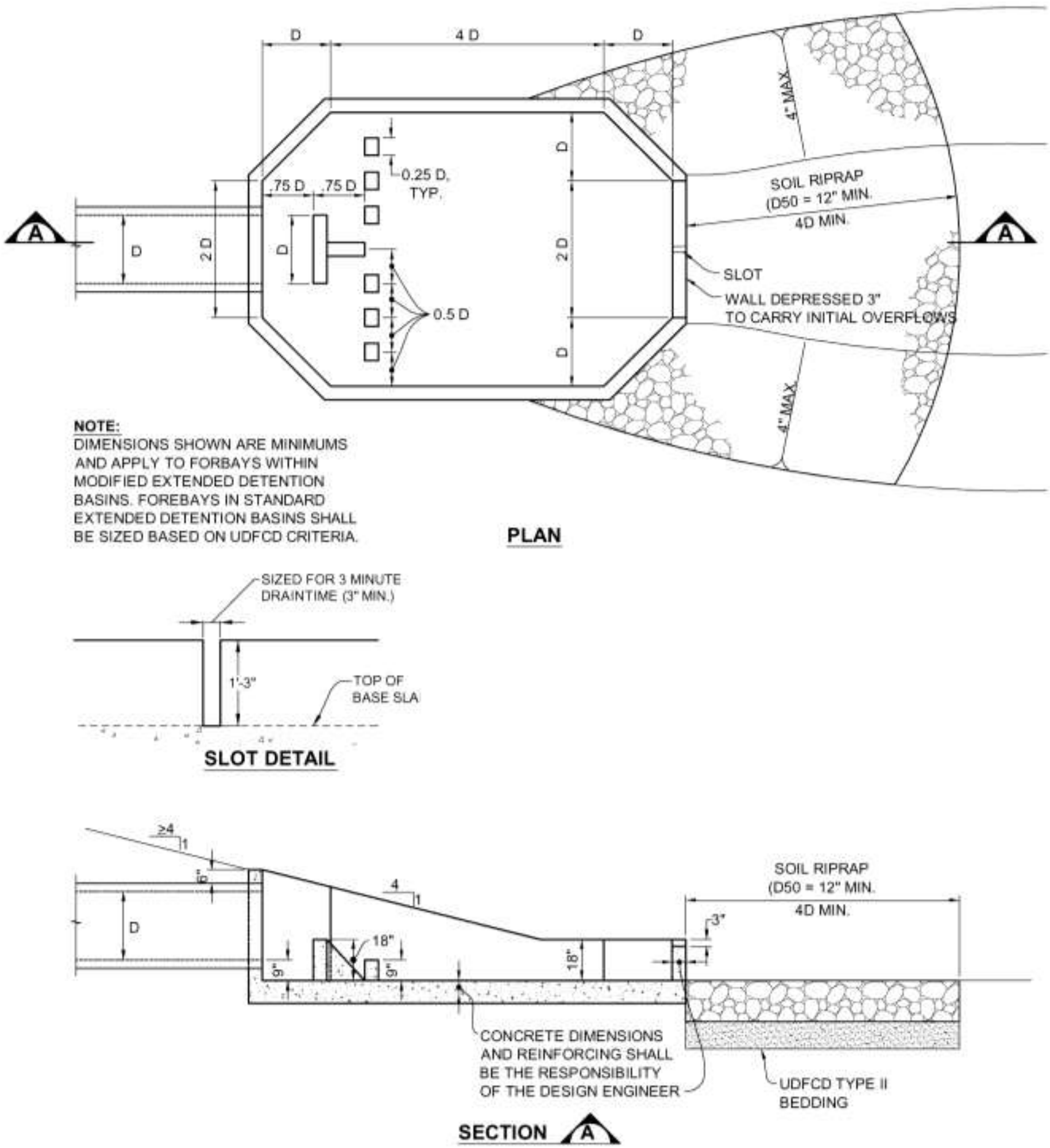


FIGURE 14-9
CONCEPT FOR INTEGRAL FOREBAY AT END SECTION

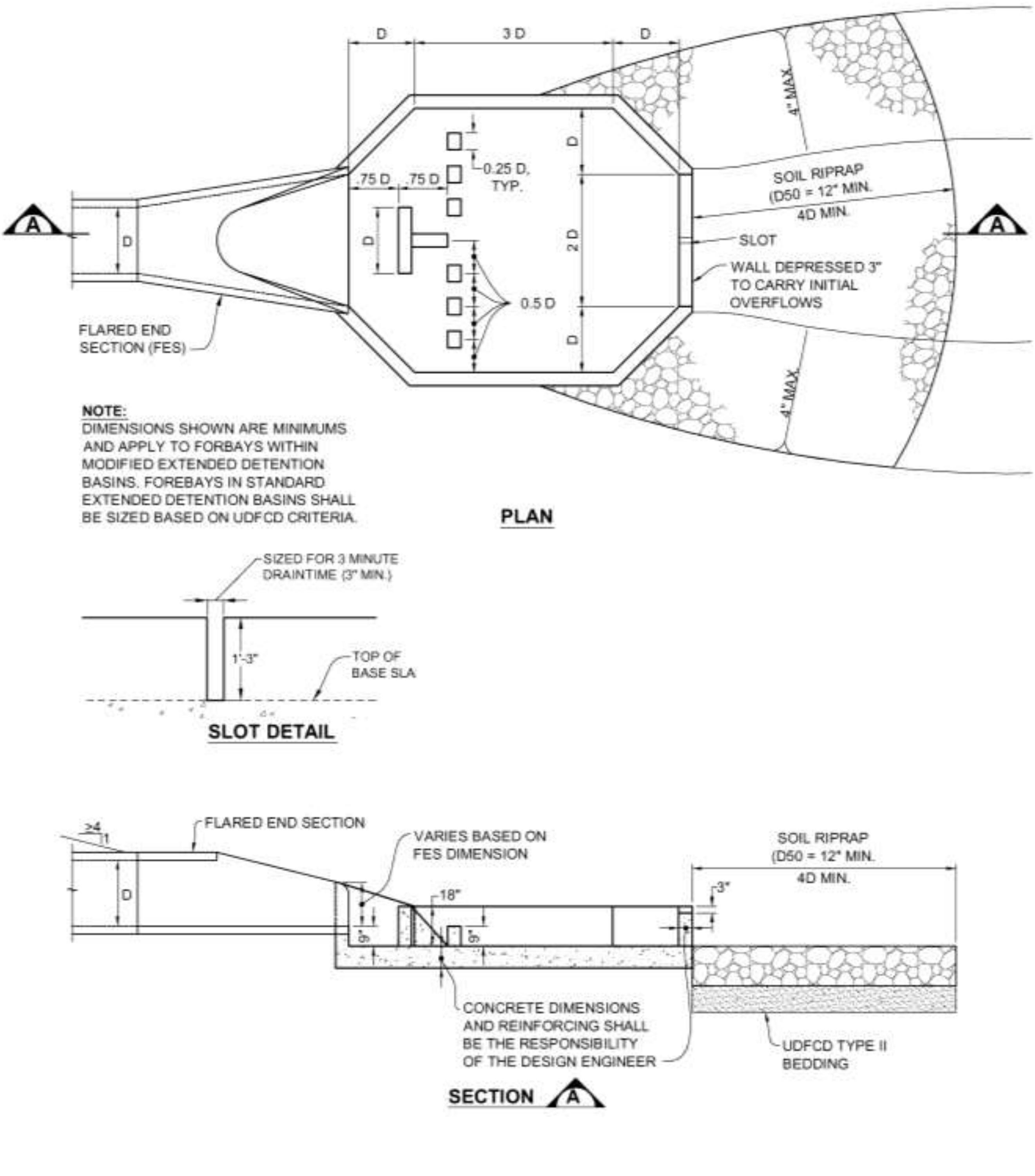


FIGURE 14-10
CONCEPT FOR MODIFIED EXTENDED DETENTION BASIN FOR SMALL SITES
(CONCRETE LOW FLOW CHANNEL SHOWN)

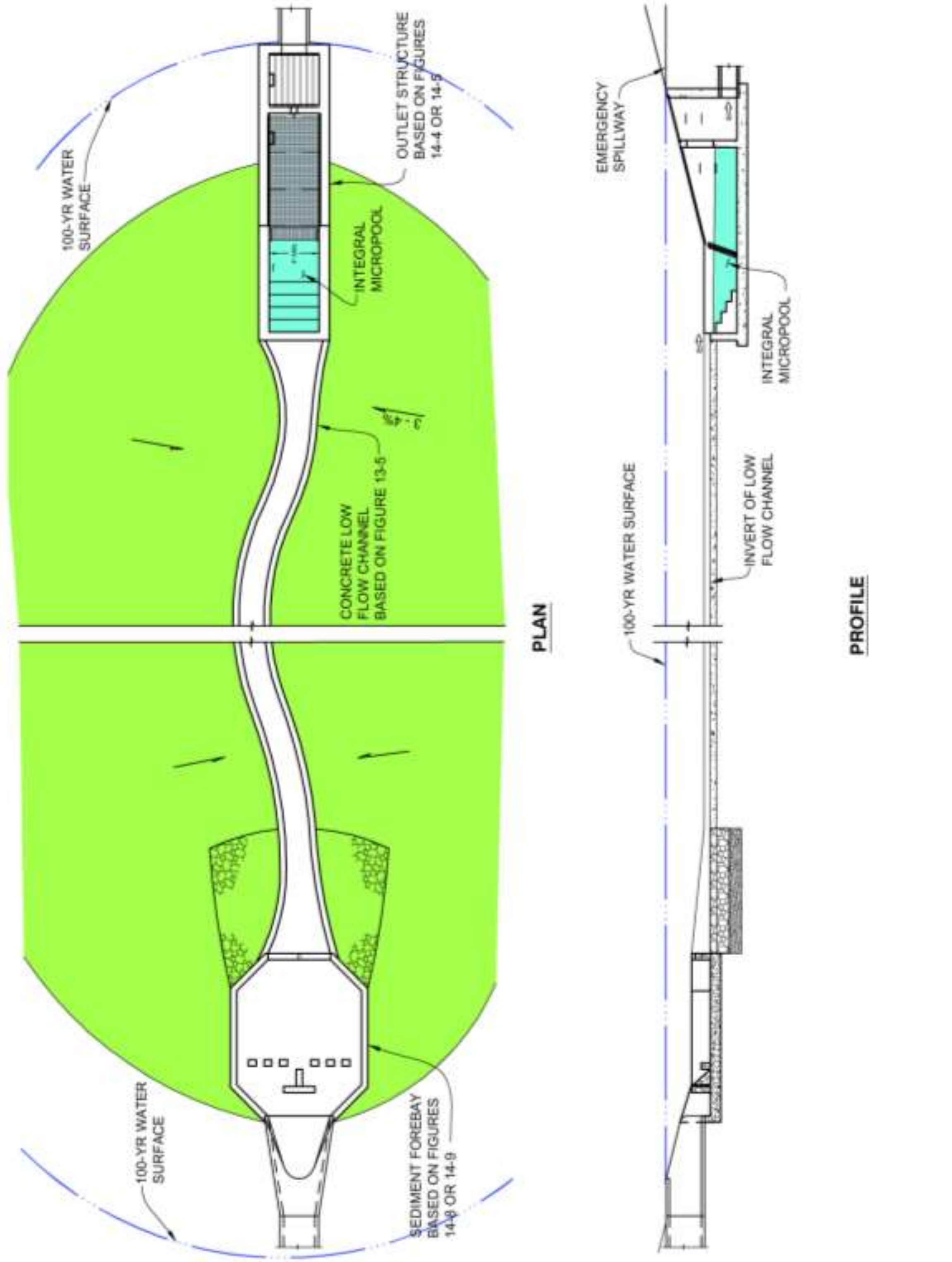


FIGURE 14-11
CONCEPT FOR MODIFIED EXTENDED DETENTION BASIN FOR SMALL SITES
(BENCHED LOW FLOW CHANNEL SHOWN)

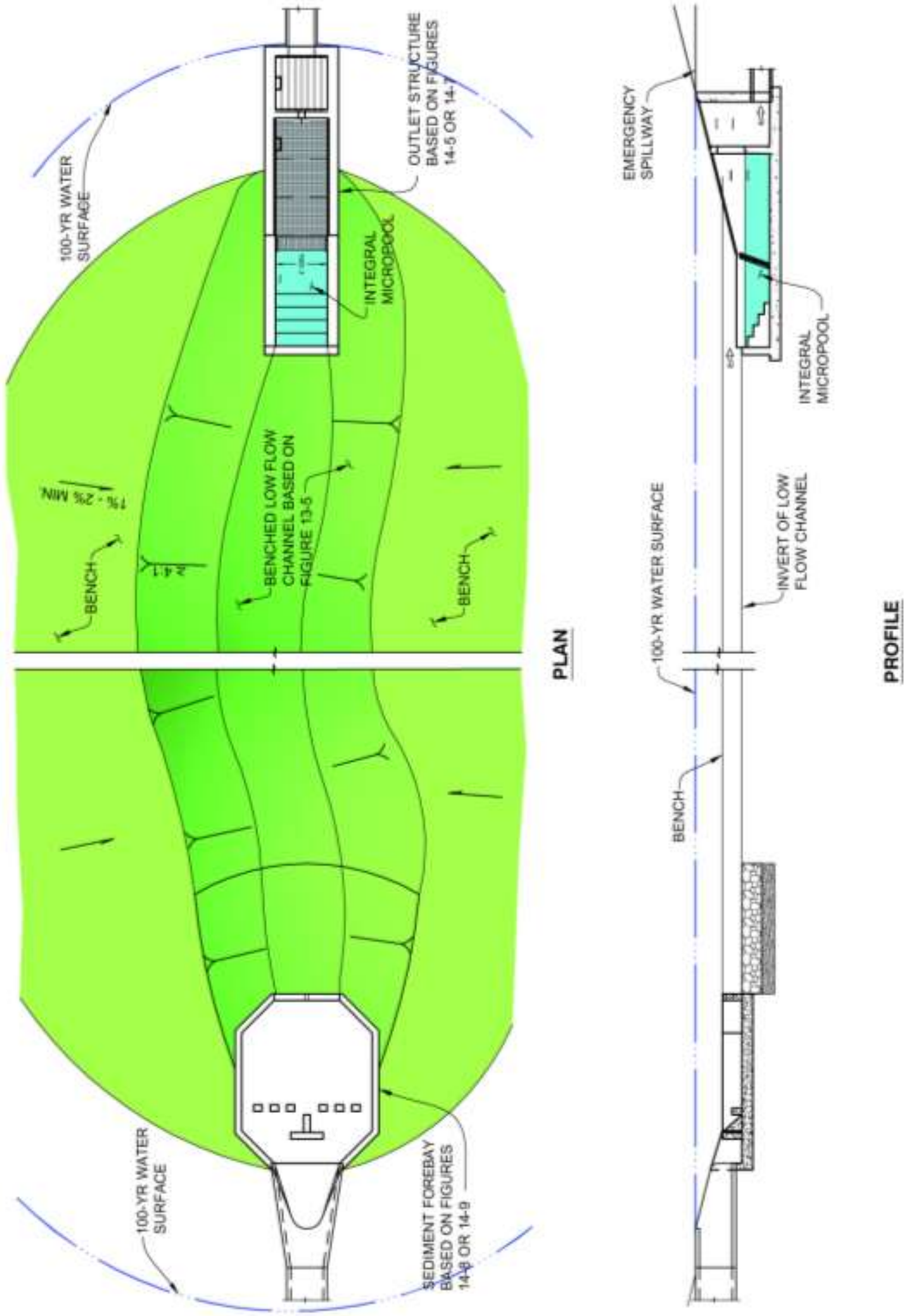
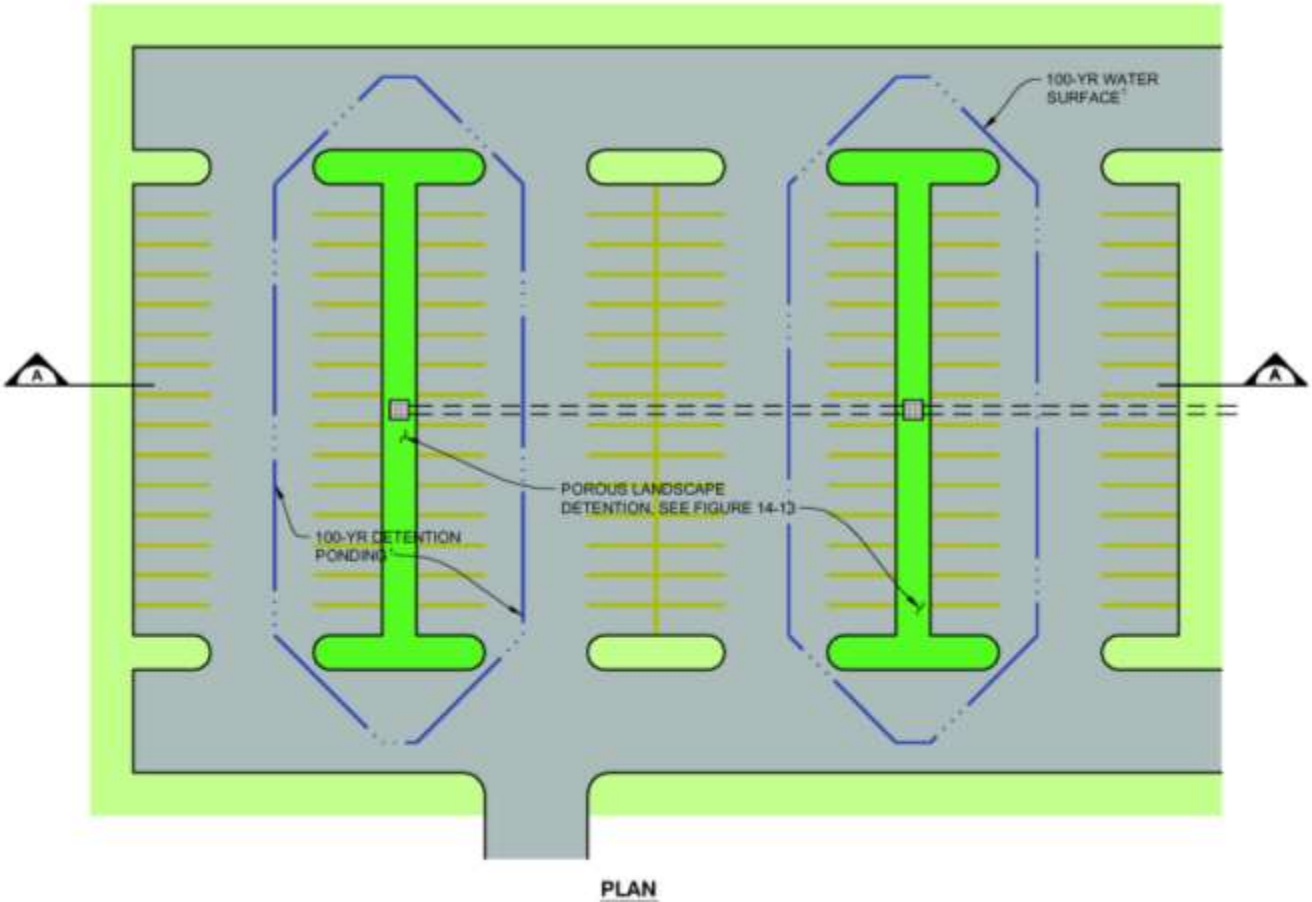


FIGURE 14-12
CONCEPT FOR POROUS LANDSCAPE DETENTION IN PARKING LOT



[†]OPTIONAL - MAY BE PROVIDED AT DOWNSTREAM FACILITY

FIGURE 14-13
CONCEPT FOR POROUS LANDSCAPE DETENTION IN PARKING LOT
(DETAILED VIEW)

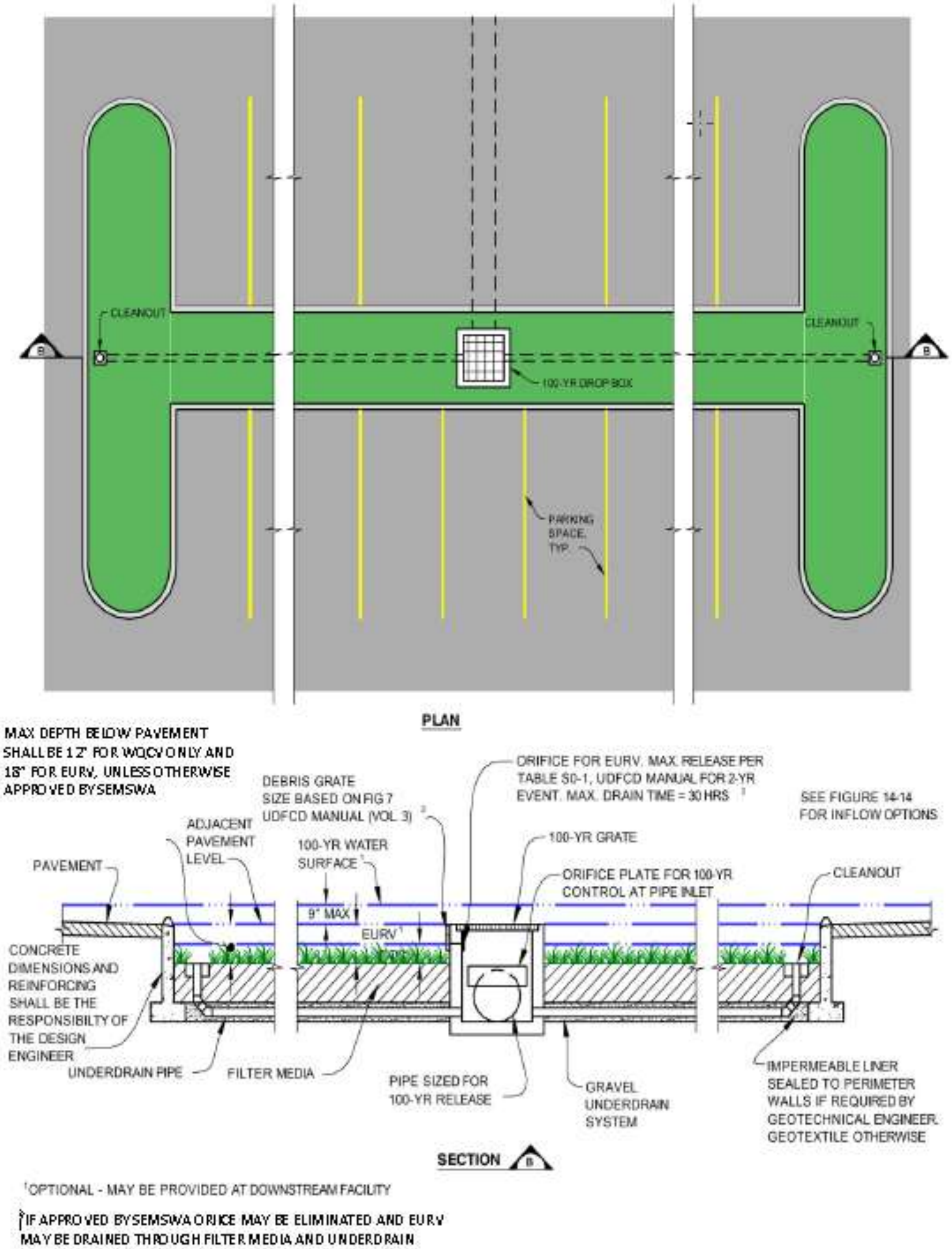
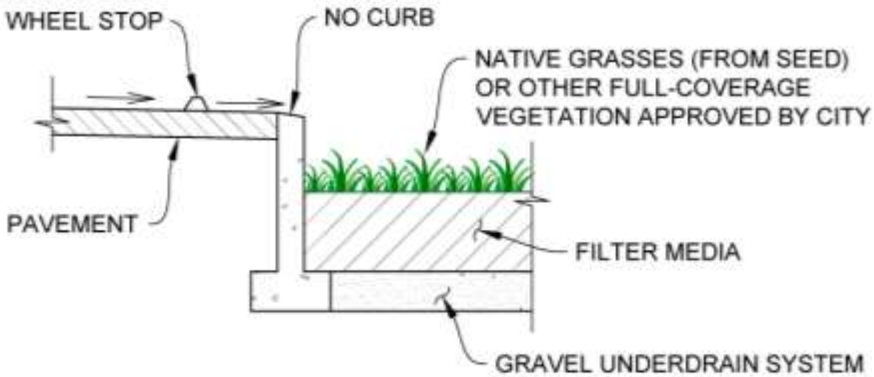
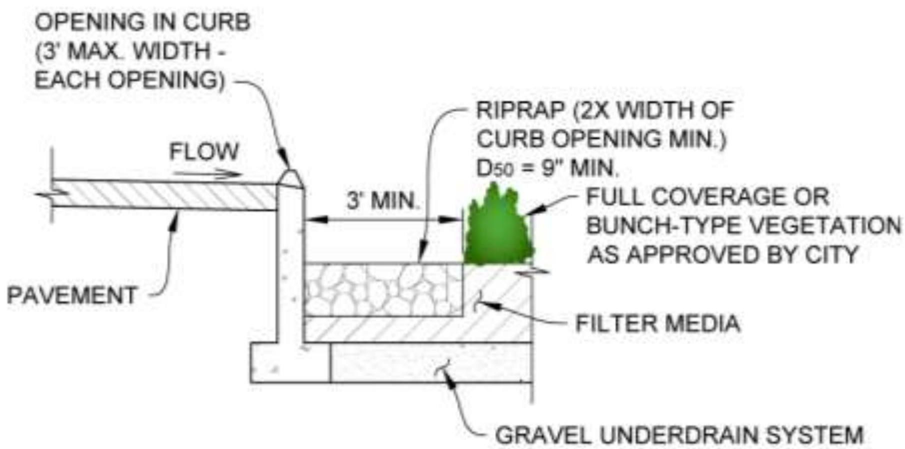


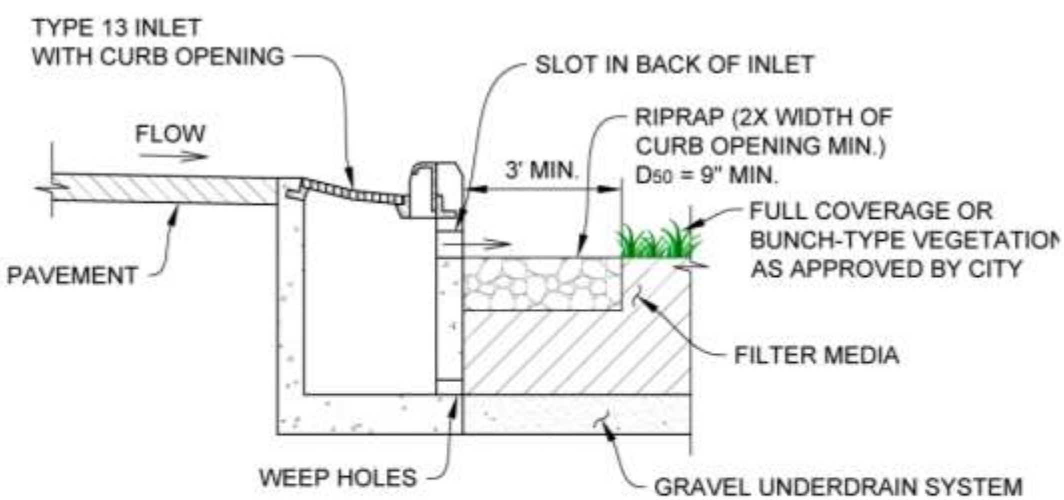
FIGURE 14-14
CONCEPTS FOR INFLOWS TO POROUS LANDSCAPE DETENTION IN PARKING LOT



OPTION 1. SHEET FLOW



OPTION 2. CURB OPENING



OPTION 3. INLET

FIGURE 14-15
CONCEPT FOR POROUS LANDSCAPE DETENTION IN LANDSCAPE AREA
(IF APPROVED BY SEMSWA)

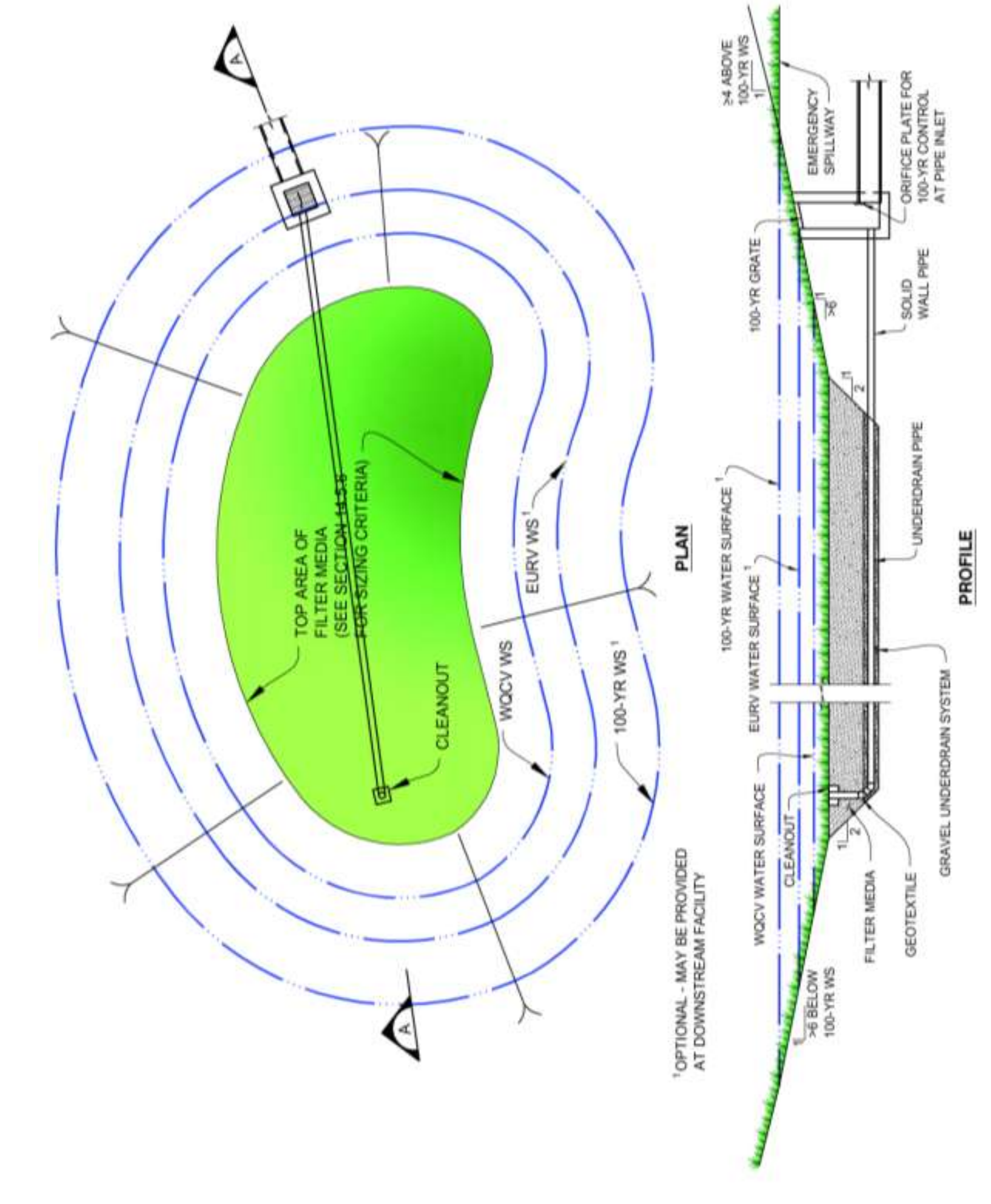
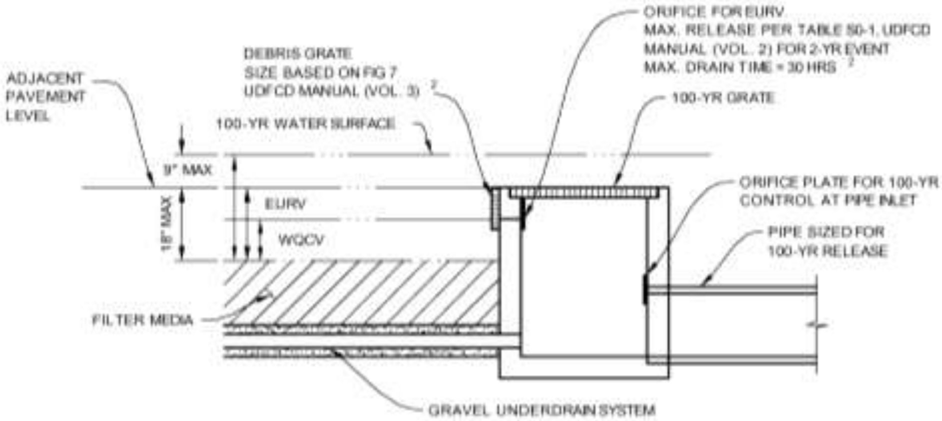
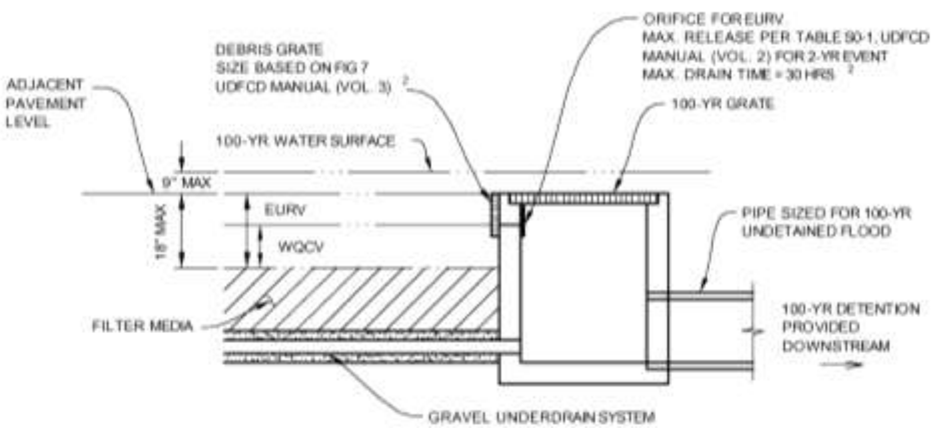


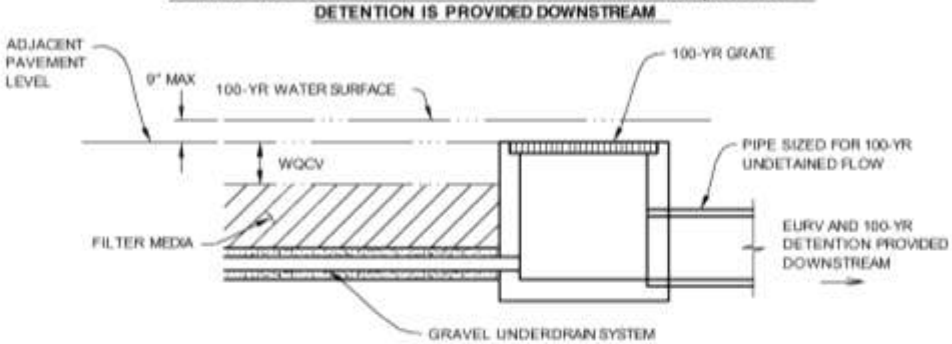
FIGURE 14-16
CONCEPTS FOR POROUS LANDSCAPE DETENTION OUTLET STRUCTURES[1]



OUTLET STRUCTURE WHERE WQCV, EURV, AND 100-YEAR DETENTION ARE COMBINED IN A SINGLE FACILITY



OUTLET STRUCTURE WHERE WQCV AND EURV ARE COMBINED; 100-YEAR DETENTION IS PROVIDED DOWNSTREAM



OUTLET STRUCTURE WHERE WQCV STANDS ALONE; EURV AND 100-YEAR DETENTION ARE PROVIDED DOWNSTREAM

[1] OUTLET STRUCTURE SHOWN MAY ALSO BE USED FOR SAND FILTER BASIN

[2] IF APPROVED BY CITY, ORIFICE AMY BE ELIMINATED AND EURV MAY BE DRAINED THROUGH FILTER MEDIA AND UNDERDRAIN