
10.0 POST-CONSTRUCTION BEST MANAGEMENT PRACTICES

10.1 GENERAL

The purpose of this section is to provide guidance on Post-Construction Best Management Practices (BMPs) in order to minimize the adverse effects of urban development and to meet post-construction storm water requirements set forth in the City of Killeen’s Municipal Separate Storm Sewer System (MS4) Phase II Permit (TXR040010) and the City of Killeen Code of Ordinance (Chapter 32, Article IV). The post-construction BMPs included in Appendix C provide several methods to meet the requirements of Chapter 32, Article IV.

These post-construction requirements are applicable to all land disturbing activities disturbing one (1) acre or more of land, land disturbing activities disturbing areas that are smaller than one (1) acre if the land is part of a larger common plan of development, and any land disturbing activities conducted within or adjacent to a Creek Buffer Zone (CBZ), as defined in Section 10.2 below.

10.2 CREEK BUFFER ZONE

The Creek Buffer Zone (CBZ) is a setback established for all property located on or adjacent to a natural, vegetated, earthen or grass lined watercourse as shown on United States Geological Survey (U.S.G.S.) maps or FEMA maps in which land disturbance is proposed. In addition, any watercourse that is shown on the maps identified above that is not within a FEMA special flood hazard area and not having side slopes of 3:1 or steeper shall not be considered as a creek buffer zone. The extent of the CBZ is defined as twenty-five (25) feet from the top of bank on either side of a watercourse and no disturbance within the CBZ is allowed. The CBZ is to be maintained in its native state to provide water quality and wildlife habitat benefits.

Limited disturbance is allowed for two BMPs. For the BMP, “Dedication and Acceptance of Linear Parks”, limited disturbance is allowed for park amenities, such as trails, playgrounds, and benches. Following acceptance of the area as a City park, limited maintenance/controlled management may be performed to meet public safety and accessibility requirements.

The second BMP that would allow disturbance within the CBZ is “Stream Restoration”. If this BMP is selected for implementation, temporary disturbance will be allowed during the implementation of restoration practices. If this BMP is being proposed, the CBZ will be delineated based on the “restored” top of bank. The restoration project shall include the restoration of riparian habitat within the CBZ that was damaged or disturbed during implementation of this BMP.

10.3 STORM WATER MANAGEMENT SITE PLANS

Storm water management site plans (SWMSPs) are required for all land disturbing activities regulated by Chapter 32, Article IV. See Section 32-49 of Killeen Code of Ordinances for specific requirements. A SWMSP shall contain the following:

- Plan/Maps
- Engineer Analysis
- Inventory of Natural Resources
- Maintenance and Repair Plan
- Maintenance Easement
- Maintenance Agreement
- Concept Plan (when adjacent properties under common ownership)

10.4 POST-CONSTRUCTION BMPs

The Post-Construction BMPs contained in this manual were selected by the City’s Drainage Stakeholder Committee and deemed to be the most appropriate for local conditions. A total of 41 different Post-Construction BMPs were considered by the Drainage Stakeholder Committee and were ranked from “most acceptable” to “least acceptable”. Based on feedback from local stakeholders on March 10, 2010 and March 28, 2012, the City selected 22 BMPs for inclusion in the Post-Construction Ordinance and this manual. The ordinance does not preclude the use of other BMPs; however, the BMPs outlined in this manual are acceptable for meeting post-construction requirements if designed according to principles outlined in this manual and Construction Standards and Details, if available.

The following BMPs were selected by the City based on Stakeholder input:

1. Preserve Special Flood Hazard Areas (Riparian Buffer)
2. Protection of Natural Features
3. Dedication and Acceptance of Linear Parks
4. Reduce Limits of Clearing and Grading
5. Open Space Design / Cluster Development
6. Minimize Directly Connected Impervious Area
7. Locate Development in Less Sensitive Area
8. Minimize Siting on Erodible Soils
9. Dedication and Acceptance of Conservation Easements
10. Urban Forestry
11. Xeriscaping
12. Parking Lot / Storm Water Islands
13. Porous Concrete / Asphalt
14. Modular Porous Pavement System
15. Bioretention (Rain Gardens)
16. Dry Extended Detention Basin
17. Stream Restoration
18. Storm Water Wetland
19. Vegetated Swales
20. Multi-Purpose Detention Areas
21. Enhanced Swales
22. Wet Ponds

Refer to Appendix C for engineering design specifications, operation and maintenance requirements, and inspection requirements for each BMP.

10.5 BMP Credits

Section 32-51 of the City of Killeen Code of Ordinances establishes BMP Credit requirements based on the size and type of development, as listed in **Table 10.1** below.

Table 10.1. BMP Credit Requirements

Type of Development	Size of Disturbed Area	Number of additional BMP Credits required
Non-Residential	1 acre \leq Disturbed Area < 5 acres	0.5
	5 acres \leq Disturbed Area < 10 acres	1
	10 acre \leq Disturbed Area < 20 acres	1.5
	\geq 20 acres	2
Residential	1 acre \leq Disturbed Area < 5 acres	0.5
	5 acres \leq Disturbed Area < 50 acres	1
	\geq 50 acres	1.5

To achieve the total BMP Credit that is required for a particular development, the developer may select a single BMP or a combination of BMPs that together meet the minimum requirements. The BMPs listed in Section 10.4 and described in detail in Appendix C provide flexibility in meeting the minimum BMP Credit requirements.

Each BMP has been assigned a value for a BMP Credit that will be awarded for successful implementation of the BMP. The BMP Credits were assigned based on pollutant removal potential. For treatment control BMPs, the value is based on the median percent removal of total suspended solids (TSS, e.g., sediment) that is available in the International Stormwater BMP Database (www.bmpdatabase.org) for that particular BMP. Site design and source control BMPs were based on perceived water quality benefits as compared to the most effective treatment control. For each BMP, a minimum implementation requirement was established to ensure adequate storm water treatment to meet post-construction water quality goals. **Table 10.2** lists BMP Credit values and minimum requirements for each BMP.

Table 10.2. BMP Credits and Minimum Requirements

Manual Section	BMP	% TSS Removal ¹	% TSS Removal ²	% TSS Removal (TCEQ)	BMP Credit ³	Minimum Requirements	Concurrent credit with other BMPs not allowed for same area ³
C1.2.1	Preserve Special Flood Hazard Areas (Riparian Buffer)	--	--	--	1 (25') 2 (55')	Minimum width 25' beyond CBZ	X
C1.2.2	Protection of Natural Features	--	--	--	1	Must be used to protect natural features outside of CBZ, minimum of 10% of developable area outside of CBZ	X
C1.2.3	Dedication and Acceptance of Linear Parks	--	--	--	1	Minimum CBZ plus an additional 25'	
C1.2.4	Reduce Limits of Grading	--	--	--	1	Minimum of 25% of developed area with natural grade, excluding preserved natural areas	X
C1.2.5	Open Space Design (Cluster Development)	--	--	--	2	Entire development must be designed based on this LID concept	X
C1.2.6	Minimize Directly Connected Impervious Area	--	--	--	1	Minimum of 25% of the impervious area should be disconnected, subject to area weighting based on percentage of impervious area disconnected	
C1.2.7	Locate Development in Less Sensitive Area	--	--	--	1	1/2 credit may be taken for certified study of ESAs on site (if no ESAs identified), full credit for plan and protection of at least 80% of ESAs identified	
C1.2.8	Minimize Siting on Erodible Soils	--	--	--	1	1/2 credit may be taken for certified study of erodible soils on site (if no erodible soils identified), full credit for plan and non-disturbance of at least 80% of identified erodible soils	
C1.2.9	Dedication and Acceptance of Conservation Easements	--	--	--	0.5	No minimum	X
C1.3.1	Urban Forestry	--	--	--	0.5 – 3.0	See Appendix C for minimum requirements.	
C1.3.2	Xeriscaping	--	--	--	0.5	Minimum of 50% of the managed landscape, excludes preserved natural areas	
C1.3.3	Parking Lot / Storm Water Islands	--	--	--	2	Minimum of 80% of parking area treated through BMP	
C1.3.4	Porous Concrete / Asphalt	36	--	89-100	0.5	Minimum of 50% of sidewalks , driveways, and parking lots	
C1.3.5	Modular Porous Pavement System	36	--	--	0.5	Minimum of 50% of sidewalks , driveways, and parking lots	
C1.3.6	Bioretention (Rain-Garden)	80	80	89	2	No minimum, subject to area weighting based on percentage of site treated, full credit at 80%	
C1.4.1	Dry Extended Detention Basin	63	65	75	1.5	No minimum, subject to area weighting based on percentage of site treated	
C1.4.2	Stream Restoration	--	--	--	2.0 (soft) ⁴ 1 (hard)	Must restore total length of degraded stream within CBZ on site as determined by licensed professional. BMP Credit of 2.5 if soft techniques are used. BMP Credit of 1 if hard techniques are used.	
C1.4.3	Storm Water Wetland	60	80	93	2	No minimum, subject to area weighting based on percentage of site treated, full credit at 80%	
C1.4.4	Vegetated Swales	52	50	70	1	No minimum, subject to area weighting based on percentage of site treated, full credit at 80%	
C1.4.5	Multi-Purpose Detention Areas	--	65	--	1.5	No minimum, subject to area weighting based on percentage of site treated, full credit at 80%	
C1.4.6	Enhanced Swales	--	80	--	2	No minimum, subject to area weighting based on percentage of site treated, full credit at 80%	
C1.4.7	Wet Pond	80	80	93	2	No minimum, subject to area weighting based on percentage of site treated, full credit at 80%	

Acronyms: TSS – Total Suspended Solids, LID – Low Impact Development

-- No Data

Notes:

1 International Stormwater BMP Database, BMP Performance Data Summary Table, November 2011, Based on median influent and effluent data available for TSS.

2 iSWM Manual - Site Development Controls, Table 1.23 BMP credits are additive; however, there are some restrictions on concurrent use of certain BMPs which are related or overlapping for the same areas

4 See Appendix C for examples of soft and hard techniques

10.6 COMPUTATION OF BMP CREDIT

For BMPs that are not subject to area weighting, if the BMP meets the minimum implementation requirements as specified in **Table 10.2** then the full BMP credit may be taken.

Certain exceptions allow for partial BMP credit values. These include the BMPs (“Locate Development in Less Sensitive Area” and “Minimize Siting on Erodible Soils”) which will require a certified study of the area to identify environmentally sensitive areas (ESAs) or erodible soils. Since there is no guarantee that ESAs or erodible soils will be found on the site to be preserved, one-half (1/2) of the full BMP credit, can be taken if studies are completed and no ESAs or erodible soils are identified. If ESAs or erodible soils are identified on the site then at least 80 percent of those identified would need to be preserved to obtain full credit for these BMPs.

Several BMPs as indicated in **Table 10.2** are similar and concurrent credits cannot be taken for the same area. The developer may choose the BMP that best fits the conditions of the site as specified in Appendix C.

Sample Calculations

Sample calculations are shown below for computation of total BMP Credit based on single and multiple BMPs.

The BMP Credit for BMPs that are subject to area-weighting as specified in Table 10.2 shall be computed as outlined below.

For Single BMPs

The BMP credit is multiplied by the percentage of disturbed area that the BMP treats. The CBZ or any other areas that are preserved in their natural state are not included in the total area that is disturbed.

For example, if a 10 acre site, contains 2 acres of CBZ (i.e., undisturbed) and if runoff from 50 percent of the disturbed area (4 acres) is treated through a wet pond, then

$$\text{BMP Credit of } 2 \times 0.5 = 1$$

For Multiple BMPs (in parallel, i.e. treating different areas)

For example, if runoff from 75 percent of the developed area is treated through a Dry Extended Detention Basin and 25 percent of the developed area is treated with Parking Lot Islands, then

$$\text{BMP Credit for Dry Extended Detention Basin} \quad 1.5$$

$$\begin{array}{r} \times \quad 0.75 \\ = \quad 1.13 \end{array}$$

$$\begin{array}{r} \text{BMP Credit for Parking Lot Islands} \quad 2 \\ \times \quad 0.25 \\ = \quad 0.5 \end{array}$$

$$\text{Total BMP Credit} = 1.13 + 0.5 = 1.63$$

For Multiple BMPs (in series, i.e. treating same area)

For example, if runoff from 50 percent of the site is treated through a Vegetated Swale and then routed to a Multi-Purpose Detention Area, then

$$\begin{array}{r} \text{BMP Credit for Vegetated Swale} \quad 1 \\ \times \quad 0.5 \\ = \quad 0.5 \end{array}$$

$$\begin{array}{r} \text{BMP Credit for Multi-Purpose Detention Area} \quad 1.5 \\ \times \quad 0.5 \\ = \quad 0.75 \end{array}$$

$$\text{Total BMP Credit} = 0.5 + 0.75 = 1.25$$

BMP computations must be included in the Engineer Analysis section of the SWMSP to support the total BMP Credit requirements for the site. Where applicable, the maps and/or plans shall indicate drainage areas and other acreage used in the BMP computations.