APPENDIX C BMP SIZING METHODOLOGIES

The following sections reiterate the storm water runoff requirements described in Section 6.2 and provide methodologies for BMP sizing for each of the requirements.

Maintaining Peak Runoff Discharge Rate Requirements

Requirement

The requirement for maintaining the peak runoff discharge rate is set by the City's SWMP and based on the **Santa Barbara County Flood Control and Water Conservation District (SBCFC)**. The City's SWMP requires that:

- Storm water runoff BMPs provide detention such that the post-development peak storm water runoff discharge rate shall not exceed the pre-development rate for the 2-, 5-, 10-, and 25-year 24-hour storm events. For redevelopment projects, the net change in peak flow rates are to be compared with the predevelopment condition.

Sizing Methodology

The following method for sizing storm water runoff BMPs to maintain the pre-development peak storm water runoff discharge rate requirement is an excerpt from the *Santa Barbara County Flood Control and Water Conservation District – Standard Conditions of Project Plan Approval.* This document can be downloaded at the following website: http://www.countyofsb.org/pwd/water/derev.htm.

- Hydrologic/hydraulic analysis: The hydrologic/hydraulic analysis of detention basins shall be performed by a California-licensed civil engineer using a commercially available version of the Santa Barbara Urban Hydrograph method. Two recommended commercial versions of SBUH are Hydraflow (www.intelisolve.com) and HydroCAD (www.hydrocad.net). It is also acceptable to use a long-term continuous simulation-based approach in place of the SBUH Method. For some single-family residential projects, an architect or other design professional may produce the analysis, dependent on City staff approval.

- The flowing parameters must be used with the SBUH:
  - Runoff Method: SBUH
  - Pond Routing Method: Storage-Indication
  - Rainfall Distribution: SCS 24-hr, Type I distribution
  - Antecedent Moisture Condition: AMC II
  - Hydrograph ordinate time increment: 0.10 hour
  - Rainfall Amounts, 24-hour totals in inches:

Area	2-Year	5-Year	10-Year	25-year
South Coast	3.20 in.	4.61 in.	5.55 in.	6.71 in.

- Hydrologic soil groups for areas within Santa Barbara County can be determined on-line at: http://websoilsurvey.nrcs.usda.gov/ and/or by viewing the Hydrologic Soil Group Map provided in Appendix B of this manual.

- Curve numbers for hydrologic soil groups per Tables 2-2A through 2-2D (Runoff Curve Numbers) of "TR-55, Urban Hydrology for Small Watersheds," published by USDA NRCS. TR-55 may be viewed on-line at: ftp://ftp.wcc.nrcs.usda.gov/downloads/hydrology_hydraulics/tr55/tr55.pdf

- Information on computing composite curve numbers to account for unconnected impervious areas and low-impact development (LID) design components is given in TR-55 and "Low-Impact Development Hydrologic Analysis" prepared by Prince George's County, Maryland, a portion of which may be viewed online at: http://www.countofsb.org/pwd/water/derev.htm

  If LID design elements are considered in the hydrologic analysis of the project, those elements must be guaranteed to remain in place for the lifetime of the project. This guarantee must be demonstrated in the form of a written statement from the owner and/or inclusion in the development's Covenants, Conditions and Restrictions.

- Basin data required to be submitted for review includes:
  - Basin input parameters listed above;
  - Watershed maps;
  - Soil Survey Map/Hydrologic Soil Group for watershed, including copy of Soil Survey Map of subject property;
  - Specifics of proposed development (area, time of concentration, including time of concentration and composite curve number calculations);
  - Proposed basin geometry;
  - Proposed outlet works and resultant outlet works hydraulics;
  - Peak depth, peak outflow, peak storage;
  - Inflow volume, outflow volume;
  - Plotted inflow and outflow hydrographs.

Volume Reduction Requirements

Requirement

Retain on-site the larger of the following two volumes from the entire project site:

- Volume difference between the pre- and post-development conditions for the 25-year, 24-hour design storm, V_{25}

- Volume difference between the pre- and post-development conditions generated from a one-inch, 24-hr storm event, $V_{one\text{-}inch}$

Sizing Methodology

- Calculate the volume difference between pre- and post-development conditions from the entire project site for the 25-year, 24-hour storm event, $V_{one-inch}$, by:

    - Generating the pre- and post-condition runoff hydrographs for the 25-year, 24-hour storm event using the County of Santa Barbara Urban Hydrograph Method (SBUH) as described above in the "maintaining peak discharge rate" section for the 25-year, 24-hour design storm for the South Coast Region (including the City of Santa Barbara) of *6.71 inches*. It is also acceptable to use an alternative long-term continuous simulation-based approach in place of the SBUH Method.

    - Calculating the volume difference between the pre- and post-development conditions for the 25-year, 24-hour storm event, V_{25}, using the following equation based on the SCS synthetic triangular unit hydrograph method:

$$V_{25} = 0.5 * \Delta Q_{25} * 2.67 * T_c$$

Where:

V_{25} = volume of runoff to be retained on-site (ft^3)
ΔQ_{25} = the difference in the Q_{25} peak runoff rate for pre- and post development conditions as determined from the hydrographs developed by the SBUH method
T_c = time of concentration = 720 seconds

- Calculate the volume generated from a one-inch, 24 hour storm event, $V_{one-inch}$ from the entire project siteThere are two options for sizing which are up to the discretion of the designer:

    - **Option 1:** Size the BMPs based on the volume of runoff generated from a one-inch, 24-hour storm using the SBUH method. This is a direct calculation of the volume that runs off a site over the 24-hr duration of a one-inch storm and BMPs using this method would be sized to retain this volume which does not account for infiltration that occurs in the BMP during the 24-hr storm period. This option gives you a larger BMP size than Option 2.
    - **Option 2:** Size the BMPs by generating a runoff hydrograph for a one-inch, 24-hour storm using the SBUH method and then routing the runoff hydrograph through the BMP over the 24-hr duration of the storm and generating the volume of runoff based on the routed runoff hydrograph. This calculation would account for the infiltration that takes place in the BMP during the storm so that the actual BMP size would be smaller than Option 1.

- Determine which volume is the larger of the two methods (V_{25} or $V_{one-inch}$). The larger volume is the design volume reduction, $V_{reduction}$, that shall be retained on-site.

Water Quality Treatment Requirements

Requirements

Water quality treatment requirements are differentiated based on whether the BMP is volumetric-based or flow-based. The criteria for both are as follows:

- Volume-based BMPs shall be sized based on a one-inch 24-hr design storm from the entire project site (not just the new or redeveloped area).
- Flow-based BMPs shall be sized based on a constant rainfall intensity of 0.25 in/hr from the entire project site (not just the new or redeveloped area)Water quality treatment shall be maintained at this rate for a minimum of four hours.

Sizing Methodology

- The following table identifies which storm water runoff BMPs are designed to treat the flow-based water quality design flow rate (Q_{wq}), or the volume-based water quality design treatment volume (V_{wq}).

Manual Section	Storm Water Runoff BMP	Design Basis
6.6.2	Vegetated Swale Filter	Q_{wq}
6.6.3	Vegetated Strip Filter	
6.11	Proprietary Devices	
6.6.1	Bioretention	V_{wq}
6.7	Infiltration Basin	
6.7	Infiltration Trench	
6.7	Dry Well	
6.9.1	Cistern/Rain Barrel	
6.9.2	Planter Box	
6.10.1	Constructed Treatment Wetland	
6.10.2	Wet Retention Basin	
6.10.3	Dry Extended Detention Basin	
6.11	Proprietary Devices	

- The water quality design treatment volume, V_{wq}, for **volume-based BMPs** is equivalent to the volume calculated above (see volume reduction requirement section) for the one-inch, 24-hour storm, $V_{one\text{-}inch}$, using the SBUH method for a one-inch, 24-hr design storm.

The water quality design flow rate, Q_{wq}, for **flow-based BMPs** is calculated using the Rational Method assuming a design storm with constant intensity of 0.25 in/hr. The runoff coefficient "(0.05 + 0.9*IMP)" is based on *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban Best Management Practices* (T. Schueler, 1987).

- This equation is as follows.

$$Q_{wq} = (0.05 + 0.9 * IMP) * 0.25 * A$$

Where:

Q_{wq}	=	water quality design flow rate (cfs)
IMP	=	percentage of tributary area draining to the flow-based BMP that is impervious, defined as the directly connected impervious area fraction. For more information on computing connected impervious areas, see http://www.countofsb.org/pwd/water/derev.htm).
A	=	tributary area draining to the flow-based BMP (acres)

Meeting Storm Water Runoff Requirements Simultaneously

It shall be noted that the volume reduction requirements and water quality treatment requirements are not additive and can be met simultaneously in many cases. Meeting the volume reduction requirements for a specific volume also meets the water quality treatment requirement. Storm water runoff BMPs that allow for infiltration shall be sized using a design volume, V_{design}, which is the larger of the volume reduction and water quality treatment requirements. Storm water runoff BMPs that do not allow for infiltration will only receive credit towards meeting the water quality treatment requirements. Other storm water runoff BMPs would then need to be used for meeting the volume reduction requirements. See Section 6.5 for suggested strategies for meeting the storm water runoff requirements.