Appendix G

Assumptions for Model Development and TMDL Calculation

G.1 Wet Weather Modeling Assumptions

The watershed and receiving water modeling system developed to represent wet weather conditions is reported in Appendix F of the Technical Report. The following assumptions are relevant to the LSPC and EFDC models developed to simulate wet weather sources of bacteria and assimilative capacities of receiving waters.

- *General LSPC/HSPF Model Assumptions* - Many model assumptions are inherent in the algorithms used by the LSPC watershed model and are reported extensively in Bicknell et al. (1996).
- *Land Use* - A combination of SCAG, SANDAG, and MRLC land use GIS datasets is assumed representative of the current land use areas. For areas where significant changes in land use have occurred since the creation of these datasets, model predictions may not be representative of observed conditions.
- *Stream Representation* - Each delineated subwatershed was represented with a single stream/storm drain assumed to be a completely mixed, one-dimensional segment with a trapezoidal cross-section.
- *Hydrologic Modeling Parameters* - Hydrologic modeling parameters were developed during previous modeling studies in Southern California (e.g., LA River, San Jacinto River) and refined through calibration to streamflow data collected in the San Diego region. Through the calibration and validation processes (reported in Appendix F of the Technical Report), a set of modeling parameters were obtained specific to land use and hydrologic soil groups. These parameters are assumed to be representative of the hydrology of other watersheds in the San Diego region that are presently ungaged and therefore unverified.
- *Water Quality Modeling Parameters* - Dynamic models require a substantial amount of information regarding input parameters and data for calibration purposes. All sources of indicator bacteria from watersheds are represented in the LSPC model as build-up/wash-off from specific land use types. Limited data are currently available in the San Diego region to allow development of unique modeling parameters for simulation of build-up/wash-off, so parameters were obtained from a similar study performed in the Los Angeles region. These build-up/wash-off modeling parameters were originally developed by SCCWRP for a watershed model of the Santa Monica Bay Beaches (Los Angeles Water Board, 2002), and are assumed representative of land use sources in the San Diego region. This assumption was validated through evaluation of model results with local data in the San Diego Region. Results of model validation were reported in Bacteria TMDL Project I (San Diego Water Board, 2007).

- *Lumped Parameter Model Characteristic* - LSPC is a lumped-parameter model and is assumed to be sufficient for modeling transport of flows and bacteria loads from watersheds in the region. For lumped parameter models, transport of flows and bacteria loads to the streams within a given model subwatershed cannot consider relative distances of land use activities and topography that may enhance or impede time of travel over the land surface. Although this limitation could result in mistiming of peak flows or under-prediction of bacteria die-off because overland losses are not simulated, impacts are assumed minimal.

- *First-order Bacteria Die-off* - Each stream is modeled assuming first-order die-off of bacteria. Bacteria die-off rates for wet weather are assumed as 0.8/day, based on sensitivity analyses performed by SCCWRP (Los Angeles Water Board, 2002).

- *In-stream Bacteria Re-growth* - The LSPC model assumes no in-stream regrowth of bacteria. No data or literature were located to provide indication that such sources are significant during wet weather or could be estimated for model input.

- *SDB and DPH Shoreline Bacteria Die-off* – The base die-off rates of the three species of bacteria were set to 0.8/day, consistent with default literature values reported by Chapra (1997). In addition to the base die-off rate, temperature and salinity dependence ratios were applied. Salinity can contribute to the death rate at a ratio of 0.02$day^{-1}ppt^{-1}$ (Chapra, 1997). There is no conclusive research to show that the die-off rates of the three indicator bacteria species are highly temperature dependent. Therefore, a low value of 1.01 day^{-1} $^{\circ}C^{-1}$ was included and was assumed to represent weak temperature dependence.

- *Direct Nonpoint Source Loading to SDB and DPH* – Loads from waterfowl and other unquantified nonpoint sources (e.g., other sources within the water) directly to the receiving waters were calculated based on dry weather modeling analyses described in the next section.

G.2 Dry Weather Modeling Assumptions

The watershed and receiving water modeling system developed for simulation of quasi-steady-state dry weather flows and sources of bacteria are reported in Appendix F of the Technical Report. The following assumptions are relevant to that discussion.

- *Steady-state Watershed Model Configuration* - Although it is understood that dry weather flows and bacteria densities vary over time for any given stream, for prediction of average conditions in the stream, flows and concentrations are assumed as steady state.

- *Sources for Characterization of Dry Weather Watershed Loads* - Data used for characterization of dry weather flows and water quality are assumed representative of conditions throughout the region.

- *Methods for Characterization of Dry Weather Watershed Loads* - The equations derived through multivariable regression analyses are assumed sufficient to represent the dry weather flows and water quality as functions of land use and watershed size.
- *Stream Bacteria Re-growth* - The dry weather model assumes no in-stream sources or regrowth of bacteria. No data or literature were located to provide indication that such sources are significant during wet weather or could be estimated for model input
- *SDB and DPH Shoreline Bacteria Die-off* – The base die-off rates of the three species of bacteria were set to 0.8/day, consistent with default literature values reported by Chapra (1997). In addition to the base die-off rate, temperature and salinity dependence ratios were applied. Salinity can contribute to the death rate at a ratio of $0.02 day^{-1} ppt^{-1}$ (Chapra, 1997). There is no conclusive research to show that the die-off rates of the three indicator bacteria species are highly temperature dependent. Therefore, a low value of $1.01\ day^{-1}\ {}^{\circ}C^{-1}$ was included and was assumed to represent weak temperature dependence.
- *Direct Nonpoint Source Loading to SDB and DPH* – Loads from waterfowl and other unidentified nonpoint sources (e.g., other sources within the water) directly to the receiving were calculated using EFDC models to take up the remaining assimilative capacity of the waterbodies after wasteload allocations to dry weather runoff.

G.3 Assumptions for TMDL Calculation

Calculation of TMDLs, load allocations, and recommended load reductions were reported in Section 8 of the Technical Report. The following assumptions are applicable to this discussion.

- *Critical Location for Loading Assessments* - For SDB and DPH shorelines, the critical locations for meeting numeric targets include the entire length of impaired shoreline. For model development, receiving waters at impaired shorelines were represented in the model with multiple grid cells (see Appendix F). Therefore, for each of the impaired shorelines, a weighted average of bacteria concentration was calculated based on respective length of shoreline (Avg. Conc. = ∑ [Length*Conc.] / ∑ Length) of each model grid cell located adjacent to that shoreline. This resulted in a single representative bacteria concentration for each impaired shoreline addressed in this TMDL.
- *TMDL Numeric Targets* – Separate numeric targets are used for wet and dry weather TMDL calculations. For wet weather, the single sample maximum WQOs were used to assess exceedance of the TMDL. For dry weather, both the 30-day geometric mean and the single sample maximum WQOs were used to assess exceedances. For each condition, selection of the applicable numeric

target provides assurance of the protection of beneficial uses in the impaired waterbodies and is consistent with state and federal guidance.

- *Wet Weather Critical Condition* – To assess the response of the receiving waters due to variable critical watershed loads, a specific 30-day period of 1993 was selected for detailed assessment. This shortened period facilitated detailed analyses of the hourly or diurnal conditions that impact the water quality, rather than a longer-term, daily evaluation of loads. A critical wet weather period of 1993 was identified from January 7th through February 5th, which corresponded to five to ten of the top 1st percentile of flow magnitudes (daily averages) simulated by LSPC from January 1, 1990 to May 31, 2004, depending on location. In addition to this 30-day critical wet weather watershed loading period, a 30-day critical tidal period was assumed based on observed data from March 7, 2001 to April 7, 2001. These two critical 30-day periods were combined in the model to provide the most conservative bacteria loading scenario.
- *Dry Weather Critical Condition* – For the EFDC model of receiving waters, the critical period for TMDL calculation assumed tidal variations based on observed data from March 7, 2001 to April 7, 2001. During this period, tidal variations were determined through modeling analyses to have critical impacts on the assimilative capacities of the receiving waters.
- *Reduction of Dry Weather Watershed Loads* - Watershed loads were reduced to bacteria densities consistent with geometric mean WQOs, thus ensuring that controllable sources of bacteria are addressed. Such conservativeness provides a MOS by ensuring that targets are met at increasing distances from the discharge, where dilution and die-off in the receiving waters occur.