APPENDIX XII. CONCEPTUAL BIOTREATMENT SELECTION, DESIGN, AND MAINTENANCE CRITERIA

The purpose of this Appendix is to provide conceptual-level guidance for selection, design, and maintenance of biotreatment BMPs. This Appendix is intended to be used as a concise reference for the biotreatment BMP design philosophy.

This Appendix is not intended to provide BMP-specific guidance or design-level specifications. BMP-specific guidance for the recognized suite of available biotreatment BMPs is provided in BMP Fact Sheets in **Appendix XIV**.

This Appendix is not intended to be use for specific criteria. Detailed and prescriptive guidance for sizing and designing biotreatment to achieve the maximum feasible infiltration and ET is provided in **Appendix XI**.

XII.1. Definition of Biotreatment BMPs

Biotreatment BMPs are a broad class of structural LID BMPs that treat stormwater using a suite of treatment mechanisms characteristic of biologically active systems. The design of biotreatment BMPs should strive to achieve the following goals, as applicable:

- Foremost, the BMP should be designed to provide the highest possible pollutant removal, with emphasis on removal of pollutants of concern.
- The BMP should be aesthetically pleasing.
- The BMP should provide multiple benefits such as aesthetic enjoyment, wildlife habitat, open space, and/or support recreational use (i.e. be an element of a trail system);
- The BMP should include educational signage for visitors if appropriate; that
- Ancillary elements (fencing, gates, and access roads) should serve to mitigate risks (i.e. drowning, vandalism) and minimize costs of maintenance.

Biotreatment BMPs provide a variety of treatment mechanisms to remove both suspended and dissolved pollutants in urban storm water runoff. All biotreatment BMPs include treatment mechanisms that employ soil microbes and plants. Biotreatment BMPs may be either flow-based (limited storage) or volume-based (storage a key design component) and are designed to treat and discharge urban stormwater runoff to a downstream conveyance system. Biotreatment BMPs can be designed to promote infiltration and ET even though they are treat-and-release BMPs. Systems not designed primarily to infiltrate or evapotranspire stormwater may still reduce the volume of stormwater via infiltration and ET. If necessary to mitigate risks to

structures, human health, or other concerns, a biotreatment BMP may also be lined to prevent infiltration of urban storm water runoff into the underlying soils.

Operations and maintenance of biotreatment BMPs should emphasize preservation of hydraulic function and the promotion of robust biological processes. Biotreatment BMPs typically utilize "soft" infrastructure (e.g., vegetative slope stabilization as opposed to rip rap slope stabilization) and therefore require an adaptive approach to maintenance and performance enhancement, more typical of landscape maintenance than maintenance of hard infrastructure.

Note that while biotreatment BMPs may provide habitat value, plant growth may damage infrastructure elements in the facility such as fencing, curbs, etc. This hazard can be mitigated by incorporating root barriers or through regular maintenance.

The following sections provide principles that should govern the design, operation, and maintenance of biotreatment BMPs installed to meet permit requirements in Orange County.

XII.2. Biotreatment Selection to Address Pollutants of Concern

Biotreatment BMPs shall be selected that provide unit operations and processes (UOPs) that address the project pollutants of concern. The process of biotreatment BMP selection shall consist of the steps described in **TGD Section 2.4.2.5**.

XII.3. Conceptual Biotreatment Design Requirements

Biotreatment design requirements shall be consistent with the following principles:

- **Biotreatment BMPs shall be sized according to permit requirements described in the** Section 2.4 of the **Model WQMP.**
- **Biotreatment BMPs shall incorporate unit processes to address pollutants of concern. See TGD Section 2.4.2.5 for guidance.**
- **Biotreatment BMPs shall be designed to achieve the maximum feasible infiltration and ET by adhering to the criteria described in Appendix XI.**
- **Biotreatment BMPs shall be designed per the published design standards contained in the BMP Fact Sheets (Appendix XIV.5) and the design manuals referenced by these Fact Sheets.**
- **Biotreatment BMPs shall support a robust vegetative and microbial community appropriate to the local climate:**
    - For bioretention systems[18], select vegetation that is drought tolerant and can also survive extended periods of saturated soils.

[18] The use of the term "bioretention systems" in this appendix refers to bioretention with underdrains, rain gardens with underdrains, planter boxes with underdrains, curb-extension planter boxes with underdrains, proprietary bioretention systems, and other similar BMPs.

- For constructed stormwater wetlands and wet detention basins (wet ponds), select native species that include significant rhizomes and provide habitat benefits.
- For constructed stormwater wetlands and wet detention basins (wet ponds) provide appropriate mix of open water to vegetated area. The appropriate mix depends on the primary target constituents. For example, where nitrate is the dominant nutrient, the appropriate mix would include a higher proportion of vegetated area such as 80% vegetated, 20% open water.
- For dry extended vegetated detention basins, vegetated swales, and filter strips, select a variety of plant species that are drought tolerant, but can also survive periodic inundation.
- Provide an irrigation system, if necessary, for plant establishment and maintenance.

- **Biotreatment BMPs shall incorporate amended media and soils designed for the intended function of the BMP.**
  - Select amended media for use in bioretention systems that is effective at removing pollutants of concern, can absorb and evapotranspirate runoff, and where appropriate, can facilitate infiltration.
  - Select media and soils that will not potentially leach pollutants, specifically dissolved nutrients and metals in some cases.
  - Amend soils in dry extended detention basins, swales, and filter strips to provide suitable soils for supporting plants, which can absorb and evapotranspire runoff and where appropriate facilitate infiltration.
  - Design wet detention basins (wet ponds) and constructed stormwater wetlands using soils that support growth of attached plants.
- **BMPs hydraulics shall be designed to maximize pollutant removal functions.**
  - For all biotreatment BMPs, design inlets or overland flow entry to BMPs to prevent scour or re-entrainment of pollutants.
  - Provide maximum flow path distance between outlet and inlet and with sufficient length to width ratio to limit short circuiting.
  - For constructed stormwater wetlands and wet detention basins, provide the storage capacity for the DCV in the wet pool at a minimum.
  - Seasonal constructed stormwater wetlands and seasonal wet detention basins should not be used unless there is a reasonable expectation that tributary land uses will provide dry weather flows during seasonally wet period to maintain vegetation and prevent stagnant water.
  - For constructed stormwater wetlands and wet detention basins designed to be continually wet (opportunities may be limited in Orange County), ensure that a low-flow source of water is present to maintain vegetation and prevent stagnant conditions.
  - Design features shall allow for monitoring of drawdown such as depth markers and monitoring ports.

- For bioretention systems, provide media contact time sufficient for pollutant removal, with upper limitations on contact time to avoid leaching of retained pollutants. Traditional media should generally be designed in the range of 2 to 12 inches per hour, while specialized media can be effective for many pollutants of concern at much higher flowrates (residence times on the order of several minutes). For bioretention systems, design media mix and layer separation systems (i.e. between media and gravel layers) to reduce potential for clogging.
- For bioretention systems that include infiltration as a component, design a gravel pool below the underdrains (where used; ensure that the soils below this area can infiltrate (i.e., do not compact, or if compacted, restore soil infiltration capacity)). The minimum depth of gravel pool should be determined based on the underlying infiltration based on the amount of water that will infiltrate in 48 hours (see **Appendix XI.2**)
- For bioretention systems that will include infiltration as a component, the soil below the gravel pool must be able to allow infiltration. The soil may not be compacted. If the soil is compacted, the soil infiltration capacity must be restored.
- Consider using hydraulic control on the outlet of bioretention systems whenever practical rather than using media with lower infiltration rates for hydraulic control. This practice aids in avoiding clogging and can improve uniformity of performance over the life of the facility.
- For bioretention systems, do not use geotextile fabrics between layers of media due to clogging issues; use progressively-graded aggregate layers to prevent migration of fines if necessary.
- For bioretention systems limit ponding depths to 12 inches, unless system is isolated from public access via fencing or equivalent, then ponding depths should be limited to 18 inches.
- Bioretention systems and dry extended detention basins shall be designed to limit surface ponding to less than 96 hours for vector control per **California Department of Health Guidelines**. To provide a margin of safety, bioretention systems and extended detention basins should be designed to limit surface ponding to 72 hours. Subsurface ponding (in stone or gravel trenches) can create a vector hazard if the media has pore spaces that vectors can breed in.
- For biotreatment BMPs that employ extended detention, design outlet structures to ensure appropriate drawdown times and patterns and prevent floatables from leaving the facility; ensure that small storms receive appropriate extended detention times. A common rule of thumb is that the bottom half of the facility volume should draw down in two thirds of the total drawdown time.
- Outlet structures should be located and designed so that they are accessible for inspection and maintenance.
- For vegetated swales and filter strips, provide level spreaders and check dams where appropriate to promote even distribution of flow across the system.

  - Design systems such that flows above the BMP design intensity are provided a flow route that bypasses the BMP or can be passed through the BMP without entraining soils, media, or captured pollutants.
- **Biotreatment BMPs shall be subject to rigorous construction oversight, acceptance, and documentation process.**
  - Provide construction oversight by trained professionals to ensure that the BMP is installed as designed.
  - Consider conducting a flow test for bioretention systems to ensure they function at the design level.
  - Require the preparation of as-built drawings that clearly indicated design features of the BMP and inlet and outlet systems.
  - Inspect BMPs after initial commissioning to ensure that they are functioning as intended. More frequent inspection during initial operation periods (i.e., first rainy season) can help to mitigate early problems and ensure design level performance.

XII.4. Conceptual Biotreatment Operation Requirements

An operation and maintenance plan shall be developed for biotreatment BMPs that includes the following elements:

- **Frequency and type of inspections,**
- **Observations during wet weather to visually observe whether the BMP is functioning as intended,**
- **List of parameters/checklists for identifying maintenance needs and triggering maintenance activities,**
- **Vegetation management plan, including routine maintenance, and irrigation, if necessary,**
- **Sediment, trash and debris removal, and**
- **Routine and major (infrequent) maintenance activities.**

Reclaimed water considerations for operation of biotreatment BMPs:

If the project utilizes reclaimed water for irrigation, the project is required to comply with all waste discharge requirements and water provider use requirements applicable to the project. It is the responsibility of the project owner to ensure that operation of the project complies with these requirements. It is the responsibility of the water provider to ensure that requirements associated with the use of reclaimed water result in BMP operations that are protective of receiving water quality.

XII.5. Conceptual Biotreatment Maintenance Requirements

Biotreatment maintenance requirements contained in the Project O&M Plan shall be consistent with the following principles:

- **Routine maintenance shall be provided to ensure consistently high performance and extend facility life.**
  - Maintain vegetation and media to perpetuate a robust vegetative and microbial community (thin/trim vegetation, replace spent media and mulch).
  - Periodically remove dead vegetative biomass to prevent export of nutrients or clogging of the system.
  - Remove accumulated sediment before it significantly interferes with system function.
  - Where filtration/infiltration is employed, conduct maintenance to prevent surface clogging (surface scarring, raking, mulch replacement, etc.).
  - Add energy dissipation and scour-protection as required based on facility inspection.
  - Routinely remove accumulated sediment at the inlet and outlet and trash and debris from the entire BMP.
- **Major maintenance shall be provided when the performance of the facility declines significantly and cannot be restored through routine maintenance.**
  - Replace media / planting soils as triggered by reduction in filtration/infiltration rates or decline in health of biological processes.
  - Provide major sediment removal to restore volumetric capacity of basin-type BMPs.
  - Repair or modify inlets/outlets to restore original function or enhance function based on observations of performance.

Detailed descriptions of BMP maintenance activities are provided in:

- Los Angeles County Stormwater BMP Operations and Maintenance Manual, Chapter 5: **http://dpw.lacounty.gov/DES/design_manuals/StormwaterBMPDesignandMaintenance.pdf**