RULE NO.: **R161-15.12**

ADOPTION DATE: **January 4, 2016**

NOTICE OF RULE ADOPTION

By: Joseph G. Pantalion, P.E., Director
Watershed Protection Department

The Director of the Watershed Protection Department has adopted the following rule. Notice of the proposed rule was posted on October 6, 2015. Public comment on the proposed rule was solicited in the October 6, 2015 notice. This notice is issued under Chapter 1-2 of the City Code. The adoption of a rule may be appealed to the City Manager in accordance with Section 1-2-10 of the City Code as explained below.

A copy of the complete text of the adopted rule is available for public inspection and copying at the following locations. Copies may be purchased at the locations at a cost of ten cents per page:

> Watershed Protection Department, located at 505 Barton Springs Road, Suite 1200, Austin, TX, 78704; and
>
> Office of the City Clerk, City Hall, located at 301 West 2nd Street, Austin, Texas.

EFFECTIVE DATE OF ADOPTED RULE

A rule adopted by this notice is effective on January 4, 2016.

TEXT OF ADOPTED RULE

R161-15.12: Additions and revisions to the Environmental Criteria Manual Section 1.4, *Erosion and Sediment Control*, and Environmental Criteria Manual Section 1.6, *Design Guidelines for Water Quality Control*, as follows:

Environmental Criteria Manual Section 1.4 – Erosion and Sedimentation Control

- **1.4.3 – Definitions**
  - Certified Inspectors: Added CESSWI to the list of licensed inspectors.
  - Permanent Stabilization: Clarified that this applies to disturbed areas which are dormant for 14 days or longer.
- **1.4.4.D.4 - Compliance Inspection by the City, Enforcement of Non-compliance by the City**
  - Replaced term "Cease and Desist" with correct terminology "Stop Work Order".
- **1.4.4.F – Maintenance Responsibilities After Construction**
  - Updated code reference.
- **1.4.6.D – Rock Riprap**
  - Added Section 6, Rock Riprap Gradation Field Verification, which refers to Standard Specification 591S for gradation field test methods.
- **1.4.7.A Vegetative Practices**
  - 6. Seed Bed Preparation – Revised language about depth of decompaction from 4 to 6-12 inches, and added sentence about not driving over decompacted soils with heavy equipment.

Environmental Criteria Manual Section 1.6 - Design Guidelines for Water Quality Controls

- **1.6.2.F – Integrated Pest Management Guidelines**
  - Updated and relocated IPM criteria.
- **1.6.3 - Maintenance and Construction Requirements**
  - A. Amended to reference SCMs- stormwater control measures, removed the term released and replaced with accepted, and clarified applicable sections of the ECM and DCM that must be met for pond acceptance.
  - B. Removed redundant pond requirements that are already required in section DCM 1.2.4.E.
  - C. Reorganized and condensed section to clarify requirements for all SCMs. Added Green Stormwater Team maintenance recommendations for GSI.
  - D. Updated and relocated irrigation guidelines for all SCMs.
- **1.6.5 - Design Guidelines for Sedimentation/Filtration Systems**
  - Removed water quality pond high flow geotextile fabric table 1.6.5.A.1 and incorporated it into standard specification 620S, Filter Fabric.
- **1.6.7.1 Introduction**

- Updated terminology to reflect proposed modification to 1.6.

- **1.6.7.C. – Biofiltration**
  - 1. Clarified splitter box/flow spreading requirement and added reference to section 1.6.2.B
  - 2. Removed redundant splitter box design language.
  - 3. Clarified splitter box/flow spreading language and added reference to section 1.6.2.B for splitter box design.
  - 4.A. Removed reference to biofiltration sequence of construction requirements. This section has been incorporated into the biofiltration standard specification.
  - 4.B. Updated section to clarify granular filter design criteria.
  - 5. Reorganized and condensed section on Landscape Design for greater clarity, less redundancy. Revised recommended plant species list and add table of plants not recommended.
- **1.6.7.E Porous Pavement**
  - 3. Design Guidelines – corrected assumed effective porosity of gravel bed to read less than or equal to 0.30
  - 6. Post Construction/Inspection – Corrected saturated hydraulic conductivity requirement clarifying that it must be great than or equal to 0.20 in/hr.
- **1.6.7.G Non Required Vegetation**
  - 2. Updated biofiltration medium reference to new standard specification
- **1.6.7.H. Rain Garden**
  - 2. Site Selection - Added the word "Zone" to the phrase Barton Springs Recharge.
  - 5. Growing Medium – Update reference to new biofiltration medium standard specification.

CHANGES FROM PROPOSED RULE

No changes were made from the proposed rule.

LIST OF COMMENTS RECEIVED AND DEPARTMENT RESPONSES TO COMMENTS

The following written comments were received regarding the proposed R161-15.12:

Comment from Casey Giles

Comment: I think gray water should be allowed to be used in SCMs while vegetation is being established, i.e. on a temporary basis during construction. using the logic in the spreadsheet, we should also not water in any area that will drain to an SCM?

Follow-up: Chris Herrington has requested that language be added to the proposed irrigation guidelines to not allow the use of treated wastewater effluent or reclaimed water to irrigate SCMs. It was decided that reclaimed water in SCM on either a temporary or permanent basis should be prohibited. I think it should be allowed on a temporary basis, especially while trying to establish any vegetation/sod.
I was also noting that using the logic presented in the list of comments (about how watering SCMs with gray water could make the SCMs less effective), it seems like irrigating in areas that eventually drain to SCMs would also make those SCMs less effective, so we shouldn't use gray water there either.

Staff Response:
As noted, reclaimed water has substantially higher concentrations of nutrients than stormwater runoff even from developed areas, and thus irrigating stormwater treatment devices with reclaimed water even on a temporary basis could reduce the ability of the stormwater control to achieve its designed functions, especially with respect to nutrient reduction. Additionally, irrigation with reclaimed water in some stormwater controls even on a temporary basis, depending on the method of irrigation and type of control, could constitute a violation of specific elements of Texas Commission on Environmental Quality (TCEQ) regulations for beneficial reuse of reclaimed water under 30 TAC 210 and could be an unauthorized discharge of wastewater effluent in violation of the state/federal law as well as City of Austin Code Title 6-5.
Watershed Protection Department studies have preliminarily identified negative water quality impacts from application of reclaimed water immediately adjacent to creeks. The primary concern is application too close to creeks, without adequately vegetated and fully-functional riparian buffers to mitigate the impacts of the reclaimed water to shallow groundwater in communication with nearby surface water or directly (overland) to the surface water.
Use of reclaimed water consistent with City of Austin code in the catchment area of the stormwater control is of much less concern than use in the stormwater control. I agree that reclaimed water application does increase nutrient loading to the environment. If applied consistent with best practices, state regulation and City of Austin code, then the reclaimed water should be applied in such a way that water resources are not directly impacted and the receiving landscape (if not immediately adjacent to creeks) would mitigate the potential water quality impacts from reclaimed water.

AUTHORITY FOR ADOPTION OF RULE

The authority and procedure for the adoption of a rule to assist in the implementation, administration, or enforcement of a provision of the City Code is established in Chapter 1-2 of the City Code. The authority to regulate water quality is established in Chapter 25-8 of the City Code.

APPEAL OF ADOPTED RULE TO CITY MANAGER

A person may appeal the adoption of a rule to the City Manager. **AN APPEAL MUST BE FILED WITH THE CITY CLERK NOT LATER THAN THE 30TH DAY AFTER THE DATE THIS NOTICE OF RULE ADOPTION IS POSTED. THE POSTING DATE IS NOTED ON THE FIRST PAGE OF THIS NOTICE.** If the 30th day is a Saturday, Sunday, or official city holiday, an appeal may be filed on the next day which is not a Saturday, Sunday, or official city holiday.

An adopted rule may be appealed by filing a written statement with the City Clerk. A person who appeals a rule must (1) provide the person's name, mailing address, and telephone number; (2) identify the rule being appealed; and (3) include a statement of specific reasons why the rule should be modified or withdrawn.

Notice that an appeal was filed and will be posted by the city clerk. A copy of the appeal will be provided to the City Council. An adopted rule will not be enforced pending the City Manager's decision. The City Manager may affirm, modify, or withdraw an adopted rule. If the City Manager does not act on an appeal on or before the 60th day after the date the notice of rule adoption is posted, the rule is withdrawn. Notice of the City Manager's decision on an appeal will be posted by the city clerk and provided to the City Council.

On or before the 16th day after the city clerk posts notice of the City Manager's decision, the City Manager may reconsider the decision on an appeal. Not later than the 31st day after giving written notice of an intent to reconsider, the City manager shall make a decision.

CERTIFICATION BY CITY ATTORNEY

By signing this Notice of Rule Adoption (R161-15.12), the City Attorney certifies that the City Attorney has reviewed the rule and finds that adoption of the rule is a valid exercise of the Director's administrative authority.

REVIEWED AND APPROVED

Joseph G. Pantalion, P.E., Director
Watershed Protection Department

Date: 12-10-15

Anne Morgan
City Attorney

Date: 12/18/15

1.4.3 - Definitions (in accordance with TPDES General Permit and COA technical manuals)

Arid Areas - Areas with an average annual rainfall of 0 to 10 inches.

Baseflow - The discharge in a channel that is relatively constant, occurring between storm runoff events. That flow which can be expected on a daily basis without storm flows.

Best Management Practices (BMPs) - Schedules of activities, prohibitions of practices, maintenance procedures, structural controls, local ordinances, and other management practices to prevent or reduce the discharge of pollutants. BMPs also include treatment requirements, operating procedures, and practices to control construction site runoff, spills or leaks, waste disposal, or drainage from raw material storage areas.

Bonded Fiber Matrix (BFM) - Bonded Fiber Matrix shall consist of long thermally refined wood fibers produced from grinding clean, whole wood chips and cross-linked hydro-colloidal tackifiers.

Certified Inspector - A person who has received training and is licensed by CPESC, CESSWI or CISEC to inspect and maintain erosion and sediment control practices.

Clearing - Any activity that removes the vegetative surface cover. Mass clearing is defined as the practice of clearing the entire site of all vegetation (except protected trees) to prepare for final grading. This is opposed to Selective clearing, which only disturbs the soil and vegetation where a road or infrastructure will be placed.

Commencement of Construction - The initial disturbance of soils associated with clearing, grading, or excavation activities, as well as other construction-related activities (e.g., stockpiling of fill material, demolition)

Common Plan of Development - A construction activity that is completed in separate stages, separate phases, or in combination with other construction activities. A common plan of development (also known as a "common plan of development or sale") is identified by the documentation for the construction project that identifies the scope of the project, and may include plats, blueprints, marketing plans, contracts, building permits, a public notice or hearing, zoning requests, or other similar documentation and activities. A common plan of development does not necessarily include all construction projects within the jurisdiction of a public entity (e.g., a city or university). Construction of roads or buildings in different parts of the jurisdiction would be considered separate "common plans," with only the interconnected parts of a project being considered part of a "common plan" (e.g., a building and its associated parking lot and driveways, airport runway and associated taxiways, a building complex, etc.). Where discrete construction projects occur within a larger common plan of development or sale but are located ¼ mile or more apart, and the area between the projects is not being disturbed, each individual project can be treated as a separate plan of development or sale, provided that any interconnecting road, pipeline or utility project that is part of the same "common plan" is not included in the area to be disturbed.

Control Plan - indicating the specific measures and sequencing to be used to control sediment and erosion on a development site during and after construction.

Discharge - For the purposes of this permit, the drainage, release, or disposal of pollutants in storm water and certain non-storm water from areas where soil disturbing activities (e.g., clearing, grading, excavation, stockpiling of fill material, and demolition), construction materials or equipment storage or maintenance(e.g., fill piles, borrow area, concrete truck washout, fueling), or other industrial storm water directly related to the construction process (e.g., concrete or asphalt batch plants) are located.

Drainage Way - Any channel that conveys surface runoff throughout the site.

Edwards Aquifer - As defined under Texas Administrative Code § 213.3 of this title (relating to the Edwards Aquifer), that portion of an arcuate belt of porous, water-bearing, predominantly carbonate rocks known as the Edwards and Associated Limestones in the Balcones Fault Zone trending from west to east to northeast in Kinney, Uvalde, Medina, Bexar, Comal, Hays, Travis, and Williamson Counties; and composed of the Salmon Peak Limestone, McKnight Formation, West Nueces Formation, Devil's River Limestone, Person Formation, Kainer Formation, Edwards Formation, and

Georgetown Formation. The permeable aquifer units generally overlie the less-permeable Glen Rose Formation to the south, overlie the less permeable Comanche Peak and Walnut Formations north of the Colorado River, and underlie the less permeable Del Rio Clay regionally.

Edwards Aquifer Contributing Zone - The area or watershed where runoff from precipitation flows downgradient to the recharge zone of the Edwards Aquifer. The contributing zone is located upstream (upgradient) and generally north and northwest of the recharge zone for the following counties: all areas within Kinney County, except the area within the watershed draining to Segment 2304 of the Rio Grande Basin; all areas within Uvalde, Medina, Bexar, and Comal Counties; all areas within Hays and Travis Counties, except the area within the watersheds draining to the Colorado River above a point 1.3 miles upstream from Tom Miller Dam, Lake Austin at the confluence of Barrow Brook Cove, Segment 1403 of the Colorado River Basin; and all areas within Williamson County, except the area within the watersheds draining to the Lampasas River above the dam at Stillhouse Hollow reservoir, Segment 1216 of the Brazos River Basin. The contributing zone is illustrated on the Edwards Aquifer map viewer at http://www.tceq.state.tx.us/compliance/field_ops/eapp/mapdisclaimer.html.

Edwards Aquifer Recharge Zone - Generally, that area where the stratigraphic units constituting the Edwards Aquifer crop out, including the outcrops of other geologic formations in proximity to the Edwards Aquifer, where caves, sinkholes, faults, fractures, or other permeable features would create a potential for recharge of surface waters into the Edwards Aquifer. The recharge zone is identified as that area designated as such on official maps located in the offices of the Texas Commission on Environmental Quality and the Construction General Permit TPDES General Permit TXR150000 The Edwards Aquifer Map Viewer, located at http://www.tceq.state.tx.us/compliance/field_ops/eapp/mapdisclaimer.html

can be used to determine where the recharge zone is located.

Erosion Control - A measure that prevents erosion.

Erosion and Sediment - A set of plans prepared by or under the direction of a certified professional

Facility or Activity - For the purpose of this permit, a construction site or construction support activity that is regulated under this general permit, including all contiguous land and fixtures (e.g., ponds and materials stockpiles), structures, or appurtances used at a construction site or industrial site described by this general permit.

Fiber Reinforced Matrix (FRM) - Fiber Reinforced Matrix shall consist of long thermally refined wood fibers produced from grinding clean, whole wood chips, crimped interlocking fibers, cross-linked hydro-colloidal tackifiers and performance enhancing additives.

Final Stabilization - A construction site status where any of the following conditions are met:

(a) All soil disturbing activities at the site have been completed and a uniform (i.e., evenly distributed, without large bare areas) perennial vegetative cover with a density of at least 95% of the vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

(b) For individual lots in a residential construction site by either:

  (1) the homebuilder completing final stabilization as specified in condition (a) above; or

  (2) the homebuilder establishing temporary stabilization for an individual lot prior to the time of transfer of the ownership of the home to the buyer and after informing the homeowner of the need for, and benefits of, final stabilization. If temporary stabilization is not feasible, then the homebuilder may fulfill this requirement by retaining perimeter controls or other best management practices, and informing the homeowner of the need for removal of temporary controls and the establishment of final stabilization.

(c) For construction activities on land used for agricultural purposes (e.g. pipelines across crop or range land), final stabilization may be accomplished by returning the disturbed land to its preconstruction agricultural use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to surface water and areas that are not being returned to their preconstruction agricultural use must meet the final stabilization conditions of condition (a) above.

Fugitive sediment - Sediment resulting from earth disturbing activities that is mobilized by wind or water and transported from the construction site to any point outside the limits of construction.

Grading - Excavation or fill of material, including the resulting conditions thereof.

Hyperchlorination of Waterlines - Treatment of potable water lines or tanks with chlorine for disinfection purposes, typically following repair or partial replacement of the waterline or tank, and subsequently flushing the contents.

Indian Country Land - (from 40 CFR 122.2) (1) all land within the limits of any Indian reservation under the jurisdiction of the United States government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation; (2) all dependent Indian communities with the borders of the United States whether within the originally or subsequently acquired territory thereof, and whether within or without the limits of a state; and (3) all Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same.

Indian Tribe - (from 40 CFR 122.2) any Indian Tribe, band, group, or community recognized by the Secretary of the Interior and exercising governmental authority over a Federal Indian Reservation.

Large Construction Activity - Construction activities including clearing, grading, and excavating that result in land disturbance of equal to or greater than five (5) acres of land. Large construction activity also includes the disturbance of less than five (5) acres of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb equal to or greater than five (5) acres of land. Large construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site (e.g., the routine grading of existing dirt roads, asphalt overlays of existing roads, the routine clearing of existing right-of-ways, and similar maintenance activities.)

Municipal Separate Storm Sewer System (MS4) - A separate storm sewer system owned or operated by the United States, a state, city, town, county, district, association, or other public body (created by or pursuant to state law) having jurisdiction over the disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under state law such as a sewer district, flood control or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, that discharges to surface water in the state.

Notice of Change (NOC) - Written notification to the executive director from a discharger authorized under this permit, providing changes to information that was previously provided to the agency in a notice of intent form.

Notice of Intent (NOI) - A written submission to the executive director from an applicant requesting coverage under this general permit.

Notice of Termination (NOT) - A written submission to the executive director from a discharger authorized under a general permit requesting termination of coverage.

Operator - The person or persons associated with a large or small construction activity that is either a primary or secondary operator as defined below:

Primary Operator - the person or persons associated with a large or small construction activity that meets either of the following two criteria:

(a) the person or persons have operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications; or

(b) the person or persons have day-to-day operational control of those activities at a construction site that are necessary to ensure compliance with a storm water pollution prevention plan (SWP3) for the site or other permit conditions (e.g., they are authorized to direct workers at a site to carry out activities required by the SWP3 or comply with other permit conditions).

Secondary Operator - The person whose operational control is limited to the employment of other operators or to the ability to approve or disapprove changes to plans and specifications. A secondary operator is also defined as a primary operator and must comply with the permit requirements for primary operators if there are no other operators at the construction site.

Outfall - For the purpose of this permit, a point source at the point where storm water runoff associated with construction activity discharges to surface water in the state and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels, or other conveyances that connect segments of the same stream or other water of the U.S. and are used to convey waters of the U.S.

Perimeter Control - A barrier that prevents sediment from leaving a site by detaining sediment-laden runoff or diverting it to a sediment trap or basin.

Permanent Stabilization - The use of practices that prevent exposed soil from eroding upon achieving final grade. Permanent stabilization includes a broad range of items such as vegetation, structures which cover the soil to protect, paving, and post development stormwater controls that shall be implemented within 7 calendar days after completion of construction activities or each phase of construction. For the purposes of this section, construction activities are considered complete upon submittal of the engineer's concurrence letter per LDC 25-1-332 and 25-8-182.

Permittee - An operator authorized under this general permit. The authorization may be gained through submission of a notice of intent, by waiver, or by meeting the requirements for automatic coverage to discharge storm water runoff and certain non-storm water discharges.

Phasing - Clearing a parcel of land in distinct phases, with the stabilization of each phase completed before the clearing of the next.

Point Source - (from 40 CFR §122.2) Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are, or may be, discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant - Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, filter backwash, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into any surface water in the state. The term "pollutant" does not include tail water or runoff water from irrigation or rainwater runoff from cultivated or uncultivated rangeland, pastureland, and farmland. For the purpose of this permit, the term "pollutant" includes sediment.

Pollution - (from Texas Water Code §26.001(14)) The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any surface water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Rainfall Erosivity Factor (R factor) - the total annual erosive potential that is due to climatic effects, and is part of the Revised Universal Soil Loss Equation (RUSLE).

Sediment Control - Measures that prevent eroded sediment from leaving the site.

Semiarid Areas - areas with an average annual rainfall of 10 to 20 inches.

Separate Storm Sewer System - A conveyance or system of conveyances (including roads with drainage systems, streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains), designed or used for collecting or conveying storm water; that is not a combined sewer, and that is not part of a publicly owned treatment works (POTW).

Site Development - The construction or reconstruction of a building or road; the placement of a structure on land; the excavation, mining, dredging, grading or filling of land; the removal of vegetation from land; or the deposit of refuse or waste on land.

Small Construction Activity - Construction activities including clearing, grading, and excavating that result in land disturbance of equal to or greater than one (1) acre and less than five (5) acres of land. Small construction activity also includes the disturbance of less than one (1) acre of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb equal to or greater than one (1) and less than five (5) acres of land. Small construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site (e.g., the routine grading of existing dirt roads, asphalt overlays of existing roads, the routine clearing of existing right-of-ways, and similar maintenance activities.)

Start of Construction - The first land-disturbing activity associated with a development, including land preparation such as clearing, grading, and filling and demolition; installation of streets and walkways; excavation for basements, footings, piers, or foundations; erection of temporary forms; and installation of accessory buildings such as garages.

Storm Water (or Storm Water Runoff) - Rainfall runoff, snow melt runoff, and surface runoff and drainage.

Storm Water Associated with Construction Activity - Storm water runoff from a construction activity where soil disturbing activities (including clearing, grading, excavating) result in the disturbance of one (1) or more acres of total land area, or are part of a larger common plan of development or sale that will result in disturbance of one (1) or more acres of total land area.

Structural Control (or Practice) - A pollution prevention practice that requires the construction of a device, or the use of a device, to capture or prevent pollution in storm water runoff. Structural controls and practices may include but are not limited to: silt fences, earthen dikes, drainage swales, sediment traps, check dams, subsurface drains, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions, and temporary or permanent sediment basins.

Surface Water in the State - Lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, wetlands, marshes, inlets, canals, the Gulf of Mexico inside the territorial limits of the state (from the mean high water mark (MHWM) out 10.36 miles into the Gulf), and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or nonnavigable, and including the beds and banks of all water-courses and bodies of surface water, that are wholly or partially inside or bordering the state or subject to the jurisdiction of the state; except that waters in treatment systems which are authorized by state or federal law, regulation, or permit, and which are created for the purpose of waste treatment are not considered to be water in the state.

Temporary Stabilization - A condition where exposed soils or disturbed areas which are dormant for 14 days or longer are provided a protective cover or other structural control to prevent the mobilization and migration of pollutants. Use of bark mulch, Fiber Reinforced Matrix (FRM), Bonded Fiber Matrix (BFM), soil retention blanket, Turf Reinforcement Mat (TRM), sod, rock rip rap, or other cover that prevents the detachment of soil particles until final stabilization is achieved.

Waters of the United States - (from 40 CFR, Part122, Section 2) Waters of the United States or waters of the U.S. means:

(a) all waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(b) all interstate waters, including interstate wetlands;

(c) all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds that the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:

    (1) which are or could be used by interstate or foreign travelers for recreational or other purposes;

    (2) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

(3) which are used or could be used for industrial purposes by industries in interstate commerce;

(d) all impoundments of waters otherwise defined as waters of the United States under this definition;

(e) tributaries of waters identified in paragraphs (a) through (d) of this definition;

(f) the territorial sea; and

(g) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR '423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA.

Watercourse - Any body of water, including, but not limited to lakes, ponds, rivers, streams, and bodies of water delineated by City of Austin, USGS, USACE or TCEQ.

Waterway - A channel that directs surface runoff to a watercourse or to the public storm drain.

1.4.4 - Plan Development and Implementation

D. **Procedures During Construction.**

4. Compliance Inspection by the City.

The Development Services Department is primarily responsible for the inspection and enforcement of erosion and sedimentation control requirements on site developments and subdivisions. The city will monitor compliance with plan requirements and judge the effectiveness of the controls during different stages of construction and before and after significant rainfall.

Compliance Criteria

The criteria used to determine the compliance or non-compliance of a project's temporary erosion and sedimentation controls include the following:

- The project must have a valid, current city development permit or site plan.

- The project must be in substantial compliance with the approved plans and specifications (ESCP) for the development permit. This is determined by inspection of various items at the site.

Structural control practices which should be inspected are the following:

- Controls must be installed in all required areas in accordance with approved plans and specifications.

- Materials must meet minimum requirements.

- Maintenance must be performed when trapped sediment exceeds allowed limits.

- Disturbances to erosion and sedimentation controls by construction activity or runoff must be repaired within 48 hours of discovery (as determined by the inspection log or by the City Inspector).

- Temporary removal of portions of controls during necessary construction activities is allowed if the controls are replaced by the end of the work day. Additions or adjustments to the ESCP are necessary if the controls cannot be replaced in their original location.

Site Management practices which should be reviewed include the following:

- Construction sequence and phasing must follow approved plans.

- Disturbed areas cannot be outside the LOC as shown on the approved plans, including fill areas, haul roads, and storage areas.

• All temporary and permanent spoil disposal areas, both on and off-site, must comply with approved plans and ordinances.

• All disturbed areas which are dormant for 14 days or longer shall be temporarily stabilized during construction to prevent soil detachment from wind or rain.

• Construction in creek channels requires that upstream flows be impounded upstream of the work site and routed around the construction area anytime there is equipment in the channel. Spoils must be removed from the channel of any creek or drainage way and its associated floodplain at the end of each work day.

The installed controls must prevent sedimentation in off-site or undisturbed areas.

If the installed erosion and sedimentation controls are in compliance with the approved plans but are not adequate to prevent the transport of sediment from the disturbed areas, plan adjustments or a plan revision must be made.

Inspection Before and After Rainfall

Controls and adjacent downstream areas should be carefully inspected just prior to expected significant (> one-half inch) rainfall and inspected following significant rainfall events to assess the effectiveness of the controls and any adjustments, repair, or maintenance necessary. Inspection of the erosion and sedimentation controls this time is the most effective way to determine whether the plan is adequate.

The following guidelines can be used to determine the adequacy of controls after a rainfall:

• All visible drainage patterns left on-site after rainfall, especially areas of channelized flow (e.g. rills and gullies), should be carefully noted and the resulting effects of these on the structural controls should be observed. Concentrated flow areas, low points in perimeters, and channels adjacent to the project will usually be the critical areas where off-site sedimentation will be most likely to occur.

• Overtopping, undermining, or bypassing of the structural controls will require repairs, adjustments, relocation, or additional controls. Before taking these actions, determine if failures were due to inadequate installation, improper location, or greater runoff than the control was designed to handle.

• Above all, note where sediment has been carried on or off site. If controls appear to be intact and contain visible, significant amounts of sediment build up, this is evidence that they are working correctly. Visible amounts of sediment carried off of the project site is evidence that the temporary controls are not working as intended and that adjustments are needed. Any sediment carried off-site shall be retrieved by the contractor and returned to the site and stabilized. Any off-site damages that occur from fugitive sediment that exits a site shall be mitigated by the contractor per a mitigation plan approved by COA. If contractor refuses to remediate, COA may retain fiscal surety deposited to cover remediation.

The inspector and site personnel can recognize sediment that has been carried off of a particular project site by noting similarities in color, texture, and grain size to the soil existing on the site. It is recommended that existing off-site conditions be noted or documented before construction in order to help assess the effectiveness of the erosion and sedimentation controls during construction. Inspectors should also note the condition and operating characteristics of detention and water quality ponds under inspection after rainfall events in order to assess their performance prior to acceptance of a project.

Revisions to Controls

Most erosion and sedimentation controls will normally require some minor adjustments or additions during construction. These are known as "field revisions" and will not require a plan revision if approved by the Engineer and the inspector. Significant modifications to the controls or the ESCP, however, may require a plan correction or revision and resubmittal to COA.

Enforcement of Non-compliance by the City The city inspector responsible for environmental regulations can take enforcement action under Section 25-1-441 of the city's Land Development Code for non-compliance with erosion and sedimentation requirement on a project site. Enforcement action can be by way of the issuance of a Stop Work Order. Issuance of a Stop Work Order stops all city inspection services and utility connections from all departments until the deficiencies are corrected and the Stop Work Order is released by the City. Violations of environmental regulations may also be enforced by the City through the suspension of the site plan or through the court system.

On projects that have obtained the required development permit/site plan from the city and where routine inspections reveal inadequacies in the controls, the inspector will give a verbal warning to the responsible personnel at the site of any noted and what corrective action is necessary. If, after a minimum period of 24 hours from this verbal warning, the deficiencies are not corrected, the inspector may deliver a written notice of non-compliance to the responsible on-site personnel. If, after an additional minimum period of 24 hours, the deficiencies are not corrected, the inspector can issue a Stop Work Order to stop work on the project until the deficiencies are corrected.

If the temporary or permanent controls fail such that construction sediment migrates off the site, it shall be the responsibility of the Contractor to: 1) retrieve the fugitive sediment to the satisfaction of the City of Austin inspector 2) restore the off-site areas impacted by fugitive sediment to pre-disturbance conditions (determined by the City inspector, pre-disturbance photos and the impacted landowner(s)); 3)revise or repair erosion and sedimentation controls within 48 hours of failure to the satisfaction of City Inspector.

Enforcement action can proceed immediately without a 48-hour warning period by the city inspector in some situations. These include the following:

- Project is within the jurisdiction of the city but has started construction without obtaining the required development permit or site plan.

- Project has a valid permit but work was initiated without the required preconstruction meeting and without installation of temporary controls.

- When significant or irreparable damage is judged to be occurring on a permitted site, the inspector may first ask the contractor to cease all work in the area of the violation. If the contractor complies with the verbal stop-work order and immediately institutes corrective measures in the area of the job violation, the inspector will not issue a Stop Work Order. If the work in violation is not stopped and corrective measures are not taken, the inspector may issue a Citation or Stop Work Order for the entire project.

F. **Maintenance Responsibilities After Construction.**

Following release or acceptance of a project (and termination of the development permit) the property owner is responsible for maintaining the project site. The release of excessive amounts of sediment in stormwater runoff is prohibited by the Environmental Control and Conservation Code (6-5-53). Any person causing stoppage, damage or restriction of flow in any storm sewer or watercourse may be liable to the city for repairs to these waterways.

D. **Rock Riprap.**

1. Description.

   A layer of loose rock or aggregate placed over an erodible soil surface.

2. Purpose.

   The purpose of rock riprap is to protect the soil surface from the erosive forces of water.

3. Condition Where Practice Applies.

   This practice applies to soil-water interfaces where the soil conditions, water turbulence and velocity, expected vegetative cover and ground water conditions are such that the soil may erode under the design flow conditions. Rock riprap may be used, as appropriate, at such places as storm drain outlets, channel banks and/or bottoms, roadside ditches, drop structures and shorelines.

4. Design Criteria.

   The design of rock riprap for erosion control includes determination of a rock size and gradation to resist movement for the design hydraulic conditions. In addition an underlying filter layer that prevents migration of soils through the armor is often required. Rock size selection is based on the water forces acting on the rock matrix during the design discharge. The design discharge for sizing rock riprap for the portion of channels and ditches protected with stone riprap shall be the peak discharge from a one hundred (100) year frequency rainfall event. The roughness coefficient, "n", of riprap is highly dependent on the size of the rock used in the gradation and the depth of flow over the armor surface. At low flow depths the relative effect of rock riprap size on roughness is greater than that at higher flow depths. Significant guidance regarding roughness estimation exists in the literature, however the equation adapted for the Federal Highway Administration Hydraulic Engineering Circular No. 15, "Design of Roadside Channels with Flexible Linings" (2005) is recommended for determining the roughness value for the constructed riprap surface:

$$n = \frac{0.262\, d^{\frac{1}{6}}}{2.25 + 5.23 \log(d/D_{50})}$$

   where:

   d = the average channel flow depth (ft)

D_{50} = median rock diameter for which 50% of the gradation is comprised of rocks of equal or smaller size (feet)

5. Rock Riprap Size and Gradation.

Rock riprap should be of sufficient size and properly graded that the stone weight and interlocking characteristics of the rock mixture resists movement when exposed to hydraulic stresses. The curve in Figure 1-22 in Appendix V of this manual provides an estimate of individual minimum rock sizes (diameter and weight of a spherical specimen) for a range of channel velocities that may be stable up to 17 feet per second. The chart was adapted from the United States Bureau of Reclamation, "Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Monograph No. 25", (1983). The rock size rating curve was based on laboratory flume tests and prototype stilling basins observed by the Bureau of Reclamation. The rock riprap sizing criteria is most applicable to high energy environments. The curve can be represented with the following expression:

$$D_{50} = 0.0105V^{2.06}$$

where:

D50 = median rock diameter (feet)

V = average water velocity (ft/sec)

Stone weight can be estimated assuming a shape midway between a sphere and a cube using the following expression (adapted from ASTM D5519).

$$W_{50} = 47.54D_{50}{}^{3}S_{g}$$

where:

W_{50} = median stone weight for which 50% of the gradation is comprised of rocks of equal or lesser weight (lbs)

Sg = specific gravity of the stone

Stone weight varies with the source of the material. For quartz the specific gravity is approximately 2.65, where many types of native Texas limestone can vary from 2.3 to 2.5. For placed rock riprap the minimum recommended specific gravity is 2.4.

Rock riprap gradation, as used herein, is defined as an allowable particle size distribution based on the median particle diameter, or D50. The rock riprap gradation shall conform to the gradation table below. Neither the width nor the thickness of a single stone shall be less than one third of its length.

Rock Riprap Gradation Table

Rock Riprap Class by Median Particle Diameter (D50)			(in) (D85				in)	D100 (in)	
Class	Diameter (in)	Min	Max	Min	Max	Min		Max	Max
I	6	3.7	5.2	5.7	6.9	7.8		9.2	12.0
II	9	5.5	7.8	8.5	10.5	11.5		14.0	18.0
III	12	7.3	10.5	11.5	14.0	15.5		18.5	24.0
IV	15	9.2	13.0	14.5	17.5	19.5		23.0	30.0
V	18	11.0	15.5	17.0	20.5	23.5		27.5	36.0
VI	21	13.0	18.5	20.0	24.0	27.5		32.5	42.0
VII	24	14.5	21.0	23.0	27.5	31.0		37.0	48.0
VIII	30	18.5	26.0	28.5	34.5	39.0		46.0	60.0
IX	36	22.0	31.5	34.0	41.5	47.0		55.5	72.0
X	42	25.5	36.5	40.0	48.5	54.5		64.5	84.0

Reference: National Cooperative Highway Research Program, "NCHRP Report 568 - Riprap Design Criteria, Recommended Specifications, and Quality Control."

The rock riprap layer thickness shall be no less than the maximum stone size (D100) or 1.5 times the D50, whichever produces the greater thickness. For applications in drainage channels the riprap layer should be a minimum of 2.0 times as thick as the median stone size specified.

6. Rock Riprap Gradation Field Verification

Rock gradations larger than Class I may require field testing as traditional test methods such as sieves or mechanical sorting machines may be impractical. Where projects require field verification of the rock riprap size class and gradation, the test methods described in City of Austin Standard Specification 591S Riprap for Slope Stabilization may be used.

7. Filter

A filter is a transitional layer of material placed between the riprap and the underlying soil surface intended to prevent soil movement through the riprap and permit relief of hydrostatic pressure within the soils. Filters can prevent loss of the underlying soil through piping or from surface water causing erosion beneath the riprap. A filter is recommended especially when the riprap is placed on noncohesive material that is subject to significant subsurface drainage. Areas where water surface levels fluctuate frequently and areas of high groundwater levels should include filters in the design of riprap revetment.

A filter can be of two (2) general forms. A fabric filter is one or more layers layer of geotextile filter fabric manufactured for that express purpose and a granular filter is one or more graded layers of sand, gravel or stone.

The proper design of filters is critical to the stability of riprap installations on channel banks. If openings in the filter are too large, excessive flow piping through the filter can cause erosion and failure of the bank material below the filter. On the other hand, if the openings in the filter are too small, the build-up of hydrostatic pressures behind the filter can cause a slip plane to form along the filter resulting in massive translational slide failure.

To determine the need for a filter and to properly design granular filters the gradation of the armor layer, filter layers and adjacent strata to meet the following criteria:

$$\frac{D_{15(Upper)}}{D_{85(Lower)}} < 5 < \frac{D_{15(Upper)}}{D_{15(Lower)}} < 40$$

In the above relationships, "upper" refers to the overlying material and "lower" refers to the underlying material. The relationships must hold between the filter and base material and between the riprap and the filter. A filter ratio of 5 or less between layers will usually result in a stable condition. The filter ratio is defined as the ratio of the 15 percent particle size (D15) of the upper/coarser layer to the 85 percent particle size (D85) of the lower/finer layer. An additional requirement for stability is that the ratio of the 15 percent particle size of the upper/coarser material to the 15 percent particle size of the lower/finer material should exceed 5 but not be less than 40. When determining the need for a filter the upper layer represents the rock armor and the lower layer represents the finer underlying substrate. In design, the filter material will be evaluated relative to the rock armor and the underlying material. In cases where the requirements cannot be met with a single gradation multiple layers of granular filter material of varying gradations may be required to meet the criteria. The thickness of a granular filter layer should be no less than 1.5

times the maximum size in the filter gradation. The minimum allowable thickness for a filter blanket shall be 102 mm (4 in).

In design of an appropriate geotextile as a riprap filter, soil retention , permeability, clogging survivability should be considered. Detailed design guidance for selection of geotextiles as a riprap filter can be found in the Federal Highway Administration "Geosynthetic Design and Construction Guidelines" (FHWA-HI-95-038). With the exception of problematic soils or high velocity conditions associated with steep channels and rundowns, geotextile filters may usually be selected based on the apparent opening size (AOS) of the geotextile and the soil type as shown in the following table from FHWA-HI-95-038.

Maximum AOS for Geotextile Filters

Soil Type	Maximum AOS (mm)
Non cohesive, less than 15 percent passing the US #200	0.43
Non cohesive, 15 to 50 percent passing the US #200 sieve	0.25
Non cohesive, more than 50 percent passing the US #200 sieve	0.22
Cohesive, plasticity index greater than 7	0.30

Although they are usually more economical than granular filters, geotextile filters are difficult to install in underwater, ultimately degrade and can create a failure slip plane when placed against non-cohesive bank material and on steep slopes. Geotextile filter fabric shall be installed with sufficient anchoring and overlap between seams according to the manufacturer's recommendations to ensure full filter barrier protection of the subgrade after riprap installation.

Riprap should not be dumped directly onto the geotextile filter fabric, because it may tear or displace the fabric. A four (4) inch minimum thickness granular cushion layer of gravel or sand may be specified over the filter fabric when the riprap stones cannot be placed as to not damage the fabric. Side slopes shall be 2:1 or flatter in order for the gravel or sand not to slide down the filter cloth before placing the riprap.

1.4.7 - Vegetative Practices

A. Temporary Vegetative Stabilization of Disturbed Areas.

1. Description.

   Stabilize soil in disturbed areas with temporary vegetation. Refer to Section 1.4.5.A. - Mulching for other temporary stabilization options.

2. Purpose.

   To stabilize the soil; to reduce damages from sediment and runoff to downstream areas; improve wildlife habitat; enhance natural beauty.

3. Conditions Where Practice Applies.

   Use vegetation to temporarily stabilize the soil on disturbed, graded or cleared areas prior to establishment of permanent vegetation.

4. Design Criteria.

   Prior to vegetative establishment, install needed erosion control practices, such as diversions, grade stabilization structures, berms, dikes, level spreaders, and sediment basins. Final grading and shaping has usually not been completed for temporary stabilization.

5. Fertilizer.

   For temporary vegetative establishment, fertilizer may be applied if a soil test indicates the need for additional nutrients. For more information, refer to Standard Specification 606S, Fertilizer. In order to avoid the conveyance of nutrients off-site, the timing of fertilization shall not occur when rainfall is expected or during slow plant growth or dormancy (i.e., during the cool season for warm-season plants). Chemical fertilizer may not be applied in the Critical Water Quality Zone.

6. Seed Bed Preparation.

   Prepare a suitable seed bed which allows good seed-to-soil contact and soil conditions that are conducive to vegetative growth. Do not disturb the soil within the critical root zone of existing trees. See Section 1.4.8.B. or information regarding the protection of trees in construction areas. Areas of compacted soil shall be loosened to minimum depths between six (6) and twelve (12) inches, or deeper, depending on the extent of compaction, the location of compaction, and the type and nature of soils affected by compaction (e.g., shallow vs deep, wet vs dry). In cases where minimum depths of six (6) to twelve (12) inches is not attainable (i.e., shallow soil above bedrock) apply decompaction to the depth of soil present. Decompaction can be achieved by tilling, plowing, discing, raking, ripping or other acceptable means before seeding. After seed bed preparation, heavy equipment must not be driven over soils. In areas where no topsoil exists, or where imported topsoil is needed for vegetative establishment, the subgrade shall be loosened by discing or by scarifying to a depth of at least two (2) inches prior to placement to permit bonding of the topsoil to the subsoil. Placement of topsoil shall not occur in such a manner or location such that stormwater runoff is likely to transport the material downstream (e.g. over bedrock in an area of concentrated flow). All disturbed areas to be revegetated are required to have a minimum of six (6) inches of topsoil. Topsoil, when used, shall meet the definition of topsoil as defined in Standard Specification 601S.3.A Salvaging and Placing Topsoil. Topsoil salvaged from the existing site may often be used, but it should meet the same standards as set forth in these standards.

The following are general threshold levels of compaction as determined by three compaction testing methods, including bulk density method, standard proctor method, and penetration resistance method. Compaction levels that are detrimental to root growth are dependent on soil type which typically varies from site to site and must be determined by an Engineer, Landscape Architect, Soil Scientist, or their designated representative before compaction testing occurs.

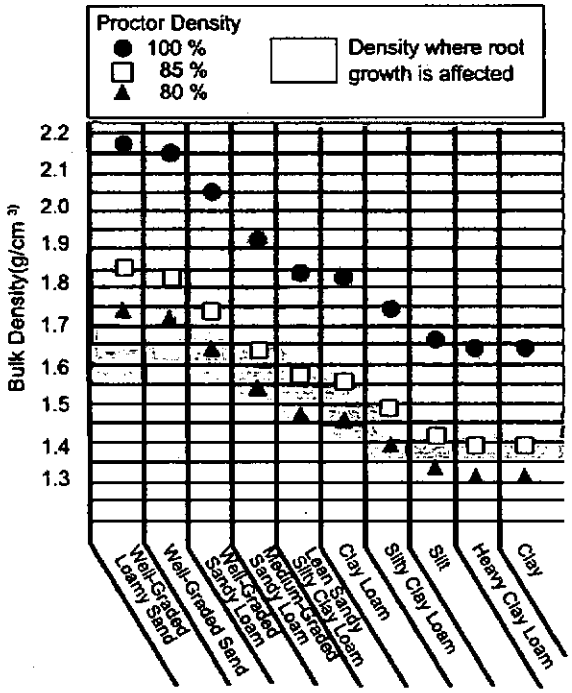
Acceptable Compaction: Good rooting anticipated, but increasing settlement expected as compaction is reduced and/or in soil with a high organic matter content.

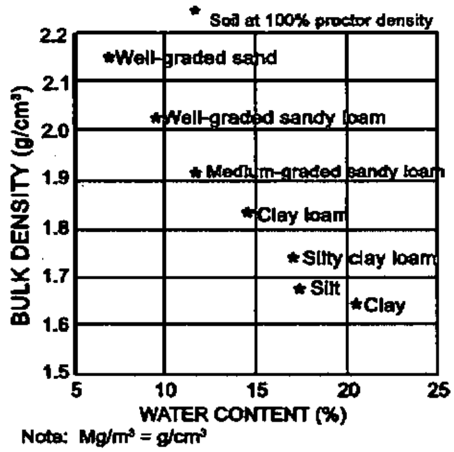
a. Bulk Density Method: Varies by soil type (see Figure 1.4.7-1).

b. Standard Proctor Method: 75 – 85 percent; soil below 75 percent is unstable and will settle excessively.

c. Penetration Resistance Method: 75 to 250 p.s.i.; soil below 75 p.s.i. becomes increasingly unstable and will settle excessively.

Figure 1.4.7-1: The relationships of soil types to bulk density and Proctor Values. Source: Urban (2008) Up by Roots.





7. Seeding.

   If seeding is to be conducted during the cool season (September 15 to March 1) plant species noted as "cool season cover crop" from the Tables in Standard Specification 604S and/or 609S. Warm season seeding (March 2 to September 14) shall follow standard specification 604S (seeding for erosion control) and 609S (native grassland seeding and planting for restoration). Apply seed uniformly with broadcast method, a seed spreader, drill, cultipacker seeder or hydroseeder (slurry includes seed, fertilizer and binder - see item 8[next]).

   Length of seed germination is dependent on weather, soil moisture, species type and other variables. For native seed it can range from two to five weeks. If inadequate germination is evidenced, reseeding shall be required.

8. Protection of Seed Bed with Hydromulch or Soil Retention Blanket.

   Newly-installed temporary vegetation must be protected by hydromulch or soil retention blanket (refer to Standard Specification 605S Soil Retention Blanket) immediately after seeding. Protection of the seed bed shall occur in a manner that will allow seed germination and that encourages effective vegetative growth. Hydromulching, when used, shall comply with the requirements of Table 1.4.7-A: Hydromulching for Temporary Vegetative Stabilization. The following hydromulch requirements are in accordance with the Erosion Control Technology Council (ECTC). The ECTC has set its mission to be the recognized industry authority in the development of standards, testing, and installation techniques for rolled erosion control products (RECPs), hydraulic erosion control products (HECPs) and sediment retention fiber rolls (SRFRs).

Table 1.4.7-A: Hydromulching for Temporary Vegetative Stabilization

Material	Description	Longevity	Typical Applications	Application Rates
100% or any blend of wood, cellulose, straw, and/or cotton plant material (except no mulch shall exceed 30% paper)	70% or greater Wood/Straw 30% or less Paper or Natural Fibers	0—3 months	Moderate slopes; from flat to 3:1	1,500 to 2,000 lbs per acre

a. Hydraulic Mulch. Hydraulically-applied material(s) containing defibrated paper, wood and/or natural fibers that may or may not contain tackifiers used to facilitate revegetation establishment on mild slopes and designed to be functional for up to 3 months. Refer to Table 1.4.7-B for mulch properties and to Standard Specification 604S - Seeding for additional mulch requirements.

Table 1.4.7-B: Properties of Hydraulic Mulch

Property (Test Method)	Required Value
Moisture content %	12.0% ±3.0% (max.)
Organic matter %	90% ±1% Oven Dry Basis (min.)
Tacking Agent	0% or greater
Water holding capacity	500% or greater

9. Watering

Supplemental watering may be required to germinate seed and maintain growth. Depending on the weather and constituents of a seed mix, new plantings may require daily watering for the first week or longer after sowing to ensure germination, with reduced irrigation post-germination to ensure growth, plant health and vigor. Irrigation shall occur at rates and frequencies determined by a licensed irrigator or other qualified professional, and as allowed by the Austin Water Utility and the current water restrictions and water conservation initiatives. Significant rainfall (on-site rainfall of half-inch or greater) may allow the postponement of watering until the next scheduled irrigation.

B. Permanent Vegetative Stabilization of Disturbed Areas.

1. Description.

Permanent vegetative stabilization may comprise the installation of vegetation such as sod and bunch grasses, forbs, shrubs, and/or trees on critical disturbed areas. When seeded, newly-installed permanent vegetation must be protected by hydromulch or soil retention blanket (refer to Standard Specification 605S Soil Retention Blanket).

2. Purpose.

To stabilize the soil, to reduce damages from sediment and runoff to downstream areas, improve wildlife habitat, enhance natural beauty.

3. Conditions Where Practice Applies.

Disturbed, graded or cleared areas which are subject to erosion and where a permanent, long-lived vegetative cover is needed.

4. Design Criteria.

- Standard Specifications

For areas that are seeded refer to Standard Specification 604S - Seeding for Erosion Control or 609S - Native Grassland Seeding and Planting for Restoration (whichever is applicable). For areas that are sodded refer to Standard Specification 602S - Sodding for Erosion Control.

- Site Preparation.

- Install needed erosion control practices, such as interceptor dikes, berms and spreaders, contour ripping, erosion stops, channel liners and sediment basins.

- Grade as needed and feasible to permit the use of conventional equipment for seed bed preparation, seeding, mulch applications, anchoring and maintenance.

5. Bed Preparation.

Prepare a suitable bed which allows good contact between the soil and the seed or sod (whichever is used).

Areas of compacted soil shall be loosened by plowing, discing, raking or other acceptable means to a depth of six (6) inches or greater prior to seeding or sodding.

In areas where no topsoil exists, or where topsoil is needed for vegetative establishment, the subgrade shall be loosened by discing or by scarifying to a depth of at least two (2) inches prior to placement of six (6) inches of topsoil to permit bonding of the topsoil to the subsoil.

All disturbed areas to be revegetated are required to place a minimum of six (6) inches of topsoil. Topsoil, when used, shall meet the definition of topsoil as defined in standard specification 601S.3.A Salvaging and Placing Topsoil.

Topsoil salvaged from the existing site may often be used, but it should meet the same standards as set forth in these standards. Placement of topsoil shall not occur in such a manner or location such that stormwater runoff is likely to transport the material downstream (e.g. over bedrock in an area of concentrated flow).

6. Fertilizer.

   For permanent vegetative establishment, fertilizer may be applied if a soil test indicates the need for additional nutrients. For more information, refer to Standard Specification 606S, Fertilizer. In order to avoid the conveyance of nutrients off-site, the timing shall not occur when rainfall is imminent, or during slow plant growth or dormancy (i.e., during the cool season for warm-season plants). Chemical fertilizer may not be applied in the Critical Water Quality Zone.

7. Seeding.

   Select the appropriate species in the tables provided in Standard Specification 604S and/or 609S. All seeding work must conform to these specifications.

8. Protection of Seed Bed with Hydromulch or Soil Retention Blanket.

   When seeded, newly-installed permanent vegetation must be protected by hydromulch or soil retention blanket (refer to Standard Specification 605S Soil Retention Blanket) immediately after seeding. Protection of the seed bed shall occur in a manner that will allow seed germination and that encourages effective vegetative growth. Hydromulching, when used, shall comply with the requirements of Table 1.4.7-C: Hydromulching for Permanent Vegetative Stabilization. The following hydromulch requirements are in accordance with the Erosion Control Technology Council (ECTC). The ECTC has set its mission to be the recognized industry authority in the development of standards, testing, and installation techniques for rolled erosion control products (RECPs), hydraulic erosion control products (HECPs) and sediment retention fiber rolls (SRFRs).

Table 1.4.7-C: Hydromulching for Permanent Vegetative Stabilization

Material	Description	Longevity	Typical Applications	Application Rates

Bonded Fiber Matrix (BFM)	80% Organic defibrated fibers 10% Tackifier	6 months	On slopes up to 2:1 and erosive soil conditions	2,500 to 4,000 lbs per acre (see manufacturers recommendations)
Fiber Reinforced Matrix (FRM)	65% Organic defibrated fibers 25% Reinforcing Fibers or less 10% Tackifier	Up to 12 months	On slopes up to 1:1 and erosive soil conditions	3,000 to 4,500 lbs per acre (see manufacturers recommendations)

a. Bonded Fiber Matrix (BFM): Bonded Fiber Matrix shall consist of organic defibrated fibers and cross-linked hydro-colloidal tackifiers. Refer to Table 1.4.7-D for mulch properties and to Standard Specification 604S - Seeding for additional mulch requirements.

Table 1.4.7-D: Properties of Bonded Fiber Matrix

Property (Test Method)	Required Value
Moisture content %	12% ±3.0% (max.)
Organic matter %	75% ±3% Oven Dry Basis (min.)
Cross-linked Hydro-colloidal Tackifiers	10.0% ±1%
Water holding capacity	500% or greater
Mass per unit area (ASTM D6566)	10.0 oz/square yard (min.)
Thickness (ASTM D6525)	0.12 inch (min.)
Ground Cover (ASTM D6567)	97% (min.)
Functional Longevity	6 months (min.)
% Effectiveness	90% (min.)
Cure time	24 hours

Vegetative Establishment (ASTM D7322)	400%

b. Fiber Reinforced Matrix (FRM). Fiber Reinforced Matrix shall consist of organic defibrated fibers produced from grinding clean, whole wood chips, crimped interlocking fibers, cross-linked insoluble hydro-colloidal tackifiers and reinforcing natural and/or synthetic fibers. Refer to Table 1.4.7-E for mulch properties and to Standard Specification 604S - Seeding for additional mulch requirements.

Table 1.4.7-E: Properties of Fiber Reinforced Matrix

Property (Test Method)	Required Value
Moisture content %	12% ±3.0% (max.)
Organic matter % - organic fiber	65% ±3.5% Oven Dry Basis (min.)
Organic matter % - reinforcing fibers	25% or less
Cross-linked Hydro-colloidal Tackifiers	10.0% ±1%
Water holding capacity	500% or greater
Mass per unit area (ASTM D6566)	11.0 oz/square yard (min.)
Thickness (ASTM D6525)	0.16 inch (min.)
Ground Cover (ASTM D6567)	97% (min.)
Functional Longevity	12 months (min.)
% Effectiveness	99% (min.)
Cure time	24 hours
Vegetative Establishment (ASTM D7322)	500%

9. Sodding.

   Sodding is an acceptable practice for permanent vegetative stabilization. Installation of sod shall comply with practices described in Standard Specification 602S - Sodding. Sod placed on slopes greater than 3:1 must be staked using biodegradable landscape staples.

10. Rooted Plants.

    Installation of rooted plants - including bare root, live root, and container-grown plants - in conjunction with other methods, is an acceptable means of achieving permanent vegetative stabilization. Installation of rooted plants shall comply with practices described in Standard Specification 608S - Planting.

11. Irrigation.

    Supplemental watering may be required to germinate seed and maintain growth of rooted plants. Depending on the weather and constituents of a seed mix, new plantings may require daily watering for the first week or longer after sowing to ensure germination, with reduced irrigation post-germination to ensure growth, plant health and vigor. Irrigation shall occur at rates and frequencies determined by a licensed irrigator or other qualified professional, and as allowed by the Austin Water Utility and the current water restrictions and water conservation initiatives. Significant rainfall (on-site rainfall of half-inch or greater) may allow the postponement of watering until the next scheduled irrigation.

12. Maintenance.

    Maintenance is a vital factor in providing an adequate vegetative erosion control cover. Monitoring, watering, mulching and weeding shall be required during the period of establishment to ensure planting success. Maintenance practices shall comply with construction methods and plant establishment requirements described in Standard Specifications 604S, 608S, and 609S.

    a. Reseeding - Inspect all seeded areas for failures and reseed as necessary per 609S.

    b. Replanting - Failure of rooted plant requires replacement per Standard Specification 608S.

    c. Weeding - Anticipate weed problems prior to planting desired plants and control weeds as necessary to curb competition and enable proposed vegetation to thrive. Weed types and amounts are dependent on weather, season, soil quality, and site conditions. Refer to Standard Specifications 604 and 609 for weed lists. Treatment methods shall be tailored for each situation, and should follow current City of Austin Integrated Pest Management (IPM) guidelines and Invasive Species Management Plan.

Source: Rule No. R161-14.26, 12-30-2014.

1.6.2.F Integrated Pest Management Guidelines

Integrated Pest Management (IPM) plans are required for the following stormwater control measures (SCMs):

Wet pond - 1.6.6
Retention/Irrigation Systems - 1.6.7.A
Vegetative Filter Strips - 1.6.7.B
Biofiltration - 1.6.7.C
Rainwater Harvesting (if used in conjunction with vegetation) - 1.6.7.D
Non-Required Vegetation - 1.6.7.G
Rain Garden - 1.6.7.H

The management of these SCMs must adhere to the techniques and control options described in this section and documented in an approved IPM plan. The requirements of this section also apply to Vegetated "Green" Roofs (Appendix W), but do not address structural pest control concerns. Also, note that Green Roofs are not considered SCMs and are not eligible for water quality credit. IPM is a continuous system of controlling pests (weeds, diseases, insects or others) in which pests are identified, action thresholds are considered, all possible control options are evaluated and selected control(s) are implemented. Control options which include biological, cultural, manual, mechanical and chemical methods are used to prevent or remedy unacceptable pest activity or damage. Choice of control option(s) is based on effectiveness, environmental impact, site characteristics, worker/public health and safety, and economics. The goal of an IPM system is to manage pests and the environment to balance benefits of control, costs, public health and environmental quality. IPM takes advantage of all appropriate pest management options.

Manage the treatment system in conformance with the following criteria:

Applicability of Plan - These performance requirements apply to the entire SCM, as well as areas immediately adjacent to and related to the facility (including access areas, easements, irrigation and infiltration areas, etc.).

Vegetation Functions - The vegetation in an SCM is integral and necessary for it to function properly. A minimum of 95% of the vegetation shall be alive and viable throughout the life of the system. No bare areas greater than 10 square feet may exist. These performance requirements apply to the entire SCM including the pond bottom, side slopes, and areas adjacent to the pond.

Mowing and/or Trimming - Mowing and/or trimming of herbaceous vegetation shall occur with certain restrictions.

1. Tall and Medium Herbaceous Plants: Trimming activities must not impinge on the growing tips (basal crown) of the bunchgrasses. Cutting these grasses below the basal crown will severely stress and possibly kill them. These plants shall be cut no

lower than 18" from the ground. In all cases, clippings and trimmings shall be bagged and removed from the site.

2. Turf and other Short Herbaceous Plants: Sod-forming grasses may be mown or trimmed to an appropriate height. These plants shall not be scalped; cut no lower than four(4) inches from the ground. All clippings and trimmings shall be bagged and removed from the site.

Weed Management - A weed is generally defined as any plant in the wrong place. Refer to the original design and construction documents when uncertainty exists as to the appropriateness of a specific plant. Preventing the introduction of weeds is the most practical and cost-effective method for their management. Avoid bare soil by minimizing soil disturbance and properly managing desirable vegetation. Remove weeds early in their growth stage; before they set seed. Allow the desired vegetation to out-compete the weeds. It is necessary to allocate greater resources on landscape maintenance during the initial 3-year establishment period. During this time weed "pressure" from the drainage area will be greatest, as will availability of bare surface areas within the treatment system. These factors allow weeds to gain a foothold, especially during the first few months of the life of the water quality control.

1. Cultivation - May be done with hand tools; using cultivating machines is not acceptable. Cultivation can be repeated at 2-3 week intervals during the growing season. Any bare areas must be re-seeded.

2. Biofiltration and Rain Garden SCMs - Mulching to control weeds by blocking light and air space is acceptable.

    a. Wood mulch, the traditional material for minimizing weeds in ornamental landscapes, is not recommended because it will tend to float or otherwise be washed out of the system. The innovative use of non-traditional mulches will be required when ornamental beds are used in biofiltration facilities. Gravel is permitted to cover the soil surface both in the sediment basin and the filter basin.

    b. Gravel or crushed recycled glass equivalent in size to gravel may be used to cover the soil surface in biofiltration.

    c. Weed fabric is not permitted in biofiltration due to the potential for clogging of the pores.

Pesticides (includes herbicides) and Fertilizer - The use of landscape chemicals, including fertilizer and pesticides, are not allowed within the treatment system without the approval of the City's IPM Coordinator. For additional information contact the Watershed Protection Department – Environmental Resource Management Division.

Invasive or Noxious plants - Plant species listed as invasive or noxious by the Texas Department of Agriculture are not allowed to be planted or grown naturally in SCMs or their associated areas. Additionally, the City of Austin has a list of recommended top invasive plants to avoid. Refer to the following website for the list of plants and additional information: http://www.austintexas.gov/invasive.

Mosquito Management - SCMs shall not be a breeding place for mosquitoes. Incidental standing water must not be present for longer than four days (96 hours). If water exists for periods longer than this, the party responsible for maintenance shall remove the water from the SCM and conduct any repairs or design flaws to ensure that this condition is not repeated.

Wildlife and Pet Management - In addition to water quality treatment, SCMs offer environmental benefits such as providing food and habitat for wildlife. Pets may also be attracted to them. Digging or burrowing by animals is particularly troublesome. Activities by animals within the SCM should be discouraged so to not interfere with its functions and design objectives. Where on-going problems with wildlife exist, fencing or similar exclusionary methods shall be implemented.

Irrigation System Performance - Not all water quality treatment facilities include an irrigation system. When an irrigation system exists evaluate the efficiency of the system on a periodic basis, especially at the beginning of each irrigation season. The evaluation shall identify problems with the system and ensure that problems are properly addressed (See Section 1.6.3.D, Irrigation Guidelines).

Erosion - Erosion damage to the treatment system shall be repaired immediately. Determine the cause of the erosion and address the situation to prevent it from recurring.

Restrictive Covenant - A restrictive covenant is required to be filed. The restrictive covenant is the legal document requiring the use of IPM on a given site.

Plan Notes -

1. For commercial and multi-family developments site plan notes will establish the requirements for the implementation and on-going maintenance of the IPM plan.

2. For residential subdivision development, the developer must include plat notes approved by the WPD regarding the use of pesticides and fertilizers through an IPM plan.

Public Education Program – All applicants proposing SCMs on residential development lots must provide these guidelines to all home owners and tenants.

Plans for Specific Pests and Other Landscape Issues - Refer to the Grow Green website for updated versions of recommended management techniques for specific pests and issues. http://www.austintexas.gov/department/grow-green

1.6.3 - Maintenance and Construction Requirements

A. **Maintenance Responsibilities.** Proper maintenance is as important as engineering design and construction in order to ensure that water quality controls, referred to herein as stormwater control measures (SCMs), will function effectively. Section 25-8-231 of the Land Development Code requires maintenance be performed on SCMs when necessary as defined by this section.

Stormwater control measures required for commercial and multi- family development shall be maintained by the property owner.

Stormwater control measures for single family or duplex residential development shall be maintained by the City of Austin once the facilities have been accepted by the City, unless otherwise determined during the review process. For the City to accept an SCM, the facility must:

1. be constructed per the approved development plan;
2. meet all applicable requirements of Section 1.6.3 and the Drainage Criteria Manual, Section 1.2.4 E.
3. complete a one-year warranty period, including the completion of all maintenance and rehabilitation activities identified by the Watershed Protection Department; and
4. obtain final warranty release approval from the Watershed Protection Department.

The City will also maintain SCMs designed to service primarily publicly owned roads and facilities. These SCMs must be designed and built according to the appropriate city standards.

B. **Maintenance Requirements—Design and Construction.**

The design of drainage facilities (including but not limited to headwalls, open channels, storm sewers, area inlets, and detention, retention and stormwater control measures and their appurtenances) shall comply with the requirements of Section 1.2.4.E of the Drainage Criteria Manual. In addition, SCMs shall comply with the following construction requirements:

1. Sediment removed during construction of a detention, retention, or water quality facilities may be disposed of on-site if properly stabilized according to the practices outlined in the erosion and sedimentation control criteria found in Section 1.4.0 of this manual. After the City of Austin has accepted a stormwater facility disposal of sediment must be at an approved landfill.

2. During construction of SCMs, temporary erosion and sedimentation controls shall be maintained.

3. If runoff is to enter the sand filtration chamber of a water quality control facility prior to completion of site construction and revegetation, inspection and maintenance of all temporary erosion/sedimentation controls are required, as described in the Environmental Criteria Manual Section 1.4.4, to prevent heavy sediment loads

caused by home construction from clogging the filtration media.

4. In all cases, trees shall be preserved according to the requirements of Section 3 of the Environmental Criteria Manual. The access drive and staging area shall be designed to preserve trees 8" (inches) in diameter and greater to the maximum extent possible. Trees 8" in diameter and larger shall be surveyed and shown for the proposed access easement at the time of construction plan permitting.

5. For filtration systems the design media depth must be verified, accounting for consolidation. If insufficient depth is present, additional media must be added and pre-soaked until the design depth is achieved. Pre-soaking - apply 5-10 gallons of water per square foot of media area within one hour.

C. Major Maintenance Requirements.

1. The following maintenance activities shall be performed on all SCMs, in addition to the requirements listed for the individual SCM types, to ensure proper function:

   a) Accumulated paper, trash and debris shall be removed every six (6) months or as necessary to maintain proper operation.

   b) Structural integrity shall be maintained at all times. Basins and all appurtenances shall be inspected annually, or more frequently if specified, and repairs shall be made if necessary. When maintenance or repairs are performed, the SCM shall be restored to the original lines and grades.

   c) Corrective maintenance shall occur:

      i. Any time drawdown of the Water Quality Volume does not occur within ninety-six (96) hours (i.e., no standing water is allowed), unless a greater maximum drawdown time is specified in the plans.

      ii. For detention ponds only, any time drawdown does not occur within twenty-four (24) hours.

   d) The inlet and outlet of SCMs shall be maintained unimpeded in order to convey flow at all times. Observed blockages to the inlet and outlet, due to vegetation, sediment, debris, or any other cause, shall be removed.

e) No unvegetated area shall exceed ten (10) square feet. This performance requirement applies to the entire pond including the pond bottom, side slopes, and areas adjacent to the pond, and is intended to limit erosion.

f) Integrated pest management shall be performed and shall adhere to Section 1.6.2.F, Integrated Pest Management Guidelines.

g) The minimum vegetation height shall be four (4) inches in the SCM and all appurtenances, including the toe of the berm or wall outside the SCM, where applicable.

h) Sediment build-up shall be removed:

i. When the accumulation exceeds six (6) inches in splitter boxes, wet wells and basins.

ii. When sediment traps are full.

iii. When sediment, of any amount, causes standing water conditions or reduces basin storage by more than 10%.

i) When sediment is removed, the following requirements apply:

i. Irrigation shall be provided, as needed, until vegetation is established (well rooted). See Section 1.6.3.D, Irrigation Guidelines.

ii. The design depth of the filtration media shall be verified. See Section 1.6.3.B.5.

iii. Tilling of the filtration medium is not allowed.

j) For subsurface ponds maintenance plan requirements, refer to ECM 1.6.2(E).

2.Sedimentation and Filtration SCMs (Section 1.6.5).

a. Vegetation within the SCM shall not exceed eighteen (18) inches in height at any time, except as called for in the design.

b. Vegetation that is mowed or cut shall be removed from the SCM.

3. Detention Basins.

a. Vegetation within the basin shall not exceed eighteen (18) inches in height at any time.

4.Wet Ponds (See Section 1.6.6).

Due to the nature of wet ponds being full of water when in operation, the need for maintenance is not easily visible. However, when the ponds are built in stable upland areas, the need for maintenance of these ponds should be infrequent. Accumulation of sediment in the basin is the primary reason the pond will require intensive maintenance. Because of this, very careful attention should be paid to adequate, well-maintained erosion and sedimentation controls in the contributing drainage area during construction. This, in combination with the sediment forebay, should prevent the requirement of maintenance of the main pool soon after the pond is put online. The following are guidelines for pond maintenance:

During Site Construction - The sediment load to the sediment forebay shall be closely monitored after every storm event. If heavy sediment loads are detected during an inspection, the source should be corrected. Sediment shall be removed from the sediment forebay when one-third of the forebay volume is lost.

Upon Completion of Site Revegetation - Any sediment build-up (greater than 5% volume loss) shall be removed from the forebay upon completion of site revegetation. The sediment build-up in the main pool shall be checked and if more the ten- percent of the volume is lost, it should be cleaned at that time.

Every Three Months for the First Two Years - During the three month initial inspection cycle, if more than fifteen percent of the volume of the forebay is lost, it shall be cleaned at that time.

Every Three Months - Turf areas around the pond should be mowed. Accumulated paper, trash, and debris shall be removed every three months or as necessary. Cattails, cottonwoods, and willows can quickly colonize shallow water and the edge of the pond. These species or any areas of plant overgrowth may be thinned at this time or as needed.

Annually - The basin should be inspected annually for side slope erosion and deterioration or damage to the structural elements. Any damage shall be repaired. Large areas, which have dead or missing vegetation, shall be replanted.

Every Three Years - The sediment build-up in the sediment forebay shall be checked. The sediment forebay shall be cleaned if more than one-third of the forebay volume is lost.

Every Six Years - The sediment build-up in the main pool shall be checked. Sediment shall be removed from the main pool when twenty percent of the main pool volume is lost.

5.Retention-Irrigation Systems (Section 1.6.7.A).

a. Basins. Structural integrity of basins shall be maintained at all times. Woody vegetation should be controlled/removed to prevent basin leakage. The ability of the basin to retain the water quality volume shall be evaluated by the COA.

b.–Irrigation Areas. To the greatest extent practicable, irrigation areas are to remain in their natural state. However, vegetation must be maintained in the irrigation area such that it does not impede the spray of water from the irrigation heads. Tree and shrub trimmings and other large debris must be removed from the irrigation area. See requirements in Section 1.6.7.A.3.(g) and (h) regarding requirements for soil and vegetation in irrigation areas.

c.–Pumps and Irrigation System. The pumps and irrigation system must be inspected or tested a minimum of six (6) times per year to show all components are operating as intended. Two (2) of these six (6) inspections should be after rain events to ensure that the irrigation system and all of its components perform as designed. This includes controls such as weather stations or rain sensors, delays, valves, alarm system, distribution lines, or other components as specified in the system design. Sprinkler heads must be checked to determine if any are broken, clogged, or not spraying properly. All inspection and testing reports must be kept on site and accessible to the City of Austin.

d.–The overall system shall be inspected for the ability to retain the water quality volume on site per ECM section 1.6.7.A.

6.-Vegetative Filter Strips (Section 1.6.7.B).

a. Filter strips shall be managed so that a dense, healthy vegetative cover is preserved.

b. Unmowed vegetative filter strips are preferred. If mowed the cutting height shall be set to a minimum of four (4) inches for turfgrass and a minimum of 18 inches for bunchgrass. Grass clippings must be removed from the VFS in order to prevent export of nutrients.

c. Bare spots and areas of erosion identified during inspections must be replanted and restored to meet specification.

d. Accumulated sediment shall be removed.

e. Any disturbance to the filter strip as a result of maintenance procedures or other reasons shall be repaired, including re-establishment of the vegetation.

f. Corrective maintenance is required if there is evidence of preferential flow paths around or through the VFS (e.g., upstream "lip" is silted in or installed too low).

g. The level spreaders shall be repaired if damaged or not functioning correctly.

7.Biofiltration and Rain Gardens (Sections 1.6.7.C and 1.6.7.H).

A. Maintenance Considerations in Design.

A lack of maintenance considerations in the design of a landscape commonly results in a site that is more maintenance intensive (i.e., costly) than necessary and/or appropriate for its purpose, and one that requires the routine use of practices that are undesirable (e.g., extensive pesticide use, intensive pruning of plants that grow too large for the spaces they occupy). The designer shall include maintenance considerations and IPM throughout the planning and design phase of a biofiltration project. Landscapes should be designed to allow for the access and aid the maneuverability of maintenance equipment (e.g., if areas of the pond are designed to be mown, acute angles should be avoided in turf areas; wide angles, gentle, sweeping curves, and straight lines are easier to mow).

B. Routine Maintenance.

Once vegetation is established, biofiltration systems should require less maintenance than sand filtration systems because the vegetation protects the filtration media from surface crusting and sediment clogging. Plant roots also provide a pathway for water to permeate down into the media, thus further enhancing the hydraulic performance of the system. Unless damaged by unusual sediment loads, high flows, or vandalism, the biofiltration media should be left undisturbed and allowed to age naturally, and biofiltration pond vegetation shall be managed so that a dense, healthy vegetative cover is preserved. The following maintenance items should be performed depending on frequency and time of year:

Biweekly during first growing season: Inspect vegetation until 95% vegetative cover is established.

Monthly: Check for accumulated sediments, remove as needed.

Quarterly: Remove debris and accumulated sediment; replace soil media in void areas caused by settlement; repair eroded areas; remulch by hand any void areas.

Semi-annually: Remove and replace dead or diseased vegetation that is considered beyond treatment (see planting specifications); treat all diseased trees and shrubs mechanically or by hand depending on the insect or disease infestation. If drawdown exceeds the drawdown time according to Section 1.6.3.C.1, lightly scarify soil with hand cultivator; if standing water remains for greater than 96 hours, remove top layer of sediment, mulch, and potentially vegetation; de-compact soil by scarification, and replace mulch and disturbed vegetation.

Late winter: trim bunch grasses; mow turf grasses; harvest other types of vegetation according to recommendations in the planting specifications. Adhere to Section 11.6.2.F.

Spring: Remove previous mulch layer and apply new mulch layer by hand (option) once every two to three years.

C. -Other items.

a.-Signage shall be used to delineate the boundaries of the biofiltration area that are maintained with minimal mowing, no fertilizers, and limited use of organic herbicides.

8.-Rainwater Harvesting (Section 1.6.7.D).

Proper monitoring and maintenance is important for any system to work appropriately and efficiently. Each configuration will perform differently. After the system has stabilized, inspection and maintenance might be needed several times a year and/or after heavy rainfall events. A pretreatment filter system (i.e., leaf guards, strainers, roof washers, etc.) is required prior to the cistern.

Maintenance activities shall be performed according to the following schedule:

Post Construction:

- The control and repair of erosion rills, from the irrigation system, should take place after each rainfall event until the vegetation is well established. Adjustments to the irrigation area should be considered as the vegetation matures and/or to minimize erosion problem areas.

Quarterly or after each rain event:

- Inspect water tanks periodically to insure proper functioning. Screen inlet and outlet pipes to keep the system closed to mosquitoes. Cap and lock tanks for safety.

- Caps should have access ports for interior inspection and maintenance.

- Clean pretreatment filter system, gutters, inflow, and outflow pipes as needed; sediment, trash, leaves, or other debris should not be allowed to accumulate to a point where it impedes the proper function of the rainwater harvesting system.

- Irrigation systems should be cleaned and damage sprinkler heads replaced.

Other items:

a. The requirements for retention/irrigation systems apply when rainwater harvesting is designed to irrigate a vegetated area - see 1.6.3.C.4.

b. The requirements for vegetative filter strips apply when a rainwater harvesting is designed to discharge to a vegetated area to be infiltrated - see 1.6.3.C.5.

9. Porous Pavement (Section 1.6.7.E).

General Maintenance

- Verify that the porous pavement receives no off-site runoff.

- Prior to final acceptance it must be demonstrated that the <u>surface</u> saturated hydraulic conductivity of any portion of the porous pavement is at least 20 inches/hour or, if the system is saturated, the entire water quality volume infiltrates into the subgrade within 48 hours.

Use the following testing methods to verify:

- For porous concrete and porous asphalt use ASTM C1701

- For open-jointed block pavement, permeable interlocking concrete pavement (PICP) or concrete grid pavement (CGP) use ASTM C1781

Construction and Post construction:

- When installing porous concrete, floating and troweling are not used, as those may close the surface pores.

- Do not seal or repave with non-porous materials.

- No piling of dirt, sand, gravel, or landscape material without covering the pavement first with a durable cover to protect the integrity of the pervious surface.

- All landscape cover must be graded to prevent washing and or floating of such materials onto or through the pervious surface. No off-site flows allowed onto the porous pavement area.

- All chemical spills inclusive but not limited to petrochemicals, hydrocarbons, pesticides, and herbicides should be reported to the owner so they can prevent uncontrolled migration.

- Chemical migration control may require flushing, and/or the introduction of microbiological organisms to neutralize any impacts to the soil or water.

Monthly:

- Ensure that paving area is clean of debris, ensure that paving dewaters between storms, and ensure that the area is clean of sediments.

Semi-annually:

- Ensure that the porous pavement is protected from clogging due to runoff from landscape areas, rooftops, and other areas that may significantly reduce the long-term permeability by diverting flows away.

Annually:

- To ensure that the entire water quality volume infiltrates into the subgrade within 48 hours the pervious surface should be vacuumed to restore the open permeable pores and lift the sediment or other contaminants out that may reduce the long-term permeability.

- It is required that this frequency be increased for areas where overhanging vegetation, excessive dirt, and pollutants are frequent.
- Inspect the surface for deterioration. As necessary, repair or replace porous pavement or, for open-jointed block pavement or permeable interlocking concrete pavement replenish aggregate within the joints.

D. Irrigation Guidelines

Irrigation is necessary to establish plants during the first 12 months after installation. Thereafter irrigation needs should be minimal and an irrigation system whether permanent or temporary may not be necessary depending on the weather, type of plants, and extent of plant establishment.

Supplemental watering after the first 12-months may be required during periods of extended drought if plant replacement occurred after the first year, for more mesic-type plants, and for trees. Trees typically require two to three years of supplemental water. The necessity for continued irrigation after the first year should be made by a landscape professional.

If an irrigation system is proposed, the design shall address both the SCM and plant health needs. In particular, overwatering is unacceptable as it will negatively impact the hydraulic performance and pollutant removal capabilities of SCM.

Treated wastewater effluent (also referred to as reclaimed water) contains nutrients at concentrations higher than stormwater runoff. Because these elevated nutrient concentrations would impair the nutrient removal function of SCM, no temporary or permanent irrigation of SCM may occur with reclaimed water or treated wastewater effluent.

The following minimum criteria will apply for permanent irrigation systems:

1. Soil water moisture sensors shall be installed and connected to the controller at appropriate depths and locations in the biofiltration basin.

2. No irrigation during periods when rainfall is occurring.

3. Irrigation shall not commence until the soil moisture content of the filtration media is ≤ 25% of the Available Water Capacity (AWC). For plants native or adapted to arid and semi-arid conditions, irrigation shall not commence until the soil moisture content is ≤ Wilting Point (WP), or 0% AWC.

4. Irrigation shall cease once the soil moisture content is ≤ 75% AWC; 50% for plants native or adapted to arid and semi-arid conditions.

1.6.5 - Design Guidelines for Sedimentation/Filtration Systems

A. **Full Sedimentation with Filtration.** In this system, the sedimentation basin receives the entire water quality volume and detains it for a draw-down time of forty-eight (48) hours. Draw-down time is the time required for the basin to empty from the full water quality volume condition. The effluent from the sedimentation basin is discharged into the filtration basin. Figures 1-51 and 1 52 in Appendix V of this manual illustrate this system. Full sedimentation/filtration or full sedimentation/biofiltration systems shall be required where the City is responsible for maintenance unless topographic constraints make this design unfeasible. Unfeasible is considered: assuming (for the purposes of this selection process only) a maximum ponding depth of three feet in the sedimentation basin, if it is not feasible to obtain an outlet for the drainage from the filtration basin within one hundred (100) feet of the crest of the filtration embankment, then the partial sedimentation/filtration configuration system may be used.

1. Basin Surface Areas. A literature review of sedimentation basins (References 76, 77, 82, 84-89, 92-95, 98-100 in the Bibliography) and slow rate filters (References 74 and 85) was conducted in order to establish design criteria.

   For sedimentation basins, the removal of discrete particles by gravity settling is primarily a function of surface loading, "Q_o/A_s", where "Q_o" is the rate of outflow from the basin and "As" is the basin surface area. Basin depth is of secondary importance as settling is inhibited only when basin depths are too shallow (particle resuspension and turbulence effects). For sedimentation, surface area is the primary design parameter for a fixed minimum draw-down time of forty-eight (48) hours. Removal efficiency is also a function of particle size distribution. For design purposes, the particles selected for complete removal in the sedimentation basin are those which are greater than or equal in size to silt with the following characteristics: particle diameter 0.00007 foot (20 microns) and specific gravity of 2.65. These are typical values for urban runoff (see References 77 and 98).

   For filtration basins, surface area is the primary design parameter. The required surface area is a function of sand permeability, bed depth, hydraulic head and sediment loading. A filtration rate of 0.0545 gallons per minute per square foot has been selected for design criteria (10.5 feet per day or 3.4 million gallons per acre per day). This filtration rate is based on a Darcy's Law coefficient of permeability of three and one-half (3.5) feet per day, an average hydraulic head of three (3) feet and a sand bed depth of eighteen (18) inches. The Technical Notes at the end of this section include an explanation of how the filtration rate and coefficient of permeability were determined. References 80, 83, 96 and 97 provide additional information.

   The following equations gives the minimum surface areas required for the sedimentation and filtration basins:

The filtration basin surface area is calculated as:

$A_f = WQV/(7 + 2.33*H)$

where "A_f" is the minimum surface area of the filtration media in square feet, the inherent drawdown time is 48 hours and "WQV" is the water quality volume as defined in Section 1.6.2.A. in cubic feet, and H is the maximum ponding depth in the filtration basin in feet. The assumed maximum ponding depth of the sand filtration basin should be at least one (1) foot less than the maximum ponding depth in the sedimentation basin, to account for tailwater effects, unless demonstrated otherwise through an engineering analysis.

2. Basin Volumes. The storage capacity of the sedimentation basin shall be greater than or equal to the water quality volume. The water quality pond design shall allow enough freeboard above the water quality volume to pass the design flow rate for the one-hundred (100) year storm over the splitter/diversion structure without overtopping of any side walls of the pond, plus an additional five (5) percent of the total fill height or three (3) inches, whichever is greater, to allow for construction irregularities and long term soil settling.

   If desired, a sediment trap may be included at the bottom of the basin and may be credited with up to five (5) percent of the water quality volume.

   The storage capacity of the filtration basin, above the surface of the filter media, should be greater than or equal to twenty (20) percent of the water quality volume. This capacity is necessary in order to account for backwater effects resulting from partially clogged filter media.

3. Sedimentation Basin Details. The sedimentation basin consists of an inlet structure, flow spreader (if inlet structure does not provide flow spreading), settling area and, outlet structure. The sedimentation basin design should maximize the distance from where the heavier sediment is deposited near the inlet to where the outlet structure is located. This will improve basin performance and reduce maintenance requirements. It is recommended that the bottom of the sedimentation basin (and invert of riser pipe) be ≥ 2 inches higher than the top of the filtration bed, to prevent excessive tailwater effects that can prolong drawdown times. See Figure 1.6.5.A.

   - Inlet Structure/Flow Spreader. The inflow of the water quality pond should pass through the splitter structure where the water quality volume is separated (see section 1.6.2.B). The water quality volume should be discharged uniformly and at low velocity into the sedimentation basin in order to maintain near quiescent conditions which are necessary for effective treatment. It is desirable for the heavier suspended material to drop out near the front of the basin; thus a drop inlet structure is recommended in order to facilitate sediment removal and maintenance.

   The maximum velocity discharged to the sedimentation basin should not exceed two (2) feet per second. To achieve the required low velocity and to uniformly distribute flow into the sedimentation basin a design such as that shown by Figure 1-48 is recommended. If a design such as that shown in Figure 1-50 is used a flow spreader will likely be necessary at the pipe outfall in order to reduce velocities and distribute flow. For energy dissipation devices do not use City of Austin Standard 508S-13 as this structure does not promote uniform flow into the basin.

• Outlet Structure. The outlet structure conveys the water quality volume from the sedimentation basin to the filtration basin. The outlet structure shall be designed to provide for a minimum draw-down time of forty-eight (48) hours. The riser pipe should be made from perforated schedule forty (40) PVC pipe. The draw-down time should be achieved by installing a removable PVC cap with the appropriate sized orifice at the end of the riser pipe (the discharges through the perforations should not be used for draw-down time design purposes). The PVC cap must be accessible for maintenance. The perforated riser pipe should be selected from the following table:

TABLE 1-8
PERFORATED RISER PIPES

Riser Pipe Normal Dia. (inches)	Vertical Spacing Between Rows (center to center in inches)	Number of Perforations per Row	Diameter of Perforations (inches)
6	4	4	1
8	4	6	1
10	4	8	1

Source: City of Austin

This information is based on commercially available pipe. Equivalent designs are acceptable.

The top of the riser should extend above the elevation of the splitter weir or should be fitted with a threaded removable cap.

A trash rack shall be provided for the riser. The trash rack should be made out of galvanized welded wire fabric with a maximum opening size of one (1) inch by one (1) inch and made from twelve (12) gauge wire. The wire joints should be joined using galvanized "J" clips. The rack must be removable to facilitate maintenance. The trash rack should be supported by galvanized or rust-proof posts set into a four (4) inch thick reinforced concrete base. The base should be square with the length of each side being three (3) feet plus the diameter of the riser pipe with the riser centered on the base. The height of the trash rack should extend above the maximum water surface elevation or should have a removable galvanized welded wire lid. If the top of the riser pipe is more than three (3) feet high from the base, removable galvanized cross bracing is required for the riser and trash rack. A cone of two (2) to three (3) inch diameter gravel shall be placed around the pipe to enhance settling. The gravel cone must not include any gravel small enough to enter the riser pipe perforations. If the discharge pipe of the riser is to extend through a concrete wall, a sleeve is required in the wall and a water proof sealant should be used to prevent leaks around the sleeve. Figures 1-53 and 1-54 in Appendix V of this manual illustrate these design considerations for risers.

- Basin Geometry. See Section 1.6.2.D for acceptable geometry and configuration.

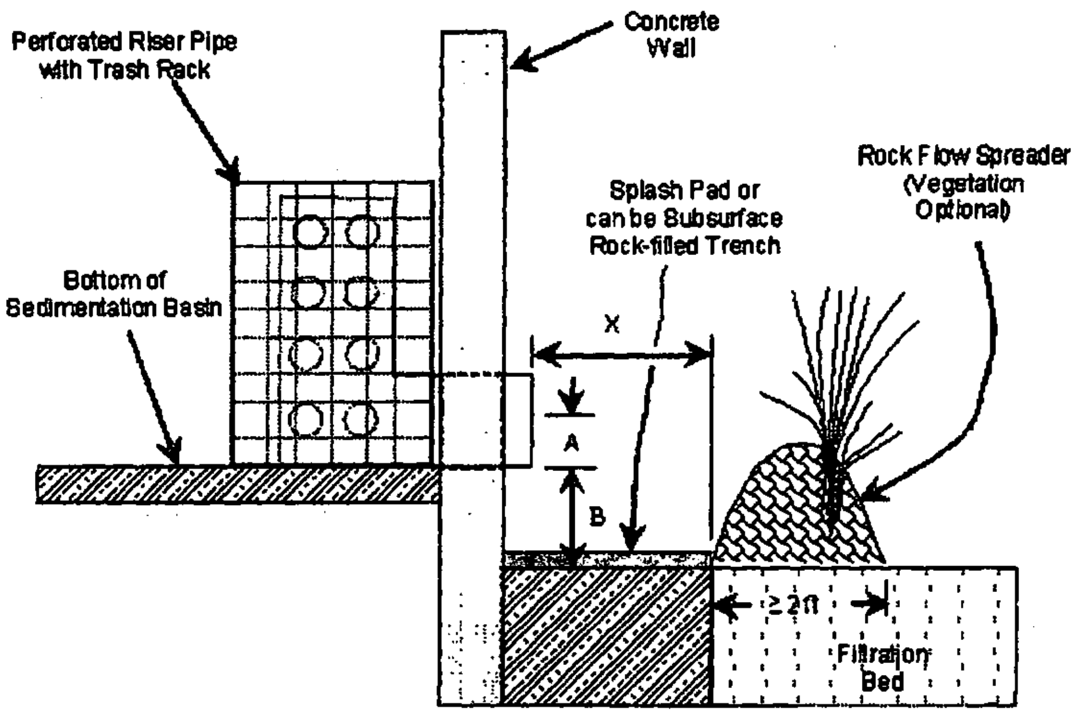
The sedimentation basin should have a minimum two (2) percent bottom slope to ensure that the pond will drain adequately even after silt accumulation.

Water collected in the sediment basin shall be conveyed to the filtration basin in order to prevent standing water from occurring. All water collected in the sediment basin shall drain out within ninety six (96) hours. The invert of the drain pipe should be above the surface of the filtration sand bed. The minimum grading of the piping to the filtration basin should be one quarter (¼) inch per foot (two (2) percent slope). Access for cleaning the sediment basin drain system is necessary.

4. Sand Filtration Basin Details. The sand bed filtration system consists of the inlet structure/flow spreader, sand bed, underdrain piping and basin liner.

- Inlet Structure/Flow Spreader. The inlet structure should spread the flow uniformly across the surface of the filter media. See Figure 1.6.5.A below for flow spreader design guidance. A rock flow spreader is recommended. The rocks directly in the flow path of the riser pipe discharge must be sized appropriately to prevent scour and erosion. For proper riprap sizing follow the design criteria located in Section 1.4.6.D, Stone Riprap.

Figure 1.6.5.A. Full Sedimentation/Filtration Riser Pipe Outlet System and Determining Location of Flow Spreader in Filtration Basin.



Determination of Dimension X, or maximum pipe discharge travel distance:

- Given known riser pipe diameter d, calculate cross-sectional area

  $Ao = \Pi d^2/4 (ft^2)$

- Calculate maximum riser pipe discharge Q (cfs) using orifice equation
- Calculate maximum discharge velocity v = Q/Ao (ft/sec)
- Calculate "fall time" for flow trajectory

$$t = \sqrt{\frac{2*(B+A)}{g}}$$

  - t is in seconds
  - B = Recommended ≥2" differential between bottom of sedimentation basin and top of filter
  - A = pipe radius including thickness + any gap between riser pipe and pond bottom (ft)
  - g = gravitational acceleration = 32.2 ft/sec2

- Calculate X ≥ 1 + v*t (ft)

1 ft is added for margin of safety

- Sand Bed. The sand bed for city-maintained filtration basins must be built to the "Sand Bed with Gravel Layer" configuration below unless topographic constraints make this design unfeasible. Unfeasible is considered: assuming (for the purposes of this selection process only) a maximum ponding depth of three feet in the sedimentation basin, if it is not feasible to obtain an outlet for the drainage from the filtration basin within one-hundred (100) feet of the crest of the filtration embankment, then the "trench design" may be used. For ponds not maintained by the city, the sand bed may be a choice of one of the two configurations given below.

Note: Sand bed depths are final, compacted depths. Consolidation effects must be taken into account. Pre-soaking of media is recommended to induce consolidation so that the correct amount of makeup material can be determined. To pre-soak apply 5-10 gallons of water per sq. ft. of filtration bed, within 1 hour. The top surface of the sand filter bed must be horizontal, i.e., no grade is allowable.

1. **Sand Bed with Gravel Layer** (Standard Details 661-1 and 661-2).

   The top layer is to be a minimum of eighteen (18) inches of 0.02-0.04 inch diameter sand which corresponds with ASTM C-33 concrete sand (smaller sand size is not acceptable). Under the sand shall be a layer of one-half (0.5) to one and one-half (1.5) inch diameter washed, rounded, river gravel which provides three (3) inches to five (5) inches of cover over the top of the underdrain lateral pipes. Clean, screened, crushed recycled glass no smaller than 3/8 inch is also acceptable. The sand and gravel must be separated by a layer of geotextile. -The geotextile fabric specifications are shown in Standard Specification 620S, Table 2: High Flow Filter Fabric Requirements.

2. **Sand Bed with Trench Design** (Standard Details 661-1 and 661-2).

   The top layer shall be twelve (12) to eighteen (18) inches of 0.02-0.04 inch diameter sand which corresponds with ASTM C-33 concrete sand (smaller sand size is not acceptable). Laterals shall be placed in trenches with a covering of one-half (0.5) to one and one-half (1.5) inch diameter washed, rounded river gravel which provides three (3) inches to five (5) inches of cover over the top of the underdrain lateral pipes and geotextile fabric. The geotextile fabric is needed to prevent the filter media from infiltrating into the lateral piping. The geotextile fabric specifications are shown in Standard Specification 620S, Table 2: High Flow Filter Fabric Requirements.

- - Biofiltration Medium Bed (Standard Detail 661-3).

  For Biofiltration Medium specifications refer to Standard Specification 660S, Biofiltration Medium.

• Underdrain Piping. The underdrain piping consists of the main collector pipe(s) and perforated lateral branch pipes. The piping should be reinforced to withstand the weight of the overburden. Internal diameters of lateral branch pipes should be six (6) inches or greater and perforations should be three-eighths (3/8) inch. All piping is to be schedule 40 polyvinyl chloride (PVC) or greater strength. The maximum spacing for the laterals should be ten (10) feet between laterals and five (5) feet from a wall or side. Lesser spacings are acceptable. The maximum spacing between rows of perforations should not exceed six (6) inches.

The minimum grade of piping shall be one-eighth (1/8) inch per foot (one (1) percent slope). Access for cleaning all underdrain piping is needed. Cleanouts with a removable PVC cap are required within fifty (50) feet of every portion of lateral, at collector drain lines, and at every bend. In order to minimize damage to these cleanouts due to maintenance equipment, vandalism, and mowing set the top of the cleanout flush with the top of the sand bed. At least one lateral must be accessible for cleaning when the pond is full. The full pond cleanout should extend above the water quality elevation and/or be located outside of the water quality volume ponding area. In order to minimize vandalism or other types of damage to this full pond cleanout the use of exposed piping shall be avoided or minimized.

• Basin Liner. Impermeable liner requirements and specifications are located in Section 1.6.2(C).

• Outfall. The surface discharge from the underdrain pipe shall be non-erosive. Where feasible the underdrain pipe should discharge to a gravel trench in order to diffuse the flow and promote infiltration and recharge. See Figure 1-52 in Appendix V. If a gravel trench is not feasible other options are shown in the Standards Details 508S-16 through 20.

1.6.7.1 - Introduction

Innovative, or alternative, water quality controls are eligible for water quality credit pursuant to § 25-8-151 of the Land Development Code (Innovative Management Practices). The green stormwater infrastructure practices included in this section have been reviewed and approved by the Watershed Protection Department. Acceptance of and the amount of credit allowed for such practices are based on:

- Technical merit
- Compliance with requirements for water quality protection and improvement
- Resource protection and improvement
- Advantages over traditional practices
- Anticipated maintenance requirements

Section 1.6.7 includes the following subsections where design criteria and guidance are provided for each practice:

A. Retention/Irrigation Systems.

B. Vegetative Filter Strips.

C. Biofiltration.

D. Rainwater Harvesting.

E. Porous Pavement.

F. [Placeholder].

G. Non-Required Vegetation.

H. Rain Garden.

Maintenance requirements of the approved stormwater control measures are provided in section 1.6.3.

1.6.7.C. - Biofiltration

1. Introduction. Biofiltration devices are a type of stormwater control measure (SCM) that uses the chemical, biological, and physical properties of plants, microbes, and soils to remove pollutants from stormwater runoff. Biofiltration systems can provide equivalent treatment to a standard sedimentation/filtration system.

   A biofiltration system is an enhanced filtration device that typically utilizes more than one treatment mechanisms for removing pollutants from stormwater runoff. A sedimentation basin is required as a first step in the SCM, to provide pre-treatment of runoff in order to protect the biofiltration medium from becoming clogged prematurely by sediment loads. Then, flows are directed through a biofiltration medium which removes pollutants. A defining characteristic of the biofiltration SCM is a community of plants and microorganisms that is rooted in the filter medium and that can provide more treatment of runoff, directly and by uptake from the filter medium. As well as enhancing removal of pollutants, the plant community tends to sustain the permeability of the biofiltration medium for longer periods of time without maintenance. It is the existence of this biological community that differentiates a biofiltration SCM from a typical sand filter, which is otherwise comparable in design and performance.

   There are several hydraulic features or components that combine to make the biofiltration system work effectively. There is commonly a splitter box or flow spreading structure at the flow entrance to ensure flows do not concentrate and potentially channelize the filter medium (see 1.6.2.B). There is a sedimentation chamber to capture coarse sediments, and in some cases (described below) a separator element. The biofiltration filtration chamber typically must have an underdrain piping system beneath it, with native or adapted vegetation rooted in the medium and selected for tolerance to ponding and dry soil conditions. Finally, there is an outlet structure from the SCM at the point of discharge.

   For biofiltration ponds to work effectively, maximum velocities into the sedimentation chamber must not be exceeded. This requirement tends to limit the size and amount of impervious cover that is practical for treatment using this kind of device. Biofiltration ponds are relatively low maintenance once native plantings are well established. These devices should be restricted from any use that may negatively affect the function of the biofiltration pond (e.g. pet use, application of herbicides and pesticides, excessive mowing, etc.). To ensure this, an approved and recorded Integrated Pest Management plan will be required for the drainage area up to and including the pond area. See Section 1.6.3 for maintenance, and irrigation requirements.

2. Basin Surface Areas and Volumes.

   The following equation gives the minimum surface area required for the filtration basin:

   $A_f = WQV*L/(k*t*(H_{max}/2+ L))$ (Equation C-1)

   Where

- A_f = required surface area of the medium in square feet.

- WQV = the water quality volume in cubic feet as defined in section 1.6.2.

- L = Depth of the filter medium (typ. 1.5 feet).

- k = Hydraulic Conductivity (3.5 ft/day for "full" sedimentation-filtration systems; 2 ft/day for "partial" systems).

- H_{max} = Maximum head over the filter medium (feet).

- t = Drawdown Time (two (2) days).

For design purposes, the hydraulic conductivity of the biofiltration medium can be assumed to be the same as that for sand filtration. Measured hydraulic conductivity of new biofiltration medium substantially exceeds 3.5 ft/day; however, a significant reduction in conductivity over time due to surface crusting and clogging of void spaces by lower-permeability silt and clay particles will occur. If surface crusting and clogging can be minimized (which should be the case for biofiltration systems due to the presence of vegetation) it is reasonable to assume that the hydraulic conductivity of biofiltration systems should be comparable to sand filters.

Full Sedimentation/Biofiltration Systems.

In these systems the entire water quality volume is stored in the sedimentation basin, and then discharges relatively slowly to the biofiltration basin (e.g. over a period of 48 hours). See 1.6.5.A. for additional design criteria and Figure 1.6.7.C-1, Full Sedimentation/Biofiltration Pond, for general details. It is recommended that the bottom of the sedimentation basin be ≥2″ higher than the top of the filtration basin in order to uniformly discharge flow at or above the biofiltration vegetation, and to prevent excessive drawdown times due to tailwater effects. See Figure 1.6.5.A.

Based on the equation and assumptions given above, the minimum surface area required for the biofiltration basin is:

Af = WQV/(7 + 2.33*H) (Equation C-2)

Where

A_f = filtration area in square feet,

WQV = water quality volume in cubic feet as defined in section 1.6.2A, and

H = maximum ponding depth in the filtration basin. The assumed maximum ponding depth of the filtration basin should be at least one (1) foot less than the maximum ponding depth in the sedimentation basin, to account for tailwater effects.

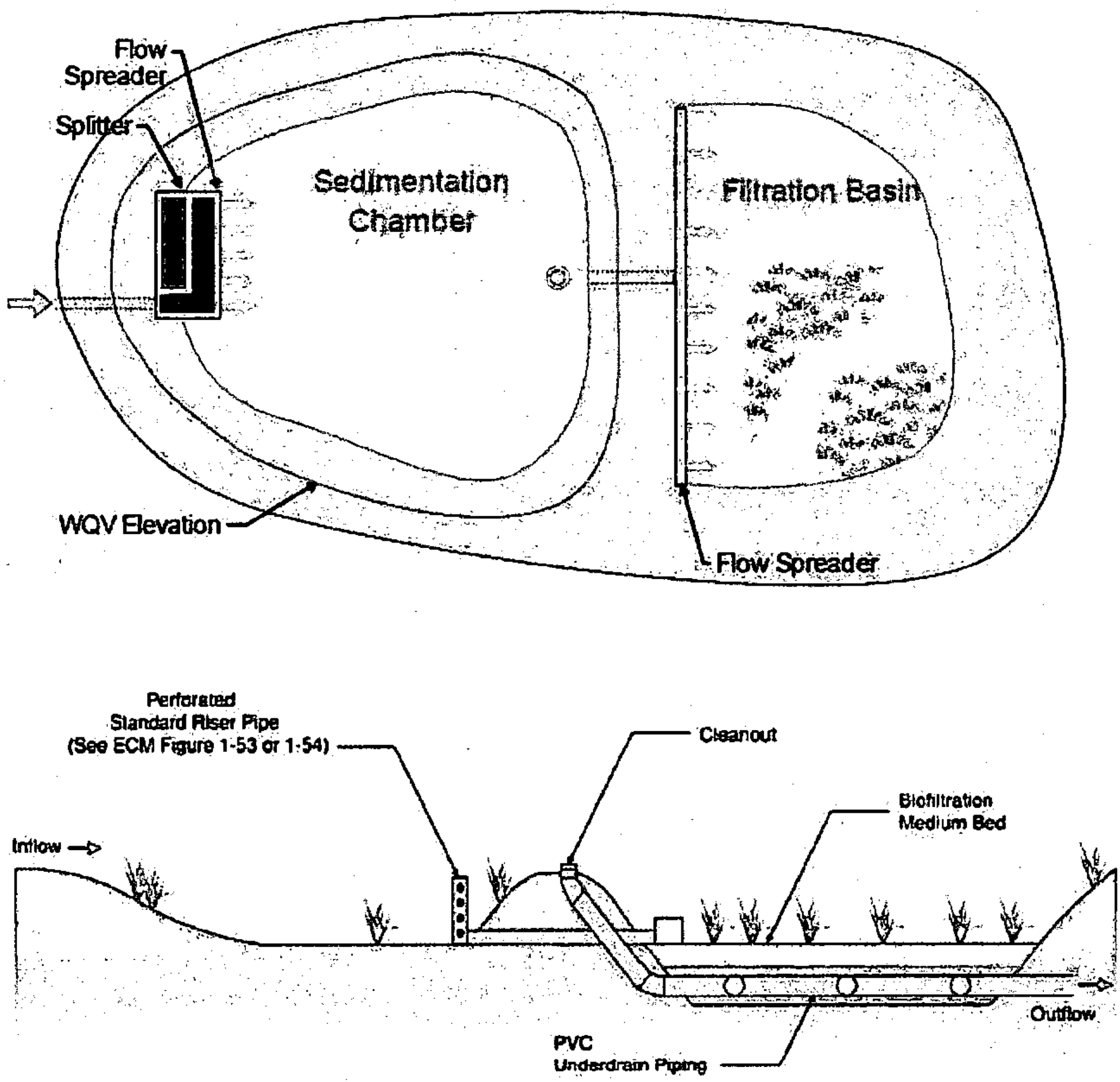


Figure 1.6.7.C-1: Full Sedimentation/Biofiltration Pond.

Partial Sedimentation/Biofiltration Systems.

In this case, the sediment chamber is not large enough to store the whole water quality volume, so that volume must be stored partly over the sediment chamber and partly over the biofilter. The combined volume of the sediment chamber and filtration basin must therefore equal to the water quality volume, i.e., $V_s + V_f$ = water quality volume where "V_s" is the sediment chamber volume and "V_f" is the filtration basin volume. The volume of the sediment chamber, "V_s", shall be no less than 20 percent of the water quality volume.

For general details see Figure 1.6.7.C-2, Partial Sedimentation/Biofiltration Pond, and Section 1.6.5.B, Partial Sedimentation/Filtration.

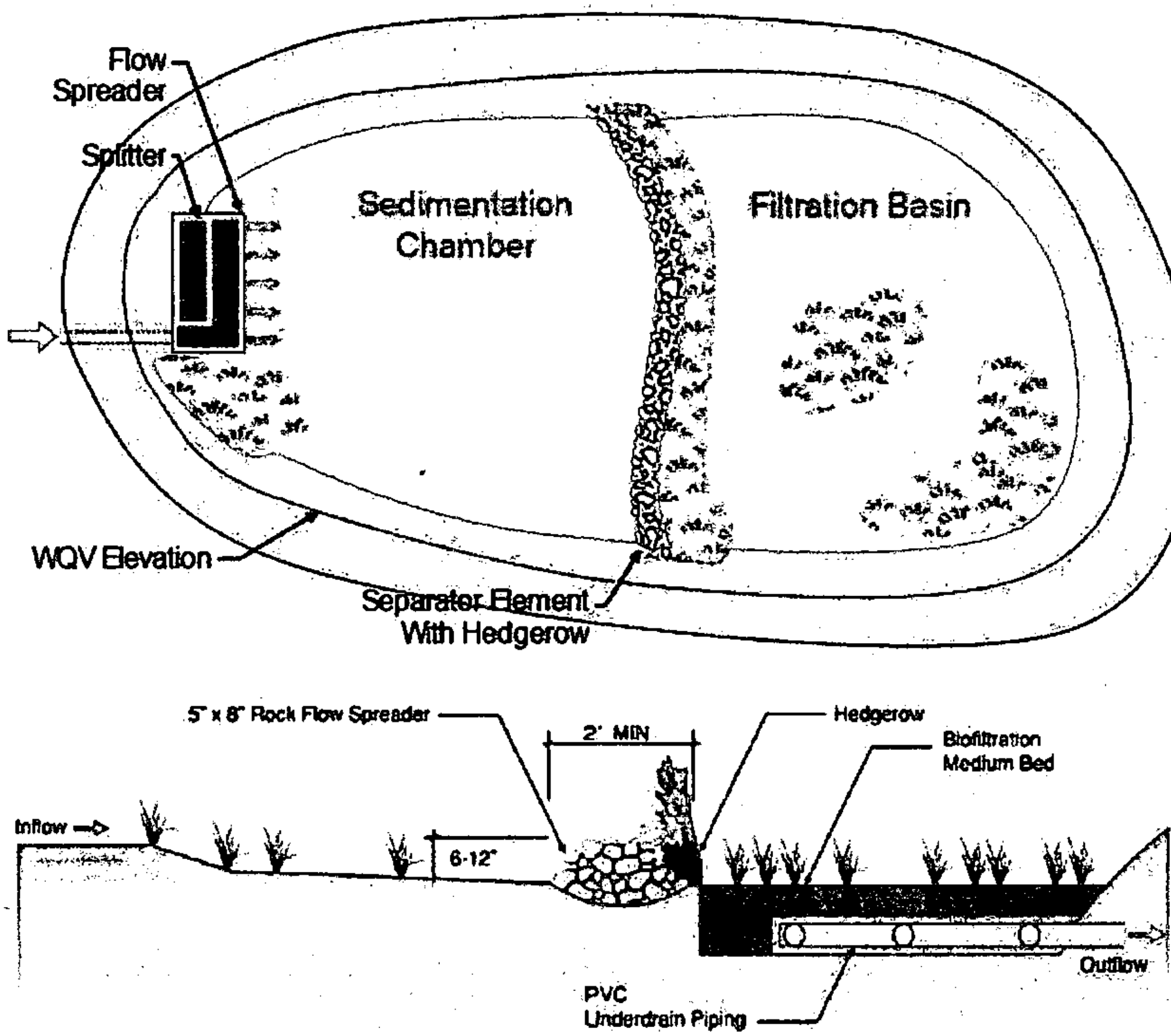


Figure 1.6.7.C-2: Partial Sedimentation/Biofiltration Pond.

Based on the equation and assumptions given above, the minimum surface area required for the biofiltration basin is:

$Af = WQV/(4 + 1.33*H)$ (Equation C-3)

Where:

Af = required surface area of the medium in square feet,

WQV = water quality volume in cubic feet as defined in section 1.6.2.A, and

H = maximum ponding depth above the filtration medium in feet.

3. Sedimentation Basin/Sediment Chamber Details. The system consists of an inlet structure, flow spreader, vegetative settling area, and separator element. It is recommended that the bottom of the sediment chamber be > 2" higher than the top of the filtration basin in order to uniformly discharge flow at or above the biofiltration vegetation, and to prevent excessive drawdown times due to tailwater effects.

   A. Inlet Structure/Flow Spreader. The inflow of the water quality pond should pass through a splitter box structure or flow spreading device (see section 1.6.2.B). Either way, the water quality volume flowing into the BMP should be discharged uniformly and at low velocity into the basin/chamber in order to promote settling of entrained sediments, to avoid re- suspension of previously deposited sediments and, in extreme cases, to avoid flow concentration and subsequent channelizing of the basin/chamber substrate. Flow spreading should be designed so as to restore the flows entering the BMP (i.e., after the inlet structure) to sheetflow conditions with a maximum velocity of two (2) feet per second for the peak flow rate of the twenty-five (25) year storm with the assumption that the catchment area has reached its fully development condition. See Section 1.6.2.D. Plantings in the sedimentation basin may provide resistance to flow and further spread the flows, thereby reducing runoff velocities further to improve settling, biological uptake, and adsorption.

   The basin/chamber should have a bottom slope of at least 2% to ensure that the pond will drain adequately even after silt accumulation. Depending on the planned approach to maintenance and sediment removal, it may be desirable for the heavier suspended material to drop out near the inlet end of the basin.

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4. Biofiltration Basin Details. The Biofiltration medium bed filtration system consists of the biofiltration medium bed, underdrain piping, and outlet structure.

   A. Biofiltration Medium. In order to provide acceptable drainage and plant growth characteristics, the biofiltration medium shall meet the following performance criteria:

   Percent Organic Matter (by weight) of 0.5 - 5.0%

   Texture Analysis (particle size distribution):

   - Percent Sand 70 - 90%
   - Percent Clay 3 - 10%
   - Percent Silt plus Clay ≤27%

There is ongoing research on the most appropriate sources of organic matter to incorporate into the media.

Suppliers of biofiltration media must have laboratory testing conducted at a minimum of six month intervals to verify percent organic matter and texture analysis. The medium must not contain any contaminated soils and be free of any household or hazardous waste. It must be free of stones, trash, and other undesirable material, and should not contain weeds or weed seeds. A saturated hydraulic conductivity of $k \geq 2.0$ in/hr. can be presumed if the organic matter and texture analysis criteria are met.

The hydraulic conductivity needs to be high enough to provide adequate drainage, support healthy plant growth, and prevent nuisance conditions.

The criteria is intended to meet the NRCS definition of soils with "moderate" to "high" available water capacity. The criteria should ensure that the medium has sufficient water holding capacity to support vigorous plant growth, enhancing the ability for plants to survive during dry periods. It should also sustain a healthy microorganism population which, in concert with the plants, should enhance biological removal of pollutants in stormwater.

The percent organic matter criterion is needed to ensure healthy vegetation. Most native soils in the Austin area have less than 4% organic matter, and native plants in the area have adapted to surviving in these types of soils. A higher organic matter content is not desirable as nutrients may be exported from the medium, which is counter to the removal that is intended in this type of device. Immature compost, manure, compost derived from animal or human sources, and unstable forms of organic matter that may export nutrients should not be included in the biofiltration medium. Recommended sources of organic matter include that found naturally in native topsoil, humus, coconut coir fiber, and mature plant-derived composts with an established fungal component. The biofiltration medium must be certified by the project engineer or their designee (e.g. contractor, soil supplier, or appropriate qualified alternative individual) as meeting the above performance criteria (based on submittal of delivery tickets, test results, etc.) before acceptance by the City.

1. Creating Biofiltration Mixture – See Standard Specification 660S, Biofiltration Medium

B. Biofiltration Bed with Underdrain. The biofiltration medium bed for biofiltration basins must be built to the Biofiltration Bed configuration illustrated in Figure 1.6.7.C- 3 (for details see Standard Detail 661-3). The biofiltration medium layer is to be a minimum of eighteen (18) inches meeting the specifications stated in Section 4A above. Other materials or substances that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations shall not be mixed or dumped within the biofiltration area. Note: Required biofiltration medium bed depths should be interpreted as final consolidated values rather than as initially placed. Under the biofiltration medium shall be an underdrain system that consists of one-half (0.5) to one and one-half (1.5) inch diameter washed, rounded, river gravel surrounding 6 inch Schedule 40 PVC underdrain lateral pipes. The maximum spacing for the laterals should be ten (10) feet between laterals and five (5) feet from a wall or side. The minimum thickness of the gravel envelope is 3 inches.

The soil medium and gravel layer must be separated by a filter material.

A filter can be of two (2) general forms. A fabric filter is a layer of geotextile filter fabric manufactured for that express purpose and a granular filter is one or more graded layers of sand, gravel or stone.

- The geotextile filter fabric must comply with Specification 620S, Table 2, High Flow Filter Fabric Requirements.

  - The gradation of a granular filter design must comply with Section 1.4.6.D.6, Rock Riprap – Filter. In cases where the requirements cannot be met with a single gradation multiple layers of granular filter material of varying gradations may be required to meet the criteria. The thickness of a granular filter layer should be no less than 1.5 times the maximum size in the filter gradation or four inches (102 mm) whichever is greater.

To avoid compaction of the biofiltration medium and promote filtration heavy equipment shall not be allowed in biofiltration area after the biofiltration medium has been placed.

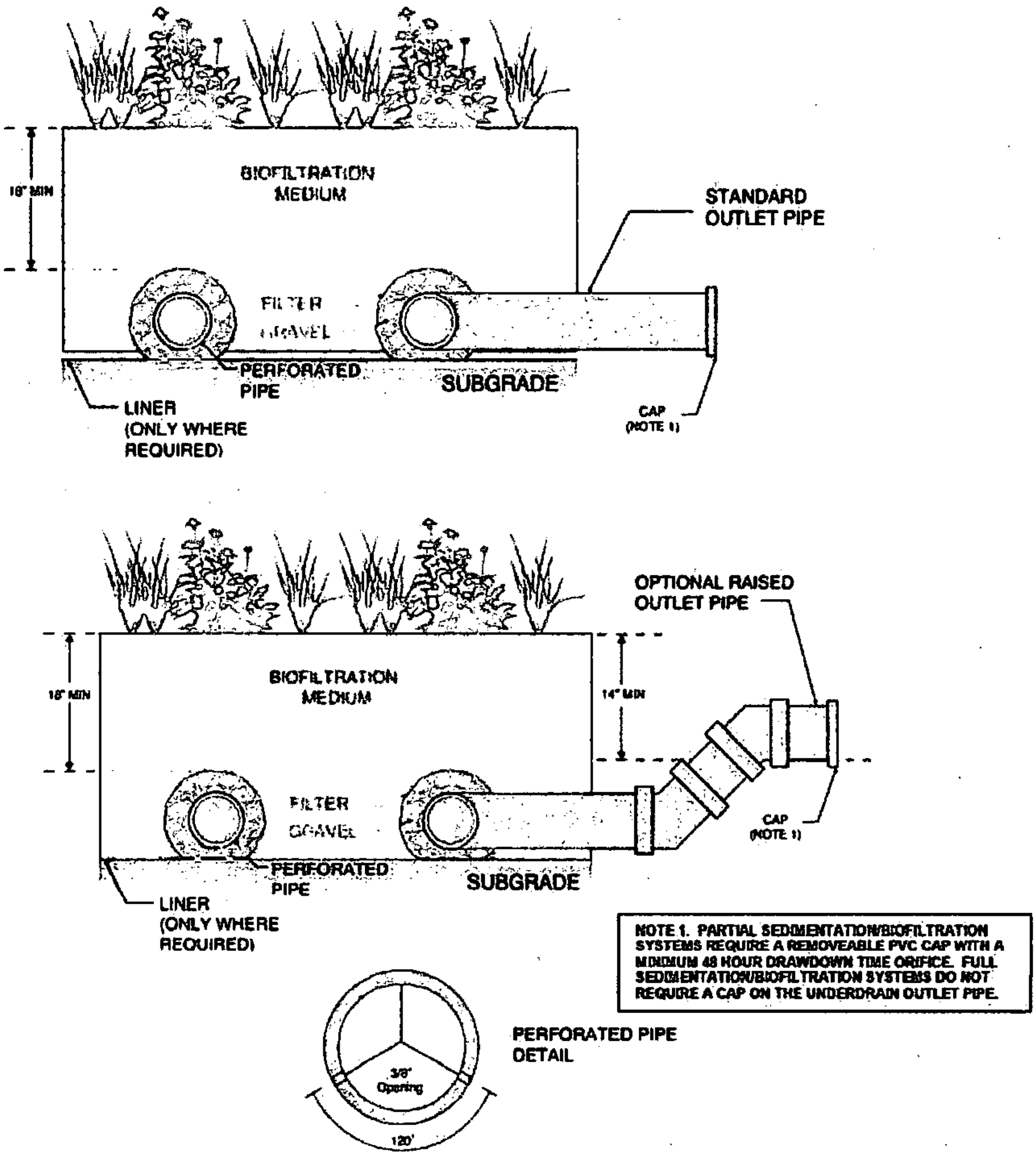


Figure 1.6.7.C-3: Biofiltration medium bed with underdrain system.

Access must be provided for cleaning all underdrain piping. Cleanouts with a removable PVC cap are required within fifty (50) feet of every portion of lateral, at collector drain lines, and at every bend. In order to minimize damage to these cleanouts due to maintenance equipment, vandalism, and mowing, the top of the cleanout should be set flush with the top of the biofiltration medium bed or ground surface from which it emerges. It is recommended that cleanouts be located outside of the water quality volume ponding area and above the water quality volume elevation when feasible to reduce short circuiting caused by loss or damage to the cleanout caps. At least one lateral must be accessible for cleaning when the pond is full. The full pond cleanout must extend above the water quality elevation and/or be located outside of the water quality volume ponding area. In order to minimize vandalism or other types of damage the use of exposed piping shall be avoided or minimized.

Note: The top surface of the biofiltration medium bed must be horizontal.

5. Landscape Design. Although an essential role of the landscaping is to make the pond attractive, the highest priority shall be to meet the pond's water quality and soil stabilization functional requirements. A diverse suite of plants should be selected based on their ability to survive under alternating conditions of inundation and extended dry periods, and in different areas within a facility (e.g., basin versus side slopes). High plant diversity will provide resiliency to the system and help prevent a situation where all vegetation is lost. Over time, the plant species that are best suited to the unique conditions of each basin will naturally self-select and spread.

   The landscape elements for the sedimentation basin or chamber may be different than for the biofiltration basin, due primarily to different soil characteristics. Compared to most native soils in the Austin area, the biofiltration medium may drain more rapidly, and have less clay content. The selection of plants for the biofiltration medium depth will also be limited because the medium depth is typically about 1.5 feet, thus plants with large root systems are not appropriate. Trees shall not be used in the biofiltration chamber with underdrains. The soil characteristics and depth, and soil moisture availability including groundwater, in the sedimentation basin or chamber will probably vary widely from site-to-site, and this will have a significant effect on the plant selection.

   City of Austin maintained biofiltration systems may be designed with turf grass and/or ground cover plants only.

   A. Plant Selection, Quantities, and Spacing.

      Vegetation shall be planted throughout the entire sedimentation and filtration basin areas as shown on a planting plan along with list of proposed plant species, container size, spacing, and quantity (Figure 1.6.7.C-4). The proposed vegetation must be diverse, appropriately distributed, and spaced according to the mature size of the particular plants. A landscape architect or other qualified landscape professional should be involved in the design to ensure appropriate plant species selection and layout.

      a. Selection

Vegetation may comprise shrubs, perennials, bunchgrasses, succulents, groundcovers or turf, and this generally requires that there be a minimum of five (5) different species planted. Annuals are not permitted, and small trees, while allowed (see below) do not count towards the minimum species requirement. The designer can chose plants from the *Grow Green Native and Adapted Landscape Plants* guide (www.austintexas.gov/department/grow-green/plant-guide). Table 1.6.7.C-3 is a list of plants from this guide that the City of Austin does not recommend based on soil depth requirements, soil moisture requirements, and undesirable plant characteristics (e.g., short-lived, weak wood, suckering, maintenance concerns [messy fruit, thorny]).

Small trees can be incorporated:

- In the filtration basin, around the perimeter of the filtration basin, above the water quality volume, as long as the underdrain system is protected from penetration by the tree root system and the structure does not meet the definition of a dam or levee/floodwall as defined in the Drainage Criteria Manual section 8.3.3.

- In the sedimentation basin, in the floor and side slopes within the water quality volume, if soil conditions and depth are appropriate, and measures are taken to prevent root penetration into the adjacent filtration underdrain system.

- See 1.6.7.C-3 for a list of trees not recommended for biofiltration facilities.

Plants must be selected and arranged carefully so that they serve their intended functions. In addition to choosing plants for their aesthetic properties, select plants that:

- are adapted to the pond hydrology (i.e. both periodic flooding and drought);
- are adapted to the soil types within the pond, whether native site soils or biofiltration media;
- are suitable for their specific function (e.g. erosion control, filtration, etc.);
- are durable, resilient and resistant to pests and disease;
- are tolerant of the pollution in stormwater runoff;
- have a root system of the desired type, mass and depth;
- are resistant to weed invasion;
- require minimal maintenance;
- are not invasive; and

- are commercially available.

Rooted plants may be provided in bare- or live-root form, sod, or in containers (e.g., trays, pots, tubes). Root mass of bare-root plants must be equal in mass to the equivalent container sizes. For the purpose of fulfilling the required minimum plant quantity, it is assumed that the plants to be installed will be 1-gallon size. Other sizes are acceptable but overall the quantity must be equivalent to the required minimum one-gallon plants. See Table 1.6.7.C-1 for equivalency.

Table 1.6.7.C-1
Plant Size Equivalents

Potential Substitute		To	
Quantity	Plant Size	Quantity	Plant Size
1	Five-gallon or larger	4	One-gallon
1	Two or Three-gallon	2	One-gallon
4	4" pots or quarts	1	One-gallon
8	Plugs	1	One-gallon
2	Pieces of Sod	1	One-gallon

b. Quantities

A certain percentage of the basins should be planted with rooted plants to provide immediate cover, whereas the other parts can be seeded or covered with turf grass (see below). All species, including turf grass will count towards the diversity minimum. No one species should comprise more than 20% of the total area of the basin. Additional rooted plants beyond the minimum is encouraged. If it can be demonstrated that there is a compelling reason to deviate from these guidelines then an alternative design may be allowed with approval from City staff.

i. Sedimentation Basin

To determine the minimum required quantity of rooted plants, multiply the total surface area (in square feet) of the sedimentation basin by ten percent (0.1). This number represents the minimum number of plants to be placed in the sedimentation basin.

ii. Filtration Basin

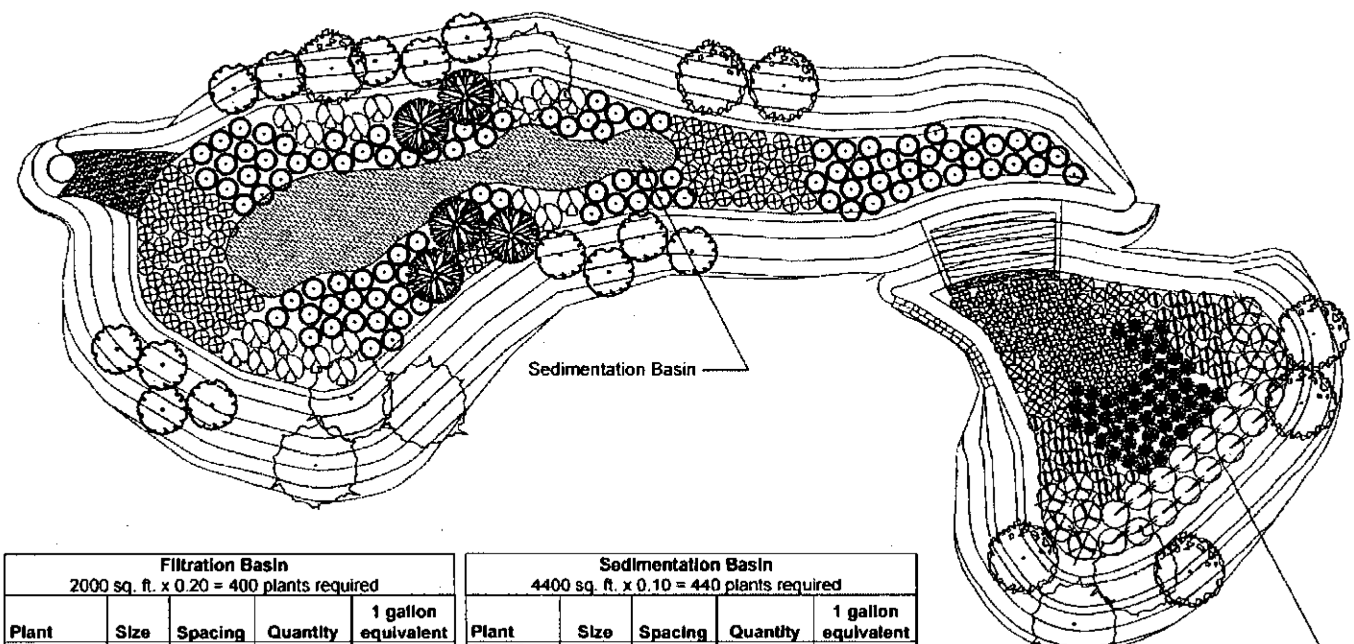
To determine the minimum required quantity of rooted plants, except turf grass, multiply the total surface area (in square feet) of the filtration basin by twenty percent (0.2). This number represents the minimum number of rooted plants to be placed in the filtration basin.

c. Spacing

The goal is to provide 95 percent vegetative coverage across the basins.

i. Rooted plants should be spaced based on mature size to allow room for growth and avoid overcrowding conditions that will cause plant mortality or impenetrable barriers for maintenance personnel.

ii. Contiguous areas of sod should be planted end to end, allowing no bare soil.



Filtration Basin 2000 sq. ft. x 0.20 = 400 plants required				
Plant	Size	Spacing	Quantity	1 gallon equivalent
Shrub	6 gal.	5' o.c.	10	40
Shrub	5 gal.	5' o.c.	15	60
Bunchgrass	5 gal.	3' o.c.	50	200
Bunchgrass	1 gal.	2.5' o.c.	25	25
Perennial	1 gal.	3' o.c.	50	50
Groundcover	4"	2' o.c.	100	25
			TOTAL	400

Sedimentation Basin 4400 sq. ft. x 0.10 = 440 plants required				
Plant	Size	Spacing	Quantity	1 gallon equivalent
Small Tree	5 gal.	10' o.c.	5	20
Shrub	5 gal.	5' o.c.	20	80
Bunchgrass	1 gal.	4' o.c.	100	100
Perennial	1 gal.	3' o.c.	100	100
Sod	square		360	180
			TOTAL	480

Figure 1.6.7.C-4: Example of Biofiltration Landscape Layout and Calculations

B. Plant Species Not Allowed or Recommended.

Various plant species are not allowed or not recommended in biofiltration facilities for various reasons. Plants listed in Table 1.6.7.C-2 are not permitted in biofiltration systems. These plants are not native, and have shown the capacity to naturalize here or in other areas of the country. The intent is to avoid future problems with invasive plants. The following restrictions apply:

- Plant species listed as invasive by the City of Austin or the state of Texas are not allowed. Refer to:

- City of Austin Top 24 list http://www.texasinvasives.org/plant_database/coa_results.php

- TDA Noxious Weed List http://texreg.sos.state.tx.us/fids/200701978-1.html

- In addition, plants in the following table are not allowed due to their potential invasiveness.

Table 1.6.7.C-2

Vegetation That Is Not Permitted For Planting

Common Name	Botanical Name	Comments
Pampas grass	*Cortaderia selloana*	Potentially invasive
Scotch broom	*Cytisus scoparius*	Invasive shrub
Weeping love grass	*Eragrostis curvula*	Invasive grass
Cogon grass	*Imperata cylindrica*	Invasive grass
Japanese silver grass	*Miscanthus sinensis*	Invasive grass
Fountain grass	*Pennisetum setaceum*	Invasive grass
Common reed	*Phragmites australis*	Tall invasive grass

Table 1.6.7.C-3
Vegetation that is Not Recommended

Plant Type	Common Name	Botanical Name	Comments
SMALL TREES/LARGE ~~SHRUBS~~	Anacua	*Ehretia anacua*	Suckers; prefers well-drained soil; cold tender
	Cherry Laurel	*Prunus caroliniana*	Requires deep soils
	Crape Myrtle	*Lagerstoemia indica*	Requires deep soils
	Goldenball Lead Tree	*Leucaena retusa*	Requires consistently dry soil
	Mexican Olive	*Cordia boissieri*	Messy fruit
	Palms (non-native)	*various*	Various
	Texas Persimmon	*Diospyros texana*	Messy fruit
	Pomegranate	*Punica granatum*	Messy fruit
	Retama	*Parkinsonia aculeata*	Suckers, short-lived
	Roughleaf Dogwood	*Cornus drummondii*	Suckers
	Flameleaf Sumac	*Rhus lanceolata*	Needs large space; suckers
	Viburnum	*Viburnum rufidulum*	Requires deep soils
	Wax Myrtle	*Morella cerifera*	Requires deep soils
	Xylosma	*Xylosma congestum*	Spiny; potentially invasive
SHRUBS	Japanese Aralia	*Fatsia japonica*	Requires shade and regular water
	Japanese Yew	*Podocarpus macrophyllus*	Requires shade and regular water
	Fragrant Mimosa	*Mimosa borealis*	Requires consistently dry soil
	Bush Germander	*Teucrium fruticans*	Requires consistently dry soil
	Globe Mallow	*Sphaeralcea ambigua*	Requires consistently dry soil
	Mock Orange	*Philadelphus coronarius*	Requires consistently dry soil
	Pineapple Guava	*Eijoa sellowiana*	Cold tender, messy fruit
	Rosemary	*Rosmarinus offinialis & prostratus*	May not tolerate poorly drained soil
	Texas Sage	*Leucophyllum frutescens*	Requires consistently dry soil
PERENNIALS	Blackfoot Daisy	*Melampodium leucanthum*	Requires consistently dry soil

	Bulbine	*Bulbine frutescens*	Cold tender
	Cast Iron Plant	*Aspidistra elatior*	Requires dry shade
	Frostweed	*Verbesina virginica*	Colonizes; limited commercial availability
	River Fern	*Thelypteris kunthii*	Requires shady, moist areas
	Gayfeather	*Liatris mucronata*	Requires consistently dry soil
	Hymenoxys	*Tetraneuris scaposa*	Requires consistently dry soil
	Shrimp Plant	*Justicia brandegeana*	Prone to spread to outside areas
GROUNDCOVERS	Monkey Grass	*Ophiopogon japonicus*	Requires shady, moist soil
	Purple Heart	*Setcreasea pallida*	Prone to root rot; cold tender
	Silver Ponyfoot	*Dichondra argentea*	Good drainage critical

1.6.7.E – Porous Pavement

3. Design Guidelines.

The designer must select the appropriate material properties, the appropriate pavement thickness, underlying layers, material types, and other characteristics needed to meet the anticipated traffic loads and hydrological requirements simultaneously.

For water quality credit purposes, a porous pavement area that meets the criteria can be deducted from the drainage area used for sizing the water quality control; however it is not eligible for impervious cover credit unless allowed under City Code Section 25-8-63 (e.g. multi-use trails, fire lanes, etc).

The following criteria must be met when designing a porous pavement system:

A. The gravel layer below porous pavement must have a minimum thickness greater than or equal to five (5) inches with an assumed effective porosity no greater than ~~or equal to~~ 0.30 to account for reduced volume due to sediment. The gravel layer must be an open graded (single size) aggregate, with little or no fines. Examples of standard open graded gravel materials that allow for storage and conveyance of storm water are those that meet C-33 ASTM Nos. 8, 9, 57, and 67.

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6. **Post Construction/Inspection.**

The porous pavement surface_saturated hydraulic conductivity must be greater than or equal to 20 in/hr.

Use the following testing methods to verify the surface saturated hydraulic conductivity:

- For porous concrete and porous asphalt use ASTM C1701
- For open-jointed block pavement, PICP, or CGP use ASTM C1781

All inspection, infiltration testing, and maintenance activities shall be documented and made available to City of Austin inspection staff upon request.

1.6.7.G. - Non-Required Vegetation

2. Water Quality Credit and Design Guidelines.

   For water quality credit purposes, non-required vegetation can be deducted from the drainage area used for sizing the water quality control; however it is not eligible for impervious cover credit.

   The following factors affect non-required vegetation Water Quality credit:

   - The available planting area, see ECM 3.5.0;
   - The anticipated rate of survival of vegetation planted;
   - The quantity of vegetation to be planted; and
   - The types of vegetation proposed.

   The vegetation area eligible for credit is the 25-year growth root system. For trees, the root system is assumed to be equal to the canopy cover. To be eligible for credit the entire spatial area of the 25-year root system must be pervious (landscape and/or ~~pedestrian-only~~ porous pavement).

   Direct rainfall is assumed to be the primary source of stormwater and no off-site runoff is allowed.

   Minimum soil depths of twelve (12) inches for new trees and eight (8) inches for plants and grasses will be required. For the soil media requirements use the biofiltration media specifications shown in Standard Specification 660S.

   For Non-required vegetation where porous pavement is used above the root zone the design criteria for porous pavement should be followed, see ECM 1.6.7 (E). However, no observation ports are required for non-required vegetation.

   Note: No Water Quality credit will be given for the 25-year growth root system of non-required vegetation located within vehicular parking areas. Additionally, porous pavement is not allowed under stormwater hot spots or areas where land use or activities generate highly contaminated runoff as described in ECM 1.6.7(E).

1.6.7.H. - Rain Garden.

2. Site Selection.

Rain gardens can be used in new developments or as a retrofit within an existing site. Unlike conventional centralized stormwater management systems, multiple rain gardens may be dispersed across a development, and incorporated into the landscape, providing aesthetic as well as ecological benefits. Rain gardens allow for all or a portion of the water quality volume (WQV) to be treated within landscaped areas, and therefore may reduce landscape irrigation requirements by making use of stormwater runoff. Rain gardens are especially suited for small sites and are typically installed in locations such as parking lot islands, site perimeter areas, and other landscape areas.

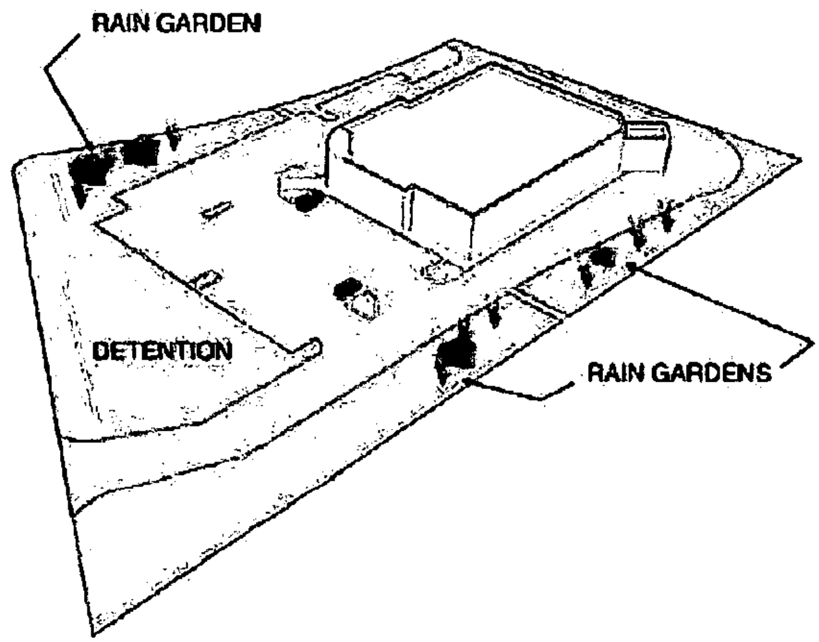

Figure 1.6.7.H-1. Multiple rain gardens may be dispersed across a development, and incorporated into the landscape, providing aesthetic as well as ecological benefits.

The following site characteristics must be considered when designing a rain garden.

Land Use - The use of rain gardens as a water quality control is limited to Commercial, Multi-Family,

Civic Uses, Public Right of Way, and single family residential projects. The restrictions on use of rain gardens for single family residential are as follows:

1. Rain Garden must be located in a dedicated common area or within a drainage easement that is accessible by standard maintenance equipment from the right of way.

2. A minimum of four (4) single family lots must be treated by the rain garden.

3. No rain gardens are to be located in backyards or fenced in yards.

4. The City of Austin will provide functional maintenance per City Code Section 25-8-231. Homeowners may add additional native landscaping and provide more frequent care.

Full infiltration and partial infiltration rain gardens are not allowed in areas where land use or activities generate highly contaminated runoff due to the potential for ground water contamination. These areas include commercial nurseries, auto recycle facilities, hazardous materials generators (if containers are exposed to rainfall), industrial process areas, gas stations, food production/distribution loading dock and trash compactor areas, vehicle fueling and maintenance areas, and vehicle and equipment washing and steam or dry cleaning facilities.

Drainage Area - Rain gardens are restricted to a contributing drainage area not to exceed two acres and a ponding depth not to exceed 12 inches.

Barton Springs Zone - At this time, an unlined rain garden is not acceptable as a primary method for controlling non-point source pollution in watersheds within the Barton Springs Recharge Zone. If a rain garden is proposed for use in the Barton Springs Recharge Zone, then a liner is required and the discharge from this facility must be managed to comply with the Save Our Springs ordinance.

Setbacks - Rain gardens must be designed to prevent adverse impacts to building foundations, basements, wellheads, and roadways from the infiltration of water.

Slopes - Rain gardens should not be located on slopes exceeding 15 percent.

Soil conditions - When siting a full or partial infiltration rain garden, appropriate soil conditions must be present. The depth to an impermeable layer must be at least 12 inches below the bottom of the rain garden. For full infiltration rain gardens, the underlying native soil must have a design infiltration rate that will draw down the full ponded depth in less than 48 hours. For example, for a 12 inch maximum ponding depth, the design infiltration rate must be at least 0.25 inches per

hour. For a 6 inch maximum ponding depth, the design infiltration rate must be least 0.13 inches per hour. For a 3 inch maximum ponding depth, the minimum design infiltration rate is 0.06 inches per hour. The design infiltration rate is based on applying at least a factor of safety of two
(2) to the measured steady state saturated infiltration rate (i.e., the design infiltration rate is equal to one half of the measured infiltration rate). A higher factor of safety may be used at the discretion of the design engineer to take into variability associated with assessment methods, soil texture, soil uniformity, influent sediment loads, and compaction during construction. For full infiltration systems the infiltration rate of the soil subgrade below the growing medium of the rain garden must be determined using in-situ testing as described in Section 1.6.7.4. If a range of values are measured then the geometric mean should be used.

Water Table - Full and partial infiltration rain gardens are not allowed in locations where the depth from the bottom of the growing medium to the highest known groundwater table is less than 12 inches.

Bedrock - Full and partial infiltration rain gardens are not allowed in locations where depth from the bottom of the growing medium to bedrock is less than 12 inches. In cases with bedrock less than 3 feet from the bottom of the growing media, soil testing should be conducted in-situ to account for the effect of this limiting horizon.

Groundwater and Soil Contamination - Full and partial infiltration rain gardens are not allowed in locations where infiltration would cause or contribute to mobilization or movement of contamination in soil or groundwater or would interfere with operations to remediate groundwater contamination. If filtration rain gardens are proposed under these conditions, the potential for incidental infiltration should be evaluated to determine whether an impermeable liner must be used.

5. Growing Medium.

The rain garden growing medium should have sufficient water holding capacity to support vigorous plant growth, enhancing the ability for plants to survive during dry periods. It should also sustain a healthy microorganism population which, in concert with vegetation, should enhance biological removal of pollutants in stormwater.

Requirements for the growing medium depend on the type of rain garden design being considered. For full infiltration rain gardens, the growing medium should be native soil. In the event the designer is not certain about the native soil's ability to support vegetation, a 6 inch layer of topsoil may be added to the soil. This additional depth of soil must be accounted for in the depth and volume required for the pond. For full filtration and partial infiltration rain gardens, only the biofiltration medium may be used. See Standard Specification 660S Biofiltration.