Appendix B: Management Practices: Glossary and Design Features

This appendix provides detailed information about pollution control structures and management practices recommended in this report, including a glossary of terms and drawings, images, and product specifications.

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Glossary

The following glossary terms relating to management practices are adopted from multiple sources, including but not limited to (USEPA 1993; Field et al. 2004; USEPA 2005; USEPA 2007)

BANK STABILIZATION	Methods of securing the structural integrity of earthen stream channel banks with structural supports to prevent bank slumping and undercutting of riparian trees, and overall erosion prevention. To maintain the ecological integrity of the system, recommended techniques include the use of willow stakes, imbricated riprap, or brush bundles.
BANKFULL EVENT (ALSO BANKFULL DISCHARGE)	A flow condition in which streamflow completely fills the steam channel up to the top of the bank. In undisturbed watersheds, the discharge condition occurs on average every 1.5 to 2 years and controls the shape and form of natural channels.
BASEFLOW	The portion of stream flow that is not due to storm runoff, and is supported by groundwater seepage into a channel.
BIOFILTRATION	The use of natural materials and vegetation to trap and remove pollutants from storm water. Grass swales and constructed wetlands can both be used for biofiltration.
BIOLOGICAL MONITORING	Periodic surveys of aquatic biota as an indicator of the general health of a waterbody. Biological monitoring surveys can span the trophic spectrum, from macro-invertebrates to fish species.
CATCH BASIN	Catch Basins collect the rainwater and Urban runoff from the street and serve as the neighborhood entry point in the MS4 system leading into the ocean.
CATCHMENT AREA	See CONTRIBUTING WATERSHED AREA. Also known as drainage catchment area.
CFS	Cubic feet per second. A measure of volumetric flow rate. One CFS is about 449 gallons per minute.
CHANNEL	A natural or artificial waterway that periodically or continuously contains moving water. It has a definite bed and banks that confine the water.
CHANNEL EROSION	The widening, deepening, and headward cutting of small channels and waterways, due to erosion caused by moderate to larger floods.
CONCENTRATION	The density or amount of a pollutant, or other constituent, in solution. This is commonly measured as the average density of pollutants and expressed as milligrams/liter (mg/l).
CONTRIBUTING WATERSHED AREA	Portion of the watershed contributing its runoff to the site or management practice in question.
CONVEYANCE SYSTEM	The drainage facilities, both natural and human-made, which collect, contain, and provide for the flow of surface water and urban runoff from the highest points on the land down to receiving water. The natural elements of the conveyance system include swales and small drainage courses, streams, rivers, lakes, and wetlands. The human-made elements of the conveyance system include gutters, ditches, pipes, channels, and most retention/detention facilities.
DEBRIS	Any material, organic or inorganic, floating or submerged, moved by a flowing stream.
DESIGN STORM	A rainfall event of specified size and return frequency (e.g., a storm that occurs only once every 2 years) that is used to calculate the runoff volume and peak discharge rate to a management practice.
DETENTION	The temporary storage of storm water runoff in a structural device to reduce the peak discharge rates and to provide settling of pollutants.
DETENTION POND	A constructed pond or vault that temporarily stores storm water runoff and releases it at controlled rates.
DETENTION TIME	Time required for detention of storm water runoff in a storm water quality facility (also see "Detention").
DISCHARGE	Outflow; the flow of a stream, canal, or aquifer. One may also speak of the discharge of a canal or stream into a lake, river, or ocean. (Hydraulics) Rate of flow, specifically fluid flow; a volume of fluid passing a point per unit of time, commonly expressed as cubic feet per second, cubic meters per second, gallons per minute, gallons per day, or millions of gallons per day.

DISSOLVED OXYGEN (DO)	Oxygen which is present (dissolved) in water and available for use by fish and other aquatic animals. If the amount of dissolved oxygen in the water is too low, aquatic animals will suffocate.
DIVERSION	A channel, embankment, or other man-made structure constructed to divert water from one area to another
DRAINAGE BASIN	A geographic and hydrologic subunit of a watershed
DRY POND CONVERSION	A modification made to an existing dry storm water management pond to increase pollutant removal efficiencies. For example, the modification may involve a decrease in orifice size to create extended detention times, or the alteration of the riser to create a permanent pool and/or shallow marsh system.
DRY-WEATHER FLOW	Flow occurring during the dry season (generally considered to be May through September) which may be associated with reservoir releases or releases of water from industrial or residential activities.
ECOSYSTEM	The interacting system of a biological community and its nonliving environmental surroundings.
EFFECTIVE IMPERVIOUS AREA (EIA)	The portion of total impervious cover that is directly connected to the storm drain network (MS4). These surfaces usually include street surfaces and paved driveways and sidewalks connected to or immediately adjacent to them, parking lots, and rooftops that are hydraulically connected to the drainage network (eg. downspouts).
EFFLUENT CONCENTRATION	The average concentration of a pollutant or other constituent in storm water runoff flowing out of the management practice.
EMBANKMENT	A bank (of earth or riprap) used to keep back water.
EMERGENT PLANT	An aquatic plant that is rooted in the sediment but whose leaves are at or above the water surface. Such wetland plants provide habitat for wildlife and waterfowl in addition to removing storm water pollutants.
END OF PIPE CONTROL	Water quality control technologies suited for the control of existing urban storm water at the point of storm sewer discharge to a stream. Due to typical space constraints, these technologies are usually designed to provide water quality control rather than quantity control.
ENERGY DISSIPATION	The loss of kinetic energy of moving water due to internal turbulence, boundary friction, change in flow direction, contraction, or expansion.
EROSION	The wearing away of the land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, or timber cutting.
EXTENDED DETENTION (ED)	A storm water design feature that provides for the gradual release of a volume of water (0.25 - 1.0 inches per impervious acre) over a 12 to 48 hour interval time to increase settling of urban pollutants, and protect channel from frequent flooding.
EXTENDED DETENTION (ED) POND	A conventional ED pond temporarily detains a portion of storm water runoff for up to twenty-four hours after a storm using a fixed orifice. Such extended detention allows urban pollutants to settle out. The ED ponds are normally dry between storm events and do not have any permanent standing water. An enhanced ED pond is designed to prevent clogging and resuspension. It provides greater flexibility in achieving target detention times. It may be equipped with plunge pools near the inlet, a micropool at the outlet, and utilize an adjustable reverse-sloped pipe at the ED control device.
EXTENDED DETENTION ZONE	A pondscaping zone that extends from the normal pool to the maximum water surface elevation during extended detention events. Plants within this zone must be able to withstand temporary inundation from 5 to 30 times per year.
FLOODPLAIN	Any lowland that borders a stream and is inundated periodically by its waters.
FOREBAY	An extra storage space provided near an inlet of a management practice to trap incoming sediments before they accumulate in a pond management practice.
FRINGE MARSH CREATION	Planting of emergent aquatic vegetation along the perimeter of open water to enhance pollutant uptake, increase forage and cover for wildlife and aquatic species, and improve the appearance of a pond.

GEOTEXTILE FABRIC	Textile of relatively small mesh or pore size that is used to (a) wallow water to pass through while keeping sediment out (permeable), or (b) prevent both runoff and sediment from passing through (impermeable). Also known as filter fabric.
GRADING	The cutting and/or filling of the land surface to a desired slope or elevation.
GRASSED SWALE	An earthen conveyance system in which the filtering action of grass and soil infiltration are utilized to remove pollutants from urban storm water. An enhanced grass swale, or biofilter, utilizes checkdams and wide depressions to increase runoff storage and promote greater settling of pollutants.
GRAVEL	Sediment particles larger than sand and ranging from 2 to 64 mm (0.25 to 3 inches) in diameter.
GRAVITATIONAL SETTLING	The tendency of particulate matter to drop out of storm water runoff as it flows downstream when runoff velocities are moderate and/or slopes are not too steep.
GROUNDWATER TABLE	The level below which the soil is saturated, that is, the pore spaces between the individual soil particles are filled with water. Above the groundwater table and below the ground surface, water in the soil does not fill all pore spaces.
DETENTION VOLUME	The volume of runoff that is held and treated in a management practice structure.
HABITAT	A place where a biological organism lives. The organic and non-organic surroundings that provide life requirements such as food and shelter.
HEAD	Pressure.
HEAVY METALS	Metals of relatively high atomic weight, including but not limited to chromium, copper, lead, mercury, nickel, and zinc. These metals are generally found in minimal quantities in storm water, but can be highly toxic even at trace levels and tend to accumulate in the food chain.
ILLICIT DISCHARGE	All nonurban runoff discharges to urban runoff drainage systems that could cause or contribute to a violation of State water quality, sediment quality, or ground-water quality standards, including but not limited to sanitary sewer connections, industrial process water, interior floor drains, car washing, and greywater systems.
IMPERMEABLE	Properties that prevent the movement of water through the material.
IMPERVIOUS SURFACE	A hard surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development and/or a hard surface area that causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, rooftops, walkways, patios, driveways, parking lots, storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam, or other surfaces that similarly impede the natural infiltration of urban runoff. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces.
INFILTRATION	The penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls. The infiltration rate is expressed in terms of inches/hour. Infiltration rates will be slower when the soil is dense (e.g., clays) and faster when the soil is loosely compacted (e.g., sands). Can also refer to seepage of groundwater into sewer pipes through cracks and joints.
INFLOW	The volume of storm water that enters a management practice.
INFLUENT CONCENTRATION	The average concentration of a pollutant or other constituent in storm water runoff flowing into the management practice.
INLET	(1) A drainage passway. (2) A short, narrow waterway connecting a bay, lagoon, or similar body of water with a large parent body of water. (3) An arm of the sea (or other body of water) that is long compared to its width and may extend a considerable distance inland.
INVASIVE EXOTIC PLANTS	Non-native plants having the capacity to compete and proliferate in introduced environments.
LAND CONVERSION	A change in land use, function, or purpose.

LAND-DISTURBING ACTIVITY	Any activity that results in a change in the existing soil cover (both vegetative and nonvegetative) and/or the existing soil topography. Land-disturbing activities include, but are not limited to, demolition, construction, clearing, grading, filling, and excavation.
LEVEL SPREADER	A device used to spread out storm water runoff uniformly over the ground surface as sheet flow (i.e., not through channels). The purpose of level spreaders is to prevent concentrative, erosive flows from occurring, and to enhance infiltration.
LOAD ALLOCATION (LA)	The portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.
LOADING CAPACITY (LC)	The greatest amount of loading [pollutant] that water can receive without violating water quality standards.
LOCAL GOVERNMENT	Any county, city, or town having its own incorporated government for local affairs.
LOWFLOW CHANNEL	An incised or paved channel from inlet to outlet in a dry basin which is designed to carry low runoff flows and/or baseflow, directly to the outlet without detention.
MASS WASTING	Dislodgement and downslope transport of loose rock and soil material under the direct influence of gravitational body stresses.
MULTIPLE POND SYSTEM	A collective term for a cluster of pond designs that incorporate redundant runoff treatment techniques within a single pond or series of ponds. These pond designs employ a combination of two or more of the following: extended detention, permanent pool, shallow marsh, or infiltration. The wet ED pond is an example of a multiple pond system.
MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4)	MS4 is a storm water conveyance system comprised of inlet, pipes and outfalls that is owned or operated by the State or local government entity, is used for collecting and conveying storm water, and is not part of a publicly owned treatment works, as defined in EPA 40 CFR Part III. MS4 systems are
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)	A national program under Section 402 of the Clean Water Act for regulation of discharges of pollutants from point sources to waters of the United States. Discharges are illegal unless authorized by an NPDES permit.
NATURAL BUFFER	A low sloping area of maintained grassy or woody vegetation located between a pollutant source and a waterbody. A natural buffer is formed when a designated portion of a developed piece of land is left unaltered from its natural state during development. A natural vegetative buffer differs from a vegetated filter strip in that it is natural and in that they need not be used solely for water quality purposes. To be effective, such areas must be protected against concentrated flow.
NONPOINT SOURCE (NPS) POLLUTION	Pollution that , unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and manmade pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. Loadings of pollutants from NPS enter waterbodies via sheet flow, rather than through a pipe, ditch or other conveyance.
NUTRIENTS	Elements or substances, such as nitrogen or phosphorus, that are necessary for the growth and development of living things (e.g., plants). Large amounts of these substances reaching water bodies can lead to reduced water quality and eutrophication by promoting excessive aquatic algae growth. Some nutrients can be toxic at high concentrations.
OIL/WATER (OR OIL/GRIT) SEPARATOR	A best management practice consisting of a three-stage underground retention system designed to remove heavy particulates and absorbed hydrocarbons. Also known as a WATER QUALITY INLET.
ON-LOT STORAGE	Refers to a series of practices that are designed to contain runoff from individual lots.
ORGANOPHOSPHATE	Pesticide chemical that contains phosphorus; used to control insects. Organophosphates are short-lived, but some can be toxic when first applied.
OTHER REPORTED MEASURES OF PERFORMANCE	These are measures other than effluent concentration. Other reported measures of performance can include percent removal or similar measures.

OUTFALL	The point of discharge for a river, drain, pipe, etc.
OUTFLOW	The volume of storm water that leaves a management practice.
PASSIVE TREATMENT FACILITY	Facilities which use natural materials and vegetation to cleanse storm water and/or reduce storm water flow. Examples include grass swales, constructed wetlands, etc.
PERCENT REMOVAL	For a management practice, the percentage difference between the effluent concentration and the influent concentration for a given pollutant parameter.
PERCENT VOLUME REDUCTION	The percentage of volume reduced between the maximum influent volume and the maximum effluent volume for a given time period.
PERCOLATION	The downward movement of water through the soil.
PERMANENT POOL	A three to ten foot deep pool in a storm water pond system that provides removal of urban pollutants through settling and biological uptake. (Also referred to as a wet pond).
PERMEABILITY	The quality of a soil horizon that enables water or air to move through it.
PERVIOUS SURFACE	Surface area which allows infiltration of water.
PHYSICAL INFILTRATION	The separation of particulates from runoff by grass, leaves and other organic matter on the surface, as the runoff passes across or through the ground.
PHYTOREMEDIATION	Mitigation of environmental problems through the use of natural plant processes and production to contain, degrade, or eliminate contaminant material such as metals, pesticides, solvents, explosives, crude oil and its derivatives, and various other contaminants, from the media that contain them.
POINT SOURCE	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.
POINT SOURCE OF POLLUTION	Discrete conveyances, such as pipes or man made ditches that discharge pollutants into waters of the United States. This includes not only discharges from municipal sewage plants and industrial facilities, but also collected storm drainage from larger urban areas, certain animal feedlots and fish farms, some types of ships, tank trucks, offshore oil platforms, and collected runoff from many construction sites.
POLLUTANT	Dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)), heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water [40 CFR 122.2].
POLLUTION	Pollution is the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the ecosystem i.e. physical systems or living organisms. Pollution can take the form of chemical substances or energy, such as noise, heat, or light. Pollutants, the elements of pollution, can be foreign substances or energies, or naturally occurring; when naturally occurring, they are considered contaminants when they exceed natural levels. Pollution is often classified as point source or nonpoint source pollution.
PONDSCAPING	A method of designing the plant structure of a storm water marsh or pond using inundation zones. The proposed marsh or pond system is divided into zones which differ in the level and frequency of inflow. For each zone, plant species are chosen based on their potential to thrive, given the inflow pattern of the zone.
POST-DEVELOPMENT PEAK RUNOFF	Maximum instantaneous rate of flow during a storm, after development is complete.
PRIORITY POLLUTANTS	Those pollutants considered to be of principal importance for control under the CWA based on the NRDC consent decree settlement [(NRDC et al. v. Train, 8 E.R.C. 2120 (D.D.C. 1976), modified 12 E.R.C. 1833 (D.D.C. 1979)]; a list of these pollutants is provided as Appendix A to 40 CFR Part 423
RECEIVING WATER	The "Water of the United States" as defined in 40 CFR 122.2 into which the regulated storm water discharges.

RETENTION POND	Retention ponds, or "wet ponds," are among the most common stormwater treatment systems used today. They are not to be confused with detention basins or "dry basins," which hold runoff for a specified period of time, and then release the entire volume of the runoff. Retention ponds retain a resident pool of standing water, which improves water quality treatment between storms. Retention ponds demonstrate a reasonably strong water quality treatment, particularly in comparison to dry pond systems.
RETROFIT	The creation or modification of an urban runoff management system in a previously developed area. This may include wet ponds, infiltration systems, wetland plantings, streambank stabilization, and other management practice techniques for improving water quality and creating aquatic habitat. A retrofit can consist of the construction of a new management practice in a developed area, the enhancement of an older urban runoff management structure, or a combination of improvement and new construction.
RIPARIAN	A relatively narrow strip of land that borders a stream or river, often coincides with the maximum water surface elevation of the one-hundred year storm.
RIPRAP	A combination of large stone, cobbles, and boulders used to line channels, stabilize banks, reduce runoff velocities, or filter out sediment.
ROOT ZONE	The part of the soil that is, or can be, penetrated by plant roots.
RUNOFF CONVEYANCE	Methods for safely conveying storm water to a management practice to minimize disruption of the stream network, and promote infiltration or filtering of the runoff.
RUNOFF PRETREATMENT	Techniques to capture or trap coarse sediments before they enter a management practice to preserve storage volumes or prevent clogging within the management practice. Examples include forebays and micropools for pond management practices, and plunge pools, grass filter strips, and filter fabric for infiltration management practices.
RUNON	Off-site flows which flows onto a site.
SCOUR	Concentrated erosive action of flowing water in streams that removes material from the bed and banks.
SEDIMENT	The product of erosion processes; the solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice.
SEDIMENT FOREBAY	Storm water design feature that employs the use of a small settling basin to settle out incoming sediments before they are delivered to a storm water management practice. Particularly useful in tandem with infiltration devices, wet ponds, or marshes.
SEDIMENTATION	The process of sand and mud settling and building up on the bottom of a creek, river, lake, or wetland.
SEEDBANKS	Refers to the large number and diversity of dormant seeds of plant species that exist within the soil. The seeds may exist within the soil for years before they germinate under the proper moisture, temperature, or light conditions. Within marsh soils, this seedbank helps to maintain above-ground plant diversity and can also be used to rapidly establish marsh plants within a newly constructed storm water marsh.
SEEPAGE	Water escaping through or emerging from the ground along an extensive line or surface as contrasted with a spring, where the water emerges from a localized spot.
SELF-MONITORING	Sampling and analyses performed by a facility to determine compliance with a permit or other regulatory requirements.
SHEET FLOW	Water, usually storm runoff, flowing in a thin layer over the ground surface.
SLOPE	The degree of deviation of a surface from horizontal, measured as a percentage, as a numerical ratio, or in degrees.
SOURCE CONTROL	A pollution control measure which operates by keeping pollutants from entering storm water
STORM DRAIN (OR STORM SEWER SYSTEM)	Above and below ground structures for transporting storm water to streams or outfalls for flood control purposes.
STORM WATER	Storm water runoff, snow melt runoff, and surface runoff and drainage [40 CFR 122.26(b)(13)].

STORM WATER DISCHARGE-RELATED ACTIVITIES	Activities that cause, contribute to, or result in storm water point source pollutant discharges, including excavation, site development, grading, and other surface disturbance activities; and measures to control storm water, including the siting, construction, and operation of management practices to control, reduce, or prevent storm water pollution.
STORM WATER RUNOFF	Excess precipitation that is not retained by vegetation, surface depressions, or infiltration, and thereby collects on the surface and drains into a surface water body.
STORM WATER TREATMENT	Detention, retention, filtering, or infiltration of a given volume of storm water to remove urban pollutants and reduced frequent flooding.
STREAM BUFFER	A variable width strip of vegetated land adjacent to a stream that is preserved from development activity to protect water quality, aquatic, and terrestrial habitats.
SUBSOIL	The bed or stratum of earth lying below the surface soil
SUSPENDED SEDIMENT	The very fine soil particles that remain in suspension in water for a considerable period of time.
SWALE	A natural depression or wide shallow ditch used to temporary store, route, or filter runoff.
TOPOGRAPHY	The relative positions and elevations of the natural or man-made features of an area that describe the configuration of its surface.
TOTAL LOAD REDUCTION	An estimate of the management practice removal efficiency target for reducing the total amount or load of pollutants (sediment, nutrients, oxygen-demanding material, or other chemicals or compounds) in storm water runoff.
TOTAL MAXIMUM DAILY LOAD (TMDL)	A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.
TOTAL SUSPENDED SOLIDS (TSS)	A measure of the filterable solids present in a sample, as determined by the method specified in 40 CFR Part 136.
TOXIC POLLUTANT	Pollutants or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the Administrator of EPA, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring. Toxic pollutants also include those pollutants listed by the Administrator under CWA Section 307(a)(1) or any pollutant listed under Section 405(d) which relates to sludge management.
TRASH AND DEBRIS REMOVAL	Mechanical or manual removal of debris, snags, and trash deposits from the streambanks to improve the appearance of the stream.
TREATMENT	The application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media adsorption, biodegradation, biological uptake, chemical oxidation and UV radiation.
TREATMENT CONTROL PRATCICE	Any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media adsorption or any other physical, biological, or chemical process.
TURBIDITY	A cloudy condition in water due to suspended silt or organic matter.
URBAN RUNOFF	That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, underflow, or channels or is piped into a defined surface water channel or a constructed infiltration facility.
VEGETATED BUFFER	Strips of vegetation separating a waterbody from a land use with potential to act as a nonpoint pollution source; vegetated buffers (or simply buffers) are variable in width and can range in function from a vegetated filter strip to a wetland or riparian area.
VELOCITY	The distance that water travels in a given direction in a stream during an interval of time.
VOLUME	The amount of storm water (expressed in liters) that enters or leaves a management practice.

WASTELOAD ALLOCATION (WLA)	The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution
WATERS OF THE UNITED STATES	All waters which are currently used, or 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, all interstate waters and wetlands, tributaries of these waters, and the territorial seas
WATER QUALITY CRITERIA	Comprised of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.
WATER QUALITY INLET	See OIL/WATER SEPARATOR.
WATER QUALITY STANDARDS	Includes three major components: designated uses, water quality criteria, and antidegradation provisions.
WATERSHED	The land area that drains into a receiving waterbody.
WEEPHOLE	A small opening or pipe left in a revetment or bulkhead to allow groundwater drainage.
WET POND	A conventional wet pond has a permanent pool of water for treating incoming storm water runoff. In enhanced wet pond designs, a forebay is installed to trap incoming sediments where they can be easily removed; a fringe marsh is also established around the perimeter of the pond.
WETLANDS	Areas that are inundated or saturated by surface or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions; wetlands generally include swamps, marshes, bogs, and similar areas.
WET-WEATHER FLOW	Water derived primarily from rain, melting snow or irrigation during the wet season (generally considered to be October through April) that flows over the surface of the ground.
WETLAND PLANT UPTAKE	Marsh plant species rely on nutrients (i.e., phosphorous and nitrogen) as a food source; thus, they may intercept and remove nutrients from either surface or subsurface flow.

Management Practice Descriptions

Management practices are structural controls or non-structural procedures used to control pollutants. Management practices depicted include both those identified as part of the *Pollution Control Strategies Report*, as well as general management practices for reference. They are described for illustration purposes only. To provide effective control of runoff and pollution, management practices must be correctly designed, installed, and maintained. Management practices can be installed along existing stormwater conveyance systems to treat pollution. They can also be installed or implemented at the source areas of pollution.

Baffle Box. The Nutrient Separating Baffle Box is a unique hydrodynamic separator. Effective at capturing sediments, TSS, and hydrocarbons; this system is specially designed to capture trash and debris, organics, and gross solids in a raised screening basket which allows these pollutants to be stored in a dry state (http://www.biocleanenvironmental.com/product/ns_baffle_box).

Bio Sorb. Hydrocarbon Absorbent Bio Sorb is an absorbent polymer ideal for removing large quantities of hydrocarbons, including: oils and grease, Total Petroleum Hydrocarbons, and polynuclear aromatic hydrocarbons. The physical properties of the media prevent leaching of absorbed hydrocarbons; incredibly this media can absorb up to three times its weight in oils and grease.

Coir logs are rolled materials made from natural fibers of coconut and other degradable materials. The logs range in diameter from 6-18 inches and length from 6-12 feet. The logs are permeable, allowing surface water to pass at a reduced rate while trapping sediments and other detritus. They are placed on slopes to reduce the slope length and slow the overland flow velocity.. They can be installed in shallow excavation trenches around the base of stock piles containing fill and along excavated runoff ditches. Vegetation such as small woody shrubs and grasses can be planted in, and at the interface of the logs at their upslope side. The logs act like sponges and are expected to aid in plant establishment by trapping sediments, retaining water, and providing a microclimate (increase R.H.). They will also provide immediate erosion control. The logs are installed by excavating shallow trenches, placing the logs in direct contact with exposed substrate, and anchoring logs with wood stakes. The depth of the excavated housing trench is a function of the insitu conditions and will vary.

Detention and Retention Practices detain runoff to attenuate peak discharge rate to protect downstream channel erosion and bank failure and developments from flooding. Both can be designed to capture bedload and fine suspended sediments. These systems can be designed as a multi-parameter approach to ecological sustainability of receiving systems.

> **Dry Extended Detention (ED) Ponds** A conventional ED pond temporarily stores a portion of storm water runoff for a specified period of time (usually 24-48 hours) which allows sediment particles and associated pollutants to settle out. The ED ponds are normally dry between storm events and do not have any permanent standing water. An enhanced ED pond is designed to prevent clogging and resuspension. It provides greater flexibility in achieving target detention times. It may be equipped with plunge pools near the inlet, a micropool at the outlet, and utilize an adjustable reverse-sloped pipe at the ED control device. Water is discharged through a hydrologic outlet structure to a downstream conveyance system. Dry ED ponds are among the most widely applicable storm management practice.

Retention Ponds use permanent pools, extended detention basin, or shallow marsh to remove pollutants. Retention ponds can include a wet pond; micropool extended detention ponds; multiple pond systems. These ponds serve the same function as an ED pond and often contain a fringe wetland installed around the perimeter of the pond for the purpose to increase habitat and pollutant removal values.

Energy dissipaters are used to prevent erosion at the outlet of a channel or conduit by reducing the velocity of flow and dissipating the energy.

Erosion mats are materials constructed of either synthetic or natural fibers. They are used to cover bare ground to reduce rainfall impacts and overland flow. Depending on the type of materials and the density of the openings, they can be used to cover areas that have been seeded or planted as part of erosion control design. Natural fiber mats are biodegradable and provide protection during the interim period between seeding or planting and establishment of vegetative ground cover. Many manufacturers claim that the by-products of the biodegrading process do not contain any substances that adversely affect aquatic flora or fauna. The key to using erosion mats is to anchor them properly to the ground surface to prevent overland flow between the mats and the ground.

Geosynthetics are a broad class of materials designed primarily for use in engineered earth applications. These materials are used in locations where biodegradation could be a problem and in situations requiring inherent strength and durability of the material. Most geosynthetic materials used in erosion control applications are made of plastic, nylon, or other synthetic materials and may contain other chemical components added to create certain physical characteristics. Geosynthetic materials are divided into several different subcategories:

Geomembranes are probably the largest categories of geosynthetics. According to the Geosynthetic Research Institute (GRI), geomembranes are “impervious thin sheets of rubber or plastic material used primarily for linings and covers of liquid- or solid-storage facilities.” GRI notes that although “nothing is strictly impermeable,” when compared with competing materials such as natural or amended clay–substances with an impermeability of 10-7 cubic meters per second (m^3/s), geomembranes offer a much smaller diffusion permeability of 10-11 to 10-13 m^3/s and are considered relatively impermeable.

Geotextiles are the second largest category of geosynthetic products. Classified as textiles because of their fabric-like consistency, geotextiles consist of synthetic fibers, which are highly resistant to degradation when in contact with soil or water. Both woven and nonwoven geotextiles are manufactured. They are porous to water flow both across and through the sheet, although the density of the weave or matting determines the porosity through the fabric. Geotextiles can be used to line road sub-grades and runoff ditches to prevent vegetation from growing up through the surfaces.

Geogrids, unlike geotextiles, contain relatively large open spaces. Geogrids are used primarily for reinforcement, such as for soil reinforcement in the construction of retaining walls. This segment of the industry is rapidly growing, with at least 25 different applications already identified.

Other geosynthetic categories include geonets or geospacers, designed to move water through a drainage area, and geosynthetic clay liners, impervious products consisting of clay sandwiched between layers of geotextile or geomembrane. These geosynthetic materials are often used at landfill sites to prevent fluid infiltration into adjacent soils.

Geotextile fabric liner is a synthetic geotextile mat that can be used to line excavated runoff ditches. The material mesh size allows to water pass, but will prevent vegetation from growing up through the matting and reducing flow capacity. It is u.v. stabilized and can be covered with a layer of large gravel/rubble. Material is installed by rolling out over the excavated ditch, tamping down, and securing using anchor pins. The material selected for this application is designed to be used in waterways and will withstand the expected shear stresses.

Geotextile erosion control material is made from polymers and is u.v stabilized. This material is used to cover steep exposed slopes, or slopes where vegetation is expected to be sparse. The material aids in reducing surface erosion by providing a permanent ground cover that will protect soil surface from rain drop displacement, increase surface shear stress resistance, and thus reduce kinetic energy along ground surface. The material is applied by anchoring into an excavated trench at the top of the slope and rolling the fabric down slope and anchoring it to the ground using soil staples. The slope to be treated will be prepped prior to application to insure that the fabric is in direct contact with the ground surface. This material has mesh size that allows grasses and other herbaceous plants to grow up through the mat without tearing the fabric.

Grassed swales are shallow grass-covered hydraulic conveyance channels that help to slow runoff and facilitate infiltration. The suitability of grassed swales depends on land use, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the grassed swale system. In general, grassed swales can be used to manage runoff from drainage areas that are less than 4 hectares (10 acres) in size, with slopes no greater than 5 percent. Use of natural, low-lying areas is encouraged and natural drainage courses should be preserved and utilized.

Green roofs consist of an impermeable roof membrane overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants tolerant of heat, drought, and periodic inundations. In addition to reducing runoff volume and frequency and improving runoff water quality, a green roof can reduce the effects of atmospheric pollution, reduce energy costs, and create an attractive environment. They have reduced replacement and maintenance costs and longer life cycles compared to traditional roofs.

Infiltration Trenches are trenches that have been back-filled with stone. These trenches collect runoff during a storm event and release it into the soil by infiltration. Infiltration trenches may be used in conjunction with another storm water management device, such as a grassed swale, to provide both water quality control and peak flow attenuation. Runoff that contains high levels of sediments or hydrocarbons (i.e. oil and grease) that may clog the trench is often pretreated with other devices such as grit chambers, water quality inlets, sediment traps, swales, and vegetated filter strips.

Native grasses can be be contained in hydromulch mixture and applied to targeted areas. The grasses should be selected based on the species' ability to propagate in the site's physiographic conditions, to provide surface cover of soils, increase tensional strength of soils and not require maintenance past the grow in period. A hydro-seed unit will be used to hydraulically disperse grass seed. The mixture will include a geo-binding agent to aid in mixture stickiness, soil amendments, mulch, and grass (seed and/or stolons).

Permanent seeding is used to establish vegetative grass cover that will prevent soil detachment by raindrop impact, reduce sheet and rill erosion, and stabilize slopes and channels. Permanent seeding can be used in conjunction with erosion control blankets and mats to provide both temporary and permanent erosion control. Perennial grasses, when used with turf reinforcement mats, provide the fibrous root network that anchors the channel linings. These treatments can greatly increase the maximum permissible velocities and are very useful in stabilizing channels and grass-lined channels.

Porous (Permeable) pavement is an alternative to asphalt or concrete surfaces that allows storm water to drain through the porous surface to a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating it into the subsoil. The appearance of the alternative surface is often similar to asphalt or concrete, but it is manufactured without fine materials and instead incorporates void spaces that allow for storage and infiltration. Underdrains may also be used below the stone reservoir if soil conditions are not conducive to complete infiltration of runoff.

Rain barrels and cisterns harvest rainwater for reuse. Rain barrels are placed outside a building at roof downspouts to store rooftop runoff for later reuse in lawn and garden watering. Cisterns store rainwater in significantly larger volumes in manufactured tanks or underground storage areas. Rainwater collected in cisterns may also be used in non-potable water applications such as toilet flushing. Both cisterns and rain barrels can be implemented without the use of pumping devices by relying on gravity flow instead. Rain barrels and cisterns are low-cost water conservation devices that reduce runoff volume and, for very small storm events, delay and reduce the peak runoff flow rates. Both rain barrels and cisterns can provide a source of chemically untreated “soft water” for gardens and compost, free of most sediment and dissolved salts.

Vegetative filter strip. A vegetated section of land designed to accept runoff as overload sheet flow from upstream development. It may adopt any natural vegetated form, from grass meadow to small forest. The dense vegetative cover facilitates pollutant removal. A filter strip cannot treat high velocity flows and is generally recommended for use in agriculture and low density development. A vegetated filter strip differs from a natural buffer in that the strip is not natural; rather, it is designed and constructed specifically for the purpose of pollutant removal. A filter strip can also be an enhanced natural buffer, however, whereby the removal capability of the natural buffer is improved the rough engineering and maintenance activities such as land grading or the installation of a level spreader. A filter strip differs from a grassed swale in that a swale is a concave vegetated conveyance system, whereas a filter strip has a fairly level surface.

Design Considerations

The proper selection and successful design of structural practices for storm water quality enhancement is the first priority of storm water management. The cost effectiveness of each control has to be considered and measured against the actual environmental benefits realized. Design objectives can be stated as in terms of technology (i.e. by specifying a particular control device) or in terms of quantitative effect (i.e. by specifying a required degree of control or a maximum allowable effect). The addition of water quality considerations in the design of management practices has created a shift from capturing peak flows during flood events to a continuous long-term rainfall-runoff design volume approach and the pollutant loads associated with these volumes. To treat the bulk of the pollutant loads from storm water runoff, a treatment volume that is designed to capture the initial component of the storm water runoff is essential.

The general design for implementing many management practices will need to take into consideration proper site suitability, drainage area, land availability, construction material selection, and maintenance requirements. Specific features will need to be considered for each management practice, some of which are listed in Table 1. This table presents general key considerations for each management practice. Each structure will require an engineering design prior to installation to insure the design is feasible for the site conditions. Feasibility of designs requires detailed analysis through an engineering process that takes into consideration all physical aspects of implementation, such as hydrology and geography.

Table 1. Design Considerations for Recommended Management Practices

Management Practice	Sizing Considerations	Design Considerations
Baffle box	• Sizing of unit function of design hydrology and sediment sizes of influent.	• Located within 15 ft. of paved surface to allow access for maintenance
Coir logs	• Site specific	• Securing method • Regevetation • Types of plant • Anchoring device selection • Additional stabilization and protection works (other than coir logs)
Curb inlet baskets	• Sediment volume	• Hooded outlet • Filtering variety • Maintenance frequency
Extended detention basin	• Drainage area • Slope • Soils/Topography • Groundwater	• For both water quality and storm water attenuation • Pretreatment/Treatment • Filter fine terrigenous sediment • Conveyance • Maintenance Reduction • Landscaping
Good housekeeping practices	N/A	N/A
Grass swale	• Drainage area • Slope • Soils/Topography • Groundwater	• A parabolic or trapezoidal cross-section with side slopes no steeper than 1:3 • Most effective when used in conjunction with other practices, such as wet ponds, infiltration strips, wetlands, etc. • Both the top and toe of the slope should be as flat as possible to encourage sheet flow and prevent erosion

Management Practice	Sizing Considerations	Design Considerations
Green roof – Green grid	• Site specific • Maximum weight load	• Types of plants • Maintenance requirements • Disability access • Liability Issues • Architectural accents
Infiltration trench	• Drainage area • Slope • Soils/Topography • Groundwater	• Native soils are excavated and replaced with an improved soil mixture column • Can be used in extremely narrow spaces • Conveyance • Maintenance Reduction • Landscaping
Invasive species control	• Site specific	• Types of plants • Time scale • Equipment needed • Maintenance requirements
Modular wetland	• Drainage area	• Type of plants • First flush • Conveyance • Maintenance Reduction • Landscaping
Natural/Native vegetation	• Site specific	• Types of plants • Maintenance
Porous pavement	• Used in a wide variety of land use settings • Overflow parking areas or other areas such as fire lanes with low traffic loads • Load bearing • Slope/Topography	• Native soils on the site should be conducive to infiltration, with an infiltration rate at least 0.3 inches/hour • Not to be used in areas with a slope > 15% • Seasonal high water table should be at least 3 feet below grade
Rain barrels	• Roof • Water demand • Rainfall Pattern • Capacity • Overflow Device	• Modify downspout to barrel inflow site • Screened inflow design • Outflow hose/barrel connection • Keep hose above barrel rim
Retention pond	• Drainage area • Slope • Soils/Topography • Groundwater	• Pretreatment/Treatment • Filter fine terrigenous sediment • Conveyance • Maintenance Reduction • Landscaping
Subsurface storage	• Drainage area • Groundwater level • Available land	• Many types of material including galvanized metal, reinforced concrete or synthetic compounds or any pre-manufactured containers adaptable to ground contact • Conveyance
Turf reinforcement mats	• Site specific	• Site preparation • Anchoring device selection • Soil type • Maintenance

Design Features

1. Baffle Box
2. Coir Log
3. Curb Inlet Basket
4. Extended-Detention Pond
5. Grass Swale
6. Green Roof – Green Grid
7. Infiltration Trench
8. Modular Wetland
9. Rain Barrel
10. Retention Pond
11. Subsurface Storage
12. Turf Reinforcement Mats

Design Feature 1. Baffle Box

The Nutrient Separating Baffle Box is a multi chambered concrete box separated with baffles used to settle out pollutants. Chambers can be fitted with absorbent membranes to trap floating pollutants, e.g. hydrocarbons. Effective at removing sediments, TSS, and hydrocarbons; this system is specially designed to capture trash and debris, organics, and gross solids in a raised screening basket which allows these pollutants to be stored in a dry state.

http://www.biocleanenvironmental.com/product/ns_baffle_box

BIO CLEAN® ENVIRONMENTAL SERVICES, INC.

Nutrient Separating Baffle Box

A Superior Stormwater Treatment System Separated from the Rest.

The Nutrient Separating Baffle Box (NSBB) is a widely accepted and desired stormwater solution chosen by civil engineers, municipalities and developers nationwide because of its superior characteristics. The NSBB is easy to install and maintain and is the only systems with a two stage maintenance option, which minimizes maintenance costs.

Hundreds of Nutrient Separating Baffle Boxes have been installed nation wide, from Florida to California because of its superior and proven design. The NSBB efficiently removes TSS, hydrocarbons, nutrients, metals and debris/organics from stormwater runoff. The patented filtration screen system captures and stores trash and organics in a dry state, which prevents nutrient leaching and bacterial build up.

System Characteristics

Traps Oil & Grease
The skimmer and hydrocarbon booms captures all forms of hydrocarbons.

High TSS Removal
The three chambered design maximizes capture of large and fine TSS.

89.8% TSS Removal
Pandit - 1996
86.3% TSS Removal
Harvey's Lake - 2004
93.3% TSS Removal
Dillard - 2006

Low Installation Cost
Bottom of structure less than 4 feet from invert of pipe.

Separates Nutrients & Trash
The patented filtration screen system captures and stores trash and organics in a dry state which prevents nutrient

Low Head Loss
Allows for easy retrofit and inline installation. Eliminates the need for expensive diversion structures.

Easy Maintenance
Unobstructed Manhole Access

POLLUTANT	REMOVAL EFFICIENCY
Trash & Debris	99%[1]
TSS	76.9%[2] to 93.3%[3]
Fine TSS (d_{50} 63 µm)	67.3%[4]
Metals	Up to 57%[5]
Total Nitrogen	38% to 63%[5]
Total Phosphorus	18% to 70%[2,5]

1. Rockledge Baffle Box Independent Field Report. Applied Environmental Technology. 2007.
2. Brevard County (Micco & Indialantic). St. Johns River Water Management District. 1994.
3. Field Test for Suntree Nutrient Separating Baffle Box. Dillard & Associates. 2005.
4. New Jersey Corporation for Advanced Technology. 2008.
5. Atlantic Beach Field Report. Blue Water Environmental. 2004.

Setting a New Standard for Hydrodynamic Separators.

The Nutrient Separating Baffle Box is designed to do more than most systems. This system is effective at removing not only TSS, but also fine TSS and gross solids making it, overall, a more effective treatment system compared to traditional swirl type separators. This system has been proven to provide the following benefits:

System Benefits

- **Can Treat 100% of the Flow.**
  Offline Configuration is Not Required.
- **Inexpensive Maintenance.**
  Patented screen system allows gross solids to be removed without vacuuming out the water.
- **Minimal Head Loss.**
  Hydraulically efficient design generates less head loss than diversion structures.
- **Custom Designs Available.**
  Can be modified to meet your needs.
- **Easy to Install.**
  Delivered in a top & bottom half to minimize weight. Shallow profile minimizes installation costs.
- **5 Year Warranty.**
  Made of precast concrete, fiberglass, aluminum & stainless steel. No cheap plastics!

BIO CLEAN® ENVIRONMENTAL SERVICES, INC.

P O Box 869, Oceanside, CA 92049
(760) 433-7640 • Fax (760) 433-3176
www.biocleanenvironmental.net

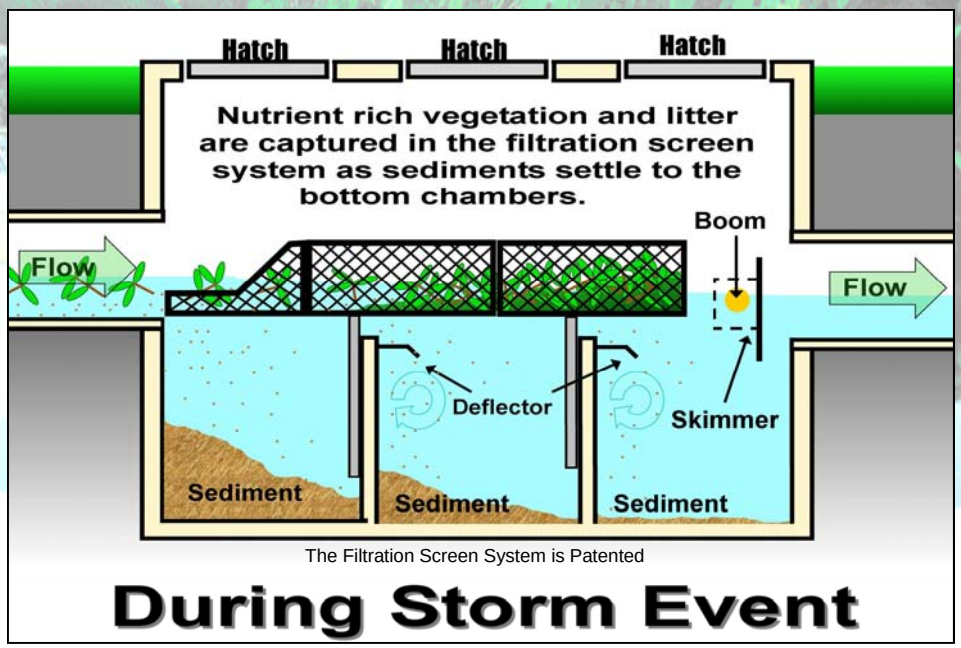
"The Stormwater Standard"

Functional Description

Captures:

- **Trash & Debris** D
- **Oxygen Demanding Substances/Organic Compounds** D
- **Hydrocarbons, Oils & Grease**
- **TSS** (including fines)
- **Nutrients** (particulates)
- **Heavy Metals** (particulates)

"Pollutants with this symbol D are stored in a dry state".



The Filtration Screen System is Patented

During Storm Event

Why Dry State Storage? D

Storing Trash, Debris, Organics, and Oxygen Demanding Substances in a Dry State Prevents:

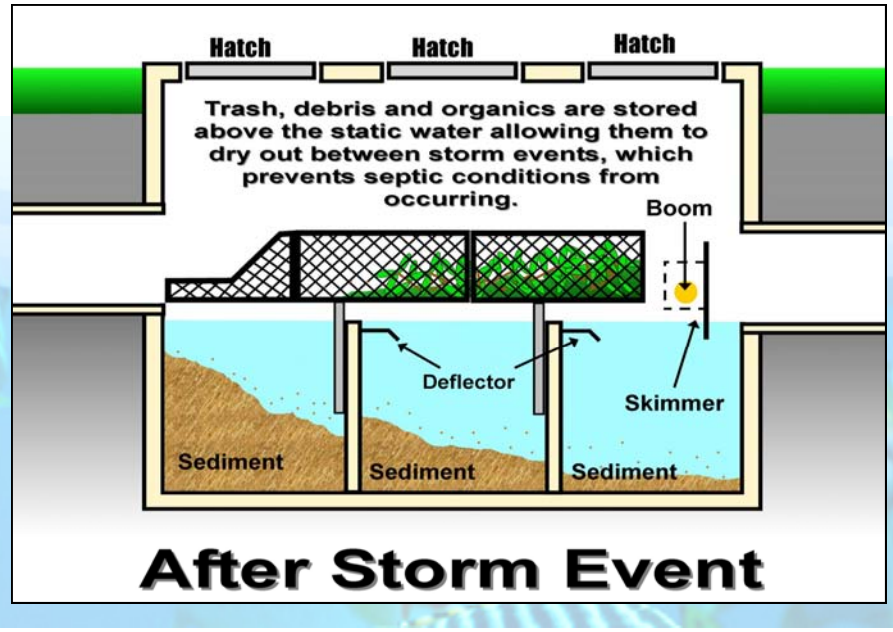
- **Prevent Nutrient Leaching**
- **Eliminate Septic Conditions**
- **Minimize Bacteria Growth**
- **Eliminate Bad Odors**

Nutrient Separating Baffle Box

Standing Water is Clear & No Bacteria Growth Visible.

Other Systems

Standing Water is Not Clear & Bacteria Growth Visible.



After Storm Event

Operation:

Skimmer & Boom
Collects hydrocarbons & controls flow velocity which improves removal efficiency.

Deflectors
Prevents re-suspension of captured pollutants at higher flows by directing water currents above sediment chambers.

Filtration Screen System
Collects and stores trash, debris, organics, and oxygen demanding substances in a dry state above the standing water. As mentioned above this has many performance benefits along with simplifying maintenance.

Multiple Sediment Chambers
Maximizes TSS removal and eliminates scouring during extreme flow rates.

BIO CLEAN ENVIRONMENTAL SERVICES, INC.

P O Box 869, Oceanside, CA 92049
(760) 433-7640 • Fax (760) 433-3176
www.biocleanenvironmental.net

"The Stormwater Standard"

Design Feature 2. Coir Log

NORTH AMERICAN GREEN®

SedimentSTOP™

BIODEGRADABLE Filtration System

The SedimentSTOP™ (Patent Pending) shall be a machine-produced 100% biodegradable sediment filtration system.

The SedimentSTOP™ shall be composed of 70% agricultural straw and 30% coconut fiber matrix evenly distributed over the entire area of the bottom netting. The SedimentSTOP™ shall consist of a bottom netting and a 2 ft. (0.61 m) top netting that covers the matrix material on the "splash apron" of the SedimentSTOP™ system. The netting shall be constructed from 100% biodegradable woven natural organic fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 0.50 x 1.00 inch (1.27 x 2.54 cm) mesh. The blanket shall be sewn together on 1.50 inch (3.81 cm) centers (50 stitches per roll width) with biodegradable thread.

Each SedimentSTOP™ shall yield a structure 50 lineal feet (15.2 m) in length, with an approximate finished diameter of 9 inches (0.23 m). The diameter of the finished structure may be increased to meet individual project specifications by spreading loose straw, pine needles, wood chips, grass cuttings, etc. across the width of the SedimentSTOP™ before rolling edge to edge.

The SedimentSTOP™ shall be manufactured by North American Green, or equivalent. The SedimentSTOP™ shall have the following properties:

Material Content

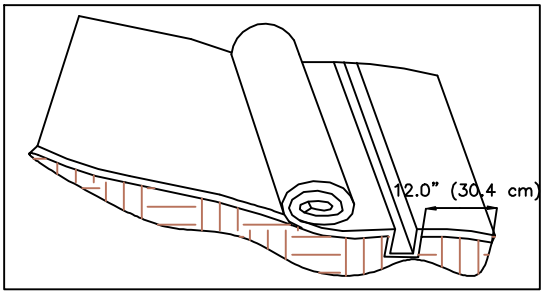
Matrix	70% Straw Fiber 1.225 lbs/yd^2 (0.665 kg/m^2) 30% Coconut Fiber 0.525 lbs/yd^2 (0.285 kg/m^2)
Netting	Bottom side, Leno woven 100% biodegradable natural organic fiber (9.30 lbs/1,000 ft^2 [4.50 kg/100 m^2] approximate weight) Top side, 2 ft. (0.61 m) strip covering the "splash apron" of the SedimentSTOP™, Leno woven 100% biodegradable natural organic fiber (9.30 lbs/1,000 ft^2 [4.50 kg/100 m^2] approximate weight)
Thread	Biodegradable

Physical Specifications

	English	**Metric**
Width	6.67 ft	2.03 m
Length	50.00 ft	15.24 m
Weight	65.00 lbs ± 10%	29.50 kg ± 10%
Stitch Spacing	1.50 inches	3.81 cm

Finished Structure Diameter - Approximately 9.00 in (0.23 m)

SEDIMENTSTOP INSTALLATION



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NORTH AMERICAN GREEN

④a

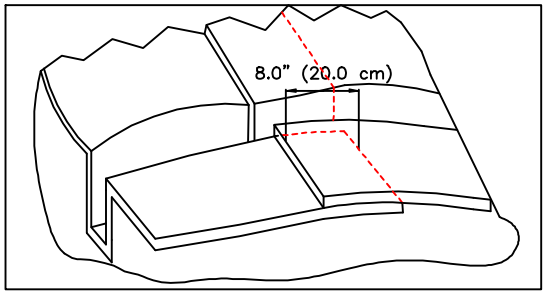
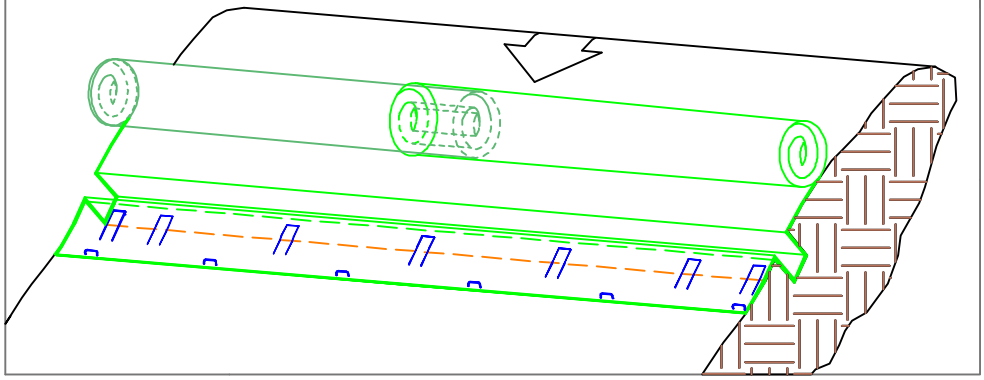


DIAGRAM A



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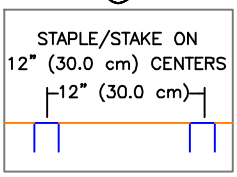

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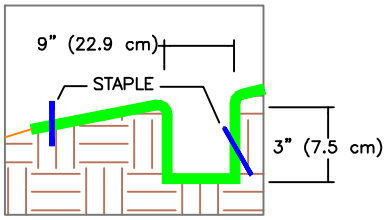
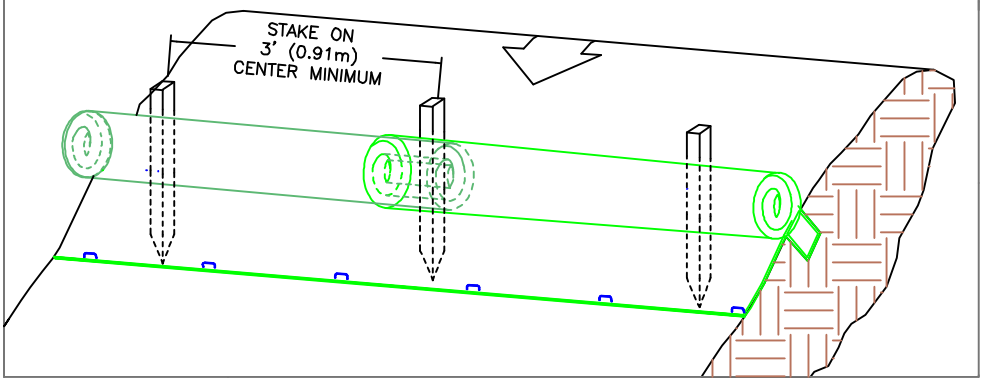


DIAGRAM B



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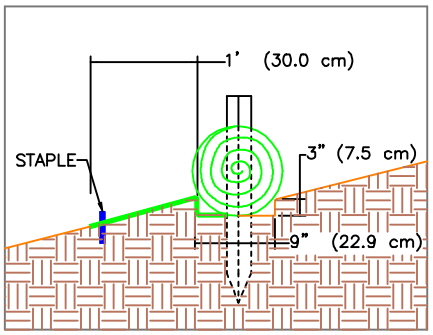


1. BEGIN AT THE LOCATION WHERE THE SEDIMENTSTOP (Patent Pending) IS TO BE INSTALLED BY EXCAVATING A 3" (7.5 CM) DEEP X 9" (22.9 CM) WIDE TRENCH ALONG THE CONTOUR OF THE SLOPE. EXCAVATED SOIL SHOULD BE PLACED UP-SLOPE FROM THE ANCHOR TRENCH.

2. UNROLL THE SEDIMENTSTOP SO THE SECTION WITH THE 2' WIDE TOP NETTING IS THE DOWN SLOPE END (SPLASH APRON). THE SPLASH APRON OF THE SEDIMENTSTOP SHOULD COVER THE ANCHOR TRENCH ENSURING THAT APPROXIMATELY 12" (30 CM) IS EXTENDED BEYOND THE LOWER EDGE OF THE ANCHOR TRENCH. NOTE: SEEDING MUST BE CONDUCTED PRIOR TO INSTALLATION OF THE SEDIMENTSTOP.

3. SECURE THE SEDIMENTSTOP IN THE ANCHOR TRENCH BY PLACING A ROW OF STAPLES/STAKES ON 12" (30 CM) CENTERS ACROSS THE ENTIRE LENGTH OF THE SEDIMENTSTOP. A SECOND ROW OF STAPLES/STAKES MUST BE PLACED ACROSS THE ENTIRE LOWER EDGE OF THE SEDIMENTSTOP SPLASH APRON ON APPROXIMATELY 12" (30 CM) CENTERS, STAGGERED WITH THE FIRST ROW OF STAPLES/STAKES.

4. BEGIN ROLLING THE SEDIMENTSTOP FROM ITS UPPER EDGE (UP-SLOPE EDGE) INTO A CONSISTENT ROLL DIAMETER UNTIL THE ROLL IS LOCATED IN THE ANCHOR TRENCH. IF A LARGER DIAMETER STRUCUTRE IS DESIRED, PLACE ADDITIONAL ORGANIC MATERIAL (I.E. STRAW, LEAVES, PINE NEEDLES OR LAWN CLIPPINGS) ACROSS THE ENTIRE WIDTH OF THE SEDIMENTSTOP PRIOR TO ROLLING. SEE DIAGRAM 4a FOR SEAMING OF ADJACENT SEDIMENTSTOP ROLLS.

5. STOP ROLLING THE SEDIMENTSTOP WHEN THE ROLL IS LOCATED IN THE ANCHOR TRENCH.

6. SECURE THE SEDIMENTSTOP STRUCTURE TO THE SLOPE SURFACE BY DRIVING APPROXIMATELY 18" - 24" (45-60 CM) STAKES THROUGH THE CENTER OF THE ROLL EVERY 3' (0.9 M) ON CENTER. IF TWO SEDIMENTSTOP STRUCTURES ARE SEAMED TOGETHER ENSURE A STAKE IS DRIVEN THROUGH THE SEAM. THE FINAL STRUTURE'S DIAMETER WILL DICTATE STAKE LENGTH. LEAVE A SUFFICIENT AMOUNT OF STAKE EXPOSED ABOVE THE SEDIMENTSTOP TO ENSURE THE STRUCUTRE IS NOT COMPRESSED. BOTH LONGITUDINAL ENDS SHOULD BE ANGLED UP SLOPE.

7. BACKFILL AND COMPACT SOIL INTO THE UP-SLOPE PORTION OF THE ANCHOR TRENCH. SMOOTH AND LEVEL ANY SOIL REMAINING ABOVE THE SEDIMENTSTOP NOT USED TO FILL THE ANCHOR TRENCH. PLACE SEED ALONG UP-SLOPE PORTION OF SEDIMENTSTOP IF REQUIRED.

14649 HIGHWAY 41 NORTH, EVANSVILLE, INDIANA 47725
USA 1-800-772-2040 CANADA 1-800-448-2040
www.nagreen.com

NORTH AMERICAN GREEN

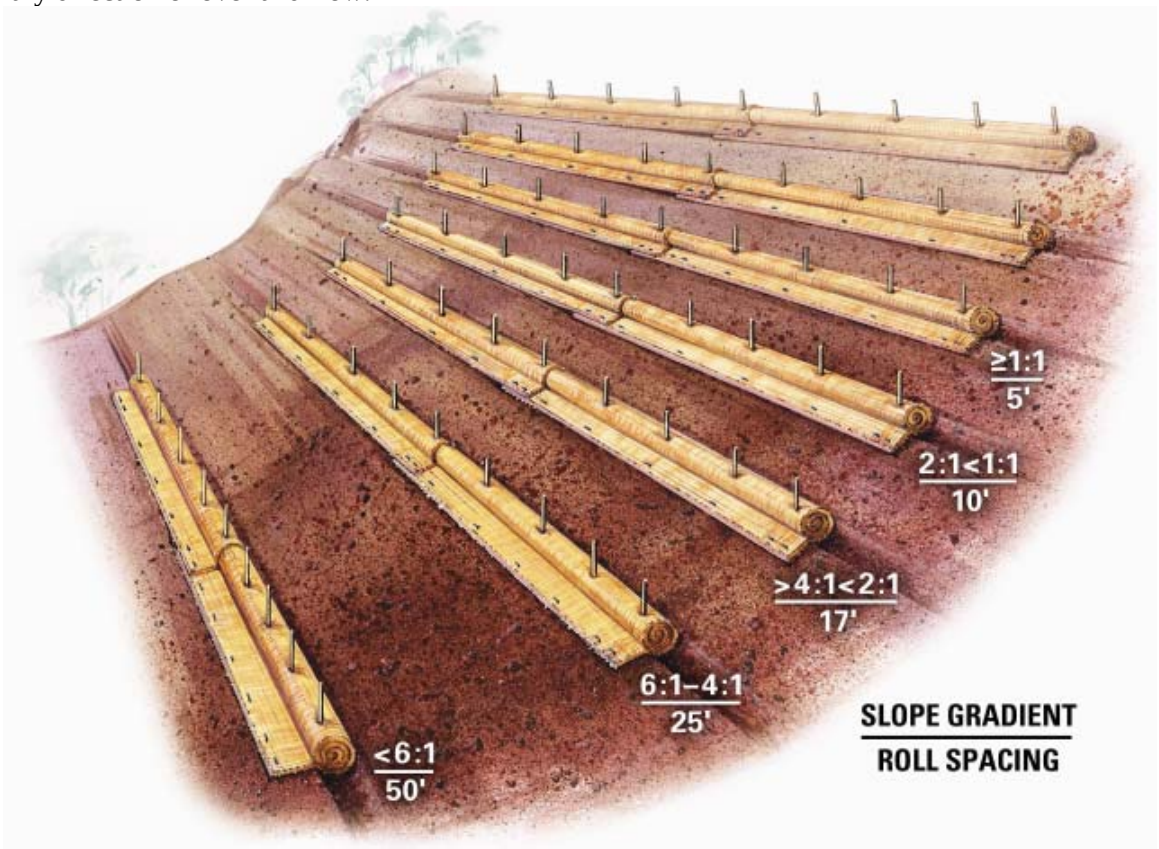
SedimentSTOP™

BIODEGRADABLE Filtration System

APPLICATION GUIDELINES

North American Green SedimentSTOP™ is a 100% biodegradable best management practice (BMP) that offers an effective and economical alternative to silt fence, straw bales, and wattles for sediment control and storm water runoff. The SedimentSTOP's combination of straw/coconut fibers and leno woven jute netting has been proven in university and field research to afford exceptional sediment control by slowing and filtering runoff and trapping sediment. The research showed that properly installed, the SedimentSTOP structure reduced initial sediment migration by up to 98% compared to unprotected control plots.

The following guidelines are provided to assist in design, installation, and structure spacing. These guidelines may require modification due to variation in soil type, rainfall intensity or duration, and amount of runoff affecting the application site. SedimentSTOP should be installed perpendicular to the primary direction of overland flow.



To maximize sediment containment with the SedimentSTOP place the initial structure at the top/crest of the slope if significant runoff is expected from above. If no runoff from above is expected, the initial SedimentSTOP can be installed at the appropriate distance downhill from the top/crest of the slope. The final structure should be installed at or just beyond the bottom/toe of the slope.

The SedimentSTOP is a temporary sediment control device and is not intended to replace erosion control blankets or turf reinforcement mats. If vegetation is desired for permanent erosion control, North American Green recommends that rolled erosion control products be used to provide effective immediate erosion control until vegetation is established. The SedimentSTOP may be used in conjunction with blankets and mats as supplemental sediment and runoff control for these applications. Like all sediment control devices, the effectiveness of SedimentSTOP is dependent on storage capacity.

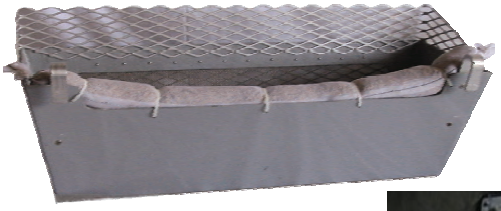
14649 Highway 41 North • Evansville, Indiana 47725 • 812-867-6632
800-772-2040 • FAX 812-867-0247 • www.nagreen.com

Design Feature 3. Curb Inlet Basket

The Curb Inlet Basket is the only filter available with the patented ‘Easy Maintenance Shelf System’, positioning the basket directly under the manhole for easy maintenance. This shelf has been tested and continues to be used in Hawai‘i with positive results and feedback.

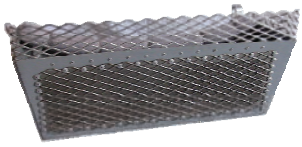
Curb Inlet Basket

w/ Easy Maintenance Shelf System



Extreme Durability—
Constructed from:

- **Heavy Duty UV Protected Marine Grade Fiberglass**
- **High Grade Stainless Steel Hardware and Screens**



"Highest Rated Catch Basin Insert"

(The Efficiency of Storm Drain Filters in Removing Pollutants from Urban Road Runoff Report, University of Hawaii, Dept of Oceanography, Honolulu, Hawaii, 2005).

5 Year Unlimited Warranty on Construction

Ask Our Competition if They Have a Warranty Like This. Then Give us a Call.

The Easiest Filter to Clean and Install

- **Maintenance and Cleaning Crews Throughout Southern California Appreciate the User Friendly Design of Our Filters.**

BIO CLEAN ENVIRONMENTAL SERVICES. INC.™

"The Stormwater Standard"

P O Box 869, Oceanside, CA 92049
(760) 433-7640 • Fax (760) 433-3176
www.biocleanenvironmental.net

BIO CLEAN
ENVIRONMENTAL SERVICES. INC.™

“The Stormwater Standard”

Case Study of Curb Inlet Filters

Prepared for The City and County of Honolulu, Hawaii

AbTech System Servicing Box-Score

	Poor		Fair		Excellen
	1	2	3	4	5
Ease of Attachment/Reattachment to Drain					√
Ease of Handling and Entry Through Manhole			√		
Ease of Cleaning and Filter-Media Replacement			√		
Prevention of Debris Loss During Removal From Drain			√		
Overall Maintenance Turn-Around Time				√	

Total Score = 18

KriStar System Servicing Box-Score

	Poor		Fair		Excellent
	1	2	3	4	5
Ease of Attachment/Reattachment to Drain			√		
Ease of Handling and Entry Through Manhole					√
Ease of Cleaning and Filter-Media Replacement		√			
Prevention of Debris Loss During Removal From Drain			√		
Overall Maintenance Turn-Around Time		√			

Total Score = 15

Hydrocompliance Servicing Box-Score

	Poor		Fair		Excellent
	1	2	3	4	5
Ease of Attachment/Reattachment to Drain	√				
Ease of Handling and Entry Through Manhole	√				
Ease of Cleaning and Filter-Media Replacement				√	
Prevention of Debris Loss During Removal From Drain		√			
Overall Maintenance Turn-Around Time	√				

Total Score = 9

BioClean System Servicing Box-Score

	Poor		Fair		Excellen
	1	2	3	4	5
Ease of Attachment/Reattachment to Drain				√	
Ease of Handling and Entry Through Manhole					√
Ease of Cleaning and Filter-Media Replacement				√	
Prevention of Debris Loss During Removal From Drain				√	
Overall Maintenance Turn-Around Time					√

Total Score = 22 **Highest Score**

Performance matrix for field tested DII systems				
Parameter	**AbTech**	**Hydrocompliance**	**KriStar**	**Bioclean**
Initial device cost (10 ft drain inlet)	10	5	15	20
Initial installation requirements	10	2.5	7.5	5
Flow capacity	5	10	2.5	7.5
Turbidity during short term test	5	10	7.5	2.5
Short term RDS retention	10	5	7.5	2.5
Short term organics retention	10	2.5	7.5	5
Long term RDS retention	2.5	10	7.5	5
Long term PAH retention (mg)	5	10	7.5	5
Long term O/G retained (mg)	10	5	2.5	7.5
Long term overall rubbish retention	5	5	10	10
Suitability for Vector Control	5	2.5	7.5	10
Unit durability	7.5	2.5	7.5	10
Media replacement Costs	5	10	15	20
Suitability for Type B basin	2.5	2.5	7.5	10
Servicing Requirements	18	9	15	22
TOTAL SCORE	**110.5**	**91.5**	**127.5**	**142**

Performance of DII is ranked from one to four, with increasing scores assigned to increasing performance of the device. Ranks for each category are scaled to 10 except initial costs and media replacement costs which are scaled to 20. Servicing requirements are based on a score of 25 as determined in Appendix A. Maximum total possible score is 185.

Highest Score

Table 17: DII Servicing Time Table

Site	DII System	Required Servicing Time (hours)	
15	Hydrocompliance	1.75	105 Minutes
17	KriStar	1.0	60 Minutes
18	AbTech	0.5	30 Minutes
19	Bioclean	0.25	15 Minutes

Prepared by
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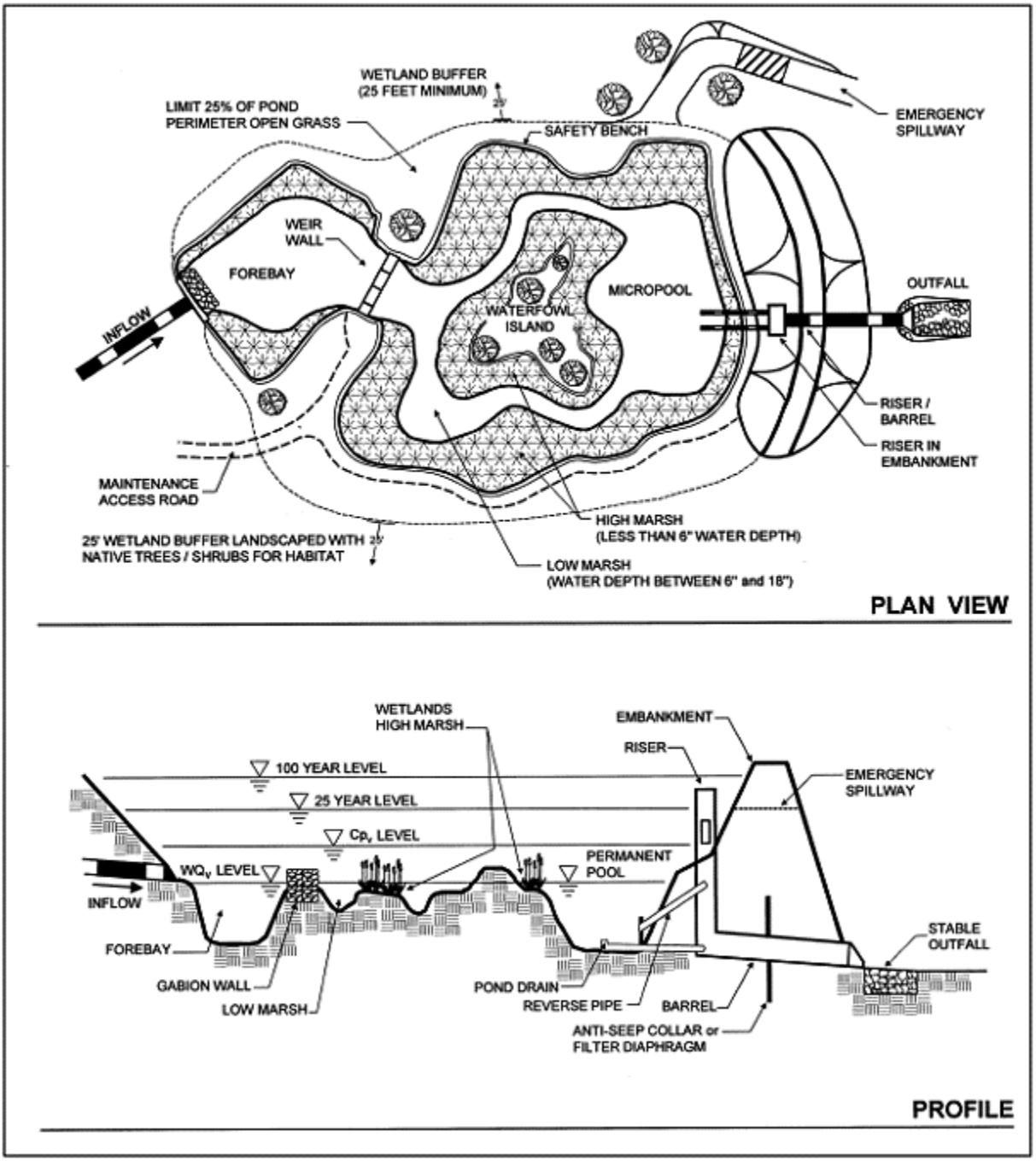
See Full Report at:
http://www.biocleanenvironmental.net/stormdrain/products/reports/reports.htm

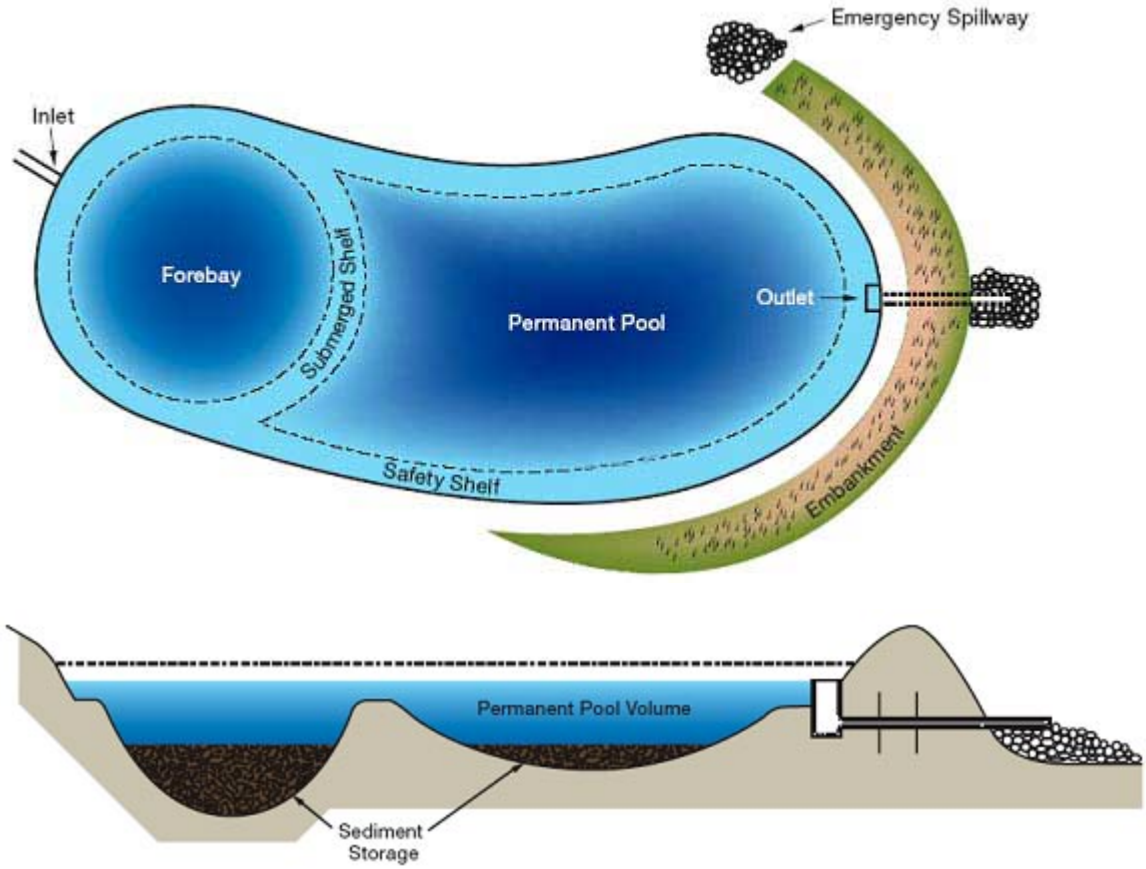
Design Feature 4. Extended-Detention Pond[1]

Schematic of a Dry Extended-Detention Pond (MDE 2000)



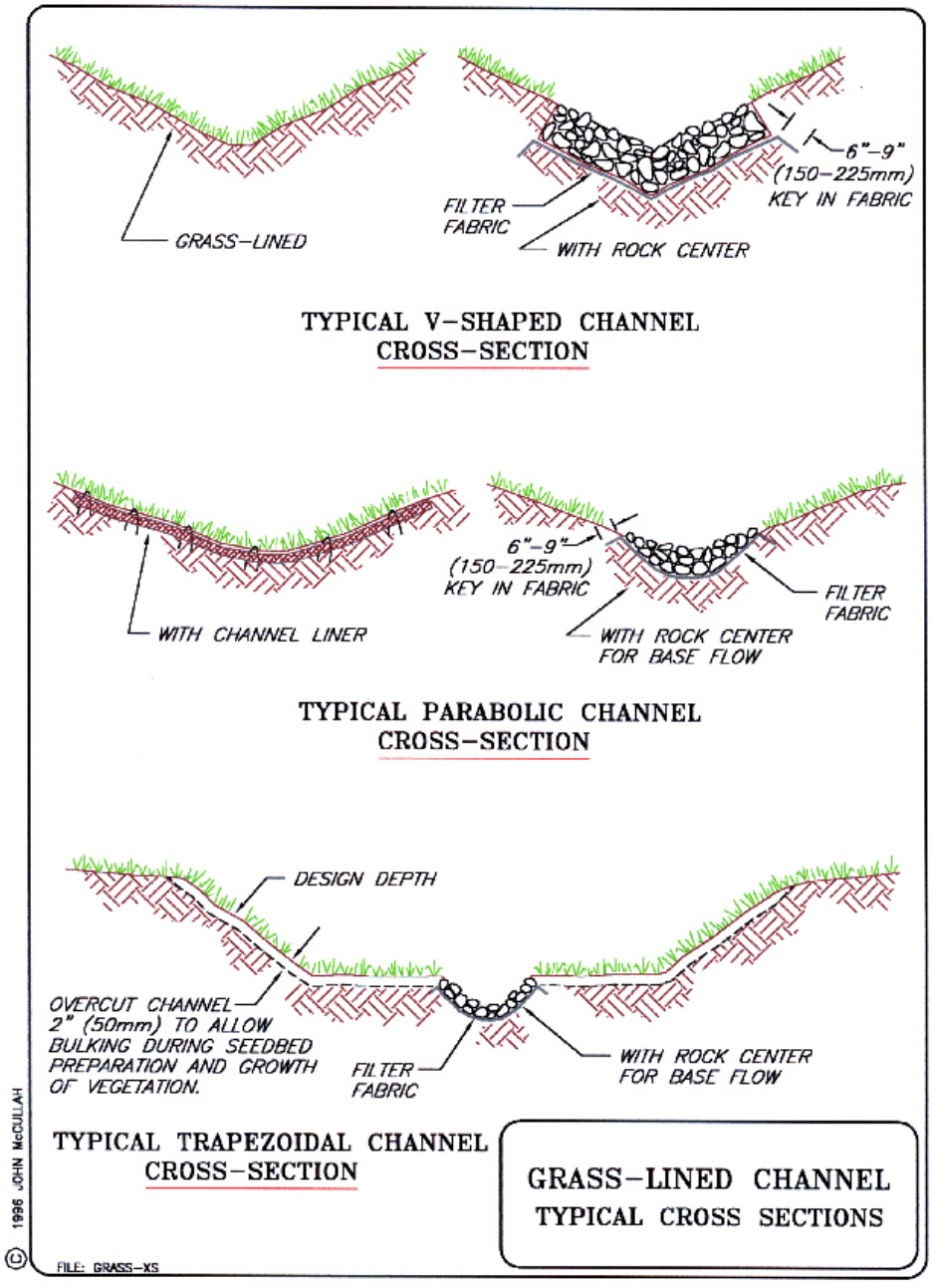
[1] Image depicts general design.

Example Detention Pond Design (Liebl 2006)



Design Feature 5. Grass Swale

Figure used with permission of Salix Applied Earthcare.

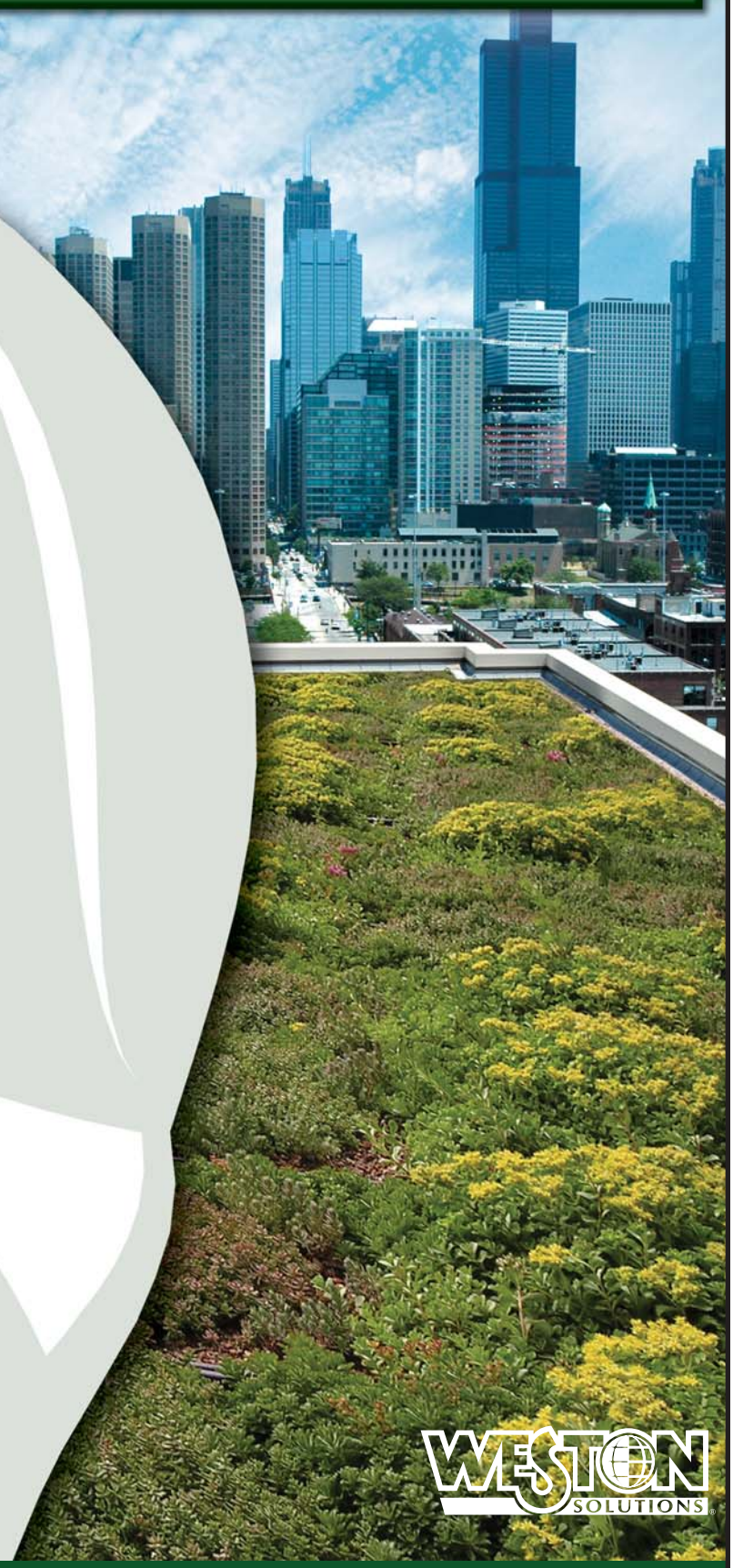


Design Feature 6. Green Roof – Green Grid

GREENGRID®
The Natural Choice for Your Roof

The PREMIER Green Roof System

The GreenGrid®
Green Roof System
offers distinct advantages over more complex systems with its simplicity in design, pre-planted modules, and movable modular features.



WESTON SOLUTIONS®

www.greengridroofs.com

Introducing the GreenGrid® Modular Green Roof System

Simplicity in design and flexibility are the hallmarks of the GreenGrid® System. The system was designed by engineering, roofing, and horticultural experts to produce an efficient, integrated green roof product. GreenGrid® offers a modular design that arrives at your site pre-planted and ready for installation. The modules contain 100% recycled plastics, and the components can be hoisted to the roof via elevator, forklift, or crane, and quickly installed in accordance with the design. The modules can be placed directly on the roof membrane or on any other surface with adequate structural capacity.

GreenGrid® Green Roof System modules are lightweight compared to many other green roof systems. The Ultra-Extensive (2.5-inch depth) modules weigh approximately 11-13 pounds per square foot (wet). The Extensive (4-inch depth) modules weigh approximately 18-22 pounds per square foot (wet). Both Ultra-Extensive and Extensive modules support highly drought-resistant ground covers that can thrive in a non-irrigated (climate dependent), rooftop environment in the project location. The Intensive (8-inch depth) modules—supporting a large variety of variety of grasses, perennials, and/or groundcovers that can thrive in an irrigated or non-irrigated, rooftop environment in the project location—weigh approximately 35 pounds per square foot (wet) and up, depending on plant selection and growth media. They can be easily arranged or rearranged to suit the needs and desires of the client. Most important, roof maintenance and repair is simple—modules can just be moved should roof repair/maintenance be required, then put back in place.

About Green Roofs

Green roofs are not a new phenomenon. Due to their excellent insulation and stormwater retention properties, these roofs have been a standard construction practice in many countries for years. Since the 1970s, green roofs increasingly have become part of the landscape in Europe, where there are over 100 million square feet of planted roofs today. Due to the complexity of some of these systems, green roofs have been somewhat slow to catch on in North America. These "European" systems are constructed in layers, starting with a waterproof membrane and drainage layer, then insulation, root barriers, soil layers, and a wind erosion blanket are put in place. The landscape is then installed, which can take considerable time to mature.

The GreenGrid® System offers distinct advantages over these complex systems with its straight-forward design, pre-planted modules, and movable modular features.

System Options

Ultra-Extensive Modules

The 2.5-inch Ultra-Extensive GreenGrid® System is an extremely lightweight green roof system of modules, composed of 2.5 inches of growth media and drought-tolerant vegetation. This functional green roof system is generally designed to require minimal irrigation and maintenance. The 2.5-inch green roof system is appropriate for small applications with limited structural capacity. The approximate weight of a wet 2.5-inch GreenGrid® ultra-extensive green roof system is 11–13 pounds per square foot, which is similar to the weight of gravel ballast placed on many conventional roofs.

Extensive Modules

The 4-inch Extensive GreenGrid® System is a lightweight green roof modular system composed of a 4-inch layer of growth media and highly drought-tolerant vegetation that is composed of ground covers that can thrive in a non-irrigated (climate dependent), rooftop environment in the project location. Like the ultra-extensive modules, this highly functional green roof system is generally designed to require minimal irrigation and maintenance. The approximate weight of a wet 4-inch GreenGrid® extensive green roof system is 18-22 pounds per square foot.

Intensive Modules

The 8-inch Intensive GreenGrid® System is designed for more elaborate roof landscapes. These rooftop gardens are typically designed to be accessible for leisurely enjoyment and therefore must have the proper structural capacity for live loads. The 8-inch depth system allows for a larger selection of plants, including grasses, perennials, natives, and/or groundcovers. The addition of paver pathways, terraces, edge treatments, and other architectural features result in beautiful and dramatic new usable spaces. Depending on the plant selection, drip irrigation systems and maintenance may be necessary, just as they would be for a traditional garden. Although a more refined application, the ecological benefits of Intensive green roofs are wide-ranging due to the utilization of larger and greater plant species diversity. The average weight of a wet 8-inch GreenGrid® intensive green roof system starts around 35 pounds per square foot, and may be higher depending on plant selection and growth media.

The Advantages a GreenGrid® System Brings to Your Building

Easy Roof Maintenance and Repair: Since the GreenGrid® system is modular, roof surfaces are always accessible for maintenance and repair. "No matter the type or age of a roof, eventually it will leak. The question is, when," said Larry Flynn, Senior Editor, *Building Design & Construction*[1]. When the roof requires maintenance or repair, the GreenGrid® modules are simply removed and then put back in place when repair is complete, without disturbing growing media or plants.

Engineered, Integrated System: All components of the GreenGrid® Green Roof System are designed and engineered to work together. This results in installation efficiencies, thereby lowering costs, and assures an integrated design.

Lightweight for Existing/New Roofs: The GreenGrid® system can be installed on any roof in good condition where structural capacity is present. The choice of lightweight modules make a green roof feasible for almost any building, without requiring upgrades to its structural capacity.

Pre-Planted and/or Pre-Grown System: The GreenGrid® modules are planted in advance at the nursery.This means modules arrive at the job site already planted and ready for installation. This feature helps reduce costs associated with labor and helps reduce installation time. Plants can also be grown at the nursery in advance of shipment to the project site.

The table below presents additional GreenGrid® advantages.

GreenGrid® Advantages	GreenGrid® Green Roof System Solution	Traditional (Built-in-Place) Systems
Easy Roof Maintenance & Repair	Modules can easily be moved then put back in place without disturbing growing media or plantings	Layers need to be cut and rolled back until repair location found; plants and layers damaged
Competitive Installed Cost	Competitive installed cost versus leading built-in-place systems	New roof surface plus mat, drainage, root barrier, moisture retention layers often costly
Quick Installation	Delivered pre-planted, ready to set in place; reduced downtime due to inclement weather	Multi-layer, built-in-place, vegetation planted at job site, time-consuming
Pre-planted	Pre-planted at the nursery; speeds installation time and reduces labor costs	Planted on site; increases labor costs
Lightweight for Existing/ New Roofs	Lightweight—installs on any existing roof surface in good condition and with structural capacity	Systems often heavy; roof surface replacement often required despite condition
Easy Rooftop Placement	All modular system components quickly put in place on roof in accordance with design	Components delivered to rooftop by multiple sources can present scheduling difficulties
LEED® Recycling Credits	All GreenGrid® modules contain 100% recycled material, contributing to LEED® recycling credits	Components generally do not contain recycled material
Built-In Water Retention	Module design provides built-in water retention	Water retention layers must be added
Easy System Alteration/Additions	Option of installing green roof in sections offers opportunity for future add-ons	Often difficult and expensive to change/add-on due to edge design requirements
Alliances	Wrap-around or full-system warranties are available as part of a Mule-Hide or Carlisle GreenGrid® Roof	Limited Warranty – Removal and re-installation of plants/vegetation generally not included

[1] *Building Design & Construction*, 1 Sept. 2003, vol. 44, no. 9, p. 66

Reduced Energy Costs: When the outside air temperature reaches 95° F, traditional black rooftop surface temperatures can be as high as 175° F. The heat load of a roof impacts the amount of energy necessary to cool the building to the desired temperature. Due to its insulating properties, GreenGrid® green roofs can significantly reduce the heat load of the roof in warm seasons.

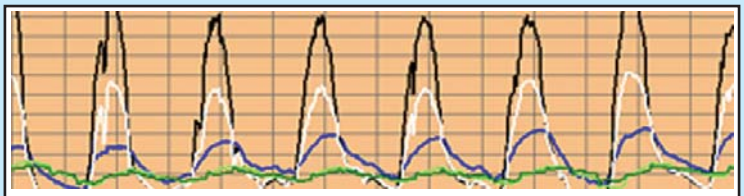
Reduced Urban Heat Island Effect: The urban heat island effect occurs in most of the large cities of the world and has actually been shown to change weather patterns in some. Roads and building rooftops absorb a significant amount of heat during the day, which in turn is radiated back into the atmosphere, causing further warming. GreenGrid® green roofs help insulate and shade buildings. Plus, the plants on green roofs transpire, cooling the atmosphere around them.

Stormwater Management: Green roofs help alleviate stormwater runoff through retention and detention of rainfall and detention of runoff from roofs. This benefit can cut costs associated with required municipal on-site stormwater retention.

Sound Insulation: The growth media, plants, and layers of trapped air in a green roof system serve as excellent sound insulators. Tests have shown that green roofs can reduce the indoor noise pollution from outdoor contributors by as much as 10 decibels per every 3 inches of soil media.

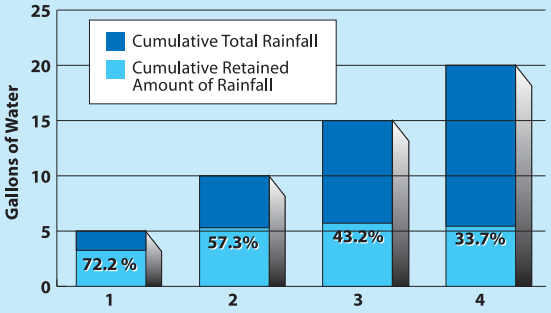
Extended Roof Life: GreenGrid® green roofs can protect roof membranes from ultraviolet radiation, extreme temperature fluctuations, and puncture or other physical damage.

Creation of Added Value and Aesthetics: Green roofs can provide an oasis of green in the urban environment by creating visually pleasing vistas, serene rooftop gardens, and functional gathering areas.



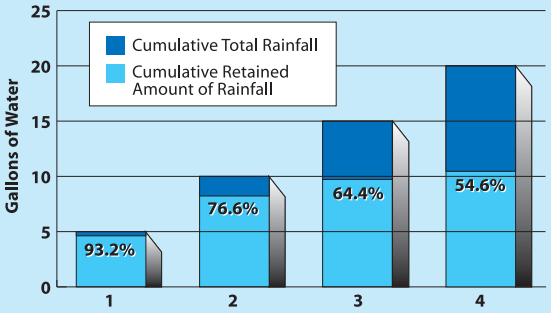
Real-time and Historic GreenGrid® Data Charts Available at GreenGridRoofs.com

Cumulative Water Retention in a 4-Inch GreenGrid® Module During a Simulated 2-Hour Rainstorm



("Storm Events" occurred in 15-minute applications per event)

Cumulative Water Retention in an 8-Inch GreenGrid® Module During a Simulated 2-Hour Rainstorm



("Storm Events" occurred in 15-minute applications per event)

GreenGrid® Projects

APPLE COMPUTER STORE - NORTH MICHIGAN AVENUE

Client: Apple Computer, Inc.
Location: 679 N. Michigan Ave., Chicago, IL
GreenGrid® Size: 2,400 Square Feet
Installation Contractor: WESTON
Landscape Design: Douglas Hoerr Landscape Architecture
Rooftop System: Extensive
Status: Completed Summer 2003

AMERICAN RED CROSS OF GREATER CHICAGO - RAUNER CENTER

Client: American Red Cross of Greater Chicago
Location: 2200 W. Harrison St., Chicago, IL
GreenGrid® Size: 2,800 Square Feet
Installation Contractor: WESTON
Landscape Design: Douglas Hoerr Landscape Architecture
Rooftop System: Extensive
Status: Completed Summer 2004

MILWAUKEE HOUSING AUTHORITY - HIGHLAND GARDENS

Client: Milwaukee Housing Authority
Location: 1818 W. Juneau Ave., Milwaukee, WI
GreenGrid® Size: 20,032 Square Feet
Installation Contractor: WESTON
Landscape Design: WESTON
Rooftop System: Extensive
Status: Completed Fall 2004

UWM GREAT LAKES WATER INSTITUTE

Client: University of Wisconsin-Milwaukee – Great Lakes Water Institute
Location: 600 E. Greenfield Ave., Milwaukee, WI
GreenGrid® Size: 6,480 Square Feet
Installation Contractor: WESTON
Landscape Design: WESTON
Rooftop System: Extensive/Intensive
Status: Completed Summer 2003

U.S. EPA REGION 8 HEADQUARTERS

Client: U.S. Environmental Protection Agency
Location: 1595 Wynkoop St., Denver, CO
GreenGrid® Size: 19,396 Square Feet
Installation Contractor: WESTON
Landscape Design: WESTON
Rooftop System: Extensive
Status: Completed Fall 2006

HASTINGS KEITH FEDERAL OFFICE BUILDING

Building Owner: United States General Services Administration
Client: J & J Contractors, Inc.
Location: Hastings Keith Federal Office Building, 56 North 6th St., New Bedford, MA
GreenGrid® Size: 3,400 Square Feet
Installation Contractor: WESTON and J & J Contractors, Inc.
Landscape Design: Oak Point Associates
Rooftop System: Extensive
Status: Completed Spring 2004

KOHL's RETAIL STORE

Client: Kohl's Illinois, Inc.
Location: 2140 N. Elston Ave., Chicago, IL
GreenGrid® Size: 32,500 Square Feet
Installation Contractor: WESTON
Landscape Design: WESTON
Rooftop System: Extensive
Status: Completed Spring 2005

BARBER PARK GREEN BUILDING

Client: Ada County Parks & Recreation
Location: 4049 S. Eckert Rd., Boise, ID
GreenGrid® Size: 3,660 Square Feet
Installation Contractor: WESTON
Landscape Design: WESTON
Rooftop System: Ultra-Extensive
Status: Completed Summer 2005

HOLY REDEEMER CATHOLIC CHURCH

Client: Holy Redeemer Catholic Church
Location: 25 N. Rosa Parks Way, Portland, OR
GreenGrid® Size: 4,464 Square Feet
Installation Contractor: WESTON
Landscape Design: WESTON
Rooftop System: Extensive
Status: Completed Summer 2005

IKEA STORE

Client: IKEA US
Location: 1 Ikea Way, Stoughton, MA
GreenGrid® Size: 21,376 Square Feet
Installation Contractor: WESTON
Landscape Design: WESTON
Rooftop System: Extensive
Status: Completed Summer 2005

CENTER FOR URBAN ECOLOGY

Client: National Parks Service
Location: 4598 MacArthur Blvd., Washington, DC
GreenGrid® Size: 6,500 Square Feet
Installation Contractor: WESTON/Platinum One Contracting
Landscape Design: U.S. Department of the Interior
Rooftop System: Extensive
Status: Completed Summer 2004

SUSTAINABLE SOUTH BRONX

Client: Sustainable South Bronx
Location: 890 Garrison Ave., Bronx, NY
GreenGrid® Size: 1,052 Square Feet
Installation Contractor: WESTON/Corporate Contractors, Inc.
Landscape Design: WESTON
Rooftop System: Intensive/Extensive
Status: Completed Summer 2005

NATTY BOH BREWERY REDEVELOPMENT

Client: Natty Boh Brewery
Location: 3600 O'Donnell St., Baltimore, MD
GreenGrid® Size: 12,000 Square Feet
Installation Contractor: WESTON
Landscape Design: Cho Benn Holback & Associates
Rooftop System: Extensive
Status: Completed Fall 2005

Optional Features

Additional features are available to enhance the benefits and aesthetic appeal of your green roof. Whether your goal is to create a pleasing and enjoyable space, or optimize the beneficial use of your building's roof space, there are many options available to make the most of your GreenGrid® Green Roof System.

Beneficial Enhancements

- Ecoballast®—These modules can be added to augment stormwater retention.
- Drip Irrigation Systems—Some configurations may require the installation of a drip irrigation system, due to climate and/or plant selection.

Ecoballast®

Drip Irrigation System

Aesthetic Enhancements

- Pavers
- Edge Treatment
- Outdoor Furniture and Planter Boxes

Pavers

Edge Treatment

Outdoor Furniture & Planter Boxes

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States not listed: *Please contact the Midwest Division*

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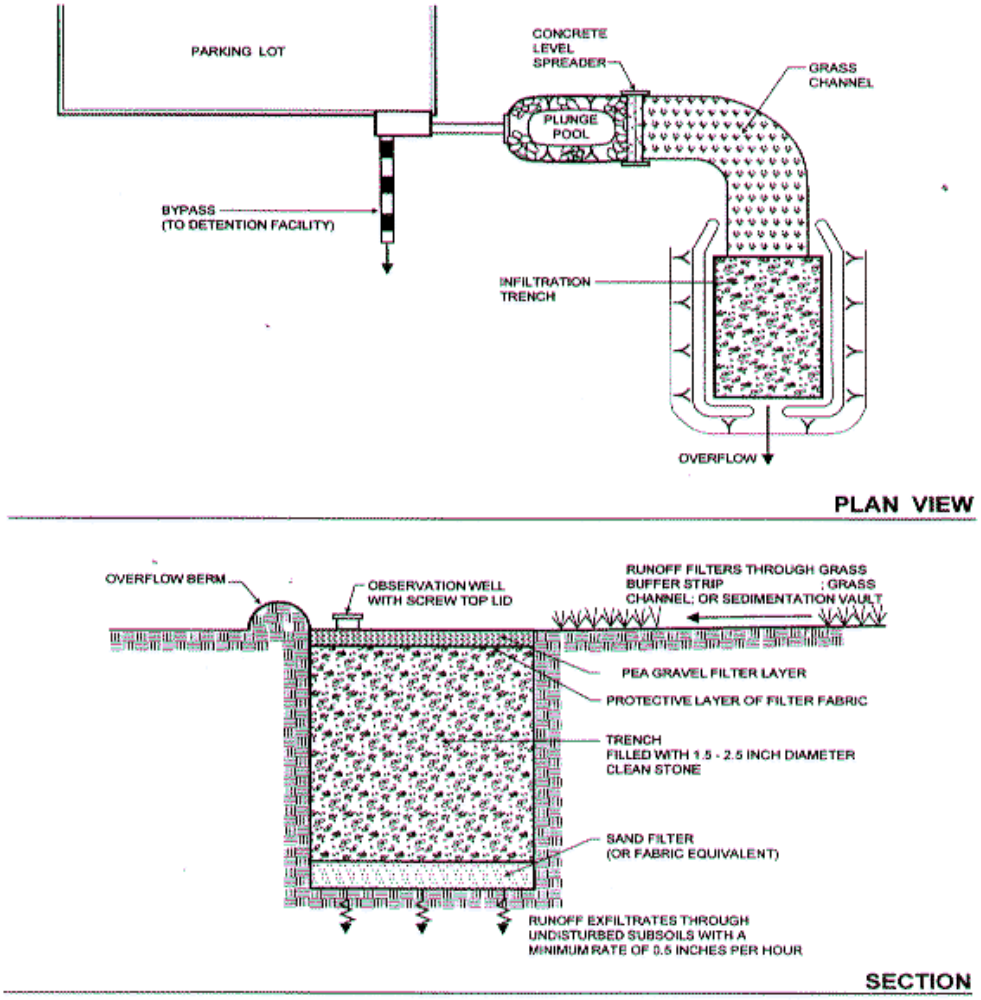
Design Feature 7. Infiltration Trench

Figure from The Storm Water Manager's Resource Center's Infiltration Trench fact sheet, http://www.storm watercenter.net/



Design Feature 8. Modular Wetland

INTRODUCING

MWS-LINEAR STORMWATER FILTRATION SYSTEM

NATURE AND TECHNOLOGY WORKING TOGETHER IN PERFECT HARMONY.

The need for a new stormwater treatment system is evident. Federal and state requirements on cities and industry to reduce stormwater runoff increase every year as our population explodes. The EPA is now reporting that stormwater runoff represents the nation s number one water quality problem, and is the reason why nearly half of our rivers and lakes are not even clean enough to support fishing or swimming. ***Nearly half.***

MODULAR WETLANDS™

To combat this catastrophe, we turned to the expert in this field: **Nature.** By developing technology that imitates the processes found in nature, we ve created the most advanced stormwater filtration system available. Years ahead of current EPA requirements, our clients understand that when they invest in our new technology, they are investing in the future. For all of us.

CONFIGURATION 1: GRATE TYPE

CONFIGURATION 2: CURB TYPE

MWS–LINEAR TESTED REMOVAL EFFICIENCIES*

TSS "Sil-Co-Sil 106"	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Dissolved Mercury	Bacteria E. Coli
98%	74%	93%	81%	80%	89%	60%

*Laboratory Testing of Quarter Scale Model- Average Removal Efficiencies. Tested at Scaled Flow Rate Equal To 120 GPM For Full Size System.

BioMediaGREEN TESTED REMOVAL EFFICIENCIES*

TSS "Sil-Co-Sil 106"	Total Phosphorus	Dissolved Copper	Dissolved Lead	Dissolved Zinc	TPH	Turbidity
85%	69%	79%	98%	78%	99%	99%

*Laboratory Testing - Average Removal Efficiencies. Tested at Flow Rate of 3 GPM Per Square Foot Media Surface Area & Minimum Head.

CURB & GRATE TYPE FLOW BASED DESIGN

- **Primary Treatment Peak Flow Rate = 120 GPM or .27 CFS**
- **Internal Bypass Peak Flow Rate = 4.28 CFS** "Grate Type"
- **Internal Bypass Peak Flow Rate = 2.01 CFS** "Curb Type"
- **O.D Dimensions = 22' x 5' x 4.8'**
- **Curb Type Minimum Fall Required = 3.57'** "Flow Line to Invert Out"
- **Grate Type Minimum Fall Required = 4.13'** "Top of Grate to Invert Out"
- **Storage Capacity = 1000 LBS** "Settling Chamber Storage"

VAULT TYPE VOLUME BASED DESIGN (Configuration not shown)

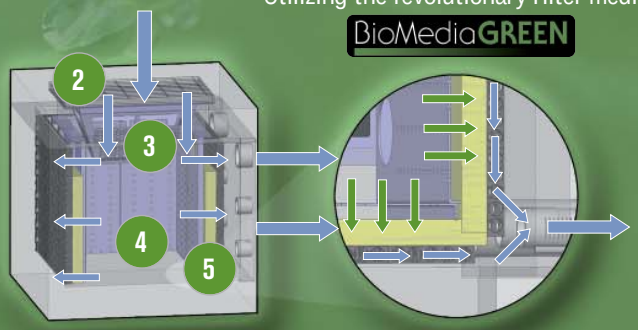
- **Peak Treatment Volume = 4000 Cubic Feet**
  "10 GPM Discharge Rate & 48 Hour Drain Down Time" "Pre-Storage Required"
- **Install External Bypass Prior To Pre-Storage**
- **O.D Dimensions (at grade) = 22' x 5' x 4.8'**
- **O.D Dimensions (below grade) = 22' x 5' x 5.6'**
- **Vault Type Minimum Fall Required = 4.13'** "Finish Grade to Invert Out"
- **Storage Capacity = 1000 LBS** "Settling Chamber Storage"

SYSTEM OPERATIONS

MWS-LINEAR IS DESIGNED TO MEET THE MOST STRINGENT STORMWATER REGULATIONS.

The system utilizes multi-stage treatment processes including the revolutionary filter media (BioMediaGreen) for primary filtration followed by a 4th generation sub-surface flow wetland for biological remediation .

Utilizing the revolutionary filter media: BioMediaGREEN



THIS SYSTEM PROVIDES THE MOST EFFECTIVE TREATMENT IN THE INDUSTRY.

FEATURES

1. **CATCH BASIN CHAMBER - Capture, Screen, Separate, Filter**
   Directs Incoming Stormwater Through The First Three Stages of Treatment.
2. **GRATE TYPE CATCH BASIN INLET**
   A standard 41" x 24" grate type traffic rated catch basin opening directs stormwater into the system.
3. **CATCH BASIN INSERT FILTER UTILIZING BIO CLEAN ENVIRONMENTAL SERVICES, INC. - CATCH BASIN FILTERS**
   Provides the first stage of treatment by capturing trash & litter, gross solids, and sediment.
4. **SETTLING CHAMBER**
   Provides the second stage of treatment by separating out larger suspended solids.
5. **PERIMETER FILTER UTILIZING BioMediaGREEN SEE TESTED REMOVAL EFFICIENCIES**
   Provides the third stage of treatment by physically and chemically capturing fine TSS, metals, nutrients, and bacteria.
6. **HIGH FLOW INTERNAL BYPASS**
   Flow rates greater than the systems treatment capacity are bypassed directly to the discharge chamber.
7. **WETLAND CHAMBER SUB-SURFACE FLOW - Biological Remediation**
   Provides the final stage of treatment through a combination of physical, chemical, and biological processes.
8. **DISCHARGE CHAMBER - Flow Control, Drain Down, Discharge**
   Controls flow rates with adjustable valves and contains a drain down filter that eliminates any standing water.
9. **MULTI-LEVEL FLOW CONTROL VALVES**
   Two 4" adjustable ball valves allows various flow rates to be set for primary and secondary treatment levels.

FSC Mixed Sources
Product group from well-managed forests, controlled sources and recycled wood or fiber
Cert no. XXX-XXX-000
www.fsc.org
© 1996 Forest Stewardship Council

MODULAR WETLANDS™

RAINFOREST ALLIANCE CERTIFIED

T 760.433.7640 E info@modularwetlands.com www.modularwetlands.com

Design Feature 9. Rain Barrels

United States Environmental Protection Agency

August 2009

What is a Rain Barrel?

Environmental Assessment & Innovation Division
EPA Region 3, Philadelphia, PA

A rain barrel is a system that collects and stores rainwater from your roof that would otherwise be lost to runoff and diverted to storm drains and streams. Usually a rain barrel is composed of a 55 gallon drum, a vinyl hose, PVC couplings, a screen grate to keep debris and insects out, and other off-the-shelf items, a rain barrel is relatively simple and inexpensive to construct and can sit conveniently under any residential gutter down spout.

A rain barrel used to collect rooftop runoff using a gutter / downspout system

What are the advantages of a rain barrel?

Lawn and garden watering make up nearly 40% of total household water use during the summer. A rain barrel collects water and stores it for when you need it most -- during periods of drought -- to water plants, wash your car, or to top a swimming pool. It provides an ample supply of free "soft water" to homeowners, containing no chlorine, lime or calcium making it ideal for gardens, flower pots, and car and window washing.

A rain barrel will save most homeowners about 1,300 gallons of water during the peak summer months. Saving water not only helps protect the environment, it saves you money and energy (decreased demand for treated tap water). Diverting water from storm drains also decreases the impact of runoff to streams. Therefore, a rain barrel is an easy way for you to have a consistent supply of clean, fresh water for outdoor use, FREE.

Where can I buy a ready-made rain barrel?

Ready-made rain barrels can be purchased from a number of companies, including hardware stores and garden supply stores. In addition, local governments sometimes offer them for a reduced price as part of their environmental education programs. Below are just a few sources (this listing does not constitute an endorsement by EPA). All links below exit EPA.

- Ace Hardware has a couple of models, 866-290-5334
- Gaiam produces the Great American Rain Barrel, 877-989-6321
- Plow & Hearth has several rain barrels including a pop-up barrel that folds flat when not needed, 800-494-7544
- Rain Barrel Source offers an extra large system, 866-912-9719
- Spruce Creek Company produces the Spruce Creek Rainsaver, 800-940-0187
- Urban Garden Center sells the Urban Rain Barrel, 866-923-1992

Design Feature 10. Retention Pond

Retention Pond

Retention ponds, or "wet ponds," are among the most common stormwater treatment systems used today. They are not to be confused with detention basins or "dry basins," which hold runoff for a specified period of time, and then release the entire volume of the runoff. Retention ponds retain a resident pool of standing water, which improves water quality treatment between storms. Retention ponds demonstrate a reasonably strong water quality treatment, particularly in comparison to dry pond systems. However, lack of maintenance often leads to pollutant export and a gradual erosion within the system for large flows.

Where to Use It

Acceptance of retention ponds is widespread, and examples of these systems can be found all over the world in any climate, soil, and development setting.

In many areas, retention ponds are the system of choice, a preference likely due to their ease of design, which can be adapted to provide water quality treatment and water quantity control in a variety of settings.

Implementation

While retention ponds are common, their use raises concerns related to human and ecosystem health. Standing water, for example, can be a drowning hazard. They also serve as a habitat for mosquitoes associated with diseases. Ponds that contain excess nutrients can foster eutrophication. In hot weather, retention ponds can superheat already warm parking lot runoff, impacting aquatic habitats and cold water fisheries. Some innovative retention pond outlet designs include the use of gravel subdrains to cool effluent.

The cost to install a retention pond system to treat runoff from one acre of impervious surface was $13,500. This does not include maintenance expenditures, which may involve routine inspection, periodic mowing, and sediment dredging, as needed. For more information about this design, contact the UNHSC.

During the first year of operation, the retention pond at UNHSC was reasonably effective in removing many of the pollutants commonly found in runoff. However, during its second year, researchers observed a reduction in its water quality performance. This indicates that its performance may continue to diminish over time.

Fast Facts

CATEGORY TYPE
Stormwater Pond, Sedimentation

BMP TYPE
Structural, Conventional

DESIGN SOURCE
New York State Stormwater Management Design Manual

BASIC DIMENSIONS
Surface Area: 46 ft X 70 ft (varies)

SPECIFICATIONS
Catchment Area: 1 acre
Peak Flow: 1 cfs
Water Quality Volume: 3,264 cf

TREATMENT FUNCTION
Physical Settling & Biological

INSTALLATION COST PER ACRE TREATED
$13,500

MAINTENANCE
Maintenance Sensitivity: Low
Inspections: Low
Sediment: Low

How the System Works

Design

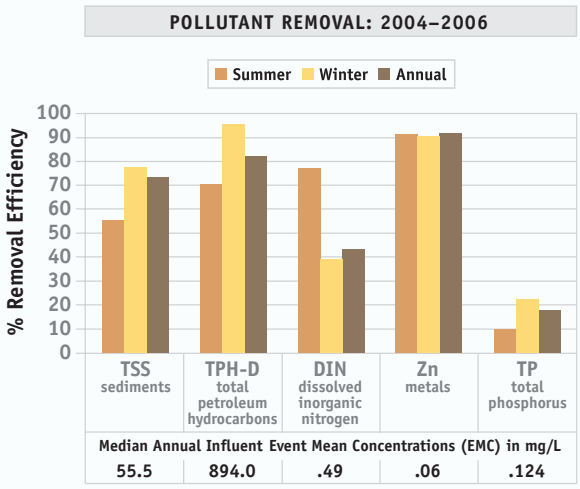
The retention pond tested at the UNHSC is comprised of a sedimentation forebay and a larger basin sized to hold a resident pool of water. It was installed below the water table to maintain a permanent pool of water, and in clay soils, which effectively act as a lining for the system. Side slopes were stabilized with grass, and spillways with stone and geotextile.

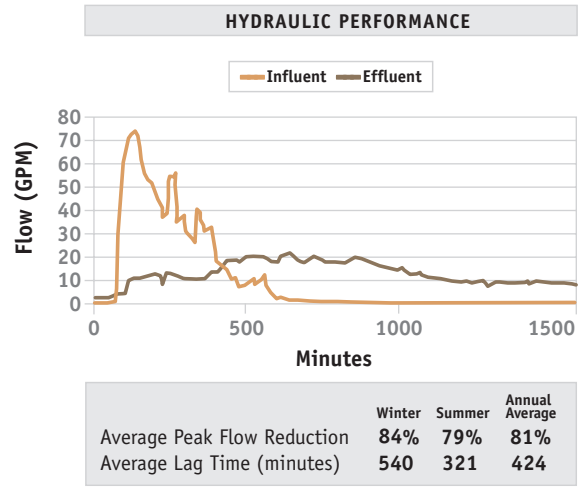
Improved designs, not used here, would include stabilization of wetland perimeter with stone and fabric. This perimeter was the location of failure for the pond. In this area, vegetation could not establish and soils were prone to erosion.

In general, these ponds can be designed either above or below the groundwater table. Ponds are commonly designed for both aesthetic and habitat function.

The system is designed to treat the water quality volume. Typically, channel protection volumes (CP_V) are conveyed through the system within 24 to 48 hours.

During conveyance protection volume (Q_p) rain events, stormwater is conveyed through the system, and bypasses the water quality treatment process.





	Winter	Summer	Annual Average
Average Peak Flow Reduction	84%	79%	81%
Average Lag Time (minutes)	540	321	424

Water Quality Treatment

During the first year of operation, the retention pond was reasonably effective in removing many of the pollutants commonly found in runoff. It consistently met EPA's recommended level of removal for total suspended solids, as well as regional ambient water quality criteria for petroleum products, metals, and nutrients. However, during its second year, researchers observed a 25 percent reduction in its TSS median removal efficiency—from 81 percent down to 71 percent. This indicates that while the pond still effectively treats most contaminants, its performance may continue to diminish. Like the other systems evaluated at UNHSC, it does not provide chloride removal, but can dampen chloride peaks.

The chart at top left reflects the system's performance in removing total suspended solids, total petroleum hydrocarbons, dissolved inorganic nitrogen, total phosphorus, and zinc. Values represent results recorded over a two-year monitoring period, with the data further divided into summer and winter components.

Water Quantity Control

Retention ponds exhibit a tremendous capacity to reduce peak flows, retain channel protection volume, and provide flood protection for up to 48 hours. In the figure at bottom left, the retention pond demonstrates effective peak flow reduction and long lag times, regardless of season. However, in general, these systems do not reduce runoff volume.

Research indicates that the extended duration effluent flows typical of retention ponds negatively impact receiving streams, particularly when post-development runoff subjects streams to erosive flows for long periods. This phenomenon is observed in urban areas, where it leads to channel instability and lost ecological value and function.

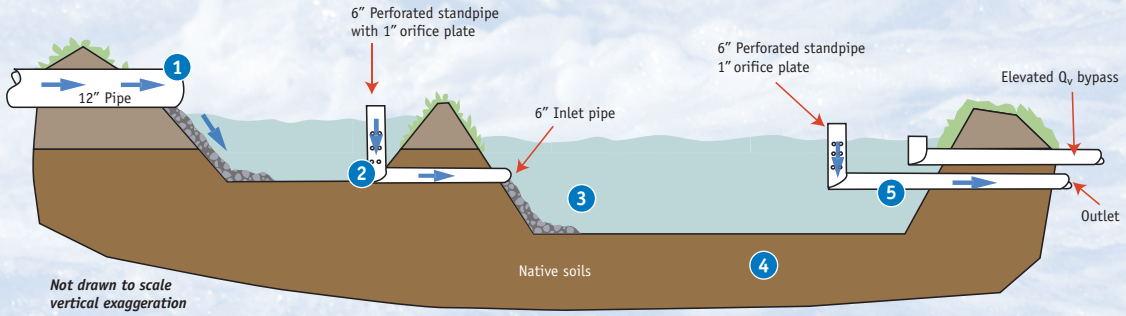
Maintenance

Minimal need for maintenance contributes to the popularity of retention ponds. However, while little maintenance may be required to support their ability to manage peak flow and floods, more frequent attention is critical for effective water quality treatment. Previous research has demonstrated that erosion and re-suspension of benthic sediments in these systems leads to sediment export. Since sedimentation is the main water quality treatment mechanism, inspections are critical to maintaining performance in sites with heavy sediment loads. Dredging for debris and trash is also needed. While not necessary for these systems to function, the establishment of a viable pond ecosystem can enhance treatment, prolong the system's lifespan, and increase aesthetic appeal.

Cold Climate

The system's ability to treat water quality and manage water quantity remained effective during cold winter months. While some variation in both kinds of performance does occur in cold conditions, it does not warrant significant alterations to system design to compensate.

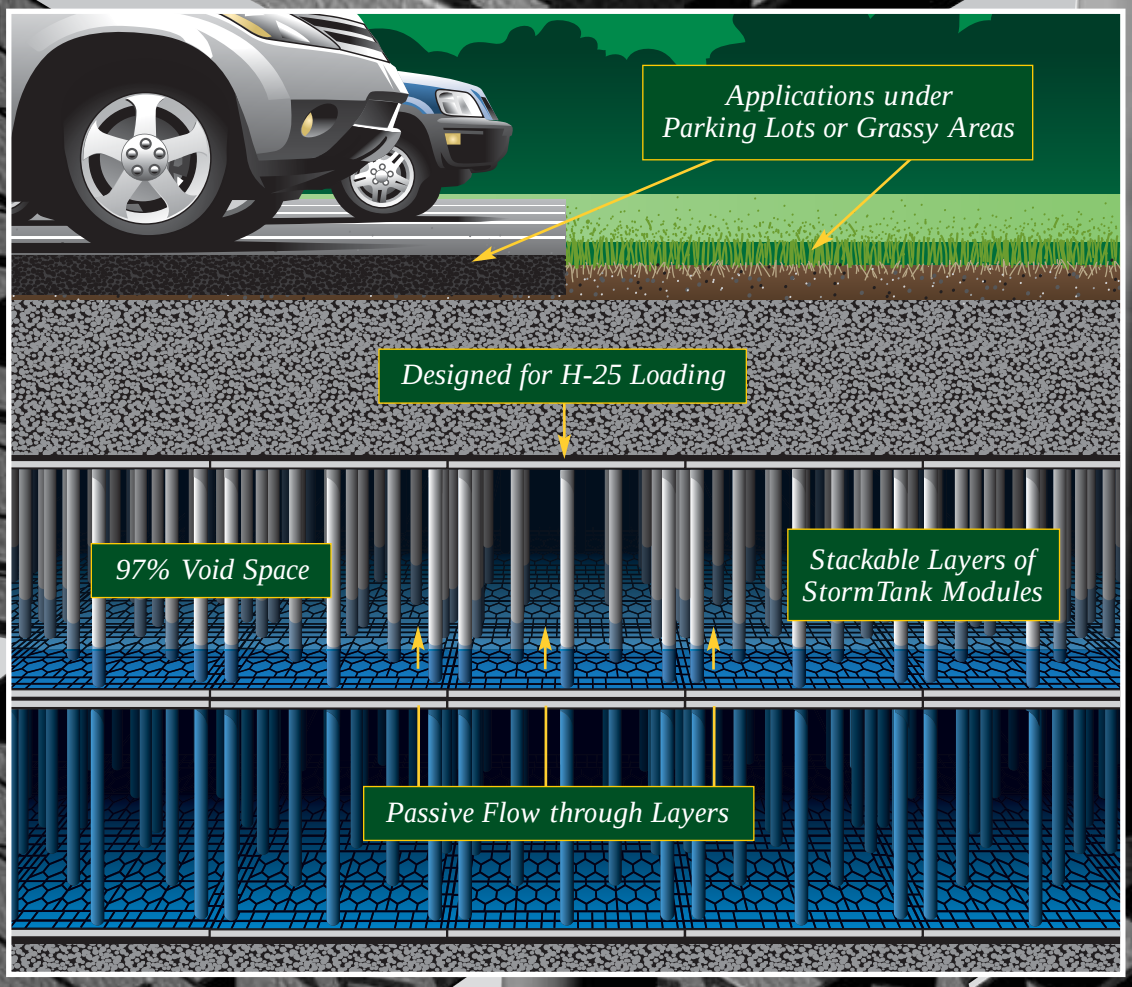
Water Quality Treatment Process



1. Runoff flows into a forebay that removes large objects and allows larger sediment particles to settle.
2. Runoff exits the forebay though a perforated standpipe and flows into the pond. When forebay capacity is reached, the overflow spills across a weir into the retention pond basin.
3. Water quality treatment is a function of storage volume and retention time, i.e., larger storage volumes and longer retention times promote better treatment. The removal of TSS, some phosphorus, petroleum hydrocarbons, and metals occurs primarily through sedimentation.
4. Several components contribute to biological treatment. Nutrients removal occurs primarily through the activity of macroinvertebrates, microorganisms, and plants. Long-term breakdown of petroleum hydrocarbons is through microbial processes. Metals that accumulate in the sediment may be taken up by the roots of aquatic vegetation.
5. The runoff is conveyed by a perforated standpipe modified with a one-inch outlet which regulates flow from the system.

Design Feature 11. Subsurface Storage

STORMTANK™ STORMWATER STORAGE MODULES

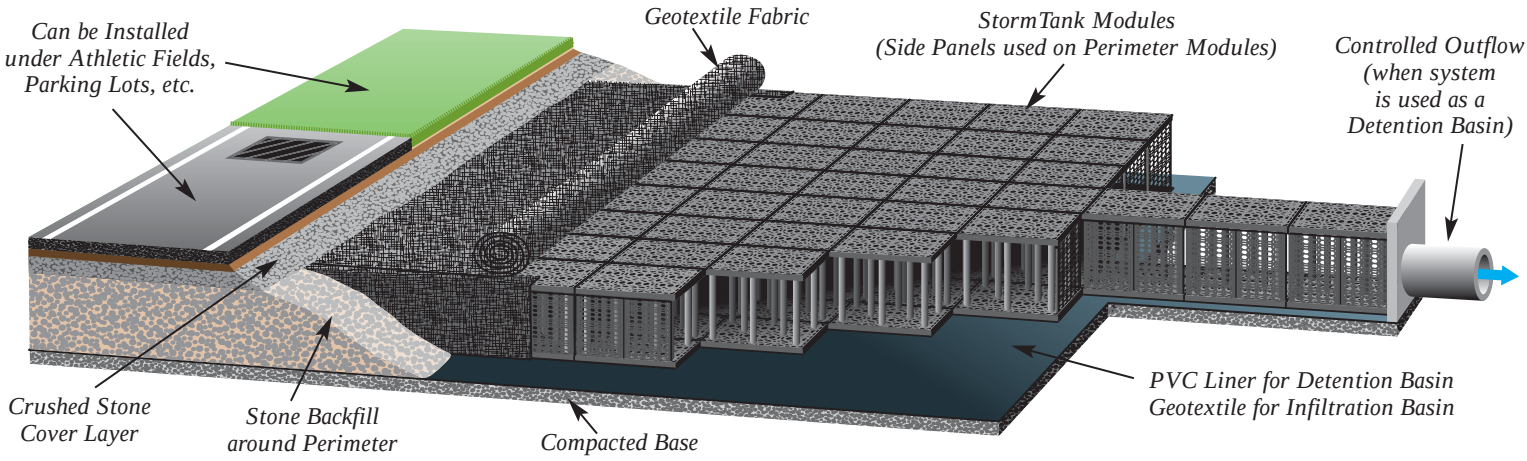


StormTank™

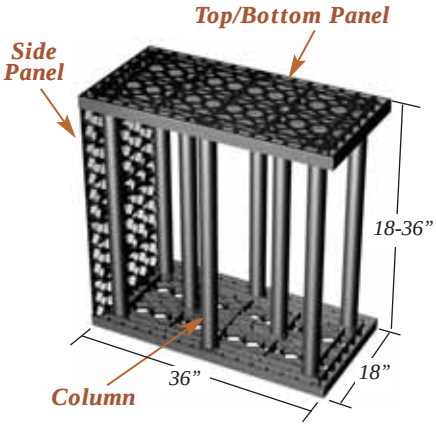
Stormwater Storage Modules are a high-void, strong, affordable alternative to crushed stone, concrete structures, or pipe chambers for sub-surface stormwater detention or infiltration basins.

BRENTWOOD INDUSTRIES

STORMTANK™ STORMWATER STORAGE SYSTEM



Brentwood's StormTank™ Stormwater Storage System is a high-void, strong, affordable alternative to crushed stone, concrete structures, or pipe chambers for sub-surface stormwater detention or infiltration basins.



HIGH VOID, HIGH STRENGTH Our modules offer the largest void space of any underground stormwater storage units currently on the market (97%), and are load-rated for use under parking lots, athletic fields, parks, etc. (Designed to exceed H-25 loading criteria)!

EASY TO INSTALL The entire StormTank Storage System is built on-site from Top/Bottom Panels and Side Panels made of rugged, lightweight polypropylene and 2-3/8" diameter PVC columns. Combinations of these three components create all the module configurations needed for a fully-functioning underground system (see example at top). To minimize shipping costs, the StormTank components are delivered unassembled, but on-site assembly is a snap! No special equipment, tools, or bonding agents are needed to assemble or install the modules. All components easily attach with a secure concentric pressure fit.

EASY TO CLEAN The open tops/bottoms and sides of the modules makes flushing and cleaning easy ... a great advantage over storage systems where access is limited.

SAVES SPACE AND MONEY Because of its 97% void space, stackability, and H-25 strength, a StormTank system offers significant space and cost savings when compared to conventional stormwater storage solutions. For example:

- A StormTank installation requires a much smaller footprint than a crushed rock system with the same amount of stormwater storage capacity. And less space used also means less expense for excavation, geotextile, liner, installation, and backfill.
- Because a StormTank system is installed underground, it frees up surface space for uses that would be otherwise unavailable with a typical detention pond.
- StormTank's stackability and variable column height (18"-36") can maximize the use of a site with limited surface area.

The Brentwood AccuPier Support System (above) has been in use for several years and is installed in over 50 biological oxidation towers throughout the U.S. and Canada. Each PVC AccuPier column, fitted with upper and lower base caps, can hold 7000 lbs. and has been compression-tested to 24,000 lbs. All the technology, materials, and experience gained from the AccuPier System have been applied to our new StormTank Modules.

BRENTWOOD INDUSTRIES

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Phone 610.236.1100 *Fax* 610.736.1280
Email wwsales@brentw.com
Website www.BrentwoodProcess.com

Printed 07/06

Design Feature 12. Turf Reinforcement Mats

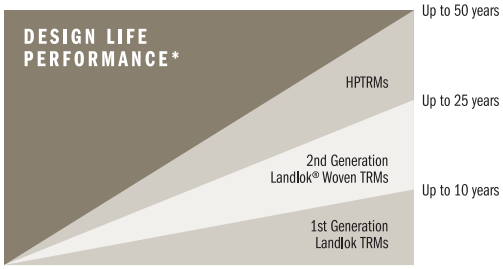
LANDLOK® TURF REINFORCEMENT MATS

Our Landlok® Turf Reinforcement Mats (TRMs) are the industry's most advanced solutions for applications requiring immediate, long-term erosion protection, vegetative reinforcement and water quality enhancement capabilities. Our first generation TRMs are constructed of a dense web of 100% polypropylene fibers positioned between two biaxially oriented nets. When vegetated, they provide twice the erosion protection of vegetation alone.

Now we've taken the same woven technology in our High Performance Turf Reinforcement Mats (HPTRMs) and used it to design the next generation of TRMs. These netless, composite-free three-dimensional second generation TRMs feature a rugged material construction that combines superior tensile strength, flexibility and UV stability. This allows them to deliver better, long-term performance over traditional methods like rock riprap and concrete paving and increased design life over first generation netted, fused, glued or stitch-bonded TRMs. All Landlok TRMs feature our patented X3® fiber technology, which provides 40% greater surface area for trapping and protecting seed and soil.

1ST GENERATION LANDLOK® TRMs FEATURES & BENEFITS

- Provides permanent turf reinforcement to enhance vegetation's natural ability to filter soil particles and prevent soil loss during storm events
- 100% synthetic and UV-stabilized components
- Utilizes X3 fiber technology for up to 40% greater surface area to protect emerging seedlings and sediment retention
- Promotes infiltration which leads to groundwater recharge
- More aesthetically pleasing than conventional methods (i.e. rock riprap and concrete paving)
- Superior product testing and performance
- Easier installation than conventional solutions (no heavy equipment required)



*Design life performance may vary depending upon field conditions and applications.

2ND GENERATION LANDLOK® WOVEN TRMs FEATURES & BENEFITS

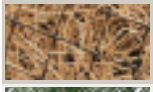
All the features and benefits of first generation Landlok TRMs, plus:

- A unique, patented matrix of pyramids formed with X3 fibers that gridlocks soil in place under high-flow conditions
- 3-D woven material with superior tensile strength for loading and/or survivability requirements
- Greater flexibility to maintain intimate contact with subgrade, resulting in rapid seedling emergence and minimal soil loss
- Completely interconnected yarns that provide superior UV resistance throughout the TRM
- A combination of superior characteristics for long-term performance and a longer design life than first generation Landlok TRMs
- Meets requirement of 5 mm^2 or less mesh size to prevent wildlife entanglement in any sensitive habitats

Outperforms and is more cost-effective than conventional erosion control methods, including:

- **Rock riprap**
- **Concrete paving**
- **Erosion Control Blankets (ECBs)**

LANDLOK® TURF REINFORCEMENT MATS PRODUCT FAMILY TABLE

PRODUCT		DESCRIPTION	FUNCTIONAL LONGEVITY	COLOR	FIBER TYPE	# OF NETS	FHWA FP-03, SECTION 713 COMPLIANCE
	LANDLOK® 450	1ST GENERATION TRM	PERMANENT	TAN OR GREEN	POLYPROPYLENE X3® FIBER TECHNOLOGY	2	TYPE 5A, 5B, 5C
	LANDLOK 1051	1ST GENERATION TRM	PERMANENT	TAN	POLYPROPYLENE X3 FIBER TECHNOLOGY (GEOTEXTILE BACKING)	1	TYPE 5A, 5B, 5C
	LANDLOK 300	2ND GENERATION TRM	PERMANENT	TAN OR GREEN	POLYPROPYLENE X3 FIBER TECHNOLOGY	0 (WOVEN)	TYPE 5A, 5B, 5C

PROPEX® | THE ADVANTAGE CREATORS.™

GEOSYNTHETICS

LANDLOK® TURF REINFORCEMENT MATS

APPLICATION SUGGESTIONS FOR LANDLOK® TURF REINFORCEMENT MATS

	APPLICATION	FUNCTIONAL LONGEVITY	PRODUCT STYLE	INSTALLED COST[1]	ANCHOR SUGGESTIONS[5]
SLOPES[2]	UP TO 1H:1V	PERMANENT	LANDLOK® 300	$10.00 - 15.00/yd² $11.96 - 17.94/m²	2.5 ANCHORS/yd² 3 ANCHORS/m²
SLOPES[2]	UP TO 1.5H:1V	PERMANENT	LANDLOK 450	$9.00 - 14.00/yd² $10.77 - 16.75/m²	2 ANCHORS/yd² 2.5 ANCHORS/m²
SLOPES[2]	UP TO 2H:1V	PERMANENT	LANDLOK 450	$9.00 - 14.00/yd² $10.77 - 16.75/m²	2 ANCHORS/yd² 2.5 ANCHORS/m²
CHANNELS[3]	SHEAR STRESS UP TO 10 lb/ft² (479 N/m²) VELOCITY UP TO 18 ft/sec (5.5 m/sec)	PERMANENT	LANDLOK 450	$9.00 - 14.00/yd² $10.77 - 16.75/m²	2.5 ANCHORS/yd² 3 ANCHORS/m²
CHANNELS[3]	SHEAR STRESS UP TO 12 lb/ft² (576 N/m²) VELOCITY UP TO 20 ft/sec (6.1 m/sec)	PERMANENT	LANDLOK 300	$10.00 - 15.00/yd² $11.96 - 17.94/m²	2.5 ANCHORS/yd² 3 ANCHORS/m²
BANKS[4]	WAVE ACTION < 1 ft (30 cm)	PERMANENT	LANDLOK 1051	$10.00 - 15.00/yd² $11.96 - 17.94/m²	2.5 ANCHORS/yd² 3 ANCHORS/m²

NOTES: 1. Installed cost estimates range from large to small projects according to material quantity. The estimates include material, seed, labor and equipment. Note that costs vary greatly in different regions of the country. 2. For slopes steeper than 1H:1V, please see our Pyramat® HPTRM product brochure. 3. Values shown are short-term fully vegetated maximums. For channels with a shear stress greater than 12 lb/ft² (576 N/m²) and velocity greater than 20 ft/sec (6.1 m/sec), please see our Pyramat HPTRM product brochure. 4. For wave action greater than 1 ft (30 cm), please see our Pyramat HPTRM product brochure. 5. For anchor size and style, please see our TRM Installation Guidelines.

KEY PHYSICAL PROPERTIES OF LANDLOK® TURF REINFORCEMENT MATS

- Tensile Strength: High-strength and low-strain minimizes seed, root damage and material under heavy loads.
- Flexibility: Greater flexibility allows our TRMs to conform and maintain intimate contact with the prepared grade, increasing the ease of successful installation.
- Seedling Emergence: Landlok TRMs, now with X3® fiber technology, offer 40% more fiber surface area to capture the critical sediment and moisture needed to increase seed germination within the first 21 days.
- UV Resistance: All Landlok TRM components are constructed with the top-tested UV stabilizers, such as carbon black and hindered amine light stabilizers (HALS).

SEVEN STEPS FOR SUCCESSFUL TRM SELECTIONS*

1. SELECT APPLICATIONS
2. DETERMINE FUNCTIONAL LONGEVITY
3. ANTICIPATE CLIMATE (ARID, SEMI-ARID OR TEMPERATE)
4. UNDERSTAND TRADITIONAL SOLUTION
5. PREDICT NON-HYDRAULIC STRESSES (MAINTENANCE STRESSES)
6. KNOW VEGETATION TYPE
7. CALCULATE HYDRAULIC STRESSES

*See Propex Engineering Bulletin or EC-DESIGN® software for more information.

LANDLOK® TURF REINFORCEMENT MAT PROPERTY TABLE[1] ENGLISH & METRIC UNITS

	PROPERTY	TEST METHOD	VALUE[2]	LANDLOK® 450	LANDLOK® 1051	LANDLOK® 300
PHYSICAL	MASS PER UNIT AREA	ASTM D-6566	MARV	10.0 oz/yd² 340 g/m²	14 oz/yd² 475 g/m²	8.3 oz/yd² 281 g/m²
	THICKNESS	ASTM D-6525	MARV	0.4 in 10.1 mm	0.4 in 10.1 mm	0.3 in 7.6 mm
	LIGHT PENETRATION	ASTM D-6567	TYPICAL	20%	5%	50%
	COLOR	VISUAL	–	GREEN, TAN	TAN	GREEN, TAN
MECHANICAL	TENSILE STRENGTH	ASTM D-6818	MARV	400 x 300 lb/ft 5.8 x 4.3 kN/m	300 x 225 lb/ft 4.3 x 3.2 kN/m	2400 x 2000 lb/ft 35.0 x 29.2 kN/m
	TENSILE ELONGATION	ASTM D-6818	MAXIMUM	50%	85%	50%
	RESILIENCY	ASTM D-6524	MARV	90%	80%	75%
	FLEXIBILITY	ASTM D-6575	TYPICAL	0.026 in-lbs 30000 mg-cm	0.022 in-lbs 25000 mg-cm	0.195 in-lbs 225000 mg-cm
ENDURANCE	FUNCTIONAL LONGEVITY	OBSERVED	TYPICAL	PERMANENT	PERMANENT	PERMANENT
DURABILITY	UV RESISTANCE	ASTM D-4355	MINIMUM	80% @ 1000 HOURS	80% @ 1000 HOURS	90% @ 3000 HOURS
PERFORMANCE	SEEDLING EMERGENCE[3]	ECTC DRAFT METHOD #4	TYPICAL	409%	220%	296%
PACKAGING	ROLL WIDTH	MEASURED	TYPICAL	6.5 ft 2.0 m	6.5 ft 2.0 m	8.5 ft 2.6 m
	ROLL LENGTH	MEASURED	TYPICAL	138.5 ft 42.2 m	138.5 ft 42.2 m	106 ft 32.3 m
	ROLL WEIGHT	CALCULATED	TYPICAL	75 lb 34 kg	101 lb 46 kg	51 lb 23 kg
	ROLL AREA	MEASURED	TYPICAL	100 yd² 84 m²	100 yd² 84 m²	100 yd² 84 m²

NOTES: 1. The listed property values are effective 06/2009 and are subject to change without notice. 2. MARV indicates Minimum Average Roll Value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the reported value. 3. Calculated as percent increase in average plant biomass with tall fescue grass seed in sand 14 days after seeding versus traditional monofilament TRMs and HPTRMs.

LANDLOK® TURF REINFORCEMENT MAT PERFORMANCE VALUES ENGLISH & METRIC UNITS

MATERIAL	FUNCTIONAL LONGEVITY	SHORT-TERM MAXIMUM SHEAR STRESS AND VELOCITY						MANNING'S "n"		
		VEGETATED[4, 7]		PARTIALLY[5]		UNVEGETATED[6]		0"-6"	6"-12"	12"-24"
LANDLOK® 450	PERMANENT	10 lb/ft² 479 N/m²	18 ft/sec 5.5 m/sec	8 lb/ft² 383 N/m²	15 ft/sec 4.6 m/sec	5 lb/ft² 239 N/m²	12 ft/sec 3.7 m/sec	0.035	0.025	0.021
LANDLOK 1051	PERMANENT	10 lb/ft² 479 N/m²	18 ft/sec 5.5 m/sec	n/a	n/a	5 lb/ft² 239 N/m²	12 ft/sec 3.7 m/sec	0.036	0.026	0.020
LANDLOK 300	PERMANENT	12 lb/ft² 576 N/m²	20 ft/sec 6.1 m/sec	–	–	–	–	0.030	0.028	0.018

NOTES: 4. Maximum permissible shear stress has been obtained through fully vegetated (70% to 100% density) testing programs featuring specific soil types, vegetation classes, flow conditions and failure criteria. These conditions may not be relevant to every project nor are they replicated by other manufacturers. Please contact Propex for further information. 5. Maximum permissible shear stress has been obtained through partially vegetated (30% to 70% density) testing programs featuring specific soil types, vegetation classes, flow conditions and failure criteria. These conditions may not be relevant to every project nor are they replicated by other manufacturers. Please contact Propex for further information. 6. Maximum permissible shear stress has been obtained through unvegetated (0% to 30% density) testing programs featuring specific soil types, vegetation classes, flow conditions and failure criteria. These conditions may not be relevant to every project nor are they replicated by other manufacturers. Please contact Propex for further information. 7. Maximum permissible shear stress achieved after only 14 weeks of vegetative establishment versus the industry standard of two full growing seasons.

For downloadable documents like construction specifications, installation guidelines, case studies and other technical information, please visit our web site at **geotextile.com**. These documents are available in easy-to-use Microsoft® Word format.

PROPEX® | THE ADVANTAGE CREATORS.™

GEOSYNTHETICS

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www.geotextile.com

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