4/25/2018
Updated 12/20/18

The purpose of these provisional standards is to provide design guidance for new practices included in the update of Ohio's Construction General Permit on 4/23/18. These provisional standards are provided until a fully updated and edited version of the Rainwater and Land Development manual (http://epa.ohio.gov/dsw/storm/technical_guidance.aspx) can be published.

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The following provisional standards are included in this document:

Structural Practices

- Underground Storm Water Management Systems
- Pretreatment

RAINWATER AND LAND DEVELOPMENT PROVISIONAL PRACTICE STANDARD #.#

UNDERGROUND STORM WATER MANAGEMENT SYSTEMS

DATE: 4/20/18

Description

Underground stormwater management systems (USMS) are large subsurface reservoirs located under pavement or other open space that manage stormwater runoff through infiltration, detention or a combination of the two. Underground reservoirs may simply be backfilled with stone, but also may utilize specially designed structures (e.g., concrete vaults, large-diameter pipes, plastic "crates", or plastic arches) to maximize storage in the space available.

USMS must include adequate water quality pretreatment practices. Often, USMS are used to manage larger runoff events to meet local peak discharge requirements and, where site and soil conditions are favorable for infiltration, may be used to reduce runoff volume or meet groundwater recharge requirements.

Credits

Purpose/Objective	Credit Available	Requirements and Notes
Runoff Reduction Volume (RRv)	Underground infiltration systems can receive a runoff reduction volume (RRv) credit to reduce the water quality volume (WQv) requirement. Up to 100% of the WQv volume.	RRv must fully infiltrate within 48 hr If the site is capable of partially infiltrating the WQv, the infiltrated runoff reduction volume (RRv) may be subtracted from the WQv using the runoff reduction method (RRM)
Groundwater Recharge Volume (GWv)	Up to 100% of the RRv.	GWv must fully infiltrate within 48 hr

Condition Where Practice Applies

Underground stormwater management systems are a viable option where space to locate a large surface practice is limited. Underground systems can be located under paved areas, as well as under athletic fields or other grassy open space.

Planning Considerations

The decision to select an underground stormwater management system will depend on several factors including:

- Acceptance by the local stormwater authority
- Stormwater management system construction costs, and operating and maintenance costs
- Value or opportunity cost of real estate needed to locate a surface stormwater practice
- Availability and elevation of discharge outlet(s)
- Infiltration capacity of the underlying soil
- Presence of shallow bedrock, a shallow groundwater table or unstable slopes
- Potential for groundwater contamination

If an USMS makes sense from an economic and site management perspective, the next major decision is whether to employ an infiltrating system (open-bottom) or one that treats the WQv with extended detention (closed-bottom or lined). An infiltrating system should be used if feasible because of the additional benefits (e.g., runoff volume reduction, peak discharge reduction, groundwater recharge) provided. Infiltrating systems work well on most new development sites with hydrologic soil group (HSG) A, B or C soils. Though infiltrating systems should be considered for previously developed sites, these sites present challenges (e.g., existing utilities, impacted soils) that may be exacerbated by the addition of infiltrated water.

Similarly, soils classified as HSG-D typically have hydrologic limitations (e.g., very low hydraulic conductivity, seasonal high-water table, shallow impermeable layer) that may make it challenging to meet minimum design criteria. Soils classified as sands, loamy sands, sandy loams, loams or silt loams at the depth of excavation typically have the infiltration capacity necessary to support an infiltrating system, whereas clays, silty clays, clay loams, silty clay loams and sandy clay loams at the excavated depth may not provide the infiltration capacity necessary to meet drawdown requirements.

Design Criteria – All Practices

Note: Design criteria are provided to assure compliance with post-construction stormwater requirements and sustain the stormwater system function over the long-term. If proprietary pretreatment or storage infrastructure is utilized, engineers shall follow design recommendations provided by the manufacturer(s).

Outlet – The drawdown control device should have a minimum orifice diameter of 1 inch and should be fitted with measures to prevent clogging (e.g. baffle or snout). Consider grates or trash racks where necessary. All outlets shall be easily accessible from the surface, requiring no underground entry for routine inspection and maintenance activities. A bypass or overflow outlet in excess of the WQv or design peak discharge requirement should be installed.

Access – USMS must have sufficient access, typically at multiple locations, to perform inspection and maintenance of the system. Access shall be provided, at a minimum, over the inlet and outlet of the system. The number of access manholes will depend on the size and configuration of the system as well as the maintenance methods required.

Pretreatment Required – Pretreatment is required for all underground stormwater management systems.

Drain Time Requirement – The WQv within the underground system must fully drain within 48-hr whether infiltrating or extended detention. The outlet structure shall not discharge more than the first half of the WQv in less than one third of the drain time.

Configuration – USMS should be configured such that flow is distributed throughout the storage. Structural storage system headers or manifolds should be designed to convey flow across the system.

Stage-Storage Data - Underground storage systems that use structural components to enhance storage volume (pipes, arches, vaults, crates, etc.) need to provide stage-storage (depth-volume) information in sufficient detail (recommend maximum 3" or 0.25 ft depth increments) to facilitate modeling and review. Stage-storage relationships are available from most manufacturers of proprietary storage infrastructure.

Resuspension – USMS utilizing closed structural storage systems should utilize measures to limit resuspension of pollutants including energy dissipation and wet forebays.

Load-bearing Capacity – The engineer is responsible for the structural integrity of the underground system and any infrastructure it supports. Concerns about the load-bearing capacity of the subgrade soil should be addressed according to manufacturer's recommendations and may include adjustments to aggregate depth or the use of geo-grids to distribute loads.

Vertical Separation from High Water Table or Bedrock – The excavated bottom of the infiltration reservoir should be at least two feet higher than the seasonal high-water table (SHWT) or underlying bedrock. The separation can be reduced to one foot when the applicant can prove the water table will subside to its pre-storm elevation in five days or less.

Design Criteria – Extended Detention / Closed USMS

Pretreatment - Extended detention USMS must include pretreatment verified to achieve 50% TSS removal.

Drawdown - For extended detention USMS, the WQv has a minimum 24-hour drawdown time, with no more than ½ of the WQv draining from the facility in the first 8 hours.

Design Criteria – Infiltrating USMS

Pretreatment for infiltrating systems must be certified to achieve 80% TSS removal.

Level Infiltration Bed – The subgrade soil surface shall be level; a stepped or terraced design can be used to locate multiple level infiltration cells on gently sloping areas.

Minimum Infiltration Bed Area – The minimum area of the subsurface infiltration bed (A_{inf}) must exceed 0.05 times the contributing impervious drainage area (A_{imp}): $A_{inf} > 0.05*A_{imp}$

Design Infiltration Rates – Accurately predicting the soil infiltration rate is a key input parameter for estimating WQv drain time and assuring the intended post-construction stormwater performance of infiltrating systems. Procedures to determine appropriate design infiltration rates are outlined in

Section X.XX Determining Design Infiltration Rates for Infiltrating Stormwater Practices [Section Title]

For infiltrating underground stormwater management systems, the WQv must be infiltrated into the subgrade soil within 48 hours. The design infiltration rate of the subgrade soil will be based on field measurements at the appropriate depth and be verified during construction (see section on measurement and verification of subgrade infiltration rate). The infiltration rate shall be based on the final, after-compaction subgrade properties, if compaction is required.

Internal Water Storage (IWS) Depth - For infiltrating systems, the underdrain must be placed above the aggregate-adjusted depth of the WQv. A 6" minimum d_{IWS} for HSG A, B & C soil is recommended, whereas a 3" minimum d_{IWS} is recommended for HSG D.

Aggregate – All aggregate must be clean, double-washed aggregate free from fines (ASTM STD). All aggregate used in storage layers must be uniform, open-graded aggregate of size #1, #2, #4, or #57 (as recommended by manufacturer if applicable). A porosity of 0.40 should be used in calculations.

Hydraulic Disconnection from Utilities – The location and condition of all existing and proposed utilities should be established before an underground system is selected. All conflicting utilities must be relocated outside the underground system, and all utilities and utility trenches must be hydraulically disconnected from the stormwater management system.

Geotextile – The sides of the trench must be lined with a Class I, non-woven geotextile filter fabric to restrict the amount of sediment entering the facility. Geotextile filters should not be used on the bottom of the infiltrating systems to prevent loss of infiltration capacity through clogging or masking of the filter fabric. If additional soil stability is desired it is recommended to use a geo-grid.

Design Considerations

- USMS with structural storage systems may have confined entry limitations per Occupational Safety and Health Administration (OSHA) regulations.
- USMS may not act as sediment basins during construction. Storm water runoff should be diverted from the USMS until site stabilization is complete.
- USMS with structural reservoir space may require buoyancy analysis.

Sample Design Calculations

Infiltration:

$T_d = WQv / (f)(A_{inf})$
Where,
T_d = drawdown time (hr)
WQv = water quality volume (ft^3)
f = infiltration rate of subgrade soil (in/hr)
A_{inf} = area of infiltration bed (ft^2)

Runoff Reduction Volume (RRv):

$RRv = WQv = A_{inf} * d_{WQv}$
Where,
RRv = runoff reduction volume (ft^3)

d_{WQv} = WQv/A_{inf} = depth of the water quality volume (ft) [Not adjusted for porosity]
Subject to the following criteria:
Entire RRv must infiltrate within 48 hours
If the WQv does not fully drain within 48 hr, the RRv is adjusted to include only the depth of water infiltrated in 48 hr (d_{48}):
RRv = A_{inf} * d_{48}
The RRv cannot exceed the WQv.

Construction

For infiltrating systems, care should be taken to minimize compaction and smearing of the bottom and sides of the excavated reservoir. Any smearing or compaction will reduce the infiltration capacity of the practice. Before placement of any aggregate, the excavated bottom of the excavation for infiltrating systems should be scarified to a depth of 3 inches to reduce the effects of smearing.

Construction sequence is key to initial and long-term function of any infiltration practice. Runoff shall not be directed into the infiltration facility until the drainage area is stabilized and all sediment removed.

Maintenance

USMS are generally less visible and more difficult to access than surface-based BMPs. Therefore, regular maintenance and early detection of performance issues are imperative to prevent significant failures.

The SWPPP should outline how and when maintenance will be performed (how, who, when/how often). For the first year of operation, underground systems should be inspected monthly and after each major (> 1") storm event. After the first year, quarterly inspections are recommended, preferably after a storm. Consult manufacturer's guidance for maintenance access, procedures and frequency.

If sediment is not removed mechanically, then great care must be taken not to flush sediments downstream into the receiving waters.

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Detail Drawing/Specs

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RAINWATER AND LAND DEVELOPMENT PROVISIONAL PRACTICE STANDARD #.#

PRETREATMENT

DATE: 4/20/18

Description

Pretreatment practices capture coarse sediments, trash, and debris, and in some cases floatable materials and oil, prior to entry into a primary treatment practice. Pretreatment practices are part of a treatment train. On their own pretreatment practices do not meet Ohio's water quality performance standards; however, the use of properly designed pretreatment:

- limits clogging of the primary treatment practice by trash and large debris,
- protects the primary treatment practice from excessive siltation,
- extends the service life of the primary treatment practice,
- reduces overall maintenance requirements and costs, and
- increases overall pollutant removal.

Pretreatment options for concentrated flow include (1) pretreatment swales, (2) forebays, (3) flow-through treatment devices, and (4) deep sump catch basins/traps. Grass filter strips (5) are recommended pretreatment for sheetflow conditions only.

Condition Where Practice Applies

Pretreatment is recommended for all projects, especially areas with the potential to generate a high volume of trash or sediment, or where the primary treatment practice has limited maintenance access.

The principle threat to infiltration practices and a common reason for their failure is sediment clogging of the permeable soil layer. An effective pretreatment sediment trapping system is an essential part of all infiltration practices.

Many practices such as such as dry Extended Detention Basins (see chapter 2.6) require pretreatment. Underground Stormwater Management Systems require pretreatment that meets TSS removal performance standards (see chapter #.#).

Planning Considerations

Pretreatment practices:

- are NOT stand-alone treatment practices,
- should hydraulically precede one or more primary stormwater management practices, and
- should not export pollutants/sediment through re-suspension and/or flushing.

By nature, pretreatment practices may require more frequent inspections and cleaning than the primary practice. As such, they should be readily accessible for maintenance and cleaning.

If it is necessary to capture fine silts, clays, and dissolved or colloidal pollutants, advanced treatment such as filtration, chemical reactions, or biodegradation should be considered.

Design Criteria – All Practices

Capacity - All pretreatment practices shall safely overflow or bypass flow in excess of the design capacity. An offline configuration is generally recommended. Any overflow or bypass resulting from clogging of the pretreatment practice should not be diverted from the primary treatment practice or treatment train. The effects of tailwater in the receiving practice or outlet on the capacity of the pretreatment practice should be considered.

Maintenance – All Practices

Because of the generally limited sediment storage capacity and limited ability to accumulate trash, inspection of pretreatment practices should be performed quarterly and after every significant (>1") rainfall event.

PRETREATMENT SWALE

Description

Pretreatment swales are shallow, grass-lined earthen channels designed to convey flow while capturing a limited amount of sediment and associated pollutants. A Pretreatment Swale differs from a grass swale for treatment in that the Pretreatment Swale is not designed for a specified hydraulic residence time, but only for a minimum length.

To utilize Runoff Reduction credits, a grass swale must be designed to the criteria in the Grass Swale standard (Runoff Reduction Practice #.#)

Design Criteria – Pretreatment Swale

Capacity - Design the pretreatment swale to discharge the WQf at less than 1 ft/s and at a flow depth of 4" or less.

Stability – Pretreatment swales should be non-erosive for 10-yr, 24-hr event. An energy dissipater and level spreader should be used if the swale receives concentrated flow.

Cross-section Shape – Pretreatment swales shall be trapezoidal in cross-sectional shape with a 4 foot to 8-foot bottom width and minimum side slopes of 3:1. The swale bottom should be flat perpendicular to the direction of flow.

Length – Pretreatment swales receiving all or 90% of their inflow from a single inlet at the top of the swale shall be a minimum of 50 ft. in length. Swales receiving inflow distributed along one or both edges shall be a minimum of 100 ft. long such that the average flow length is 50 ft.

Slope – The maximum longitudinal grade is 4%.

Design Considerations – Pretreatment Swale

See Chapter #.#.

Maintenance – Pretreatment Swale

See Chapter #.#.

FOREBAY

Description

A forebay is an impoundment or basin located at the inlet of the primary treatment practice. A properly designed forebay includes measures to both:

(1) dissipate the energy and prevent scouring from incoming concentrated flow, and

(2) promote initial settling of coarse sediments.

Design Criteria - Forebay

Energy Dissipation – A forebay must include energy dissipation when receiving concentrated flow from a pipe or channel. Energy dissipation can be achieved through a submerged outlet pipe, rock apron or plunge pool.

Settlement Zone – A forebay should include a basin large enough to avoid resuspension of trapped sediment with a minimum depth of 3 ft. The depth of the forebay should gradually decrease towards the forebay's outlet {graphic}. A minimum length to width ratio of 1:1 is recommended to prevent short-circuiting.

Forebay Size – A forebay for a single inflow point should be 10 to 20% of the Water Quality volume. The forebay volume may be divided among multiple outlets with no single forebay less 5% of the normal pool area. Multiple inlets may require total forebay volume in excess of the minimum.

Forebay Outlet – Provide an outlet consisting of a level spreader or submerged level dike. A submerged dike separating the forebay from the main pool should be 6" to 12" below the normal water surface elevation and provide a non-erosive overflow. It should be planted with hardy emergent wetland vegetation. See the wetland extended detention pond section below for more information on planting. The design outlet discharge (q_o) should be equal to the inlet discharge (q_i).

A permanent vertical sediment depth marker should be included to facilitate inspection and cleanout.

Design Considerations - Forebay

To accommodate relatively frequent sediment cleanout, easy equipment access should be provided to the forebay (i.e. gradual slopes and free of obstructions). An access easement is recommended. A concrete or block-mat forebay bottom can facilitate cleanout. If necessary, a drain under the dike may also be included to facilitate maintenance.

Fully vegetated (wetland) forebays are effective in dissipating energy and retaining sediment.

Storage above the permanent pool may be included in the WQv.

Maintenance – Forebay

Construction – Forebay

FLOW-THROUGH TREATMENT DEVICES

Description

Several manufacturers offer a number of proprietary treatment devices that can provide pretreatment of stormwater runoff by settling, vortex flow, and/or filtration to separate trash and coarse and, in some cases, fine sediment before it enters the primary treatment practice. These devices typically treat stormwater as it flows through the practice with no significant storage or extended detention. Flow-Through Treatment Devices are often referred to as Manufactured Treatment Devices and can be classified as:

- Hydrodynamic separators,
- Oil/grit separators,
- Media filters,
- Treatment chambers, or
- Water quality inlets.

Design Criteria – Flow-Through Treatment Devices

Note: Design criteria are provided to assure compliance with post-construction stormwater requirements and sustain the stormwater system function over the long-term. Engineers shall follow design specifications and recommendations provided by the manufacturer(s) of all proprietary pretreatment devices.

Capacity - Devices must be sized for the required efficiency at the appropriate water quality flow (WQf) for the contributing drainage area. Devices must be placed offline or fitted with an internal high-flow bypass. In some cases, flows exceeding the design rate may continue to receive reduced treatment; however, this must be weighed against the risk of resuspension at high flows. An off-line configuration is recommended. The effects of tailwater from the bypass, outlet or primary practice should be evaluated. Hydraulic losses within the system should also be evaluated.

Access – All flow-through treatment devices must have sufficient access for inspection and maintenance. Manholes provided for access should be of sufficient diameter to permit needed access as well as be labeled or identified. All sediment storage zones, filters, cartridges, or removable components must be easy to access.

All pipe joints and other connections must be watertight connections.

Design Considerations – Flow Through Treatment Devices

Underground practices should be designed for the appropriate traffic loading and dead loading at the surface.

Consider clearance and accessibility for maintenance.

Underground practices may not be suitable for locations where spill control is necessary.

Maintenance – Flow-Through Treatment Devices

All flow-through treatment devices must be inspected and maintained in accordance with the manufacturer's instructions and/or recommendations.

DEEP SUMP TRAP OR CATCH BASIN

Description

A deep sump trap or catch basin is an overly deep manhole or vault-like structure designed to intercept trash and debris, as well as collect coarse sediment through limited settling. The sump may receive surface flow from an open grate or curb inlet or be a closed sump within a piped drainage system.

Design Criteria – Deep Sump Trap / Catch Basin

Capacity – Individual deep sump traps / catch basins should not receive more than 1 acre of impervious area runoff.

Outlet - The outlet pipe must be fitted with a "hood" designed to prevent floating materials from exiting the structure.

Sump – The minimum sump depth is 4 ft. or 4 times the outlet pipe diameter, whichever is greater. The inlet should be no more than 6 in. above the outlet pipe invert. The sump volume should be 10% of the WQv for the drainage area of the sump.

Cover – Unless receiving surface flow through a properly designed grate or curb inlet, the sump should be tightly covered to limit mosquito breeding.

Design Considerations – Deep Sump Trap / Catch Basin

Underground practices should be designed for the appropriate traffic loading and dead loading at the surface.

Consider clearance and accessibility for maintenance.

Maintenance – Deep Sump Trap / Catch Basin

PRETREATMENT GRASS FILTER STRIP

Description

Pretreatment grass filter strips are uniform areas of dense turf or meadow grasses with mild slopes that receive diffuse runoff from impervious surfaces. The dense turf within a grass filter strip improves the water quality of sheet flows from developed areas by slowing runoff velocity and causing deposition and filtration of suspended solids. Other pollutant removal mechanisms include nutrient uptake, adsorption and infiltration. Grass filter strips are generally not very effective for treating soluble pollutants.

To utilize Runoff Reduction credits, a grass filter strip must be designed according to the Sheet Flow to Grass Filter Strip or Conservation Area standard (Practice #.#)

Design Criteria – Pretreatment Grass Filter Strip

Filter Area - The filter width (perpendicular to direction of flow) should be equal to the width of the area draining onto it and flat. The minimum flow length (parallel to direction of flow) should be a minimum of 10 feet at slopes steeper than 10:1 (see figure). The flow length on slopes flatter than 10:1 may be as little as 5 ft.

Slope - To avoid concentrating flow, longitudinal slopes of 5:1 to 10:1 are recommended, slope should not be steeper than 4:1.

Grass Establishment – Maintain a dense, turf-forming grass cover at 4 in. to 6 in. in height. Recommend a mixture of climate appropriate grasses (may include: perennial ryegrass, tall fescue, red fescue, Kentucky bluegrass). Filter strips should be protected from vehicle or constant pedestrian traffic through the use of parking blocks and designated walkways. Flow should be diverted from the filter strip until 80% cover is established or an Erosion Control Blanket or matting should be used.

Flow Dispersion – The filter strip must receive only sheetflow from the contributing drainage area. A gravel verge or level spreader should be used at the beginning of the filter strip. Runoff may need to be redistributed where flow is restricted by parking stops/bumpers.

Design Considerations – Pretreatment Grass Filter Strip

See Sheet Flow to Grass Filter Strip or Conservation Area (Chapter #.#)

Construction – Pretreatment Grass Filter Strip

See Sheet Flow to Grass Filter Strip or Conservation Area (Chapter #.#)

Maintenance – Pretreatment Grass Filter Strip

See Sheet Flow to Grass Filter Strip or Conservation Area (Chapter #.#)

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