T-11. Manufactured Treatment Devices (MTDs)

Description

Manufactured Treatment Devices (MTDs) include different proprietary systems and devices using various treatment processes that remove pollutants to varying degrees, depending on their designs and treatment efficiencies, from stormwater runoff. For example, some MTDs are more suitable for pretreatment and gross solids removal, while others incorporate advanced strategies targeting metals, nutrients, and other pollutants to meet desired stormwater quality objectives. Standardized testing protocols and third-party performance verification are provide support with MTD selection to meet treatment objectives at a site.

This fact sheet discusses two types of stormwater MTDs:

- Sedimentation-based MTDs – Sedimentation-based MTDs (or sedimentation MTDs) refer to separation devices. Separation devices include hydrodynamic separation devices or hydrodynamic separators (HDSs). These sedimentation MTDs commonly contain a storage chamber for sediment deposition and a treatment chamber (designed in various configurations such as swirl concentrators, vault systems, or inclined plate separators) to trap trash, sediments, oil, grease, or other pollutants.
- Filtration MTDs: Filtration-based MTDs (or filtration MTDs) refer to filtration devices. Filtration devices generally refer to high-rate filtration systems categorized as either high-rate media filters (HRMFs) or high-rate biofilters (HRBFs). These filtration MTDs contain a sediment collection chamber and a filtering media section (designed with engineered media or vegetation) to remove target pollutants such as nutrients, metals, and bacteria via filtering.

MS4 Permit Applicability (Design-Dependent)	**HDS**	**HRMF**	**HRBF**
Meets Runoff Reduction Standard	No	No	No[3]
Meets WQCV Capture Standard	No	No	No
Meets Pollutant Removal Standard	No[1]	Yes	Yes
Typical Effectiveness for Targeted Pollutants[1,2]			
Sediment/Solids	Medium	High	High
Total Phosphorus	Low	High	High
Total Nitrogen	Low	Low-Medium	Low
Total Metals	Low	High	High
Bacteria	Low	Low-Medium	Low-Medium
Common Applications			
Step 1: Runoff Reduction	No	No	No[3]
Pretreatment (in Treatment Train)	Yes	No	No
Primary Treatment	No	Yes	Yes
WQCV + Flood Control	No	No	No
Cost			
Life-Cycle Costs	Medium	Medium-High	Low

[1] Typical effectiveness for HDSs is based on New Jersey Department of Environmental Protection Technical Acceptance and Reciprocity Partnership (TARP) protocol for performance in a laboratory setting, with testing requirements for specific composition and gradation, average particle size, influent concentration, required inflow rates, and other parameters.

[2] Filtration MTD performance varies based on proprietary media/filter designs and targeted pollutants. "Typical" effectiveness descriptions are based on Washington Ecology's approved treatment technologies based on the Technology Assessment Protocol–Ecology (TAPE) use designation and the International Stormwater BMP Database 2020 Summary Statistics.

[3] The Runoff Reduction Standard is not met with HRBF devices sold as-is. HRBFs can be designed/retrofitted with additional appurtenances, such as extra underdrain pipe(s) or a chamber on the downstream side of the device, which will detain and regulate the release of treated stormwater and allow for infiltration.

Sedimentation-based MTDs

Sedimentation-based MTDs (or sedimentation MTDs) refer to hydrodynamic separators (HDSs) and other separation devices to treat stormwater and target sediment removal via centripetal force coupled with strategically placed components to separate, settle, trap, and retain coarse particulates. The primary target pollutant of sedimentation-based MTDs is suspended sediment.[1] Some systems target sediment exclusively, while others provide trash and debris removal, oil and grease separation, or sediment removal. Collected pollutants are typically directed to and stored in a collection chamber within the device, and treated stormwater is discharged back into the storm drain system.

Sedimentation MTDs Terminology

There are several commonly used terms that are used to define how a sedimentation-based MTD functions, such as swirl concentration, cyclonic separation, vortex separation, and screening. These terms are synonymous, each referencing the process of using centripetal force and/or gravity, coupled with a target velocity, to provide the required centripetal force and hydraulic residence time, respectively, to remove sediment from stormwater. This process has become most widely referred to as hydrodynamic separation, and the MTDs that perform this process are called HDSs.

Some sedimentation MTDs incorporate additional storage to increase residence time and promote gravitational settling in a quiescent environment. However, to meaningfully increase residence time, significant additional storage is usually needed, increasing costs, which is a reason that flow-through HDSs are the most common types of sedimentation MTDs.

Sedimentation MTDs are often constructed as concrete vaults with maintenance access. Concrete vaults typically use swirl concentration, baffles in series, weir plates, or a combination of these sediment removal elements. These MTDs can be manufactured from various materials, such as corrugated metal pipe (CMP) and polyvinyl chloride (PVC) pipe, but precast concrete is most common and generally more durable. These materials (concrete/CMP/plastic) serve as housing for the internal MTD components. As a result, the materials, components, and configurations differ across products and manufacturers.

HDSs are a widespread type of sedimentation MTDs installed in the Front Range of Colorado. Unlike SCMs that detain and release, filter, or infiltrate the WQCV (with some capable of providing full-spectrum detention), stormwater that enters an HDS is treated over a shorter residence time – typically providing a lower level of treatment than storage, filtration, or infiltration SCMs. Therefore, as stand-alone practices, sedimentation-based MTDs generally do not meet the Runoff Reduction, WQCV, or Pollutant Removal Standards[2] in the MS4 Permit. Therefore, these MTDs are most appropriate for a stormwater treatment train system as a pretreatment component. Additionally, many separation devices can remove coarse particulates and buoyant materials like trash and debris; therefore, they can play an essential role in providing pretreatment to reduce maintenance requirements and costs for downgradient SCMs in a treatment train.

[1] Suspended solids are often measured as suspended sediment concentration (SSC), which is similar to total suspended solids (TSS), but typically is a slightly higher concentration due to the inclusion of larger particles as a result of the SSC sampling method. See Gray (2000) for additional information.

[2] As of 2022, HDSs have not met the 30 mg/L effluent Pollutant Reduction Standard when following standard TAPE or TARP laboratory testing protocols.

Components of Sedimentation-based MTDs

The primary components of most HDS include: 1) an inflow pipe that conveys runoff into the device, 2) a "swirl" or treatment chamber that removes pollutants, 3) a storage chamber for removed pollutants, 4) various internal plates or weirs that promote sedimentation, 5) an outlet pipe that conveys treated runoff to the downstream storm drain system, and 6) maintenance hole that provides access to the chambers. These components often are housed in a precast concrete vault or maintenance hole.

PLACEHOLDER FOR FIGURE 1

Figure 1. Typical configurations and components of sedimentation-based MTDs

Component	Description/Intent
Inlet Pipe	To convey runoff into the MTD.
Treatment Chamber	To create hydraulic conditions allowing removal of sediment, trash, debris, and other pollutants (components vary by device). The treatment chamber often has a cylindrical shape to create a vortex as runoff flows through the device. Sediment is removed by gravitational settling, centripetal forces, screens, and weirs.
Storage Chamber	To store pollutants removed from the treatment chamber.
Internal Bypass	To provide an integrated internal bypass mechanism to convey flows that exceed the peak design flow of the system.
Outlet Pipe	To convey runoff out of the MTD.
Maintenance Access Cover	To provide access for inspection and maintenance of chambers via a maintenance access shaft or maintenance access hatch (at grade).

Filtration-based MTDs

Filtration-based MTDs (or filtration MTDs) refer to filtration devices or media filters used to treat stormwater runoff by filtering stormwater through engineered materials, most commonly via engineered media at high infiltration rates. The high-rate media filters are widely installed filtration MTD using media or vegetation to treat and remove specific target pollutants (such as nutrients, metals, and other bacteria) at high infiltration rates. These filtration MTDs are commonly categorized as high-rate media filters (HRMFs) or high-rate biofilters (HRBFs) - depending on the internal media and materials of the filtration system.

HRMFs use one or more media types to remove pollutants from stormwater. Commonly used materials include sand, peat, crushed rock, volcanic rock, granular activated carbon, compost, minerals, granular organic materials, and/or fabrics. Containment of the filter media, the configuration of internal parts, and the hydraulics of HRMFs are proprietary and differ from one HRMFs to another.

HRBFs treat stormwater with bioengineered media (or biofiltration media) that support vegetation. Physical, biological, and chemical processes occur between the media and the plant life of an HRBF. Treatment processes include filtration, transpiration, evaporation, settling, biological, microbiological, and pollutant transformation.

Both HRMFs and HRBFs are well suited to provide permanent treatment in densely developed urban settings, new developments with limited available space, urban retrofits, and large-scale projects compared to traditional bioretention, which may become cost-prohibitive due to the treatment rate of the surface area required to meet desired treatment objectives. Additionally, HRMFs and HRBFs are considered "high-rate" when stormwater can infiltrate through the media faster than the infiltration rate of typical saturated Type A and B soils. Some products have been third-party verified as infiltration rates between 100-200 inches per hour while meeting target treatment performance standards (Washington Ecology 2020). Although HRMFs and HRBFs do not meet the Runoff Reduction Permit Standard, they can be configured as a treatment train with a pipe or downstream storage chamber that enables infiltration of treated stormwater.

Components of Filtration-based MTDs

The primary components of HRMFs and HRBFs include: 1) an inflow pipe that conveys runoff into the MTD, 2) a chamber that contains the various layers of filter media (HRMF/HRBF) to remove pollutants, 3) one or more storage chambers for removed pollutants (HRMFs only), 4) an outlet pipe to convey treated runoff to the downstream storm system or other outfalls, and 5) a means of access to the filter media and storage chambers (maintenance access point). For HRBFs, the filter media layers include shredded hardwood mulch as the top layer, a proprietary biological media mixture, and a granular, well-draining, compactible rock subbase layer to support the media above it and facilitate drainage to the outlet pipe.

PLACEHOLDER FOR FIGURE 2

Figure 1. Typical configurations and components of filtration-based MTDs

Components	Intent
Inlet Pipe	Conveys stormwater into the MTD.
Housing Chamber	Components of HRMFs and HRBFs are housed in concrete vaults, maintenance holes, steel containers, plastic containers, and steel mesh baskets.
Filter Media (HRMF only)	Removes targeted pollutants via filtration through proprietary media and a specific type of filtration process. Media filter and hydraulic configurations vary substantially among devices (e.g., cartridges or other filter units, upflow or downflow).
Bioengineered Filter Media (HRBF only)	Shredded Hardwood Mulch: Removes coarse particulates and other buoyant materials from runoff, helps media retain water for later vegetative use, provides pretreatment for different filter media layers. Bioengineered/Biofiltration Media: Filters and treats stormwater through physical, biological, and chemical processes and biological interaction with vegetation. Decomposes organics reduces heavy metals through adsorption and removes fine particulates and hydrocarbons. Enables biological growth. Granular Rock Subbase: Provides subsurface structural support for components and drainage to the outlet pipe.
Storage Chamber	Provides internal storage for collected pollutants.
Outlet Pipe	Conveys treated stormwater out of the filtration MTD.
Maintenance Access	Access to pollutant storage chambers or media chambers to facilitate inspection and maintenance activities. Enables repairs and part replacements (e.g., replace filter cartridges, wash filters.

Site Considerations for MTDs

MTDs are most applicable in highly developed, space-limited urban areas because they require a nominal area of land at grade. Underground MTDs generally are located beneath parking lots, sidewalks, and low-traffic streets. HRBFs are often situated along sidewalks and curbs.

Consider the following factors when determining if an MTD is suitable for a site:

- **Tributary Area:** As the first step in MTD selection and sizing, characterize the tributary drainage area of the site, land use and imperviousness, pollutant types and sources, and soil erosion characteristics. Use this information to evaluate whether various MTDs can effectively control pollutants at the site. For example, a sedimentation-based MTD is unlikely to provide meaningful treatment for areas where targeted pollutants are fine sediment, nutrients, or dissolved pollutants. Conversely, an appropriately sized and maintained sedimentation-based MTD can serve as an effective pretreatment practice if a site has coarse sediment, trash, and debris.
- **Third-Party Verification for Treatment Objectives:** Review information provided in third-party verification programs to verify whether performance expectations for the MTD meet the treatment needs at the site and MS4 permit design standards. For example, treatment objectives could include pretreatment for a stormwater facility, treatment for targeted pollutants, or specific pollutant removal objectives in critical areas. Treatment capabilities among MTDs vary; therefore, review of third-party performance verification is an essential step in MTD selection.
- **Geotechnical Considerations:** Consult with a geotechnical engineer to determine if soils on a site will provide the necessary bearing capacity for the MTD without settlement over time and identify any soil preparation or backfill requirements needed for a stable foundation and appropriate backfill around the device. If soils are contaminated, and the MTD does not require imported fill to be used as backfill, consider specifying a soil-tight MTD.
- **High Water Table:** Avoid underground MTDs in areas with a shallow water table due to issues with the exfiltration of stormwater to groundwater or groundwater infiltration into the device. Surface-based MTDs are more appropriate in areas with high water tables because they require less depth to install than underground MTDs. MTDs should also be used with caution in areas with contaminated soils. Additional waterproofing may be necessary to prevent the exfiltration of stormwater from the MTD into the contaminated soils or infiltration of contaminated water into the MTD system. In some cases, high groundwater is not anticipated or evaluated during design and before construction. In such cases, waterproofing methods are recommended similar to those used for sanitary maintenance access holes. Buoyancy must continually be assessed and usually results in implementing an anchoring system to resist buoyant forces acting on the MTD.
- **Location and Access:** Evaluate land uses above the MTD to ensure clear and unobstructed access for routine and emergency inspection and maintenance activities. Areas directly above the MTD should be clear of structures, vehicles, and other items that could obstruct access or visual inspection at any time. When feasible, avoid locating maintenance access holes or vaults beneath traffic lanes, so traffic control is not required for routine maintenance activities. When possible, provide signage related to the facility to ensure others do not block maintenance access or use the location as a staging area (for materials or snow storage). Additionally, the MTD will need to be rated for traffic loads if the device is located under a street or parking lot.
- **Parking Structures and Other Structures Built Above MTDs:** Avoid installing MTDs beneath parking structures or other types of buildings. In cases where no alternatives are feasible, local governments should consider additional requirements to ensure adequate maintenance access and operation throughout the MTD's life cycle. Coordination with geotechnical and structural engineers is required to ensure that the device will not interfere with the building foundation, structural support, dewatering

systems, or other utility lines. MTDs installed beneath parking garages or other structures must be accessible at all times (e.g., access maintenance holes cannot be located beneath parking spots, frequent access routes, or storage areas). Parking garages often limit height clearances and do not provide enough vertical clearance for maintenance vehicles to enter and access subsurface MTDs during maintenance operations.

- **Elevation Constraints:** Evaluate elevation constraints. The depth of the MTD and the invert elevations of the inlet and outlet pipes are often dependent on the local storm drain outfall elevation when a site discharges treated stormwater into a public storm drain system. Consider the normal high water elevation when discharging to a stream or river. Verify that the MTD will work with pipes installed at elevations that give enough fall to the public storm drain system or receiving water and that the depth of the device is adequate to provide the necessary treatment and storage volumes. Assess the potential effects of tailwater from the downstream conveyance system. Tailwater effects can impede MTD performance by affecting the hydraulics of the device.
- **Existing Underground Utilities**: For retrofits or projects proposed in developed areas, identify existing underground utilities that may constrain the footprint and depth at which the MTD can be placed.

Organizations with Testing Protocols for MTDs

ASTM – American Society for Testing and Materials is currently developing a national standard for the performance of MTDs. The standard is consistent with the NJDEP TARP protocol and, once published, can be used to evaluate the performance of MTDs.

NJCAT – New Jersey Corporation for Advanced Technology has a Technology Verification Program that specifically encourages collaboration between vendors and users of technology. This program evaluates vendor-specific performance claims.

STEPP –The National Municipal Stormwater Alliance (NMSA) established the National Center for Stormwater Testing and Evaluation for Products and Practices (STEPP) to promote development of a national testing and verification program for manufactured products as well as public domain practices in the stormwater sector. STEPP will provide a program for third-party testing and verification of pretreatment MTDs, primary treatment MTDs, and traditional surface-based SCMs that will be a useful reference for designers and reviewers once the program is launched.

TAPE – Technology Assessment Protocol–Ecology is the stormwater quality treatment certification program implemented by the Washington State Department of Ecology for evaluating the performance of emerging technologies to treat polluted stormwater.

TARP – Technology Acceptance Reciprocity Partnership is the stormwater treatment certification protocol required by New Jersey Department of Environmental Protection (NJDEP) to certify the level of treatment performance of manufactured stormwater treatment products.

Community Values

The primary benefit of underground MTDs to the surrounding community is maximizing the amount of surface space dedicated to other uses that may be needed in dense urban environments, including plazas, parking areas, and other services that benefit the community.

To avoid creating a nuisance from mosquitos or odors, perform regular maintenance and treat standing water in sedimentation MTDs using larvicides to control mosquitos in the summer months.

In the case of HRBFs, which include a limited vegetated surface area, native plants or trees are a component of many HRBFs, which can serve as an aesthetic amenity in urban areas while still having a relatively small surface footprint.

Maintenance

Maintenance requirements are a fundamental consideration when specifying an MTD. Proper routine maintenance is critical for the adequate function of the MTD. Before MTD selection, obtain and review manufacturer's maintenance guidance, including inspection methods, maintenance frequency, equipment, maintenance methods, and cost. Also, consider confined space entry requirements, availability of maintenance contractors, materials replacement cost/frequency, and sediment disposal requirements. Maintenance requirements can vary significantly depending on the specific MTD.

Additionally, actual maintenance frequencies may be more (or less) frequent, depending on site conditions. Therefore, an operations and maintenance plan is needed for each installation. As part of the MTD selection process, request estimates of life cycle costs for MTDs under consideration from the manufacturer.

Most sedimentation MTDs require a vacuum truck with a hose that will extend to the storage chamber. This can be used to remove most trash and debris in addition to sediment. In some MTDs, trash, litter, and debris may be stored in a separate compartment from accumulated sediment, and access may be through a different maintenance hole or hatch. Confined space entry access may be necessary.

For sedimentation-based MTDs that act as traps for trash, debris, and sediment, the need for maintenance is indicated by sediment accumulation, with triggers for maintenance typically specified by the manufacturer. Frequency of maintenance is ultimately a function of available storage capacity, pollutant loading rates for the tributary watershed, and the removal efficiency of the treatment devices.

HRMF maintenance focuses on its filter media and filter configuration; therefore, each HRMF has a unique set of maintenance requirements based on media type and the unit's hydraulics. Typical maintenance involves cleaning the filter media or replacing it with new media. The former usually involves thoroughly rinsing the filter media with clean water and removing any collected pollutants. When maintenance requires the replacement of filters or a component of the filter, the manufacturer's instructions should provide clear information on methods, costs, and expected frequencies.

Maintaining HRBFs typically requires routine replacement of the shredded mulch on the top layer of the MTD and removal of trash and debris that has accumulated on top of the mulch or against the inlet trash rack or grate. Over time, sediment will clog the mulch layer and inhibit stormwater from flowing through the underlying media layer as intended. The shredded hardwood mulch specified by the manufacturer should be used exclusively when replacing the mulch layer. The biofilter media below the mulch layer and the plants or trees are typically self-preserving with a low media replacement frequency (e.g., ten years). Proper irrigation of HRBFs is necessary; therefore, water availability for irrigation is an essential consideration for HRBF selection.

Maintenance Considerations During MTD Selection

To avoid selection for MTDs with onerous maintenance requirements, consider the following maintenance practices:

- Review manufacturer's maintenance guide to determine the frequency and types of maintenance activities required. The guidance should clearly describe how to inspect and maintain the device, triggers for maintenance, and methods for measuring accumulated pollutants to determine when maintenance is needed.
- MTD collection chambers must be accessible by maintenance equipment, and unimpeded by internal weirs and baffles. MTDs that allow visual observation of collected pollutants are easier to inspect and maintain than devices that do not provide visual indicators.
- Assess how much time it will take to inspect and maintain the MTD and whether the time requirement is a reasonable expectation for the entity responsible for maintenance.
- Avoid MTDs that require confined space entry for routine maintenance activities. Be aware of confined space entry requirements for clearing out clogged orifices, pipes, and weirs that will likely be required under certain conditions for underground MTDs.
- Identify and review documents, forms, and tools needed for inspection and maintenance. These may include an inspection and maintenance plan, inspection forms, required personal protective equipment, and equipment necessary for maintaining the MTD.
- For HDSs, identify how a vacuum truck will access the different chambers of the MTD and ensure that standard suction hose lengths can reach the bottom of the vault of the maintenance hole. MTD designs should allow easy access with the suction hose to maneuver the vacuum suction hose to extend to the bottom and the full extent of each device's chamber.
- Salts from deicing contribute to the deterioration of concrete and other materials in sedimentation-based MTDs. Therefore, for installations where deicing activities regularly occur during the winter, plan on a few additional inspection and maintenance visits during winter to rinse accumulated salts out of the device with a hose.Salt may also affect plant growth in HRBFs.

When evaluating MTDs, it is also essential to identify the pollutants targeted for treatment and the overall treatment efficiency for those pollutants, along with the maintenance frequency needed to maintain performance. The amount of collected pollutants serve as a primary indicator for the maintenance of most MTDs. However, frequency of maintenance is ultimately a function of available storage capacity and pollutant loading rates characteristic of the tributary basin. Lack of storage capacity can measurably reduce treatment efficiency. Since storage capacities vary widely among the many available sedimentation-based MTDs today, functional storage is critical when selecting MTDs.

Typical Benefits and Limitations of Different MTD Types

Characteristic	HDS	HRMF	HRBF
Removes trash, debris, and other buoyant materials and stores material below ground (out of sight).	Yes	Yes	No
Depending on the product, it may include processes to remove oil and grease.	Yes	Yes	Yes
Effective pretreatment for primary treatment SCMs and detention facilities.	Yes	No	No
Effective treatment at high surface loading rates with a small footprint. Suitable for constrained sites in highly urbanized areas (space-efficient).	Yes	Yes	Yes
Delivered as one package for assembly and installation	Yes	Yes	Yes
Provides vegetated features in urban areas.	No	No	Yes
Allows other uses of surface area due to underground installations.	Yes	Yes	No
Meets one or more MS4 Permit design standards. (Effective for stand-alone treatment of stormwater.)	No	Yes	Yes
Depending on the product and its media design, it may remove fine particles, targeted metals, or phosphorus.	No	Yes	Yes
Potential for resuspension of captured pollutants.	Yes	No	No
Maintenance needs are visible on the surface.	No	No	Yes

Design Procedure and Guidance

Design procedures and criteria are specific to the type of MTD selected and must follow the manufacturer's design and specification procedure. Most sedimentation and filtration MTDs are sized based on discharges; however, some can be sized based on flow rate and volume. The general steps for sizing and specification based on flow rate are described below as general guidance, recognizing that some variation in the procedure may be required for various MTDs.

There are a few ways to size sedimentation MTDs depending on desired treatment objectives, whether the MTD is flow-through or storage-based, or other site-specific constraints or factors. For consistency of sizing SCMs within the region, minimum discharge of flow-based MTDs is recommended to be sized based on a design discharge that corresponds to the water quality event (WQE). The WQE represents the rainfall depth equal to the 80th percentile runoff producing storm event within the region. See the Runoff chapter in Volume 1 for guidance on calculating the discharge associated with the water quality.[3] Other design storms also must be considered, up to and including the 100-year event, to design a bypass and evaluate the effects of surcharged conditions on the retention of pollutants.

1. **Calculate water quality event (WQE) discharge, Q_{WQ}:** Sedimentation MTDs and filtration MTDs are typically sized based on design flowrates. Therefore, the water quality discharge (Q_{WQ}) is the peak discharge associated with the 80^{th} percentile runoff event, corresponding to a storm depth of 0.6 inches. Since sedimentation-based and filtration-based MTDs typically serve small, highly impervious drainage areas (time of concentration is typically 15 minutes or less), apply the Rational Method to calculate the water quality discharge:

$$Q_{WQ} = C \cdot I \cdot A$$

   Where:

   Q_{WQ} = water quality peak flow rate (cubic feet per second [cfs])
   C = runoff coefficient for tributary drainage area; see Runoff chapter
   I = design rainfall intensity for water quality event (inches/hour)
   A = tributary area draining to stormwater control measure (acres)

2. **Determine the maximum treatment flow rate, Q_{MAX}:** The maximum treatment flow rate is the highest flow conveyed through all MTD treatment components without an excessive scouring of accumulated sediment while attaining the manufacturer's TSS removal rate and maintenance intervals.

   The manufacturer specifies the maximum treatment flow rate for a given type and size of a specific sedimentation-based MTD for separation devices. The performance standard for removal efficiency of TSS is 50% for a particle size distribution having a d_{50} of 75 microns based on a weighted, cumulative average of the percent of pollutants removed at flow rates through the device at 25%, 50%, 75%, 100% and 125% of a device's Q_{MAX} (NJCAT 2013). All the products on the "Laboratory Verified and NJDEP Certified" list have been verified as achieving this standard.

[3] If storage-based sedimentation-based MTDs are selected, size them to provide the WQCV in accordance with extended detention basin criteria. Storage-based MTDs are not discussed further in this fact sheet.

3. **Identify potentially appropriate MTDs:** To select an appropriately sized MTD, compare the calculated water quality discharge (Q_{WQ}) with the maximum treatment flow rate (Q_{MAX}). The MTD is acceptable for further consideration if Q_{MAX} is greater than or equal to Q_{WQ}.

   Because various MTDs will meet the water quality discharge requirements for a given site, the designer should then consider which devices are best suited to site characteristics, the pollutants targeted at the site, and the ability to meet MS4 permit design standards. Ideally, performance claims should be verified through established testing protocols, including based third-party verification programs (see Blue Box).

Verifying Performance When Selecting an MTD

MHFD does not have a technology verification program or maintain a list of "approved" MTDs. Instead, designers should utilize information available through other state and national verification programs to support MTD selection. National verification programs such as STEPP, supported by new ASTM standards, are under development as of publication of this fact sheet and may be appropriate for use in the future. Two existing well-established programs that can be used to support MTD selection are described below. Ultimately, it is the responsibility of the design engineer, not the manufacturer, to ensure that the specified MTD will meet the water quality requirements for a given project.

NJDEP for Sedimentation-based MTDs

Sedimentation-based MTDs on the "Stormwater Technologies: Laboratory Verified and NJDEP Certified" list on the NJDEP's website (http://www.njcat.org/verification-process/technology-verification-database.html) are verified to provide levels of treatment that are suitable for pretreatment of runoff. If a product claims to be "NJCAT-verified" but is not on the list referenced above, it is not an acceptable pretreatment device. This is because NJCAT "verification" is not synonymous with TARP "certification" through NJDEP. A product can receive verification from NJCAT for any performance criterion it can demonstrate it meets; however, the performance criterion for which it receives verification may not meet the performance standards in the TARP protocol required by NJDEP (and likely does not meet them).

More than a dozen sedimentation-based MTDs on the NJDEP list are verified to meet the performance standards outlined in the TARP program; however, not all offer internal bypass capability. Most devices target TSS, but not trash, and many, but not all, can remove oil and grease using absorbent pads. Storage capacities vary widely between the different devices, as do maximum treatment flow rates necessary to meet the pollutant removal standard for a given device size.

TAPE for Filtration-based MTDS and Other MTDs

The Technology Assessment Protocol – Ecology (TAPE) is the program implemented by Washington State Ecology for reviewing and certifying proprietary MTDs. The agency's website (https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies#tape) categorizes proprietary products approved for use in Washington State based the level of use each product has been approved for, and the type of treatment each product provides, in accordance with the TAPE program.

Sedimentation MTDs suitable for pretreatment, but not expected to meet Colorado's MS4 performance standard for 30 mg/L TSS, include those with a GULD for Pretreatment on TAPE's website.

Filtration MTDs expected to meet Colorado's MS4 performance standard for 30 mg/L TSS include those with a General Use Level Designation (GULD) for Basic, Enhanced, or Phosphorus treatment categories.

4. **Evaluate inflow and outflow pipes configurations:** Allowable pipe configurations vary widely between products, and designers must understand vertical and horizontal pipe placement constraints. The angle between the inlet and outlet pipe, often dictated by the proposed storm drain system layout, is crucial for sedimentation MTDs to function as intended. The design engineer must understand the manufacturer's allowable pipe layouts and entrance/exit locations, any pipe orientation or angle constraints, and horizontal and vertical placement requirements for the MTD. Some sedimentation-based MTDs accommodate multiple inlet pipes, while others only allow one inlet and one outlet pipe. Some devices require a 180-degree angle between the inlet and outlet pipes, while others allow for variable angles and multiple inlet pipes. During design, check that inflow and outflow elevations are appropriate for the MTD being specified and within the design flow recommendations from the manufacturer. Some types of sedimentation-based MTDs are susceptible to inlet and outlet elevations, and a difference of an inch can influence whether the MTD functions as intended or not.

5. **Evaluate internal flow components:** Internal flow components in a sedimentation-based MTD facilitate sedimentation and retain captured pollutants despite the short hydraulic residence times of runoff in these types of devices. Internal flow components may include baffles, weirs, deflection plates, screens, and other features and are typically standard features designed by the manufacturer rather than the design engineer. Therefore, the designer should evaluate the ability of internal flow components to control targeted pollutants, ease of maintenance, and durability when comparing different MTD alternatives.

6. **Assess storage chamber size and access and size:** Most sedimentation-based MTDs have a separate chamber or sump area that stores collected pollutants. The storage chamber is designed to retain sediment, litter, and debris removed in the treatment chamber and minimize the potential for resuspension. Consider the sediment, trash, and debris loads from the contributing drainage area, and select a device with sufficient storage to limit routine maintenance to once or twice per year. An undersized storage chamber leads to nuisance conditions and frequent maintenance. Provide a direct access line from street level to the storage chamber for inspection and maintenance.

7. **Specify selected MTD.** The remaining design steps for the specified MTD can be completed once the MTD has been selected based on the process and considerations above.

8. **Size the internal bypass:** An internal bypass is built into some sedimentation-based MTDs to divert flows that exceed the water quality event discharge and is conveyed around the treatment and storage chambers to prevent resuspension of pollutants. It is called an "internal bypass" because the pipe or weir that bypasses the larger flows is typically incorporated as a component of the MTD. Internal bypasses generally tend to be less expensive than an external bypass, which requires additional maintenance holes and more pipe. Internal bypass configurations vary widely between devices, and the layout of the bypass must be compatible with the storm drain system's upstream and downstream elevations and hydraulics. Size the internal bypass peak flow rate for the maximum design flows expected in the upstream and downstream storm drains. An external bypass is required if a sedimentation-based MTD does not have an internal bypass.

9. **Compute the Hydraulic Grade Line (HGL) and Energy Grade Line (EGL):** Compute the HGL and EGL for the MTD and the upstream and downstream storm drain system. Refer to the procedures and criteria in the Streets, Inlets, and Storm Drains chapter of Volume 1. The bypass should be

designed to avoid pressurized flow and prevent resuspension of accumulated pollutants. When backwater conditions are present, account for high tailwater when evaluating the hydraulics of the MTD and bypass, and verify that the device will operate as intended (some MTDs require a specific range of velocities within the treatment chamber to create unique hydraulic effects to remove sediment).

10. **Plan access to all chambers:** Access chamber configurations vary between products. Direct, unobstructed access to all compartments of a sedimentation-based MTD is required for maintenance operations and repair.

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