Volume 3, Chapter 4- Treatment BMPs

Users' Guidance:

If a UDFCD *Section* number in this chapter is **skipped**:
It was adopted as is; please refer to that Section in the **corresponding** **UDFCD Manual**, Volume, Chapter and *Section.*

If a UDFCD *Section* number in this chapter is **amended** **or a new COFC *Section* in this Chapter** **is added**:
It is **listed below**; please refer to it in **this document**.

If a UDFCD *Section* in this chapter is **deleted** **then** it was **not** adopted by the City of Fort Collins; The deleted UDFCD *Section* number will be **identified as deleted in the text below**.

(1) *Fact Sheet T-5* is adopted with the following modification:

All references to "Excess Urban Runoff Volume or (EURV)" and "Full Spectrum Detention" are deleted.

(2) *Figure EDB-3* is adopted with the following modification:

"Micropool" Depth = 0

(3) *Table EDB-4* is adopted with the following modification:

All references to "Micropools" are deleted.

(4) *Fact Sheet T-7* is adopted with the following modification:

All references to "Retention Pond" are replaced with the term "Wet Pond".

(5) *Fact Sheet T-11* is amended to read in its entirety as follows:

Description

Underground stormwater BMPs include proprietary and non-proprietary devices installed below ground that provide stormwater quality treatment via sedimentation, screening, filtration, hydrodynamic separation, and other physical and chemical processes. Conceptually, underground BMPs can be categorized based on their fundamental treatment approach and dominant unit processes. Some underground BMPs combine multiple unit processes to act as a treatment train.
Historically, underground stormwater quality treatment devices have not been recommended based on City policies and criteria. This is due to several factors including problems with unmaintained or poorly maintained devices, remobilization by wash-out (scour) of accumulated pollutants during larger events, lack of performance data for underground devices in the region, and other issues discussed in this Fact Sheet. While

underground flood-control detention is still discouraged, this section provides criteria for determining when the use of underground BMPs may be considered for water quality. When surface BMPs are found to be infeasible, underground BMPs may be the only available strategy for satisfying regulatory water quality requirements, especially in highly built-up urban areas where water quality measures must be implemented as a part of a retrofit to meet regulatory requirements.

Underground BMPs should not be considered for standalone treatment when surface-based BMPs are practicable. For most areas of new urban development or significant redevelopment, it is feasible and desirable to provide the required WQCV on the surface. It is incumbent on the design engineer to demonstrate that surface-based BMPs such as permeable pavements, rain gardens, extended detention basins and others have been thoroughly evaluated and found to be infeasible before an underground system is proposed. Surface-based BMPs provide numerous environmental benefits including infiltration, evapotranspiration, groundwater recharge, aquatic habitat, mitigation of "heat island effect", and other benefits associated with vegetation for those that are planted. Additionally surface-based BMPs are much easier to monitor and maintain.

Site Selection

The most common sites for underground BMPs are "ultra urban" environments with significant space constraints. These could include downtown lot-line-to-lot-line development projects, transportation corridors, or small (less than 0.5 acre) redevelopment sites in urban areas. Important site features that must be considered include the following:

Depth to Groundwater: Due to the potentially large displacement caused by an underground vault, if there is seasonally high groundwater, buoyancy can be a problem. Vaults can be sealed to prevent infiltration of groundwater into the underground system and these systems can be anchored to resist uplift. If seasonally high groundwater is expected near the bottom of an underground system, the engineer should evaluate the potential for infiltration of groundwater and uplift forces and adjust the design accordingly.

Proximity to Public Spaces: As material accumulates in an underground system, there is potential for anoxic conditions and associated odor problems.

Gravity versus Pumped Discharge: The ability to drain to the receiving storm drainage system via gravity is an important consideration. In the city of Fort Collins a gravity outfall system is required for all underground BMPs.

Access: Equipment must be able to access all portions of the underground BMP, typically at multiple locations, to perform maintenance. As the size of the underground system increases, so must the number of access points.

Traffic Loading: Due to space constraints, in some situations, underground BMPs may be located in a right-of-way or other location where there may be traffic loadings. Many underground BMPs are or can be constructed for HS-20 traffic loading. Take additional measures when necessary to ensure that the BMP is designed for the anticipated loading.

Potential for Flooding of Adjacent Structures or Property: For underground BMPs, it is important that the hydraulic grade line be analyzed to evaluate the potential for backwater in the storm sewer system. In addition, some types of underground BMPs, such as catch basin inserts, have the potential to clog and cause flooding if not frequently maintained.

Designing for Maintenance

All underground BMPs must be sized so that routine maintenance is not required more than once per year. The only exception to this is inlet inserts which may need to be cleaned as frequently as following each runoff producing event. **Because underground BMPs are generally less visible and more difficult to access than surface-based BMPs, regular maintenance and early detection of performance issues can be a challenge.**

When developing a design for an underground BMP, the engineer should ensure that all portions of the underground facility can be accessed with maintenance equipment. For multi-chambered systems, access should be provided to each chamber, and openings should be of sufficient size to accommodate the equipment recommended by the manufacturer or designer for maintenance.

Underground BMPs are generally considered confined spaces and OSHA confined space training typically will be required if a person must enter the underground BMP to perform maintenance. In all cases, a maintenance plan should be developed at the time that the underground BMP is designed. The maintenance plan should specify, at a minimum, quarterly inspections with maintenance performed as needed based on inspections. The required inspection frequency may be reduced to biannually if, after two or more years, the quarterly regimen demonstrates that this will provide adequate maintenance. Owners of underground BMPs must provide written inspection and maintenance documentation to the City to ensure that required inspection and maintenance activities are taking place. All maintenance records must be kept on file by the owner and must be provided to the City promptly upon request. Owner must demonstrate that maintenance activities are occurring on an annual basis or on other frequencies as specifically required.

Design Procedure and Criteria

Two primary options are available for underground BMPs:

1. Underground BMPs Based on a Surface BMP design: BMPs that satisfy the requirements for capture and slow release of the WQCV and that are based on and designed in substantial conformance with the criteria for surface-based BMPs described in this Manual.

2. Underground Proprietary BMPs: Proprietary BMPs that satisfy the requirements for capture and slow release of the WQCV. The owner needs to demonstrate that the BMP will at a minimum treat the design storms flow rates and volumes as stated in this Manual as well as the slow release of the WQCV and provide a level of treatment for targeted pollutants that is comparable to that of the surface-based BMPs provided in this Manual.

1. Underground BMPs Based on a Surface BMP Design

This class of underground BMP includes sand filter basins and retention facilities designed for below grade installation. The design must provide the WQCV and empty it over a time period of 12 hours or more. Not all of the surface-based BMPs that provide the WQCV can be adapted for underground use. For example, the vegetative components

of a constructed wetland pond render it unsuitable for underground use. Underground extended detention basins are also problematic due to historical problems with remobilization of collected sediment. The most commonly used underground BMP to date in the City is the underground sand filter.
In addition to the criteria for an above ground sand filter, underground sand filters should meet the following criteria:

a) A pretreatment chamber for removal of coarse sediments with a volume equivalent to 0.10 times the WQCV should be provided. The pretreatment chamber must be separated from the underground BMP sand filter chamber by baffles, and serves as the sediment forebay to reduce the frequency of maintenance required in sand filter. Also consider incorporating a vertical baffle to trap oil and grease. This can be easily incorporated into the forebay and should be included where oil and grease are target constituents. Absorbent mats or booms could also be used for this purpose.

b) For flows in excess of the water quality design event, a diversion must be sized so that excess flows bypass the sand filter chamber and the sand filter is not surcharged (in terms of depth or hydraulic grade line) beyond the WQCV maximum elevation.

c) Maintenance access must be provided to each chamber. Access must be sufficient to allow complete removal and replacement of the filter material. Allow for at least 6 feet of headroom (from the surface of the filter) to facilitate maintenance. All areas need to be designed to facilitate human access.

2. Underground Proprietary BMPs

In some situations, the use of an underground manufactured or proprietary BMP may be the only practicable solution due to site or engineering constraints. In such cases the use of a proprietary BMP may be appropriate. There are numerous proprietary BMPs with wide variability in performance, design flow rates, unit processes, and volume of storage provided (if any). Sizing methodologies for proprietary devices vary from device to device—some are flow based, some are volume based, some consider surface/filter hydraulic loading, etc. As a result, this Manual does not seek to provide a one-size-fits-all sizing methodology for proprietary BMPs. Instead, this Manual provides criteria for determining what type of proprietary BMP should be used and whether a specific proprietary BMP is acceptable for use.

Once it has been determined that use of this BMP category is warranted due to site or engineering constraints, the proprietary BMP must meet the following requirements:

a) Technology Verification: The proprietary BMP must be verified for use by a nationally recognized technology verification program.
For the two main categories of proprietary BMPs, these programs are:

For hydrodynamic separators:

The New Jersey Corporation for Advanced Technology (NJCAT) Technology Verification Program (http://www.njcat.org/verification/protocol.cfm) Tier II (Field Testing) verification is required.

For filters or other technologies receiving standalone treatment designation:

The NJCAT Tier II (Field Testing) verification or completion and approval by the Washington State Department of Ecology (2002) TAPE protocol and General Use Level Designation for TSS are required. Reference: Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol – Ecology (TAPE), October 2002 (Revised June 2004), Publication Number 02-10-037. (http://www.ecy.wa.gov/biblio/0210037.html).

Verification by both programs is preferred. If the specific design flow rates for the filters differ, then the most conservative flow rate should be used since sediment loads within the Fort Collins region tend to be fine.

To receive an approval for use by the City, the manufacturer must also provide final verification statements for the technology in consideration.

b) Performance Standards:

Once accepted for use, the sizing of the BMP must be done in accordance with the verification and also achieve the treatment level required by the City. In general, the proprietary BMP approved for standalone treatment should be capable, on an annual basis, of producing an effluent quality with a median TSS concentration of no more than thirty (30) mg/L, Event Mean Concentration (EMC), for the WQCV within a twelve (12) hour drawdown time for influent TSS concentrations of one hundred forty (140) mg/l or less. This level of treatment is comparable to the long-term effluent median concentrations from the International Stormwater BMP Database for surface-based BMPs. For influent TSS concentrations of one hundred forty (140) mg/l or more an eighty (80) percent load removal rate by the proprietary BMP is required.

Depending on long-term median effluent concentrations and whether or not the BMP provides the required WQCV, a proprietary underground BMP will fall into one of three categories:

1. Not recommended: This category is for underground BMPs that have not demonstrated the ability to capture the required WQCV or meet the performance expectation of thirty (30) mg/l TSS effluent for influent TSS concentrations that are less than one forty (140) mg/l or an eighty (80) percent removal rate for influent TSS concentrations of one forty (140) mg/l or more. Even for underground BMPs that meet these conditions, these are not recommended if they are deemed by the City to be too difficult and, or too expensive to maintain compared to a surface BMP alternative. The City is the final determining authority regarding whether these are considered too difficult or too expensive to maintain over the long term.

2. Pretreatment: This category is for underground BMPs that generally provide little, if any, surcharge storage WQCV. BMPs in this category may be useful as an initial step in a treatment train approach to water quality. A BMP meeting these criteria could be used in conjunction with a downstream BMP that provides slow release of the WQCV. For pretreatment applications, verification programs remain the same however since the volume storage and fine fraction of the TSS are addressed through separate unit processes, the primary design criteria are that the BMP be sized to meet the peak hydraulic flow association with the entire treatment train.
To avoid washout, the peak treatment flow will be the same as verified by NJCAT associated with the eighty (80) percent removal rate of the NJCAT PSD. Flows in excess of the water quality design event Flows in excess of the water quality design event need to be bypassed to avoid re-suspension and washout of accumulated sediments.

3. Standalone: This category is for underground BMPs that demonstrate the ability to meet the performance expectation of thirty (30) mg/l TSS EMC effluent for influent concentrations that are less than one hundred forty (140) mg/l or an eighty (80) percent removal rate for influent TSS concentrations of one hundred forty (140) mg/l or more. "Standalone" devices must be designed to provide for the release of the WQCV in no less than twelve (12) hours. Furthermore, this category of BMP can only be used where it is determined that surface BMPs are not feasible.
In some situations such as in highly urbanized areas with existing infrastructure, right of way issues, achieving this level of treatment for the entire WQCV using a twelve (12) hour drawdown period may not be practicable. In such cases the design of the proprietary BMP must be done to the Maximum Extent Practicable (MEP).

The MEP design approach for underground manufactured BMPs will only be allowed when this is the only practicable alternative available to achieve any level of water quality treatment. In such cases, the design engineer must present sufficient information to:

- Gain acceptance of a specific proprietary BMP, using the verifications described above
- Demonstrate that due to site and engineering constraints that this approach is the most viable solution
- Demonstrate that the technology is sized and designed in accordance with the applicable verification
- Show that the MEP approach was used to approach to the maximum extent practicable the treatment levels and volumetric goals required above.

See Figure UG-1 for typical underground BMPs that may fall into each category. The City does not maintain a list of specific devices that fall into each of these categories. It is the responsibility of the designer to identify the appropriate category for the BMP based on whether the required treatment level can be provided in the underground BMP. The City, reserves the right to prohibit altogether the use of underground BMPs, proprietary or not. In addition, the City may require the presentation of the proprietary underground BMPs' performance and maintenance records, in locations where they have been previously installed, and more particularly in areas with climatic conditions similar to the Colorado Front Range area. Additionally, the City may require agreements that run in perpetuity attached to the property served by the BMPs, assuring that they will be inspected and maintained by the owner as required by the City (or recommended by the manufacturer).
Finally, a standard operating procedures manual must be submitted and approved by the City for all underground facilities. A final copy of the approved Standard Operating Procedures manual must be provided to the City and must be maintained on-site by the entity responsible for the facility maintenance. Annual reports must be prepared and submitted to the City discussing the frequency and results of the maintenance program.

Construction Considerations

Improper installation will cause poor performance of proprietary underground BMPs. This problem has been noted not only by manufacturers, but also by a number of Colorado municipalities who have observed that the "as built" BMPs often vary

significantly from the design. Most underground BMPs already face challenges due to limited vertical fall and because of head losses, so they may be sensitive to slight changes in elevation. In addition, many of the proprietary underground BMPs require assembly of special baffling or patented inserts that may not be familiar to contractors.
For these reasons, it is important to discuss the installation of the underground BMP with the manufacturer prior to selecting a contractor so that the installation requirements are clearly understood. Construction observation by the design engineer, and, if possible, a manufacturer's representative is essential for proper installation. At a minimum, the installation must be inspected by the manufacturer's representative once completed. Any deficiencies of the installation identified by the manufacturer's representative inspection must be immediately corrected.

(6) *Table UG-1* is deleted.

(7) *Fact Sheet T-12* is adopted with the following modification:

All references to "Micropools", "EURV"and "Full Spectrum Detention" are deleted.

(8) *Table OS*-4 is adopted with the following modification:

All references to *Figure OS-2* and *Figure OS-7* are deleted

(9) *Figure OS-2* is deleted in its entirety.

(10) *Figure OS-3* is adopted with the following modification:

All references to "Permanent Water Surface Elevation (WSE)" are deleted.

(11) *Figure OS-4* is adopted with the following modification:

Add Note: Lowest opening must be set at the invert of the pond.

(12) *Figure OS-5* is adopted with the following modification:

All references to "Micropools" are deleted.

(13) *Figure OS-6* is adopted with the following modification:

All references to "Micropools" are deleted.

(14) *Figure OS-7* is deleted in its entirety.

(15) *Figure OS-8* is adopted with the following modification:

All references to "Micropools" are deleted.

(16) *Figure OS-9* is added.

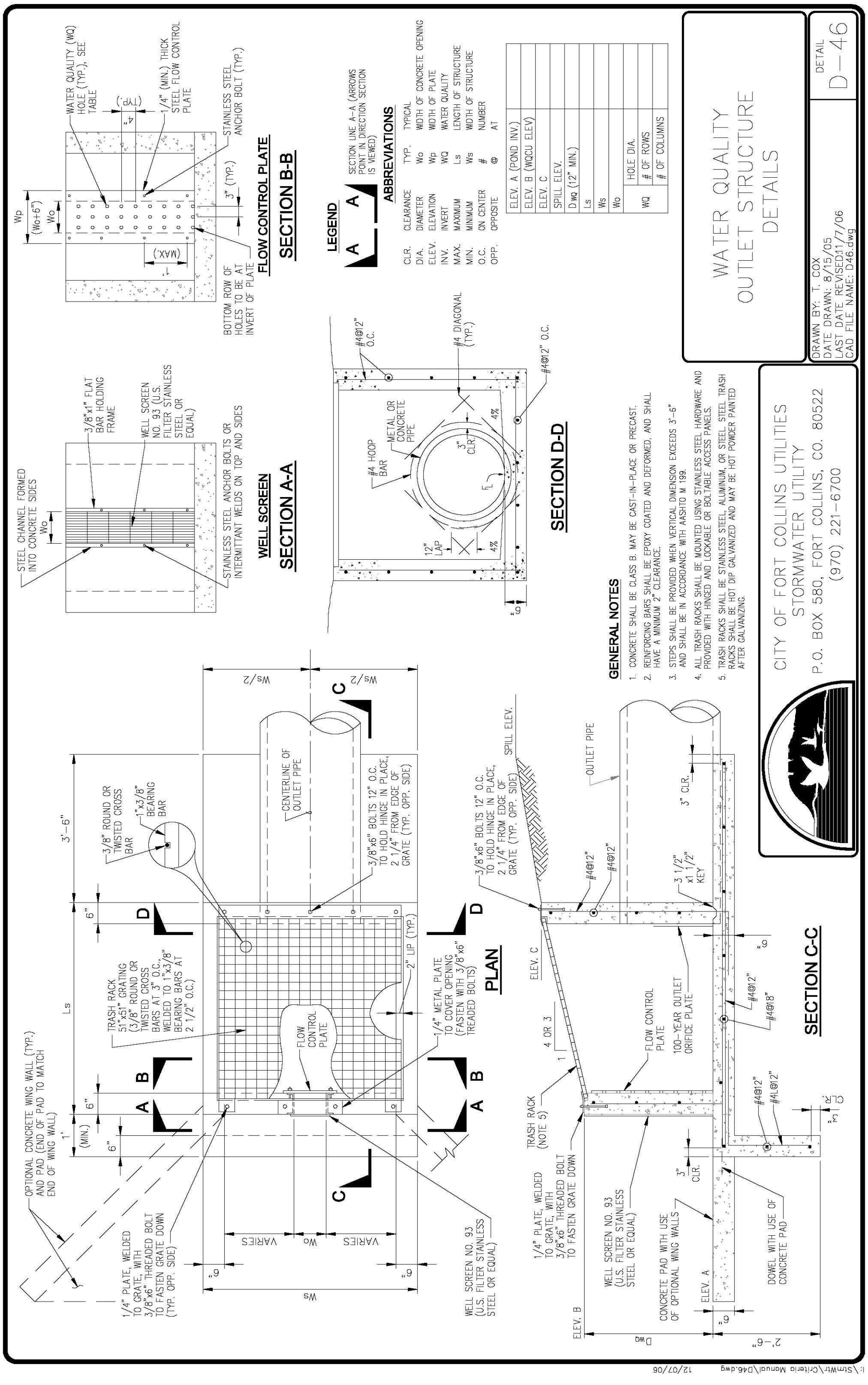

Figure OS-9, City of Fort Collins Water Quality Outlet Structure Details