Technical Design Guide – Stormwater Cartridge Filters

This Technical Design Guide summarises the general requirements for the design of cartridge filters where the treatment system is incorporated within an On-Site Detention (OSD) system. This is a technical document intended to assist developers and engineers.

Revision	Summary	Date
A	Design Guide for Stormwater Cartridge Filters	December 2021

Application

For developments where cartridge filters are proposed as part of the WSUD strategy, Council requires specific arrangements which are detailed in this document.

The design of the treatment system chamber within the OSD system is complex and may vary from one site to another. This technical guide provides general information for designers; however, Council may request for a specific design considering site-specific conditions, as necessary. This is a general guide and should be read in conjunction with other site-specific information provided by Council. Designers shall contact Council if the information provided in this document needs to be revised.

Summary

Water Sensitive Urban Design (WSUD) strategies should consider a range of measures to reduce the volume of stormwater including rainwater tanks, raingardens and/or other constructed ecologies which can detain, retain and reuse stormwater. Council recognises that further treatment by proprietary stormwater quality improvement devices may be also required to achieve water quality targets.

Cartridge filters are designed to improve stormwater runoff quality. The system will reduce pollution in urban waterways by treating the polluted runoff reaching receiving environments and by providing a primary filtration that improves the quality of water leaving the system.

When cartridge filters are proposed in an OSD system, Council prefers the OSD system to be designed based on the 4th Edition of the Upper Parramatta River Catchment Trust (UPRCT) handbook. If for any reason, the system cannot be designed based on the 4th edition, the applicant's engineer shall provide a detailed discussion on the site-specific constraints that will require the system to be designed based on the 3rd Edition of the Upper Parramatta River Catchment Trust (UPRCT) handbook.

Design Process

The system is to be generally designed and sized by the criteria outlined in this document. The following documents should be submitted to Council along with any application:

i. Detailed plans are to be submitted including at least three cross-sections showing the configurations of the filtration system in relation to the OSD system.

ii. All relevant OSD and filtration system calculations shall be submitted including orifice adjustment calculations when required.

iii. A MUSIC model is to be provided demonstrating compliance with the Water Management controls listed in the relevant Development Control Plan.

iv. A report should be provided summarising the model setup and a table showing the results and compliance.

v. A sub-catchment plan is to be provided in accordance with the sub-catchments used in the MUSIC model. The sub-catchment plan should be incorporated into the submitted stormwater plans.

vi. A certificate from the water quality devices manufacturer is to be obtained and submitted to Council verifying that the design of the proposed stormwater treatment system and the setup of the MUSIC model are in accordance with the manufacturer specifications, Council approved configuration method, and in accordance with the derived performance based on field studies. The Field study report used as the basis for Generic Node Target Elements and Transfer Functions must be publicly available.

Step 1 – Sizing and Arrangement

OSD system Designed based on UPRCT 4th Edition

This section provides an overview of the key design issues that should be considered when conceptualising and designing a cartridge filter treatment system within an OSD system that is designed based on the 4th Edition of the UPRCT. A typical system is illustrated in Figure 1. The system should be designed by a competent hydraulic/stormwater engineer and the following shall be considered in the design: This section provides an overview of the key design issues that should be considered when designing a cartridge filter treatment system within an OSD system that is based on the 4th Edition of the UPRCT.

Applicant will need to ensure their submissions to Council detail the following items:

a) The primary and secondary outlets shall be provided and designed to the UPRCT 4th edition handbook requirements.
b) All or majority of inlet pipes to the OSD must connect directly to the Stormwater Filter Chamber (referred to as SF Chamber within this document).
c) Where is practical and for larger systems, a dissipation wall should be included.
d) The SF chamber shall adhere to the manufacturer design requirements (i.e. size, quantity, model), and to be kept as small as practical. Volume is relative to the base of the cartridge inlet zone to the top of weir ie. the effective weir height. This volume must match the inputs within the SF Chamber Node in the MUSIC Model. The overflow weir shall be at the correct height to ensure cartridge siphon's will engage appropriately. All remaining surrounding walls are to be full height or at a minimum height equal to the 1% AEP TWL within the OSD system. There should be generally no backflow from the OSD tank to the SF chamber in the majority of storm events unless an additional head in the SF chamber adversely impacts the treatment system function. In circumstances where the orifice adjustment results in <25mm diameter, the remaining surrounding walls will be lowered but must not be less than the 1.5yr TWL or the appropriate cartridge overflow weir height, whichever is greater. Council must be consulted for scenarios such as this.
e) The Stormwater filter weir height must not be lower than the recommended minimum advised by the manufacturer.
f) Overflow from the SF chamber shall discharge to the main OSD storage area where the primary outlet is located.
g) Treater flow via the cartridge underdrain pipes will discharge directly to the outlet/overflow chamber and bypass all orifice controls.

h) The outlet pipes from the SF chamber shall meet any requirements in the manufacturer design guidelines.
i) Sizing and configuration of the underdrain pipes shall be designed by the manufacturer. The total peak flow through the cartridge underdrains shall be calculated based on the maximum head available for the 1.5yr and 100yr scenarios. The manufacturer can provide a calculator for this purpose. (Please refer to the filter manufacturer's specifications).
j) An equivalent flow to the SF chamber outflow shall be reduced from the Site Reference Discharge from the extended detention storage (SRD_L) in the OSD calculations and the 1.5yr orifice size should be adjusted to account for the flow through the SF chamber.
k) If for any reason i.e. the minimum orifice size (25mm) cannot be achieved, the outflow (cartridge underdrains) from the SF Chamber shall be directed into the OSD system. To ensure the proper function of the treatment system and prevent backflow, the invert level of the outlet pipe from the SF Chamber should be equal to or higher than the 1.5yr TWL in the OSD tank ensuring ongoing operation, i.e. there should be a sufficient positive head difference between the water level in the SF Chamber and the OSD system. **Figure 2** illustrates the general arrangement of such a system. If there are further restrictions i.e. the minimum head clearance in the SF chamber for practical access and maintenance, the OSD system can be designed in accordance with the UPRCT 3rd edition subject to Council approval.

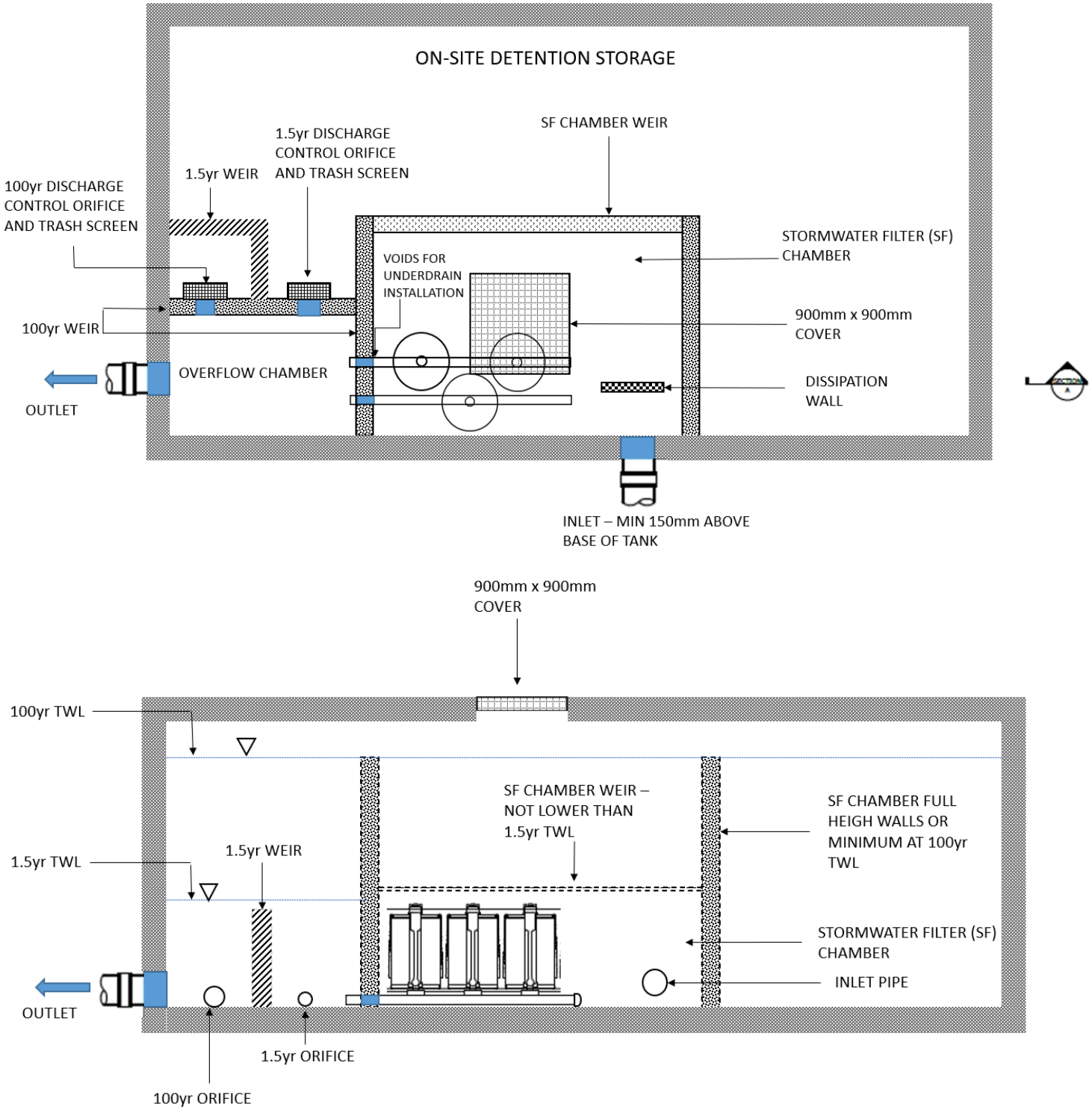

Figure 1 Typical cartrdigecartridge filter system incorporated within the OSD system. The OSD system is designed based on the UPRCT 4th edition and the outlet from the SF chamber past the OSD system. 1.5yr orifice size must be adjusedadjusted.

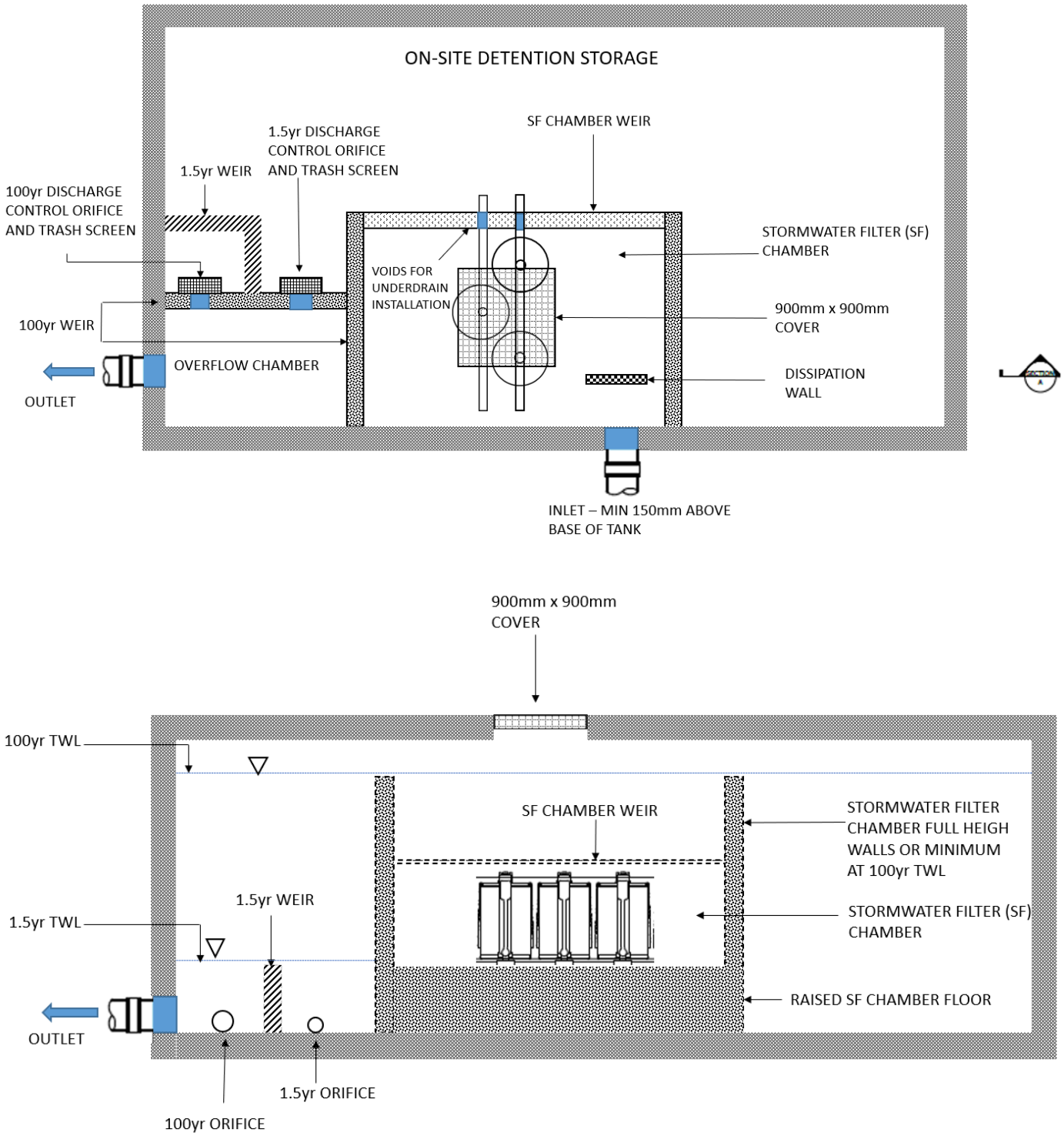

Figure 2 Typical cartridge filter system incorporated within the OSD system. The OSD system is designed based on the UPRCT 4th edition and the outlet from the SF chamber discharges into the main OSD storage. Orifice adjustment is not required for this system but the bottom of the SF chamber must be raised subject to providing there is enough head clearance in the SF chamber for maintenance.

OSD system Designed based on UPRCT 3rd Edition

This section provides an overview of the key design issues that should be considered when conceptualising and designing a cartridge filter treatment system within an OSD system that is designed based on the 3rd Edition of the UPRCT. A typical system is illustrated in **Figure 3**.

When the OSD system is designed based on the High Early Discharge (HED) concept, it is critical to ensure that the high early discharge is achieved at the early stage of the storm. In this regard, the SF chamber must be kept as small as practical. The time that it takes for the SF chamber to overflow to the HED chamber should be estimated for 1% AEP - 5 minutes storm event. The ongoing outflow from the SF chamber underdrains (bottom outlet) should be considered in such calculations. The estimated time should be reported and accordingly Council may request for a High Flow Bypass (HFB) chamber to be included in the system. If the HFB chamber is required, please refer to the next section for details; otherwise, the system shall be designed as detailed in this section.

The system should be designed by a competent hydraulic/stormwater engineer and the following to be considered in the design:

a) The HED chamber and HED orifice shall be provided and designed by the UPRCT 3rd edition handbook.
b) All or majority of inlet pipes should be connected directly to the Stormwater Filter (SF) chamber.
c) The SF chamber shall include an energy dissipater.
d) The SF chamber shall be sized and designed by the manufacturer design requirements, and to be kept as small as practical. Except for the SF weir, all walls around the SF chamber are to be set as high as 1% AEP Top Water Level (TWL) in the OSD tank (or full height). There should be generally no backflow from the OSD tank to the SF chamber in the majority of storm events unless an additional head in the SF chamber adversely impacts the treatment system function and/or cause a conflict with the minimum orifice size (25mm) after the orifice is adjusted. In such scenarios, the revised design should be discussed with the Council's engineer.
e) Cartridge filter manufacturer generally requires a minimum SF weir level to provide enough hydraulic head in the system. The SF weir height shall not be smaller than the minimum manufacturer requirements.
f) The HED chamber (Discharge Control Pit (DCP)) is to be located downstream of the SF weir.
g) Overflow from the SF chamber is discharged to the HED chamber where the HED orifice is located.
h) The outflow (bottom outlet) from the SF chamber shall be directed into the overflow pit past the OSD system.
i) The outlet pipes from the SF chamber shall meet the requirements of the manufacturer's design guidelines.
j) The total outflow from the SF chamber shall be calculated based on the maximum head within the SF chamber. The manufacturer may have specific calculators for this purpose (Please refer to the filter manufacturer's specifications).
k) An equivalent flow to the SF chamber outflow shall be reduced from the Permissible Site Discharge (PSD) in the OSD calculations and the orifice size shall be adjusted to account for the flow through the SF chamber.
l) If for any reason i.e. the minimum orifice size (25mm) cannot be achieved, the issue shall be discussed with Council's engineer.

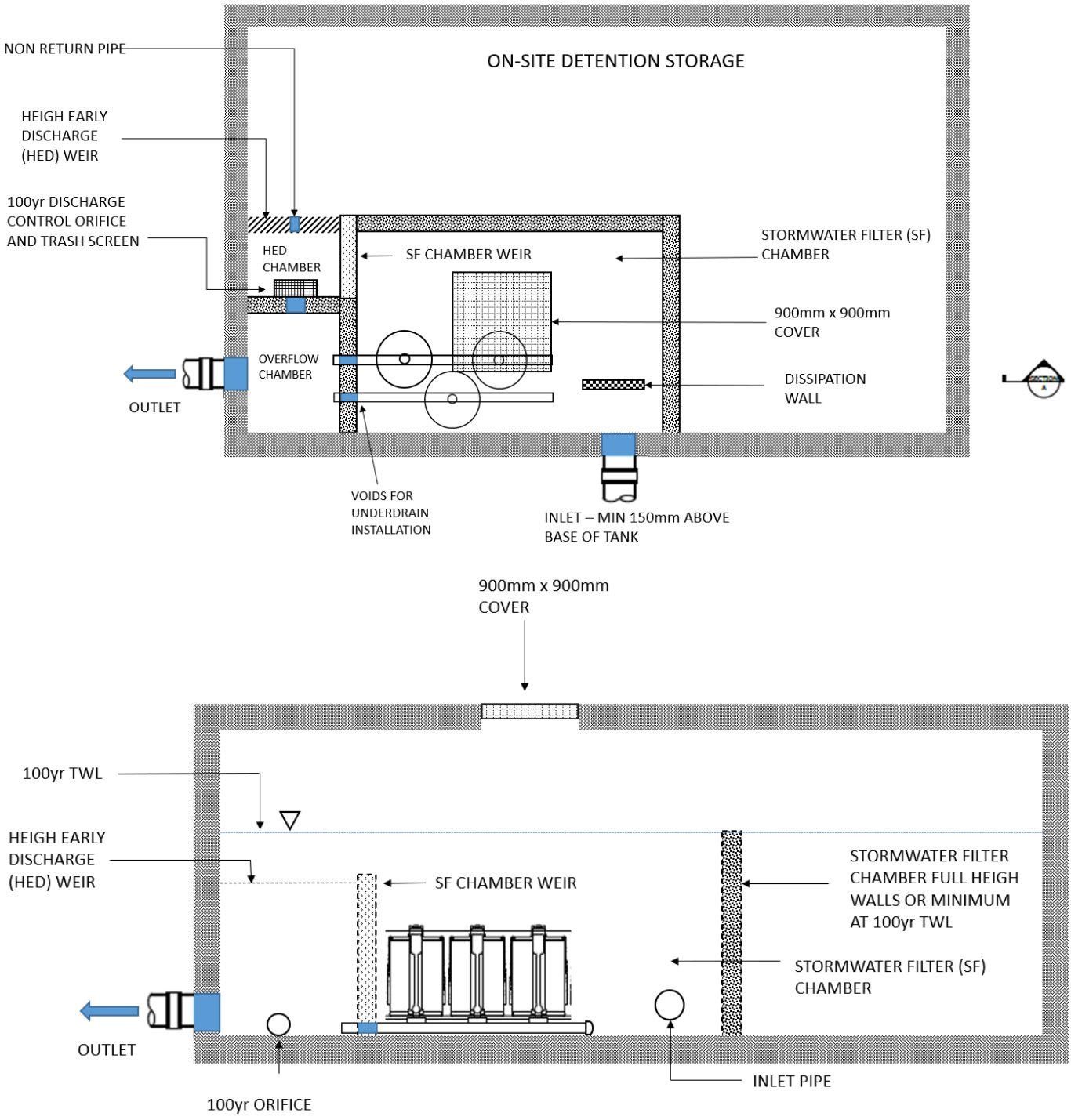

Figure 3 Typical cartridge filter system incorporated within the OSD system. The OSD system is designed based on the UPRCT 3rd edition and the outlet from the SF chamber past the OSD system. The orifice size must be adjusted.

OSD system Designed based on UPRCT 3rd Edition including High Flow Bypass (HFB) Chamber

This section provides an overview of the key design issues that should be considered when conceptualising and designing ana cartridge filter system within an OSD tank that is designed based on the 3rd Edition of the UPRCT handbook when ana High Flow Bypass (HFB) chamber is requested by the Council. A typical system is illustrated in **Figure 4**. **It should be noted that this design must be used as the last resource and Is not the preferred option.** The system should be designed by a competent hydraulic/stormwater engineer and the following to be considered in the design:

a) The HED chamber and HED orifice shall be provided and designed by the UPRCT 3rd edition handbook.
b) An HFB chamber (1mx1m chamber) shall be located upstream of both the OSD system and the filtration treatment system.
c) All inlet pipes are directly connected to the HFB chamber.
d) An orifice diverts up to the 4EY storm flow to the Stormwater Filter (SF) chamber. This orifice is called HFB orifice. The HFB orifice shall be sized based on the available hydraulic head in the HFB chamber i.e. Top Water Level (TWL) of the HFB chamber to the HFB orifice Centre Line (CL) and to allow the 4EY flow to enter the SF chamber.
e) The HED chamber (Discharge Control Pit (DCP)) to be located downstream of the HFB weir. The HFB chamber overflows to the HED chamber via a weir which diverts flow over the 4EY storm into the OSD system. This is called HFB overflow weir. The HFB overflow weir acts as the SF weir. Stormwater cartridge filter manufacturer specifications generally require a minimum SF weir level to provide enough hydraulic head in the filtration system. The HFB weir height shall not be smaller than the minimum manufacturer requirements. The HFB weir should be equal to or higher than the High Early Discharge (HED) weir.
f) The capacity of the filtration system chamber (SF chamber) should be sufficient to hold 4EY flow volume for a 5 minutes storm event. The chamber dimensions are therefore to be based on the designed head in the SF chamber.
g) All walls around the SF chamber to be set as high as 1% AEP Top Water Level (TWL) in the OSD tank.
h) The outflow (bottom outlet) from the SF chamber shall be directed into the overflow pit past the OSD system.
i) The outlet pipes from the SF chamber shall meet the requirements of the manufacturer's design guidelines.
j) The total outflow from the SF chamber shall be calculated based on the maximum head within the SF chamber. The manufacturer may have specific calculators for this purpose (Please refer to the filter manufacturer's specifications).
k) An equivalent flow to the SF chamber outflow shall be reduced from the Permissible Site Discharge (PSD) in the OSD calculations and the orifice size shall be adjusted to account for the flow through the SF chamber.
l) There should be generally no backflow from the OSD tank to the SF chamber in the majority of storm events unless an additional head in the SF chamber adversely impacts the treatment system function and/or cause a conflict with the minimum orifice size (25mm) after the orifice is adjusted. In such scenarios, the revised design should be discussed with the Council's engineer.
m) If for any reason i.e. the minimum orifice size (25mm) cannot be achieved, the issue should be discussed with Council.

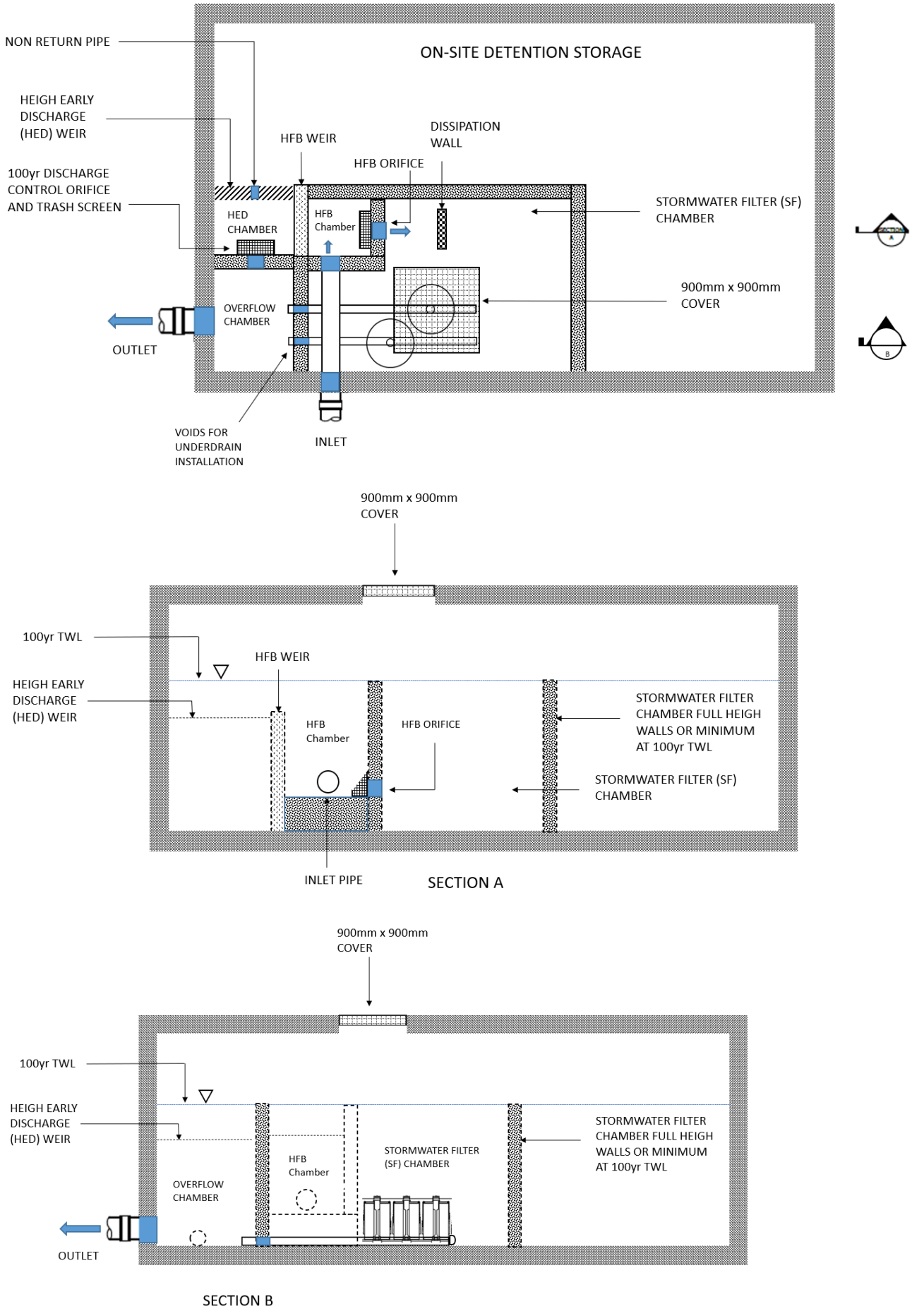

Figure 4 Typical filtration system incorporated within the OSD system. The OSD is designed based on the UPRCT 3rd edition and a High Flow Bypass chamber is required. The outlet from the SF chamber past the OSD system. Orifice adjustment is required for this system.

Step 2 – MUSIC Modelling

An assessment of the pre- and post-development stormwater quality to be undertaken using MUSIC software. Council MUSIC Link information must be used to setup a model.

Treatment nodes

a) A separate catchment and treatment train shall be used for each dwelling.
b) The treatment nodes to be setup based on the manufacturer recommendation. Reduction efficiencies need to be justified by testing.
c) Rainwater tanks shall not be included in the model as Council does not accept credit for rainwater tanks unless detailed water balance modelling is undertaken. For further information, contact Council's Development unit.
d) The treatment system shall be modelled as two nodes being; the cartridge chamber modelled as a detention node in series and immediately upstream of the cartridge filters being the generic node.
e) For the detention node ensure:
    i. The Extended Detention represents the effective weir height and therefore must account for the false floor thickness or any permanent water body below the cartridge
    ii. Any node such as the SF Chamber representing the filtration area must adjust 'k' value to 0
    iii. The Surface Area input must account for lost volume consumed by the cartridges.
f) To account for overflow from the SF chamber, it is recommended to add a secondary link from the chamber to the junction/receiving node. The secondary link to be set as weir overflow.
g) To ensure that the proposed treatment train has been designed and modelled based on the manufacturer specifications, a certificate shall be provided from the manufacturer to certify that the proposed design and the MUSIC model is based on their specifications.

Consideration of Rainwater Tanks

Council does not accept credit for rainwater tanks unless a detailed water balance modelling is undertaken. To include rainwater tanks in the WSUD strategy, the following considerations must be included:

1. Re-use to be considered based on the type of development. For residentials (single dwellings, dual occupancies, villas and town houses), the reuse to be considered for internal uses i.e., toilet flushing and laundry based on 39% of the total use. The outdoor reuse to be considered as 25% of the total use. The total use to be estimated in accordance with the Sydney Water usage data (available: https://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdgw/~edisp/dd_080908.pdf). For outdoor usage, if the lot size is smaller than 500 m^2, the outdoor usage of 0.25 KL/year to be considered.
2. For apartments and home units, 0.1 KL/day is to be considered as internal reuse for each unit. Irrigation of landscape area (excluding turf) to be based on 0.4 kL/year/m^2.
3. For schools, internal reuse (toilet flushing) should be estimated based on 0.06 kL/day per toilet unit. Where the site is only occupied 5 days per week, the daily usage rate is to be proportioned by 5/7. Irrigation of landscape (excluding turf) to be based on 0.4 kL/year/m^2.
4. For industrial and business developments, internal reuse (toilet flushing) should be estimated based on 0.1 kL/day per toilet unit. Where the site is only occupied 5 days per week, the daily usage rate is to be proportioned by 5/7. Irrigation of landscape (excluding turf) to be based on 0.4 kL/year/m^2.
5. For motels, hotels and care facilities, the daily demand for toilets in a private room is 0.025 KL/day and 0.1 KL/day for toilets in public areas.
6. All external re-use should be modelled as annual demand, scaled by a daily PET-RAIN option in the re-use box in the MUSIC software.

7. All external re-use should be modelled as annual demand, scaled by a daily PET-RAIN option in the re-use box in the MUSIC software.
8. Internal reuse should be modelled as an average daily demand in the MUSIC software.
9. Each rainwater tank shall be modelled separately.
10. A maximum of 80% of the physical capacity of the rainwater tank is to be used for modelling.
11. The rainwater tank must be sized efficiently using efficiency curves based on the provided supply and the demand.