Introduction

Stormcell® is a product which has been used for storing surface water runoff over the past decade. A total volume of over 50,000 m³ has been installed over this period, with an average individual installation size of approximately 150 m³. It comes in block form and basically consists of a matrix of plastic hexagonal vertical ‘tubes’ of 20 mm cross – flats dimension. The structure of the block gives it its strength. Vertically, the block can withstand occasional loads of 400 kN/m² and long term design loads of 40 kN/m² (eg. when used underneath roads to avoid creep). Lateral loading of 20 kN/m² can be accommodated. The Stormcell® block has a void ratio of 95%, ie. it has 95% air. It is these voids that are filled with rainwater during storm events. Stormcell® has the advantage of:

• being lightweight (a 2.4m x 1.2m x0.52m block only weighs 63kg and is easily handled manually).
• being relatively cheap (especially in terms of construction costs), simple to install.
• having a short delivery period (typically 2-3 weeks for volumes below 1000m³).

It is typically used in one of two ways:

• below a permeable surfacing, in which case rainwater fills it from above; or
• above a perforated pipe system, in which case it fills from below.

As the latter is the more common system utilised in the UK, it is this system to which the following design and installation guidelines apply.

What are the Main Elements of the Stormcell® Storage System?

The typical Stormcell® Storage System (SSS) (Figures 1a and 1b) is composed of:

1) an impermeable membrane wrapped around the Stormcell® blocks which prevents stormwater from escaping into the surrounding ground.

2) large single size stone as a support base for the Stormcell® blocks which also aids even distribution of stormwater throughout the plan area of the blocks and allows drain down through the outlet.

3) perforated pipes to further facilitate the stormwater distribution when filling and collection and delivery to the outlet when emptying and to avoid unwanted back pressure to the upstream sewer or drain.

4) geotextile on the top of the Stormcell® blocks to prevent the migration of fines from above into the vertical voids.

5) granular backfill to the top of the tank to assist structural loading distribution and the movement of air during filling and emptying.
6) Stormcell® blocks.

For reasonable sized volumes high level perforated pipes may be placed directly on top of the Stormcell® blocks to further aid the evacuation of air during filling and to allow air to return during drain down. For smaller volumes a more simple venting arrangement can be used. In common with all other types of underground stormwater storage, the SSS requires an inlet pipe, outlet pipe, control chambers and a Hydro-Brake® Vortex Flow Control.

The Stormcell® system can be constructed either on-line or off-line. It can be practically any shape, depth and size.
3-D Image Illustrating a Typical Stormcell® Storage System

- Geotextile (Covering Top Face of Stormcell®)
- Granular Backfill
- Perforated Pipes for Air Venting
- Impermeable Membrane
- Perforated Pipes
- Stormcell® Blocks
- Outlet

Figure 1a

Schematic Drawing of Stormcell® Storage System

- Geotextile
- Stormcell® Blocks
- Perforated Pipes
- Impermeable Membrane
- Surfacing/Road Makeup
- Perforated Venting Pipes
- Storage
- Single Stone Size

Figure 1b
Simple Steps

The design is basically quite simple. The use of good engineering practice and awareness of the limitations of all materials used will avoid construction and operational problems.

The basic parameters which need to be addressed in the design are:

1) **STORAGE VOLUME** - Calculation of required storage volume.

2) **LOCATION** - Selection of the most appropriate location.

3) **EXCAVATION AND DIMENSIONS OF SYSTEM** - Identification of the plan area, cross-sectional area, depth to invert and depth of cover.

4) **DISTRIBUTION AND COLLECTION SYSTEM** - Design of the stormwater distribution and collection system.

5) **STORMCELL® BLOCKS** - Selection of the most suitable Stormcell® block sizes and geotextile protection.

6) **VENTING** - Design of the air vent system.

7) **BACKFILLING** - Design of the backfill and surfacing.

The following pages consider each of the steps in more detail.
DESIGN STEPS

1) Storage Volume

The system designer needs to calculate the volume of storage required. There are a number of suitable methods which can be used to calculate the storage volume (see references). These vary from manual methods to sophisticated simulation models. Hydro can provide a Hydrological Analysis service using either Micro Drainage or the Stormphase program to identify the storage volume and permissible discharge rate for designers who do not have access to other methods of calculation. This establishes rainfall runoff volumes for a variety of storm events and calculates the optimum storage volume needed.

2) Location

The system designer needs to consider the most appropriate and cost-effective siting for the storage facility. The flexibility afforded by Stormcell® allows the system designer to design storage into locations which with other storage systems would be impossible. Very shallow depth of underground storage is achievable. Irregular plan areas offer no obstacles as the blocks of Stormcell® can be cut on site with an ordinary saw to the required shape. Obstructions such as trees, pipework and rock outcrops can be easily circumvented.

The Stormcell® Storage System can be installed practically anywhere including under roads, footpaths, car parks, public open spaces, landscaped areas, gardens, tennis courts and playing fields.

Note:

Significant cost savings can be achieved by distributing the requisite storage volume at the upper reaches of the catchment (reference 10). The system designer must ensure that the preferred depth of storage is achievable using the depths of Stormcell® blocks available (refer to Section 5 - Stormcell® blocks).

3) Excavation and Dimensions

The Stormcell® Storage System is highly flexible and allows the system designer to consider a range of options not normally available with other storage systems. There are, however, several limiting factors which must be considered. These are:-

i) Lateral Loadings

Stormcell® has excellent structural properties in the vertical direction, being capable of withstanding occasional loads of up to 40 tonnes/m² and long term design loads of up to 4 tonnes/m². It is however, somewhat limited in the horizontal direction, being capable of
accommodating only 2 tonnes/m² of lateral force. These limitations must be taken into account when deciding upon the cross-sectional area and depth of Stormcell® system. Figures 2, 3 and 4 illustrate the limitations.
1.8 m Maximum

Minimum Depth of cover - 500 mm

Maximum 2.5 m

Depth of Tank - 3 m maximum

Figure 3

Recommended Depth Limits in the Vertical Plane

Depth Limitations in Sloped Excavation

Natural angle of repose

Depth to bottom of tank not limited

Figure 4
ii) **Depth of Backfill**

The recommended depth of backfill above the top surface of the Stormcell® is 500 mm, particularly for situations in which the system will be subjected to loading from traffic. In situations where there is minimal loading over the Stormcell®, 300 mm of cover could be accommodated. The 300 mm depth of cover allows the dispersion of surface loading (especially of point loads) such that the loading of the top of the Stormcell® blocks is distributed evenly and limited to no more than 4 tonnes/m². Whilst the system can take occasional vertical loads of up to 40 tonnes/m², the maximum long term loading should be no more than 4 tonnes/m² to allow an acceptable factor of safety and to avoid problems with creep. For heavy traffic loading, eg. from large trucks, a depth of cover of approximately 1 m is usually required. It will be the designers responsibility to ensure that the depth of backfill is sufficient to disperse the loading safely to the top of the Stormcell®.

iii) An appropriate heavy duty impermeable membrane, typically 460 g/m² (500 micron thick), is required to ensure water tightness. For larger volumes where several sheets are required the sheets need to be overlapped and sealed in accordance with the membrane manufacturer's recommended method.

4) **Distribution and Collection System**

i) The rate flow, and the plan area of the storage system dictate the nature of the distribution and collection system.

It is advantageous in most circumstances for the perforated pipework to be as large a diameter as possible to reduce the headloss associated with smaller diameter pipes.

ii) Where a pipework distribution/collection system is required the following factors need to be considered:

a) **Distribution/Collection.**

   The diameters of the distribution/collection pipework should be established by:

   1) establishing the capacity required to ensure an even distribution of the flows for pipe length, dependent upon the arrangement chosen (ref. 4.ii.c) and;

   2) the capacity of the perforated pipes for allowing flows to exit and enter the pipes. The recommendations of the perforated pipe manufacturers must be adhered to.

   The gradients of the pipework should generally be a minimum of 1-1.5% to obtain adequate self-cleansing characteristics. Care must be taken for both on-line and off-line configurations to ensure that the self-cleansing criteria is satisfied.
b) Trenches and Bedding to Pipework

The trenches should be excavated in accordance with the pipe manufacturer's recommendations. In order to minimise the depth of excavation and the volume of single size stone under the Stormcell®, it is possible for the pipes to be constructed in a shallow trench as indicated in Figure 5.

The bedding to the pipework should be in accordance with the pipe manufacturer's recommendations. The design loading to the pipework should assume that the Stormcell® is acting as conventional backfill.

![Typical Cross Section](image)

Figure 5

Typical Cross Section

c) Pipework Arrangement

There are several methods of arranging the pipework (ref. Figures 6 and 7). The main underlying principle is to ensure that the flows through the perforated pipes into the single size stone layer do not have to travel more than 2 m from the pipes. This is to ensure an even distribution of the stormwater throughout the Stormcell® media.

The most suitable arrangement depends on the available gradients and the dimensions of the tank.
d) Rodding Points

In some circumstances, if there is a likelihood of siltation within the distribution/collection pipework, it may be appropriate for rodding points to be provided at the end of each pipe run. The rodding points can be sited at ground level in suitable locations a short distance from the distribution/collection pipework.
5) **Stormcell® Tank and Geotextile Protection**

The actual storage section is comprised of Stormcell® blocks, which are placed above the distribution/collection layer. The layout of the blocks should be designed in such a way as to achieve a stretcher bond arrangement wherever possible. Consideration of the depth to invert is important in deciding the number and type of blocks, which are available in 2.4 m lengths, 1.2 m widths and varying depths. The depths of blocks available are:

- 520 and 120 mm.

The range of block depths allows a high level of flexibility in the design of the depth of the tank. Falls in ground level from inlet to outlet can therefore easily be accommodated thereby minimising the volume of excavation.

The most cost-effective solution would be to use 2.4 x 1.2 x 0.52 m deep blocks. Due to the increased production costs of producing the smaller sized blocks, they are slightly more expensive (contact Hydro for further details).

A layer of close textured geotextile, typically 95 g/m², should be placed on top of the uppermost layer of Stormcell® blocks to prevent the intrusion of fines from the upper layers of backfill.

6) **Venting**

For large volumes the air venting arrangement consists of perforated pipes with typically 100 mm diameter arranged in a regular pattern embedded in a layer single size stone, typically 25/40 or 6/10 on the top of the Stormcell® blocks. The pipes do not need to be laid with any fall and should be placed with their openings facing downwards. They should be connected to the upstream and/or downstream control/inspection chambers.

For smaller volumes the stone above the Stormcell® blocks may be sufficient in itself to act as an air conduit. In this case pipes spanning from the edges of the Stormcell® to the upstream and downstream chambers may be sufficient.

Care must be taken with the depth of the stone layer to ensure that the intended loading does not exceed the structural capacity of the air vent pipe.

7) **Backfilling**

The backfill to the top layer of the Stormcell® is dependent upon the surfacing above the system. All backfill must be carefully compacted to avoid penetration of the geotextile layer. Backfill is required to the edges of the system between the impermeable membrane and the edge of the excavation to consolidate the and stabilise the structure. The backfill can be either compacted sand, concrete or granular material. A gap of a minimum width of 100 mm should be left between the edge of the excavation and the outer edges of the Stormcell® blocks.
TYPICAL INSTALLATION METHOD

To be carried out in accordance with advice given by Hydro.

1) Excavate a slightly larger hole than that required to house the Stormcell® blocks, to the required depth.

2) Excavate a trench to house the main through flow perforated pipe which will carry low flows, hence bypassing the storage system (Photograph 1).

3) Assuming all surface water is to be discharged into the continuation drainage system (ie. that no soakage to the soil below is permitted), lay an impermeable membrane over the base of the excavation and up the sides (Photographs 2 and 3).

4) Lay the through flow pipe in the trench, surrounded by appropriate aggregate* as a bedding material (Figure 5) (Photograph 4).

5) Install any distribution/collection perforated pipework that may be required to spread the surface water beneath the entire area of the Stormcell® installation.

(Refer to pipe manufacturer's technical information regarding flow capacity through perforations. The pipework should be capable of passing the peak flow rate for the design storm through these perforations into the storage system above). Again, appropriate bedding should be used and these pipes should be laid to self-cleansing gradients, draining into the through flow pipe (Photograph 5).

6) Lay a levelled volume of aggregate to cover this pipe system (Photographs 6 and 7).

7) Position the Stormcell® blocks within the void in stretcher bond fashion wherever possible. No connections between blocks are required (Photographs 8, 9, 10 and 11).

8) On top of the Stormcell® blocks lay a light geotextile to prevent aggregate from infiltrating and clogging the top of the Stormcell® ‘tubes’ (Photograph 11).

9) Lay a venting pipe system (typically 100 mm diameter perforated pipes laid holes down and surrounded with aggregate) over the Stormcell® and connect this to the upstream and downstream manhole chambers. This allows the air that will be pushed upwards by the rising water level in the tank to escape.

10) Cover with the impermeable membrane to create a watertight seal in accordance with the membrane manufacturer’s recommendations (Photograph 12).
11) Fill the trenches around the sides of the installation using either sand, granular material, or concrete. This protects the weaker sides of the Stormcell® block from damage.

12) Lay the appropriate surfacing on top to a minimum dimension of 300 mm if traffic is required to pass over the installation. This depth is required for works traffic to pass over during installation of the site but can be reduced, as appropriate, following completion of site works.

- All aggregate should be of a consistently large size single stone with no fines, eg. 25 to 40 mm.
Maintenance Instructions

There should be little maintenance required with the Stormcell® system provided the Design and Installation Guidelines manual, as issued by Hydro, is followed.

The major aim of a maintenance regime will be to prevent siltation of the throughflow/distribution pipes which are below the Stormcell®. To this end these pipes should be laid to achieve self-cleansing velocities wherever possible.

A catchpit chamber immediately upstream of the Stormcell® tank is a useful addition to the system. It is imperative that the collection sump is not allowed to overfill which would lend to silt carry-over into the distribution pipes.

As all schemes are different, the frequency at which the catchpit should be emptied will need to be determined on site. This is simply a function of the sump volume and the volume of settleable grits and silts entering it.

As per the Hydro-Brake® Flow Control installation, it is recommended that the system be inspected monthly for 3 months and thereafter at 6 monthly intervals. In addition, it is suggested that the installation should be inspected immediately following the first major storm event, whenever this should occur after installation.

It should also be noted that more regular inspections may be required should the catchpit fill more frequently than at 6 monthly intervals.
References (for further reading)

1) Sewers for Adoption published by the Water Research Centre (1989) Plc.
2) WASSP suite of programs available from Wallingford Software, Hydraulics Research Limited.
3) WALLRUS suite of programs available from Wallingford Software, Hydraulics Research Limited.
4) The Micro Drainage suite of programs available from Micro Drainage.
6) TN86/1 WASSP technical leaflet available from Hydro.
9) Hydro Works Suite of programs available from Wallingford Software.
Photo 1

Photo 2

Photo 3