Cambridge Northern Fringe East

Surface water drainage space allocation for master planning

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GREATER CAMBRIDGE SHARED PLANNING

CAMBRIDGE CITY COUNCIL

South Cambridgeshire District Council

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1. Introduction

The purpose of this document is to determine the required volume and corresponding area that is required for surface water drainage attenuation and water quality treatment prior to being discharged from the development site.

This document is only related to surface water drainage and not flood risk. The purpose is for master planning and space allocation only and is not to be used for detailed design of the surface water drainage systems for the individual allocated sites.

2. Policy and context

The design parameters for this document are the following national and local policies, with the relevant sections reproduced for ease of reference.

National Policy:

National Planning Policy Framework 2019

165. Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

a) take account of advice from the lead local flood authority;

b) have appropriate proposed minimum operational standards;

c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and

d) where possible, provide multifunctional benefits.

Non-statutory technical standards for sustainable drainage systems 2015

Peak flow control

S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume control

S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is *reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.*

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Flood risk within the development

S7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

Local Policy:

South Cambridgeshire Local Plan 2018

Policy CC/7: Water Quality

1. In order to protect and enhance water quality, all development proposals must demonstrate that:

a. There are adequate water supply, sewerage and land drainage systems (including water sources, water and waste water infrastructure) to serve the whole development, or an agreement with the relevant service provider to ensure the provision of the necessary infrastructure prior to the occupation of the development. Where development is being phased, each phase must demonstrate sufficient water supply and waste water conveyance, treatment and discharge capacity;

b. The quality of ground, surface or water bodies will not be harmed, and opportunities have been explored and taken for improvements to water quality, including renaturalisation of river morphology, and ecology;

c. Appropriate consideration is given to sources of pollution, and appropriate Sustainable Drainage Systems (SuDS) measures incorporated to protect water quality from polluted surface water runoff.

Policy CC/8: Sustainable Drainage Systems

Development proposals must incorporate appropriate sustainable surface water drainage systems (SuDS) appropriate to the nature of the site. Development proposals will be required to demonstrate that:

a. Surface water drainage schemes comply with the Sustainable Drainage Systems: Non-statutory technical standards for sustainable drainage systems and the Cambridgeshire Flood and Water Supplementary Planning Document or successor documents;

b. Opportunities have been taken to integrate sustainable drainage with the development, create amenity, enhance biodiversity, and contribute to a network of green (and blue) open space;

c. Surface water is managed close to its source and on the surface where it practicable to do so;

d. Maximum use has been made of low land take drainage measures, such as rain water recycling, green roofs, permeable surfaces and water butts;

e. Appropriate pollution control measures have been incorporated, including multiple component treatment trains; and

f. Arrangements have been established for the whole life management and maintenance of surface water drainage systems.

Policy CC/9: Managing Flood Risk

1. In order to minimise flood risk, development will only be permitted where:

d. There would be no increase to flood risk elsewhere, and opportunities to reduce flood risk elsewhere have been explored and taken (where appropriate), including limiting discharge of surface water (post development volume and peak rate) to natural greenfield rates or lower, and

e. The destination of the discharge obeys the following priority order:

i. Firstly, to the ground via infiltration;

ii. Then, to a water body;

iii. Then, to a surface water sewer;

iv. Discharge to a foul water or combined sewer is unacceptable.

Cambridge City Council Local Plan 2018

Policy 31: Integrated water management and the water cycle

Development will be permitted provided that:

a. surface water is managed close to its source and on the surface where reasonably practicable to do so;

b. priority is given to the use of nature services;

c. water is seen as a resource and is re-used where practicable, offsetting potable water demand, and that a water sensitive approach is taken to the design of the development;

d. the features that manage surface water are commensurate with the design of the development in terms of size, form and materials and make an active contribution to making places for people;

e. surface water management features are multi-functional wherever possible in their land use;

f. any flat roof is a green or brown roof, providing that it is acceptable in terms of its context in the historic environment of Cambridge (see Policy 61: Conservation and Enhancement of

Cambridge's Historic Environment) and the structural capacity of the roof if it is a refurbishment. Green or brown roofs should be widely used in large-scale new communities;

g. there is no discharge from the developed site for rainfall depths up to 5 mm of any rainfall event;

h. the run-off from all hard surfaces shall receive an appropriate level of treatment in accordance with Sustainable Drainage Systems guidelines, SUDS Manual (CIRIA C753), to minimise the risk of pollution;

i. development adjacent to a water body actively seeks to enhance the water body in terms of its hydromorphology, biodiversity potential and setting;

j. watercourses are not culverted and any opportunity to remove culverts is taken; and

k. all hard surfaces are permeable surfaces where reasonably practicable, and having regard to groundwater protection.

Policy 32: Flood risk

Potential flood risk from the development

Development will be permitted providing it is demonstrated that:

a. the peak rate of run-off over the lifetime of the development, allowing for climate change, is no greater for the developed site than it was for the undeveloped site;

b. the post-development volume of run-off, allowing for climate change over the development lifetime, is no greater than it would have been for the undeveloped site. If this cannot be achieved then the limiting discharge is 2 litre/s/ha for all events up to the 100-year return period event;

c. the development is designed so that the flooding of property in and adjacent to the development would not occur for a 1 in 100 year event, plus an allowance for climate change and in the event of local drainage system failure;

d. the discharge locations have the capacity to receive all foul and surface water flows from the development, including discharge by infiltration, into water bodies and into sewers;

e. there is a management and maintenance plan for the lifetime of the development, which shall include the arrangements for adoption by any public authority or statutory undertaker and any other arrangements to secure the operation of the scheme throughout its lifetime; and

f. the destination of the discharge obeys the following priority order:

• firstly, to ground via infiltration;

• then, to a water body;

• then, to a surface water sewer.

Discharge to a foul water or combined sewer is unacceptable.

Cambridgeshire Flood and Water Supplementary Planning Policy Document 2016

Cambridgeshire SuDS Design Principles:

- *Plan in SuDS from the start*
- *Mimic natural drainage*
- *Use the SuDS management train*
- *Water reuse first*
- *Follow the drainage Hierarchy*
- *Use infiltration where suitable*
- *Keep surface water on the surface*
- *Place-making through SuDS design*
- *Landscape-led approach*
- *Design for wildlife and biodiversity*
- *Design for easy maintenance and access*
- *Design open spaces to incorporate SuDS*
- *Design streets to incorporate SuDS*
- *Design SuDS to match the density of developments*

3. Site context and constraints

3.1 Previous use

In the areas of land that are currently business parks, building usage ranges from offices through to heavy industrial. Each will have to be approached on a case by case basis to determine the level of contamination based on the previous use of the site.

The former use of the section of the Area Action Plan as a sewage treatment works/water recycling centre for in excess of 100 years, will mean that there will be contamination present across the site. This has been confirmed through ground investigations associated with current and previous planning applications. Investigations will have to be undertaken on a site by site basis to determine the level of contamination.

3.2 Groundwater

Groundwater is also known to be high in this area. For infiltration to be an acceptable form of surface water discharge, there must be a minimum of 1m unsaturated ground beneath the base of any infiltration device. None of the current new developments or re-developments are utilising infiltration.

The previous site use as heavy industrial and sewage treatments works/water recycling centre coupled with the presence of high groundwater is highly likely to preclude the use of infiltration devices. Discharge to a surface water body is the next destination on the drainage hierarchy, and this will be the assumed destination in this report. However, each individual site should undertake ground investigations for contamination and measure and monitor groundwater levels to determine the individual design constraints, and the use of infiltration should not be ruled out at this stage.

3.3 Discharge locations

The likely surface water body discharge location is the First Public Drain, which in turn discharges into the River Cam. This is downstream of Baits Bite Lock.

3.4 Downstream structures and restrictions

First Public Drain – Culverts, bridges and siphons:

There are a number of structures and restrictions along the First Public Drain and these include culverts and bridges under roads within the Cambridge Science Park, a siphon under Milton Road, a bridge under Cowley Road, two access bridges within the Science Park, three culverts under the A14, a culvert under the railway line and a gateway culvert and outfall downstream of Baits Bite Lock.

The River Cam – Bottisham Lock:

The main downstream restriction on the River Cam is at Bottisham, which is around 2.5 miles downstream.

3.5 Allowable discharge rates

As infiltration is unlikely to be a suitable method of surface water discharge, it is assumed that discharge will be to the First Public Drain. With infiltration not being used, the total volume of water discharging from the site will be difficult to control and therefore discharges should be restricted to 2 l/s/ha or Qbar whichever is the higher on the assumption that interception storage is fully utilised. Without any interception storage rates will have to be reduced further to 2 l/s/ha. The calculations in this report are based on the use of interception storage.

3.6 Types of storage

The total attenuation that is required for a development is broken down into the following categories. All of these added together will give the amount of attenuation required.

Interception storage: Before any site has been developed, when most rainfall events (which are small in size and intensity) that happen in any normal year occur, no measurable surface water runoff leaves the site and makes its way to a watercourse. However, an impermeable surface, such as a standard macadam road or a tiled roof, will generate runoff in all rainfall events. This runoff can be polluted and can cause downstream issues. The assumption here is that interception storage will be contained so that it does not leave the site.

Interception storage can be provided by green roofs, rain gardens, bio-retention tree pits and permeable paving and is usually provided close to where the rain falls.

Attenuation storage: This provides the main storage for a development site based on discharge rates calculated from soil characteristics and local hydrological characteristics. Any flow after the development must not exceed the rate of flow of water leaving a site or the total of volume leaving the development.

Attenuation storage can be provided in features such as ponds, wetlands, swales etc. In some instances, it can be provided in tanks, but this is dependent on the amount of interception and treatment storage that is also provided.

Treatment storage: The function of sustainable drainage is also to provide treatment to surface water run-off. Treatment storage is the body of water in which dilution and partial treatment of surface water run-off can take place. This can be by physical (such as sedimentation), chemical and biological means. This is usually the volume of water in ponds and wetlands in normal dry weather.

Tanks that are empty in dry weather do not provide this type of storage.

3.7 Water reuse and integrated water management

The proposals represent an opportunity to re-use existing infrastructure for the purposes of water re-use that could potential offset the demand for supply of water. This could be through site wide rainwater harvesting or greywater. This should be considered on a site by site basis as well as development scale basis. If designed correctly this could be used as a method of reducing the amount of attenuation that is stored in attenuation features across the site and reducing the overall volume of water that is leaving the site.

4.0 Storage requirements for master planning at Cambridge Northern Fringe East

The storage requirements below have been calculated using HR Wallingford's UK SuDS online tool, using FEH and the dominant soil host class data. A figure of 40% for climate change was also used. This is intended to give an approximation of the storage requirements across the site to allow appropriate space to be allocated to enable Cambridge City Council and South Cambridgeshire District Council policy to be adhered to.

Based on the figures in the table below 0.12m^3 of total storage is required for every impermeable square meter. If the site was completely impermeable and totally flat, this would equate to 120mm across the whole of the site.

Total storage = Interception storage plus attenuation storage. Treatment storage is presented as part of the attenuation storage figure.

The whole of the area action plan boundary:

Percentage of impermeable area	Site impermeable area (ha)	Interception storage required (m^3)	Attenuation storage required (m^3)	Treatment storage required (m^3)	Total storage required (m^3)	Qbar (l/s)
100%	109.0073	4361	125365	13081	129724	150
90%	98.1066	3925	112817	11773	116741	136
80%	87.2058	3487	100272	10466	103759	122
70%	76.3051	3052	87739	9156	90793	107
60%	65.4044	2616	75195	7848	77821	91

Note: This currently excludes all highways, as these areas are not currently available.

If the attenuation was only provided in surface ponds with an assumed 0.75m depth of available storage, this would equate to the land take below:

Percentage of impermeable area	Site impermeable area (ha)	Square meters of total storage (ha)	Percentage of total developable area
100%	109.0073	17.2965	15.8%
90%	98.1066	15.5654	15.8%
80%	87.2058	13.8345	15.8%
70%	76.3051	12.1057	15.8%
60%	65.4044	10.3761	15.8%

The water recycling centre area only:

Percentage of impermeable area	Site impermeable area (ha)	Interception storage required (m^3)	Attenuation storage required (m^3)	Treatment storage required (m^3)	Total storage required (m^3)	Qbar (l/s)
100%	26.0686	1043	30245	3128	31288	36.31
90%	23.4617	938	27221	2815	28159	32.68
80%	20.8549	834	24196	2503	25030	29.05
70%	18.2480	730	21172	2190	21902	25.42
60%	15.6412	626	18147	1877	18773	21.79

Note: This currently excludes all highways, as these areas are not currently available.

If the attenuation was only provided in surface ponds with an assumed 0.75m depth of available storage, this would equate to the land take below:

Percentage of impermeable area	Site impermeable area (ha)	Square meters of total storage (ha)	Percentage of total developable area
100%	26.0686	4.1717	16%
90%	23.4617	3.7545	16%
80%	20.8549	3.3373	16%
70%	18.2480	2.9202	16%
60%	15.6412	2.5030	16%

There is 16.46 ha of open space associated with the water recycling centre, and attenuation storage could potentially be between 15% and 25% of that open space, depending on the depth of storage. This could be a combination of dry multifunctional and wet biodiverse attenuation storage.

Any reduction in the depth of available storage would increase the overall storage requirements. It is essential that more space-efficient sustainable drainage features are employed to reduce the overall land take as explained below.

5.0 Master planning storage implementation

5.1 Site density and sustainable drainage systems

The density of each individual parcel will determine the final attenuation requirement during detailed design. The type and form of the development will also determine the type of sustainable drainage features that can be utilised.

5.2 High density

In the highest density sites, common sustainable drainage features are green/brown/blue roofs, permeable paving, rain gardens, rainwater harvesting and multifunctional spaces.

The most space-efficient sustainable drainage systems are those that are effectively self-attenuating. For example green/brown/blue roofs will provided the required attenuation for a building if it fully covers the entire footprint of the building. However, these roofs can only be used as an effective storage feature if the roofs are flat. It should be noted that blue roofs do not provide the required amount of interception storage as they will collect and discharge all the rain that falls on them.

Permeable paving also provides the required amount of attenuation in the structure required to support the road. Again, this is a very space-efficient sustainable drainage feature. Permeable paving is limited to use in non-adoptable roads due to current Cambridgeshire County Highways policy.

Raingardens and bio-retention tree pits also provide localised interception storage and can reduce the amount of treatment storage that is required as part of the required attenuation storage. These are also limited to private areas due to adoption constraints.

Rainwater harvesting can also be used as a contribution to strategic attenuation and to interception storage if there is adequate demand. This does not include water butts as a method of rainwater harvesting due to the non-quantifiable demand based on the behaviour of individuals.

An approach for high-density areas would be the following:

1. Maximise the use of green/brown roofs.
2. Maximise water re-use through rainwater harvesting.
3. Maximise the use of permeable paving.
4. Use rain gardens and bio-retention tree pits wherever possible.

This would limit the size of large ponds and underground tanks and meet current local planning policy.

5.3 Multi-functional areas

Multi-functional spaces are an additional possibility for attenuation storage. These can be in the form of attenuation basins that are also useable open spaces. They can be both hard and soft landscaped and are applicable as attenuation storage only as they do not provide any water quality benefits. These could be public open spaces or hard paved squares. They are usually only employed in extreme events and therefore will be dry and useable public open space for the majority of the time.

5.4 High-medium density

If the sustainable drainage systems required to achieve high-density sites cannot be reached, for example if pitched roofs are preferred and roads are required to be adopted, then additional sustainable drainage features will be required such as swales, ponds and wetlands will be required. These features will require additional space not only for the physical requirement but also for long-term maintenance requirements.

An approach for medium density areas would be the following:

1. Maximise the use of sustainable drainage features used in high-density sites and as a minimum meet the requirements for interception storage.
2. Provide the remainder of the attenuation storage and treatment storage in swales, basins, ponds and wetlands.
3. The required treatment storage must be provided in an appropriate feature.

The above would meet current local planning policy.

5.5 Connectivity

The area of consideration has limited gradient and may not be able to drain fully by gravity if only served by a piped network. Maximising the use of above-ground features would minimise any pumping requirements. Swales in strategic locations should be a consideration as an alternative to a piped network. If the main attenuation storage is provided within each parcel instead of at the end of the system, the swales would only be carrying attenuated flow, and their size could be minimized.

5.6 Strategic features

Strategic features could potentially be used to provide the attenuation storage; this would be dependent on the required interception storage being provided with each parcel and suitable connectivity being achievable. These could be bio-diverse ponds and wetlands.

6.0 Use of existing settlement tanks on the water recycling centre

There are several settlement tanks in the water recycling centre site. These provide treatment in a number of stages. At the Milton centre, they have been constructed at different times to different specifications. The re-use of these thanks would be dependent on the following:

1. The ability for the tanks to be fully remediated and fully de-contaminated from their current use.
2. The age and condition of the structures.
3. The size, location and invert of the structures. It would not be acceptable for pumping to be used in order for the tanks to remain due to the unsustainable nature of pumping.
4. The suitability of the tanks to be located in public areas of the proposed development. The tanks are concrete with a raised edge to a height of up to 1.5m in places and have a very functional appearance.
5. Natural soil would need to be introduced into the tanks to provide the necessary planting medium, and suitable planting would need to be introduced.
6. The cost of remedial and conversion works to enable them to be used as surface water drainage infrastructure.

In order to enable the feasibility of the structures re-use to be adequately considered, each tank would require an assessment of the appropriateness of location in relation to the proposed development, the existing and proposed invert levels, the existing structural design and the contamination remediation methods.

7.0 Reducing existing flood risk

The National Planning Policy Framework paragraph 157 requires all plans to take into account existing flood risk by *“using opportunities provided by new development to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques)”.* There is an opportunity for works on the first public drain to be undertaken to both provide an element of strategic attenuation storage and to be able to reduce the cause and impact of existing flooding. This could be undertaken by the re-naturalisation of the channel, which is a local planning policy of both South Cambridgeshire District Council and Cambridge City Council. This could involve the introduction of meanders and to have a variable width channel with a two-stage profile in locations in various locations. The variation of this modified channel could increase the range of habitats along the watercourse. It could also provide additional storage in the event of an extreme flood event.

8.0 Adoption and long-term management and maintenance

Since the introduction of the amended National Planning Policy Framework in February 2019, there is a requirement for local planning authorities to ensure that major developments incorporate sustainable drainage systems and they should ‘*have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development*’. This means that any features should be adopted where possible by an appropriate body. Changes are forthcoming that will give water companies the ability to adopt sustainable drainage features that meet a minimum standard. The features that would be adoptable are strategic features such as swales, ponds, wetlands etc. This may introduce an additional land take to allow for easements and access requirements.

9.0 Sustainable drainage features removal restrictions

Where storage features are used in private curtilage, and they contribute to the overall storage provision, the features should be protected through appropriate measures such as planning conditions and restrictive land charges. This is required to ensure the features have an acceptable standard of operation for the lifetime of the development.

10. Precedent examples and land take guidance

The following are examples of guidance on sustainable drainage space allocation in the master planning process.

- Cambridgeshire Flood and Water Supplementary Planning Document. Adopted by Cambridge City Council and South Cambridgeshire District Council.

  Section 6 refers to sustainable drainage and 6.3.2 - 6.3.4 provides recommendations for the planning of SuDS and the allocation of space within a master plan.

- Water. People. Places. - A guide for master planning sustainable drainage into developments Prepared by the Lead Local Flood Authorities of the South East of England

  https://www.midsussex.gov.uk/media/2909/water-people-places-a-guide-for-master-planning-sustainable-drainage-into-developments.pdf

  This document provides a step by step process to integrating and master planning sustainable drainage into new development.

11. Conclusions and master planning spatial recommendations:

11.1 The total storage requirements for the area are approximately 120mm per square meter of impermeable surface, depending on the type of feature. Between 10-15% of the overall development parcel should be allowed for. This is highly dependent on the nature of the sustainable drainage features employed and may not be required in the detailed design, but it would be a sensible allocation of space when master planning.

11.2 The interception storage requirement for each plot is 5mm per square meter of impermeable surface. This would need to be provided close to where the rain falls in features such as green/brown roofs, rain gardens, permeable paving and other vegetated features. The use of blue roofs and underground tanks alone will not meet this Cambridge City Council local planning policy requirement.

11.3 Water quality treatment is required by both South Cambridgeshire District Council and Cambridge City Council local plan policy. This cannot be provided by hard engineered structures and needs vegetated and soil-based features to provide the required benefits. Blue roofs and underground tanks alone would not meet this requirement.

11.4 As the site has limited gradient, the majority of the features should be on the surface and swales used to convey the water long distances; this will provide a strategy that would minimise any pumping requirements.

11.5 It may be possible to utilise the existing infrastructure; however physical constraints and contamination may mean they are not an economical solution.

11.6 A sustainable drainage masterplan setting out the sustainable drainage requirements, space allocations and conveyance routes is recommended, to ensure that it is adequately considered at an early enough stage to determine the most efficient use of space and to ensure that any development meets local plan policy requirements and is an exemplar of sustainable drainage design and delivery.