MEDIUM SCALE RESIDENTIAL DEVELOPMENT

DESIGN STAGE D: PREFERRED STRATEGY

Design Discussion

The master plan was developed to include three 'character areas' which offer different housing styles to buyers. Each of these character areas has different SuDS opportunities as shown by the adjacent table.

SuDS Concept Plan

Character Area	SuDS Opportunities	
Waterbury Terrace: The area to the west is near the school and prioritises family housing at a medium density. It includes private gardens and a 'home zone' route to encourage pedestrian movement and play as well as necessary vehicle movement in a shared surface.	Home zone – could include distributed bioretention gardens and tree pits which are used as traffic medians to slow vehicles. Shared surface would suit block paving which could be permeable. Medium density terraced housing – Variety of SuDS suitable for front and back gardens. Inclusion of green back gardens for families will increase permeability.	① 
Waterbury Heights: The central area is centred around the primary through-route for the development, where there is a higher density of housing aimed at young professionals.	The central route - could be 'greened' through the use of a central or side formal swale, bio-retention tree planters or permeable paving strips along the side. Higher density apartment blocks - will drain to communal gardens that can include centrally managed bioretention gardens.	② 
Waterbury Gardens: The eastern end of the development offers a stronger community feel with a mix of units for older people and family housing. A community green and small allotment is favoured in this area to lend appeal to the development.	Development facing the green – can be treated as a 'pod' where all roofwater is intercepted by water butts for gardening supply, with excess channelled to the community garden area where it is filtered in a bioretention garden and allowed to infiltrate or directed to underground storage beneath a green area.	③ 

MEDIUM SCALE RESIDENTIAL DEVELOPMENT

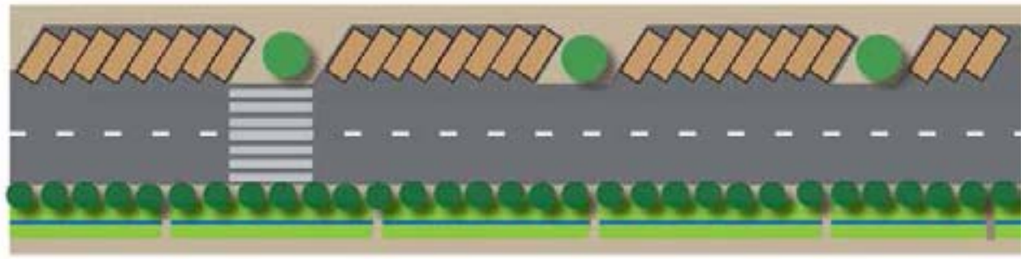
DESIGN STAGE E: DESIGN REFINEMENT

Design Discussion

The design of the specific SuDS features will prioritise infiltration, though in major events when features are overwhelmed, water may need to be conveyed elsewhere. There is a combined sewer in the area, but a separate discharge to the river is being constructed near the school. A separate surface water drainage system would be favoured to take overflows and minimise additional pressure on the existing sewers and wastewater treatment plant.

Detailed design of the homezone favoured the use of bioretention gardens to slow and discourage traffic while improving the look of the street through the addition of self-irrigated street trees. A formal swale was used in the central street (see Ashford case study) which also allowed integration of street greening. The local council favoured the delivery of allotments in the community garden, so all roof water draining to the front of the houses enclosing the garden will be directed to a central storage tank for irrigation with overflow to the bioretention garden.

Homezone with bioretention traffic medians and permeable pavement parking bays



Roadside swale

SuDS Brief

① Swale

② Tree pits and permeable parking area within homezone area

③ Source control in back gardens

④ Bioretention area in communal green

Water Reuse Benefit: Water is captured around the community garden for use in watering the allotments.

Biodiversity Benefit: The focus on green SuDS will promote urban ecology and help to achieve the planners objectives for the development. The greening of the development will increase house values.

Amenity Benefit: The use of SuDS in the homezone doubles as traffic calming measures.

Heritage and Character Benefit: The differing SuDS strategies for the character areas have been designed to suit the focus of the local area.

Water Treatment: Pre-treatment of all water is delivered before water is then encouraged to infiltrate, removing water from the town's sewers.

LARGE SCALE URBAN EXTENSION

DESIGN STAGE A

Site Plan

The local Council is looking to develop a 29ha greenfield site on the south western edge of South East Waterbury. They intend to develop a master plan and an accompanying developers brief for the site and release the land to several developers. The vision is to create a mixed use urban extension of approximately 500 units.

DESIGN STAGE B

SuDS Opportunities and Constraints Diagram

- High point
- Low Point
- Direction of flows
- Flood risk zone
- Biodiversity areas

Site Benefits	Site Benefits Appraisal	Designer Reaction
Attenuation	Runoff needs to be matched to Greenfield runoff rates.	
Water Treatment	Environment Agency concerned about diffuse pollution to river.	
Infiltration	Good potential for groundwater recharge in the north.	
Water Re-use	The sustainability officer wants to meet Code for Sustainable Homes level 5.	Opportunity to use rainwater and surface water runoff harvesting to supply non-potable water to homes.
Biodiversity and Habitat	As a Greenfield site, there is a requirement to protect and enhance biodiversity and natural habitats.	Opportunity to integrate SuDS with large wild habitats to be more cost-effective.
Education	The development will mostly cater for families, creating a SuDS educational opportunity for a variety of ages.	
Amenity	The developer wants to maximise the desirability of homes and quality of living environment.	Use SuDS features to provide aesthetic value such as views of green space and water.
Open Space	The proposal will contain large areas of recreation space and play space for families to enjoy.	Integrate SuDS with recreational routes and play spaces.
Character	The area's rural landscape setting to be reinforced.	Well-designed road side swales can enhance the rural character of the scheme.
Microclimate	Opportunity for strategic blue-green corridors to naturally provide cooling and shelter	Think about ecological corridors.

Site Condition	Site Conditions Appraisal	Designer Reaction
Flood Conditions	Part of site falls within a tidal/fluvial flood risk zone in the south where it borders the Waterbury River.	Areas within the floodplain have a high groundwater table Development should limit grading and the development of surface features to avoid erosion.
Groundwater	Groundwater is likely to be less than 3 metres below the ground surface for at least part of the year across the site.	Some SuDS may require a liner.
Topography	Site records show a natural descent towards the river in the south. Two depressions run though the centre of the site. A gulley to the west has a relatively steep gradient.	Opportunity to align natural drainage corridors with key routes. Secondary routes could be angled to feed into these principal corridors.
Soils and Geology	The SuDS map requested from the British Geological Survey shows areas of restricted permeability to the south of the site although there are some areas of good permeability in the north.	Some areas may be suitable for infiltration in the north.
Contaminated land	No record of contamination on site.	
Existing Infrastructure	Existing combined sewers along the roadways to the north and west. No existing drains or other utilities on site.	
Space constraints	Space constraints are low.	Opportunity to provide multi-functional green open spaces.
Runoff Characteristics	General urban runoff from residential and commercial areas and minor roads. 60 percent impermeable surfaces anticipated - roads, pavements, roofs and squares. Permeable surfaces include private gardens and public recreation space.	
Existing Habitat	Hedgerows on site and a number of existing trees, especially around existing drainage corridors. May be water voles near river.	
Ownership and maintenance	Roads will be adopted as public roads by the Highways Authority, and open spaces to be adopted by Local Authority.	

LARGE SCALE URBAN EXTENSION

DESIGN STAGE C: INITIAL TESTING

Design Discussion

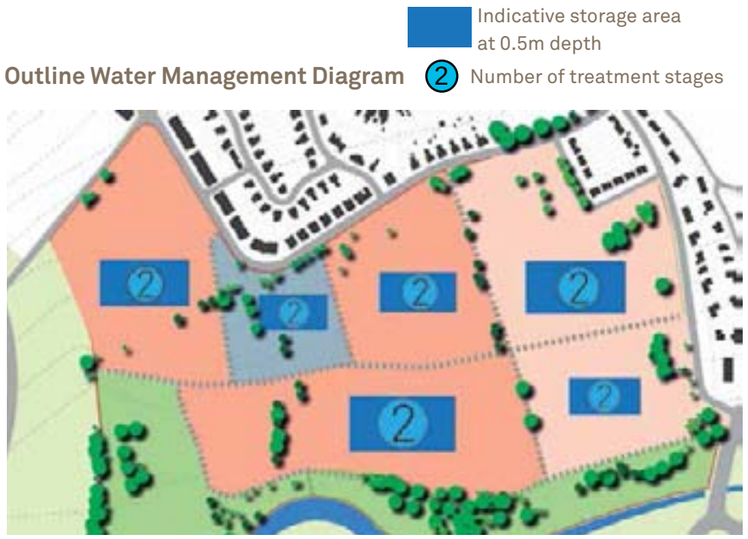
As a large master planned site, it is important to make good early decisions around land use distributions and drainage conveyance paths in order to maximise benefits. An allocation of green space was required for the site by the Council, and the development must include good pedestrian and cycle links as well as a local centre to provide community facilities for residents. At this scale, it is possible to build in a strategic SuDS network. The river is a prime attraction, and the urban designers were keen to bring connections from the town centre to the river. Riverfront property is also at a premium, but needed to be positioned outside of the flood zone to gain planning permission. Two broad options were developed for the site, by examining key routes, favoured locations for the community centre and landscape links:

SKILLSET

Land use plan option 1 and option 2

Option 1: A basic grid system was put in place which will take advantage of the south-sloping site to maximise rows of housing that enjoy a river view. The open space allocation is focussed on the area in the flood zone and the area adjoining the Greenfield boundary to the southwest. Key connections run through and across the site to link the development with the surrounding area.

Option 2: Discussions between the urban designers and water engineer led to an alternative option which will make better use of natural drainage paths and open space to accommodate strategic SuDS for the site. There were clear benefits in maintaining the existing vegetation around the drainage paths, and the urban designers favoured the use of two linear parks. This could efficiently deliver open space which was better distributed through the development, while also raising property values by providing additional homes which overlook green areas.



Outline Water Management Diagram

Green Corridor

LARGE SCALE URBAN EXTENSION

DESIGN STAGE D: PREFERRED STRATEGY

Design Discussion

Options were discussed with stakeholders and the developer group, and Option 2 was favoured due to the increased amenity value for the majority of the development provided by the green corridors. The green corridors were envisaged as key character features for the development, which would be flexible in use, and could accommodate play areas, allotments, pedestrian and cycle paths and SuDS. A business case analysis showed that a larger number of homes could be delivered under this option and that a higher proportion would enjoy green views. The end of the green corridors provided an ideal location for a 'destination' landscape feature that leads into the larger open space adjoining the river. This open space was favoured as an informal grassed space which is able to accommodate flooding as needed. In developing the block structure, the roads were aligned in a slight herringbone structure, so that topography will favour natural drainage towards the green corridors. Phasing discussions favoured the progression of development from east to west, with the green corridors being delivered similarly to provide phased drainage capacity.

Sub-catchments have been defined to mirror the phasing and land use pattern. The amount of attenuation that needs to be achieved in the northern areas is greater due to the infiltration opportunity with more permeable soils, leaving the site-wide features to manage more flow from the southern sub-catchments.

Street structuring for gravity surface drainage

SuDS Concept Plan

CASE STUDIES

SuDS in a Groundwater Source Protection Zone

Augusta Park is a residential area situated on a major chalk aquifer in source protection zones 1 and 2, with restricted discharge of surface water runoff. The development's strategy is for all surface water to be managed through infiltration, in 26 distinct sub catchments designed for the 1 in 100 year flood event + 30% climate change allowance. The design includes shallow swales alongside highways and infiltration and detention basins at the lowest point of the site.

Raising property values in Elvetham Heath

Elvetham Heath is a large site, which due to the high water table, was limited in its ability to manage drainage with infiltration at source. Swales provide the main conveyance route to detention and retention ponds, where runoff is stored and treated. The retention pond is the central feature of the development, improving the amenity and value of surrounding homes. In fact, housing close to SuDS features have seen an estimated 10% increase in property value.

LARGE SCALE URBAN EXTENSION

DESIGN STAGE E: DESIGN REFINEMENT

Design Discussion

While the large green space to the south provides a logical place for strategic-scale SuDS, the high groundwater table, sensitive ecology and flood risk zone requires some careful design consideration. The green corridors themselves can be designed to slow flow and provide significant storage. 'Gateway' features at the end of the corridors were designed as wetlands with horizontal flow and some storage provision. These were positioned outside of the flood zone, so that the SuDS system remains functional in times of flood. A controlled outflow from the wetland can regulate discharge to the river, and back up into storage areas in the green corridors when necessary. The wetland has been designed to be maintained in sections so that habitat can be protected. The western side of the development can make use of a bioretention basin as a landscape feature in the open space outside of the flood zone.

The design of the street hierarchy allocates three street typologies: streets alongside the green corridor swales, main routes which will include bioretention tree pits or permeable paving with shallow drainage that drain to the green corridors and smaller streets that have short kerb runs which connect to the main routes.

Discussion with the sustainability consultant has highlighted a need for a non-potable water source to meet Code for Sustainable Homes level 5. The filtered water from the wetlands and bioretention basin is to be stored in an underground tank for redistribution around the site. A water company has agreed to operate the scheme due to the number of homes requiring delivery of non-potable water.

The strategic SuDS are designed to provide a certain amount of attenuation and also store water for the reuse scheme. The developers brief will include requirements for runoff rate limits, attenuation requirements and treatment stages in each sub-catchment so that developers are clear on how much runoff can be transferred to the strategic SuDS, and what SuDS need to deliver within the development plots. Developers for the northern plots will be encouraged to explore infiltration techniques where soil conditions are more favourable.

SuDS Brief

1. Blue-green corridor with swale
2. Streets with bioretention tree pits/permeable parking area
3. Source control within the subcatchment
4. Bioretention area
5. Storage tank for recycled water

Runoff recycling scheme

Grovelands Farm, Hailsham

Water Reuse Benefit: A site-wide rainwater harvesting scheme uses SuDS to filter water for storage and reuse to meet sustainability targets in a cost-effective manner.

Attenuation Benefit: Storage is accommodated in the development plots and strategic features to store water outside of the flood zone.

Amenity Benefit: The maintenance of drainage paths increases land value by increasing the number of homes with a green space frontage.

Biodiversity Benefit: Existing landscape features were maintained through retention of natural drainage corridors.

Water Treatment Benefit: A treatment train is developed across the site by using strategic features as well as SuDS within the development areas.

Open Space Benefit: Multi-functional green space was distributed around the site, using SuDS as gateway landscape features and drainage pathways as key walking and cycling links.

BUSINESS AND INDUSTRIAL PARK

DESIGN STAGE A

Site Plan

Private developers are looking to develop a business and industrial estate on a site north-west of South East Waterbury. Half the site was previously developed as an industrial site, and the remaining part of the site is greenfield. The site is situated alongside the town's railway with direct access to the station.

DESIGN STAGE B

SuDS Opportunities and Constraints Diagram

- High point
- Low Point
- Direction of flows
- Railway Station
- Reasonably permeable zone
- Contaminated land
- Existing combined Sewers
- Entry to site
- Railway line

Site Benefits	Site Benefits Appraisal	Designer Reaction
Attenuation	Local authority wishes whole site to meet Greenfield runoff rates. Some runoff comes to site from the adjacent railway area.	Could intercept railway runoff with a linear swale to stop additional runoff migrating onto developable area.
Water Treatment	Runoff discharged to ground must not be contaminated.	Run off from the previously developed land could contain pollutants.
Infiltration	Groundwater recharge beneficial in Greenfield area.	
Water Re-use	Office accommodation has to meet high sustainability targets. Irrigation for the landscaped area.	
Biodiversity and Habitat	This edge-of-settlement location requires that biodiversity and wildlife habitats are enhanced.	Focus on biodiversity in western area.
Education	Employees can appreciate SuDS features in their place of work.	
Amenity	The developer wants to create an attractive setting to attract businesses to the site.	Use SuDS to create an amenity feature for offices.
Open Space	Tranquil recreational areas for employees to relax in and take a break.	Look to integrate SuDS features that can create a recreational opportunity such as a retention pond.
Character	The business park should provide high quality office accommodation within an attractive green setting.	Opportunity for water feature.
Microclimate	Workers will appreciate pleasant sheltered areas for sitting outside.	

Site Condition	Site Conditions Appraisal	Designer Reaction
Flood Conditions	The site is not within a flood risk zone, but is a surface water flooding hot spot due to a culverted watercourse beneath the site.	Opportunity to 'daylight' culverted watercourse and discharge directly.
Groundwater	Groundwater is likely to be more than 5 m below the ground surface throughout the year.	Groundwater levels are low and recharge is desirable in suitable areas.
Topography	Site records show a fairly steep slope in a southeast direction away from the railway line.	Opportunity to retain natural gully
Soils and Geology	Bore hole records show reasonable permeability across the site.	
Contaminated land	Contamination recorded in the eastern part of the site which was previously an industrial site. Greenfield area is contamination free.	Infiltration only suitable in western area
Existing Infrastructure	Existing combined sewers along the roadways to the south. Existing utility infrastructure located in the previously development plot. Culverted watercourse.	Design to consider existing utility trenches
Space constraints	Restricted by railway to north and existing properties to east, but otherwise has sufficient space.	
Runoff Characteristics	Industrial proposals include the handling of industrial chemicals and heavy vehicle movements. Business park has a lower pollutant risk. Approximately 70 percent impermeable: including roads, pavements, car parking pavements, large roof areas.	Need to segregate high risk industrial areas
Existing Habitat	Greenfield area required ecological survey, but protected areas identified.	
Ownership and maintenance	Site privately managed.	

BUSINESS AND INDUSTRIAL PARK

DESIGN STAGE C: INITIAL TESTING

Design Discussion

Runoff was a crucial factor to consider in the land use allocation of this site due to the variation in the pollutant risk associated with the mix of uses. A recycling centre is a land use which could give rise to contaminated runoff which will need to be treated as industrial waste. Warehousing and office buildings present a much lower pollutant hazard and surface water management should be separated in these areas from the recycling centre so that runoff can be gathered and filtered by SuDS features. Uncontaminated runoff can then be directed to a new separate surface water drainage network or allowed to infiltrate in the southern Greenfield area. The northern half of the site also has contaminated soils, meaning that infiltration SuDS need to be avoided and water should be managed on surface where possible. A contamination specialist and water engineer worked with the design team to position the recycling centre in the northern area of the site. The distribution warehouse was deemed to be the most suitable partner use on the brownfield portion of the site, while offices were allocated in the Greenfield section.

Outline water management diagram

Indicative storage area at 0.5m depth

2 Number of treatment stages

Chiswick Business Park

SKILLSET

Urban Design · Architecture · Landscape Design · Contamination Advice · Water Engineering · Planning · Highway engineering · Flood risk advice

CASE STUDIES

Innovative and collaborative thinking in the Highways Authority

As part of Greater Ashford's regeneration effort, the Town Centre Development Frameworks determined that the one way ring road needed to be removed to increase safety and make the town centre more attractive. The design involved a radical plan to remove highway signage and markings to introduce an element of uncertainty so as to ensure that pedestrians, cyclists, and motorists had to negotiate their way through the city. Through using an interdisciplinary team of landscape architects, engineers, highways authority, and artists the final design combined creativity with functionality. In terms of drainage, West Street integrates sustainable drainage systems within a central linear park, which takes advantage of the existing topography and hydrology. The design showcases what is normally a hidden, engineered process of managing rainwater.

BUSINESS AND INDUSTRIAL PARK

DESIGN STAGE D: PREFERRED STRATEGY

Design Discussion

Key impermeable surfaces that will generate runoff are now distributed around the site and the structuring of SuDS features begin to take shape. The recycling centre has been separated from the drainage system. In the brownfield area, the emphasis is on reducing runoff and conveying it to the southern area where infiltration is more suitable. To avoid contact with contaminated soil, options such as a green roof or rainwater harvesting are favourable for the large warehouse roof, and additional runoff will be conveyed to the southern area using a lined swale or pipe. The business park developer favours the use of a central water feature for the business park to add prestige and character. This provides the opportunity to position a pond feature around the low point in the site which will act as an entrance feature for the business park. The business park requires a large amount of car parking, which has been positioned at the back of the site adjoining the railway, providing opportunities to capture and treat water at the north before transferring runoff to the southern pond. Options include permeable paving or integrated rain gardens.

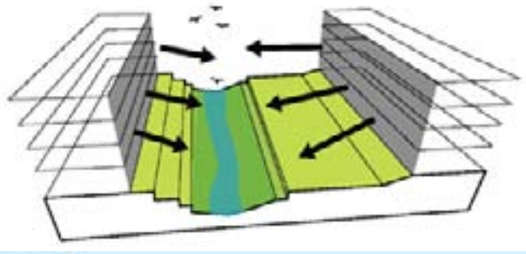
The designers were also aware that runoff was shedding onto the site freely from the railway corridor. To intercept this flow, a swale has been placed along the back boundary of the site, also draining the back access road that links the carparks. A culverted watercourse exists on site running diagonally across the central southern area. Discussions were held with the architects to see if offices could be positioned to retain this as a central feature if it was 'daylighted' (deculverted) and it was seen as a unique design opportunity. The presence of a watercourse onsite also provides a discharge point for runoff following treatment and attenuation via the SuDS network.

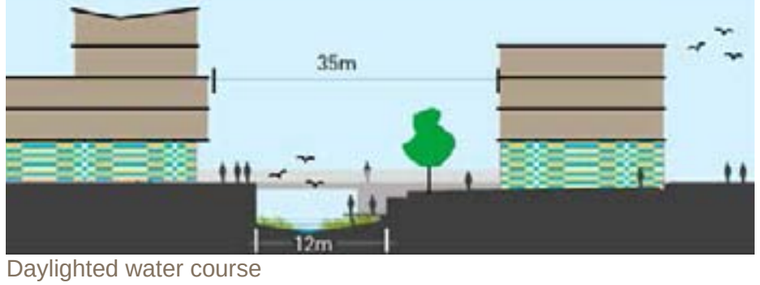
SuDS Concept Plan

- Railway Station
- Roof drainage
- Parking runoff
- Swale
- Retention pond
- Parking with permeable paving
- Existing stream
- Railway line

SuDS Ideas

①





Daylighted water course

BUSINESS AND INDUSTRIAL PARK

DESIGN STAGE E: DESIGN REFINEMENT

Design Discussion

The daylighted watercourse was designed sensitively to allow it to rise and fall with varying flow while maintaining useful public realm edges. Natural planting was included to help provide natural treatment of the watercourse. The watercourse itself maintains separation from the SuDS system until water is discharged from the ponds at a controlled rate at the southern end of the site. The SuDS options for each key sub-catchment were appraised to decide on the optimal selection of features.

Sub-catchment	SuDS Proposed for sub-catchment runoff	
	Within Sub-Catchment	In wider-site
Roofs	- Rainwater harvesting for toilet flushing - Bioretention gardens in forecourt - Rill connections	- Pond (with infiltration)
Back road and railway tracks	- Adjoining swale	- Pond (with infiltration)
Car-park	- Integrated bioretention rain gardens or permeable paving (with infiltration)	- Adjoining swale - Pond (with infiltration)
Warehouse	- Green roof	- Swale / Rill for overflow - Pond (with infiltration)

SuDS Brief

1. Pond
2. Daylighted water course
3. Swale
4. Permeable paving or bioretention
5. Warehouse green roof

Water Treatment Benefit: Runoff is managed to avoid contamination where possible.

Amenity Benefit: Central pond provides a selling point for the business park. Green roof on large warehouse provides improved view from elevated railway.

Attenuation Benefit: Existing runoff from railway tracks is gathered and treated by perimeter swale.

Biodiversity Benefit: Addition of pond and bioretention gardens in the southern area along with the green roof will promote integration of the development with its Greenfield surroundings.

08

FURTHER INFORMATION AND GUIDANCE FOR DETAILED DESIGN

FURTHER GUIDANCE

This document presents what needs to be considered when designing SuDS at the initial and concept design stage of a master plan. Guidance for detailed design of SuDS is available from a number of sources to inform the next stage of design. A list of resources is available from Susdrain: The Community for Sustainable Drainage.

There are also legislative requirements for the design of SuDS. Current requirements are provided by Defra and your Lead Local Flood Authority.

Brighton & Hove City Council

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kent.gov.uk

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