Grey to Green Phase 1, Sheffield

Fig.1 SuDS Swales in mid-summer in the 1st year of establishment Photo - SCC

SuDS used

- *25 swale/bioretention cells in linear sequence*

Benefits

- *Positive transformational change of the environment of an important inner city area for economic, habitat and wellbeing benefits*
- *Reduction in impermeable areas draining to the combined sewer and diversion of controlled and cleaned surface water to the River Don*

1. Location

West Bar, north side of city centre of Sheffield S3 8PH

2. Description

Grey to Green is a key strategic component in the regeneration of Sheffield's city centre. Intended to transform the Riverside Business District and create a more attractive environment within which to live and work and attract investment. The gardens, functioning as SuDS features, gathering spaces, sculpture and generous footpaths establish a definitive sense of place and mark this area out as a distinctive and desirable business address.

The area was once dominated by unattractive dual carriageways and complex junctions severing areas of townscape. The completion of the new inner relief road in 2008 diverted much of the traffic away from the Riverside. The City's intention was to forge a distinctive townscape from the redundant highways, making full use of the generous spaces available to introduce new activities and a very different type of environment that would soften the surrounding architecture. This 0.7km project forms the first phase of a projected 1.3km green corridor.

A central tenet of the approach to the site was to place SuDS at the heart of the scheme, celebrating their function and using it as an organising factor. By doing so the alignment, engineering and particular mixture of planting help to set the character and establish the identity of the area. The scheme is opportunistic in terms of SuDS rather than driven through surface water problems, it is a demonstration that SuDS can be achieved in an inner city urban environment.

Fig. 2 SuDS cascade through areas of significant level change, together with wetland planting – Photo SCC

3. Main SuDS components used

- Flush kerbs allowing immediate flow from highway into receiving resin bounded gravel filter strip

Subsequent receiving ornamental planted swale adapted with 25 run-off storage compartments (cells) provided by check dams for larger storm events with control structures ensuring the attenuation and subsequent drawdown of run-off.

- Shallow connectivity between green areas through dished channel drains
- Attractive protected inlets providing connectivity to final river discharge point

4. How it works

The location and scale of the new green landscape was influenced by numerous factors including provision for bus, pedestrian and cyclist movement and the need to create spaces for the working, living and visiting communities. This, combined with the levels of the highway and known service locations, created the spatial framework for how the SuDS would be designed and what it could deliver in terms of hydraulic benefits. It was not a case of setting standards, for example discharge rates, rather a case of working with the environment to see how it could maximise benefits whilst making a safe and attractive environment.

SuDS principles are used to manage surface water with it being captured, treated at source, controlled and conveyed on or near the surface providing an opportunity for water to be part of the landscape. The scheme manages flows from the new paved pedestrian/cycle surfaces as well as half of the highway (service depths made it difficult to re-profile whole highway). Runoff is collected via simple over edge flush kerbs into a swale running the length of the scheme.

Fig.3 SuDs Cell edge treatment Photo - Nigel Dunnett

The shallow swale is formed using engineered soils made from recycled compost and glass mixed with crushed sandstone and low proportions of loam. This is planted with a diverse mix of open dry and wet perennial planting and mulched with crushed sandstone. Carrying on a strong tradition of city centre horticulture, this was intended to provide a long range of seasonal interest as well as an opportunity for wildlife. 25 check dams provide the containment of flows along the length of the swale, with provision for below ground control through protected orifices, as well as above ground weirs providing for connectivity down through the system.

Within the swales a crushed stone mulch absorbs energy from the runoff and allows sediments to be deposited along the swale length, reducing the likelihood of localised accumulation and allowing the natural breakdown of pollutants (eg hydrocarbons). The system is largely unlined and while there were some areas of clay visibly holding water during construction there will be some losses through infiltration. It is expected water treatment processes will occur on the surface as well as within the actual growing media.

Everyday flows remain within the growing media with water that is not infiltrated passed to the next cell via a draw down system comprising of a collection perforated pipes, control chambers and subsequent perforated distributor pipes.

With the high proportion of SuDS landscape to impermeable contributing area the losses through evapotranspiration and infiltration mean the 5mm criteria for interception losses should be easily surpassed for this scheme. Orifices at each check dam were modelled to optimise the system's storage with an acceptable 3-4 hour drawdown of runoff within each cell. There are three different orifice sizes to simplify construction/maintenance (30mm, 50mm, 75mm). It was only at the completion of the scheme that a clear picture of hydraulic benefits was understood.

Overtopping of the check dams is also controlled with slot weirs and horizontal cut outs with extreme events being able to overtop the whole dam width which was set just below highway level.

Flows out of the system are via domed inlets to ensure reduced risk of blockage. These redirected, controlled and cleaned flows to the River Don are taken away from the combined sewer.

Fig.4 People using the spaces that were previously devoid of activity – Photo – SCC

5. Specific project details

The principle of an environmental scheme was established within the masterplan. However it was a funding opportunity that galvanised the client within the city regeneration team to action delivery. The strong experience of the Council urban design team meant the lead design role was quickly assembled. A history of collaboration with highway designers now employed by Amey consulting (Amey are also the highway maintenance contractor under a PFI) meant a scheme was able to be assembled quickly. A lack of SuDS experience was addressed through employing SuDS designers Robert Bray Associates to provide close design supervision and modelling input from Anthony McCloy Associates. The innovative perennial planting design was supported by advice from Professor Nigel Dunnett at the University of Sheffield Landscape Department.

From early consultation responses the concerns of local business and residents were focussed on the poor quality of environment and lack of social space. The project was developed through regular contact with the Riverside Business Association with attendance at meetings and public exhibitions, enabling many of the difficulties associated with congestion and diversions that arose during the construction phase to be addressed in an established forum. Individuals businesses were written to inform them of key dates and this was supported by a regular newsletter produced by the contractor.

Robust design principles – wide footways and robust construction details of the footpaths, concrete check dam walls, highway edge details and the control mechanisms of the water flows. In a city of

makers, substantial elements of the engineering such as the check dams, outfalls and grilles are celebrated as positive aspects of design rather than hidden or disguised.

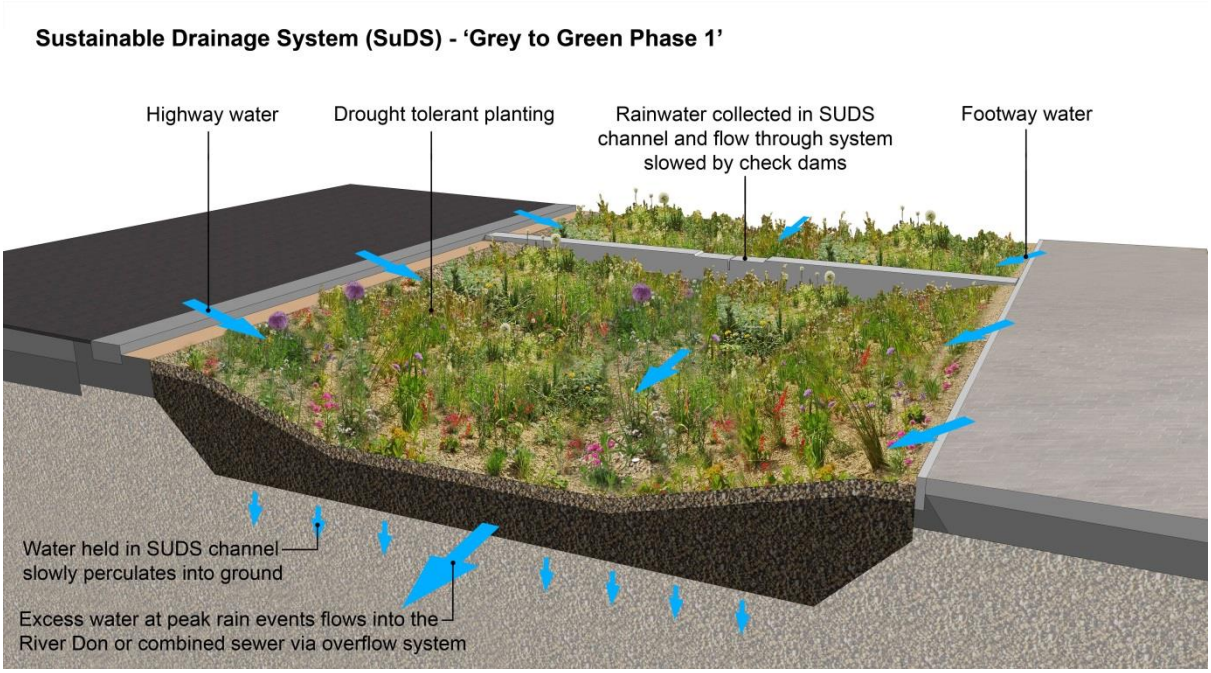

Fig. 5 SuDs cell visualisation used for consultation and interpretation Image – SCC

6. Maintenance & operation

The development of this scheme has lead to an on balance reduction in maintenance costs associated with removing bituminous surfacing, gulleys and traffic management equipment and replacing with landscape. However specifically with the SuDS, the close working with the Highways maintenance client and contractor concluded that the drainage function of the SuDS landscape combined with the unimpeded run-off of flow into the landscaped SuDS areas was of very low risk and maintenance input. The low maintenance high impact planting using one cut a year was also intended to keep costs down (with weeding in spring and self-seeders such as Buddleia removed sporadically). 3 years of establishment maintenance through a specialist local contractor is ensuring the scheme maintains a high standard.

Fig.6 Seasonal interest is maintained throughout the year – Autumn in the 2nd year of establishment SCC

7. Monitoring and evaluation

The initial modelling process to optimise the system suggested the scheme would have significant hydraulic benefits in slowing discharge offsite to the River Don. These were then later refined based on the as built drawings. The Infoworks (ICM) modelling showed the scheme could contain a 60 minute, 1 in 30 year event with discharge from the whole scheme to the river reduced from 47.3l/sec to 9l/sec. A 1 in 100 year, 60 minute event would start to overtop the weirs but nevertheless reduces rates from 69.6l/sec to 9.2l/sec. These post construction rates were lower because infiltration could be considered as a result of the final scheme being unlined. Although the ground varies, a rate of $1x10^{-5}$ m/sec was included within the ICM modelling. The output from the system to the river was estimated to be 12.1l/sec for a 1 in 100 year event plus 30% for climate change.

The range of the species selected allows for the ebb and flow of the success of individual species and the tolerance of the mix to sustain a certain amount of damage before springing back.

8. Benefits and achievements

Flows should be diverted away from the sewer utilising the landscape rather than contributing to river flows in intense storms through uncontrolled discharge.

Heat island effects are currently being monitored but early signs are showing positive reductions to the ambient temperatures for the surrounding area compared to the almost one hundred percentage coverage of bitmac surface prior to the scheme starting (source current PhD study).

A series of new habitats have been created from this low base, with both soil and plant-based communities able to establish. The species diversity and length of flowering times of the bulbs and perennials mean that insect pollinators have a good source of nectar throughout the year. The linear nature and degree of plant cover, including 40 semi-mature trees, provides a near continuous corridor which will connect with the river Don in future phases.

The success of this phase of the project has now encouraged future phases and given confidence to the city that this approach should be developed further.

9. Lessons learnt

Close working with Highways allowed fears over the design approach to be addressed, for example achieving the flush kerb edge to the highway.

There is a need to challenge the default of needing to line SuDS features within the typical contaminated inner city. The team insisted on a geotechnical environmental impact assessment of infiltrated water on contaminant mobilsation which lead to a more favourable unlined system with connectivity between the growing medium and lower subsoils and improved losses through infiltration.

Despite site investigation work, the precise nature and location of services cannot be fully determined. Design teams need to remain flexible to incorporate such constraints, for example a very high voltage cable required design changes through the scheme delivery.

A willingness to explore an innovative approach to public realm and the highway environment and to take what could be perceived as risks is massively facilitated by a cooperative team of in-house designers with a strong stake in the success of the city.

Fig.7 The established areas attracting people to inteact with the new landscapes – Photo – Nigel Dunnett

10. Interaction with local authority

Details of interaction with local authority (or client)

11. Project details

Construction completed: Practical completion Spring 2016. Suds part of overall main NEC contract

Cost: Total project Cost £3.4m

Extent: Total project area is 1.0Ha and the total length is 0.7km Project team.

12. Project team

Funders	• Sheffield City Region Investment Fund • European Union ERDF programme Sheffield City Council
Clients	• Sheffield City Council
Designers	• Lead Design Sheffield City Council • Highway Design – AMEY • SUDS advice and flow Modelling– Robert Bray Associates • Planting advice – University of Sheffield, Nigel Dunnett
Contractors	• Main contractor - North Midland Construction • Softworks contractor – Ashlea • Softworks maintenance - Green Estates
Other	• Project and cost management - Turner and Townsend