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permeable paving for amenity

CASE STUDY
ROBERT BRAY ASSOCIATES
SUDS PROJECTS

Interpave

THE PRECAST CONCRETE PAVING AND KERB ASSOCIATION

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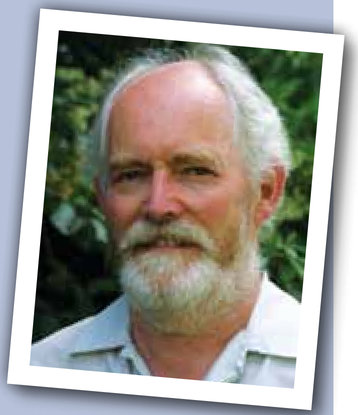
Adding an extra dimension to SUDS

Robert Bray Associates are Sustainable Drainage Consultants and Landscape Architects and Principal Bob Bray has been closely involved with sustainable drainage for 15 years designing schemes, lecturing and training, and writing on the subject. He has provided in-house training for Local Authorities, Regulators and Consultancies, undertaking National SUDS Training with CIRIA since 2004. He is the author of ‘Promoting Sustainable Drainage Systems - Design Guidance for Islington’ and a co-author of The SUDS Manual C697 2007 and a recent design guide for Cambridge City.

He has developed an environmental approach to SUDS which delivers sound, cost-effective drainage solutions that also exploit the potential for amenity and habitat enhancement. This approach goes beyond just compliance with planning requirements and legislation, aimed at helping to prevent flooding, and recognises that there are real opportunities – often missed – to make the most of improved quality water to add to the amenity of a scheme.



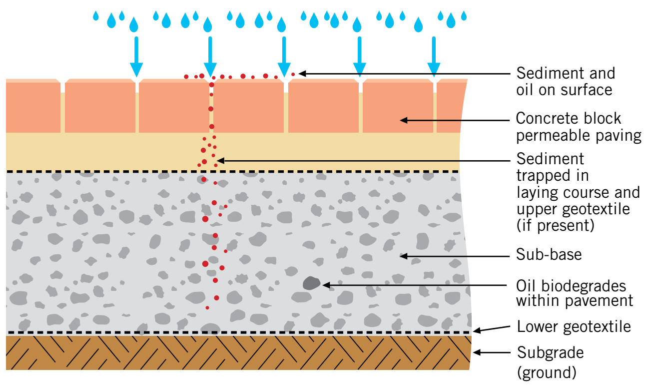
This wider view of sustainable drainage recognises that there are three ‘pillars’ of SUDS:

- Quantity – reducing and controlling runoff
- Quality – improving water quality by removing pollutants
- Amenity with biodiversity – enhancing the environment.

The first of these is well-known with engineering based solutions, guidance documents and, due shortly, National Standards. SUDS are also an important component of both the Code for Sustainable Homes and BREEAM, as well as a national planning policy requirement. But there are real opportunities – often missed – for designers to make the most of improved water quality to add to the amenity and habitat enhancement of a scheme. It is here that the unique capabilities of concrete block permeable paving take on particular importance. The following case studies have been selected to showcase the benefits of permeable paving in providing good quality water close to ‘source’.

Permeable Paving Capabilities

Permeable paving deals with surface water close to where rainfall hits the ground, which is known as ‘source control’ and is fundamental to SUDS philosophy. It also reduces the peak rate, total volume and frequency of runoff. It helps to replicate green-field runoff characteristics from development sites, as well as requiring no any additional land take - particularly relevant on high-density schemes. In fact, it can handle runoff from roof drainage and adjacent impermeable surfaces, as well as rain falling on the permeable paving itself.



Concrete Block Permeable Paving provides a steady flow of clean water for:

- Landscape Design
- Biodiversity
- Education & Play
- Water Harvesting
- Sustainability
- A better Environment

Importantly, concrete block permeable paving is also very effective at removing a wide range of pollutants from runoff, so improving water quality. The pollutants may either remain on the surface or be flushed into the underlying pavement layers, where many are filtered and trapped, or degrade over time. Oil separators are also not needed with permeable paving.

As a result of these capabilities, concrete block permeable paving offers designers the exciting potential of a gradual supply of clean, treated water for a wide variety of uses – something that Bob Bray has already seized upon in his projects. The following examples illustrate this approach and how it can be applied in different ways to suit specific local needs and site conditions. Each scheme is based on sound drainage engineering principles, developed as an integral part of the landscape design to add interest, biodiversity and fun to the external environment

Percentage Removal of Pollutants	
Total suspended solids	60-95%
Hydrocarbons	70-90%
Total phosphorus	50-80%
Total nitrogen	65-80%
Heavy metals	60-95%
(source: CIRIA C609, 2004)	

Water Quality Treatment Potential	
Removal of total suspended solids	High
Removal of heavy metals	High
Removal of nutrients (phosphorus, nitrogen)	High
Removal of bacteria	High
Treatment of suspended sediments & dissolved pollutants	High
(source: CIRIA C697, 2007)	

Hazeley School Milton Keynes

At this pioneering school, a terraced sequence of concrete block permeable pavements – used for car parking – step down the hill, to provide a retention time enabling effective pollutant removal. They effectively form a series of storage tanks, controlled at each level change.

This substantially improves the quality of water serving two ponds intended to encourage long-term population by wildlife - notably the 'protected' great crested newts indigenous to the site. Wildlife is also protected with an absence of traditional drainage gulleys and other traps – an important benefit of concrete block permeable paving.

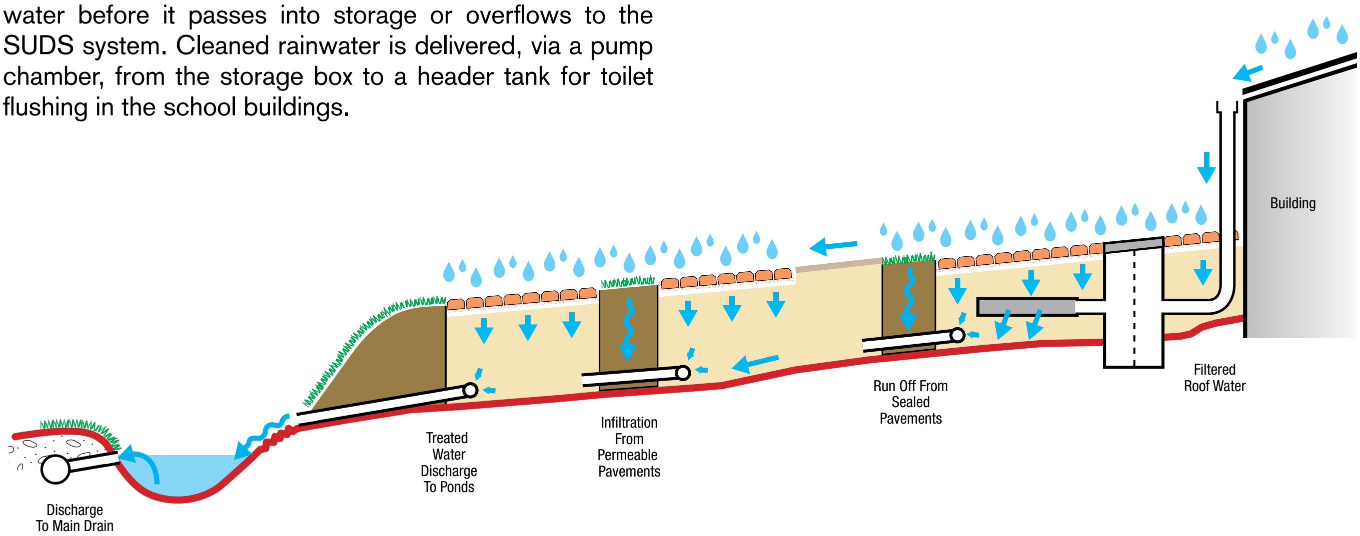
Learning Resource

The ponds themselves are highly vegetated and designed to filter the water, particularly during times of low flow, effectively acting as a 'polishing' feature or a second stage in the SUDS 'management train'. In addition to providing wildlife habitats, the ponds and related areas offer a valuable teaching and learning resource for the school.

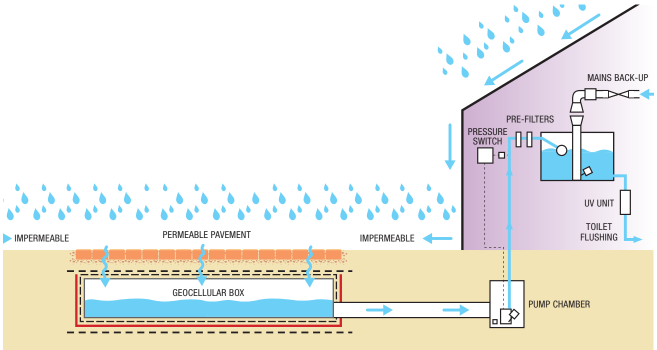
Rainwater Harvesting

Other sections of concrete block permeable paving, on level areas used for play, collect direct rainfall and runoff from adjacent hard games surfaces and roofs. Below the paving, geocellular storage boxes and a geomembrane form an open tank. This arrangement filters and treats the water before it passes into storage or overflows to the SUDS system. Cleaned rainwater is delivered, via a pump chamber, from the storage box to a header tank for toilet flushing in the school buildings.

Wildlife pond fed with clean water, via outlets from concrete block permeable paving car parks above.



Concrete block permeable paving accepts runoff from asphalt roads as well, then stores and treats water for amenity.



Extensive playground areas in permeable paving collect rainwater and runoff from roofs and other areas for recycling.

With correct detailing, permeable paving can be used right up against buildings and accept roof-water.

Wildlife ponds act as a final SUDS management train 'polishing' feature after terraces of permeable paving.

Riverside Court, Stamford

The idea of SUDS becoming an integral part of urban design is developed at Riverside Court in Stamford, Lincolnshire – a high-density (106 units/hectare) town-centre housing scheme. Most public areas between the buildings are concrete block permeable paving which also accepts runoff from other hard areas and roofs.

The (System B) permeable paving does enable some infiltration to the ground but stored, treated water also passes from the paving directly into planted rills and canals, which add interest and much-needed greenery to the courtyard environment. Finally, the treated water can flow out into the adjacent River Welland.

Extensive areas of concrete block permeable paving also collect roof-water.

Treated water from permeable paving feeds planted rills.

Excess, treated water from planted canals discharges into the river.

Springhill Co-Housing, Stroud

This innovative Co-Housing Project of 34 homes and communal facilities is laid out along a central pedestrian street. The drainage design had to deal with runoff on a steeply sloping site. Here, SUDS is considered as an integral part of landscape design and urban space.

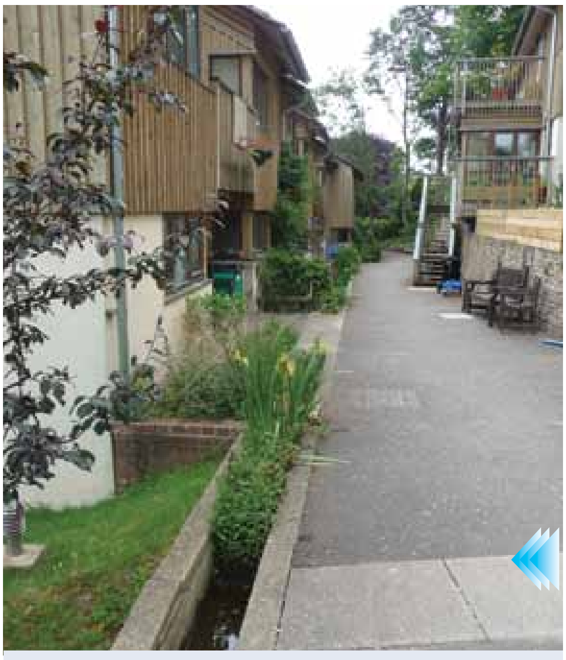
Vehicle access and car parking is limited to the top of the site where concrete block permeable paving gathers up runoff, treats it and stores it. Discharge from the tanked (System C) permeable paving, together with some roof water, is directed to a 'waterfall' flowing onto a densely planted swale below. From here, water makes its way naturally through the site alongside the pedestrian street via rills planted by individual house occupants, a wildlife pond and a play area which also acts as a detention basin – augmented by below-ground storage – eventually meeting up with an established stream.

> *"Springhill clearly demonstrates the potential for concrete block permeable paving as a steady source of clean water to improve the environment of the whole site. In my view, landscape and urban designers should view permeable paving positively as an important SUDS component, not just a means to satisfying regulations."*
>
> Bob Bray

Concrete block permeable paving at the top of the site provides clean water for amenity.

Planted rills carry water alongside the pedestrian street.

Permeable paving attenuates and treats runoff before discharging through a waterfall, down a tile-hung panel, onto a planted swale.



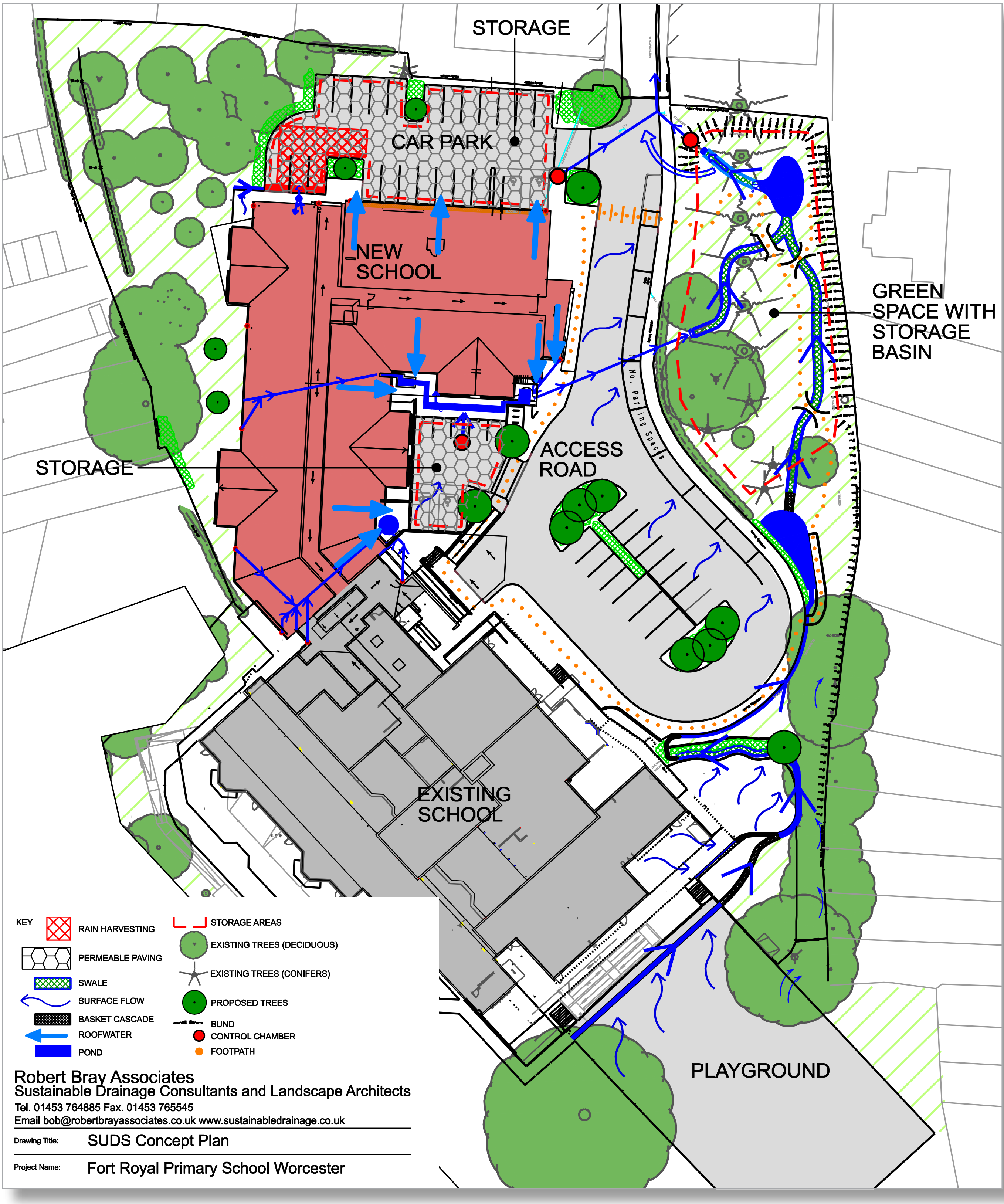
Water works its way naturally through the site encouraging plants and insects.

Water from the permeable paving feeds a small wildlife pond.

Fort Royal Community Primary School Worcester

Fort Royal is a purpose-built, generic primary school for 150 children with a range of special educational needs. These include moderate, severe or profound and multiple learning difficulties, sensory impairment, physical disability, behavioural difficulties or an autistic spectrum disorder. The SUDS scheme maximises opportunities for pupil interaction, play and enjoyment.

> *"Every project needs some hard surfaces, often for traffic which can deposit pollution. Using concrete block paving as a source control at the head of the SUDS management train is a particularly useful solution with a range of benefits."*
>
> Bob Bray



Water from roofs simply trickles down rainwater cup-chains or flows from stainless steel spouts onto concrete block permeable paving in the upper car park where it is stored and treated. Clean water then discharges through a retaining wall via a dramatic stainless steel pipe and chain: the extremely cold winter of 2010 provided an interesting demonstration of the permeable pavement continuing to gradually discharge unfrozen water, which then immediately froze on the chain.

Feeding into Natural Features

This water is collected, together with other roof-water, into a planted rill. From here it is transferred to a natural, green play-space at the bottom of the site, together with runoff from uphill playground areas, via a glass-sided pool. This green space includes a pond and is contained by a bund to protect adjacent properties. The lower, front car park permeable paving also collects water from roofs on the building and its hydropool. The water is stored and treated before being re-used for toilet flushing.

The permeable paving on this scheme is invaluable in supplying a controlled flow of treated water for use on various amenities on site. Any excess water from both routes at the bottom of the site passes into a combined sewer. Storage in the permeable pavement and the green space detention basin provides 'greenfield' rate of runoff for the new school buildings, i.e. 5l/sec/ha, and a significant storage contribution for existing play space to ensure there is no additional rate of flow from the re-development site.

The lower car park collects water for re-use with toilet flushing.

Upper car park permeable paving also collects roof-water.

Discharge from the permeable paving is via a stainless steel outlet and chain.

Water from the upper car park finally makes its way into a natural play space and pond.

Red Hill C of E Primary School Worcester

Interestingly, concrete block permeable paving takes a different role here, compared to the previous projects where it is generally at the head of the SUDS management train. On this occasion, the permeable paving is used on car parking at the **lowest** point of the site, providing essential storage and treatment before discharging clean water to the storm-water sewer to satisfy drainage authority requirements – and ensuring the viability of the scheme. No other SUDS technique could collect and clean water, and provide the enhanced storage volume needed in this situation. A diversity of other SUDS techniques could then provide amenity elsewhere on the site. This project also provides a demonstration – which follows - of the fully-engineered drainage approach essential to the success of all the projects covered in this document.

The School is situated in a site of 18,413m^2 (i.e. approaching 2 hectares) with the school and surrounding hard areas comprising 5,305m^2. Discussions with Severn Trent Water confirmed a requirement to discharge runoff separately to the storm-water sewer at a controlled rate of 10l/sec for the whole site. It was acknowledged that, due to historical development, there was no access to a watercourse or an overland flood route from the site. Therefore, flows in excess of the 30-year flood will discharge to the sewer directly, as they have done in the past. As a result, the SUDS design endeavours to maximise storage of runoff wherever possible.

Holistic Design Approach

The site falls from higher ground to the east, down to the new school, where runoff is directed around both sides of the building (routes 1 and 2). The southern route 2 flows from the play area, along a sett channel, into a short collector swale before entering a pipe taking water below the access road into the woodland basin. This includes a swale maze for play and education which is particularly popular with children. The water is cleaned and stored in the basin before it flows slowly to the sewer or overflows – in extreme events - directly to the site outfall.

The northern route 1 flows from the lower play area to the car park, where water with possible pollution from cars is cleaned in the concrete block permeable paving, before below-ground storage and eventually entering the storm-water sewer. A cleverly-designed, raised, conventional block-paved entrance walkway (shown) acts as an emergency bund, with an overflow grating to allow extreme events to flow directly to the outfall, as well as a traffic-calming element.

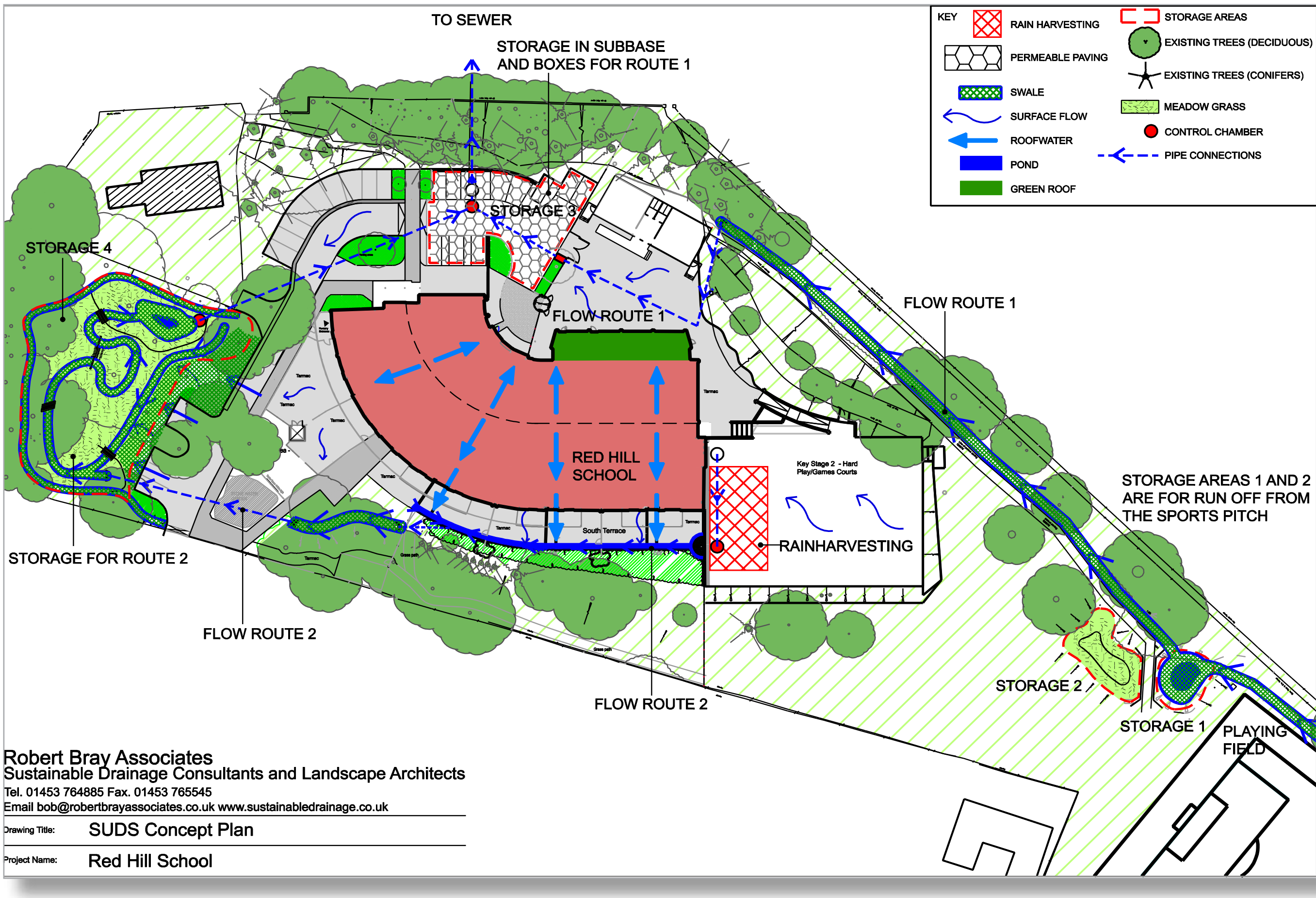
Calculated Performance

The area of developed site leading to the woodland basin is 3,351m^2 which, for a 30-year return period, requires 120m^3 storage. Assuming 200mm storage in the 910m^2 basin, there is 182m^3 of volume available, giving 62m^3 additional storage volume.

The area of developed site leading to the permeable pavement is 1,954m^2 requiring a 30-year return period storage of 70m^3. The car park is 365m^2, offering 54.75m^3 of storage, assuming a 600mm overall depth. This exceeds the 1 in 10-year storage (50.8m^3) but with a shortfall of 15.55m^3. This will be accommodated by providing an additional 15.25 + 4.6 (lost storage) = 19.85m^3 of geo-cellular box storage below-ground.

The SUDS scheme can therefore provide storage needed to meet the 1 in 30-year attenuation required by Severn Trent, a minimum of one treatment stage for all runoff required by SUDS guidance and various amenity opportunities for the school.

Concrete block permeable paving provides essential storage and treatment, contained by a slightly raised walkway with emergency overflow.



"The projects shown here aim to use water collected and treated by concrete block permeable paving as a positive contribution to sensitive landscape design. But the starting point every time is hard-nosed engineering to meet the drainage requirements of the site, supported by detailed analysis and calculation. Once that aspect is satisfied, we can explore how the permeable paving, with other SUDS techniques, can be used with the natural site characteristics to enrich the environment, improve biodiversity and sustainability – and add some fun."

Bob Bray

The swale maze and woodland basin at Red Hill are particularly popular with children.

"My experience of using concrete block permeable paving over a decade or so reinforces the need to get the design, detailing and construction right from the start – particularly avoiding joint-clogging by soil or building materials. Once that is achieved, the paving needs minimal maintenance – probably none for at least 5 years. And even if localised clogging occurs, it becomes obvious and easily resolved. I am sure there is scope for designers to use permeable paving in fresh, inventive ways as part of sustainable drainage and landscape schemes."

Bob Bray

Acknowledgement

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