October 2016

Uniclass L534:L217

- Projects designed by Robert Bray Associates
- Optimising performance of permeable paving
- Precast concrete & landscape design with SuDS

INNOVATIONS WITH SUDS & HARD LANDSCAPE

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Interpave
THE PRECAST CONCRETE PAVING AND KERB ASSOCIATION

Hazeley Academy, Milton Keynes - designed on slopes, in terraced compartments with flow controls, the permeable paving supplies a steady flow of clean water to wildlife ponds inhabited by great crested newts.

INTRODUCTION

Robert Bray Associates (RBA) are sustainable drainage (SuDS) consultants and landscape architects. Founder Bob Bray, a leading SuDS designer since 1996, has completed over 50 SuDS projects including housing, schools and commercial developments, as well as civic and public realm enhancements. He writes and speaks extensively on SuDS, authoring and contributing to articles, design guides and academic papers, as well as presenting SuDS training courses.

RBA have developed an environmental and design approach to SuDS that delivers exciting, attractive, cost-effective and easily managed solutions that also exploit 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.

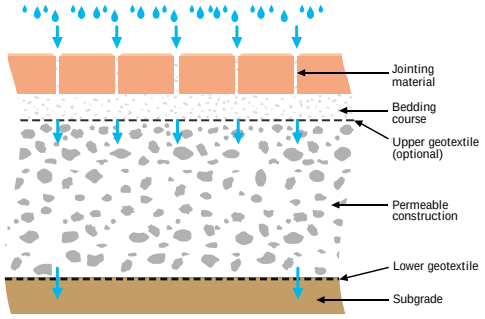
Recognising its potential as a key, multifunctional SuDS technique, RBA have been designing with concrete block permeable paving for many years. They have made the most of permeable paving to deliver a gradual flow of clean water for amenity, landscape design, biodiversity, education and recycling on numerous schemes, including those discussed here and in Interpave's case study:
• *Permeable Paving for Amenity, Robert Bray Associates SuDS Projects* – 2011

Importantly, they continue to develop innovative design approaches to optimise the potential of permeable paving and other readily available precast concrete landscape elements in SuDS schemes, exemplified here and in Interpave's:
• *Hazeley Academy Milton Keynes* – 2015
• *St. George's Primary School Kiddeminster* – 2013

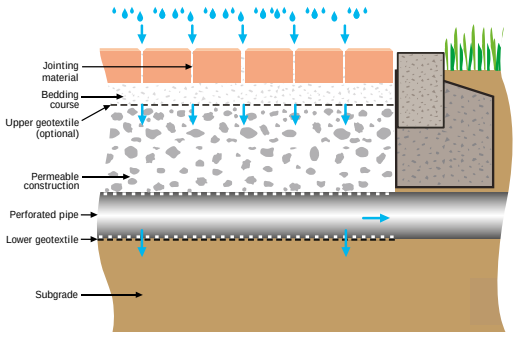
All the above and other case studies can be downloaded from www.paving.org.uk

The RIBA Award winning St George's School, Kidderminster, utilises concrete block permeable paving and other readily available precast concrete landscape elements within a fully developed SuDS management train.

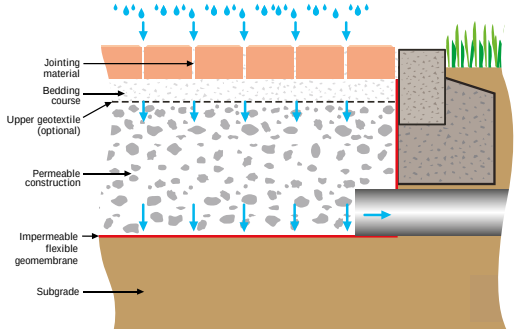
PERMEABLE PAVING PRINCIPLES



System A - total infiltration



System B - partial infiltration



System C - no infiltration

After more than two decades of use in the UK, concrete block permeable paving has proved to be a predictable, reliable and low-cost SuDS technique. Of course, it provides attractive, hard surfaces needed on any project – whether for traffic (including HGVs), parking, pedestrians or play – but it also creates an inherent drainage system, addressing both flooding and pollution issues by attenuating and cleaning surface water runoff at source.

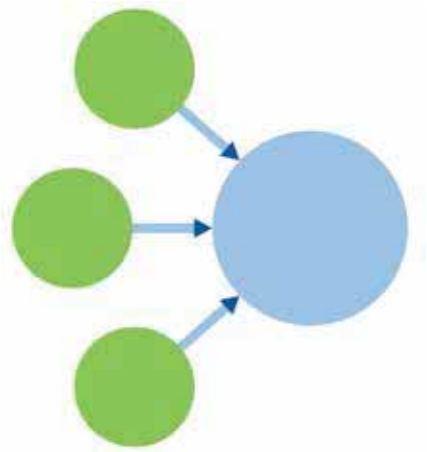
Concrete block permeable paving deals with surface water close to where rainfall hits the ground, which is known as 'source control', and is fundamentally important to any SuDS scheme. It can handle runoff from roof drainage and adjacent impermeable surfaces, in addition to rain falling directly on the permeable paving itself.

Three paving systems enable infiltration to the ground (where conditions allow) or transmission to other SuDS features along the 'management train' or conventional drainage, or a combination of both. 'Interception losses' through evaporation occur within the paving construction where the remaining water is attenuated, treated and conveyed to an outfall, or infiltrates into the ground.

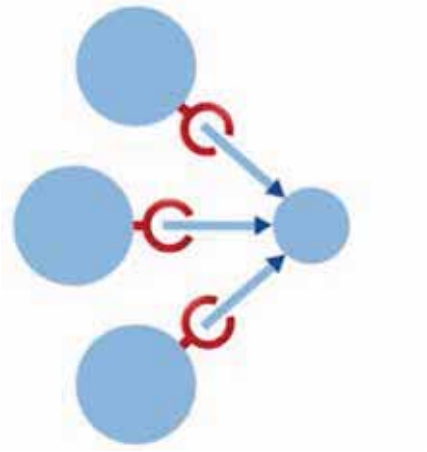
Importantly, concrete block permeable paving is also particularly effective at removing a wide range of pollutants from runoff, so improving water quality. This enables discharge from the paving to be used safely in other open SuDS features along the management train or for various recycling applications. It also offers designers the potential of a gradual supply of clean, treated water within landscape design – something that RBA have exploited to the full in their projects.

PERMEABLE PAVING POTENTIAL

The capability of concrete block permeable paving to attenuate water flow during rainfall for gradual discharge is well known. But it also provides a fresh opportunity to meet the need for longer term water storage on site – a key requirement for SuDS schemes in meeting planning and other regulatory requirements – without additional land-take.

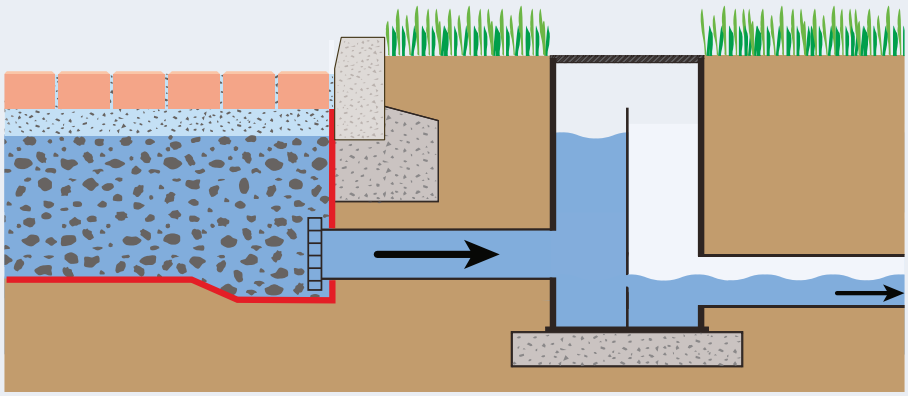


Inefficient SuDS design without flow control requires substantial downstream water storage.



Permeable paving with flow control minimises or eliminates additional storage and land-take.

This is achieved by designing distinct storage 'compartments' of permeable paving using straightforward orifice flow controls, with access for observation and adjustment if needed, on the outlets. This enables water storage to be deployed around a site, with flow controls demonstrating compliance to local planning authorities as part of the SuDS design approval process.



An orifice flow control chamber fitted to the outlet optimises water storage within concrete block permeable paving.

Additional storage on valuable land with associated excavation and construction costs, is avoided and SuDS requirements on high-density urban schemes can be met without expensive storage structures. This approach is also useful for controlling flows to maximise permeable paving storage on sloping sites or to increase treatment times, optimising removal of pollutants within the pavement.

RBA have refined these techniques, as demonstrated in the following projects (and previous case studies discussed earlier). They also continue to explore other innovative applications for concrete block permeable paving, including use as an overlay surface and drainage medium on existing road bases – as the first case study illustrates.

AUSTRALIA ROAD LONDON

The Australia Road urban renewal project in White City began as a SuDS initiative by Hammersmith and Fulham Council to introduce permeable paving into the streetscape. It introduces the innovative concept of concrete block permeable paving as a thin overlay for existing streets, removing rainwater straight from the surface without gulleys and providing some attenuation and treatment before discharging to adjacent planted basins.

Landscape Design

Consultation with local people and a realization of the potential for the site led to an integrated design that linked two disconnected spaces and created a social arena celebrating rainfall. Concrete block permeable paving was used to break the existing formal road alignment and introduce a 'piazza' within the Bridget Joyce Square.

However, the scheme also connected the Randolph Beresford Early Years Centre to an adjacent play area and generated a social hub for parents and children. Meandering through the whole space is the 'wiggly wall' – a reminder of a low wall used as a balance beam by residents in their youth.

SuDS Design

The SuDS landscape, designed in conjunction with McCloy Consulting, celebrates roof water collection with sculptural gutters, downpipes and twisted steel halyards bringing water into planted raingardens. Some roof water, together with car park runoff, flows along sett channels and through stainless steel letterboxes into planted basins.

The concrete block permeable paving overlay simply replaces a tarmac road surface over the original road base. The same blocks and 2-6mm grit bedding layer and jointing material as used in permeable pavements generally are here installed over a geo-composite conveyance sheet that transports water horizontally, on an impermeable membrane covering the road base. Water is attenuated and treated within the paving, then released horizontally via the stainless steel letterbox slots into the planted basins.

Finally, two flow control chambers on outlets from the basins protect the combined sewer, allowing water to flow from the site at 1litre/second through 20mm orifices. Thus, rainfall remains within the SuDS landscape until storms have passed and the sewer can deal with water again.

Sculptural metal rainwater elements feed into raingardens.

Water is transported via conveyance sheets...

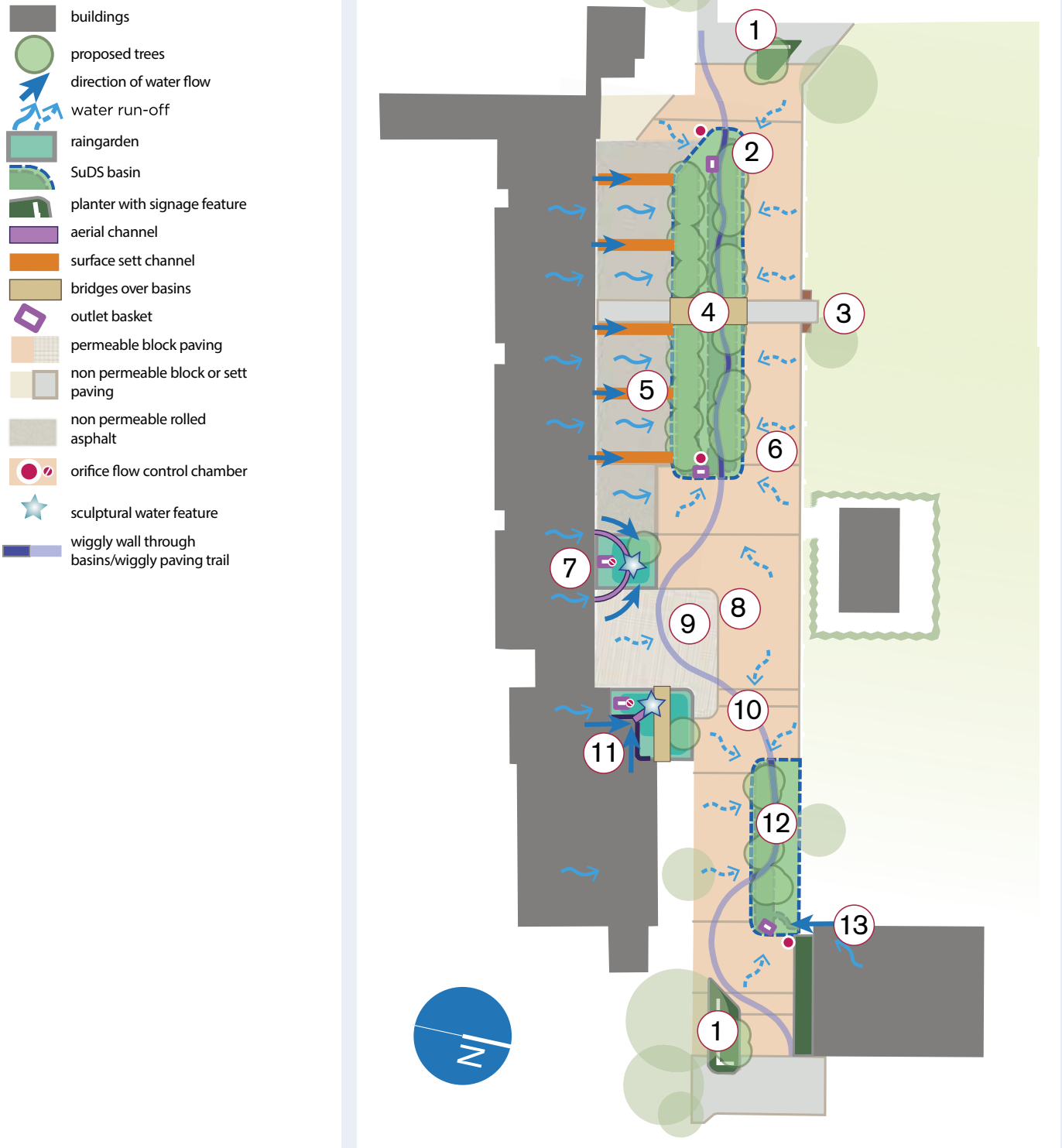
...to slots in side-walls discharging water from the permeable paving into planted basins.

The original road surface has been replaced with attractive, 'self-draining' concrete block permeable paving.

Clean water from the permeable paving passes into the planted basins. The 'wiggly wall' feature meanders through both paving and planting.

AUSTRALIA ROAD LONDON

Design Strategy Layout Plan



AUSTRALIA ROAD LONDON

Key to Layout Plan

1. Prominent gateway features create a sense of entrance into a new space. A change of paving signals the pedestrian realm.
2. The main planted basins feature the ‘wiggly wall’ weaving between Birch trees and tall grasses. Each of the two basins stores rainwater collected from the surrounding permeable paved areas and the school roof and releases it slowly to the sewer.
3. New gateway allowing access directly from the park to the playground.
4. SuDS Basin 1.
5. Surface sett channels take rainwater from the downpipes and carry it to the main basin.
6. Paved areas are permeable, collecting and cleaning rainwater before conveying it to the basins via the sub-base layer.
7. Raingarden 1.
8. Main plaza.
9. The school entrance is more open and welcoming with permeable paved area, bench seating and rain sculptures bringing rainwater down from the school roof to the flowering raingardens
10. A natural stone paving feature weaves through the park from one end to the other providing visual interest and a fun trail for children to follow.
11. Raingarden 2.
12. SuDS Basin 2.
13. Adventure playground building.

PARKSIDE
BROMSGROVE

The Edwardian, Grade II listed Parkside School building, with surrounding landscape, has been re-developed into a Civic Centre and library for the town. The landscape project for courtyards, access, parking and other areas around the building complex has a fully infiltrating SuDS scheme using permeable surfaces, optimised by flow controls, to manage rainfall on the site. All rainwater storage is at the surface within landscape features or underground within voided stone sub-base to paved areas.

Parking Areas

Proposed parking to the north of the access road is on contaminated ground and so required a liner beneath the System C concrete block permeable paving. Water is collected, cleaned and stored in the pavement, with each compartment having a flow control chamber, with internal overflows in case of exceedance rainfall conditions. The flow from the car park continues down the western boundary in solid pipes next to buildings but then through perforated pipes and stone trenches where infiltration can be achieved.

The Courtyard

The main courtyard is designed as an extensive, wall-to-wall infiltration blanket using concrete block and flag permeable paving, grass and free draining plant beds. The adjacent tarmac access road is laid on open graded crushed stone linked to that below the rest of the courtyard area.

The central grass lawn is slightly lower than its surroundings and can function as a detention basin in very heavy rain. A perforated pipe at the lowest part of the site provides a flow route, via a control chamber, to the western boundary as calculations suggest water may not soak away quickly enough beyond the 1 in 30 year return period. There is a final pipe link to the storm sewer that may also receive water from the library entrance.

Roof Water

Roof water from the western elevation is collected by downpipes and conveyed to a 225mm stainless steel spout that pours water down a cascade into a wetland rill formed within the concrete paving. Some water is diverted to a tank and re-circulated down the cascade by a solar pump when the sun shines.

Fully accessible permeable surfaces, managed by a series of flow control chambers to ensure full infiltration potential, define the SuDS solution. The infiltration rate for the site, together with the storage provided within the pavement profiles, very nearly meet the 1 in 100 year return period including a 30% allowance for climate change.

The main courtyard acts as a complete infiltration blanket with concrete block and flag permeable paving. The wetland rill is fed with roof water via a cascade, with some water stored and re-circulated by a solar-powered pump.

Parking areas adjacent to the courtyard are also concrete block permeable paving, differentiated by a red colour mix. The new library building to the right side completes the courtyard.

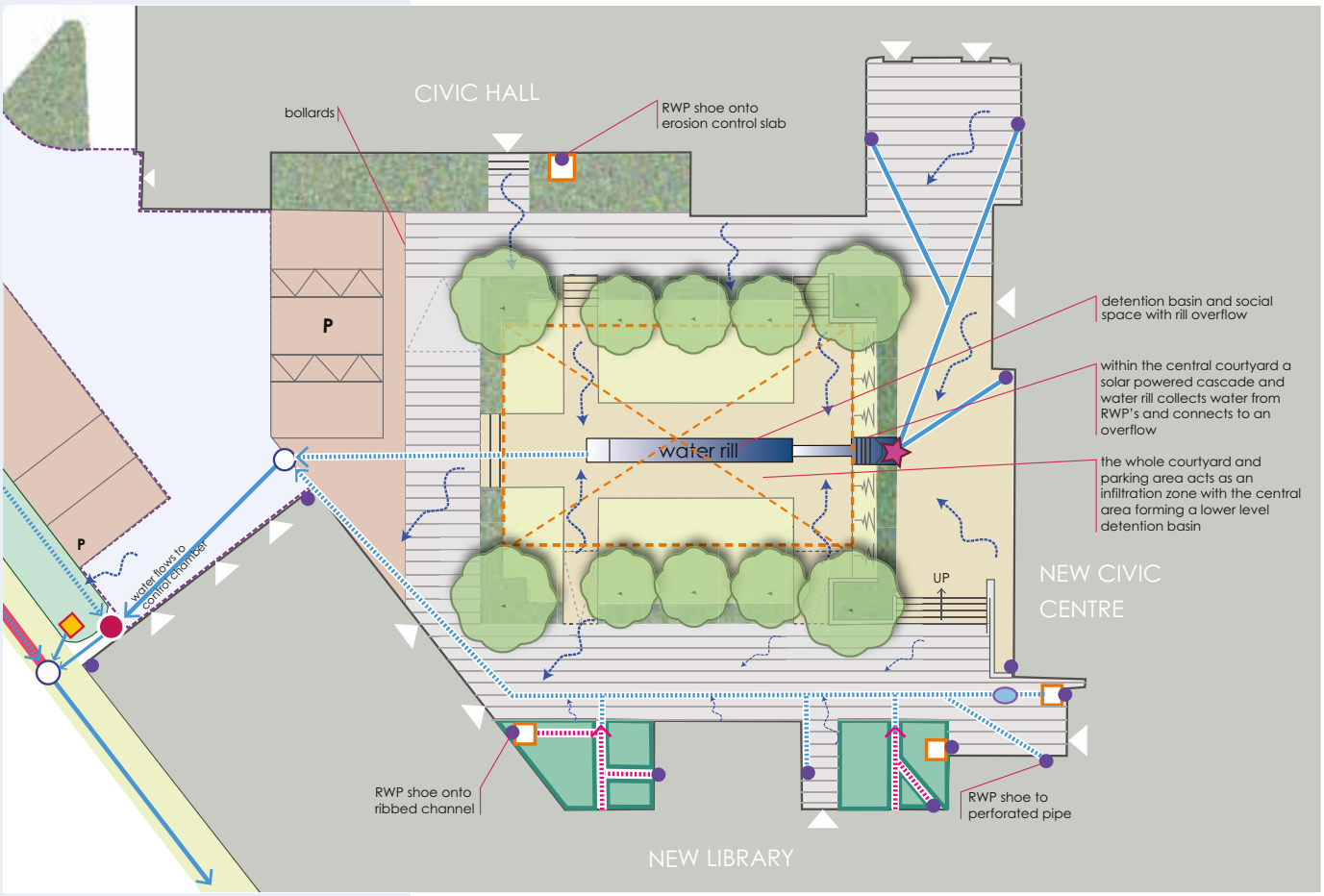
PARKSIDE
BROMSGROVE

Design Strategy Layout Plan

PARKSIDE
BROMSGROVE

Key to Layout Plan

1. Permeable block parking bays.
2. Water overflows from raingardens to existing combined sewer.
3. Access court with raingardens.
4. The whole courtyard and parking area acts as an infiltration zone with the central area forming a lower level detention basin.
5. Unlined permeable block in access courtyard to library.
6. Water infiltrates into permeable block paving car park bays and then continues under the impermeable tarmac area through the voided stone layer, or into an underdrained swale.
7. Rainwater is collected in sett channels and then flows into infiltration planters.
8. The control structures prevent unrestricted flow from the system after heavy rainfall and maximise the storage capacity of each feature.



BEWDLEY SCHOOL

The Bewdley School and Sixth Form Centre is located on the banks of the River Severn to the southeast of the town. This SuDS scheme relates to a new Science Block on existing school grounds formerly used as a playing field. It controls the rate, volume and frequency of runoff, prevents and treats pollution of runoff to groundwater and receiving watercourse, and provides amenity benefits for the school with biodiversity enhancement.

In addition to concrete block permeable paving the design includes fresh applications of other standard concrete components to deliver effective, interesting and attractive SuDS features on the surface. The scheme provides very positive educational benefits to students and an attractive, functional environment whilst also delivering a high level of water quality treatment and flood mitigation.

SuDS Design

A small watercourse, Riddings Brook, runs adjacent to the site with the ground falling gently towards it, steepening as it approaches the brook's valley profile. The SuDS scheme manages water on the site for the 1:100 year storm, plus 30% allowance for climate change effects, and a greenfield rate of 7.3l/sec/hectare has been applied. Surface water runoff is slowed by collection and conveyance in a series of channels, rills, and grass swales, and stored in open basins, a pond and storage swales before release to Riddings Brook.

The plaza in front of the building is paved with concrete block permeable paving infiltrating to the ground and with an overflow into the main swale in case of exceedance. It provides more storage capacity than is required for the 1:100+30% rainfall event and will drain down within 24 hours of such an event.

Water is collected from the building's roofs either by aerial channels, which intercept the flow from rainwater pipes above head height (enabling animated discharge features below) or by surface channels at ground level. Opposing roof planes result in two distinct flow paths for roof run-off which combine at the southern tip of the building, before continuing along the main storage swale to the final discharge point into Riddings Brook.

Landscape Design

The scheme aims to provide a high level of design for amenity and educational potential. Of particular note are the water flow demonstration features that provide visual amenity, play potential and an educational resource and the pond with dipping platform offering access to biodiversity for study purposes. In particular, the network of rills (some planted) creates a very visual portrayal of the flow of water when it rains. This is formed with standard, enhanced surface finish precast concrete kerb and paving units, providing a high degree of visual amenity.

Standard precast concrete products are used in an interesting and attractive way to form rills.

In the background, a downpipe discharges roof water through side perforations in changing patterns reflecting rainfall levels.

BEWDLEY SCHOOL

Design Strategy Layout Plan

BEWDLEY SCHOOL

Key to Layout Plan

1. School building.
2. Planted rill takes overflow from raingarden.
3. Decorative raingarden basin to treat and store runoff from roof, delivery access area and path.
4. Swale.
5. Permeable paved plaza.
6. Formal planted rill along building façade treats and conveys rainwater flow.
7. Flush bridge crossings over rills at access points.
8. Aerial rain channel carries water above head height and into a kinetic rain sculpture. Water flow can be intercepted by students for experiments.
9. Water from the channel irrigates the tree pits.
10. Birch tree planting reduces solar gain in summer without dense shading.
11. Water from the roof and outdoor teaching spaces is directed to a formal rill channel. This can be used for flow experiments.
12. Habitat wetland area with dipping/viewing platform.
13. Storage zone.
14. Playing field access point
15. Swale continues down to the new enterance point and connects to Riddings Brook by bridge.
16. Conveyance and storage swale adjacent to entrance path provides attractive linear features on arrival with soft grasses, flowering meadow plants and wildlife.
17. Flow control chamber.

HARD LANDSCAPE AND INTERPAVE

Interpave is the Precast Concrete Paving and Kerb Association, promoting and developing concrete products – ranging from domestic uses to the most taxing heavy industrial applications. The Interpave website **www.paving.org.uk** provides the definitive source of background and technical information with project case studies celebrating the transformative power of inspired hard landscape in our cities.

Precast Concrete Paving

- Visually attractive and able to deliver distinctive local character
- Helping to deliver 'Manual for Streets' and other guidance
- Capability for clear differentiation between distinct areas
- Accessible to all with consistent slip and skid resistance
- Durable and maintainable with reliable product supply
- Sustainable – in every sense.

a diversity of shapes, styles, finishes and colours for contemporary design.

Concrete Block Permeable Paving

- Reducing, attenuating & treating rainwater near the surface
- Direct infiltration to the ground or conveyance to SuDS or sewers
- Multi-functional SuDS meeting current requirements
- Low cost storage using flow controls without additional land-take
- Established technology with decades of proven performance
- Safe, level, puddle-free, shared surfaces for all.

a gradual supply of clean water for landscape, biodiversity and harvesting.

Acknowledgements

Interpave acknowledges with thanks contributions to this case study from Robert Bray Associates, including project layout plans.

Case study prepared by Hodsons.
www.hodsons.com

Photos courtesy of: Bob Bray, Kevin Barton and Chris Hodson.

Spring Hill Co-housing, Stroud - concrete block permeable paving with flow control at the top of this hillside project discharges clean water to a cascade and planted swale, then a wildlife pond that also provides storage.

Interpave

THE PRECAST CONCRETE PAVING AND KERB ASSOCIATION

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