Sustainable drainage - getting under the surface?

LANDF♦RM event: E8513

Sponsored by: Interpave

Report of a workshop organised by LANDF♦RM held at Classic House, Old Street, London on the 3rd December 2008.

LANDF♦RM is a new network primarily for local authorities to share experiences and discuss policy and research outputs regarding drainage and flood risk management. LANDF♦RM is funded by the Environment Agency, Mouchel and Interpave.

Speakers	Steve Wilson	Environmental Protection Group (EPG)
	Jenny Barker	Cherwell District Council
	Barry West	Oxfordshire County Council
	Roger Nowell	Sheffield City Council
Chairman	Paul Shaffer	CIRIA & LANDF♦RM

THE ISSUES

The major flooding across the UK in 2007 served as a reminder of the need for sustainable drainage to be considered in all proposed developments. The Pitt Review into the 2007 floods places a great emphasis on the need for proper surface water management and permeable surfaces in high density, urban areas.

Local authorities may be required to produce surface water management plans (SWMP's) for their catchment area and Sustainable Drainage Systems (SUDS) will have to play a key role in such plans. While we are still waiting for the governments official response to the Pitt review there is other guidance for local authorities to consider. In October 2008, DCLG started an initiative to promote permeable paving within the curtilage of buildings. Defra's consultation document, *Improving surface water management,* released in February 2008, and of course, PPS25 *Development and flood risk*, should form guidance for local authorities looking to develop SWMP's. So what issues are there facing local authorities with SUDS implementation and surface water management in general? How should they go about incorporating SUDS into their policies and dealing with SUDS in planning talks?

LEARNING POINTS

1. Concrete block permeable paving has a proven track record in the UK as part of a SUDS treatment train and can be used to provide source control close the buildings.
2. The key to permeable surfaces working is to tailor each design to the location using first principles, use the correct specification of materials and to avoid silting of surface during construction.
3. Planning authorities should have policies requiring SUDS in their local development documents and those who don't already should use PPS25 and upcoming guidance on SWMP's to tailor appropriate policies.
4. Oxfordshire County Council has a set up a core design team for major projects with appointed officers from the planning, highway and drainage authorities to overcome the barriers that can exist between different local authority departments.

5. Section 38 of the Highways act is the mechanism for highway authorities to adopt SUDS and there are a number of examples of successfully adopted systems in Oxfordshire.
6. SUDS in Malmo are planned on a strategic scale with major inputs from the water, parks and planning departments, which are all part of the local authority. Allowing for joined up, sensible and perhaps more cost effective SUDS to be implemented.
7. SUDS in Malmo at several sites lacked good source control and perhaps planning authorities do not push enough for source control from private developers.

STEVE WILSON, THE ENVIRONMENT PROTECTION GROUP LTD

Role of permeable pavements in SUDS

- *Steve has a background in geotechnical engineering and has been involved in environmental engineering for the last 20 years. He has contributed in the past to CIRIA guidance documents for sustainable drainage and green roofs and also is involved in providing technical support to DCLG about permeable surfaces.*

SUDS have a major role to play in surface water management and will increasingly become a requirement rather than an option in new developments. Any successful SUDS has to be able to provide an element of source control, that is, to harness and attenuate rainfall close to the area where it lands. It also has to be able to control the volume and rate of runoff from the site to a rate equivalent of a greenfield site of the same area and to prevent pollution of natural watercourses by trapping silt, oil debris and litter. Well designed and constructed permeable surfaces (concrete block paving, reinforced gravel, porous asphalt etc) should be able to achieve all these aims and are particularly suitable in urban areas where space is at a premium.

There are a variety of possible permeable or porous surface types that can be used on roads and car-parks that allow water to drain into the sub-surface and either seep into the ground underneath or be conveyed to retention ponds via perforated pipes within the subsurface. While asphalts, gravels and different types of blocks can be used, the predominant material used in UK permeable paving is concrete blocks.

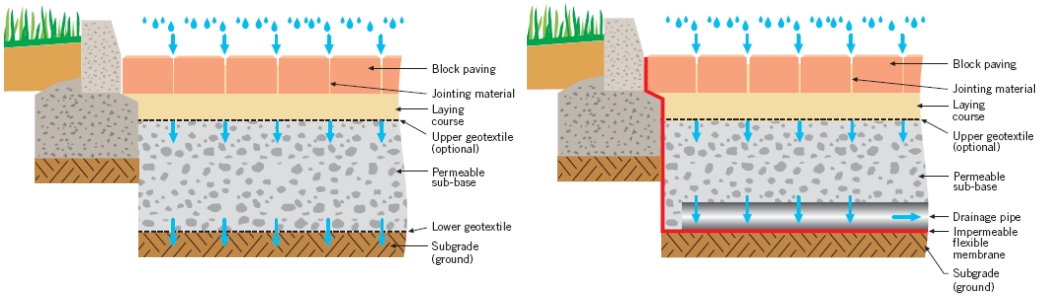

Figure 1 – cross section of permeable paving with infiltration (left) and with conveyance to a downstream SUDS or traditional drainage system (right). Reproduced from Interpave guidance document 'Understanding Permeable Paving'.

CIRIA began to get involved with permeable paving in 2001 and found that pavement engineers were sceptical about the idea of water coming into contact with sub-base 1 material, which normally results in a weakening of the paving structure. But concrete block permeable paving has been proven to work. During design, engineers should allow for water in the sub-base as well as on the sub-grade but that overall the system is well drained. A very useful guidance document on design aspects of permeable paving has been produced by Interpave and is available on their website. However it is recommended that guidance documents be used to complement engineering judgement. A design engineer should still be able to understand any system they design from first principles rather than simply copying an example from guidance documentation. If site conditions require a different layout to the

manufacturers guidance yet the developer blindly follows the guidance then they, and not the block manufacturer, should be liable for any problems with the performance of the system.

The correct specification of materials is another factor crucial to the success of permeable paving. The grade of sub-base material used is important and needs to be open grade to allow the free flow of water. If water drains poorly from some areas of sub-base then when vehicles on the surface apply downward pressure the pore pressure of the trapped water will add localised stresses to the construction. Furthermore the lack of fines in permeable sub-base means that greater stresses in point to point loading occur when vehicles are on the pavement surface, requiring the sub-base material to be strong and hard. The laying course has to be specified to fit well with the sub-base. It has to be coarse enough to allow rapid infiltration of water and to not creep downward into gaps between underlying sub-base, yet fine enough to provide a flat layer to lay concrete blocks upon. The guidance recommends an optional upper geotextile between the laying course and sub-base which would allow for a finer laying course. However, some research at Coventry University suggests an upper geotextile may weaken the paving in terms of load bearing capacity.

Even with the correct design and materials, poor construction can cause the system to fail. There is a need to educate contractors on-site, the most common problem is silting up of the jointing between blocks during construction because fine materials have been stored on the surface, muddy construction traffic has been driven over the surface or runoff from muddy and poorly covered soil in surrounding areas has ended up going to the permeable paving. To avoid this problem, runoff should be directed away from the permeable paving during construction with temporary drainage swales or perhaps even by simply installing some silt fences around the permeable paving area. Where the problem has already occurred, a sweeper can help restore the paving to its original design performance.

Permeable pavements are one part of an integrated drainage solution and can be linked to other SUDS components in the ‘treatment train’. When linked to wetlands or ponds, the quality of water in those ponds is much better. Trapped silt in permeable paving is much easier to remove than in wetlands or ponds, making the system more robust. Better quality wetlands will also be better for local wildlife and will be more appealing to the local community.

Comparison of 2 sites with and without source control

The importance of source control can be investigated by comparing one site, which has permeable paving with box storage acting as a source control (Stamford, Leicestershire), with another site where runoff enters road gullies which discharge direct to swales and then attenuation wetlands (Upton, Northampton). Both sites were observed following a high rainfall event and evaluated for how they cope with construction silt and the effect on downstream elements of SUDS.

In response to the same weather conditions, the Stamford site responded much better than the Upton site. At Upton considerable runoff flows were visible in culverts and the water reaching the wetlands carried high silt loads caused by erosion. At Stamford there was barely any evidence of runoff flow with most being stored in the box storage underground. Locals at Stamford claim they have never seen any standing water on the site.

In conclusion it can be said that permeable paving allows for excellent source control and can contribute strongly as part of a robust SUDS treatment train. The design of permeable paving systems is well established and useful guidance documents and technical standards are already available. With regards to ease of maintenance, the swales at Upton were relatively deep and steep sided, making it difficult to trim the grass. At Upton the planting was not sympathetic to SUDS and input from experienced landscapers introducing plants with root systems that help bind soil particles together at the soil surface can greatly reduce the quantity of silt lost from new swales. Removing silt from permeable pavements can be achieved with a sweeper and only needs to be carried out twice a year. Even in examples of permeable paving with grass growing through the joints, water will flow laterally a few inches before finding a permeable joint to drain into.

DISCUSSION

Q? About the Stamford development, when considering building regulations, is the drainage system far enough (5m) away from properties?

A? Yes, you can work around the building regulations because permeable paving is a diffuse, rather than point source loading of runoff. Thinking about the challenge pragmatically and in terms of drainage, there is little difference between a lawn and permeable paving. There are no laws restricting how close a lawn can be to a property. But when roof water is also run to the permeable paving you have to make sure the catchment area is not considerably higher than the permeable paving area otherwise it could be perceived as more of a point loading discharge of runoff. A single house sending rain and roof runoff to its permeable driveway should be fine though.

JENNY BARKER, CHERWELL DISTRICT COUNCIL

Planning for sustainable drainage and permeable surfaces

- *Jenny is team leader for major developments within Cherwell district councils planning department and has 20 years experience as a town planner. She is currently involved with a number of urban development projects which will be looking to put SUDS into the ground.*

A great SUDS scheme does not necessarily guarantee it will be approved for construction, however it can help. Development must be in accordance with local development documents unless material considerations require otherwise. However PPS25 states that the disposal of surface water **is** a material planning consideration when considering proposals for the development and use of land. Most planning departments do not have specific policies on drainage at a local level and are therefore going to use PPS25 as their main guidance on SUDS. However there are other good documents such as the 'Good Practice' guide and the Governments Water Strategy – Future Water (available via Defra).

SUDS are especially considered when looking at applications for development in flood risk areas to provide an opportunity to reduce the risk of future flooding both onsite and/or at downstream sites. PPS25 specifically encourages the use of SUDS with quotes such as:

> "*Local Planning Authorities in determining planning applications should give priority to SUDS*" (paragraph 8). and …
>
> "*Local Authorities should promote the use of SUDS for the management of run-off*".

Regional and local planning groups should further encourage the use of SUDS by incorporating favourable policies within regional spatial strategies, adopting policies for the incorporation of SUDS in local development documents and by directly encouraging developers during the planning process. Planning authorities should also look to actively engage with the EA and sewerage undertakers to develop joint strategies to reduce the rate and volume of surface flows.

Developers must be able to demonstrate that their plans comply with policies in local development documents and PPS25. They must also carry out a flood risk assessment and demonstrate that they reduce flood risk to the development and elsewhere, by incorporating SUDS (as per Annex F of PPS25) and where necessary flood resilience measures (as per Annex G of PPS25). Opportunities to enhance biodiversity and create amenity can add value to developments and go beyond the planning requirements.

Annex F of PPS25 also states that; "*It is essential that the ownership and responsibility for maintenance of every sustainable drainage element is clear*". This should be outlined in the

developers flood risk assessment. If the surface water drainage system solely serves the proposed development then the developer is deemed fully responsible for the construction and ongoing maintenance costs and this can be contractually bound by Section 106 (of the Town and Country Planning Act) agreements. It is important that the adoption and maintenance issues of SUDS are thought of at the very first stage in planning. Some county councils such as Oxfordshire, will adopt SUDS but will charge the developer a commuted sum to cover 15 years maintenance.

In practice it is important to plan for SUDS early so that any potential impact on the net developable area, density of development and open space provisions can be known. Also the earlier SUDS are discussed in the planning process the sooner issues with adoption can be sorted. The best SUDS solution will be specific to each site and depend on what the development is trying to achieve. The planning authority only have 8-13 weeks to approve plans so a well planned SUDS at an early stage, where compromises have been agreed from different stakeholders, can save a lot of time and stress.

Consultation between designers, the highway authority, landscapers and ecologists can help contribute to SUDS that are not only practical and willing to be adopted but contribute to local biodiversity, amenity and place making. Safety requirements can ruin the visual impact of SUDS such as dry ponds that are fenced off with signs warning of deep water! Also future development near existing SUDS should be carefully considered, an example being a footpath built next to an existing swale which required an unsightly barrier to prevent cyclists accidentally veering off into the swale. In general wet ponds are more aesthetically pleasing to people than dry ones. With swales that take runoff from roads with no kerbside, consideration must be given to people potentially parking their cars on the swale verge, bollards and signs may be necessary. Finally consider that a SUDS system that is successful at one site may not work well at another, tailor the solution to the site.

SUDS represent an excellent opportunity to contribute to sustainable development in the UK and reducing flood risk but a good scheme takes a lot of time and effort to design. There have been many problems and delays with SUDS in the planning process, however it is something which will reduce with experience and that can be minimised right now by the developer considering SUDS early in their plans and consultations.

DISCUSSION

Q? PPS25 recommends that commuted sums should cover 25 years maintenance yet Oxfordshire only ask for 15 years, why?

A? There is no official recommendation for 25 years maintenance. Some local authorities actually only ask for 10 years. We go for 15 as after that time the costs can be transferred to the highways authority and accounted for in council taxes.

BARRY WEST, OXFORDSHIRE COUNTY COUNCIL

Delivering sustainable drainage and permeable surfaces

- *Barry has been a Highways Adoption Officer with Oxfordshire County Council for the last 15 years. He has an excellent grounding in SUDS and plays a major role in discussions between developers and planning authorities, he has contributed to the successful adoption of a number of SUDS in Oxfordshire via Section 38 agreements of the Highways Act.*

Oxfordshire has frequently suffered from flooding in the past two years and is keen to implement sustainable drainage as much as possible. From recent experience we have seen that SUDS schemes have withstood the recent storm events that produced flooding in many areas where traditional drainage systems could not cope. Permeable paving has the added advantage of leaving no standing water. Our experience with swales, even when built on clay

soils, is that they don't flood. Swales can also be used with check dams to provide storm water storage, even on sloping sites. These systems clearly make sense for county office councillors and the people who live on these developments. The type of SUDS employed depends on the area of land available. Ponds, swales and wetland areas are all relatively land intensive whereas permeable pavements and kerb-line drainage linked to nearby SUDS features can be fitted in to higher density urban areas.

At Oxfordshire we started looking at how to embrace sustainable drainage10-12 years ago by setting up a design team for major projects with appointed officers from the local planning authorities and drainage authority and highways adoption authority, the EA, street lighting officers and whoever the relevant developer, local parish church and town councils and landscape architects are in an individual project. For small scale projects, we have area liaison officers who work directly with district council planners can call upon the experience and expertise from the major project staff if necessary.

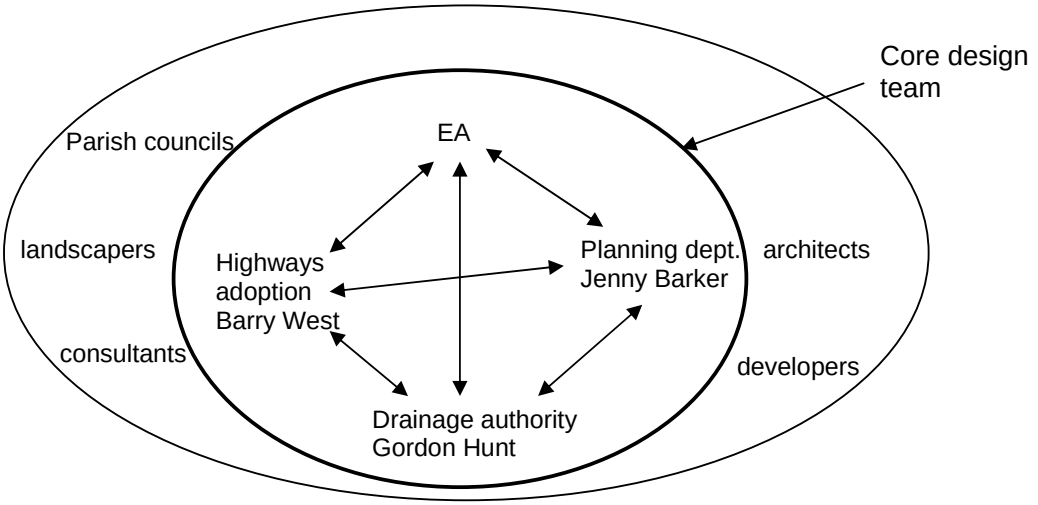

Figure 2 – set-up of design team for Oxfordshire County council for major developments

With SUDS design, we accept in principle MAS and Formpave designs however only after thoroughly checking them to ensure the proposed design will fit the proposed site. The design team look at all aspects of design codes and master planning. It is essential to understand what each stakeholder is trying to achieve and this can only come through discussion. With ecologists, landscapers, architects, developers and local authority departments sat around a table, compromises can be reached that suit all parties. The fact that the local authority stakeholders already have an understanding of what each are trying to achieve smoothes the whole process. It is during these meetings that the thorny issue of SUDS adoption is discussed. If we are happy with the SUDS design and construction then we will adopt the system and maintain it as long as commuted sums are paid to cover 15 years maintenance. Obviously there is scope for argument about how to calculate such sums. We use a standard formula that takes account of interest and depreciation. The idea of commuted sums is relatively new to developers and, in the Lancashire 'opinion' where a developer challenged the use of Section 38 to charge for commuted sums, may have an uncertain legality. However independent research by has suggested adopting authorities should charge for as much as 60 years maintenance. Fortunately the Department for Transport are due to produce a guidance document on commuted sums for infrastructure that closely follows our existing model and that clearly states what can be charged for and for how long.

From our growing experience we tailor our requirements for SUDS design and construction. For example we require a geotextile membrane below the grit layer in permeable paving as it is much easier to replace the grit should maintenance fail. We have also carried out studies to determine the optimum suction angle for removing silt but not jointing material. For permeable paving we would charge costs for sweeping the surface every 6 months, applying weedkiller once per year and an annual application of a slow release fertiliser to boost microbial activity after winter.

In the beginning there were difficulties trying to convince developers of the benefits of SUDS, particularly when also requiring a commuted sum for maintenance. SUDS are far simpler than traditional drainage systems to construct though, there are no kerblines, no manholes, no gullies, no major lengths of pipe and no oversized pipes which can represent significant cost savings.

However SUDS can go wrong too, there are two examples of SUDS failure in Oxfordshire. In one, a permeable pavement flooded but it transpired that this was because it was built in existing floodplain. The other example was with a local authority all weather sports pitch which had a drastically undersized SUDS system, was connected to existing SUDS and overloaded the system. Even where a design is agreed with a developer, making sure construction workers actually implement the design is another challenge. Ground workers are very quick at picking up what is required if you can explain it to them on site, however you cannot simply rely on the fact the design is specified in a document to ensure it will be there on the ground. We have experience with contractors making swales too steep and with services being laid and accessed outside of specified service corridors.

The Pitt Flooding Review reinforces what we have been doing at Oxfordshire. We have recommended that the water authorities should not take responsibility for surface water drainage and instead it should be the EA and Highways authorities that take charge in collaboration with local authorities. With traditional highway drainage, storm water overflows can seriously affect aquatic life due to pollution released in first flushes. We recommended Thames to run the road drainage to a SUDS treatment train but they were not interested. As there were no oil interceptors in the drains we decided to charge for emptying gullies three times per year instead of once, to minimise the chances of pollution to the river.

An exciting example of the way ahead is with a new development at Kings Mere, Bicester. There are no public surface water sewers and a full range of different SUDS components. In the case of SUDS failing, an overland flood route has been designed for redundancy. We spent two years approving and creating the design code. The surface water drainage is firmly entrenched in the design code and approved by Cherwell district council. If anyone later buys this site, they will not be allowed to interfere with the SUDS infrastructure without permission. An added advantage of having no surface water public sewers is that road adoption will be quicker because there is no need to wait for the water utility to adopt the sewers. In Oxfordshire we are also looking to incorporate rainwater gardens into new and existing developments.

The process of implementing surface water drainage systems is changing drastically, but with widespread and multiple benefits. We are in a transitional period as traditional stakeholders need to change their approaches to drainage but eventually, with the help of good practice documents, government advice and real life examples; we can find a mechanism of implementing sustainable drainage that suits all.

DISCUSSION

Q? The EA are now undertaking pilot surface water management plans, do you foresee these being integrated into design tools?

A? Yes

Q? Why, when we talk about the potential ecological benefits of SUDS, are you applying weedkiller to permeable paving?

A? Yes, I agree this is part of a very conservative approach to maintaining the SUDS. But as with any highway, we are severely restricted in the type of weedkiller we can use. A risk assessment carried out by Coventry University showed that most weedkiller applied to permeable paving was not detected in discharge.

Q? Could the weedkiller also adversely affect the microbes in permeable paving? What is the preferred choice between microbial oil degradation and physical oil interceptors?

A? We would prefer microbes to degrade the oil but for redundancy we have to also rely on oil interceptors, especially in sites near petrol stations where there is the possibility of an oil tanker spill or on roundabouts where a tanker could turn over. In these situations we would kerb the roundabout and have oil interceptors. Our oil interceptors are set to alarm when full so that we can empty them as required.

ROGER NOWELL, SHEFFIELD CITY COUNCIL

Memories of Malmo

- *Roger works with the Parks team at Sheffield City Council and oversees the development of parks and green spaces. He has been involved with sustainable drainage particularly in regeneration projects and is currently working on the production of a green space strategy for Sheffield and looking at the potential roles parks can play in surface water management plans (SWMP's).*

While it is right to focus on SUDS here in the UK, it is worthwhile to look at what is happening in other countries and to see if we can learn from their successes and avoid any of their problems. Malmo in Sweden has been looking at sustainable drainage for around 25 years and is considered to be ahead of the UK in many respects. In Sweden the "SUDS triangle" addressing principles of quality, quantity and amenity are considered in a similar approach to the UK.

Sweden has much more space than the UK and has a culture that is more amenable to understanding the need to make space for water in urban and landscaped environments. Furthermore most of the sewers in Sweden are separated into foul and storm water whereas in the UK many combined drains exist.

Malmo created a stormwater policy in 2000, which took about two years to put into practice and gives each district the responsibility for planning, designing, constructing and maintaining SUDS. Generally SUDS are designed for a 1 in 10 year event with overland flow routes specified for exceedance. The majority of roads drain to swales. Different public departments assume specific responsibilities. Drivers for SUDS include basement flooding and water quality, with concerns about algal growth and impact on the environment. They are also valued for the potential to contribute to biodiversity in Sweden, which has been severely reduced by agriculture and for their educational value and improving peoples understanding of stormwater movement through the built environment.

Water services in Malmo are actually provided by the local authority rather than the private utilities we have in the UK. In Sweden the water department takes an active role in the planning process and specify storm water detention for runoff from public and private developments. There is a co-operative spirit between departments and a respect for each others specialist knowledge. The key to the success of this set-up is to establish planning guidelines that are accepted by all departments, to use the skills of other departments when designing open water systems and to be aware of the maintenance aspects. The Parks department in Malmo have a key role in the design of open storm water systems and this allows for the potential of parks for storm water storage to be maximised.

Clear responsibilities are crucial to the successful implementation of SUDS. The Water and Parks departments need to agree costs for design, construction and maintenance of systems as well as to be clear over liabilities for damage. The financial arrangement is that water companies charge residents and developers and pass on some of this to the Parks department to cover their costs. Some conflicts can arise in designing storm water systems regarding; footprint requirements, safety considerations, costs for design, construction and maintenance and with natural watercourse pollution. Safety concerns have led to systems

with shallower slopes in ponds with lower depths, removing the requirement for fences, which is more aesthetically pleasing than traditional fenced culverts.

An example of retrofitting is in Augustenborg, which is a municipal housing development built in the 1950's that suffered from basement flooding. Between 1998 and 2005 government supported investment was provided to fit a storm water system in consultation with local residents. The solution resulted in a 20% decrease in tenancy turnover. The solution was a hard engineered system with concrete conveyance channels and ponds. School playgrounds have been used creatively to provide storm water storage capacity and some of the conveyance channels have drainage water re-circulated during drier periods to provide some form of water feature or at least a reminder of the function of the structure. There are questions about the use of so much high embodied energy concrete in the solutions and the energy costs of pumping drainage water around conveyance channels. The hard solutions seemed simply for conveyance and storage, with little consideration given to source control and water quality. However the second phase of the system at Augustenborg uses softer conveyance features which do provide an element of water purification and lead to landscaped gardens with numerous small wet ponds. Augustenborg is also famous for it green roof safari where municipal buildings have had green roofs retrofitted, the school in figure 3 has green roofs on it.

Figure 3 – a school playground amphitheatre also functioning as a storage structure for 1 in 10 year storm events.

Another example was Vintrie, which originally drained road stormwater via a steep ditch near a housing estate. It was decided to widen the ditch considerably onto existing public land to allow and to baffle the channel to allow for some form of storage. The solution involved concrete baffles and lots of crushed stone on the channel bed, which was interesting as we considered that the same effect could have been achieved with earthworks alone. The designers stated that the reason for this approach was to mimic the conditions of a mountain stream, which is associated with pure water and something of a novelty in the relatively flat land around Malmo where waters carry considerable loads of silt.

Figure 4 – Example of improvement to stormwater drainage from an industrial area. Images show the original structure (left), the improved structure (centre) and the improved structure providing retention following a storm event (right).

In Malmo there were very few examples of permeable paving, with many drainage features dominated by hard conveyance to detention ponds. However there were also some examples

of excellent soft features such as rainwater gardens in the courtyard of buildings and reedbeds around the periphery of commercial buildings.

Figure 5 – examples of hard (left) and soft (right) drainage features in dense urban environments in Malmo.

In Malmo the use of public land for SUDS and the fact that the water department is part of the local authority remove some of the major obstacles to implementing SUDS on the ground. The size of SUDS in Malmo was much larger and more joined up than in the UK. There is an economic incentive for people to disconnect from traditional drainage systems and this centralised system results in numerous developers indirectly paying for regional stormwater drainage which may be a fairer way of costing for small sites, which normally occur disproportionate design and construction costs with SUDS.

From the examples seen in Malmo the general impression was that while public SUDS are simpler to design, planners were not requiring private developers to provide any source control, which can adversely impact water quality in downstream SUDS. In Malmo SUDS were dominated by hard, concrete systems and it was felt that there was more potential for green landscaped features. Some systems may have been much more cost effective than others but they are difficult to identify due to the single public budget allocated to SUDS. The systems in Malmo are a reminder of how important it will be for us to use surface water management plans as an opportunity to incorporate SUDS into spatial planning. In the UK, developers are beginning to consider how to work with rather than against storm water and as more innovative designs are built we can learn and grow towards better, more sustainable and holistic drainage solutions that actively contribute to the water environment.

DISCUSSION

Q? Some additional information about the Upton scheme is that permeable paving was considered but rejected because swales alone were thought to be sufficient.

A? It is likely that is would be advantageous to include permeable paving and that there may have been some pre-conceived ideas against permeable paving that lack justification.

Q? Why do some London boroughs refuse to adopt permeable paving?

A? This depends on specific circumstances of the local authority. The Highways Act, particularly Section 38, is the mechanism to adopt permeable paving. The act only tells you about the adoption procedure, not what can and cannot be adopted. It is up to the individual highways authorities to decide what they will and won't adopt. At Oxfordshire we have some acceptable designs we will accept but if something different comes along which also works well, we are happy to adopt that too. Once a SUDS is adopted by the highways authority it cannot be built upon without their express permission. So there are really no reasons why highways authorities shouldn't adopt SUDS.

Q? With future climate predictions of greater storms and droughts in areas, should our approach to sustainable drainage go beyond simply 'avoiding flooding' and for about seeing storms as a valuable source of water that can be later harvested?

A? Some developments have considered rainwater harvesting linked to site drainage but the designs were dropped due to cost issues. It is perhaps something that will become more established as people become aware of the benefits. SUDS are designed to fill up and drain, to reduce peak storm flow rates to greenfield levels. So rainwater harvesting makes perfect sense, but you have to provide a separate storage volume to the SUDS system. But this requires thinking outside the box and applying first principles to individual sites. In Oxfordshire we are thinking of draining school playing fields to underground tanks and using water for flushing toilets, reducing water usage and bills. An important barrier to SUDS and rainwater harvesting are decision makers having misconceptions about the actual costs of SUDS.

Q? Is porous asphalt a good idea? Are there any design/adoption issues?

A? Tarmac are one of the leaders in design and construction of porous asphalt in the UK. However it's area that may require additional research. The key to this material working is getting the bitumen mix just right and requires extensive experience. You need enough bitumen to coat the particles but not to fill the voids between them. And even with the right mix, if the road is not properly filled, the system can fail. With adoption, opinions differ about porous asphalt, Oxfordshire's approach is fairly open. A private developer is not obliged to enter a Section 38 agreement and can simply make a security payment under Section 220 to the Highways authority and enter a private road agreement. However at Oxfordshire we will not release this security until we are satisfied that the quality and design of the road are appropriate and that a suitable maintenance schedule has been implemented.

Q? Concrete block permeable paving seems to work well, but may not be acceptable in more prestigious developments? Is there any guidance on the use of natural stone in permeable paving?

A? Oxford city understandably want to use a lot of natural stone. Marshalls are currently working on this. In theory you could design any slab material to be permeable though thanks to the surrounding jointing.

Q? Is there any advice or examples of SUDS in high density, inner city areas?

A? Yes, it is possible to incorporate SUDS into existing dense urban areas. One example in Oxfordshire was of drainage from a parking area being let to infiltrate into the soil. However for redundancy we allowed drainage exceedence to be directed to an existing storm water drain. The water authority wanted money if we were actually discharging to the drain however camera surveys revealed no exceedence. Technically, there is no site in the UK in which you cannot use SUDS. All landscaped areas and roofs can be considered as potentially multifunctional, for storm water storage.

Q? Often when trying to approach planning departments we are told to go for pre-app discussions, but how is that funded if we don't pay until the formal application?

A? Pre-app discussions are not a statutory function, but can be a useful tool to ensure that developments are well prepared and decisions made within the 13 week time limit. Some authorities charge for pre-application discussions and it is money well spent if good advice is given. But when planning departments are under pressure, they may feel there are no resources to hold pre-app discussions, which is ultimately counter-productive. So do push for pre-app discussions.

Q? Why do local authorities not already account for SUDS in their local development documents more often? Are they going to use SWMP's as an opportunity to form a firm policy on SUDS that will send a clear signal to developers?

A? Local development frameworks should already have policies related to SUDS. The South East plan actually requires SUDS unless they can be proven to be undesirable. But yes, there is a need for more focused policies that can come through in SWMP's.