Yorkshire Water

Environment Agency

the Natural Step

2020 Vision Series No.3:
Sustainable Drainage Systems (SuDS)

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I. Introduction

Life is made possible on this planet through life-support cycles that purify the air and water, provide food and other natural resources (including economic goods), and support our "quality of life". The water cycle is one of the most critical of these, and fresh waters are central to every aspect of our lives. It is a paradox that water and aquatic systems have been so comprehensively overlooked in the ways that urban environments have been planned. The legacy of urbanisation has been loss of wetlands, riverside land and wet habitats, and constraints upon the natural flow of river systems. At the same time, we have placed spiralling demands on water resources that have reduced river flows and groundwater levels. Our engineered cityscapes contribute directly to their own flooding problems. It is timely to reappraise the relationship between the water cycle and our built environment. The EU Water Framework Directive and other measures seek to internalise more of the environmental costs of water supply and, particularly in the light of recent widespread flooding here in the UK, there is an increased awareness of the inherent wisdom of Integrated Catchment Management (co-ordinated planning at the watershed scale).

Against this background, The Natural Step (TNS) in the UK has, in collaboration with Yorkshire Water Services and the Environment Agency, instigated a study into one aspect of water management: the need for more sustainable approaches to drainage of urban areas. This study explores the sustainability issues around existing approaches to drainage, the form that more sustainable approaches might take, and the ways in which they could be achieved. The Natural Step Framework – the core TNS set of science-based tools for addressing sustainable development – is used for this purpose within the TNS *2020 Vision* consensus-building process.

The TNS Framework is based on a systems view of the sustainable natural cycles of this planet. This approach reflects the need for all materials and processes to be considered within a holistic science-based framework of sustainability. In this study, the four TNS System Conditions (see Box 1) are used to assess the overall sustainability of traditional and SuDS (sustainable drainage systems) approaches to urban drainage and water management, and also provide the basis for developing a vision of a fully sustainable solution and steps towards it.

Box 1: The Four System Conditions of The Natural Step Framework

In the sustainable society, nature is not subject to systematically increasing:

1. … concentrations of substances extracted from the Earth's crust
2. … concentrations of substances produced by society
3. … degradation by physical means
and
4. human needs are met worldwide

A profile of all supporting organisations of this 2020 Vision project is provided on the inside back cover of this summary document. This summary report is also available at The Natural Step's web site: www.naturalstep.org.uk. The detailed report *Sustainable Drainage Systems (SuDS): An Evaluation Using The Natural Step Framework* is available from The Natural Step's office in the UK, priced £20 to cover production and handling costs (for contact details see the inside back cover of this summary report).

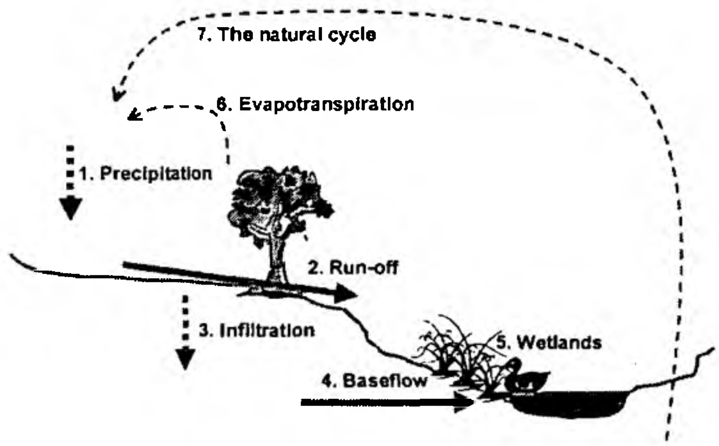
II. Background

The urban environment has become increasingly impermeable, displacing the natural "services" of ecosystems that purify and store water, and giving rise to a wide range of problems of flooding and diffuse pollution (pollution that does not arise from identifiable point sources). Surface water drainage in both urban and rural areas is a major contributor to flows in sewerage systems and to the unsatisfactory performance of Combined Sewer Overflows (CSOs – defined in Section 3). Traditional approaches treat this as a local engineering problem, and solutions such as ever-larger pipework are proposed accordingly. However, these solutions are not necessarily sustainable if we take into account wider implications for energy use, pollution, rapid displacement of water downstream, etc. Nor do they necessarily achieve environmental targets. The floods in the UK throughout 1999 and 2000 have focused our minds on the need for more sustainable approaches to drainage, working with and not against natural processes, and using investment and development opportunities more creatively. We need to tackle flooding, water quality, urban ecology and amenity on a more systemic basis.

2.1 The Basic Hydrological Cycle

In order to explore more sustainable approaches to urban drainage, a clear understanding of the benefits to society stemming from the natural water cycle is required. The key processes operating are identified in Fig 1. These processes are discussed in greater detail in the full report from this *2020 Vision* project, which is available from The Natural Step (see *Introduction* page for details).

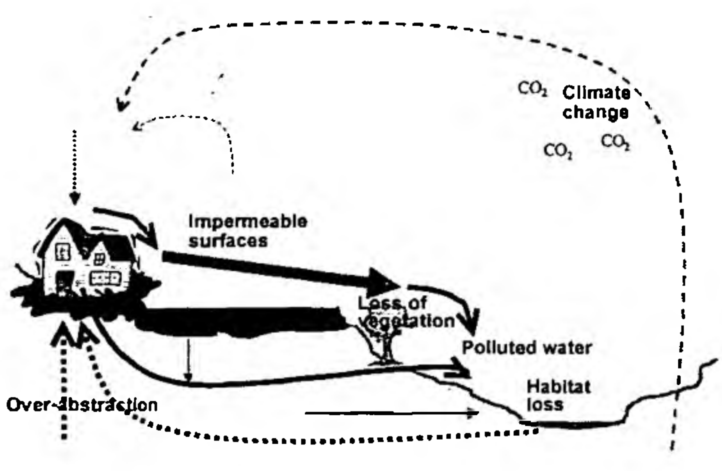
Figure 1: The Water Cycle



2.2 Disruption of the Natural Water Cycle

Economic development and associated urbanisation have delivered many benefits to society. However, where development has taken place without sufficient care, such as by destroying vegetation or using too many impermeable surfaces, it has served to undermine the very water cycle upon which it depends. Fig 2 illustrates key means by which unsympathetic urban drainage and water management can overlook the way that nature actually works, thus undermining its supportive capacities. These processes are also discussed in greater detail in the full report.

Figure 1: The Water Cycle



Sustainable development necessarily works with – and not in opposition to – these natural life-support processes, recognising the benefits they deliver to society. A great deal of progress is required to protect, and ideally restore, ecosystem functions integral to the water cycle.

III. Alternative Approaches to Urban Drainage

The urban environment needs adequate drainage to remove surface water. There are various ways in which this can be done, and these tend to be categorised as either "traditional" approaches or as SuDS (sustainable drainage systems). This section of the report briefly summarises these two different approaches. More detail is provided in the full report of the *2020 Vision* project (available from the TNS office, see the *Introduction* page).

3.1 Traditional Approaches to Drainage

Traditional approaches to dealing with urban storm water involve directing it into drains as quickly as possible, and transporting it to the nearest discharge point. There are two main types of piped surface water drainage system for urban areas.

- **Storm sewers** receive stormwater runoff from impermeable surfaces. They can be partial systems (providing only road drainage and not connected to building drains) or complete systems that provide both road drainage and storm connections to buildings.

- **Combined sewer systems** utilise the same pipes to transfer domestic sewage, rainwater and industrial wastewater for treatment. Because the sewers carry sanitary (sewage-related) wastes and are connected to basement floor drains, any surcharging (overloading) could cause "foul flooding": a backup of untreated sanitary sewage. Consequently, such systems must be designed to accommodate large storms without surcharging. Combined sewers are common in the older sections of most large municipalities.

A number of problems are associated with traditional approaches to urban drainage, including implications for flooding, water quality and water resources, outlined below.

- **Flooding and pollution from CSOs** (Combined Sewer Overflows) due to overloads in the capacity of the conveyance or treatment system during heavy rainfall. Traditional engineering solutions – "end-of-pipe" rather than strategic – including *increasing the storage capacity* of the system or some degree of *separation* of stormwater from municipal wastewater.

- **Water quality** issues arising from urban runoff is an increasing source of water pollution. The major pollutants are suspended sediments and solids, which may also act as the carrier for other pollutants, as well as road salts, heavy metals, street litter, solvents, organic waste, oil and other hydrocarbons, and nutrients.

- **Water resources**. Traditional approaches to urban drainage result in the rapid transport of water away from local areas, rather than managing its infiltration into groundwater reserves or storing it in local ponds or wetland systems. Increased urbanisation is leading to more stormwater runoff, increasing the risk of flooding, erosion and damage to habitats.

3.2 Sustainable Drainage Systems (SuDS)

SuDS is an umbrella term for a number of approaches to urban drainage, comprising new more sustainable methods for the management of water resources in urban areas. SuDS are founded on integrating different needs: to reduce peak flows, enhance water quality, and to improve urban ecology and amenity. They may comprise a sequence of management practices and control structures designed to drain surface water, addressing issues of water quantity, quality, ecology and amenity in their design. This necessarily involves protection or restoration of the natural ecosystem functions – hydrological processes such as floodwater detention and water storage, purification processes and biogeochemical cycling, habitat provision, groundwater recharge, amenity and landscape – and the benefits that they deliver to society. Restoration or protection of these natural wetland functions is an essential feature of sustainable development, and must be addressed at the wider catchment scale, with SuDS playing a potentially key role at the local scale. For the purposes of this report, SuDS comprise one or more structures built to manage surface water runoff, used in conjunction with good management of the site, to prevent flooding and pollution. SuDS are commonly grouped into four general methods of control:

- **Filter strips and swales**. Filter strips and swales are vegetated surface features (gentle sloping areas and long shallow channels, respectively) that drain water evenly off impermeable areas. Rainwater running through the vegetation is slowed down and filtered.

- **Filter drains and permeable surfaces**. Filter drains and permeable surfaces are devices that have a volume of permeable material below ground to store surface water. The permeable surfaces – such as grass, reinforced grass, gravelled areas, solid paving blocks with gaps or vertical holes, porous paving blocks with gaps, continuous surfaces with an inherent system of voids – directly intercept the rain where it falls.

- **Infiltration devices**. Infiltration devices drain water directly into the ground. They work by enhancing the natural capacity of the ground to store and drain water. Enhanced drainage occurs through providing a large surface area in contact with the surrounding soil through which the water can pass.

- **Basins and ponds**. Basins and ponds store water at the ground surface, either as temporary flooding of dry basins (such as floodplains or detention basins) or in permanent ponds (e.g. balancing and attenuation ponds, flood storage reservoirs, lagoons, retention ponds or wetlands) which hold more water when it rains. They can be designed to control flow rates by storing floodwater and releasing it slowly once the risk of flooding has passed.

All four types of SuDS can be used together. They should be located as close as possible to where rainwater falls, helping to slow down the rate of flow to prevent flooding and soil erosion. Historically, there has been a perception that the expense and difficulty of retrofitting SuDS in existing urban areas have been prohibitive. Retrofitting techniques are now increasingly becoming available to the SuDS designer, and the retrofitting of SuDS in existing urban areas need not now be expensive particularly if the need to clean and attenuate (detain, slow down and store) runoff is accepted as a design criterion. In the short and medium term, the main application of SuDS is likely to remain in draining new developments. There nevertheless exists a need to continue the innovation of techniques for retrofitting SuDS-type techniques in older developments, to communicate these options, and to resist the tendency of developers to promote traditional piped approaches.

3.3 Responsibility for Urban Drainage

Management of both storm sewers and combined sewer systems lies with sewerage undertakers. However, a range of organisations and individuals are jointly involved in land drainage functions more generally. Other key responsibilities lie with:

- The **Environment Agency** which is responsible for designated main rivers.
- **Local Authorities and Internal Drainage Boards** responsible for "non-main rivers".
- **Sewerage undertakers** responsible for ensuring areas are "effectually drained".
- **Householders** responsible for drainage within the curtilage.
- **Local Authorities and Landowners** responsible for landscapes, which may play an important role in infiltration or detention of rainwater.

Any changes to traditional approaches to urban drainage are likely to come about from joint action by two or more of the above groups. There are new drivers for more sustainable approaches to drainage, such as the need to consider amenity and open space in urban design, which may create greater incentives for developers and other land-owners. SuDS deliver wider social, community and environmental benefits than traditional drainage schemes, creating an additional incentive for broader community and landowner (private or public) promotion, ownership and management of the systems.

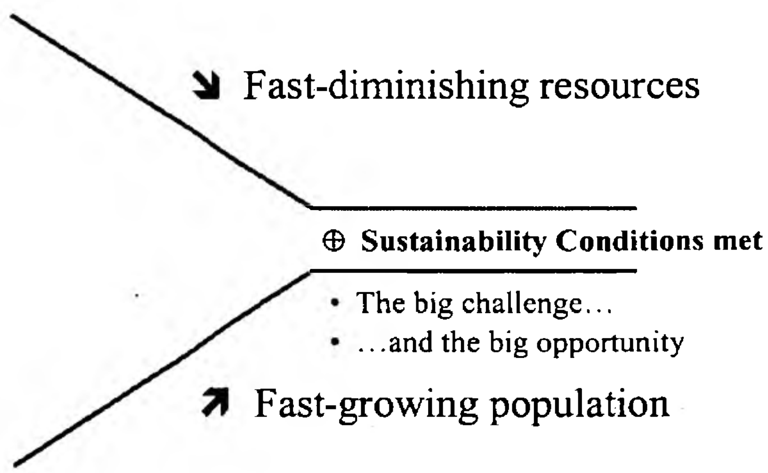
IV. Application of The Natural Step Framework

The *2020 Vision* process revolves around the application of the Natural Step Framework to selected issues – in this instance sustainable drainage – as the basis for consensus-building about the major sustainability issues and the way ahead towards the goal of full sustainability.

We all acknowledge that we live in a fast-changing world, in which the pace of change is accelerating. Thinking back just twenty years, and plotting the changes we've faced – in our day-to-day lives but particularly in business decisions – we become aware of the scale of this change. Although the pressures that have forced these changes may appear random or unforeseeable, many stem from the "squeeze" of a world with a rising population – which is consuming more and more per capita – and a diminishing resource base. The Natural Step (TNS) uses the metaphor of the "funnel" to describe how decreasing environmental and social headroom – the "license-to-operate" granted by a society facing the conflict of rising population and dwindling natural resources – will impinge upon the freedom of operation of a business (Fig 3). As one approaches the "walls" of this metaphorical funnel, the impacts on the business manifest themselves in diverse ways which include resource scarcity and costs (critically including the resource of absorption of waste), more stringent regulations, reputation with markets and the public, health and safety concerns, difficulty in securing capital, and so forth. Pertinent examples for drainage include flood risk, increasing liabilities, loss of amenity and habitat, more stringent planning controls, and under-valuation of water service companies. Sustainable development pressures have been with us for many years and will, inevitably and increasingly, define the future business agenda.

The four System Conditions of the TNS Framework provide a science-based conceptualisation of basic conditions that must be met in a sustainable world. From this conceptual model, we can do two things. Firstly, we can make an objective assessment of our current state of sustainability, by running present approaches to drainage under the "lens" of the four System Conditions. And then we can build a vision of fully sustainable drainage based upon this same conceptualisation of sustainability.

Figure 3: The TNS "Funnel"



Once we know where we are today and where we need to get to tomorrow, we are then in a position to "backcast" from this vision, identifying the incremental steps necessary to reach that sustainable future. By starting from the "end-goal" perspective, backcasting can help make sustainable development tractable. It can also help organisations make short-term investment decisions which, though not delivering the end-goal themselves (full sustainability is remote from where society is today), nevertheless contribute to a progressive reduction in contributions to breaches of the System Conditions. These short-term measures will then also constitute steps leading incrementally towards further future actions that eventually lead to the desired goal of full sustainability.

If tackled proactively, sustainable development will not only enable us to avoid the "walls of the funnel" but also to identify the new business opportunities available in a more sustainable future world. If we continue to react to issues as we go on blundering into those walls, we will merely perpetuate the historic pattern of responding reactively, at substantial cost and disruption to business and society, as issues hit us one after the other. Proactive and strategic decisions are in the end more intelligent and cost-effective than merely reacting to sustainability issues as they inevitably arise. A true commitment to sustainable development is therefore about a great deal more than altruism, as it helps deal strategically with the sustainable development pressures that inevitably define the future.

[1]NCBS, previously NCBE (National Centre for Business and Ecology), can be contacted at: www.ncbe.co.uk

V. Sustainability Analysis of Drainage Systems

The various approaches to drainage of urban areas outlined in Section 3 all have different impacts on the environment and society. As explained on the previous page, the "lens" of the four System Conditions provide an objective and science-based set of criteria for making a sustainability assessment of the current state of approaches to drainage. Tables 1 and 2 below document the findings, System Condition by System Condition, of the assessment of the 2020 Vision project team with respect to the two primary sets of approaches to urban drainage.

5.1 Traditional Drainage Schemes

Table 1: Sustainability Analysis of Traditional Approaches

The TNS System Conditions *In the sustainable society, nature is not subject to systematically increasing ...*	
☺	☹
1. ...concentrations of substances extracted from the Earth's crust	
• Metallic pollutants are diverted to STWs	• Energy use in trench digging and construction, pumping, and handling increased loads passing through STWs • Metals used in grids, etc • Tarmac and aggregates used for covering urban surfaces and in backfill • Pollution of ecosystems from contaminated runoff and CSO overflow (metallic pollutants)
2. ...concentrations of substances produced by society	
• Organic pollutants are diverted to STWs	• Plastics use in pipework and fittings • Increased chemical use in STWs due to high loads through treatment works • Pollution of ecosystems from contaminated runoff and CSO overflow (organic pollutants)
3. ...degradation by physical means	
• Reduced local land take for drainage	• Enhanced flood risk downstream • Destruction of wetlands through drainage and diversion of water (and increased water need due to inefficient use) • Soil and river bank erosion during flooding (exacerbated by increased frequency and intensity)

	• Reduced groundwater and soil moisture (and impact on ecosystems) • Destruction of productive areas of nature in urban design using impermeable surfaces • No buffer for low flows due to reduced retention of water • Loss of feeding or breeding habitats for fish stocks And, in that society...
4. ...human needs are met worldwide	
• Health protection through the provision of waste water treatment • Provision of services to deal with society's waste • Provision of services to deal with surface water flows in urban areas	• Health impacts associated with flooding containing untreated sewage (foul flooding) • Social and economic impacts of flooding (distributed unfairly and increasing flood peaks lower in the catchment) • Water shortages in some areas due to low groundwater levels • Reduced amenity (through wetland loss, lack of vegetated areas, etc) • Impacts on property values • Reduced aesthetic quality where sewage-derived litter is present

5.2 SuDS

The benefits and disadvantages of SuDS will depend on the type and scale of the mechanisms used. Table 2 shows the general sustainability impacts associated with SuDS. Impacts associated with specific SuDS approaches are indicated in parentheses using the key at the foot of the table.

Table 2: Sustainability Analysis of SuDS

The TNS System Conditions	
In the sustainable society, nature is not subject to systematically increasing ...	
☺	☹
1. ...concentrations of substances extracted from the Earth's crust	
• Passive SuDS means less energy derived from fossil fuel for pumping through schemes' life (particularly for larger-capacity SuDS)	• Energy required for pumping (although ideally good design would eliminate this) • Use of gravel, stone and asphalt surfaces (PS) • Use of aggregates for filter/fill (FD&PS, ID) • Energy for digging drains and pipes (FD&PS), and soakaways, trenches, basins, etc (ID, BP)

	• Some use of metals • Water pollution from contaminated runoff where treatment is ineffective (some FD&PS)
2. ...concentrations of substances produced by society	
• Reduced throughputs in STWs mean that less synthetic chemicals are required • Less synthetic pipework and fittings (especially FS&S, ID, BP) • Less tarmac for urban surfaces	• Use of plastics in pipes (small ones in FD&PS) • Use of plastics and chemicals in permeable surfaces (e.g. reinforced grass) (FD&PS) • Use of weedkillers on surfaces (FD&PS) • Water pollution from contaminated runoff where treatment is ineffective (some FD&PS)
3. ...degradation by physical means	
• Provision and creation of wildlife habitats (e.g. planting of IDs, BP) • Enhanced natural ecosystem processes • Erosion control • Groundwater recharge • Increased soil moisture content • Improved water quality through treatment, (esp some FDs, IDs, BP) • Reduced "land take" (FD&PS) • Improved biodiversity (BP)	• Problems of soakaways in industrial areas • Maintenance needs (particularly BP and ID) • Reduction of productive areas of nature where permeable surfaces other than grass/vegetation used (FD&PS)
And, in that society... *4. ...human needs are met worldwide*	
• SuDS provide amenities for local communities • Increased natural capital • More water available for essential needs • Reduced demand for irrigation, etc • Visual/landscape improvement (ID and BP) • Reduced wastage of water • Efficient use of space	• At present, lower confidence in systems • Risk of overload/flooding (which should be lower than conventional drainage if well designed) • Safety issues (children playing in grassy/water areas – esp IDs, BP). Safety must be carefully reviewed to clarify design risks versus natural risks • Loss of land for certain uses (e.g. can't drive on IDs, can't build on BPs)

General comments:

FS&S: The scale of these methods is such that they will not deal with huge quantities of water, so benefits are limited, but the materials and energy used in their construction is minimal.

FD&PS: The sustainability impacts of filter drains and permeable surfaces vary according to the materials being used and the scale of the system.

Key:				
	FS&S:	filter strips and swales	ID:	infiltration devices
	FD&PS:	filter drains and permeable surfaces	BP:	basins and ponds

VI. Vision of a Fully Sustainable Drainage System

The TNS *2020 Vision* process enables the development of a vision of a fully sustainable drainage system, based on the four System Conditions. This is a long-term vision, setting goals that will rarely be immediately achievable in today's unsustainable world. However, it guides our thinking by offering a clear target for incremental steps that may be taken today, as well as helping us identify necessary partners and spot the economic opportunities of a more sustainable world. Several key points emerging from the first approach to a vision are listed below. These were developed by participants in the *2020 Vision* seminar.

In the sustainable society, nature is not subject to systematically increasing ...

1. ...concentrations of substances extracted from the Earth's crust

- Reduced energy intensity, with energy needs met by renewable means
- Recycled aggregates used
- Pollutants from the earth's crust minimised at source
- Minimal release of persistent pollutants from motor vehicles (brake linings, oils, etc)

2. ...concentrations of substances produced by society

- SuDS design manages pollutants at front end
- Synthetic pipework, etc, recycled
- Chemical inputs to STWs not increased by storm drainage

3. ...degradation by physical means

- Natural recharge of aquifer
- SuDS solutions support biodiversity
- Natural hydrology restored
- Naturally-treated water exiting SuDS is reused
- Impermeable areas in cities minimised

And, in that society...
4. ...human needs are met worldwide

- Unsustainable urban drainage no longer the accepted norm
- SuDS provides amenity where possible, adding value to community
- No increased flood liability downstream
- Institutional arrangements established to support implementation and adoption
- Foul sewerage is fully separated from surface drainage systems
- Health issues addressed
- Effective methods exist to re-engineer urban areas
- Minimised use of materials
- Minimised mobilisation of pollutant loadings
- Source control (dealing with rainfall where rain/precipitation first impacts).

VII. The Challenges of Delivering Sustainable Drainage

As outlined in Section 4, it is possible to 'backcast' to the present from a vision of full sustainability, and to identify incremental steps leading there from today. This helps make sustainable development tractable, and also helps organisations make short-term investment decisions that build stepwise towards the long-term goal of sustainability.

Delegates at the *2020 Vision* Seminar identified a range of issues that need to be addressed on the journey towards our vision of fully sustainable drainage (covered in greater detail in the full report), which are summarised below as six key sustainability challenges for urban drainage.

Challenge 1. Develop clear life-cycle costings of SuDS and traditional drainage systems
This must take account of the full range of benefits, downstream implications and maintenance implications of each system so as to enable holistic and comparative cost-benefit-risk assessment.

Challenge 2. Increase awareness about multiple benefits of SuDS
This must include the multiple values they bring to society, ranging from flood storage, chemical and microbial treatment, wildlife and amenity value, etc.

Challenge 3. Embody SuDS within appropriate legislation
It is no longer acceptable that the "best practice" norm should be unsustainability, and so there is a need to revise relevant legislation (e.g. planning) such that SuDS are accepted as "best practice". This challenge must include redressing the current bias within AMP (the current framework regulating expenditure by the water industry) towards "hard engineering" schemes, as well as creating the necessary incentives for promotion, ownership and management by other sectors of society.

Challenge 4. Establish protocols for the adoption and maintenance of SuDS
This is essential to ensure their ready acceptance, and for all to be clear about maintenance requirements and responsibilities. Guidance needs to be clear, and to be appropriate for a range of situations. As noted in the previous challenge, the wider benefits of SuDS and other incentives need to be established such that ownership and management of SuDS schemes rests with the bodies (water companies, private or public land-owners, etc) appropriate to the individual SuDS scheme.

Challenge 5. Divert funding to SuDS from other areas of public expenditure

Since SuDS address a range of problems and also deliver a range of benefits to different aspects of society – flooding and pollution control, wildlife, amenity and landscape – it will be important also to create a mechanism for providing funding for Public Open Space / Local Authority ownership for above ground SuDS design and management. This is necessary since these streams of public expenditure have not traditionally been associated with the single issue of "drainage", but are appropriate to a mulit-benefit SuDS scheme.

Challenge 6. Overcome the technical shortcomings of SuDS

It will be necessary to continuously improve SuDS design to deliver multiple benefits, and provide guidance and demonstration projects on their effectiveness in a range of situations.

There is no doubt that considerable further progress is required to change from today's situation where traditional drainage designs widely acknowledged as unsustainable are, for a variety of historic reasons, the *de facto* "best practice" norm. Some relevant work is in hand. The Environment Agency is, for example, already working on accreditation of SuDS designs to retain and gain critical acceptance (addressing in part Challenge 6), whereas PPG Planning Policy Guidance notes are beginning to promote SuDS schemes more widely (Challenge 3). The consensus of the *2020 Vision* project team remains that adoption of SuDS schemes presents the most significant obstacle, which is further discussed in the full project report *Sustainable Drainage Systems (SuDS): An Evaluation Using The Natural Step Framework.*

VIII. Making Progress With Sustainable Development

The six Sustainability Challenges, delivered through the consensus-building *2020 Vision* process based upon the sustainability principles and tools of TNS, provide a framework for making progress with increasingly sustainable drainage. Each of the bodies represented within this *2020 Vision* process therefore has "bought into" ownership and advancement of the Sustainability Challenges. Delivery of fully sustainable drainage will however depend upon the engagement of an increasing circle of decision-makers across society. This will need to occur at two scales: the *generic development of SuDS and the application of SuDS on a site-specific basis.*

8.1 The Generic Development of SuDS

The many contentious issues – technical, social, ecological and economic – addressed by the six Sustainability Challenges represent what must be addressed if we are to make *sustainable* approaches to drainage the norm. It is an absurd world that makes the converse – approaches widely acknowledged as unsustainable – the de facto "best practice" norm. All parties entailed in their development therefore have a role in promoting the Challenges more widely, and seeking to influence other decision-makers entailed in their realisation.

8.2 Application of SuDS on a Site-specific Basis

A further logical stage in the *2020 Vision* process is to apply these six Sustainability Challenges as a filter for a major development. The TNS tools provide a basis for consensus-building between different interests on the site – investors, developers, wildlife groups, regulators, development planners, highways planners, architects, etc – about the most sustainable and mutually advantageous way forward.

TNS is seeking to engage partners in future "hands on" projects exploring the practical application of these Sustainability Challenges to drainage on target sites.

IX. About the 2020 Vision Seminar

There are many contentious issues – technical, social, ecological and economic issues – that present a number of challenges to those responsible for urban drainage systems. The aim of the *2020 Vision* process, and the focus of the *2020 Vision* seminar, was to involve a range of participants to share information and build consensus about the place of SuDS in a sustainable world, and the steps necessary to achieve that goal. The process helps create a vision of the kind of environment and sustainable future to which society aspires. The following people were involved in the development of this project

Attending the 2020 Vision Seminar

From The Natural Step
Dr Mark Everard
Penny Street, TNS Researcher

Yorkshire Water
Jane Leverington
Lisa McKenzie
Deborah Pedley

From the Environment Agency
Prosper Paul
Helen Richardson
Hugh Roberts
Jill Stone
Jenny Thomas

Other Invited Guests
Prof Bob Andoh, HRD Ltd
Professor Richard Ashley, Bradford University
Brian D'Arcy, SEPA
Steve Evans, Water UK
Morag Garden, East of Scotland Water
David Harley, SEPA
David Sellers, Leeds City Council
Bruce Sharpe, Forum for the Future
Dr Heidi Smith, Bradford University
Dr Rob Stoneham, Sheffield Wildlife Trust
Norman Walker, Leeds City Council

Corresponding Members of the *2020 Vision* Project

From The Natural Step
David Cook

From Water Service Companies
Brian Crathorne, Thames Water
Dr Dan Green, Wessex Water
Perry Hobbs, Anglian Water
Andrea McHugh, United Utilities
Dr Adrian Rees, Yorkshire Water
Julie Robinson, Severn Trent Water

From the Environment Agency
John Batty
Mervyn Bramley
Stefan Carlyle
Phil Chatfield
Chris Chubb
David Griffiths
Dr John Holmes
Dr Jacqueline Vale

Other Participants
Jane Anderson, Building Research Establishment
Bryan Bell
Erik Bichard, National Centre for Business and Sustainability
Dr Jeremy Biggs, Ponds Conservation Trust
Carole Bond, Carbon Data
Bryan Boult, Hampshire County Council
Bob Bray, Robert Bray Associates
Mike Bridgeman, Hampshire County Council
David Brownless, Bryant Homes Northern Ltd
David Buckland, South Gloucestershire District Council
Sue Cosgrove, Tesco
Robert Cunningham, Wildlife Trusts Water Team
Jas Dhami, Carillion Building
Suzy Edwards, Building Research Establishment
Craig Elliot, CIRIA
John Griggs, Building Research Establishment
John Handley, Manchester University
Matt Hill, University of Bradford
Colin Hygate, the Environmental Solutions Company
Prof Quentin Leiper, Carillion Building
John Lomax, Nicholls Jones and Lomax
Katherine Pygott, WS Atkins Water
Donna Rispoli, Forum for the Future
Mike Robinson, South Gloucestershire Council
Chris Seeley, Just Business
Mike Smith, Quest Futures
Dr Roger Sweeting, Freshwater Biological Association
Ben Tuxworth, Forum for the Future
Rebecca White, Building Research Establishment
Christopher Williams, HRD Ltd

About the *2020 Vision* Series

The ***2020 Vision Series*** of publications aims to provide information about a range of contentious issues, many of which have featured in the media. The Natural Step office in the UK, together with SATIS (the Scientific and Technical Information Service of the Environment Agency), runs a series of ***2020 Vision Seminars***. These seminars involve invited participants in the sharing of information and debate about the place of specific contentious issues in a future more sustainable world. This *2020 Vision* Series publication reports on the sustainability analysis using the System Conditions of TNS, as well as the outcomes of the *2020 Vision* Seminar on PVC. This summary document is also available at The Natural Step's UK web site: http:\\www.naturalstep.org.uk. (You can also find the *2020 Vision Series No.1* and *No.2* documents, respectively on GMOs and PVC, on the same web site.) The detailed report *Sustainable Drainage Systems (SuDS): An Evaluation Using The Natural Step Framework* is also available from The Natural Step office in the UK, priced £20 to cover production and handling costs, using the contact details at the end of this document.

About The Natural Step

The Natural Step (TNS) Framework is a science-based learning and decision-making programme aimed at helping organisations to understand and apply the concept of sustainable development. It was developed in Sweden in the late 1980s. The Natural Step office in the UK has been operating as a charity, chaired by the well-known environmentalist Jonathon Porritt, since the beginning of 1997. It has already been successful in helping a range of large companies[1] address sustainable development as a strategic issue. The science-based model of a sustainable world, which lies at the heart of TNS, together with a range of other specialist TNS tools, provides an "intellectual round table" for the building of consensus about various social, environmental and economic aspects of contentious issues and their place in a future more sustainable world. The Natural Step office in the UK, which is supported by the Environment Agency, is a partner of the Agency in the *2020 Vision* series of seminars and publications.

About Yorkshire Water Services Ltd

Yorkshire Water Services Ltd (YWS) is part of the Kelda Group and provides households (a population of 4.5 million domestic customers) and 140,000 businesses in the Yorkshire region with their water and sewerage services. It operates 116 water treatment works producing 1.2 billion litres of water every day, as well as 612 waste water treatment works that treat 0.8 billion litres of domestic sewage, industrial effluent, and run off from roads and roofs. This is served by a network of 30,000 kilometres of water mains, and 30,000 kilometres of sewers – more than enough pipework to circle the earth. YWS employs 3,000 people as well as many suppliers and contractors in the region. SuDS offer YWS an alternative, more sustainable and perhaps more cost-effective, approach to alleviating urban flooding, controlling pollution at source, and preventing overloading the sewerage system.

About the Environment Agency

The Environment Agency has wide-ranging powers and duties relating to water management, environmental protection and pollution control across England and Wales. Its principal aim is to exercise them so as to contribute to sustainable development. The Agency therefore has strong interests in the application of science to decision-making – both its own and that of other sectors of society – as an important part of its contribution towards the achievement of sustainable development. Involvement in the *2020 Vision* series of seminars and publications has stemmed from the Agency's aspiration to envisage the kind of environment that it wishes to work towards. *2020 Vision* provides an expert analysis of the place that a range of contentious issues occupy in a future sustainable world.

[1] Pathfinder partners of TNS in the UK comprise: Air BP, Carillion, the Co-operative Bank, DuPont, Interface, Sainsbury's, Sun Microsystems, Tarmac Quarry Products, Wessex Water Facilities Management, Yorkshire Water and HP Bulmer.

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