Yorkshire Water

Environment Agency

the Natural Step

Sustainable Drainage Systems (SuDS):

An Evaluation Using The Natural Step Framework

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1. 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. Water comprises around 60% of our body weight, and we exchange 3% of this with the world around us every day. Successive cultures arose by rivers and lakes, which provided for their drinking, cleaning, cooking, food, transport, energy and waste disposal needs. There are many examples of towns where watercourses are a defining feature of landscapes and communities, and this is often reflected in their name. Fresh waters, in short, are central to every aspect of our lives.

It is then a curious paradox that water and aquatic systems have been so comprehensively overlooked in the ways that urban environments have been planned. Treating water as a commodity that is always available on tap, or overlooking the impacts of the built environment upon the water cycle, serves to undermine our perception of its critical life-support role and leads to significant social and environmental damage. The legacy of urbanisation has been the massive loss of wetlands, "squeeze" of riverside land and wet habitats, constraints upon the natural flow of river systems, spiralling demand that lowers river flows and groundwater levels, and an engineered cityscape that contributes directly to its own flooding problems.

It is particularly 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, there is an increased awareness of the inherent wisdom of Integrated Catchment Management.

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. The background, process and outcomes of the study are presented in this report, with the flow of topics addressed covered in the following sections.

Section 2	Background to the study, including the basic sustainability principles used by The Natural Step and a closer look at the hydrological cycle.
Section 3	Overview of the various current approaches to urban drainage.
Section 4	Sustainability analysis of these different approaches.
Section 5	Vision of a fully sustainable drainage system.
Section 6	The challenges entailed in delivering more sustainable forms of urban drainage, including some steps that may be taken towards addressing some of these challenges.

II. Background

2.1 Urban Drainage and the Challenge of Sustainable Development

Rapid urbanisation and population growth during the Industrial Revolution resulted in increasing development of land, and installation of "hard" engineered drainage systems to remove floodwater. Piecemeal encroachment on land, with the loss of its natural capacity to detain and slowly absorb floodwater, compounds problems associated with flood management. Perpetuation of the Industrial Revolution solutions to getting rid of flood water rapidly can merely shift the problem elsewhere. Increasingly, this has led to the realisation that engineered approaches to drainage may not be sustainable.

The urban environment has become increasingly impermeable, displacing nature's hydrological and water purification services and giving rise to a wide range of flooding and diffuse pollution problems. 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). 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 served recently to reinforce our view of this situation. In reviewing the impacts on society resulting from the unprecedented rainfall across England and Wales in Autumn 2000, the Environment Agency acknowledges that effects were exacerbated by a legacy of unsustainable development and land use, noting that, for flooded properties, "*The Association of British Insurers (ABI) estimate that storms and flood damage claims for last autumn will total between £700 and £750 million*"[1].

More sustainable approaches would emphasise solutions that work with and not against natural processes, for example restoring the permeability of the urban environment and capturing the resource for supply. At the same time, there is a need to ensure that pollutants picked up from the urban environment do not contaminate groundwater or rivers. Such solutions also need to provide a range of benefits, including reduced flood peaks and improved urban ecology and amenities.

The existing water industry investment process in England and Wales – Asset Management Planning (AMP) – has the potential to deliver far more sustainable results. However, for a variety of reasons, there is resistance to these alternatives despite the potential also for lower capital and maintenance costs. There is therefore a pressing need to open up thinking and form a consensus about new solutions to surface water management that are consistent with a sustainable future. Above all, there is a need to spread awareness amongst the water engineering community that sustainable development is not about additional tasks at additional costs, but is as much about innovating in how one approaches challenges and uses existing funding more creatively.

[1] Environment Agency. (2001). Lessons Learned: Autumn 2000 Floods. Environment Agency, Bristol.

2.2 Using The Natural Step Framework

This study explores the sustainability issues around existing drainage of urban areas, the form that more sustainable approaches to urban drainage might take, and the ways in which they could be brought about. The Natural Step Framework – the core TNS set of science-based tools for addressing sustainable development – is used to examine existing and alternative approaches to urban drainage.

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. The TNS Framework, including the four System Conditions, is explained in more detail in Annex 2. In this study, the four TNS System Conditions (see Box 1) are used to assess the overall sustainability of traditional and SuDS approaches to urban drainage and water management, and also provide the basis for developing a vision of a fully sustainable solution.

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.

Consensus around the key issues is sought through The Natural Step's *2020 Vision* process[2]. The study goes on to identify the potential role of more sustainable forms of urban drainage, and the key challenges facing their adoption.

2.3 The Basic Hydrological Cycle

In order to develop and implement more sustainable approaches to urban drainage, there must be a clear understanding of the way in which the water cycle operates, and the potential for society to disrupt it. Figure 1 illustrates the way in which human settlements benefit from the natural functions of an unperturbed water cycle. The social and economic benefits derived from this cycle are outlined below.

1. Precipitation. Water purified by the solar-powered water cycle, falling in liquid or solid form, cleanses the air of pollen, dust, exhaust emissions and other particulates.

2. Runoff. Water running across the surface of the land washes away wastes, redistributing matter and accelerating the biogeochemical cycles that keep life going. Land is watered, and decomposition processes and biogeochemical cycling are enhanced.

[2] An outline of the *2020 Vision* process is provided at Annex 1. Further information on the *2020 Vision* series, including reports on GMOs and PVC, can be found at http://www.naturalstep.org.uk/

3. Infiltration. Rainwater percolates into groundwater through permeable surface layers, where it is filtered and further purified by biological activity. This process recharges groundwater resources in underlying aquifers.

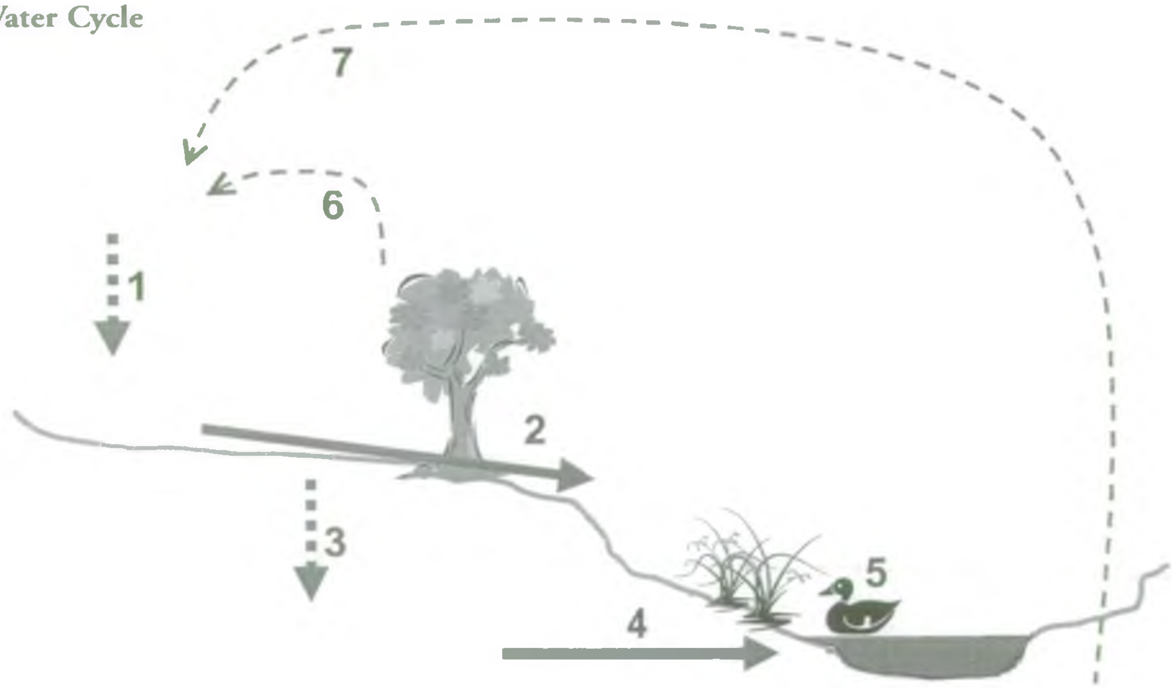
4. Baseflow. Discharge from groundwater maintains flows in rivers and water levels in stillwater bodies, also maintaining wetland systems.

5. Wetlands. Wet habitats, ranging from permanent still and flowing waters to periodically inundated habitats, form a hydrologically connected set of environments supporting important wildlife. Wetlands also perform important hydrological and biochemical processes as well as contributing to the amenity value of land.

6. Evapotranspiration. Water (intercepted from precipitation or absorbed from soils) is released into air by vegetation creating a microclimate by contributing to cooling and humidity, and improving air quality.

7. The natural cycle. The water cycle is completed at larger scales, right up to global level, as water evaporated from lakes, rivers, vegetation and damp land surfaces and the seas is recondensed, falling as purified precipitation.

Figure 1: The Water Cycle



2.4 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.

Figure 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 are outlined below:

A. **Impermeable surfaces.** Infiltration of water into subsoil strata is prevented by hard surfaces, including metalled roads and car parks, roofs, concrete and compacted soils. Absence of vegetation means that surface flows are not slowed, magnifying runoff as percolation through surface layers is inhibited. This contributes to problems such as pick-up of surface pollutants, soil erosion, lack of recharge of aquifers and flash flooding.

B. **Habitat loss.** When habitat is lost, a range of wetland services is also lost, and the following problems (amongst others) can arise: flash flooding, higher flood peaks, drying out of soil and aquifers, loss of purification capacity, loss of feeding/breeding habitats for aquatic life, and degraded leisure opportunity.

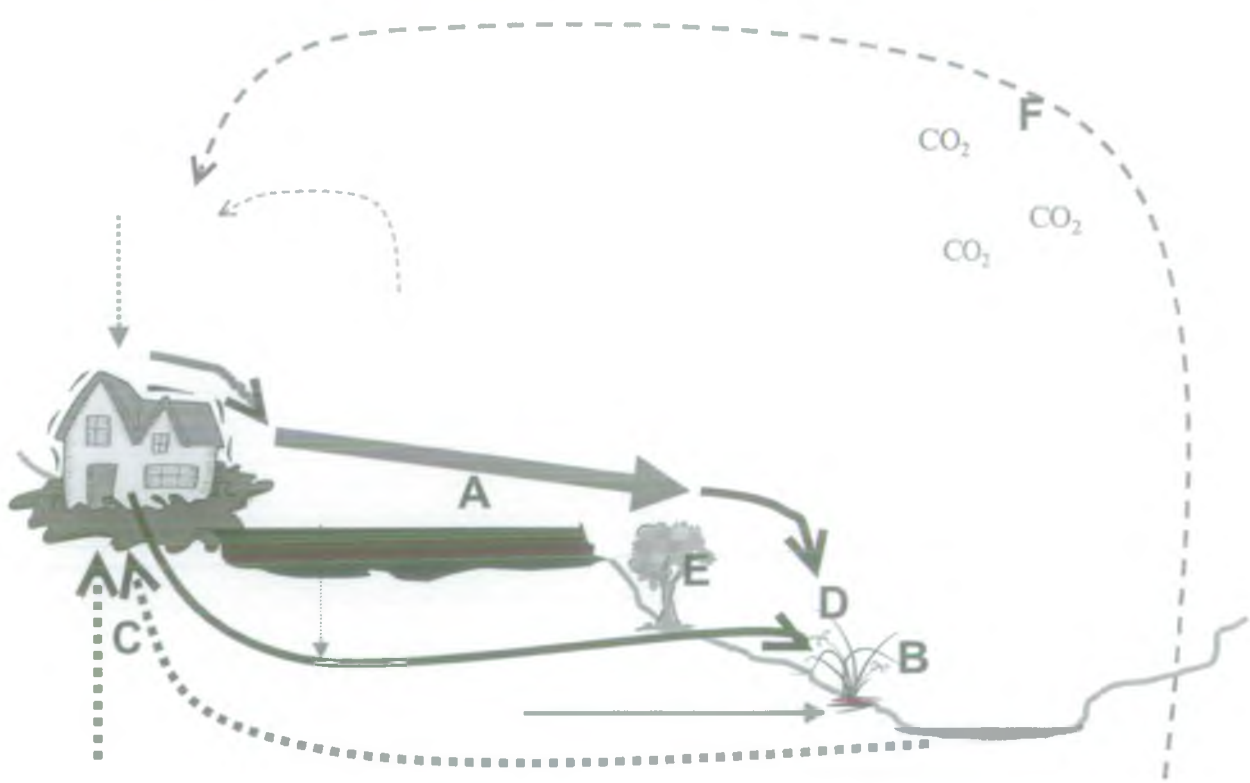
C. **Over-abstraction.** Rising demands for fresh water commonly result in over-abstraction of groundwater and surface water resources.

D. **Polluted water.** Runoff is contaminated by pick-up of pollutants from hard surfaces, and waste water streams from buildings also necessitate sewerage and treatment infrastructure. When these two waste water streams combine, as is commonly the case, contaminated urban drainage overloads sewerage infrastructure (see Section 3).

E. **Loss of vegetation.** As urban development displaces trees and other vegetation, their capacity to clean and maintain microclimates is lost, together with the slowing down of surface flows that aid percolation of water into the soil and support purification processes.

F. **Climate change.** At a global scale, society's use of fossil carbon fuels and release of other greenhouse gases contributes to a changing climate. This threatens to change precipitation regimes.

Figure 2: Disruption of the Natural Water Cycle



III. Summary of Alternative Approaches to Urban Drainage

The nature of the urban environment is such that there is a need to provide adequate drainage to remove surface water rapidly. 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). SuDS is an umbrella term for a number of more sustainable approaches to urban drainage. This section of the report summarises these two different approaches.

3.1 Traditional Approaches

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: separate storm sewers and combined sewers. Combined sewers are the most common, particularly in older areas of cities.

Storm sewers receive stormwater runoff from roads, roofs, lawns and other hard 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. Buildings with basements are protected against high groundwater levels by the installation of drainage pipes around the basement footings which discharge to a storm or combined sewer or a sanitary sewer or basement sump.

The **combined sewer system** utilises the same pipes to transfer domestic sewage, rainwater and industrial wastewater for treatment. Because the sewers carry sanitary wastes and are connected to basement floor drains, any surcharging could cause "foul flooding": a backup of untreated sanitary sewage into basements. Consequently, such systems must be designed to accommodate large storms without surcharging, while still receiving sanitary flow. Combined sewers are common in the older sections of most large municipalities.

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.

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

- **Flooding and pollution from CSOs**. During dry weather, all flow collected by the combined sewers is directed to waste water treatment facilities. During rainfall, the treatment plant may be able to accept 1.5-3 times the dry weather flow. However, a widespread problem is that during intense storm events, the capacity of treatment systems can be exceeded. Thus, the excess stormwater, combined with municipal wastewater, must be discharged to the receiving waters through combined sewer overflows (CSOs) without proper treatment. Two basic approaches have generally been taken to address this problem:

  – Storage of some proportion of the excess flow (e.g. in unused sewer capacity, tanks, or reservoirs) for subsequent treatment. Although not eliminating the problem of overflows, remedial levels of treatment are aimed at alleviating the impact on receiving waters. This is the focus of much of the investment in AMP3, the third round of the Asset Management Planning programme (2000-2005) in England and Wales.

  – Some degree of separation of stormwater from municipal wastewater. (Complete separation is perceived as the best option, although this is not seen as economically viable in most places.) Separation of stormwater from sanitary sewage would minimise the risks of sanitary wastes backing up into basements or overflowing into receiving waters, by ensuring that all municipal waste of foul sewer origin is treated, and surface water is deposited back into the environment. However, it would not address what is increasingly being seen as a major problem associated with stormwater – that of contamination from surface runoff (see below).

- **Water quality**. Urban runoff is increasingly being seen as a major source of water pollution. This diffuse or non-point source pollution occurs as precipitation (rainfall or snowmelt, etc) passes over the ground surface in urban areas. Although its significance is in dispute, given the lack of quantitative evidence as to its contribution to the downgrading of river quality, diffuse pollution is assuming increasing importance for UK and other European watercourses, largely due to success in tackling the formerly dominant industrial and sewage effluent point sources[3]. During its passage, water can pick up a number of pollutants including, for example:

  - sediment
  - heavy metals
  - solvents
  - oil and other hydrocarbons
  - road salts
  - street litter
  - organic waste
  - nutrients

  Sediments and solids tend to constitute the largest proportion of pollutants loading, and can act as the carrier for other pollutants.

- 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. Many drinking-water boreholes are at an all-time low, and naturalists are anxious about wetland habitat loss and low river flow[4]. Further ecological damage occurs as more urbanisation takes place. Increased urbanisation is leading to more stormwater runoff from impermeable surfaces, and thus we are seeing increased likelihood of high frequency floods with knock-on effects such as erosion of riverbanks and damage to habitats.

[3] "The diffuse pollution challenge", ENDS report 310, November 2000, pp.20-23.
[4] Chris Baines, "I've seen the future and it's a sponge". Green Futures, July/August 2000, pp.46-48.

3.2 Sustainable Drainage Systems (SuDS)

In view of the problems associated with existing systems of urban drainage and the poor performance of CSOs, new more sustainable approaches are being sought to the way in which water resources are managed in urban areas. Such approaches are founded on the need to reduce peak flows, enhance water quality, improve urban ecology and amenity, etc. The generic term for such approaches is SuDS – Sustainable Drainage Systems.

According to the Construction Industry Research and Information Association (CIRIA), SuDS are "*…a concept that includes long term environmental and social factors in decisions about drainage. It takes account of the quantity and quality of runoff, and the amenity value of surface water in the urban environment*"[5]. SuDS comprises a "*…sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques*"[6]. In particular, SuDS attempt to balance the key impacts of urban drainage on the environment, by addressing issues of quantity, quality, ecology and amenity in their design.

As already noted, the most severe problems associated with traditional approaches to drainage are the displacement of natural ecosystem functions and the benefits that they deliver to society, due to progressive unsympathetic development. These functions include hydrological processes such as floodwater detention and water storage, purification processes and biogeochemical cycling, habitat provision, groundwater recharge, amenity and landscape. Restoration or protection of these natural wetland functions is an essential feature of sustainable development, and must be addressed at the catchment scale, with SuDS playing a potentially key role at the local scale[7]. In this report, we will not consider large-scale natural and man-made treatment wetlands under the title of SuDS, although we acknowledge their importance.

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. CIRIA groups SuDS into four general methods of control, and the following descriptions of these four main SuDS methods are based on those provided by CIRIA in its Design Manual on SuDS[8]:

- **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. As rainwater runs through the vegetation, the flow is slowed down and filtered. Swales can also be designed to increase attenuation and infiltration, for example through the use of check dams. Both systems are effective at removing polluting solids through filtration and sedimentation. Vegetation traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients.

[5] CIRIA, Sustainable Urban Drainage Systems: Design Manual for England and Wales. Construction Industry Research Association, London, 2000, p.1.

[6] Ibid, p.ix.

[7] Everard, M., Powell, A. and Sweeting, R.A. (2001). What Rio+10 must do for the freshwater environment. FBA News.

[8] Ibid.

- **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. The water then passes through the permeable surface to the filter drain. The amount of water stored depends on the voids ratio of the permeable fill or sub-base, the plan areas and depth. Water can be disposed of by infiltration, an underdrain or can be pumped out. Overflow can be via a high-level drain or controlled surface flow. The permeable fill or sub-base traps sediment and thus improves quality of runoff. Design factors must take into account:

  – the need for sufficient structural strength to cope with likely loads from construction and expected traffic use;

  – if runoff is through infiltration, supporting soil will need to retain strength when saturated;

  – the surface should be permeable enough to cope with the design rainfall intensity.

- **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 storage takes place in devices such as:

  – soakaways and infiltration trenches – these are completely below ground, in a chamber lined with porous membrane and filled with coarse crushed rock;

  – infiltration basins and swales – these store water temporarily on the ground surface, but are dry except in periods of heavy rainfall;

  – filter drains and ponds.

  Enhanced drainage occurs through providing a large surface area in contact with the surrounding soil through which the water can pass. The infiltration devices may be used at source or the runoff may be conveyed in a pipe or swale to the infiltration area. They are designed for limited storage and disposal. Limitations to their effectiveness occur where the soil is not very permeable, the water table is shallow, or the groundwater under the site may be put at risk. The amount of water that can be disposed of within a specified amount of time depends on the infiltration potential of the surrounding soil, the size of the device and the density of any fill material.

  Runoff is treated in different ways in an infiltration device, including:

  – physical filtration to remove solids;

  – adsorption onto the material in the soakaway, trench or surrounding soil;

  – biochemical reactions involving micro-organisms growing on the fill or in the soil.

  – Pre-treatment may be required before polluted runoff is allowed into an infiltration device.

Infiltration devices can make a positive contribution to amenity and wildlife. They can be used as recreational areas or public open spaces, and they can be planted with trees/shrubs thus improving appearance and providing wildlife habitats.

- **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. They can also influence the amount of water that infiltrates the ground (if there is no risk to groundwater quality).

  Runoff is treated in different ways such as: settlement of solids in still water; adsorption by aquatic vegetation or the soil; or biological activity. The longer the water is held, the more effective the treatment is. For example, balancing ponds have limited treatment capacity compared to ponds with longer retention times, and still conditions in lagoons allow for settlement of solids, but no biological treatment.

  Basins and ponds tend to be used where source control cannot be fully implemented, where extended treatment of runoff is required, or if they are required for wildlife or landscape reasons.

All four types of SuDS can be used together and, where wildlife and amenity benefits are of importance, put in a sequence that reduces pollutant loadings to open areas of water or wetland that may become biologically diverse. For all four types of SuDS, the controls should be located as close as possible to where the rainwater falls, thus helping slow down the rate of flow to prevent flooding and erosion. They also provide varying degrees of treatment for surface water, using natural processes of sedimentation, filtration, absorption and biological degradation. The choice of control method can take into account the wishes of different stakeholders and risks associated with each option.

Given the expense and difficulty of retrofitting SuDS in existing urban areas, the main role of SuDS – certainly in the short and medium term – is likely to be in draining new developments. This will serve to lessen the load on existing sewerage systems and help prevent the development of new ones. There nevertheless exists a need to innovate techniques for retrofitting SuDS-type techniques in older developments, restoring natural ecosystem functions, and averting flood and pollution risk.

IV. 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. This section of the report provides a sustainability assessment of the various approaches, in terms of their impact against the four TNS Systems Conditions. The TNS System Conditions are also used as the primary basis for developing a vision of fully sustainable urban drainage, as well as for identifying the key sustainability challenges for delivering fully sustainable urban drainage (these will be discussed further in Sections 5 and 6).

4.1 Traditional Approaches

A detailed sustainability assessment of traditional drainage approaches, using the four TNS System Conditions, is shown in Table 1.

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 for trench digging and construction • Energy use for pumping water • Energy use to handle 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 used 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

4.2 SuDS

The benefits and disadvantages of SuDS will clearly depend on the type and scale of the mechanisms used. Table 2 shows the general sustainability impacts associated with SuDS. Where impacts are particularly associated with specific SuDS, this is shown in parentheses using the following abbreviations:

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

Table 2: Sustainability Analysis of Generic 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 as filter/filler material (FD&PS, ID) • Use of energy for digging drains and pipes where used (FD&PS), and for soakaways, trenches, basins, etc (ID, BP) • Some use of metals • Pollution of ground/surface waters from contaminated runoff where treatment by SuDS is not effective (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 man-made chemicals in some permeable surfaces (e.g. reinforced grass) (FD&PS) • possible use of weedkillers to keep surfaces clear (FD&PS) • Pollution of ground/surface waters from contaminated runoff where treatment by SuDS is not effective (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 filtration, sedimentation, biological treatment, etc (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 • Increased availability of water for essential needs • Reduced demand for water for watering, 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.

V. 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 during 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).

VI. The Challenges of Delivering Sustainable Drainage

From a vision of full sustainability, it is possible to "backcast" to the present, 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 (see Section 6.1 below). These are summarised as six key sustainability challenges for urban drainage (Section 6.2).

6.1 Issues to be Addressed

1) There is a perception that SuDS adoption brings with it risks and costs, particularly in maintenance throughout life. However, it is often overlooked that traditional piped systems also have associated risks and costs. The following issues will need to be included within holistic comparative cost/benefit/risk assessments:

- the largely externalised costs of traditional drainage, including increased risk of downstream flooding, pollution control and maintenance costs, CSO overflows, overload of STWs and the costs of bigger infrastructure (capital and operating);

- the potential wider benefits of SuDS to both the water environment (water quality, water resources, flood control, fisheries and conservation) and also to landscape, amenity, educational opportunity, etc. These wider benefits are not traditionally weighted in cost/benefit decisions, but have to be taken account of fully if we are to engage in sustainable development;

- the reduced capital and maintenance costs entailed in reductions in downstream flood defences as a result of more effective source control;

- the costs of maintenance of SuDS but also of traditional systems incurred by inputs of storm water.

These will have been communicated through clear life-cycle costings of SuDS and traditional schemes. This need to account transparently for costs for use of the water environment will be necessary as an aspect of the EU Water Framework Directive 2000.

2) There should be an elevated awareness about the multiple benefits of SuDS, and their multiple values to society, particularly to:

- the informed public;

- the water industry, wherein according to the contributors to this *2020 Vision* project, awareness of SuDS is currently alarmingly low;

- regulators, and in particular key staff within the organisations (Environment Agency, Water Service plcs, OFWAT & DEFRA) involved in quadripartite agreement in England and Wales on Asset Management Planning (AMP) spend;

- key people in the construction industry;

- more local authorities, who will need to be informed of the benefits of SuDS to local amenity and landscape, Best Value, and the duty to contribute to sustainable development by all means under the Local Government Act 2000;

- wildlife and conservation interests concerned with the protection and restoration of species, habitats and ecosystem functions.

3) SuDS need to be embodied within legislation on planning (particularly Planning Policy Guidance notes, or PPGs), water, construction and highways, such that *unsustainable* drainage is no longer automatically accepted as the best practice norm.

4) Protocols for adoption of SuDS will need to be agreed, and clear maintenance criteria established. Flexibility will be necessary to enable the adoption and maintenance of different types of SuDS in different situations. For example:

- SuDS maintenance could stimulate local enterprise, with some community ownership of the schemes.

- Creation of employment in SuDS maintenance could contribute to overcoming social exclusion.

5) The diversion of AMP and other forms of public expenditure will be necessary, particularly for example from local authority parks and landscape funding streams where SuDS schemes contribute to local amenity, natural beauty, utility, conservation value and landscape.

6) Form cross-sectoral partnerships to develop consensus about the sensitive and most sustainable implementation of SuDS on a site-specific or a regional "best practice" basis. This may use the checklist of **key challenges** in Section 6.2 of this report, or else utilise the TNS *2020 Vision* process for consensus-building. Partnerships should comprise foresighted housing associations, local authorities, sewerage undertakers, Highways Agencies, the Environment Agency and communities will have been achieved early on in major development projects to initiate action and provide demonstration projects.

7) Research and technological development will need to be carried out to address the current shortcomings of SuDS (e.g. in pollution control) and to provide guidance on design and installation. Demonstration projects will be available as a way of showcasing latest developments and encouraging uptake. Particular technical and R&D challenges identified throughout this *2020 Vision* process include:

- Design guidance
- Monitoring of performance
- Professional/technical training to an accepted method
- Clear specifications for ready implementation
- Co-ordination of the various strands of innovation and research currently taking place.

6.2 Key Challenges

This broad range of factors is summarised below into a set of six key sustainability challenges.

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 approproiate 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.

6.3 Tackling the Sustainability Challenges

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.

Many of these Sustainability Challenges are not for the water industry alone, and indeed will rely upon cooperation and exploration of optimally sustainable outcome between a wider group of decision-makers even than those represented in this limited consensus-building process. The achievement of sustainability will entail partnerships with other sectors of society, such as central and local government, local communities, planners, developers, education institutions, and regulators such as the Environment Agency/SEPA, OFWAT, etc.

Planning incremental steps to tackle these challenges will be a complex task. Work during the *2020 Vision* seminar helped to identify a number of actions or "next steps" that could be taken. A few of those identified by the *2020 Vision* seminar delegates to begin to address Challenge 2 (awareness raising) and Challenge 4 (adoption issues) are further elaborated in Annex 3.

Annex 1: About the *2020 Vision* Seminar

There are many contentious issues around developing and adopting more sustainable forms of drainage of urban areas. Such issues relate to technical, social, ecological and economic issues, and 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. Key points arising during the seminar are included in the main body of this report (and some also in Annex 3).

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

End of Annex 1

Annex 2: Sustainable Development and The Natural Step

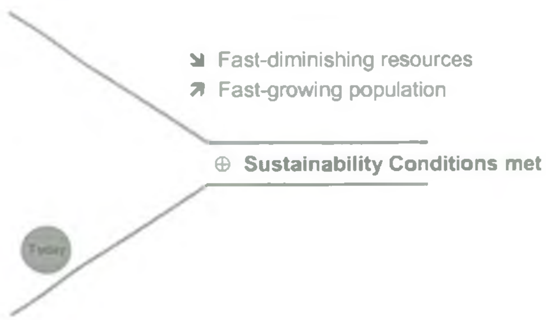
The challenge of sustainable development affects us all. Most of us can agree that it is an important concept, but what does it actually mean and how do you go about getting to grips with it in the messy world in which we live? This short annex defines what sustainability and sustainable development mean – they are quite distinct – and the scientific principles that help us understand them. It then introduces The Natural Step (TNS); both the organisation and the principles and tools of TNS that are known as the *TNS Framework*. TNS and its tools are founded upon the application of this science in educating about sustainability, and the practical application of sustainable development.

A2.1 About Sustainability and Sustainable Development

Growing world population, increasing demands upon and depletion of natural resources, accelerating levels of global pollution and resource depletion, and concerns about the impacts of businesses on society both at home and overseas, are not new problems.

Neither are they avoidable. They will increasingly constrain the "freedom to operate" of organisations and society at large. The Natural Step (TNS) uses the metaphor of "the funnel" to describe the inevitable tightening of these constraints, and the pressures to become more sustainable (Fig A1). Sustainable development addresses these challenges proactively, based upon a sound understanding of what sustainability means and implies for us.

Fig A1: The TNS "Funnel"



A sustainable system is one that can continue indefinitely. A sustainable society is one that does not impair or overload the life-support systems that provide for its needs. A sustainable product, process or organisation is one that respects nature's non-negotiable limits and the rights of those with whom it interacts, however remotely. It is that basic and, at the same time, that remote from what we do today!

All too often, problems are addressed reactively, using technical means to cure symptoms after problems have arisen. True sustainable development goes a long way beyond merely complying with basic environmental and social obligations, and differs from traditional "end-of-pipe" solutions to pollution and social problems. It addresses issues "upstream", in the early decision-making process, such that the pursuit of business does not systematically create the kinds of social and environmental problems that will, sooner or later, harm business performance and reputation.

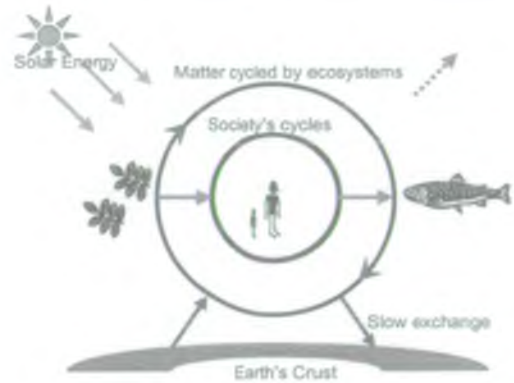
How does one move from concept to practice, and begin applying it in the messy world in which we live? If we chase them back far enough, it is easy to see that businesses ultimately depend upon natural and human resources including for example, energy, timber, clean air and water, as well as the ingenuity and labour of people that converts these natural resources into economic goods. We all share the same world, and therefore our activities inevitably affect that same world and all those with whom we share it.

Since sustainability challenges are unavoidable, sustainable development is also possibly the greatest business opportunity of the age. It is firstly essential to acknowledge that the inherently sustainable Earth ecosystem, upon which we are fully dependent, operates in definite ways – ways that it is possible to define using science – which ultimately determine what is and what is not sustainable. The Natural Step's approach to sustainable development is based upon a systematisation of these scientific principles.

A2.2 The Natural Step Framework

The Natural Step (TNS) Framework presents a set of principles and strategic tools based on the scientific principles governing the Earth's ecosystem, the inherently sustainable system that supplies all our needs. At the heart of the TNS Framework is a science-based systems model of this sustainable Earth system (Fig A2). The Framework defines what sustainability means and helps organisations get to grips with sustainable development in their decision-making processes.

Fig A2: The TNS Systems Model of Resource Cycles



It can also be used to explore the sustainability implications of today's products and processes, and the measures that must be undertaken to make them more sustainable. The TNS Framework comprises four elements:

A. **Sustainability awareness** comprises an understanding of sustainability, or in other words the conditions that must be met in the mouth of the funnel. The TNS Framework includes four necessary System Conditions for sustainability stemming from the science-based systems model. These four TNS System Conditions are illustrated in Fig A3 and listed below:

Fig A3: The Four TNS Systems Conditions

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

…concentrations of substances extracted from the Earth's crust
…concentrations of substances produced by society
…degradation by physical means

and, in that society. . .

4. …human needs are met worldwide.

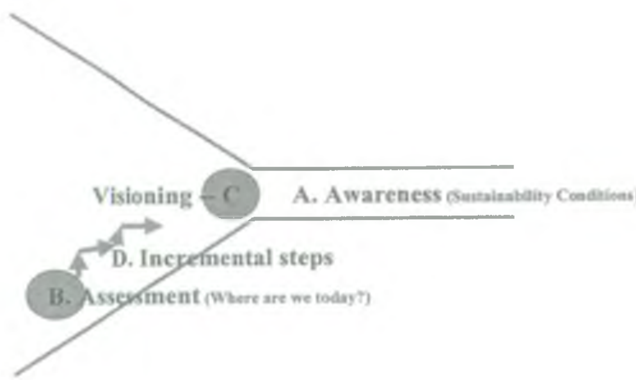
B. On the basis of these four necessary System Conditions of sustainability, one is then in the position to make an objective Sustainability Assessment of one's present degree of sustainability.

C. **Visioning**. Having used the System Conditions to determine one's present state of unsustainability, one can then use them as a helpful tool to create a vision of how one might operate in a fully sustainable future. If based on the System Conditions, our scenario-planning is based not merely on possibilities we might conceive today, but on the scientific realities of the future into which society will unavoidably be squeezed.

D. **Backcasting** is a process by which one determines the incremental steps that we have to take to reach our vision from where we are today. This differs radically from today's more common technique of *forecasting*, which is an extrapolation from today's knowledge, situation and trends to predict the future. Whilst yielding short-term gains, forecasting overlooks the inevitable changes and discontinuities with current trends that will arise through sustainability pressures. Incremental steps derived from backcasting acknowledge current constraints to full sustainability (for example limits to capital investment or the readiness of the market). However, they also reflect the progressive steps that can be made today, from which further future steps can be taken to lead along a clear path towards the vision of full sustainability.

The A,B,C,D steps for applying the TNS framework are illustrated in the context of "the funnel" in Fig A 4. Together, they help define in unambiguous terms what sustainability means, and provide a readily-understandable framework to get to grips with the practicalities of sustainable development. They help the integration of sustainable development into strategic planning, communication of complex ideas, the sharing of these concepts with partners and across social sectors, and making strategic judgements about the steps we need to take now towards a more sustainable future.

Fig A4: A, B, C, D and the "Funnel"



It helps us address the fact that we can not realistically hope to achieve sustainability immediately in a world that is far from sustainable, but enables us to "navigate" increasingly towards sustainability through incremental decisions. Importantly, the strategic approach to sustainable development enabled by backcasting – at odds from today's more common eco-efficiency emphasis which merely makes unsustainable practice more "lean" – helps organisations avoid decisions that may represent "blind alleys" that do not lead on a strategic path towards a clearly-articulated end-goal of sustainability.

A2.3 About The Natural Step

The Natural Step (TNS) organisation was established in Sweden in the late 1980s as a means for tackling the difficulties facing society. TNS is now an international charity based in nine countries including Sweden and the UK, the USA and Canada, Australia and New Zealand, South Africa, Japan and Israel. The purpose of The Natural Step is:

> *"To deepen a genuine commitment to sustainable development throughout UK society using The Natural Step Framework."*

TNS has worked with a wide range of major companies to help them address their sustainability challenges, including DuPont, Electrolux, Tarmac, Carillion, IKEA, Interface, Mitsubishi, Air BP, Nike, The Co-operative Bank, Wessex Water, Sun Microsystems, etc. In addition, we have applied the TNS Framework as a form of "intellectual round table" around which to build consensus about the place of contentious issues in a sustainable future. This consensus-building programme, known as "2020 Vision" in the UK where it is run in collaboration with the Environment Agency, has covered topics including GMOs, PVC, bulk printing, material resource use, etc. TNS principles have also been used to illuminate a wide range of scientific matters, including the more sustainable use of materials such as phosphorus, PVC, metals, construction materials, etc., and the reorientation of environmental tools such as LCA (life cycle assessment) or ISO 14001 from eco-efficiency towards sustainable development.

The Natural Step office in the UK was established in early 1997 as an activity of the charity *Forum for the Future*, which is itself dedicated to the promotion of a practical commitment to sustainable development across UK society. The Chairman of TNS in the UK is Jonathon Porritt, the leading environmentalist, Chair of the government's Sustainable Development Commission, and Programme Director and founder of Forum for the Future. The scientific work of TNS in the UK is kindly supported by the Environment Agency via the secondment of Dr Mark Everard as its Director of Science.

A2.4 More Information About The Natural Step

There is clearly a great deal more to The Natural Step than it is possible to convey in this brief annex. We believe that TNS offers a unique tool for getting to grips with sustainable development, putting it into practice within enterprises, building consensus about contentious issues, and for doing so as a matter of "enlightened self-interest". For further information about TNS, or the TNS Framework, please contact us directly using the information on the back cover of this report.

End of Annex 2

Annex 3: Tackling the Sustainability Challenges

Delegates of the *2020 Vision* seminar identified a number of practical steps that could be taken to help address the challenges associated with moving towards more sustainable drainage (see Section 6). Some of the initial actions identified by seminar delegates to address Challenges 2 and 4 are shown below.

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.

- Practical steps are needed to gain commitment to SuDS. There is a need to move people from the "*out of sight, out of mind*" comfort zone into the "*uncomfortable*" zone. A targeted approach is needed for different sectors of society and for different key decision makers, such as:
  - General public – use spearheading groups (e.g. wildlife groups, NGOs), use drama (TV).
  - Educators – relates to demand and funding bodies
    - Identify key decision groups and forward-looking universities
    - Target particular courses (engineers, urban design, architects)
    - Develop SuDS as part of a wider sustainability package within higher education.
  - Schools (children) – via national curriculum.
  - Professional institutions.
  - Highway Engineers noted as a particularly difficult group – requires more work on safety.
  - Developers/house builders – need to involve them because they initiate schemes. Need to get Housebuilders Federation to workshops.
- A range of possible mechanisms exists for increasing awareness/improving knowledge of SuDS in different groups. These include:
  - Use existing capacity – wildlife trusts, EA, etc, and draw on long-standing groups.
  - Use of benchmarking, e.g. through LA 21 process, % of SuDS-managed water rather than traditional schemes. Can also be used to publicise the information.
  - Need to overcome inertia and get commitment from middle managers – use workshops, videos, joint meetings, changes to UDP – supplementary guidance relating to sustainable development. Requires evangelists in institutions. Can be taken forward internally.
  - Key demonstration sites are very useful to show the viability of schemes (this links closely to R&D). Also need a raft of case study write-ups that have been well monitored.

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.

- There is a need to establish protocols for the adoption of SuDS. There are several possible options, each of which have advantages and disadvantages. The *2020 Vision* seminar identified five main possibilities for ownership/adoption:

  – The Scottish model (taking on board the arrangements for SuDS in Scotland)
  – Local authority ownership or Environment Agency taking sole responsibility
  – Sewerage undertakers responsibility
  – Community ownership
  – Setting up a separate agency to manage SUDS.

- The advantages and disadvantages of three of the options were discussed during the *2020 Vision* seminar, as shown in Table 3.

Table 3: Advantages and Disadvantages of Different Models of SuDS Ownership

	☺	☹
Scottish model	• Good starting point	• Far from an ideal system, has many pitfalls • Very different in terms of regulatory approach and physical conditions (much lower reliance on ground water sources)
Local authorities	• Experience of and infrastructure for 'above ground' maintenance of groundwater system • Already have control of Highway drains which is a major facet of the SuDS issue • Planning authority and highway authority	• Lack of resources – time, money • Lack of cohesion between different authorities SuDS would be applied differently between different authorities • Departmental competition on ownership of the SuDS as many of the issues of SuDS would be cross departmental
Sewerage undertakers	• Financially beneficial (potentially) • Have many of the technical skills in-house for the development of SuDS • Integration of CSO issues	• Not core business – sewerage undertakers have in general tended towards a focus of the supply and treatment of water and moved towards lower manual input operative systems and these would require potentially much more input.

	• Liability – key issue as the effects of liability are widely felt within sewerage undertakers as the main restriction to the adoption of SuDS • Have no specific experience of how to manage swales, reed beds etc. Would require some specialist training or contract out. • Issues of conflicting interests – currently no remit to manage land drainage issues and the legislation specifies that this is within Local Authority and regulatory management.

End of Annex 3

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