# It was good enough for the Victorians: We know it works

Professor Richard Ashley 1st September 2014

'We know it works' is the response of many civil engineers when challenged about Thames Water's supersewer in London. How ironic that the 19th century civil engineers tried to stop Edwin Chadwick's sanitary revolution, preferring to maintain the status quo at the time, as 'we-know-it-works'[1].

There is much evidence that big sewers work; they collect and store excessive flows of water, much of it surface or stormwater mixed with sanitary or foul sewage collected in combined sewer systems. In the UK we have £bns of valuable existing sewerage assets built during the Victorian era when the UK had lots of money from the British Empire. The need to separate storm and sanitary sewage has been known about at least since the end of the 19th Century[2]. Yet, even where sewers are separated in the UK, they invariably recombine before the combined flow is dealt with for example, at a treatment works, with excesses discharged from sewer overflows (CSOs).

In the 20th century an understanding grew, firstly about the impact of all discharges into natural water bodies from drainage systems, as even those separated were found to cause environmental damage[3]. At the same time, there was growing evidence that: (a) all forms of water are in fact potential resources, not necessarily problems; (b) that piped drainage systems (known as 'big-pipe-in'[4]) were wasteful of resources, expensive and unnecessary on the scale they had been used in the past; i.e. unsustainable

Much of the evidence was collected in the State of Victoria in Australia, where ten years of drought meant that they had to develop ways to utilise all forms of water, including stormwater and sanitary sewage as opportunities to provide

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[1] Hamlin C. (1992). Edwin Chadwick and the Engineers, 1842-1854: Systems and Antisystems in the pipe-and-brick sewers war. Technology & Culture, Vol. 33, No. 4 Oct. pp 680-709.
[2] Staley, C., & Pierson, G S. (1899). The Separate System of Sewerage, Its Theory and Construction. New York: Van Nostrand.
[3] Novotny V., Brown P. (2007) (Eds.) Cities of the Future. IWA Publishing. ISBN 1843391368.
[4] Newman P., Kenworthy J R. (1999). Sustainability and cities: overcoming automobile dependence. Washington: Island Press.

both supply water and support ecosystems (in different classes)[5]. Ironically the 'we-know-it-works' desalination movement, fronted by the energy providers in Australia, displaced this world-leading research[6]. Now the Victorians have to pay high prices to keep their brand new desalination plant mothballed as the drought has broken there and it is much cheaper to abstract and treat water conventionally.

The Victorians (in England) in the 19th century did not realise that problems (and opportunities) are best addressed at or near source, ie. with demand management, stormwater harvesting etc. (learning from the waste management hierarchy)[7]. Today's Victorians and contemporary private water companies are well aware of the hierarchy, yet choose not to follow it as being 'too difficult' and we cannot be 'sure-that-it-works'.

Although Australia has spearheaded much of the water sensitive urban design (WSUD) philosophy and details of application[8], other parts of the world including the UK, have been developing sustainable drainage systems (SuDS)[9], which are the drainage components of the sustainable urban water management approach that WSUD brings together[10]. As part of the SuDS approach, there is increasing interest in the green infrastructure opportunities and the multi-benefit, multi-functional infrastructure vision that is now bringing together stormwater with ecological enhancements and ecosystem services[11]. New projects are variously providing guidance as to how to deliver 'blue-green'

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[5] Centre for Water Sensitive Cities (2011) Cities as Water Supply Catchments. Executive summary – literature review and practice summary. January.
[6] Head B W (2014). Managing urban water crises: adaptive policy responses to drought and flood in Southeast Queensland, Australia. Ecology and Society 19(2): 33. http://dx.doi.org/10.5751/ES-06414-190233
[7] Allen M. (2008) Cleansing the city. Ohio University Press. Athens Ohio. ISBN 10:0-8214-1771-1
[8] Fletcher T D., Shuster W., Hunt W F., et al (2014): SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage. Urban Water Journal.
[9] Ashley R M., Lundy L., Ward S., Shaffer P., Walker L., Morgan C., Saul A., Wong T., Moore S. (2013). Water-sensitive urban design: opportunities for the UK. Proceedings of the Institution of Civil Engineers. Municipal Engineer 166 June. Issue ME2. Pages 65–76 Paper 120004
[10] CIRIA (2013). Creating Water Sensitive Places: Scoping the potential for Water Sensitive Urban Design in the UK. Report C724.
[11] CIRIA (2011) Delivering biodiversity benefits through green infrastructure. Report C711.

infrastructure[12,13]; monetised benefits assessment for using SuDS with GI[14]; and in revising the CIRIA SuDS Manual[15]. These are drawing on the clear, well detailed and case histories of how to deliver best value to society and to ecosystems and services from around the world[16].

'We-know-it-works': yes, WSUD, SuDS, green infrastructure and multi-valued, multiply beneficial, multi-functional land use in urban areas increases sustainability, liveability, amenity and biodiversity. A major benefit of these systems is their flexibility and adaptability in regard to uncertain futures. This flexibility is recognised in the way in which natural systems and ecosystem services are promoted by and accepted in economic analysis for flood-defence-grant-in-aid[17]. And the use of 'real-options' analysis by both the Environment Agency and Defra, as promoted by HM Treasury[18]. So far, none of these approaches has even been considered by EA/Defra for stormwater management using SuDS, despite recent guidance[19].

The supersewer provides a single outcome: reducing the number and volume of combined sewer overflows to the river. It adds nothing to flood security to London, is inflexible to future uncertainty and provides no ecological benefits other than to reduce the impacts from spills on the river. The standards by which the spill reductions have been set are internally defined by the Environment Agency based on computer models that at best are +/- 100%s in accuracy[20]. Yet no benefit cost assessments have been made that consider the risks against costs

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[12] Blue Green Cities (2013). Delivering and Evaluating Multiple Flood Risk Benefits in Blue-Green Cities. Inception report. EPSRC Project EP/K013661/1.
[13] RSA/WWF (undated) Dealing with the Deluge: Urban Water management in a changing climate.
[14] CIRIA (2014). Demonstrating the multiple benefits of SuDS - a business case. Phase 2. Project RP993.
[15] CIRIA (2014). Update of the SuDS manual. Project RP992.
[16] e.g. USEPA (2013) Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Nonpoint Source Control Branch (4503T). Washington, DC 20460. EPA 841-R-13-004. August.
[17] Brouwer R., Ozdemiroglu E., Provins A. et al (2010) Flood and coastal erosion risk management: Economic Valuation of Environmental Effects. Handbook. Eftec. Mortimer Street, London.
[18] Defra (2009) Accounting for the effects of climate change. June 2009—Supplementary Green Book Guidance
[19] CIRIA (2012). Retrofitting to manage surface water. Report C713.
[20] Schellart A., Tait S J., Ashley R M. (2010). Towards quantification of uncertainty in predicting water quality failures in integrated catchment model studies. Water Research 44. 3893 - 3904.

that these uncertainties bring. In terms of value for money, the supersewer cannot be justified with any confidence, compared with taking a WSUD/SuDS/GI approach. In parts of the world, life cycle analyses have shown that the 'big-pipe-in' way of managing combined sewer overflow spills has a net damaging overall effect on environmental systems due to resource use, energy consumption and greenhouse gas emissions[21]. The need for some 15,000,000 kWh of pumping to empty a tunnel that will have recurrent problems with sediment deposition each and every time it is used[22], at a time when energy use is clearly to be minimised is astounding.

With the Lee tunnel completed, many of the original problems defined in the early tideway studies have already been dealt with, as illustrated by the results from the original computer models used by the Water Research centre.[23]

Sadly, despite the invective from the Mayor of London that he wishes the City to be the greenest in the world[24], he fails to understand that stormwater is a resource and an opportunity to irrigate the new green infrastructure and offset London's demand for water. Thames Water's approach to the shortage of potable water in London and water stress in the south east is, just like the Victorian's (State), to build desalination plants; in the face of an adequate amount of rainfall per year, to rely on expensive energy consumptive technology.

In conclusion it is evident that the approach to the handling of excess stormwater in London is resource consumptive, inflexible, lacking in promotion of biodiversity and amenity (it focuses on one component of this alone, see Table 2 at the end of this note for liveability and amenity provided by WSUD) and in short, unsustainable. The supersewer will rapidly become a 'stranded-asset', which given the funding model, will mean that just like (the State of) Victoria, Londoners will be paying for something that will not be being used just to satisfy the investors. The missed opportunity is colossal especially for the amenity and

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[21] De Sousa M R C., Montalto F A., Spatari S. (2013). Using Life Cycle Assessment to Evaluate Green and Grey Combined Sewer Overflow Control Strategies. Journal of Industrial Ecology. Volume 16, Number 6. 901-913.

[22] The equivalent combined sewage storage systems in Brussels constructed in the 1990s had to be abandoned due to sedimentation each and every time it was used.

[23] Martin N., Dempsey P. (2004). Thames Tideway Project – Integrated Wastewater and Estuary modelling for Water Quality Compliance Assessment. WaPUG conference, Blackpool, November.

[24] Mayor of London (2012). green infrastructure and open environments: the all London green grid - supplementary planning guidance

biodiversity that could be created all over London by spending and doing it differently. Gradually, all combined sewage overflows would cease, if we do it this way, unlike for the tunnel where overflows will continue especially as climate changes mean that the capacity of the supersewer becomes inadequate.

Of course, such dispersed green systems as are being constructed in Philadelphia[25], bringing $3m of added benefits to the City and in such a way that would also help with managing local flooding will be the responsibility of local communities and will not add to Thames' Water's asset base and hence profitability.

London has a population of 12,681 people per square mile as compared with Philadelphia's 11,379 per square mile, so of course, fitting and retrofitting new green areas that provide multiple benefits (see Table 1), will be harder (*really?).* Appendix E of the tideway tunnel study reports suggested that in many parts of London, this would be eminently feasible[26].

Table 1 Examples of benefits accruing from using SuDS for stormwater management in urban areas[14]

| SuDS benefit category | Examples of SuDS contribution | SuDS group the example belongs to Quantity/quality/amenity/biodiversity |
|---|---|---|
| Air quality | Particulate filtering | Amenity |
| Amenity / Liveability | Visual enhancement | Amenity |
| Recreation | Quality of life | Amenity |
| Biodiversity (habitats) | Ecosystems | Biodiversity |
| Carbon | Sequestration | Amenity |
| Flood risk | Peak flow attenuation | Water quantity |
| Pollution (water bodies and groundwater) | Runoff treatment | Water quality, biodiversity |
| Reduced treatment / pumping | Runoff removal and interception | Water quantity & quality |
| Population growth / network capacity | Add buffering capacity for expansion | Water quantity & amenity |
| Air temperature | Green and blue areas lower | Amenity |
| Groundwater | Replenish / protect quality | Water quantity, quality, biodiversity |

[25] Philadelphia Water Department, 2009, Philadelphia Combined Sewer Overflow - Long Term Control Plan Update - Supplemental Documentation Volume 2. Triple Bottom Line Analysis. Updated October 1st http://www.phillywatersheds.org/ltcpu/Vol02_TBL.pdf [accessed 10-01-11].

[26] Stovin V R., Moore S L., Wall M., Ashley R M. (2013). The potential to retrofit sustainable drainage systems to address combined sewer overflow discharges in the Thames Tideway catchment. Water and Environment Journal 27 (2013) 216–228

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|---|---|---|
| Health | Sports opportunities | Amenity |
| Water resource/ rainwater harvesting | Water storage | Water quantity |
| Crime | Reduced due to enhanced environment | Amenity |
| Economic growth | Inward investment attracted | Amenity |
| Education | Outdoor classroom facilities | Amenity |
| Flexible infrastructure / CCA | Easily adaptable | Amenity |
| Noise | Mitigate traffic noise | Amenity |
| PR – business / CSR | Demonstrate green credentials | Amenity |
| Tourism | Attractive places | Amenity |
| Traffic calming | Dual use of street rain gardens | Amenity |

But, above all, it must be remembered: 'we/they know it works'!