21st century sewers
Challenges and opportunities: the view from the United Kingdom

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CIWEM Chartered Institution of Water and Environmental Management
Urban Drainage Group

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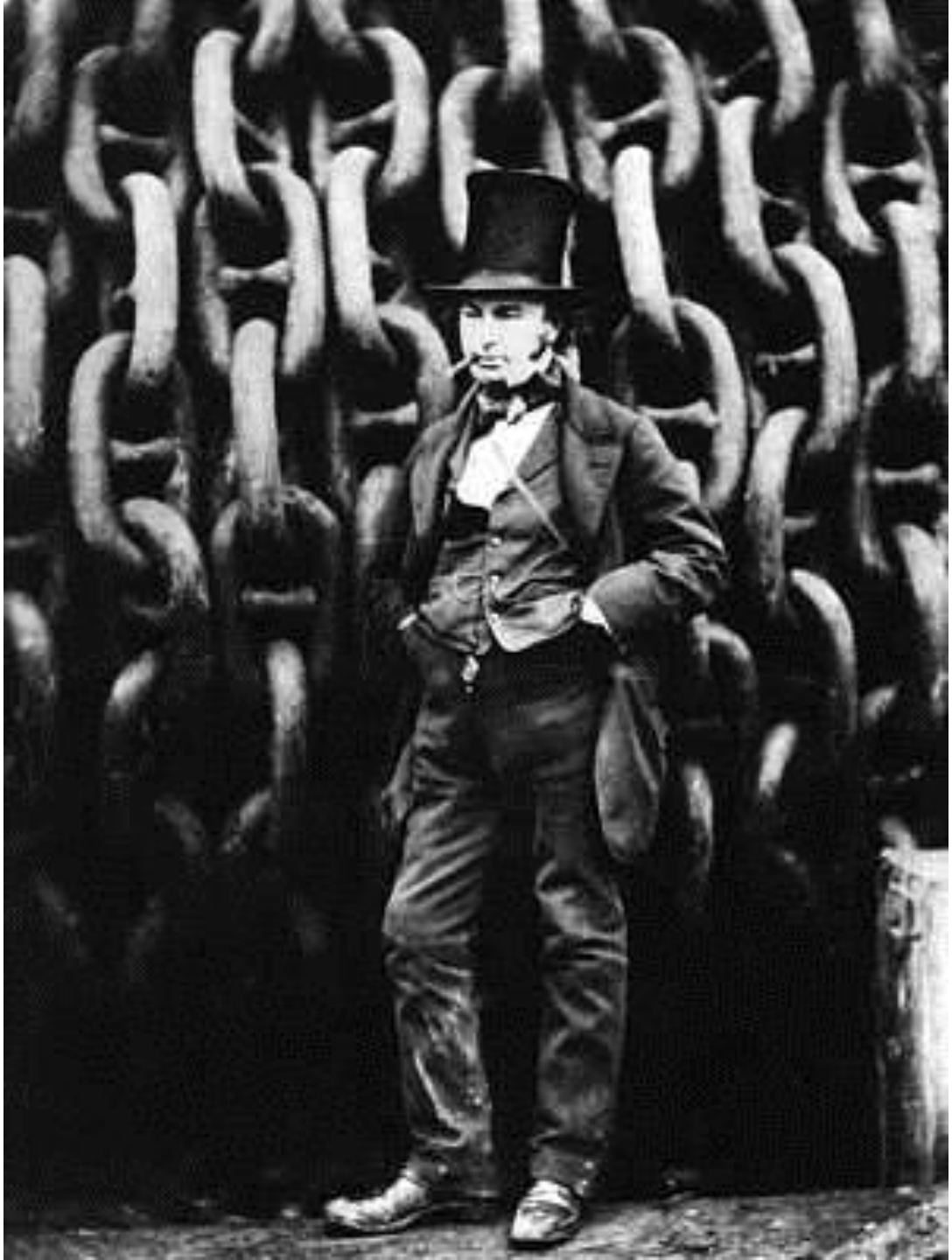
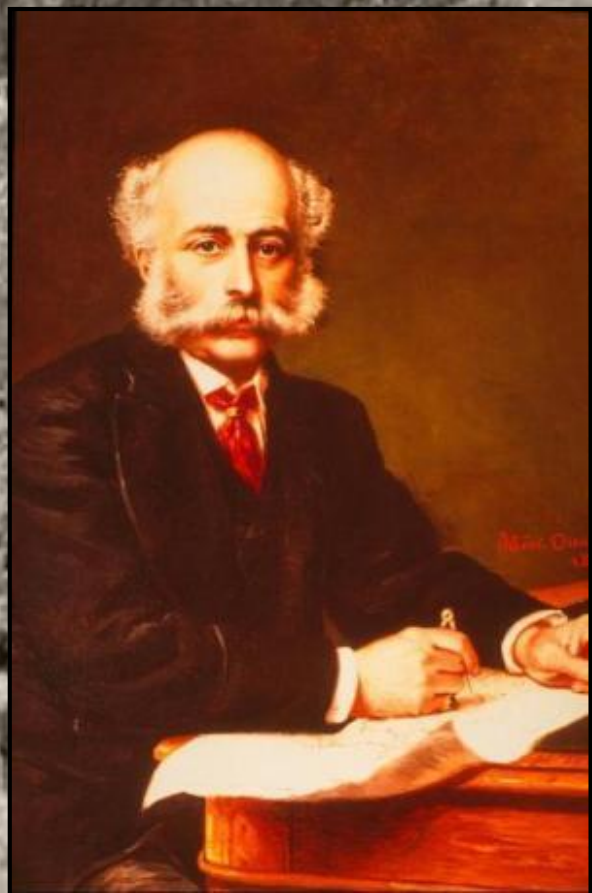


Joseph Bazalgette
London 1860



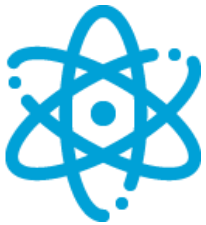

London 2016
Ground investigations
Thames Tunnel

London 2016
Lee Tunnel

Side-by-side, we help solve our clients' biggest challenges

We begin by listening, by truly knowing our clients and their goals. We take their needs and challenges and make them our own. We anticipate obstacles and spot new opportunities. Above all, we focus all our knowledge, skill, and creativity on what our clients need to achieve — big or small, complex or straightforward — and help them find a way to get it done.


Transportation


Nuclear


Energy


Water


Industry


Environment


Governments


Cities

We take pride in the projects we deliver with our clients, but we never forget what our work is really about: clean water to drink, affordable energy, sustainable cities for families now and in the future, more closely connected communities and so much more.

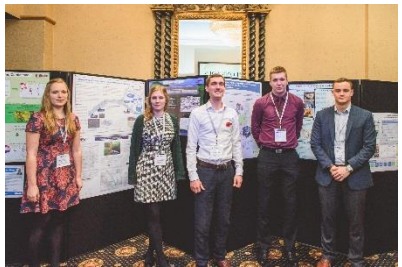
Her Majesty Queen Elisabeth II, and her heirs and successors, 'wills and ordains' that we:

CIWEM Chartered Institution of Water and Environmental Management

Urban Drainage Group

1. Advance the science and practice of urban drainage management for the public benefit
2. Promote training, study and research in urban drainage management
3. Establish and maintain approporaite standards of competence for urban drainage management professionals

Urban drainage management means the application of engineering, scientific, planning and analytical knowledge to the collection, treatment, control and disposal of foul and stormwater. Urban drainage management benefits society through maintaining and improving: public health, environmental water quality and levels of flood risk



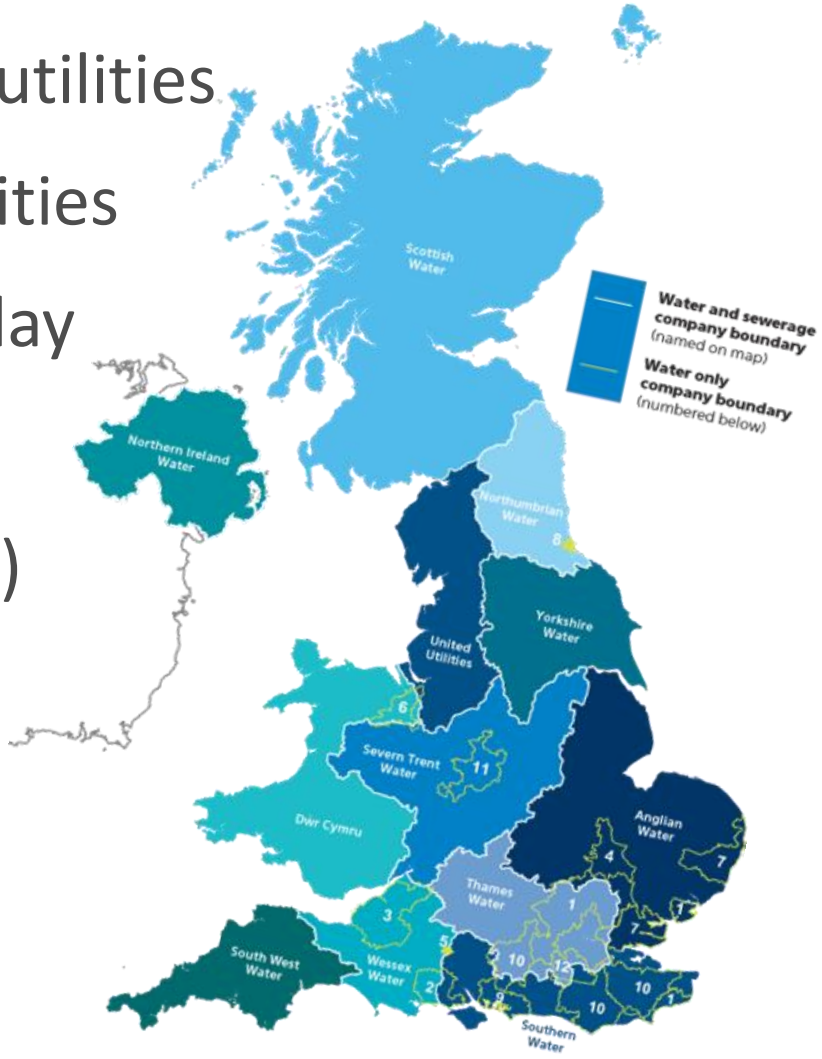
Agenda

- Facts & figures for sewerage* in the UK
- What are the challenges of the 21st Century
- Some of the solutions being adopted
- The future. What next?

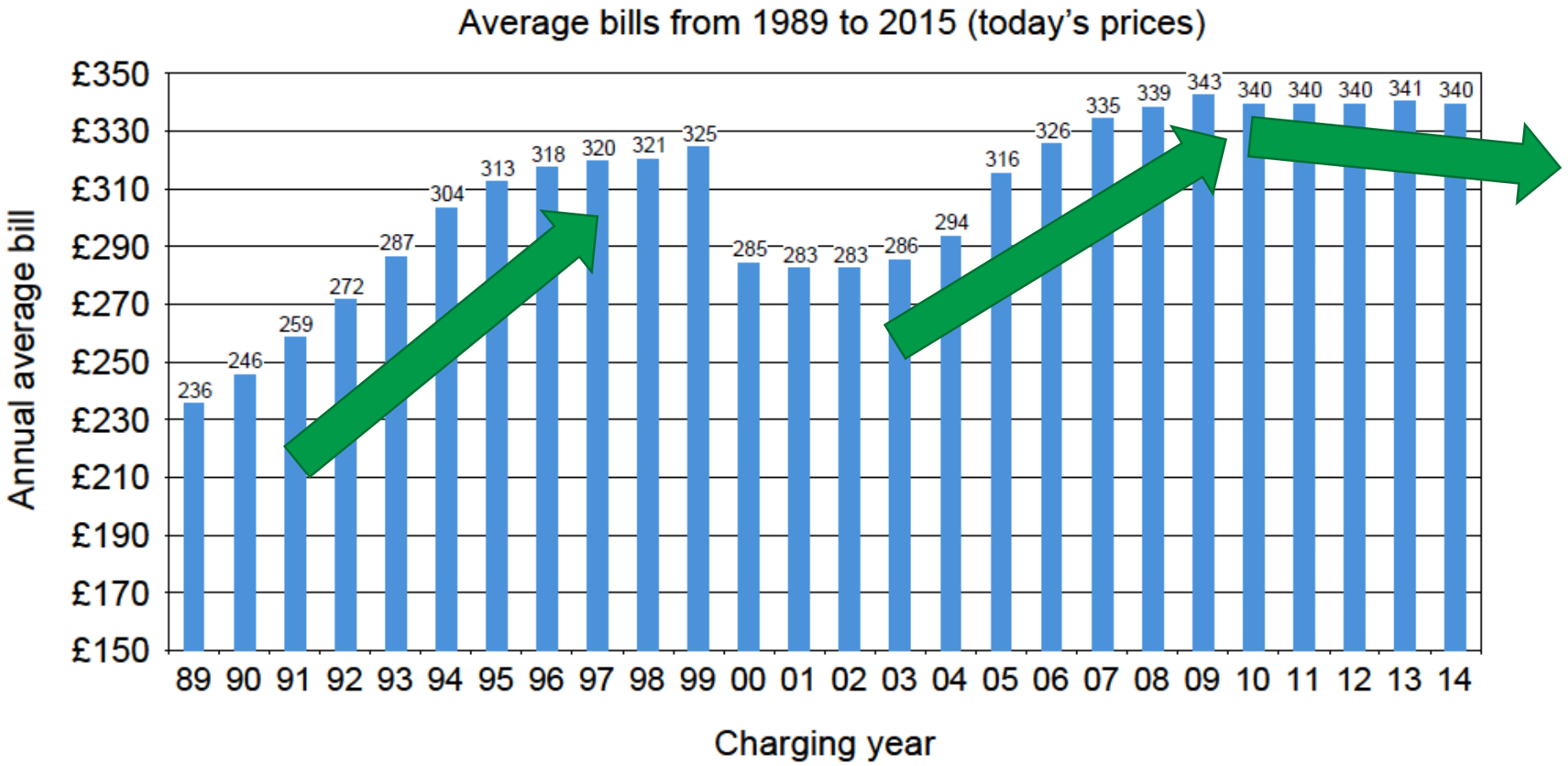
* wastewater collection / wet weather / drainage

Wastewater in the UK – facts & figures

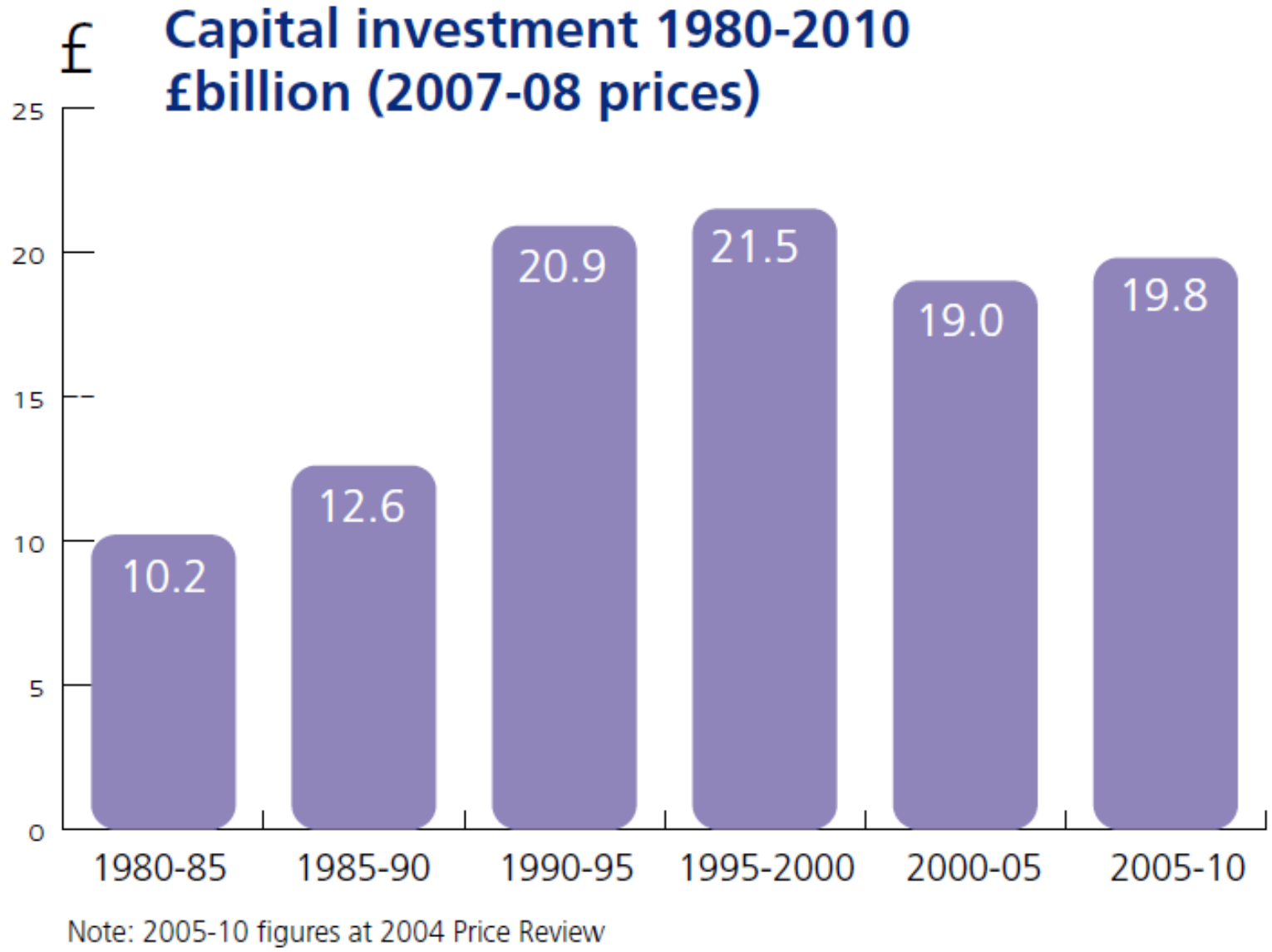
- 12 regional water & wastewater utilities
- 6000 wastewater treatment facilities
- 10,000,000,000 litres effluent / day
- 400,000 km of sewer
- 19,000 CSOs (90% to fresh water)



What do customers pay?



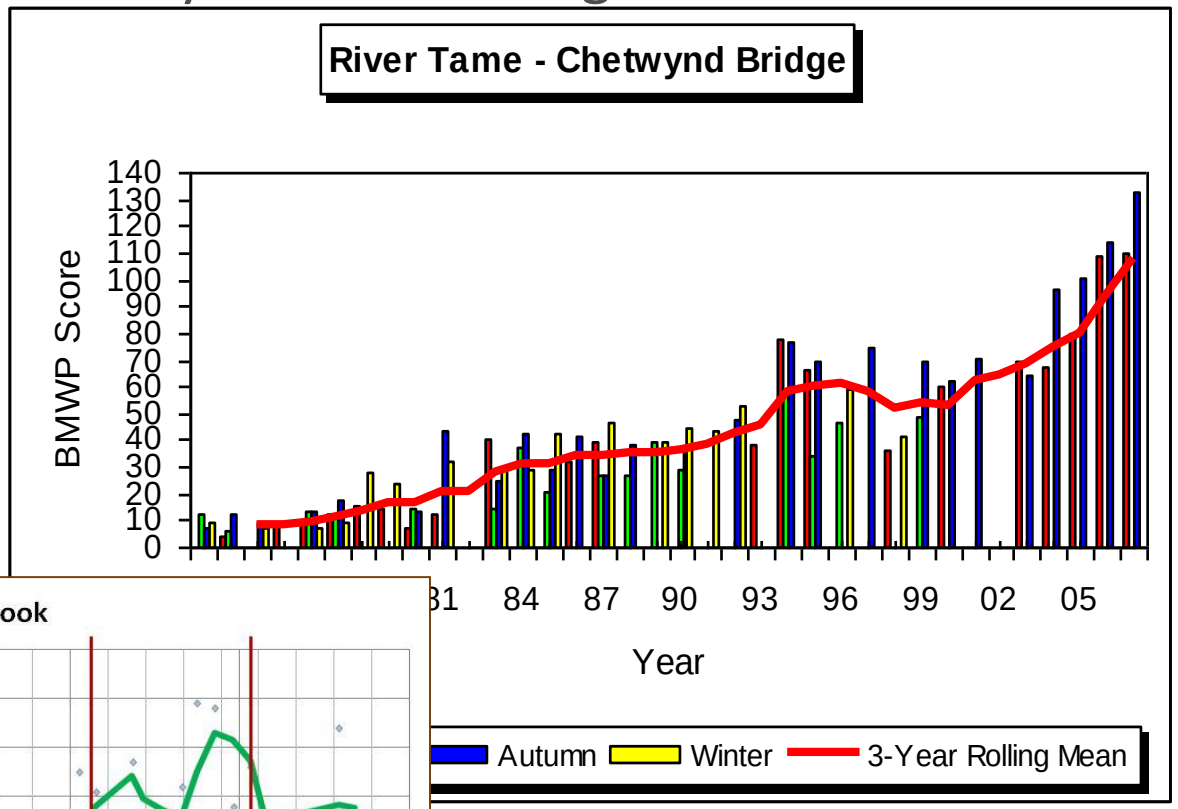
How much investment?

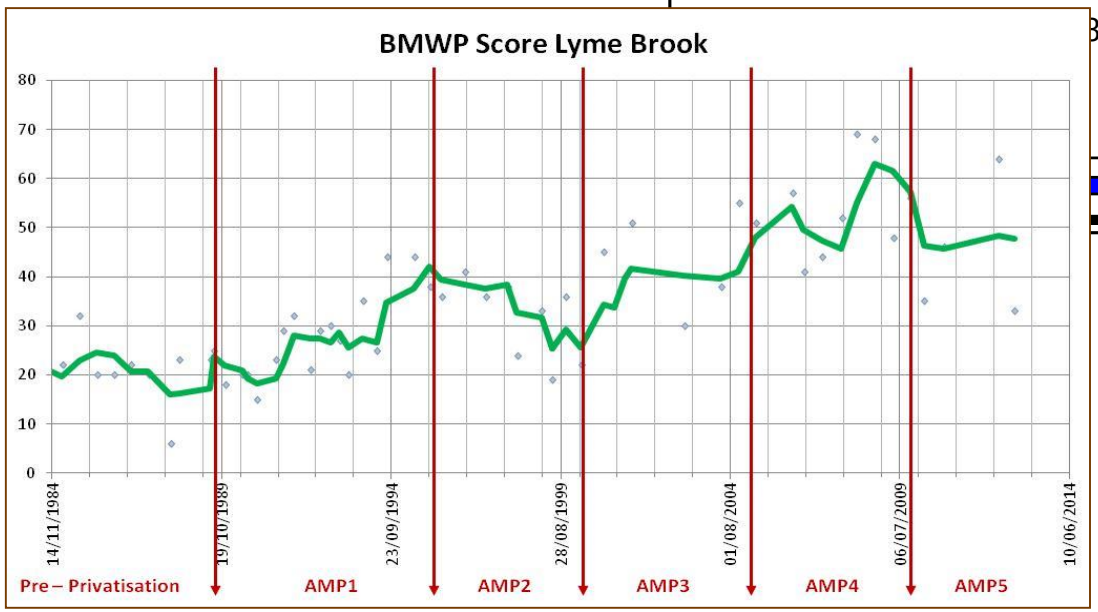


Note: 2005-10 figures at 2004 Price Review

Significant & lasting benefits delivered

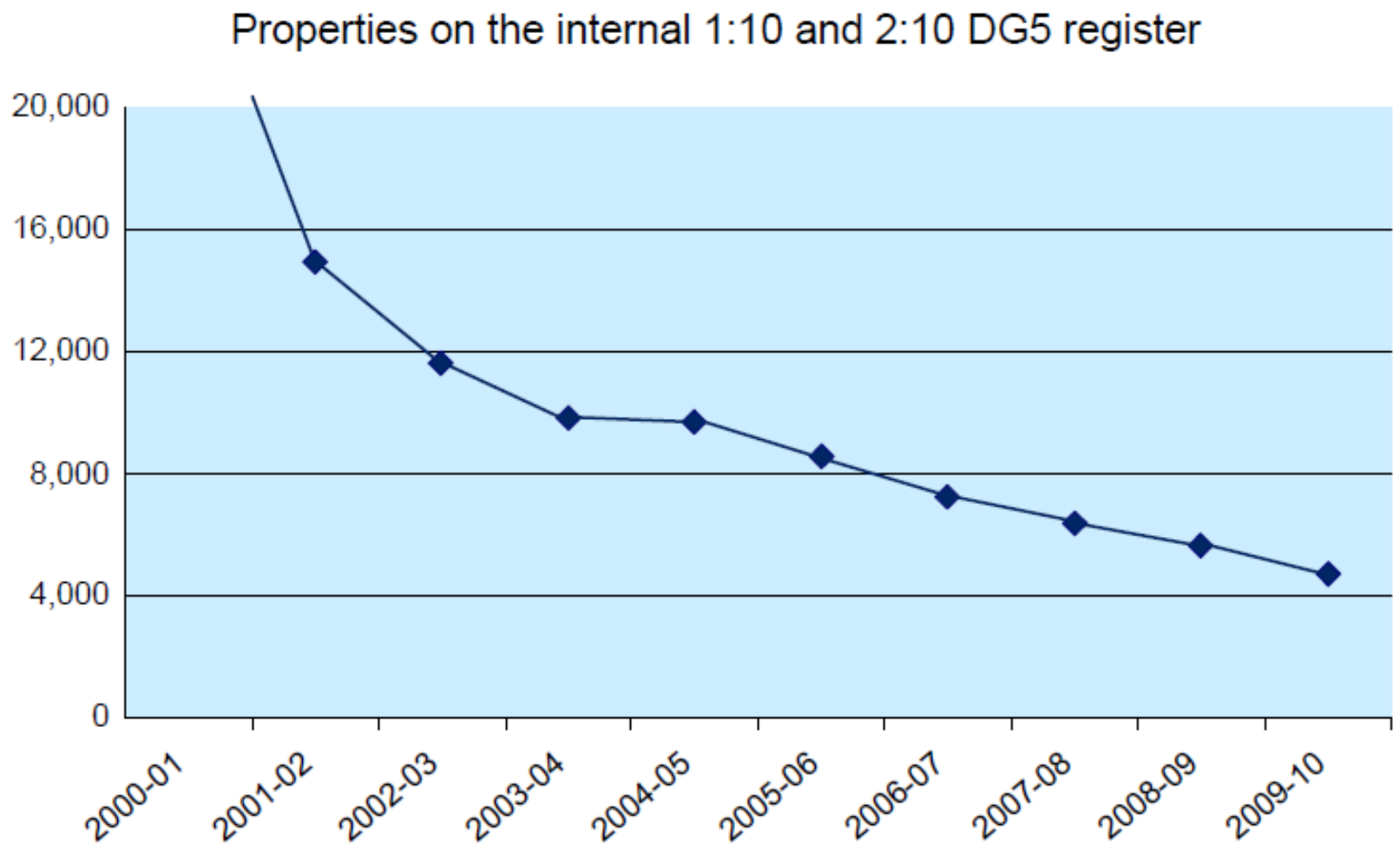
2 urban rivers with successive years of sewerage investment





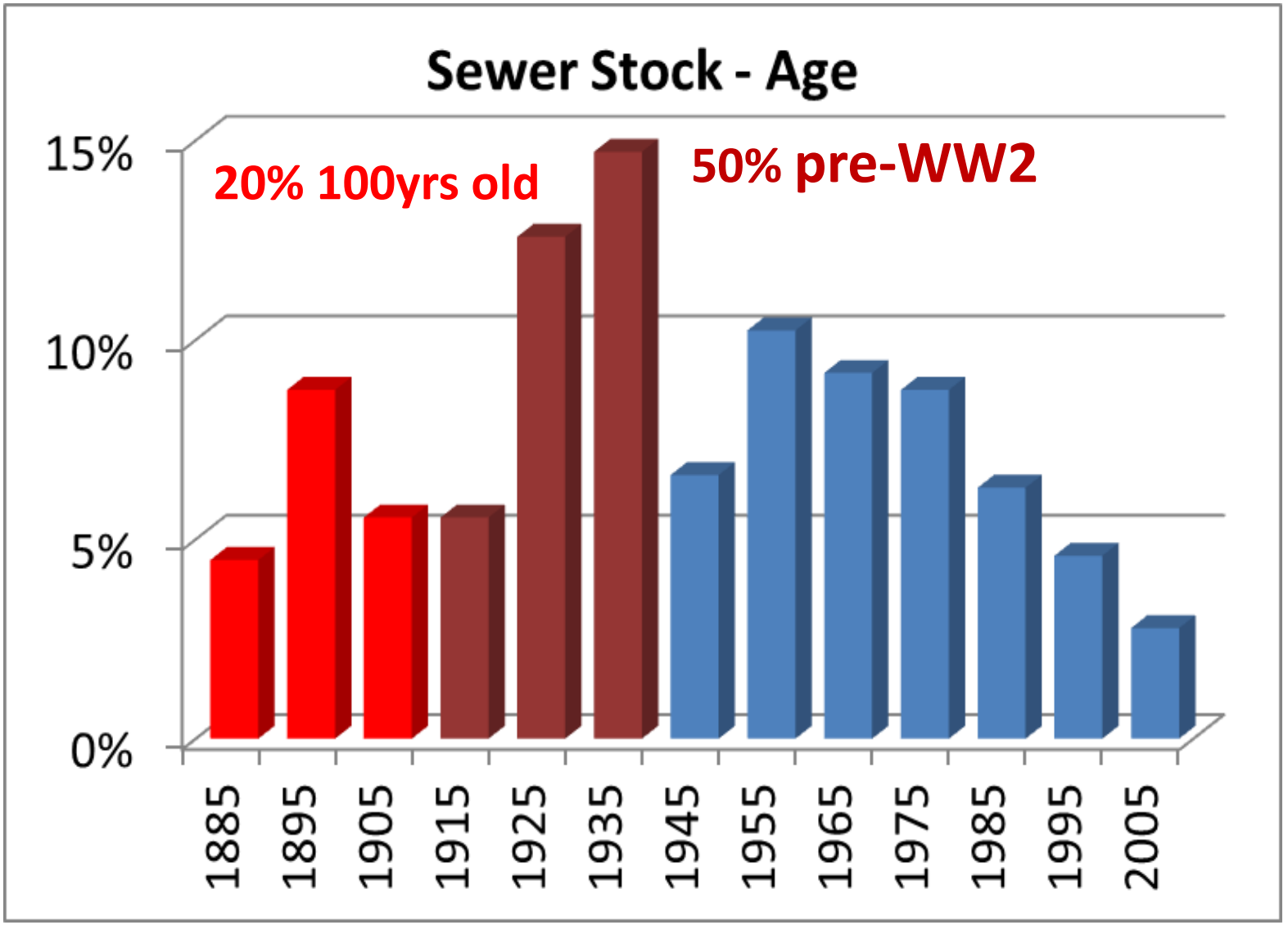
Significant & lasting benefits delivered

Dramatic reduction in properties flooding 1/10 years and 2/10 years because of hydraulic under capacity

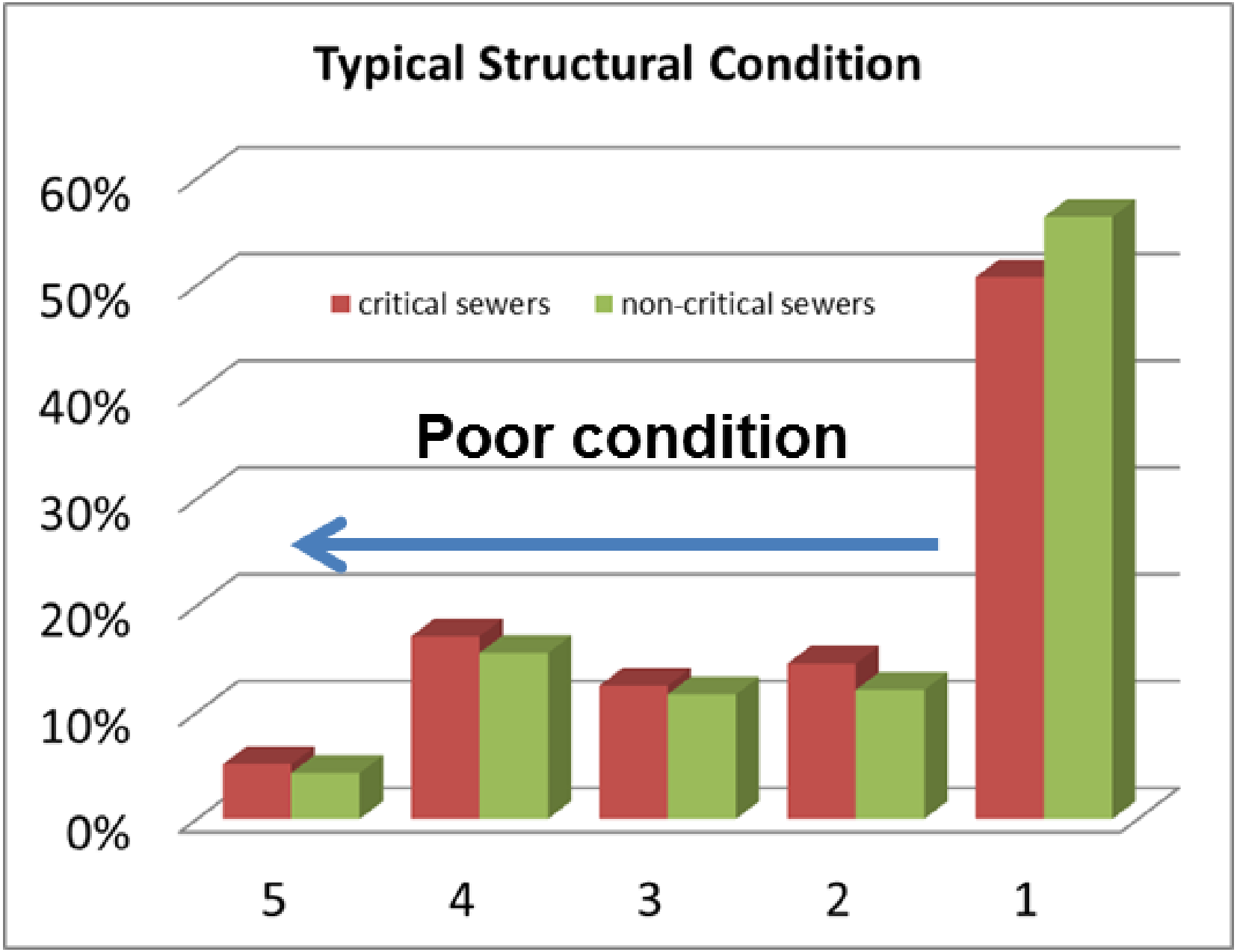


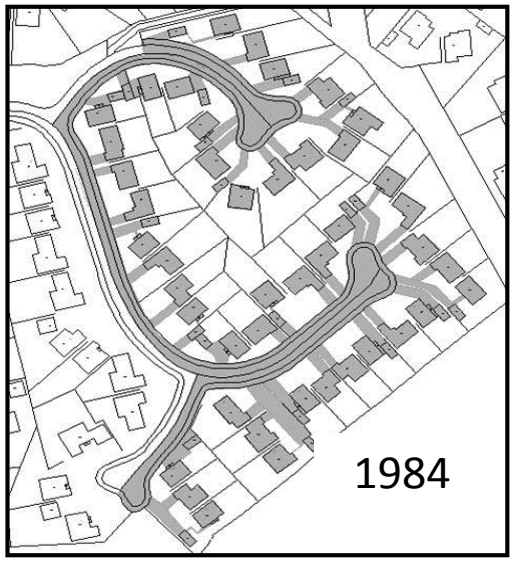
21st century challenges

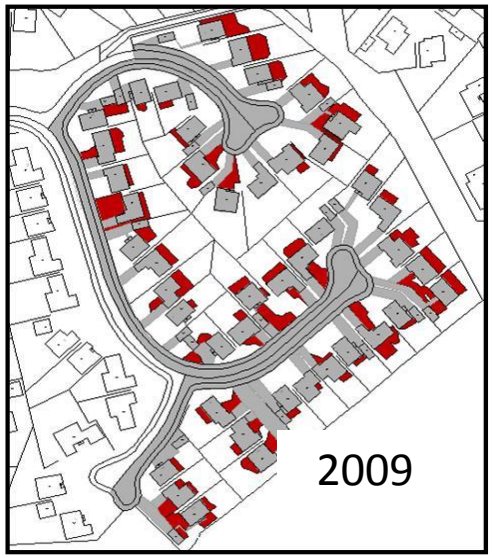
Ageing infrastructure

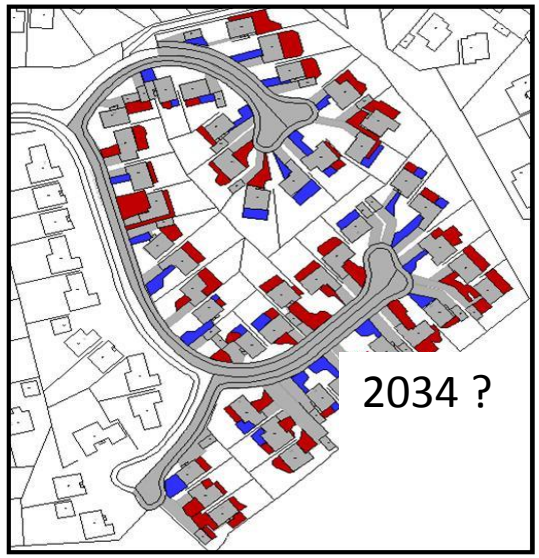


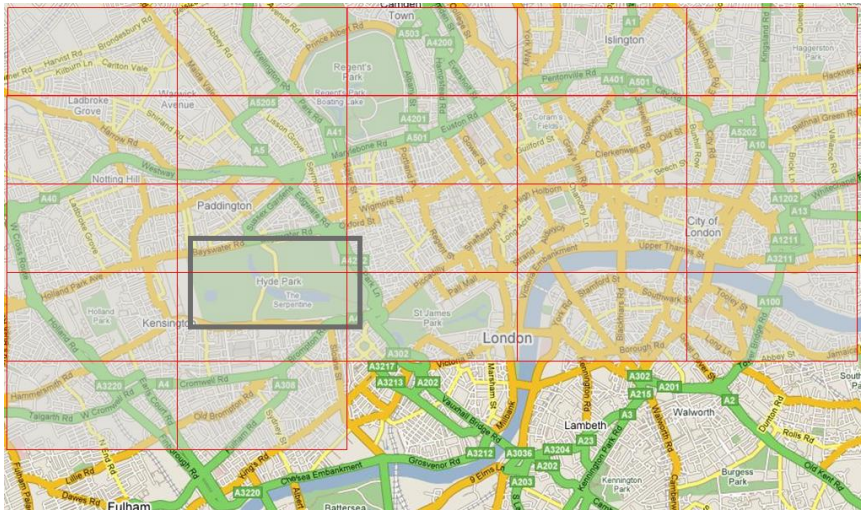
Ageing infrastructure







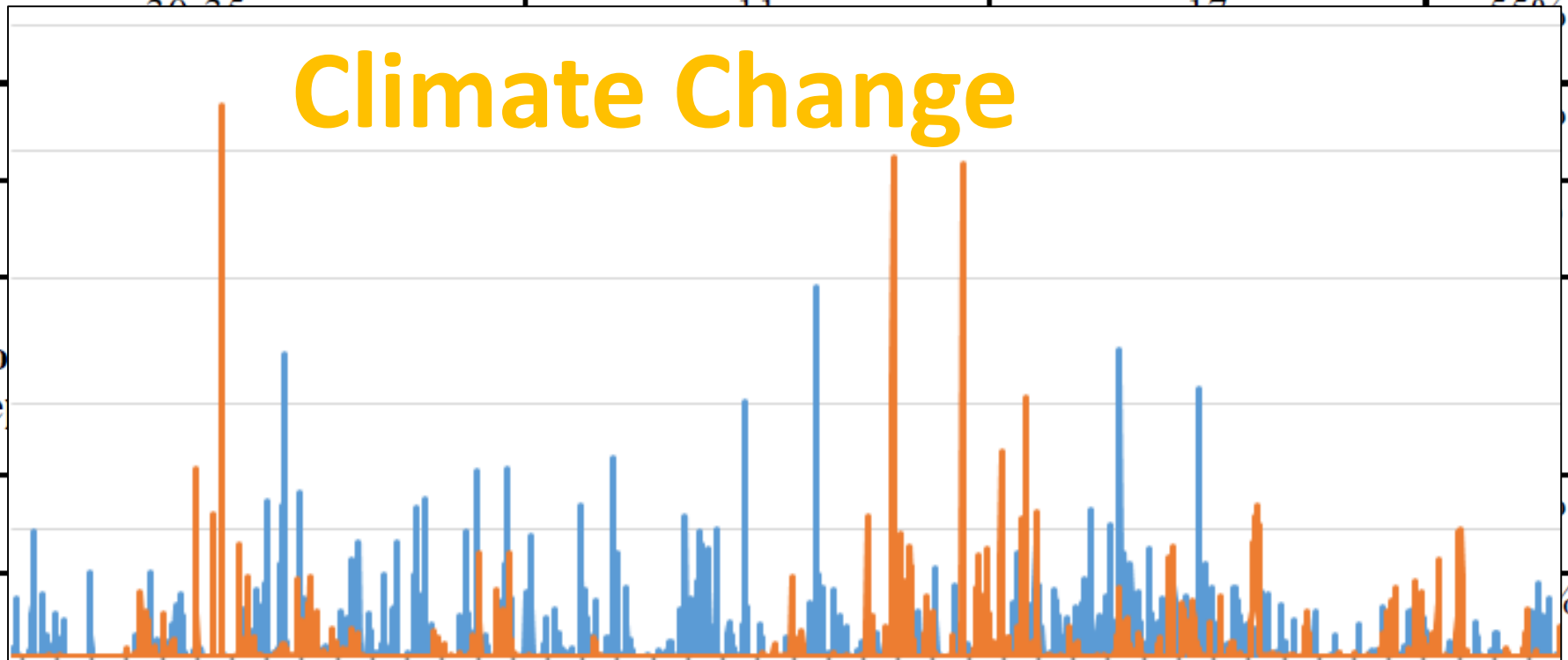




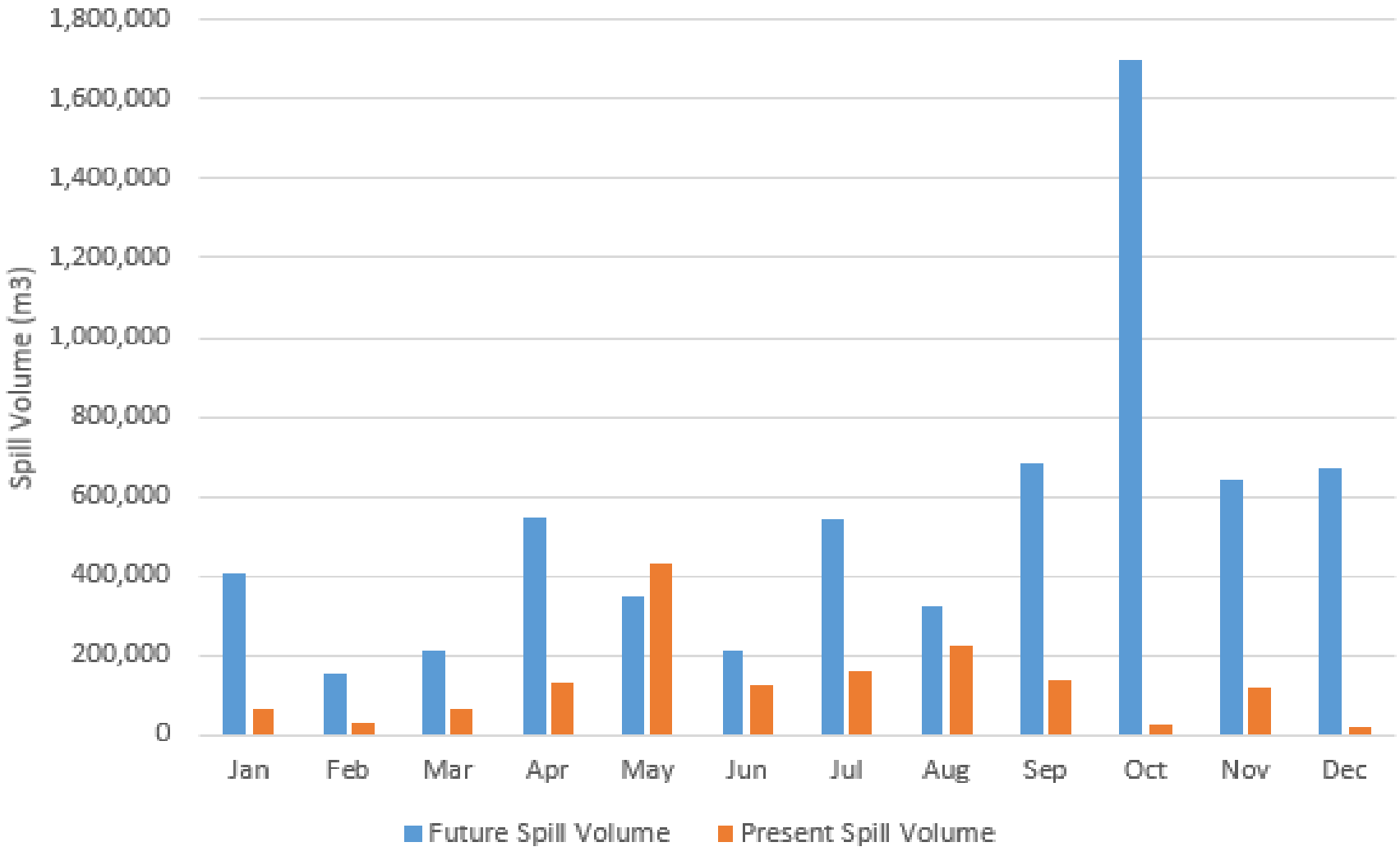
URBAN CREEP

- Approx. 1m^2 /house/year
- London has added the paved area equivalent to 22 Hyde Park's since 70s

Daily Average Rainfall Depth Thresholds	Number of occurrences (current climate)	Number of occurrences (future climate)	% change
>50mm	3	11	267%
45-50mm	2	7	250%
40-45mm	7	9	29%
35-40mm	6	12	100%

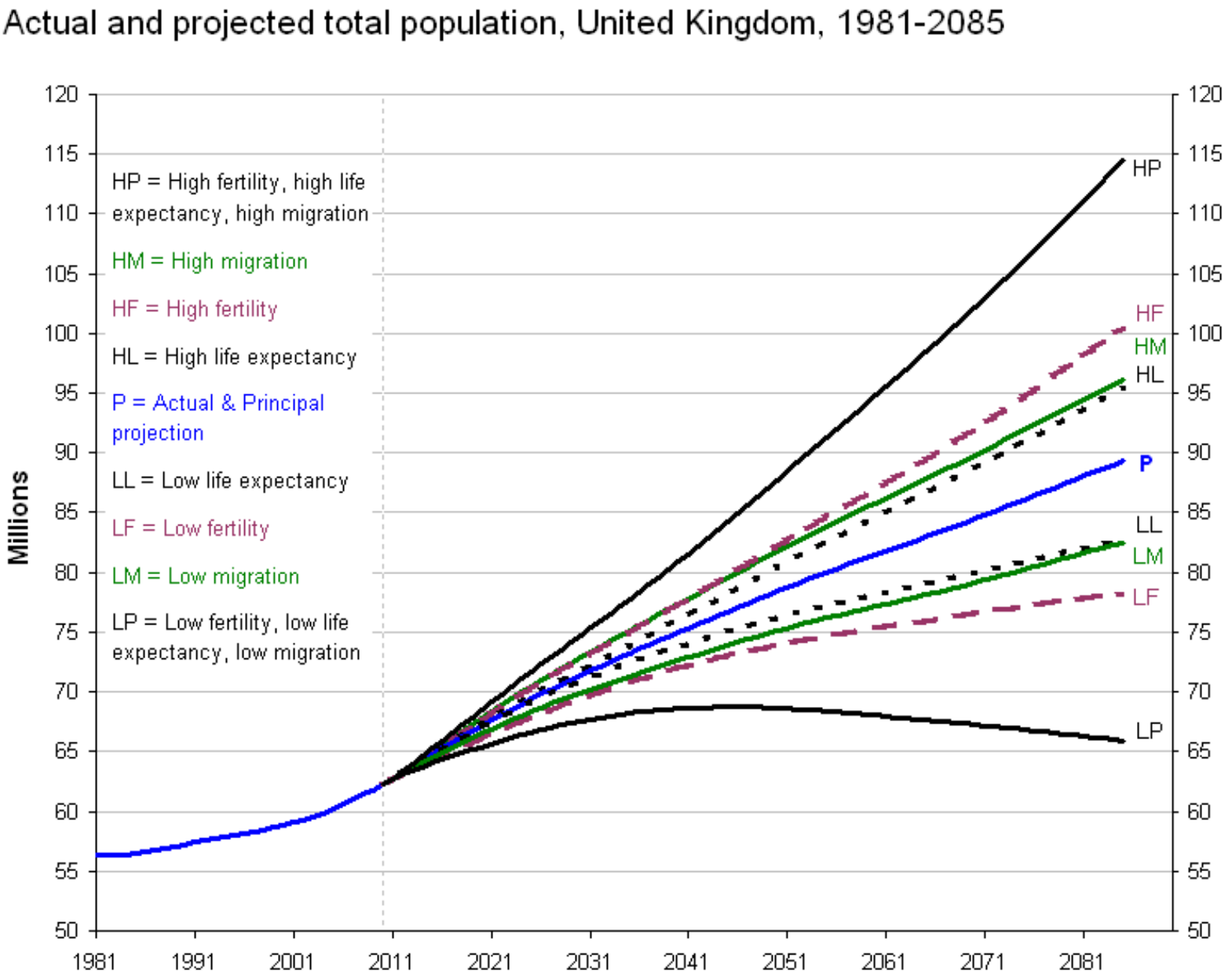


CSO discharge vol /year 2015 vs 2080



Population Growth

Office for National Statistics



Customer, government & society expectations

“Resilience is the ability to cope with, and recover from, disruption, trends and variability in order to maintain services for people and protect the natural environment now and in the future”

21st century solutions

Sewerage Management Plans

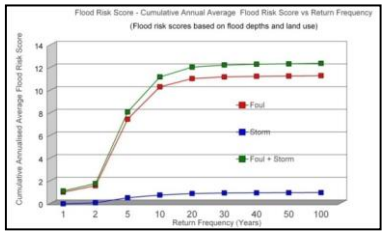
Waste Water Services

SEVERN TRENT WATER

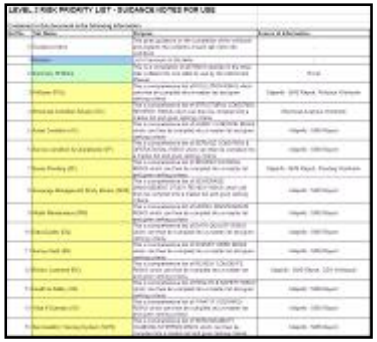
River Water Quality Assessments

Flood Risk Plans

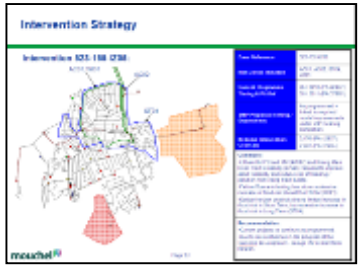
Annualised Cost Damage



Risk Priority List

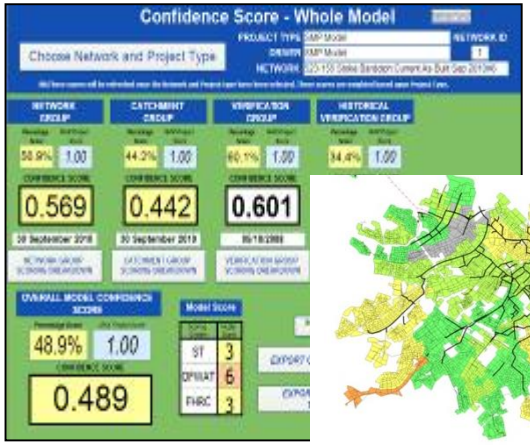


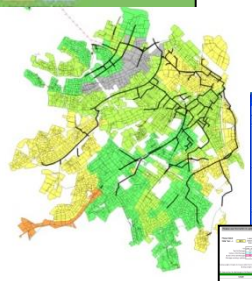
Intervention Strategy



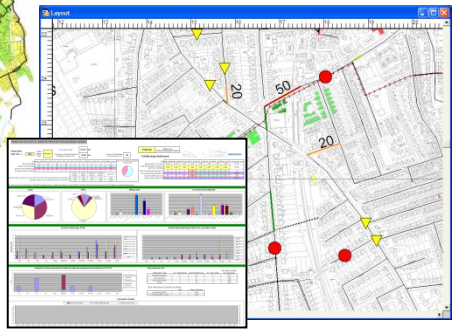
Sewerage Management Plan

Model Confidence

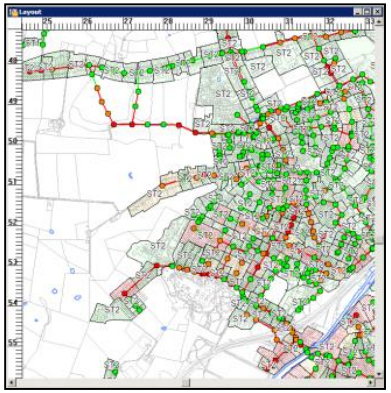




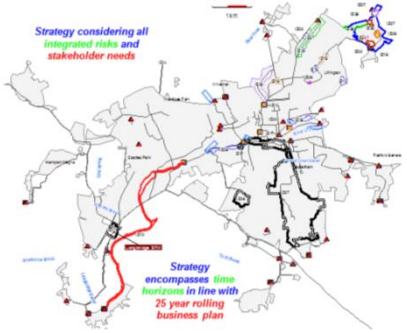
Service & blockage Assessment



Understanding Headroom for Growth & Climate Change

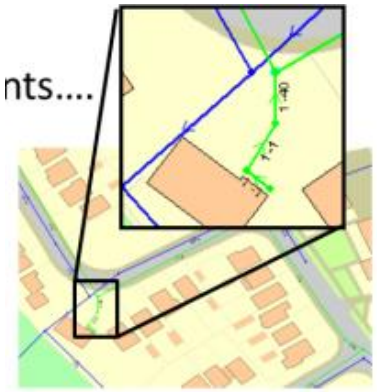


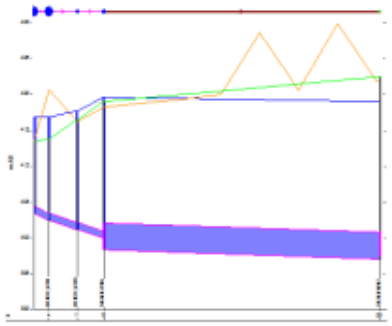
Strategic Plan



Sewerage Management Plans

Presenting model outputs in terms of risk

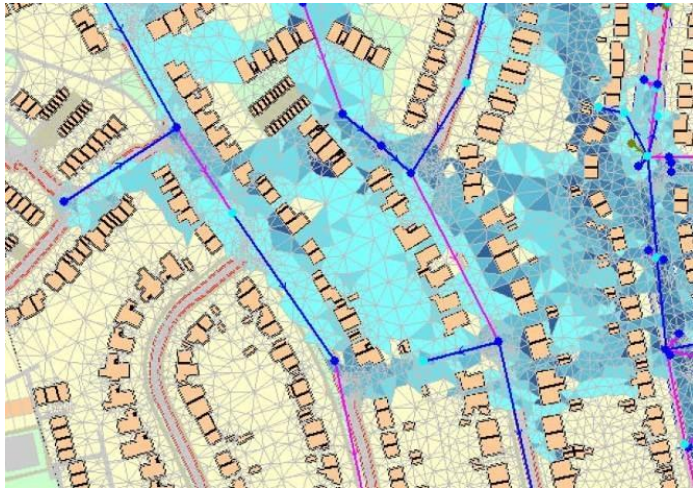


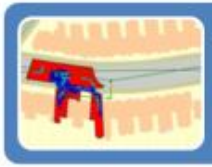


Likelihood

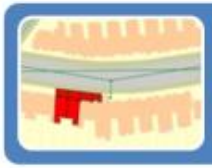
Consequence

High	Medium	Low
• Hospital • Critical infra • School • Habitable buildings • Critical w/c	• Gardens • Main roads • Curtilage • Garage • Parkland • Outhouse	• Low priority watercourse • Fields • Waste ground



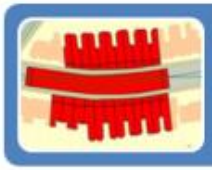


2D overland flow modelling
- Accurate representation of consequence
- Different levels / accuracy available



Lateral / Type III & Lidar
- Improved flooding mechanism representation
- Can be enhanced with simple rolling ball models

Horizontal & Lidar
- Takes some account of overland direction
- Can be enhanced with simple rolling ball models

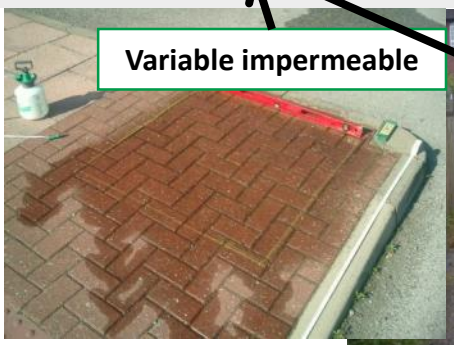


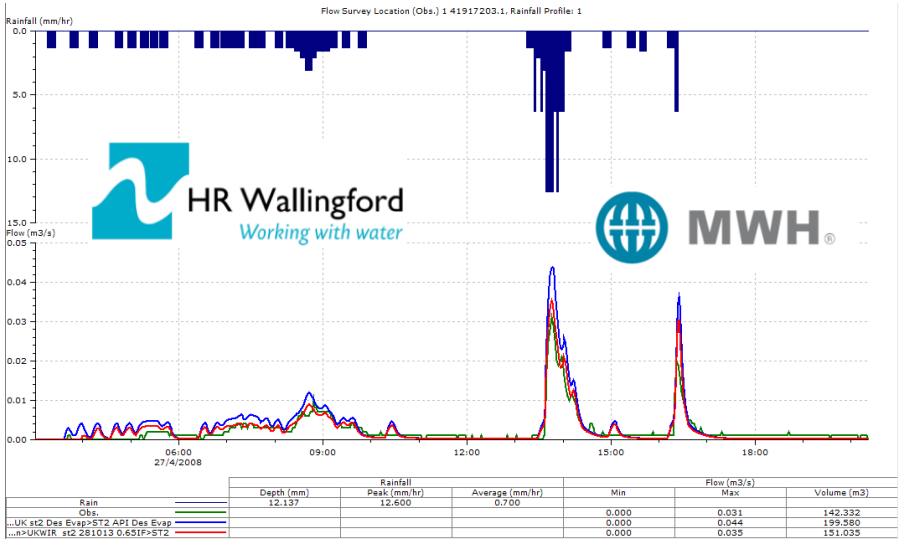
Horizontal Projection
- All properties in model subcatchment
- Within a certain distance of flooding manhole

Confidence & Local Focus

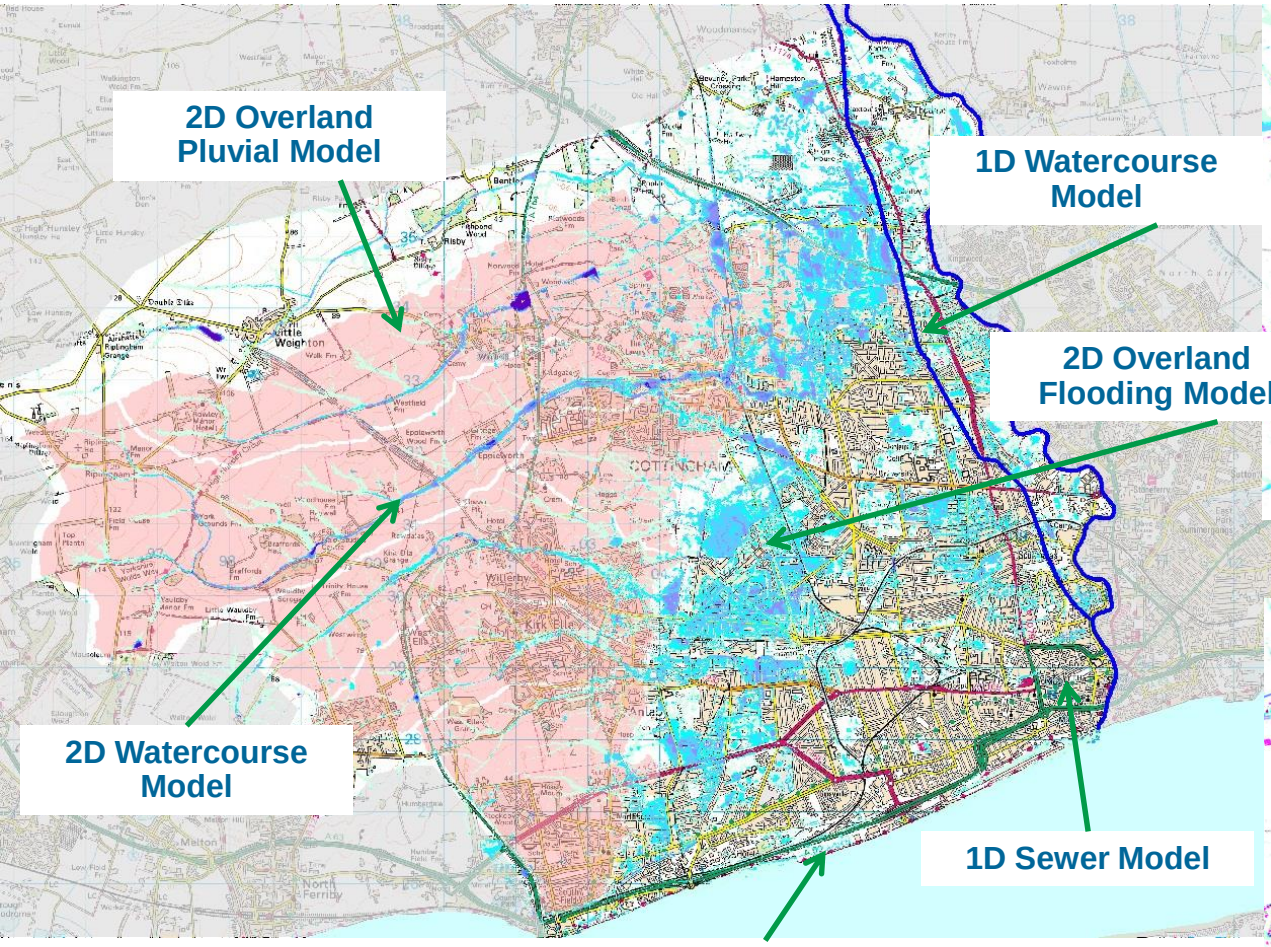
Much improved runoff models

$$PR = \sum_{n=1}^{N} \left[IF_n \times PIMP_n + (1 - IF_n) \times PIMP_n \times \frac{PI_{pv}^{\beta}}{PF_{pv}} \right] + \left[(1 - PIMP_{TOTAL}) \times \frac{((NAPI_s + PI_s)^{Cr} \times SPR)}{PF_s} \right]$$





Hull & Haltemprice Integrated Flood Modelling



Interventions

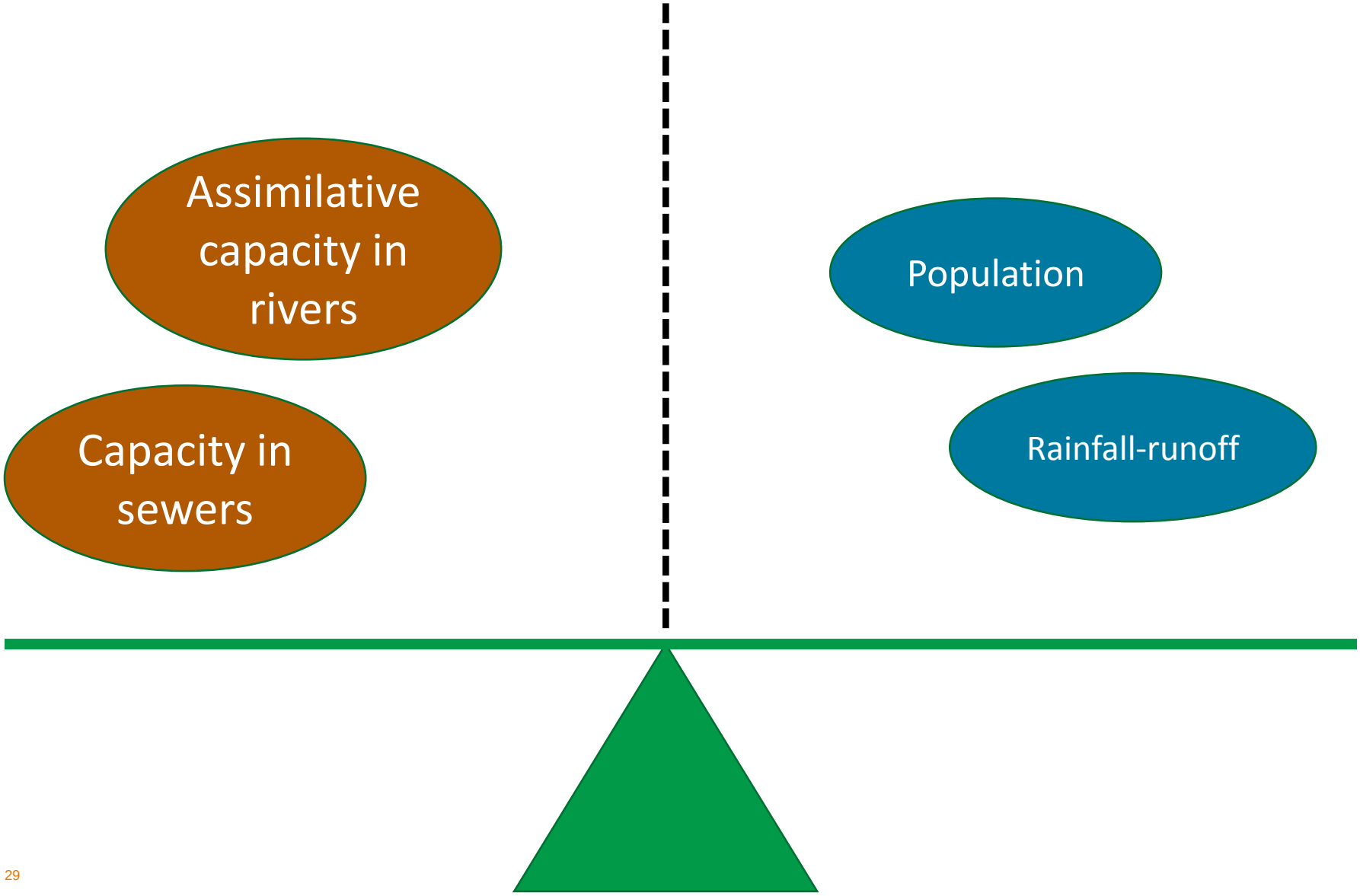
Urban Pollution Management (UPM)

Concentration – duration – frequency standards for DO in sustainable cyprinid waters		
Allowable return period	Dissolved oxygen concentration (mg/l)	
	1hr	6hrs
1 month	4.0	5.0
3 months	3.5	4.5
1 year	3.0	4.0

- Used through modelling to demonstrate that wet weather pollution from sewers and treatment plants can be modified to deliver Good Ecological Status under WFD
- Avoids use of expensive to apply or ineffective 'rules of thumb' – e.g. Y spills / year or X m^3 /ha /yr discharge
- Smarter, more effective, lower cost

www.fwr.org/UPM3/

Think about supply & demand



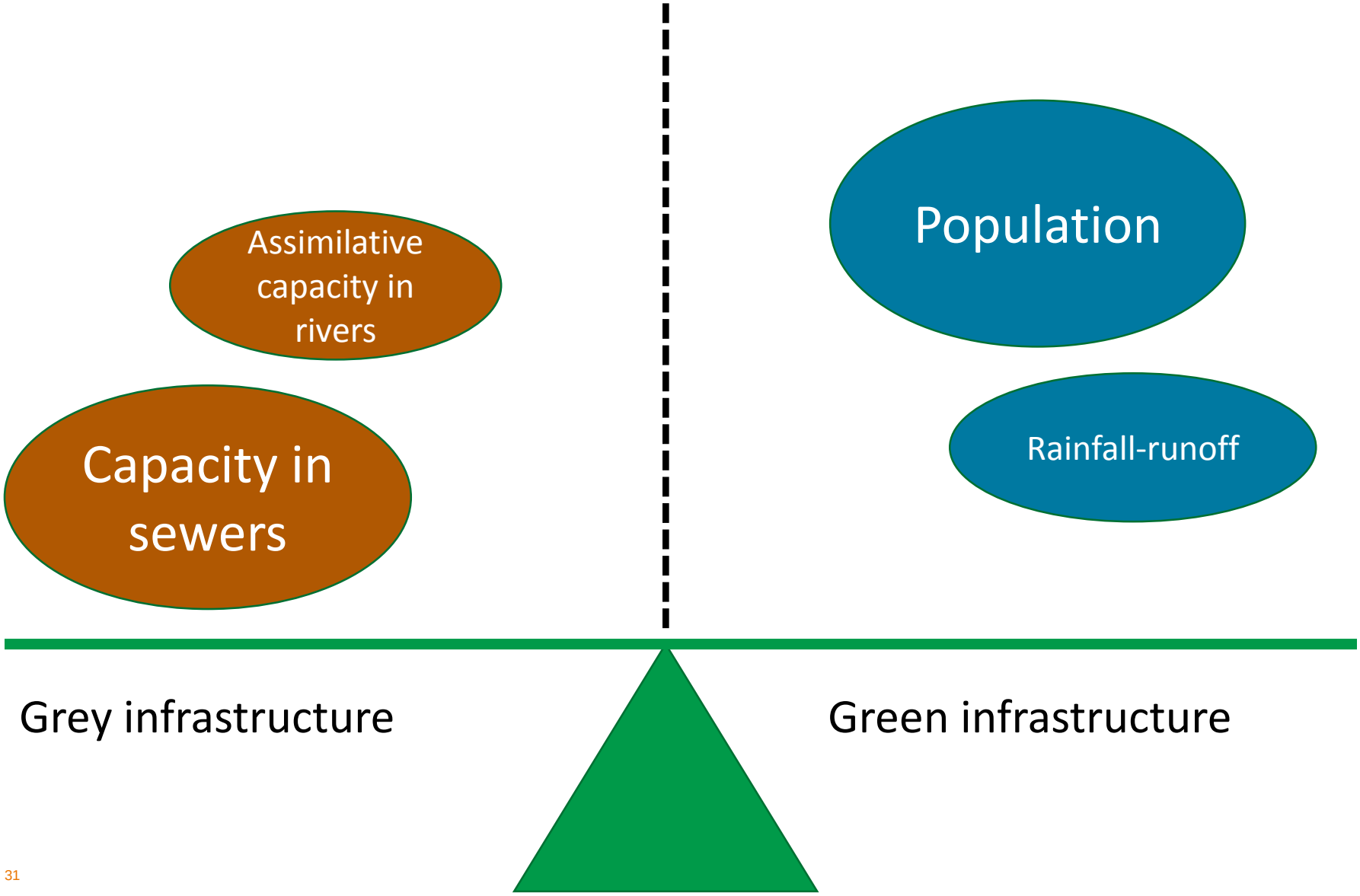
Think about supply & demand

Urbanisation & climate change

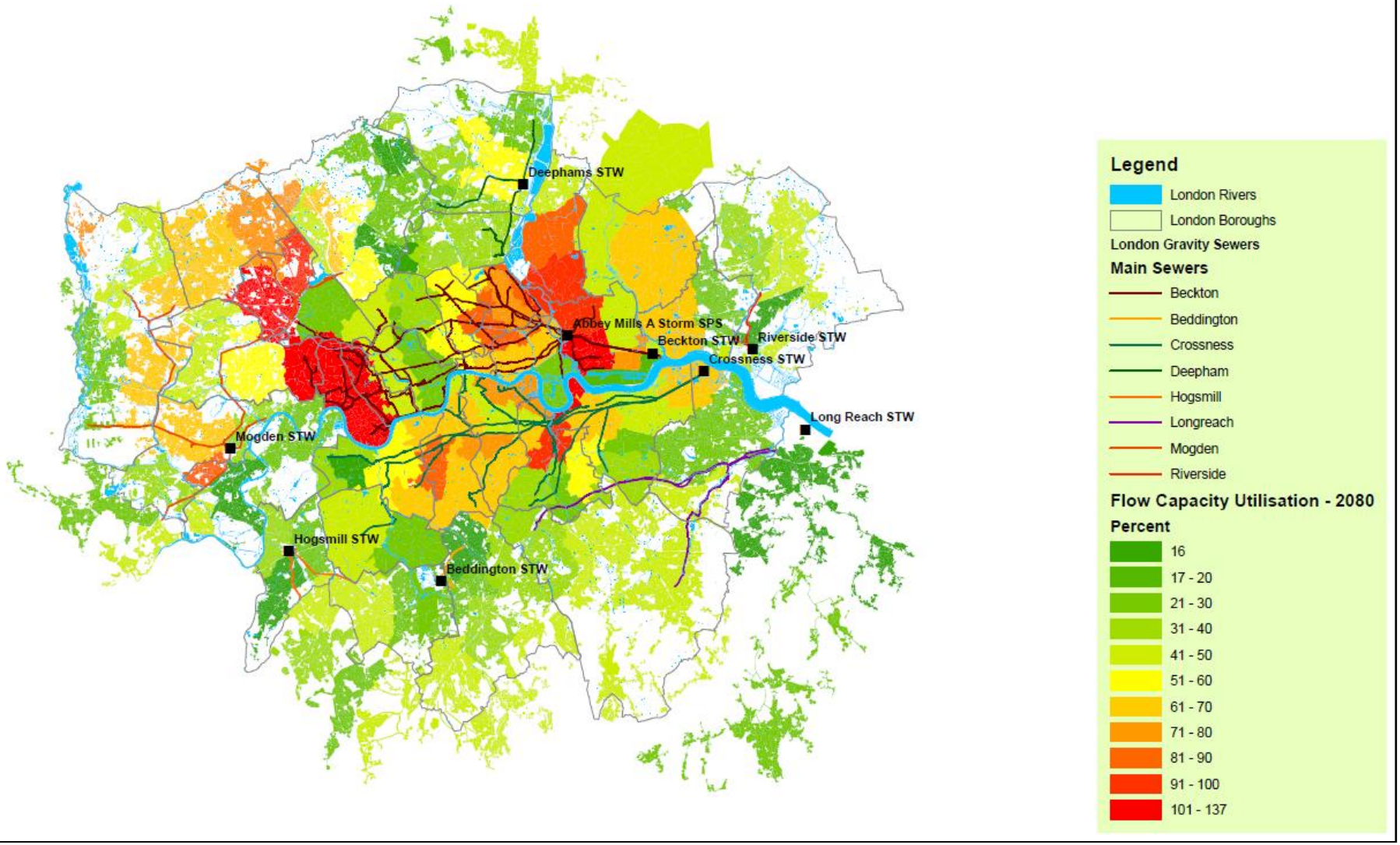
Population

Rainfall-runoff

Think about supply & demand

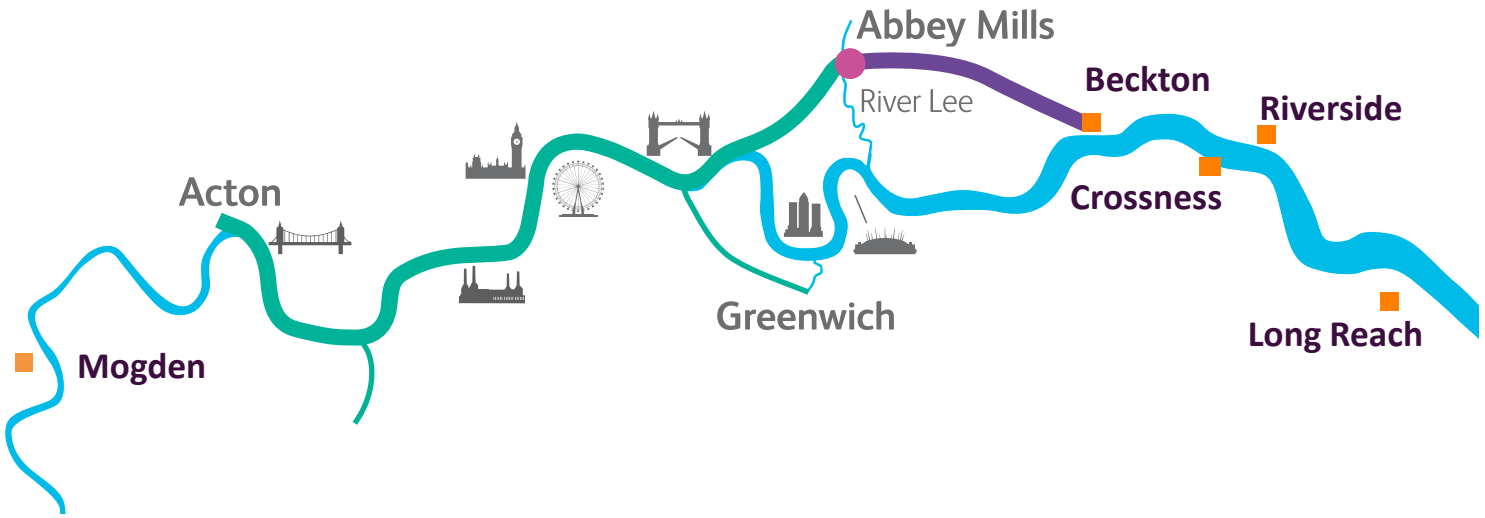


Capacity – are we full yet?



CSOs in the Thames Tideway

Grey infrastructure solution – Thames Tideway Tunnel



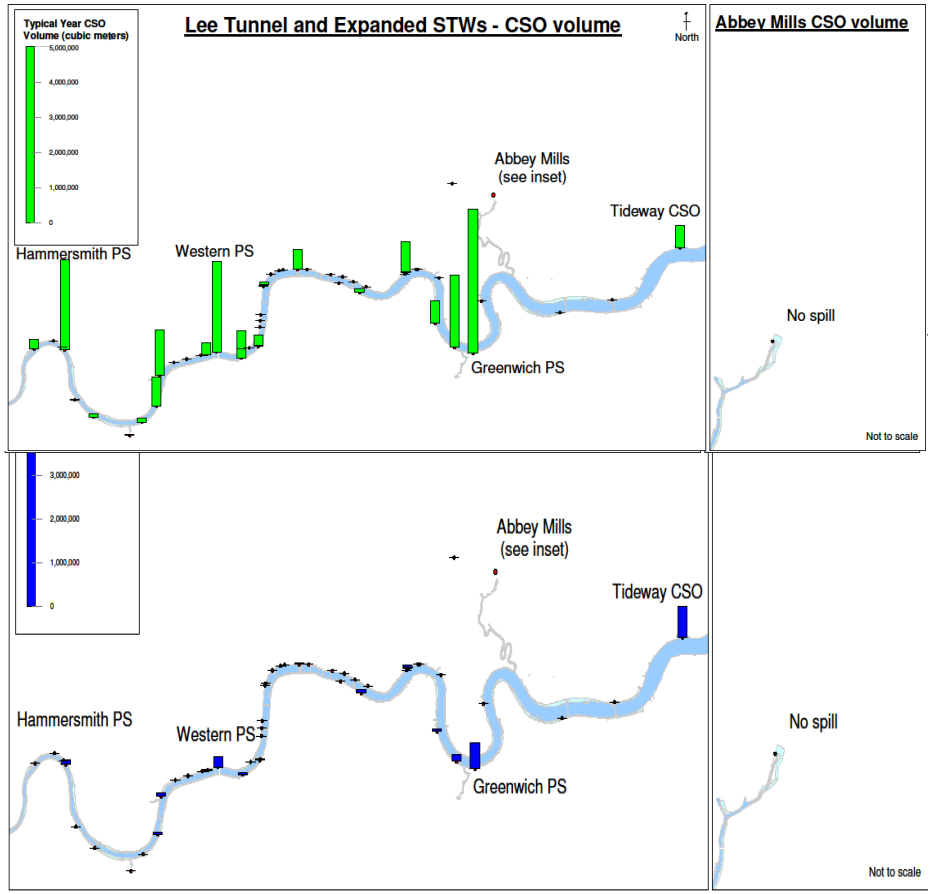
Tunnel statistics

- Length: 25 kilometres
- Gradient: Falls one metre every 790 metres to be self-cleansing
- Largest Diameter: 7.2 metres
- Volume: 1.6 million cubic metres (include Lee Tunnel)

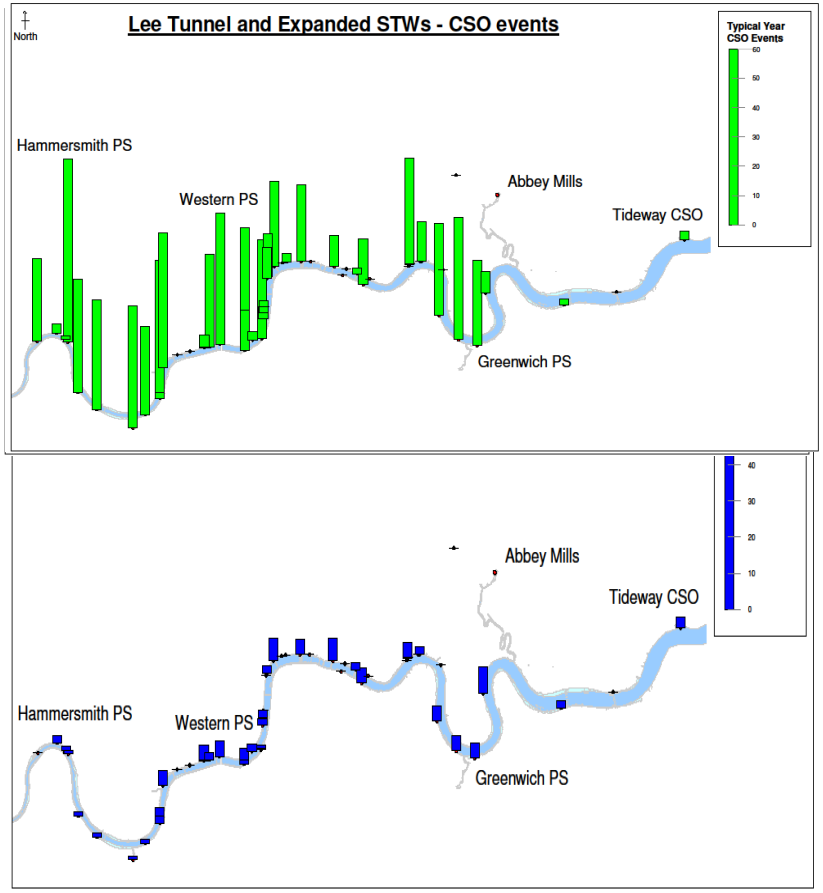
35

Impact on CSO discharge volume and frequency of operation

Typical year – CSO volume comparison



Typical year – CSO event comparison



The future

- Obstacles to delivering a sustainable and affordable sewerage service through to 2100 are substantial
- 19th Century legacy has served us well & imaginative investment planning and analysis have maximised 'bang for buck'
- Thames Tideway Tunnel type solutions are likely unaffordable in most cities
- Solutions: green & grey infrastructure in balance; advanced monitoring and control
- **21st Century Drainage Review (ready for 2020-2025)**
  - Government, Utilities, Regulators, Customers
  - Capacity, asset deterioration, network misuse, regulation, education
  - Affordable | Sustainable | Resilient

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10 May, 2017 Birmingham. CIWEM UDG Spring Conference

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