ASSESSING THE UNDERWORLD

The Wider Context – A More Sustainable Approach to Streetworks

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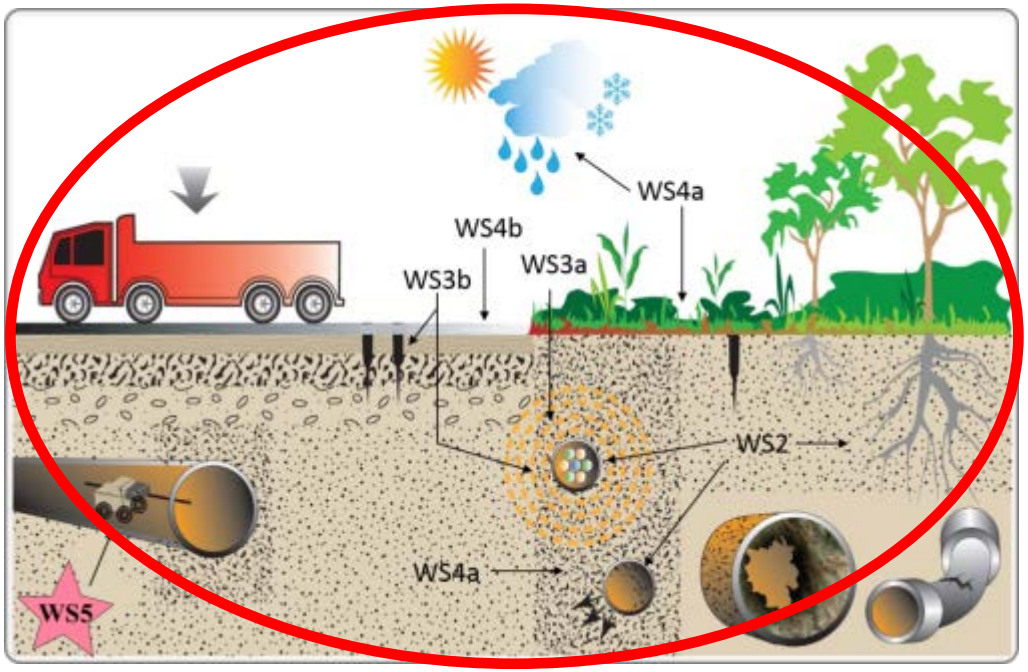

Three Infrastructure Interdependencies

We need to be aware of the consequences of excavating trenches in the streets – *ideally before rather than after doing it*

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Adverse Consequences of Trench Excavation

We need to be aware also of the social and environmental consequences of excavating trenches in the streets

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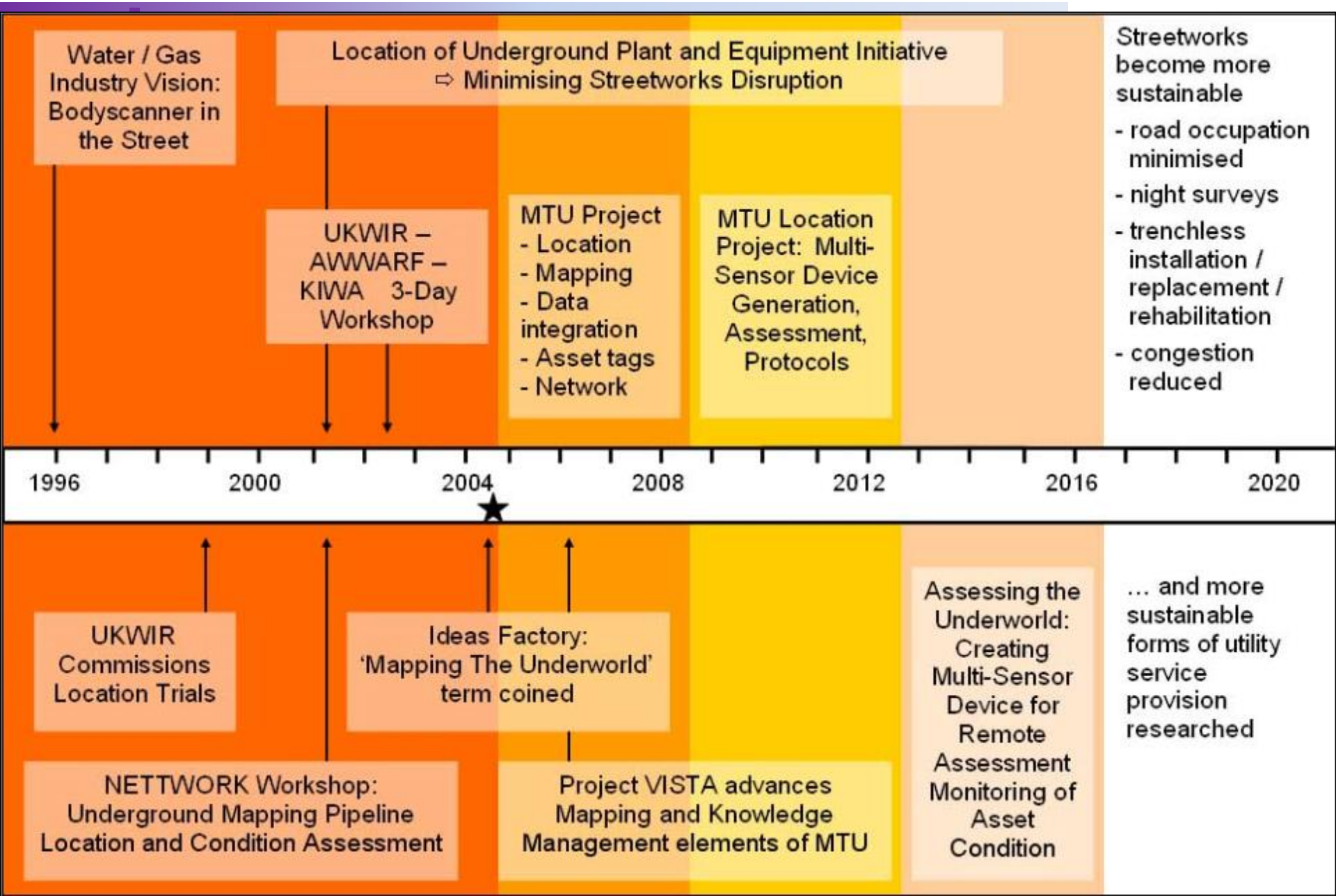
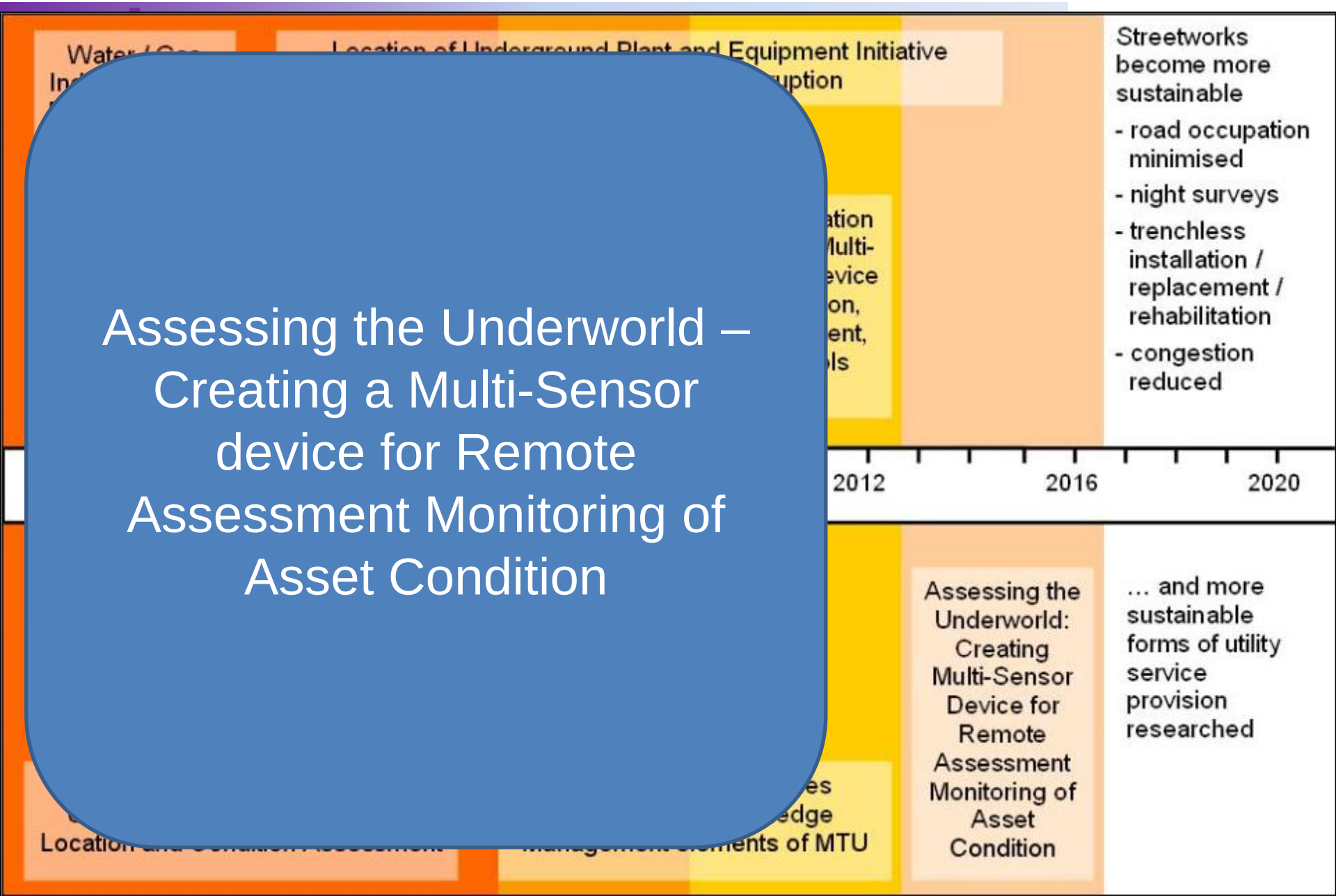
Mapping the Underworld Timeline



Mapping the Underworld Timeline



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ATU's Core Proposition

We contend that what is buried in, and on, the ground is to some degree controlled by the ground

> *... if the ground properties change, or the ground moves, the adjacent / overlying infrastructure responds accordingly*

Considering buried utility services – we seek to create a system able to manage, coherently, what we do to the buried infrastructure (add new services, repair / renovate existing services, leave it alone for now). For this

> *... we need to be informed by the ground conditions and how the ground might react to any new activity or intervention*

The same argument holds true for the transport infrastructure

ATU's Core Proposition

ATU is using MTU's multi-sensor platform, with amendments and additions, and robotic in-pipe pigs to

assess the condition of buried pipelines and cables,
and of the ground in which they are buried,
and of the surface infrastructure that overlies it

Wikipedia

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ATU's Conceptual Framework

ATU's vision is to prove the concept of a single, integrated national 'model' for the UK's infrastructure

... and explore how remote sensing technologies data can reveal the infrastructure's condition

The only sensible base into which to add details of the utility service and transport infrastructures, and their condition, is the 3D geological 'map' (or 'model') held by the British Geological Survey

The ultimate outcome is any civil engineering intervention in this system can be undertaken intelligently

... being informed by a level of integrated and coherent information heretofore unavailable

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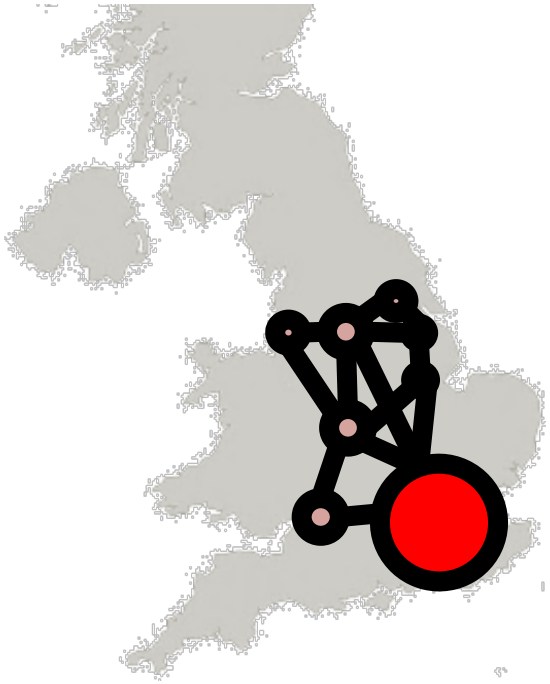
Where are UK's Future Infrastructure Needs ?

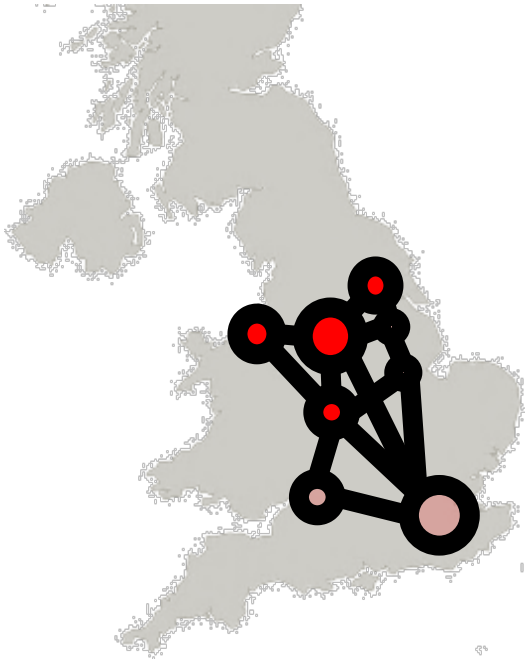
Government Office for Science

Foresight

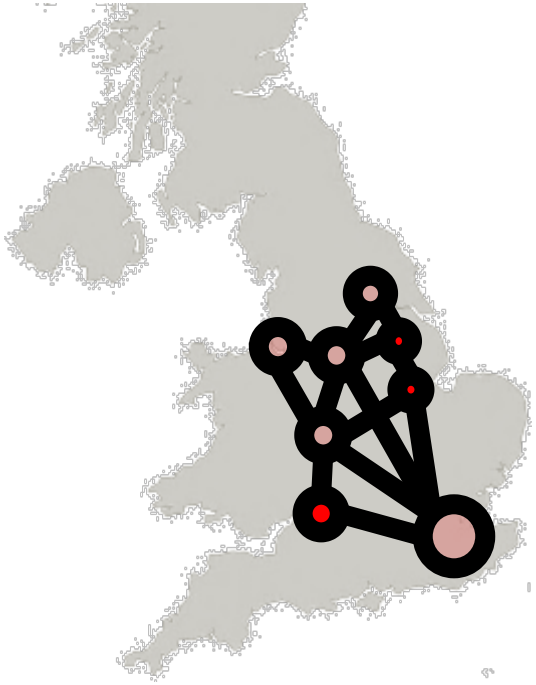
How will the UK accommodate an additional 10 million citizens?



London-centric



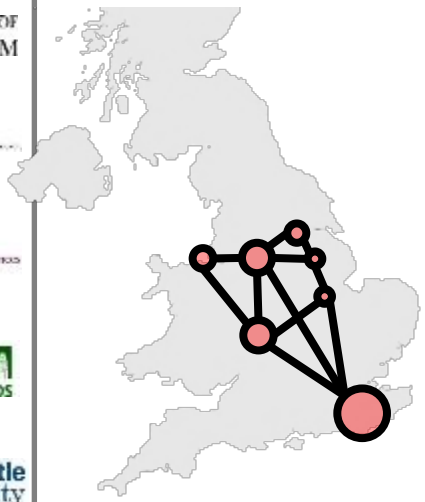
Major city empowerment



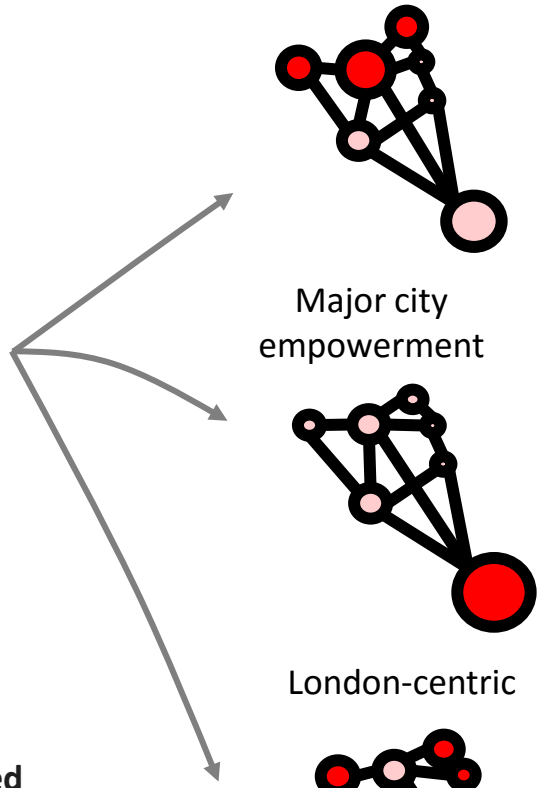
Smaller cities focus

Where are UK's Future Infrastructure Needs ?

… and what are the consequences? – Scenario Narratives



Baseline 2037



Major city empowerment

London-centric

Smaller cities focus

3 **'what-if' scenarios** of **distribution** of **projected population** and employment: a basis for exploring potential future paths for UK cities.

Manchester, Liverpool, Leeds population growth is double that of baseline projection.

- ***What are the implications for housing provision and local economies?***

London's population grows by 34%. Five cities go into population decline.

- ***How can we manage population decline?***

Several towns in northern England have population growth rates exceeding 30%.

- ***Where might cities expand?***

Source: Foresight Future of Cities

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Sustainability Assessment of Streetworks

Conceptualising the Streetworks Sustainability Assessment Framework (SSAF) framework uses two approaches:

- … Decision making tool (SPeAR-based methodology)
- … Social and environmental accounting (whole-life costing)

SPeAR® is being adapted to assess utility streetworks projects

Based on the impacts on the three pillars of sustainability

- … *with an additional focus on indirect economic costs*

Four sets of indicators are being developed, with the impacts clustered under four categories:

- … *Direct Economic Impacts*
- … *Indirect Economic Impacts*
- … *Social Impacts*
- … *Environmental Impacts*

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Sustainability Assessment of Streetworks

Each category of impact is considered for both the Construction and Maintenance phases of streetworks projects as *Headline Indicators*, and each has associated sub-indicators. For example:

Headline Indicator	Indicator Category
Construction Direct Economic Impact	Planning and Design
	Labour and machinery
	Construction materials
	Construction works
	Traffic management
Maintenance Direct Economic Impact	Planned maintenance
	Monitoring
	Access
	Emergency repairs
	Decommissioning
Construction Indirect Economic Impact	Third Party utility damage
	Compensation to businesses for loss of profit
	Compensation to customers for interruptions to services
	Loss of income to asset owners or utilities
	Compensation to local authorities for damage to their assets
Maintenance Indirect Economic Impact	Goodwill
	Required Training (upskill)
	Insurance
	Loss of business to competitors
	Lost Opportunity Cost

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Sustainability Assessment of Streetworks

Headline Indicator	Indicator Category
Construction Social Impact	Delay costs to road users
	Disruption to businesses
	Disruption to local community
	Health and Safety (nuisance)
	Costs to local authorities
Maintenance Social Impact	Delay costs to road users
	Disruption to businesses
	Disruption to local community
	Health and Safety (nuisance)
	Costs to local authorities
Construction Environmental Impact	Energy efficiency
	Materials and waste production
	Carbon footprint
	Water consumption and pollution
	Biodiversity (flora and fauna)
Maintenance Environmental Impact	Energy efficiency
	Materials and waste production
	Carbon footprint
	Water consumption and pollution
	Biodiversity (flora and fauna)

The detailed impacts are being established for each sub-indicator

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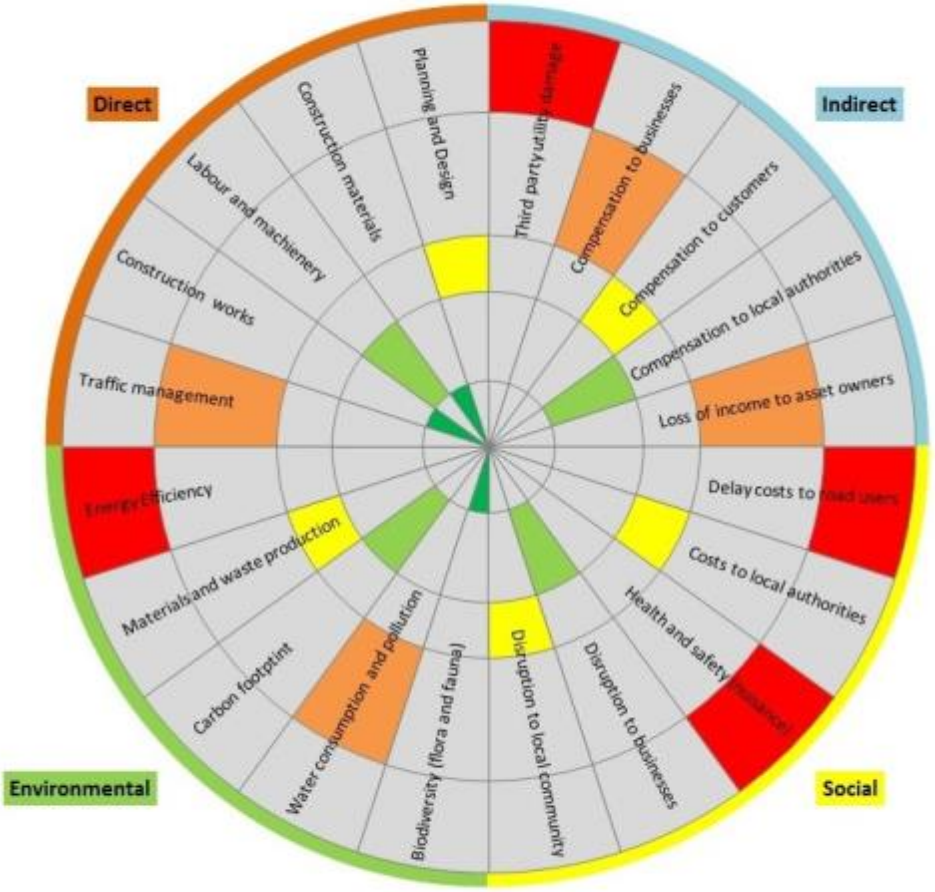
Sustainability Assessment of Streetworks

Total Sustainability Cost (TSC) of streetworks is defined as:

TSC = Direct [economic] + Indirect [economic] + Social + Environmental



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New EPSRC-Funded Research

University of Bath

University of Birmingham

British Geological Survey

EPSRC Engineering and Physical Sciences Research Council

University of Leeds

Newcastle University

The University Of Sheffield.

University of Southampton

UKWIR

Balancing the Impact of City Infrastructure Engineering on Natural Systems using Robots

Ambition: *Zero disruption from Streetworks in UK Cities by 2050*

Vision : *A city where infrastructure is autonomously maintained and dynamically responsive to secure the health & wellbeing of its citizens, contribute to flourishing and sustainable natural systems, and create positive economic and societal outlook*

… to rid our cities of the socially and environmentally damaging air, noise, light and waste pollution that occurs from infrastructure maintenance associated with streetworks

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New EPSRC-Funded Research

The topics to be researched are:

- *autonomous systems for minimally invasive infrastructure sensing, diagnosis and repair*
- *advanced robots for deployment in complex live city environments*
- *the socio-technical intricacy of the robot – human – natural systems interfaces*

We will start with three case study systems:

- *"Perch and Repair"* – remote maintenance and modernisation of lighting columns to promote their use as multifunctional platforms for city communication nodes
- *"Perceive and Patch"* – swarms of flying vehicles for autonomous inspection, diagnostics, repair and prevention of highway defects (e.g. potholes)
- *"Fire and forget"* – hybrid robots designed to operate indefinitely within live utility pipes performing inspection, repair, metering and reporting tasks

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Conclusions

The move towards more sustainable streetworks requires a comprehensive evidence base of the consequences of the alternative streetworks activities

this is being captured in the bespoke streetworks assessment framework

The wider context of the future of the UK's city systems, and the UK's system of cities, needs to be considered also

population growth, demographics, migration, citizen demands and expectations …

… both in terms of service provision, and lack of disruption

The development of new and smart technologies must be accommodated into this thinking

… and all must be captured in ATU's Decision Support

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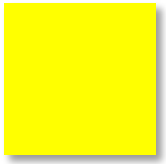
How Might We Solve Your Problems?

Propose one change to practice that you would wish to see happen, and when.

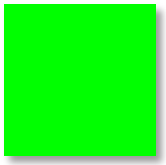


This could be in terms of design, construction, operation, maintenance or whatever associated with streetworks

Propose one change to governance of streetworks that you would wish to see happen, and when.

This could relate to policy, regulation, legislation, financial arrangements / taxation, or whatever

Propose one new research programme that you would commission if you were in charge of the Government's research budget



Title and aims

We'd like you to

Record these on post-it notes, add to flip chart sheets, and discuss in breakout groups