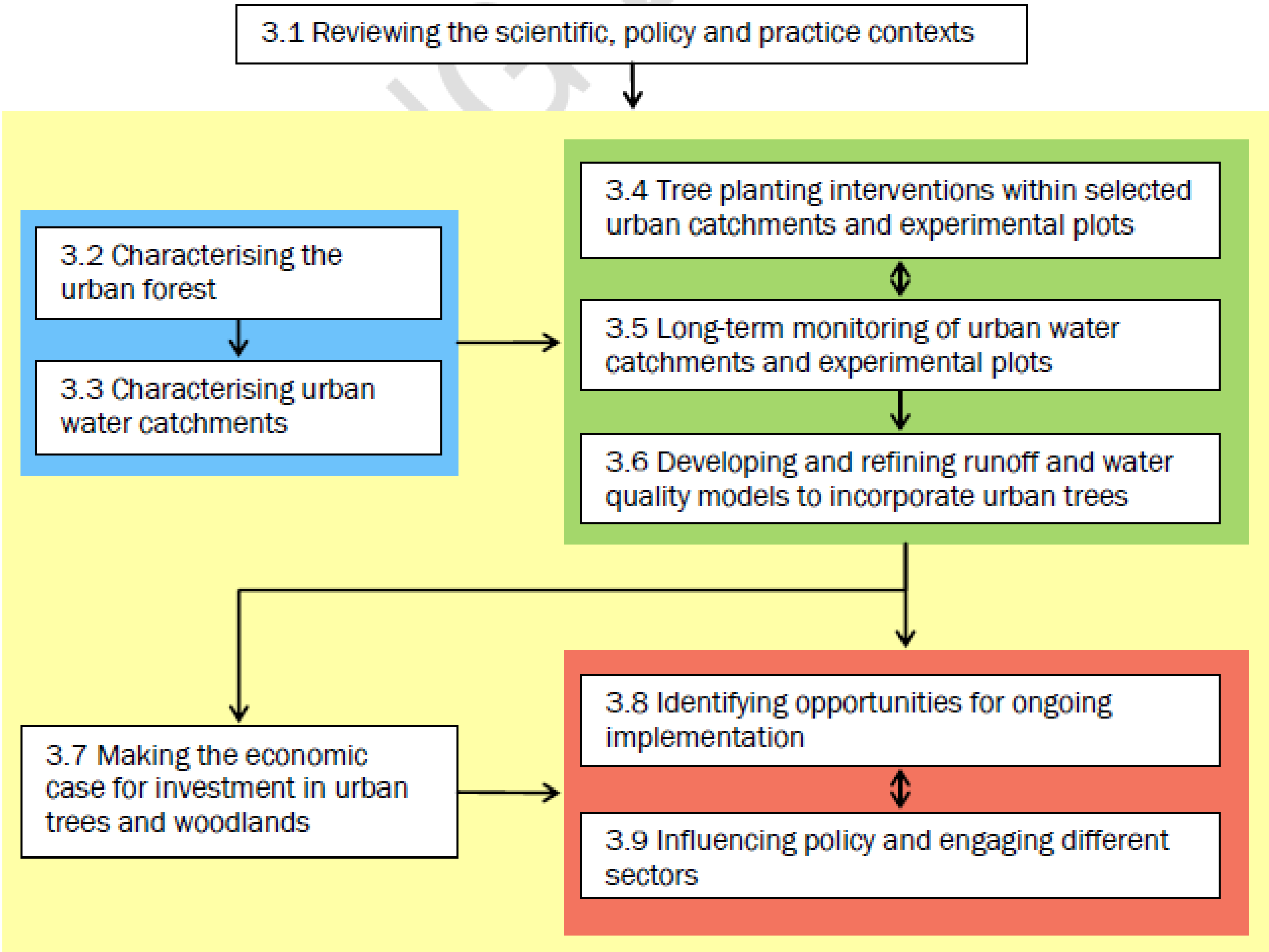
Urban Catchment Forestry Overview

Susannah Gill, The Mersey Forest

THE MERSEY FOREST
more from trees

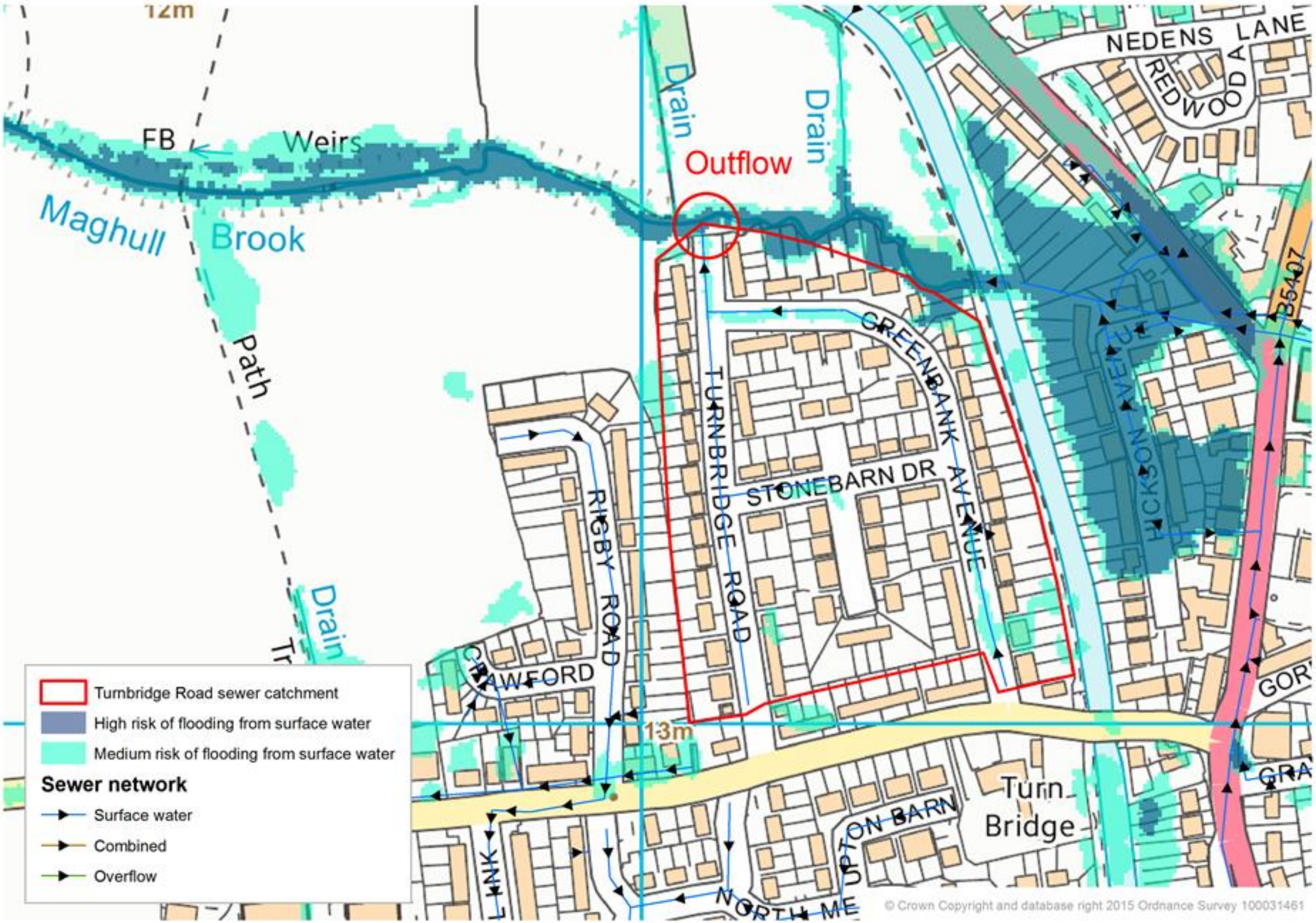
Urban Catchment Forestry:

The strategic use of urban trees and woodlands to reduce flooding, improve water quality, and bring wider benefits


3.1 Reviewing the scientific, policy and practice contexts
3.2 Characterising the urban forest
3.3 Characterising urban water catchments
3.4 Tree planting interventions within selected urban catchments and experimental plots
3.5 Long-term monitoring of urban water catchments and experimental plots
3.6 Developing and refining runoff and water quality models to incorporate urban trees
3.7 Making the economic case for investment in urban trees and woodlands
3.8 Identifying opportunities for ongoing implementation
3.9 Influencing policy and engaging different sectors

Series of projects

- Existing projects?
- Catchment Partnership Action Fund – UCF pilot for Mersey Estuary & Alt Crossens
  - £62k (plus in-kind); possibly up to £130k
  - 2015-16
  - 5 tree pits per street, 2 streets
  - Surface water draining to outflow on river with WFD issues from urban diffuse pollution
  - No monitoring at tree pit / sewer, some at outflow
- Other funds – e.g. Interreg



12m
FB
Weirs
Maghull
Brook
Drain
Drain
Outflow
Path
Drain
NEDENS LANE
REDWOOD A
B5407
GREENBANK AVENUE
STONEBARN DR
TURNBRIDGE ROAD
RIGBY ROAD
CRAWFORD
13m
UPTON BARN
NORTH ME
Turn Bridge
GOR
GRA
Turnbridge Road sewer catchment
High risk of flooding from surface water
Medium risk of flooding from surface water
Sewer network
Surface water
Combined
Overflow
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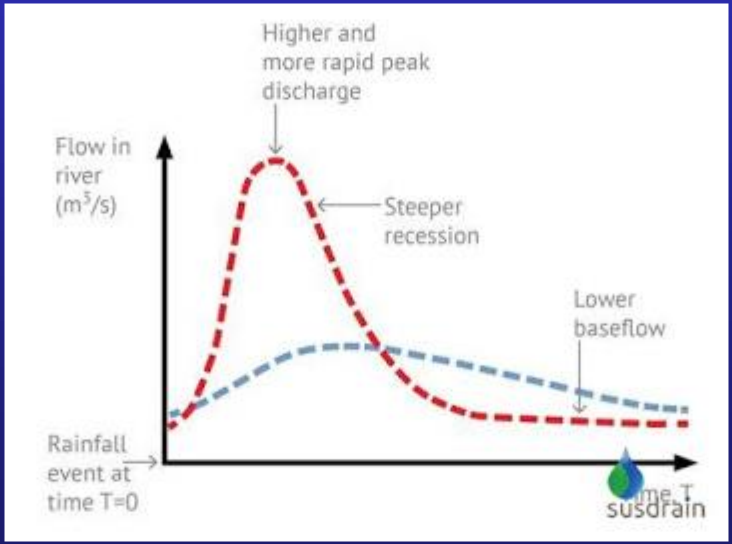
The Hydrological benefits of Urban Trees

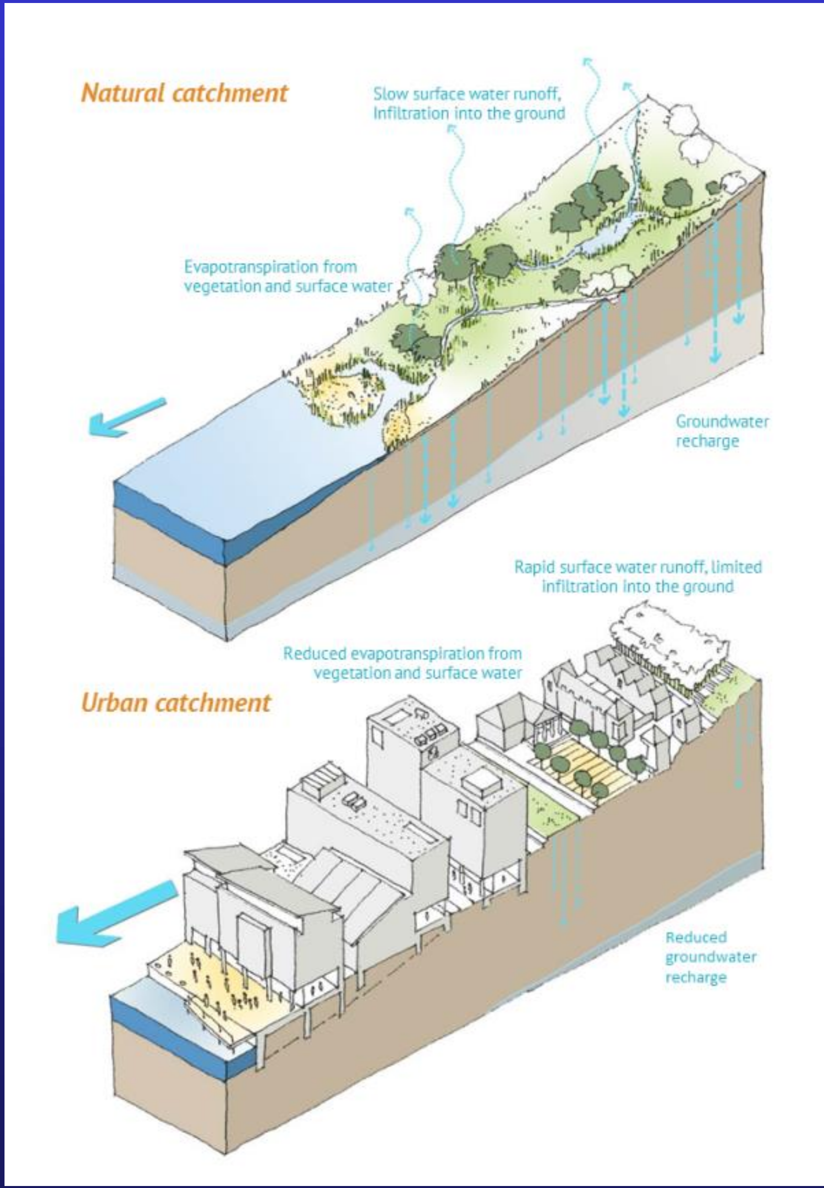
Roland Ennos

University of Hull

The Hydrological Effects of Urbanisation

Replacement of greenspace by buildings results in earlier and greater runoff of rainfall.

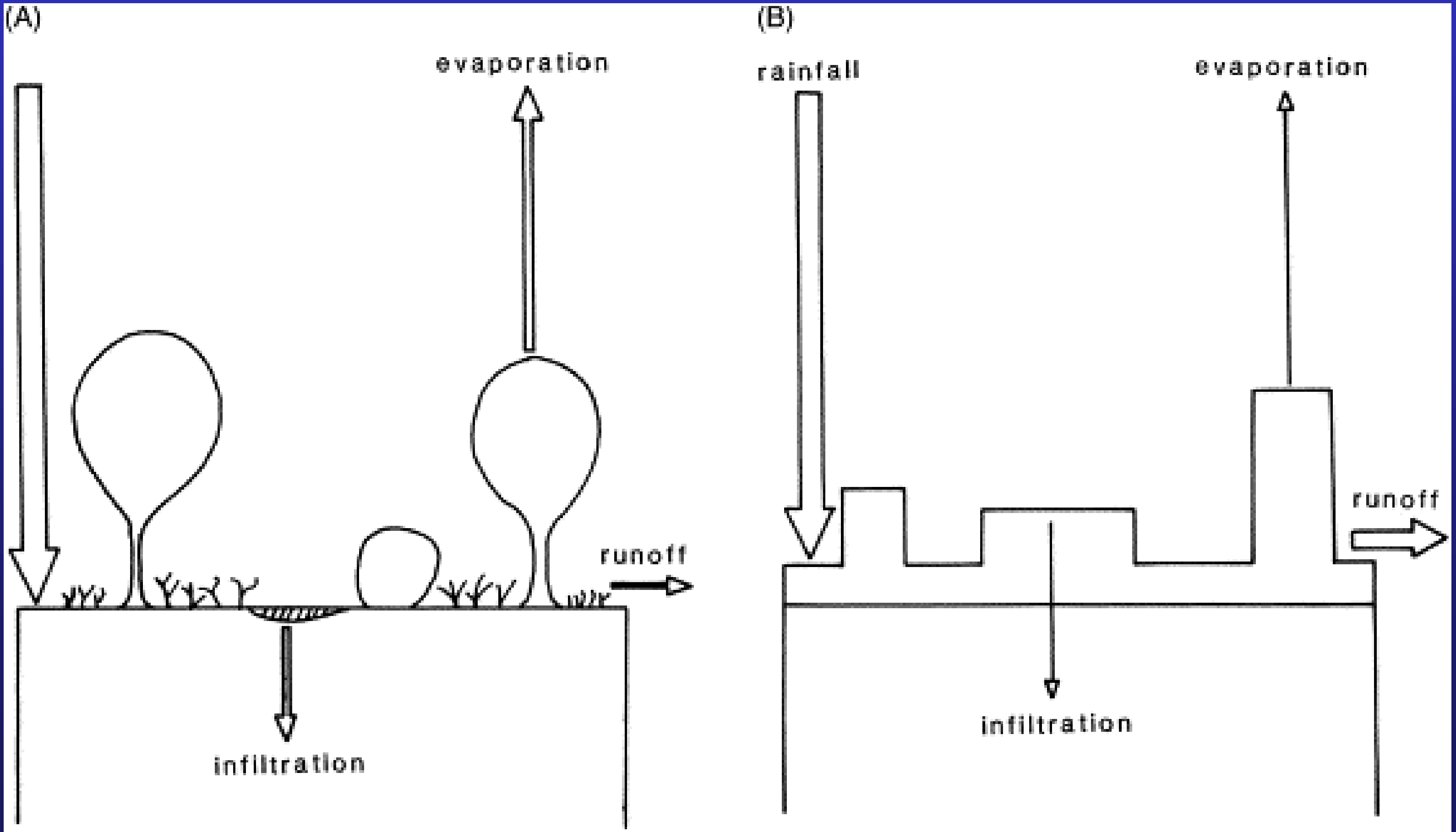




Climate change will increase the likelihood of surface flooding

How Trees Can Help – the Mechanisms

Trees **Intercept** rainfall, some of which **Evaporates**
Soil beneath trees **Stores** water and lets it **Infiltrate**
All this reduces the **Runoff**



How Trees Can Help – the Difficulties

1. Trees are all different.
2. Soils are all different.
3. Conditions vary at different times of the year.
4. Rainstorms are all different, varying in size, intensity and duration.
5. Trees may act either **In Parallel** with other surfaces (ie Trees in pavements and parks) or **In Series** with drainage from buildings and roads (ie SUDS and biofiltration installations).

Therefore it is impossible to give a single % value for the benefit of a single tree or stand of trees.

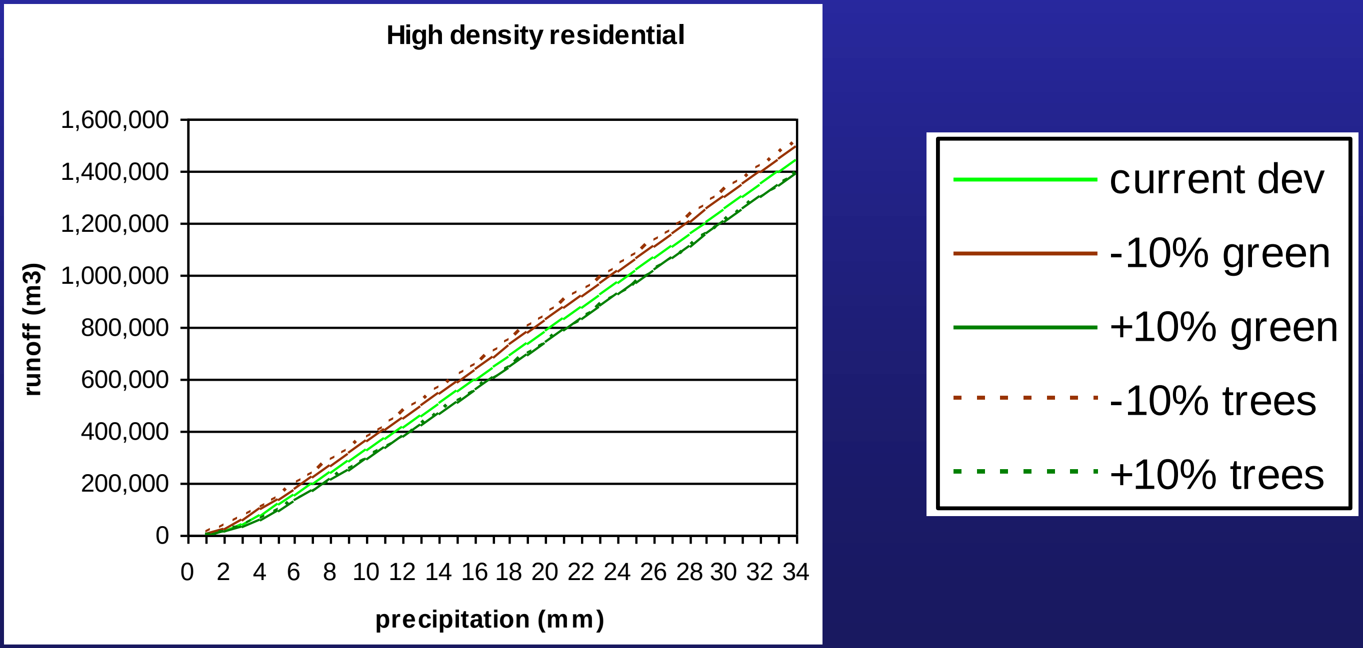
Methods used: Modelling

a) The curve number approach eg the SCS.

Calculates runoff of an area depending on antecedent soil moisture and rainfall by adding up its consituents

Eg Woodland has a runoff of only 50-60%, compared with 95-98% for the built environment.

- Adding 10% tree cover would reduce runoff by up to 5%, well below the forecast increase in runoff of 80%.

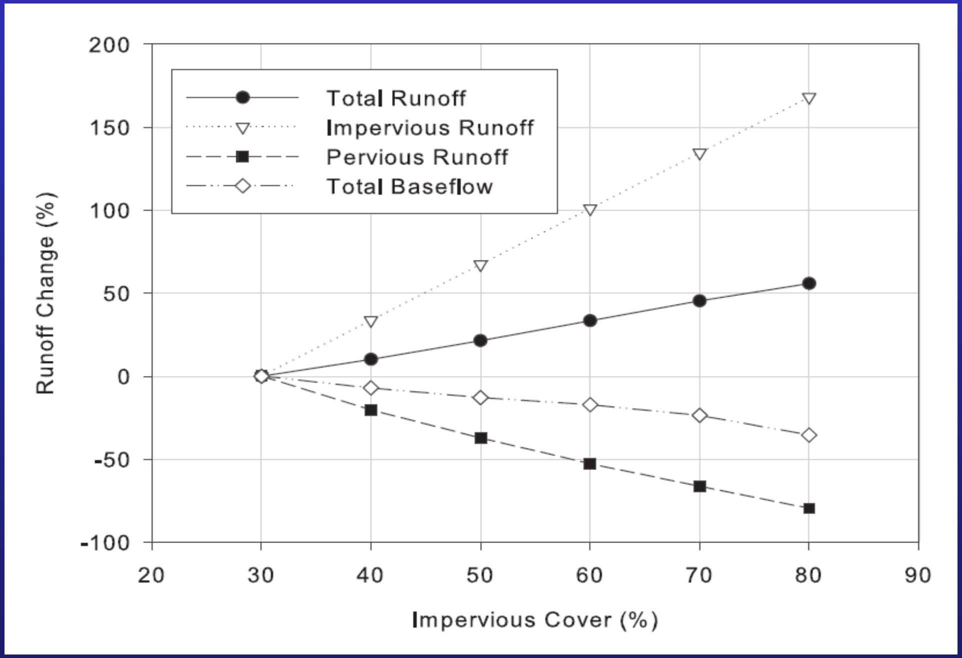


Methods used: Modelling

b) Mechanistic Models eg the UFORE Hydro Model

Calculates interception, evaporation, storage and infiltration on all surfaces including

Trees above pervious vs Trees above impervious



Effects of increasing tree cover are small but

NB Effects of trees on soil have not been considered

Methods used: Experimental

Many studies have examined canopy interception

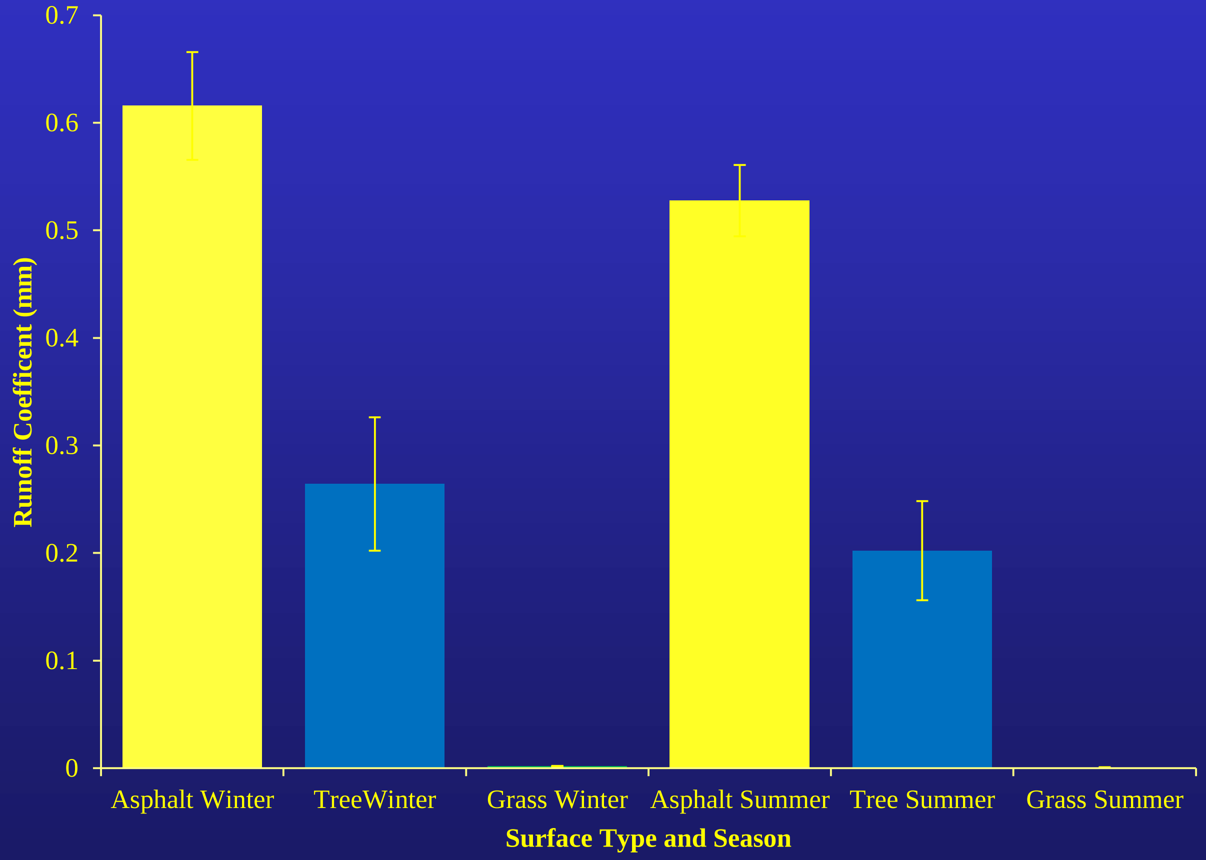
Results are very varied: 5-35%

but few have looked at infiltration or runoff.

We designed experimental plots to measure runoff.

Results

Trees reduced runoff by 60% across the whole plot: grass by 99%!



The Problem with Both Modelling and Experimental Studies

1) They ignore the effect of trees on the permeability of soils.

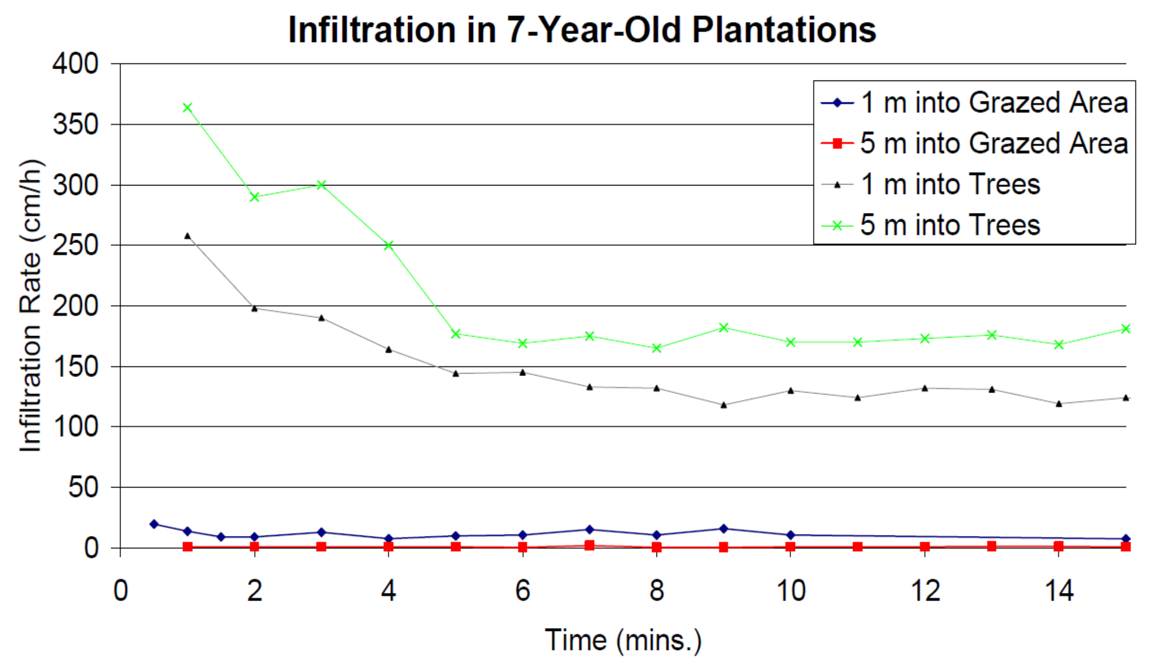


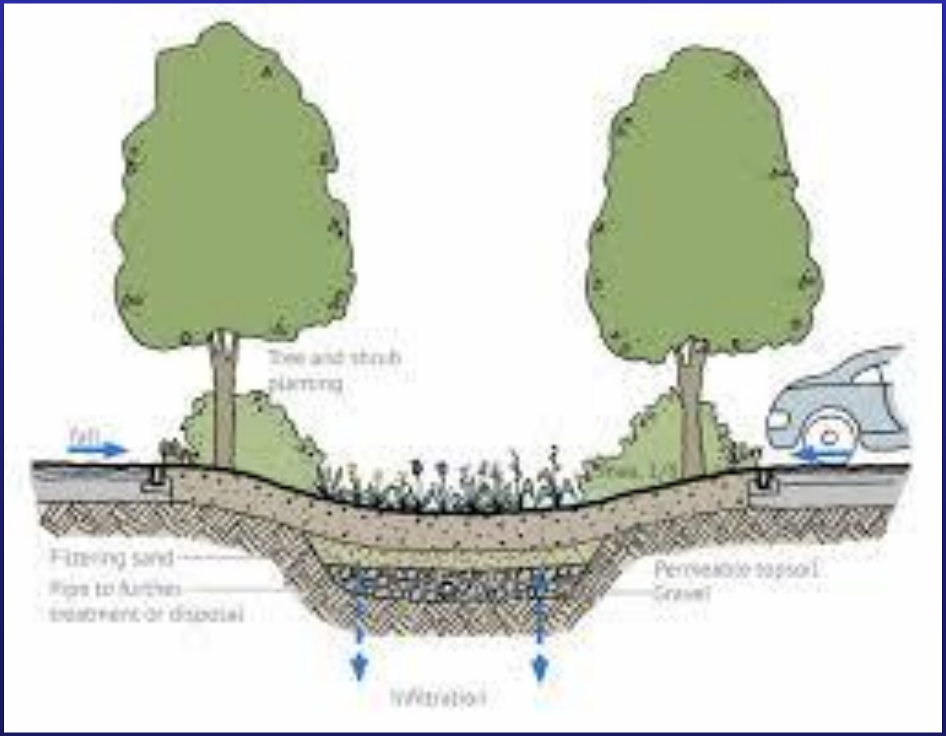
Figure 4.5 Mean infiltration rates per time interval for 7-year-old plantations (Sites A, F, and G).

Results for Pontbren

This suggests trees would be more effective than grass!

What we still need to know in the UK

1) The effect of trees on the permeability of compacted urban soils.
2) The relative performance of soil around street trees and open-grown trees.
3) The effectiveness of trees when grown in SUDS schemes.



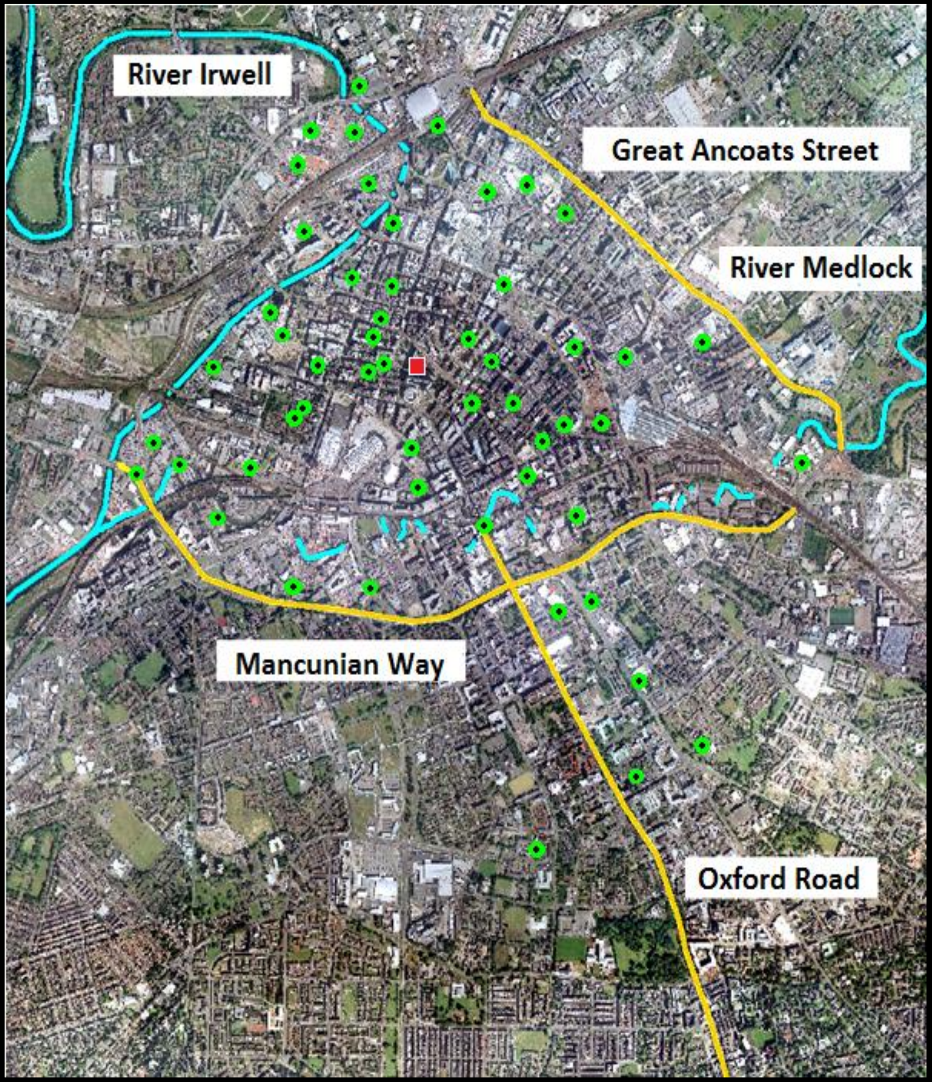
Greater Manchester Urban Diffuse Pollution Research

James Rothwell *(University of Manchester)*
Katherine Causer *(Environment Agency)*
Pete Stringer, Mike Savage & Tony Hothersall *(Red Rose Forest)*
Steve Mangan and Matt Ryan *(Urban Vision)*
Steve Chatwin-Grindey *(DeepRoot)*

1. Gully Pot Project

2. Tree Pit Project

Gully Pot Project: Sampling



- 53 gully pots across Manchester City centre
- Sites sampled over 4 days in February 2013 *[spatial snapshot]*
- Gully pots sampled across an impervious cover gradient [50-100%]
- 50m land cover buffer calculated for each gully pot

Key Results: Concentrations – Basal sediment

Sediments	Gully pot mean concentration	TEL [1]	PEL [1]	Gully pots exceeding TEL (%)	Gully pots exceeding PEL (%)
Metals (mg/kg)					
Arsenic	35.4	5.9	17	2	2
Cadmium	1.59	0.596	3.53	4	2
Chromium	103	37.3	90	89	57
Copper	231	36.7	197	98	66
Nickel	42	18	35.9	85	58
Lead	425	35	91.3	94	89
Zinc	992	123	315	96	85
PAHs (µg/kg)					
Phenanthrene	7661	41.9	515	86	76
Fluoranthene	11344	111	2355	95	46
Pyrene	9072	53	875	95	81
Benzo(a)anthracene	3643	31.7	385	68	54
Chrysene	3891	57.1	862	78	43
Benzo(a)pyrene	3861	31.9	782	73	38

TEL = Thresholds Effect Level; PEL = Probable Effects Level

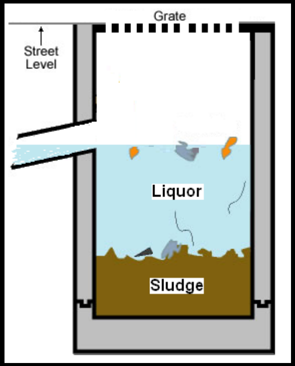
Gully pot sediments are contaminated with metals and PAHs

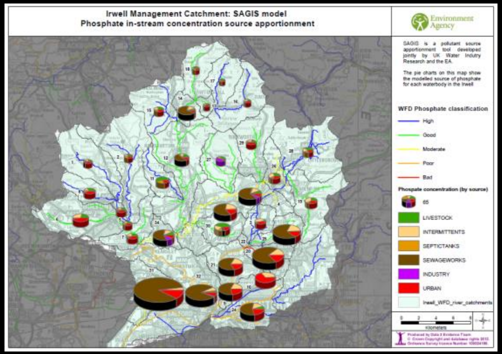
Key Results: Concentrations – Pot water

Dissolved	Gully pot mean concentration	Environmental standard	Gully pots exceeding standard (%)
Physico-chemical [1]			
Dissolved Oxygen (% saturation)	69.4	50	19
Biochemical Oxygen Demand (mg/l)	2.61	9	0
Ammonia (mg/l)	3.60	2.5	21
Phosphate (µg/l)	60.1	500	2
Metals (µg/l) [2]			
Arsenic	0.37	50	0
Cadmium	0.2	0.08	40
Cobalt	0.75	3	2
Chromium	1.68	5	2
Copper	6.27	1	91
Iron	485	1000	11
Nickel	1.64	4*	11
Lead	0.34	1.2*	9
Zinc	71.5	8	96
Anions (mg/l) [2]			
Chloride	1929	250	38
Sulphate	25.2	400	0
PAHs (µg/l) [2]			
Anthracene	0.02	0.1*	4
Fluoranthene	0.21	0.0063*	74
Naphthalene	0.07	2*	0
Benzo(a)pyrene	0.18	0.00017*	51
Benzo(b/k)fluoranthene	0.33	0.03	55
Benzo(ghi)perylene	0.13	0.002	49
Indeno(123-cd)pyrene	0.10		
Microbiology (cfu/100ml)			
E-coli [3]	358	900	6
Faecal strep. [4]	321	100	57

Gully pot water is contaminated with Cu and Zn, and some PAHs

Key Results: Loadings



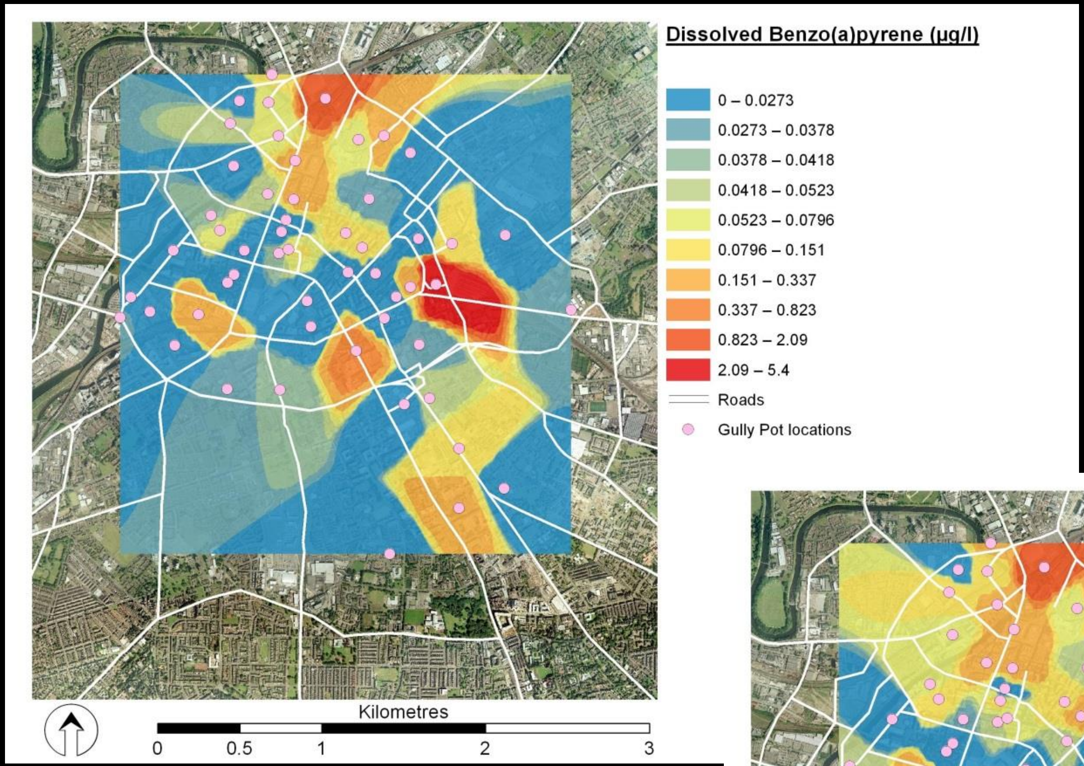


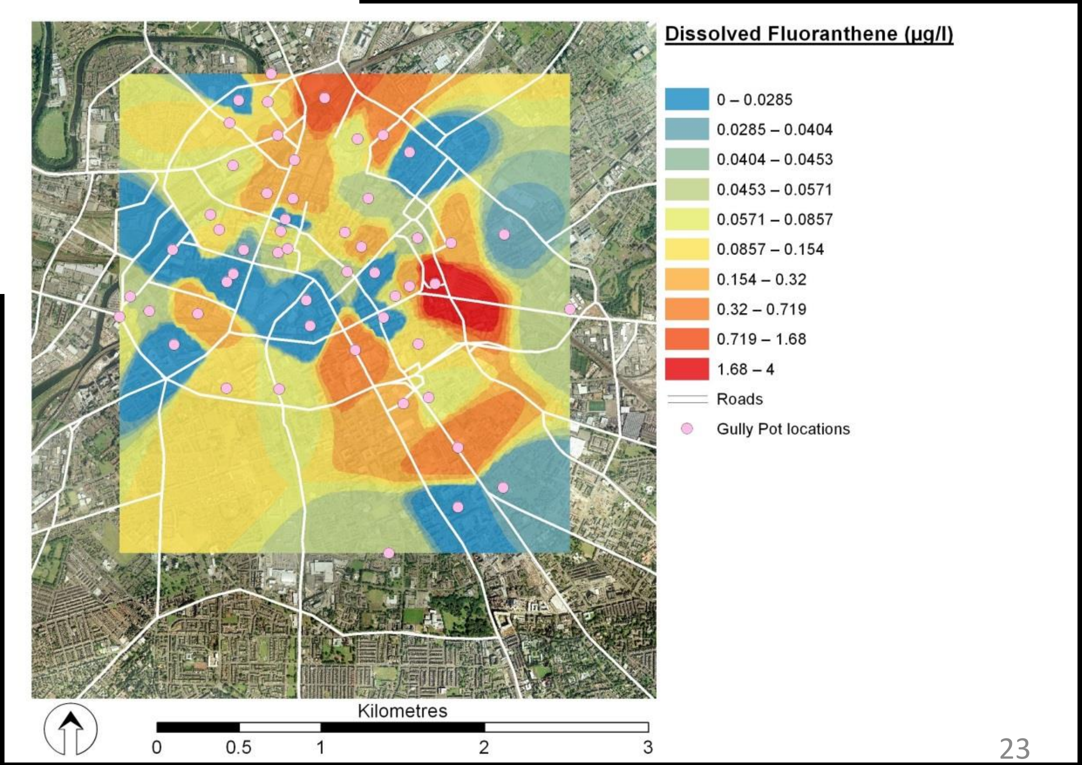
	Gully pot loading as % of SAGIS urban runoff load	
	Irwell	Medlock
Metals		
Copper	2	10
Cadmium	1	3
Lead	5	22
Nickel	1	3
Zinc	2	8
PAHs		
Anthracene	23	110
Benzo(a)pyrene	13	63
Benzo(b/k)fluoranthene	19	91
Benzo(ghi)perylene	7	34
Fluoranthene	23	110
Indeno(123-cd)pyrene	7	33
Naphthalene	2	8
Nutrients		
Phosphate	0.0001	0.0004
Nitrate	0.00001	0.00004

SAGIS: Source Apportionment Geographical Information System

Gully pots are a major contributor of urban runoff

Key Results: Patterns & Controls





PAH hotspots in close proximity to train stations

Is there a link between pollutant levels and existing green infrastructure in the city?

Low impervious cover – Green space

High impervious cover – Tarmac/concrete

	Vegetation cover	
Physico-chemical		
Dissolved Oxygen		
Biochemical Oxygen Demand		
Ammonia		
Phosphate		
Metals		
Arsenic	D	S
Cadmium	D	S
Cobalt	D	S
Chromium	D	S
Copper	D	S
Iron	D	S
Nickel	D	S
Lead	D	S
Zinc	D	S
Antimony	D	S
Anions		
Calcium		
Magnesium		
Chloride		
Sulphate		
PAHs		
Anthracene	D	S
Fluoranthene	D	S
Naphthalene	D	S
Benzo(a)pyrene	D	S
Benzo(b/k)fluoranthene	D	S
Benzo(ghi)perylene	D	S
Indeno(123-cd)pyrene	D	S
PAH - total	D	S
Total Hydrocarbons	D	S
Microbiology		
E-coli		
Faecal strep.		

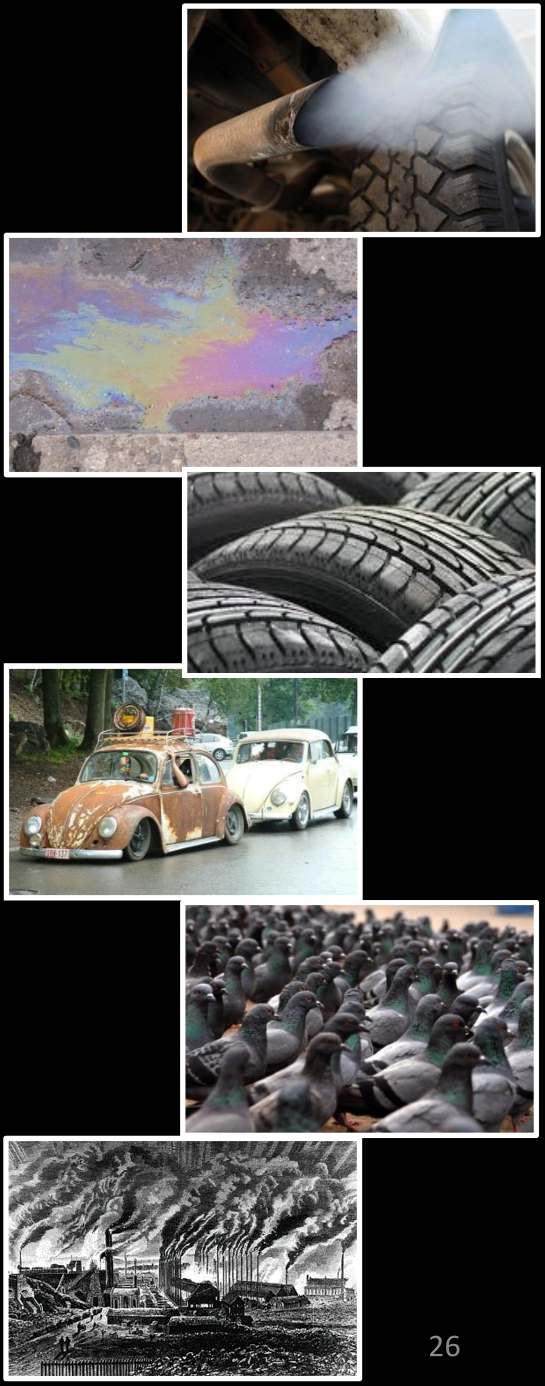
Yes,

but not for

all pollutants

Gully Pot Project - Summary

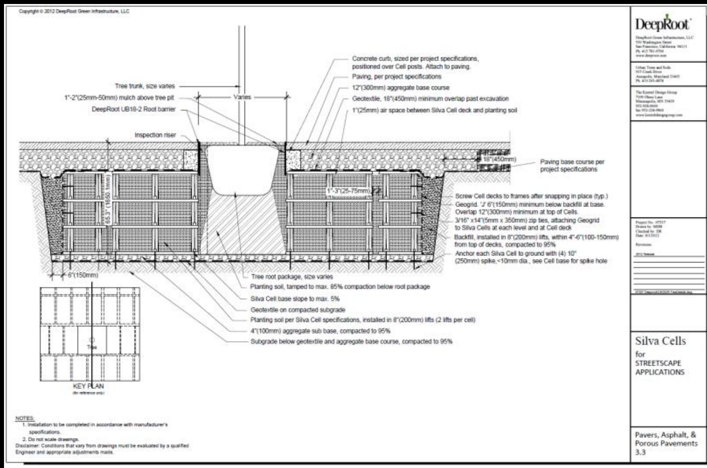
- Excellent baseline for Manchester
- High pollutant variability
- Zn and Cu as a key pollutants
- PAHs are of major concern……..current risk may be under-estimated?
- Multiple controls on gully pot pollutants
- Link to GI

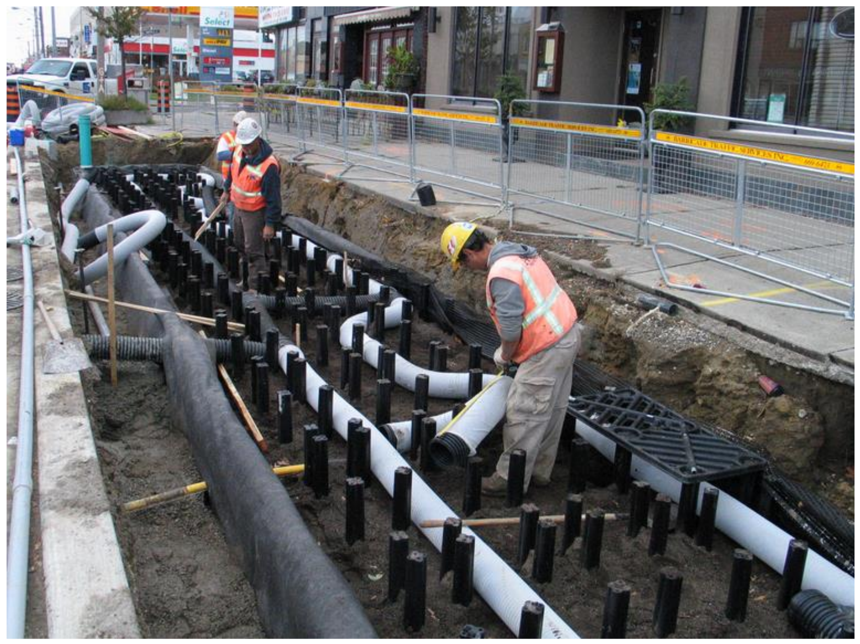


What next?

Urban Pollution Cascade

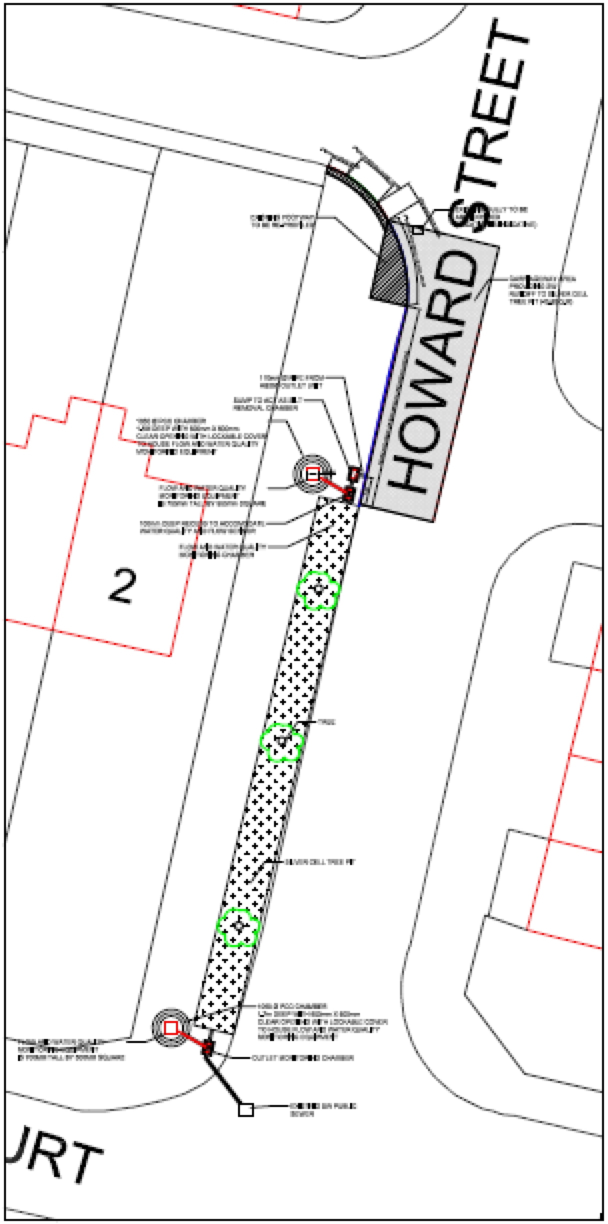
Tree Pit Project



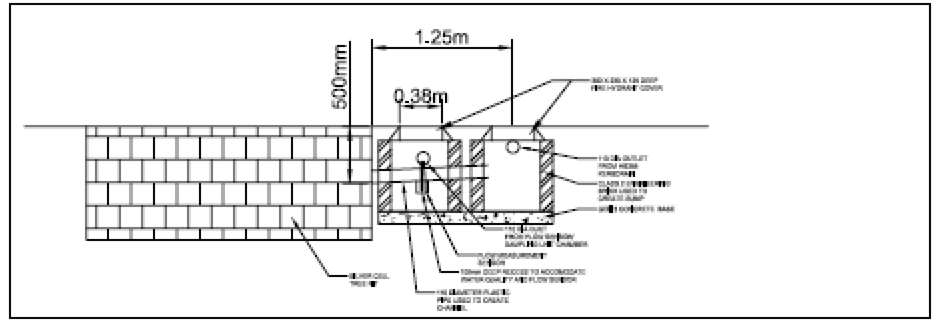


Direct road runoff into a tree pit

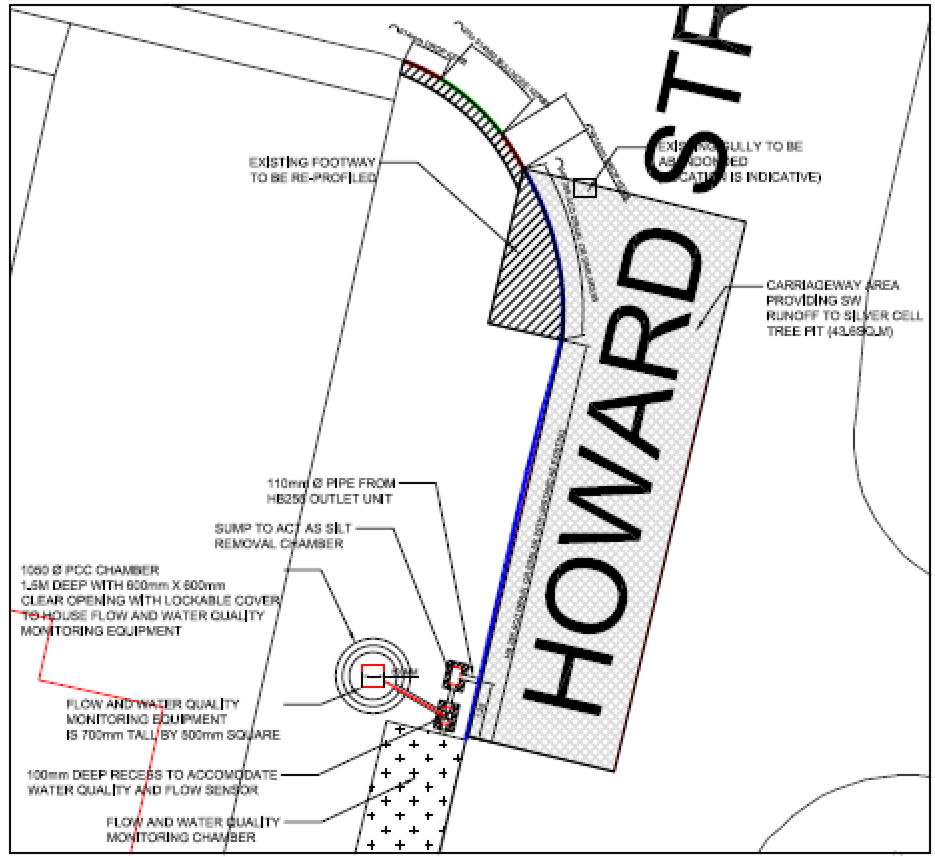
Monitor water quality <u>and</u> quantity on the inflow <u>and</u> outflow



GENERAL ARRANGEMENT (SCALE 1:100)



SECTION THROUGH SUMP AND MONITORING CHAMBER (SCALE 1:20)



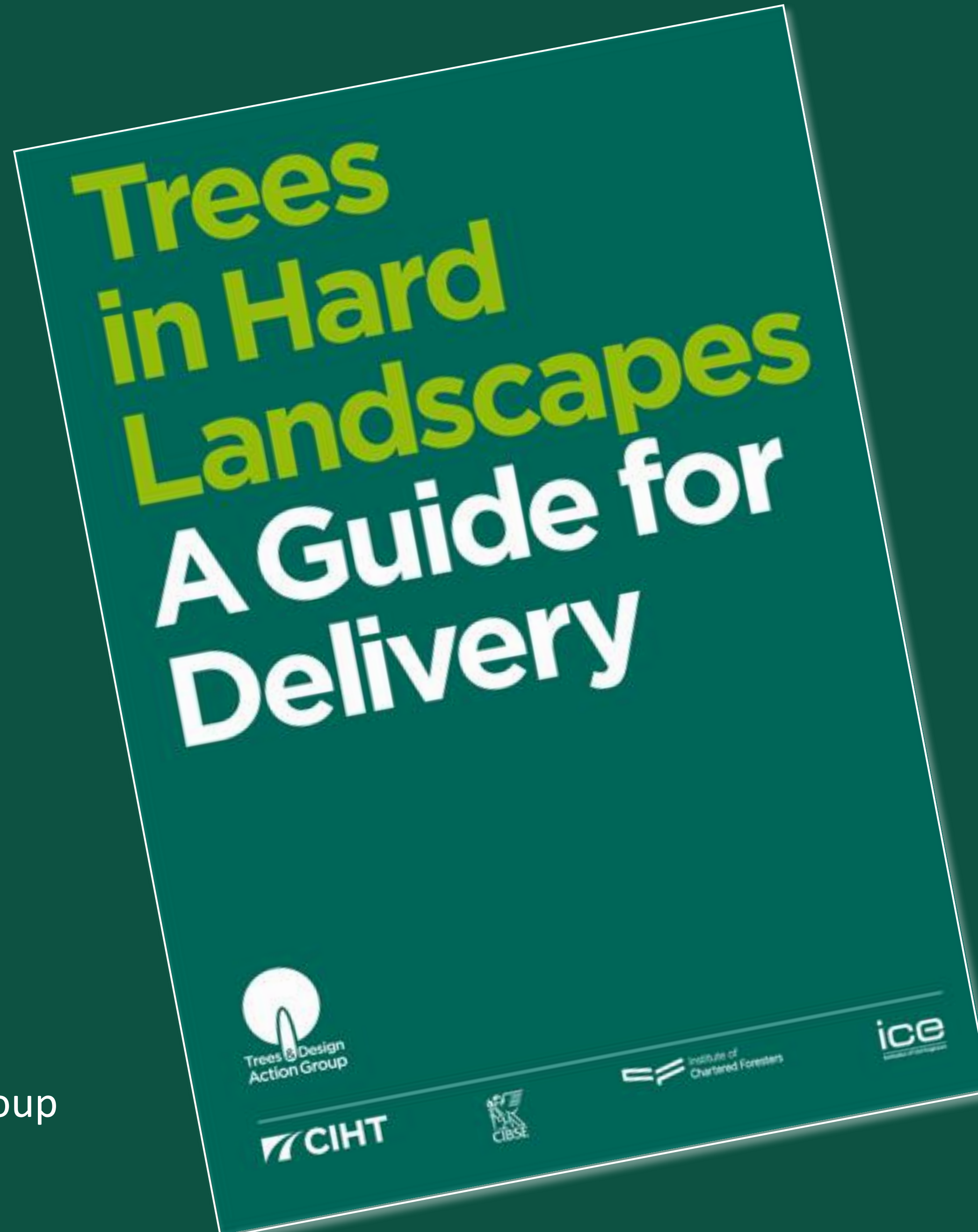
PLAN OF KERBLINE ALTERATIONS (SCALE 1:50)

Tree Pit Project …. *Outcomes ???*

1. Reduce pollutant loading to surface waters
2. Store and attenuate water….reduce flooding
3. Reduce water and pollutant delivery to STWs….£££ benefit
4. Other ecosystem services
5. Demonstration project for wider roll-out across GM and beyond

Sample of case studies illustrating the use of trees as part of SuDS & WSUD strategies

Drawing from:



Trees & Design Action Group

Presented by Anne Jaluzot
Urban Catchment Forestry Steering Group

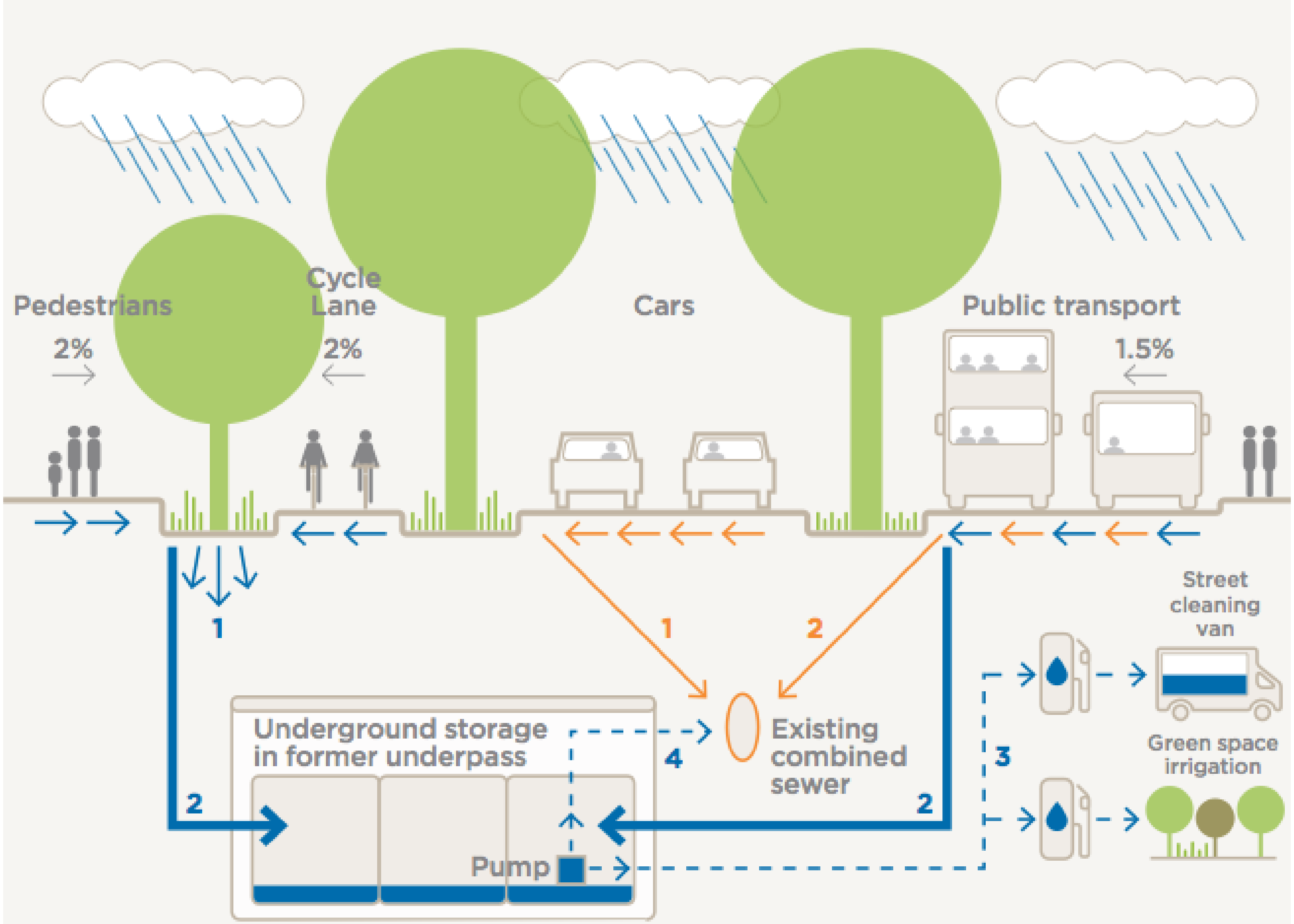
Lyon, France

Garibaldi Street, Lyon, France


After
ibis

Water management strategy for Garibaldi Street refurbishment

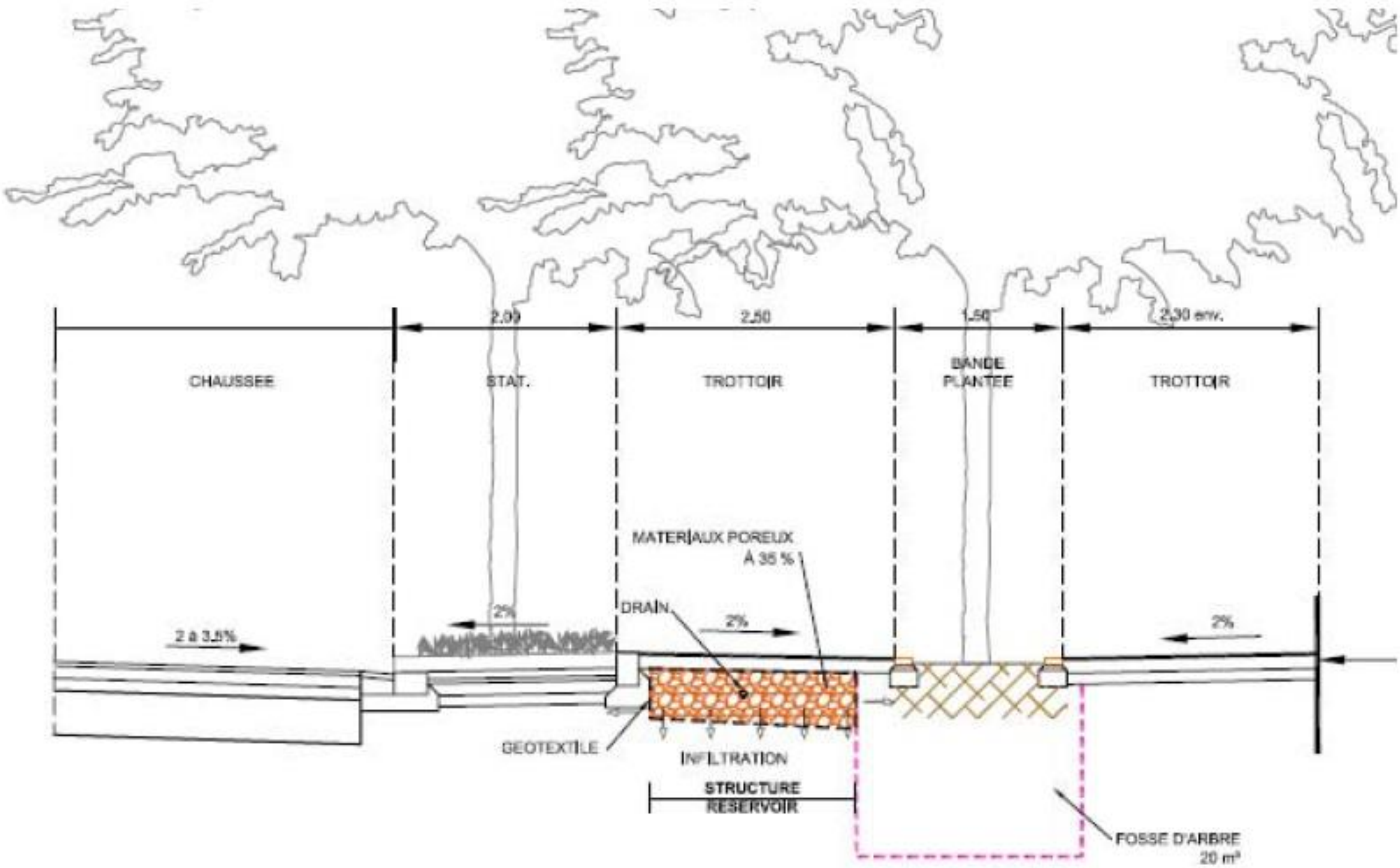
— Polluted surface water runoff
— Non-polluted surface water runoff



1. Surface water runoff infiltration
2. Overflow and/or storage of surface water runoff
3. Surface water runoff re-use
4. Controlled rate outflow into combined sewer (during heavy storms)

1. Remains directed to existing combined sewer
2. Only directed to combined sewer when winter treatment is applied to the bus lanes


416FXE92


2,00
2,50
1,50
2,30 env.
CHAUSSEE
STAT.
TROTTOIR
BANDE PLANTEE
TROTTOIR
MATERIAUX POREUX À 35 %
DRAIN
2 à 3,5%
2%
2%
2%
GEOTEXTILE
INFILTRATION
STRUCTURE RESERVOIR
FOSSE D'ARBRE 20 m³


BUS


30

Stockholm, Sweden

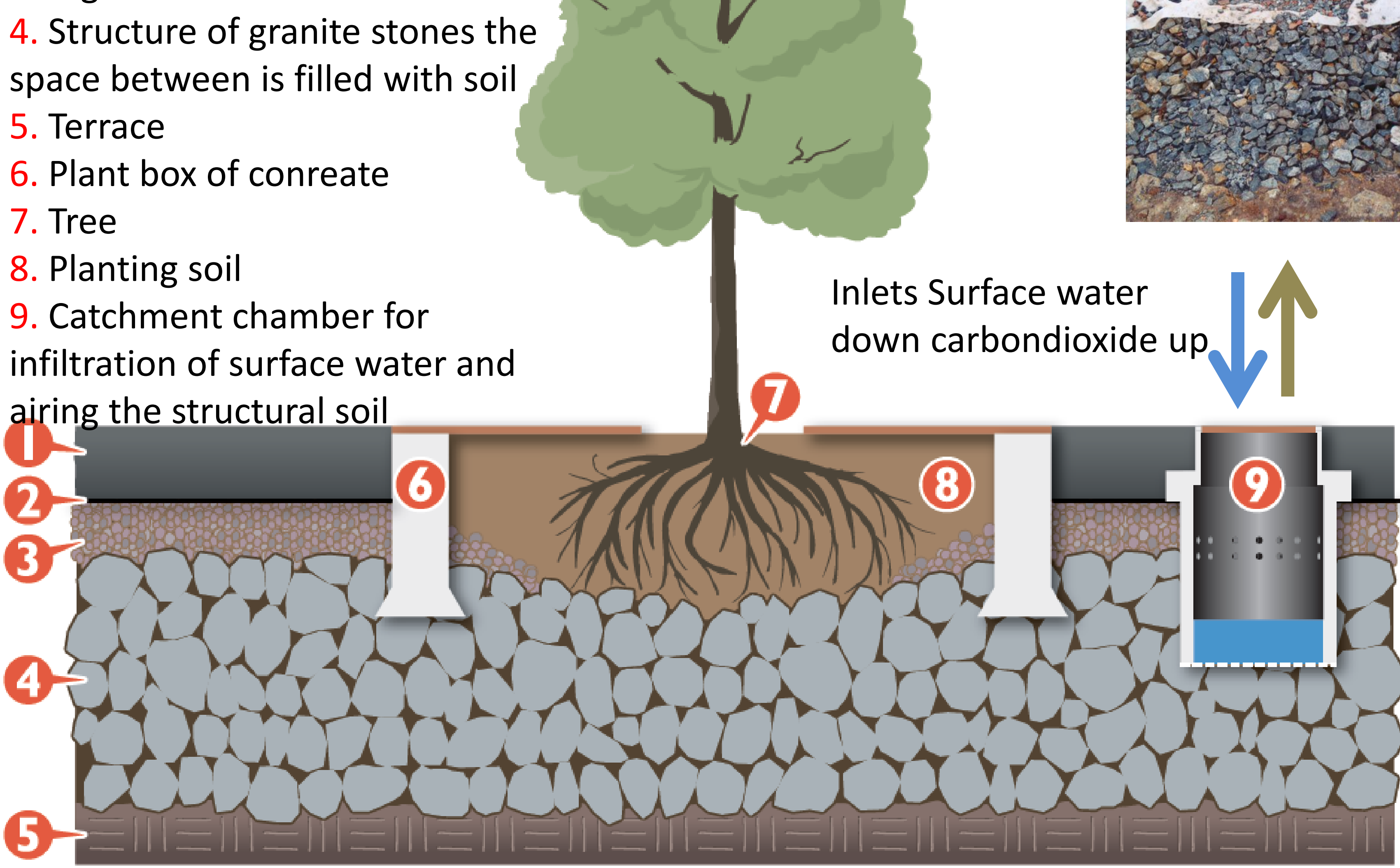
Erik Dahlbergsallèn, Stockholm, Sweden

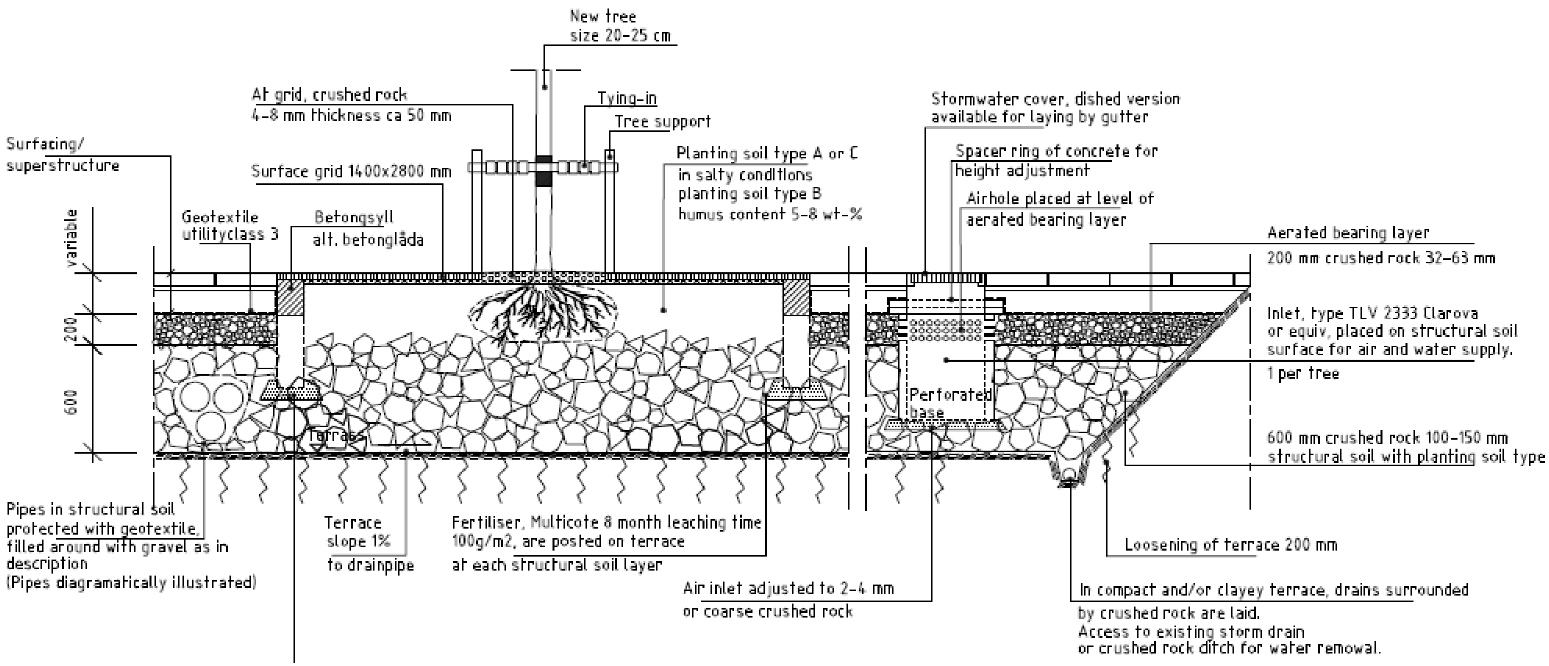
Case study 20, p124

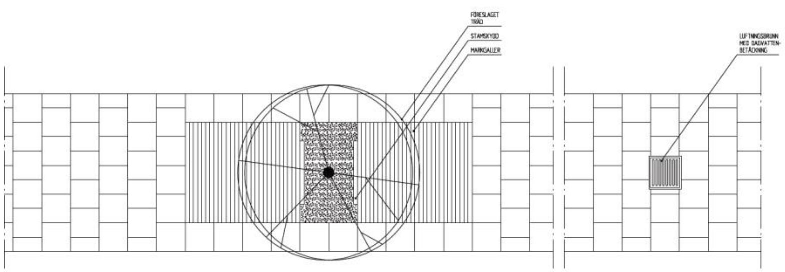
How to create good growing conditions and taking care of the surface water

1. Pavement
2. Geotextile
3. Layer of crushed rock for infiltration of surface water and airing of the soil
4. Structure of granite stones the space between is filled with soil
5. Terrace
6. Plant box of conreate
7. Tree
8. Planting soil
9. Catchment chamber for infiltration of surface water and airing the structural soil

Inlets Surface water down carbondioxide up







TRÄDGROP I HÅRDGJORD YTA MED MARKGALLER,
STAMSKYDD SAMT LUFTNINGSBRUNN
PLAN
SKALA 1:20

TYRENS LANDSKAPSARKITEKTER
STOCKHOLM 2005-06-02

NOTES
Soil equipment such as gratings, trunk guards, tree support are specifically adapted to the project.
Fine crushed rock must not be used in structural soil profile for adjusting air inlet or concrete bunker.
In specially constructed tree holes with narrow dimensions tree root diameter must be observed.
With increasing trunk circumference clump diameter increases, see Quality regulations for nursery plants, GROs Plantskolesektion, 3:e upplagan, augusti 2003.

NOTESANMÄRKNING
All data in mm unless otherwise specified.

Status: TH-TYPRITNING
Datum: 2009-02-23
Godkänd: B.EMBRÉN

TRAFIKKONTORET
Box 8311, 104 20 Stockholm, Tel 08-508 27 200

TREE IN PAVED AREA
WITH SURFACE GRID

SECTION

Skala	Ritningsnr	Foto	Reg.
1:20(A2)/1:40(A4)	THVB004		

- We take water from roofs and pavements and lead it down to the structural soil by inlets

- Roof and pavement surface 4600sqm
  Rainfall 600mm year (2 feet)
  Approximately 2.3 million liters of water year
  Saved cost for the treatment of stormwater = 2300 £ /year
  Reduced load on the Baltic Sea / and lakes at torrential rains

If the percolation layer is full, the storm water flows into the old street inlet.

- We take water from roofs and pavements through inlets to the aerated bearing layer and the structural soil.

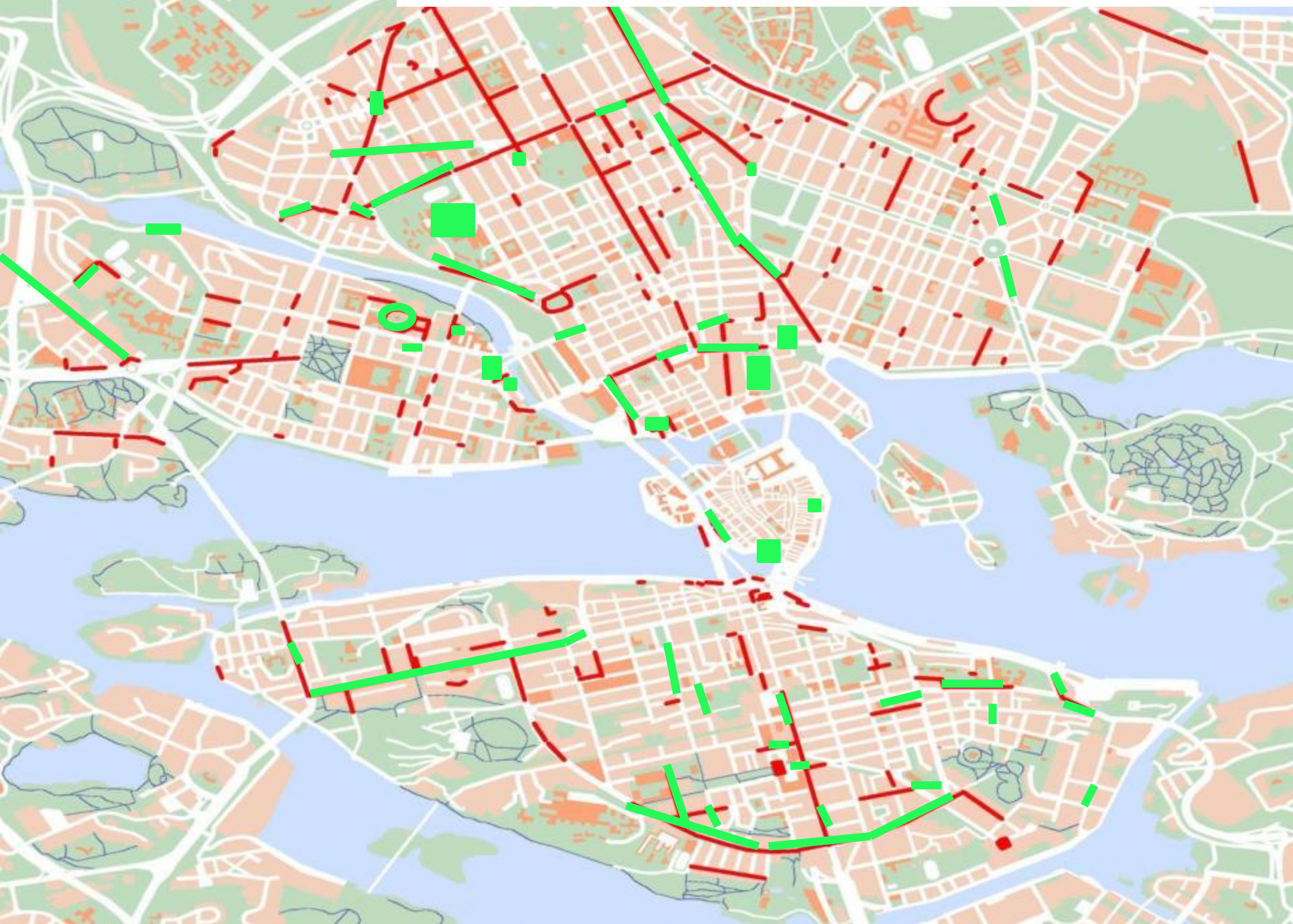
On the left = 80-year old tree, on the right = 6-year old tree

Planted in 2004, size =	35-40 cm	
2008	60-65 cm	
2012	70-83 cm	


4 years after planting
3.5 meters from tree
Erik Dahlbergsallén

and as a proof that we are on the right path, we find mykorrhitza in our structural soils which only thrives in good conditions

Approximately 2 000 planting beds have been rebuilt



Third North Apartments, Minneapolis, USA
Case study 4, p33

Charcoal is incredibly stable if we dig down into the ground, it stays there for thousands of years as a Co2 sinker

Biochar is a name for charcoal when it is used for particular purposes, especially as a soil amendment. Like all charcoal, biochar is created by pyrolysis of biomass. Biochar is under investigation as an approach to carbon sequestration to produce negative carbon dioxide emissions.[1] Biochar thus has the potential to help mitigate climate change, via carbon sequestration.[2] Independently, biochar can increase soil fertility, raise agricultural productivity and reduce pressure on forests, though the degree to which results offer long term carbon sequestration in practice has been challenged.[3] Biochar is a stable solid, rich in carbon and can endure in soil for thousands of years.[1]

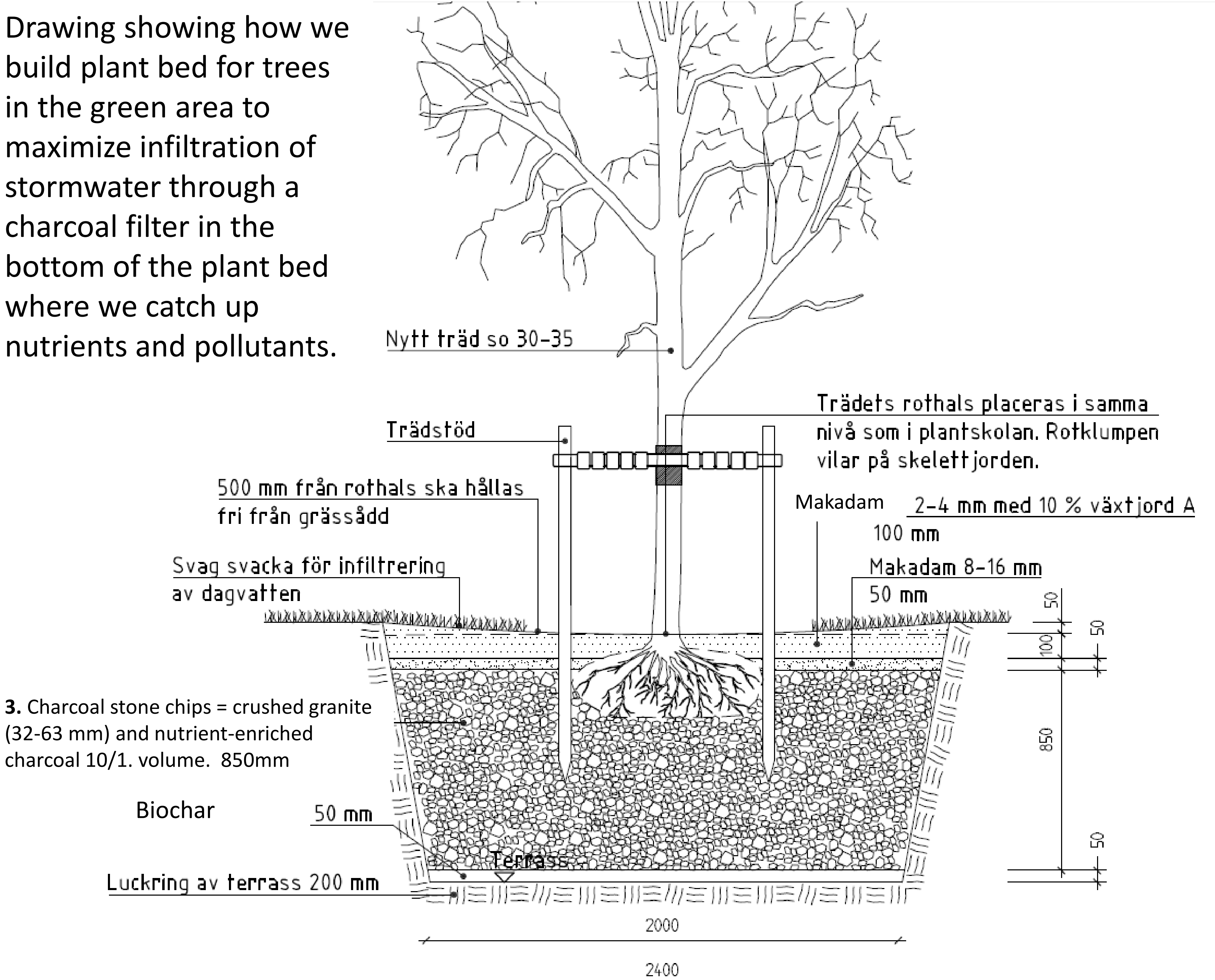
Wikipedia

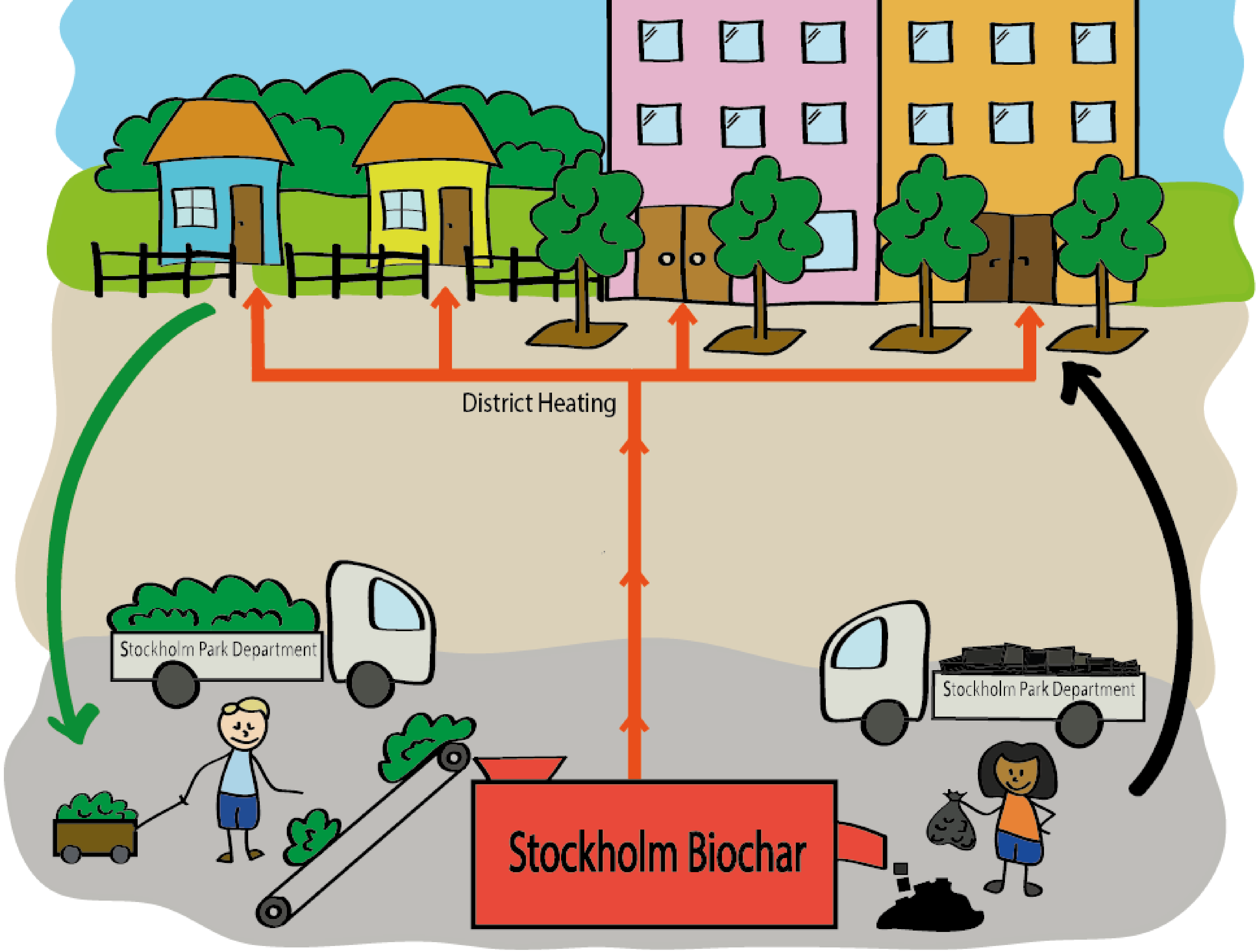
- The first time we use charcoal filters in structural soil was 2013 at Swedenborgsgatan.

One block with coals under airy base course and in one block belowe the structural soil.

Plant bed for street trees charcoal macadam = crushed granite 32-63 mm mixed with 10% nutrient-enriched charcoal

Drawing showing how we build plant bed for trees in the green area to maximize infiltration of stormwater through a charcoal filter in the bottom of the plant bed where we catch up nutrients and pollutants.




District Heating
Stockholm Park Department
Stockholm Park Department
Stockholm Biochar

Chicago, US

Forest Research

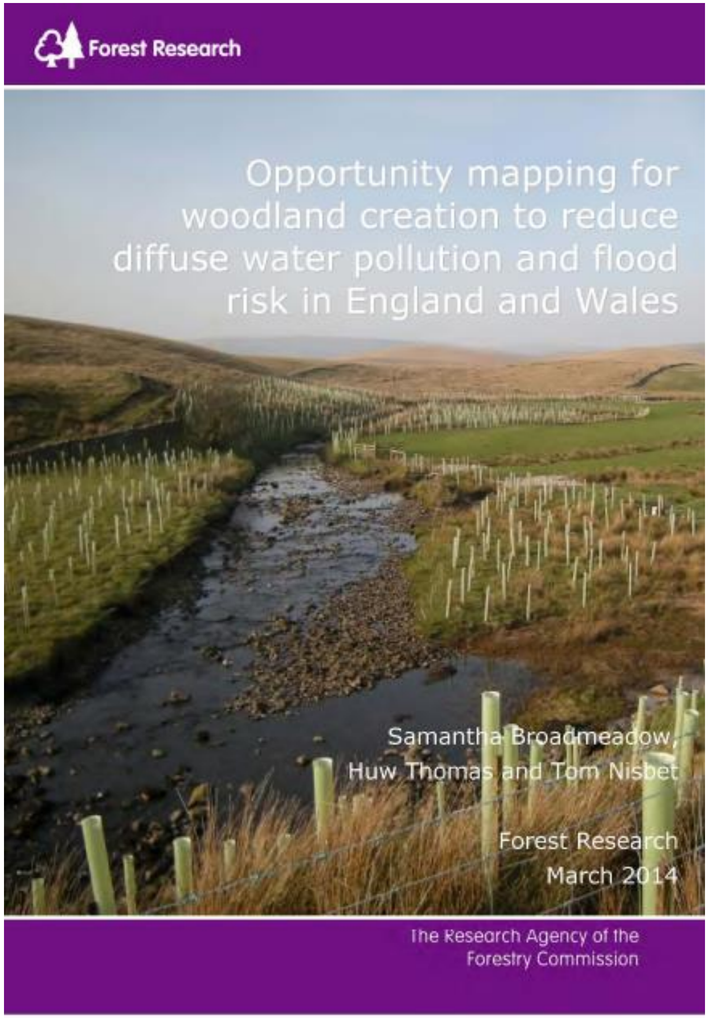
Opportunity Mapping for Targeting Land Management Measures

Tom Nisbet & Samantha Broadmeadow,

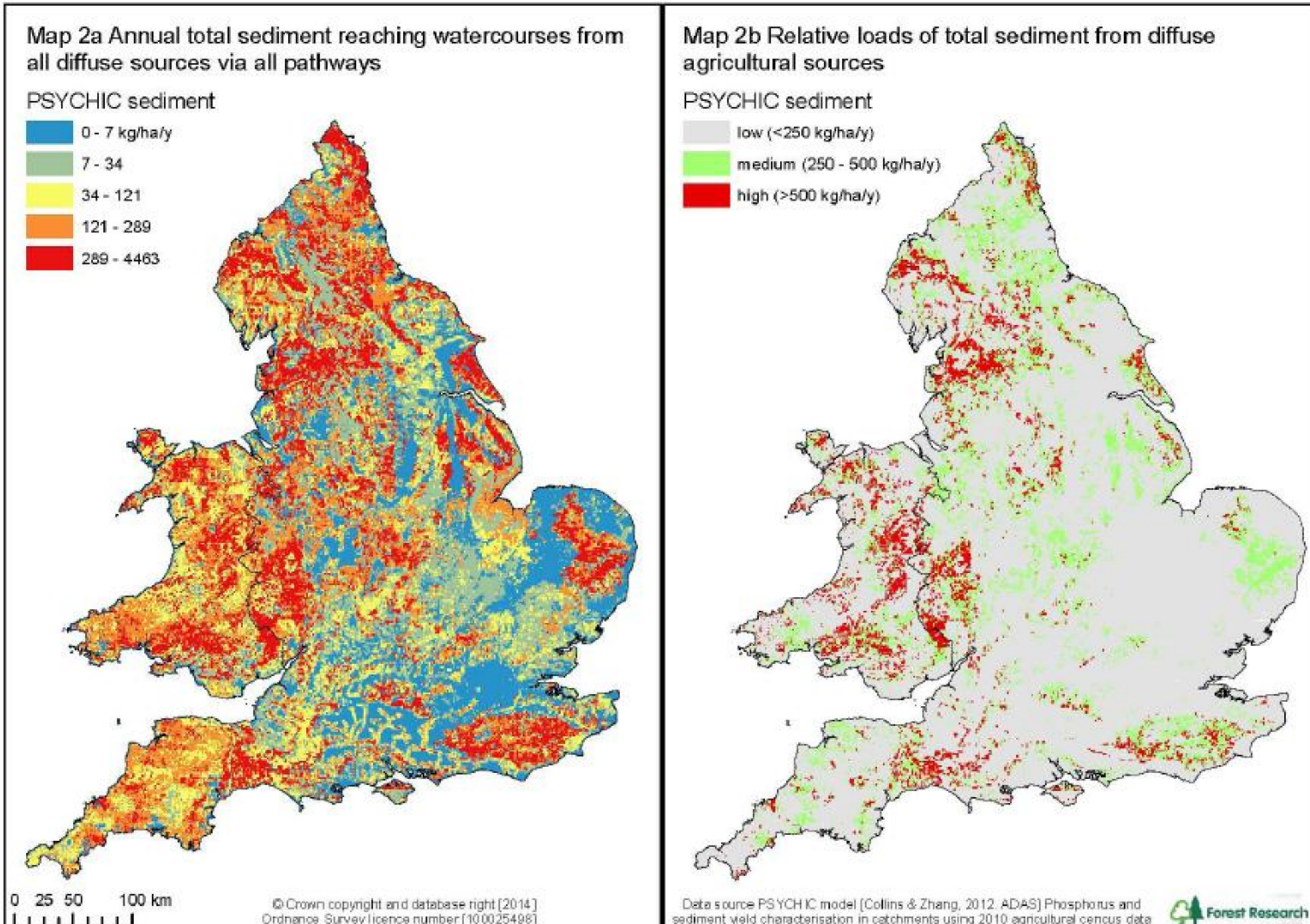
Centre for Ecosystems, Society and Biosecurity

Approach

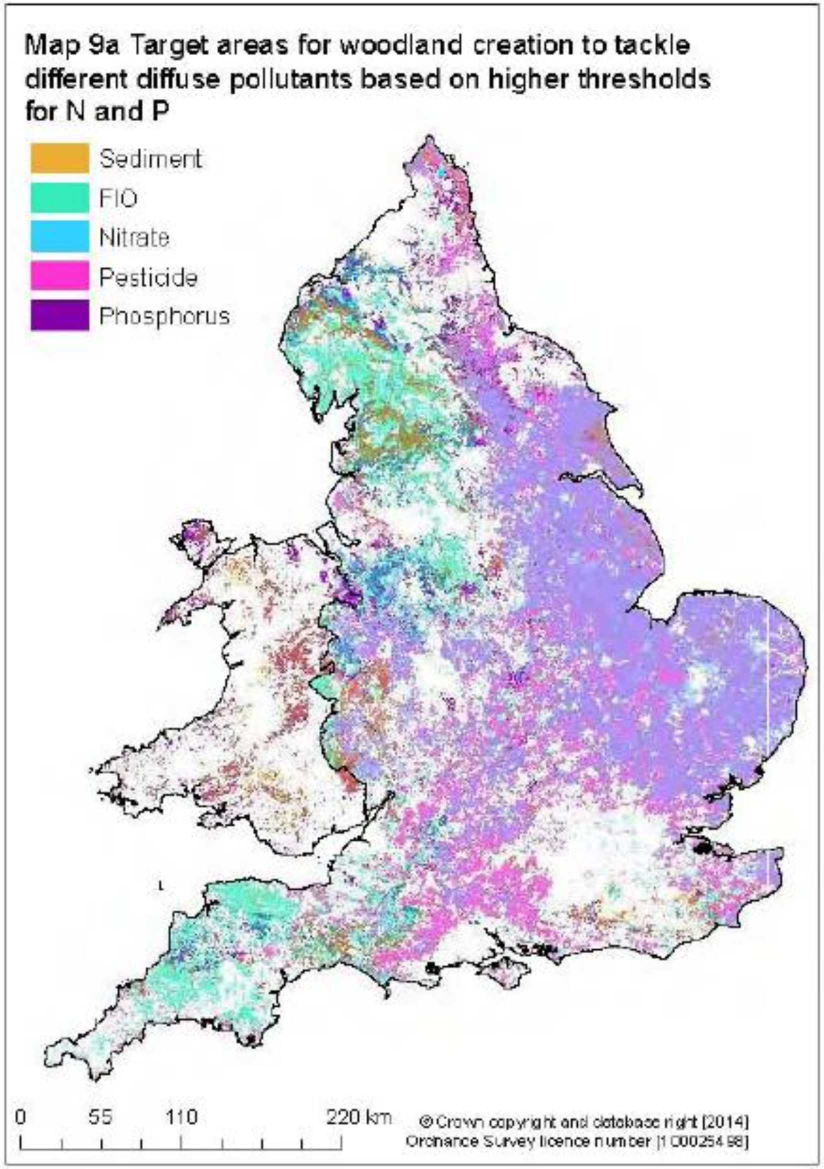
- Uses existing spatial data sets;
- Identifies constraints and sensitivities to woodland creation;
- Assesses scope for woodland creation to reduce flood risk;
- Identifies opportunities to reduce agricultural diffuse pollution;
- Assesses potential water trade-offs;
- Identifies priority areas for woodland creation for water.

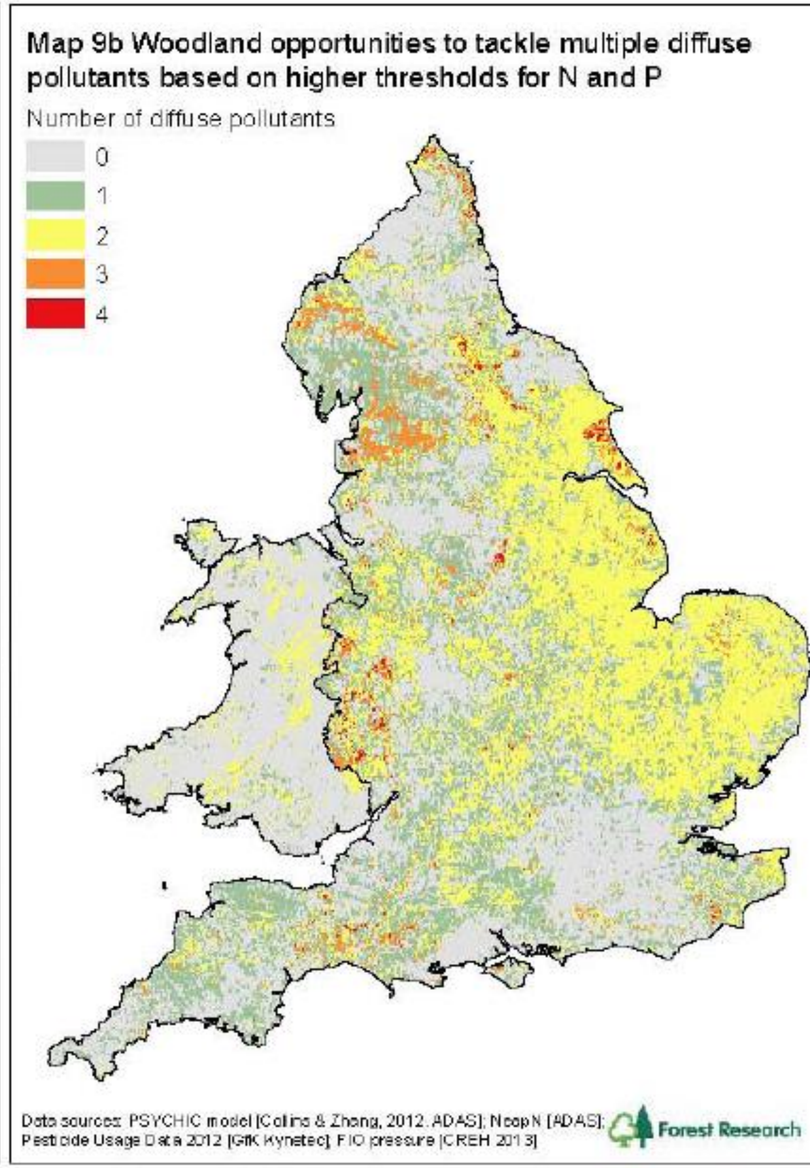


Diffuse Sediment Pollution

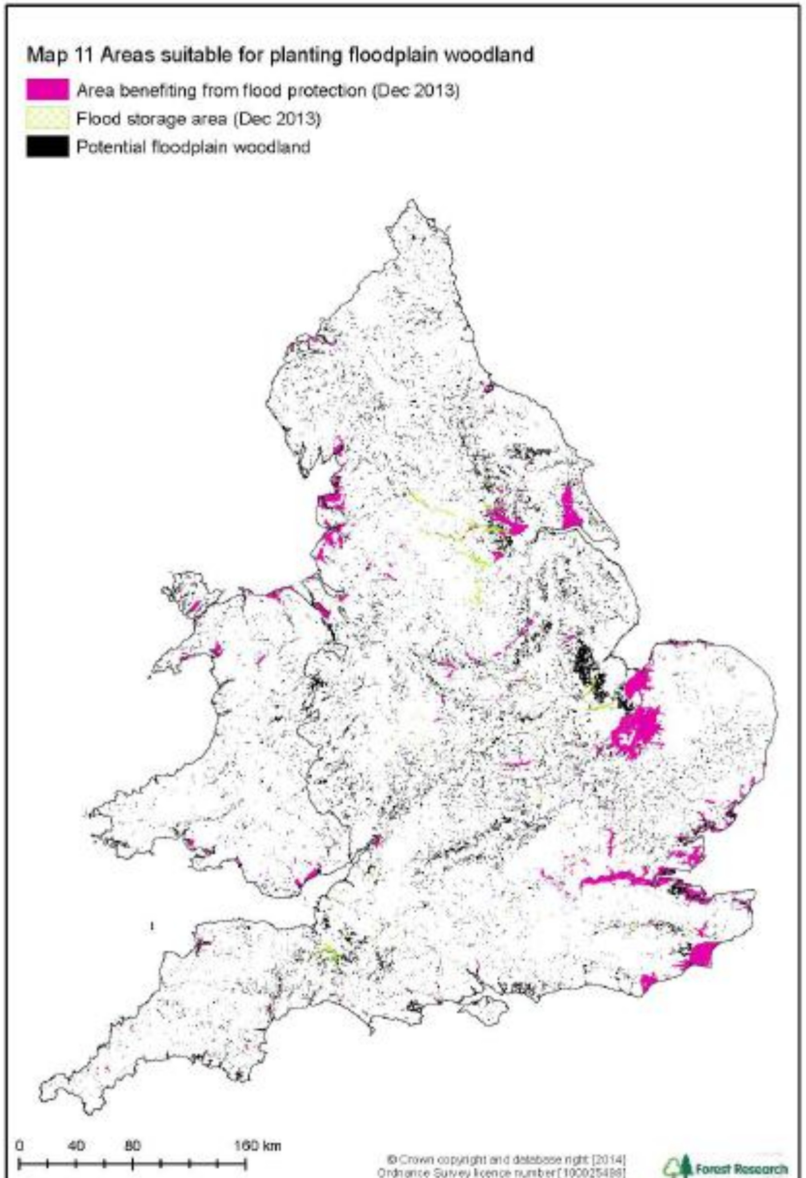


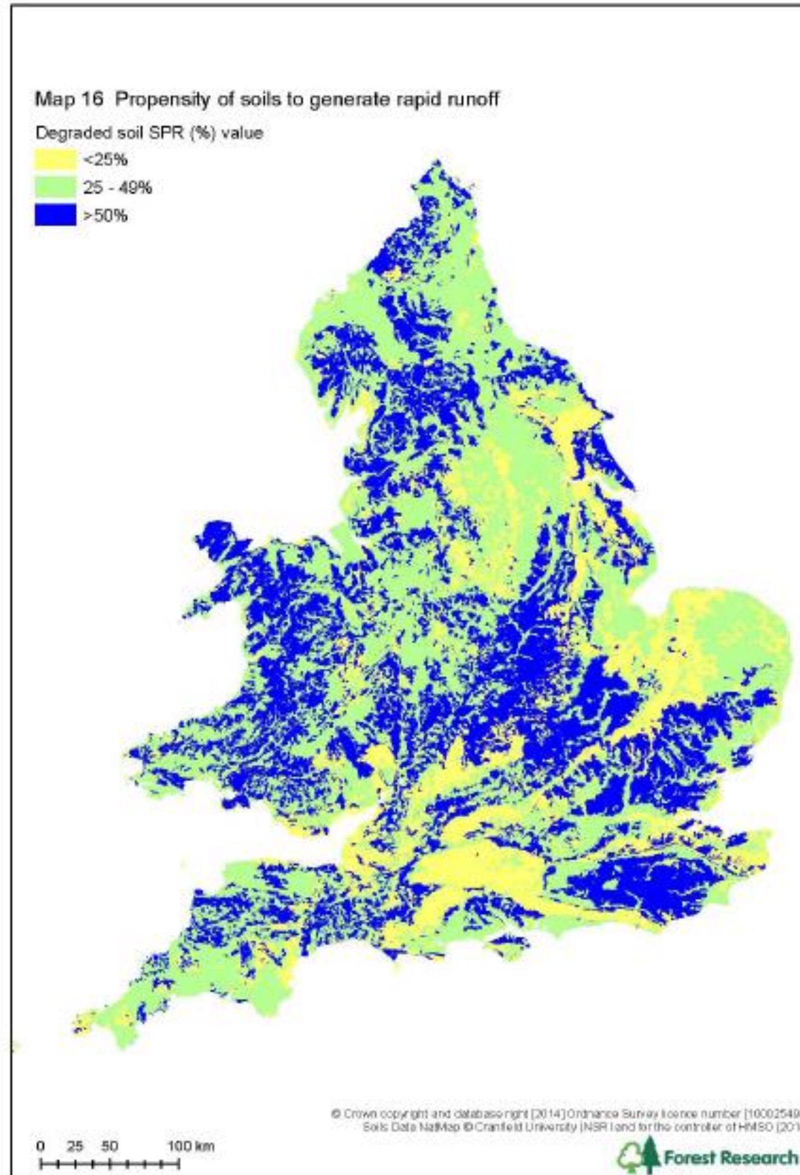
Tackling Five Diffuse Pollutants





Flood Risk Management





Potential Win-Wins