Stormwater as a Resource in the Urban Water Cycle: A Case Study in the SWITCH Demonstration City of Birmingham, UK.

J Bryan Ellis, Lian Lundy and D Michael Revitt
Urban Pollution Research Centre
Middlesex University, The Burroughs, Hendon.
NW4 4B. London, UK.

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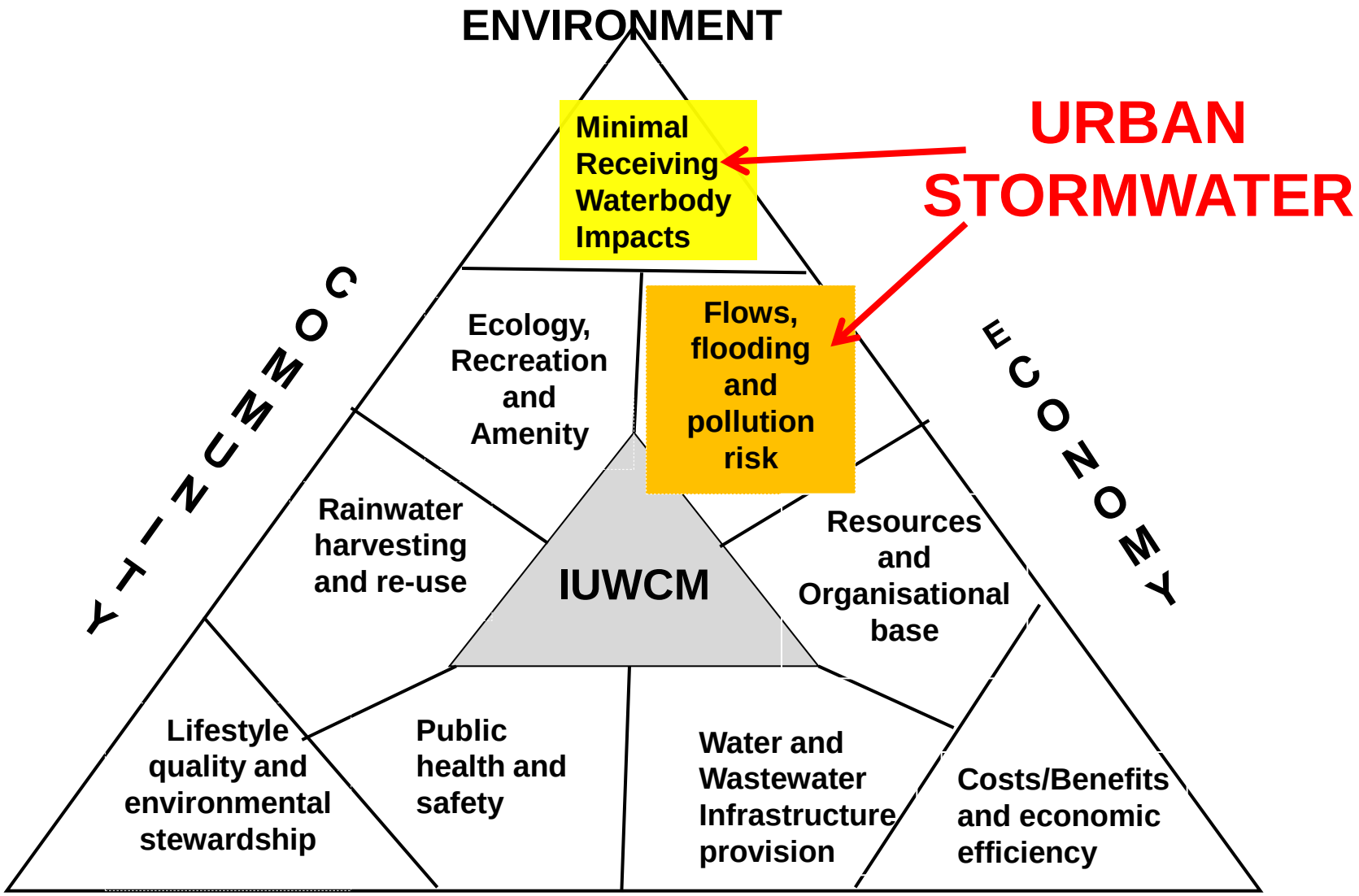
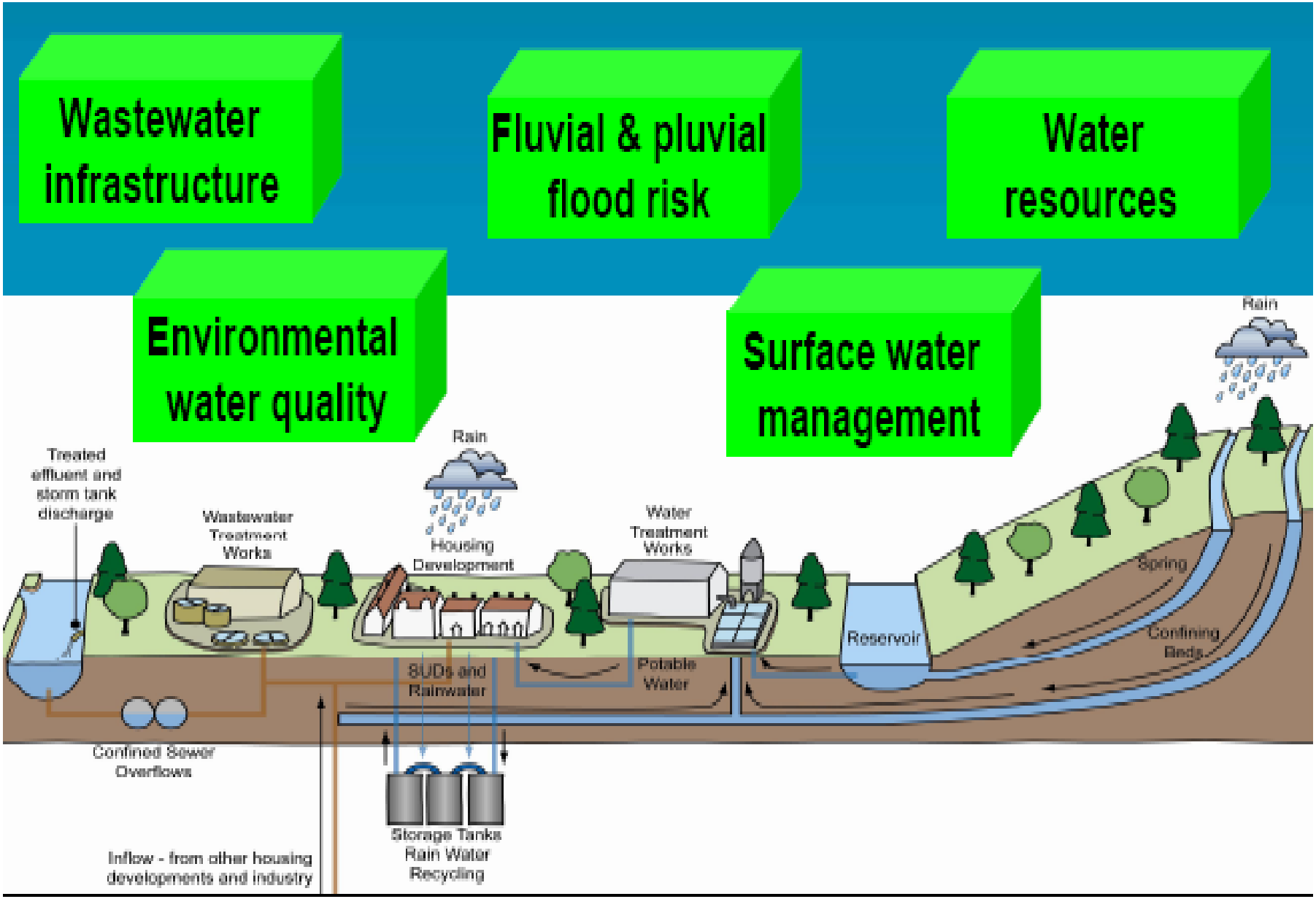


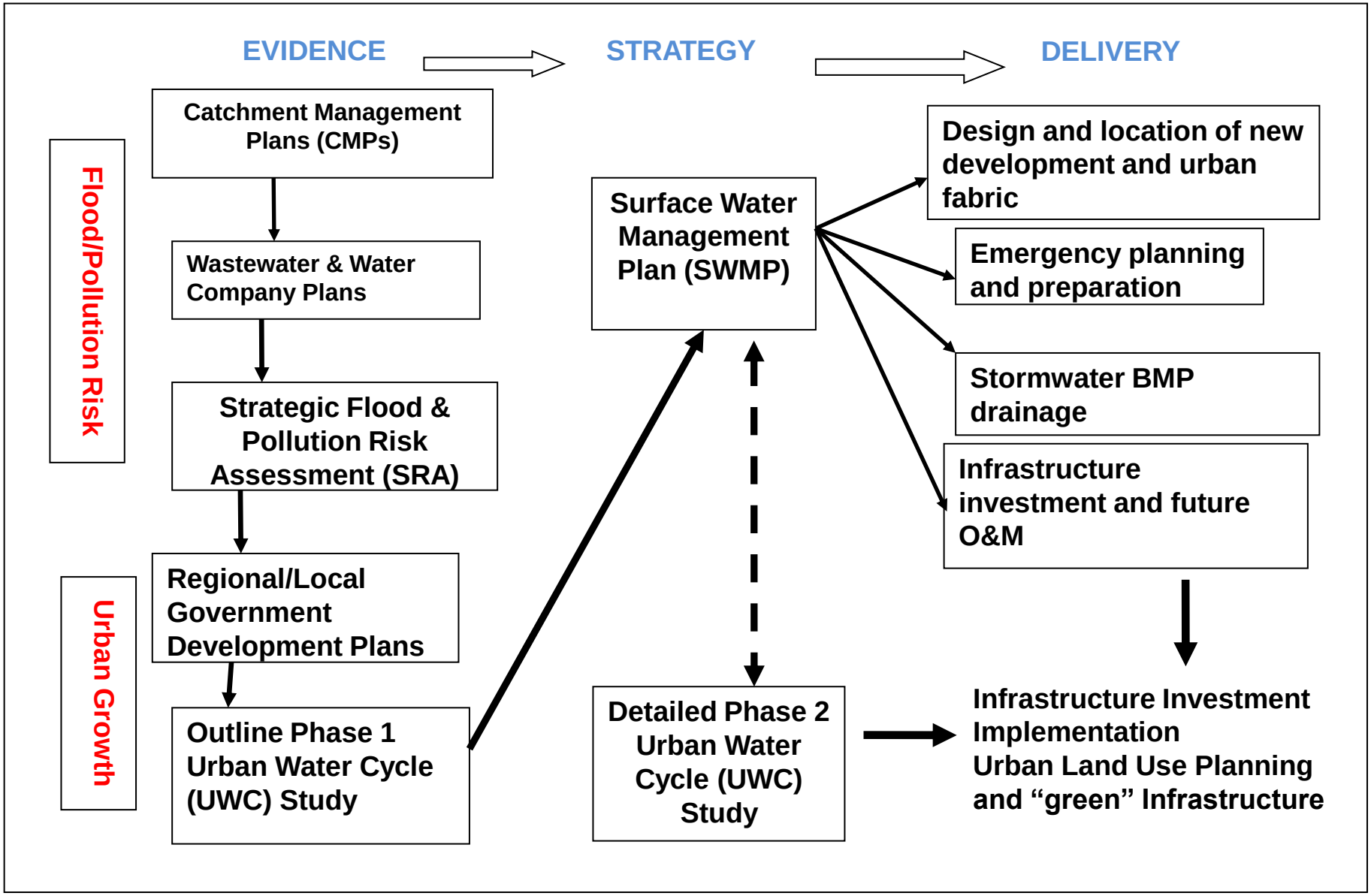
Integrated Urban Water Cycle Management (IUWCM)



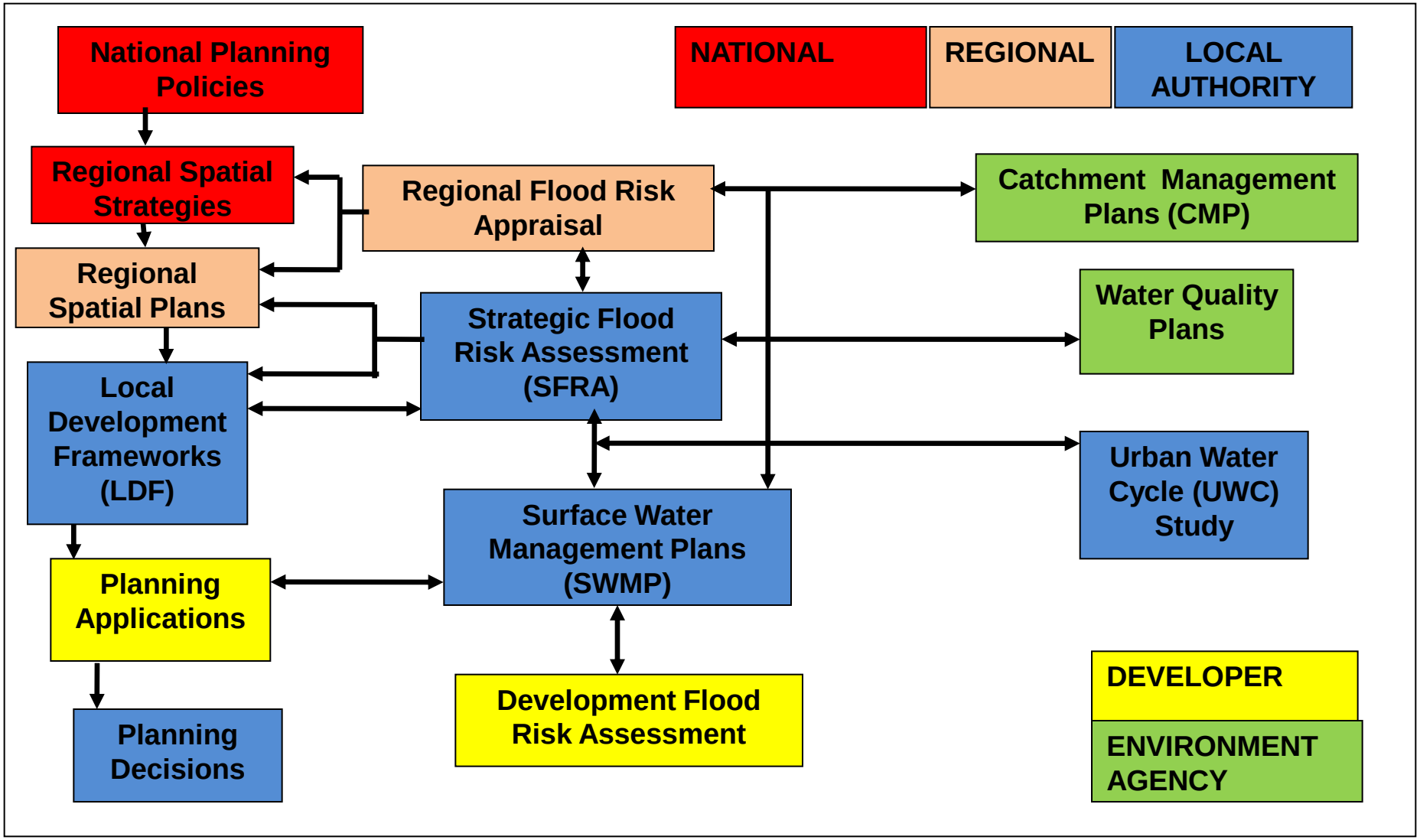
Stormwater Management and the Urban Water Cycle

An urban water cycle (UWC) study can be regarded as being:

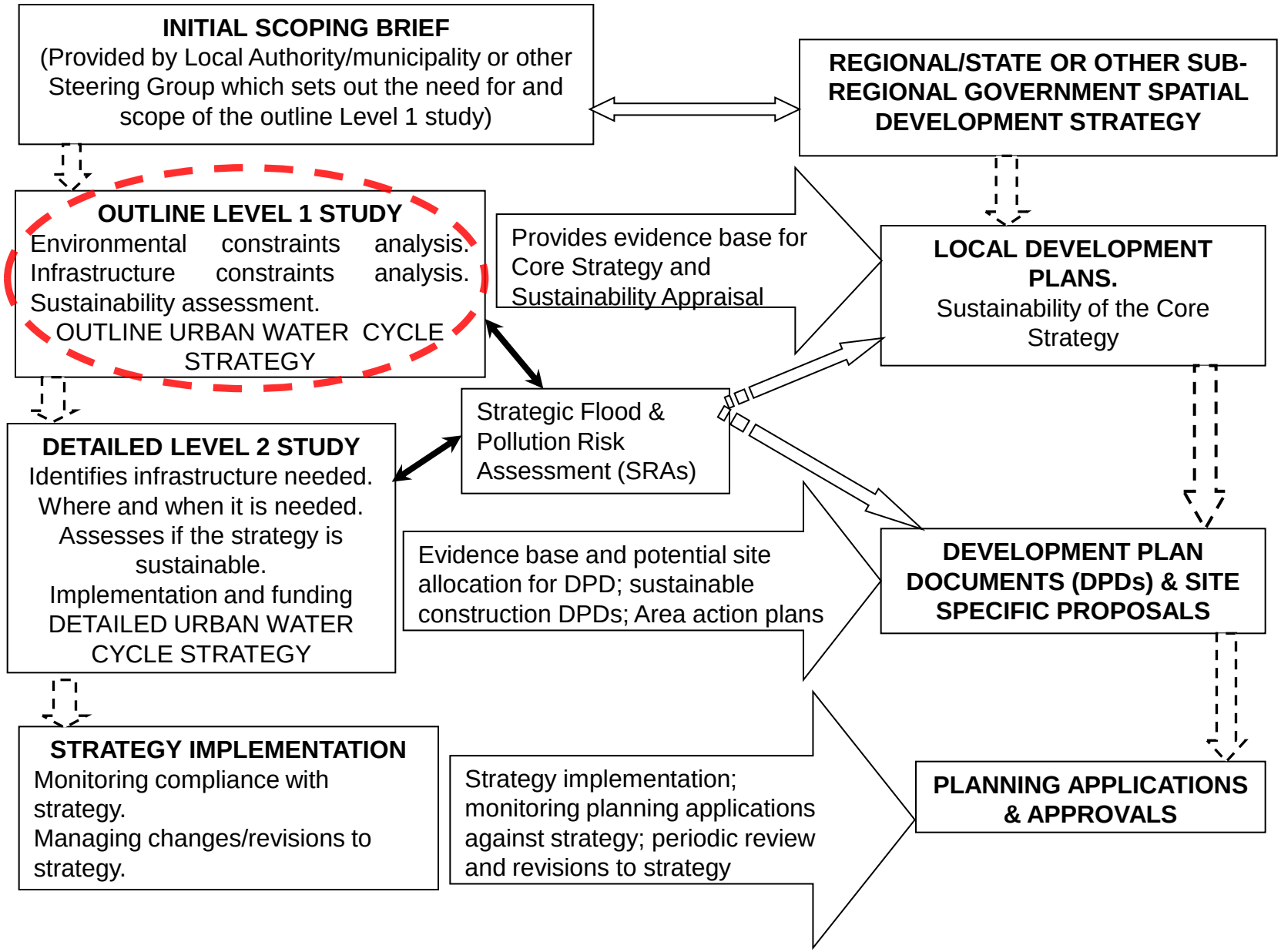
- **a methodological approach for determining what water resource infrastructure is required, as well as where and when it will be needed,**
- **a risk-based approach ensuring that the planning process makes best use of environmental capacity and is adapted to environmental, technical, costing and other major local/regional constraints**
- **a structural framework for stakeholder engagement and collaboration,**
- **a process procedure whereby diverse and disparate knowledge and information is brought together to make better and more integrated risk-based decisions on the urban water environment,**
- **a basis for developing stormwater management plans (SWMPs) and preliminary strategic flood and pollution risk assessments (SRAs) as well as ensuring compliance with other regulatory requirements such as required under the EU Water Framework Directive (WFD) and with local/regional development planning policies and regulations.**



SWMPs and Urban Water Cycle Studies



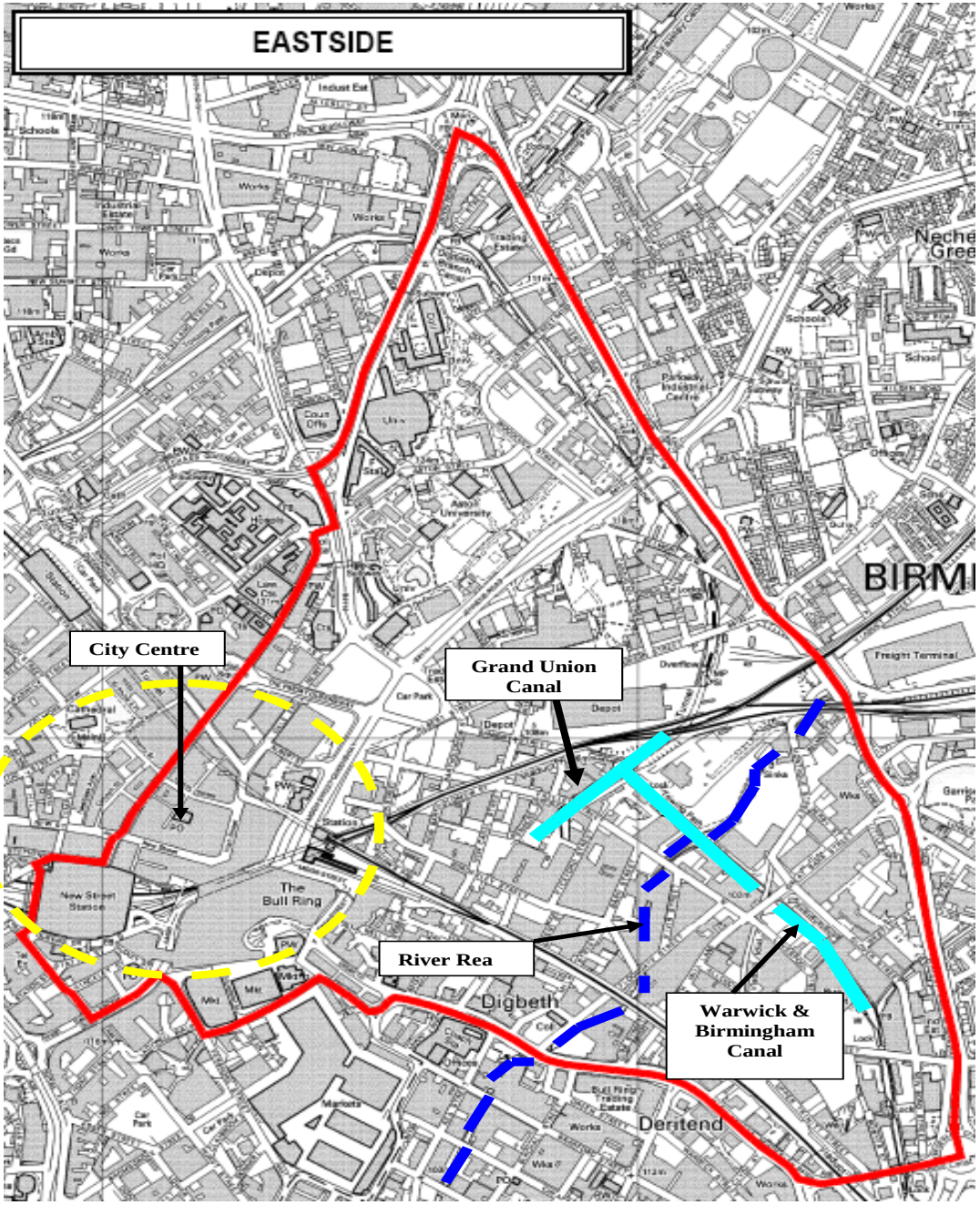
Planning and Flood Risk Strategy Statutory Documents at National, Regional and Local Levels.



Stages in an Urban Water Cycle (UWC) Study.

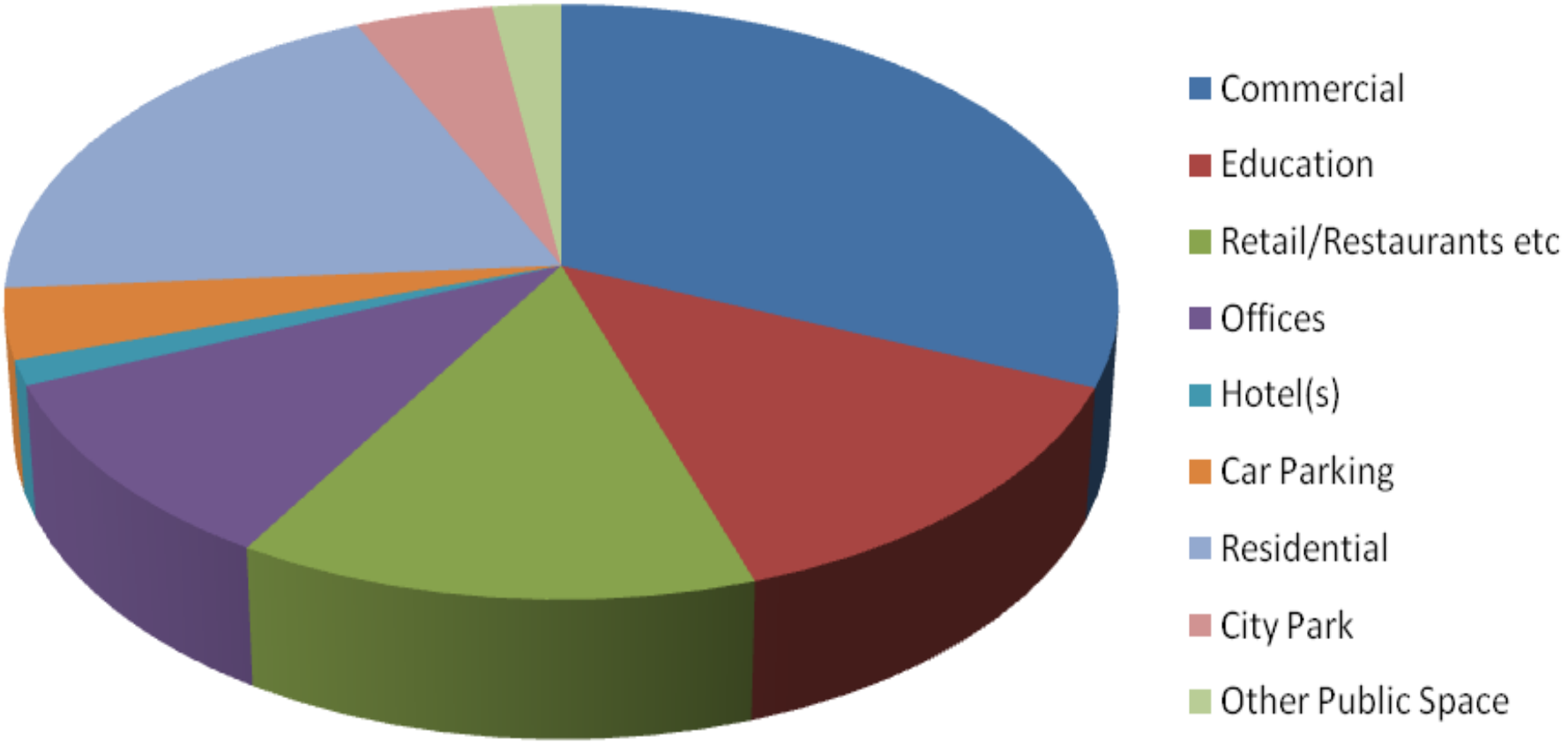
The brief for a water cycle study strategy study should contain the following elements:

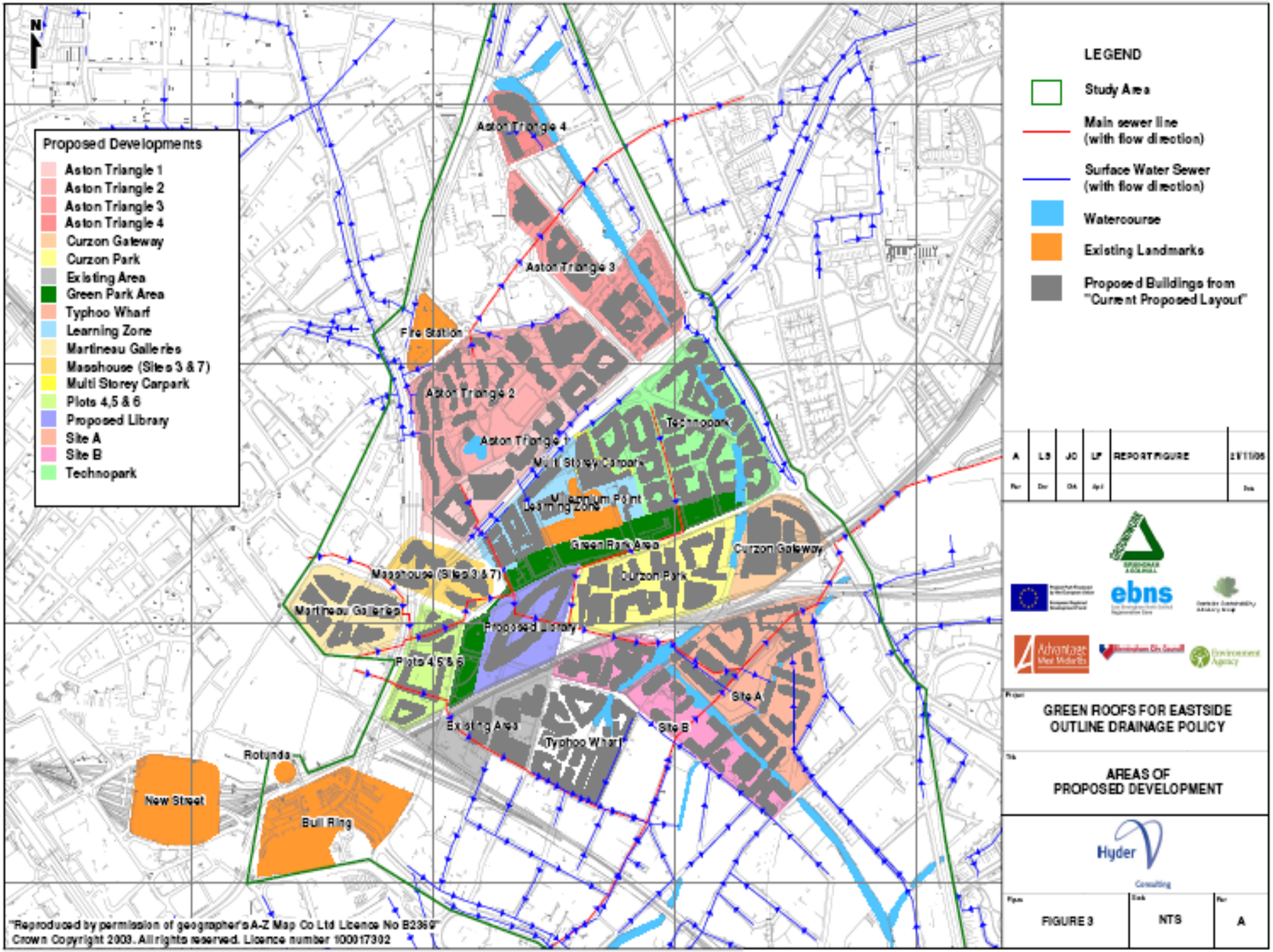
- **the background and context to the reasons why a water cycle strategy is required together with the prevailing legal and planning framework.**
- **the scope of the strategy and the key outputs and deliverables required of the water cycle strategy study.**
- **suggested information and data sources as well as skills required to undertake the UWC study should be stated. Lead and key partners to the study should also be identified together with any project steering review group.**
- **any particular issues that the UWC needs to address in more detail in terms of further study, analysis and consultation. This will comprise the core of the Outline Level I Initial Scoping Study.**
- **a summary and recommendations of the inputs necessary to progress the water cycle study strategy to any detailed Level II study.**



Birmingham Eastside Development Area.

Proposed Landuse Activities for Birmingham Eastside





The primary concerns for surface water drainage infrastructure provision across Eastside include:

- water demand, usage rates and wastewater flows and the capacity to meet requirements
- the need for on-site attenuation, storage and/or infiltration facilities especially in respect of overland flows associated with extreme storm events
- the need to maintain and/or extend the drainage infrastructure, including retrofitting, where appropriate
- the timetable for staged and integrated planning and delivery of drainage infrastructure controls
- the costs, operational reliability and sustainability of the drainage network resources being delivered.

Water Resources		Wastewater		Surface Water Drainage and Pluvial Flood Risk	Fluvial Flood Risk		
Water Resource Availability	Water Supply Network	Sewer Network	Sewage Treatment Works (STW)		FZ1	FZ2	FZ3
Water resource available to meet planned developments	Existing network available with spare capacity	Existing sewer network can accommodate the proposed developments	Existing STW flow headroom can accommodate the proposed developments and there are no compliance issues	Low risk of flooding within sites or downstream	Flood Zone 1; Low probability of annual exceedance (<0.1%; <1:100)		
Water resource available but may need new source(s) to meet developments	Existing network available with no spare capacity	Existing sewer network may need to be upgraded	Existing STW flow headroom can accommodate the proposed developments but there are compliance issues	Medium risk of flooding within sites or downstream	Flood Zone 2; Medium probability of annual exceedance (1% - 0.1%; 1:100 – 1:1000)		
Existing resources not adequate to meet developments	No existing network available to serve the specific development parcel(s)	Existing sewer network cannot accommodate the proposed developments	Existing STW flow headroom cannot accommodate the proposed developments	High risk of flooding on development site(s) or downstream	Flood Zone 3; High probability of annual exceedance (>1%; >1:1000)		

Development Constraint Matrix

The outputs from the outline Phase 1 UWC study should be reports that address the following questions:

- **what and where are the risks from surface water flooding for development proposals and will these developments be resilient to the effects of future climate change and the likely impacts on flood risk drainage and water supply?**
- **how will the effects of staged "parcel" development impact on the provision of an integrated, sustainable drainage infrastructure?**
- **how can rainfall-runoff and associated overland flows be managed within the development area for extreme storm events and what is the potential for source control BMP/SUDS implementation?**
- **are there locations that can be safely utilised for attenuation, infiltration and/or storage of exceedance flows?**
- **what water savings and demand management approaches can be implemented within the developments, especially in respect of potential rainwater contributions to other components of the urban water cycle?**
- **will there be a water quality impact on the receiving watercourses and/or groundwater resources?**
- **how will other outstanding concerns and uncertainties in respect of urban surface water drainage infrastructure be addressed e.g costs, adoption, maintenance etc.?**
- **identify any information, data, funding or policy/planning gaps and technical uncertainties that require further exploration in a more detailed Phase 2 UCW study in conjunction with the local development planning process.**
- **identify procedures and supporting structures to ensure a coordinated stakeholder approach to strategic water resource management.**

Development Parcel	Contributing Area (m^2)	Peak (Average) Water Demand (l/s)	Peak Wastewater Discharge (l/s)
1 City Park	42900	22.0	50
2 Curzon Park	40470	**32.5** (5.8)	314
3 Curzon Gateway	16200	6.0 (2.1)	120
4 VTP200			
5 BCU	14164		105
6 Ventureast	52609	**58.0** (4.5)	**401**
7 Masshouse	62483	(3.8)	**462**
8 Martineau Galleries	54997	(2.5)	**407**
9 Gate	18939	(6.2)	140
10 Millenium Point	48562	1.4	360
11 Multi-storey Carpark	8462	Negligble	63
12 Warwick Bar	18600	**10.0** (1.0)	104
13 House			
14 Typhoo Wharf	37400	(1.1)	277
15 UB40	3965	(0.5)	29
16 Aston Science Park	89030	(3.0)	**659**
17 Aston University	254450	(3.5)	
TOTAL	**77 (ha)**	**~106**	**3491**

Summary of Peak Flow Data for Eastside Water Services

Sewer Node	Contributing Parcel(s)	Pipe Capacity		Flow in Pipe (m^3/s)	Surcharge Potential
		Minimum (m^3/s)	Maximum (m^3/s)		
A	1,4,6,11	0.9	1.8	0.5	Unlikely
B	1,2,4,5,7,8,9,10,11	0.9	1.7	2.3	Probable
C	1 - 12, 14, 15	5.1	5.1	2.8	Unlikely
D	4,11	0.1	0.1	0.06	Unlikely
E	1,4 - 11	0.9	1.7	1.9	Probable
F	6	0.6	0.6	0.4	Unlikely
G	7	0.1	0.1	0.5	Probable
H	8	0.6	0.6	0.4	Unlikely
I	8,9	0.4	0.4	0.5	Probable
J	1,4,6,10,11	0.9	1.8	0.8	Unlikely
K	11	0.1	0.1	0.1	Unlikely
L	1,2,4 – 12,14,15	8.3	8.3	2.7	Unlikely
M	13	0.08	0.07	0.04	-
N	14	0.1	0.1	0.3	Probable
O	1,2, 4 - 11, 15	0.9	1.7	2.3	Probable
P		0.9	1.8	0.7	Unlikely

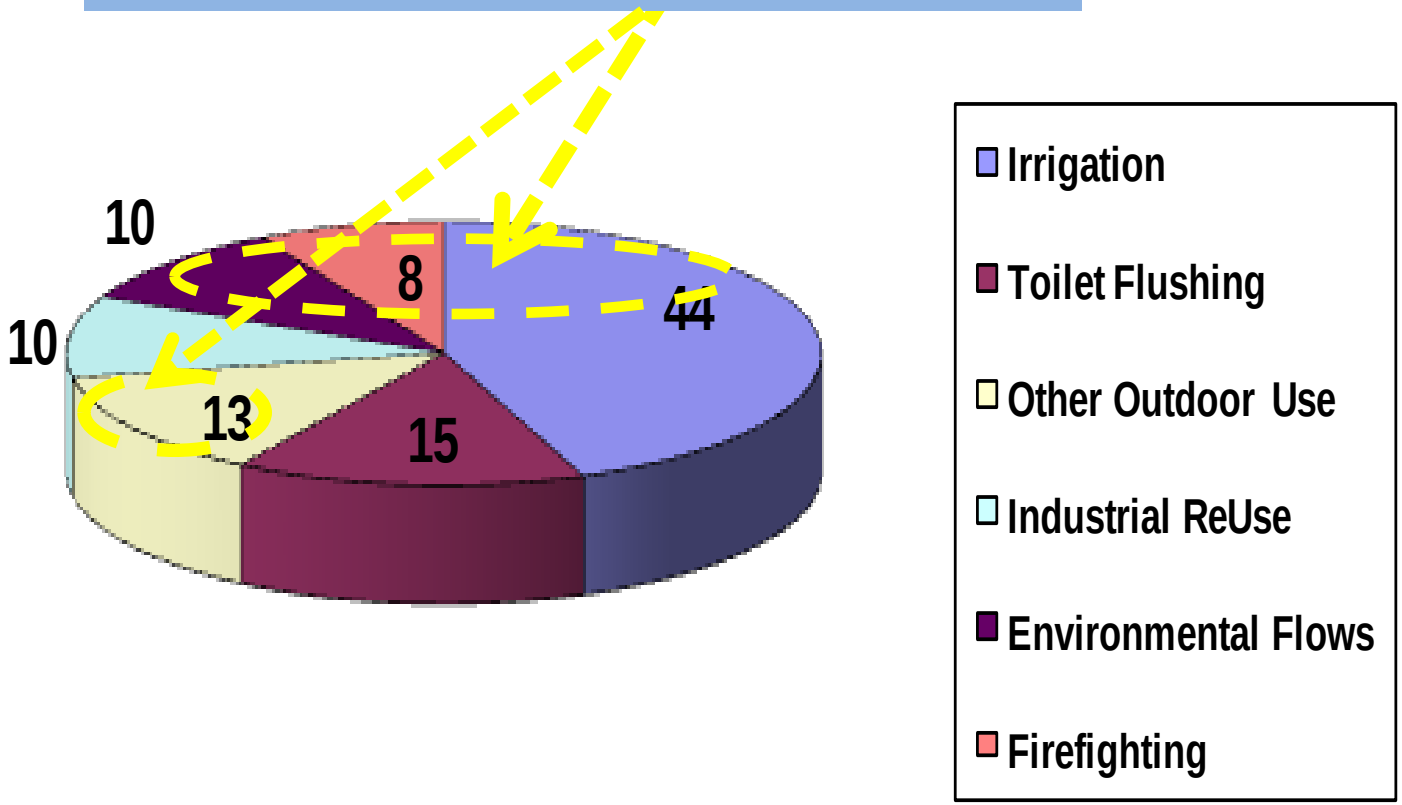
Peak Flows in the Eastside Surface Water Sewer System

Stormwater and Greywater Re-Use in Birmingham Eastside.

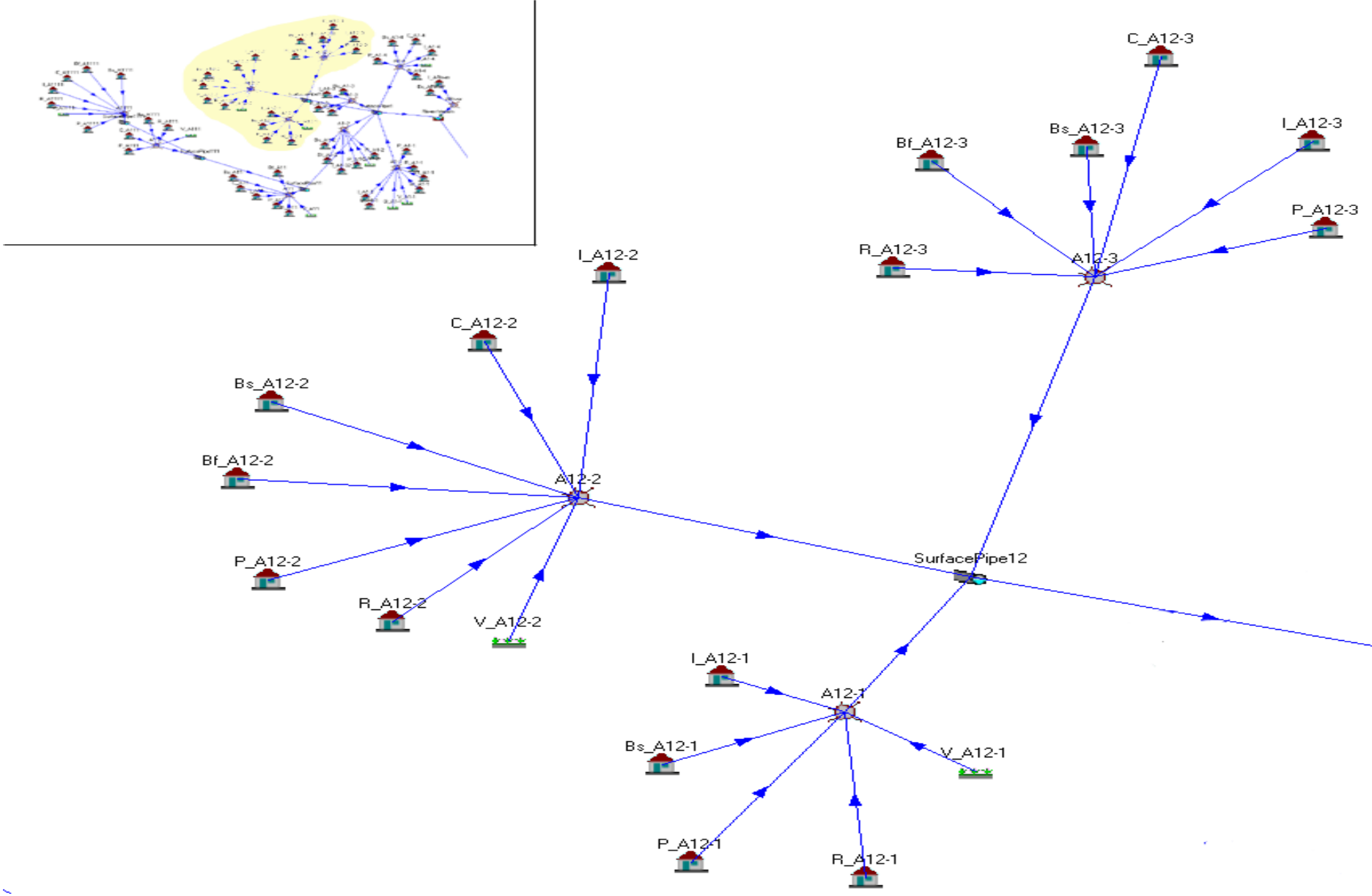
LANDUSE SECTOR	RAINWATER HARVESTING		GREYWATER RECYCLING	
	Potential	Payback Time (Years)	Potential	Payback Time (Years)
Single residential	✓	16	✓	44
Shared residential	✓✓	3.1	XX	-
Public community buildings	✓	6.9	XX	-
Hotels	✓	38.4	✓	10.5
Commercial office buildings	✓	?	XX	-
Retail buildings	See Mixed use development			
Industrial buildings	✓	?	?	?
Leisure buildings	✓	6.1	✓	7.8
Public open space	✓✓	?	XX	-
Mixed use developments	✓✓	?	✓✓	4.1

KEY: ✓ Potential; ✓✓ High potential; XX Negligible potential

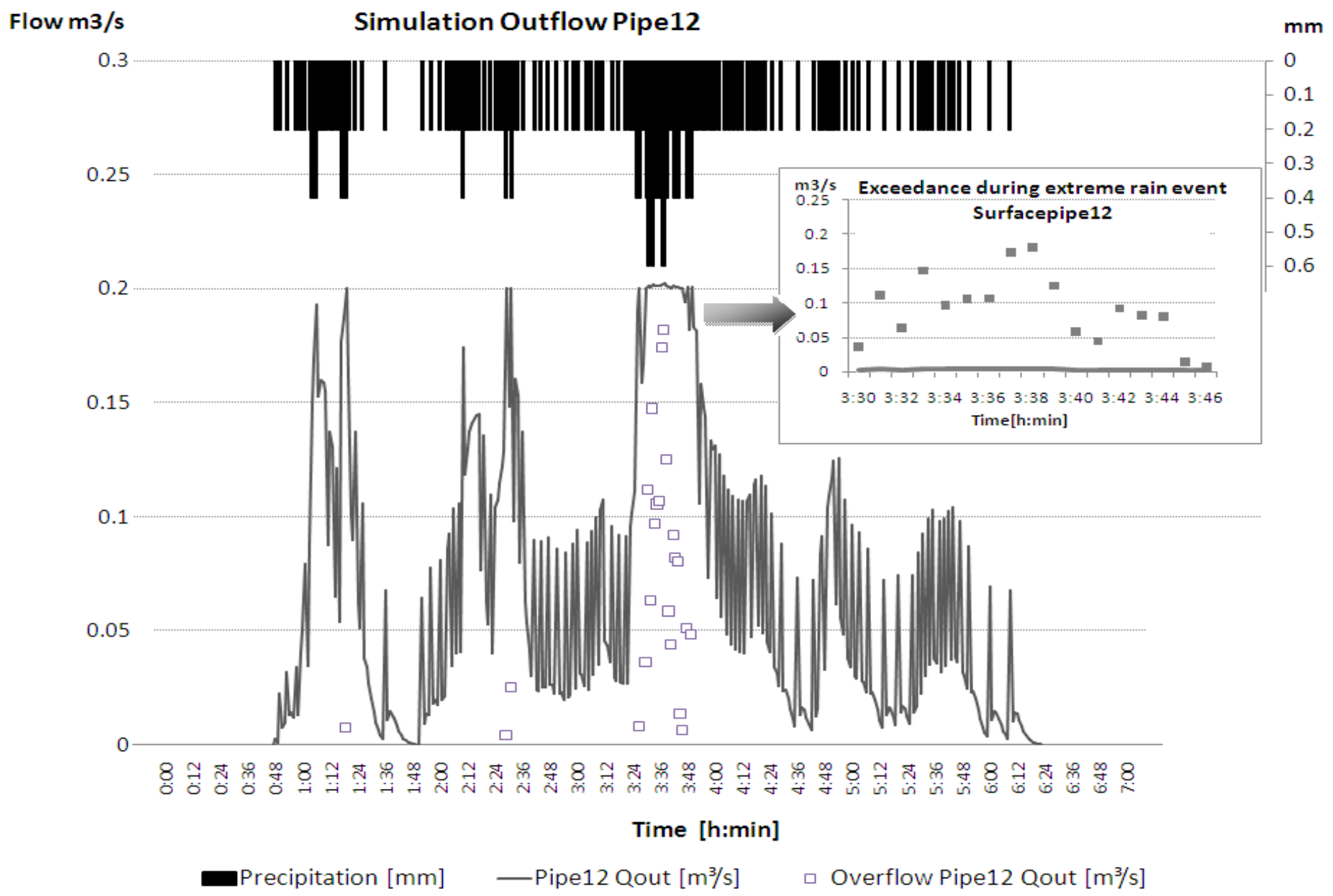
Probable re-usages in Birmingham Eastside



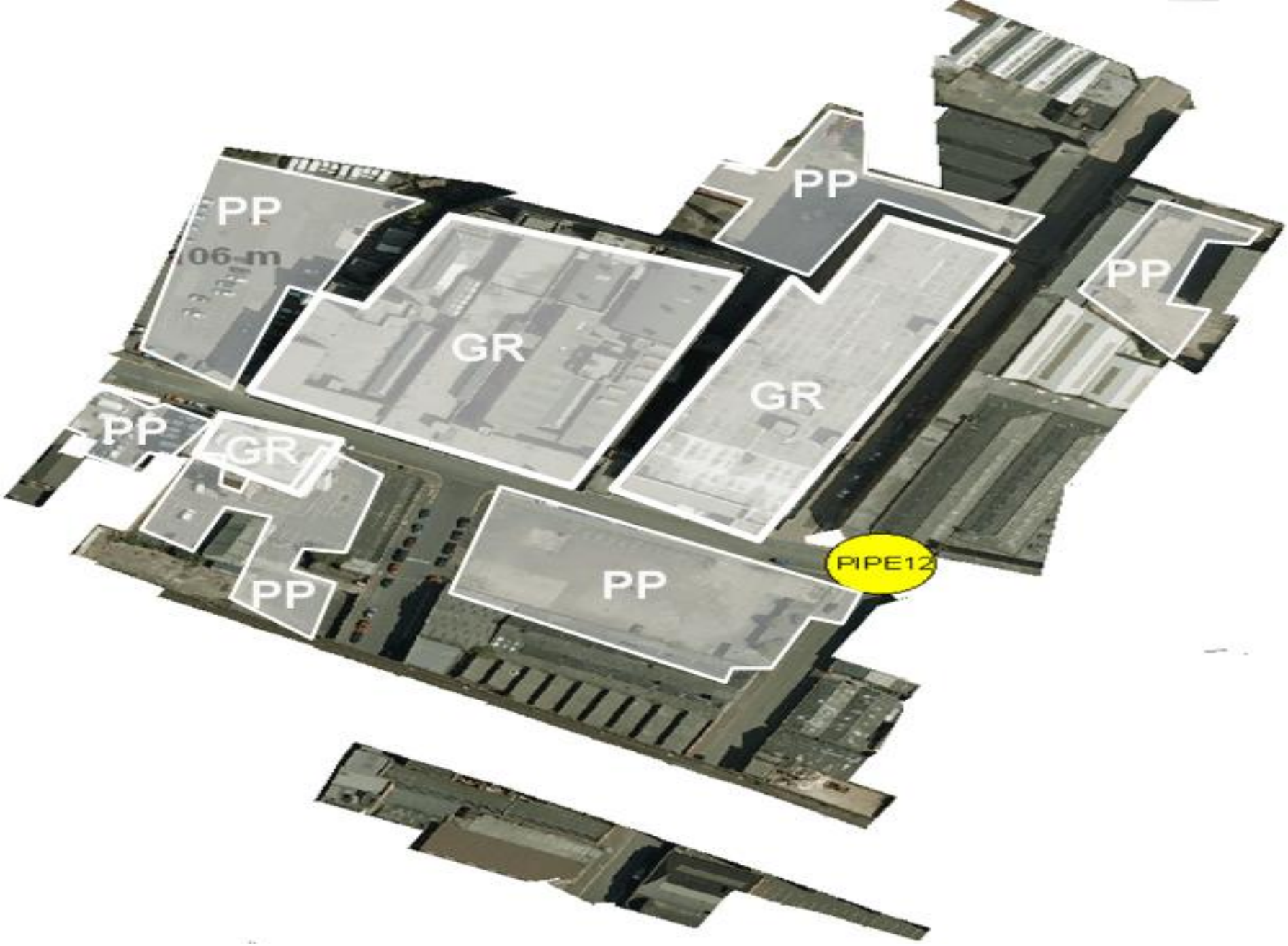
POTENTIAL STORMWATER RE-USE IN AUSTRALIA



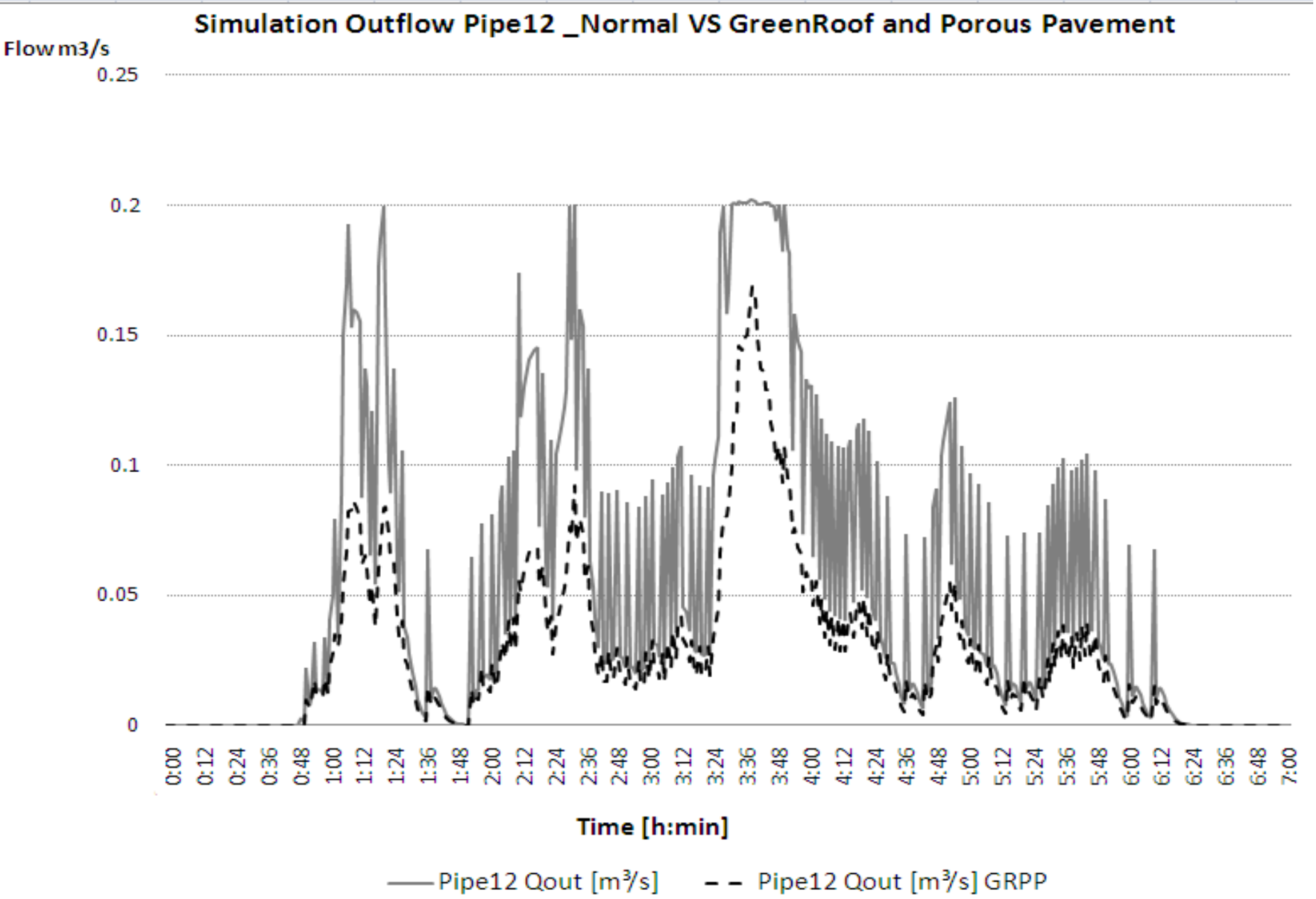
The STORM modelled sewered sub-catchment in Eastside



Predicted flow distribution and exceedance overflows for an extreme storm event



Identified Green Roof (GR) and Porous Paving (PP) placement in the studied catchment.



Comparison between predicted flow distributions with and without BMPs installed

		FLOW (m^3)			FLOW REDUCTION (%)	
Time Period	Precipitation (mm)	Normal	Green Roof	Porous Pavement	Green Roof	Porous Pavement
1am-2am	5.6	230	169	174	26%	25%
2am-3am	7	304	227	220	25%	28%
3am-4am	13	568	425	410	25%	28%
4am-5am	5	228	171	166	25%	27%
6am-7am	3.2	143	107	104	25%	27%
7am-8am	0.2	13	10	10	23%	22%

Birmingham Eastside BMP Runoff Volume Reductions.

CONCLUSIONS

- **A preliminary Urban Water Cycle (UWC) study for the Birmingham Eastside development area has identified that stormwater discharges can make significant contributions to other components of the urban water cycle and to future strategic urban water resource management**

- **These contributions can be at plot, site and sub-catchment levels and would reduce water demand as well as pluvial flood and pollution risks**

- **The application of BMP/SUDS drainage infrastructure would substantially reduce flood (peak flow) and pollution risks (~60% - 70%) as well as offering recreational, amenity and other benefits**

- **Strategic UWC studies can make substantial inputs to flood risk assessment, surface water management plans (SWMPs) and to wider catchment management plans (CMPs)**

- **Stormwater management within an UWC is essentially a "wicked" problem dominated by barriers at institutional and social levels reflecting the diversity of stakeholder responsibilities and interests**

- **Sustainable urban water resource management requires successful stakeholder consultation processes and delivery structures**