British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Gateway to the Earth

Investigating the Impact of Sustainable Drainage Systems (SuDS) on Groundwater

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Session 7.02 Urban Hydrogeology

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- Site
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- Data output
- Features
- Some analysis
- Future programme
- Applications

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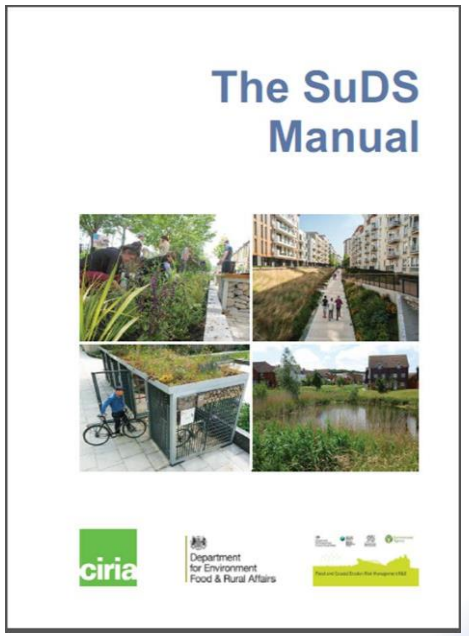
Project Motivation

Since April 2015, in the UK, lead local flood authorities have been expected to ensure that sustainable drainage systems are incorporated into the design of housing and commercial developments.



By mimicking natural drainage regimes, the application of infiltration Sustainable Drainage systems (SuDS) aims to reduce surface water flooding and improve water quality, although the impact of enhanced recharge on groundwater, both quality and level, are poorly understood.

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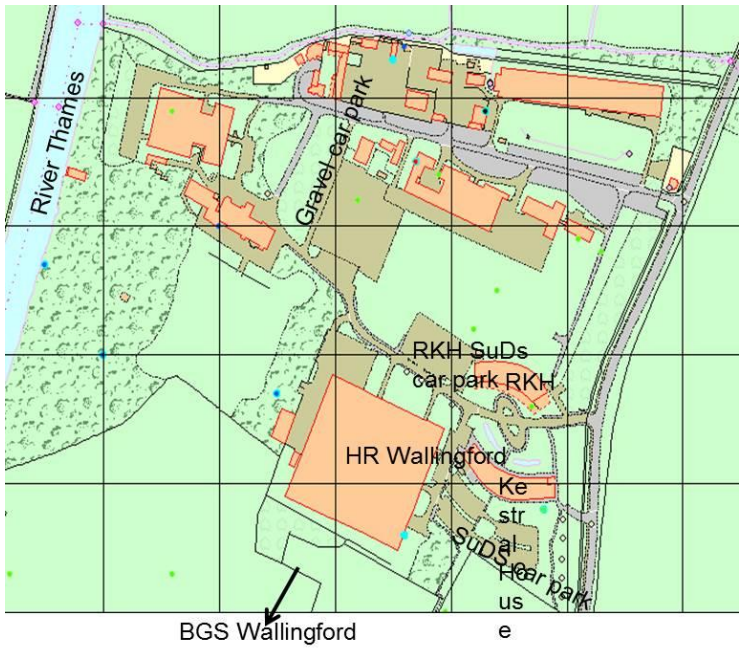
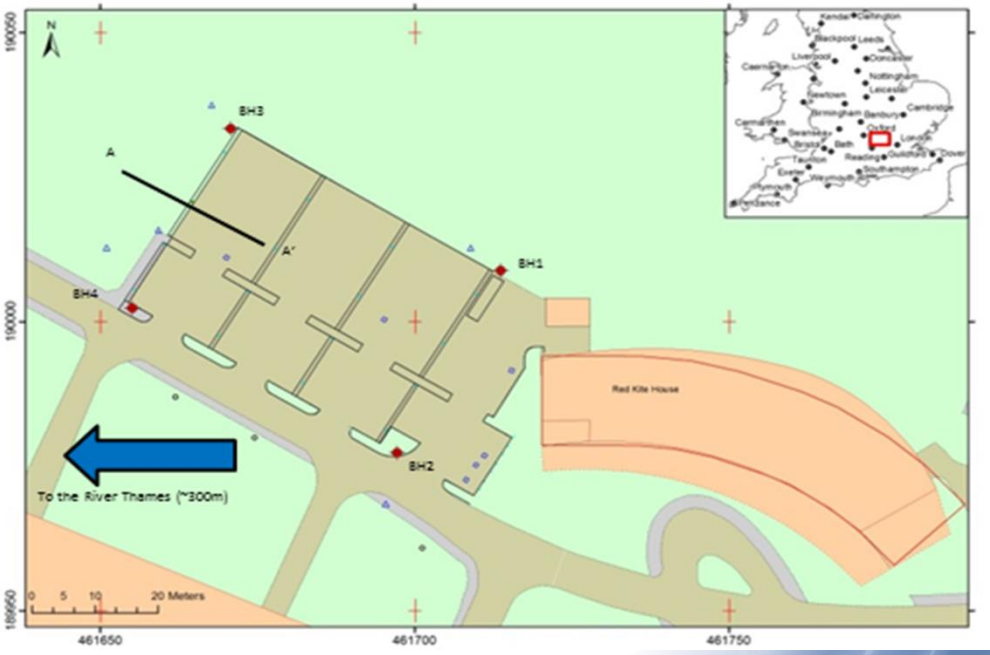
Site

A SuDS Observatory has been established where a permeable pavement car park was constructed in 2005. The car park is made up of permeable block paving at the surface, with a sand and gravel layer and a geotextile below for bio-attenuation.





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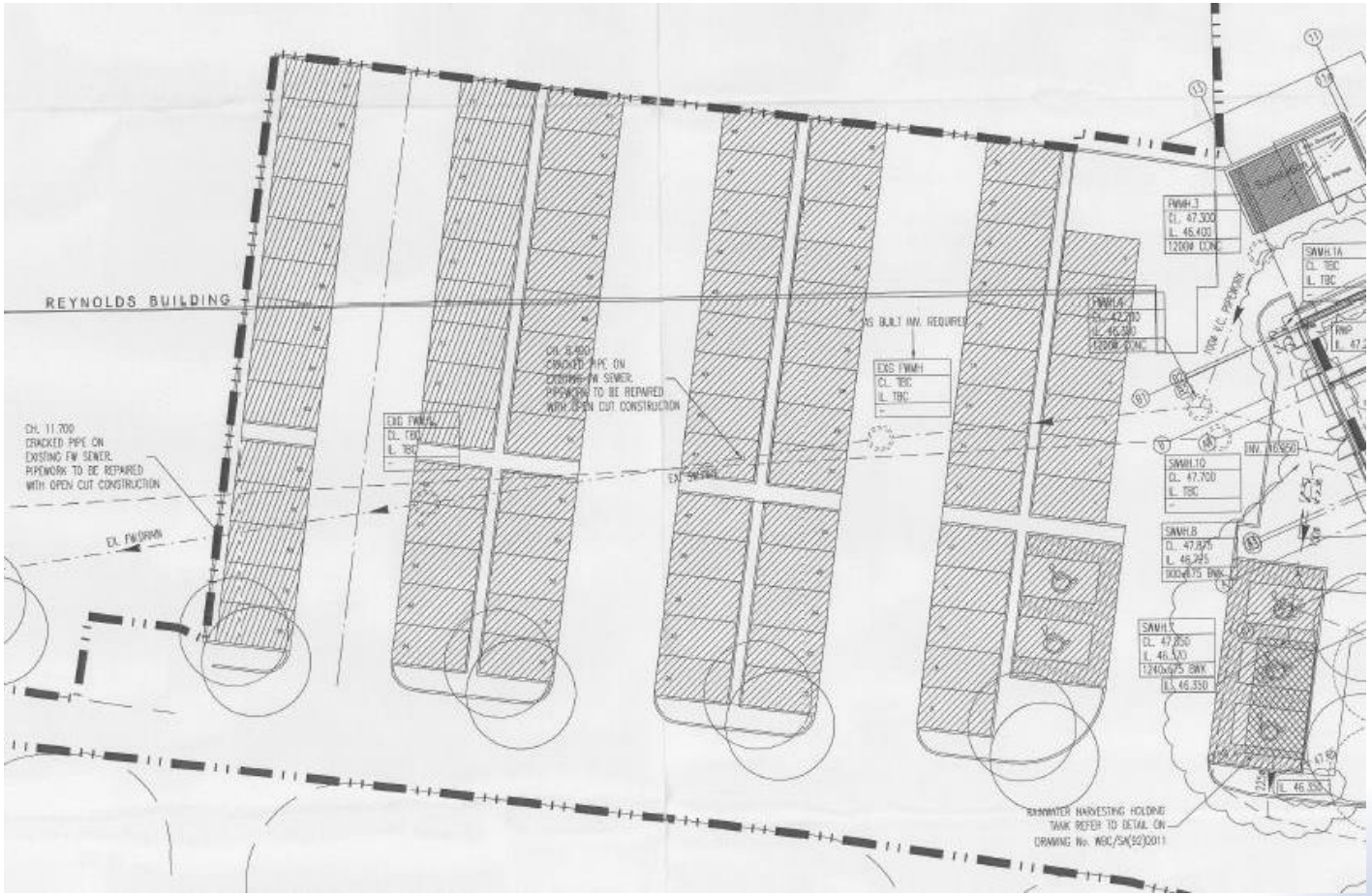
Site

SuDS Observatory: construction details of original carpark



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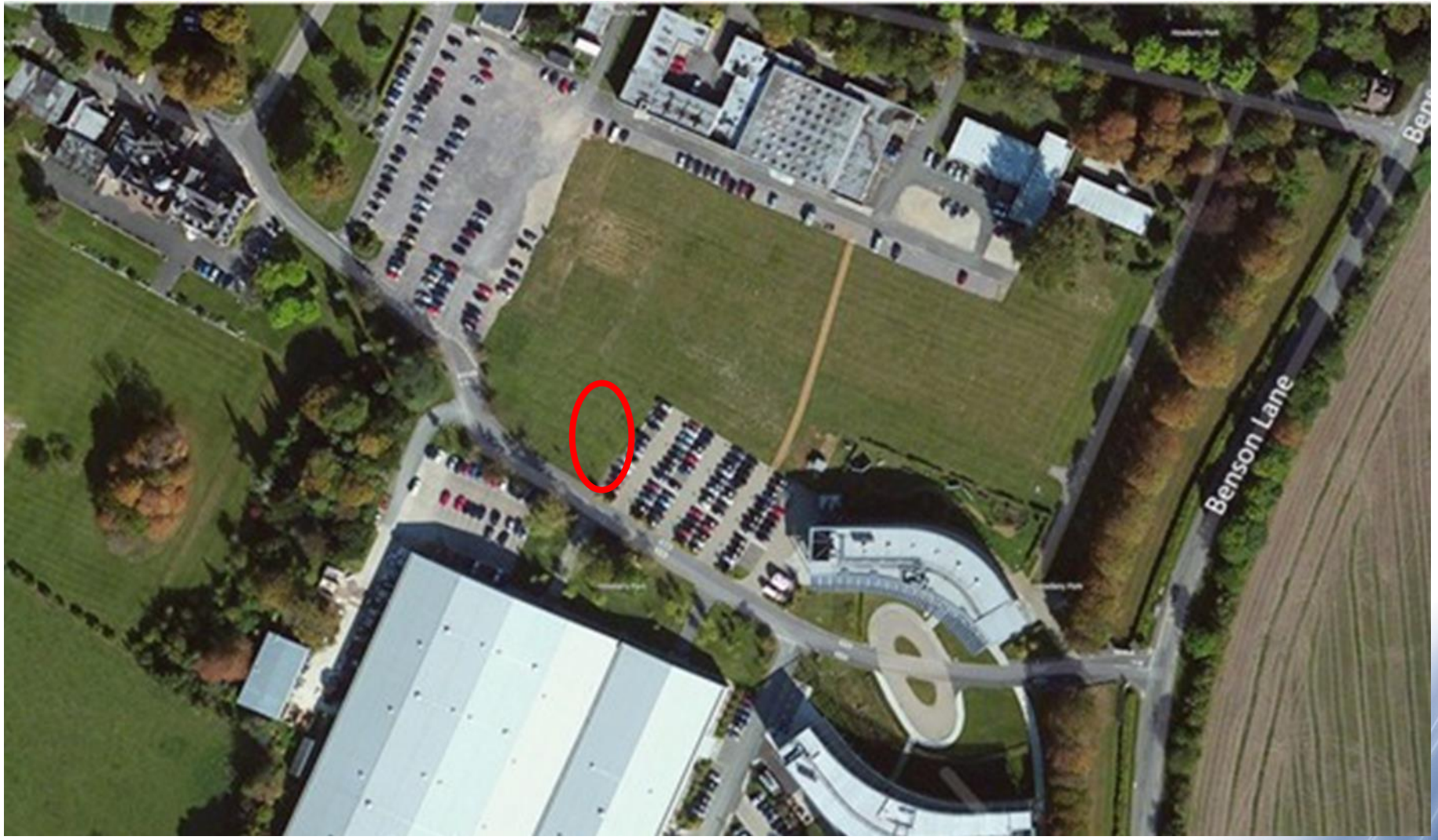

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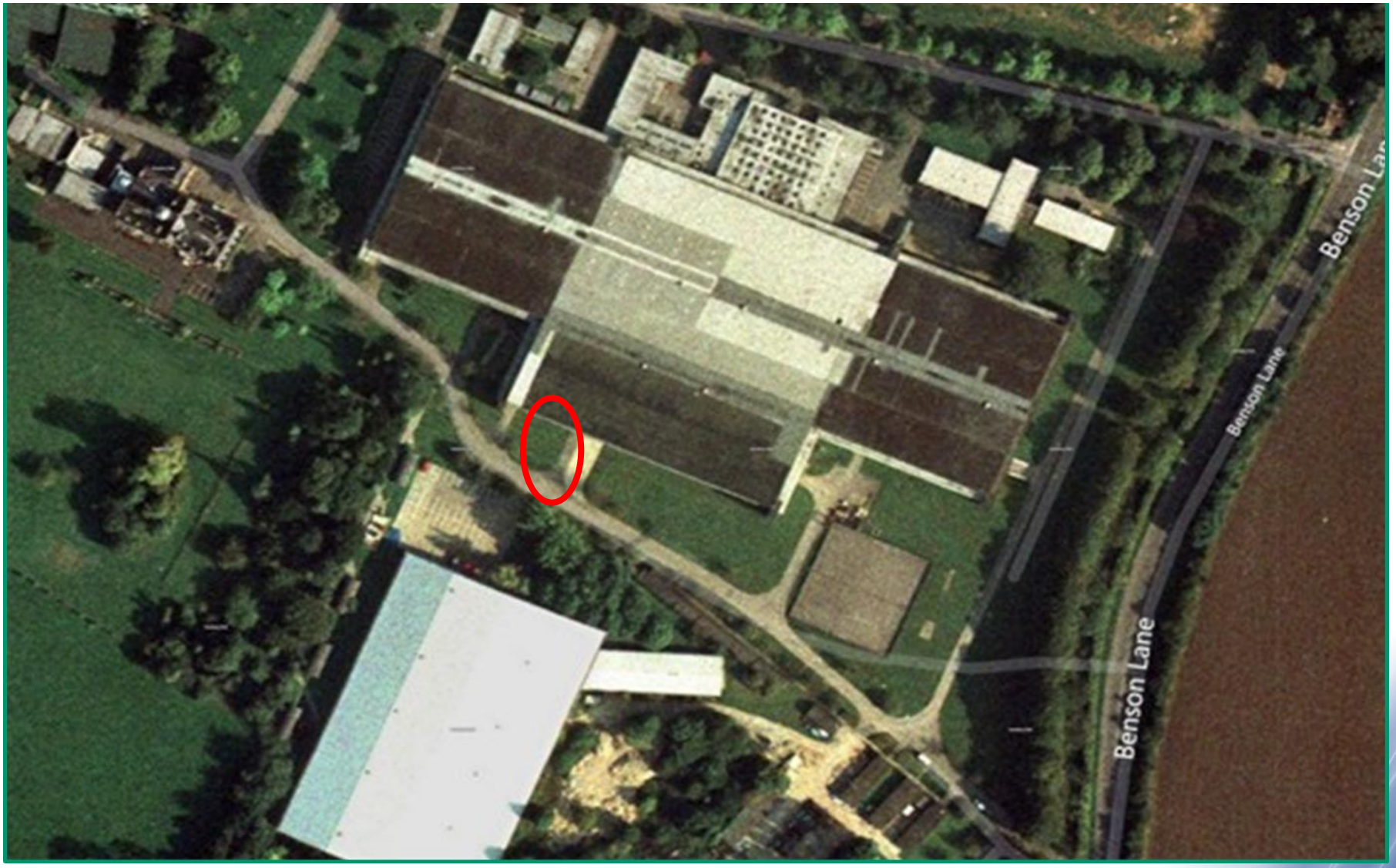

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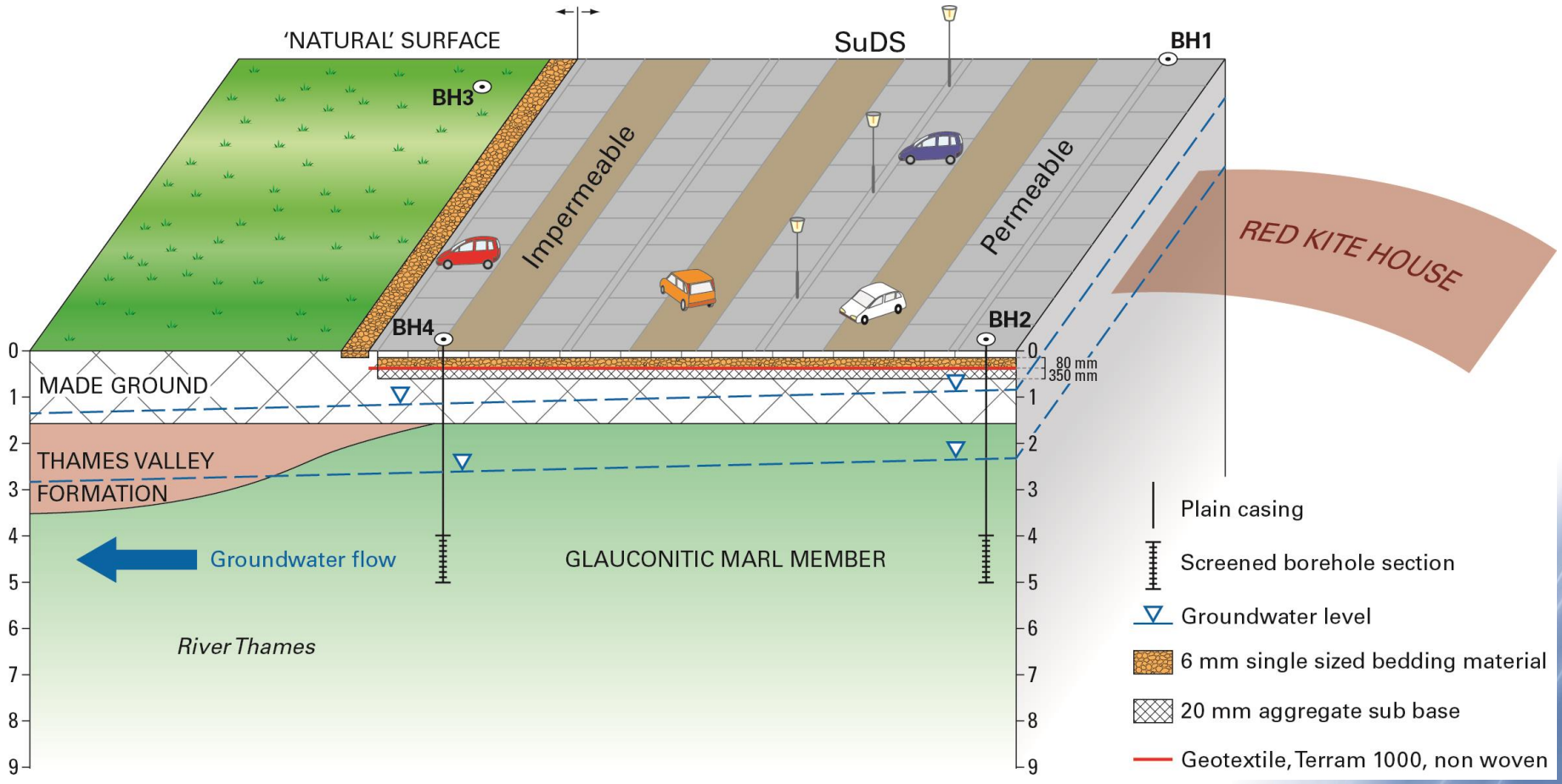
The
INNOVATION

Site

The underlying geology of the area is made ground and river terrace sand and gravel, underlain by glauconitic marl.



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Site

First SuDS car park comprises permeable and impermeable areas.

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Site

First SuDS car park comprises permeable and impermeable areas

Non-parking bays

Parking bays

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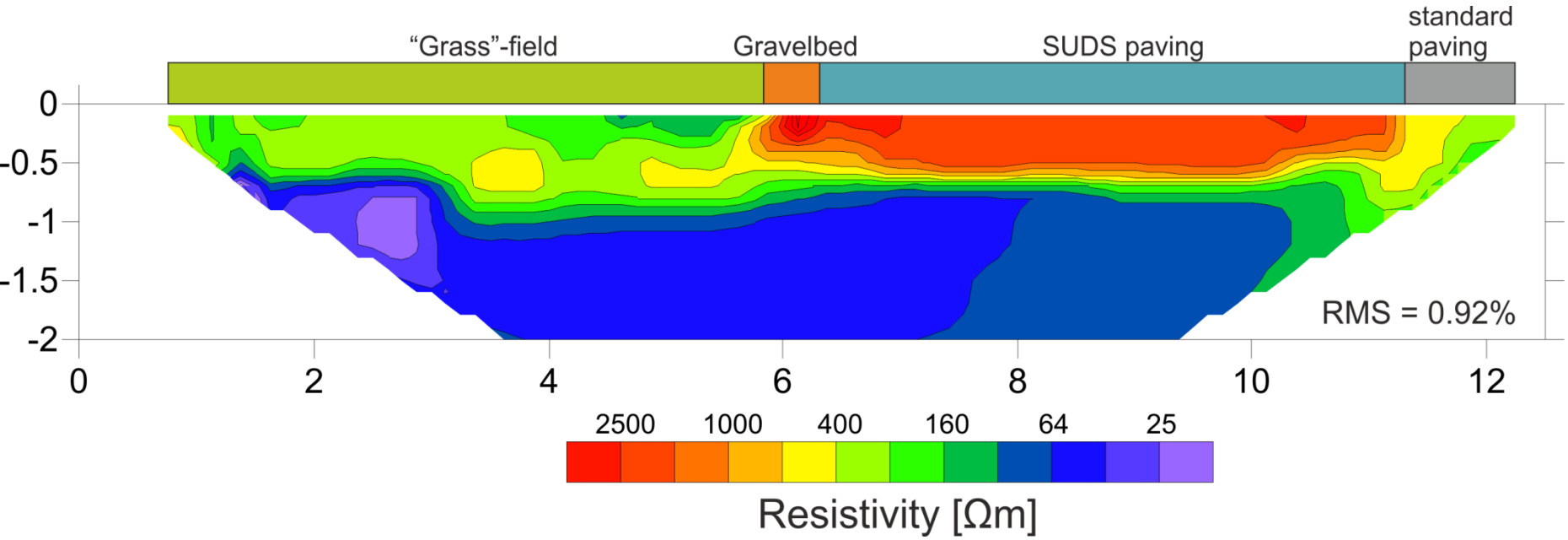
Site Characterisation



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Site

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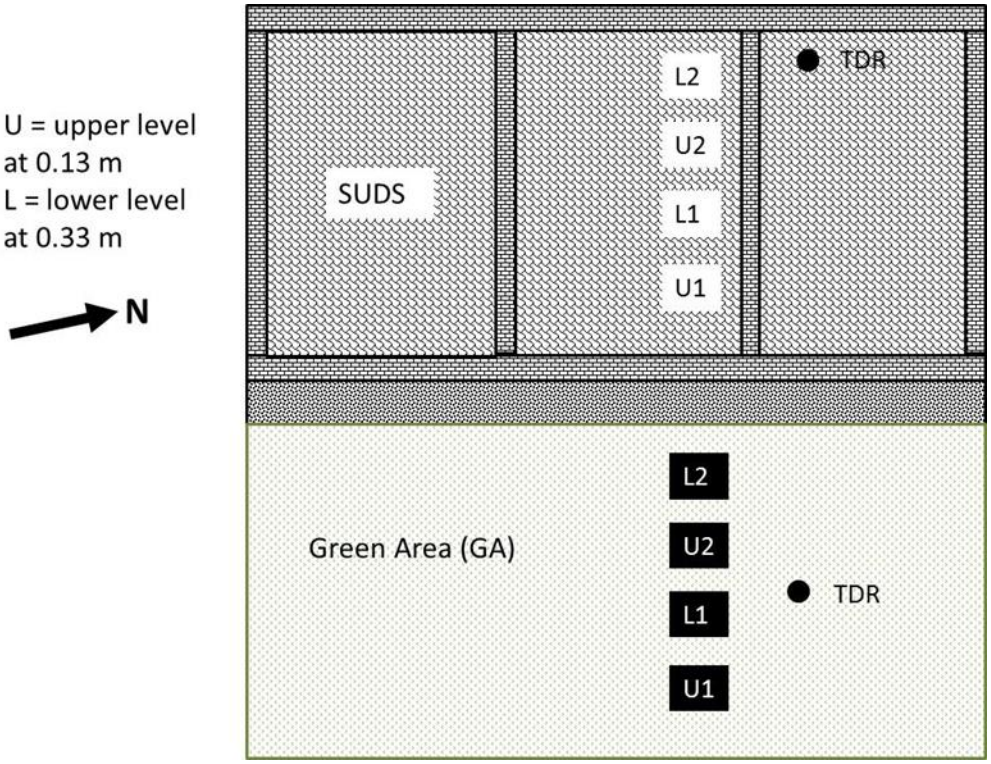
Establishing equipment, sensors and loggers

The Observatory now contains a number of soil moisture sensors, both in the SuDS and the adjacent natural grassland. Within the SuDS, the upper sensors are in the fine gravel layer above the geotextile and the lower sensors are in the coarser gravel below the geotextile, in an effort to investigate the flux of water through the unsaturated zone.



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Site instrumentation

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Data Output

Sensor output is via cable to datalogging units adjacent to the site (these could be telemetered in more remote locations).

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Data Output

The preliminary data from the sensors highlight that in the grassland, water is stored even after rainfall events; the SuDS act effectively by holding very little water and completely draining at certain points.

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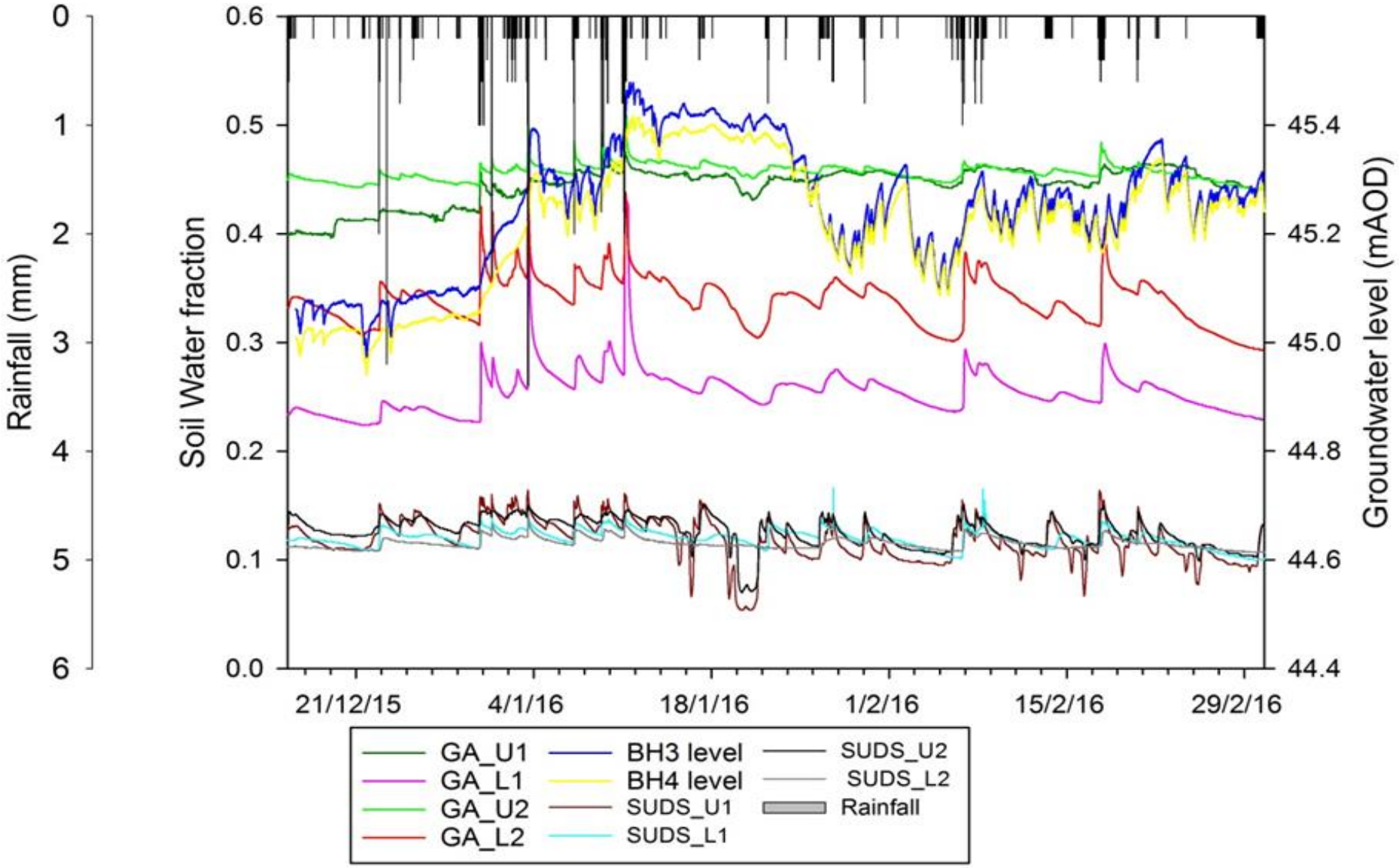
Data Output



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Data Output

Groundwater levels also appear to impact on the efficiency of these systems; an increase in hydrostatic pressure can slow down drainage from the SuDS, even though groundwater levels may still be below the system. An understanding of the surface and subsurface (vadose and water table) components can greatly improve an assessment of the efficiency of these SuDS.

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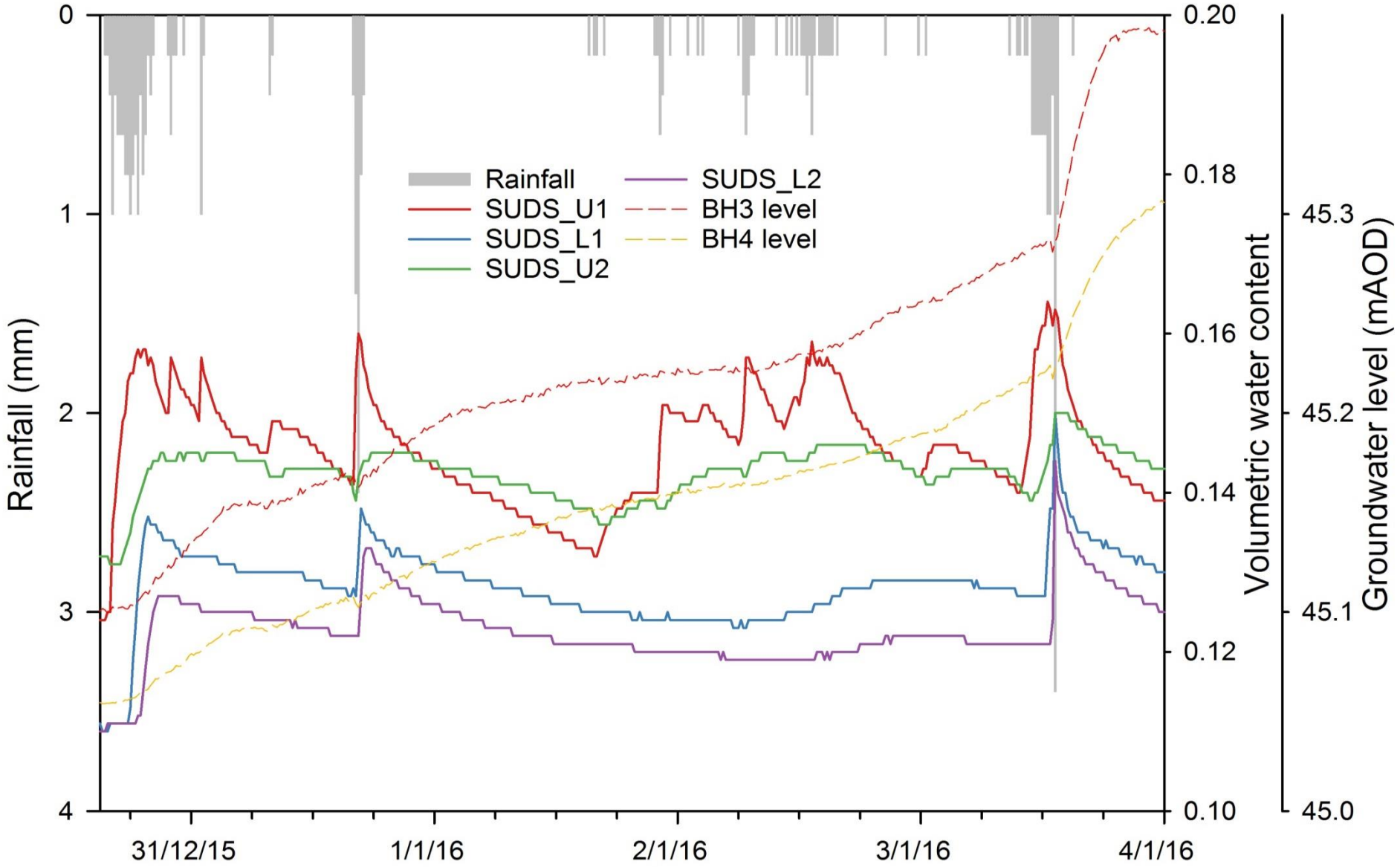
SuDS area soil moisture and local groundwater levels



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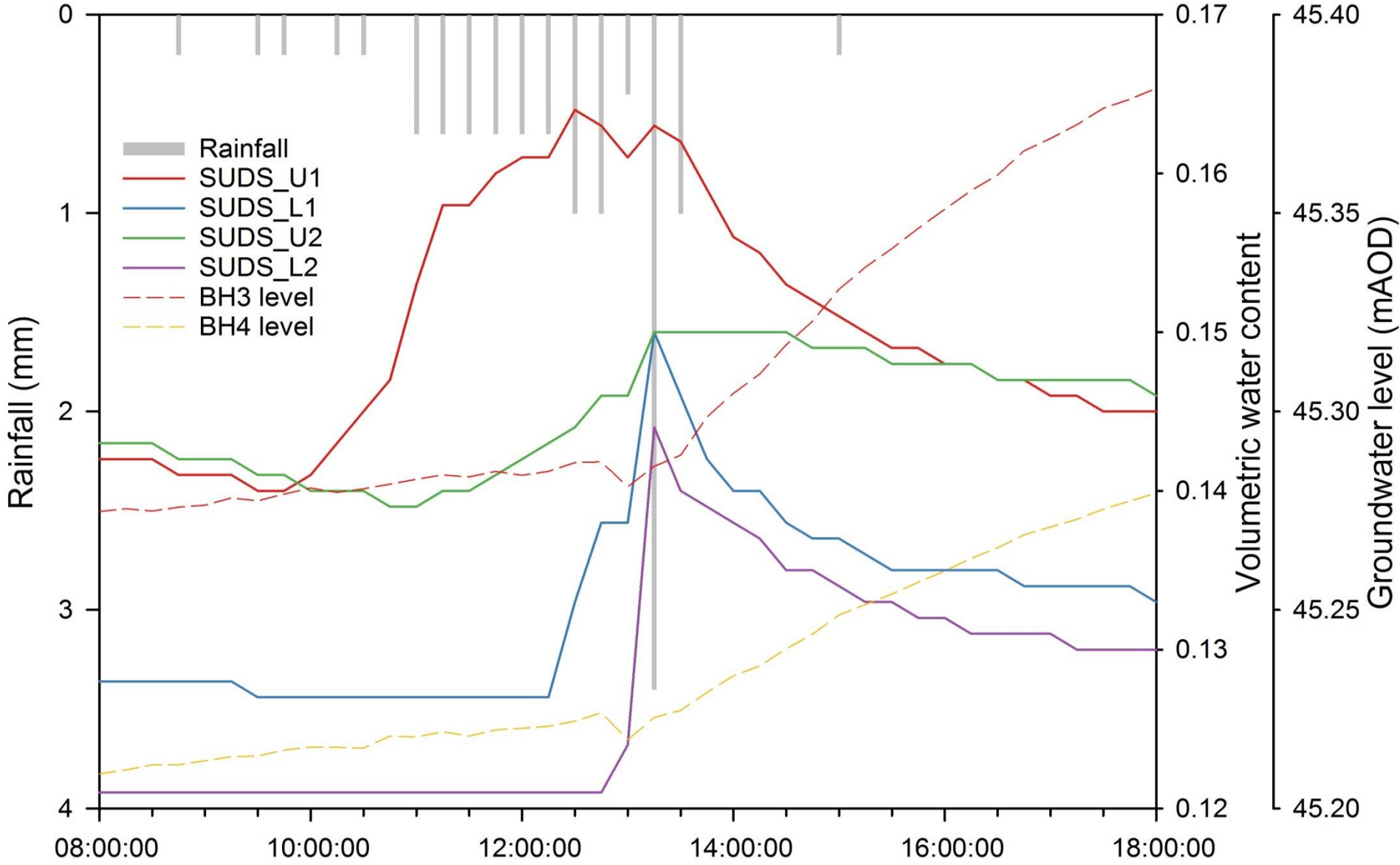
SuDS area soil moisture and local groundwater levels



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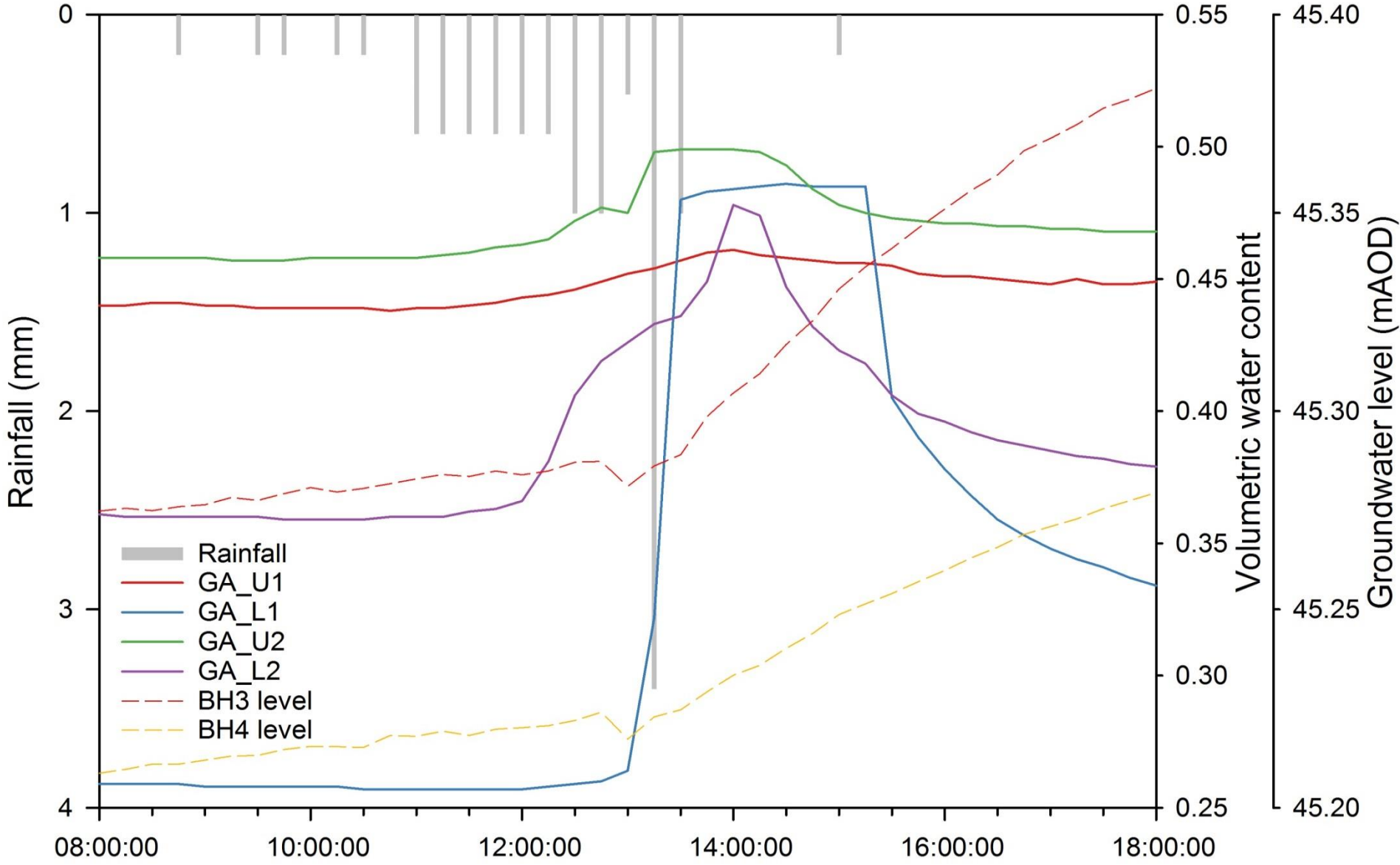
Green area soil moisture and local groundwater levels



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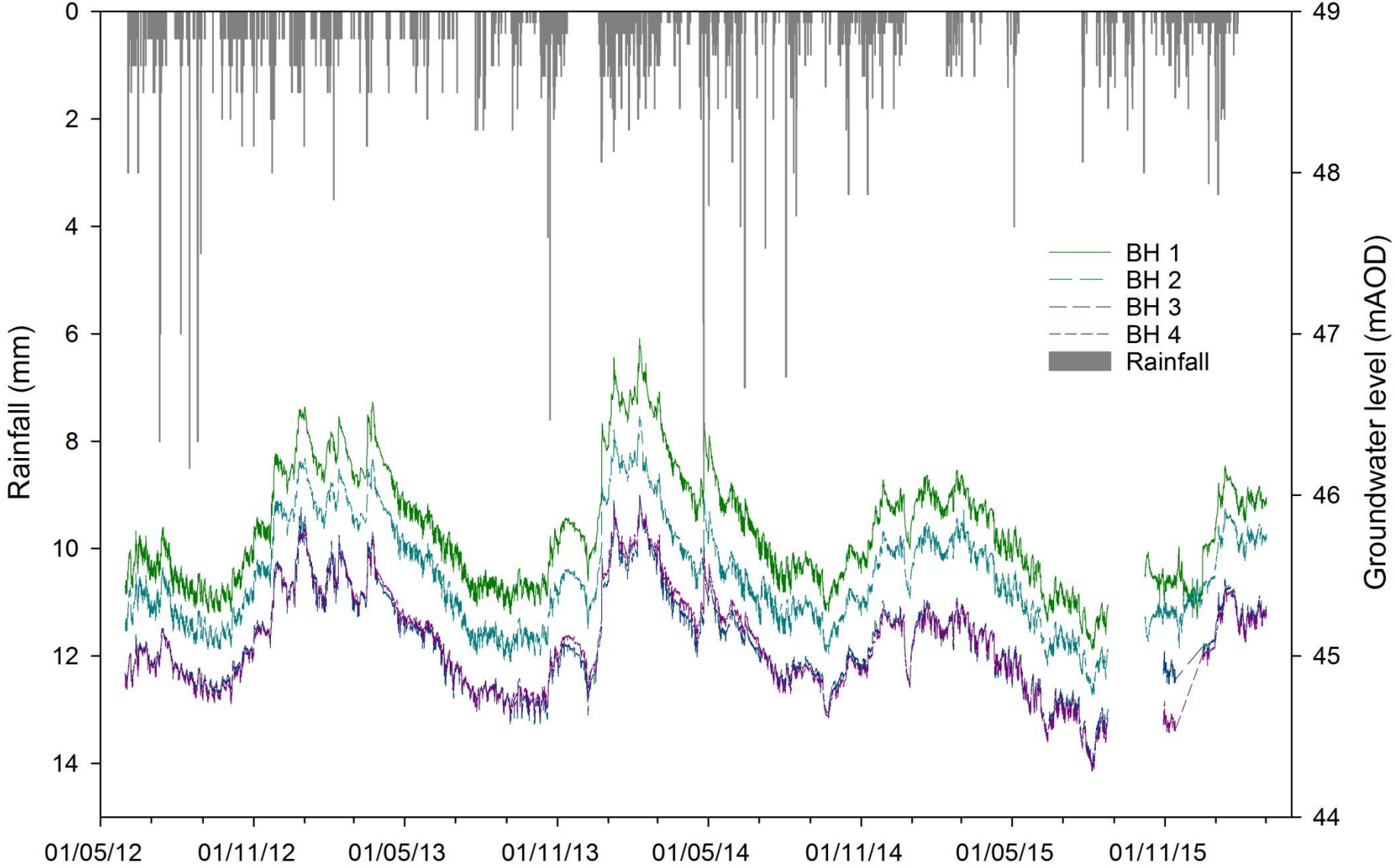
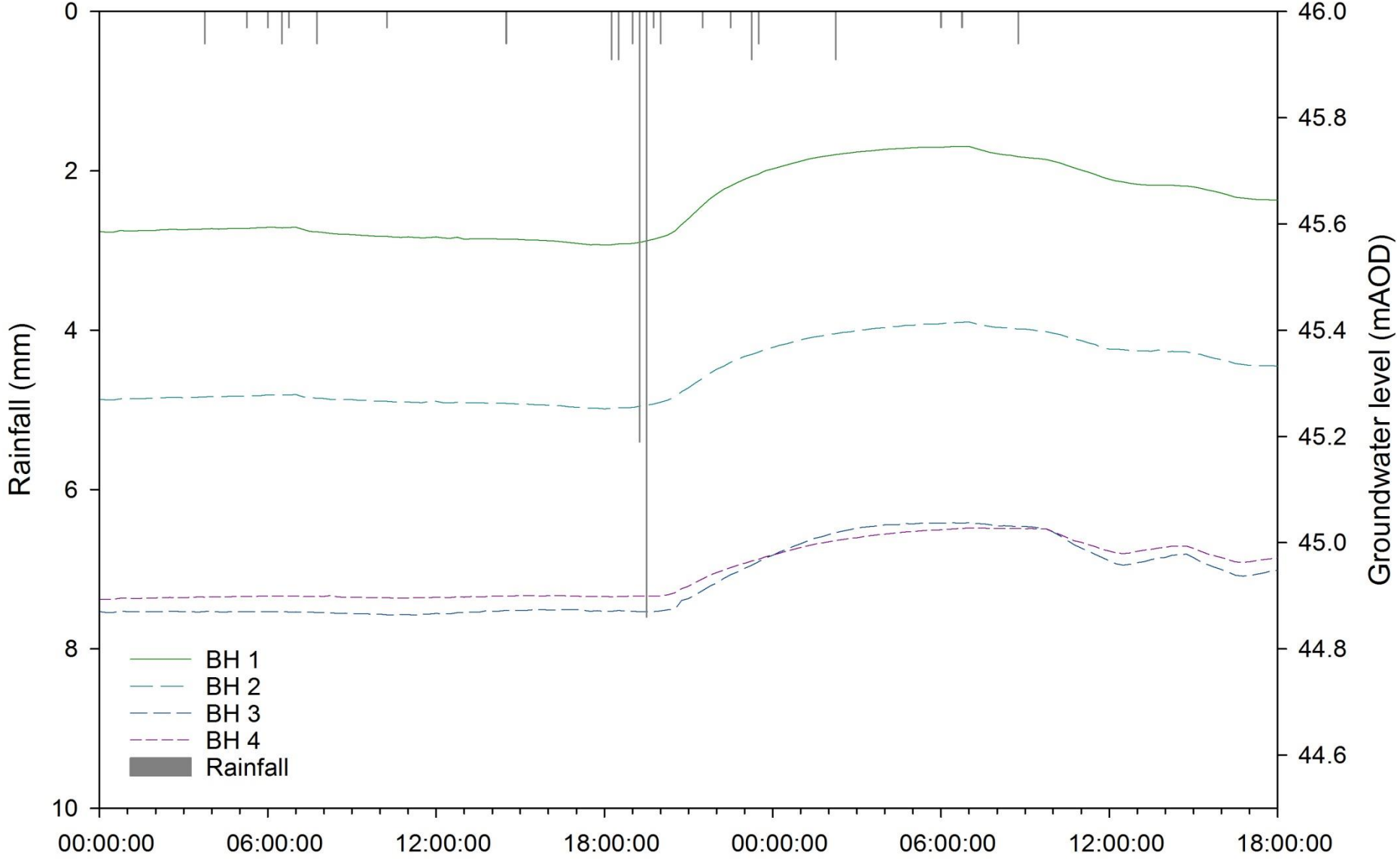
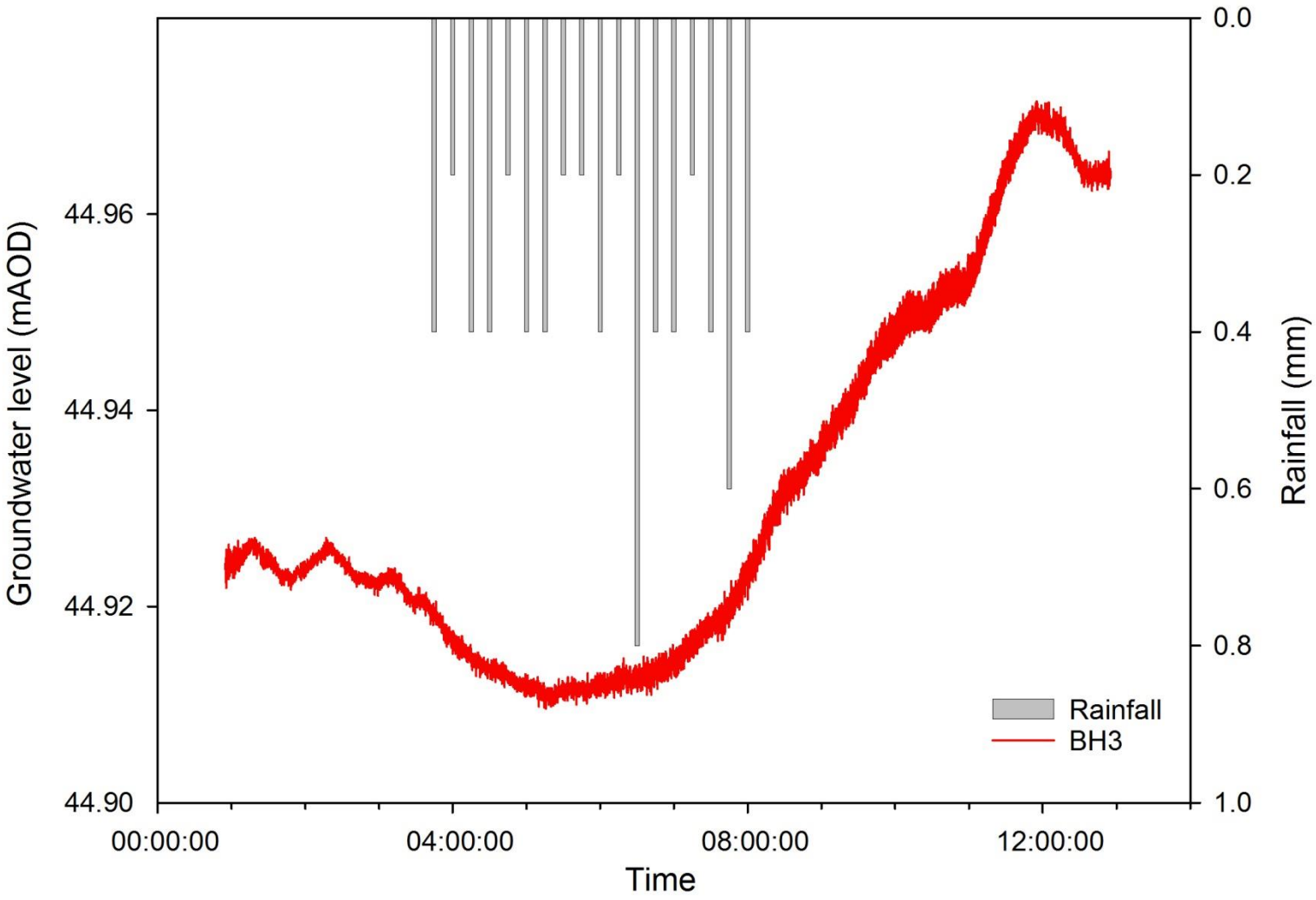

Rainfall (mm)
Groundwater level (mAOD)
0
2
4
6
8
10
12
14
49
48
47
46
45
44
BH 1
BH 2
BH 3
BH 4
Rainfall
01/05/12
01/11/12
01/05/13
01/11/13
01/05/14
01/11/14
01/05/15
01/11/15


Rainfall (mm)
Groundwater level (mAOD)
0
2
4
6
8
10
46.0
45.8
45.6
45.4
45.2
45.0
44.8
44.6
BH 1
BH 2
BH 3
BH 4
Rainfall
00:00:00
06:00:00
12:00:00
18:00:00
00:00:00
06:00:00
12:00:00
18:00:00



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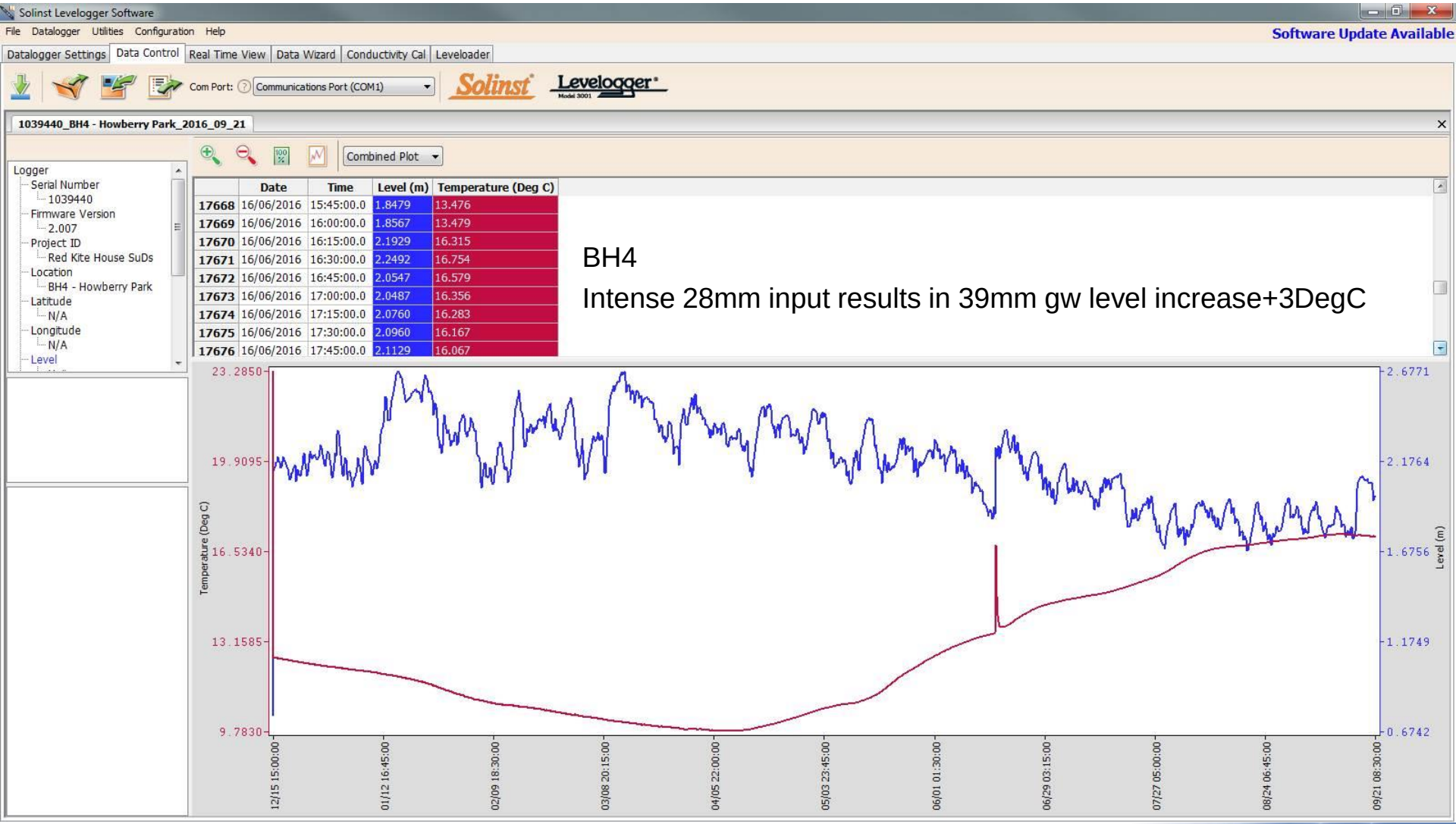
Groundwater responses to intense rainfall



BH4

Intense 28mm input results in 39mm gw level increase+3DegC

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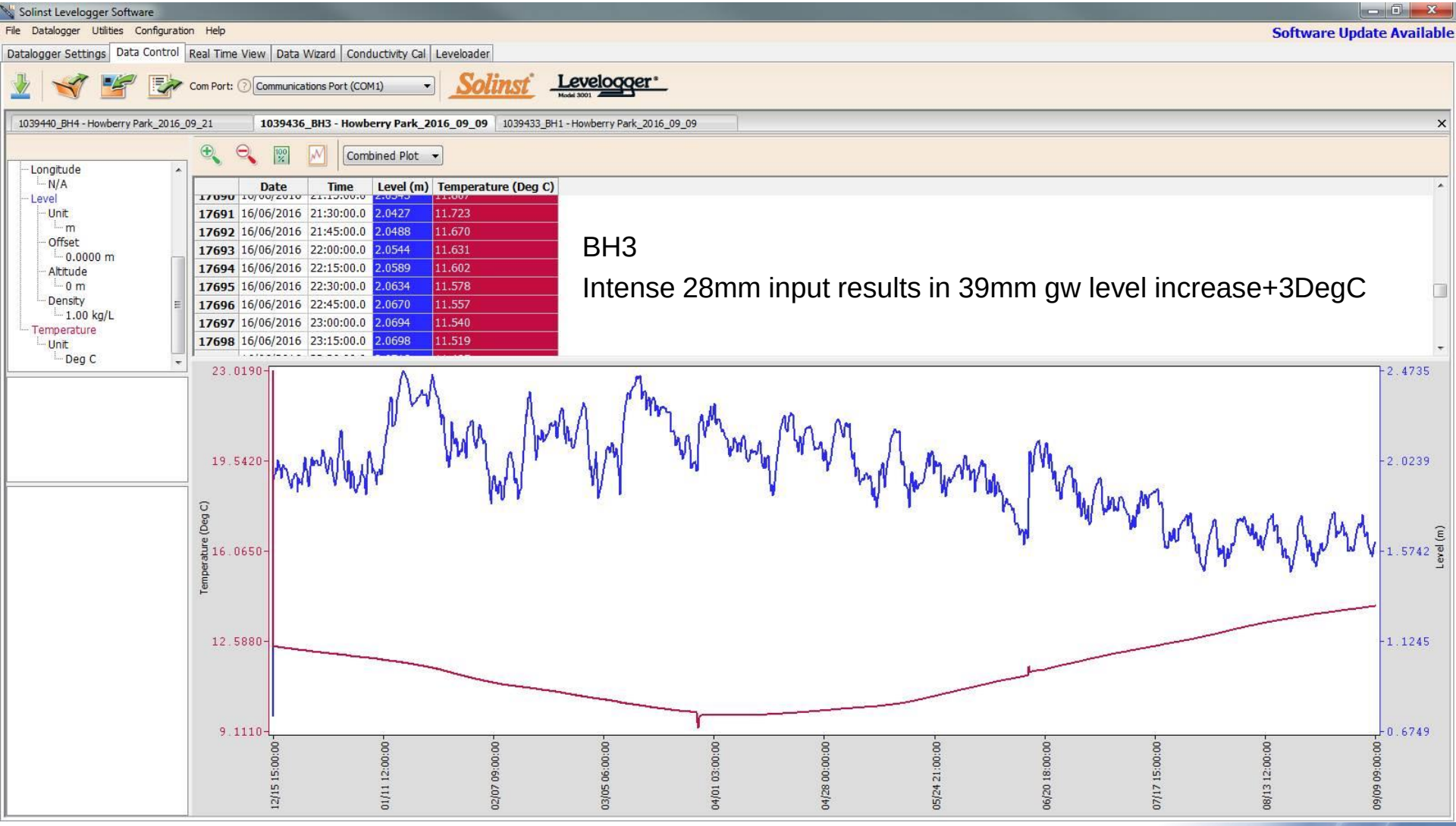

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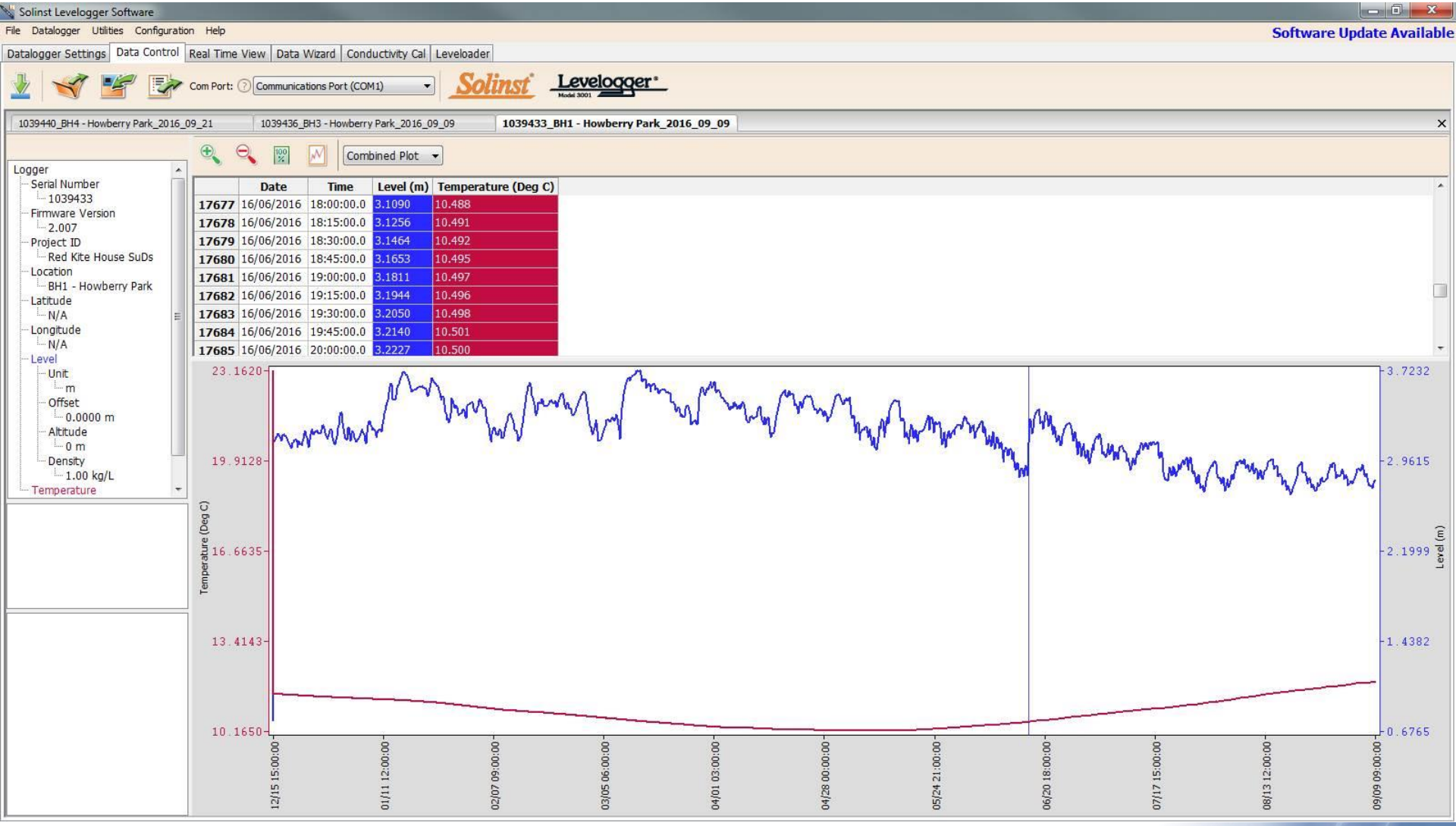

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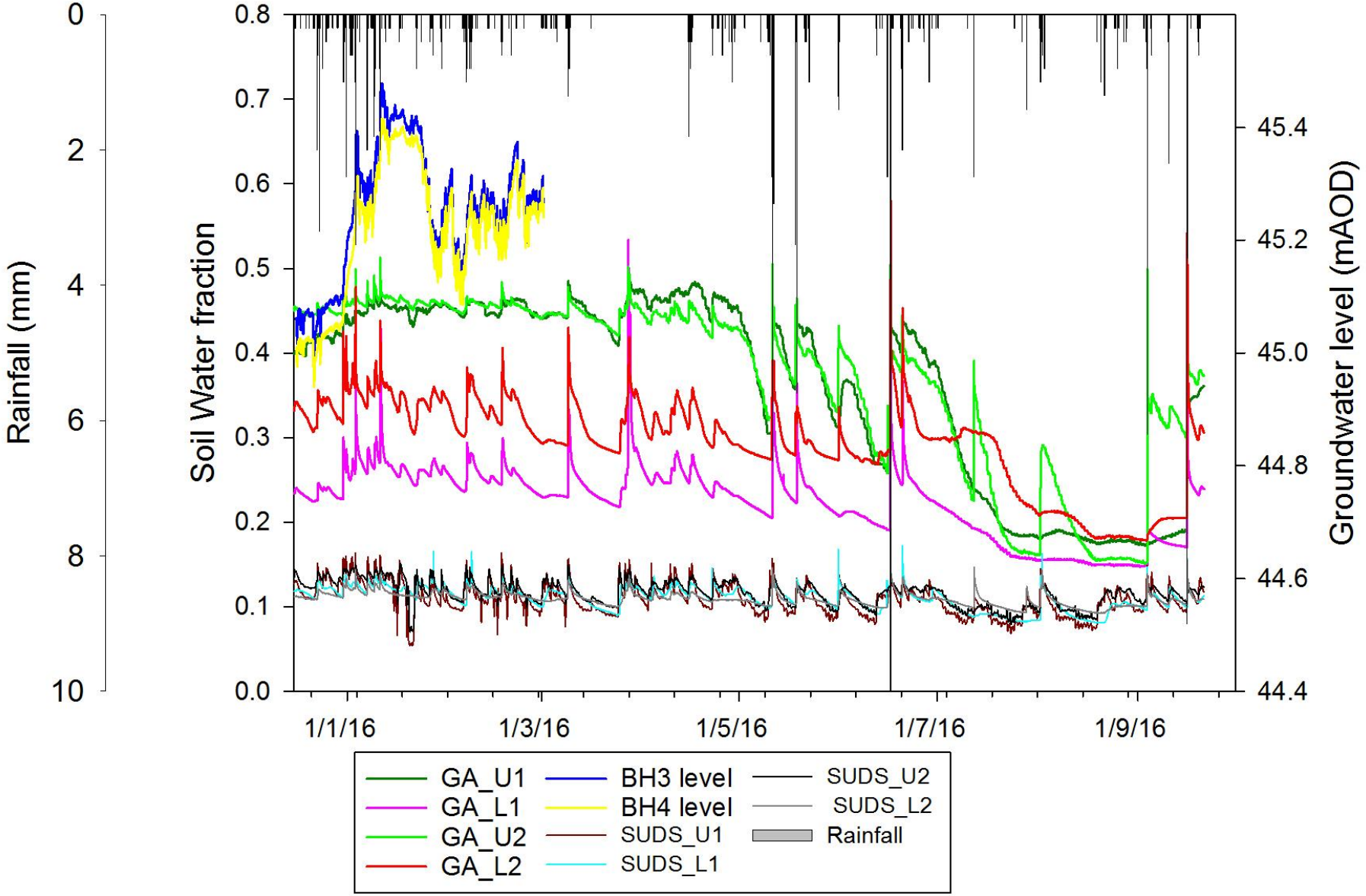
Detailed groundwater responses to rainfall:



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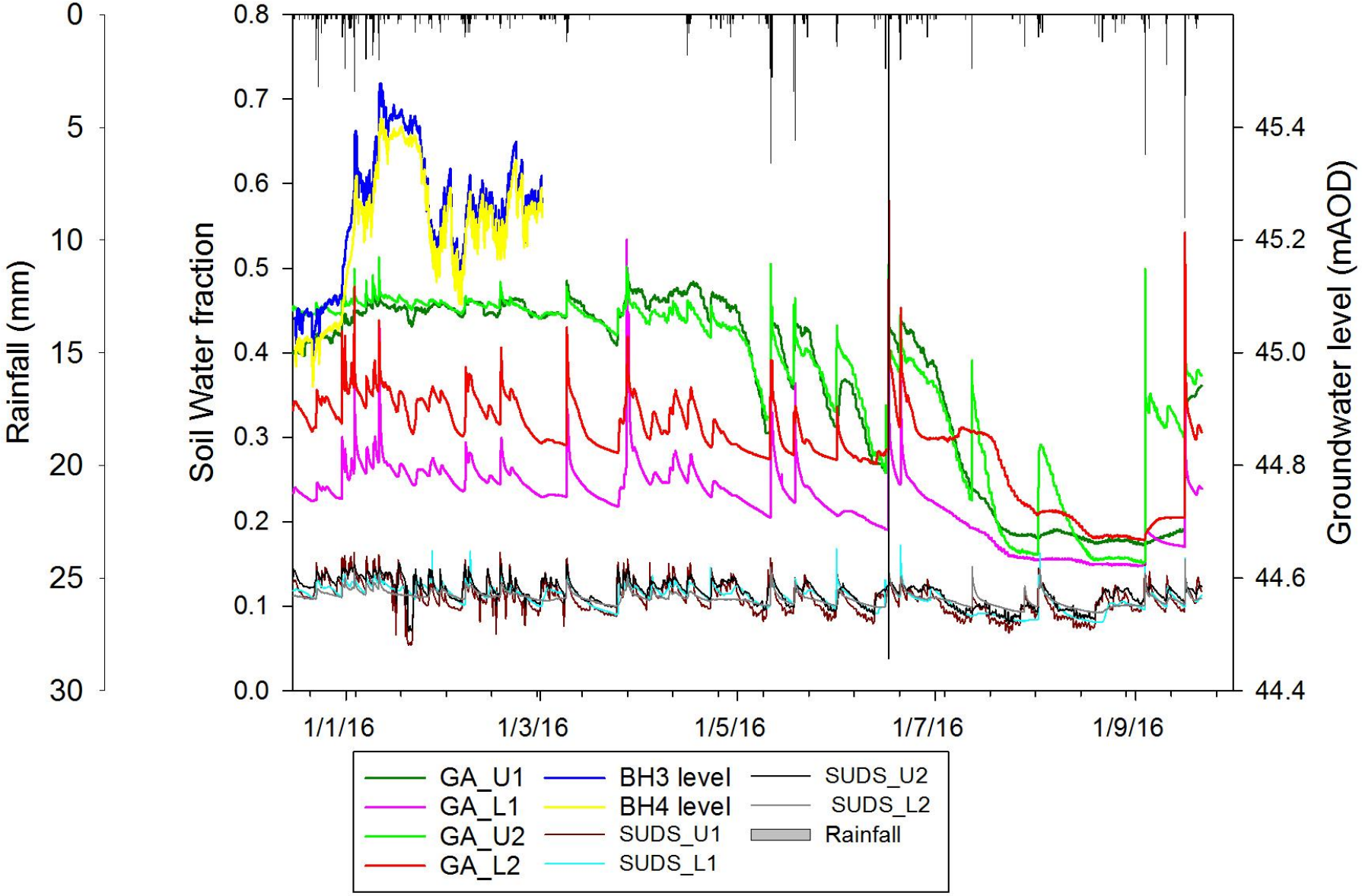
Detailed groundwater responses to rainfall:



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Detailed responses to rainfall:

Steady

Intense

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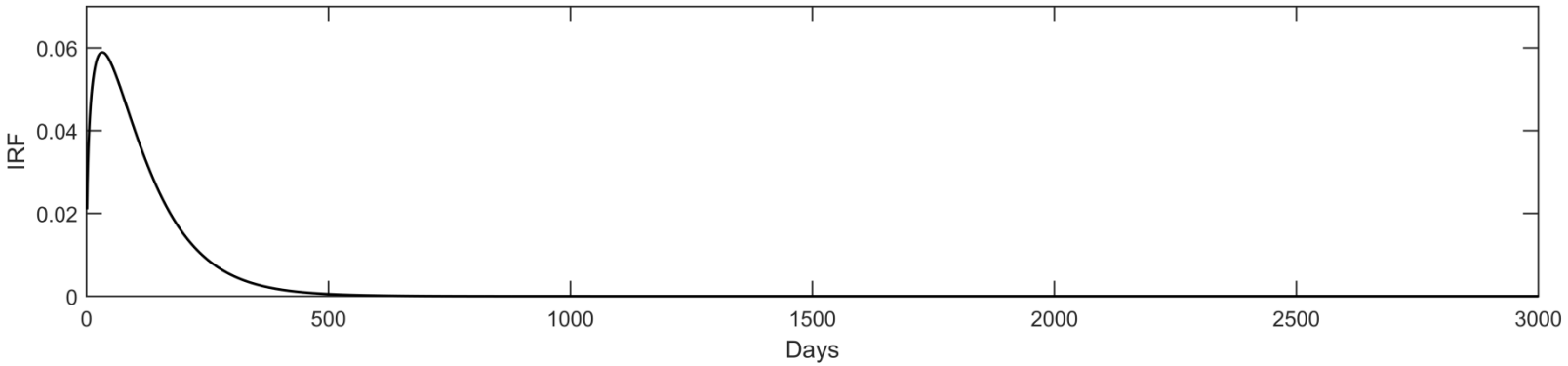
Impulse Response Function

Marginal change in groundwater level (GWL) (as a function of time) caused by 1mm of effective rainfall at time zero.



$$\mathrm{IRF} = \frac{A a^n t^{n-1} \exp\left(-at\right)}{\Gamma\left(n\right)}$$

Need to estimate three parameters to minimize difference between modelled and observed GWLs

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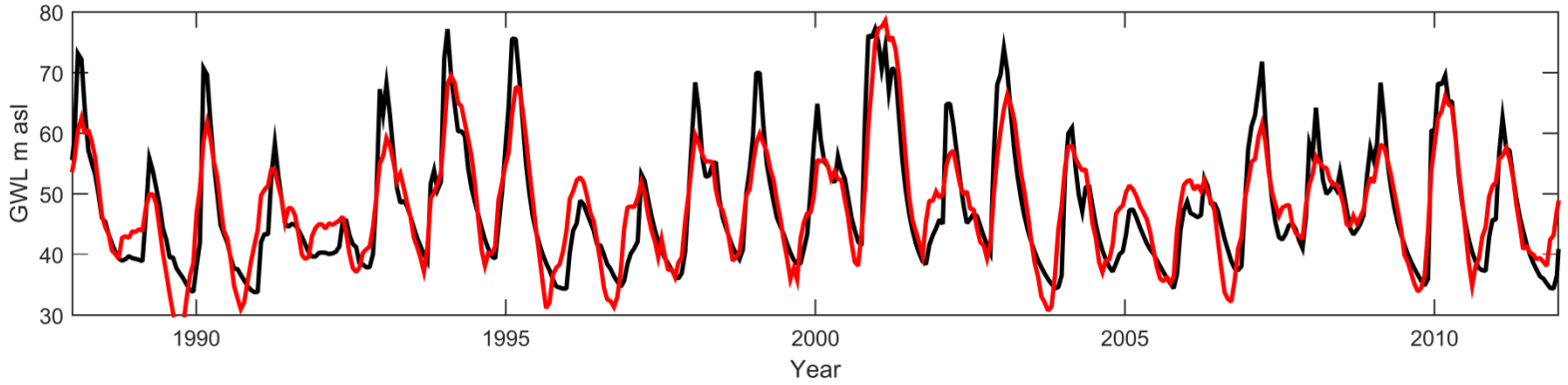
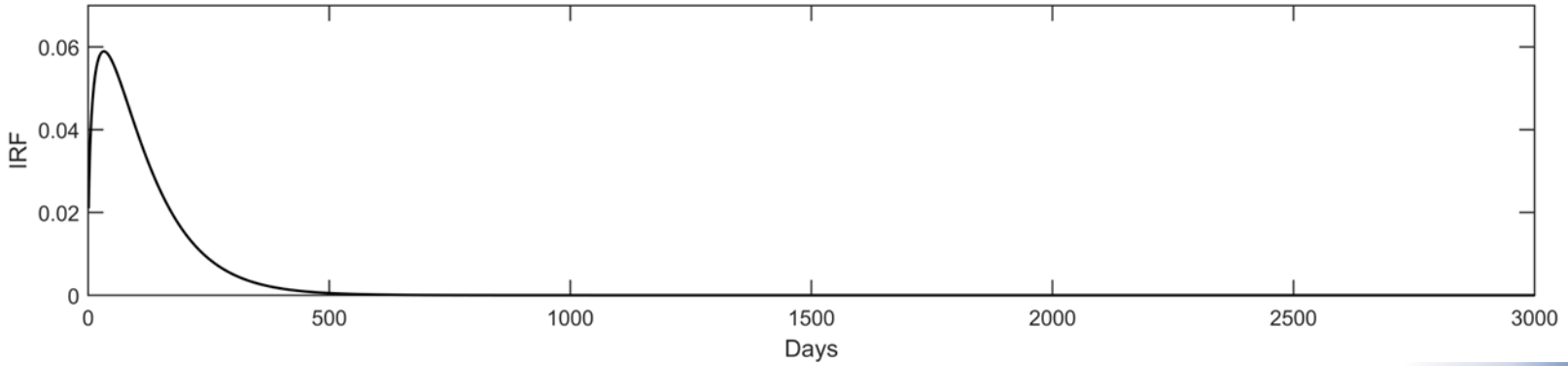
Modelled Values

Modelled
Observed

Chilgrove House





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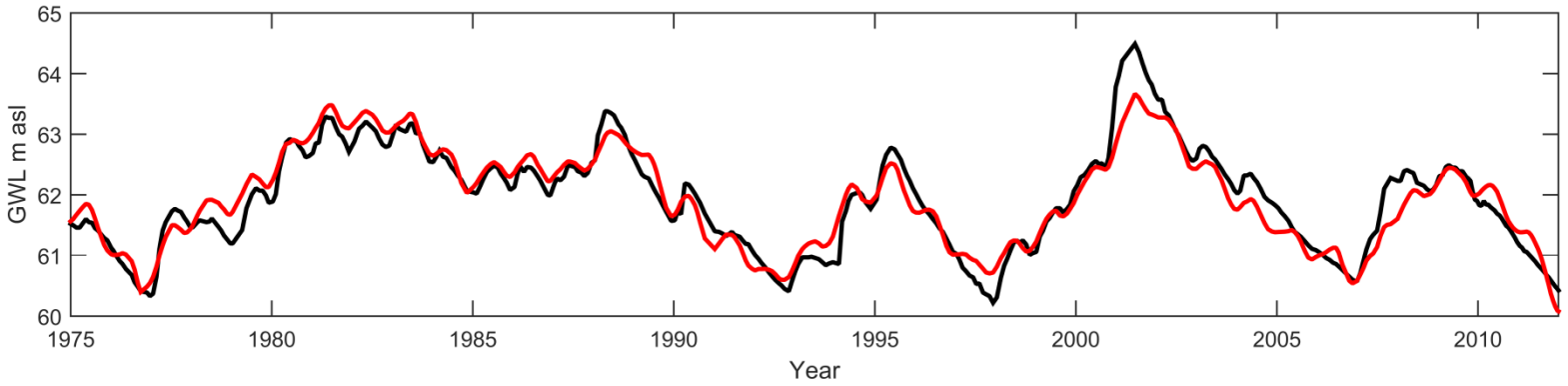
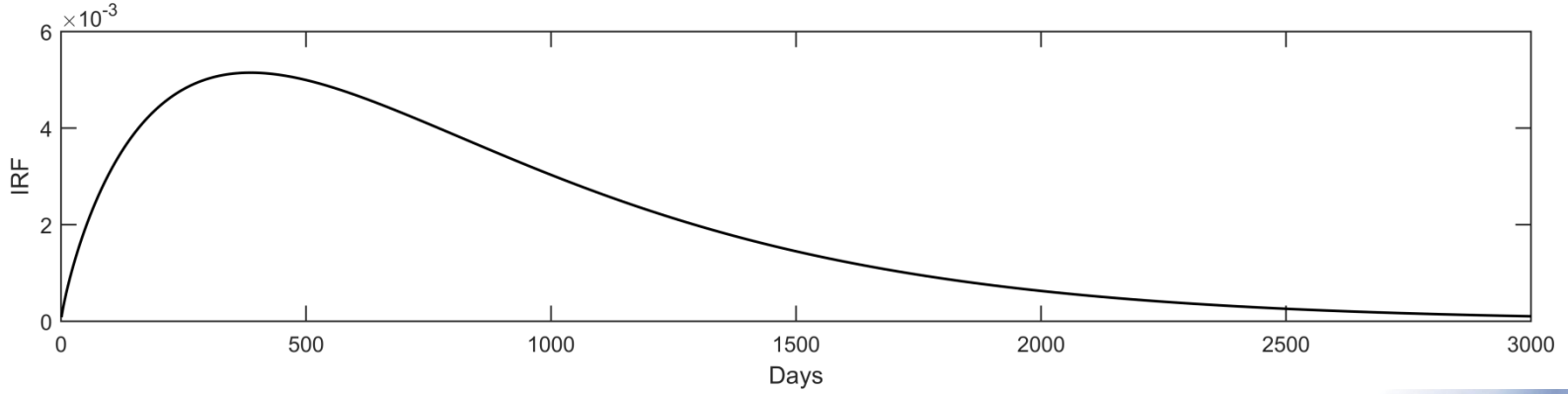
Heath Lane

Modelled
Observed





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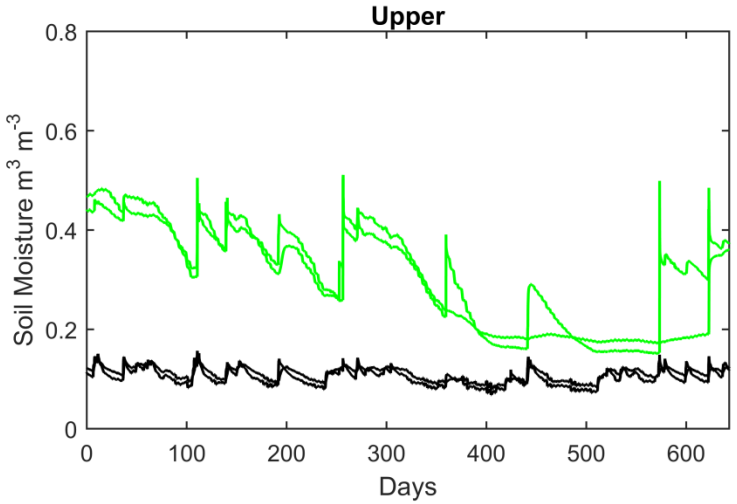
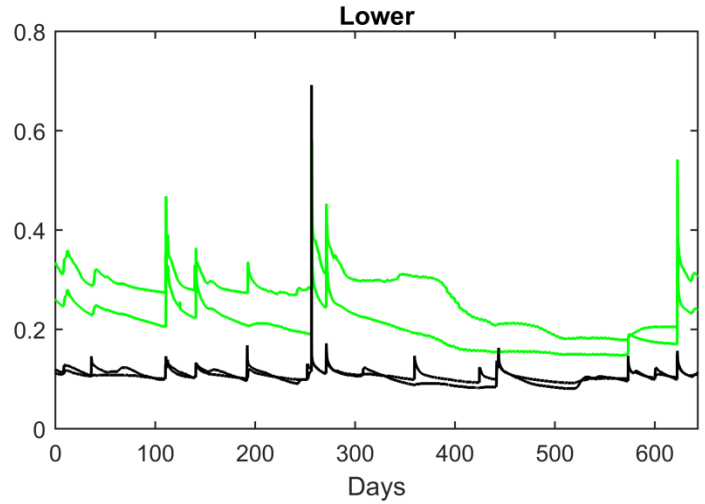
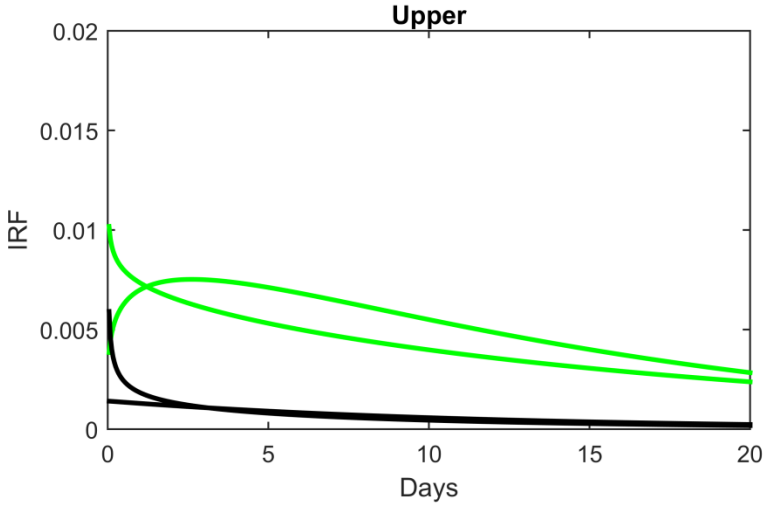
SuDS Comparison

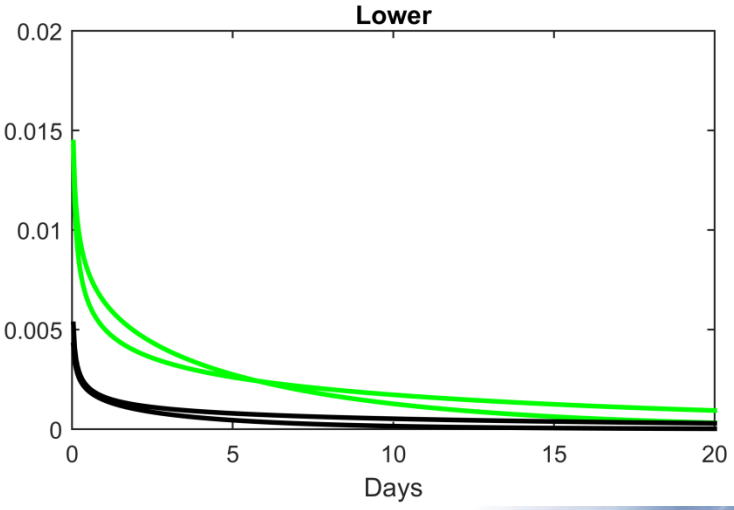
Grass

SuDS









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Future programme

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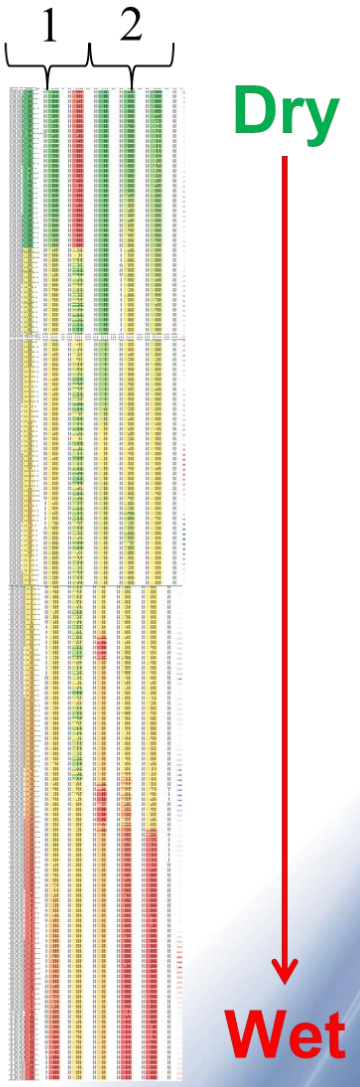
Future programme

Soil moisture probe data

	No	Time	#1:%vol:35848	#2:°C:(do.)	#3:%ampl:(do.)	#4:%vol:35849	#5:°C:(do.	#6:%amp
1	Logger: #000185 'GlobeLog10' - www.IMKO.com - V2.01 - Jul 14 2010							
2	No	Time	#1:%vol:35848	#2:°C:(do.)	#3:%ampl:(do.)	#4:%vol:35849	#5:°C:(do.	#6:%amp
3	(GPRS ERROR Login: No SIM Card / Signal:0 / 22.05.2014 08:21:06)							
4	5101	22.05.2014 09:00:00	10.53	0	75.8	6.32	0	
5	5102	22.05.2014 09:20:00	10.56	0	76.1	6.27	0	
6	(GPRS ERROR Login: No SIM Card / Signal:0 / 22.05.2014 09:24:18)							
7	5103	22.05.2014 09:40:00	10.66	0	76.2	6.29	0	
8	5104	22.05.2014 10:00:00	10.71	0	76.2	6.29	0	
9	5105	22.05.2014 10:20:00	10.53	0	75.8	6.32	0	
10	(GPRS ERROR Login: No SIM Card / Signal:0 / 22.05.2014 10:24:34)							
11	5106	22.05.2014 10:40:00	10.71	0	76	6.29	0	
12	5107	22.05.2014 11:00:00	10.53	0	75.6	6.26	0	
13	5108	22.05.2014 11:20:00	10.65	0	75.8	6.32	0	
14	(GPRS ERROR Login: No SIM Card / Signal:0 / 22.05.2014 11:24:50)							
15	5109	22.05.2014 11:40:00	10.7	0	75.8	6.26	0	
16	5110	22.05.2014 12:00:00	10.55	0	75.4	6.24	0	
17	5111	22.05.2014 12:20:00	10.53	0	75.4	6.31	0	
18	(GPRS ERROR Login: No SIM Card / Signal:0 / 22.05.2014 12:25:06)							
19	5112	22.05.2014 12:40:00	10.7	0	75.6	6.29	0	
20	5113	22.05.2014 13:00:00	10.62	0	75.4	6.31	0	
21	5114	22.05.2014 13:20:00	10.66	0	75.4	6.34	0	
22	(GPRS ERROR Login: No SIM Card / Signal:0 / 22.05.2014 13:21:07)							
23	5115	22.05.2014 13:40:00	10.53	0	75.2	6.29	0	
24	5116	22.05.2014 14:00:00	10.64	0	75.3	6.33	0	
25	5117	22.05.2014 14:20:00	10.58	0	75.1	6.33	0	
26	(GPRS ERROR Login: No SIM Card / Signal:0 / 22.05.2014 14:21:06)							
27	5118	22.05.2014 14:40:00	10.55	0	75	6.3	0	
28	5119	22.05.2014 15:00:00	10.57	0	75	6.37	0	
29	5120	22.05.2014 15:20:00	10.5	0	74.9	6.34	0	



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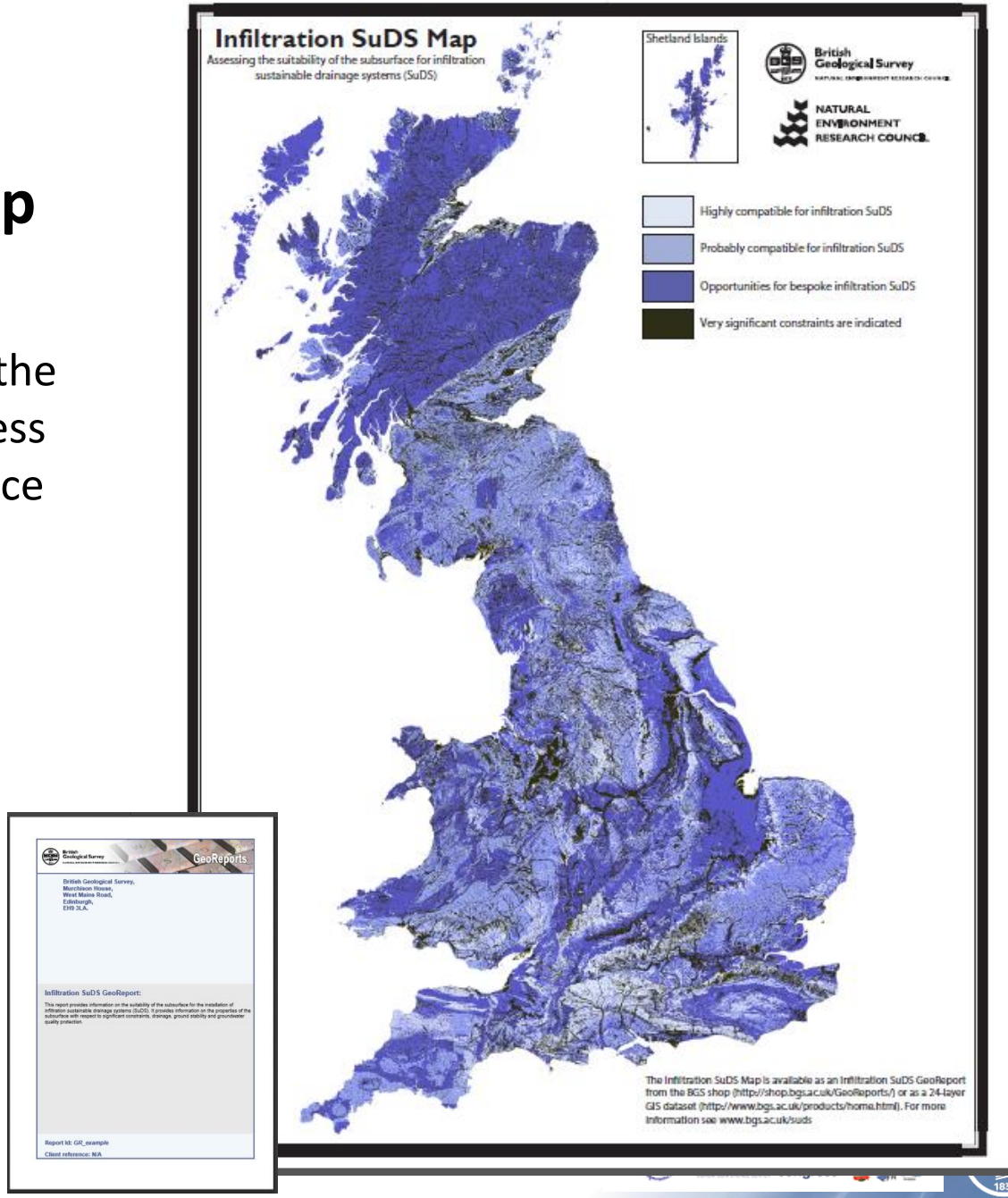
Applications

Infiltration SuDS Map

A national map that provides the information necessary to assess the suitability of the subsurface for infiltration SuDS

SUSTAINABLE DRAINAGE & FLOOD MANAGEMENT INITIATIVE OF THE YEAR
WATER INDUSTRY ACHIEVEMENT AWARDS 2013
WINNER



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Applications

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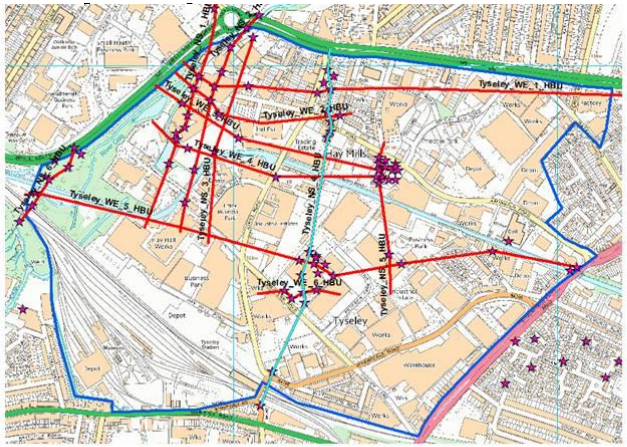
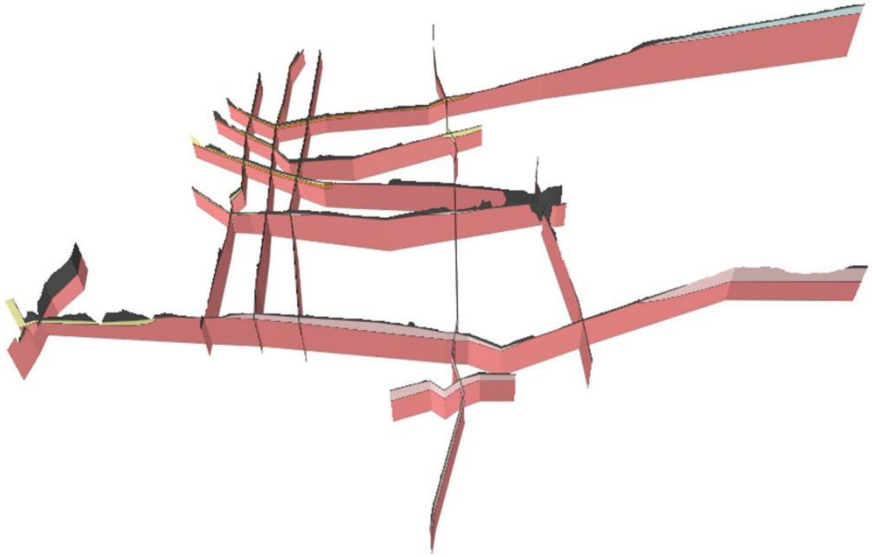
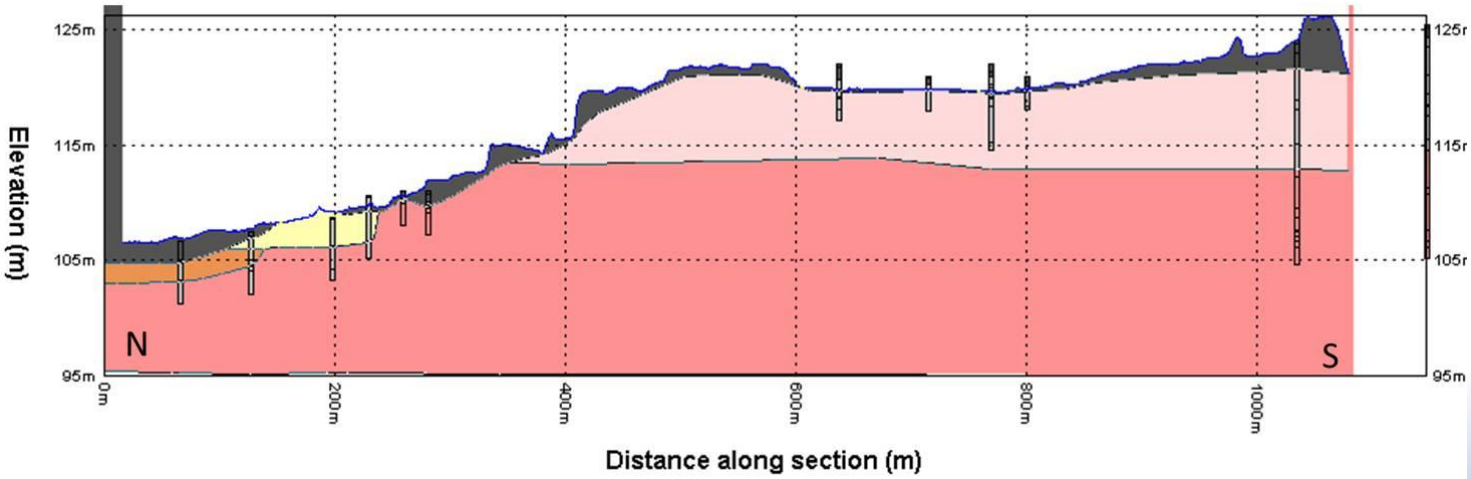
Applications







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Perhaps a worthwhile application?

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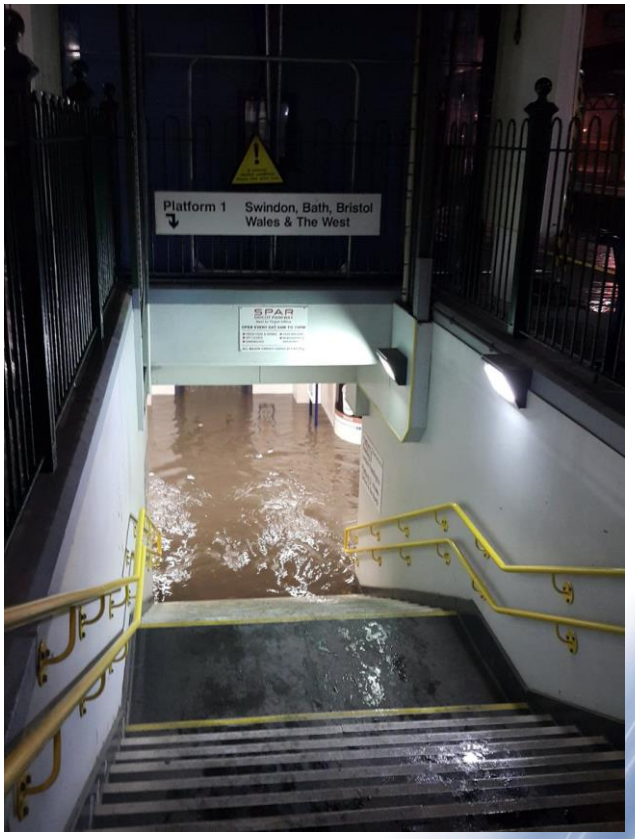
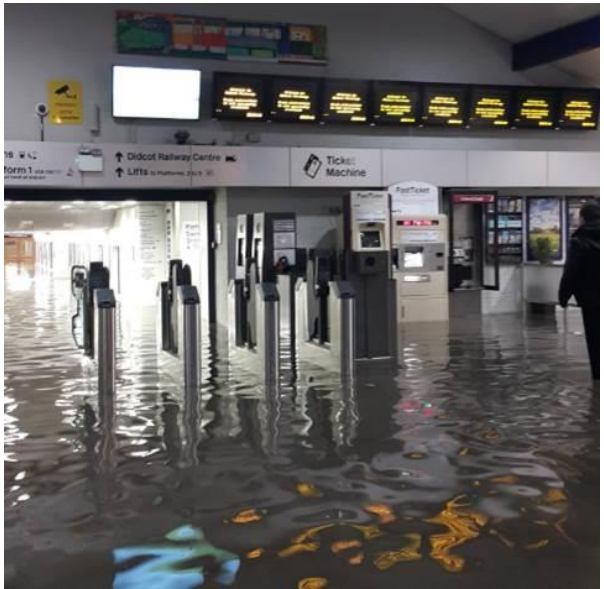
Didcot Parkway railway station £8m revamp complete *BBC News*





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