



Tayside Biodiversity Partnership



Angus Council and Tayside Biodiversity Partnership

## ANGUS COUNCIL SuDS AUDIT AND BIODIVERSITY VALUE REVIEW



Sarah CLEMENT, April 2017

## Contents

<b>Introduction</b> .....	<b>1</b>
<b>I. Materials and Methods</b> .....	<b>2</b>
a. Watering places identification .....	2
b. SuDS identification .....	2
c. Table of attributes .....	3
d. SuDS survey .....	3
i. How clean is the water? .....	3
ii. Is the water acid or alkaline? .....	4
iii. How healthy are the SuDS? .....	4
e. Anecdotal public reports .....	5
<b>II. Results</b> .....	<b>6</b>
a. Watering places identification .....	6
b. SuDS identification .....	6
c. Surveys and table of attributes .....	7
d. Qgis results .....	14
<b>III. Discussion</b> .....	<b>15</b>
a. Lochs, ponds and private ponds .....	15
b. SuDS identification .....	15
c. Amphibian survey .....	15
d. OPAL survey .....	15
e. Qgis map ( <i>Figure 31</i> ) .....	15
f. Public understanding .....	16
<b>IV. Conclusion</b> .....	<b>16</b>
<b>V. Recommendations and further works</b> .....	<b>17</b>
<b>VI. Acknowledgements</b> .....	<b>17</b>
<b>Bibliography</b> .....	<b>18</b>

## List of figures

<b>Figure 1:</b> <i>The Sustainable drainage triangle concept for multiple benefits of SuDS (B. D’Arcy 2000)</i> .....	1
<b>Figure 2:</b> <i>Example of a plan geo-referenced and the drawing of the contours</i> .....	2
<b>Figure 3:</b> <i>Picture of the OPALometer, provided by OPAL for the water survey</i> .....	4
<b>Figure 4:</b> <i>Pictures of some invertebrate that can be found in the SuDS</i> .....	4
<b>Figure 5:</b> <i>Picture of the message post on the Angus Council Intranet</i> .....	5
<b>Figure 6:</b> <i>Map of Angus with all the ponds and lochs</i> .....	6
<b>Figure 7:</b> <i>Location of SuDS in Angus, with their ID and their status</i> .....	6
<b>Figure 8:</b> <i>Picture of the SuDS n<sup>o</sup>1 - Forfar</i> .....	7
<b>Figure 9:</b> <i>Picture of the SuDS n<sup>o</sup>2 - Forfar</i> .....	7
<b>Figure 10:</b> <i>Picture of the SuDS n<sup>o</sup>3 - Forfar</i> .....	8
<b>Figure 11:</b> <i>Picture of the SuDS n<sup>o</sup>6 - Arbroath</i> .....	8
<b>Figure 12:</b> <i>Picture of the SuDS n<sup>o</sup>7 - Forfar</i> .....	8
<b>Figure 13:</b> <i>Picture of the SuDS n<sup>o</sup>8 - Friockheim</i> .....	8
<b>Figure 14:</b> <i>Picture of the SuDS n<sup>o</sup>9 - Lunan</i> .....	8
<b>Figure 15:</b> <i>Picture of the SuDS n<sup>o</sup>10 - Forfar</i> .....	8
<b>Figure 16:</b> <i>Picture of the SuDS n<sup>o</sup>11 - Forfar</i> .....	9
<b>Figure 17:</b> <i>Picture of the SuDS n<sup>o</sup>13 - Auchmithie</i> .....	9
<b>Figure 18:</b> <i>Picture of the SuDS n<sup>o</sup>15 - Lunan</i> .....	9
<b>Figure 19:</b> <i>Picture of the SuDS n<sup>o</sup>16 - Montrose</i> .....	9
<b>Figure 20:</b> <i>Picture of the SuDS n<sup>o</sup>17 - Arbroath</i> .....	9
<b>Figure 21:</b> <i>Picture of the SuDS n<sup>o</sup>18 - Arbroath</i> .....	9
<b>Figure 22:</b> <i>Picture of the SuDS n<sup>o</sup>19 - Arbroath</i> .....	10
<b>Figure 23:</b> <i>Picture of the SuDS n<sup>o</sup>20 - Forfar</i> .....	10
<b>Figure 24:</b> <i>Picture of the SuDS n<sup>o</sup>21 - Forfar</i> .....	10
<b>Figure 25:</b> <i>Picture of the SuDS n<sup>o</sup>23 - Birkhill</i> .....	10
<b>Figure 26:</b> <i>Picture of the SuDS n<sup>o</sup>24 - Birkhill</i> .....	10
<b>Figure 27:</b> <i>Picture of the SuDS n<sup>o</sup>28 - Minifieth</i> .....	10
<b>Figure 28:</b> <i>Picture of the SuDS n<sup>o</sup>32 - Forfar</i> .....	11
<b>Figure 29:</b> <i>Picture of the SuDS n<sup>o</sup>33 - Monifieth</i> .....	11
<b>Figure 30:</b> <i>Picture of the SuDS n<sup>o</sup>35 - Brechin</i> .....	11
<b>Figure 31:</b> <i>Map of Angus with the report of amphibian, the 1km buffer around the SuDS and the ponds....</i>	14

## List of tables:

<b>Table 1:</b> <i>Amphibian species dispersal distances (M. Rae, 2015)</i> .....	3
<b>Table 2:</b> <i>Attribute table for the biodiversity aspect</i> .....	7
<b>Table 3:</b> <i>Table of the 12 SuDS suitable for amphibians</i> .....	12
<b>Table 4:</b> <i>Table with all the information collected during the OPAL survey</i> .....	13
<b>Table 5:</b> <i>Table continued from previous page</i> .....	14

## Introduction

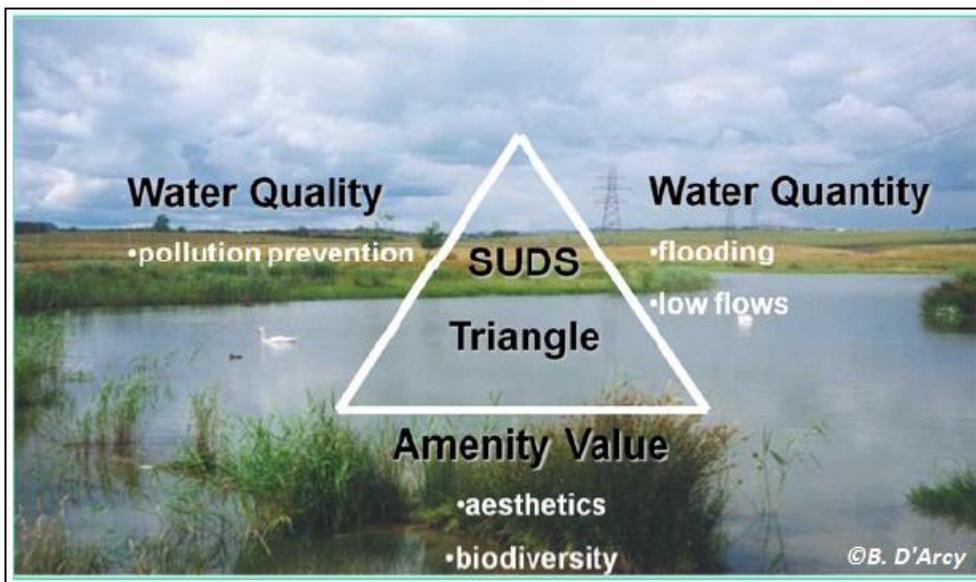
In many cases urbanisation can have a negative impact on wildlife. The artificialisation of the ground, the development of towns and cities and climate change, can all increase the risk of flooding and cause fragmentation of species populations. Indeed, the rise of impermeable surface hinders the water to soak into the ground and improve the speed of water flows<sup>1</sup>.

Since the Water Environment & Water Services (Scotland) Act 2003<sup>2</sup>, the construction of SuDS (Sustainable Drainage Systems) is mandatory in all new development. By definition, SuDS are “a sequence of management practices and control systems designed to drain surface water in a more sustainable manner than some conventional techniques”<sup>3</sup>.

There are different types of SuDS: ponds, detention or retention basins, swales, pervious pavements or green roofs<sup>1</sup>. Even if their first role is to prevent flooding, they can also provide a habitat for wildlife, amenity space for residents and help to decontaminate the water. They can be useful in developed areas as well as in the countryside and can be a significant part of both blue and green corridors.

SuDS benefits for amphibians have been proven in a lot of studies. One of them has been prepared by C. David O’Brien in Sustainable Drainage System (SuDS) Ponds in Inverness, UK and the Favourable Conservation Status of Amphibian<sup>4</sup>. Three other studies have been done, two within Perth and Kinross Council by Andrew Law of Tayside Biodiversity Partnership: “The Amphibians in Drains Project 2014”<sup>5</sup> and “The PKC SuDS Biodiversity Review and Report”<sup>6</sup> (2015). The third study was completed by Marcia Rae in Inverness: “The Biodiversity Value of SuDS in Inverness and their Ability to Provide Multiple Benefits Within the Urban Environment”<sup>7</sup> (2015).

The current study aims to prepare a similar study of the one from Perth and Kinross Council for Angus Council. This study has two objectives - the first, similar to the Perth and Kinross Council audit, to determinate the potential biodiversity of SuDS in the Angus area, the second to record habitat types within a 1km buffer of the SuDS to determine how SuDS in Angus can be integrated into green and blue corridors.



**Figure 1:** The Sustainable drainage triangle concept for multiple benefits of SuDS (D’Arcy 2013)<sup>8</sup>

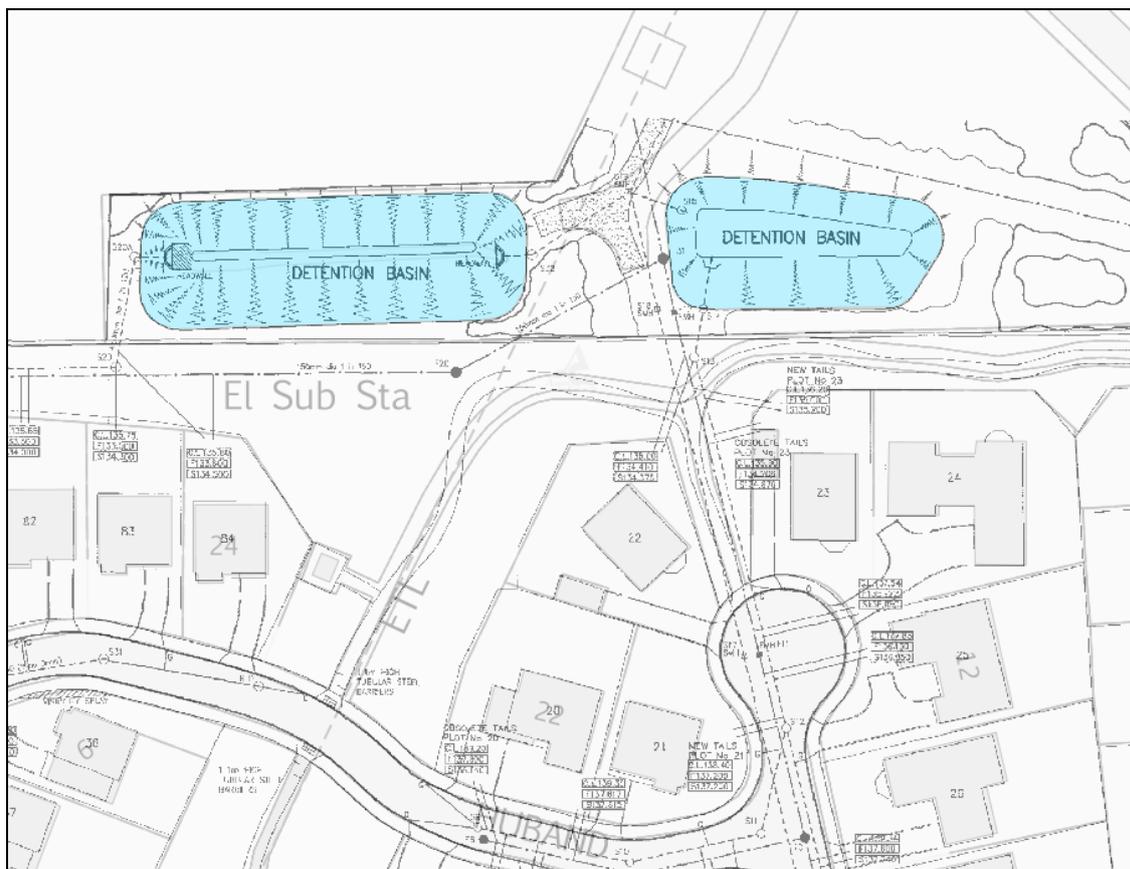
## I. Material and Methods

### 1) Watering places identification

To ascertain possible blue corridors, all watering places in Angus were mapped: an OS map and aerial view layers from the Council’s GIS systems were used with a grid from 1 kilometre side length. Every square has been studied in a systematic way and every watering place has been mapped in a layer. To try to find some private ponds, we used the OPAL (Open Air Laboratories) website. Indeed, this organisation proposes surveys on different subjects and one in particular is about the quality of water in ponds. A score is attributed to each pond, reflecting its quality. All the surveys can be found on the website in the form of a map. Unfortunately, there is no survey completed within Angus at present so no pond has yet been mapped with this method.

### 2) SuDS identification

The first part of the work is to identify all the SuDS in Angus. An email asking for information was sent to the Council’s planning team of Angus Council. Then, every plan of new developments from 1992 were studied to find all the SuDS. These plans were on the Angus Council computer system. All information received was checked against an OS map and an aerial view from the Council’s GIS systems on the software Qgis. Some SuDS could not be found because of the age of the layers. Once all the SuDS identified, they were mapped on Qgis as polygons. The PDF plans have been put on Qgis and geo-referenced. The polygons have been created, following the trails of the plan (*Figure 2*).



**Figure 2:** Example of a plan geo-referenced and the drawing of the contours

### 3) Table of attributes

Two tables of attributes have been created, one to reflect the biodiversity aspect and another for the Council's Road Service. Thus, it is possible to have only one layer but two tables. The table for the roads contains various information, including the ID of the SuDS, the feature (whether it is a Detention basin, Retention basin or Swale), its status (Prospective or In place), the USRN (Unique Street Reference Number), the road name, the coordinates, the basin area, the water area, the volume of water, the volume of the basin, the number of inlets, the number of outlets or the discharge rate. For our usage, the additional table contains six more column as the type of SuDS (Wet or Dry), the OPAL score, if it's a migration route, if there is gullypot near it, the habitat within one kilometre and the amphibian species found on the SuDS.

### 4) SuDS Survey

As the swales are rarely wet, we chose to concentrate our effort on the detention and retention basins. These seem to be a better place for amphibians to choose to spawn. An initial survey was done on Qgis during March 2017. We created a buffer of one kilometre around the detention and retention basin and identified all the habitats around thanks to the aerial view. We chose a kilometre according to the table from Marcia Rae's report (*Table 1*). A kilometre almost contains all the dispersal distances except the maximum recommended inter-pond distance for Palmate newt. Furthermore, with the help of another layer with all the gullypots in Angus, we have noticed the presence or absence of gullypots near to the SuDS. We have thus begun to fill the attribute table with this information.

**Table 1:** Amphibian species dispersal distances (M. Rae, 2015)

Species	Upper migration distance	Maximum recommended inter-pond distance
Toad	5000m	1000m
Frog	2000m	1000m
Palmate	1000m	500m

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After this first survey, we did another one on the sites. At first, we looked to see if any amphibians or their spawn was on site and which species. Then, we completed the OPAL survey. Open Air Laboratories (OPAL) is an organisation which offers different citizen science activities to collect scientific data by local people. One of these surveys is about the water quality of ponds. We chose to use it to evaluate the water quality of our SuDS. OPAL provides a comprehensive pack to help undertake the survey: guidelines, a Freshwater Invertebrate Identification Guide, an OPALmeter, some pH strips and an OPAL magnifier. To be able to do the survey, the Tayside Biodiversity Partnership provided a pond net, a tray and plastic bottle. The survey was divided into three activities:

#### *i. How clean is the water?*

To determine the transparency of the water, a 1p coin was taped to the back of the OPALmeter and then put in the bottle (*Figure 3*). The bottle had been filled with water from the SUDS and after a few moments, the number of OPAL logos had been counted by looking in the top of the bottle. We also noticed the colour of the water.



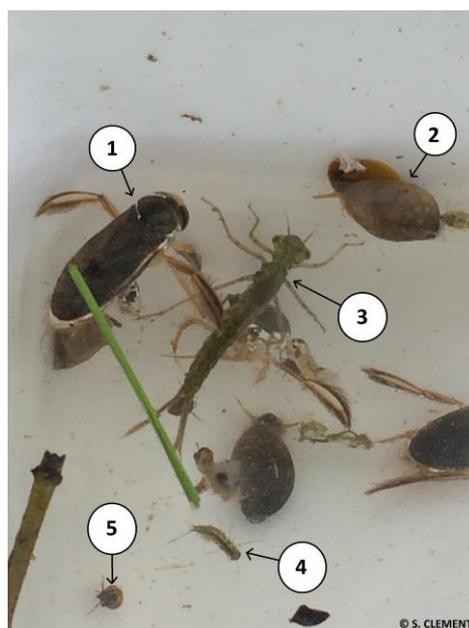
**Figure 3:** Picture of the OPALometer, provided by OPAL for the water survey

*ii. Is the water acid or alkaline?*

The pH strip was put in the water for 3 seconds and after 2 minutes, it was possible to read the colour of the indicator zone and determine the pH of the water.

*iii. How healthy are the SuDS?*

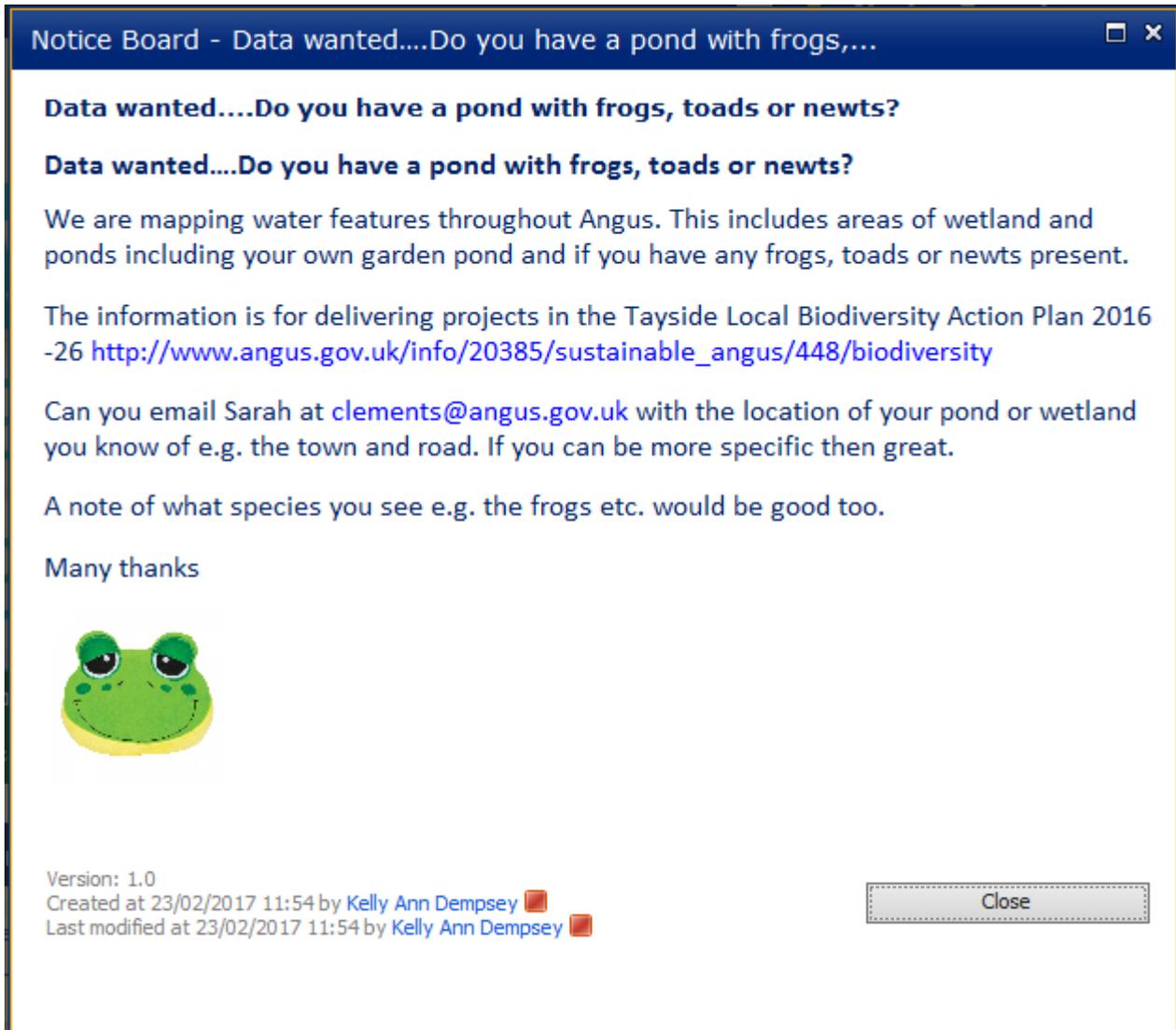
The first check was to see if there were any insects skating on the surface. If there were any, they were identified and noted. Then, some water from the SuDS was collected and put in the tray. With a figure-of-eight motion, the net was put on the plants of the SUDS and the contents decanted into the tray. All the animals in the tray were identified thanks to the Freshwater Invertebrate Identification Guide provided (*Figure 4*). This activity was repeated several times for each SuDS, in different places and in different habitats. The book provided gave a number for each type of insect and at the end of the identification session, a score was attributed to the SuDS. A score of 31 or more meant that the SuDS is very healthy; a score between 6 and 30 meant that the SuDS is quite healthy; a score between 5 and 0 meant the SuDS needs to be improved. For example, according to *Figure 4*, we can identify invertebrate n<sup>o</sup>1 as a Water bug which is worth 5 units, n<sup>o</sup>2 is a snail and worth 1 units, n<sup>o</sup>3 is a Damselfly larvae and worth 10 units, n<sup>o</sup>4 is a Mayfly or Stonefly larvae and worth 5 units and to finish, n<sup>o</sup>5 is a Water mite and for these score, is not worth anything. In this picture, therefore, we reach the score of 21. With just these invertebrates in the tray the OPAL score of the SuDS is 21 and the SuDS is deemed “quite healthy”.



**Figure 4:** Pictures of some invertebrate that can be found in the SuDS.

## 5) Anecdotal public reports

As we wanted to find as many watering places as possible and as the Angus Council intranet can be accessed by up to 5,000 people we decided to post a message on it. This was posted to capture anecdotal reports of amphibians in people's gardens or other watering places (Figure 5). Thus, it was possible to collect reports of where amphibians are breeding and information about individuals. Moreover, according to Beebee T.J.C.<sup>9</sup> garden ponds are really important for amphibians in urban places.

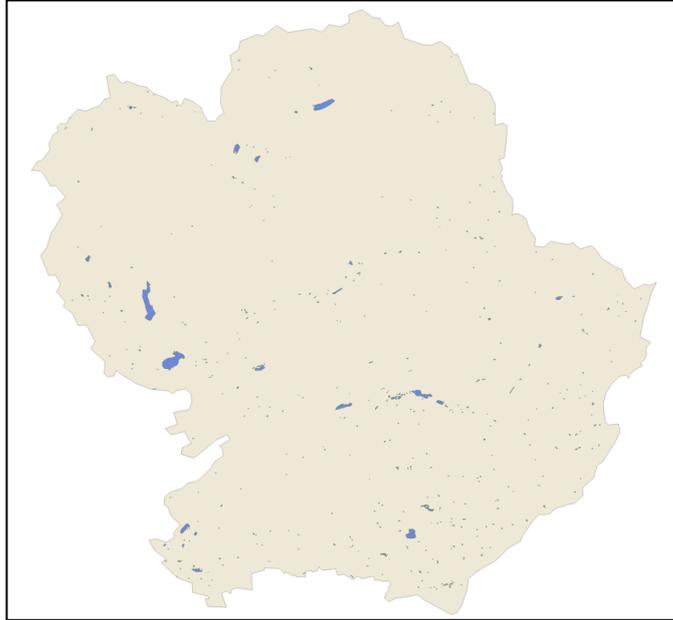


**Figure 5:** Picture of the message post on the Angus Council Intranet

## II. Results

### 1) Watering places identification

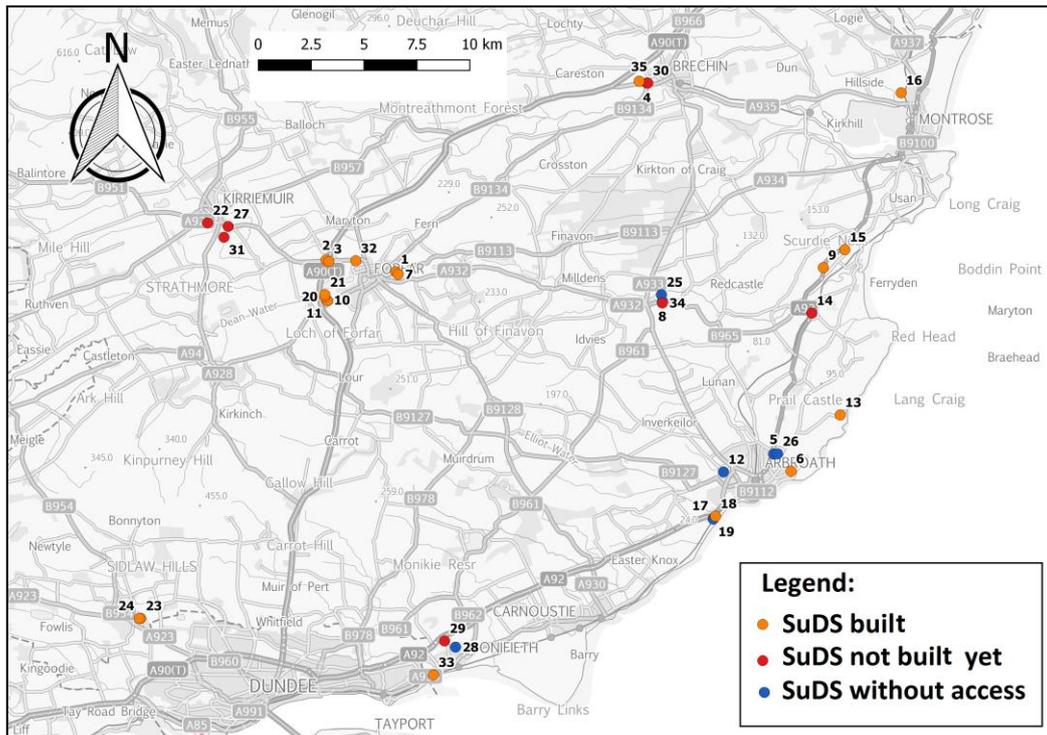
A total of 573 ponds and loch have been mapped, distributed around the territory (*Figure 6*). The smallest one was 5 m<sup>2</sup> and the largest one was 1, 793, 724 m<sup>2</sup>.



**Figure 6:** Map of Angus with all the ponds and lochs

### 2) SuDS identification

35 SuDS have been found in Angus with only detention basins, no retention basins. 20 of the detention basins were already built, 8 were not built yet and 7 cannot be accessed (*Figure 7*).



**Figure 7:** Location of SuDS in Angus, with their ID and their status

### 3) Surveys and table of attributes

**Table 2: Attribute table for the biodiversity aspect**

SuDS ID	Qgis ID	Road name	Town	Feature	Status	Easting	Northing	SuDS type	Opal Score	Migration route	Gullypots	1 km buffer habitats	Species
1	108	Montrose Road	Forfar	Detention basin	In place	346914	751098	Dry		Unlikely			
2	126	A90(T) West	Forfar	Detention basin	In place	343617	751675	Wet	17	Definitely	Yes	Farmland, Road	Frogs, Toads
3	127	A90(T) East	Forfar	Detention basin	In place	343740	751586	Wet	16	Definitely	Yes	Farmland, Road	Toads
4	116	Dubton Farm West	Brechin	Detention basin	Prospective	358778	760082						
5	105	Montrose Road	Arbroath	Detention basin	In place	364774	742414	No access					
6	91	Cliffburn Road	Arbroath	Detention basin	In place	365596	741598	Dry		Unlikely			
7	137	Priority Wynd	Forfar	Detention basin	In place	347017	750972	Dry		Unlikely			
8	113	Gardyne Street	Friockheim	Detention basin	In place	359503	749654	No access					
9	128	A92 West	Lunan	Detention basin	In place	367125	751289	Wet	42	Definitely	No	Woodland, Farmland, Road	Toads
10	154	Orchardbank North	Forfar	Detention basin	In place	343650	749743	Dry		Possible			
11	153	Orchardbank South	Forfar	Detention basin	In place	343674	749720	Wet	16	Possible	No	Car park, Wetland, Woodland	None
12	123	East Muirland Road	Arbroath	Detention basin	Prospective	362389	741576						
13	129	Kirkbank	Auchmithie	Detention basin	In place	367922	744273	Dry		Unlikely			
14	124	Keilor Way	Inverkeilor	Detention basin	Prospective	366580	749116						
15	130	A92 East	Lunan	Detention basin	In place	368138	752143	Wet	32	Likely	Yes	Woodland, Farmland, Road	None
16	82	Mallard Drive	Montrose	Detention basin	In place	370807	759617	Wet	37	Likely	Yes	Urban, Farmland	None
17	131	Walmar Cottage	Arbroath	Detention basin	In place	361921	739358	Dry		Unlikely			
18	135	Elliot bridge	Arbroath	Detention basin	In place	362025	739452	Dry		Unlikely			
19	133	Walmar Cottage	Arbroath	Detention basin	In place	361922	739312	No access					
20	151	Orchard Loan South	Forfar	Detention basin	In place	343549	749908	Wet	1	Definitely	Yes	Woodland, Wetland, Road	Frogs, Toads, Newts (Forfar Loch)
21	152	Orchard Loan North	Forfar	Detention basin	In place	343556	750001	Wet	11	Definitely	Yes	Woodland, Wetland, Road	Frogs, Toads, Newts (Forfar Loch)
22	4	Sunnyside	Kirriemuir	Detention basin	Prospective	338003	753420						
23	84	Huband East	Birkhill	Detention basin	In place	334847	734590	Wet	1	Unlikely	Yes	Urban, Farmland	None
24	83	Huband West	Birkhill	Detention basin	In place	334788	734588	Wet	1	Unlikely	Yes	Urban, Farmland	None
25	85	Millgate Dam	Friockheim	Detention basin	In place	359469	749998	No access					
26	107	Montrose Road	Arbroath	Detention basin	Prospective	364974	742445						
27	110	Pathhead Farm	Kirriemuir	Detention basin	Prospective	339014	753264						
28	114	Ashludie Hospital	Monifieth	Detention basin	In place	349721	733214	No access					
29	115	the Grange	Monifieth	Detention basin	Prospective	349210	733498						
30	117	Dubton Farm East	Brechin	Detention basin	Prospective	358820	760079						
31	122	East Muirhead of Logie	Kirriemuir	Detention basin	Prospective	338824	752757						
32	157	Communities Building	Forfar	Detention basin	In place	345013	751620	Wet	16		Yes	Grassland, Road	None
33	156	Ferry road	Monifieth	Detention basin	In place	348687	731895	Dry		Possible			
34	112	Gardyne Street	Friockheim	Detention basin	Prospective	359506	749595						
35	150	Brechin Business Park	Brechin	Detention basin	In place	358417	760168	Wet	17	Likely	Yes	Urban, Farmland, Road	None

The survey on the software Qgis allowed us to identify the habitats around the SuDS. The variable “Road” means that there is a major road just near to it. Also, with the help of the layer with the gullypots, we have been capable to determine if there are any gullypots near to the SuDS. Indeed, a lot of amphibians are trapped and die in these drains when they migrate to their breeding place. Thus, we’re going to be able to determine in which gullypot we need to put ladders to help them to escape (Trevor Rose and Clare McInvoy, 2015)<sup>10</sup>.

During the survey on site, we have taken pictures of the SuDS to be able to follow the evolution for them (Figure 8 to 30).



**Figure 8:** Picture of the SuDS n<sup>o</sup>1 - Forfar



**Figure 9:** Picture of the SuDS n<sup>o</sup>2 - Forfar



**Figure 10:** Picture of the SuDS n<sup>o</sup>3 - Forfar



**Figure 11:** Picture of the SuDS n<sup>o</sup>6 - Arbroath



**Figure 12:** Picture of the SuDS n<sup>o</sup>7 - Forfar



**Figure 13:** Picture of the SuDS n<sup>o</sup>8 - Friockheim



**Figure 14:** Picture of the SuDS n<sup>o</sup>9 - Lunan



**Figure 15:** Picture of the SuDS n<sup>o</sup>10 - Forfar



**Figure 16:** Picture of the SuDS n<sup>0</sup>11 - Forfar



**Figure 17:** Picture of the SuDS n<sup>0</sup>13 - Auchmithie



**Figure 18:** Picture of the SuDS n<sup>0</sup>15 - Lunan



**Figure 19:** Picture of the SuDS n<sup>0</sup>16 - Montrose



**Figure 20:** Picture of the SuDS n<sup>0</sup>17 - Arbroath



**Figure 21:** Picture of the SuDS n<sup>0</sup>18 - Arbroath



**Figure 22:** Picture of the SuDS n°19 - Arbroath



**Figure 23:** Picture of the SuDS n°20 - Forfar



**Figure 24:** Picture of the SuDS n°21 - Forfar



**Figure 25:** Picture of the SuDS n°23 - Birkhill



**Figure 26:** Picture of the SuDS n°24 - Birkhill



**Figure 27:** Picture of the SuDS n°28 - Monifieth



**Figure 28:** Picture of the SuDS n°32 - Forfar



**Figure 29:** Picture of the SuDS n°33 - Monifieth



**Figure 30:** Picture of the SuDS n°35 - Brechin

With the survey on site, we were able to confirm the type of surrounding habitats. Also, it allowed us to fill the column “Status” with the two variables “In place” or “Prospective”, the column “SuDS type” with three variables: “Wet”, “Dry” or “No access”, the “OPAL score” column according to the OPAL survey method and the “Species” column with the observation of amphibian individuals or spawns.

The “Migration route” column was filled according to the “SuDS type”, the “OPAL score” and the species found on the site. Thus, four terms have been chosen to fill the column, based on Andrew Law’s previous work<sup>6</sup>. The term “Definitely” was for the SuDS which have amphibians or spawns, “Likely” is for the SuDS without amphibians found but with good potential to host them, “Possible” for the SuDS which need to be improve to welcome amphibians and “Unlikely” for the SuDS which are dry and do not appear to be suitable for amphibians. By deleting the SuDS with “Unlikely” for the “Migration route”, the one inaccessible and the one which is not build yet, we found 12 SuDS which are of interest for amphibians (Table 3).

**Table 3: Table of the 12 “good” SuDS**

SuDS ID	Ogis ID	Road name	Town	Feature	Status	Easting	Northing	SuDS type	Opal Score	Migration route	Gullypots	1 km buffer habitats	Species
2	126	A90(T) West	Forfar	Detention basin	In place	343617	751675	Wet	17	Definitely	Yes	Farmland, Road	Frogs, Toads
3	127	A90(T) East	Forfar	Detention basin	In place	343740	751586	Wet	16	Definitely	Yes	Farmland, Road	Toads
9	128	A92 West	Lunan	Detention basin	In place	367125	751289	Wet	42	Definitely	No	Woodland, Farmland, Road	Toads
10	154	Orchardbank North	Forfar	Detention basin	In place	343650	749743	Dry		Possible			
11	153	Orchardbank South	Forfar	Detention basin	In place	343674	749720	Wet	16	Possible	No	Car park, Wetland, Woodland	None
15	130	A92 East	Lunan	Detention basin	In place	368138	752143	Wet	32	Likely	Yes	Woodland, Farmland, Road	None
16	82	Mallard Drive	Montrose	Detention basin	In place	370807	759617	Wet	37	Likely	Yes	Urban, Farmland	None
20	151	Orchard Loan South	Forfar	Detention basin	In place	343549	749908	Wet	1	Definitely	Yes	Woodland, Wetland, Road	Frogs, Toads, Newts (Forfar Loch)
21	152	Orchard Loan North	Forfar	Detention basin	In place	343556	750001	Wet	11	Definitely	Yes	Woodland, Wetland, Road	Frogs, Toads, Newts (Forfar Loch)
32	157	Communities Building	Forfar	Detention basin	In place	345013	751620	Wet	16	Possible	Yes	Grassland, Road	None
33	156	Ferry road	Monifieth	Detention basin	In place	348687	731895	Dry		Possible			
35	150	Brechin Business Park	Brechin	Detention basin	In place	358417	760168	Wet	17	Likely	Yes	Urban, Farmland, Road	None

All the information collected during the OPAL survey was put into a table (*Table 4*).

**Table 4: Table with all the information collected during the OPAL survey**

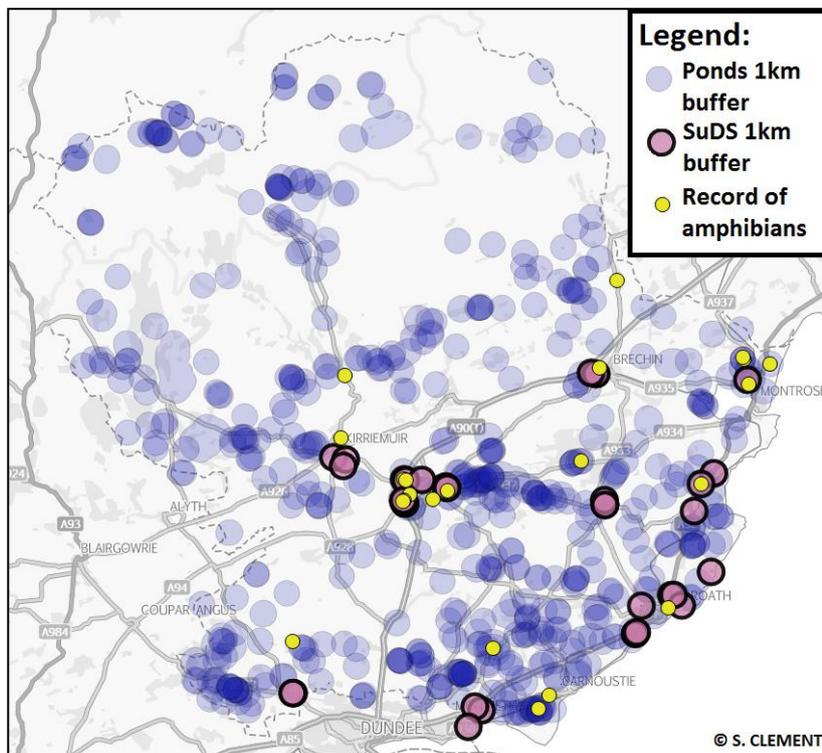
SuDS number Town	Date of survey	Time	Weather	Area around		Edge of the SuDS	Pollution	Type	OPAL logos	Water colour	pH	Pond Health Score	Species	Spawns
21 Forfar	28/03/2017	10.00 am	Cloudy	Urban <b>Woodland</b> Garden Park	Farmland Grassland <b>Wetland</b> School	Paving stone <b>Long Grass</b> Bare ground Mown grass Trees	Industrial chimneys <b>Rubbish in pond</b> Discharge pipes Foam Road less than 20m Algal bloom	Wet	11	Yellow/ Brown	7.5	11		1 from frog
7 Forfar	29/03/2017	10.00 am	Cloudy	Urban <b>Woodland</b> Garden <b>Park</b>	Farmland Grassland Wetland School	Paving stone Long Grass Bare ground <b>Mown grass</b> Trees	Industrial chimneys <b>Rubbish in pond</b> Discharge pipes Foam <b>Road less than 20m</b> Algal bloom	Dry						
2 Forfar	29/03/2017	10.30 am	Cloudy with little rain	Urban Woodland Garden Park	<b>Farmland</b> Grassland Wetland School	Paving stone Long Grass <b>Bare ground</b> Mown grass Trees	Industrial chimneys <b>Rubbish in pond</b> Discharge pipes Foam <b>Road less than 20m</b> Algal bloom	Wet	12	None	6.5	17		3 from frog 2 from toad
3 Forfar	29/03/2017	11.00 am	Cloudy with little rain	Urban Woodland Garden Park	<b>Farmland</b> Grassland Wetland School	Paving stone <b>Long Grass</b> Bare ground Mown grass Trees	Industrial chimneys <b>Rubbish in pond</b> Discharge pipes Foam <b>Road less than 20m</b> Algal bloom	Wet	12	None	7	16	4 toads	
10 Forfar	29/03/2017	12.00 am	Cloudy	Urban Woodland Garden Park	Farmland <b>Grassland</b> Wetland School	Paving stone <b>Long Grass</b> Bare ground Mown grass Trees	Industrial chimneys <b>Rubbish in pond</b> Discharge pipes Foam Road less than 20m Algal bloom	Dry						
11 Forfar	29/03/2017	12.10 am	Cloudy	Urban Woodland Garden Park	Farmland <b>Grassland</b> Wetland School	Paving stone <b>Long Grass</b> Bare ground Mown grass Trees	Industrial chimneys <b>Rubbish in pond</b> Discharge pipes Foam Road less than 20m Algal bloom	Wet	12	None	7	16		
20 Forfar	29/03/2017	12.30 am	Cloudy	Urban <b>Woodland</b> Garden Park	Farmland Grassland <b>Wetland</b> School	Paving stone <b>Long Grass</b> Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam <b>Road less than 20m</b> Algal bloom	Wet	2	Brown/ Black	7.5	1		
23 Birkhill	30/03/2017	9.30 am	Cloudy	Urban Woodland Garden Park	<b>Farmland</b> Grassland Wetland School	Paving stone <b>Long Grass</b> Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam <b>Road less than 20m</b> Algal bloom	Wet	12	None	7	1		
24 Birkhill	30/03/2017	10.00 am	Cloudy	Urban Woodland Garden Park	<b>Farmland</b> Grassland Wetland School	Paving stone <b>Long Grass</b> Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam <b>Road less than 20m</b> Algal bloom	Wet	12	None	6.5	1		
32 Forfar	06/04/2017	16.15 pm	Sunny	Urban Woodland Garden Park	Farmland <b>Grassland</b> Wetland School	Paving stone Long Grass <b>Bare ground</b> <b>Mown grass</b> Trees	Industrial chimneys <b>Rubbish in pond</b> Discharge pipes Foam Road less than 20m Algal bloom	Wet	12	None	7.5	16		
9 Lunan	07/04/2017	15.00 pm	Sunny	Urban <b>Woodland</b> Garden Park	Farmland Grassland Wetland School	Paving stone Long Grass <b>Bare ground</b> Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam <b>Road less than 20m</b> Algal bloom	Wet	12	None	6.5	42		Probable spawn of toad (find some eggs)

**Table 5:** Table continued from previous page

15 Lunan	07/04/2017	15.30 pm	Sunny	Urban Woodland Garden Park	Farmland Grassland Wetland School	Paving stone Long Grass Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam Road less than 20m Algal bloom	Wet	12	None	7	32		
35 Brechin	10/04/2017	11.30 am	Sunny	Urban Woodland Garden Park	Farmland Grassland Wetland School	Paving stone Long Grass Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam Road less than 20m Algal bloom	Wet	9	Yellow/ Green	6.5	17		
16 Montrose	10/04/2017	12.10 pm	Sunny	Urban Woodland Garden Park	Farmland Grassland Wetland School	Paving stone Long Grass Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam Road less than 20m Algal bloom	Wet	12	None	7	37		
13 Auchmithie	10/04/2017	12.40 am	Sunny	Urban Woodland Garden Park	Farmland Grassland Wetland School	Paving stone Long Grass Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam Road less than 20m Algal bloom	Dry						
33 Monifieth	11/04/2017	10.00 am	Cloudy	Urban Woodland Garden Park	Farmland Grassland Wetland School	Paving stone Long Grass Bare ground Mown grass Trees	Industrial chimneys Rubbish in pond Discharge pipes Foam Road less than 20m Algal bloom	Dry						

#### 4) Qgis results

With all the information put in the software Qgis, we've been able to create several maps. One of the most interesting is the one with the buffer of 1 kilometre around the ponds and the SuDS and with the report of amphibians by the public (*Figure 31*).



**Figure 31:** Map of Angus with the report of amphibian, the 1km buffer around the SuDS and the ponds

### III. Discussion

#### 1) Lochs, ponds and private ponds

Even although a lot of attention was given to mapping the ponds and lochs in Angus, some of them may well have been missed as, the method is not fail-proof. For the private ponds, many will have been missed as the message of our search was not received by all the inhabitants of Angus. A second phase of this study would enable all the ponds and lochs to be properly mapped. A colourful flyer, asking local people to provide basic information about their ponds and about their possible records of amphibians would prove useful and would help expand the Tayside Biodiversity Partnership's existing "Pooling our Ponds" community-based project. It will be important to keep the layers in Qgis for this information fully updated.

Further information could be logged where the wetlands in Angus are concerned. These were specifically excluded from this study but as they are important places for amphibians, it would be extremely useful to map all the wetlands in another layer. Moreover, wetlands are a vital part of the blue corridor in Angus.

#### 2) SuDS identification

The methods used to identify all the SuDS are not fail-proof. It is possible that some of them were not mapped so it will be important to keep this layer updated. When a plan of a new development with a SuDS is passed to the Roads Service, the new SuDS should be routinely mapped on the software. The corresponding attribute table must also be kept updated when a new SuDS is created and also if a SuDS which has yet to feature as "Prospective" is now built. In this case, the feature has to be changed and updated in the computer and reporting layer.

#### 3) Amphibian survey

Very few amphibians were seen on site. Even if the observation of spawn helped to determine if there were any toads or frogs, the presence of newts was more complicated to evaluate. It is recommended that other amphibian surveys are carried out on these sites at the appropriate time of year. This could be a task for the Tayside Amphibian & Reptile (TayARG) volunteers or a future internship. These surveys will provide critical information about amphibian breeding places and will help to determine the migration routes and future management of both SuDS and nearby gullypots.

#### 4) OPAL survey

We found 12 wet SuDS. After the OPAL survey on these 12 SuDS, 3 were "very healthy", 6 were "quite healthy" and 3 "need to be improved". It is apparent therefore that the SuDS in Angus are not very healthy and most of them can be improved for biodiversity. The median of the OPAL scores is 16 and the average is 17.25. Therefore the water quality of the SuDS is quite good.

In addition to the OPAL survey, it would be extremely useful to undertake a study about the level of pesticides in the SuDS, particularly nitrate and phosphorus.

#### 5) Qgis map (*Figure 31*)

This map is very interesting because it shows potential blue corridors and the beginning of several migration routes. SuDS can be very important in these migration routes and have the potential to contribute towards the safeguarding of local amphibian populations. For example, the three SuDS in

Kirriemuir could help the amphibians to cross the town in the axis North-West/South-East. In Arbroath, they can provide a very good place for them to breed. Globally, the SuDS are covering the biggest part of the towns, permitting the amphibians to migrate. The ponds and lochs are quite well distributed on Angus. The north is more fragmented but there are a lot of wetlands in this area which compensate this lack of ponds and lochs.

## 6) Public Understanding

According to Thompson C.W.<sup>11</sup>, greenspaces help to reduce stress in local residents. Also, they increase the chance to interact with natural spaces in an urban environment. Thus, SuDS and greenspaces can help people understand the environmental processes and why they are so important.

A very useful study would be to undertake a survey on awareness of SuDS function for the inhabitants of Angus, asking about the three aspects of SuDS (*Figure 1*).

On another level, flyers, press releases and local community meetings could help inform people of all ages about the SuDS utility and the benefits they can provide to each of us.

## IV. Conclusion

The first objective of SuDS is to provide flooding and not to inherently provide good habitats for local biodiversity. However, some small settlements can change them into pristine habitats for amphibians, invertebrates and other animals. The SuDS can easily become part of the Green and Blue corridors system. Importantly it is becoming recognised that SuDS play a major part in safeguarding populations and migration routes of key Tayside Priority Species.

In addition, SuDS can provide an easily accessible and a very valuable education tool about nature, overall ecosystem services and why it is important to raise awareness to local people on their benefits. Public bodies and local authorities have a Biodiversity Duty and SuDS can also be looked upon a key way forward to meet this Duty, involving a wide partnership of organisations and companies.

It is clear that this study is just the beginning of a bigger project and only lays the foundation for further works.

## V. Recommendations and further works

- 1) Repeat the water quality survey during the months of July and August
- 2) Discuss the potential for a study about pesticides in the SuDS (Nitrate and Phosphate)
- 3) Add all new SuDS to the existing database and keep the attribute table up to date
- 4) Arrange amphibian surveys of the SuDS to draw up proposals to improve management for amphibian species
- 5) Map and survey gullypots in 500m around the SuDS
- 6) Undertake Phase 1 habitat survey of the SuDS in the kilometre buffer
- 7) Add new data for the layer of the amphibian records
- 8) Draw up a simple survey form to distribute to the local communities in the vicinity of the SuDS, outlining the work we have done and asking them to let us have their records of amphibians
- 9) Undertake the mapping of all wetlands in Angus
- 10) Raise awareness of the biodiversity benefits of SuDS by sharing this report and future survey requirements to as many people as possible, including the local communities

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## Bibliography

1. Graham A. Day J. Bray B. and Mackenzie S. « Sustainable Drainage Systems, Maximising the Potential for People and Wildlife, A Guide for Local Authorities and Developers ». RSPB and WWT, December 2012. [http://www.rspb.org.uk/Images/SuDS\\_report\\_final\\_tcm9-338064.pdf](http://www.rspb.org.uk/Images/SuDS_report_final_tcm9-338064.pdf)
2. Water Environment and Water Services (Scotland) Act 2003, 2003. [http://www.legislation.gov.uk/asp/2003/3/pdfs/asp\\_20030003\\_en.pdf](http://www.legislation.gov.uk/asp/2003/3/pdfs/asp_20030003_en.pdf)
3. CIRIA. « Sustainable urban drainage systems – design manual for Scotland and Northern Ireland », 2000.
4. O'Brien, C. David. « Sustainable drainage system (SuDS) ponds in Inverness, UK and the favourable conservation status of amphibians », 8 August 2014. [https://www.researchgate.net/publication/264581824\\_Sustainable\\_drainage\\_system\\_SuDS\\_ponds\\_in\\_Inverness\\_UK\\_and\\_the\\_favourable\\_conservation\\_status\\_of\\_amphibians](https://www.researchgate.net/publication/264581824_Sustainable_drainage_system_SuDS_ponds_in_Inverness_UK_and_the_favourable_conservation_status_of_amphibians)
5. Law, Andrew. « Amphibians in Drains Project 2014 », 2014 (Tayside Biodiversity Partnership). <http://www.taysidebiodiversity.co.uk/>
6. Law, Andrew. « Perth & Kinross Council SUDS Biodiversity Review and Report, A Study of Mitigation », August 2015. <http://www.taysidebiodiversity.co.uk/>
7. Rae, Marcia. « The Biodiversity Value of SuDS in Inverness and Their Benefits within the Urban Environment », 2015.
8. D'Arcy Brian J. "Managing Stormwater: From Aspirations to Routine Business". 2013
9. Beebee T.J.C. «Habitats of the British amphibians (2): suburban parks and gardens». Biol Conserv, 1979. [https://www.researchgate.net/publication/229147068\\_Habitats\\_of\\_the\\_British\\_Amphibians\\_2\\_suburban\\_parks\\_and\\_gardens](https://www.researchgate.net/publication/229147068_Habitats_of_the_British_Amphibians_2_suburban_parks_and_gardens)
10. Rose T. McInroy C. «Trialling amphibian ladders within roadside gullypots in Angus, Scotland: 2014 impact study», 2015. <https://www.thebhs.org/publications/the-herpetological-bulletin/issue-number-132-summer-2015/363-04-trialling-amphibian-ladders-within-roadside-gullypots-in-angus-scotland-2014-impact-study/file>
11. Thompson C.W. Roe J. Aspinall P. Mitchell R. Clow A. and Miller D. «The effectiveness of "shared space" residential street intervention on self-reported activity levels and quality of life for older people», 2012. [https://www.researchgate.net/publication/274634716\\_The\\_effectiveness\\_of\\_%27shared\\_space%27\\_residential\\_street\\_interventions\\_on\\_self-reported\\_activity\\_levels\\_and\\_quality\\_of\\_life\\_for\\_older\\_people](https://www.researchgate.net/publication/274634716_The_effectiveness_of_%27shared_space%27_residential_street_interventions_on_self-reported_activity_levels_and_quality_of_life_for_older_people)