

*Update Surveys of Aquatic Invertebrate  
Diversity and *Vertigo moulinsiana*  
abundance at The Springs, Norfolk  
(Northern Distributor Road)*

**2022 Sampling**

Carried out for:

**Norfolk County Council**

Prepared by:

**Abrehart Ecology**

The Barn, Bridge Farm

Friday Street

Brandeston

Suffolk IP13 7BP

Tel: 01728 684362

e-mail: [info@abrehartecology.com](mailto:info@abrehartecology.com)

[www.abrehartecology.com](http://www.abrehartecology.com)

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## 1 Introduction

Abrehart Ecology was commissioned by Norfolk County Council to monitor the diversity of aquatic invertebrate species following initial assessments carried out in 2018 and initial monitoring surveys in 2019 and 2020, as part of development works undertaken as for the Northern Distributor Road near Norwich. The survey acts to continue to monitor populations of the species of conservation interest that may have been impacted by pollutants and run-off during construction works and to highlight any new species that may have colonised the waterbody.

The Springs Lake County Wildlife Site (CWS) is located approximately 1km north-west of Rackheath in Norfolk and is bordered to the south by the A1270 (the Norwich Northern Distributor Road) (Figure 1). The sample sites were located around the lake, within tributary streams, and throughout surrounding terrestrial habitats.

The aim of the survey detailed in this report was to monitor aquatic invertebrate and mollusc diversity following development works (measured against baseline and initial monitoring surveys). This can then be used to inform mitigation, future monitoring, and assist the effective management of the site. The main survey objectives were to provide information on:

- Species richness (of macro-invertebrates);
- Species abundance (of macro-invertebrates); and
- The continued presence and extent of any species of conservation interest, such as *Bithynia leachii* and *Plea minutissima*.

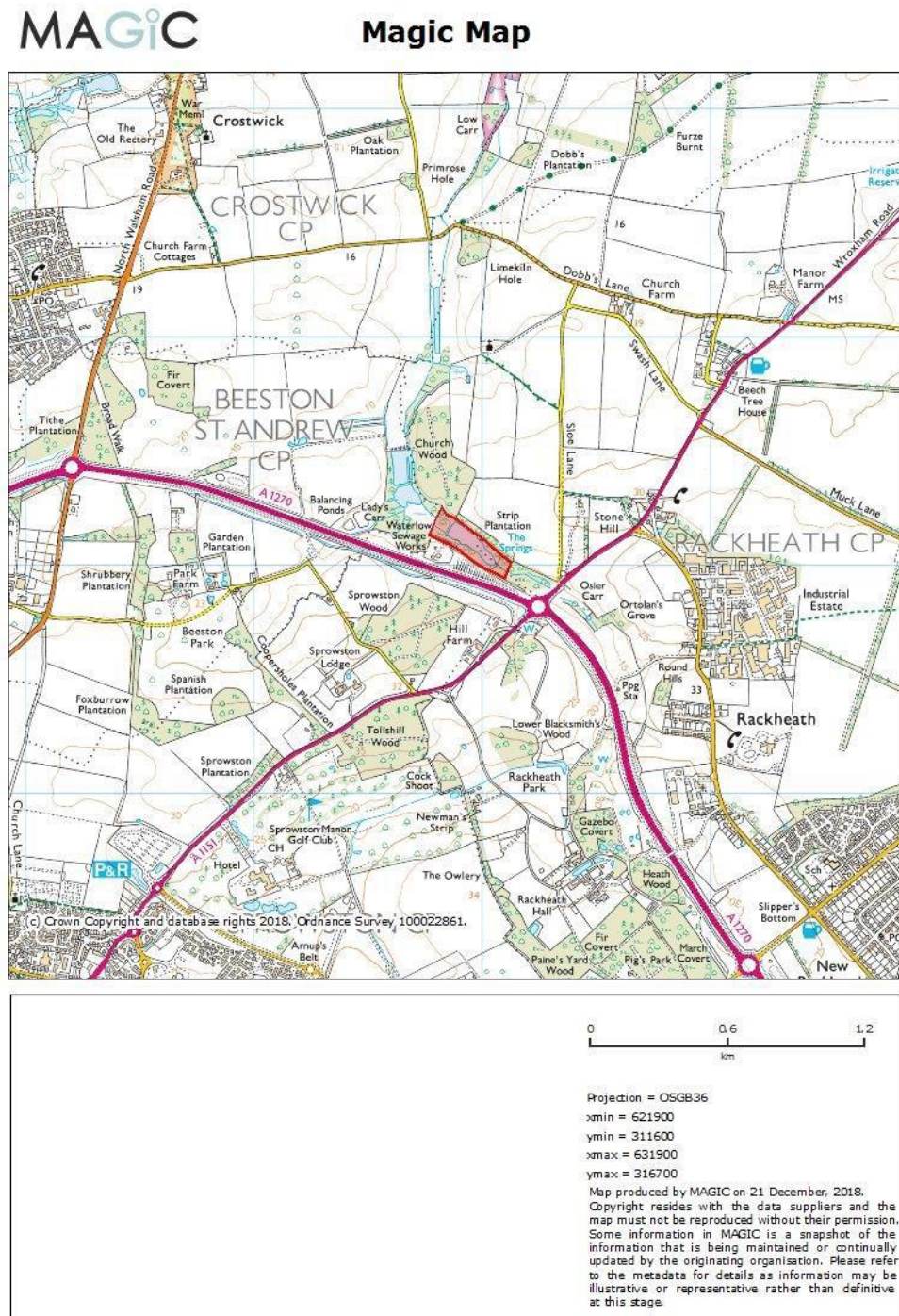


Figure 1: Location of survey area

## 2 Methods

Sampling points were distributed around The Springs CWS, as close as possible to sample locations used in the 2018, 2019 and 2020 surveys conducted by Abrehart Ecology Ltd and previous surveys conducted by Mott MacDonald (Figure 2). Sample collection was undertaken by a pair of surveyors, including an experienced on-site surveyor (Toby Abrehart) and a team member responsible for recording botany, habitat characteristics, and water body features (ecologists from Norfolk County Council (NCC)). All sampling was undertaken in May and August 2022.

### 2.1 Aquatic invertebrate sampling

Ten sweep samples (six sample locations – each with two sweeps performed, in August access was limited to the main fishing lake only) were collected using ten-second sweeps of a net with 0.5mm mesh. Sweeps were repeated three times in different sections of the ditch profile, i.e., floating vegetation (where present), the benthic layer and the submerged edge of the nearside bank. Once collected each sample was placed into a 5-litre bucket and preserved in 99.9% ethanol for long-term storage.

For identification, all invertebrates were separated from the retained sediment, detritus, and vegetation under 40 - 80x stereo, binocular microscopes. All specimens were then separated into major taxonomic groups, preserved in fresh 99.9% ethanol, and referred to an appropriate taxonomist for identification. Where possible, all specimens were identified to species level. Exceptions to this are groups that require specialist, time-consuming preparatory techniques such as head capsule dissection for chironomid larvae and prolonged clearing procedures for oligochaetes species. Such procedures are beyond the remit of this study.

### 2.2 Water chemistry sampling

Abiotic parameters were recorded in the surface 10cm of water including pH, conductivity, total dissolved solids, temperature (all measured using a Hanna HI83303 Aquaculture Photometer). Each sample point was recorded on an Archer2 sub-metre DGPS unit.

Water samples were taken using a five-litre bucket within the surface 15cm of water. These were generally taken from banksides, as these areas were most accessible during survey visits and prevented excessive disturbance which would have been caused through entering the waterbodies.

### 2.3 Mollusc sampling

Non-destructive sampling techniques were used at each selected sample point. A white plastic tray was held near the base of the vegetation and the vegetation was bent over the tray and shaken vigorously. The samples were analysed quantitatively in the field. Specimens of *Vertigo moulinsiana* were recorded as adults or juveniles. Those with a developed lip and apertural teeth were counted as adults and others as juveniles.

### 2.4 Assessment of habitat characteristics

At each sample location ground moisture and vegetation structure were recorded. Ground moisture levels were recorded using a scale of 1-5, using the following criteria (suitable ground moisture levels for *Vertigo moulinsiana* are between 3-5):

1. Dry: no visible moisture on ground surface;
2. Damp: ground visibly damp, but water does not rise under pressure;
3. Wet: water rises under light pressure;
4. Very wet: pools of standing water, generally less than 5cm deep; and
5. Site under water: entire sampling location is in standing or flowing water over 5cm deep.

The average height (in metres) of the main vegetation components within the sample (before beating) was measured using a 2m ruler. The measurement was used in the condition assessment and provided valuable information for assessments. The dominant plant species were recorded and other plant species within the sample were noted.

Thatch depth (measure in centimetres) and percentage canopy cover were also noted. Thatch is a loose, organic layer of dead and living shoots, stems, and roots which is essential for a number of mollusc species.

## 2.5 SAFIS analysis

Data collected during the surveys were processed using SAFIS analysis (Site Analysis for Freshwater Invertebrate Surveys v.30.0). This was used to give an indication of the current conservation value of The Springs, to assess water quality, and to highlight any species of conservation interest already present.

## 2.6 Limitations

Species within the orders Hirundinea (leeches) and Tricladida (flatworms) can be affected by preservation in ethanol (damage to eyes and genital pores – often key features of identification). During future monitoring surveys, samples should be preserved using preservatives such as Bonuin’s or Fleming’s fixative, as recommended by Elliott & Mann (1998) among others.

Sites 5 and 6 were inaccessible during the summer survey (August 2022) as the vegetation was too thick to perform sweep net samples. Therefore, these sites were only sampled in the spring (May 2022).

*Table 1. Water chemistry readings for each sample point 2022.*

### Summer 2022

Sample point	pH	Cond	PPM	Temp
1	5.1	0.74	531	15.7
2	5.7	0.75	536	15.4
3	5.5	1.96	1451	14.3
4	5.6	0.75	535	15.3
5	5.9	0.57	412	13.3
6	6.4	0.73	570	15.5



Figure 2: Locations of sampling points at The Springs CWS

### 3 Results

#### 3.1 Overall

One Red Data Book species was recorded during the surveys, a single specimen of Desmoulin's whorl snail *Vertigo moulinsiana* found in 'The Springs'.

Twelve species listed as 'Local' by SAFIS were identified, these are listed in Table 2 and 3 below and described in Section 3.3 – one more than was found in 2020 and three more than were found in 2019.

One "Migrant/ Vagrant" species was identified within the sample – *Lestes viridis*. These were only found in the lakes sample point 1, 3 and 4 in 'The Springs'. Four "Notably rare" species were found *Ilybius guttiger*, *Aquarius paludum*, *Enochrus quadripunctatus* and *Ilybius fenestratus*.

Three invasive species, the amphipod *Crangonyx pseudogracilis* and the molluscs *Potamopyrgus antipodarum* and *Physella acuta* were found within the survey area. *C. pseudogracilis* and *P. acuta* were ubiquitous, whereas the distribution of *P. antipodarum* was patchier.

In total, at least 107 taxa of aquatic invertebrates were recorded during the monitoring surveys; of which, 71 were identified to species. The overall species richness of aquatic invertebrates & others varied from a minimum of 21 taxa to a maximum of 40 taxa in a sample. Areas of high overall species richness were predominantly found throughout the lake (sample points 1-4) and outflow (sample point 6), corresponding with a generally improved water quality. Full species lists for each sampling point are provided in the appendices.

Table 2. Notable species found during Spring 2022 surveys.

Local	Notable	RDB
<i>Bithynia leachii</i> <i>Erythromma najas</i>	<i>Ilybius guttiger</i>	<i>Vertigo moulinsiana</i>
<i>Haliphys flavicollis</i>	Not applicable	Not applicable
<i>Ilyocoris cimicoides</i>	Not applicable	Not applicable
<i>Laccobius minutus</i>	Not applicable	Not applicable
<i>Plea minutissima</i>	Not applicable	Not applicable

Table 3. Notable species found during Summer 2022 surveys.

Local	Notable	RDB
<i>Bithynia leachii</i>	<i>Aquarius paludum</i>	Not applicable
<i>Corixa dentipes</i>	<i>Enochrus quadripunctatus</i>	Not applicable
<i>Corixa panzeri</i>	<i>Ilybius fenestratus</i>	Not applicable
<i>Erythromma najas</i>	Not applicable	Not applicable
<i>Haliphys flavicollis</i>	Not applicable	Not applicable
<i>Haliphys fulvus</i> <i>Haliphys obliquus</i>	Not applicable	Not applicable
<i>Ilyocoris cimicoides</i> <i>Notonecta maculata</i>	Not applicable	Not applicable
<i>Notonecta viridis</i>	Not applicable	Not applicable
<i>Plea minutissima</i>	Not applicable	Not applicable



### 3.1.1 Sample Site 1 -4 (Lake)

Spring: This contained at least 59 taxa of aquatic invertebrates within the sample; of which 44 were identified to species. The samples were dominated by *Asellus aquaticus*, The invasive: *Crangonyx pseudogracilis*, *Chironomidae sp.*, and the gastropods *Radix balthica* and *Planorbis planorbis*.

Species of interest were recorded within the sample; One “RDB2” species *Vertigo moulinsiana* (Desmoulin’s whorl snail); One “Nb” species *Ilybius guttiger* (predatory aquatic beetle in the family Dytiscidae); and five “Local” species *Bithynia leachii* (Leach’s bithynia), *Ilyocoris cimicoides* (great saucer bug), *Plea minutissima* (pygmy backswimmer), *Laccobius minutus* (water scavenger beetle in the family Hydrophilidae) and *Haliphus flavicollis* (crawling water beetle in the family Haliplidae). The amphipod *Crangonyx pseudogracilis* (northern river crangonyctid) was recorded in high abundance which is “Locally common”, and *Physella acuta* (acute bladder snail), which are both non-native species originating from North America. *Lestes viridis* (willow emerald damselfly) was recorded which is “Migrant / Vagrant” but has now colonised the eastern UK.

Summer: At least 65 taxa of aquatic invertebrates were noted within the sample, of which 51 were identified to species. Species of interest were recorded within the sample; Three “Nb” species *Aquarius paludum* (pond skater), *Enochrus quadripunctatus* (water scavenger beetle in the family Hydrophilidae) and *Ilybius fenestratus* (predatory aquatic beetle in the family Dytiscidae); and 11 “Local” species *Bithynia leachii* (Leach’s bithynia), *Corixa dentripes* (water boatman), *Corixa panzer* (water boatman), *Ilyocoris cimicoides* (great saucer bug), *Notonecta maculata* (backswimmer), *Notonecta viridis* (backswimmer), *Plea minutissima* (pygmy backswimmer), *Erythromma najas* (damselfly), *Haliphus flavicollis*, *Haliphus fulvus*, and *Haliphus obliquus* (crawling water beetles in the family Haliplidae).

Two non-native species were recorded – *Crangonyx pseudogracilis* and *Physella acuta*.

### 3.1.2 Sample Site 5 (Northern ditch bordering lake)

Spring: At least 21 taxa of aquatic invertebrates were recorded, with 8 of these identified to species. The samples were dominated by *Asellus aquaticus* and *Chironomidae sp.*

The amphipod *Crangonyx pseudogracilis* (northern river crangonyctid and mollusc) was recorded which is “Locally common” and is a non-native species originating from North America.

### 3.1.3 Sample Site 6 (outflow stream from lake)

Spring: At least 34 taxa recorded; of which 24 were identified to species. The samples were dominated by *Asellus aquaticus*, The invasive: *Crangonyx pseudogracilis*, *Chironomidae sp.*, and the gastropods *Radix balthica* and *Planorbis planorbis*.

Two ‘Local’ species were identified: *Bithynia leachii* (Leach’s bithynia) and *Erythromma najas* (damselfly). The amphipod *Crangonyx pseudogracilis* (northern river crangonyctid and mollusc) was recorded in high abundance which is “Locally common”, and *Physella acuta* (acute bladder snail), which are both non-native species originating from North America. The invasive New Zealand mud snail *Potamopyrgus antipodarum* was also found.

## 3.2 Vertigo Moulinsiana

### 3.2.1 Sample Site A

This was the most species diverse sample site, with all samples supporting at least three species and up to five species recorded in a single sample (A4). *Succinea putris* (amber snail), *Deroceras reticulatum* (grey garden slug), and *Galba truncatula* (dwarf pond snail) were recorded in all five sub-samples. This was the only location in which *Vitrina pellucida* (pellucid glass snail) was recorded. This sample area had moderate levels of shading (50%), a moisture level of 1-3, and a thin thatch layer (1cm). The greatest species diversity coincided with the highest moisture level (moisture level of 3 at sample point A4).

No species of interest were recorded.

### 3.2.2 Sample Site B

Species diversity was lower here; however, animals were recorded at all sub-sample points. The most abundant species within these samples was *Succinea putris*, of which there were 23 individuals in subsample B2. Shading was greater here (90%), the moisture level was consistently dry (always 1), and a thin thatch (1cm).

No species of interest were recorded.

### 3.2.3 Sample Site C

Species diversity was variable at Sample Site C, with zero to three species recorded. The habitat ranged from 100% shaded sub-samples with dry, thin thatch (moisture level 1 and thatch of 1cm), to substantially wetter samples (moisture level 3) with similar high shading. This was the only sample site that supported *Bithynia tentaculata* (common bithynia), a species typically associated with freshwater habitats.

No species of interest were recorded.

### 3.2.4 Sample Site D

Sample Site D had consistently low numbers of species recorded within sub-samples – either one or two species found. The species recorded here were *Cepaea nemoralis* (brown-lipped snail), *Cepaea hortensis* (white-lipped snail), and *Deroceras reticulatum*. *Cepaea nemoralis* was not recorded at any other sample site. This sample site had moderate shading (60%) but was uniformly dry across its extent – never more than a moisture level 1.

No species of interest were recorded.

### 3.2.5 Sample Site F

Sample Site F had a range of species diversity recorded across the sub-sample survey area, ranging from zero to three species within a sample. All sample points had heavy shading (90%), a moisture level of 1 or 2, and a thin thatch (1cm). Sample Site F was the only area in which *Bathyomphalus contortus* (twisted ram's-horn) and *Oxychilus cellarius* (cellar snail) were recorded.

No species of interest were recorded.

### 3.2.6 Sample Site G

This sample site had the most consistent species diversity across its subsample sites – with two species recorded at each. In total, four species were recorded at this site, with *Succinea putris* recorded at all four locations and often dominated the sample – with up to 13 individuals recorded in a single sample. Sample Site G had the lowest shading of all the sample locations (30%), was one of the wettest (moisture levels either 2 or 4), and had the thickest thatch layer (2cm at G3-5).

No species of interest were recorded.

### 3.2.7 Sample Site H

This sample location had the fewest sub-samples taken (two) and was the wettest sample area (both sites had a moisture level of 4). Only two species were recorded here, *Succinea putris* – which was recorded in both samples – and *Zonitoides nitidus* (shiny glass snail) – which was only found in H1.

No species of interest were recorded.

### 3.2.8 Sample Site 3

Although *Vertigo moulinsiana* was not found at any of the 8 sample locations studied in the past (Sample sites A-H), somewhat unexpectedly a single adult *Vertigo moulinsiana* was identified in the aquatic invertebrate sample from sample site 3, sampled close to the marginal *Carex riparia*.

### **3.3 SAFIS analysis – Aquatic invertebrates**

Full results from SAFIS are presented in Appendix A.

Water quality varied across the site with the lake samples (sample points 1-4) having good water quality (in spring and summer), the outflow stream (sample point 6) having moderate quality, and the northern ditch (sample point 5) having poor quality.

Five species of conservation interest (according to SAFIS criteria this is defined as a species listed as 'Notable' or above) and twelve 'Local' species were recorded according to SAFIS. This is an increase in occurrence of species of importance when compared to the 2021, 2019 and 2018 surveys.

According to the CCI value produced by SAFIS, sample sites surveyed are of "very high" (in spring) to "high" (in the summer) conservation value at sample points 1-4. Sample point 6 is of "fairly high" conservation importance and sample point 5 is of "low" importance. This assessment considers both the overall taxon richness at a sample site, and the presence of conservation priority species (for example rare species or species with limited distributions, such as *Vertigo moulinsiana*).

## 4 Discussion and Mitigation

The surveys detailed in this report monitored the diversity and conservation value of aquatic invertebrate communities at six locations in May and four in August 2022, at The Springs Lake CWS, near Norwich. This was required as part of monitoring effort following works undertaken for the Northern Distributor Road.

The results indicate that a large portion of the area is of very high / high conservation value, reflected in the presence of five species of interest (Notable or above), including the RDB2 species *Vertigo moulinsiana*. This is also supported by the results of SAFIS analysis. This is an improvement from the 2020 the 2019 survey results which indicated that the Site was of moderate to fairly-high importance for aquatic invertebrates – due to either the absence of or reduced numbers of more ‘Notable’ species. If we exclude the single specimen of *Vertigo moulinsiana* from the results, the conservation value of the site is still high (Appendix A). However, sample point 5, a ditch running parallel to the lake to the north, had low conservation value with no notable species being found, possibly caused by extensive periods of drought throughout the year drying up portions of the ditch.

It had been feared that the addition of blue dye to the lake (used to prevent algal growth) in 2018 would impact the aquatic invertebrate communities using the Site. The results appear to show that the taxa diversity has not been negatively impacted, however, the water quality and light quality (LQI) appears to have suffered in the site overall with water quality dropping from excellent in 2019 to good in this survey and the LQI dropping from A++ in 2020 to B in this survey (appendix A).

Species found (and certainly the species found in greatest abundance) were common and generalist species and invasive species were recorded throughout the survey area. In particular, the amphipod *Crangonyx pseudogracilis* was recorded in almost every sweep sample in high abundance. *Potamopyrgus antipodarum* was only recorded in the outflow stream at sample point 6 and the mollusc *Physella acuta* was ubiquitous but was only recorded in lower numbers. Species composition was generally similar to the updated surveys conducted in 2018, 2019, and 2020; however, seasonal variations were noted and a higher number of taxa and species were identified in these surveys.

The order with the highest abundance and taxa richness in spring 2022 were molluscs. Crustaceans and Dipterans (true flies) were the next highest in abundance while Odonata (dragonflies & damselflies) and Coleoptera (beetles) held the next highest taxa richness in spring. These patterns shifted in summer, with Crustaceans being more abundant than molluscs and Ephemeroptera (mayflies) becoming the third most abundant order. Hemiptera (true bugs) were also the second-most taxa rich order in the summer, while Dipterans (true flies) showed a dramatic decrease in both abundance and richness in the summer. When we compare the aquatic invertebrate community in 2022 with the same site’s community in 2013 (Mott MacDonald, 2013) we see that Molluscs, Dipterans, Crustaceans, and Beetles have all remained in high abundance and richness. However, groups such as Trichoptera (caddisflies) and Oligochaete worms have since shown a dramatic decrease in abundance and richness since 2013, with no caddisflies being recorded in summer 2022, and no Oligochaetes being recorded in either 2022 survey. Ephemeropterans (mayfly) have shown an increase in both abundance and richness since 2013. All the data can be found in Appendix B.

Several invertebrates recorded in samples were not identified to species level, due to these groups requiring either specific preservation techniques or identification skills which are beyond the remit of this study. Consequently, disparity exists between the SAFIS species richness results and taxon richness actually recorded. This is caused by the spreadsheet used for the analysis (which requires a certain level of identification) and has been taken into account in this assessment.

Continued care should be taken to avoid hazardous materials from construction works entering the watercourses, to prevent impact to these important habitats, and spill kits should be kept with each vehicle. Should hazardous materials enter the watercourses, then the area should be re-surveyed to assess the impact to invertebrate fauna.

## **Vertigo moulinsiana**

The *Vertigo moulinsiana* survey showed that there were still none located at the survey points. However, a single adult specimen was found during the aquatic invertebrate survey at sample point 3. *Vertigo moulinsiana* has not been recorded at the site since 2013 where a few individuals were found (Mott MacDonald, 2013). Before that, *Vertigo moulinsiana* had been found in high numbers in 2008 (Mott MacDonald, 2013) and its presence has been noted in Crostwick marsh, 2.5 km north of the site, from 1965-2001 (NBIS Records), where a large population used to exist. It appears that there is a small residual population at the survey site meaning there is a potential to try to improve the habitat across the site and reintroduce it throughout. A further study to identify the extent of this residual population, outside the confines of the predetermined sample sites in these surveys would be valuable, in order to promote recovery of the species in the area.

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## Appendix A – SAFIS results

### SAFIS comparison from 2006-2022 of the overall site

	<i>Mott MacDonald, 2013</i>	<i>Mott MacDonald, 2013</i>	<i>Mott MacDonald, 2013</i>	<i>Abrehart Ecology Ltd, 2018, 2019, 2020, 2022</i>	<i>Abrehart Ecology Ltd, 2018, 2019, 2020, 2022</i>	<i>Abrehart Ecology Ltd, 2018, 2019, 2020, 2022</i>	<i>Abrehart Ecology Ltd, 2018, 2019, 2020, 2022</i>	<i>Abrehart Ecology Ltd, 2018, 2019, 2020, 2022</i>	<i>Abrehart Ecology Ltd, 2018, 2019, 2020, 2022</i>
	<b>2006</b>	<b>2007</b>	<b>2013</b>	<b>2018</b>	<b>2019</b>	<b>2020 - Spring</b>	<b>2020 - Autumn</b>	<b>2022 - Spring</b>	<b>2022 - Summer</b>
taxa	72	63	88	82	90	78	72	77	65
Revised BMWP	104.3	101.2	169.5	141.6	132.5	119.6	129.7	86.6	94
ASPT	4.01	4.22	4.58	4.43	4.42	4.27	4.32	3.94	3.92
Water Quality	Very good	Very good	Excellent	Excellent	Excellent	Excellent	Excellent	Good	Good
LQI	A	A+	A++	A++	A++	A+	A++	B	B
CCI	26.52	10.61	14.38	11.12	17.2	15.75	11.63	25.31	19.71
Conservation value	Very high	Fairly high	Fairly high	Fairly high	High	High	Fairly high	Very high	High
Species of interest	10	6	8	8	12	9	11	10	15

**SAFIS analysis of distinct sample areas of the site - 2020**

	<b>Sample points 1-4 Spring</b>	<b>Sample points 1-4 Spring (Exclu. <i>V.moulinsiana</i>)</b>	<b>Sample points 1-4 Summer</b>	<b>Sample point 5</b>	<b>Sample point 6</b>
taxa	59	60	65	21	34
Revised BMWP	86.6	86.6	94	24.4	39.6
ASPT	3.94	3.94	3.92	3.49	3.3
Water Quality	Good	Good	Good	Poor	Moderate
LQI	B	B	B	F	E
CCI	24.76	16.73	19.71	3.75	10.58
Conservation value	Very high	High	High	Low	Fairly high
Species of interest	9	8	15	1	3



## Appendix B – Aquatic invertebrate abundance and richness

Mott MacDonald (2013)	Mott MacDonald (2013)	Abrehart Ecology Ltd (Spring 2022)	Abrehart Ecology Ltd (Spring 2022)	Abrehart Ecology Ltd (Summer 2022)	Abrehart Ecology Ltd (Summer 2022)
Order	Number of individuals	Order	Number of individuals	Order	Number of individuals
Diptera	2608	Mollusc	2330	Crustaceans	1253
Crustaceans	2047	Crustaceans	2309	Molluscs	679
Molluscs	1204	Diptera	1176	Mayflies	395
Oligochaeta (worms)	233	Hemiptera	216	Odonata	178
Caddisflies	150	Leeches	59	Diptera	156
Leeches	50	Odonata	48	Hemiptera	76
Hemiptera	45	Beetles	41	Leeches	68
Beetles	44	Mayflies	26	Beetles	23
Odonata	21	Caddisflies	11	Flatworms	2
Megaloptera (alderflies)	13	Amphibia	4	Fish	1
Flatworms	7	Stoneflies	3	Not applicable	Not applicable
Mayfly	3	Flatworms	1	Not applicable	Not applicable
Not applicable	Not applicable	Arachnid	1	Not applicable	Not applicable
Order	Number of taxa	Order	Number of taxa	Order	Number of taxa
Molluscs	19	Mollusc	24	Molluscs	18
Caddisflies	19	Odonata	9	Hemiptera	15
Beetles	14	Beetles	9	Beetles	10
Diptera	13	Hemiptera	8	Leeches	7
Hemiptera	7	Diptera	7	Odonata	5
Leeches	4	Leeches	6	Crustaceans	4
Odonata	4	Mayflies	4	Mayflies	2
Crustaceans	2	Crustaceans	3	Diptera	2

Mott MacDonald (2013)	Mott MacDonald (2013)	Abrehart Ecology Ltd (Spring 2022)	Abrehart Ecology Ltd (Spring 2022)	Abrehart Ecology Ltd (Summer 2022)	Abrehart Ecology Ltd (Summer 2022)
<b>Order</b>	<b>Number of individuals</b>	<b>Order</b>	<b>Number of individuals</b>	<b>Order</b>	<b>Number of individuals</b>
Megaloptera (alderflies)	2	Caddisflies	3	Flatworms	1
Oligochaeta (worms)	1	Flatworms	1	Fish	1
Flatworms	1	Stoneflies	1	Not applicable	Not applicable
Mayfly	1	Arachnid	1	Not applicable	Not applicable
Not applicable	Not applicable	Amphibia	1	Not applicable	Not applicable

## Appendix C – Invertebrate results

### Sample points - Spring 2022 (May)

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b
Tricladida	Tricladida sp	Not applicable	0	0	0	0	0	0	0	0	0	1	0	0
Gastropoda	Acroloxus lacustris	Common	0	8	0	0	0	1	0	7	0	0	2	2
Gastropoda	Anisus vortex	Very common	2	6	6	3	3	0	4	7	0	0	11	21
Gastropoda	Bathymphalus contortus	Not applicable	0	0	0	0	0	0	0	0	0	0	0	1
Gastropoda	Bithynia leachii	Local	2	33	6	0	0	4	21	16	0	0	34	18
Gastropoda	Bithynia tentaculata	Very common	3	30	63	2	4	6	24	21	0	0	33	18
Gastropoda	Gyraulus crista	Common	0	0	0	9	6	3	2	2	0	0	4	4
Gastropoda	Hippeutis complanatus	Frequent	0	15	10	12	0	17	11	9	0	0	16	19
Gastropoda	Lymnaea stagnalis	Common	0	0	0	0	0	0	0	1	0	0	0	0
Gastropoda	Physa fontinalis	Very common	1	13	1	0	0	0	0	0	0	0	0	0
Gastropoda	Physella acuta	Invasive non-native	0	4	0	0	0	0	1	0	0	0	1	7
Gastropoda	Pisidium sp.	Unknown	0	12	0	0	0	0	0	0	0	0	0	0
Gastropoda	Planorbis carinatus	Common	0	0	0	42	3	19	8	0	0	0	7	14
Gastropoda	Planorbis planorbis	Very common	10	51	20	179	52	29	35	43	0	0	64	47
Gastropoda	Potamopyrgus antipodarum	Invasive non-native	0	0	0	0	0	0	0	0	0	0	7	9
Gastropoda	Radix balthica	Very common	4	112	51	1	127	63	71	58	0	1	47	98
Gastropoda	Succinea putris	Very common	0	2	0	0	0	0	0	0	0	0	0	0

## NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b
Gastropoda	Valvata cristata	Common	0	67	14	0	8	16	5	4	0	0	29	32
Gastropoda	Valvata piscinalis	Common	0	0	4	3	1	8	0	12	0	0	7	8
Gastropoda	Vertigo moulinsiana	RDB2	0	0	0	0	0	1	0	0	0	0	0	0
Bivalvia	Musculium lacustre	Occasional	2	3	0	0	1	0	0	0	0	0	0	1
Bivalvia	Pisidium henslowanum	Frequent	0	0	0	0	0	2	0	0	0	0	3	0
Bivalvia	Pisidium personatum	Frequent	0	0	0	0	0	0	0	0	0	6	0	0
Bivalvia	Pisidium subtruncatum	Frequent	0	0	0	0	0	0	0	0	0	0	7	9
Bivalvia	Sphaerium corneum	Very common	8	62	26	3	4	2	49	20	0	0	11	16
Hirudinea	Erpobdella octoculata	Very common	2	3	2	1	2	0	7	7	8	0	3	8
Hirudinea	Glossiphonia complanata	Very common	0	0	0	0	0	0	1	1	1	1	2	0
Hirudinea	Helobdella stagnalis	Very common	0	0	1	0	0	1	0	0	1	1	0	2
Hirudinea	Hemiclepsis marginata	Occasional	0	0	0	0	0	0	0	0	0	0	0	1
Hirudinea	Theromyzon tessulatum	Common	0	0	0	0	0	0	0	1	0	0	1	0
Hirudinea	Alboglossiphonia heteroclita	Occasional	0	0	0	0	0	0	0	0	0	0	0	1
Isopoda	Asellus aquaticus	Common	78	222	50	54	73	76	179	197	121	51	142	108

## NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b
Amphipoda	Crangonyx pseudogracilis	Locally common and invasive non-native	18	169	71	52	52	51	178	141	0	1	127	87
Odonata	Aeshna sp	Not applicable	0	0	0	0	0	0	0	1	0	0	0	0
Odonata	Coenagrion puella	Common	2	0	0	0	0	0	0	0	0	0	0	0
Odonata	Coenagrion pulchellum	Occasional (Britain) & Common (Ireland)	0	0	0	0	0	0	1	2	0	0	0	0
Odonata	Coenagrion sp	Not applicable	3	9	2	1	1	1	5	3	0	0	1	0
Odonata	Coenagrionidae sp	Not applicable	1	0	2	0	0	0	3	0	0	0	0	0
Odonata	Enallagma cyathigerum	Very Common	0	1	0	0	1	0	0	0	0	0	0	0
Odonata	Erythromma najas	Local	0	0	0	0	0	0	0	0	0	0	2	0
Odonata	Ischnura elegans	Very common	1	0	0	0	0	0	2	0	0	0	0	0
Odonata	Lestes viridis	Migrant / vagrant	1	0	0	0	1	0	1	0	0	0	0	0
Hemiptera	Callicorixa praeusta	Frequent	1	0	0	0	0	0	0	0	0	0	0	0
Hemiptera	Corixa affinis/panzeri	Not applicable	2	0	0	1	0	0	0	0	0	0	0	0
Hemiptera	Corixa punctata	Very common	0	0	0	1	0	0	0	0	0	0	0	0

NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b
Hemiptera	Corixidae sp	Not applicable	65	3	3	19	4	0	6	63	0	0	1	0
Hemiptera	Cymatia coleoprata	Frequent	0	0	2	1	0	0	0	0	0	0	0	0
Hemiptera	Ilyocoris cimicoides	Local	2	1	0	0	0	0	1	0	0	0	0	0
Hemiptera	Notonecta sp early instar	Not applicable	2	13	3	2	0	4	0	4	1	0	10	0
Hemiptera	Plea minutissima	Local	0	0	0	0	0	0	0	1	0	0	0	0
Coleoptera	Beetle larvae	Not applicable	1	0	0	0	1	1	0	1	0	0	0	0
Coleoptera	Chrysomelidae sp	Not applicable	0	0	0	0	1	0	0	0	0	0	0	0
Coleoptera	Dysticus sp larvae	Not applicable	0	3	0	0	0	2	0	0	0	0	0	0
Coleoptera	Dytiscidae sp larvae	Not applicable	1	4	0	0	1	2	1	3	8	0	0	0
Coleoptera	Elmidae sp larvae	Not applicable	0	0	0	0	0	0	0	0	0	2	0	0
Coleoptera	Halipus flavicollis	Local	0	5	0	0	0	0	1	0	0	0	0	0
Coleoptera	Hyphydrus ovatus	Common	0	1	0	0	0	0	0	0	0	0	0	0
Coleoptera	Ilybius guttiger	Nb	0	0	0	1	0	0	0	0	0	0	0	0
Coleoptera	Laccobius minutus	Local	0	1	0	0	0	0	0	0	0	0	0	0
Trichoptera	Limnephilus lunatus	Very common	1	4	0	0	0	1	0	3	0	0	0	0

NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b
Trichoptera	Limnephilus sp	Not applicable	0	0	0	0	0	0	0	0	1	0	0	0
Trichoptera	Potamophylax cingulatus	Common	0	0	0	0	0	0	1	0	0	0	0	0
Ephemeroptera	Baetidae sp	Not applicable	1	2	3	3	0	2	1	0	0	0	0	1
Ephemeroptera	Baetis vernus	Common	0	0	0	0	0	0	0	0	0	1	0	0
Ephemeroptera	Cloeon dipterum	Very Common	3	0	5	0	1	1	0	0	0	0	0	0
Ephemeroptera	Cloeon sp damaged	Not applicable	0	0	0	0	0	0	0	2	0	0	0	0
Diptera	Chironomidae sp	Not applicable	7	139	32	174	183	62	96	3	96	99	97	124
Diptera	Eristalis sp larvae	Not applicable	0	0	0	0	0	0	0	0	1	2	0	0
Diptera	Orthoclaadiinae sp larvae	Not applicable	0	0	0	0	0	0	0	0	12	22	0	3
Diptera	Pedicia sp larvae	Not applicable	0	0	0	0	0	0	0	0	8	9	0	2
Diptera	Sciaridae sp larvae	Not applicable	0	0	0	0	0	0	0	0	0	3	0	0
Diptera	Simulium sp larvae	Not applicable	0	0	0	0	0	0	0	0	1	0	0	0
Diptera	Tipulidae sp larvae	Not applicable	0	0	0	0	0	0	0	0	1	0	0	0
Cladocera	Cladocera group	Not applicable	0	9	0	1	0	1	0	0	0	0	0	0
Plecoptera	Isoperla sp damaged	Not applicable	0	0	0	0	0	0	0	0	1	2	0	0

NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b
Arachnida	Mite	Not applicable	0	0	0	0	0	0	1	0	0	0	0	0
Amphibia	Tadpoles	Not applicable	0	2	0	1	0	0	1	0	0	0	0	0

## Sample points - Summer 2022 (August)

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b
Tricladida	Tricladida sp	Not applicable	1	1	0	0	0	0	0	0
Gastropoda	Hippeutis complanatus	Common	0	0	6	0	5	16	0	0
Gastropoda	Musculum lacustris	Common	0	0	0	0	1	1	0	0
Gastropoda	Valvata cristata	Common	0	0	2	0	2	3	0	0
Gastropoda	Valvata piscinalis	Common	0	0	4	0	2	1	0	0
Gastropoda	Acroloxus lacustris	Common	0	0	0	0	1	0	0	0
Gastropoda	Bithynia leachii	Local	0	3	39	0	16	14	0	0
Gastropoda	Anisus vortex	Very common	7	1	1	0	2	34	0	1
Gastropoda	Bithynia tentaculata	Very common	18	14	52	68	15	11	2	3
Gastropoda	Lymnaea stagnalis	Very common	0	1	0	0	0	0	1	0



## NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b
Gastropoda	Planorbis carinatus	Very common	1	0	0	2	4	0	0	0
Gastropoda	Planorbis planorbis	Very common	31	28	26	28	31	42	1	1
Gastropoda	Radix balthica	Very common	0	1	32	0	26	22	0	0
Gastropoda	Succinea putris	Very common	0	1	0	0	0	0	0	0
Gastropoda	Gyraulus crista	Not applicable	0	0	0	0	0	1	0	0
Gastropoda	Physella acuta	Invasive non-native	0	0	1	0	1	2	0	0
Bivalvia	Pisidium henslowanum	Common	0	0	0	0	0	2	0	0
Bivalvia	Pisidium subtruncatum	Common	0	0	0	0	0	6	0	0
Bivalvia	Sphaerium corneum	Very common	0	2	5	8	8	16	2	1
Hirudinea	Theromyzon tessulatum	Common	0	3	2	2	0	0	0	0
Hirudinea	Piscicola geometra	Common (Rare in N)	1	0	0	0	0	0	5	1
Hirudinea	Alboglossiphonia heteroclita	Occasional	0	0	1	0	0	0	0	0
Hirudinea	Hemiclepsis marginata	Occasional	0	0	0	0	0	0	1	0
Hirudinea	Erpobdella octoculata	Very common	0	1	1	1	3	0	7	1
Hirudinea	Glossiphonia complanata	Very common	0	1	1	1	0	0	1	0

## NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b
Hirudinea	Helobdella stagnalis	Very common	8	3	4	16	0	0	3	0
Isopoda	Asellus aquaticus	Common	12	31	141	156	164	58	81	35
Isopoda	Proasellus meridianus	Common	0	0	3	0	1	2	0	0
Amphipoda	Crangonyx pseudogracilis	Locally common and invasive non-native	6	47	42	167	71	123	51	52
Odonata	Aeshna grandis	Common	0	0	0	0	0	0	1	0
Odonata	Erythromma najas	Local	0	0	0	0	1	0	0	0
Odonata	Anax imperator	Occasional	0	0	0	0	0	0	0	3
Odonata	Coenagrion sp.	Not applicable	6	10	2	1	21	63	19	43
Odonata	Coenagrionidae sp.	Not applicable	4	0	1	1	0	2	0	0
Hemiptera	Hesperocorixa sahlbergi	Common	0	0	1	0	0	0	0	0
Hemiptera	Callicorixa praeusta	Frequent	1	0	0	0	0	0	0	0
Hemiptera	Cymatia coleoptrata	Frequent	0	1	0	0	1	0	0	1
Hemiptera	Corixa dentipes	Local	1	0	0	0	0	0	0	0
Hemiptera	Corixa panzeri	Local	1	1	0	1	0	0	0	0

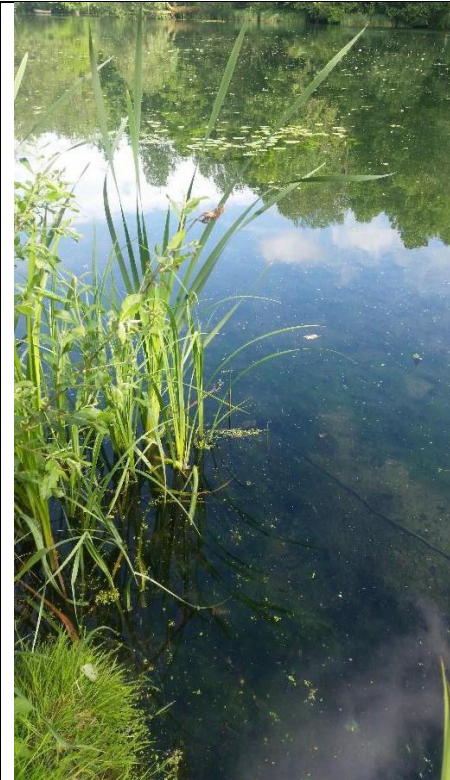
## NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b
Hemiptera	<i>Ilyocoris cimicoides</i>	Local	0	0	0	0	4	2	1	3
Hemiptera	<i>Notonecta maculata</i>	Local	1	0	0	0	0	4	0	1
Hemiptera	<i>Notonecta viridis</i>	Local	1	0	0	0	0	0	0	0
Hemiptera	<i>Plea minutissima</i>	Local	0	1	0	0	0	0	2	6
Hemiptera	<i>Aquarius paludum</i>	Nb	0	0	0	0	0	0	2	0
Hemiptera	Corixidae sp.	Unknown	1	0	3	2	0	0	2	0
Hemiptera	Gerris sp.	Unknown	2	0	1	0	0	0	0	0
Hemiptera	<i>Corixa punctata</i>	Very common	10	0	1	2	0	0	0	1
Hemiptera	<i>Notonecta glauca</i>	Very common	4	0	0	0	2	5	0	1
Hemiptera	<i>Corixa affinis/panzeri</i>	Not applicable	2	0	0	0	0	0	0	0
Coleoptera	<i>Haliphus confinis</i>	Common	0	0	0	1	0	0	0	0
Coleoptera	<i>Hyphydrus ovatus</i>	Common	0	0	1	0	1	0	0	1
Coleoptera	<i>Haliphus flavicollis</i>	Local	0	0	1	1	0	0	0	0
Coleoptera	<i>Haliphus fulvus</i>	Local	0	1	0	1	0	0	0	0
Coleoptera	<i>Haliphus obliquus</i>	Local	0	0	1	0	0	0	0	0

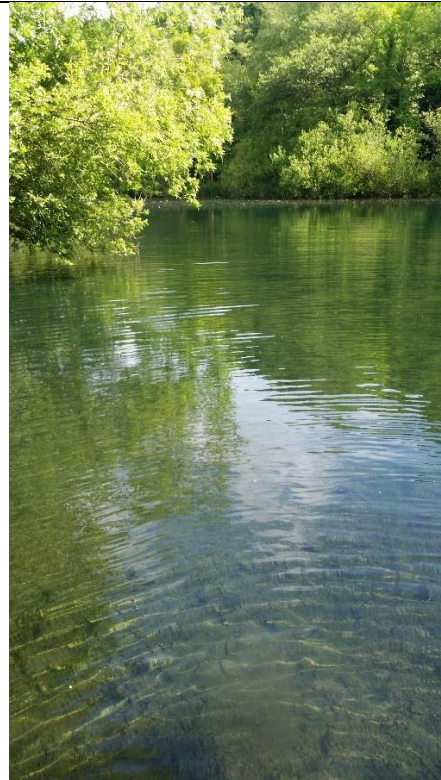
## NDR

BMWP group	Species	Status	1a	1b	2a	2b	3a	3b	4a	4b
Coleoptera	<i>Enochrus quadripunctatus</i>	Nb	0	0	1	0	0	0	0	0
Coleoptera	<i>Ilybius fenestratus</i>	Nb	2	0	0	0	2	2	0	2
Coleoptera	<i>Haliplus sibiricus</i>	Not applicable	1	0	0	0	0	0	0	0
Coleoptera	Latridiidae sp.	Not applicable	0	0	0	0	0	2	0	0
Coleoptera	Spercheidae sp larvae	Not applicable	0	0	1	0	0	0	1	0
Ephemeroptera	Baetidae sp.	Unknown	0	0	2	0	0	0	21	7
Ephemeroptera	<i>Cloeon dipterum</i>	Very Common	61	86	89	35	3	0	63	28
Diptera	Chironomidae sp.	Unknown	2	17	4	4	106	2	4	5
Diptera	Orthoclaadiinae sp. larvae	Not applicable	1	6	2	0	0	0	3	0
Fish	Carp fry	Not applicable	0	0	0	0	1	0	0	0
Cladocera	Cladocera group	Not applicable	0	0	4	4	1	0	0	1

Appendix D – Site photos



Sample Point 1



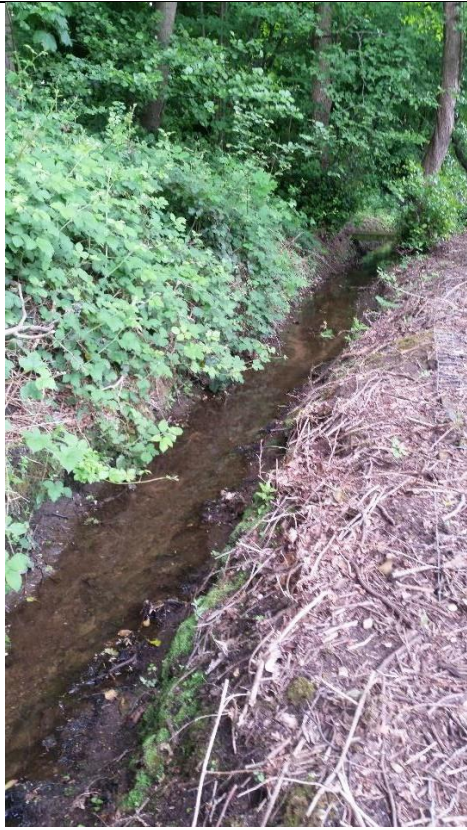
Sample Point 2



Sample Point 3



Sample Point 4



Sample Point 5



Sample Point 6