EXHIBIT RXG4: RIVER CRANE BIOLOGICAL ASSESSMENT DATA REPORT BY FORCE UPDATE APRIL 2013

Introduction

This data report has been produced by Friends of the River Crane Environment (FORCE). It summarises the historical invertebrate and water quality data prior to the pollution of 29th October 2011 and sets out the sampling undertaken by APEM and FORCE following that pollution incident. Other data and records from third party organisations, FORCE members and local residents are also included.

This report will be updated every few months as more data are collected. It is a collation of historical and field data and third party observations. It is not intended to be definitive but it is our current best understanding of the situation. FORCE actively encourages the receipt of further information and proposed amendments to the existing data sets from all interested parties in order to improve and further develop this report.

Data Sets

The Brent and Crane Report – water quality, ecology and fishery data 1999 to 2010 (EA, 2010), collates the data collected over that 11 year period and makes some comments on earlier data sets. The Environment Agency has a biological monitoring point on the river in Crane Park around 200 metres downstream of Crane Park Island. A second site is in Feltham, just above the confluence with the upper DNR. These sites are sampled up to twice per year, in the spring and autumn.

There are four fish monitoring sites on the Crane – in Cranford Park (above the A4), Hounslow Heath, Crane Park and Moormead Park (on the lower Crane below the DNR outflow). These are sampled every 5 years – and were done in 2000, 2005 and 2010.

The sewage pollution of October 2011 entered the river from an outfall into the middle reaches, where it flows beneath the A4, and severely impacted all the reaches below this on the Crane and the lower Duke of Northumberland's River (DNR). An initial sampling exercise in response to the pollution was undertaken by APEM on behalf of Thames Water on 3rd November 2011 (APEM Scientific Report 411908). This sampled one site 50 metres upstream and another 200 metres downstream of the A4 crossing; a site in Crane Park at TQ12697 72952 (the accompanying map indicates this is opposite the dipping platform at the upstream end of Crane Park Island) and a site in Silverhall Park near the base of the lower DNR.

A second sampling exercise was carried out by APEM on behalf of Thames Water on 18th June 2012 and returned to these same sites.

FORCE has carried out regular kick sampling for small fish and invertebrates approximately every three months from March 2012, the samples being taken from the River Crane at the Crane Park Island dipping platform. Sample dates are as follows:

- 8th March 2012
- 30th March 2012
- 29th May 2012
- 27th August 2012
- 7th November 2012
- 16th January 2013
- 9th April 2013

FORCE samples the macro-invertebrates by doing three minute kick samples, across a variety of in-river habitats, and analysing the catch at the bank side in a white tray. The intention is not to produce a BMWP score for the river but rather gain a first-hand impression of the recovery of the invertebrate community. Selected individuals are taken away for further microscope identification.

FORCE has also asked its members and other local people to send in their records and observations of river life and these have been received regularly over the period since the pollution. Where relevant these have also been recorded herein.

Historical Sampling

Historical water quality data for the River Crane indicate that the river achieves moderate to poor status at three sites on the upper and middle Crane with respect to Phosphate. P levels varied from 0.2 to 0.5 mg/l at the sites monitored over the 10 years from 2000 to 2010. Phosphate, in urban areas such as this, is typically a product of poor and missed drain connections. The impact of phosphate on the Crane is particularly important given that dissolved oxygen and ammonia levels in the river achieve good or high status in each of the 10 years recorded.

Invertebrate data for the Crane are plotted on figures 4.9 and 4.10 of the Brent and Crane report and show BMWP scores of between 80 and 120 in Crane Park – whereas the upper Crane above the upper DNR scores between 50 and 130. ASPT scores are around 4.7 for Crane Park and 4.2 for the upper Crane. Both scores indicate around 20 scoring taxa per sample.

The report records these scores as being essentially moderate; occasionally good and occasionally poor; and concludes that the conditions exist for healthy invertebrate populations – and could perhaps exist more consistently with better water quality (particularly reduced phosphate) and habitat conditions. The general (although small) improvement in scores below the upper DNR link may be due to the beneficial effects of the inflow of better quality water, via the DNR, from the River Colne to the west.

A report by the NRA in 1995 recorded the Crane as having fair biological quality with BMWP scores of between 50 and 100.

The old (pre 2000) method of recording quality was through the GQA system. Before 1990 the river was classed as Grade D (moderate) or Grade E (poor). There was some improvement between 1990 and 1995 when the river was generally classed as Grade D, apart from the Crane Park area which was classed as Grade C (fair). Between 1996 and 2002 the river continued to be classed as either Grade D or Grade C.

The biological and water quality data together indicate a small but significant improvement in water quality from the 1980's to 2010.

Three sets of fisheries data for Crane Park, between 2000 and 2010, record a total of 12 species (three spined stickleback; bullhead; perch; stone loach; minnow; gudgeon; European eel; roach; bleak; dace; chub; and barbel); with the numbers and biomass increasing between 2000 and 2010. The species composition is similar throughout the 10 year period with low numbers of barbel, large numbers of chub, and a few dace, roach and gudgeon. The presence of dace and minnows are said to indicate good water quality (EA, 2010).

Five species were recorded at Cranford Park (perch; gudgeon; roach; dace; and chub); eight species at Hounslow Heath (tench; stone loach; three spined stickleback; gudgeon; minnow; European eel; dace; and chub); and thirteen species at Moormead (three spined stickleback; chub-dace hybrid; perch; stone loach; minnow; gudgeon; European eel; roach; bleak; dace; chub; barbel; and flounder – bullhead is the only species missing from the Crane Park list). Presumably the flounder have migrated upstream from the Thames.

These data compare with a total of seventeen species of fish (including goldfish) collected from the river and taken to Mogden following the October 2011 pollution event (see Table 1 below for more details). The other species not recorded previously are pike (possibly due to its resistance to electro-fishing – 4 only) carp (3 only) and common bream (1 only). Note also a public comment that a pike was often seen in the river in Crane Park over many years before the pollution incident.

Other species known to have inhabited the river are American signal crayfish (large numbers of which are understood to have been fished at Crane Park prior to the pollution event) and Chinese mitten crab (sighted at various locations in the lower and middle reaches).

There is a long term resident population of water voles at Crane Park Island. Water voles have also, in the last few years, been identified as resident on the lower DNR, both at Kneller Gardens and at Chase Bridge School. A population is known to have been resident along the Crane at Feltham Marshalling Yards (although the habitat along this reach has become overgrown in recent years).

Evidence has been seen of water vole presence on the main river channel through Pevensey Road nature reserve and water voles have also been seen recently on other reaches of the Crane in Crane Park. There has been a significant amount of work undertaken to provide improved habitats for water voles along this part of the river over the last few years.

Kingfishers have used two artificial nesting banks on Crane Park Island to raise at least one brood per year over the period from 2004 to 2011. Kingfishers are also believed to have used natural river banks as nesting sites on the lower DNR opposite the LB Richmond council depot. Other nesting sites are understood to be used along the lower Crane below Moormead Park and there are also likely to be further natural nesting sites on the Crane upstream above Crane Park. Kingfishers have been an increasingly common sight all along the lower DNR and Crane, including the lower Crane below Mereway Road weir, in recent years, and are known to move from the Thames into the Crane and lower DNR at Isleworth.

There are nesting populations of moorhens, coots, mallards and yellow wagtails along the Crane and DNR. Mandarins have nested successfully at Kneller Gardens for several years and, historically, little grebe have nested in Crane Park and continue to be regular visitors. Herons are seen regularly throughout the Crane and DNR although they are not known to have nested along the lower Crane.

There is a healthy population of bats along the Crane valley including Pipistrelle 45 and 55; Daubenton's; Leisler's and brown long eared.

Fish mortality count from the October 2011 Pollution Incident

Thames Water contractors filled 51 bags with dead fish from the river banks following the pollution incident and took these to Mogden STW. A proportion of these were then counted by EA staff over the four day period from 31st October to 3rd November. These data are presented in Table 1 below.

Table 1: Record of fish mortality count produced by EA staff, following fish collection by TW contractors, between 31st October and 3rd November 2011.

	Bags collected	Bags counted	Multiplier for extrapolation
River Crane	22	9	2.444
DNR	29	13.5	2.148

Fish Species	Crane (actual)	Crane (extrapolated)	DNR (actual)	DNR (extrapolated)	Total	Extrapolated
Chub	208	508	223	479	431	987
Dace	21	51	86	185	107	236
Roach	46	112	122	262	168	384
Gudgeon	92	225	436	937	528	1162
Bleak	1	2	52	112	53	114

Minnow	324	792	1250	2685	1574	3477
Pike	2	5	2	4	4	9
Perch	3	7	2	4	5	11
Stickleback	18	44	121	260	139	304
Bullhead	34	83	9	19	43	102
Stone loach	9	22	6	13	15	35
Common carp	0	0	3	6	3	6
Goldfish	0	0	1	2	1	2
Barbel	5	12	1	2	6	14
Eel	34	83	26	56	60	139
Common bream	1	2	0	0	1	2
Tench	0	0	2	4	2	4
Total	798	1949	2342	5030	3140	6979

The actual count data have been extrapolated by considering the percentage of bags counted for each river to estimate a total number of fish collected of around 7000.

The actual number of fish killed is not known. However, it is known that the collection was by no means comprehensive and many other fish were taken by animals or floated into the Thames. Nor did the collection include the lower Crane below Mereway Road weir. The collection is presumed to have only included mature fish with fish fry not included. It is therefore reasonable to assume that in the order of 10,000 mature fish were killed in the incident.

The distribution of fish recorded between the Crane and the DNR is not necessarily indicative of the actual live distribution as it will also reflect the subsequent downstream movement of fish carcasses.

These data have been reviewed by one of our members who is also a local fisherman with many years experience on the river. His report is quoted verbatim below:

> *"Looking at the facts and figures provided by the Environment Agency (EA), the most striking feature is undoubtedly the modest number of 'official' victims. Just 3140 recorded casualties following a major pollution incident affecting several miles of the Crane and Dukes River. In contrast, a more minor incident back in July 1999 and said by the EA to have had only "a very localised effect on the resident fish population" around the Meadway area of the Crane, claimed 2026 fatalities.*
>
> *This apparent discrepancy however can be accounted for. The very nature of the October 2011 incident would have seen large numbers of fish ailing very quickly and being swept downstream very quickly, seemingly supported by the fact that many more victims were retrieved from the Dukes River rather than from the*

Crane. Many could have been swept all the way through the system and into the Thames before any clean-up operation even began!

Similarly, any fish swept down the St Margaret's arm of the Crane and left stranded would have probably been beyond the power of recovery as access is so poor along most of its length.

Add to this the huge amount of ground the EA had to cover, essentially EVERYWHERE downstream of Cranford, and predators such as herons, gulls, crows, rats, foxes etc would have had ample opportunity to claim easy free meals in numerous locations before any clean-up took place.

Without a doubt, a significant number of fatalities have gone unaccounted for. Nevertheless for the purpose of this analysis, the composition of the 3140 identified victims will be accepted as being a typically representative cross-section sample of the Crane/Dukes River fish population pre-pollution.

Somewhat disappointingly, a staggering seventy three percent of the total comprised minor species with little or no angling value - minnows, gudgeon, sticklebacks, bullheads and stoneloach. Although these are commonly found in many small rivers and streams nationwide, the disparity between their numbers, particularly between minnows (1574) and sticklebacks (139) was very surprising.

Of the major fish species, chub were always likely to be the most abundant, but just 168 roach was a far cry from the heady days of the 1990's when they dominated the Crane. Similarly, a total of 107 dace hardly supported the EA's view that they were prevalent in the upper river alongside Hounslow Heath (Fishery Survey 2011).

It was tragic that only 5 perch, 3 carp and 1 bream were recovered. Back in the 1990's, before the water level was lowered above Mill Road Weir, it was possible to catch these fish anywhere between Kneller Gardens and the Shot Tower weir pool. While they were never 'common' as such, it appeared as though a small but significant breeding colony of each of these species existed. This was certainly the case for the carp, the weird and wonderful array of hybrids being produced supporting this assertion.

However after 1998, all three started to become increasingly scarce on the much shallower middle reaches of the Crane and within a relatively short space of time, their distribution was predominantly confined to the deeper areas on the lower river.

For another interesting comparison, it is worth noting that of the 2026 victims claimed from the 1999 Meadway incident mentioned earlier, 20 of these were bream.

Equally as depressing was the almost total lack of barbel. Back in the autumn of 1999, a bold decision was made to introduce 400 young specimens into the Crane just below Hospital Bridge. The subsequent consensus of opinion was that, against expectations, most of these fish had seemingly chosen to migrate way downstream and settle in the deeper, slower-flowing reaches of the lower river. A return of just 6 samples out of an original consignment of 400 would suggest that they failed to acclimatise successfully.

To end on a more upbeat note, 60 eels was a heartening result and somewhat surprising. Eel populations elsewhere, especially on the Thames, have plummeted alarmingly in recent years. Strange that the Crane should apparently buck this trend. Many were respectable specimens too, several between one and three pounds noted.

Taken at face value, these data would seem to define the Crane and Dukes River as fisheries of relatively poor quality. The overwhelming predominance of minor species is very reminiscent of the utmost upper reaches of the Crane, including Yeading Brook, which past studies have often identified as being both ecologically and biologically poor and containing perhaps some of the poorest environments within the entire Crane catchment area.

The implication that the Crane is merely developing into an extension of Yeading Brook is extremely alarming, clearly highlighting the decline which has taken place. Moreover, doubts must now exist concerning the river's ability to support and sustain a reasonable and diverse population of typical coarse fish and any re-stocking programme needs to be very well-considered indeed."

These are interesting and broad ranging conclusions that have implications for any re-stocking programme as well as for any future works to improve the environmental value of the river system.

APEM sampling in early November 2011 (immediately following the pollution)

The first site monitored was 200 metres upstream of the CSO, on the A4 Cranford Lane Bridge, and was used as a control. This showed a good diversity of macro-invertebrates and they were all alive and vigorous. A total of 18 species were recorded including pollution sensitive Leptoceridae (caddisfly) and Caenidae (mayfly), along with a high abundance of Gammaridae (fresh water shrimp). This indicates a relatively clean watercourse, although the high abundance of Asilledae (water louse) is indicative of long term enrichment – presumably by phosphates.

Site 2 was 50 metres below the CSO site. The macro-invertebrates consisted of 12 mainly pollution tolerant families including various snails (Valvatidae, Bithynidae, Planorbiidae and Lymnaeidae) limpets and worms. The overall mortality rate was high at around 58 per cent and the sample was indicative of severe pollution.

Site 3 was within Crane Park, around 200 metres below Crane Park Island and 5.3km downstream of the CSO. The sampling provided around 18 species in total, including pollution tolerant species. However the mortality rate was virtually 100 per cent, indicating a very severe pollution incident. The exceptions were the hydrobiidae (operculate snails) which were alive and abundant, presumably because of their ability to seal themselves into their shells for a period. Even very pollution tolerant Chironomidae (midges) showed a mortality rate of 94 per cent, indicating the severity of the pollution.

Site 4 was in Silverhall Park on the DNR, around 12km downstream of the pollution input. The faunal diversity and abundance in the sample was lower than for site 3 above with only 6 families present. All the specimens in the sample were dead with the exception of single specimens of Chironomid, Olygochaeta and Hydrocarina (water mite). The overall mortality was over 98 per cent and the high mortality of chironomids (1 alive out of more than 100 sampled) again indicated the severity of the pollution.

FORCE sampling on 8th March 2012

FORCE undertook an initial field visit to sample for small fish and invertebrates on the River Crane, adjacent to Crane Park Island, on Thursday 8th March 2012. There was heavy rainfall on Wednesday 7th March (around 10-15mm of rain) and the river was still turbid and quite high on Thursday at around 1pm, although the weather was dry with a temperature of around 10C, when the initial samples were taken.

Site 1 was the gravel bank immediately upstream of Crane Park Island. This gravel bank is used regularly by LWT for river dipping with school children and the macro-invertebrate fauna of the site is reasonably well known. It was noted that the gravel had a dark organic coating not seen on site visits over the previous three years. This is considered likely to be due to the pollution incident. Note also that some excess silt had been introduced into the river following the removal of toe boards earlier in 2011, although this was understood to have been largely flushed through during the interim period.

Two samples were taken at this site.

Table 2: Sample 1 from site 1: 8th March 2012

Species		Numbers	Comment
Fresh water shrimp	Gammaridae	Rare	Adults
Hog Louse	Asellidae	Rare	
Non biting midge larvae – dancing midge	Choronomidae	Very many	
Round worm	Oligochaeta	Many	
Copepod	Cyclops sp.	Several	
Leech	Erpobdellidae	Rare	

Water mite	Hydracarina	Rare	

Table 3: Sample 2 from site 1: 8th March 2012

Species		**Numbers**	**Comment**
Fresh water shrimp	Gammaridae sp.	Several	Adults
Mayfly	Betidae	Rare	
Non biting midge larvae – dancing midge	Choronomidae	Many	
Water mite	Hydracarina	Several	
Copepod	Cyclops sp.	Several	

Note: prior to the pollution incident, sampling of this site would have produced many fish fry and adults, mayfly, caddis fly, damselfly nymphs, a variety of molluscs and leeches, water boatmen etc.

Site 2 was a fast flowing, narrow and well vegetated channel with a silt base, on the south side of Crane Park Island and around half way along. Sample 3 was taken from here.

Table 4: sample 3 from site 2: 8th March 2012

Species		**Numbers**	**Comment**
Mayfly	Betidae	Rare	
Water mite	Hydracarina	Many	
Non biting midge larvae – dancing midge	Choronomidae	Many	

Site 3 was a deep scour channel, fast flowing with a sand base, immediately downstream of the island. Sample 4 was taken from here.

Table 5: sample 4 from site 3: 8th March 2012

Species		**Numbers**	**Comment**
Hog Louse	Asellidae	Rare	
Non biting midge larvae – dancing midge	Choronomidae	Many	
Round worm	Oligochaeta	Several	
Copepod	Cyclops sp.	Several	
Bivalves and gastropods	Mixed species	Many - all dead	

Comments on the 8th March Sampling

These data indicate that a recovery of the river has started, although there are only a few invertebrate species at present.

Water mites and midge larvae are present in large numbers - more prevalent than previously - and may have a temporary advantage from the lack of predators. These species reproduce rapidly and their introduction may largely post date the pollution incident.

Shrimp are present in small numbers. These are adults and may have moved in from upstream, as a result of their relative mobility. Hog lice may be in the same category.

The presence of several may fly is the most encouraging sign of recovery. These were not anticipated to be re-colonising this quickly.

Round worms, leeches and copepods were all present. These may have survived the pollution and are currently benefitting from the lack of competition

The absences are as significant as the species present. There were no fish fry found and this contradicts the observation from LWT the previous week. It may though have been due to the previous day's high rainfall. There was also though an absence of molluscs, caddis fly and damselfly nymphs for example.

FORCE Sampling on 30th March 2012

FORCE carried out a second sampling exercise on 30th March – also sampling from the river immediately upstream of Crane Park Island. This followed two weeks of warm and dry weather. This exercise focused around Site 1 from the previous sampling of 8th March. A composite sample was taken from the various habitats at this site, including shallow gravel riffle, deeper fast flowing channel, and slow moving silt bottomed vegetated bank side.

The sampling from 8th March had resulted in a kick sample line of clean washed gravel within the river bed. It was interesting to note that this had disappeared completely in the interim three weeks, indicating that the re-suspension and settling of dark organic detritus was ongoing over this period. Given that this gravel riffle historically has been clean and free of organic matter this would appear to be an ongoing effect of the pollution incident.

Table 6: Sample 1 from 30th March

Species		Numbers	Comments
Fresh water shrimp	Gammaridae	Many	Adults and young – a significant number of the adults have a fungus growing on them which had not been seen here before

			(LWT comment). May be indicative of ongoing pollution impact
Hog Louse	Asellidae	Rare	
Non biting midge larvae – dancing midge	Choronomidae	Very many	Adult forms also present in significant numbers over the river
Round worm	Oligochaeta	Several	
Copipod	Cyclops sp.	Several	
Leech	Glossipnoniidae	Rare	
Water mite	Hydracarina	Rare	
Blackfly	Simuliidae sp.	Occasional	Biting fly
Mud snail	Hydrobiidae		
Caddis fly	Leptoceridae	Rare	High scoring on BMWP
Mayfly	Betidae	Rare	High scoring on BMWP
Wandering snail	Lymnaia	Rare	Large mature shelled specimen – probably survived the pollution.
Ram's horn snail	Planoribidae	Rare	Shelled
Pea mussel	Sphaeriidae sp.	Rare	Shelled
River snail	Bithyniidae	Rare	Shelled
Valve snail	Valvanta sp.		Shelled

This is a larger number of species than from March 8th although there is still not a wide range, and the increased numbers may be a result of sampling a larger number of habitats. Key absences include damselfly nymphs, water boatmen and all fish. Many of the species present are shelled and may have survived the pollution by sheltering in their protective covering. Others such as the midge and black fly have a short reproductive cycle and may be the initial beneficiaries of a lack of competition and predators.

The presence of Gammaridae, particularly young, is of some encouragement, although the presence of fungus on many of the adults is a concern and an indication that conditions are not yet ideal for this species. This would also indicate that there is an ongoing problem with the quality of either the water or the substrate, and this may be linked to the organic covering on the gravel.

The presence, although rare, of caddis fly and mayfly, provides the most encouragement of some recovery. The process is however still in its early stages and the absence of fish fry from two sets of samples indicates strongly that fish have not yet returned to the river.

Reports from FORCE members and others: November 2011 to April 2012

Mallards, coots and moorhens returned to the river within a couple of weeks of the pollution incident, once the main pollution had been flushed through the system. These birds feed on riverbed flora as well as fauna and, in a park side environment, will also feed on bread from park visitors as well as grazing the adjacent short grassed areas.

A little grebe was seen several times in the few months until April 2012. This bird is a diver for invertebrates and small fish, and its presence indicates the return of a living food source, in this case possibly fresh water shrimp.

Herons were seen occasionally in the river, but their numbers were considerably down on previous years. Kingfishers were a very occasional presence, much reduced on previous years, and there was no sign of kingfishers nesting on Crane Park Island. These are both indicators that there had been little or no fish in the river up until April.

Water voles were seen on Crane Park Island and elsewhere in Crane Park, but there were no sightings on the DNR. The direct impact of the pollution on water voles may well have been minor. It should though be noted that the populations are small and fragile and the species may be at risk from water borne disease for example, or increased predation from herons.

There were no confirmed sightings of fish, or for that matter, crayfish. Neither were any fishermen seen on the river over the three months to April.

The Environment Agency surveyed the river for effluent sediment in the months following the pollution incident and eight pollution hot spots were identified. The weather over the first three months of 2012 has been unusually dry and a walking survey by FORCE members in early April 2012 indicated that these hot spots were still in poor condition, with a surface slime and the regular release of gases.

FORCE sampling on 29th May 2012

A third sampling exercise was undertaken on 29th May following a period of wet and unsettled weather. This exercise focused around Site 1 from the sampling of 8th March and adopted the method used on 29th March. Several samples were taken in the various habitats present including shallow gravel riffle, deeper fast flowing channel, and slow moving silt bottomed vegetated bank side.

The sampling followed an extended period of rainfall and this appeared to have been reasonably effective in cleaning the gravel at this site, which had a much reduced organic sediment cover compared to March. However, there was an extensive algal mat formed and/or migrated into the back channel around Crane Park Island, effectively pushing much of the river flow into the southern channel.

Two observations were made during the sampling – firstly a 10 to 12 ounce chub lying beneath the bridge to the island, presumably having washed down from upstream, and secondly two banded demoiselles seen on the island. Given the absence of damsel flies elsewhere in the lower Crane these were assumed to have hatched from the pond on the island rather than the river.

Table 7: Sample from 29th May

Species		Numbers	Comments
Fresh water shrimp	Gammaridae.	50 to 100	Adults and young. No fungal growths seen this time
Hog Louse	Asellidae	20	Much more abundant than in March
Non biting midge larvae – dancing midge	Choronomidae	1000 plus	Hugely abundant
Copepod	Cyclops sp.	20 to 50	More abundant than previously
Large leech	Erpobdellidae	1	Not seen previously
Yellow leech	Helobdella sp.	4	
Water mite	Hydracarina	20 to 50	More abundant than previously
Blackfly	SimuliidaeSimuliidaeSimuliidae	50 to 100	Biting fly – a lot more abundant than in March
Whirlygig beetles	GyrinidaeGyrinidae	3	Seen in adult form
Mayfly	Betidae	50	More common than previously. High scoring on BMWP
River snail	Linnaea	1	
Round worm	Oligochaeta	1	
Fish fry		1	Not identified further – possibly a chub; definitely this season

This record shows a much greater abundance of individuals in each species than in March. The range of species did not increase much however, and there was a reduction in the number of snails. Possibly the largest change recorded was the presence of a single fish fry.

The numbers of may fly increased significantly and this was encouraging, however no caddis larvae were seen this time. There were also no records of damselfly or dragonfly larvae.

APEM survey report June 2012

APEM undertook a survey of macro-invertebrates and fish populations in the Crane on 14th June 2012. The invertebrates report has been viewed by FORCE whereas the fish report has not yet been seen.

Four sites were sampled as in November 2011. Site 1 is immediately upstream of the discharge point and site 2 immediately downstream; site 3 is by Crane Park Island and the FORCE monitoring site and site 4 is in Silverhall Park at the base of the DNR.

The macro-invertebrate counts at these four points were then compared with data collected in November 2011. Note however that the data were not compared with counts carried out in the unaffected river before this date.

The report data can be summarised as follows:

- Records for site 1 are similar to site 2
- The record for site 3 is similar to the FORCE record
- The record for site 4 shows a lower diversity than the other sites
- All sites show an ammonia level of between 0.1 and 0.35mg/l

The report concludes that the river is recovering – but that the conditions in site 3 and site 4 are still showing some residual effects from the pollution. The report also proposes that the ammonia concentration is due to diffuse run-off and is not a residual effect of the pollution.

It is disappointing that the data are not compared to invertebrate data from before the incident. Our belief is that the invertebrates at site 3 continued to be significantly affected, in both diversity and distribution of species, as a legacy of the pollution incident.

The report assumes that invertebrate numbers are now limited by the elevated ammonia levels. However, there has been no mechanism, other than downward drift, for the river to recover its invertebrates. This (along with the lack of fish predation) may better explain the current species diversity and distribution. Note that the ammonia levels are now similar to those recorded prior to the incident but that the ammonia itself is still sufficiently low to qualify as good to very good status. The main water quality problem with the river historically has been phosphate, at levels of around 0.25mg/l and below the good threshold, and this was not measured by the APEM survey.

Reports from FORCE members and others: April to August 2012

There were several reports of one or more large fish seen in the Crane as well as small shoals of smaller fish and fish fry.

The 25cm chub was recorded at Crane Park Island on several occasions from mid May and around a dozen sticklebacks were reported at Crane Park Island on 25th May

On 14th June an observer to electro-fishing on the Crane at Crane Park Island noted 9 fish recorded including gudgeon, barbel, roach and some bullhead. Around 40 fish fry were recorded from above the dipping platform and a further 20 from below the platform.

The numbers of fish fry and small fish appear to have become more abundant from July onwards. On 5th July, pockets of tiny fish fry 80-100 strong were seen in numerous locations between the A316 bridge and Crane Park Island with maybe 3 or 4 smaller groups just below the Mill Road Weir. On 26 July, a much larger group of fry (maybe 200-250 strong) was seen in Kneller Gardens.

Three shoals of thirty to forty fish of between 10 and 20cm length were reported in the lower Crane at St Margaret's on 13th August. Many of these were believed to be chub with at least one small perch.

On 18th August a limited number of 3 to 4cm long fry were seen at two locations along the lower DNR; a dozen or so just above Chase School footbridge and a similar number just above Queens Bridge.

A report from Crane Park Island on 22nd August noted "thousands of young fish in the river. I have never seen so many fish fry as there are now".

A separate report on the same day noted; "yesterday afternoon I saw another whole load of 1cm fry in Kneller Gardens. This is hard to explain for two reasons;

1) The river has been flowing too sluggishly for the last 3-4 weeks for fry to be washed down en-masse from way upstream as before.

2) These are very late hatchlings. I don't think I've ever seen such tiny fish during late August. Most river fish tend to spawn sometime during April, May or June so their offspring will be well developed enough to cope with the usual increase in flow rates from October onwards. This latest batch won't be very well developed by October.

Clearly some fish have only just spawned in the last 3-5 weeks - rather unusual"

Another report on 23rd August noted "A more recent development has been the sightings of larger fry (3 to 4cm) in the lower DNR and I wonder if they've been there since hatching or just recently migrated."

There were several records of kingfishers on the Crane in July and August, although LWT volunteers noted that they had not bred on the island this year, which would be the first year with no breeding since the kingfisher banks were installed in 2004. Herons have also been seen occasionally, but not in the numbers seen previously.

Another record from August noted "whirligig beetles seen on various parts of the Crane (we don't usually see them here). Is this because there are no predator fish? Water crickets in greater numbers than usual and, (at least on Crane Park Island), a good range of damsel flies and dragonflies."

Others sightings by the public include three sightings in September and October of crayfish in the area of Kneller Gardens and eight reported sightings of kingfishers over the September-October period.

Finally, "there are still terrapins in the Crane after the pollution incident. One was seen this week at Kneller Gardens and there is one downstream of Crane Park Island. I caught one earlier this year next to the Island and we have a photograph of me holding it, a yellow-bellied terrapin from North America".

On a less positive note there have been two reports of minor pollution incidents on the river in the last six months. One report noted a discharge of turgid liquid into the Crane from a pipe in Crane Park and the other a discharge of around 2l/s of milky liquid in to the Crane at Kneller Gardens. Both were reported to the EA and the latter was deduced to be water based emulsion paint.

FORCE sampling on 27th August 2012

A fourth sampling took place on 27th August, at the end of a wet summer period. This sampling repeated the procedure of 27th May. Several samples were taken in the various habitats present including shallow gravel riffle, deeper fast flowing channel, and slow moving silt bottomed vegetated bank side.

A fine brown algal coating was noted on the gravels. An LWT volunteer reported a young kingfisher seen the previous day – and speculated it may have migrated from upstream as none have bred on the island this year.

There were many whirligig beetles noted on the water surface as well as a common pond skater and a lesser water boatman. Whirligigs were not seen commonly at this site prior to the pollution.

Table 8: Sample from 27th August

Species		Numbers	Comments
Fresh water shrimp	Gammaridae	100+	
Hog Louse	Asellidae	5+	Fewer than in May – possibly due to reduced detritus
Non biting midge larvae – dancing midge	Choronomidae	10 to 20	Hugely reduced in number since May – due to predation by other species?
Cased caddis	Unknown species	50+	
Water cricket	Veliidae	2+	
Common pond skater	Gerridae	1	
Banded demoiselle larvae	Calopterygidae		Seen for the first time since the pollution

Blue wing olive may fly	Ephemerellidae	10+	
Leech	Glossipnoniidae	5 to 10	
Ram's horn	Planorbidae	2	
Water mite	Hydrachnida	2-5	Much reduced numbers
Whirligig beetles	Gyrinidae	10+	Seen in adult form
Mayfly	Baetidae	50+	
River snail	Lymnaeidae	5 to 10	Snails more common than in May
River snail	Bithyniidae	20 to 50	
Round worm	Oligochaeta	1	
Stickleback		5	First identified – many being recorded elsewhere on the river
Stone loach		1	First identified
Fish fry		3	First identified

This sample is greatly changed from the sample of late May. Numbers of hog louse, midges and water mites are much reduced whereas the numbers and variety of other species have greatly increased. Several species are in greater numbers than would normally be seen at the site and this may well be due to the lack of mature fish.

The numbers of small fish such as sticklebacks and stone loach have increased and there are more fish fry. However, there are no bullheads as yet and there are no larger fish.

FORCE sampling on 7th November 2012

The river is quite high following a week or more of moderate rain. There is more silt present than in August. Ranunculus is still present and growing.

Table 9: Sample from 7th November

Species		**Numbers**	**Comments**
Fresh water shrimp	Gammaridae	500+	A huge abundance – more than seen at any other time
Hog Louse	Asellidae	5+	Fewer than in May – possibly due to reduced detritus
Non biting midge larvae – dancing midge	Choronomidae	10 to 20	Hugely reduced in number since May – same number as in August. Now in balance due to predation by other species
Cased caddis	Unknown species	1	Compared to 50+ in August. Is this seasonal?
Pea mussel	Spheridae	10	

Black fly	Simulidae	5	
Water cricket	Veliidae	0	
Common pond skater	Gerridae	0	
Banded demoiselle larvae	Calopterygidae	1	Single specimen as per August
Blue wing olive may fly	Ephemerellidae	50+	
Leech	Glossipnoniidae	5 to 10	
Ram's horn	Planorbidae	2 – 5	
Water mite	Hydrachnida	20+	Increase since August – less predation?
Whirligig beetles	Gyrinidae	0	Seasonal
Mayfly	Baetidae	10+	
River snail	Lymnaeidae	0	
River snail	Bithyniidae	20 to 50	
Round worm	Oligochaeta	1 – 2	
Stickleback		1	
Stone loach		0	
Coarse fish fry		1	Fewer than in August

A sample more dominated by shrimp with fewer number of most other species and still good numbers of may fly. Low numbers of fish fry is potentially a concern

Fish Stocking

In December 2012 Environment Agency officers started restocking the River Crane with fish from the Calverton Fish Farm. A total of 1,500 chub, 1,500 dace, 1,500 roach and 1,000 barbel of 12 months plus age were released in the Brazil Mill Woods area of the central River Crane and several kilometers above Crane Park island.

FORCE sampling on 16th January 2013

It had been very cold overnight and just above freezing during the sampling. There had been several months of good flow preceding the sampling and the river looked healthy with a good flow down both channels, healthy patches of ranunculus and not much silt.

Table 10: Sample from 16th January

Species		**Numbers**	**Comments**
Fresh water shrimp	Gammaridae	500+	A huge abundance – as per November. Present in all sizes
Hog Louse	Asellidae	2	Only two small specimens present – continuing low numbers seen in November
Non biting midge	Choronomidae	10	Further small reduction in

larvae – dancing midge			numbers from November
Cased caddis	Unknown species	2+	
Caseless caddis	Rhyacophilidae	5 to 20	May be new to this sample
Caseless caddis	Hydropsychidae	50+	May be new to this sample
Pea mussel	Spheridae	0	Non living but plenty of shells
Black fly	Simulidae	0	
Water cricket	Veliidae	0	
Common pond skater	Gerridae	0	
Banded demoiselle larvae	Calopterygidae	0	
Blue wing olive may fly	Ephemerellidae	0	Compared to 50+ in November
Leech	Glossipnoniidae	5 to 10	
Leech	Erpopdellae	2	First sighting
Ram's horn	Planorbidae	1	
Water mite	Hydrachnida	0	Disappeared since November
Whirligig beetles	Gyrinidae	0	Seasonal
Mayfly	Baetidae	50+	A significant increase in number since November
River snail	Lymnaeidae	0	
River snail	Bithyniidae	20 to 50	Living
Gastropod	Hydrobidae	1	First record
Round worm	Oligochaeta	2-5	
Green worm		2+	Seen for the first time
Stickleback		4	
Stone loach		0	
Coarse fish fry		0	None seen despite fish stocking

Some species were no longer present, this may be as a result of seasonal changes in the invertebrate community. On the other hand the numbers and varieties of caseless caddis appeared to be increasing. The continued lack of coarse fish species beyond the occasional stickleback is a concern – although kingfisher sightings are fairly common again.

Observations in early 2013

The weather was cold for extended periods in January and February. The river in Crane Park was noted as a having a green tinge on or around 4th February. A small amount of grey "sewage fungus" was seen in Crane Park on 20th February. On 4th March the river at Pevensey Road was recorded as having extensive "sewage fungus" along the river bed with some of the ranunculus being partly coated in fungus.

On 3rd March FORCE received a message from a member that included:

> *Could you please tell me who to contact at Heathrow Airport regarding the toxic waste they are putting into the river crane from the balancing reservoir they own? We have photos and a video of the disgusting polluted water coming from the outlet from the reservoir directly into the river crane. We stood on the metal bridge at the river end of the outlet yesterday 2nd March and observed the terrible polluted water and dead little fish coming out of the outlet from the balancing reservoir…."*

The pollution was observed by FORCE Trustees and LB Hounslow staff at the Pevensey site and was reported to the EA and BAA on 4th March 2013.

On 6th March a FORCE member sampled the invertebrates at Crane park island along with around 18 local children and found a sludge covered river bed with only around a dozen gammaridae and a few other species, considerably reduced from previous weeks and months.

A visit to the river adjacent to the Heathrow outfall, along with invertebrate sampling, was carried out be a FORCE member on 8th March and reported as follows:

> "I sampled about 100 m downstream *(of the Heathrow Outfall*) in Donkey wood. The river bed was covered with thick layer of grey/brown filamentous slime. I did a 1 minute sample and found Gammaridae, 2 species of leech (Glossiphoniidae and Erpobdellidae), Oligochaeta and Asellidae. Numbers were low and it was very hard to look properly through the sample because of the amount of grey sludge.
>
> 100m upstream of the outfall the picture is much more as it when we sampled Crane Park in January, showing a much greater abundance and diversity. I found all species found downstream plus mayflies, probably baetidae in large number and 2 Ephemeridae, < 5 cassed caddis, chironomidae, mixed molluscs and corixidae (boatmen).
>
> I sampled the lower DNR just downstream of River Gardens Weir to see if that was ok. Although the abundance wasn't quite as high as above the Heathrow outfall it did have mayflies and there was no grey sludge to be seen.
>
> I went to have a look at the 'Heathrow lake'. They must know they have a problem as there were 4 blowers pumping air or oxygen into the lake. Around each was a mound of foam (this only forms when you have very heavy organic loads in fresh water – surface-active organic molecules form around the bubbles)."

This report was sent to the EA and BAA.

The issue was discussed with a chemical engineer experienced in the treatment of glycol from both the water and oil industries and the following points were made:

- The problem may well be due to the application of glycol as a de-icer at heathrow.
- There are three types commonly used; monoethylene, tri-ethylene and propylene glycol; all are light hydrocarbons and dissolve in water; typically used at a concentration of around 30 per cent and applied both to the aircraft itself and the runways
- Glycol has a very high TOC and BOD and can break down by aeration or biological action. The breakdown process is much slower in cold conditions
- Oxygen is added to the lakes at Heathrow to break down the glycol by aeration. Any remaining glycol can result in blooms of algae on the river bed which in turn suck the oxygen out of the river water and impact upon the invertebrates and fish

It would be very helpful to see the EA data on (a) the consented discharge from the Heathrow site and (b) records of DO, TOC and BOD downstream of the site and these have been requested from the EA.

FORCE reps met with BAA on 23rd April to review the treatment process and discuss the pollution impacts. BAA acknowledged at the meeting that the pollution had been due to glycol from the airport.

FORCE sampling on 9th April 2013

Cold and damp overnight following weeks of fairly cold weather and a spring commonly believed to have been delayed by around six weeks. Ranunculus remains on the southern channel around the island but not in good condition. The gravels in the main channel are covered by a thick filamentous algae, which appears to have died and formed a sludge covering the sediment and collected in the sample nets. Filaments of these dead algae are also floating down river from upstream.

Comment [j1]: I don't think it's algal probably principally bacterial, fed by the glycol.

Table 11: Sample from 19th April

Species		Numbers	Comments
Fresh water shrimp	Gammaridae	100+	Reduced numbers from January. Also a number of the larger specimens have algal growths on them as in early 2012. Due to pollution or a seasonal issue?
Hog Louse	Asellidae	2	Only two small specimens present – continuing low numbers seen in November and January
Non biting midge larvae – dancing midge	Choronomidae	100 +	Larger numbers than November and January. Again is this seasonal and/or a pollution effect?

Comment [j2]: fungal

Cased caddis	Unknown species	0	
Caseless caddis	Rhyacophilidae	1 to 5	Reduced numbers from January
Caseless caddis	Hydropsychidae	1 to 5	Reduced numbers from January
Pea mussel	Spheridae	1	Alive plus many dead ones
Black fly	Simulidae	0	
Water cricket	Veliidae	0	
Common pond skater	Gerridae	0	
Banded demoiselle larvae	Calopterygidae	0	
Blue wing olive may fly	Ephemerellidae	2 to 5	Compared to 50+ in November and none in January
leech	Glossipnoniidae	1	
leech	Erpopdellae	0	First sighting
Ram's horn	Planorbidae	0	
Water mite	Hydrachnida	0	Disappeared since November
Whirligig beetles	Gyrinidae	0	Seasonal
Mayfly	Baetidae etc	50+	Mixed species
River snail	Lymnaeidae	0	
River snail	Bithyniidae	20+	Mostly dead – compared to living in January
Gastropod	Hydrobidae	0	
Round worm	Oligochaeta	0	
Green worm		0	
Stickleback		1	Damage around the gills
Stone loach		0	
Coarse fish fry		0	

Comment [j3]: we saw one case that I don't think warrants a mention

Comment [j4]: Ian mentioned this but I think it just had debris under the operculum – probably from being scooped up in the net.

This sample shows a fairly good recovery, given the major concerns raised by informal sampling in early March and reported above. The numbers of mayfly in particular are higher than anticipated, given what was caught in the same part of the river on March 6th, and there are low numbers of caseless caddis now present.

This indicates that the dissolved oxygen levels downstream of Donkey Wood probably quickly reverted to normal once the glycol discharge stopped. Periods of heavy rainfall over the following few weeks and the associated higher river flows would have helped bring oxygen levels up and also wash invertebrates down from upstream of the polluted stretch

The condition of the gammaridae may or may not indicate lingering pollution problems.

A further concern remains around the lack of fish in the river. The local volunteer site manager at the island noted that a male kingfisher had been staking out this territory over the winter but has now left, indicating that fish numbers have been heavily depleted.

This is supported by this latest sampling and by observations along the remainder of the river over the last month.

Observations in late April 2013

A series of observations have been received noting small shoals of fish fry seen in the river during the last few days of April. Locations include Pevensey Road nature reserve, Crane Park Island, Kneller Gardens and the lower DNR. The weather has warmed over the last few days and this would indicate an early hatching of fish fry in response.

A separate observation was of a large pike laying up in the lower DNR local to Mogden STW. This was noted to be 70cm plus in length.

Conclusions

Prior to the pollution of October 2011 the river was generally in a fair condition with between 5 and 15 fish species found along it. There were a total of seventeen species of dead fish recorded at the Mogden survey following the pollution incident. Note however the concerns expressed by a local fisherman regarding the composition of species and the low numbers of some of the larger species, making the main Crane more indicative of a smaller stream fishery. There was a reasonably rich macro-invertebrate fauna with around 20 species and BMWP scores of between 50 and 130.

It appears that the river quality had been improving slowly over the previous thirty years, from moderate to poor quality in the 1980's to fair condition in 2011. The quality also improved, but not markedly, downstream of the DNR inflow, and this is the key reach which has been impacted by the pollution incident. The main pollution problem recorded historically was high phosphate levels and, if this was improved, there appeared to be scope for the river to achieve "good ecological potential". There is however concern regarding the quality of the fishery and some evidence that this has declined over the last 10 to 20 years. It is suggested this is due to a change in the habitat provided in the lower Crane and a reduction in deeper water habitat. This may have removed some of the deeper hollows providing habitat for the larger coarse fish.

The pollution of late October 2011 appeared to have killed all the fish between the A4 CSO and the Thames on both the Crane and the lower DNR, and also decimated the invertebrate population, with the only survivors being a few snails. As a result the resident populations of kingfisher and heron left the river.

Six months later, in April 2012, there was still significant evidence of polluted sediment within back channel areas of the river. In the main river there had been a recovery of some invertebrates, most notably dancing midges and a range of snails and other shelled species. Clouds of adult dancing midges were seen over much of the river and may have been indicative of a boom in numbers due to its rapid reproductive rate and a lack of predators.

Gammaridae (fresh water shrimp) had returned although adult specimens had a fungal infection not seen previously. This may have been indicative of ongoing pollution problems, possibly related to the dark organic coating found over the gravel river bed. More encouraging was the presence of mayfly and caddis fly larvae, traditionally indicators of better water quality. There were at that time no signs of fish, nor other invertebrates such as damselfly or water boatmen.

In the spring and early summer 2012 there was an extended period of heavy rainfall and the river bed was starting to appear noticeably cleaner. There was also, over this period, more evidence of a slow recovery of invertebrate numbers, although not all varieties were present. Damselflies were known to have bred in the ponds of Crane Park Island but there were insufficient numbers of damselflies or dragonflies in the rest of the lower Crane to confirm any widespread emergence along the river. The fishery was also slowly recovering. Small numbers of chub and sticklebacks had been seen as well as fish fry.

By August there had been a substantial increase in the numbers of fish fry and small fish, to a level reported as unusual for the time of year. The numbers of mature fish remained very low. The number of invertebrate species had increased since May and the numbers and variety were greater than seen prior to the pollution. The distribution of invertebrates may be due to the continued lack of larger mature fish as predators. Note that as yet no bullheads had been recorded.

By winter 2012/13 some species declined and disappeared, possibly due to seasonal die back, whilst the numbers and variety of caddis for example appeared to be growing. Fresh water shrimps were at unprecedented levels, probably due to a lack of fish predators. Although there had been a first fish re-stocking the numbers and varieties of fish remained a concern.

In February and March 2013 there was evidence of a further significant pollution incident on the river with a major bloom of "sewage fungus". Evidence pointed to this being due to high TOC and BOD within the discharges from Heathrow and a result of the application of de-iceing agents. Local people have noted that this occurs regularly during the winter and subjective records indicate similar algal/bacterial blooms in the winters of 2011 and 2010.

Initial records indicated a major reduction in the number and diversity of invertebrates downstream. Further measurements in April indicated a partial recovery among the invertebrate population. Of greater concern at that time was the lack of small fish in the river, particularly as recorded at Crane Park Island, and the subsequent disappearance of kingfishers from this area.

By late April, and possibly in response to the first warm weather of the year, small shoals of fish fry were seen. A kingfisher was also seen at the island and there remains hope that they could nest this year.

Comment [j5]: I don't think we can refere to this as a recovery as it implies we know what condition the river should be recovering to.

I think we should be talking in terms of " april's monitoring shows an encouragingly rapid recolonisation"

Comment [j6]: I don't understand this heirachy of concerns as the lack of fish is a direct result of the repeated decimation of animals at the base of the food chain.