## SECTION 7: ECOLOGY RELATED TO WFD

### 7.1: Ecological components of WFD

The Wandle Catchment Plan recognises the importance of WFD in prioritising work to restore the Wandle's natural processes.

For the purposes of assessing GEP, WFD classification focuses on fish and fisheries, macrophytes, invertebrates and phytobenthos as key indicators of ecosystem health.

### 7.2: Fish and fisheries

*Our Vision is a river that supports a mosaic of habitats with high biodiversity*

*Wandle Catchment Plan Objective 4: Thriving populations of native fish associated with chalk rivers are present and able to move freely*

***"We like seeing responsible fishing on the river – it's part of the Wandle's history, and a great way for kids and adults to relax and reconnect to the environment."***

***- from Ketso community and stakeholder workshops***

As indicators of the health of the entire aquatic ecosystem, fish and the fisheries they provide are key metrics for any assessment of the productivity and resilience of streams, rivers and lakes.

For the purposes of WFD, fish stocks are scored with the Fish Classification System (version 2) (FCS2) tool: a Baysian statistical model which classifies the fish quality of rivers based on observed fish catch against the "expected catch" of an undisturbed site. It is also possible for technical experts to make site-specific recommendations that depart from the FCS2 model, or add to the expected species list, particularly if there is historical evidence for any particular species' presence.

Fish status on the Carshalton water body is classified as Poor, on a basis of a single sampling site at Butter Hill. Fish on the Croydon – Wandsworth water body were classified as Poor in the 2009 Thames River Basin Management Plan, but this status has now been raised to Moderate on a basis of surveys in 2010, 2011 and 2012. Both water bodies are thought to be failing Good status due to deficiencies in water quality, habitat, flow and barriers to fish migration: $PO_4$ has also been noted as a constraint on the Croydon – Wandsworth water body.

For the purposes of the Wandle Catchment Plan, as discussed in Section 1.8, the Wandle's two water bodies have been further subdivided into functioning reaches which the Fish and Surface Water TAGs consider distinct for fish. Together with consideration of fish guild structure, this analysis should allow river restoration measures to be targeted most effectively, and will also facilitate monitoring progress towards GEP:

1: Carshalton water body (Carshalton Ponds source to confluence with Croydon branch at Wilderness Island)
2: Beddington reach (Croydon source to confluence with Carshalton branch at Wilderness Island)
3: Confluence to Beddington Sewage Treatment Works effluent carrier outflow at Mill Green
4: Effluent carrier (the outflow from Beddington STW at Mill Green)
5: Effluent carrier to confluence with River Graveney
6: River Graveney (including the Norbury Brook)
7: Confluence with River Graveney to tidal creek (EDF weir)
8: Tidal creek to mouth of the River Thames

By a process of combining the FCS2 predictions with expert knowledge, the Fish TAG has agreed that the following species are expected for these reaches after appropriate river restoration measures:

| | **Reaches** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5 & 7** |
| | **Carshalton reach** | **Beddington reach** | **Confluence to effluent carrier** | **Effluent carrier** | **Effluent carrier to Tidal Creek** |
| **Eel** | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Brown trout** | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Bullhead** | ✔ | ✔ | ✔ | ✔ | # |
| **Chub** | | | ✔ | ✔ | ✔ |
| **Dace** | # | # | ✔ | ✔ | ✔ |
| **Roach** | | | # | ✔ | ✔ |
| **Barbel** | | | | ✔ | ✔ |
| **Grayling** | = | = | = | = | = |
| **Stoneloach** | ★ | # | # | # | # |
| **Minnow** | | | # | # | # |
| **Gudgeon** | | | | # | # |
| **Perch** | | | | # | # |
| **Pike** | | | | # | # |
| **3-spined stickleback** | # | # | # | # | # |

| ***Legend*** | |
|---|---|
| ✔ | *GEP species* |
| # | *Possibly present, particularly depending on outcome of habitat restoration, but not a GEP indicator* |
| = | *Possibly present if reintroduced* |

*Fig 7a: Fish species agreed by the Fish TAG, using FCS2 outputs combined with expert knowledge, for each reach of the Wandle following appropriate restoration works, which could be used as GEP indicators. (NB Reach 6 (Graveney) is heavily culverted and polluted, and Reach 8 (Tidal Creek) is not currently part of the Croydon-Wandsworth water body under WFD, so these reaches have not been included in this analysis).*

The Wandle is currently designated as a cyprinid fishery, and FCS2 expects a mixed population of coarse and salmonid species. Accordingly, the Wandle Catchment Plan's Fish TAG suggests defining GEP on a basis of thriving fish populations, with ecosystem function demonstrated by sustainable recruitment.

General priorities for achieving GEP for fish are outlined below and in the tables at the end of this Section. These have been addressed as Actions for water (Objectives 1-3), macrophytes and wider habitat features (Objective 5) as well as fish (Objective 4).

- Balancing use of the groundwater system so that characteristic chalk stream inputs and the associated chemical and thermal conditions are restored and maintained.

- Re-naturalising the river's hydrograph. This will require detailed assessment of current abstraction practices and augmentation system, as well as deeper understanding of how

the surrounding landscape interacts with the river, and ongoing consideration of effective flood risk management. By restoring a wide diversity of microhabitats, including backwater refugia, pool and riffle hydromorphology and channel sinuosity, colonisation and survival by fish and many other species will be greatly enhanced.

- Restoring connectivity for both up- and downstream migration. The removal or reduction of impounding structures will also turn reduce sedimentation of gravel substrates which are vital to successful spawning for many fish species. Restoring the river's natural gradient will also assist scouring of silt and sediment transport.

  To facilitate fish passage for all species, weirs have been removed or reduced at Mill Lane (Carshalton) (2010), Three Arch Bridge (2011), Poulter Park (2012), Ravensbury Park back channel (2012), Culvers Island (2014) and Butter Hill (2014).

- Reducing the impact of contaminants: both acute pollution spill events and chronic degradation of water quality resulting from misconnected pipes and from road runoff containing heavy metals, hydrocarbons and other pollutants in solution and associated with sediments. This will require deeper understanding of the bioavailability of pollutants and how contaminants may bioaccumulate within the Wandle. Monitoring the intensity and duration of pollution incidents will enable more accurate predictions about severity and effectiveness of any remedial action taken.

As work is undertaken to restore ecological processes and reverse the degradation of the Wandle's natural chalk river characteristics, existing fish distribution, populations and biomass are likely to change. Although both Wandle water bodies are currently failing GEP, it will still be important to demonstrate no deterioration from the current situation. Trout, salmon and bullhead are also designated as UK BAP species.

Restocking has taken place since the pollution incident of 2007, but the EA's regular amenity stocking of coarse fish ceased in 2010. Even after fish kills resulting from pollution incidents, the EA no longer restocks fish automatically, preferring to invest any funds in habitat enhancements and multi-species fish passage improvements, to improve the river's underlying resilience and enable natural recolonisation.

Angling is a highly popular recreational activity offered by the Wandle, and the enthusiasm of the local angling community has driven many recent habitat improvements on the river. For instance, the Wandle Piscators fishing club co-ordinates monthly riverfly monitoring throughout the catchment: an ongoing, award-winning project which has set national standards for full-catchment coverage, and has contributed to several investigations including designation of the Wandle as a nutrient-sensitive area. Such angling interest is a valuable ecosystem service in an inner-city area, and should be taken into account when setting a course for the Wandle's future fish populations, including the possibility of boosting population levels of some species (eg barbel) via targeted maintenance stocking. It has also been noted that coarse fish tend to live longer and grow more slowly than trout, so amenity stocking of juvenile fish may take several years to show satisfactory results for anglers.

Fig 7b (below) shows fish population density and biomass estimates from 12 EA survey sites along the Wandle in 2011: a snapshot of the river's fish populations at the time of compiling this Catchment Plan. Although many species of fish are still not completing their life cycles in the Wandle with full success, it is hoped that as a result of this Catchment Plan a wide variety of limiting factors can be identified and projects developed to fulfil WFD targets, in order to restore the river to its former glory as a self-sustaining fishery.

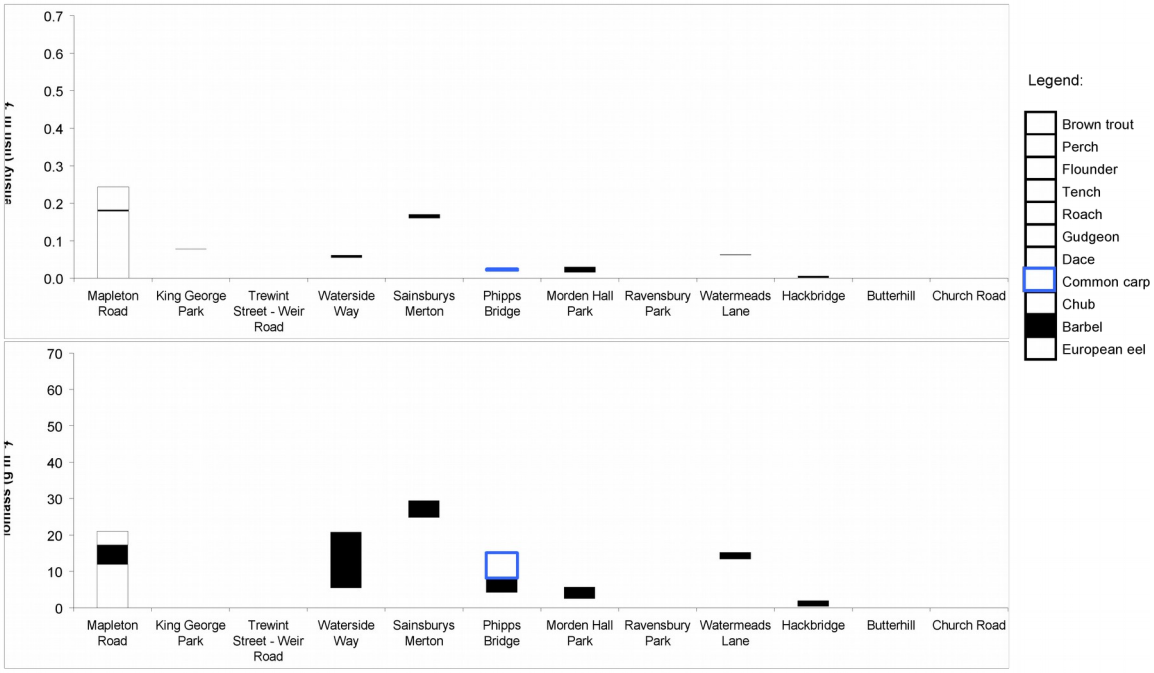


*Fig 7b: Fish population density (top) and biomass (bottom) estimates from the River Wandle survey sites 2011 (source: EA, 2011)*

### 7.2.1: Trout, salmon and grayling

As discussed in Section 3.2, the Wandle enjoyed a national reputation for the quality of its trout fishing from the medieval until the late Victorian era.

The much-quoted footnote to the 1833 and 1835 editions of Izaak Walton's *Compleat Angler* refers to Wandle trout "with marked spots like a tortoise", while Gilliat Hatfeild's unpublished *Fly Fishing in the Wandle* records that "the Wandle trout are of a very peculiar sort all covered with tortoiseshell and red spots" (c1840). Alfred Smee identified two separate strains of Wandle trout, one with red and one with white flesh (Smee, 1872): he also noted that Wandle trout tended to spawn late, "about the third week of January… till the end of February or the first few days of March", a statement corroborated by Francis Francis in his *Practical Management of Fisheries* (1883).

The Wandle's natural trout population was supplemented by extensive stocking, including French sea trout procured from Huningue by Smee himself before 1870, and trout from a hatchery at Watermeads operated by the Wandle Fisheries Association c1895 (Montague, 2005) but it is no longer known to what extent the native strains were affected by genetic introgression. The last old Wandle trout is popularly supposed to have survived until 1934 (Courtney Williams, 1945), but a very sparsely-spotted strain of trout in sections of the Sussex Ouse catchment may represent a surviving remnant of the original Wandle phenotype (pers comm. Dave Brown, 2013).

Between 1978 and 1991, the water authorities periodically stocked adult trout into the Carshalton and Hackbridge area, either for angling amenity or as a proxy test for water quality. The Wandle Trust's Trout in the Classroom environmental education programme began introducing Itchen-strain trout fry to the upper river from 2003. With water quality improvements in the Butter Hill and Hackbridge areas, these have survived and thrived: early spawning attempts by adult trout were

first noted in winter 2007-2008, and the first confirmed wild-spawned trout fry was found during riverfly monitoring at Hackbridge in early 2010 (pers comm. Theo Pike, 2014). Anecdotal evidence also suggests that the Wandle Trust's stocking of Trout in the Classroom fry at Richmond Green on the Croydon arm of the river in 2008 survived until they were killed a year later by a red diesel pollution incident.

In partnership with the Environment Agency and the Wild Trout Trust, the Wandle Trust is now developing a strategy to restore a sustainable population of "urban-adapted" wild trout to the upper river. Research carried out by Exeter University on the River Hayle in Cornwall has identified a healthy population of trout which has adapted to levels of Pb and Cu normally considered lethal to salmonids (Uren Webster, 2013). Applying this principle to the Wandle will involve sourcing trout parr from similar urban rivers like the Buckinghamshire Wye and Dover Dour, which have already adapted to high levels of urban runoff including metals and PAHs, and allowing the resulting genetic palette to self-select further according to prevailing conditions in the restored upper Wandle. By ensuring a healthy trout population in the upper river, this project is designed to deliver Good WFD status for fish in the Carshalton water body.

In order to complete their lifecycle successfully, wild brown trout require the following range of habitats:

| **Trout** | **Water depth** | **Mean water velocity** | **Substrate** | **Other** |
|---|---|---|---|---|
| Spawning and alevin | 25-60cm | 25-75cm/sec | Loose, well-sorted gravel with little fine sediment | Nearby cover for spawning adults: deeper water, undercut bank, boulders, weed |
| Fry | 5-40cm | 0-30cm/sec | Cobbles, gravel, woody debris or gravel with rooted plants | Abundant bankside and / or instream cover |
| Parr | 10-60cm | 5-50cm/sec | Cobbles, gravel, woody debris or gravel with rooted plants | Abundant bankside and / or instream cover |
| Adult | >30cm | 10-60cm/sec | Wide range: gravel and weed to boulders and large woody debris | Abundant bankside and / or instream cover |

*Fig 7c: Habitat requirements of all life stages of wild trout (The Wild Trout Trust, 2012)*

On the Carshalton branch of the river, the following measures are being put in place, in the hope that they will maximise the habitat potential for wild trout and improve the water body's status to Good for fish by 2015:

- Water quality: reduction of urban runoff, including sediment, heavy metals, PAHs and other pollutants, is likely to increase spawning success as well as survival of vulnerable juvenile fish. (Fine entrained sediment smothers fish eggs, depriving them of oxygen, while metals and PAHs bind easily to fats which form a high proportion of eggs)

- Water temperature: the average range of temperatures in the upper Wandle is well within the tolerances of trout, whose comfortable optimum ranges for growth are 7- 9°C and 16-19°C (Solbé, 1997). However, reduction of impoundments will help to reduce unnecessary solar heat loading

- Connectivity: numerous historic and flood risk management structures still fragment the connectivity of the Wandle and restrict the ability of fish to migrate between reaches to complete different stages of their lifecycle. These have also prevented recolonisation of the Wandle by sea trout from the River Thames. Future work to remove or bypass obsolete structures, particularly at Beddington Park, Shepley Mill, Goat Bridge, Watermeads and Merton Abbey Mills will be an important component of restoring sustainable trout populations to the Wandle.

- Channel morphology: centuries of anthropogenic modifications have left the Wandle's channel highly simplified. Ongoing habitat works, which include reconstructing pool and riffle sequences, and introducing large woody debris, will improve hydromorphological diversity and habitats for all life stages. Consideration should also be given to creating deep pool habitat, currently provided by large impoundments such as Shepley Mill and Goat Bridge weirs, as deep-water refugia during natural low flow conditions.

Apart from trout, research does not reveal significant contributions to the historic Wandle fishery from any other salmonids. This may have resulted from very early industrialisation in the Wandsworth area, where mills are known to have been operating (and obstructing fish passage for salmon and sea trout) from 1371 (Steel and Coleman, 2012). Decreasing water quality on the upper river may have led to the failure of Smee's attempt to introduce grayling from Derbyshire to the Beddington area, which survived and spawned for many years, but never recruited successfully (Smee, 1872).

In the modern era, 150 salmon fry were released in Carshalton as a precursor to the Trout in the Classroom project, and occasional adult salmon have reportedly been caught by anglers on the lower Wandle since around 2005 (pers comm. Wandle Piscators, 2014). Grayling were stocked annually on the upper river 1978-1981, and seem to have survived until a serious pollution incident in 1983: one or more were reported from the Mill Green area before the September 2007 pollution incident, and similarly lower down the river (pers comm. Wandle Piscators, 2014). The EA would prefer to re-establish a sustainable trout population in the upper river before addressing grayling: however the Fish TAG has noted research from Scandinavia which suggests that grayling thrive better than trout in highly simplified channels (pers comm. Dave Brown, 2012). This implies that grayling could thrive in the upper Wandle, above the heat loading effect from Beddington STW, if other water quality and habitat objectives are met.

### 7.2.2: Coarse fish

Since the late 1980s, a variety of coarse fish species have provided excellent angling for local people.

Historically the Wandle was predominantly noted for trout and eels (see above and below), but other species were also found in the middle river. In LB Merton, Nelson's downstream neighbour James Perry fished for pike c1805, probably at what is now Connolly's Mill, while Gilliat Hatfeild caught perch up to ¾lb below Ravensbury Mill in 1841, and recorded that roach and dace were plentiful in Merton (Hatfeild, c1840). William Morris stocked perch from the upper Thames at Merton Abbey in 1882, and lamprey, bullhead and dace were recorded during the 1870s in Mitcham and Beddington (Smee, 1872). In 1894, Alfred Jardine wrote in the *Fishing Gazette* that roach were multiplying and that jack pike had also increased in numbers.

The Wandle's coarse fishery suffered the same fate as its more celebrated trout interests through the mid 20$^{th}$ century, but was revived almost as soon as sewage treatment technology permitted. The first modern stocking record dates from 1978, when chub, dace, gudgeon, perch and roach were stocked by the water authorities between Hackbridge and Goat Bridge. Roach in particular were stocked through the 1980s, with more chub and dace in the 1990s. Barbel were introduced at Morden Hall Park in 1996.

In fulfilment of its statutory duty to maintain, improve and develop fisheries, the EA stocked barbel, dace, chub and roach at several points on the Wandle (as well as the Hogsmill and Beverley Brook) annually between 2006 and 2010. At this point, when electrofishing records showed that very few coarse fish were completing their lifecycles successfully, EA fisheries staff took the decision to suspend stocking until factors limiting recruitment were identified and addressed.

To assess the lifecycle habitat requirements of coarse fish, it is usual to classify species according to the concept of "spawning guilds" (Barcellos, 1997):

- Lithophilic species (barbel, chub and dace) deposit their eggs on clean gravel in flowing water. These requirements tend to limit the distribution of these species, and make them susceptible to environmental changes.

- Psammophilic species (bullhead, gudgeon and stone loach) scatter their eggs on sand or under rocks, principally in flowing water

- Phytophilic species (carp and tench) spawn on aquatic or flooded vegetation

- Phytolithophilic species (bream and roach) have very flexible spawning requirements, and are known to spawn on moss, willow roots, *Phragmites* and gravel

A summary of these species' lifecycle habitat requirements (as relevant to the Wandle) appears below:

| **Species and spawning guild** | **Life stage** | **Water temp** | **Life stage preferred habitats** |
|---|---|---|---|
| | | | |
| **Barbel** | Spawning | >14°C | Over clean gravel among open weed beds |
| *Barbus barbus* | Fry habitat and diet | | Riparian cover and reed beds: floodplain connectivity may also be important |
| Lithophilic | Adult | | Lowland river reaches with clean water, clean gravels and weed beds. Fast water by bridges and weirs is favoured |
| | | | |
| **Chub** | Spawning | >12°C | Over weed beds: eggs stick to weeds, stones and gravel |
| *Leuciscus cephalus* | Fry habitat and diet | | Hatched fry drift to shallow, slow flowing water. Diet: initially minute invertebrates, then plant material and larger invertebrates |
| Lithophilic | Adult | | Middle and lower river reaches with mixed habitat where riffles alternate with slower pools with weed and silt |
| | | | |
| **Dace** | Spawning | 12-15°C | Shallow sections of riffle, over gravel or stony substrate with some weed. Egg survival may be poor in areas of high silt and low gravel content |
| *Leuciscus leuciscus* | Fry habitat and diet | | Diet: diatoms, then larger invertebrates and terrestrial insects |
| Lithophilic | Adult | | Middle reaches of clean, fast-flowing streams and rivers, mainly in lowland areas: not small streams |
| | | | |

| | | | |
|---|---|---|---|
| **Perch** | Spawning | 10-15°C | Shallow water over submerged macrophytes or woody debris |
| | Fry habitat and diet | | Survival is affected by temperature, with long warm summers best: Diet: invertebrates from aquatic plants |
| Phytolithophilic | Adult | | Slow flowing rivers |
| | | | |
| **Roach** | Spawning | >12°C | A wide variety of substrates, with eggs deposited just below the surface. As a result they may be vulnerable to dessication after any sudden fall in water level. |
| *Rutilus rutilus* | Fry habitat and diet | | Young fry remain attached to weed or other spawning substrate, feeding on invertebrates and vegetable matter |
| Phytolithophilic | Adult | | Very adaptable to still or slow flowing waters including canals and lakes: tolerant of some pollution, able to feed on detritus as well as algae, molluscs and invertebrates |
| | | | |
| **Bullhead** | Spawning | | Males excavate nests under large stones for females to deposit eggs. In areas without suitable stones, woody debris may also be used |
| *Cottus gobio* | Fry habitat and diet | | Shallow stony riffles. Diet: small crustaceans |
| Psammophilic | Adult | | Moderate or fast-flowing water with coarse substrates, more than 5cm deep |
| | | | |
| **Gudgeon** | Spawning | >14°C | Shallow water among plants and gravel |
| *Gobio gobio* | Fry habitat and diet | | Weed and gravel. Diet: small crustaceans |
| Psammophilic | Adult | | Fast flowing water with sand / gravel substrate, plus weed beds for cover |

*Fig 7d: Lifecycle requirements of the Wandle's key species of coarse fish*

A combination of regular stocking and downstream drift of all fish species have tended to mask the dynamics of the Wandle coarse fishery. However, some information can be gleaned from a variety of studies to show that limited recruitment has been taking place in certain areas:

- Phytolithophilic wild-spawned roach were found in large numbers at Wilderness Island, and in smaller numbers in King George's Park, in 1997. Small numbers of phytolithophilic perch were also found in these areas (Barcellos, 1997)

- Wild-spawned roach were found at Morden Hall Park in 2009 and 2011. In 2011 they were also found at Trewint Street and King George's Park (EA, 2011)

- Lithophilic wild-spawned chub were found at Ravensbury Park and Trewint Street in 2011 (EA, 2011)

- Lithophilic wild-spawned dace were found at Trewint Street in 2011 (EA, 2011)

- The first lithophilic wild-spawned barbel on the Wandle was recorded at King George's Park in 2011 (EA, 2011)

- Psammophilic stone loach and gudgeon have been recorded as recruiting naturally in several areas (Barcellos, 1997). Incidental records from riverfly monitoring on the upper river show bullhead recruiting strongly on the Carshalton water body, as well as on the Croydon-Wandsworth water body at Hackbridge and Goat Bridge (Wandle Piscators, 2014).

Overall, while the post-industrial Wandle may have seemed suitable from a water quality point of view for maintenance stocking as an amenity coarse fishery, the river's highly simplified hydromorphology appears to militate against sustainable recruitment by most coarse species. Barcellos noted that the only recruitment areas for highly-adaptable phytolithophilic roach and perch were characterised by excellent marginal macrophyte cover, offering protection from current and predators (Barcellos, 1997): this is likely to apply to all species.

Growth rates of most coarse fish species in the Wandle appear to be slightly below average compared to the growth of species in "southern" rivers. In 2011, Percentage Standard Growth (PSG) of barbel was 97%, chub was 93%, roach was 86%, while dace was 111%, indicating that conditions in the Wandle suit this species if enough suitable habitat for spawning and development is available (EA, 2011).

Although traditional fisheries management often draws strong distinctions between the requirements of trout and coarse species, many lifecycle requirements are startlingly similar, including the need to migrate to different parts of the river system at different times of the year. On the Wandle, habitat improvements of almost any kind are likely to have far-reaching benefits for many species:

- Water quality: ongoing improvements to water quality, and sediment reduction as a result of rubbish removal, are probably already contributing to more successful recruitment by lithophilic species. In areas with less fine sediment, coarse fish eggs will be less exposed to heavy metals and PAHs.

- Water temperature: throughout most of the river, average water temperatures during the usual coarse fish spawning season (ostensibly mid-March to mid-June) are well within the trigger range for spawning activity. However, the Carshalton arm may only reach temperatures above 12°C towards the end of June, potentially limiting recruitment opportunities for some species.

- Water flow: Barcellos notes that roach eggs deposited just below the water's surface, on weed beds or tree roots, may be very vulnerable to sudden decreases of water level as a result of weed cutting or operation of locks and sluices (Barcellos, 1997). Due to the diurnal effluent release pattern from Beddington STW, water levels below Goat Bridge commonly rise and fall by many centimetres, sometimes several times over 24 hours. This factor may be contributing significantly to roach recruitment failures on the middle and lower Wandle.

  Except at Merton Abbey Mills, little weed cutting currently takes place on the Wandle. However, if *Ranunculus* and other macrophytes become more widely established, consideration may need to be given to cutting regimes that do not adversely impact fry survival. Low flows at migration times may also exacerbate fish passage issues.

- Connectivity: traditional fisheries management has not adequately recognised the significant migratory needs of many coarse fish species. A study of barbel on the River Nidd has showed that weirs delay or prevent upstream migration to key spawning areas,

while chub studied on the River Spree in Germany prefer to return to spawn on the "imprinted" gravels where they themselves hatched (Ashby, 2012: Fredrich et al, 2003). On the Wandle, weirs at Beddington Park, Shepley Mill, Goat Bridge, Watermeads, Ravensbury Park, Merton Abbey Mills and Connolly's Mill are likely to be hindering migrations of many species. It is hoped that fish passage improvements such as the Wandle Trust's rock ramp fish pass in Ravensbury Park will help to reconnect significant longitudinal reaches of the river to enable fish of all species to fulfil their migratory instincts.

Much of the middle and lower Wandle is currently disconnected from its floodplain by hard engineering. However, for juveniles of many species including barbel, latitudinal river-to-floodplain connectivity may also be important, enabling them to take refuge from high fluvial flows and forage in nutrient-rich and warmer shallow-water environments.

- Channel morphology: centuries of anthropogenic modifications have left the Wandle's channel highly simplified. Together with the exaggerated flashiness of the river's urbanised hydrograph, this is almost certainly resulting in fish of all age classes being progressively washed downstream over weirs and other structures which they cannot re-ascend - including very vulnerable fry which emerge at the time of the "European monsoon" in June (Wandle Piscators, 2014).

  As discussed in Section 5.8.5, fish of all species may also be relying on large pieces of fly-tipped rubbish as habitat, including shopping trolleys in the absence of more natural features, in the highly-engineered middle and lower Wandle (Barcellos, 1997). The Wandle Trust has noted an urgent need to improve the hydromorphological diversity of such channelised reaches, by introducing well-designed habitat structures which do not collect silt and other debris, or increase flood risk (Wandle Trust, 2014).

  A programme of fish passage works, backwaters and other refugia will be essential for establishing sustainable coarse fish populations in the Wandle. Even in the less hardened upper reaches of the river, ongoing projects to improve morphological diversity (including weir removal, pool and riffle reconstruction, and introducing large woody debris) will improve habitats for all life stages. Consideration should also be given to creating deep pool habitat, currently provided by large impoundments such as Goat Bridge weir, as deep-water refugia during natural low flow conditions.

### 7.2.3: Eels

The River Wandle's historic reputation as an eel fishery appears to have been second only to its fame as a trout stream. Even on the upper river, more than 8 miles from the Thames, Smee wrote that "next to the trout, the eel is our most important fish" and recorded major migrations of elvers (May – July) and adult eels (July – September) through his garden at Beddington en route to and from the river's headwaters in Croydon (Smee, 1872).

For most of the Wandle's history it is likely that eels have made up the dominant fish biomass: however, the river's population has probably reflected the global decline of this species by approximately 90% since the 1980s. Nevertheless, EA surveys in 2009 and 2011 showed that eels made up 42% and 38% of the total fish biomass captured in the course of these surveys (EA, 2011).

European eels are classified as a UK BAP species. They are catadromous fish which spend most of their lifecycle in fresh water before migrating to the area of the Sargasso sea to breed. The fry drift on ocean currents for several years, reaching the shores of western Europe as "glass eels" or elvers, and migrating up rivers during summer months when temperatures have exceeded 15°C. This migration is driven by population density, with high mortality noted where high density

exists, so impassable structures can be detrimental to eel populations. European eels are sexually dimorphic: fish over 450mm in length are considered female, while those below this length are male, with any below 300mm indeterminate (Houston, 2010). Sexual development tends to be density-related, with low densities of predominantly female eels in east coast UK rivers, and high densites of predominantly males on the west coast (Knight et al, 2001).

Despite severely reduced numbers, the Wandle is still regarded as a key stronghold for European eels in the Thames Basin, and EA monitoring results from 2009 and 2011 show no decline between these years, nor any change in the rate of decline with increasing distance upstream (Fig 7e, below).

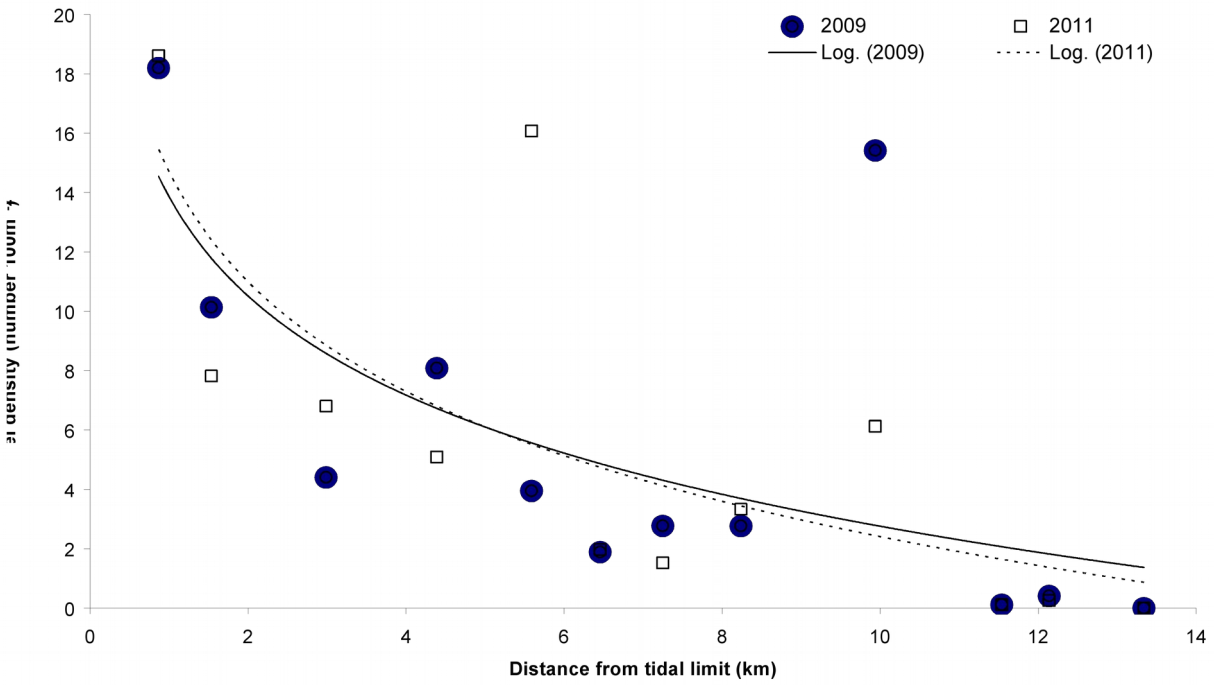


*Fig 7e: Density of eels across 12 monitoring sites surveyed in 2009 and 2011 (source: EA, 2011)*

The following observations and recommendations may be made with regard to eel populations in the Wandle:

- Water quality, temperature and flow are all likely to be within the normal toleration range for European eels, with the exception of very severe pollution events such as the 2007 pollution incident from Beddington STW.

- Connectivity: upstream-migrating elvers are hindered by weirs and other obstructions, which can even cause density-related mortality as noted above.

  An IFM diploma study in 2010 identified at least 2 “break points” on the river where fish passage obstructions appeared to be blocking upstream migration of elvers (Houston, 2010). Population densities dropped sharply between survey sites at Sainsbury’s Merton and Phipps Bridge, indicating a fish passage problem at the Merton Abbey Mills tilting weir. A second break point occurred above Watermead Lane, where the tilting weir at Goat Bridge also appears to present an almost impassable obstacle. (By extrapolation against very low figures, it is likely that the culverts and weirs at Shepley Mill present similar difficulties).

To address eel passage problems, eel passes have been installed at Watermeads, Ravensbury Park (lake weir and tilting weir), Merton Abbey Mills, and the weirs behind Topps Tiles in Wandsworth. Monitoring suggests that these measures have proved successful in moving elvers upstream. A dedicated eel pass has also been installed as part of the multi-species fish pass which forms part of the National Trust's hydropower installation at Morden Hall Park.

To facilitate fish passage for eels and other fish species, weirs have been removed or reduced at Mill Lane (Carshalton) (2010), Three Arch Bridge (2011), Poulter Park (2012), Ravensbury Park back channel (2012), Culvers Island (2014) and Butter Hill (2014).

- Channel morphology: European eels are photosensitive, preferring slow flowing areas with silt and crevices for refuge during daylight hours. The highly-engineered River Wandle provides comparatively few of these refugia except in heavy complex rubbish: volunteers at Wandle Trust community river cleanups have noted the likelihood of finding several eels hiding within the structure of motorbikes removed from the lower and middle river. As above, the Wandle Trust recommends increasing habitat for eels by means of well-designed habitat structures which do not collect silt and other debris, or increase flood risk (pers comm. Wandle Trust, 2014).

<u>Further information required:</u>

Further monitoring of the designated reaches

Further investigation of limiting factors for all fish species in the River Wandle, including endocrine disruption

<u>Further reading:</u>

Appendix A: Environment Agency (2014) WFD summary sheets

Ashby (2012) *Restoration of coarse fish populations in the River Wandle* (MSc dissertation)

Barcellos (1997) *Investigation into the current status of coarse fish recruitment in the River Wandle* (MSc dissertation)

Environment Agency (2004) *Fisheries Survey Sites on the River Wandle 2004*

Environment Agency (2011) *River Wandle Fish Population Survey 2011*

Environment Agency (2011) *Summary of European eel surveys on the River Wandle*

Thames Water (1988) *River Wandle Fisheries Survey 1988*

Uren Webster, Bury, van Aerle and Santos (2013) *Global Transcriptome Profiling Reveals Molecular Mechanisms of Metal Tolerance in a Chronically Exposed Wild Population of Brown Trout*

Wild Trout Trust (2012) *The Wild Trout Survival Guide (third edition)*

Zoological Society of London (Gollock, Pryor, Godsall and Debney) (2012) *River Thames catchment European eel Anguilla anguilla (L.) monitoring report 2008*

### 7.2.4: Fish and fisheries action tables

The information in these tables has been assembled from suggestions made in community consultations, TAG meetings and specific stakeholder input to develop a series of Objectives, Targets and Actions. Information on existing projects has been collated and used to identify gaps, and where additional projects may need to be developed to fulfil Actions, Targets and Objectives.

**Actions to achieve the Catchment Plan's overall aim for habitat and wildlife: the river supports a mosaic of habitats with high biodiversity**

**Objective 4: Fish and fisheries : thriving populations of native fish associated with chalk rivers are present and able to move freely**

**Specific Actions to attain GEP**

| Target | Actions | Project | MM | Indicative cost to deliver these Actions |
|---|---|---|---|---|
| 4.1: Fish can move freely through the entire length of the Wandle<br>Carshalton WB by 2015<br>Croydon-Wandsworth WB by 2027 | 4.1.1 – Understand all possible barriers to fish movement (eg physical, chemical, thermal, flow speed) in different river conditions (eg high flow, low flow). | A1, B3, B14, B22, B23, B24, B25, B26, B27, B28 | 5 | Action 4.4.1 has been fulfilled to a large extent by the EA's existing analytical reports and by previous independently funded work.<br><br>As with other Actions relating to underpinning habitat enhancement works and restoring chalk stream fluvial processes, it is difficult to estimate cost without reach-specific or structure-specific evaluation. However, comparable projects involving hydraulic modelling, weir removal, creation of fish bypass channels, insertion of woody debris and other habitat enhancements important to all fish life stages suggest **such work would cost some millions, with indicative costs accruing as follows:** |
| | 4.1.2 – Identify all obstructions that can be physically removed (eg weirs) and seek opportunities to maximise multiple benefits (eg deliver habitat work at the same time or support future habitat work). | B14, B21, B22, B23, B24, B25, B26, B29, B30, C4, C5, | 1, 5 | |
| | 4.1.3 – For obstructions that cannot be removed, perhaps because they provide flood control measures, identify mitigations to enable fish passage (including technical solutions and bypass channels). | | 5 | |

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| | 4.1.4 – Raise funds / work with others to implement options. | | 5 | Modelling the feasibility of removing or modifying weirs which are causing a barrier to fish migration and identifying flood risk implications is **estimated to cost £100,000 to £200,000**.<br><br>Physical removal of impoundments such as weirs is very heavily dependent on the complexities of the structure. Comparatively simple structures are **estimated to cost £30,000 per weir to remove** though this may be reduced to £20,000 if removing multiple weirs facilitates economies of scale. A proportion of this cost may be required for modelling. Conversely, to remove a large, heavily engineered weir and make good afterwards could cost as much as **£250,000. Costs may be higher where weirs are keyed into river walls.**<br><br>There are limited opportunities for implementing bypass channels for fish passage on the Wandle, including habitat enhancements for different fish lifecycle stages because of the highly urbanised landscape. Most opportunities exist only in parkland and conditions vary greatly. Thus an **estimated cost range is between £50,000 - £250,000**. |

| Target | Actions | Project | MM | Indicative cost to deliver these Actions |
|---|---|---|---|---|
| 4.2: The fish population is self-sustaining (including successful reproduction and growth with sufficient habitat to support all life stage of fish) Carshalton WB by 2015 Croydon-Wandsworth WB by 2027 | 4.2.1 – Agree on a definition for 'self-sustaining population' (eg survives without need for stocking, demonstrable recruitment occurs at accepted levels) and how it relates to GEP. | None | N/A | The TAG is fulfilling this Target, with input from the Steering Group as appropriate. Both the Steering Group and TAG have demonstrated a commitment to remain constituted and complete the implementation of these Actions.<br><br>Independent work to improve habitat quantity and complexity suitable for all fish life stages as per Actions 4.2.4 is **estimated to cost between £150 and £350 per linear metre**, depending on the particular characteristics of a reach, such as accessibility for machinery and the level of channel reinforcement needing attention. Work would typically include introducing in-stream woody debris, sculpted gravel substrates, bank re-profiling, planting marginal vegetation, channel narrowing to increase flow velocity, and creating meanders and pool and riffle systems. Please note: costs for longer reaches may be less per linear metre than for shorter ones, due to economies of scale with equipment, materials and labour.<br><br>The TAG is fulfilling this Target, with input from the Steering Group as appropriate. Both the Steering Group and TAG have demonstrated a commitment to remain constituted and complete the implementation of these Actions. |
| | 4.2.2 – Develop a programme to move away from stocking to that of a naturally occurring population without deterioration under WFD. | C3 | N/A | |
| | 4.2.3 – Define the different requirements of the various life stages of the species/populations, including water quality, quantity and dynamics of flow, food sources, habitats for spawning, nursery and refuge from pollution incidents or flush out during spate conditions etc. Identify and quantify the areas of these habitats in the river to assess possible bottlenecks and guide restoration priorities. | None | N/A | |
| | 4.2.4 – Create a work programme and secure funding to improve habitat quantity and complexity as per Action 4.2.3 including winter refuges and spawning and nursery habitat. | B1, B10/C9, B11/C10, B13, B14, B20, B21, B22, B30, B31, B33, C1, C4, C5, C6 | 2, 3, 4, 6, 8 | |
| 4.3 The river contains refuges for fish to escape unfavourable | 4.3.1 – Restoration work is undertaken which includes online backwater refuges from predation, pollution incidents and flush out during extreme weather events. | B1, B10/C9, B11/C10, B13, B14, | 2, 3, 6, 8 | A prime location to consider for these measures is the effluent channel at Mill Green, LB Sutton. Estimation of cost for this work is difficult without undertaking a site assessment first; particularly as |

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| conditions (eg high flows, low flows and pollution) | | B20, B21, B22, B30, B31, B33, C1, C4, C5, C6 | | it features constant large volumes of high velocity water, and consequently large quantities of concrete reinforcement and other engineering structures. Accessibility of machinery is anticipated to be easy, however.<br><br>Work to re-naturalise banks and create fish refuges is anticipated to cost **between £150 and £350 per linear metre** for less engineered sites. For engineered sites, such as Mill Green, the cost is likely to be in excess of this. Thames Water, the owners of the effluent channel, may consider supporting these costs.<br><br>Work would typically include introducing in-stream woody debris, re-profiled gravel substrate, bank re-profiling, planting marginal vegetation, channel narrowing and creating meanders and pool and riffle systems. Please note: costs for longer reaches may be less per linear metre than for shorter ones due to economies of scale. |

| **Wider Actions to improve the ecological functioning of the river** | | | | |
|---|---|---|---|---|
| **Target** | **Actions** | **Project** | **MM** | **Indicative cost to deliver these Actions** |
| 4.4: The fish population reflects that of a healthy chalk river | 4.4.1 – Define the composition of a healthy chalk river fish population in terms of species presence and relative abundance, in each of the distinct functioning ecological reaches of the Wandle. | C3 | | The TAG is fulfilling this Target, with input from the Steering Group as appropriate. Both the Steering Group and TAG have demonstrated a |

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| | 4.4.2 – Compare the current species community composition to the ideal species community composition, and identify what changes would need to be made to the river's habitat and environmental conditions to enable a natural transition from current species to ideal species. | C3 | | commitment to remain constituted and complete the implementation of these Actions. |
| | 4.4.3 – Create a work programme and secure funding to enable a shift from current species community composition to ideal species community composition as identified in 4.4.2. | B1, B10/C9, B11/C10, B13, B14, B20, B21, B22, B30, B31, B33, C1, C4, C5, C6 | | |
| | 4.4.4 – Identify whether any desired fish species are missing from current fish populations, and evaluate whether a strategy for re-introduction is necessary: if so, develop this strategy and secure funding to carry out the re-introduction. | C3 | | |

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| 4.5: Self-sustaining populations of brown trout are present in the River Wandle | 4.5.1 – Use the survey outputs (from 4.4) and analysis on habitat bottlenecks (Action 4.2.3) to guide the development of a restoration plan that will support all life stages of brown trout. Ensure sufficient overhead winter cover and cover at fish passes is included. | C1, C3, C6 | | Independent work to identify and obtain a genetically appropriate urban-adapted donor population of brown trout is underway: **estimated to cost between £5,000 and £10,000**<br><br>Independent work to enhance habitat and water characteristics, including connectivity through removal of impoundments, and interception of road runoff and silt, is difficult to estimate without reach-specific or structure-specific evaluation. However, in-stream and bank enhancement works are estimated to cost **between £150 and £350 per linear metre**, depending on the particular characteristics of a reach, such as |
| | 4.5.2 – Obtain funding and implement the action plan to achieve the requisite conditions to support a population of brown trout. | C3 | | |
| | 4.5.3 – Trout are likely to require reintroduction: locate and source a genetically appropriate donor population of brown trout parr. | C3 | | |

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| | 4.5.4 – Develop and implement a monitoring programme to record and evaluate translocation and recruitment success, and to enable any necessary amendments to the action plan to support a self-sustaining population of brown trout in the Wandle. | C3 | | accessibility for machinery and the level of channel reinforcement needing attention.<br><br>Physical removal of impoundments such as weirs is very heavily dependent on the complexities of the structure. Comparatively simple structures are **estimated to cost £30,000 per weir to remove** though this may be reduced to £20,000 if removing multiple weirs facilitates economies of scale. A proportion of this cost may be required for modelling. Conversely, to remove a large, heavily engineered weir and make good afterwards could cost as much as **£250,000. Costs may be higher where weirs are keyed into river walls.**<br><br>The Environment Agency is expected to undertake annual monitoring, including electrofishing. Support for this activity could be provided independently with volunteers counting trout redds at minimal cost once equipment was purchased and training was undertaken. **Estimated start up and annual maintenance cost over 5 years £3,000 plus a recommendation to continue monitoring beyond this period**. |
| 4.6: Any fishing on the Wandle is sustainable and contributes to local engagement with and knowledge of the river | 4.6.1 – Undertake education and awareness-raising amongst anglers to promote catch and release for all species. | None | | This Target falls within the remit of the EA, working with the local authorities and local fishing clubs and other interest groups. |
| | 4.6.2 – Devise and implement a responsible angling scheme that anglers can sign up to. | None | | |
| | 4.6.3 – Devise and implement a data collection programme whereby anglers collect data that can inform river management work (eg catch return information). | None | | |

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| 4.7: The potential impacts of contaminants on fish populations is understood, including how 'urban adapted species' may evolve, and the effects are mitigated where possible | 4.7.1 – Investigate existing fish populations to see if they display any signs of pressure from pollutants, eg lack of survival at a particular life stage. | None | | This Target is best fulfilled via research undertaken by ecotoxicologists and independent fisheries experts, working with the Environment Agency.<br><br>Design and installation of silt traps being retro-fitted in an urban environment is **estimated to cost £40,000** (small), **£50,000** (medium) and **£60,000** (large).<br><br>The cost of installing micro-wetlands is highly dependent on a number of factors, notably land prices. An **indicative cost, based on a location in Hackbridge, LB Sutton, is estimated at £20,000 per acre to install, plus monthly management costs and health and safety considerations such as fencing** Estimations of cost for the whole river would be dependent on walkover surveys and detailed feasibility studies drawing on the local authorities' Surface Water Management Plans. |
| | 4.7.2 – Identify any particular pollutants, or combination of pollutants, that might compromise fish population health. Connected to actions within Target 2.2 - Identify likely pollution pathways and investigate options for interception. | None | | |
| | 4.7.3 – Research other examples of freshwater fish populations that are known to survive in polluted rivers and seek to learn from their examples (eg Cornish streams containing levels of metals that laboratory analysis identified as lethal to fish yet fish are surviving and recruitment is occurring). | None | | |

### 7.3: Macrophytes, trees and the wider river habitat

*Our Vision is a river that supports a mosaic of habitats with high biodiversity*

*Wandle Catchment Plan Objective 5: Plant communities associated with chalk rivers are abundant along the river, providing good habitat for wildlife and for people*

***"We like having lots of varied flora along the river banks and in the water, with rushes, wild flower areas and overhanging willow trees."***

***- from Ketso community and stakeholder workshops***

The term "macrophytes" is commonly used to describe larger plants that are seen easily with the naked eye. For the purposes of WFD, the UKTAG has defined it to refer to aquatic species, including all vascular plants (those that bear seeds), bryophytes (mosses and liverworts), stoneworts (*Characeae*) and macro-algal growths.

Macrophytes play a vital role in chalk rivers, helping to bind sediments, stabilise banks and riverbeds and absorb nutrients. They increase habitat complexity by interacting with fluvial flow to create a variety of flow speeds and directions, and can buffer the river from extremes of light, wind disturbance and diffuse pollution. They also provide habitat for many species of wildlife.

Because of their luxuriant growth in chalk rivers, macrophytes can produced immediate effects on water quality, together with pronounced diurnal fluctuations in DO levels. These fluctuations result from photosynthetic activity during daylight hours, when plants are giving off oxygen (sometimes even leading to DO supersaturation): by contrast, DO levels can fall very low at night when plants are respiring and taking up oxygen instead.

The multitude of roles played by aquatic macrophytes makes them good indicators of ecosystem health: they cannot move and so the species that are present at a given site may reveal important information about the amount of water available, its flow regime, nutrient status, and other physico-chemical factors such as exposure to sunlight, pollutants, disturbance, soil and underlying geology.

Chalk rivers characteristically support communities of *Callitricho-Batrachion* vegetation (commonly known as CB communities). These submerged plant types are priority communities in the UK Biodiversity Action Plan and comprise water crowfoot (*Ranunculus*) and water-starwort (*Callitriche*) species. Three main sub-types of CB community have been defined, based on geology and river type, and it is possible for rivers to show a transition to one sub-type from another, as substrate type changes from chalk to clay. The River Wandle does just this, despite its urban setting and modified nature, and supports some good examples characteristic of both sub-types 1 and 2 such as stream water crowfoot (*Ranunculus penicillatus sp. Pseudofluitans*), blunt-fruited water starwort (*Callitriche obtusangula*), lesser water parsnip (*Berula erecta*) and other water crowfoots and water starworts identified only to Family level.

For the purposes of WFD, macrophytes are scored under the 5 indices of the River LEAFPACS system:

- Nutrient concentrations
- Hydromorphology (flow)
- Number of aquatic species
- Number and presence of different growth forms
- Extent of filamentous algae

These scores are compared to those expected for undisturbed reference conditions to generate a final Ecological Quality Ratio (EQR). EQR score ranges from 0 (for highly degraded sites) to 1 (for un-impacted or natural sites). WFD utilises 5 such bands of EQR score, corresponding to High, Good, Moderate, Poor and Bad.

Macrophytes on the River Wandle are currently classified as Moderate (Quite Certain) for both River Wandle water bodies. This classification fails Good status on grounds of elevated phosphate concentrations and poor hydromorphological conditions, with modified channel structure reducing habitat opportunities. Although sampling has only taken place on the Croydon-Wandsworth water body, the EA considers that the historic sampling site at Goat Bridge (ie upstream of the major nutrient input from Beddington STW) should be also be representative of the Carshalton water body for macrophytes. However, this assumption may require confirmation.

Orthophosphate concentrations emerging from Beddington STW are <1mg/l as required by the Urban Waste Water Treatment Directive (UWWTD). Expert observational experience has found that c1mg/l is often a tipping point between systems supporting *Ranunculus* and *Cladophora* filamentous algae, with algae preferring the higher concentration, leading to *Ranunculus* being replaced. The presence of *Cladophora* is indicative of elevated nutrient concentrations, and CB communities can be compromised by poor water quality, depleted flows and the effects of urbanisation.

Despite Moderate classification under LEAFPACS for WFD, however, aquatic macrophyte species richness and diversity of plant types currently recorded on the Wandle exceeds expected scores for GEP. Many species characteristic of chalk rivers, such as watercress (*Rorippa nasturtium-aquaticum*), fool's watercress (*Apium nodiflorum*), water forget-me-not (*Myosotis scorpioides*), water mint (*Mentha aquatica*), great willowherb (*Epilobium hirsutum*) water figwort (*Scrophularia auriculata*), bittersweet (*Solanum dulcamara*), brooklime (*Veronica beccabunga*), flag iris (*Iris pseudacorus*) and branched bur-reed (*Sparganium erectum*) are found on the River Wandle alongside several species of water starwort (*Callitriche sp*.), water crowfoot (*Ranunculus sp*.), moss, sedge (*Carex sp.)* and willow (*Salix sp*.). Management practices should therefore aim to ensure no deterioration of these indices whilst seeking to improve the failing targets.

The following expert advice has been received from the Wandle Catchment Plan TAG:

- Nutrient concentrations should be reduced sufficiently to enable macrophyte communities with a River Macrophyte Nutrient Index (RMNI) score of 5.8 or lower to thrive. This will be assisted by phosphate stripping at Beddington STW within AMP6, but is unlikely to reduce the orthophosphate level sufficiently to pass the WFD standard of 0.12mg/l for Good status. Indeed the WFD standard is likely to change to an even lower value in the next RMBP, which would make achieving the standard even more challenging in future

- Hydromorphological conditions should be improved such that flow supports macrophyte communities with a River Macrophyte Hydraulic Index (RMHI) score of 6.4 or below

- The number of functional macrophyte groups (NFG) should maintain the higher than expected NFG index score of 4.1, and ideally remain higher than the lowest 2012 score of 7 (to demonstrate no deterioration)

- The number of truly aquatic species richness (NTAXA) maintains the higher than expected NTAXA index score of 5.3, 5.6 and ideally remains higher than the lowest 2012 score of 8 (to demonstrate no deterioration)

- CB communities should be present in all reaches except the River Graveney (reach 6), with an ongoing and ideally increasing presence over the long term. The viable level to be assessed by expert judgement. *Ranunculus* beds are characteristic aesthetic

chalkstream features and should also be maintained as an ecosystem service benefit to local people

As suggested above, attaining Good classification for macrophytes overall will depend largely upon reducing nutrient concentrations and increasing flow.

These issues are addressed in Objective 5 (below) and associated water Actions in Objectives 1, 2 and 3. Improvements to the macrophyte community will in turn greatly benefit fish (Objective 4) as well as the wider ecology of the river. For example, restoring baseflows, sediment transport and channel roughness will help plants to grow, which in turn will create highly valuable micro-habitats for fish at all life stages as they seek food and shelter from predators.

The more complex the habitat created by plants, the more fish can be accommodated within a given area. This contributes to successful and sustainable recruitment, as it enables fish energy to be conserved for growth rather than risk being expended in territorial conflict or simply holding against peak flows in a featureless channel.

Further information required:

Extend macrophyte assessment to the Carshalton water body as soon as possible to confirm Moderate (Quite Certain) or better classification for WFD. The Croydon arm of the Croydon-Wandsworth water body above Beddington STW should also be assessed.

Monitoring and further research should be undertaken for *Cladophora* and CB communities' cover and density with a view to establishing a clear understanding of what can be termed an 'acceptable' quantity for ideal nutrient concentrations and flow dynamics to achieve Good status.

There is also strong anecdotal evidence that CB communities on the Wandle, in particular *Ranunculus*, are being replaced by *Elodea canadensis* or *E. nuttallii* (to be confirmed - most likely as a consequence of increased nutrient concentrations and reduced flow). Further evidence is needed to confirm this, with targets that are specific to the conditions on the Wandle (eg what percentage of the riverbed should be covered by the CB community?)

Further information required:

Extend macrophyte sampling to the Carshalton water body and the Croydon arm of the Croydon-Wandsworth water body above Beddington STW

Confirm replacement of CB communities on the Wandle with *Elodea canadensis* or *E. nuttallii*

Further reading:

Appendix A: Environment Agency (2014) WFD summary sheet

### 7.3.1: Macrophytes action tables

The information in these tables has been assembled from suggestions made in community consultations, TAG meetings and specific stakeholder input to develop a series of Objectives, Targets and Actions. Information on existing projects has been collated and used to identify gaps, and where additional projects may need to be developed to fulfil Actions, Targets and Objectives.

**Actions to achieve the Catchment Plan's overall aim for habitat and wildlife: the river supports a mosaic of habitats with high biodiversity**

**Objective 5: Macrophytes†, trees and the wider river habitat: communities associated with chalk rivers are abundant along the river, providing good habitat variety for wildlife and for people**

*† The UKTAG defines Macrophytes as larger plants of fresh water which are easily seen with the naked eye, including all vascular plants (plants that bear seeds), bryophytes (mosses and liverworts), stoneworts (Characeae) and macro-algal growths.*

**Specific Actions to attain GEP**

| Target | Action | Project | MM | Indicative cost to deliver these Actions |
|---|---|---|---|---|
| 5.1: Nutrient concentrations in the river, particularly phosphate, are sufficiently low to sustain the expected communities of macrophytes associated with healthy chalk rivers and filamentous algae cover in-stream is low<br>Carshalton WB by 2015<br>Croydon-Wandsworth WB by 2027 | 5.1.1 – As part of their statutory requirement to reduce orthophosphate concentrations emerging from Beddington STW to <1mg/l under the Urban Waste Water Treatment Directive, Thames Water have included orthophosphate stripping in their AMP6 Business Plan and work towards obtaining Ofwat's agreement (due in 2014) for it to be implemented at the earliest possible opportunity and no later than Year 5 of AMP6 (2020). | None | N/A | This Action is being fulfilled by Thames Water's ongoing preparation of their AMP6 Business Plan for submission to Ofwat in 2014. Liaison, additional financial outlay for further investigations and future recommendations for good practice working that maintain required treated effluent discharge quality will be led by the EA, Thames Water and Ofwat. |
| | 5.1.2 – Address and reduce diffuse sources of pollution, such as misconnected pipes and urban surface runoff, sufficiently to enable macrophyte communities with a GEP RMNI index score of 5.8 or lower to thrive. | A2, A4, B12, C1, C2, B34 | 3, 6, 9 | These Actions are likely to be fulfilled by Thames Water and the EA in part at least, with additional expert input from the TAG as appropriate. |

| | | | | |
|---|---|---|---|---|
| | 5.1.3 – Projects relating to EA Mitigation Measure 10 (educate landowners on sensitive management practices – urbanisation). are undertaken in all locations identified as relevant as soon as possible and ongoing | None | 10 | Independent walkover surveys and associated investigations, eg dye tracing, mapping and consultations is **estimated to cost £35,000**.<br><br>Independent monitoring could be run with volunteers at minimal cost once monitoring equipment and analysis capabilities were obtained (such as data-analytical computer software). It is also dependent on ongoing support from local authorities and other landowners and managers. **Estimated cost for start up and maintenance for 10 years £15,000**. |
| | 5.1.4 – Agreement to be reached as to what an 'acceptable' percentage of in-channel cover by filamentous algae might be for GEP classification in each distinct functional reach. (Filamentous algae is indicative of elevated nutrient concentrations). | None | N/A | |

| | | | | |
|---|---|---|---|---|
| | 5.1.5 – Monitoring of nutrient concentrations is not currently undertaken consistently along all distinct functional reaches* of both Wandle water bodies. It is therefore necessary to expand the current monitoring programme to determine orthophosphate concentrations and those of other nutrients in all distinct functional reaches identified in both water bodies (safe physical access permitting) on an ongoing basis. | A1 | N/A | Independent analysis of WSUD techniques for the whole catchment, including the suitability and cost-implications of various SUDS measures to help replicate natural drainage patterns is **estimated to cost £100,000**.<br><br>The cost for installing SUDS and other measures to help replicate natural flow patterns varies considerably, depending on the location, ease of access, flood risk implications, ease of installation and maintenance, and whether such work can be incorporated into new developments or has to be retro-fitted. For example, **porous and permeable paving can cost between £100 per 20m$^2$ driveway** (to purchase and install gravel) and **£2000** to purchase and install Concrete Block Permeable Paving for the same area.<br><br>The cost of installing micro-wetlands is highly dependent on a number of factors, notably land prices. An **indicative cost, based on a location in Hackbridge, LB Sutton, is estimated at £20,000 per acre to install, plus monthly management costs and health and safety considerations such as fencing.** Estimations of cost for the whole river would be dependent on walkover surveys and detailed feasibility studies drawing on the local authorities' Surface Water Management Plans.<br><br>Design and installation of silt traps being retro-fitted in an urban environment is **estimated to cost £40,000** (small), **£50,000** (medium) and **£60,000** (large). |

| | | | | |
|---|---|---|---|---|
| 5.2: Hydromorphological conditions in the river enable fluvial flows and macrophyte habitats characteristic of healthy chalk rivers to exist<br>Carshalton WB by 2015<br>Croydon-Wandsworth WB by 2027 | 5.2.1 – Undertake channel re-naturalisation and enhancement projects (including EA Mitigation Measures 1, 2, 3, 6 and 8) to increase flow, reduce detrimental siltation and increase the number of microhabitats (such as bars, islands, pool and riffle systems, meanders etc) so that it is sufficient to support macrophyte communities with a GEP RMHI index score of 6.4 or lower. | A4, A6, A7, A8, B4, B6, B1, B2, B5, B10/C9, B15, B16, B28, B30, B31, B33, B34, B11/C10, B14, B19, B20, B21, C1, C4, C5, C6 | 1, 2, 3, 6, 8 | Work to improve habitat quantity and complexity is **estimated to cost between £150 and £350 per linear metre**, depending on the particular characteristics of a reach, such as accessibility for machinery and the level of channel reinforcement needing attention. Work would typically include introducing in-stream woody debris, sculpted gravel substrates, bank re-profiling, planting marginal vegetation, channel narrowing to increase flow velocity, and creating meanders and pool and riffle systems. Please note: costs for longer reaches may be less per linear metre than for shorter ones, due to economies of scale with equipment, materials and labour. |
| | 5.2.2 – Urban River Survey monitoring is carried out along the full length of both water bodies (safe physical access permitting) and results aggregated to obtain scores for each distinct functional reach*. Repeated surveys will enable evaluation of project success and indicate whether any adjustments are necessary so that the system is always improving and there is 'no deterioration'). | None | N/A | |

| | | | | |
|---|---|---|---|---|
| 5.3: Riverbed and bank substrate materials and condition are appropriate to support the expected macrophyte communities of a healthy chalk river<br>Carshalton WB by 2015<br>Croydon-Wandsworth WB by 2027 | 5.3.1 – Undertake work to ensure substrate materials are appropriate (eg gravels dominate the bed rather than debris such as brick rubble) and their condition is good (eg gravels and sands are of an appropriate size for the river, and are not silted or impacted). Likewise, bank materials and condition are good (eg not reinforced or reveted wherever possible, taking into account urbanisation and flood protection requirements). Project work to conserve and enhance substrate should include EA Mitigation Measures 2, 3, 4, 6 and 8. | B1, B2, B14, B20, B21, B30, B33, C1, C4, C5, C6 | 2, 3, 4, 6, 8 | As 5.2 above |
| | 5.3.2 – Include substrate monitoring as part of the wider management monitoring for both water bodies to maintain condition and avoid deterioration over time. | None | N/A | |
| 5.4: Macrophyte communities present are abundant, highly diverse and include good numbers of characteristic chalk river species.<br>Carshalton WB by 2015<br>Croydon-Wandsworth WB by 2027 | 5.4.1 – Monitoring of macrophyte communities is not currently undertaken consistently along all distinct functional reaches of both Wandle water bodies (indeed the Carshalton water body is not currently assessed for macrophytes). It is therefore a priority to commence macrophyte community monitoring, using the River LEAFPACS methodology, annually along the full length of both water bodies (safe physical access permitting) and for the results to be shared so that projects to attain GEP can be evaluated and amended as necessary. | None | N/A | As 5.2 above |

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| | 5.4.2 – Projects to conserve and enhance the ecological value of in-stream, marginal, bankside and riparian habitat (including EA Mitigation Measures 1, 2, 3, 6, 8, and 10, and works to reduce or eliminate siltation, overshading, presence of INNS, filamentous algae dominance etc) are undertaken. These projects will cumulatively produce the following priority outcomes:<br><br>Firstly, that the number of functional macrophyte groups continues to surpass its GEP N FG index score of 4.1 and remains higher than the lowest score recorded in 2012 of 7 in order to demonstrate 'no deterioration'.<br><br>Secondly, that the number of truly aquatic species richness continues to surpass its GEP NTAXA index score of 5.3 and remains higher than the lowest score recorded in 2012 of 8 in order to demonstrate 'no deterioration'. | A6, A7, A8, B4, B5, B6, B10/C9, B15, B16, B28, B31, B32, B33 B11/C10, B14, B19, B20, B21, C1, C4, C5, C6 | 1, 2, 3, 6, 8, 10 | |

| **Wider Actions to improve the ecological functioning of the river** | | | | |
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| **Target** | **Action** | **Project** | **MM** | **Indicative cost to deliver these Actions** |
| 5.5: Macrophyte, shrub and tree communities present are those characteristic of high quality chalk rivers | 5.5.1 – Work is undertaken to conserve and enhance the extent of macrophyte and tree species composition in each of the distinct functional reaches so that it reflects the most appropriate of the five standard categories of chalk watercourse (R1 = winterbournes, R2 = perennial headwaters, R3 = classic chalk streams, R4a = classic chalk rivers, R4b = mixed geology chalk rivers (Mainstone, 1999). | A4, A6, A7, B4, B5, B6, B10, B11, B12, B13, B14, B19, B20, B21, B28, B30, B31, B32, B33, C1, C4, C5, C6, | 1, 2, 3, 6, 7, 8, 9, 10 | Independent work to improve habitat quantity and complexity is **estimated to cost between £150 and £350 per linear metre**, depending on the particular characteristics of a reach, such as accessibility for machinery and the level of channel reinforcement needing attention. Work would typically include introducing in-stream woody debris, sculpted gravel substrates, bank re-profiling, planting marginal vegetation, channel narrowing to increase flow velocity, and creating meanders and pool and riffle systems. Please note: costs for longer reaches may be less per linear metre than for shorter ones, due to economies of scale with equipment, materials and labour |

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| | 5.5.2 – Work is undertaken to conserve and enhance the presence of *Ranunculus-Callitriche* species communities present on the Wandle, in recognition of their importance as UK Biodiversity Action Plan priority habitat types. These are formally defined as 'Rivers with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation' (CB communities) and are characterised by the abundance of water-crowfoots (*Ranunculus* spp.). Many variants of this habitat type exist, depending on geology and river type. They are associated with different assemblages of aquatic plants including water cress, water-starworts, water parsnips, water-milfoils and water forget-me-not: the cover of these may exceed that of *Ranunculus* species. Three main habitat sub-types have been defined according to substrate type, and a few southern rivers (including the Wandle) show a transition from one sub-type to another, as geology changes from chalk to clay. | A4, A6, A7, B4, B5, B6, B10, B11, B12, B13, B14, B19, B20, B21, B28, B30, B31, B32, B33, C1, C4, C5, C6, | 1, 2, 3, 6, 7, 8, 9, 10 | 5.5.3 This Action could be assisted via an MSc student desk-based research project |

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| | 5.5.3 – Research is carried out to identify whether the localised replacement of *Ranunculus* species by *Elodea* species has wider implications for chalk river ecosystem function, beyond the loss of important UK Biodiversity Action plan priority habitat type, or whether it provides the same ecological function (such as modifying flow, promoting fine sediment deposition and providing shelter and food for fish and invertebrates). | None | N/A | |
| 5.6: The Wandle supports a mosaic of macrophyte habitats and rich biodiversity suitable for a wide range of aquatic and riparian faunal species | 5.6.1 – Management of the riparian landscape is such that macrophytes, trees and shrubs provide important variety of habitat with structural complexity (such as standing dead wood, large woody debris, nesting and roosting sites, exposed tree roots, dappled shade, channel braiding etc) without dominating the landscape and resulting in lowered biodiversity or reduced human access. (The riparian landscape is important for ecological functioning including reducing sediment and nutrient input to the river. It also facilitates connectivity between terrestrial and aquatic communities. Interactions between land and water are to be encouraged wherever possible, taking into account flood protection requirements and health and safety). | A4, A6, A7, B4, B5, B6, B10, B11, B12, B13, B14, B19, B20, B21, B28, B30, B31, B32, B33, C1, C4, C5, C6 | 2, 6, 8, 10 | This Target and Actions are likely to be lead by local authorities and other landowners and managers, with guidance from the EA and environmental NGOs.<br><br>Independent work to improve habitat quantity and complexity is **estimated to cost between £150 and £350 per linear metre**, depending on the particular characteristics of a reach, such as accessibility for machinery and the level of channel reinforcement needing attention. Work would typically include introducing in-stream woody debris, sculpted gravel substrates, bank re-profiling, planting marginal vegetation, channel narrowing to increase flow velocity, and creating meanders and pool and riffle systems. Please note: costs for longer reaches may be less per linear metre than for shorter ones, due to |

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| | 5.6.2 – Management of amenity green spaces is sensitive to the needs of wildlife and is clearly communicated to visitors as a benefit for engagement, education and public enjoyment. (Examples include relaxation of mowing regimes, particularly in proximity to banksides; creation and / or maintenance of 'wild refuge' areas where wildlife can remain undisturbed, particularly during key lifecycle stages such as nesting; installation of bird and bat boxes to compensate for any lacking natural sites). | None | 10 | economies of scale with equipment, materials and labour. |
| | 5.6.3 – Invasive non-native species (INNS) are controlled or eradicated according to the Wandle Invasive Species Action Plan. | A7, A8, B4, B5, B6, B10, C9, | 1, 3, 6, 8, 10 | |

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| | 5.6.4 – As part of the Biodiversity Action Plan aim to re-introduce water vole to the River Wandle, regular surveying (perhaps using the water vole Habitat Suitability Index) should be undertaken along the full length of both water bodies, with particular attention paid to the upper Wandle planned re-introduction zone – between Wandle Park, Croydon and Morden Hall Park, Merton – to monitor suitability. Such monitoring will also provide broader assessment of the flora and wider landscape than can be surmised from the River LEAFPACS survey. Habitats that are suitable for water vole are also suitable for a wide range of other faunal species such as birds and bats, and thus may provide a helpful proxy of wider ecosystem quality. The H.S.I. survey can also highlight wider enhancement opportunities such as bank softening | B27, B28 | N/A | |
| 5.7: Effluent channel from Beddington STW incorporates refuges for wildlife in the event of an accidental harmful discharge from the STW | 5.7.1 – Canalised effluent channel on Mill Green is modified (preferably to enable the establishment of natural processes), to provide wildlife refuges from any pollution incidents. | None | 9 | Estimation of cost for this work is difficult without undertaking a site assessment first; particularly as it features constant high flow velocity and large volumes of water and consequently large quantities of concrete reinforcement and other engineering structures. Accessibility of machinery is anticipated to be easy however.<br><br>Independent work to re-naturalise banks and create refuges for fish and other wildlife at this site is **could potentially cost in excess of the anticipated cost of between £150 and £350 per linear metre** at sites with less engineering on |

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| | | | | the River Wandle but it is expected that Thames Water would fund this in part at least. Work would typically include introducing in-stream woody debris, sculpted gravel substrates, bank re-profiling, planting marginal vegetation, channel narrowing and creating meanders and pool and riffle systems. Please note: costs for longer reaches may be less per linear metre than for shorter ones, due to economies of scale with equipment, materials and labour. |

## 7.4: Macroinvertebrates

*Our Vision is a river that supports a mosaic of habitats with high biodiversity*

*Wandle Catchment Plan Objective 6: The diverse invertebrate communities associated with chalk rivers are abundant along the river, playing important roles in ecosystem function and complexity, such as providing a food source for other wildlife*

***"It's important to have a wide range of aquatic insects, but there are too many midges in some places – we should encourage the birds and bats to eat them, and get the river flowing faster in these areas."***

***- from Ketso community and stakeholder workshops***

Aquatic invertebrates are a key biological element group under WFD. Like macrophytes and phytobenthos, invertebrates can be good indicators of water quality, particularly the impacts of pollution. The group is very diverse and includes families such as mayflies and stoneflies (which can be very sensitive to pollution) to worms and midges (which are very pollution-tolerant).

Since they are constantly exposed to any variations in aquatic water quality, as well as being relatively easy to sample and identify to group level with the naked eye, sampling aquatic invertebrates can be used as a method which allows rapid and accurate water quality assessments according to the sensitivity of the families which are found.

Aquatic invertebrates are monitored for WFD using RICT (the UKTAG's River Invertebrate Classification Tool) and are classified using 4 different indices:

- ASPT (Average Score Per Taxon): organic pollution index
- No Taxa (Number of Taxa): diversity index
- LIFE (Lotic Invertebrate Flow Evaluation): flow sensitivity index
- PSI (Percentage Sediment Index) : sedimentation index

As with macrophytes, these observed scores are then compared to expected scores for natural, undisturbed reference sites to produce a final Ecological Quality Ratio (EQR) score. Again, the EQR scores are divided into 5 bands for WFD purposes: High, Good, Moderate, Poor and Bad.

Invertebrates on the River Wandle are currently classified as Good on the Carshalton water body, whilst the Croydon-Wandsworth water body is classified as Moderate. As a consequence of this failing score, sampling for WFD assessment since 2009 has taken place only on the Croydon-Wandsworth water body. However, invertebrate monitoring is carried out on the Carshalton arm under other drivers: a drought monitoring site at Three Arch Bridge has been sampled twice yearly since 2013, with the same methodology as sampling for WFD. As a result, this data can be used to confirm Good WFD classification in the future. (River habitat data will also be collected at this site in 2014, and every six years subsequently).

Current WFD failure for invertebrates on the Croydon-Wandsworth water body is due to a combination of water quality and habitat issues: phosphate levels are too high, leading to indirect effects including algal growth smothering substrates, and data from 2009-10 indicates diurnal fluctuations in dissolved oxygen and spikes of ammonium.

In many areas the river also suffers from excessive sedimentation and lack of suitable habitat due to its heavily urbanised, modified channel and absence of macrophytes, causing stress to the invertebrate community in a number of ways:

- Increased hard and impermeable surfaces across the river's catchment can quickly lead to greater quantities of contaminated urban surface runoff entering the river in times of heavy rainfall. This can render the water turbid from re-suspension of riverbed sediments or toxins, as well as particulates flushed in from roads and storm drains.

- Nutrient enrichment from Beddington STW, misconnected pipes and other diffuse pollution sources can cause both acute and chronic stress to invertebrates in the form of short-term toxic spikes and ongoing degradation of water quality. Larger pollution incidents from Beddington STW are probably also responsible for keeping populations of more sensitive invertebrates suppressed and unable to re-establish.

- Modification of the river channel including weirs and over-widening causes impoundment of water and degrades natural flow and sediment transport regimes. This leads to excessive fine sedimentation which can affect invertebrates by smothering gravels and reducing habitat suitability for many macrophytes which invertebrates need.

- Culverting, straightening and deepening many areas of the river's channel has reduced naturally complex substrates to smooth, bare concrete or clay which are difficult for invertebrates to cling onto, or otherwise escape high flows.

Following the EA's Stage 3 investigation for WFD failure in December 2012, this expert advice has been received:

- The invertebrate community is likely to be stressed by a range of pressures, including pollution, flow, sedimentation and lack of macrophytes.

- These factors, and possibly more that are currently unidentified, interact with one another in ways that make it difficult to isolate any particular actions that would be sure to improve invertebrate EQR score.

- General improvements to riverine conditions, such as those designed more specifically to benefit fish and macrophytes, would also be likely to benefit invertebrates: in particular, identifying and reducing misconnections, and preventing and remediating runoff from the urban environment.

- Instead of focusing on setting specific targets for invertebrates at this stage, expert opinion is that long-term monitoring of the individual scores for each index should be undertaken. These can then be analysed to identify any trends that show a response to river process restoration which might suggest what is achievable for invertebrates on the Wandle.

- After some initial improvement, invertebrate response may plateau despite any continuing habitat enhancement work, and this level may represent GEP for the Wandle.

An overall EQR score of 0.71 or above is the threshold for achieving 'Good' status for invertebrate communities. As above, this overall EQR is calculated using 4 biotic indices (ASPT, No Taxa, LIFE and PSI), which are also recommended for long-term monitoring to establish a realistic GEP score for invertebrates on the Wandle.

It should be noted that all the classifications above have been derived using existing classification tools: once new classification tools (eg WHPT rather than BMWP) are introduced, some classifications may alter as an artefact of this new process.

The Actions in Objective 6 (at the end of this chapter) are designed to address current pressures upon invertebrates in the River Wandle.

They complement the underlying priority aims for the river of improving water quality and restoring naturalised hydromorphological functioning (Objectives 1-3). Actions to improve habitat quality (Objective 5) will in turn benefit invertebrates in providing refuge from flood conditions or pollution incidents, influencing flow dynamics and binding nutrient-rich sediments.

In addition to targets for attaining GEP, efforts should be made to conserve the nationally uncommon populations of *Bdellocephala punctata* that have been recorded on both Wandle water bodies. *Bdellocephala punctata* is the largest of Britain's flatworm species. It is geographically wide-ranging in Britain across a number of distinct distribution types, but is often scarce in the habitats where it does exist. Actions to enhance habitat in adjoining areas (Objective 5) may help encourage an expansion of areas currently colonised at Goat Bridge in LB Sutton (confirmed by EA sampling in spring 2014), Morden Hall Park in LB Merton and on the Carshalton water body.

Reintroduction of species should be considered on a case by case basis, if they were present historically and can be shown to cope with enhanced prevailing conditions. For biosecurity reasons, reintroductions should be carefully controlled, especially in relation to the source of any reintroduction specimens.

Further information required:

Further detailed interpretation of current and historic invertebrate data

On the Carshalton arm, use invertebrate data gathered for drought monitoring purposes to confirm Good classification for WFD.

Long-term monitoring is recommended to establish a realistic GEP score for invertebrates on the Wandle.

Monitoring and further research should be undertaken for the nationally uncommon flatworm *Bdellocephala punctata* populations currently extant, to ensure they remain and, if possible, expand.

Further reading:

Appendix A: Environment Agency (2014) WFD summary sheet

Knight, L. (2011) *The River Wandle (Carshalton branch): a baseline ecological survey prior to habitat restoration works (September 2010)*

### 7.4.1: Macroinvertebrates action tables

The information in these tables has been assembled from suggestions made in community consultations, TAG meetings and specific stakeholder input to develop a series of Objectives, Targets and Actions. Information on existing projects has been collated and used to identify gaps, and where additional projects may need to be developed to fulfil Actions, Targets and Objectives.

**Actions to achieve the Catchment Plan's overall aim for for habitat and wildlife: the river supports a mosaic of habitats with high biodiversity**

| **Objective 6: Invertebrates: the diverse communities associated with chalk rivers are abundant along the river, playing important roles in ecosystem function and complexity, such as providing a food source for other wildlife** | | | | |
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| **Specific Actions to attain GEP** | | | | |
| **Target** | **Actions** | **Project** | **MM** | **Indicative cost to deliver these Actions** |
| 6.1: Water quality in the river is improved sufficiently to enable the expected invertebrate communities associated with healthy chalk rivers to be sustained. Carshalton WB by 2015 | 6.1.1 – As part of their statutory requirement to reduce orthophosphate concentrations emerging from Beddington STW to <1mg/l under the Urban Waste Water Treatment Directive, Thames Water are to put orthophosphate stripping into their AMP6 Business Plan and work towards obtaining Ofwat's agreement (due in 2014) for it to be implemented at the earliest possible opportunity and no later than Year 5 of AMP6 (2020). | None | N/A | This Action is being fulfilled by Thames Water's ongoing preparation of their AMP6 Business Plan for submission to Ofwat in 2014. Liaison, additional financial outlay for further investigations and future recommendations for good practice working that maintain required treated effluent discharge quality will be led by the EA, Thames Water and Ofwat. |

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| Croydon-Wandsworth WB by 2027 | 6.1.2 – Address and reduce diffuse sources of pollution, such as misconnected pipes and urban surface runoff, sufficiently to enable invertebrate communities with an overall EQR (Ecological Quality Ratio) score of 0.71* or above to thrive. Particular attention should be paid to making progress towards Good / High scores for ASPT (organic pollution index) and Number of Taxa (diversity index). ** 0.71 is the threshold for achieving Good status.* | A2, A4, B12, C1, C2, B34 | 3, 6, 9, 10 | These Actions are likely to be fulfilled by Thames Water and the EA in part at least.<br><br>Independent work to undertake walkover surveys and associated investigations, eg dye tracing, mapping and consultations is **estimated to cost £35,000**.<br><br>Independent monitoring to assist this could be run with volunteers at minimal cost once monitoring equipment and analysis capabilities were obtained (such as data-analytical computer software). It is also dependent on ongoing support from local authorities and other landowners and managers. **Estimated cost for start up and maintenance for 10 years £15,000**. |
| | 6.1.3 – Projects relating to EA Mitigation Measure 10 (educate landowners on sensitive management practices – urbanisation) are undertaken in all locations identified as relevant as soon as possible and ongoing | None | 10 | |

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| | 6.1.4 – Monitoring of nutrient concentrations is not currently undertaken consistently along all distinct functional reaches of both Wandle water bodies. It is therefore necessary to expand the current monitoring programme to determine orthophosphate concentrations and other key chemical parameters (particularly dissolved oxygen and ammonia) in all distinct functional reaches (safe physical access permitting) on an ongoing basis. Real-time monitoring (for periods of one month at least) is recommended as it will reveal evidence of spikes and diurnal variations that are important to invertebrates but may not be detected using spot sampling alone. | A1 | N/A | Independent analysis of Water Sensitive Urban Design techniques for the whole catchment, including the suitability and cost-implications of various SUDS measures to help replicate natural drainage patterns is **estimated to cost £100,000**.<br><br>The cost for installing SUDS and other measures to help attenuate surface runoff and replicate natural flow patterns varies considerably, depending on the location, ease of access, flood risk implications, ease of installation and maintenance, and whether such work can be incorporated into new developments or has to be retro-fitted. For example, **porous and permeable paving can cost between £100 per 20m$^2$ driveway** (to purchase and install gravel) and **£2000** to purchase and install Concrete Block Permeable Paving for the same area.<br><br>The cost of installing Micro-wetlands is highly dependent on a number of factors, notably land prices. An **indicative cost, based on a location in Hackbridge, LB Sutton, is estimated at £20,000 per acre to install, plus monthly management costs and health and safety considerations such as fencing.** Estimations of cost for the whole river would be dependent on walkover surveys and detailed feasibility studies drawing on the local authorities' Surface Water Management Plans.<br><br>Design and installation of silt traps being retro-fitted in an urban environment is **estimated to cost £40,000** (small), **£50,000** (medium) and **£60,000** (large). |

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| 6.2: Hydromorphological conditions in the river are characteristic of healthy chalk rivers and support good numbers of expected invertebrate communities<br>Carshalton WB by 2015<br>Croydon-Wandsworth WB by 2027 | 6.2.1 – Undertake channel re-naturalisation and enhancement projects (including EA Mitigation Measures 1, 2, 3, 6 and 8) to create an appropriate flow regime that removes detrimental silt and increases the number of microhabitats (such as bars, islands, pool and riffle systems, meanders etc) without flushing away gravels or invertebrate refuge habitat. Progress towards achieving GEP can be measured by working towards enabling invertebrate communities with an overall EQR (Ecological Quality Ratio) score of 0.71* or above to thrive. Particular attention should be paid to making progress towards Good / High scores for LIFE (flow sensitivity index) and PSI (sedimentation index). * *0.71 is the threshold for achieving Good status.* | A4, A6, A7, A8, B4, B6, B1, B2, B5, B10/C9, B15, B16, B28, B30, B31, B33, B34, B11/C10, B14, B19, B20, B21, C1, C4, C5, C6 | 1, 2, 3, 6, 8 | Independent work to improve habitat quantity and complexity is **estimated to cost between £150 and £350 per linear metre**, depending on the particular characteristics of a reach, such as accessibility for machinery and the level of channel reinforcement needing attention. Work would typically include introducing in-stream woody debris, sculpted gravel substrates, bank re-profiling, planting marginal vegetation, channel narrowing to increase flow velocity, and creating meanders and pool and riffle systems. Please note: costs for longer reaches may be less per linear metre than for shorter ones, due to economies of scale with equipment, materials and labour.<br><br>As with other Actions relating to underpinning habitat enhancement works and restoration of chalk stream fluvial processes, it is difficult to estimate cost without reach-specific or structure- |

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| | 6.2.2 – Annual Urban River Survey monitoring is carried out along the full length of both water bodies (safe physical access permitting) and results aggregated to obtain scores for each distinct functional reach on an ongoing basis. (This will enable evaluation of project success and for any necessary adjustments to be made so that the system is always improving and there is 'no deterioration'.) | None | N/A | specific evaluation. However, comparable projects involving hydraulic modelling, weir removal, creating fish bypass channels, introducing woody debris and other habitat enhancements important to all fish life stages suggest **such work would cost some millions. Here are some examples of how the costs might accrue:**<br><br>Modelling the feasibility of removing or modifying any weirs which are causing a barrier to fish migration and identify flood risk implications is **estimated to cost £100,000 to £200,000**.<br><br>Physical removal of impoundments such as weirs is very heavily dependent upon the type of engineering that is involved in the structure. Comparatively simple structures are **estimated to cost £30,000 to remove per weir** though this may be reduced to £20,000 with removal of multiple weirs facilitating economies of scale. Conversely, to remove a large, heavily engineered weir and make good afterwards could cost as much as **£250,000 each costs may be higher where weirs are tied into river walls.**<br><br>There are limited opportunities for the design and creation of a bypass channel for fish passage, including habitat enhancement important to fish life stages on the Wandle because of the highly urbanised landscape. Most opportunities exist only in parkland and conditions vary greatly. Thus an **estimated cost range is between £50,000 - £250,000**. |

| **Wider Actions to improve the ecological functioning of the river** |
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| Target | Actions | Project | MM | Indicative cost to deliver this Action |
|---|---|---|---|---|
| 6.3 Nationally uncommon species are conserved | 6.3.1 – Populations of *Bdellocephala punctata* are conserved and where possible encouraged to expand through the enhancement of adjoining habitat. (*B. punctata* is the largest of Britain's flatworm species. It is geographically wide-ranging in a number of distinct distribution types, though it is often scarce in the habitats where it is found). On the River Wandle it has been recorded on the Carshalton water body and at Goat Bridge, Beddington Park and Morden Hall Park on the Croydon-Wandsworth water body. | None | N/A | N/A |

## 7.5: Phytobenthos

*Our Vision is a river that supports a mosaic of habitats with high biodiversity*

*Wandle Catchment Plan Objective 7: Good populations of phytobenthos associated with chalk rivers are present along the river*

Also known as diatoms, phytobenthos are microscopic plants, typically algae, which live in or near the bottom of rivers and other freshwater systems. They form slippery brownish coverings known as 'biofilm' over larger plants and stones. Various species have different habitat preferences, including nutrient concentrations: as a result, the species present in a river, and their relative abundance, can say much about the water quality. Diatoms are the main phytobenthic groups that are used for such assessments: with distinctive silica shells, often intricately patterned, they are easy to identify under a microscope.

Diatoms are assessed using the standard DARES methodology (Diatom Assessment for River Ecological Status) to measure the River Trophic Diatom Index. This methodology involves counting the number of species present, assessing the proportion of each species in all the samples gathered, and comparing these observed figures to what might be expected in undisturbed reference conditions to produce an Ecological Quality Ratio (EQR) score.

WFD classifies EQR scores into 5 bands for Good Ecological Status: High, Good, Moderate, Poor and Bad. Failure to achieve a Good or High score for diatoms under WFD is most likely to be caused by nutrient concentrations (typically phosphate) being too high. However, no status criteria for GEP on HMWBs like the Wandle have yet been defined.

Water chemistry assessments on the Croydon-Wandsworth water body have already identified that phosphate concentrations in the mid to lower reaches of the river far exceed the standard required under both the Urban Waste Water Treatment Directive (<1mg/l) and the Water Framework Directive itself (0.12mg/l for Good status): mean concentration for the Wandsworth sampling site in 2011 was 2.87mg/l.

Unsurprisingly, therefore, the Croydon-Wandsworth water body has a Poor classification for phytobenthos, predominantly due to elevated phosphate concentrations and general nutrient enrichment from diffuse pollution, which exert a direct effect on populations of phytobenthos a situation which is unlikely to change until phosphate and other nutrient concentrations are lowered substantially. The main cause of these eutrophic conditions is the effluent from Beddington STW, which provides the majority of flow from the approximate midpoint of Croydon-Wandsworth water body. Even when phosphate stripping equipment is installed at Beddington STW in AMP6, phosphate may remain bound in the river's sediments for many years, releasing intermittently in high fluvial flows or other disturbance. Removing this bound-up source of eutrophication presents a serious challenge, but should nevertheless be a long-term Action.

By contrast, water chemistry on the Carshalton branch of the river already attains GEP, so phytobenthos on this water body is inferred to be Good, with a focus on ensuring no deterioration. However, more information is needed to help inform management practices for the future.

So far, phytobenthos sampling has taken place at only one site on the River Wandle, at Trewint Street in Wandsworth. Phytobenthos monitoring has not been carried out on the Carshalton water body due to the high alkalinity of the water: in areas of high alkalinity, the EA generally considers macrophytes to be the only tool which can provide a realistic measure of nutrient impact. This is due to the nature of the diatom classification tool, in which the taxa resulting in 'Good' status classifications tend to be those present in acidic waters.

Following the Environment Agency's stage 3 investigation for WFD failure in December 2012, expert advice confirms that the full suite of reasons for phytobenthos failure is currently unclear and likely to be complex:

- Nutrient concentrations on the Wandle generally are considered to be too high and likely to be causing stress to phytobenthos populations

- Efforts to reduce nutrients generally will be beneficial, but to what extent improvements can be expected in the phytobenthos EQR score, or how long it might take to achieve, is unknown

In view of this advice, the only specific quantifiable target that can reasonably be set for phytobenthos GEP at this stage is:

- Orthophosphate concentrations emerging from Beddington Sewage Treatment Works are <1mg/l (as required by the UWWTD).

As per the EA's advice for invertebrates (above) monitoring should be continued, and any changes observed after river restoration work analysed for trends that might reasonably suggest what is achievable for phytobenthos on the Wandle. This score can then be set as the Wandle's own GEP standard for phytobenthos.

Actions for Phytobenthos (Objective 7 at the end of this chapter) aim to address the issues set out above, building on the fundamental aims to improve water quality in the Wandle (Objective 2). Additionally, because of their close association with higher plants and gravel and stone substrates, diatoms will benefit from complementary Actions to enhance macrophytes and substrate (Objective 5) and channel morphology (Objective 3).

Further information required:

Long-term monitoring is recommended to establish a realistic GEP score for phytobenthos on the Wandle.

Further reading:

Appendix A: Environment Agency (2014) WFD summary sheet

### 7.5.1: Phytobenthos action tables

The information in these tables has been assembled from suggestions made in community consultations, TAG meetings and specific stakeholder input to develop a series of Objectives, Targets and Actions. Information on existing projects has been collated and used to identify gaps, and where additional projects may need to be developed to fulfil Actions, Targets and Objectives.

**Actions to achieve the Catchment Plan's overall aim for habitat and wildlife: the river supports a mosaic of habitats with high biodiversity**

**Objective 7: Phytobenthos † – good populations associated with chalk rivers are present along the river**

*† Aquatic flora, typically algae, that live at or near the bottom of rivers and form slippery brownish coverings over larger plants and stones. An important group are diatoms, which are unicellular algae encased in silicate capsules that assume a wide variety of intricately patterned designs.*

**Specific Actions to attain GEP**

| Target | Actions | Project | MM | Indicative cost to deliver these Actions |
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| 7.1: Nutrient concentrations in the river, particularly phosphate, are sufficiently low to sustain good communities of diatoms associated with healthy chalk rivers. Carshalton WB by 2015 Croydon-Wandsworth WB by 2027 | 7.1.1 – Undertake further research for full understanding of the diatom communities most commonly associated with healthy chalk rivers, including their habitat preferences and relative abundance, so that SMART target projects can be carried out to encourage their colonisation of the river and conservation. | None | N/A | This Action is likely to be led by the TAG in liaison with the EA, Thames Water and Sutton & East Surrey Water companies. |
| | 7.1.2 – Instigate a programme of annual monitoring using the standard DARES methodology (Diatom Assessment for River Ecological Status), employed by the EA, to create a robust baseline against which annual scores can be compared and longer term trends can be identified to infer the progress being made to attain GEP for phytobenthos. | None | N/A | This target is likely to be fulfilled by the EA with support from other experts. |

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| | 7.1.3 – As part of their statutory requirement to reduce orthophosphate concentrations emerging from Beddington STW to <1mg/l under the Urban Waste Water Treatment Directive, Thames Water are to put orthophosphate stripping into their AMP6 Business Plan and work towards obtaining Ofwat's agreement (due in 2014) for it to be implemented at the earliest possible opportunity and no later than Year 5 of AMP6 (2020). | None | N/A | This Action is being fulfilled by Thames Water's ongoing preparation of their AMP6 Business Plan for submission to Ofwat in 2014. Liaison, additional financial outlay for further investigations and future recommendations for good practice working that maintain required treated effluent discharge quality will be led by the EA, Thames Water and Ofwat. |
| | 7.1.4 – Address and reduce diffuse sources of pollution, such as misconnected pipes and urban surface runoff, with particular reference to reducing phosphate concentrations. | A2, A4, B12, C1, C2, B34 | 3, 6, 9, 10 | This Action is likely to be fulfilled by Thames Water and the EA in part at least.<br><br>Independent walkover surveys and associated investigations, eg dye tracing, mapping and consultations is **estimated to cost £35,000**.<br><br>Independent monitoring could be run with volunteers at minimal cost once monitoring equipment and analysis capabilities were obtained (such as data-analytical computer software). It is also dependent on ongoing support from local authorities and other landowners and managers. **Estimated cost for start up and maintenance for 10 years £15,000**.<br><br>Independent analysis of WSUD techniques for the whole catchment, including the suitability and cost-implications of various SUDS measures to help replicate natural drainage patterns is **estimated at £100,000**.<br><br>The cost for installing SUDS and other measures to help replicate natural flow patterns |

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| | | | | varies considerably, depending on the location, ease of access, flood risk implications, ease of installation and maintenance, and whether such work can be incorporated into new developments or has to be retro-fitted. For example, **porous and permeable paving can cost between £100 per 20m$^2$ driveway** (to purchase and install gravel) and **£2000** to purchase and install Concrete Block Permeable Paving for the same area.<br><br>The cost of installing micro-wetlands is highly dependent on a number of factors, notably land prices. An **indicative cost, based on a location in Hackbridge, LB Sutton, is estimated at £20,000 per acre to install, plus monthly management costs and health and safety considerations such as fencing.** Estimations of cost for the whole river would be dependent on walkover surveys and detailed feasibility studies drawing on the local authorities' Surface Water Management Plans.<br><br>Design and installation of silt traps being retro-fitted in an urban environment is **estimated to cost £40,000** (small), **£50,000** (medium) and **£60,000** (large). |
| | 7.1.5 – Seek additional ways of reducing phosphate concentrations in the river (eg promoting domestic use of phosphate-free washing powder). The orthophosphate concentration standard for Good status under WFD is 0.12mg/l: phosphate stripping at Beddington STW alone is unlikely to achieve this downstream of the effluent channel at Mill Green, LB Sutton. | None | N/A | This Action is likely to be led by the TAG in liaison with the EA, Thames Water and Sutton & East Surrey Water companies. |