

SECTION 3: CATCHMENT CHARACTERISTICS OF THE WANDLE: AN OVERVIEW

3.1: Location and landscape

“We love the Wandle because it’s a London river that hasn’t been covered and built over – it’s a peaceful green haven in an urban environment”

- from Ketso community and stakeholder workshops

The Wandle is a lowland chalkstream which rises from a line of springs on the dip slope of the North Downs and flows 17.5km (11 miles) north to join the tidal Thames at Wandsworth. Due to the meandering course of the river, the total length of its main stem increases to 23.5km, and additional milling leats and other channels may add as much as another 6.4km: a total of almost 30km of perennial river.

The Wandle catchment falls at an average gradient of 1:75 from a peak of around 200m AOD (Above Ordnance Datum) on the Downs to below 50m AOD at the Thames floodplain. The Wandle’s perennial headwaters in Carshalton and Croydon are at 33.5m and 35.6m AOD respectively, and the River Thames is at 5m AOD.

Over the course of many centuries, the Wandle has been extensively straightened and modified for industrial, ornamental, sewage disposal and flood risk management purposes: as a result, much of its channel is hardened with concrete, steel piling and wooden toe-boards, and very few reaches are now likely to follow their original course.

In 1999 the EA’s Local Environment Agency Plan (LEAP) for the Wandle assessed the catchment as follows:

- Urban: 46.1%
- Semi-natural grassland: 25.6%
- Woodland: 9.3%
- Managed grassland: 8.9%
- Tilled land: 8.4%
- Heathland: 0.8%
- Bare ground: 0.8%
- Inland water: 0.1%

The northern, fluvial area of the catchment is almost entirely urbanised, contributing most of its total population of at least 800,000 people. However, this very high population density in close proximity to the river means that the Wandle offers a uniquely valuable blue green space for recreation and contact with nature, often in areas which are noticeably lacking in such opportunities and classified as Areas of Multiple Deprivation. Thanks to the Wandle Trail and many riverside parks and other public open spaces, access is notably better than many comparable urban rivers.

South of the Croydon – Carshalton spring line (which continues west to give rise to the headwaters of the Hogsmill at Ewell) the Wandle’s catchment extends as far as the M25, covering an area of approximately 200km² (77 square miles). Annual average rainfall in the catchment varies, with the upper catchment on the North Downs typically receiving more (760mm) than the lower catchment around the river itself (630mm). The 2006 Environment Agency Catchment Abstraction Management Strategy (CAMS) noted that this was considerably less than the national annual average rainfall of 897mm. After losses to evaporation and transpiration, these rainfall figures reduce to 320mm in the upper catchment and 160mm in the lower catchment.

The permeable Chalk geology of the upper catchment enables rainfall to enter the ground and percolate slowly into the aquifer, but in the areas around the river the urban character of the landscape (featuring an abundance of impermeable surfaces coupled with clay-based soil) results in the majority of rainfall running off the surface and entering the river system. Below Goat Bridge, the river's natural hydrograph and chalkstream characteristics are further masked by the high proportion of additional flow which is contributed by effluent from the Beddington sewage treatment works.

Further reading:

British Geological Survey (2008) *The Chalk Aquifer of the North Downs*

Environment Agency (1999) *Local Environment Agency Plan: Wandle, Beverley Brook and Hogsmill*

English Nature / Environment Agency (1999) *Chalk Rivers: Conservation and Management*

3.2: History and culture

“The Wandle Valley is full of important landmarks and reminders of the river’s history, mills and people. We want to use plaques, information boards, maps and websites to make sure the Wandle’s heritage and culture are never forgotten”

- from Ketso community and stakeholder workshops

As one of the closest chalkstreams to London, the Wandle's ecosystem services and their economic and cultural influence have extended far beyond the geographical confines of the river's own catchment. Global aspects of industry, religion, art and fishing have all been influenced by the Wandle, and have left their own marks upon it up to the present day.

Industry

The Wandle has frequently been described as “the hardest worked river for its size in the world” (Malcolm, 1805 cited by Twilley and Wilks, 1974) and “London's engine room” (Steel and Coleman, 2012), offering both the benefits of a steep gradient, which proved ideal for hydropower, and proximity to the markets of the capital.

Domesday Book recorded 13 mills on the Wandle: at the height of London's industrial revolution in the 19th century, it is generally estimated that at least 90 mills were working on the river. This concentration of mills attracted investment by entrepreneurs and industrialists from all over Britain and Europe, including Huguenot weavers and printers as well as later textile specialists like William Morris and Arthur Lazenby Liberty. From the 18th century a wide variety of herbs and plants were cultivated in the Wandle valley, including lavender, opium, watercress and osiers, and both the river and its surrounding landscapes were managed with increasing intensity.

Most milling sites were retooled many times in their history, and the river powered a wide variety of industries according to market forces. Sectors known to have operated on the Wandle include textile printing, weaving and dyeing, brewing and medical distillation, oil, leather, paper, snuff, gunpowder, cannon boring and machine tooling (Shew, 2012). Despite at least one attempt to modify the Wandle for navigation, the river's mill-owners put up effective resistance to this idea, and the river remained uncanalised to that extent. However, repeated re-engineering for milling purposes has still left the river highly modified, which continues to mask many of its natural characteristics.

Fortunes were made in the course of this industrial boom, and many mill owners invested their wealth in large houses, formal gardens and riverside estates adjacent to their mills. Several of these grounds still survive as public parks, and offer levels of public access to the river (along the Wandle Trail) which compare very favourably with many other urban waterways.

Religion

Merton Priory was founded in 1115 on a site straddling the old Roman Stane Street, adjacent to its ancient crossing point over the Wandle. The priory and church fell victim to Henry VIII's dissolution of the monasteries, but not before the Statute of Merton was passed in 1236 during what can be seen as the world's first recognisable sitting of Parliament.

Today, much of the Merton Priory site is buried beneath the Sainsbury's Savacentre car park: only the foundations of the former Chapter House are visible under the adjacent Merantun Way flyover, together with a stretch of perimeter wall. However the Merton Priory Trust's plans to revitalise this historic space are now well underway, thanks to belated Section 106 funding and incorporation into the Wandle Valley's successful Heritage Lottery Fund urban landscape bid.

Art

Together with the smaller River Hogsmill, the Wandle was the cradle of the Arts & Crafts movement.

William Morris' decision to relocate his manufacturing (fabric printing and weaving) base to Merton Abbey in 1881 attracted other members of this aesthetic, philosophical and cultural movement including Philip Webb, Edward Burne-Jones, and William de Morgan whose premises were located on Byegrove Road. Morris' own "river prints" series of floral designs includes a design named "Wandle" in order "to honour the helpful stream" (Morris cited by Parry, 1983).

From around 1877, Liberty's department store sourced most of its fabric printing from Littler's block-printing works in the old Merton Abbey precinct, and took over the factory's entire production in 1904. The company maintained a design studio on the Merton Road until c2000.

Fishing

As early as 1606 the quality of fieldsports offered by the Wandle was recognised by designation as a royal hunting and fishing preserve. The river's reputation as a trout stream lasted for the next 300 years at least, with huge catches of trout recorded in 18th and 19th century accounts, and no guarantee of permission to fish, even for the most prestigious Victorian fishing writers.

A reference to Wandle trout "with marked spots like a tortoise" appears in a footnote to the 1833 and 1835 editions of Izaak Walton's *Compleat Angler* (Merton Historical Society, 2009), and Nelson is popularly supposed to have fished the Wandle before his death at Trafalgar, although research shows that Sir William Hamilton, husband of Lord Nelson's lover Emma Hamilton, was by far the keener angler (pers comm.Theo Pike, 2010).

The Wandle made a permanent impression on the global cultural development of fly-fishing c1868 when the young Frederic Halford learned the "Carshalton Dodge" from local anglers: a technique designed to deceive wary, clear-water trout by casting a dry fly upstream from behind their tails rather than standing in full view to swinging a wet fly downstream towards them. As pollution gradually destroyed the Wandle as a fishery, Halford started searching further afield for his sport, and introduced the dry-fly technique to the Test, Itchen and Kennet. From these rivers, it has spread internationally as a practical and aesthetic sporting code.

To maintain this level of sport, the river was experimentally stocked with several different species of trout including French sea trout and char (Smee, 1872), and a group of concerned local fishery owners formed the Wandle Fisheries Association c1880 with the objective of reversing the river's decline. Despite establishing a trout hatchery in Watermeads, with a bailiff living in one of the Fisheries Cottages at Mitcham Bridge, their efforts proved a losing battle (Montague, 2005). The upper river's fishery seems to have survived until 1914, when Charles Dingwall ascribed the death of most of his trout to tar laid on the roads (Wilks and Rookledge, 2002), although tradition suggests that the last old Wandle trout was caught by a coarse angler in 1934.

From the 1980s onwards the river was stocked with roach, dace, chub and barbel by successive water authorities as an amenity cyprinid fishery, developing a very strong local culture of freely-available inner city angling which research has shown to confer many social and environmental benefits (Substance, 2012).

Early stockings of trout and grayling as proxy tests for water quality did not survive, but as polluting factories closed and water quality improved incrementally, trout have been reintroduced to the river by the Wandle Trust's Trout in the Classroom programme, and were confirmed to be spawning successfully in 2012. This community-driven initiative has inspired the Wild Trout Trust to develop a national network of Trout in the Town projects, using trout as an iconic indicator species to promote the restoration of other post-industrial streams.

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 addressed to fulfil WFD targets, and restore the river to its former glory as a self-sustaining fishery.

Further reading:

Braithwaite (1861) *On the Rise and Fall of the River Wandle: Its springs, tributaries and pollution*

Hayter (2002) *FM Halford and the Dry-Fly Revolution*

Parry (1983) *William Morris Textiles*

Steel and Coleman (2012) *River Wandle Companion and Wandle Trail Guide*

3.3: Local designations

“We enjoy the many wonderful parks along the Wandle Trail, which provide places for both people and wildlife in the city”

- from Ketso community and stakeholder workshops

Although the River Wandle has no statutory designations, it is a Site of Metropolitan Importance for Nature Conservation (SINC).

The Local Environment Agency Plan (LEAP) for the Wandle, Beverley Brook and Hogsmill (1999) ascribes this designation largely to the river's aquatic plant life, particularly in the upper reaches, being typical of a chalk-fed river. As such, the upper river is also identified as a Site of Metropolitan Importance for Nature Conservation.

However, the river's catchment encompasses a wide range of nature reserves and other sites of ecological significance.

Sites of Importance for Nature Conservation (SINC)

Beddington Farmlands, a large area of sewage treatment sludge lagoons to the north of Croydon, is one of the best sites for birds in London, and is now in the process of being restored as a nature reserve.

Habitats include marsh/swamp, pond/lake, ruderal, running water, wet ditches, wet grassland and wet woodland/carr, providing feeding, resting and breeding areas for many species of waders and other wetland birds. A detailed discussion of Beddington Farmlands can be found in Section 3.8.

Sites of Metropolitan Importance for Nature Conservation (SMI)

There are several Sites of Metropolitan Importance within the Wandle catchment, some of which are associated with the riparian landscape, while others are good examples of chalk habitat:

- Addington Hills
- Bell Lane Creek
- Bennetts Hole
- Croham Hurst
- Farthing Downs and Happy Valley
- Kenley Common
- Mitcham Common
- Morden Hall Park
- Riddlesdown
- Roundshaw Downs
- Spencer Road Wetland
- Therapia Lane Rough
- Wilderness Island
- Woodcote Park Golf Course.

Sites of Special Scientific Interest (SSSI)

The Wandle's wider catchment includes 5 SSSIs:

- Chipstead Downs: chalk grassland with associated scrub and secondary woodland, as well as large areas of ancient woodland
- Croham Hurst: ancient woodland
- Farthing Downs and Happy Valley: extensive expanses of species rich chalk and neutral grassland, and an area of ancient woodland
- Riddlesdown Common: the largest single expanse of long-established chalk scrub and herb-rich chalk grassland
- Woldingham and Oxted Downs: rich chalk grassland, scrub and mature and secondary woodland

Local Nature Reserves (LNR)

There are 9 LNRs along the banks of the river, including:

- Spencer Road Wetland: a 1.04 ha site on the eastern bank of the river at Goat Bridge, developed as the primary site for London Wildlife Trust's water vole reintroduction project

- Watermeads
- Bennetts Hole
- Wilderness Island: a 2.72 ha wetland area at the junction of the Croydon and Carshalton branches of the river, with a variety of habitats including a mosaic of ponds, sedge bed and damp hollows, supporting 30 species of birds and 70 kinds of wildflower
- Wandle Meadow Nature Park
- Wandle Valley Wetland: a 0.62 ha site near the river at Goat Bridge that includes open water, marginal vegetation and seasonal pools supporting invertebrates such as dragonflies and damsel flies
- Sutton Ecology Centre

Across the wider catchment, the following nature reserves also offer important havens for wildlife and local people:

- Roundshaw Downs
- The Spinney, Carshalton
- Ruffet and Bigwood
- Myrna Close

Further reading:

Green Environmental Consultants (1996): *River Wandle Catchment Summary*

3.4: Geology and geomorphology

“Chalk streams like the Wandle are a unique kind of habitat, and it’s even rarer to find one in a city. We’re glad that some improvements are already underway, but we want to see the river full of fresh, clean water, and less of the banks covered up by concrete and other infrastructure”

- from Ketso community and stakeholder workshops

Cretaceous chalk is a soft and highly porous form of limestone, 98% pure calcium carbonate, formed from the compressed shells of millions of coccoliths (calcite plates of marine algae) laid down in a warm marine environment between 70 and 88 million years ago (Toghill).

Subsequent millennia of climatic cooling and erosion have now lifted and exposed these calcium beds high above sea level, forming extensive areas of chalk hills which dominate many areas of southern and eastern England.

Winter rain falling on chalk geology infiltrates easily, recharging vast underground aquifers which later discharge via springs where the chalk meets less permeable rock. Water is also thought to move within chalk aquifers via fissures and veins of flint. This slow process of percolation provides a filtering effect, giving the water a high mineral content (typically calcium and magnesium ions) and a consistent temperature of around 10°C at the point of discharge. Based on seasonally abundant rainfall, this annual cycle of recharge and discharge typically gives chalk rivers a highly predictable (and comparatively unvarying) flow regime, which combined with the high mineral content of the water can support an exceptionally productive ecosystem.

In the case of the River Wandle, some theories suggest that it once rose on the Wealden Dome and may have been responsible for much of the erosion of its height, through the now-dry valleys in the Chipstead area, before falling victim to headwater capture by the River Mole (Hobson, 1914). The

very intermittent appearance of winterbournes in the Caterham and Coulsdon valleys, approximately once every 7 – 10 years is a reminder that the fluvial river system also includes these valleys as a result of the Wandle's geomorphological history.

Today, the perennial Wandle rises from a distinct line of Cretaceous Chalk springs in Croydon, Beddington and Carshalton on the northern dip slope of the North Downs. (This spring line also extends west to Ewell, supplying the headwaters of the Hogsmill River). The Wandle then runs rapidly onto Bromley Tertiary deposits of Thanet Sand: a sandy layer interspersed with outcrops of chalk which connect to the deeper chalk bedrock and may supply additional fluvial flow. North of the Thanet Sands and the Lambeth Group, from a point marked by "the Cut" at Wilderness Island, the river's course passes out over impermeable London clay, which isolates the river from any further interaction with the underlying chalk. However, the London basin also contains extensive deposits of glacial moraine: flint gravels which hold water in the river's hyporheic zone and may also provide some direct contribution to fluvial flow. Geologically-younger fluvial deposits of sand lenses also hold water and have been exploited as aquifers during the urbanisation of the London area.

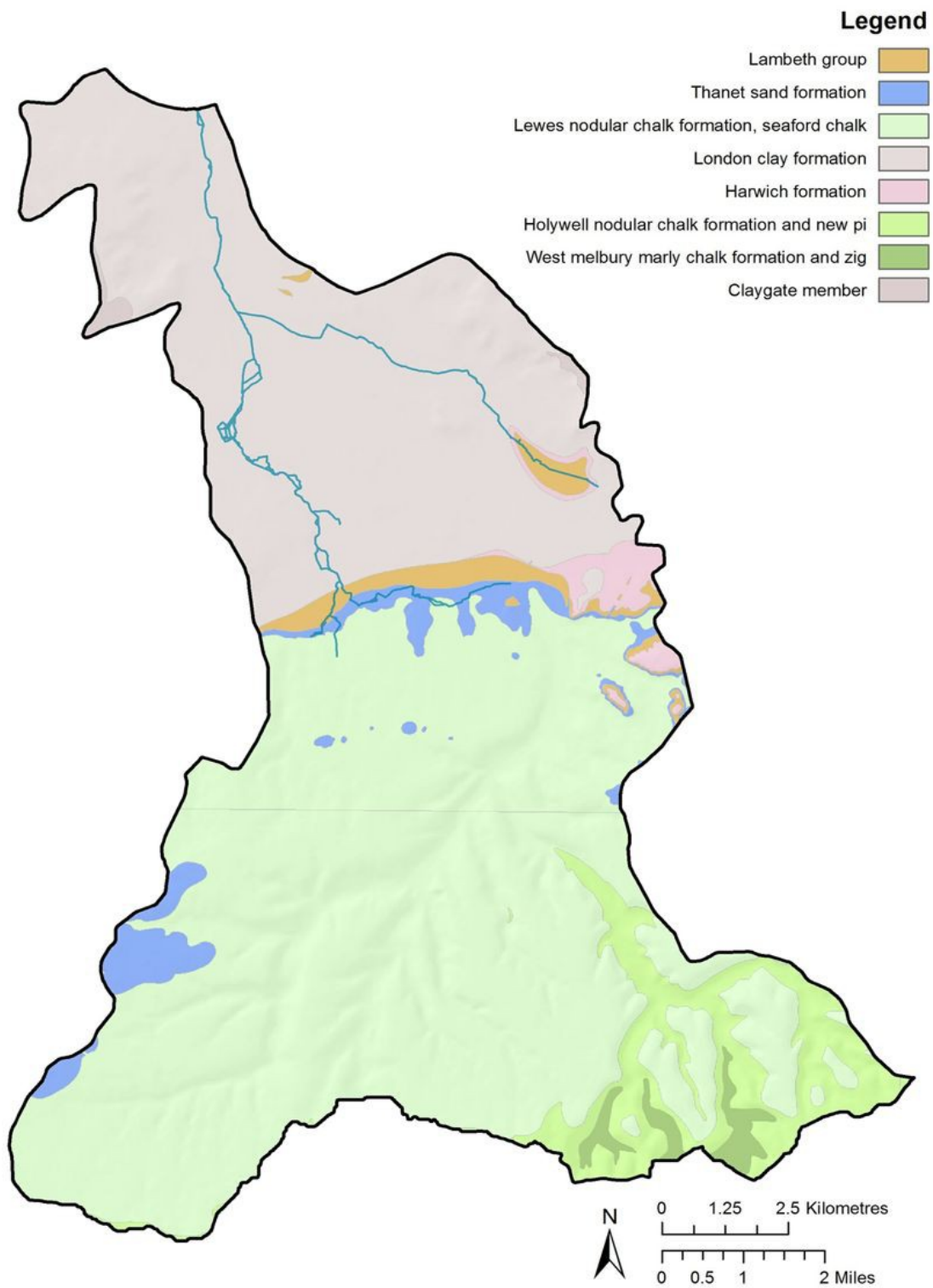
As urbanisation of the northern Wandle catchment has increased, the river's hydrology and hydrograph have become less natural and more 'flashy' (water levels rising quickly in response to rainfall events). The proliferation of hard urban surfaces has reduced infiltration into the London basin gravels, and increased direct runoff into the river: indeed the Wandle has been deliberately maintained as a flood channel to remove rain falling on south London as rapidly as possible to the Thames.

In light of these complex factors of hydrology and geomorphology, some experts believe that it may not be possible to regard the Wandle as a true chalk river for its entire length, preferring the term "chalk fed" instead (pers comm. Steve Barrow, 2012).

Based on geology, the EA's National Chalk Stream Working Group recognises the following extent of chalk stream habitat on the Wandle (pers comm. Dave Webb, 2014):

- The Carshalton water body
- The Grotto arm (ephemeral at present)
- The Croydon arm from a point near the top of Beddington Park to its confluence with the Carshalton water body at Wilderness Island
- A stretch of the Wandle's original course through Beddington Farmlands, now used for flood risk management in conjunction with the Beddington Park flume
- The main river from Shepley Mill downstream to Goat Bridge

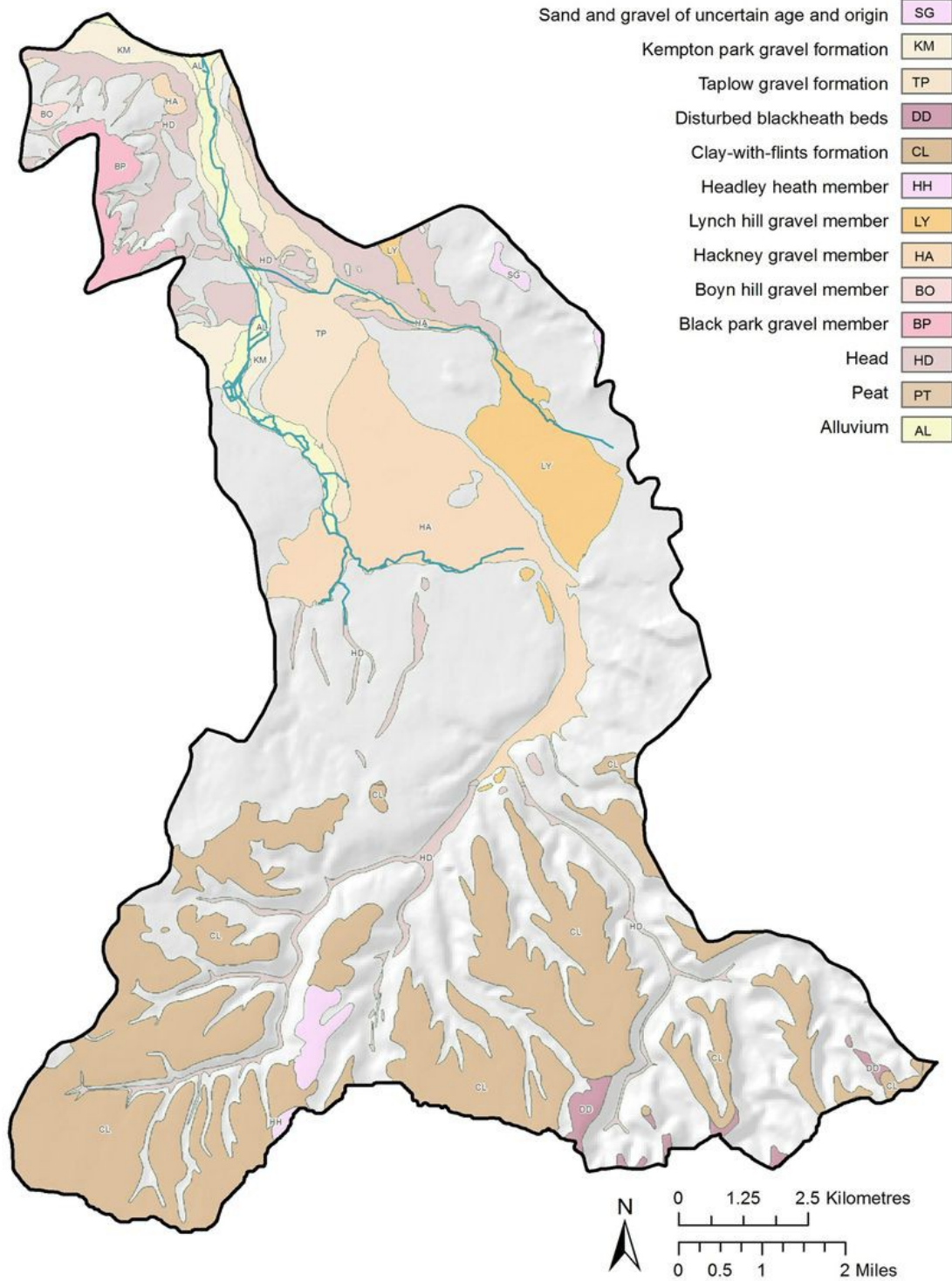
The EA's map of the chalk stream reaches of the Wandle in this area is contained in Appendix H.



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Fig 3a: Bedrock geology of the Wandle catchment

Legend



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Fig 3b: Superficial deposits in the Wandle catchment

3.5: Ground water and aquifers

The Wandle catchment includes two ground water bodies: the Epsom North Downs Chalk (GB40601G602200) and the Bromley Tertiaries (GB40602G602300).

For the purposes of the WFD, both of these water bodies are classified as Poor for quantitative quality and Good for chemical quality: the same classifications are predicted for 2015.

Ground water quality is monitored by the water companies to ensure that water used for potable supply is of high quality, but changes are difficult to detect due to the slow rate of ground water movement, so that impacts are often slow to manifest themselves. The Chalk of the North Downs is threatened by pollution by nitrates and pesticides because of the high permeability of its soils and geology: indeed high nitrate levels have already been detected in many parts of the Epsom North Downs Chalk ground water body, which are eventually likely to have an impact on surface water systems such as the Wandle. The terrace gravels that overlay the London Clays are also vulnerable ground water resources and have been subject to widespread local contamination from past industrial activities.

The EA aims to protect ground water quality via a series of non-statutory policies outlined in the *Groundwater Protection: Principles and Practice* (3PG) document. Topics include landfill activity, current and former industrial sites, use of soakaways (including road and rail drainage), effluent discharges and agricultural activity. Ground water vulnerability maps indicate areas vulnerable to pollution infiltration from the land surface and depends on the nature of the overlying soils, the underlying geology and the depth to the water table. Safeguard Zone Action Plans for future work are developed around any boreholes or wells where monitoring shows that the ground water quality is poor or deteriorating, and can be made available to facilitate understanding of the catchment.

Although the Wandle Catchment Plan is primarily concerned with enhancing the Wandle's two surface water bodies, the condition of the aquifers providing the river's natural flow is inseparable from the condition of the river itself.

As such, the WFD classification of both ground water bodies, due to their potential effects on the catchment's surface water bodies, should be an ongoing cause for concern. At the time of writing, investigations into both the Carshalton water body and the upper Croydon – Wandsworth water body are being carried out under the EA's National Environment Programme (NEP):

- Carshalton water body: Royal Haskoning for Sutton & East Surrey Water
- Upper Croydon – Wandsworth water body: AMEC for Thames Water

The formal end point for these investigations is 31st March 2015: however conclusions may be available before this date (see Section 3.6 below).

3.6: Abstraction and licensing

“Not enough people know how their actions can directly affect the Wandle, including how much water they use. If necessary, agreements with water companies should also be changed to help the river”

- from Ketso community and stakeholder workshops

The Wandle's aquifers are an important source of public water supply, but they have a long reputation for sensitivity to varying levels of recharge and modern pressures of abstraction.

Historic flows were jealously guarded by mill owners whose businesses relied on the power of the river, and periodic schemes to abstract water directly from the Wandle to supply London and its expanding suburbs met with fierce resistance. In 1610 a proposal to pipe 10% of the flow from the springs at Waddon directly to the City of London was abandoned. But in a test case in 1859 (*Chasemore vs the Croydon Local Board of Health*) the House of Lords ruled that “no right could be acquired to subterranean water flowing or percolating in indefinite channels, and that the rules of law applicable to surface waters do not apply to subterranean streams.” (Smee, 1872). The precedent established by this case survived for more than 100 years until regulatory abstraction licensing was instituted in the 1960s.

In 1881, a railway engineer estimated that the dewatering effect of the Oxted railway tunnel had effectively transferred two square miles of the Wandle’s catchment area to the Eden (Latham, 1904 cited by Bourne Society, 2012). Further impacts became evident in 1906 when a railway borehole sunk at Carshalton reduced the springs to half flow and caused a drop of a foot in the general level of the river after only two days of test pumping. By the 1920s the springs at Carshalton were failing on a regular basis: in 1921-22, 1934-35, 1944-45 and more regularly and frequently during the 1950s and early 1960s (Twilley and Wilks, 1974). In addition to boreholes for public water supply, private businesses also abstracted large volumes of water: Payne’s confectionery business sank its own borehole in 1921 and continued to operate it until the factory closed in 2002, while even deeper wells were opened after the Second World War to supply Croydon B power station with water for cooling (Shew, 2012).

By the 1960s, public amenities like Carshalton Ponds and Wandle Park boating lake in Croydon had almost permanently dried up. In 1964 the Wandle Park lake was filled in, with any intermittent baseflow culverted over (Shew, 2012), while water levels in Carshalton Ponds were maintained for amenity purposes by lining them with concrete and recirculating a sweetening flow from the Wandle at Goat Bridge (however, this system was not designed to maintain the ecology of the Carshalton branch of the river).

The right to abstract up to 20,000 litres a day without a licence is enshrined in law, based on the amount of water that could reasonably sustain one small farm, its workers and livestock. Today, this right is rarely exploited in south London, and is virtually unheard of in the inner boroughs. The EA is unaware of any from or near the Wandle, although such abstractions might only be discovered if such an abstraction were specifically reported, or if routine EA monitoring revealed a site-specific and otherwise inexplicable drop in water level (pers comm. Steve Barrow, 2012).

Current abstraction licences permit the following abstractions from the Wandle aquifers which may influence fluvial flow in the river’s headwaters:

- Licence reference 28/39/41/69 (The Oaks) permits Sutton & East Surrey Water (SESW) to abstract a total 19,638 m³/d from the 3 boreholes associated with the Oaks Park pumping station
- Licence reference 28/39/40/8 (The Cheam Group) permits SESW to abstract 2,273 m³/d from Langley Park which may also influence fluvial flow in the upper Wandle
- Licence reference 28/39/41/12 permits Thames Water to abstract 15,502 m³/d at Waddon pumping station

Average abstraction from Waddon is 7,580 m³/d, peaking at 15,500 m³/d: this abstraction has some impact on Waddon Ponds and the River Wandle, but its effect varies according to prevailing groundwater levels, and requires further investigation in conjunction with SESW’s abstractions (pers comm. Thames Water 2014)

- Licence reference 28/39/41/86 permits Thames Water to abstract 17,950 m³/d at Brantwood Road pumping station, and 15.911 m³/d at Surrey Street (currently disused and aggregated with Brantwood Road)

The Brantwood Road pumping station has very little impact on the River Wandle (pers comm. Thames Water 2014)

- Three other minor permits have also been issued for ground water abstraction: two are currently defunct (at the theatre on Carshalton High Street and at a site north of Waddon Ponds), while a third at a car showroom in Beddington operates solely as a ground source heat exchange system, with no net loss to total ground water

Under the EA's London Catchment Abstraction Management Strategy (2006), these abstractions contribute to placing the Water Resource Management Unit which covers the Wandle (WMRU1) in the No Water Available category for increased consumptive abstraction licensing. This assessment was confirmed by the EA's most recent London Abstraction Management Strategy, which states that the unconfined Chalk in the upper reaches of the Wandle is subject to unsustainable ground water abstractions impacting spring flow. In order to protect the Thames, which is already heavily impacted by abstractions, WRMU1 is heavily restricted for licensing. No further consumptive abstraction will be available during low flows, and abstractions will only be allowed at times of higher flow with a flow constraint to protect the river environment.

Current abstraction regimes are also under scrutiny as part of the EA's Natural Environment Programme (NEP) and Restoring Sustainable Abstraction (RSA) programme, which suggests a possible deficit of almost 90% of total annual rainfall across the Wandle's catchment area (Sutton & East Surrey Water, NEP phase 1 report). It is suspected that in addition to the impact of individual abstraction boreholes, the river may be suffering from adverse flow conditions arising from the cumulative effect of several boreholes acting together, and the EA would encourage a water company to relocate an abstraction borehole if good evidence were found to support this hypothesis.

On the Carshalton arm, the EA has identified the possibility of ground water abstractions from Oaks Park and Langley Park causing or contributing to failure of Good Ecological Potential (GEP), based on the following assessment (SESW, NEP phase 1 report):

- Poor status assessment of fish biological quality under WFD
- A calculated flow deficit in this branch of the river based on gauged river flows at Carshalton Mill
- A very high proportion of SESW's recent ground water abstraction estimated to be contributing to the calculated flow deficit in the River Wandle

The aims of the investigation, which started in 2010 and will conclude in 2015, are to:

- Determine if SESW's ground water abstraction is causing or contributing to the failure of GEP
- Quantify the impact that this water company licence is having on the Carshalton water body
- Identify if a change to any of SESW's ground water abstraction licenses or operations is required in order to achieve and maintain GEP

On the Croydon arm of the Croydon-Wandsworth water body, Thames Water's investigation into the impact of Waddon pumping station on Waddon Ponds and the River Wandle has not been definite in its conclusions. The EA has requested completion of an options paper in conjunction with SESW, including investigation of impacts of both Thames Water's and SESW's groundwater abstractions. This is planned for the next AMP (2015 – 2020),

Further information required:

Final results and analysis of NEP investigations into abstraction and low flows on the Carshalton and Croydon arms of the river: the formal end date for these investigations is 31st March 2015, however conclusions may appear sooner.

Results and options appraisal of joint Thames Water / SESW's investigation into impacts of their abstraction points in combination, due to be undertaken during AMP6 (2015 – 2020)

Further investigation and finalisation of water balance calculations across the Wandle's catchment

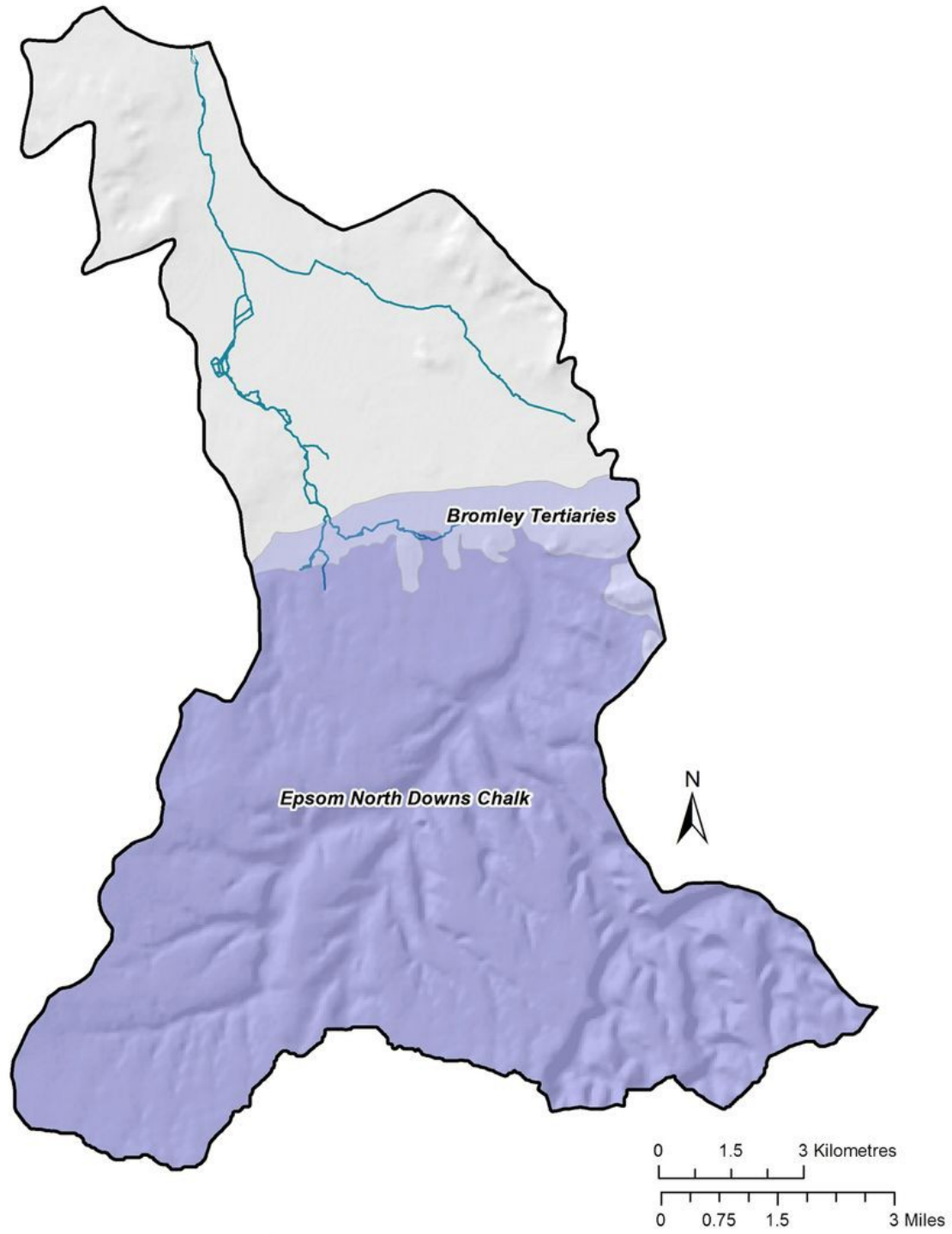
Further reading:

Environment Agency (2006) *London Catchment Abstraction Management Strategy*

Environment Agency (2013) *London Abstraction Licensing Strategy*

Sutton & East Surrey Water PLC (2011) *River Wandle National Environment Programme (NEP) Investigation (Phase 1 report)*

Thames Water *River Wandle National Environment Programme (NEP) Investigation (references needed)*



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Fig 3c: Ground water bodies in the Wandle catchment

3.7: Hyporheic connectivity

A river's hyporheic zone is the saturated layer of gravels between its surface channel and its catchment's ground water, with hyporheic water deriving either from the river itself or via infiltration through the surrounding landscape.

Hyporheic flow can often be equal in volume to visible fluvial flow, and the interactions in the hyporheic zone play an important role in improving water quality, removing nutrients from the fluvial river, and regulating extremes of river temperature. Research into low-gradient rain-fed rivers in North America's Olympic Peninsula has revealed hyporheic zones more than 600 metres deep, with lateral reaches of 3 – 5 kilometres, containing more than 95% of the river's total biomass, including migratory fish fry and macroinvertebrates (Rose, 2003). In rivers with good connectivity to their hyporheic zone, subterranean parafluvial flow occurs at sharp bends where the flow bypasses the bend and flows in a straight line: this flow can exist up to 2km from the actual river in large systems like the Danube, and is likely to occur along the reach of any river which still has connectivity with a porous aquifer (eg chalk) underneath (pers comm. Lee Knight, 2014).

Historic records strongly suggest that the fluvial Wandle once had extensive hydraulic interaction with its hyporheic zone, even in the river's lower reaches (see Section 4.1, below: Braithwaite citation). However, this lateral connectivity has now been severely compromised, both by hard engineering which has physically isolated the river from its ground water (eg the concrete channels through Earlsfield and Wandsworth), and by two distinct programmes of abstraction:

- Historic and current general abstraction for domestic and industrial use (see Section 3.6)
- Strategic abstraction to control ground water levels in the London basin.

London's confined chalk aquifer is complex in structure, with ground water apparently existing in different volumes and various degrees of quality in different locations. Between the early 1800s and around 1940, ground water abstraction in the London basin rose from c9 million cumecs/year to 83 million cumecs/year. This led to a decline in ground water levels from 35m below ground level in 1845 to 90m below ground level by 1960. From this date onwards, however, as ground water-dependent industries such as breweries and paper mills began to move away from London, ground water levels began to recover until studies considered that they threatened the structural integrity of many buildings, as well as infrastructure like the London Underground system.

In 1992, the General Aquifer Research Development & Investigation Team (GARDIT) was formed by Thames Water, the EA and London Underground with support from other organisations including the Association of British Insurers, with a remit to "control ground water levels in the chalk aquifer under central London in order to maintain the integrity of underground structures and foundations in the London Clay" (EA, 2007). GARDIT re-opened old boreholes and constructed new ones to increase abstraction levels by up to 70,000m³/day. By 1994 a cone of depression more than 40m below sea level had been created under central London. By 2000, ground water levels had stabilised, and abstraction was capped at a total 50,000m³/day, with two boreholes near the Wandle in Wandsworth and Lambeth.

In view of this ongoing programme of abstraction to protect London's infrastructure, it is unlikely that the Wandle's historic connectivity to its hyporheic zone, except perhaps in the river's upper reaches, can ever be restored. This supposition is reinforced by a study in 2011 in which several springheads were surveyed for hypogean (subterranean) fauna. During the survey process most of the springheads were found to be clogged with silt, indicating a lack of flow exchange with ground water. Indeed, in a survey of four springs, only one individual subterranean shrimp was found – although the detection of hypogean crustacea in one spring suggests that some connectivity still exists between the benthos and hyporheos (Knight, 2011 and pers comm. 2014)

The Wandle Catchment Plan's Fish TAG has warned that this lack of hyporheic connectivity may have far-reaching consequences for the river's ecology. In particular, lack of upwelling ground water may result in fluvial water temperatures rising above upper avoidance limits for species which might otherwise thrive in the Wandle (eg grayling), and other species may also suffer negative effects.

Further information required:

Investigation of the Wandle's hyporheic zone throughout an appropriate length of the river (initially by desk study or walk over to identify areas of upwelling and downwelling flow in the river, as indications of connectivity with the hyporheic zone)

Investigation of ground water inputs into the Wandle in order to help define a good baseline flow

Further reading:

Braithwaite (1861) *On the Rise and Fall of the River Wandle: Its springs, tributaries and pollution*

Johns (2011) *The Groundwater Animals Project*: downloadable from
<http://hcrs.freshwaterlife.org/sites/172.16.0.99.hcrs.local/files/GWAnimalsProjectReport.pdf>

Hyporheic Network: <http://www.hyporheic.net/>

Rose (2003) *The Color of Winter: Steelhead Fly Fishing on the Olympic Peninsula* (probably referencing Naiman, Cantor and Bilby (eds) (2001) *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*)

3.8: Wetlands

Although the Wandle's lateral connectivity with its floodplain and original surrounding wetlands has been severely compromised by the pressures of urbanisation, a number of wetlands still survive or have been created as nature reserves along the river's corridor.

These include Wilderness Island, Spencer Road Wetland, Wandle Valley Wetland, Bennetts Hole, Watermeads and parts of Morden Hall Park - several of which have been identified as potential release sites for London Wildlife Trust's water vole reintroduction project (see also Section 3.3).

Additionally, the Wandle's catchment encompasses Beddington Farmlands: a large area of sludge lagoons and gravel pits which is already one of the best sites for birds in London, and is now being progressively restored as a SINCDesignated nature reserve with a mixture of habitats, including marsh/swamp, pond/lake, ruderal, running water, wet ditches, wet grassland and wet woodland/carr.

Beddington Farmlands already supports important populations of breeding, wintering and passage species. The sludge drying beds present a range of early successional habitats, initially providing mud and bare ground for feeding waders, seasonally succeeded by seed-rich weed stands which attract finches. Breeding waders include lapwing, little ringed plover and redshank, while large numbers of teal, shoveler and snipe overwinter. Waterfowl including egret, osprey and avocet have been seen on the lake, and a wide range of migrating species are recorded on passage, including one or two national rarities in most years.

The site is also important to feeding bats, and is one of very few places in London where the serotine is regularly recorded.

Until relatively recently, Beddington Farmlands supported up to 100 pairs of tree sparrows, which was by far the largest colony in London of this nationally declining, UK BAP priority species. However, this colony's population has fallen precipitously in recent years, maybe as low as one single breeding pair in 2014 (pers comm. Derek Coleman, 2014).