[Page 103]

Chapter 9

UTILITIES

One of the twin, back-to-back Staines reservoirs of the West Middlesex Water Company, photographed with the water down in 1998.

The provision of safe and adequate water supplies, of sanitation, energy for lighting and power, and increasingly sophisticated means of communications, have all given rise to major industrial undertakings from the nineteenth century onwards.[1] Besides the basic water, sewerage, gas, electricity, signalling and telecommunications industries discussed below, Surrey has a significant connection with the postal service in that the architect John Wornham Penfold, designer of the hexagonal 'Penfold' pillar box, was born in Haslemere and remained closely associated with the town.[2] In a more specialised field, the Royal Greenwich Observatory had an outpost at Abinger from 1924 to 1957 to avoid interference with magnetic signals.[3]

Water supply

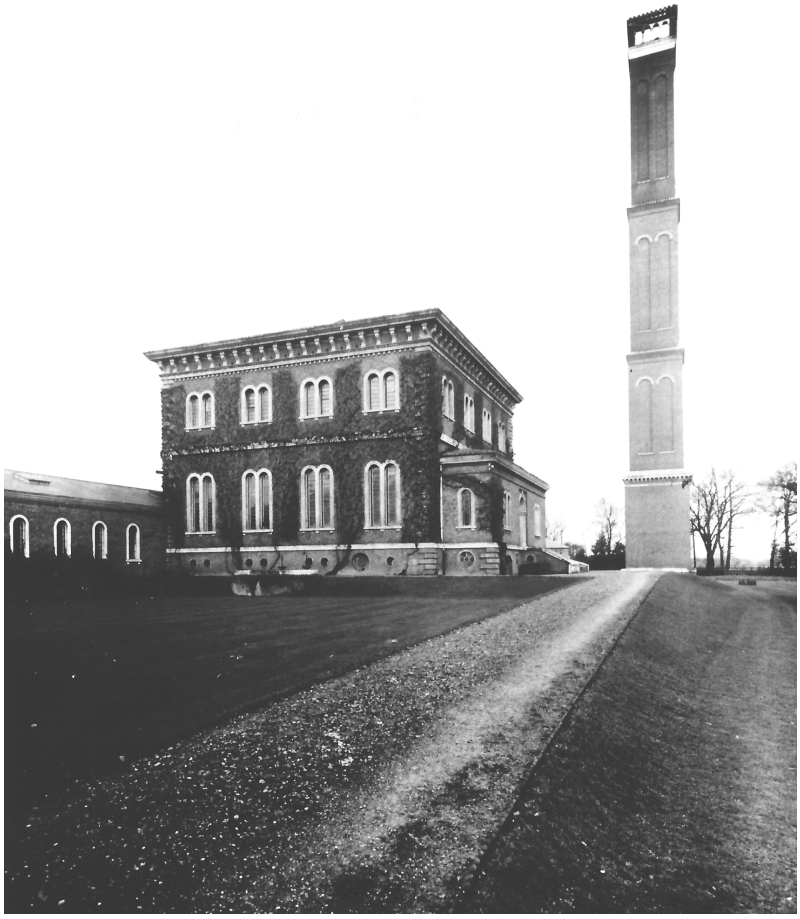
Surrey largely depends for its water supply on two great water-bearing strata, the Chalk and the Lower Greenland, which traverse the county from east to west. A line of springs issuing at the outcrop of the Chalk from beneath the overlying tertiary beds gave rise to a chain of towns and villages from Guildford through the Clandons, Horsleys, Bookhams, Fetcham, Leatherhead and Epsom as far as Sutton and Croydon. Other early spring-fed settlements are the British camp on St George's Hill, south of Weybridge, and Waverley Abbey, where a Lower Greensand spring provided a supply in 1179.

Wells are more reliable than naturally occurring springs as they can be extended below the range of variation of the water table and can penetrate relatively impermeable strata, such as the Gault Clay, to reach aquifers beneath. The depth of wells in Surrey varies considerably. Most Greensand wells are less than 60 metres deep, but those in chalk are often much more — for example 155 metres at Polesden Lacey. The yield of wells is sometimes increased by driving 'headings' — horizontal adits — to intercept water-bearing fissures, particularly in the chalk. Notable examples include Woking Waterworks' 40 metres-deep well at West Horsley which has headings extending 183 and 400 metres, and the Banstead Hospital (now HM Prisons) wells which are 90 and 116 metres deep and have galleries totalling 150 metres. Haslemere Waterworks, whose 32 metres well is in the Lower Greensand, has an easterly heading 167 metres long.

[Page 104]

Well-sinking is a hazardous craft akin to mining. In loose or saturated strata, lining or 'steining' is provided to support the sides. This is commonly constructed of brickwork placed on a curb which, by its own weight, forces itself down the shaft, or of cast iron sections bolted together. Forced ventilation by bellows or fan is commonly needed.

By 1880 there were over 200 Lower Greensand wells, located in a broad sweep from Thursley and Farnham in the west to Bletchingley in the east, and over 100 chalk wells from Guildford to Chelsham and Warlingham. Wells were deepened by boring, initially by chiselling and bailer action and later by rotary drilling. In the nineteenth century the provision of boreholes in Surrey was largely by private firms but by the turn of the century the county was becoming a principal supplier of deep-seated water. Borehole sources over 245 metres deep were in use at Chertsey Brewery, Caterham Waterworks and East Horsley as well as one of 365 metres at Dunsfold and one of 484 min Ottershaw Park at Chertsey. Significant among private suppliers were hospitals and institutions, such as Holloway Sanatorium at Virginia Water and Brookwood Asylum at Woking, and commercial undertakings such as laundries and breweries.



The Hanworth Road works of the Metropolitan Water Board in March 1934. *Thames Water Utilities*.

Surface supplies have been used in some parts of the county. In the Wey valley, a supply was taken by channels from the Abbey Stream to the twelfth century Newark Priory near Send. In the mid-seventeenth century, a piped water supply was taken from one of the ponds on the Tillingbourne to Wotton House and its gardens created by John Evelyn. Dorking was a leader in major pumped supplies in 1738 when the Pippbrook was impounded and 'water mills, works and engines' were installed. After more than a century the works were put up for sale with 'a six-feet overshot wheel, 5 feet wide [with] universal joints, having an extra crank available in case of accident' as well as a 'three-barrel engine' or pump. Surface run-off from the greater part of the District of Tandridge is abstracted from the River Eden in Kent, stored in Bough Beech Reservoir and pumped back to serve the area east of Reigate and south to Horley and Gatwick.

An early distributed water supply was provided at Guildford in 1701 when William Yarnold received a grant from the corporation to erect a waterwheel and pumps to raise water from a well near the fulling mills on the River Wey to a reservoir at the foot of Pewley Hill. A company was formed of which the corporation held three-and-a-half of the eight shares and which it acquired in full in 1865. A new well was then sunk which became contaminated from a fractured sewer, resulting in 264 cases of typhoid fever. Development continued however and in 1898 the water manager reported that power sources for the supply comprised gas and steam engines, water turbines and three waterwheels.

Guildford was not alone in having typhoid. The County Medical Officer's report of 1898 admitted that the only sanitary districts with no fatalities from the disease during the past three years had been Weybridge and Chertsey. Water

[Page 105]

supplies were not sufficiently safe until the mid-twentieth century when routine sterilization was adopted following a notorious outbreak of typhoid in Croydon in 1937.

Nevertheless, new water supplies were not always received with open arms. It was reported in 1905 that tenants of cottages at Weydon Mill were using river water in preference to that which came through the Farnham Water Company's mains; and when the South West Suburban Water Company proposed to

Interior of the Victoria Reservoir, Farnham, a typical covered reservoir. The photograph was taken during cleaning and renovation in 1999, 100 years after the reservoir was opened.

bring water to Windlesham in the 1890s, the parish responded unfavourably as they were content with their well supplies.[4] After other unsuccessful moves in 1898, 1900 and 1905, when charges for water were the usual stumbling block, agree-ment was finally reached in 1910 to accept a mains supply. Again, when Woking Water and Gas Company proposed to lay mains in the parish of Ockham, the Parish Council and the Earl of Lovelace opposed the scheme on the grounds that the general health of the district had not suffered from the existing well supply.

The water companies had been the dominant suppliers since the eighteenth century. Until the Waterworks Clauses Act of 1847 they were authorised by their own special Acts to afford a supply and the new legislation standardised their powers and facilitated the setting up of new companies. At least 25 such companies have existed in the county at one time or another. Most sold out or were taken over for economic reasons or because of resource constraints so that the number was eventually reduced to four.

The sell-out might be controversial, as in the case of the Reigate Water Works Company, established in 1858, which sold its assets to East Surrey in 1896. Reigate Corporation, caught unawares by the deal, tried without success to delay the passage of the enabling Bill through the House of Commons. They also failed to obtain the resignation of the Town Clerk for failing to inform them of the sale although he was a director of the Company himself. The Corporation then promoted its own Bill with the object of altering the proposed rates and charges, which they considered 'exorbitant to a degree'. This move attracted hostile comment in the press. Eventually a compromise was reached by which marginal differences in the charges for baths and additional water closets were reconciled and a number of public faces were saved.

The East Surrey Company was one of the four which has continued to the present day. Its records at the beginning of the twentieth century illustrate its activities. In 1900 there were 758 new consumers and 42 km of new mains, including a large arterial from Kenley to Merstham via Purley and the first borehole at Purley. The second borehole was ready in 1901 when there were 551 new consumers and 37 km of new mains, including the large main from Merstham to Nutfield.

The other three surviving companies are the South East, North Surrey and Sutton District water companies. Their combined supply areas, which exclude those covered by Thames Water, may represent the highest proportion of supply by commercial companies in any county in England and Wales.

[Page 106]

Besides securing its own supplies, Surrey has been involved in the supply of water to London. In the 1850s, the London water companies were forced to obtain their supplies from the Thames from further upstream, above the tidal range. The Lambeth Water Works Company inaugurated an intake, filters and pumping station at Seething Wells, Surbiton, in 1852 and the Chelsea Water Works Company followed suit in 1856. James Simpson, engineer to both companies, had developed the slow sand filter in 1827 for the Chelsea company and his design was adopted throughout the world. The Lambeth company installed two pairs of Woolf compound beam engines, the first to be used by a London waterworks, and these were followed in 1891 by a Worthington triple-expansion engine. In the 1870s both the Lambeth and Chelsea companies again moved upstream to construct new intakes and storage at Molesey.

Meanwhile the East London Water Works Company had built an intake on the left bank of the Thames at Sunbury and waterworks alongside Hanworth Road. Here, so much water was encountered in the excavations through the gravel that it was decided to collect it by a novel method. Perforated hollow iron piles were driven through the gravel into the underlying clay and connected there to a brick culvert. Water from the gravel passed through the piles and culvert to a well from which it was pumped, together with river water, to the filters.

[Pages 107-108]

The Metropolitan Water Board was established in 1902. Increasing demand made storage necessary to balance periods of low river flow and a series of large reservoirs was built: Staines North and South, commissioned in 1904, Walton Knight and Walton Bessborough in 1907, Island Barn in 1911, Queen Mary in 1925, King George VI in 1947 and the Queen Elizabeth II reservoir in Elmbridge in 1962. As storage also purifies water, the Board decided to pass all London's Thames supplies through the reservoirs. These have earth embankments with central puddled clay cores keying into the underlying London Clay.

Sub-surface sources have continued to be developed. In west Surrey, in the area now supplied by South East Water, wells were sunk in 1963 at Tongham, which had been supplied by the Aldershot Water Company, and in 1970 at Tilford, previously fed by the Wey Valley Water Company. At Fetcham there is a group of ten artesian springs where water issues from the underlying Chalk and is pumped by the East Surrey Water Company to its Elmer Works at Leatherhead.

Surrey's Sewage and Refuse Disposal

Sewage in Surrey, as elsewhere in the country, had been allowed to run into open drains, leaky cesspits or straight into water courses until fairly recent times. The contents of privies and cesspits were simply dumped on to the land. This allowed plagues such as cholera to spread even in rural areas, as happened in 1848 in the village of Windlesham. The first attempts to improve the situation was by local authorities employing night-soil men to collect sewage and cart it to a dump outside the inhabited area. The irregularity of collection would have led to intolerable conditions were it not for influential residents, who unlike those of today lived in the centres of towns, insisting on the regular emptying of cesspits and collection of foul refuse. A parallel situation arose nationally in 1858 when the Houses of Parliament were so affected by the smell of the Thames that they speedily implemented a plan to convey London's sewage to treatment works prior to its discharge into the river. Sir Joseph Bazalgette, engineer to the Metropolitan Board of Works, built five main sewers, two of which ran south of the Thames, through areas then in Surrey and on into Kent, to the southern outfall works at Crossness.

Some of the old unhygienic practices of sewage disposal continued well into the twentieth century. In the 1930s some farms still had privies placed over streams. Even in 1945 at Stanwell, a village now on the border of Heathrow Airport, earth pails were still in use and were emptied on to the land. Some early small isolated sewage works, probably little better than cesspits, though long since disused, are marked on large-scale Ordnance Survey maps. One of these was in Windsor Great Park.

[Page 109]

Real improvement did not start until after the passing of the Public Health Acts in the 1870s. These divided the country into urban and rural sanitary authorities whose duty was to provide good water supplies and proper treatment of sewage. Even then progress was slow because of the difficulty of raising sufficient funds. Nevertheless the volume of sewage was increasing all the time, not only because of the increase in population but also because improving standards of living brought an increase in the use of water closets. Fortunately the general adoption of Thomas Crapper's 'Water Waste Preventor', now the universal type of lavatory cistern, prevented water closets being left to flush continuously and restricted the increase in the volume of sewage. The slow provision of public sewers led in some cases to developers providing their own, as in 1907 at the Ridgemount Estate in Sunningdale, where however the sewers merely led to the nearest stream.

Some of the earliest sewers were built primarily as drains for surface water and were connected to take domestic sewage illegally, as at Dorking, and considerable pollution resulted. When purpose-built sewers were eventually constructed they made maximum use of gravity to convey the sewage to the treatment works, which were therefore built on the lowest available sites, usually near water courses. Where this was not possible, costly pumping arrangements had to be made to lift the sewage above the level of the treatment works. Sewers also required vents to remove toxic gases such as hydrogen sulphide and inflammable gases such as methane. Sewage vent pipes are widely distributed throughout the county and resemble tall lamp posts without their lamps. Decorative examples can be seen on the London Road at Sunningdale and around Leatherhead.

Sewage treatment plants were built in the county from the 1880s onwards, for example at Frimley in 1884, Woking in 1899 and Camberley in 1907. Dorking Rural Sanitary Authority's system, connected to a treatment works at Pixham, served 95 per cent of the town by 1892 but needed major reconstruction a year later. Lyne sewage treatment works, serving much of the present Borough of Runnymede, was built before the First World War and in 1925 Lightwater sewage works, which also served Bagshot, was completed.

Weybridge sewage works became well known to the public because it was situated beside Brooklands Race Track and featured in the film 'Those Magnificent Men in their Flying Machines', in which an unfortunate pilot crashes into the sludge beds. The works have since been moved to the other side of the railway viaduct.

Early sewage works were extended and modernised, in some cases also to handle refuse and recover waste products. From 1950 to the 1970s, for example, at the Leatherhead sewage works off Randalls Road, refuse was passed along conveyor belts and women, who travelled daily from London, were employed to remove salvageable items. The remainder was composted with sewage sludge, to produce a friable fertiliser for sale.

[Page 110]

Sewage treatment works also exist at Esher, Farnham, Guildford, Hersham, Horley, Merstham, North Camp, Reigate, Wisley and Worplesdon. Some of the county's sewage is however treated outside the county. The works at Staines (formerly in Middlesex), which had replaced direct discharge into the Thames in 1899, was closed in 1936 when the large Mogden Works in Isleworth was built to treat all the sewage of west Middlesex. Unfortunately for the local inhabitants, the treated sludge from Mogden was pumped back to their district at Perry Oaks for final treatment and conversion to 'Morganite', a fertiliser which was sold to the public. Sales were eventually stopped because of the possibility of contamination with toxic metals. In the 1990s Perry Oaks is threatened with closure to make way for a fifth terminal at Heathrow Airport.

Sewage from parts of the Borough of Reigate and Banstead and from Tandridge District is treated outside the modern county at Beddington on a site which has been in use for over a century. Originally the sewage was merely allowed to flow over the ground, being partially purified as it went. Proper treatment plant was installed between 1902 and 1912 and in 1932 was extended to provide for the novel system of using the treated sewage as cooling water in a power station. Methane produced by the digestion of the sewage sludge was used to drive corporation vehicles. In 1966-69 the works were completely rebuilt.

Many of Surrey's disused sand, clay and chalk pits have been used for the disposal of refuse. Croydon Corporation began dumping in abandoned chalk pits at Merstham in the 1960s and in the following decade landfill became national policy and the scale of dumping greatly increased. A disused pit is lined with a plastic membrane to prevent foul water from contaminating the local water table. The refuse can be dumped and compressed down for many years during which water is collected for treatment and methane is tapped off through pipes and either flared off or burnt to produce electricity. When the pit is full it is earthed over and the land can be used for grazing. Numerous large pits have thus been filled in Surrey, leaving little evidence of the industries they once supported.

Gas

William Murdoch, gave the world's first demonstration of lighting by coal gas in 1792. He made the gas by heating coal in an iron retort and passed it through pipes to light his home at Redruth in Cornwall, where he was erecting steam engines for the firm of Boulton & Watt. Later he returned to their Soho Works in Birmingham and in 1801 lit the premises with gas to celebrate the Peace of Amiens. The next major developments were in the London area. In 1812 the Gas Light & Coke Company became the world's first company to supply gas for public use and built works in Horseferry Road, Westminster. In 1813this supplied the world's first gas public lighting on Westminster Bridge, then on the boundary between Surrey and Middlesex.

The first gasworks in the historic county of Surrey was Munroe & Company's works at Bankside in 1814, and in 1833 the South Metropolitan Gas Light & Coke Company completed its first gasworks in the Old Kent Road adjoining the Grand Surrey Canal, which was used to bring in coal.

[Page 111]

The popularity of gas for both public and domestic lighting grew rapidly and by 1830 there were 200, and by 1850, 800 gasworks in Britain. At that time the main use for gas was for lighting, both public and domestic since, although the design of burners had improved, the production of light still depended upon the luminosity of a non-aerated flame which deposited soot on any surface it touched. The use of gas for other purposes, such as cooking and heating, was made possible by the development of a practical aerated flame by Bunsen in 1855.

The invention of the electric arc lamp with its greater brilliance for public lighting and of the electric incandescent filament lamp for domestic use began to threaten the dominance of gas lighting. The discovery of 'Limelight', produced by heating a refractory substance such as lime to incandescence, led many people to try to adapt this principle to gas lighting. The solution was eventually found by Welsbach, who used an aerated gas flame to heat a mantle containing a mixture of oxides of thorium and other rare earths, to incandescence. This timely invention saved the gas industry from a premature decline.

The growth in the number of gasworks in the early nineteenth century continued until almost every town, village and even some individual buildings had their own gasworks. Inevitably the smallest and least remote of these works were taken over and closed down by larger neighbours, as happened at Bagshot, Chertsey, Chobham, Redhill, Reigate, Sunbury, Sunningdale and Woking. Large isolated premises with their own mini-gasworks included the Royal Earlswood Hospital in Redhill, Holloway Sanatorium, the Wentworth Estate in Virginia Water and King Edward's School at Witley, where remains of the gas-producing plant survive today.

Because of its proximity to London, Surrey never had a major gasworks and drew some of its supplies from Croydon, Wandsworth and Hampton Wick. However there were medium-sized works at Cobham, Dorking, Egham, Camberley, Leatherhead and Walton & Weybridge. The Dorking Gas Light Company, for example, built its works in 1834 to supply public lighting, coal being delivered from Dorking Town station by horse and cart. The works was later extended and in 1928 the company amalgamated with the

Low-pressure storage gasholder at Oxted.

Redhill Gas Company to become the East Surrey Gas Company. Like nearly all gas companies in Surrey, this became part of the South Eastern Gas Board on the nationalisation of the industry in 1948. A new gasholder was built in the Dorking works in 1951 but coal gas production ceased in 1956.

In 1832 the Staines & Egham Gas Light & Coke Company built works on The Causeway at Egham, to become the first of the public utilities on this road, followed by water and electricity. It was later taken over by the Brentford Gas Company which in turn was bought up by The Gas Light & Coke Company. On nationalisation of the industry, this works became the only one in Surrey to become part of the North Thames Gas Board's area. In spite of all these changes in ownership, gas production not only survived but even steadily increased until the 1960s when the district changed to natural gas and production of coal gas ceased.

[Page 112]

The Leatherhead Gas and Lighting Company works opened in 1851 near the site of the future railway station. Coal was delivered by road from Epsom until the railway arrived in 1859. The Cobham Gas Light & Coke Company was bought up in 1912 and the Leatherhead Company itself was absorbed by the Wandsworth Gas Company in 1936. Gas was then supplied to the district from Wandsworth and the Leatherhead works closed in 1938.

On the nationalisation of the gas industry in 1948 there were still over a thousand gasworks in Britain, of which sixty were in the South Eastern Gas Board's

An illustration from *The Graphic* of 1881 showing Godalming's pioneer street lighting.

area which included Surrey, Sussex, Kent and south London. Most of these were closed down in a plan to concentrate production on only four or five sites, none of them in Surrey. The discovery of natural gas in the North Sea in 1960 then saved the gas industry from a steady decline in the face of competition from electricity and cheaper oil. Instead the industry has gone from strength to strength, becoming the nation's most popular fuel for heating and cooking.

The sites of the closed works have generally been redeveloped — Dorking's for example as a modern business park and Guildford's in the redevelopment of the town's riverside — but traces of the industry have not disappeared entirely as some of its most prominent features, gasholders, were retained for the storage of North Sea gas, as at Camberley, Chertsey, Dorking, Egham, Oxted and Whyteleafe. Gasholders, or gasometers as they are popularly known, store gas over

[Page 113]

water and rise and fall with the volume of gas in them, disappearing completely from view when empty. Dry gasholders on the other hand do not visibly change with the volume of gas but have an internal piston which rises and falls. Egham was the only gasworks in Surrey to have one of this type as well as the more common wet gasholders. It was so large that it became a local landmark from its erection in 1928 until 1985, when it was demolished, although the smaller wet gasholders were retained.

Other modern gas installations include valve stations, high pressure mains, whose positions can sometimes be seen from their small concrete marker posts, and at Mogador, north of Reigate, there is a pressure-reducing station for natural gas.

Electricity

Surrey has a particular claim to fame in that, fifty years after Faraday's discovery of electromagnetic induction in 1831, the first public electricity supply in Britain was provided at Godalming.

At the end of September 1881 the annual contract for lighting the town's streets by gas expired. As well as a tender for renewal of the contract from the Godalming Gas and Coke Company in the sum of £210 the Town Council received an offer from Messrs Calder & Barrett, electrical engineers and contractors of Westminster Bridge Road, London. A demonstration was given in which part of the town was lit by a single Siemens arc light and several Swan incandescent lamps, using electricity generated at the Westbrook Mill of R & J Pullman, leather dressers, on the River Wey. The equipment was inspected by the mayor and council on 28 September and on 30 September the council placed a contract with Calder & Barrett to light the town for a year from 1 October 1881 in the sum of £195.

ELECTRICITY GENERATING STATIONS IN SURREY

Station	Position	Started	Closed	Installed capacity Initial kW	Installed capacity Max kW	Survival of building†
Caterham	85 Croydon Rd	1903	1924	88	180	
Dorking	Station Rd	1904	1939	180	1,000	■
Egham	164 High St	1905	1912	*	*	■
Egham	The Causeway	1912	1924	188	680	
Epsom	Depot Rd	1902	1954	220	2,050	
Farnham	East St	1912	1954	180	530	
Godalming	Westbrook Mill	1881	1884	4.5	4.5	
Godalming	Borough Rd	1902	1949	380	600	■
Guildford	Onslow St	1896	1913	60	750	
Guildford	Onslow St (extn)	1913	1927	1,100	1,610	■
Guildford	Woodbridge Rd	1927	1968	7,500	11,250	
Hindhead	Tower Rd	1901	1953	38	925	■
Leatherhead	Bridge St	1902	1941	75	2,210	
Reigate	Wray Common Rd	1901	1936	230	2,742	■
Weybridge	Church Walk	1890	1896	70	70	■
Weybridge	Thames St	1902	1922	180	780	
Woking	Board School Rd	1890	1959	40	7,000	

Source: Garcke's Manual of Electrical Undertakings.
*This station does not appear in the published statistics but a contemporary report states that the machinery is 'sufficient to light several hundred lamps' (Egham and Staines News, 1 April 1905).
†In 1997.

[Page 114]

The scheme included three arc lights in the town and three in the mill and 27 Swan lamps in the town and seven at the mill. A Siemens alternator with a capacity of 4.5 kW was installed in the mill. Motive power was provided by first one, and later two, waterwheels which were provided by Pullmans in exchange for lighting the mill and mill house. The significance of this hydro-electric installation at Godalming lies in the fact that as well as providing street lighting and serving the mill, it was also intended to make the supply available to the public. The first public supply was taken from this system before the end of the year.

Problems arose with voltage drop in the conductors feeding the lamps in the town, and there were also difficulties with the waterwheels when the river was in flood. By the end of 1881 the generating plant had been moved to a shed at the back of the White Hart inn where it was driven by a steam engine.

In the following April Calder & Barrett withdrew and the Council entered into a contract with Messrs Siemens to light the Borough for 12 months. They improved and extended the installation but by 1884 Siemens declined to tender as the demand was insufficient for them to extend the system to a viable capacity. So from May 1884 the street lighting of Godalming reverted to gas, and the private electricity consumers lost their supply, although it appears that private generation continued at the mill.

In the year after the Godalming project began, the Electric Lighting Act, 1882, was passed. This enabled the Board of Trade to authorise the supply of electricity by any local authority, company or person and to grant powers to install a system of supply, including powers to break up streets. Licences, which could not be granted without the consent of the local authority, were to be for periods not exceeding seven years, although they could be renewed. Alternatively the Board of Trade could grant a Provisional Order for an undertaking, although the Act gave local authorities the right to take over the assets of com-panies after a period of 21 years. Overhead lines could only be erected with the consent of the local authority. Because of the right to buy by local authorities, who would pay for the plant but not the business, there was little enthusiasm for starting undertakings. How-

The Electric Theatre, Guildford, formerly the 1913 electricity works.

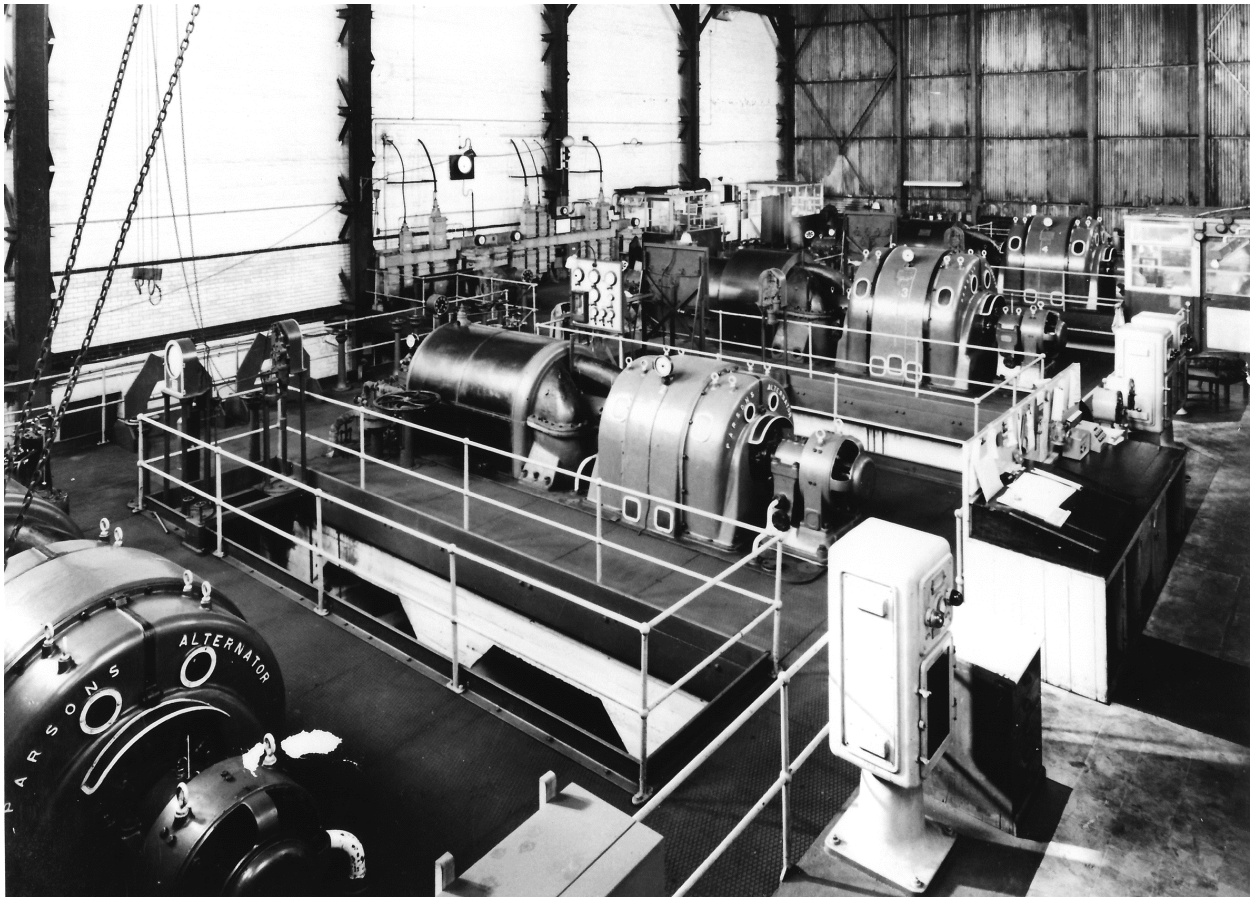
ever, the Electric Lighting Act of 1888 extended the period after which the purchase right could be exercised to 42 years and required the undertaking to be valued as a going concern. Consent was now required from the Board of Trade for the erection of overhead lines. These provisions and the increased availability of incandescent filament lamps resulted in a number of applications for Provisional Orders by local authorities and private companies. Many were cancelled or transferred while finances were sorted out before any electricity was supplied. Each of the early undertakings built small generating stations with a capacity to supply only those consumers in their immediate vicinity. Plant was extended as demand increased and as provisional orders were received from a wider area.

[Page 115]

The supply voltage varied from undertaking to undertaking, with some generating direct current (DC) and others alternating current (AC). A DC system could be operated in two shifts, with the station batteries maintaining the night load. In AC generation, the use of transformers allowed higher voltage distribution so that the station could be further from the load. Most early stations were steam-driven by reciprocating engines, but many of the smaller ones converted to diesel plant before they eventually closed down. Some stations, including Farnham and Egham, were diesel-driven from the start.

After the demise of its pioneering scheme in 1884, Godalming was without a public supply until a station was opened in Borough Road by the Urban Electricity Supply Company in 1902. This station had steam-driven dynamos giving an output of 380 kW in its early years but, interestingly, in 1922 a 20 kW water-driven set was added so that once more the Wey at Godalming was producing electricity.

Weybridge also has a claim to distinction as the first town in England to be wholly lit by electricity using incandescent lamps. Its generating station, built in 1890 adjacent to the River Wey in Church Walk, contained a water-tube boiler and duplicate steam-driven 35 kW alternators generating at 1,000 volts. Power was distributed throughout the town using about 6 miles of overhead lines supplying 111 incandescent filament street lamps as well as a number of private consumers. The plant closed down in 1896. Problems were caused mainly by objections to the overhead lines and the decision of the newly-formed Weybridge Urban District Council to enter into a contract with the Walton-on-Thames Gas Co Ltd for street lighting in Weybridge. Part of the generating station in Church Walk was converted to cottages in 1898 and the building still survives in the 1990s. Electricity generation returned to the town in 1902 when the Urban Electricity Supply Company Ltd opened a new station in Thames Street. This was in operation until 1922, by which time a bulk supply was available from Twickenham and the Weybridge station was demolished.



Interior of the power station in Woodbridge Road, Guildford. A*mberley Museum*.

[Page 116]

Another station which came into operation in 1890 was in Board School Road, Woking. This had duplicate 20 kW AC machines which only operated from sunset to sunrise. Its capacity increased until it closed in 1959 with 7,000 kW of plant; it was always steam-driven but the final machines were all turbo-alternators.

Guildford's first station was built in 1896 at the old militia barracks in Onslow Street by the Guildford Electric Supply Company with an initial installed capacity of 60 kW. An extension was built adjacent to the works in 1913. The system became unreliable and, after pressure from local businesses, in 1921 the company was taken over by the town Corporation. A completely new station was built in Woodbridge Road and was in service by 1927. This had turbo-alternators and an eventual installed capacity of 11,250 kW, although the building was designed to be extended to have an ultimate capacity of 42,000 kW. This station operated until 1968 after which it was demolished. The 1913 building, with the legend '1913 ELECTRICITY WORKS' on the wall facing the River Wey, was converted to a theatre — named the `Electric Theatre' — by Guildford Borough Council in the 1990s.

[Page 117]

The new Guildford generating station was the largest in the modern county and the last to be available to generate. Other larger stations at Kingston and Croydon, both in historic Surrey, have now been closed for some years and have been demolished.

The increased demand for electricity caused by the First World War highlighted the deficiencies of a number of undertakings, and soon afterwards the Electricity Supply Act (1919) was passed. This established the appointment of Electricity Commissioners with the duty of 'promoting, regulating and supervising the supply of electricity'. The commissioners established Electricity Districts and hoped to set up regional schemes for centralising generation in a relatively small number of larger stations owned by joint Electricity Authorities (JEAs). The London and Home Counties JEA, set up in 1925, included a large part of Surrey. The scheme had only limited success however as the JEAs had no compulsory powers.

[Page 118]

By the 1920s there was pressure to establish a transmission network for the whole country to concentrate generation at the most efficient stations and, at the same time, improve the security of supply. In 1925 the government set up the Weir Committee to review the national problems of the supply of electrical energy. This committee proposed the establishment of an

independent body, the Central Electricity Board (CEB), with the duty of constructing a 'gridiron' of transmission lines, which became known as the National Grid. This interconnected selected power stations and the various distribution systems. The stations were operated by their existing undertakings but under the control of the CEB, which purchased the electricity generated in the selected stations and sold it to authorised suppliers. It was suggested that about 430 non-selected stations would close. The committee's recommendations were incorporated in the Electricity (Supply) Act of 1926. Basically, the scheme enabled power stations to be interconnected with 132 kV ring mains, while transforming stations fed lower voltage (66 kV and 33 kV) secondary systems.

Surrey was part of the South East England Electricity Scheme, initially with two 33 kV rings, one connecting Croydon with Epsom, Leatherhead Dorking and Reigate, and the other connecting Guildford with Woking, Godalming, Farnham, Hindhead and Aldershot. A 132 kV substation, Woking Grid, was established at West Byfleet in 1932 with 132 kV connections to Luton via Willesden and to Wimbledon via Uxbridge. At the same time a 132 kV substation was put in service at Croydon on the Wimbledon-Northfleet line. The security of the Epsom ring was improved in 1937 when a 132 kV substation was built at Leatherhead in the Woking-Wimbledon line.

[Page 119]

Before the CEB system was in place, a few small power stations had closed when bulk supplies had been obtained from neighbouring undertakings, such as at Egham, Weybridge and Caterham. However, once the grid system was established most of the tiny stations began to run down and none has operated since the 1970s. Some undertakings, such as those supplying the Camberley and Horley areas, never generated their own power but bought it in bulk from the start.

The industry was nationalised in 1948, and the first post-vesting station in the country, at Kingston, was put into service in the same year.

By 1949 it was realised that the grid system of the 1930s would be inadequate, and in 1950 it was agreed to construct a 275 kV supergrid to be superimposed on the 132 kV system. Later, in 1962, plans were in hand for the 400 kV supergrid system, the first line being commissioned in 1963. The only substation with 275 kV or 400 kV connections in Surrey is one at West Weybridge which was put into service in 1957.

The Central Electricity Board set up its research laboratories at Leatherhead during the Second World War. The high voltage test line built by the Central Electricity Generating Board still remains and is now used by the National Grid Company. Following privatisation

High voltage electricity transmission lines at Weybridge.

the industry was split into a number of competing companies but the transmission system continued to be operated as an integrated network. Thus the power generation for public supply in Surrey started with a small hydro-electric station at Godalming, went through a period when most towns had their own small power stations which were gradually closed as the transmission facilities developed, until in the 1990s no electricity is generated closer than the Thames estuary.

Before public supplies became available, many factories and large houses had their own electricity generators, and in rural locations many kept their ment in operation well into the 20th century. For example Dennis Bros' motor works in Guildford had a power house built in 1915 containing four diesel-driven generators which was still operating sixty years later. In fact, another 'first' claimed for Surrey in the history of the use of electricity was at the Ferry Works, Thames Ditton, which is reputed to have been the first factory in the world entirely lit by electricity. It was occupied from 1880 by Willans & Robinson, whose high-speed steam engines were used for driving dynamos for early supply systems.

Chatley Heath semaphore tower, restored and re-opened in 1990,
showing (a) the exterior and (b) the operations room.

[Page 120]

Commununications

ADMIRALTY TELEGRAPHS

Communication lines between the Admiralty in London and the naval dockyard in Portsmouth ran through Surrey. Mechanical means of signalling, first by shutter telegraph and then by semaphore, were used in the first half of the nineteenth century.

The Shutter System

At the time of the Napoleonic Wars the Admiralty began to see a need for speedy communication with its naval bases around the east and south coasts of England. Following the development of the visual telegraph system by the Abbé Claude Chappe in France, a competition was held resulting in a network being built to the design of another cleric, the Reverend Lord George Murray.

The system between the Admiralty in London and Portsmouth dockyard came into operation in 1796. It employed a chain of ten huts sited at high points of mutual visibility. At each site there was a gantry above the hut supporting a series of six panels or shutters that could be opened or closed by ropes or chains from inside the building, somewhat in the manner of venetian blinds. The pattern formed by a group of panels was used to represent a particular letter of the alphabet or a number, the changing patterns allowing messages to be sent along the chain of stations. A look-out with a telescope would watch to see what settings were being made by the neighbouring station, and call these to an operator who would set the same pattern to be repeated down the line.

Four such stations were established in the Surrey section of the route at Putney Heath, Cabbage Hill (Maiden Rushett), Blind Oak Gate on Netley Heath and Telegraph Hill, Hascombe. Nearer the coast a branch left the London to Portsmouth route for Plymouth.

Despite some limitations, such as mechanical problems, the misreading of some characters and the fact that it could only be used during daylight in periods of good visibility, the shutter system worked reasonably well until 1816, when hostilities ceased and it was dismantled.

The Semaphore System

Already in 1815 an Act had been passed for the establishment of a permanent system, and in 1818 surveying began for a new line which opened in 1822. This comprised fifteen stations which employed the semaphore principle of signalling as proposed by Admiral Sir Home Riggs Popham. They were brick-built, mostly single-storey houses but with some taller buildings and a few towers. Atop each building was a mast on which two arms were pivoted, one above the other, their positions representing characters as in naval hand-flag signalling. The masts were hollow and hexagonal in cross section, about 50 cm across and mostly about 9 metres high above the roof of the building. The arms were 2.5 metres long and 37 cm wide, pivoted at one end at points 3.7 metres up the mast and at its top. They could be 'parked' in the mast casing when not in use. In some cases the arms may originally have been moved by chains but by 1828 an arrangement of cranks, bevel gears and rods was employed at all sites. By means of a worm and pinion the cranks also drove pointers in the operations room to indicate to the operator the positions of the arms above. These mechanical parts were manufactured and maintained by Maudslay & Field.

[Page 121]

The semaphore line to Portsmouth ran a little to the west of the route of the earlier shutter system, with stations in Surrey at Putney Heath, Kingston Hill, Cooper's Hill (Hinchley Wood), Chatley Heath, Pewley Down (Guildford), Bannicle Hill near Witley and Haste Hill (Haslemere). Construction of a branch line was begun in 1825 to run between Chatley Heath and Plymouth. Stations were built at Worplesdon Glebe and at Poyle Hill on the Hog's Back near Tongham, but none were equipped, nor was the line completed, and the Plymouth branch was abandoned in 1831. Although never used 'in anger', the London-Portsmouth route continued in operation until 1847. It was then overtaken by the electric telegraph which had the distinct advantage of being able to operate by night or day, and in all weathers. Uniquely, one of the original semaphore stations remains at Chatley Heath and is open to the public. The tower building has been completely restored and preserved by Surrey County Council, with a fully operational semaphore signalling mechanism and descriptions and demon-strations of the shutter and semaphore systems. It received the SIHG Conservation Award in 1990. The houses at Cooper's Hill and Pewley Hill survive in private occupation.

[Page 122]

ELECTRIC TELEGRAPHS AND TELEPHONES

The first practicable electric telegraph system was introduced in 1837 by Cooke and Wheatstone, who used a system of pointers to send and display the letters

making up a message. It was adopted by the newly-developing railway companies and the first publicly available line opened in 1838 between Paddington and West Drayton on the Great Western Railway. At about the same time Samuel Morse invented his telegraphic code, which was to become the accepted standard. The telegraph network expanded so that all the towns in Surrey and most larger villages had a telegraph office, often at the local Post Office.

In the USA Alexander Graham Bell patented his telephone in 1876. Britain's first public telephone exchanges, where connections between subscribers were made manually, came to London three years later. Others followed throughout the country and were operated by seven main companies and the Post Office. The National Telephone Company was formed on the merger of six of those companies in 1885 and was itself taken over by the Post Office on 1 January 1912.

Connections

Early telegraph and telephone connections between subscribers and central exchanges or offices were made with bare copper wires, supported by wooden telegraph poles. The overhead wires ran beside railway lines and roads and presented many problems of maintenance and vulnerability in poor weather conditions. They were also unsightly and the poles were often difficult to place in densely populated areas. Reliable forms of insulation allowed the wires to be placed below ground and, in towns, they came to be accommodated in glazed earthenware ducts for much of their route, rising above ground only for local connection. Covers giving access to the ducts are to be seen everywhere on roads and footways throughout the county.

Because of the relatively high cost of burying copper wires in underground ducts, overhead lines continued to be used for connections between towns and cities, but various means were developed to permit a number of conversations to share one pair of wires. Later, mufti-channel carrier systems employing radio techniques enabled many telephone conversations or telegraph messages to be grouped together and passed over one coaxial cable circuit. With repeater stations en route to provide signal amplification and correction, longer distance underground connections became more viable.

In the late 1940s, microwave radio allowed many carrier groups to be taken out of the ground and combined on to radio circuits with the capacity to carry hundreds of individual conversations. These systems required tall masts to permit the necessary line-of-sight linking between stations, and a network of these developed which continues to provide the means of distributing telephone, TV and data signals. A typical example of a microwave radio relay site is at Old Dean Common near Bagshot, with its massive lattice tower supporting the highly directional parabolic dish and horn aerials.

[Page 123]

Epsom Telephone Exchange

The development of the telephone service can be illustrated by the example of the Surrey town of Epsom, where the UK's first automatic public telephone exchange opened in 1912. The first public telephone service in the town had been set up in 1893 by the National Telephone Company, using a manual magneto system, initially of 100 line capacity. In 1905 the General Post Office (GPO) opened a rival exchange with a similar initial capacity, but employing central battery signalling (CBS).

On 1 January 1912, the Post Office took over the National Telephone Company to become the monopoly telephone service provider in Great Britain. The 'Ex-National Company' subscribers in Epsom were transferred to the GPO exchange, enduring duplicate sets of apparatus during the transition. All connections between subscribers had been effected manually by human operators but on 18 May the automatic exchange went into operation, replacing the manual system and serving 340 subscribers from the Post Office premises in Station Road (now Upper High Street).

The exchange equipment was two-wire Strowger type, initially of 500-line capacity but ultimately capable of handling 1,500 lines, which together with the subscribers' apparatus was supplied second-hand by the Automatic Electric Company of Chicago. It was installed by British Insulated & Helsby Cables Ltd, whose Automatic Telephone Manufacturing Company of Liverpool had recently been formed, with patent rights from the Chicago company to become the first manufacturer of automatic telephone equipment in the UK.

The system was seen as experimental, to allow GPO engineers to assess the operation of such features as public coinboxes, trunk connections, charge meters and subscribers' foibles. Epsom was chosen for the trial as it offered the most suitable conditions. It was near HQ, it already had direct connections to the manual exchanges at London Central, Croydon and Sutton and a 'long distance' line connection with Leatherhead and its manual exchange had the highest percentage of local traffic of any London Post Office exchange. Epsom was also considered suitable for testing the economic 'break point', judged to shift from manual to automatic systems at about 500 lines, and was expected to show the effect on automatic switches when they were subjected to high rates of calls, such as would be experienced during the races, especially on Derby Day.

Epsom automatic exchange remained in operation for twenty years but, according to a policy of limiting automatic working to the area within 10 miles of Oxford Circus, on 20 July 1932 the Epsom system reverted to manual operation from new exchange premises which had been built in East Street. Thus it remained until 6 October 1965 when automation was restored with full Subscriber Trunk Dialling (STD) facilities, 999 emergency calls and the Speaking Clock, TIM. In the 1990s the system is mainly electronic and provides the full range of British Telecom services. Both of the original exchange sites in Epsom have been redeveloped.

[Page 124]

CABLE COMMUNICATIONS

The 1990s saw the introduction of cable communications in Surrey. By means of an underground network of copper, broadband coaxial and fibre-optic cables,

as many as sixty TV channels together with fm radio and telephone services may be supplied to homes and businesses in an area. Familiar to many will be the roadside local distribution cabinets that have sprung up in the county over the past few years.

At the heart of the network is the main centre or 'head end' which is equipped to receive broadcasts from a number of sources, and to redistribute them. The centre will also house the control processing equipment and, possibly, local programme production facilities. There would also be a digital telephone exchange or switch for connecting local subscribers in the area, and equipment to link to the networks of other service providers.

In 1997, four companies held franchises to provide cable communications services to most of the county.

Notes

1. Information has been kindly provided by the East Surrey Water Company, Thames Water and British Telecom Archives.
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4. Smith, E, *Edwardian Farnham* (1979), 98; Eedle, Marie de G, *A history of Bagshot and Windlesham*, 198.