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PARISH PUMP TO PRIVATE PIPES: LONDON'S WATER SUPPLY IN THE NINETEENTH CENTURY

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Water is an essential item in our diet, and in many of the procedures which make up our daily lives. A constant supply of safe domestic water laid on to our homes, places of work, and places of entertainment has been, until quite recently, an unquestioned convenience of modern life. A hundred and fifty years ago, however, this standard of civilization was little more than a dream, which medical men and sanitary reformers were beginning to work towards; our recent anxieties are of a different order from those which exercised Victorian health reformers. In London, it took almost eighty years of endeavour before constant piped water was laid on to most homes, and it was not until the 1920s that domestic water supplies could finally be guaranteed free from accidental organic pollution. The problems to be overcome before the dream was implemented were immense, and began with the very sources of London's water, the rivers Thames and Lea, and the surface wells which had supplied homes in the city for centuries. At the beginning of the nineteenth century, most Londoners were supplied with domestic water, raw and unfiltered, from one of these sources, either commercially or by their own private efforts. Under either arrangement, supplies were uncertain and intermittent, and water had to be stored in the home, and was generally subject to further domestic pollution. Quality, quantity, and continuity of supply were the issues which were to dominate public health concern with water until the end of the century.

In a famous passage published in 1869, William Morris urged his readers to, "dream of London small, and white, and clean, / The clear Thames bordered by its gardens green". Although it is doubtful if London was ever clean, or the Thames clear, it was a powerful image. Morris was brought up in Walthamstow, then a village to the east of London, in the 1830s: it was, he recorded, a pleasant place, but later became "terribly cocknified and choked up by the jerry builder".[1] Morris's experience of the changes that accompanied the fantastic growth of city and industry in these years, which was among the factors that shaped his utopian vision, was not unique, but was shared by all who remembered London, or some part of it, from the earlier years of the century. The conditions which provoked the desire for reform were brought about, at least in part,

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[1] Philip Henderson, *William Morris*, London, Pelican, 1973, 17.

by the tremendous growth of the city. In 1801, London's population was just under one million; by 1851, it had more than doubled to some 2,360,000; by 1901, it had reached over 4,500,000. In 1820, the limits of London stretched to Vauxhall Bridge, Victoria, Edgware Road, Regent's Park, City Road, Limehouse, Rotherhithe, and Lambeth. The following years saw the period of most rapid development in East and South London: by 1835, the city limits reached Paddington, St Pancras, Islington, Bethnal Green, Bow Road, Poplar, Deptford, Kennington, and Walworth. By 1872, continuous building stretched out to Walham Green, Hammersmith, Kensal Green, Hampstead, Highgate, Finsbury Park, Clapton, Hackney, Old Ford, East India Docks, Blackheath, New Cross, Peckham, Norwood, Streatham, and Tooting.[2]

The rapid growth and spread of London from the early years of the century placed an increased strain upon her resources and facilities, and her water supply was no exception. The principal sources of London's water were for most of the century fourfold: the river Thames, the river Lea, shallow wells within the city, and, from 1862, deep chalk wells in the Surrey hills. Of these, the Thames played an increasingly major role. Piped water supplies were sent through the city by eight water companies.[3] Four of these, the Lambeth, West Middlesex, Grand Junction, and Chelsea, obtained their supplies exclusively from the Thames. The Southwark and Vauxhall obtained its supplies partly from the Thames, and partly from deep wells. The Kent Company used the Thames and the Ravensbourne until 1862, and deep wells exclusively thereafter. The supplies of the New River Company came entirely from the Lea, supplemented, in the later years of the century, by deep wells in summer; those of the East London were derived mainly from the Lea, a maximum of 10,000 gallons daily to be taken from the Thames. As London's population increased, so did the quantity of the water supplied by the companies. In 1828, they were supplying on average 28,800,000 gallons daily; by 1898, this had risen to 202 million (see table 1). Domestic consumption, meanwhile, rose from some 20 gallons per capita a day in 1850 to 24 in 1870, 25 in 1890, and 27·8 in 1900.[4]

TABLE 1. ORIGINS OF LONDON'S PIPED WATER, AS A PERCENTAGE OF THE TOTAL SUPPLY

Year	*Thames*	*Lea*	*Deep wells*
1828	56	44	–
1866	49	44	7
1898	59	25	16

Sources: Royal Commission on the Water Supply of the Metropolis, BPP 1828 ix, pp. 56–8; F. Bolton and P. A. Scratchley, *The London water supply*, 2nd ed., London, 1888, p. 20; A. Shadwell, *The London water supply*, London, Longmans, 1899, p. 43.

The distribution of the river and deep well waters through the city was a commercial operation, until the Metropolitan Water Board assumed responsibility in

[2] R. S. R. Fitter, *London's natural history*, London, Collins, 1945, 65.

[3] For the history of the companies, see H. W. Dickinson, *The Water supply of Greater London*, London, Newcomen Society, 1954.

[4] These figures are taken from Bill Luckin, 'Typhoid and typhus in London', in R. Woods and J. Woodward (eds), *Urban disease and mortality*, London, Batsford, 1984, 112; and from the annual reports of the Water Examiner for London.

1904.[5] In 1828, the companies were said to serve some 177,000 households and premises,[6] in a city which contained probably 200,000 houses. A proportion of these tenants were industrial premises, the rest perhaps largely wealthy and middle class. In 1843, the Southwark Company was supplying 18,000 tenants, of whom 4,000 (22 per cent) had individual supplies through ¾-inch lead pipes, 10,000 (55 per cent) through ¾-inch pipes with branches to the dwellings on each side, 900 (5 per cent) by pipes with three branches to adjacent tenements, and 2,000 (11 per cent) by common stand-pipes. About 1,000 others (5·5 per cent) were what were known as "consumers": tanners, fellmongers, hairwashers, glue-makers, curriers, dyers, hatters, brewers, distillers, steam-engine-works, railway stations, pubs, hospitals, etc.[7] Some 5,000 houses, representing 30,000 persons, were not supplied by any company within this district, and were dependent on other sources of supply. The Southwark Company thus supplied 72 per cent of the units in its district. In 1854, the water companies in general claimed to supply some 302,400 houses, exclusive of manufacturers and public establishments, and by 1866, the figure had risen to 470,000.[8] By this time, it is likely that most houses in London had access to company water, but a number of the companies already supplied districts outside the bounds of metropolitan London, so that these figures must be treated with some caution, for they represent "Water London" and not Metropolitan London (see table 3 below).

Before the 1870s, the provision of company water was a matter for individual householders and landlords. In 1850, it cost £4 to lay on company water to a fourth-class house;[9] in the 1840s, annual rentals varied from five to seven shillings for a two-room (fourth-class) house to ten to fourteen shillings for a four-room house.[10] If the charges were paid by the occupants, the rate was set at about 3*s.* 6*d.* per room, if paid by the landlord, at about 2*s.* 11*d.*[11] Under the prevailing intermittent system, these rates secured access to piped water for two hours or less daily, or on alternate days. Until 1872, water was never supplied on Sundays.[12] In poor-class housing, company water was generally supplied to a common standpipe in the yard, or one mains connection was shared between several houses or tenements on a branch system. Even at the end of the century, standpipes were commonly used to supply poor quarters, and company figures for "households supplied" must be taken as meaning households with access to company water, not households with private supplies.[13] When constant supply began to be widely introduced after 1870, the installation of regulation fittings to receive the service cost a further £5[14] (see table 2).

[5] The Metropolitan Water Board was created by the Metropolis Water Act 1902, (2 Edw. VII, c. 41), but did not take up its duties until 31 March 1903. The Board first met on 2 April 1903; it took over the water companies in 1904.

[6] *Royal Commission on Metropolitan Water Supply*, BPP 1828, ix, pp. 56–8.

[7] *Royal Commission on the State of Large Towns*, BPP 1844, xvii, q. 5874.

[8] *Report on the Metropolitan Water Companies*, BPP 1854, lxi, pp. 529–31.

[9] W. M. Stern, 'Water supply in Britain', *Royal Sanitary Institute J.*, 1954, **74**: 1000.

[10] *Royal Commission 1844*, q. 5871.

[11] Ibid.

[12] Metropolis Water Act 1871, (34 & 35 Vict. c. 113), 6.

[13] *Annual Report of the Water Examiner*, BPP 1892, xxxviii, 236. The Examiner nevertheless noted that the figures might be regarded as "approximately correct".

[14] *Lancet*, 1888, **ii**: 530.

TABLE 2. LONDON WATER COMPANY CHARGES, *c.*1895

Company	*£10*	*£20*	*£30*	*£50*	*£100*
	Rateable value of property				
New River	8*s.*	16*s.*	£1.4.0	£2.10.0	£5.1.0
Grand Junction	8*s.*	16*s.*	£1.4.0	£2.10.0	£5.1.0
Chelsea	8*s.*	16*s.*	£1.4.0	£2.10.0	£5.1.0
West Middlesex	7*s.* 5*d.*	14*s.* 10*d.*	£1.2.3	£2.9.11	£4.13.5
Kent	12*s.*	£1.4.0	£1.11.0	£3.8.0	£5.2.0
Lambeth	15*s.*	£1.10.0	£2.12.0	£4.13.0	£7.2.6
East London	10*s.*	£1.0.0	£1.10.0	£3.2.0	£7.7.6
Southwark	10*s.*	£1.0.0	£1.10.0	£3.0.0	£6.1.0

Source: Shadwell, *Water supply*, p. 67.

Except where tenants were reliable, and where rental could successfully be made to cover the cost, these considerable sums were a disincentive to the installation of company water. The extension of piped water to all houses in London became one of the foremost objectives of the public health movement when it got off the ground in the 1840s, and the Waterworks Clauses Act of 1847 provided that the companies should supply constant piped water to all dwellings in London.[15] Even so, it was a long haul. In the poorer districts, landlords were reluctant to provide individual tenements with company water, because the fittings were only too likely to be sold by the tenants for scrap.[16] The companies equally were reluctant to install constant water supplies because of the likelihood of waste, the possibility of consumer opposition, and the complexity of the actual installation. The companies were only responsible for mains services, and all domestic water plumbing was left to the consumer. Domestic plumbing was generally very badly done, especially in poor areas. London had a particularly bad reputation in this respect. One observer went so far as to remark that "in no town in the world do plumbers' work and the plumbing trade stand lower than in London".[17] Leaky joints, non-functioning ballcocks and dripping taps were commonplace. Consumers were neither scrupulous nor thoughtful. Where several houses were on one branched service pipe, it was quite common for the occupant of the principal house served to tie down the ballcock, and so ensure that he received an extremely efficient service during water hours, while any reduction in pressure cut off his neighbours' supply entirely.[18]

The deficiencies of the intermittent water supply system had to be made good if domestic life was to continue outside water hours. In households with direct mains connection, the problem was generally met by installing storage cisterns into which the piped water supply was delivered. These cisterns and their filters were seldom if ever cleaned, and with years of use were liable to become foul. Complaints of the delivery of foul water by the companies were often attributed by disinterested witnesses to the condition of storage cisterns, rather than to company negligence;[19]

[15] Waterworks Clauses Act 1847 (10 & 11 Vict. c. 17), sec. 35.

[16] *Medical Officer's Annual Report (MOAR)*, Camberwell, 1883–1884, 159. See also Francis Sheppard, *The Great Wen*, London, Secker & Warburg, 1971, 262.

[17] BPP 1872 xlix, *Reports made by William Pole to the Board of Trade on the system of constant water supply*, 732.

[18] Ibid.; *Reports relating to the recent failure of water supply in Bermondsey*, 704.

[19] F. Bolton and P. A. Scratchley, *The London water supply*, 2nd ed., London, 1888, 10.

the problem was certainly not limited to poor households, but was found in every class of house.[20] In the homes of the poor, water-butts, buckets, jars, tubs, and barrels were used for storage. These were generally uncovered, and were liable to contamination in overcrowded and unclean conditions. They were frequently kept next to the privy; and the water so stored was used and reused for a variety of domestic purposes before being finally discarded.[21]

Given the irregularity of water-company supplies, many households relied heavily on local water sources, as did those who had no access to company water. Those who lived along the rivers and canals went direct to source with their jars and buckets. In Wandsworth in 1858, for example, the poor were dependent on the Thames and Wandle for supply;[22] in Stepney in 1866, 200 cholera deaths within a 200-yard radius of the Regent's Canal bore mute witness to the probable local uses of that stretch of water.[23] Those not so conveniently situated near a river or canal relied on even more local sources of supply. The shallow wells of London were an ancient and a popular institution. Although the value of these well-waters was said to be popularly estimated by the brilliancy with which they sparkled,[24] their flavour was also important in their popularity. The notorious Broad Street pump, for example, was so much to one lady's taste that she regularly had its water brought to her home in Hampstead. Many wells were found on private premises. In Fulham in 1856, of 1,009 houses inspected by the Medical Officer of Health, 758 (75 per cent) were supplied by wells, of which 508 were supplied by 108 pumps only—4·7 houses per pump. Of the remainder, 147 (14·5 per cent) had water laid on (that is, company water) and 104 (10·3 per cent) were wholly without water. In Hammersmith, of 1,810 houses examined, 405 (22·3 per cent) were supplied by 81 pumps (5 houses per pump), 428 (23·6 per cent) had water laid on; 218 (12 per cent) were without water; and 26 (1·4 per cent) had water entirely unfit for drinking. The remaining 733 houses (40·4 per cent) were supplied by their own pumps.[25] But private wells constituted only part of the supply. Many others were public, situated in the streets and giving free access to residents and passers-by.

It is impossible to estimate the total number of wells, or to give any indication of how much water was drawn from them, but it is clear that their use was declining from at least the 1840s. In 1858, there were twenty-seven pumps in Lambeth, besides the Spring Well in Wandsworth Road,[26] and there were thirty-four wells operational in the City of London in 1861, when the Medical Officer of Health, Dr Letheby, condemned them all as far worse than the New River Company water.[27] These included the famous Idol Lane well, from which the Billingsgate fishermen habitually filled their casks to take to sea, and that in Leadenhall Market, whose water was "enormously charged" with salt from the pickled hides displayed on the market

[20] *Lancet*, 1868, ii: 528; *MOAR*, Kensington, 1897, 166–8.
[21] *Select Committee on the Metropolis Water Bill*, BPP 1851, xv, qq. 3715–3717.
[22] *MOAR*, Wandsworth, 1858, 8.
[23] *MOAR*, Limehouse, 1866, 5.
[24] *Lancet*, 1858, i: 510.
[25] *MOAR*, Fulham, 1856, 7.
[26] *MOAR*, Lambeth, 1858, 12.
[27] *MOAR*, City, 1861–1862, 17–19.

ground. By 1872, a survey of all the public surface wells in London listed 161 as closed, thirty-six as open of which two were accessible only to those who held a key, three as open but non-functional, and eight as used for non-domestic purposes only (street-watering and the supply of horse-troughs).[28]

Throughout the 1860s and 1870s, the local authorities were energetic in closing down and filling in both public and private wells. With the extension of constant supply, the need for wells diminished, but numbers of private surface wells still existed in the 1890s. There were eleven in St George-the-Martyr in 1892, none of them safe, being highly charged with sewage and other organic matters. A few surface wells remained in the late 1890s, for builders in Chelsea were still using movable pumps in their operations, but it seems unlikely that much of this water was used for drinking. All public pumps were thought to have gone by then: one of the last had been the historic Aldgate Pump. This, by a sagacious fraud, had been supplied by the New River Company for many years at the instigation of the Medical Officer of Health, but it was not until the pump was replaced by a tap that the local population began to complain about the alteration in the flavour of the supply. It seems probable that operational surface wells had all but disappeared by 1900, but it was known that private supplies still existed both in London and in the area generally.[29]

The gradual disappearance of the shallow wells, and of reliance on alternative water sources, and the general introduction of piped water supplies was a feature of the second half of the century. The new public health authorities which came into being in 1856,[30] supported the extension of piped water because of its greater convenience (as an inducement to cleanliness), and because of its higher quality. Although well closures were unpopular,[31] many wells deteriorated at this period and were voluntarily abandoned. In 1872, for instance, the water was said to have gone from two wells in St Peter Cornhill because of the excavations for the Great Eastern Railway in Broad Street.[32] Deterioration was particularly marked on the south side of the Thames, where the water table was much higher than on the north. In Southwark, for example, wells needed to to be sunk only to a depth of 8 or 12 feet, while in the City they had to be sunk to between 30 and 80 feet.[33] As more houses and tenements were built, and as population densities became higher in the early years of the nineteenth century, more cesspools were sunk, and were sunk deeper. By the 1840s, cesspools were being deepened to the first stratum of sand, that is 6 to 10 feet. At this level, the cutting generally carried the cesspool into a spring, which relieved it of liquid refuse. This, of course, was very economical, since the cesspool did not need emptying so frequently, and, as one observer pointed out, instead of having a wagon to carry liquid refuse away, one could make do with a cart because the refuse was solid.[34]

[28] BPP 1872 xlix, *Return . . . of every public surface well within the Metropolis*, 851–5. The Idol Lane well was at the corner of the Lane and St Dunstan's Alley.

[29] *MOAR*, St George Southwark, 1892, 26; *Lancet*, 1897, i: 540.

[30] Under the Metropolis Local Management Act 1855, London was divided into 46 civil parishes for local administrative purposes. Among the obligations of these new authorities was the appointment of medical officers of health.

[31] Anne Hardy, 'Water and the search for public health in London', *Med. Hist.*, 1984, **28**: 272.

[32] *Return of surface wells*, op. cit., note 28 above, 851.

[33] *Royal Commission 1844*, q. 5891.

[34] Ibid.

However, the new cesspool techniques often had serious consequences for local water supplies, since the permeation of springs by cesspool matter became swifter and greater. In Paradise Row, Rotherhithe—inaptly named, since it was unsewered—a new cesspool was put in about 1840. It was made as deep as possible—"to suit the present levels"—and before long there was trouble. The first effect was to drain the wells, but then, some time later, as the cesspool began to fill, discoloured and foul-tasting water flowed back into the wells. Similarly, in Battersea, the cesspools of a new estate of six houses permeated the wells within a matter of days. In both cases, the residents turned to the local company for water.[35] By 1844, throughout south London, it was said, ancient and celebrated springs were being abandoned by the inhabitants. The pumps, however, remained, and were used by poor passers-by, who did not know their reputation.[36]

The pollution of the shallow wells by cesspool drainings was only one feature of a phenomenon which shaped the whole history of London's water supply in the nineteenth century: the problem of sewage pollution. Not only were the wells and springs affected, but also the rivers and the piped supplies drawn from them. The evidence points to a deterioration in the condition of the Thames between about 1815 and 1830, which became more rapid between 1830 and 1850. Leslie Wood, in his study of the history of the river's pollution, is of the opinion that the quality of the Thames water in the later eighteenth century was not very different from what it is today, but that by 1850 the river had become "putrid, noisome and dead".[37] Population growth and the commercial introduction of the water-closet were mainly responsible. London's population, as we have seen, grew from 1 million in 1801 to 2·36 million in 1851. Wastes increased accordingly, like the pressure on housing, and the demand for water supplies. Traditionally, London's wastes had been disposed of in cesspools, to be removed by nightsoil men, a procedure which kept the Thames largely free of sewage contamination. Until 1815, in fact, house drains were not allowed direct connection with the city's sewers, which were deemed to be for the passage of rainwater only. When this prohibition was lifted, the water-closet came into its own. The flush from the new closets found its way via the house drains into the sewers and thence to the river. In 1828, it was calculated that between 139 and 145 sewers were discharging effluent into the Thames,[38] mostly within a limited area: all the city's major outfalls entered the river between the King's Pond sewer at Vauxhall Bridge and the Black Ditch at Limehouse.[39] From about 1830 on, things got progressively worse, as the water-closet became an accepted facility. By the 1840s, the London water companies were commonly providing "high service"—that is, to the upper floors of houses—which was used principally for the flushing of closets,[40] and

[35] Ibid., qq. 5883, 5891.
[36] Ibid.
[37] Leslie Wood, *The restoration of the tidal Thames*, Bristol, Adam Hilger, 1982, 19, 26.
[38] *Royal Commission 1828*, 113, 200.
[39] Michael Durey, *The return of the plague: British society and the cholera, 1831–2*, Dublin, Gill & Macmillan, 1979, 62. See ibid., 53–65, for a graphic account of sewage pollution and water supply in London *c.* 1830.
[40] *Royal Commission 1844*, q. 5719.

closets were widely used in wealthy and newly-built districts.[41] By the early 1870s, water-closets were commonly provided in all London housing—a feature that distinguished London's sanitary arrangements from those of all other major English cities except Liverpool, although it was unusual to find water laid on to closets in the poorer class of housing.[42]

Although the Thames occupies pride of place in the water literature of the period, the Lea undoubtedly suffered a similar fate. The East London cholera epidemic of 1866 bears witness to the polluted state of the untreated Lea, which received water from numerous sewers, cuts, and canals,[43] besides the drainage of towns and industries situated on its upper reaches: Luton, Wheathampstead and its paper-mill, Hatfield and Ware. In addition, the river carried a considerable barge traffic, passing up with manure, bricks, and timber and returning with malt, corn, and wool—a traffic carrying a population notoriously uncleanly in its habits.[44] The waters of the Lea and the Thames, and of all the water companies, in the later 1820s, were similarly indicted in the complaint registered against the Grand Junction Company in March 1828,[45] that it sent up,

> through iron tubes, unto the habitation of seven thousand families, to be used daily at the breakfast table; in the composition of bread, pastry, soups, broths; and in the boiling of meats, poultry, pulses—a fluid, saturated with the impurities of fifty thousand homes—a dilute solution of animal and vegetable substances in a state of putrefaction—alike offensive to the sight, disgusting to the imagination, and destructive to the health.

The quality of the piped water supplied to London became an important public health issue in the second half of the century, and continued to be a matter of concern until the introduction of chlorination in 1915 finally removed fears of the accidental pollution of filtered supplies.[46] The intial public distaste at drinking water from visibly highly polluted rivers, which surfaced in 1828,[47] was soon given a deeper theoretical foundation.[48] Water and disease had been linked in a general way from the early days of the public health movement. In the 1840s, for example, Thomas

[41] Edwin Chadwick, *Report on the sanitary condition of the labouring population of Great Britain* (1842), M. W. Flinn (ed), Edinburgh University Press, 1965, 120; *Royal Commission 1844*, q. 181.

[42] Pole, op. cit., note 17 above, 730. But see Martin Daunton, *House and home in the Victorian city*, London, Edward Arnold, 1983, 246–59 for sanitary provision in other English cities, and especially p. 257 for critical contemporary comparison of the closet systems of London and Liverpool.

[43] *Lancet*, 1866, **i**: 134.

[44] Ibid., **ii**: 130, 217.

[45] Anon [J. Wright], *The dolphin*, London, T. Butcher, 1828, 61.

[46] For river pollution, drinking-water, and water analysis, see Christopher Hamlin, *A science of impurity: water analysis and the manufacture of expertise in nineteenth century Britain*, Bristol, Adam Hilger, 1990; and *idem*, 'What becomes of pollution? Adversary science and the controversy on the self-pollution of rivers in Britain, 1850–1900', PhD thesis, University of Wisconsin-Madison, 1982; and Bill Luckin, *Pollution and control; a social history of the Thames*, London, Adam Hilger, 1986.

[47] *The dolphin* (note 45 above) was the first shot in the campaign for pure domestic water supplies. Hardy, op. cit., note 31 above, 260; W. M. Stern, 'J. Wright: pamphleteer on London water supply', *Guildhall Misc.*, 1953, **2**.

[48] See Christopher Hamlin, 'Providence and putrefaction: Victorian sanitarians and the natural theology of health and disease', *Victorian Studies*, Spring 1985, **28**: 381–411.

Southwood Smith observed that in the London districts regularly and severely visited by fever, there was "uniformly bad sewage, a bad supply of water, a bad supply of scavengers, and a consequent accumulation of filth".[49] The association was between water and cleanliness, and filth, putrefaction, and disease, rather than directly between water and disease. The role of water supply as a conveyor of specific infections only emerged in 1848, when John Snow and William Budd independently observed a connection between polluted water supplies and the spread of cholera. The events of the epidemic of 1854, which supplied the evidence of the Broad Street pump and of the Southwark and Vauxhall Company's waterfield, placed polluted water supplies firmly among the factors to be considered in outbreaks of cholera. Although it was some years before this conclusion was fully accepted by the medical profession, its implications were usually taken into account in the practical measures taken when cholera threatened in the years after 1854.[50]

While the medical profession continued to debate the viability of the water transmission theory, and of the exact ways in which water transmitted disease, progress was made towards a purer water supply. The general quality of company water improved steadily through the century. From issuing untreated river water in the 1820s, the companies were by the 1850s standardly resting and filtering supplies before distribution.[51] Although water was mostly taken within London's limits, and thus from where it was subject to the highest levels of pollution up to 1852, the Metropolis Water Act of that year required the Thames intakes to be moved to the river above Hampton Court, and more stringent regulations were adopted concerning the filtration and storage of water.[52] By the 1870s, the quality of company water had been significantly improved,[53] and progress continued to be made in filtration and resting techniques until chlorination resolved any remaining doubts about the ultimate purity of filtered river supplies.

Throughout the latter half of the century there was no question among health officers and medical observers that company supply was infinitely preferable to wells and other local water sources. Company water quality could be, and was, monitored, and if it was unsatisfactory, representations could be made. As early as 1857, in the second year of its existence, Camberwell Vestry was complaining of the quality of both the Kent and the Southwark Company water at the behest of its Medical Officer, and as late as 1895 achieved an inquiry by the then Metropolitan Water Examiner, Major-General Scott, into the quality of the water supplied by the two companies.[54]

[49] *Royal Commission 1844*, q. 920. For the background of medical theory in this period see W. Luckin, 'The final catastrophe—cholera in London, 1866', *Med. Hist.*, 1977, **21**: 32–42; Margaret Pelling, *Cholera, fever and English medicine*, Oxford University Press, 1978.

[50] For the debates about water transmission see Hamlin, 'Pollution', note 46 above; Luckin, op. cit., note 49 above; Pelling, op. cit., note 49 above. It may be noted that the *Lancet*, admittedly a progressive journal, observed in 1868 that the medical profession "almost unanimously" supported the official view that cholera was transmitted by water: *Lancet* 1868, i: 538.

[51] Dickinson, op. cit., note 3 above, 119–21.

[52] Metropolis Water Supply Act 1852 (15 & 16 Vict., c. 84).

[53] BPP 1872 xlix, pp. 812–13; 1883 xxviii, Appendix B no. 40, 299. This was generally true. There were persistent problems with natural events (e.g. flooding) and carelessness on the part of the companies. See Luckin, op. cit., note 46 above, ch. 4.

[54] *Camberwell Vestry Minutes*, 4 October 1857; 9 December 1857; 22 May 1895.

The relative purity of company water and its potential for universal and continuous distribution made it a desirable property in public health terms; the intermittent system and alternative supplies, with the risks of further contamination in domestic storage which they involved, were a priority for abolition. Legislative provision for constant water service had first been made in the Waterworks Clauses Act of 1847, and was restated in 1852 and in the Metropolis Water Act of 1871.[55] The companies were required to lay constant service where asked by the local authority to do so, or where petitioned by a majority of the inhabitants; but specific requests probably played little part in the extension of constant service. Agitation by John Liddle, the Medical Officer for Whitechapel, and the acceptance of the necessity of the service by the companies seem more likely to have determined the introduction of constant supply than local requirements or legislation. A more immediately effective provision of the 1871 Act was for the appointment of a Water Examiner by the Board of Trade to monitor the quality of the London company supplies.

The extension of constant service to houses throughout the city was the principal feature of London's water history after 1870, the continuing debates about water quality apart. By the mid-1860s, it seems probable that most houses in London had access to company water, whether by direct connection or by standpipe. In Hackney in 1866, the East London and New River companies between them served 16,617 houses;[56] at the 1871 census there were 19,345 occupied houses in the district. The distribution of cholera in the East End in 1866 also suggests the availability of company water, if only by standpipe, in the poorer quarters.[57] At this date, the intermittent system remained the usual means of supply. In 1874, when Francis Bolton began his series of reports to the Local Government Board as Water Examiner, just 10·3 per cent of the houses served by the companies were on constant supply, the great bulk of them (some 45,000 or 8·87 per cent) in the East London Water Company's district. The pattern of the extension of constant service in the years after 1870 may be followed in the Water Examiner's reports; but caution must be exercised in using the aggregate figures presented in contemporary material: by the 1880s London's water had become a highly political issue,[58] and on these grounds clear distinction was not always made between figures applying to "Water London" and those applying to Metropolitan London. There was some difference between the two: "Water London" was a much larger area than Metropolitan London, extending, by 1891, to 393 square miles containing 167,135 houses and a population of over one million outside the Metropolitan area (table 3). London County Council papers in particular have to be treated carefully, as the Council almost from its creation in 1889 was zealous in its attempts to win control of the city water supply.[59] On the other side, it should also be remembered that the company figures for houses supplied included those supplied by standpipe only.

[55] Metropolis Water Act 1871 (34 & 35 Vict., c. 113).
[56] *MOAR*, Hackney, 1866, 21.
[57] PP 1867 xxxvii, App. B no. 7, J. Netten Radcliffe, 'Cholera in London', 299.
[58] A. K. Mukhopadhyay, 'The politics of London water', *London J.*, 1975, **2**: 207–12. See also *idem*, 'The politics of London water supply, 1871–1971', PhD thesis, London University, 1972, ch. 3.
[59] Ibid., 209.

TABLE 3. LONDON WATER COMPANY DISTRICTS[60]

Company	*Population Metropolitan*	*Population Extra-Met.*	*Houses supplied Metropolitan*	*Houses supplied Extra Met.*	*Areas (sq.m) Metropolitan*	*Areas (sq.m) Extra-Met.*
Chelsea	277,403	–	35,226	–	5·0	–
East London	806,962	442,650	97,000	65,000	13·5	66·0
Grand Junction	354,916	148,708	34,626	21,244	6·5	40·0
Kent	343,200	93,252	57,200	15,542	30·0	147·0
Lambeth	449,891	181,566	64,271	25,938	25·0	36·5
New River	1,024,000	124,000	132,393	20,745	16·0	77·0
S & V	804,460	28,560	107,528	4,280	21·0	8·75
West Middlesex	436,320	107,895	58,176	14,386	9·5	17·75
Totals "Water London"	4,497,158	1,126,631	586,420	167,135	126·5*	392·75

*Less 5 square miles for areas supplied in common
Source: BPP 1890 xxxiii, Appendix B no. 62, p. 237

The companies varied considerably in their introduction of constant water supplies. The record of the East London was the best. As early as 1866, constant was the Company's preferred method of service, and was commonly laid on to new houses.[61] Following agitation by the Medical Officer for Whitechapel, John Liddle,[62] the company agreed to supply all courts in that district with water direct from the main, and by early 1868, Liddle could report that the poorer quarters of Whitechapel were now better provided for in the way of water than any other district of London. A few years previously, about seventy courts had been supplied on intermittent by standpipes only.[63] The company began introducing constant as a regular policy in 1869, and by 1872 30 per cent of its houses were said to be so served.[64] In the course of 1873, it gave constant supply to 6,328 houses in Bethnal Green (the total number of houses had been 15,899 in 1871), and in 1874 announced its intention of extending the service throughout its district. In that year, constant service was extended to a densely populated area in the neighbourhood of Whitechapel, Shoreditch, and Spitalfields, containing some 3,000 houses. At this date 43 per cent of the Company's houses were on constant, and by 1887 the whole of the East London district within the metropolitan area was on constant,[65] that is, the entire East End beyond the Minories.

Second to the East London came the Lambeth Company, which began giving constant to poor-class houses in the early 1870s, and the systematic introduction of constant service in 1877. By 1884, its entire metropolitan area and adjacent surburban districts from the Thames to Brixton Hill were so served.[66] The New River Company also began giving the system to selected poor areas, notably to houses in the courts

[60] In view of the 1891 census, and evidence presented to the Royal Commission on London's water supply in June 1892, the figures for population and houses given in this table should be regarded as approximate. The Grand Junction and the East London companies in particular had overestimated their populations supplied. *Water Examiner's Report*, BPP 1892 xxxviii, Appendix B no. 52, 220.

[61] Radcliffe, op. cit., note 57 above, 299.

[62] *Lancet*, 1867, ii: 685.

[63] Ibid., 1868, i: 273.

[64] Pole, op. cit., note 17 above, 728–9.

[65] *Water Examiner*, BPP 1888 xlix, Appendix B no. 41, 341.

[66] Ibid., BPP 1884–1885 xxxii, Appendix B no. 30, 233. This area contained only 51 per cent of the houses supplied by the Company.

and alleys of the City and Whitechapel.[67] Its area was enormous, adjoining that of the East London, covering the City and west-central districts and thence running due north through Islington, Camden Town, and Highgate, and it was slow in implementing a constant policy. By 1887, its "constant" area covered only parts of Shoreditch and St Pancras; the parish of Edmonton; the northern part of Stoke Newington; the southern part of Clerkenwell; two large building estates in Tottenham; several new roads in Hornsey; and various courts, alleys, and poor-class dwellings throughout the district.[68] By 1891, only 45 per cent of the houses in the New River Company's whole area were on constant.

The West Middlesex, a small company whose area covered the North West, coming down through Marylebone to Oxford Street, was also slow. In 1891, 43 per cent of its houses were on constant, including its part of Marylebone and St Pancras, and many isolated portions of Kensington, Hammersmith, and Fulham. The Grand Junction, which shared the West End with the Chelsea Company and served the western suburbs as far as Hounslow and Hampton, was a very late starter, only beginning to introduce constant in 1880. It was also very efficient. By 1881, the whole of its area west of Notting Hill was on constant, as well as all new buildings in north Paddington. It was the first company to achieve constant supply throughout its area, which it did in 1893. The Chelsea, the smallest of the companies, served the West End; it exercised a very negative policy towards constant service. It was prepared to give it where requested, but otherwise only on new estates. In 1887, its constant services were located principally in Fulham, Chelsea, and St George's Hanover Square; in 1891, only 24 per cent of its houses were on constant, the smallest proportion of any of the companies.

South of the river, as we have seen, the Lambeth made good progress between 1877 and 1887 in introducing constant supply. The Kent Company, which served the whole of the south-eastern district, early began extending constant. In March 1874, it had 4,700 tenants in Rotherhithe, Deptford, and Plumstead so served, and in 1875 extended its operations into Woolwich. Between 1874 and 1891, the percentage of Kent houses on constant increased from 5 to 58; the service was given principally in the poorest and most densely populated areas.[69] The Southwark and Vauxhall Company, which served the riverside parishes from Kew to Rotherhithe, began giving constant to new estates in 1878,[70] and in 1883 to existing customers in Southwark and Lambeth. By 1887, the parishes of St Mary Newington, St George-the-Martyr, St Saviour, St Olave, and Wimbledon were on constant, together with parts of Lambeth and Clerkenwell, Bermondsey, and Rotherhithe.[71] The directors had by then decided to extend constant to the whole of their district as rapidly as possible, and progress thereafter was steady: by 1891, the Company was second only to the East London in the percentage of its houses supplied with constant, having been second from the bottom in the league with 31 per cent in 1887 (table 4).

[67] Ibid., BPP 1876 xxi, Appendix B no. 25, 261; *Lancet*, 1868, i: 273.
[68] *Water Examiner*, 1888, 343.
[69] Ibid., BPP 1887 xlix, Appendix B no. 41, 341.
[70] Ibid., BPP 1880 xxvi, Appendix B no. 51, 276–7.
[71] Ibid., BPP 1888 xlix, Appendix B no. 41, 344.

TABLE 4. LONDON WATER COMPANIES; HOUSES ON CONSTANT SERVICE PER CENT OF TOTAL SERVED IN "WATER LONDON"

Company	*1874*	*1887*	*1891*	*1901*
Chelsea	0·3	17	24	100
East London	43	86	98	100
Grand Junction	–	77	75	100
Kent	5·1	50	58	99·8
Lambeth	6	51	53	77·5
New River	1	35	45	95·7
S & V	0·5	31	77	93
West Middlesex	0·7	33	43	100
Water London	10·3	47·5	65	95·3

Source: Water Examiner's reports

The extension of constant water supply was by no means as easy to accomplish as the idle observer might assume. Although the companies were responsible for the mains, the individual householder was responsible for the entire organization of the supply to his own premises, including the pipes which connected him to the main. Under the intermittent system, the short hours of supply served to fill domestic storage cisterns, and the pressure at which the water was discharged was relatively low. In order to achieve constant supply, the water pressure needed to be considerably greater, and the domestic supply pipes were generally not strong enough to cope with the increased pressure. It was to meet these problems that regulations were drawn up under the 1871 Water Act specifying the type and standard of domestic supply equipment that had to be met by the householder before the companies were obliged to provide constant service.[72] On the one hand, the organizational effort involved in preparing a district to receive constant supply was considerable, as all new fixings had to be inspected and approved by the company; on the other, it involved individual property owners in considerable expense, since it generally demanded the almost entire reconstruction of the distribution arrangements in the district concerned.[73]

The expense of the transfer and the bother of the work involved evidently discouraged much private initiative towards constant. The engineer, William Pole,[74] who carried out a feasibility study on constant supply for the Board of Trade in 1871, considered that any attempt by the water companies to exercise their powers over domestic fittings would meet with considerable public resistance.[75] For this reason, the burden of initiative was thrown on the public and the metropolitan sanitary authorities in 1872, while the subsequent history of constant service extension proved Pole reasonably correct. The Lambeth Company in the early years of its extension

[72] Metropolis Water Act 1871, sec. 10.

[73] Some companies were more exacting in their requirements than others. The New River, for example, insisted on strict compliance with the regulations, whereas the West Middlesex was more flexible, demanding alteration only where existing fittings were inefficient and wasted water: *Lancet*, 1888, ii: 530.

[74] William Pole FRS (1814–1900). Pole was a freelance consulting engineer regularly employed on government work. Between 1848 and 1852 he had been business manager to James Simpson, and had assisted in the establishment of the Lambeth Company works at Thames Ditton. He was Professor of Civil Engineering at University College London from 1859 to 1867, and acted as Secretary to the 1867 Royal Commission on Water Supply. He was elected Fellow of the Royal Society in 1861, and Fellow of the Royal Society of Edinburgh in 1877: *DNB*.

[75] Pole, op. cit., note 17 above, 730.

policy met with considerable opposition from landlords and others, who objected to putting new water fittings in their houses to receive constant supply.[76] The Kent Company observed that where houses were well supplied with cisterns there was no general desire to change to daily service.[77] The Chelsea Company felt itself justified over the years in its policy of non-extension by the almost universal apathy of its customers: no public authority and scarcely any private individuals applied for the service.[78] The New River Company, which on two or three occasions laid on constant supplies at the request of local authorities, as well as to many blocks and groups of dwellings at the request of owners, observed that the inhabitants did not generally manifest much interest in the proceedings except to object to the preparation of fittings.[79] The directors of both the Grand Junction and the Southwark companies remarked on the indifference of local authorities to the venture.[80]

Local authorities were, of course, reluctant to court unpopularity by forcing electors into the expense of constant service. In 1888, for example, the City Corporation refused an application by several City parishes to obtain constant service for the areas under their jurisdiction, giving the New River Company's insistence on the regulation fittings, and their cost, as reasons for not proceeding. It was not fair, the Corporation argued, that householders who in ignorance had installed non-regulation fittings should be compelled to make expensive changes.[81] The Corporation had some justification for its assessment of householders' views: in St Pancras the Medical Officer had recorded "some heart-burning" among the inhabitants in the face of the New River's stringent requirements for constant service.[82] It was only in 1889, when a narrow belt of houses near Regent's Park served by the West Middlesex were the only ones in the parish left on intermittent, that St Pancras Vestry got around to requesting they be put on constant. The Vestry's application was, however, turned down by the Company, and the London County Council had to be brought in to effect the desired result.[83]

During the 1890s, as a result of the LCC's intervention, the pace of constant supply introduction quickened, and by the end of the century, all company-supplied houses within the metropolis proper were on constant supply (with a very few exceptions, such as 200 houses at the top of Shooter's Hill which were above the pressure-line of the Kent Company, and for which special arrangements were made within a few years). In the 1890s, the focus of the water problem shifted again, to centre on the question of the overall adequacy of supply. This problem first began to concern the Water Examiner in the dry summer of 1887. The problem was partly caused by the increasing growth of Water London. It was estimated then that the water companies' customers increased in number by between 100,000 and 130,000 each year, or by 14,000–18,000 houses.[84] Drought was estimated to increase water demand by 18 to 22

[76] *Water Examiner*, BPP 1882 xxx pt. 1, Appendix B no. 39, 194.
[77] Ibid., 1888, 342.
[78] Ibid., BPP 1878–79 xxviii, Appendix B no. 44, 168; 1884–85, 235; 1892, 236.
[79] Ibid., 1888, 343.
[80] Ibid., 341, 344.
[81] *Lancet*, 1888, ii: 530.
[82] *MOAR*, St Pancras, 1885, 21.
[83] Ibid., 1889, 26.
[84] *Water Examiner*, 1888, 315.

per cent in intermittent areas, and by 25 to 28 per cent in constant areas.[85] In south and west London, supplied by the Thames and by deep wells, there were no grounds for immediate anxiety. The east and north, and their adjacent districts, were, however, a different matter. In the summer, the River Lea was practically used up by the demands of the New River and East London companies, and a further 15 million gallons were drawn from wells, and 10 million from the Thames, daily.

Problems with the Lea supply had been foreseen as early as 1869, but it was calculated then that, in five dry summers, the water passing over Feilde's Weir, above the East London's intake, had never been less than 22 million gallons—a quantity deemed sufficient for foreseeable daily supplies. In August 1887, however, the flow over Feilde's Weir fell to 21 million gallons, or just below the desired margin. Anxieties were raised for the future. Scott estimated that, in order to meet the possible maximum demand of 1895, supposing it to be a dry summer, the joint well-capacity of the two companies would have to be increased by 30·5 million gallons. It was not possible to increase further the East London's supply from the Thames, since this was subject to statutory limitation. The problem was in effect particular to the East London Company, since its Lea intake lay below that of the New River, which thus had first call on the river's supply; at this date, the company mains were entirely separate, and there was no arrangement whereby they could assist each other in emergencies. Already in 1887, the East London Company was compelled to restrict supplies during part of the summer, and it was clear that the maximum daily supply of nearly 45 million gallons from all sources recorded in the week ending 8 July, was by no means equal to the maximum consumer demand.

The East London Company was not unaware of its supply responsibilities. By 1888, the Company was sinking wells and driving adits (exploratory shafts) on a considerable scale in an attempt to meet possible future requirements. In January 1891, a further dimension to the problem manifested itself, when a period of severe frost led to an increase in daily consumption to 53 million gallons, or 7 million gallons over the daily average for July and August (a total rate of 44·7 gallons per head daily, as against a daily average of 35·9 for 1891). The Company was increasingly anxious, and in the following year was, according to Major-General Scott, engaged in adding to its well supply "with considerable success".[86] In 1892 also, the Company bought additional land for new works, and in 1893, brought a bill before Parliament to allow it to increase its reservoir capacity by 600 million gallons, and to increase its well yield by 3 million gallons a day. Because of obstruction from the LCC, the bill was not passed until 1894.[87] The works that should have been begun in 1893, and which the Local Government Board had estimated would be complete by June 1895, were not finally completed until 1896.

Meanwhile, the vagaries of nature and the demands of the Company's ever-increasing number of consumers overstretched the Company's resources on two occasions in 1895, and again in the summer of 1896. The supply broke down again in

[85] Ibid., 1892, 233.
[86] Ibid., BPP 1893–94 xliii, Appendix B no. 48, 151.
[87] Ibid., BPP 1896 xxvi, Appendix B no. 72; A. Shadwell, *The London water supply*, London, Longmans, 1899, ch. 7.

1898. In 1895, the year of the Great Frost, which lasted with an interval of only seven days (14–20 January) from the beginning of the year until 9 March, consumer service pipes burst and sprang undetected leaks in their thousands, and even company mains, hitherto virtually unaffected by frosts, suffered.[88] There followed, in the summer of 1895, a drought which reduced the East London Company's supply of filtered water from its normal reserve of 16·9 days' supply to a mere half-day's. The Company's whole district was put on intermittent supply on 15 July, and constant was not fully restored until 8 October. In the following year, 1896, drought in the Lea basin lasted from May to August inclusive. The flow of the Lea over Feilde's Weir fell in June, July, and August to 22, 19, and 14 million gallons respectively. The East London was again compelled to resort to intermittent on 17 July, and the supply was not fully restored until 19 September. In 1898, things were even worse. The flow at Feilde's Weir between June and October was recorded at 16, 12, 6, 2, and 5 million gallons. The East London's reservoirs were full with 1,200 million gallons on 20 June; by 22 August they were down to 308 million gallons. Supply was restricted from that date on, and was not fully restored until 14 December.[89] Needless to say, the inconvenience to consumers, who were by now accustomed to constant supply, and whose cisterns had in any case largely been removed on its introduction, leaving them without emergency supplies when the mains failed, was considerable.[90]

The problems which nature presented to the East London Company in these unusual years were compounded by the behaviour of consumers. It was freely acknowledged by both government officials and water companies that whenever an emergency arose in constant supply areas, all control of the supply passed to the consumer. And consumers were not considerate water-users. In times of frost, they turned all their taps on to prevent water freezing in the pipes, and let them run day and night. In hot weather they watered their gardens copiously, filled ornamental pools, ran fountains for pleasure, and, worst of all, turned on all their taps and left them running to flush the drains, fastening down the valves of closets to get a continuous flush for the same purpose.[91] It was only in the 1890s, that, with extraordinary pressure on supply, these habits became a matter of concern to water administrators. The problems raised by the deficiency of the Lea supply were finally resolved in 1898 by connecting the mains of the East London Company with those of the Kent and Southwark companies, and those of the New River with the West Middlesex and Grand Junction.[92] Nevertheless, the growth of London did not cease, and available water supplies remained subject to the limitations of nature. The disappearance of the water companies in 1904 did not mark any significant progress towards a permanent solution to water shortages. In the drought of 1921, for example, the Metropolitan Water Board found itself issuing urgent pleas to

[88] Between 27 January and 18 February the mean minimum night temperature was only 19° F—a series unprecedented in the Greenwich Observatory records: *Water Examiner*, 1896, 263.

[89] Ibid., BPP 1889 xlix, Appendix B no. 42, 222.

[90] The East London district was almost alone in having had domestic cisterns removed. With the exception of the Southwark Company, forty per cent of whose consumers were without cisterns in 1903, the other companies largely maintained domestic storage facilities: BPP 1904 xxv, p. clxxxii.

[91] *Water Examiner*, 1889, 342–3; 1890, 239–40; 1894 xxxviii, Appendix B no. 50, 204.

[92] Ibid., BPP 1900 xxxiii, Appendix B no. 42, 222–3.

consumers to regulate their water demands during the summer months,[93] and in the 1990s the problem remains.

If certain problems of supply continued into the twentieth century, the creation of the Metropolitan Water Board in 1902–3 instituted a new era in London's water supply history, with the replacement of private enterprise by public responsibility. In many respects, however, the modern structure of water distribution was already established by this date, for during the course of the nineteenth century the scale and nature of London's water provision had been largely transformed. From being a commodity which usually had to be worked for, and always had to be conserved, water became a continuous domestic facility. Where eye and tongue had been employed to assess, often mistakenly, the quality of water, considerable progress had been made towards relieving the individual of care for the purity of his supply. Nevertheless, only a half-way stage had been reached towards modern conditions. Although piped water was supplied on constant service, among working families and the poor this might still be to a standpipe, or commonly, where laid on to the house, to one floor only. In shared accommodation families living on the upper floors still had to fetch and carry water, and were still dependent on domestic storage facilities. Even in model housing, where water was laid on to each floor at least, there was usually only provision for cold water. Bathrooms were still a rarity.[94] Although delivery to the home at all hours of water which met a standard of purity, free of visible and invisible taints, had become a general expectation by 1900, considerable improvements in the nature of the service were still to be made.

Yet if London differed from other English cities in that its water supply remained in private hands until the twentieth century, it has not yet been proved that for this reason London's experience was inferior.[95] The size of the city, the speed of its growth, and the social problems which accompanied its expansion all contributed to complicate the administration of services, while the rising standards which accompanied the nineteenth-century public health revolution demanded the continual reassessment of facilities provided. The London water companies were constantly criticized by contemporaries, and consequently have been given a bad press by historians,[96] but their achievement in the latter years of the nineteenth century was considerable. As one critic admitted,[97]

[93] *Metropolitan Water Board Annual Report*, BPP 1922, viii, 33.

[94] Anthony S. Wohl, *Endangered lives: public health in Victorian Britain*, London, J. M. Dent, 1983, 63–4.

[95] For positive and critical contemporary views on the water companies' performances see Arthur Silverthorne, *London and provincial water supplies*, London, Crosby, Lockwood, 1884; Shadwell, op. cit., note 87 above, ch. 5. Wohl, op. cit., note 94 above, 62–3, offers some further comparisons. The issues of the East London water shortages in the 1890s are best studied in the pages of the *Lancet*. The whole London "water question" is much confused by the political propaganda generated by the issue of private versus public ownership, notably that put out by the LCC in its unsuccessful bid to win control of the supply in the 1890s.

[96] See for example, B. Weinreb and C. Hibbert (eds), *The London encyclopaedia*, London, Macmillan, 1983; Luckin, in *Pollution and control* (note 46 above), also adopts the traditional hostile view of the water companies.

[97] Siverthorne, op. cit., note 95 above, 47. The *Lancet*, reviewing this work, noted that Silverthorne gave "great and deserved praise" to the companies' general management: *Lancet*, 1885, i: 256.

> in common justice it must be remarked . . . that as regards the magnitude of the supply and the responsibility of keeping it up regularly, and keeping pace with the annual requirements of the metropolis, the people who are constantly discrediting the character of the supply . . . fail altogether in doing justice to the splendid and costly undertakings with which this metropolis has been fortunately endowed. The system may be excellent of its own kind and yet not free from administrative criticism; that is the case with the water companies.

There is room for more detailed research on the history of the London water companies, and on the interests and motives of the men who managed them. They were certainly not without their faults, yet their financial and administrative commitment to London water in the last thirty years of the nineteenth century was substantial.[98] The extension of constant domestic supplies of piped mains water, like the extension of house drains to meet mains sewage provision, was no inconsiderable technical and administrative feat in the late-Victorian city.[99]

[98] PP 1901 xxv, Appendix B no. 55, 286. In the period 1872–1901, the companies' capital expenditure amounted to £19,641,090.

[99] Asa Briggs, *Victorian cities*, Harmondsworth, Penguin, 1963, 16–17: "Perhaps their [Victorian cities'] outstanding feature was hidden from public view — their hidden network of pipes and drains and sewers, one of the biggest technical and social achievements of the age, a sanitary 'system' more comprehensive than the transport system."